

# The Mapping of Land Use Using Object-Based Image Analysis (OBIA) in Klaten Regency

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**Abstract.** Klaten Regency is one of the regencies in Central Java Province that has an increasing population every year. This can cause an increase in built-up land for human activities. The built-up land needs to be monitored so that the construction is in accordance with the regional development plan so that it does not cause problems such as the occurrence of critical land. Therefore, it is necessary to monitor land use regularly. One method for monitoring land use is the remote sensing method. The remote sensing method is much more efficient in mapping land use because without having to survey the field. The remote sensing method utilizes satellite imagery data that can be processed for land use classification. This study uses the sentinel 2 satellite image data with the Object-Based Image Analysis (OBIA) algorithm to obtain land use classification. Sentinel 2 satellite imagery is a medium resolution image category with a spatial resolution of 10 meters. The land use classification can be used to see the distribution of built-up land in Klaten Regency without having to conduct a field survey. The results of the study obtained a segmentation scale parameter value of 60 and a merge scale parameter value of 85. The classification results obtained by 5 types of land use with OBIA. Agricultural land use dominates with an area of 50% of the total area.

**Keywords:** Land Use, Object-Based Image Analysis, and Remote Sensing

## 1 Introduction

Every year, population growth increases which cause changes in land use in an area. With strong further urbanization expected over the coming decades, they will cover increasing areas of the earth's surface and host the majority of the human population [1]. Land change is one of the key processes of global environmental change [2]. Land change causes increasingly limited availability of agricultural land and open land. The studies on the topic have gradually advanced from a focus on patterns of land-use and land-cover change to an

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analysis of dynamic interactions within socio-ecological systems and the resulting impacts on, for example, ecosystem services and biodiversity [3]. In this context, land change is understood as the result of interacting political/institutional, economic, cultural, technological, and natural/spatial driving forces and the respective actors [4]. Land change can occur in an area and cannot be avoided. Land change causes negative impacts, one of which is the change in the environmental order which causes a decrease in environmental quality. Land change can cause drought and erosion if land management is done carelessly. Spatial patterns of land use and land cover change, especially in areas susceptible to accelerated soil erosion, provide further reason to re-evaluate former qualitative approaches, considering the worldwide increase of croplands and pastures by 279 million hectares (ca. 16.7%) between 1985 and 2013 [5].

Land change does not only occur in urban areas but has already spread to suburban areas. Land change in suburban areas is caused by the limited availability of land in urban areas, causing changes in physical properties in the area [6]. This happened in Klaten Regency which is a connecting district between Solo City and Yogyakarta Special Region Province. Klaten Regency has a strategic location so that it experiences development. Development causes changes in land use so that it can cause critical land if there is no monitoring of land-use changes. Monitoring is done by mapping the use of land in an area. Mapping aims to determine the use of land used by the community. One method for mapping land use is the remote sensing method. The remote sensing method has advantages compared to conventional mapping because it can see the condition of the earth's surface without visiting the entire location so that it accelerates the mapping process.

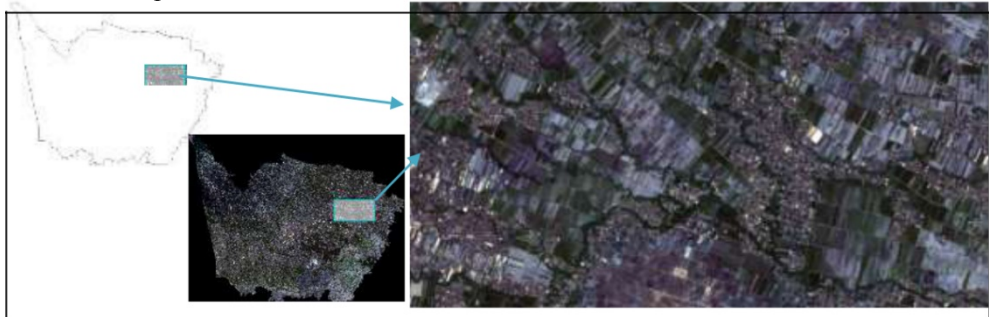
The remote sensing method utilizes image data obtained from satellite recording. The data describes the surface of the earth so that it can obtain information about land use. Satellite data are classified to obtain land use information. This method is an effective method in mapping land use for a wide area coverage compared to direct mapping in the field. Satellite image data extraction can use manual and digital classification. Manual classification of high-resolution images can produce good classification accuracy [7]. However, manual classification has advantages in the accuracy of the results compared automatically but has a weakness in the classification process time that takes a long time. Classification can automatically use 2 ways, namely pixel-based classification and Object-Based Image Analysis (OBIA). Object-based image analysis (OBIA) has gained prominence in the field of remote sensing over the last decade. It is credited to have the potential to overcome weaknesses associated with per-pixel analysis such as, for instance, disregarding geometric and contextual information [8], [9]. The results of object-oriented classification are carried out in a field validation process to see how accurate the classification results are. Therefore, this study aims to map land use using an object-based classification in Klaten Regency.

## **2. Materials and Methods**

### **2.1 Study Area**

The research location is in Klaten Regency, Central Java Province, Indonesia. Klaten Regency is bordered by the province of the Special Region of Yogyakarta. Geographically, Klaten Regency is located between 110 ° 30'-110 ° 45 'East Longitude and 7 ° 30'-7 ° 45' South Latitude. The area of Klaten regency reaches 655.56 km<sup>2</sup>. In the east, it borders Sukoharjo Regency. In the south, it is bordered by the Gunungkidul Regency (Special Region of Yogyakarta). In the west, it borders Sleman Regency (Yogyakarta Special Region) and Magelang Regency and in the north, it borders Boyolali Regency. Climate conditions in

Klaten Regency include tropical climates with rainy and dry seasons alternating throughout the year, the average air temperature is 28 ° -30 ° Celsius with an average wind speed of about 153 mm per month.



**Fig. 1.** The study area located in Klaten Regency from Sentinel 2 imagery.

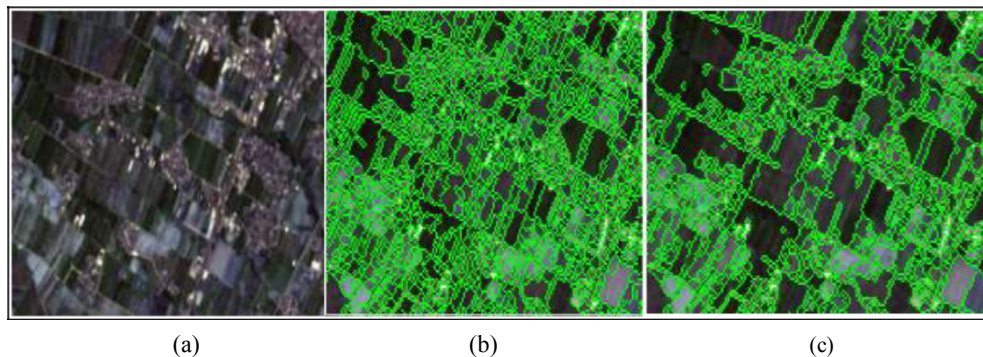
## 2.2 Dataset Used

This research used a multispectral Sentinel 2 L1C satellite image on October 03, 2019, with 10-m spatial resolution, DEMNAS from Geospatial Information Agency, Rainfall data from 2009 to 2019 sourced from Meteorology, Climatology, and Geophysical Agency (BMKG), Type Land, Geological Data, Hydrological Data and administrative boundary data from Bappeda Klaten.

## 2.3. Image Segmentation

Object-based image analysis contains two major steps, i.e. image segmentation and classification [10]. Segmentation is an important stage in OBIA. It can be defined as a "partitioning process of an image into homogeneous and non-overlapping regions that are later identified as objects" [11]. The purpose of segmentation is to make an object based on objects with homogeneous characteristics. The result of segmentation is a form of object/group of pixels participating in the object-based classification and is not a single pixel. Each pixel has the same spectral value grouping in forming an object [12].

The object segmentation results depend on determining the value of the segmentation given to produce the object segmentation size. Segmentation with large values will produce large objects and vice versa. Therefore, determining the value of segmentation is important in the success of OBIA. Each level of segmentation produces different amounts and sizes. Determination of the value of segmentation based on the appearance of appropriate delineation to avoid the existence of under and over-segmentation in the segmentation process. In subsequent steps, the smaller image objects were merged into larger objects based on the chosen scale, color, and shape parameters, which define the growth in heterogeneity between adjacent image objects. [13].



**Fig. 2.** Image Segmentation: (a) Sentinel 2 L1C image; (b) scale parameter 50; (c) scale parameter 60

Figure 2 illustrates the results of segmentation on Sentinel 2L1C images in Kelaten District (a), while

(b) the scale parameter segmentation is worth 50, and (c) the segmentation scale parameter is worth

60. Figure 2 shows that the greater the scale parameter given, the object delineated will get bigger. Therefore, determining the scale of segmentation parameters is important because it shows the delineation of the shape of the object. Determination of scale segmentation parameters can be used as a reference to measure the results of classification.

## 2.4 Identifying Land Use

Extraction from multispectral image based on spatial, spectral, and texture characteristics. The extraction of images is carried out to obtain information on land use in an area, such as agriculture, built-up land, shrubs, and others. Extraction of images can use Object-Based Image Analysis (OBIA). Land use identification uses the results of segmentation based on spatial, spectral, and texture. These results form an object delineation boundary to produce a polygon shape. Polygons are classified based on land use that can be interpreted directly from the image. The ability to interpret images is needed to produce a good classification. Image interpretation is done for the sample in determining the classification. Classification using KNN (k-nearest neighbor) algorithm. KNN algorithm is a non-parametric method for classification and regression that predicts the "value" of objects or class memberships based on the closest training examples in the feature space [14]. In this case, the training area is needed in the selection of samples of the results of image interpretation. Image interpretation must be done carefully so that land use classification gets good results. The sample selection of each class is based on the results of segmentation.

## 2.5 Accuracy Assessment

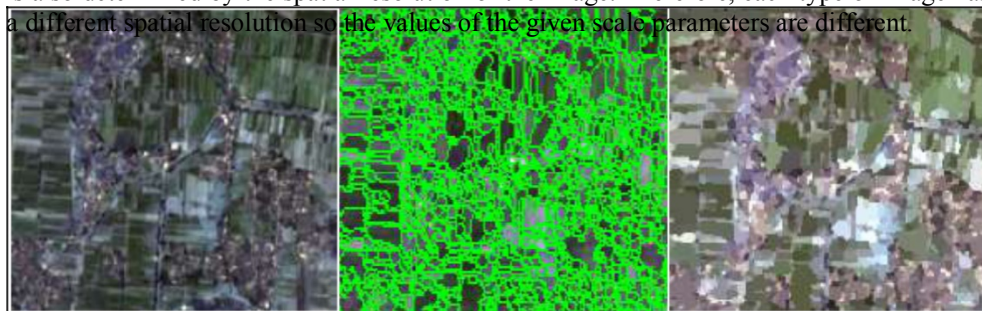
An accuracy assessment is needed to evaluate the quality of classification results [15]. It is important because it can provide evidence of how well the classifier is capable of extracting the desired objects from the remote sensing image [16]. Therefore, accuracy assessment provides an analysis of the level of confidence of the classification results. Accuracy assessment can be calculated by this matrix is the overall accuracy, producer's accuracy, user's accuracy, and kappa accuracy [17]. Accuracy assessment is determined empirically by selecting samples at each pixel and analyzing reference data (obtained based on field

surveys). Reference data are existing data obtained directly in the field, while pixels are chosen to assess the results of their accuracy. The percentage rating of each pixel in each class is based on the proportions of each class, then labeled. The values listed in the table are the actual number of pixels in the field, in every case of right and wrong given label [18]. Accuracy assessment is seen based on the evaluation value calculated by a contingency matrix or confusion matrix.

### 3 Results and Discussion

#### 3.1 Image Segmentation

This initial stage of the research is segmentation by determining a value for the scale parameter. The value of the scale parameter determines the large or small delineated object to form a polygon. The size of the object delineation depends on the classification requirements and the scale of the map output. In this case, carefulness to determine the value of the scale parameter is important. Less optimal segmentation results can cause poor classification results. The value of the scale parameter has no standard rules about how much value is assigned to a particular spatial resolution category. The value of the scale parameter is also determined by the spatial resolution of the image. Therefore, each type of image has a different spatial resolution so the values of the given scale parameters are different.



(a)

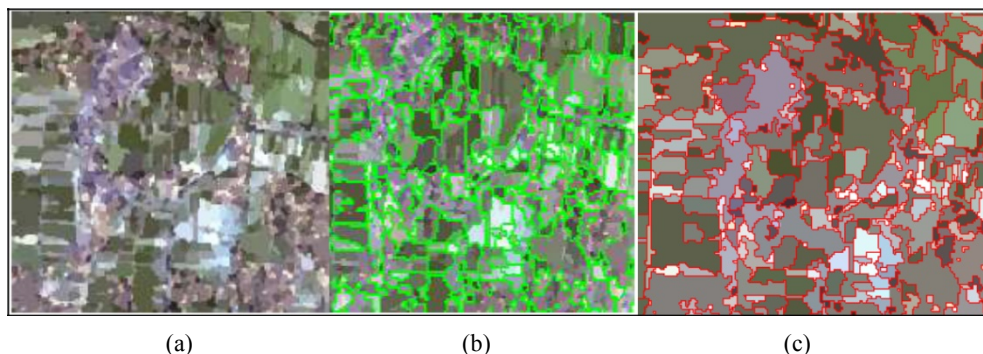
(b)

(c)

**Fig. 3.** Implementation of segmentation on sentinel 2 L1C (a) citra sentinel 2L1C; (b) determining value for scale parameter; (c) results of segmentation.

Figure 3 shows the results of the segmentation of the Sentinel 2 L1C image in Klaten Regency. This study uses a scale parameter 60 based on the smallest object in the form of an agricultural land class. Figure 3 (b) shows the delineation of each object in sentinel image 2 based on scale parameters. Delineation is done automatically with homogeneous pixel collections with spatial, spectral, and texture characteristics based on the reference value for the scale parameter. The results of segmentation can be merged between adjacent objects. Merging aims to increase the size of the object delineation so that it makes it easier to do the classification.

This study uses a merge value of 85 based on the appearance of the object to facilitate classification, the results of the merge process can be seen in Figure 4. The merged object has a larger size than the segmentation results. This can facilitate the classification of land use. Agricultural land in Klaten Regency has different characteristics such as planting time, type of plant, and landform so that it can be difficult in the classification process. Therefore, the merge is done to combine objects in the same class to facilitate classification



**Fig. 4.** Implementation of Merge: (a) results of segmentation; (b) determining value of the scale parameter; (c) result of merge

Classification is generated based on the determination of the sample in the training area. Samples appear an important role in classification so the determination of samples must be careful when interpreting images. Image interpretation is based on the appearance of the image that depends on the spatial resolution of the satellite imagery. The higher the spatial resolution, the easier it is to interpret satellite imagery by using elements of image interpretation. The sample selection is based on predetermined land use classes and each class has proportionally chosen.

### 3.2 Land Use

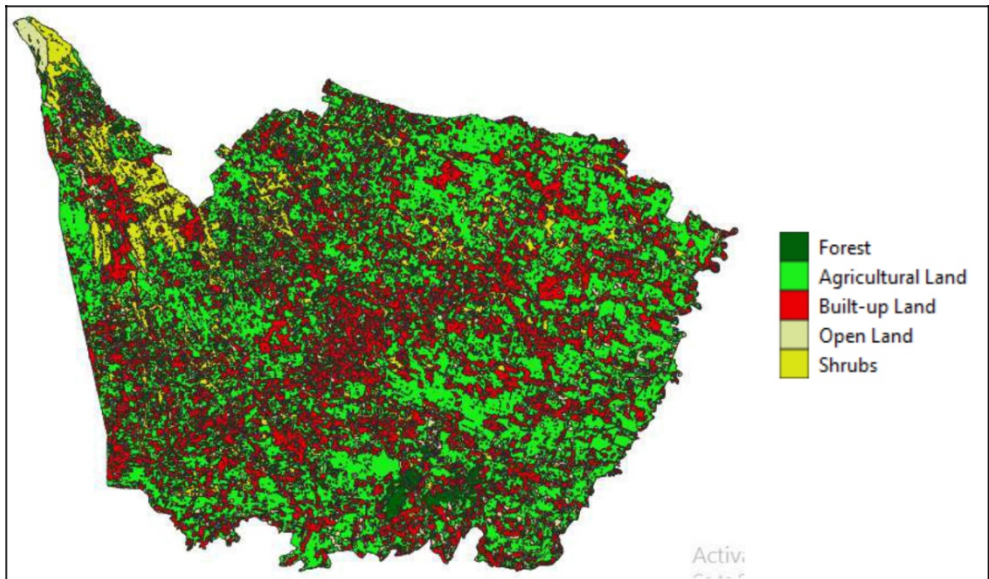
This study produces land use classification using sentinel 2 images. Classification is done automatically using object-based image analysis (OBIA). The OBIA results obtain a land-use classification that can then be calculated in the area of each class. The classification results can be seen in Table 1.

**Table 1.** Land use classification

<b>Jenis Penggunaan</b>		<b>Luas Area (m<sup>2</sup>)</b>	<b>Presentase (%)</b>
1.	Built-up Land	199,614,834	28
2.	Open Land	70,379,803	10
3.	Forest	24,738,373	4
4.	Agricultural Land	350,223,382	50
5.	Shrubs	55,276,774	8

Based on the classification results in Table 1, Klaten Regency is dominated by agricultural land with a total area of 50% of the total area. The built-up land class is the widest area number 2 after the agricultural land class with a total area of 28%. The built-up land is more centered on the Klaten Regency office activities center. The further away from the center of Klaten Regency, the less land is developed and dominated by agricultural land. Based on the results of the classification it can be concluded that the majority of Klaten Regency people still use agricultural land as a community income sector. This needs to be maintained so that national food security can be maintained. Therefore, land use mapping

needs to be done to monitor community activities in using existing land. The results of the classification can be seen in Figure 5.



**Fig. 5.** The results of land use classification

## 4 Conclusion

Based on the research it can be concluded that sentinel 2 L1C satellite imagery can be used for land use classification. Land use classification is done automatically using the OBIA method. In the initial stage of segmenting the image with a scale parameter value of 60 and a merge parameter value of 85. The determination value of the parameter is based on the size of the delineation that is deemed to be following the shape of the object. Segmentation utilizes the spatial, spectral, and texture elements of objects in the image. The classification results obtained by 5 types of land use because the 5 objects that can be interpreted properly in the image. The classification results show that the class of agricultural land dominates land use in Klaten Regency and is followed by the built-up land class.

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