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Land cover analysis using object based image analysis based on Landsat 8 OLI images in the city of Jember

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Abstract. Jember area has a status as a PKW area (Regional Activity Center). This has resulted in diversifying activities of the population and increasing demand for land, so that land use change is inevitable. Real time land cover data updates in the City of Jember with Landsat 8 OLI imagery using OBIA can be used as an alternative to find out information on land cover classes. This study aims to determine the accuracy of land cover data extraction using OBIA. Using the OBIA method which involves the segmentation process with a multiresolution segmentation algorithm and a classification process with the nearest neighbor algorithm. The results showed the level of accuracy of land cover extraction using OBIA was 90%. These results indicate that the OBIA method for data extraction of land cover in urban areas has high accuracy.

1. Introduction

One of the dynamic developments in urban areas is characterized by the diverse activities of the city population which in turn will affect environmental conditions in the city area [1]. Jember Regency is designated as a Regional Activity Center (PKW) area based on the Spatial Plans of Jember Regency Nomor 1 Tahun 2015 which consists of Kaliwates, Patrang, and Sumbersari Sub-Districts. PKW has a main function as a development area in the fields of government, trade and services, education and health.

Kaliwates, Patrang, and Sumbersari Sub-Districts, here in after referred to as the Jember City area, in their development have a built-in land cover area that is wider than other sub-districts in Jember Regency. As an area that has a status as PKW, the City of Jember is an area capable of attracting residents from outside the region to come for activities. The more diverse activities of the population will be balanced by the increasing demand for land [1].

Urban areas have a strong appeal for people to continue to come, whether they are doing activities or staying. The increasing number of urban areas will increase the demand for land which functions as a space for urban population activities [2]. Agricultural land that has fertility values will be changed according to the needs of the diverse spatial needs of urban residents. Information on land cover in urban areas that is obtained periodically through remote sensing images is very important to do, because it is closely related to aspects of supervision, planning, and area development [3]

The land cover information generated through the interpretation of remote sensing images is highly dependent on the classification system used. Broadly speaking, land cover refers to the vegetation or non-vegetation area of part of the earth's surface [4]. Determination of land cover types can be done by means of observation from satellite imagery or aerial photographs, besides checking in the field is required [5][6][7].

This study examined land cover in the City of Jember which includes Kaliwates, Patrang, and Sumbersari Sub-Districts. Remote sensing data extracted from the Landsat 8-OLI image covering the City of Jember recorded on November 18, 2019. To get more detailed information regarding the objects in each land cover class, using the Object Based Image Analysis (OBIA) method. Melville *et*

al [8] applied the OBIA method using Landsat ETM + imagery for mapping grasslands and this research is proven to have a high degree of accuracy. Previously, Campbell *et al* [9] also applied object based image analysis to Landsat images and produced more accurate accuracy measurements. In this study, the authors apply the OBIA method with object segmentation and classification techniques on Landsat 8-OLI imagery covering the City of Jember.

The formulation of the problem in this study: Landsat 8-OLI imagery covering the City of Jember which was acquired on 18 November 2019, the level of accuracy and accuracy in producing information related to land cover is not yet known, and using the OBIA method on Landsat 8-OLI imagery covering the City of Jember, to get better accuracy that focused on land cover objects. This study aims to determine the accuracy of land cover data extracted from Landsat 8-OLI imagery using the OBIA method. The accuracy of land cover data in the City of Jember area analyzed based on the results of Landsat-OLI image processing which is integrated with a geographic information system. The benefit of this research is to increase the applied value of remote sensing by using medium spatial resolution imagery in the field of land cover studies in urban areas.

2. Methods

The main data used Landsat 8 OLI imagery recorded on November 18, 2019 in the multispectral channel covering the City of Jember, which include Kaliwates, Patrang, and Sumbersari Sub-Districts. Image pre-processing is done by applying radiometric correction to obtain the ToA (*Top of Atmospheric*) reflectance value. Corrected image was then classified using the OBIA method through the segmentation and classification process. The segmentation process applied multiresolution of segmentation with the parameters used, namely scale, color, shape, and compactness in producing segments; and the classification process applied the nearest neighbor (NN) by classifying each segment that has membership in more than one class using the feature space value for each segment [10]. Sampling of training areas using the classification system Anderson *et al* [11] with modifications (Table 1).

Table 1. Classification of Land Cover Types in Cities

Types of Land Cover	Description
Agricultural Vegetation	Rice field, plantation
Non-Agricultural Vegetation	Green open space, green field
Built-Up Land	Settlements, trade centers, office complexes
Open Field	Field without vegetation

Source: Anderson *et al* with modifications[11]

After the classification procedure carried out, then the accuracy test carried out as a quality control of the resulting data. Accuracy assessment is done by calculating the overall accuracy. The data for the accuracy test were obtained from samples from field checks by looking at variations in land cover objects. Based on the results of field validation, the accuracy of Landsat 8 OLI imagery will be known using the OBIA method, which then be laid out to become the Jember City Area Cover Map.
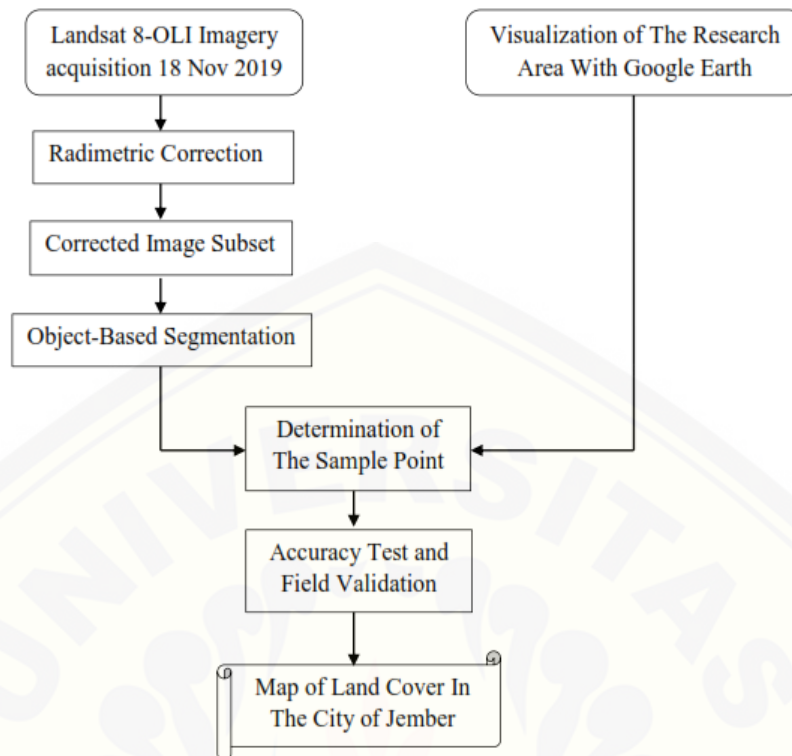
Figure 1. Research Flowchart

3. Result and Discussion

Image pre-processing with radiometric correction reaches the stage of obtaining the ToA reflectance value. This was done to get the spectral value of the object that closer to the actual value of the object in the field. The next stage was to make cuts according to the study area, namely the city of Jember which consists of Patrang, Sumbersari, and Kaliwates Sub-Districts. The application of the OBIA method begun with object segmentation, which used parameters of scale, color, shape, and cohesiveness. Each value for each parameters was a scale of 30; shape 0.2; and compactness 0.5.

(a)   (b)
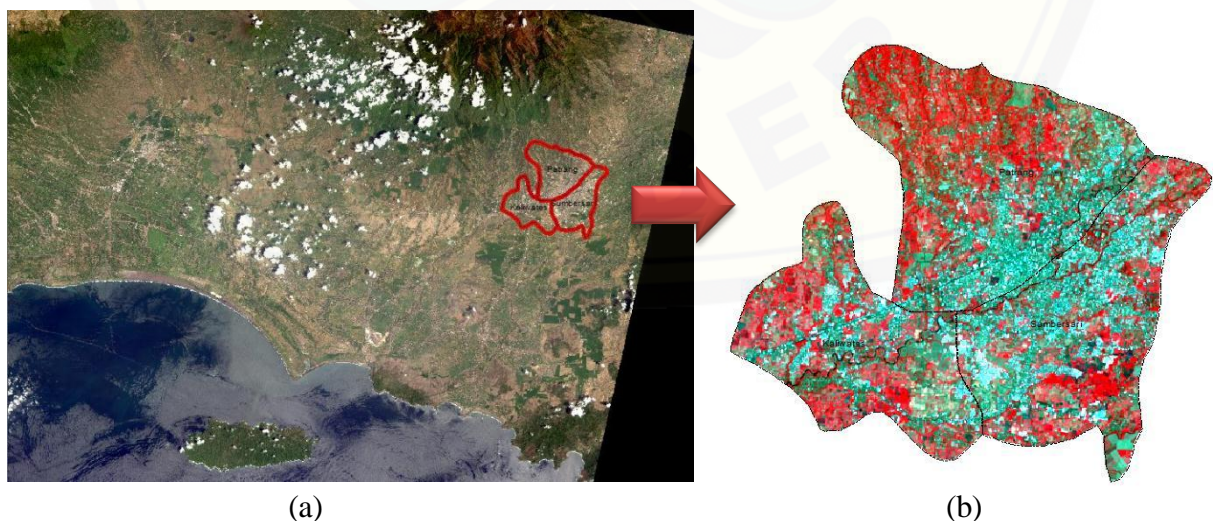
Figure 2. Landsat 8-OLI imagery Coverage of parts of the city of Jember (a), and Landsat 8-OLI imagery for the city of Jember, corrected by radiometry (b)

In addition to the parameters of scale, shape, and compactness, color parameters were also used which refer to the classification system used (Table 1). After segmenting the object according to the classification system used, then the accuracy test carried out to determine the accuracy of the results of the extraction of land cover data in the Landsat 8-OLI imagery covering the City of Jember. The selected accuracy test points are spread across the study area and represent land cover classes. Calculation of the level of accuracy using the accuracy test error matrix. Based on the accuracy test in the field, an accuracy value of 90% is obtained, in more detail can be seen in Table 2 below.

Table 2. Accuracy Test Error Matrix

Field Category	Interpretation Result Category				Total Rows	Accuracy of Interpretation Result
	Agricultural Vegetation	Non-Agricultural Vegetation	Built-Up Land	Open Field		
Agricultural Vegetation	**9**	-	-	1	10	
Non-Agricultural Vegetation	-	**18**	-	-	18	54/60 = **90%**
Built-Up Land	2	-	**24**	2	28	
Open Field	-	-	1	**3**	4	
Total Coloumn	11	18	25	6	**60**	

Source: Data Processing, 2020

Based on Table 2 above, the land cover class for agricultural vegetation and open land has similarities in appearance to other objects in the image, so that when the accuracy test carried out in the field there were several accuracy test points that indicate other objects. The land cover class of agricultural vegetation is identified in the field as another land cover class, namely constructed land, this occurs when object sampling carried out in the image, the built-in land object coincides with the dominance of agricultural vegetation objects, so that the color hue that appears in the image shows the object of agricultural vegetation. Similar to open land objects, when object sampling carried out, the constructed land object has a spectral value similar to open land. The similarity of this spectral value occurs because part of the built land which was a settlement uses a roof or tile made of soil, so that the spectral value of the object recorded on the image sensor has the same as the spectral value of the constructed land object. This also happens to objects that are identified as open land, but when checking in the field it was found that these objects are objects of agricultural vegetation. Agricultural vegetation objects with a spectral value that tend to be the same as the spectral value of open land in the field indicate that the rice field object has finished planting, and there is no more vegetation above it, this was what then makes this agricultural vegetation object look like an open land object in imagery.

The results of the accuracy test were used as input for making the Land Cover Map for the City of Jember using the OBIA method. As can be seen in Figure 3, the dominant land cover class was built-up land. The object of built land consists of settlements, trade centers and office complexes. The land cover class for non-agricultural vegetation consists of vegetation making up green open space and grass fields. This land cover class is mostly found in the northern part of Patrang Sub-District. While the land cover class for agricultural vegetation is spread fairly evenly in 3 sub-districts, however, Kaliwates Sub-Districts has a wider range of agricultural vegetation objects than Patrang and Sumbersari Sub-Districts.
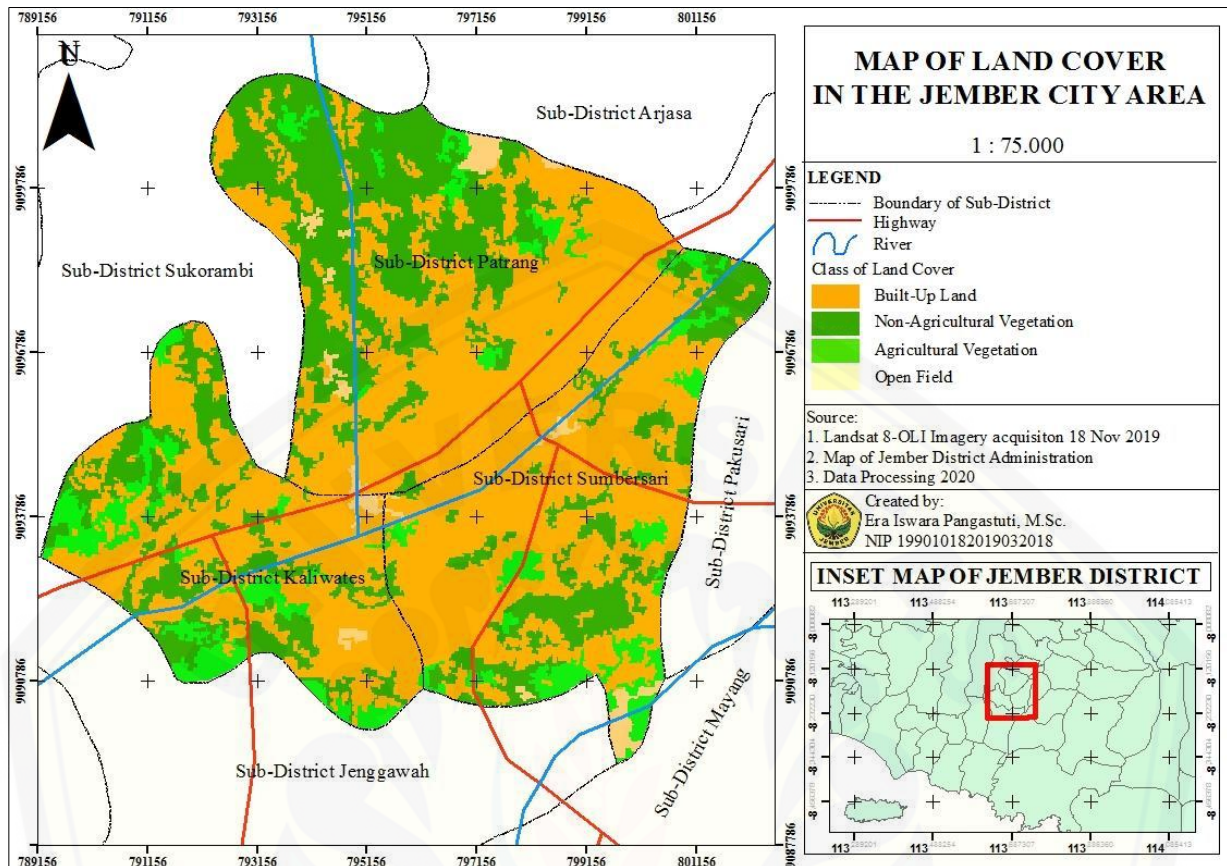

Figure 3. Map of Land Cover In The Jember City Area

Overall, object sampling with the OBIA method can increase the accuracy value in this study, which is 90%. By using OBIA, object sampling focuses on the appearance of the object. In addition to the use of scale parameters, color, shape, and compactness, the application of interpretation elements is also very helpful in the introduction of land cover classes in Landsat 8-OLI imagery covering the City of Jember.

4. Conclusions

Based on the results of the research that has been done, the authors conclude that the OBIA method can be applied for the extraction of land cover in urban areas using Landsat 8-OLI imagery. The results of testing the accuracy of OBIA-based land cover maps show an accuracy rate of 90%. This shows that the OBIA method used for the extraction of Landsat 8-OLI data for the coverage of the City of Jember has a high degree of accuracy.

Acknowledgments

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