

Identification of Oil Palm Plantation on Multiscatter and Resolution of SAR Data Using Variety of Classifications Algorithm (Case Study: Asahan District, North Sumatera Province)

S. Darmawan¹, I. Carolita² and E. Ananta¹

¹Department of Geodesy Engineering Institut Teknologi Nasional, P.H.H Mustofa No. 23, 40124 Bandung, West Java, Indonesia.

²Indonesian National Institute of Aeronautic and Space, Remote Sensing Application Center, Jl. Kalisari 8, Pekayon, Pasar Rebo, Jakarta, Indonesia

Email: soni_darmawan@itenas.ac.id

Abstract. The purpose of this study was to find the best classification algorithm for determining the classification of oil palm plantation area on SAR data. This research begins with collecting primary data and secondary data, where primary data in the form of radar images include Sentinel-1, ALOS PALSAR, and TerraSAR-X images, while secondary data of palm oil age block data are used as a references derived from plantation agency of Indonesia and high resolution imagery, after that radiometric and geometric corrections, classification and accuracy assessment. The classification methods to be used are Parallelepiped, Maximum Likelihood, and Support Vector Machine. The results of this study is the Support Vector Machine algorithm has the highest overall accuracy value among the three methods used with 77.57% for TerraSAR-X, 86.18% for Sentinel-1 and 91.17% for ALOS PALSAR, The other results on this study are map of land cover for oil palm plantations in the district of Asahan, North Sumatera Province.

1. Introduction

Palm oil (*elaeis guineensis*) is a species of palm tree that is widely planted in Southeast Asia, especially in Malaysia, Indonesia and Thailand. Palm oil has the ability as source for producing cooking oil, industrial oil, and fuel which are widely used in daily life and industry [1,2]. Palm oil obtained from seeds or kernels in a hard *mesocarp* shell that produces about 80% saturated fatty acids that can also be used as source for soap, detergents and other substance on *oleochemicals* industry [3,4]. Palm oil is very potential as a biofuel in the future [5]. Oil palm can produce large profits so that many forests and old plantations are converted into oil palm plantations. Indonesia is one of the largest exporters and producers of palm oil in the world which reached 38.17 million tons in 2017 [6] so that palm oil is one of the mainstay export commodities from Indonesia to meet world and domestic market demands.

In addition to production, Indonesia also occupies the top position in achieving the total area of oil palm plantations with an area of 8.9 million ha in the form of mature crops (TM). The bright prospect of palm oil commodity in the world vegetable oil trade has pushed the Indonesian government to spur the development of palm oil plantation areas in every province in Indonesia [7]. Today, remote sensing technology has been used to conduct observations on oil palm plantations, both for observing the number of trees up to the age of oil palm [8]. Remote sensing is the science and art of obtaining



information about an object, area, or phenomenon through analysis of data obtained with a device without direct contact with the object, area, or phenomenon being studied [9]. According to [10,11,12,13] although sensors in the optical range of electromagnetic spectrum have gotten the best consideration and have been widely used, considerable effort has been invested into the utilization of radar sensors.

Previous research on palm oil has been carried out including [14], conducting research on the use of ALOS PALSAR 2 remote sensing imagery to investigate the age and yield of oil palm fresh fruit bunches. [15] conducted research on the use of PALSAR remote sensing imagery to map oil palm plantations in Cameroon using a 50 meter resolution mosaic image. [16] conducted research on the use of remote sensing image ALOS conducted image data integration to detect smallholder oil palm plantations in South Sumatra, Indonesia. [17] conducted research on the use of remote sensing imagery in the form of SAR data applications for oil palm tree discrimination. [18] conducted research on the use of remote sensing imagery to estimate aboveground biomass and oil palm plantations using ALOS PALSAR data. [19] conducted research on the use of remote sensing imagery to map oil palm expansion using SAR to study the effects on the CO₂ cycle. Furthermore the purpose of this study was to find the best classification method for determining the classification of land cover on oil palm plantation area using SAR data.

2. Methodology

2.1 study area and data

Study area in Asahan district of Nort Sumatera Proviencie, geografis location on 2°03' - 3°26' N - 99°1' - 100°0' E (Figure 1). Asahan district has larges area of 3.732 km² and one of bigger oil palm production in Indonesia. Also we collect primary and secondary data collection such as ALOS PALSAR was acquired on June 01, 2015, Sentinel-1 was acquired on June 21, 2018 and TerraSAR-X August 29, 2018, and secondary data as references derived from Plantation Agency of Indonesia.

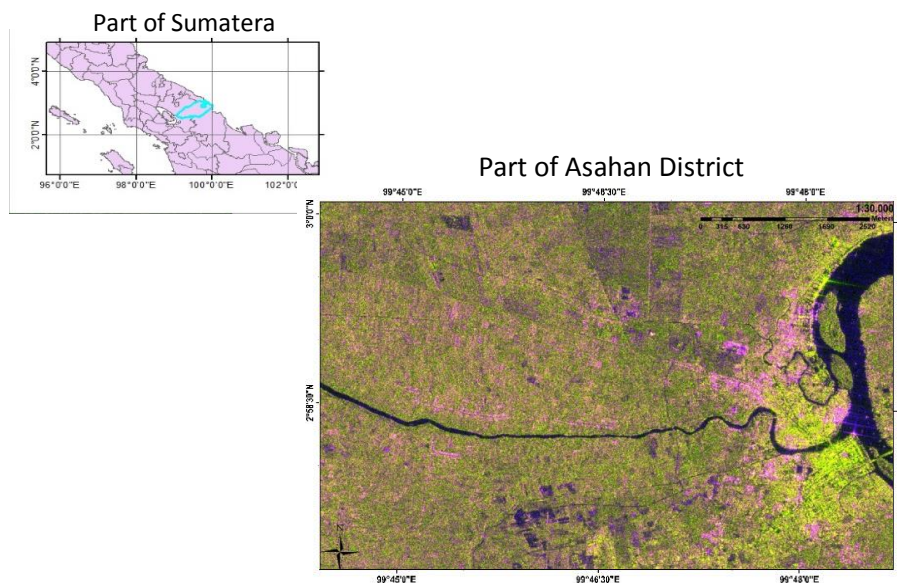


Figure 1. Study area in Asahan district of Nort Sumatera Proviencie

2.2 Method

The research methodology was carried out in several stages, first preparation of tools and materials as well as the collection of literature studies, primary and secondary data collection such as ALOS PALSAR, Sentinel-1 and TerraSAR-X, and secondary data as references derived from plantation

agency of Indonesia, geometric corrections for each image, overlaying images and selecting Region of Interest (ROI), taking training samples and validating training sample results, classifying each training sample using the Parallelepiped, Maximum Likelihood, and Support Vector Machine algorithm, testing the accuracy of the classification results of each method, determining the best classification method, and conducting making maps of the results of the classification of land cover for oil palm plantations. The research methodology can be seen in Figure 2.

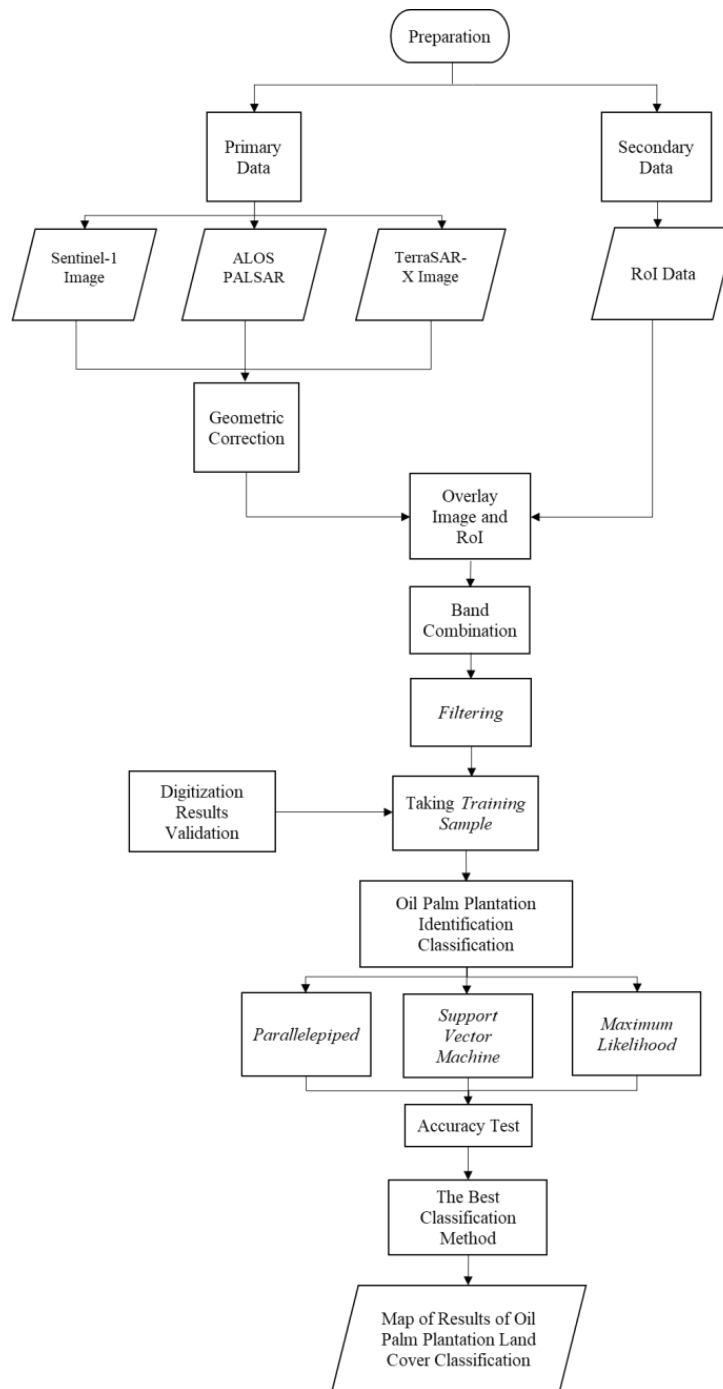
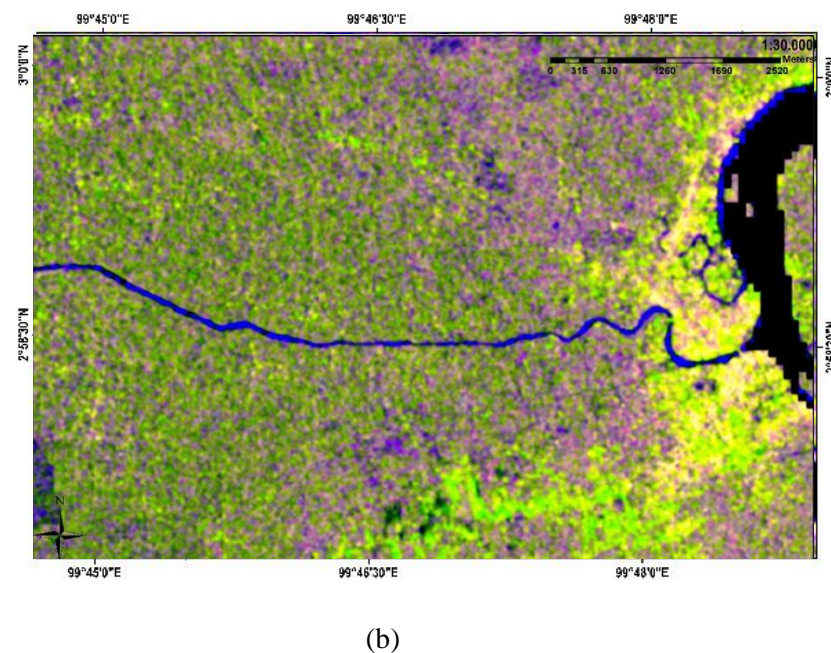
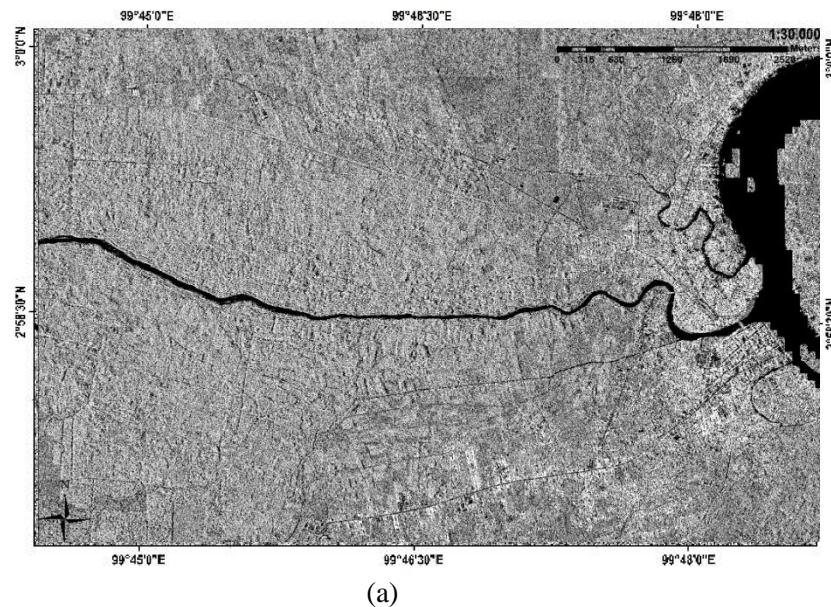


Figure 2. Methodology on this study

2.3 Image processing and training sample

Image processing is done by SNAP software, first geometric and radiometric correction, filtering using Lee algorithm and identifying training sample derived from land cover map from Plantation Agency of Indonesia. Actually on this case we have ALOS PALSAR only on HH and HV, Sentinel - 1 only on VV and VH and TerraSAR-X only on HH. SAR imagery after processing can be seen on the Figure 3.



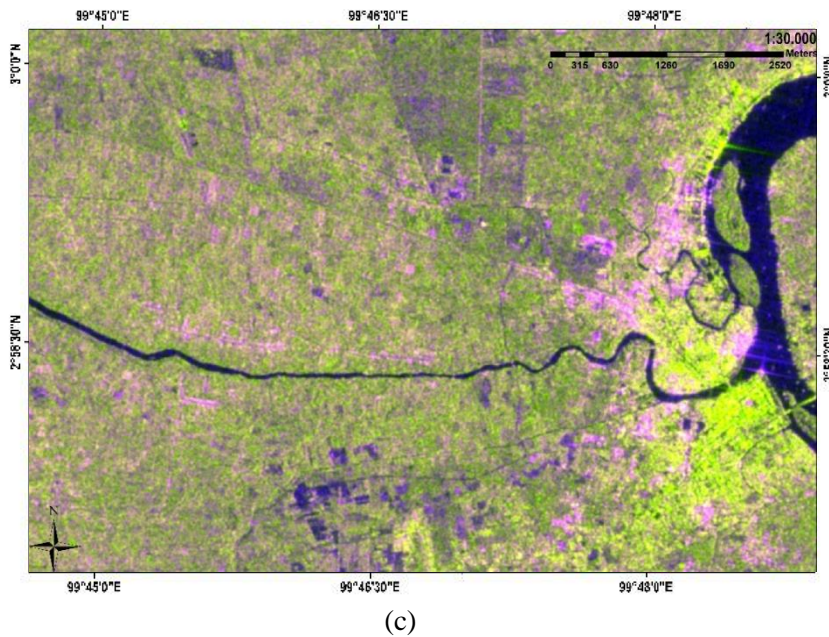


Figure 3. SAR data on TerraSAR-X (a), Sentinel-1 (b) and ALOS PALSAR (c)

Also we collect training sample around 3000 pixel with each land cover on 3x3 pixels. We collect training sample for oil palm, forest, urban and water area on the study area, training sample can be seen on Table 1.

Table 1. Training sample on study area

No	N	E	On the SAR image	On the height resolution image	Land cover type
1	2°58'33,38"	99°40'01"			oil palm
2	2°56'07,45"	99°42'46,78"			forest
3	2°56'32,47"	99°48'06,26"			urban
4	2°59'04,16"	99°40'55,05"			water

2.4 classification and accuracy assessment

Classification uses Parallelepiped, Support Vector Machine, and Maximum Likelihood algorithm. After classifying the training samples taken, the accuracy of the results of the classification will then be done using the confusion matrix. Confusion matrix is a method used to calculate accuracy in the concept of data mining or decision support systems. In Confusion Matrix can also determine the classification method that has the best accuracy value

3. Result

3.1 TeraSAR - X

TeraSAR imagery based on X band which wavelength on 2.4 - 3.8 cm. Classification result using Parallelepiped and Support Vector Machine algorithm can be seen on figure 4, and accuracy assessment can be seen on the Table 2. Based on table 2 image classified using Support Vector Machine in this case has highest accuracy which overall accuracy on 77.58 %.

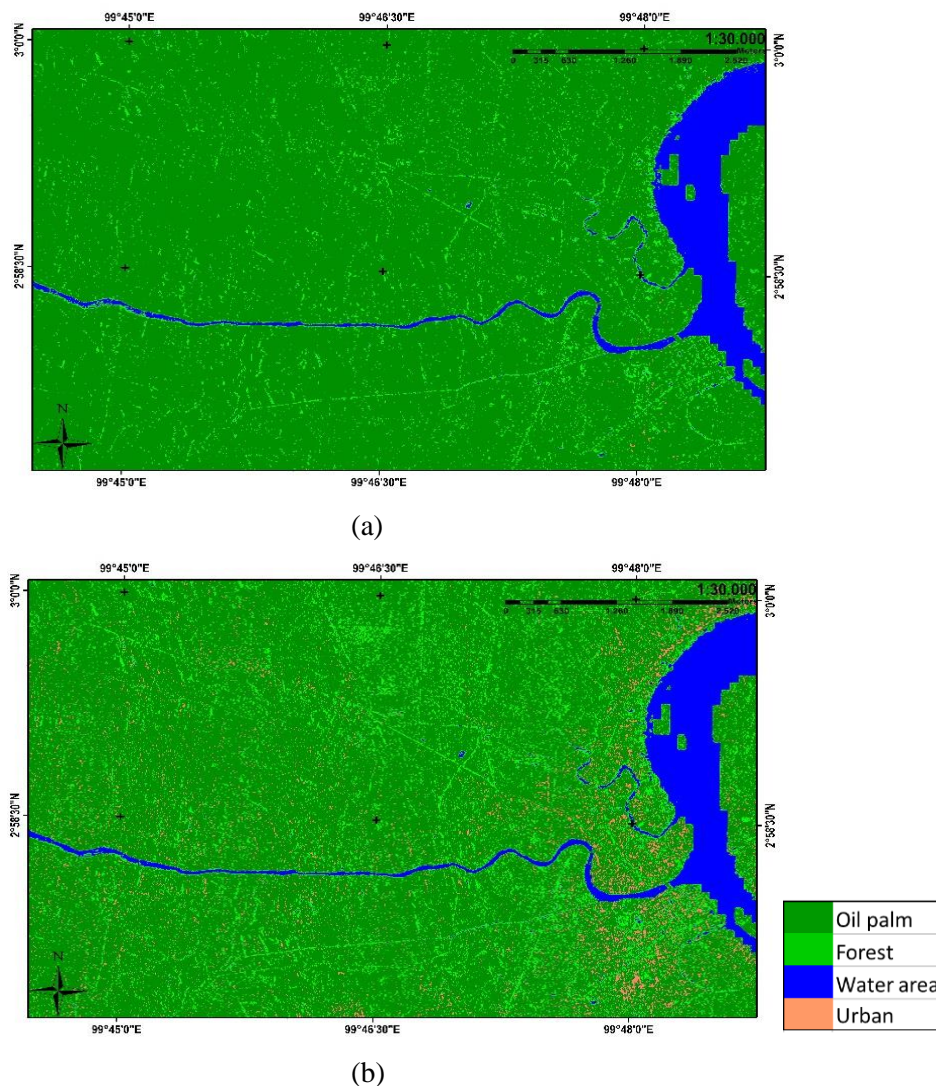


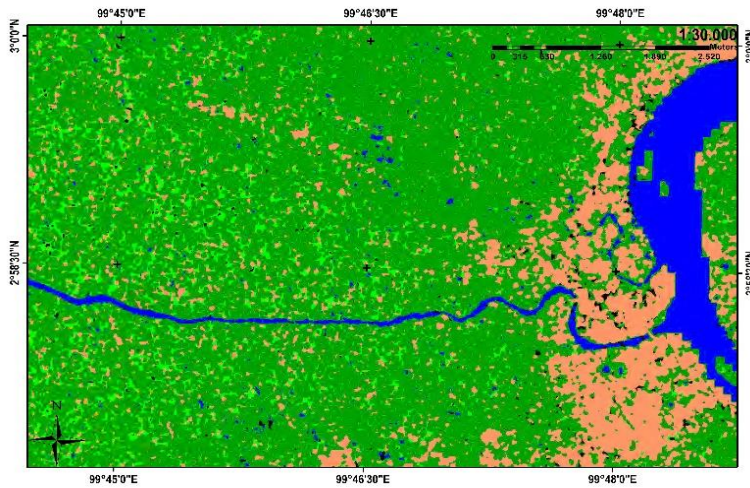
Figure 4. TerraSAR image classified using Parallelepiped (a) and Support Vector Machine (b)

Table 2. accuracy assessment of TerraSAR-X imagery

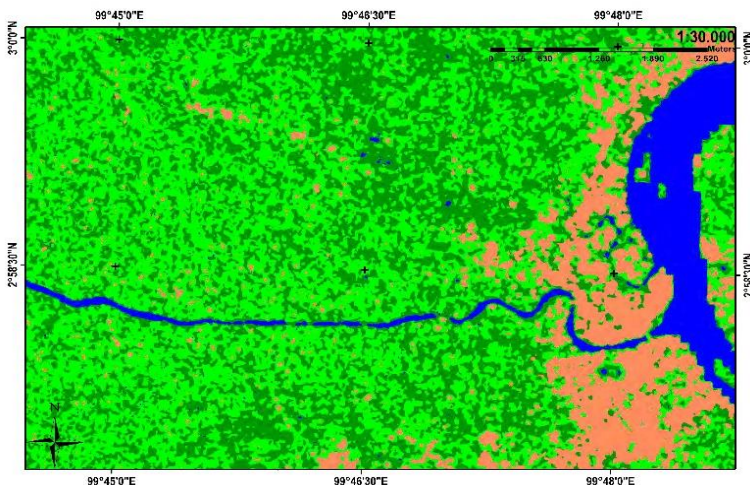
Metode	Parameter	Band
		HH
Parallelepiped	Accuracy	69,16%
	Kappa Coefficient	0,485
Support Vector Machine	Accuracy	77,58%
	Kappa Coefficient	0,6495

3.2 Sentinel-1

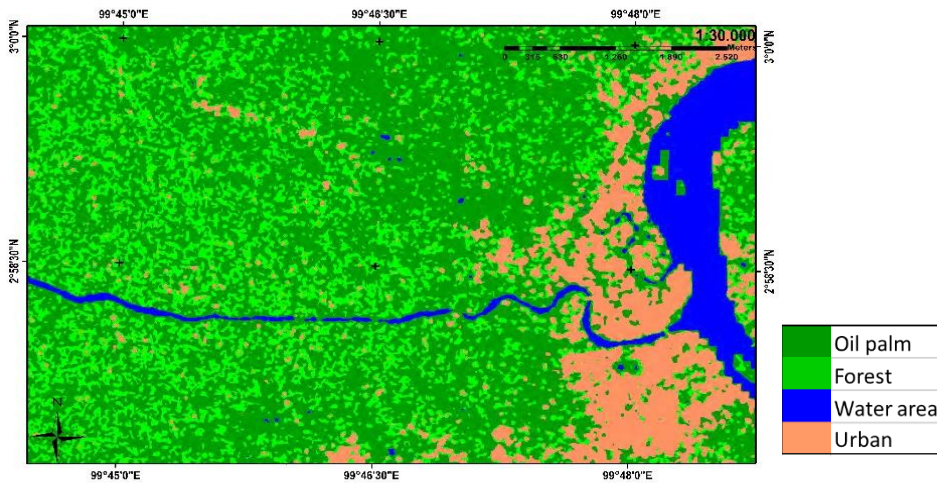
Sentinel-1 imagery based on C band which wavelength on 3.8 – 7.5 cm. classification result using parallelepiped, Maximum Likelihood and Support Vector Machine algorithm can be seen on Figure 5, and accuracy assessment can be seen on the Table 3. Based on Table 3 image classified using Support Vector Machine in this case has highest accuracy which overall accuracy on 86.18 %.



(a)



(b)



(c)

Figure 5. Sentinel-1 image classified using Parallelepiped (a), Maximum Likelihood (b) and Support Vector Machine (c)

Table 3. Accuracy assessment of Sentinel-1 imagery

Metode Klasifikasi	Parameter	Kombinasi	
		VH_VV_VH/VV	VV_VH_VV/VH
Parallelepiped	Accuracy	81,04%	81,21%
	Kappa Coefficient	0,7090	0,7184

3.3 ALOS PALSAR

ALOS PALSAR imagery based on L band which wavelength on 15 – 30 cm. Classification result using Parallelepiped, Maximum Likelihood and Support Vector Machine algorithm can be seen on Figure 6, and accuracy assessment can be seen on the Table 4. Based on Table 4 image classified using Support Vector Machine in this case has highest accuracy which overall accuracy on 91.18 %.

Table 4. Accuracy assessment of ALOS PALSAR imagery

Metode Klasifikasi	Parameter	Kombinasi	
		HH_HV_HH/HV	HV_HH_HV/HH
Parallelepiped	Accuracy	78,19%	77,30%
	Kappa Coefficient	0,6648	0,6568

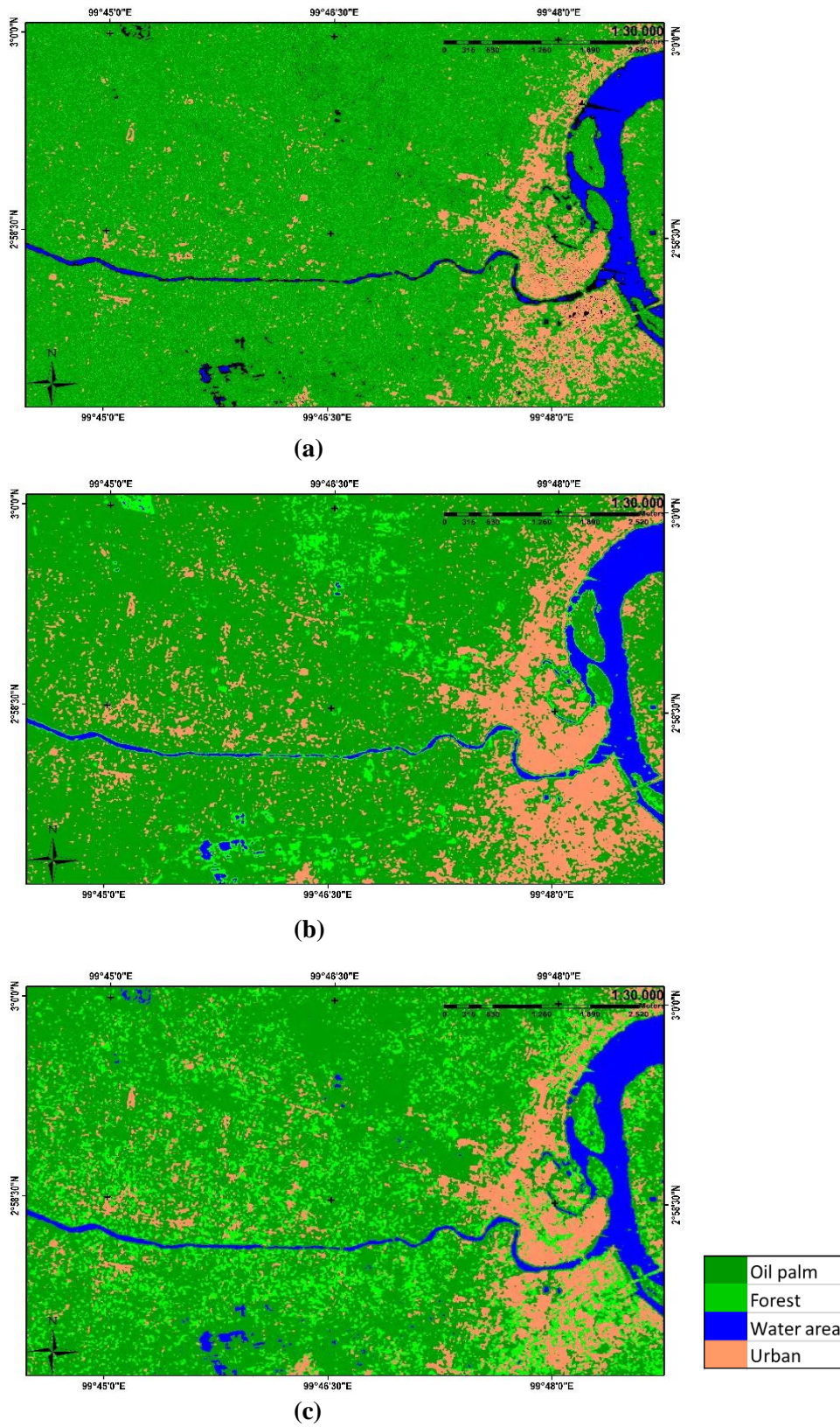


Figure 6. ALOS PALSAR image classified using Parallelepiped (a), Maximum Likelihood (b) and Support Vector Machine (c)

4. Conclusion

Based on the accuracy value generated from each method used shows that the best method with the highest accuracy value is the Support Vector Machine, the results of this study indicate that the accuracy of each image has a different value. The overall accuracy of the TerraSAR-X imagery of 77.57%, the Sentinel-1 imagery of 86.18% and ALOS PALSAR imagery of 91.17%. However distribution, size and location of training sample is very influent for accuracy value and still more improvement for SAR processing.

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