

Land Cover Analysis by Using Pixel-Based and Object-Based Image Classification Method in Bogor

Birohmatin Amalisana^{1*}, Rokhmatullah², and Revi Hernina³

¹Bachelor Program of Geography, Universitas Indonesia, Depok – Indonesia

²Department of Geography, Faculty of Mathematic and Natural Science, Universitas Indonesia, Depok – Indonesia

amalisanaa@gmail.com

Abstract. The advantage of image classification is to provide earth's surface information like landcover and time-series changes. Nowadays, pixel-based image classification technique is commonly performed with variety of algorithm such as *minimum distance*, *parallelepiped*, *maximum likelihood*, *mahalanobis distance*. On the other hand, landcover classification can also be acquired by using object-based image classification technique. In addition, object-based classification uses image segmentation from parameter such as scale, form, colour, smoothness and compactness. This research is aimed to compare the result of landcover classification and its change detection between parallelepiped pixel-based and object-based classification method. Location of this research is Bogor with 20 years range of observation from 1996 until 2016. This region is famous as urban areas which continuously change due to its rapid development, so that time-series landcover information of this region will be interesting.

Keywords: land cover, pixel-based classification, object-based classification

1. Introduction

Remote Sensing has an advantage to apply in many sectors. Through the remote sensing data, it can be present representation of earth surface. Remote sensing data is raster image that obtained from sensor of satellite. One of the satellite that provide image data is Landsat which released by USGS (United States Geological Survey). Landsat image consist of Landsat 4, 5, 7 and 8. Each Landsat has different sensor component, for example the Landsat 5 has MSS and Thermal Sensor then Landsat 8 has more sensor like OLI, Panchromatic, Cirrus and Thermal. The used of this sensor is relatively similar especially for classification methods or thermal methods. Landsat image has 30 m resolution for each pixel at band multi spectral that include visual band and infrared band. Landsat image was include in optical image type that easily obtained and available in various of time continuously so giving the information about change on the surface easily.

The most application of remote sensing widely used is classification techniques to determine the distribution of earth surface cover. This landcover classification methods using multispectral sensor that contain visual band and infrared so the image can represent the visualization of earth surface in real sight. The other advantage of remote sensing in addition to reaching the area that is difficult to achieve,



it also can record the data in various time so this method really better for monitoring function. The classification method which provide by geographic information system include supervised classification and unsupervised classification. Supervised classification method was the most used to interpret landcover from image but this method still has many shortages especially if there a lot of changes on high spatial resolution. supervised and unsupervised classification works based on the value per pixel. In addition of that classification method, there was a method which based on object of the image. This classification still new and hasn't been widely used to remote sensing application. The basic concept of object-based classification is to generalize the shape and texture of a pixel in the image into an object with the meaning area. That generalization was done by segmentation method based on predetermined parameters.

Application of pixel-based and object based classification was located at Bogor City, West Java. Bogor City included in Jabodetabek region because the location was near from the capital city, DKI Jakarta. So, Bogor City has changed and developed quickly. The Landcover change will be observed during 20 years since 1996 until 2016. This research aims to compare two methods of image classification for landcover. The classification is based on pixel and based on object. Pixel based classification had been used for many studies to get the information of landcover, meanwhile the object based classification is being developed to add the variety of image classification methods. Therefore, this compare of two classifications at this research to be used to know the different between these two classifications to representation landcover. The result of this landcover identification can be used to earlier studies for planning, problem solving about environmental and etc.

2. Methodology

This research is located in Bogor City, Jawa Barat Province that knows as buffer city or hinterland because the location is near from the capital city of Indonesia, DKI Jakarta. Bogor City is one of the target for resident to build a settlement. This research located at Bogor City, West Java. Bogor City become the main destination of urban who want to live peacefully at the sub-urban area but did not has the long distance with the central of urban area. That phenomenon caused Bogor City has been changed in many ways as a consequence of settlers from rural area. The migrant is increasing population growth which is caused urban problems and development.

Image classification is defined as the pixel assigning process of raster data specified in classes [1]. In general mean, landcover classification using remote sensing image is to group the pixels into land cover classes based on certain parameters. Landcover identification in this study using remote sensing data such Landsat 5 and Landsat 8 OLI with 30 meters resolution which observed for 20 years from 1996 until 2016. Landsat image classification method is divided into two steps method:

a. Pixel-Based Classification

This method used digital number identification for each pixel that had been classified into landcover type as expected. This research used parallelepiped method to determine the landcover through software ENVI 5.1 and ArcGIS 10.2.1. Pixel-based classification generally done by grouping pixels into predefined classes based on the mean and variance of spectral value each pixels [2]. This classification method is the most widely used and easiest method to apply pixels to the landcover. Pixel-based classification has the disadvantage at extracting information content in high-resolution data and the result of classification is inconsistent.

b. Object-Based Classification

This method is done by using the identification of each object's appearance on the image then grouped into certain types of landcover classes. Object-based classification in this study uses segmentation method to determine land cover with eCognition software application. OBIA approach is carried out through two steps; segmentation and classification. Object was formed through the process of grouping pixels segmented adjacent in the same quality. Identification of

landcover in the process of segmentation and classification is derived from the extraction of shapes, textures and spectral information. The process of segmentation is the most important step in object-based classification because in this process the image data will be interpreted into landcover class based on geometry shape and etc. In addition, the segmentation also pay attention to account the color and hue of the object to generalize the landcover class. So there was no pixels are classified singly because the object created as a group of several pixels neighbour that have the same information [2]. Segmentation phase uses parameters that should be as accurate as possible in reality.

Landsat image data processing is done using *software* ENVI 5.1, eCognition dan ArcGIS 10.3. The study workflow used is shown as Figure 1.

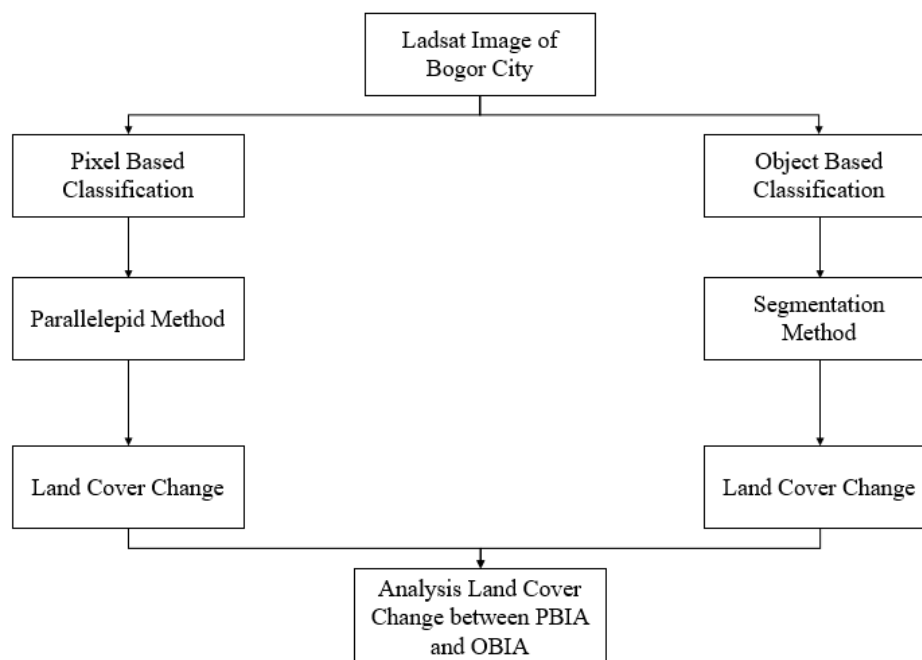


Figure 1. Research Workflow

Landsat Image in 1996 and 2016 each is carried out the method of classification based on pixel using parallelepiped and based on object using segmentation method. The class division of landcover is based on four class that is Non Built Area, Vegetation Area, Builtup Area and Water Body Area. After obtaining the result of classification, then carried out the samples for validation using Google Earth Image and field observation in 2016. This validation aims to see the accuracy of Landsat image classification and then will be compared the value of accuracy with detailed description and spatial analysis. Assessment of accuracy of landcover classification in both methods using overall accuracy with the formula below [3]

$$OA = \frac{\sum_{i=1}^c E_{ii}}{N} \quad (1)$$

Where c is the number of classes, N is the number of the certain classes and E_{ii} is the error Error matrix diagonal cell. Error matrix is like a confusion matrix which is a square array of number set out

in rows and columns and expresses the relationship between the samples in the reference and classified image [3].

3. Result and Discussion

3.1. Pixel Based Image Classification 1996 and 2016

Pixel-based classification of Landsat 5 for 1996 and Landsat 8 OLI for 2016 was conducted in the study area using parallelepiped method which available in ENVI 5.1. That four classes become the training area on each image to produce pixel value extraction. Figure 2 shows the maps of landcover in Bogor city in 1996 from Landsat 5 image classification whereas Figure 3 represents the maps of landcover in Bogor City in 2016. The classification has heterogeneous pixel values but still looks fine in class vegetation area and builtup area. While the non built area and water body area has so many mixed pixels who shows a noise on the landcover classification results. This was because the pixel-based classification method could classify the pixels as a one meaning class. The single classified pixel that scattering was not generalizable so it remains identified by 30 meters area according to the given training sample. This classification is deemed to have the possibility of improper interpretation or provide less general landcover information.

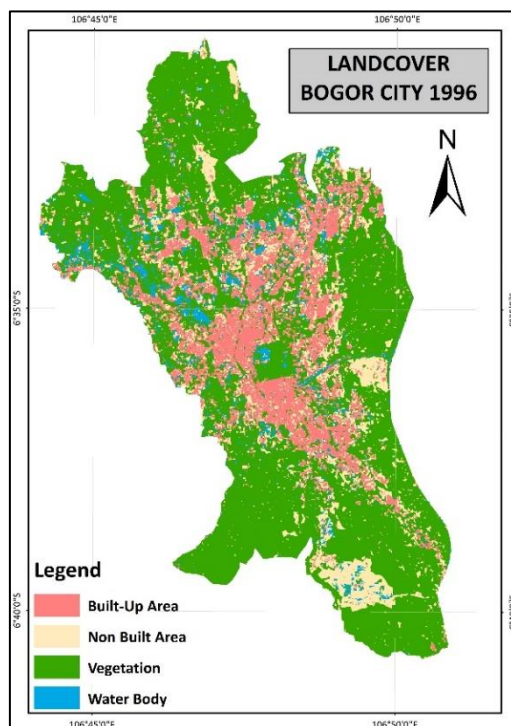


Figure 2. Landcover in Bogor City 1996 using Pixel Based Classification

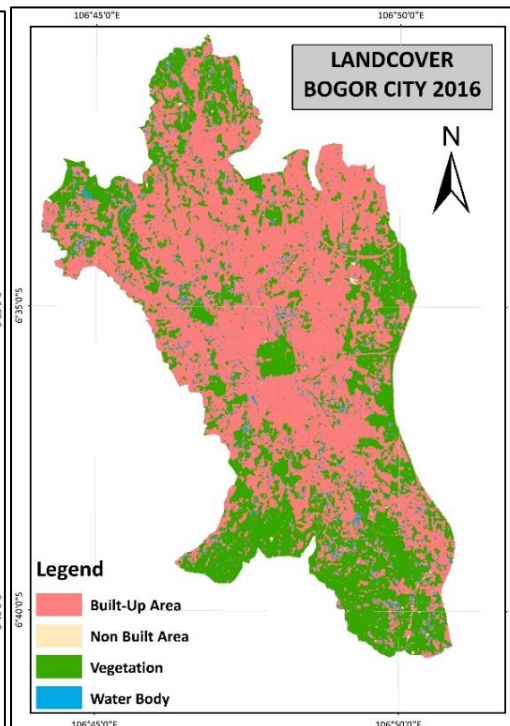


Figure 3. Landcover in Bogor City 2016 using Pixel Based Classification

3.2. Object Based Image Classification 1996 and 2016

Object-based classification was through the process of image segmentation into a homogeneous region meaning based on the spectral value of neighbouring pixels and the object's spatial shape shown in Figure 4 and 5.

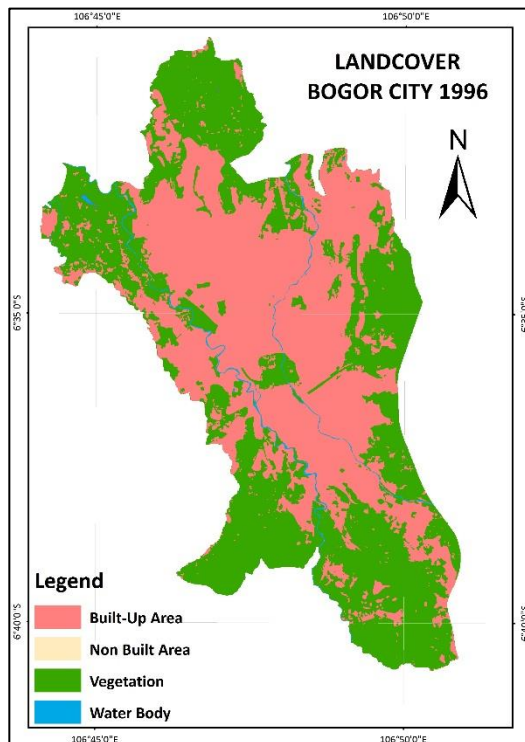


Figure 4. Landcover Bogor City 1996 using Object Based Classification

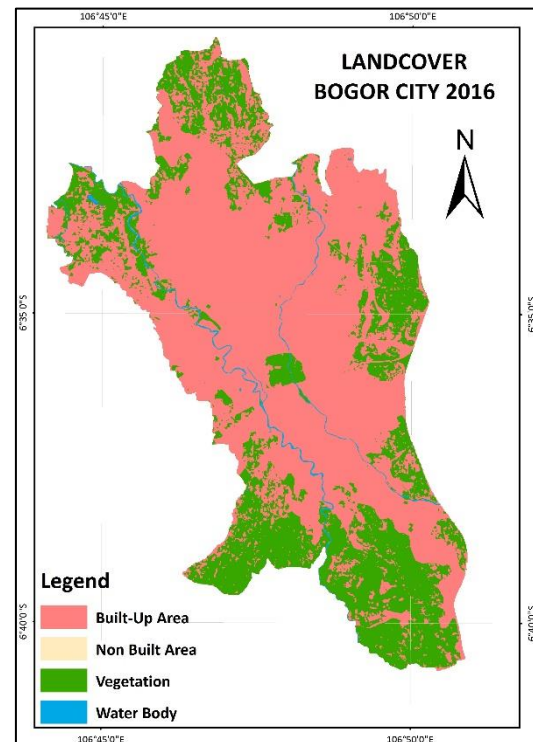


Figure 5. Landcover Bogor City 2016 using Object Based Classification

Figure 4 shows the result of landcover classification in 1996, while Figure 5 shows the result of landcover classification in 2016 with all of them using object-based segmentation methods. The result of image interpretation of landcover classification is more general and cleaner than landcover classification using pixel-based. There was no pixel noise that scattered as a classified area. As seen on figure 4 and 5 there is no single class pixel classified so the segmentation process helps in generalizing the pixel value into the spectral and the shape corresponding to the neighbour pixel. The shape of the object is also becoming increasingly more clear than the pixel-based classification as an example is water body area that more visible in object-based classification.

3.3. Accuracy Landcover Comparison Between Pixel Based Image Analysis (PBIA) and Object Based Image Analysis (OBIA)

Classification accuracy is used to determine the precision between training sample in reality and classified data. Training sample is carried out by taking sample on high-resolution image such as Google Earth Image as well as field observation to add validation steps. The accuracy table of these two classifiers can be found in table 1 below.

Table 1. Overall Accuracy Presentation for Pixel Based Classification and Object Based Classification

Accuracy Statistics	Parallelepiped Classification (%)	Segmentation Object Classification (%)
Overall Accuracy	61.481	82.15

The comparison between landcover classification based on pixel and object based is shown with the percentage of accuracy value for each other 61.481% and 82.15%. The highest value of accuracy was an object-based classification using segmentation methods. Object-based classification has the advantage of interpreting image with high homogeneity and could identified no single classed pixel distribution. While the pixel-based classification has an accuracy percentage is 61.841% which means there are still many errors that are encountered due to the distribution of single classified pixels. This presentation of accuracy value chows that object-based classification using segmentation more accurate than pixel-based classification.

3.4. Land Cover Change during 20 years Since 1996 until 2016 at Bogor City

The changes in landcover that occurred in Bogor City from 1996 to 2016 is show as Figure 1 and 2 above. The most striking changes is found on built up area which more wide than before. The area of landcover in 1996 adn 2016 is listed in table 2 below.

Table 2. The change of area landcover classes for 20 years in Bogor city

Landcover Classes	Year (km ²)	
	1996	2016
Built Up Area	21,15	68,15
Vegetation	70,548	40,058
Non Built Area	0,2341	7,815
Water Body	5,1334	3,9929

The builtup area shows changes to the area more than 100% from 21.15 km² increased to 68.15 km². in addition to the built up area, the non built up area also increased more than 100% from 0.2341 km² to 7.815 km². While for the vegetation area decreased of almost 50% than before from 70.548 km² to 40.058 km². The changes that occur in Bogor City leads to the growth following the needs of living place for human. They shows that urban expansion is leading the changes in Bogor City as a sub urban area.

4. Conclusions

Based on the results of the study showed that the classification based on pixels and objects can be used in Landsat images with a resolution of 30 meters to identify land cover. But, object-based classification using segmentation method more accurate than pixel-based classification. Object-based classification results the landcover interpretations with more generous and homogeneous coverage and clear boundaries between classes whereas the pixel-based classification has an errors in the distribution of a single calssified pixels that make the results more heterogeneoous and have a lot of noise.

Reference

- [1.] Y. H. Araya and C. Hertagen. 2008. *A Comparison of Pixel and Object-based Land Cover Classification : A Case Study of The Asmara Region, Eritrea*. WIT Transaction on Built Environment Vol 100, ISSN 1743-3509 (Geo-Environment Landscape Evolution III)
- [2.] Manalu, Johanes R., Sutanto, Ahmad., and Trisakti, Bambang. 2016. *Comparison Between Pixel-based and Object-based Methods For Landcover Classification using PiSAR-L2 Data*. LAPAN : Jurnal Penginderaan Jauh Vol. 13 No 1 Juni 2016 : 49 – 60.
- [3.] Roostaei Sh., Alavi S.A., Nikjoo, M.R., and Kamran Valizadeh Kh., 2012. *Evaluation of Object Oriented and Pixel Based Classification Methods for Extracting Changes in Urban Area*. Iran : International Journal of Geomatics and Geoscience Vol 2. No. 3 ISSN 0976 – 4380.