ESTIMATION THE AGE OF OIL PALM USING PALSAR ALOS (CASE STUDY: LANDAK, WEST KALIMANTAN)

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Abstract. World production of palm oil increased spectacularly in the last 20 years, especially in Indonesia and Malaysia. As the largest producer, good management in oil palm plantation is very important, the expansion of plantation also must be well planned, because its existence must not affect the surrounding environment. Therefore the information of oil palm age or condition of their growth is needed. Remote sensing has significant potential to aid oil palm monitoring and detection effort. It also provodes a cost-effective method to these purpose and at same time provides side specific assessments of management areas, Synthetic Aperture Radar (SAR) is crucial for this task. The SAR is an active sensor that operates in all weather condition and daylight independen delivering information all year around at the time that is needed. SAR is sensitive to texture, size and orientation of structural objects, moisture content and ground conditions. This paper present the preliminary study that has objective to develope method for prediction of oil palm age by using PALSAR ALOS in Ngabang, Landak District, West Kalimantan. The study is focused in oil palm plantation of Government Oil PalmPTP N 13 Kalimantan.Data and information about oil palm blocks and it's age were collected from this company. The statistic analysis by using regression method indicates that oil palm age can be estimated by using backscatter values, with logaritmic model and R^2around 0.60 at HV polarization of PALSAR ALOS.

Keywords: oil palm plantation, PALSAR ALOS, backscatter

1. Introduction

Oil palm (*Elaeis guineensis Jack*.) is one of the world's most important tropical tree crops. It is grown commercially in Southeast Asia, Africa and Central and South America for its palm oil, the world's second most widely consumed edible oil (Salunkhe et al. 1992). World production of palm oil has increased spectacularly in the last 20 years, especially in Indonesia and Malaysia. Indonesia is the largest producer of palm oil (data of oil world).

As the largest producer, good management in oil palm plantation is very important, such as detecting unhealthy plants, fertilization plan, irrigation management. Therefore the information of oil palm age or condition of their growth is needed. Those are important for increasing quality and yield of palm oil. The taxes that must be paid also can be estimated. The expansion of plantation also must be well panned, because its existence must not affect the surrounding environment. Identification, mapping and monitoring are therefore required to impose such ideal working environment.

Remote Sensing has significant potential to aid oil palm monitoring and detection efforts. It also provides a cost-effective method to these purposes and at the same time provides site-specific assessments of management practices and growth performance of the palms. Some aspects of oil palm monitoring have been studied. Within the domain of land cover classification, previous studies show that oil palm can be mapped, for instance, have reported that oil palm plantation in some South East Asian countries can be observed by coarse-scale MODIS (Koh et al. 2011). Satellites data including Landsat Thematic Mapper (Morrow 2001, Wahid et al. 2005) and SPOT (Lukman and Poeloengan 1996) have been successfully used to identify oil palm growing areas and to map stand age at early stages of their growth. The expansion of plantation also must be well panned, because its existence must not affect the surrounding environment. Identification, mapping and monitoring are therefore required to impose such ideal working environment. RS has significant potential to aid oil palm plantation monitoring and detection efforts. It also provides a cost-effective method to map oil palm and at the same time provides site-specific assessments of management practices and growth performance of the palms.

Age of oil palm is the main parameter in estimate the yield of oil palm. Figure 1 shows there is strong correlation between age and oil palm productivity (Sutarta et al. 2006, Anonim 2008). Therefore the mapping and monitoring of oil palm to estimate of yield is important. It will help Ministry of Agriculture because the data that collected by conventional method doesn't give pretty information with high accuracy level and not in spatial distribution format.

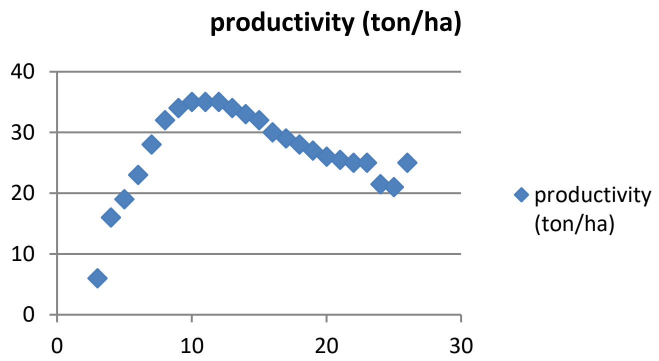

Figure 1. The Productivity of oil palm according to it's age (Sutarta et al. 2006)

Satellites imaging data of Landsat Thematic Mapper (Morrow 2001, Wahid et al. 2005) and SPOT (Lukman and Poeloengan 1996) have been successfully used to identify oil palm growing areas and to map differences in palm age at early stages of growth. Research by LAPAN (Sitorus 2004) on oil palm plantation in Lampung Sumatera Indonesia showed that the regression coefficient between Landsat spectral band and oil palm age is 69%. Band 5 of Landsat, IRI (Infra Red index), and MIRI (Middle Infra Red Index) of Landsat give the biggest correlation with oil palm age. Research by LAPAN (Carolita et al. 2015) also showed that the growth of oil palm can be explained by NDVI of SPOT6 with determination coefficient around 87%.

Since many oil palm plantations arelocated in tropical areas, Synthetic Aperture Radar (SAR) is crucial for this task. The SAR is an active sensor that operates in all weather condition and daylight independent delivering information all year around at the time that is needed. SAR is sensitive to texture, size and orientation of structural objects, moisture content and ground conditions (Pohl 2016).The differences in characteristics of optic and SAR will give complimentary performance of oil palm trees mapping. The usage of single optical or SAR sometimes give erroneous interpretation for oil palm identification and monitoring. Using fully polarimetric SAR it is possible to derive a relationship between backscatter, texture and crop status.

ALOS (Advanced Land Observation Satellite) is one of satellite that has SAR sensor. The post-ALOS program of JAXA has the goal to continue the ALOS (nicknamed Daichi) data utilization - consisting of ALOS-2 (SAR satellite) and ALOS-3 (optical satellite) in accordance with Japan's new space program. In 2010, ALOS has been operated for more than four years since January 2006 to accomplish four mission goals, including: cartography, regional observations, disaster monitoring, and resource surveys. ALOS-2 will continue the L-band SAR observations of the ALOS PALSAR (Phased Array L-band Synthetic Aperture Radar) and will expand data utilization by enhancing its performance (Anonim).

ALOS-PALSAR penetrates through the foliage and interact primarily with the woody components of vegetation. Horizontally transmitted waves are either depolarized through volume scattering by branches in the canopy, with a proportion of vertically polarized microwaves returning to the sensor, or penetrate through the canopy and interact with the trunks, returning primarily through double bounce scattering as a horizontally polarized wave (Lucas et al. 2007). Longer L-band (e.g. L-band 15-20 cm) microwaves have a greater likelihood of penetrating the foliage and small branches at the upper canopies of the forest, and interacting with woody trunks and larger branch components as well as the underlying surface (Tsomon et al. 2002, Lucas et al. 2004). It has been proven that radar is sensitive to the structure of the canopy. The received backscatter intensity represented in the image is a composition of interactions with the crown, the trunk and the ground surface. Using fully polarimetric SAR it is possible to derive a relationship between backscatter, texture and crop status (Darmawanet al. 2016). The studies of ALOS PALSAR for estimation the age of oil palm show there is strong correlation with age and backscatter value that accepted by satellite sensor. The function is logarithmic function, and the highest correlation is in HH polarization (Darmawanet al. 2016, Avtar 2014).

This study has aims to identify oil palm trees by using PALSAR ALOS satellite and to analyze it's growth profile. This model can be used by users (in this case the Oil Palm Company) to monitor the growth of its palm oil in each block. Furthermore, the information that will be taken by comparing the growth profile of oil palm by PALSAR ALOS with the normal growth profile of oil palm can be as important information about the health of oil palm trees. Growth profile of oil palm also can be used to etimate the age of oil palm trees, so the productivity of oil palm can be estimated as well.

2. Methodology

2.1. Study Area

The Study Area of this study is Ngabang in Landak, Kalimantan. Oil Palm Plantation area of PTP N 13. Landak District, West Kalimantan, Indonesia. Landak District region located in area of 0 ° 10 '- 1 ° 10' North latitude and 109 ° 5 '- 110 ° 10' East Longitude. Porcupine District can be categorized as an area of high intensity rainfall. In general, the average rainfall is 160 mm per month.] Based on the topographic map scale of 1: 250,000 series AMS, morphology of Landak generally is undulation. The soil type in this District include red-yellow podzolic (sedimentary rock). Figure 2 shows the area in SPOT image..

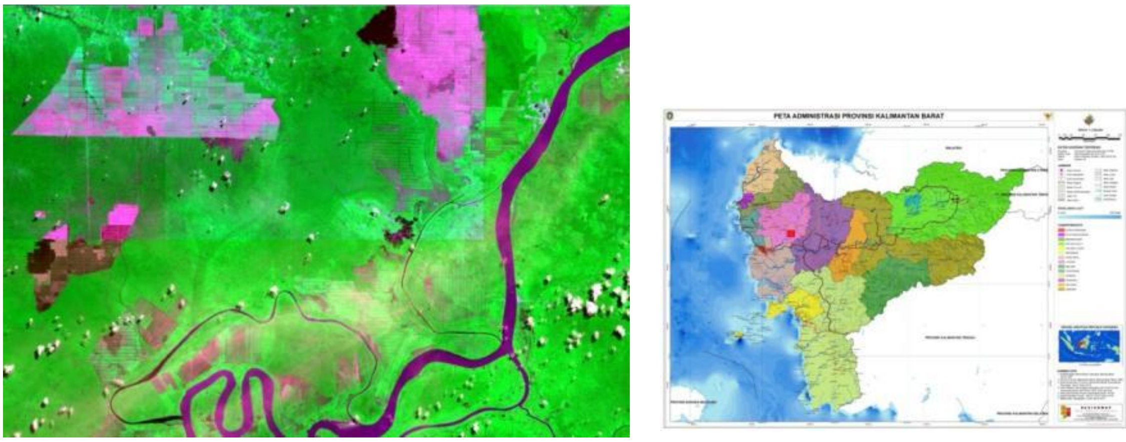

Figure 2. Area study, Ngabang,

2.2. Methods

This study follows the flow chart as in figure 3. Identification and classification of land use to identify oil palm plantation was done by using RGB image with combination HH, HV, VV. Extraction of backscatter values was also done for each polarization image and on each age of oil palm.

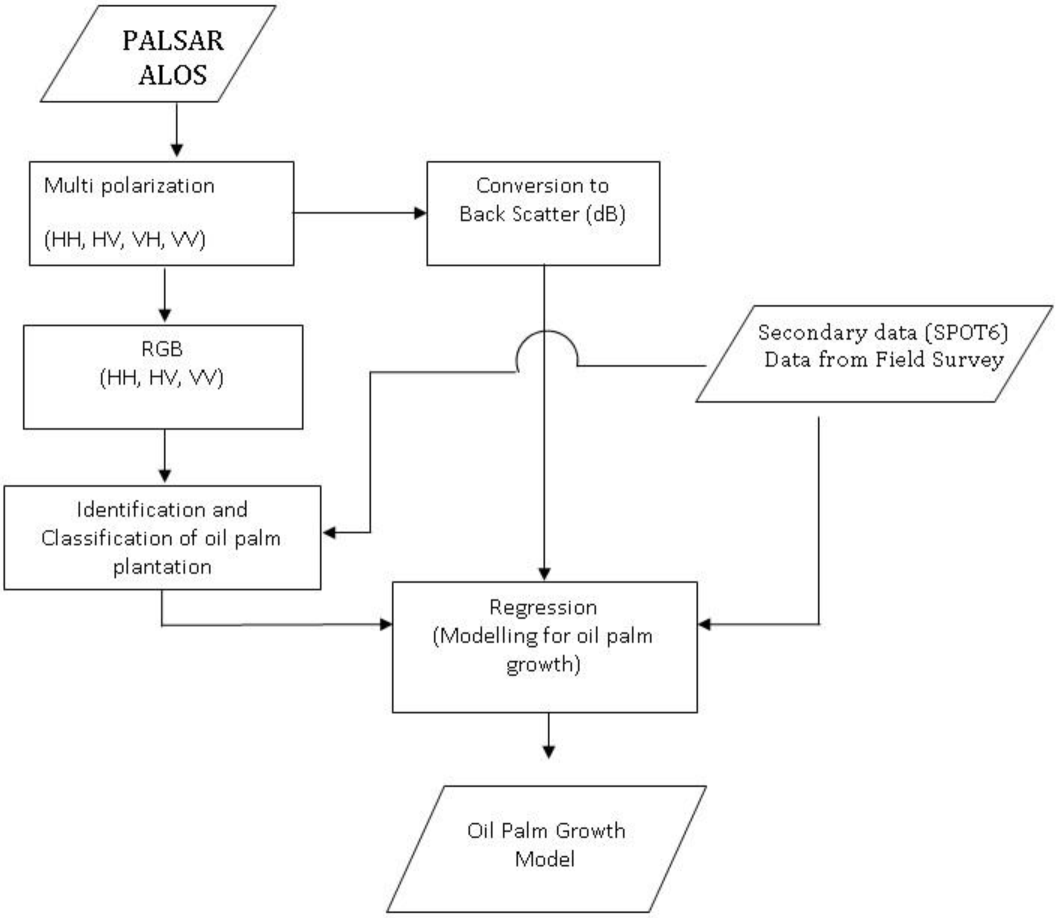

Figure 3. Flow Chart of Data Processing

Backscattering coefficient Data are stored as digital number (DN) in unsigned 16 bit. The DN values can be converted to gamma naught values in decibel unit (dB) using the following equation:

$$\gamma 0 = 10 \log10\langle DN2 \rangle + CF \quad \ldots\ldots\ldots\ldots (1)$$

where, CF is a calibration factor, and <> is the ensemble averaging. Please use -83.0 dB for the CF value (Shimada 2009)

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2.3.Data Collection

Satellite data that used in this study is PALSAR ALOS with date March, 2015. Observation and measurement in field is needed for analyze of oil palm growth profile. In this case LAPAN team assisted by a team of PTPN 13 did measurement in oil palm plantation area of PTPN 13 company in Ngabang, Landak, West Kalimantan, Indonesia.Field measurements performed by checking the age of oil palm trees and comparing it with the backscatter of SAR in some polarization as well as it's RGB combination (HH, HV, VV) image on same positon and location. The position and location are measured by using GPS Trimble Juno series. In study area, the data was collected from oil palm block at age 2, 3, 4, 5, 6, 10, 16, 30, 32 years .

3. Result and Discussion

The ALOS PALSAR data that have been used in this study has 3 polarization : HH, HV and VV. The image of each polarization are shown in figure 4.

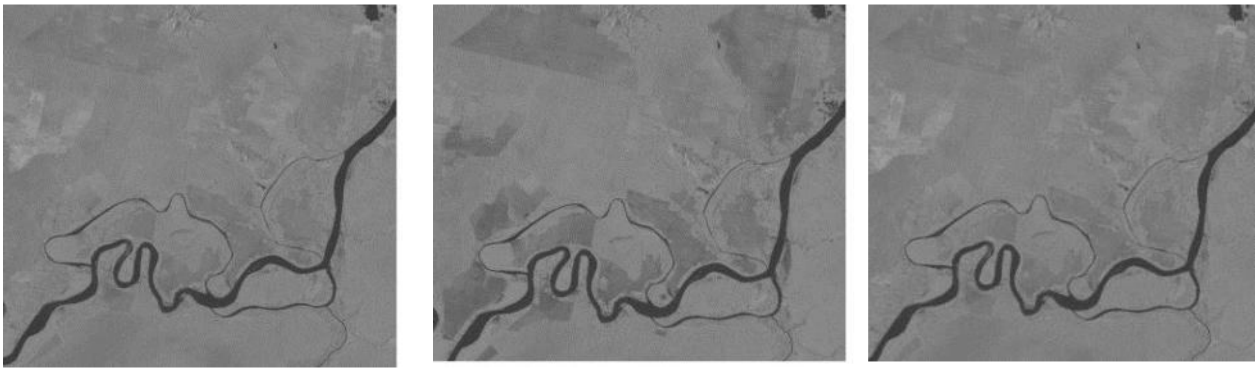

Figure 4. Image of ALOS PALSAR the study area : HH, HV and VV

The combination (RGB) of this images was made to investigate the land use of area. Figure 5 is the RGB combination of these images, where HH is put in red, HV in green and VV in blue.

Figure 5. ALOS PALSAR imagery L -HH , L -HV and L-VV displayed in Red, Green and Blue

The image of ALOS PALSAR RGB shows that the oil palm plantation have different colour from dark purple, dark red and light red. The dark purple is the area of oil palm with younger age, the dark red is the oil palm with middle age and light red is the oil palm with old age. The measurement of oil palm's canopy diameter shows that the diameters will increase until age around 18 years, and then the diameters become decrease. Figure 6 the results of measurements of canopy diameters in oil palm plantation of PTPN 13.

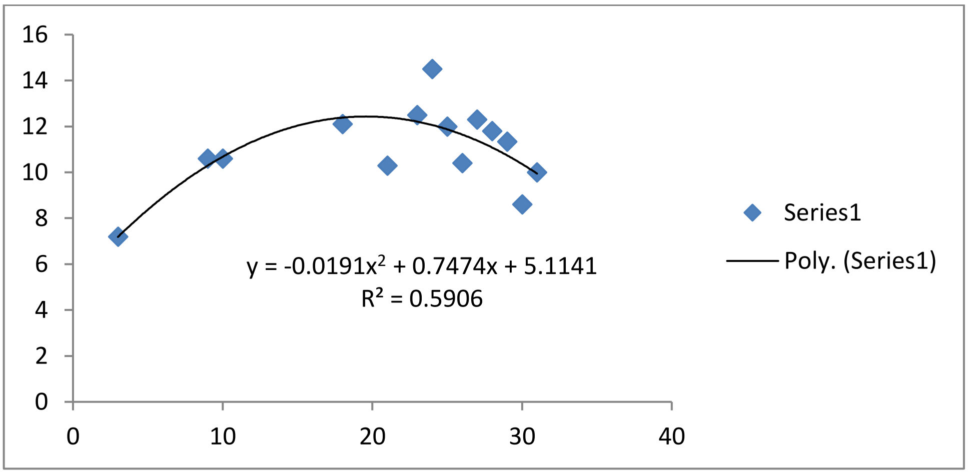

Figure 6. Graphic of canopy diameter (Y axis) and age (X-axis)

This condition will give the different backscatter of oil palm trees in different age, because the dense of canopy will give different back scatter. This fact is one of the reason for this study to investigate the relationship between backscatter and age. The analysis of backscatter on each of ages for each polarization done to investigate this relationship. The analysis results show that the backscatter of oil palm trees increase from age 1 year until around 16 years. The increase of backscatter the become slowly after that age. The results show that the curve for each relationship is logarithmic function, and the highest relationship is in HV polarization.

The relationship between HH, HV derived from ALOS PALSAR 2 and age of oil palm is moderate. R^2 is 0.57 for HV and 0.41 for HH that be indicated increasing of age of oil palm as increasing of HV and HH value. Estimation and monitoring of oil palm age can be done by using formula Y = 0.354 ln (X) – 14.756, where X is age of oil palm and Y is the backscatter of ALOS PALSAR –HV.

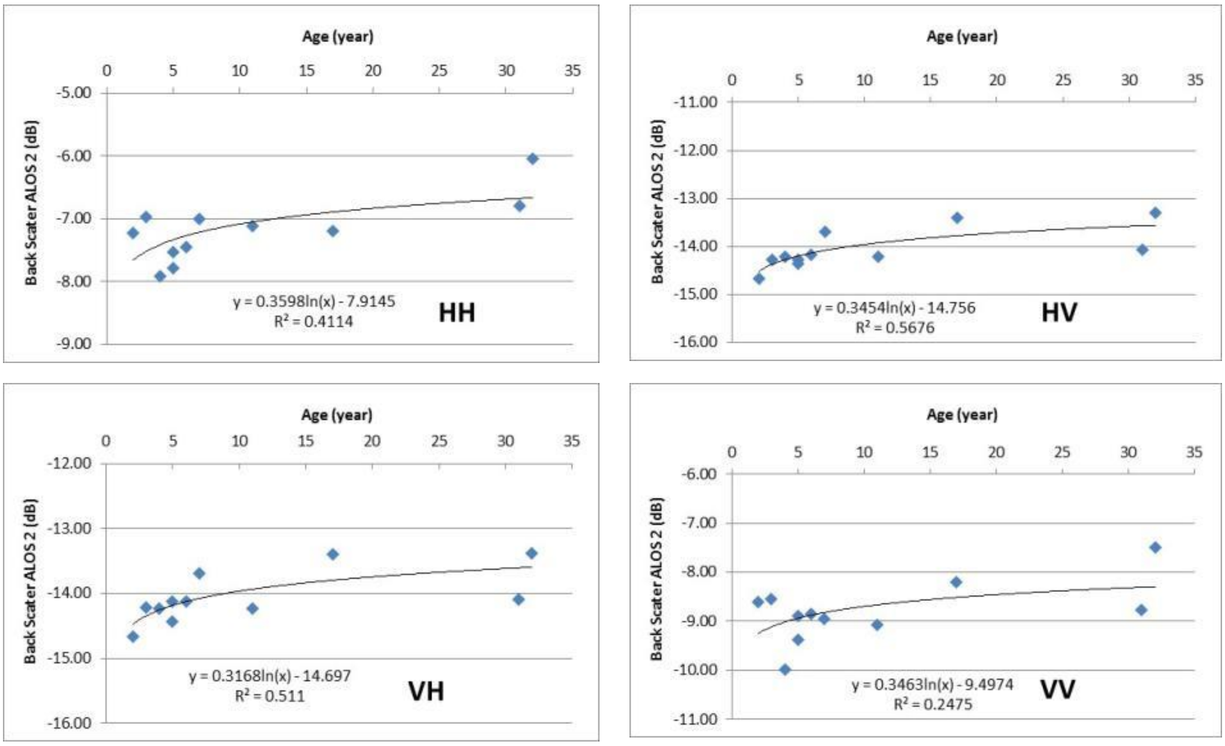

Figure 7. The relationship between age of oil palm and backscatter of ALOS PALSAR

4. Conclusion

This study found found relationship between HH, HV derived from ALOS PALSAR 2 and age of oil palm is moderate. R^2 is 0.57 for HV and 0.41 for HH that be indicated increasing of age of oil palm as increasing of HV and HH value. The utilization of ALOS PALSAR 2 can be use for monitoring and management of oil palm plantation, but need more ALOS PALSAR and samples of oil palm for mapping. Condition of oil palm also effected by soil type, rainfall and topography of oil palm plantation. Therefore the models give different R^2coefficients and with other models in other area.

Acknowledgment

Authors give sincere gratitude LAPAN Remote Sensing Application Center and PTPN 13, as well as JAXA for giving us the chances to carry out this study, and for all data and facilities that authors got during the study and field survey.

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