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Utilization of ALOS PALSAR-2 Data for Mangrove Detection Using OBIA Method Approach

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Abstract. Mangroves have an important role for climate change mitigation. This is because mangroves have high carbon stock potential. The ability of mangroves to absorb carbon is very high and it is estimated that the mangrove carbon stock reaches 1023 Mg C. The current problem is the area of mangrove forest is decreasing due to land conversion. One technology that can be used to detect changes in the area of mangrove forest is by utilizing ALOS PALSAR-2 satellite imagery. The purpose of this research is to detect mangrove forest area from ALOS PALSAR-2 data by using object-based image analysis (OBIA) method. The location of the study is Taman Nasional Sembilang in Banyuasin Regency of South Sumatra. The data used are ALOS PALSAR-2 dualpolarization (HH and HV), recording year 2015. The calculation of mangrove forest area in Sembilang National Park has ~ 82% accuracy. The results of this study can be used for various applications and mapping activities.

Keyword: mangrove, ALOS PALSAR-2, OBIA

1. Introduction

[1] defines mangroves as typical coastal vegetation along tropical and sub-tropical sheltered beaches, influenced by tidal sea water, and able to adapt in brackish waters. One of the important functions of mangrove forests is as carbon reserves to reduce greenhouse gas emissions. [2] stated that the potential of carbon stock from mangrove is 1023 Mg C per hectare. The current problem is the degradation of mangrove forests. [3] released information that in 2005, the area of mangrove forest in Indonesia reached 3,062,300 ha and continues to decrease to date. Mangrove forests are much reduced due to land conversion into settlements, ponds, agriculture, industry, and so forth. Therefore, it is necessary to identify mangrove forest changes. One of the technologies that can be used is by utilizing satellite images of Advanced Land Observing Satellite-Phased Array Type L-Band Synthetic Aperture Radar (ALOS PALSAR) 2.

PALSAR-2 is an instrument of ALOS 2 with a frequency of L-Band (1.2 GHz) which has the primary objective to monitor disasters at any time and weather conditions. The main missions of ALOS PALSAR-2 are for disaster monitoring, monitoring of global environmental issues (deforestation, polar ice caps reduction), and for economic and food issues. Compared to previous generations, the ability of ALOS PALSAR-2 is better than basic satellite capacity, resolution, channel, and temporal resolution. The resolution of ALOS PALSAR-2 is 1x3 m, whereas in PALSAR the...
previous generation is 10 m. Temporary resolution is also getting faster, i.e., 14 days. ALOS PALSAR-2 has three modes, Spotlight, Strip Map, ScanSAR. ALOS PALSAR-2 has a single polarization (HH, HV, VH, VV), dual (HH + HV, VH + VV), and full polarimetry (HH + HV + VH + VV) [4].

Research by using ALOS PALSAR-2 has been done, among others [5] using ALOS PALSAR-2 for damage assessment of buildings caused by earthquake, [6] identify the location and characteristics of mangrove species in Hai Phong Vietnam. [7] used ALOS PALSAR-2 to calculate the stem volume of a forest area, [8] using ALOS PALSAR-2 for rapid response to floods that occurred in the Kanto and Tohoku areas.

One technique that can be used for image identification is object-based image analysis (OBIA). OBIA is a classification technique that not only classifies objects based on pixel hue or texture, but based on unity of objects. Simply stated, OBIA is a classification that not only uses spectral values but also considers the spatial aspects of objects [9]. [10] states that object-based classification is able to define object classes based on spectral and spatial aspects at once. The OBIA technique has been widely used for the identification of objects from images, among which are tidal site location maps [11], mapping of geomorphological zone of coral reef ecosystem [12], detection of land use change [13,14], mapping of mangrove composition [15], and karst morphology [16]. The purpose of this research is to detect mangrove forest area from ALOS PALSAR-2 data by using object-based image analysis (OBIA) method. It is hoped that the results of this research can be used for application and mapping activities.

2. Material and Methods

2.1. Study Area

The research location is Taman Nasional Sembilang (TNS) located in Banyuasin Regency, South Sumatera Province which geographically located at 104°11’-104°94’ East Longitude and 10°53’-20°27’ South Latitude (Figure 1). TNS region has estuarine habitat because many have estuaries of ± 70 rivers with the largest river is Sungai Sembilang. All the river flows to the South China Sea and Bangka Strait. The mangrove forest area in TNS is 78,597.55 ha with eight (8) mangrove species, including Excoecaria agallocha, Rhizophora apiculata, Avicennia alba, Rhizophora mucronata, Avicennia officinalis, Brugueira gymnorrhiza, Xylocarpus granatum and Nypa fruticans [17].

Figure 1. TNS from Landsat 8 image.

2.2. Materials

The data used in this study is the image of mosaic ALOS PALSAR-2 in 2015, with dual SAR polarization mode HH and HV. Besides ALOS PALSAR-2 data, data from One Map Mangrove Nasional is used as mangrove location validation.
2.3. Methods
The initial process is geometric correction which refers to ALOS PALSAR-2 metadata. The geometric correction method used is a rigorous satellite sensor with 1.96 sigma accuracy. Digital Number (DN) is converted to sigma-zero normalization value using equation:

\[ \sigma_0 \text{[db]} = 10 \cdot \log_{10}(DN)^2 + CF \]  

where:
- \( \sigma_0 \): backscattering coefficient
- DN: Digital number
- CF: Calibration Factor (-83 db)

The next step is a filtering that aims to reduce the speckle (noise). The filters used in this study were Goldstein and Low Pass filters. After getting the image free of noise, the next process is classification with OBIA segmentation approach. In the process of segmentation, the example object used for each class is 60. Segmentation using the multiresolution method with parameters used are scale, shape, compactness.

3. Results and Discussion
Filtering results by using Goldstein and Low Pass filter, able to remove speckle (noise) on ALOS PALSAR-2 image. To get the real view, a channel combination process (RGB) is performed. The combination used is Red: HH, Green: HV, Blue: (HH + HV)/3. Visually, mangrove looks darker than other vegetation objects, this is influenced by mangrove growing places in the form of muddy areas. Water in muddy areas causes a darker look. This is because water absorbs more electromagnetic waves than other objects. In addition to mangrove and water, other visible objects are non mangrove vegetation and open land. Non mangrove vegetation looks brighter and open field looks purplish. To clarify mangrove location in ALOS PALSAR-2 data, transect is done to see the DN profile of the object. Transects are performed at three locations that are considered to represent objects in the image. The RGB combination and object transect locations are shown in Figure 2.

![Figure 2. RGB combination and transect locations.](image)

The transect results show different patterns for each object. Of the three transect sites, non mangrove vegetation has a higher DN profile than mangrove and open land, while water has a very low profile (Figure 3). This is due to the water having properties to absorb electromagnetic waves and slightly reflected compared to other objects.

Results transect helps to determine the location of objects that were sampled for segmentation. Segmentation is done to classify objects in the image into three classes, namely mangrove, non
mangrove, and water. In the process of segmentation, each object is represented by 60 homogeneous samples. The segmentation used in the research is the multiresolution method, which minimizes the average heterogeneity of the object of an image at a certain resolution. This segmentation process uses the parameters of scale, shape, and compactness.

The value of each parameter will affect the segmentation result. The scale parameter is the term for the determination of the value of the maximum heterogeneity allowed on an object and its value is directly proportional to the size of the object. Needed modification on the scale parameters, the greater the value of the scale parameters then the homogeneous object will be less so that the results will be more coarse segmentation and the resulting object has a larger size.

The shape parameter influences the color parameter value so it must be adjusted to the study done. The larger the shape parameter values, then the segmentation process will be affected by the texture. The compactness parameters are used to separate compact objects from non-compact ones. The greater the value of the compactness parameters used then the resulting object form will be more compact [18]. In this study, the values used for each parameter are scale 30; shape 0.5; and compactness 0.5.

Prior to the homogeneity of classification according to the object, the boundary between the land with the water looks very clear, but the object is still difficult to distinguish. Classification is done to separate between mangrove, open land, non-mangrove vegetation, and water. Open land and non-mangrove vegetation are described as non mangrove so that the final result of segmentation is three classes ie mangrove, non mangrove, and water. To clarify the three objects of study, then the smoothing process has been done. This is shown in Figure 4.
The smoothing results from the segmentation give a clearer picture of the object. Mangrove was seen around the coastal area and a small portion at a location some distance to the mainland. Vegetation on the land is partly described as a mangrove, this is possible because of the similarity to the homogeneity of the object image. In addition to mangroves, non mangrove classes are also seen in TNS areas. Non mangrove class besides non mangrove vegetation and open land, in this segmentation result, part of river flow is described as non mangrove (Figure 5).

To validate the existence of mangrove, overlay done between mangrove from segmentation result with mangrove vector from One Map Mangrove National activity. The overlay result shows that mangrove from segmentation result is 82% according to One Map Mangrove vector. The area of mangrove forest of TNS segmentation is 73,854 ha while mangrove from One Map Mangrove activity has wide 90,085 ha (Figure 6).
Figure 6. Mangrove in TNS from segmentation

4. Conclusions
ALOS PALSAR-2 ScanSAR mode can be used for object detection one of them is mangrove forest. By using OBIA segmentation method, mangrove forest in TNS can be detected clearly. Based on the result of overlay between mangrove result of segmentation with mangrove from One Map Mangrove National activity has 82% accuracy. Further research is needed to obtain a combination of scale, shape, and compactness parameters suitable for mangroves.

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