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Identification of mangrove forest change using object-based analysis in Bontang, East Kalimantan

Vina Nurul Husna[1], Pungki Ari Wibowo[1], Nurul Ihsan Fawzi[2]

[1]Center for Environmental Research, Bogor Agricultural University, Dramaga, Bogor, Indonesia 16680
[2]Alam Sehat Lestari, Sukadana, West Kalimantan, Indonesia 78852

E-mail: vinahusna@gmail.com

Abstract. In past half century, 35-86% of global mangrove forest already loss due to conversion into ponds, urban development and timber harvest. This is become challenging because in some area we don't have data about distribution and what mangrove species in that forest. We mapping mangrove forest in Bontang city using PlanetScope images acquired at 2017 and 2018. Remote sensing analysis using OBIA method we obtain mangrove extend in Bontang City in 2017 and 2018 are 2,659.2 ha and 3,155.9 ha respectively. With this result, we already loss 491 ha or 13.5% from the initial extend in 1988. Our finding on this research are although have high accuracy, mangrove mapping with 3-meter resolution gave not quite good result. This is because we only obtain mangrove and non-mangrove classification, not until species determination. The factor mainly atmosphere condition which Bontang area have cloud or many aerosols that hamper light transmission. In future need to mapping with species differentiation with this challenge.

1. Introduction

Mangrove forest are the most abundance ecosystem in Earth and provide US$ 1.6 billion per year as an ecosystem service [1]. In pristine mangrove forest, carbon stock is high like rainforest with average is over 1,000 Mg carbon per hectare [2]. Mangrove forest become important for resilience of coastal ecosystem in response of climate change and future global change [3]. Mangrove advantage to environment can sink marine litter and trap original litter to prevent it float to the sea [4].

Total area mangrove approximately is 137,760 km^2 in 118 countries, most of distribution between 5° N and 5° S latitude [5]. In past half century, 35 – 86% of global mangrove forest already loss due to conversion into ponds, urban development and timber harvest [2,6], and more than 36,000 ha loss because climate change [7]. Long term survival of mangrove forest in region will be at risk because deforestation and fragmentation.

Rate of mangrove loss each region is different, and need to ecosystem risk assessment every mangrove forest. In our research area, mangrove loss in Bontang City mainly caused by enlargement of industrial area on mangrove ecosystem such as petrochemical factory, and the rest is abandoning a fish pond. This is become challenging because in some area we don't have data about distribution and what mangrove species in that forest. Limited information needs to be solved with mapping of mangrove forest. Terrestrial survey become promising because providing accurate and detail information. However, terrestrial survey requires longest time and money. Remote sensing become more promising and provide high quality spatial data and efficient. The aim of this research is to determine the extent of

mangrove forest in Bontang City using PlanetScope images. This research to address the gap of mangrove information in Bontang City and become reference in the future.

2. Method

2.1. Study Area
This study conducted in Bontang City, East Kalimantan. Bontang is located between 117° 23′ E and 117° 32′ E and 0° 01′ N and 0° 12′ N. Bontang is coastal city with 178,718 inhabitants [8]. The Bontang City area in the north and west borders East Kutai Regency, east of the Makassar Strait, and south by Kutai Kartanegara Regency (figure 1). Main income of the city is industrial and businesses related to agriculture, farming or fishing. Bontang has 3 large companies in different fields, Badak NGL (natural gas), Pupuk Kaltim (fertilizer), and Indominco Mandiri (coal mining). All this company work at coastal area and can affected coastal ecosystem.
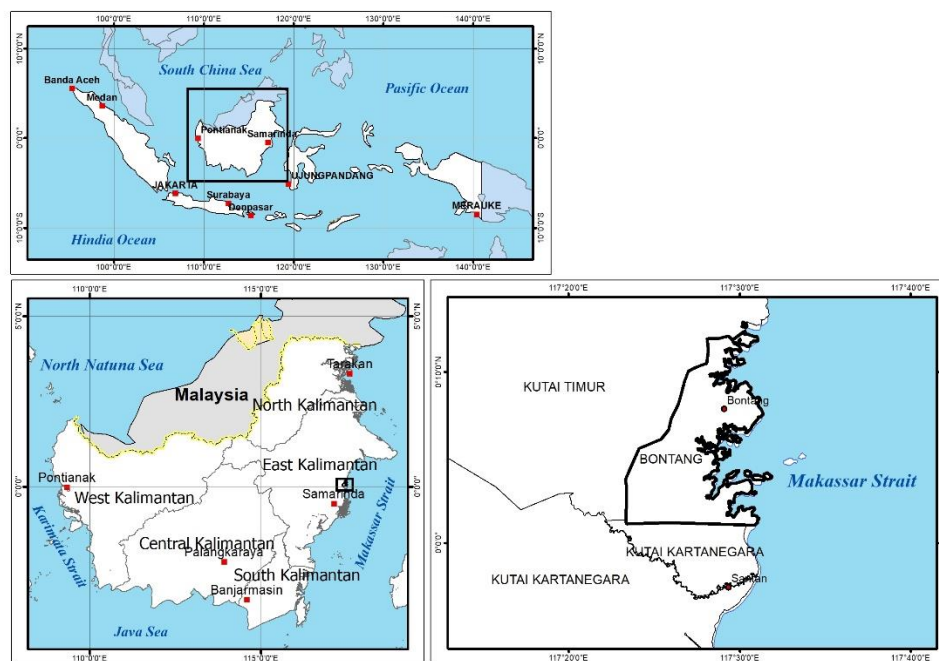

Figure 1. Study area in Bontang City.

2.2. Remote Sensing Data and Analysis
We used PlanetScope images with 3-meter resolution that acquired in 2017 and 2018. The image already geometrically corrected. For classification, we using Object-based Image Analysis (OBIA). OBIA segments an object in images and grouping small pixel together into vector object. After the image was segmented, object classified into mangrove forest, water, non-mangrove vegetation and built-up area. The mangrove classification results are then used as a basis for determining sampling and continued with testing the classification accuracy using confusion matrix. To compare mangrove forest change with previous condition, we using Landsat 5 TM acquired at March 29, 1988.

3. Result and Discussion
The result from OBIA classification for mangrove forest in Bontang City in 2017 and 2018 are 2,659 ha and 3,156 ha respectively. We found mangrove area increase over 18%. This additional of mangrove area because the presence of cloud in 2017 image and rehabilitation program of mangrove area by the companies. If we compare the 2018 result with classification mapping in 1988, the mangrove extend are 3,647 ha. We already loss 491 ha or 13.5% from the initial extend in 1988.

Field survey was conducted on 11 – 14 April 2018 to identified mangrove species in the forest. We obtain 15 species along the coast area (table 1). Data from field survey was used for confusion matrix analysis, the map accuracy is 90%. We found the accuracy of handheld GPS not suitable for higher resolution image. This limitation makes us taking dept into mangrove forest for field survey to obtain species data and to avoid miss-classification data.

Table 1. Mangrove species in Bontang coastal.

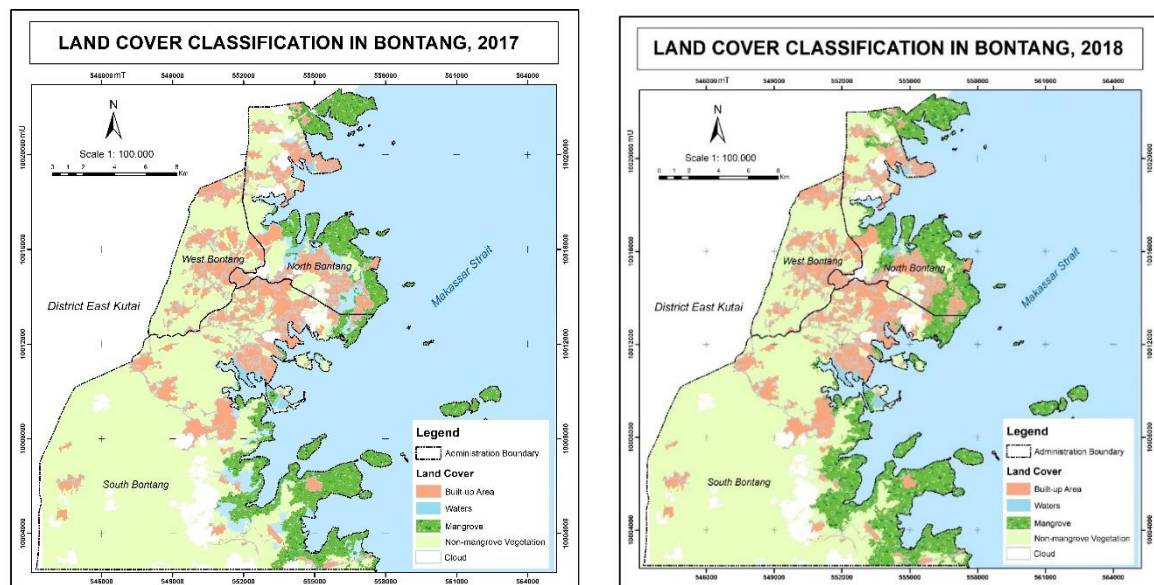| No	Family	Species	Abundance	Density (ind per ha)
1	Rhizophoraceae	*Rhizophora apiculata*	++	*1,933*
		Rhizophora mucronata	+++	*3,000*
		Bruguiera gymnorrizha	+	
		Ceriops tagal	+	
2	Sonneratiaceae	*Sonneratia alba*	+++	*2,833*
		Sonneratia caseolaris	+	
3	Meliaceae	*Xilocarpus granatum*	+	
4	Euphorbiaceae	*Excoecaria agallocha*	+	
5	Acanthaceae	*Acanthus ilicifolius*	+	
6	Avicenniaceae	*Avicennia alba*	++	
		Avicennia marina	+	
		Avicennia lanata	+	
7	Rubiaceae	*Scyphiphora hydrophyllacea*	+	
8	Combretaceae	*Lumnitzera racemosa*	+	
		Lumnitzera littorea	+	

Figure 2. Mangrove distribution on Bontang City from OBIA classification.

From this result, we can obtain mangrove distribution and condition at Bontang coastal (figure 2). We can use this data for retrieving up to date information about mangrove ecosystem in this area for management and decision-making processes [9]. We obtain that the most abundance species are *Rhizophora mucronata* with 3,000 individual per hectare and *Sonneratia alba* with 2,833 individual per hectare. Following by other species with less abundance (figure 3). In short, with PlanetScope images gave advantage for mangrove studies and useful to monitor the distribution of mangrove ecosystem on Bontang coastal [10]. Our finding on this research are although have high accuracy, mangrove mapping

with 3-meter resolution gave not quite good result. This is because we only obtain mangrove and non-mangrove classification, not until species determination. The factor mainly atmosphere condition which Bontang area have cloud or many aerosols that hamper light transmission. It's hard to obtain free cloud on Bontang and this one challenge in future research. The other reason is mangrove in Bontang have no zonation, so every species mixed according the salinity adaptation. But with this result, mangrove forest on Bontang looks promising life with conservation support from many stakeholders to reduce mangrove forest change to built-up area.
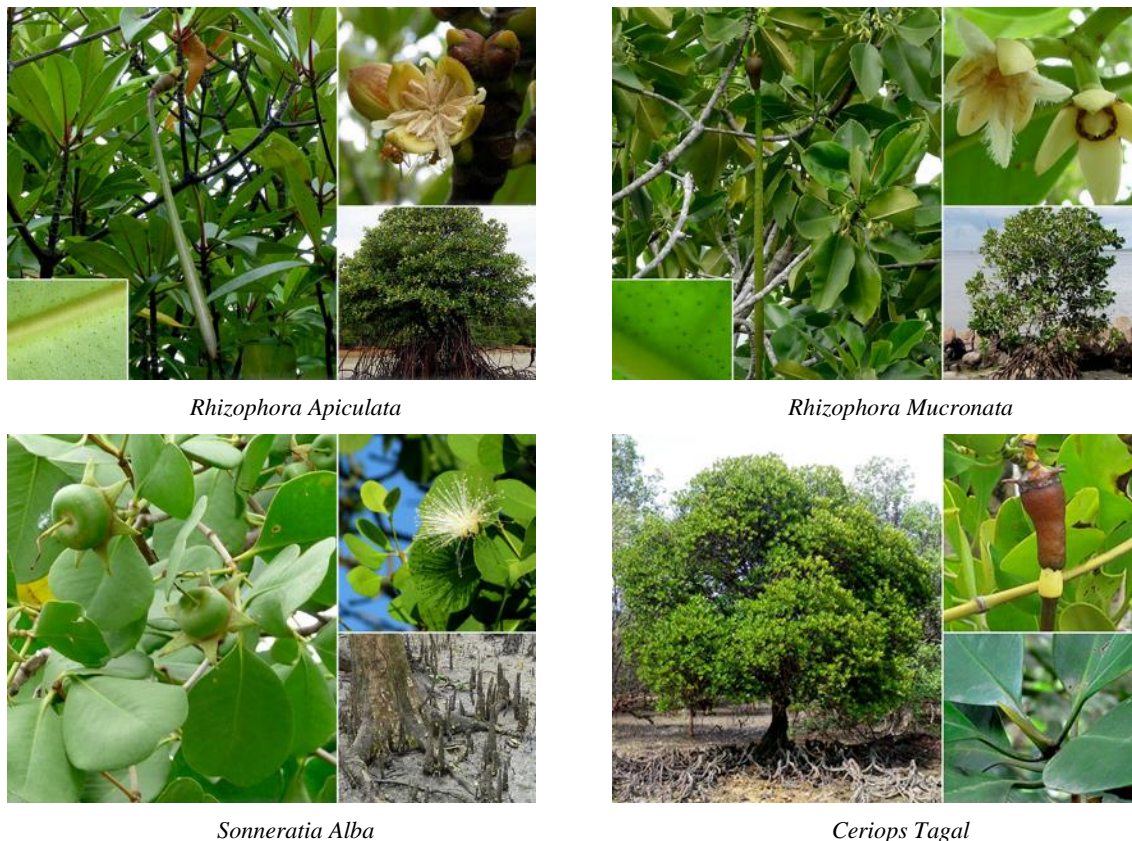

Rhizophora Apiculata   *Rhizophora Mucronata*

Sonneratia Alba   *Ceriops Tagal*

Figure 3. Mangrove species in Bontang.

4. Conclusion

Remote sensing analysis using OBIA method we obtain mangrove extend in Bontang City in 2017 and 2018 are 2,659.2 ha and 3,155.9 ha respectively. With this result, we already loss 491 ha or 13.5% from the initial extend in 1988. Our finding on this research are although have high accuracy, mangrove mapping with 3-meter resolution gave not quite good result. This is because we only obtain mangrove and non-mangrove classification, not until species determination. The factor mainly atmosphere condition which Bontang area have cloud or many aerosols that hamper light transmission. In future need to mapping with species differentiation with this challenge.

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