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Land Cover Mapping using GEOBIA to Estimate Loss of *Salacca zalacca* Trees in Landslide Area of Clapar, Madukara District of Banjarnegara

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Abstract. Landslide is an unpredictable natural disaster which commonly happens in highslope area. Aerial photography in small format is one of acquisition method that can reach and obtain high resolution spatial data faster than other methods, and provide data such as orthomosaic and Digital Surface Model (DSM). The study area contained landslide area in Clapar, Madukara District of Banjarnegara. Aerial photographs of landslide area provided advantage in objects visibility. Object's characters such as shape, size, and texture were clearly seen, therefore GEOBIA (Geography Object Based Image Analysis) was compatible as method for classifying land cover in study area. Dissimilar with PPA (PerPixel Analyst) method that used spectral information as base object detection, GEOBIA could use spatial elements as classification basis to establish a land cover map with better accuracy. GEOBIA method used classification hierarchy to divide post disaster land cover into three main objects: vegetation, landslide/soil, and building. Those three were required to obtain more detailed information that can be used in estimating loss caused by landslide and establishing land cover map in landslide area. Estimating loss in landslide area related to damage in Salak (*Salacca zalacca*) plantations. This estimation towards quantity of Salak tree that were drifted away by landslide was calculated in assumption that every tree damaged by landslide had same age and production class with other tree that weren't damaged. Loss calculation was done by approximating quantity of damaged trees in landslide area with data of trees around area that were acquired from GEOBIA classification method.

Keywords: GEOBIA, Land Cover Mapping, Aerial Photography, Landslide, Loss Estimation

1. Introduction

Landslide is described as a mass movement of materials, including rocks, soil or debris that happens in slope area and is affected by gravitation force. Landslide mainly occurs in area with steep slope, significant rainfall, developed soils, and hilly topography. This area can be found commonly in Banjanegara region. On March 25th 2016, an event of landslide occurred and caused loss in infrastructure yet no human injury. The landslide area extends from north-west to south east of Clapar


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area. It became a necessity to collect and measure data of landslide area and land cover affected by the event.

OBIA (Object-Based Image Analysis) is a classification method based on object which can be applied in imagery data. This method is divided into two parts of processes, which are image segmentations and classification on each segment [5]. This method classifies object recorded by aerial photography or satellite imagery based on three parameters which are object scale, object shape, and object compactness.

This method has more advantages related to object classification, resulting more accurate and higher precision of classification. This method is also easier and more time-efficient in image processing and object classification than pixel-based classification [1]. Furthermore, this classification considers not only object's spectral aspect, but also its spatial aspect [4].

This paper presents how OBIA classification detecting differences between each land cover that surrounds over landslide area. The segmentation process results three types of image segmentation based on three types of land covers, which are landslide area itself, vegetation, and building/local settlements. The result was used to generate a land cover map, and also to measure the extent of each type of land covers. These measurements can be used to calculate on how much loss in each type of land cover area, especially in salak plantations. This paper shows the manifestation of using OBIA into identifying and measuring loss caused by local disasters in small scale area by detecting and differentiating between damaged land cover and undamaged land cover.

2. Study Site

Clapar village is located in an area with a high-level intensity of landslide hazard. This level can be seen from how the landslide is occurred frequently in this region, Banjarnegara. Data provided by Badan Nasional Penanggulangan Bencana (BNPB) shows that there were 25 landslide locations had been recorded, including Clapar Village, in range from 11-12 December 2014. The largest landslide in Clapar Village itself was occurred in March 25, 2016, swallowing almost half of the village's region. The hazard happened due the spring that should be flowing down form the river but because the lack of space, the water seeped onto the ground, making the soil very soft, and causing the ground to flow as gravitation pull it down. The physical characteristics of the site itself also had quite-impacting factors to the landslide, such as low-stability type of soil and steep slope, making the motion to move faster.

Topology area with steep slope makes the condition of soil moving faster. Rainfall reaching in Clapar is calculated for about 301 to 400 millimeters per month. Clapar has a specific rock formation called Rambatan Formation. Crown Clapar landslide in the village is located at an elevation of 837 meters above sea level with a slope of 23%. While the tip of the tongue landslide Clapar located at an elevation of 705 meters above sea level with a slope of 12%. The crown part of the landslide was known to be used in plantation of *Salacca zalacca* or Salak. Clapar possible landslides village lied in fault zones or fault of the north-south direction.

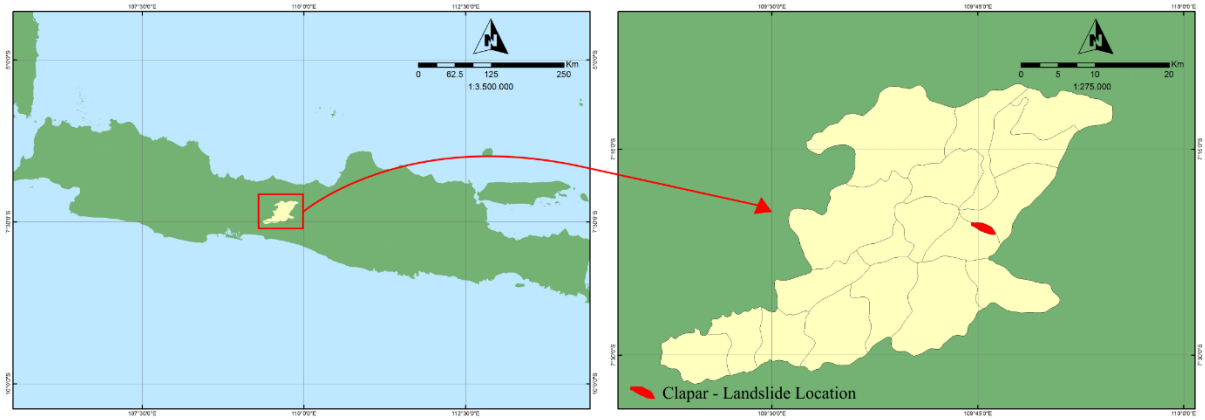


Figure 1. Location of landlides on Clapar, Madukara District of Banjarnegara.

3. Methods

Land cover mapping used GEOBIA to estimate loss of Salak trees consist of 5 steps: 1) processing aerial photographs segmentation using the example based feature extraction method edge in ENVI 5.2; 2) sampling for each object defined as landslides, vegetation, and settlement; 3) classifying aerial photographs segmentation results based on the sample that has been taken; 4) masking landslide areas with consideration of landslide potential area; and 5) estimating loss of Salak using the data of landslide areas and data of plantation space of Salak tree.

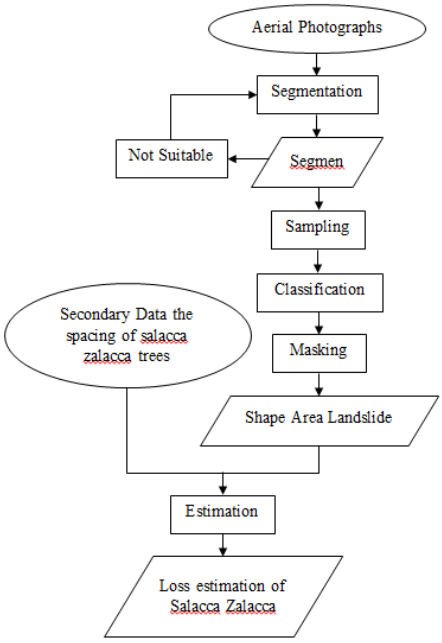


Figure 2. Flowchart

Example based feature extraction is a method of segmentation in ENVI 5.2 utilizing the sample as a basis for classifying objects. This method is a simple OBIA method that uses two algorithms, which are intensity algorithms and edge algorithms. Intensity is suitable method for data that has a continuous spectral value. The algorithm works by converting pixel values into intensity values on

Object Creation Panel. Edge is suitable method for objects that have clear boundaries and internal parts consisting identical pixel value. The land cover objects existing in aerial photographs shows clear boundaries between each type of land cover, so that edge algorithms for segmentation is selected. To combine identical segments, merge function is used. There are two algorithms on the merge function, which are Full Lamda Schedule and Fast Lamda. Fast Lamda combines segments pixels with similiar values and limits. Values merge level selected number 13.5 with Lamda Fast algorithm that produced the segment is sized to fit.

Segmentation result needs to be classified as types of required land covers. Samples are required for each required type so that the system can recognize the characteristics of each segments. The required amount of sample was taken for each class adjusting the level of diversity. For landslide, 3029 segments were taken as sample, 565 segments were taken as sample for local settlement, and 5414 segments were as sample for vegetation. Samples were taken equally on each spectral range for each class. Classification was processed using gained samples into three required types of existing land use.

Loss of damaged Salak tree was estimated in landslide area, therefore, measurement of landslide area was needed. Estimating landslide area was limited in area formerly identified as Salak plantations, which was determined by association between each land cover. The results determining potential landslide area was calculated by dividing Salak area with plantation space between each Salak tree.

$$L = \frac{SA}{ST}$$

L : Loss value of *Salacca Zalacca*
SA : Area of landslide (m^2)
ST : Spacing distance between each Salak tree/Salak canopy (m^2)

Plantation space of salak tree was used to model the area of one salak canopy. Seven samples of plantation space was measured in the field. The means of the samples is 197,85 cm. Sample's mean was used to build salak canopy model to estimated thea area of one salak tree. Area of one salak tree canopy is 3.9145 m^2.

Table 1. Plantation space between samples in the filed

Sample	Space (cm)
1	243
2	222
3	123
4	175
5	212
6	166
7	244
Mean	197.85

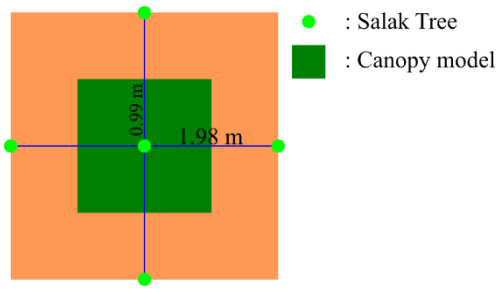


Figure 3. Canopy Model

4. Results

4.1. Land cover map

Land cover map generated from GEOBIA classification consisted of three types of land cover, which were landslide area/soil, vegetation, and building/local settlement. This simple classification of land covers was intended to gain clear form of boundaries between landslide area and other land covers.

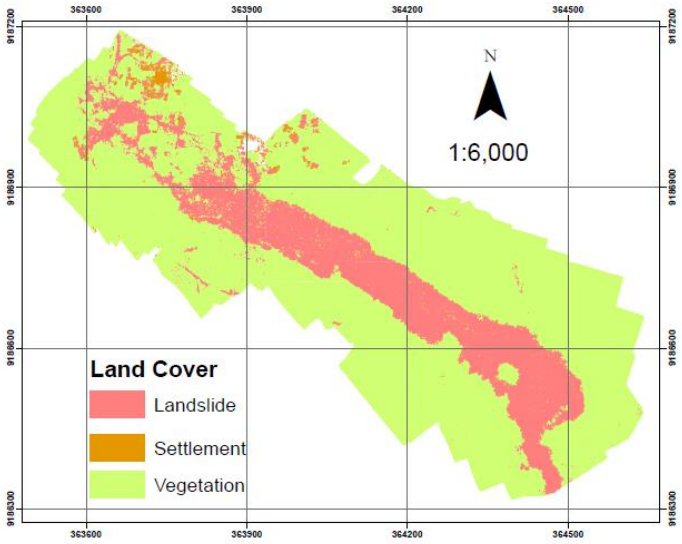


Figure 4. Land cover map generated by GEOBIA method

Accuracy assessment was performed to check the accuracy of the land cover map. 35 samples generated using stratified random sampling method. Unfortunately, only 20 samples checked because of the hard terrain and bad weather. All samples were classified correctly so the accuracy of this output map is 100%. Main factor why this land cover map accuracy is 100% because the classification quite simple. It's only consists of three main object, there there are landslide/soil, vegetation, and building/local settlement.

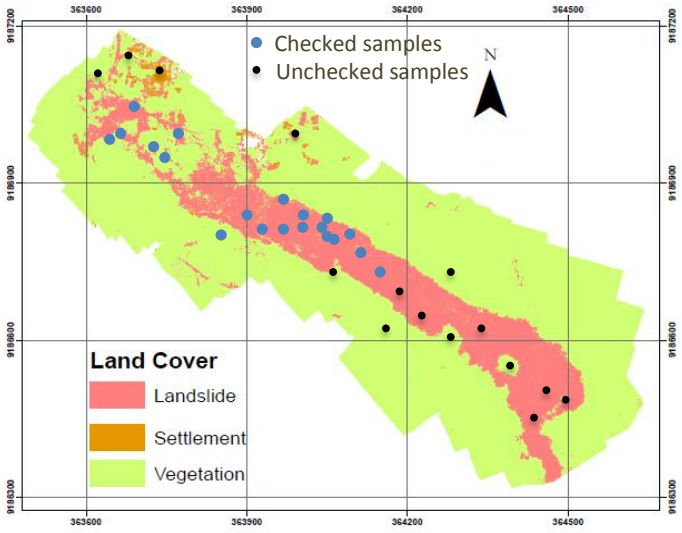


Figure 5. Distribution of samples

4.2. Estimation result

About 16.585 Salak trees were lost due to landslides and 64,923.9197 m2 of land area damaged by landslide were estimated from GEOBIA method. The result was obtained from the assumption of the extent of tree canopy calculated as 3.9145 m^2.

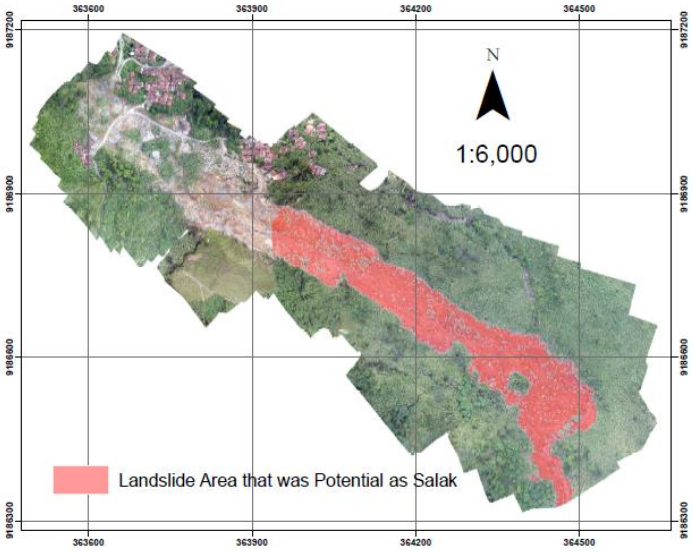


Figure 6. Landslide area formerly identified as Salak plantations map

5. Discussion

Segmentation process with OBIA method generated three types of land cover. Segmentation were processed by edge method which differentiated each segments by considering angular differences of each object. This method was suitable with aerial imageries that shown clear differences between objects and spectral gradation. In this segmentation method, scale factor value dan merge level value were needed and adjusted by aerial imageries condition with various type of land cover. The greater the scale and merge level, the classification will be generalized. Hence, scale factor around 55 and merge level around 30.1 were selected so that the segmentation result would be suitable with aerial imageries's appearance.

The output of segmentation was classified by example-based method. This method was using example samples based on each type of required classes. The distribution of sample was considering characteristics of each object. The amount of sample can be reviewed in figure 5, with amount of sample of landslide material was 3,029 segments, amount of sample of local settlement was 565segments, and amount of sample of vegetation was 5,414 segments.

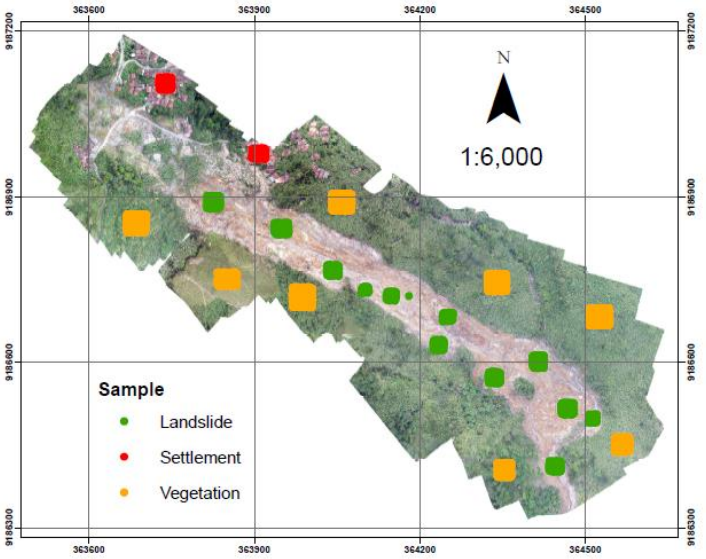


Figure 7. Samples distribution map

The result of classification showed three different types of land cover around landslide area, which was vegetation, local settlement, and materials of landslide itself. This result can be used to measure area of each land cover type, with the result showed that vegetation has largest area in the study area. By comparing between Salak area affected or not affected by landslide, we can estimate the damaged area of Salak plantation. Determining the extent of Salak area damaged by landslide was done with masking method. Masking method was processed by intersecting area formerly identified as Salak area. After that, interpretation manual were processed to determine the extent of masked area. The result showed that the masked area, also identified as damaged Salak area, extended to 64,923.9197 m2. This result showed that there were 16.585 canopies of Salak were damaged. This result also showed that OBIA method was suitable to estimate the amount of canopies which were damaged by landslide. Total canopies damaged by landslide were calculated by area of damaged Salak divided with area of each canopy.

6. Conclusion

GEOBIA segmentation can be used to land cover mapping and estimate loss of Salak in Clapar, Banjarnegara. The result of classification showed land use's appearance which was assumingly suitable with real object condition. The size of landslide area that was formerly potential as Salak area was calculated to 64,923.9197 m2 with 16,585 damaged Salak canopies were estimated. It is considered quite reasonable because the size of the landslide area and the density of canopies or spaces between each Salak tree. The recommendation for further research is to use this method in other area with different land cover to check its capability.

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