Evaluation of land resource balance using interpretation and object-based classification method (case study: BWP Lumajang, Lumajang district)

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Abstract. Utilization of Natural Resources (SDA) is one of the bases used in implementing development in Indonesia. As the center of government and the economy, the Lumajang BWP has the highest population in Lumajang Regency. The annual growth of the Lumajang BWP population results in significant land changes. Calculation of land resources at BWP Lumajang is needed to determine the amount of land reserves and utilization in the area. This research was carried out to compile Lumajang BWP Land Resource Balance (NSDL) in Lumajang Regency using the on screen digitization (interpretation) method and image segmentation as object-based classification method. The results of this study are at a higher level of accuracy, the digitizing on screen method is 94.521%, for the image segmentation method it is 89.041%. In both methods, the land cover which has the largest decrease in area is irrigated rice fields and the largest increase is plantations.

1. Introduction
Natural resources have a strategic role as the main capital of nation and state development. Indonesia is a country that has abundant natural resources that can be used as one of the capital to carry out development with appropriate and wise management. With the advancement of science and technology, economic and industrial growth and significant population growth have resulted in diminishing availability of natural resources. The Indonesian government has implemented the concept of sustainable development in the medium-term national development plan. With one of the related policies, natural resources and the environment which is a green economy, namely improving the management and utilization of sustainable natural resources by balancing between utilization and sustainability [1]. Natural Resource Balance (NSDA) is a scale that is prepared to calculate the availability of resources and the potential that can be generated and provide information about the amount of resources that have been utilized, and reserves that are still filled with resources Natural Resource Accounts (NSDA) are scales compiled for calculate the availability of resources and the potential that can be generated and provide information about the amount of resources that have been utilized, as well as reserves that are still filled with resources. The preparation of NSDA is used in the management of natural resources that are socially, economically and environmentally beneficial as well as sustainability for the welfare of the community for the current generation and future generations. Land Resource Balance (NSDL) is an asset scale and land resource liability. Preparation of land resource balance sheet is used to determine the amount of initial land resource reserves expressed in assets, and
the amount of utilization stated in liabilities, so that changes in reserves can be known the amount of remaining reserves expressed in balances in an area and within a period of time [2].

Part of the Lumajang Urban Area (BWP) consists of Lumajang and Sukodono Districts. As the center of government and economy, Lumajang District has the highest population, reaching 2,706 people / km2. Then, the second highest second is Sukodono Subdistrict of 1,719 people / km2 [1]. With the annual population growth, especially in the BWP Lumajang, it results in significant land changes in the region. The Lumajang Urban Area (BWP) consists of Lumajang and Sukodono Districts. As the center of government and economy, Lumajang District has the highest population, reaching 2,706 people / km2. Then, the second highest second is Sukodono Subdistrict of 1,719 people / km2 [1]. With the annual population growth, especially at the BWP Lumajang, it has resulted in significant land changes in the region.

In the process of preparing the Lumajang NSDL there are several methods that can be used. Data processing methods used in this study include the results of digitizing screen digitization and digital classification, namely object-based classification. Therefore, in this study applying digital classification is object-based classification to compile the land resource balance at BWP Lumajang, analyzing the comparison of the results of data processing on digitalized on-screen interpretation with the results of digital classification in the preparation of NSDL BWP Lumajang changes in the region.

2. Data and Study Areas

The location of this research was conducted in Lumajang area, Lumajang regency, East Java. This area is geographically located between 8°4'38,87" - 8°9'22,53" South Latitude and 113°12'4,458" - 113°16'30,124" East Longitude.

![Figure 1. Research Area](image)

The data used in this research, among others:

a. Pleiades 1-A High Resolution Satellite Image (CSRT) with 0.5 m precision panchromatic and 2 m multispectral accuracy in orthorectified Lumajang Regency.

b. Validation of Lumajang Administrative Border Data 2016 from Lumajang BAPPEDA.

c. RDTR Data from Lumajang Planning Results 2013-2033.

d. Map of Rupa Bumi Indonesia (RBI) 1: 25,000 in 2009.

e. RBI Raw Map of Lumajang Regency Scale 1: 25,000 in 2009

3. Methodology

A. Subsetting Image
This steps using RBI map year of 2009 and Pleiades Satellite Imagery year of 2016, it aim to subset image in accordance with the Boundaries of Other Areas of Use (APL) BWP Lumajang, Lumajang Regency

B. Interpretation Image
This step using two method of interpretation such as image interpretation of digitization on screen results and image interpretation of the digital classification results, especially object-based classification. The interpretation process in both methods is as follows:

a. Image interpretation of digitization on screen using Pleiades 1-A Satellite Imagery
   i. Land Cover Digitation
      Digitization of land cover was carried out with scale of 1: 25000. land cover classes which is carried out digitizing, among others:
      - Settlement (polygon)
      - Road (line and polygon)
      - River (line and polygon)
      - Land Use (polygon)
   ii. Image Interpretation of Digital Classification
      The classification process was carried out in accordance with the interpretation according to the key interpretations such as tone, size, shape, texture, association, shadow, site, pattern [3].

b. Image interpretation of image classification
   i. Image Segmentation
      The segmentation step was dividing homogeneous images by grouping pixels with the same spectrum. It to partition an image into a collection of set of pixels. Image segmentation plays a crucial role in various image processing applications in several domains, including industrial as well as medical applications. It describes the task of partitioning an image into several segments or regions [4]. The segmentation process is done by using the multiresolution segmentation method, which is to conduct trial and error by entering several values in the parameters used, namely scale, shape and compactness to produce the appropriate data processing results.
   ii. Image Classification
      Image classification is defined as the process of categorizing all pixels in an image or raw remotely sensed satellite data to obtain a given set of labels or land cover themes [5].

C. Classification Accuract Test
The accuracy assessment of a supervised image classification problem involves three different steps: the sampling design, the response or measurement design to obtain the true classes for each sampling (usually requiring an expert) and the analysis of the obtained data. The common way to measure the accuracy in the site specific assessment, is by using the error matrix. The error matrix is a table that displays statistics for assessing supervised classification accuracy by showing the degree of misclassification among classes. The error matrix is also known as a confusion matrix, a contingency table or a classified error matrix [6]. The classification accuracy is usually assessed by comparing the classification with some reference data that is believed to accurately reflect the true land cover. Sources of reference data include, among other things, ground truth, higher resolution satellite images, and maps derived from aerial photo interpretation. We should note that virtually all reference data (even ground truth data) are inaccurate to some degree [7].

D. Extraction of Land Cover Processing On Screen Digitization and Object Based Classification
Land resource extraction is a process of inventory area, type and location of land use changes in period of time. In this study, Lumajang land resource extraction was carried out in Lumajang BWP APL Area on Lumajang BWP RBI Map in year of 2009 and Land Cover Result of On-Screen Digitization Data Processing and Object-Based Classification in year of 2016. On Lumajang BWP RBI Map in 2009 will produce asset map. On-Screen Digitization and Land Cover Maps and Classification Based on Object Lumajang BWP 2016 as a liability map.

E. Spatial Analysis
Spatial analysis is a general ability to manipulate spatial data into different forms and extract additional meaning as a result [8]. Spatial analysis was used by overlapping using intersect method between asset map and liability map. The results of data processing at this stage will get the final results of Lumajang NSDL Map on the Result of Digitization on Screen and Object Based Classification in 2016.

4. Results and Discussion

4.1. BWP Lumajang Image Segmentation and Classification Results
After the image is cropping in accordance with the research area, namely at APL BWP Lumajang. Furthermore, in the OBIA classification, image segmentation is carried out, namely dividing objects into images to segments according to gray level. Segmentation is done using eCognition software. A relatively new classification method, object-based image analysis (OBIA), sometimes referred to as feature extraction, feature analysis or object-based remote sensing, appears to work best on hyperspatial satellite and aerial imagery as well as LiDAR [9].

Land use/land cover (LULC) classifications are often created to visually assess the composition of urban landscapes and quantify different aspects of the environment. "Land cover" describes natural and built objects covering the land surface, while "land use" documents human uses of the landscape [10]. The segmentation process uses the multiresolution segmentation method. In the segmentation process with the multiresolution segmentation method, parameters of scale, shape and compactness are used. Remote sensing imagery effectively captures characteristics of the Earth's surface, but it takes an interpreter's knowledge about shape, texture, patterns, and site context to derive information about land use activities from information about land cover [11]. The parameters that most influence in this segmentation process are scale parameters. This is because the scale parameters can divide the heterogeneity of clearly generated segments. The greater the scale value given, the greater the level of segment heterogeneity and the greater the size of the segment. So, in the process of data processing a trial and error process is carried out on the scale value, for parameters of form and compactness using the default value, that is, the shape is 0.1 and smoothness is 0.5. The segmentation process is carried out by trial and error method, namely trying to enter the values on each parameter, namely scale, shape and compactness to get the most appropriate results.

There are several villages in Lumajang Subdistrict that are included in the BWP Lumajang area. The villages included in Lumajang BWP Lumajang Regency include Citrodiwangsan Village, Jogotrunan Village, Jogoyudan Village, Kepuharjo Village, Rogotrunan Village and Tompokersan Village. There are several villages in Sukodono Subdistrict that are included in the Lumajang BWP area of Lumajang Regency include Bondoyudan, Ditotrunan, Karangsari, Kutorenon, Selokbesuki, Selokgondang and Sumberejo villages.

After the segmentation process is done, then the data processing is done by the classification process. Classification is the process of giving classes to each segment according to the land cover class. In the results of data processing that has been done, detected classes have 5 (five) classes, namely settlements, plantations, fields or fields, irrigated rice fields and rivers. In the results of the classification that has been done, in each land cover has a different color as a representative for each land cover. The following is a representative color description of land cover at Lumajang BWP, Lumajang Regency. When high-resolution images are used for analyses, they provide more detailed spatial information. However, conventional pixel value-based classification methods create excessively large data volumes during
calculations and ignore the implication of adjacent pixels, which results in errors [12]. The following is an elaboration of the results of the classification on the segmentation of each village in the Lumajang BWP which has been carried out data processing. The results of segmentation and classification in each village in Lumajang and Sukodono Subdistrict which is included in the BWP Lumajang area can be seen in table 1.

### Table 1. Segmentation and Classification Results

| District | Village   | Segmentation Results                                      | Classification Results                                                                 | Image Results |
|---------|-----------|-----------------------------------------------------------|----------------------------------------------------------------------------------------|---------------|
|         | Citrodiwangsan | - value of the scale is 500                              | 3 (three) land cover classes, namely settlements, rivers and irrigated fields          |               |
|         |            | - Form 0.1                                                |                                                                                        |               |
|         |            | - compactness 0.5                                         |                                                                                        |               |
| Lumajang| Jogotrunan | - value of the scale is 1000                              | 2 (two) classes of land cover, namely settlements and irrigated fields                 |               |
|         |            | - Form 0.1                                                |                                                                                        |               |
|         |            | - compactness 0.5                                         |                                                                                        |               |
|         | Jogoyudan  | - value of the scale is 950                               | 5 (five) land cover classes, namely settlements, irrigated rice fields, plantations, |               |
|         |            | - Form 0.1                                                | fields or fields and rivers                                                           |               |
|         |            | - compactness 0.5                                         |                                                                                        |               |
|         | Kepuharjo  | - value of the scale is 600                                | 2 (two) land cover classes, namely settlements and irrigated fields                    |               |
|         |            | - Form 0.1                                                |                                                                                        |               |
|         |            | - compactness 0.5                                         |                                                                                        |               |
|         | Rogotrunan | - value of the scale is 600                               | 4 (four) land cover classes, namely settlements, fields or fields, rivers and irrigated|               |
|         |            | - Form 0.1                                                | fields                                                                               |               |
|         |            | - compactness 0.5                                         |                                                                                        |               |
|         | Tompokersan| - value of the scale is 600                               | 3 (three) land cover classes, namely settlements, rivers and irrigated fields          |               |
|         |            | - Form 0.1                                                |                                                                                        |               |
|         |            | - compactness 0.5                                         |                                                                                        |               |
| District | Village    | Segmentation Results | Classification Results                                                                 | Image Results |
|----------|------------|----------------------|--------------------------------------------------------------------------------------------|---------------|
|          | Bondoyudan | - value of the scale is 600  
- Form 0.1  
- compactness 0.5 | 4 (four) land cover classes, namely settlements, rivers, plantations and irrigated fields |               |
|          | Ditotrunan | - value of the scale is 950  
- Form 0.1 compactness 0.5 | 2 (two) classes of land cover, namely settlements and irrigated fields |               |
|          | Karangsari | - value of the scale is 700  
- Form 0.1 compactness 0.5 | 2 (two) classes of land cover, namely settlements and irrigated fields |               |
| Sukodono | Kutorenon  | - value of the scale is 500  
- Form 0.1 compactness 0.5 | 5 (five) land cover classes, namely settlements, plantations, fields or fields, fields and irrigated fields |               |
|          | Selokbesuki| - value of the scale is 800  
- Form 0.1 compactness 0.5 | 3 (three) classes of land cover, namely settlements, plantations and irrigated fields |               |
|          | Selokgondang| - value of the scale is 950  
- Form 0.1 compactness 0.5 | 4 (four) land cover classes, namely settlements, plantations, rivers and irrigated fields |               |
|          | Sumberejo  | - value of the scale is 600  
- Form 0.1 compactness 0.5 | 4 (four) land cover classes, namely settlements, fields or fields, rivers and irrigated fields |               |
4.2. Accuracy Test Calculation Results

From the data taken from the sampling points in each class covered in the field, it is used to determine the calculation of the accuracy test results of data processing. For the value of accuracy used in the processing of accuracy test data is 85%. If the accuracy of the results of data processing can be stated that the data is accurate. If the results of data processing carried out <85% then it is stated that the data is less accurate. So, reprocessing must be carried out, especially in the processing of the return data until the accuracy value is as big as classification errors are due, at least in part, to limitations of the imagery used therein. These can be broken down into three categories: spectral content, spatial detail and temporal availability (seasonal) [12]. Calculation of accuracy test is done by using the method of confusion matrix (confusion matrix) and to find out the closeness of the accuracy between the results of classification and reference point samples is done using the calculation of accuracy kappa.

After processing the accuracy test, the overall accuracy and kappa accuracy values are obtained. The following data processing results are a table of the overall accuracy calculation results using the confusion matrix and kappa accuracy methods. Calculation of the 2016 On Screen Digitized Accuracy Test Results and the 2016 OBIA Image Classification Accuracy Test Calculation can be seen in Table 2.

Table 2. On Screen Digitized Accuracy Test Results

| Class             | Lake | Industry | Moor | Settlement | Plantation | Irrigated Rice Fields | Rainfed Rice Fields | River | Total | Omission | MA   |
|-------------------|------|----------|------|------------|------------|------------------------|--------------------|-------|-------|----------|------|
| Lake              | 1    | 0        | 0    | 0          | 0          | 0                      | 0                  | 0     | 0     | 0        | 100  |
| Industry          | 0    | 1        | 0    | 0          | 0          | 0                      | 0                  | 0     | 0     | 0        | 100  |
| Moor              | 0    | 0        | 5    | 0          | 0          | 0                      | 0                  | 0     | 0     | 0        | 50   |
| Settlement        | 0    | 0        | 0    | 24         | 0          | 2                      | 0                  | 0     | 26    | 2        | 89,655|
| Plantation        | 0    | 0        | 0    | 0          | 10         | 0                      | 0                  | 0     | 10    | 0        | 100  |
| Irrigated Rice Fields | 0    | 0        | 0    | 1          | 0          | 21                     | 0                  | 0     | 22    | 1        | 84,615|
| Rainfed Rice Fields | 0    | 0        | 0    | 0          | 0          | 0                      | 1                  | 0     | 1     | 0        | 100  |
| River             | 0    | 0        | 0    | 0          | 0          | 1                      | 0                  | 0     | 6     | 7        | 87,5 |
| Total             | 1    | 1        | 5    | 26         | 10         | 23                     | 1                  | 6     | 73    | 1        | 87,5 |
| Commission        | 0    | 0        | 0    | 1          | 0          | 3                      | 0                  | 0     | 0     | 0        | 0    |

Overall Accuracy (%) 94,521
Kappa Accuracy 0,927
According to the calculation of the accuracy test using the confusion matrix method that has been carried out on both data processing methods, namely on the results of digitizing digitized data processing and OBIA classification, it is known that data processing methods that have higher accuracy are digitized on screen with overall values accuracy is 94.521% and kappa accuracy is 0.927. Whereas, in the OBIA classification method has an overall accuracy value of 89.041% and kappa accuracy of 0.851. So, the digitizing method is a more accurate and accurate method than the OBIA method in conducting land cover interpretation at Lumajang BWP Lumajang Regency. In both data processing methods that are digitized on screen and the OBIA classification has an accuracy value of more than 85%. So, the data from the processing that has been done can be declared accurate and accurate.

4.3. Land Resources Balance Results

On the results of the Asset Map and the Liability Map that have been obtained. Next, overlay to find out the size of assets, liabilities and balance sheet in NSDL BWP Lumajang. The following are the results of the NSDL BWP Lumajang asset, liabilities and balance sheet. Land use/land cover needs to be classified at a very fine scale to be effective for city planning and urban land management [4,12]. The greatest area expansion is in the plantation land cover class of 113,859 Ha and the largest area of land cover is irrigated rice field which is equal to 127.122 Ha. This is because the change in paddy fields has changed its utilization into other land cover, especially plantation land cover.

After overlaying between the Asset Map and the liability, the assets, liabilities and balance sheet values of land cover occur at intervals. Below is a table and graph of 2016 Lumajang NSDL BWP Data on the results of the Pleiades 1-A 2016 Object-Based CSRT Data Classification (OBIA). The type of land cover that has the largest area increase is the type of plantation land cover, which is 119,097 Ha and land cover has decreased the biggest is irrigated paddy, which is equal to 98.608 ha. This is because the change in paddy fields has changed its utilization into other land cover, especially plantation land cover.

5. Conclusion

Based on the processing and analysis of data that has been done, here are the conclusions that the authors get in this thesis research:

a. The results of processing data in this final assignment study found that the digitized on screen method has the overall accuracy of 94.521% and Kappa Accuracy 0.927 with strength of
agreement which is very strong. Whereas, in the OBIA classification method the overall accuracy is 89.041% and Kappa Accuracy 0.851 with strength of agreement is very strong.

b. The most extensive land cover in 2009 and 2016 was irrigated rice fields. With the area of irrigated rice cover area in 2009 amounting to 2064,036 Ha and in 2016 amounting to 1936,914 Ha in digitized on screen and 1965,428 Ha on OBIA classification results. This indicates that the majority of people in Lumajang Regency have a livelihood as farmers. The reduction in land, especially rice fields in Lumajang Regency, is the biggest change into plantations and settlements

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