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Identification of Land Use Classes Using Sentinel 2A Imagery in Laloeha Village, Kolaka District

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Abstrack. Land use in Laloeha Village Kolaka District continues to change. Mapping and identifying land cover types using the Maximum Likelihood method is more accurate than other methods. This research aims to analyze the capabilities of Sentinel 2A Imagery and the Maximum Likelihood classification method for mapping and identifying land use types in Laloeha Village in Kolaka District. This research was carried out from July to September 2023 and was carried out in 4 stages, namely the first stage of image pre-processing by carrying out the layer stacking process. The second stage is image analysis and classification. The third stage is carrying out a ground check, and the fourth stage is validation and accuracy testing. The value of the accuracy test results with Overall Accuracy (OA) is 88.75% which is in the good category. The results of the land cover classification obtained 7 land cover classes, namely land use is the plantation class covering an area of 827.91 ha or 37.76%, the secondary dry land forest class covering an area of 557.83 Ha or 25.44%, the shrub class covering an area of 323.40 or 14.75%, the agricultural class covering an area of 277, 46 Ha or 12.65%, the residential class is 174.27 Ha or 7.95%, the open land class is 19.83 Ha or 0.90% and the water body is 11.92 Ha or 0.54% of the area of Laloeha Village, Kolaka District.
Keywords: Sentinel 2A, Land Use, Unsupervised Classification, Maximum Likelihood.

1. INTRODUCTION

Kolaka Regency was formed based on Law Number 59 of 1959. Since its establishment as a district until now, Kolaka Regency has been expanded twice into new autonomous regions, namely North Kolaka Regency and East Kolaka Regency (Badan Pusat Statistik Kabupaten Kolaka, 2023).

Population density can affect the quality of life of its residents. In areas with high density, efforts to improve the quality of the population will be more difficult. This raises socio-economic problems, welfare, security, land availability, clean water, and food needs (Suni et al., 2023).

The implications of population growth have an impact on land needs, including agriculture, housing, services, and transportation facilities. Pressure on used land will have an impact on land use which will lead to land conversion. On the other hand, land use is human activity carried out on land to fulfill certain purposes. Land cover and land use in some cases can have the same designation (Van Noordwijk et al. 2008).

Eroded land cover is a serious problem in urban land management which continues to experience significant changes from year to year. Changes in land use mainly occur in the conversion of paddy and non-rice paddy agricultural land which experiences a decrease and an increase in built-up land (Hidayat & Noor, 2020).

Remote sensing has the ability to cover large areas of the earth's surface in one recording. Remote sensing methods are used to obtain information data by recording reflected energy and processing it in the form of interpretation. By using remote sensing techniques, areas on the earth's surface can be covered efficiently in a relatively short time, producing results that can be explained in terms of accuracy (Safitri & Giofandi, 2019).

The Sentinel 2 MSI satellite is a satellite belonging to the European Space Agency (ESA) which was launched on June 23, 2015. Sentinel 2 MSI has an inclination angle of 98.62o with a rotation period of 40 minutes and records the earth's surface at 10:30 a.m. local time with the aim of obtaining results with minimal cloud cover and appropriate sunlight (Suhet, 2014).

The development of changes in land cover in an area can be analyzed by utilizing remote sensing data in the form of multi-temporal satellite imagery. The use of remote sensing technology is one way to quickly determine land use change. Land conversion can also be interpreted as a change to another use caused by factors that broadly include the need to meet the needs of an increasing population and increasing demands for a better quality of life (Suni, & Baharuddin, 2023).

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Supervised classification involves intensive analyst interaction, where the analyst guides the classification process by identifying objects in the image (training area). So sampling needs to be done by considering the spectral pattern at each particular wavelength so that a good reference area is obtained to represent a particular object. Supervised method (with guidance), in this method, the analyst first determines several training areas (sample areas) in the image as a class of appearance of a particular object. This determination is based on the analyst's knowledge of the area in the image regarding land cover areas. The pixel values in the sample area are then used by computer software as a key to identify other pixels. Areas that have similar pixel values will be put into a predetermined class (Suni et al., 2023)

Kaimuddin (2008) said that encroachment on forest areas is currently often found in areas that directly border forest areas, due to the increasingly limited land used for agricultural cultivation and plantations, the pressure on forest areas is getting higher.

Continuously increasing development and population growth influence land cover changes every year in Laloeha Village Kolaka District. Based on these conditions, it is necessary to carry out research on land cover analysis in Laloeha Village, Kolaka District as a result of looking at the class and area of land cover from the development and growth process, so that the latest information regarding changes can be obtained.

2. THEORETICAL STUDIES

The increase in population and improvement in economic structure influence the need for non-agricultural land which tends to increase (Buraerah et al., 2020). The existence of inequality in the form of limited land availability and capacity accompanied by changing human activities causes an increase in demand for land, resulting in changes in land use, especially undeveloped land to built-up land (Hapsary et al., 2021).

Analysis of land use changes by utilizing temporal-spatial data is very useful, especially for monitoring locations experiencing changes in land use by paying attention to visual appearances and estimates of increases and decreases in land area (Nuraeni et al., 2017).

Changes in land use mainly occur in the conversion of paddy and non-rice paddy agricultural land which experiences a decrease as well as an increase in built-up land (Hidayat & Noor, 2020). Population density can affect the quality of life of its residents. In areas with high density, efforts to improve the quality of the population will be more difficult. This raises socio-economic problems, welfare, security, land availability, clean water, and food needs (Suni et al, 2023).

Remote sensing is defined as obtaining information about an object without any physical contact with the object. Information in remote sensing is obtained by detecting and measuring changes in generalized objects with optical conditions around them, including electromagnetic, acoustic and potential. Electromagnetic fields are emitted and then reflected by objects, acoustic waves are reflected or scattered by objects (Rahmatsyah et al., 2020).

The development of changes in land cover in an area can be analyzed by utilizing remote sensing data in the form of multi-temporal satellite imagery. The use of remote sensing technology is one way to quickly determine land use change. Land use change can also be interpreted as a change to another use caused by factors that generally include the need to meet the needs of an increasing population and increasing demands for a better quality of life. good (Suni, & Baharuddin, 2023).

The development of land cover changes in a region can be analyzed by utilizing remote sensing data in the form of multi-temporal satellite imagery. The use of remote sensing technology is one way to quickly determine land use change. (Suni et al, 2023).

Remote sensing images can provide an overview of space and size which is useful data in studying phenomena or the appearance of the earth's surface, which can then be used as a basis for planning and practical use (Feri, 2007). provides information about the characteristics of the vegetation cover of a forest under study. Maullana & Darmawan (2014) stated that remote sensing is a method for identifying objects on the earth's surface without direct contact with the object. Supervised classification involves intensive analyst interaction, where the analyst guides the classification process by identifying objects in the image (training area). So sampling needs to be done by considering the spectral pattern at each particular wavelength so that a reference area is obtained.

3. METHOD

This research was carried out in July - September 2023. in Kolaka District, Kolaka Regency, which is administratively included in the region, of Southeast Sulawesi Province. Astronomically, Kolaka Regency is located in the southern part of the equator, extending from North to South between 3°36' - 4°35' South Latitude and stretches from West to East between 120°45'- 121°52' East Longitude (Figure 1)

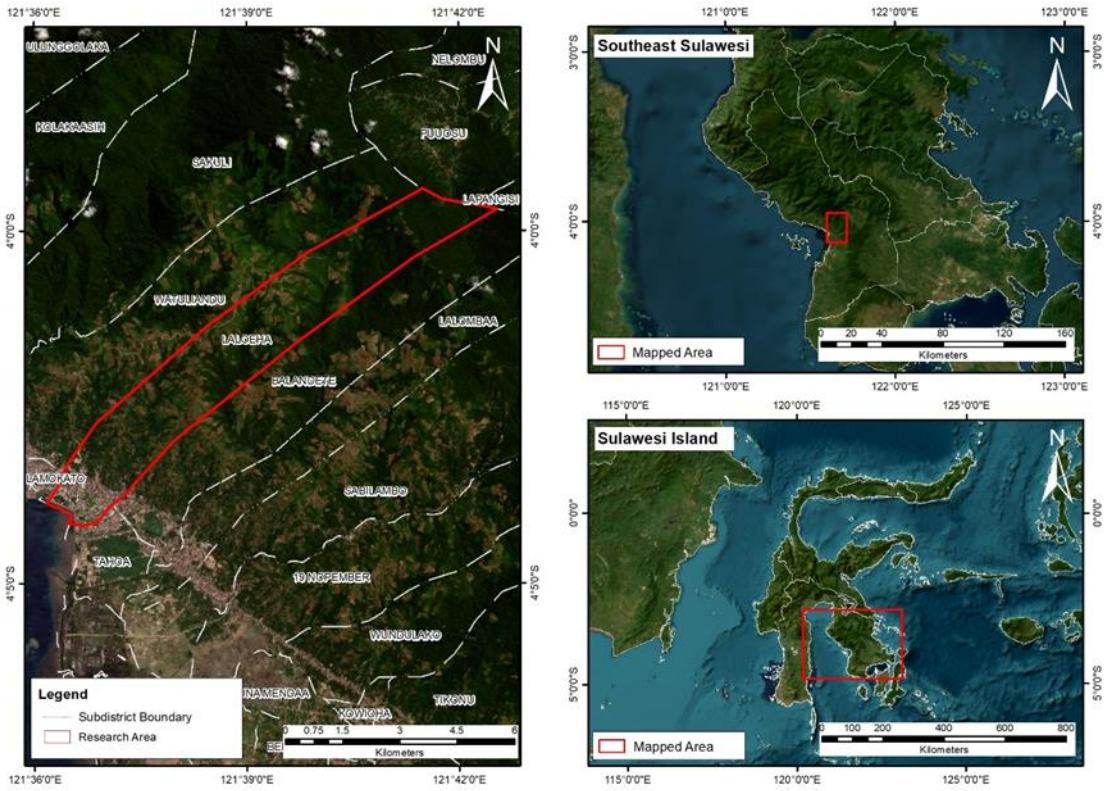

Figure 1 Research Location Map

3.1 Tools and materials

The materials used are secondary data in the form of Sentinel 2-A imagery covered in September 2023 sourced from Copernicus (https://scihub.copernicus.eu), Google Earth satellite imagery, a 1:50,000 scale Indonesian Earth Map in 2019. The tools used are a laptop with 8 Gb RAM specifications, ArcGIS 10.8 software, SAS software Planet, and Google Chrome.

3.2 Data analysis

In general, research is carried out in several stages, namely: image pre-processing, visual interpretation of images, creating image classification class characteristics, ground checks, and accuracy tests. The pre-processing stage carried out is the preparation of tools and materials.

Firstly Image preprocessing, image preprocessing is the first step in processing satellite images. Several steps in image processing include data importing, composite bands, image sharpening, image cropping, and image coordinate transformation. Second classification of Land Use Imagery, image classification is a process of arranging, or grouping all pixels (contained in the image band in question) into several classes based on a criterion or object category, thereby producing a "thematic map" in raster form. In digital image classification, there are generally two groups of unsupervised and supervised classification methods. Digital image classification aims to identify the spectral appearance of objects (Muttaqin, 2011).

The advantage of unsupervised classification is that operator errors are minimized and unique classes are considered distinct units. The disadvantages are unclear correspondence to informational classes, limited control over classes, and spectral classes are not constant. This research uses two types of unsupervised classification, namely K-Means, and IsoData (Septiani, 2019). Unsupervised classification is the process of grouping pixels in an image into several classes using cluster analysis (Wibowo, 2013).

Third Field Survey (Field Inspection), Field surveys were carried out to check and identify land use classes, taking coordinate points, after carrying out image analysis in the ArcGIS 10.8 application. Fourth Test of Accuracy, the results of this study used the Confusion Matrix method ≥ 80%. Accuracy calculations are carried out by comparing the data obtained from the classification (Maximum Likelihood) with the results of field checks.

Calculation of accuracy is done by comparing the data from the analysis results with the results of field checks. The accuracy test aims to see analysis errors so that the percentage of accuracy (accuracy) can be determined. Commission error is a misclassification in the form of an excess number of pixels in one class due to the inclusion of pixels from another class. The level of mapping accuracy is determined by using a classification accuracy test referring to Hanifa & Suwardi (2023) with the formula:

MA = (Xcr pixel)/(Xcr pixel + Xo pixel + Xco pixel)*100%

Information:

MA = mapping accuracy
Xcr = corrected number of class X
Xo = number of class X who entered another class
Xco = number of additional X classes from other classes

4. RESULTS AND DISCUSSION

4.1 Land Cover Classification

The results of the analysis using the Maximum Likelihood classification method from Sentinel 2A imagery in Laloeha Village, Kolaka District, Kolaka Regency, showed that 8 land cover classes were identified consisting of secondary dry land forest, plantations, open land, agriculture, shrubs, residential areas. , and water bodies which can be seen in Figure 2 and obtained data on the area of 8 types of land cover in Kolaka District, Kolaka Regency (Table 1).

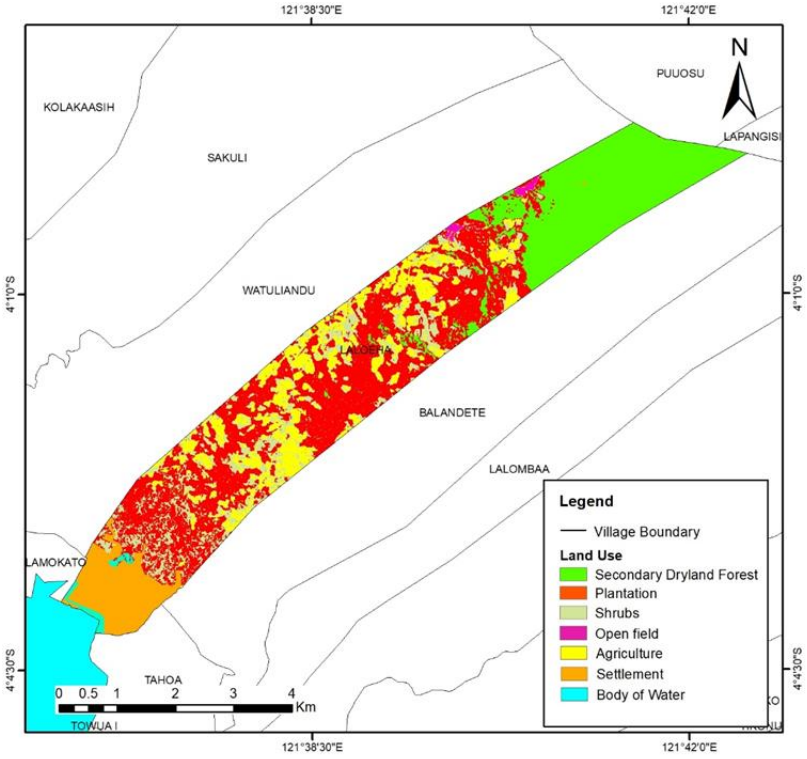

Figure 2 Map of Land Cover in Laloeha Village

Table 1 Land use class of 2023

Land cover class	Area (Ha)	Percent
Secondary Dryland Forest	557.83	25.44
Open Field	19.83	0.90
Settlement	174.27	7.95
Plantation	827.91	37.76
Agriculture	277.46	12.65
Shrubs	323.40	14.75
Body Water	11.92	0.54
Total Area	**2192.62**	**100**

Based on Table 1, the most extensive type of land use is the plantation class covering an area of 827.91 ha or 37.76%, the secondary dry land forest class covering an area of 557.83 Ha or 25.44%, the shrub class covering an area of 323.40 or 14.75%, the agricultural class covering an area of 277, 46 Ha or 12.65%, the residential class is 174.27 Ha or 7.95%, the open land class is 19.83 Ha or 0.90% and the water body is 11.92 Ha or 0.54% of the area of Laloeha Village, Kolaka District.

4.2 Accuracy Test

Testing the accuracy of image processing results is needed to produce information that is in accordance with the conditions it should be in. This process was carried out due to potential errors in previous processes, which could shift the existing information to be less accurate. The calculated value is the meeting diagonal value of each data matrix which is then entered into the Overall Accuracy (OA) calculation formula. The maximum value of OA is 100%, where the closer to the maximum value, the more correct the classification results are (Yanur & Resha, 2018; Suni, Muis & Arianingsih 2023)

Table 2 Supervised Classification Accuracy Test Results

Land Cover	A	Hs	Pm	Kb	P	B	T	Column Total	Producer Accuracy	User Accuracy	Overall Accuracy
A	7	0	2	0	0	1	0	10	100	70	
Hs	0	9	0	1	0	0	0	10	100	90	
Pm	0	0	9	0	0	1	0	10	81.82	90	
Kb	0	0	0	9	1	0	0	10	90	90	**87.14**
P	0	0	0	0	9	1	0	10	75	90	
B	0	0	0	0	1	9	0	10	81.82	90	
T	0	0	0	0	1	0	9	10	100	90	
Rows Total	7	9	11	10	12	11	9	70			

Information: A (water body), Hs (secondary dry land forest), Pm (settlement), Kb (plantation), B (shrubs), T (open land), P (agriculture)

From the data in Table 2, it can be seen that the level of accuracy or precision of the results of satellite image processing using the supervised classification method has an Overall Accuracy (OA) level of 87.14% with details of the highest Producer Accuracy being in the secondary dryland forest,

water bodies and open land at 100% and the lowest was in the agriculture class at 75%. Meanwhile, the highest User Accuracy is found in classes other than water bodies, 90% and the lowest in the Water Body class, 70%.

The United States Geological Survey (USGS) has set a minimum level of classification or interpretation accuracy using remote sensing, namely 85% (Derajat et al., 2020). This research produced a map with an accuracy of 87.14%. The results of the accuracy test can conclude that the supervised classification method is accurate to use. Abellera explained that an accuracy result of 85% was considered very satisfactory. Susanto explained the criteria for accuracy in ranking as follows 80% (very good) and 60-70% (good) (Akhbar, et al. 2013).

5. CONCLUSION

The value of the accuracy test results with Overall Accuracy (OA) is 87.14% which is in the good category. The results of the land use classification based on digital image interpretation using the Maximum Likelihood classification in Kolaka District with the training area obtained 7 land cover classes, namely land use is the plantation class covering an area of 827.91 ha or 37.76%, the secondary dry land forest class covering an area of 557.83 Ha or 25.44%, the shrub class covering an area of 323.40 or 14.75%, the agricultural class covering an area of 277, 46 Ha or 12.65%, the residential class is 174.27 Ha or 7.95%, the open land class is 19.83 Ha or 0.90% and the water body is 11.92 Ha or 0.54% of the area of Laloeha Village

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