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Land Cover Classification Using Sentinel 2A Image in Kolaka Subdistrict, Kolaka Regency, Southeast Sulawesi

Muhammad Adam Suni[1*], Ramad Arya Fitra[2], Mohamad Fahrul Himalaya Umar[3]
Balai Besar Taman Nasional Lore Lindu, Indonesia | muhammadadamsuni[1]
Universitas Sembilanbelas November, Indonesia | ramadbio12@gmail.com[2]
Badan Penangulangan Bencana Daerah Sulawesi Tengah, Indonesia | mohammad.fahrul46@gmail.com[3]
Correspondence Author*

Abstrak

Tutupan lahan di Kecamatan Kolaka terus menerus mengalami perubahan. Pemetaan dan identifikasi jenis tutupan lahan dengan metode Maximum Likelihood lebih akurat dari metode lain. Penelitian ini bertujuan untuk menganalisis kemampuan Citra Sentinel 2A dan metode klasifikasi Maximum Likelihood untuk pemetaan dan mengidentifikasi jenis tutupan lahan di Kecamatan Kolaka. Penelitian ini dilaksanakan pada bulan Juli sampai September 2023 dan dilaksanakan dalam 4 tahap yaitu tahap pertama pra pengolahan Citra dengan melakukan proses layer stacking. Tahap kedua yaitu analisis citra dan klasifikasi. Tahap ketiga yaitu dengan melakukan Ground Check, dan tahap yang keempat adalah validasi dan uji akurasi. Nilai hasil uji akurasi dengan Overall Accuracy (OA) sebesar 88,75 % yang masuk ke kategori baik. Hasil klasifikasi tutupan lahan diperoleh 8 kelas tutupan lahan yaitu hutan lahan kering sekunder seluas 3974.20 Ha atau 31.84 %, tutupan lahan perkebunan seluas 3,886.87 Ha atau 31.14 %, Semak belukar adalah 1,641.42 Ha atau 13.15 %, tutupan lahan pertanian lahan kering campur seluas 1,415,62 Ha atau 11.34 %, tutupan lahan pemukiman seluas 744.26 atau 5.96 %, tutupan lahan sawah seluas 613.53 Ha atau 4.92 %, tutupan lahan terbuka seluas 148.66 Ha atau 1.19 % dan tutupan lahan tubuh air seluas 56.22 Ha atau 0.45 % dari luas total Kecamatan Kolaka.

Kata kunci: *Citra Sentinel 2A Imagery, Tutupan Lahan, Klasifikasi Tak Terbimbing, Kemungkinan Maksimum*

Abstract

Land cover in 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 cover types 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 8 land cover classes, namely secondary dry land forest covering an area of 3974.20 Ha or 31.84%, plantation land cover covering an area of 3,886.87 Ha or 31.14%, dense bushes covering an area of 1,641.42 Ha or 13.15%, mixed dry land agricultural land cover covering an area of 1,415.62 Ha or 11.34%, residential land cover of 744.26 or 5.96%, paddy field cover of 613.53 Ha or 4.92%, open land cover of 148.66 Ha or 1.19% and water body land cover of 56.22 Ha or 0.45% of the total area of Kolaka District.

Keywords: Sentinel 2A Imagery, Land Cover, Unsupervised Classification, Maximum Likelihood

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 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 objects that are generalized to the optical conditions around them, including electromagnetic, acoustic, and potential. The emitted electromagnetic field is then reflected by the object, acoustic waves are reflected or scattered by the object (Rahmatsyah, Juliani, & Tampubolon, 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 98.62^{o} 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 Kolaka District, Kolaka Regency. Based on these conditions, it is necessary to carry out research on land cover analysis in Kolaka District, Kolaka Regency 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.

Research 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).

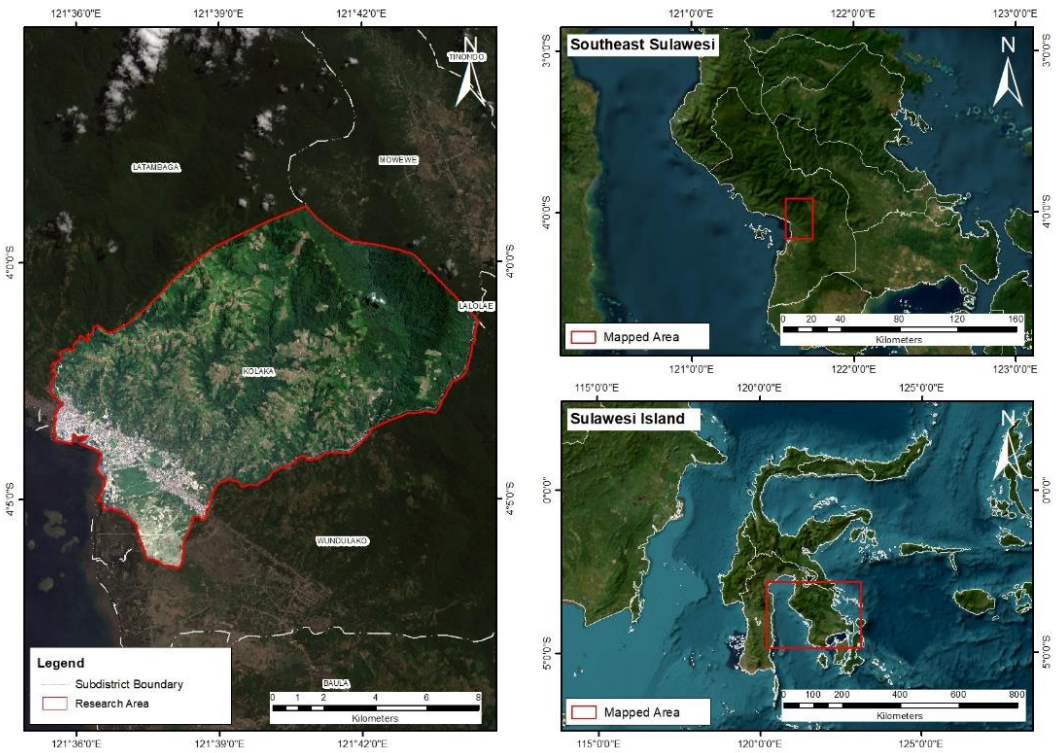

Figure 1. Location Map

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.

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.

1. Image pre-processing

Image pre-processing 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.

2. Land Cover Image Classification

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).

3. Field Survey (Ground Check)

Field surveys were carried out to check and identify land cover classes, taking coordinate points, after carrying out image analysis in the ArcGIS 10.8 application.

4. Accuracy Test

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

Results and Discussion

1. Land Cover Classification

The results of the analysis using the Maximum Likelihood classification method from Sentinel 2A imagery in Kolaka District, Kolaka Regency, showed that 8 land cover classes were identified consisting of secondary dry land forest, plantations, open land, rice fields, mixed dry 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).

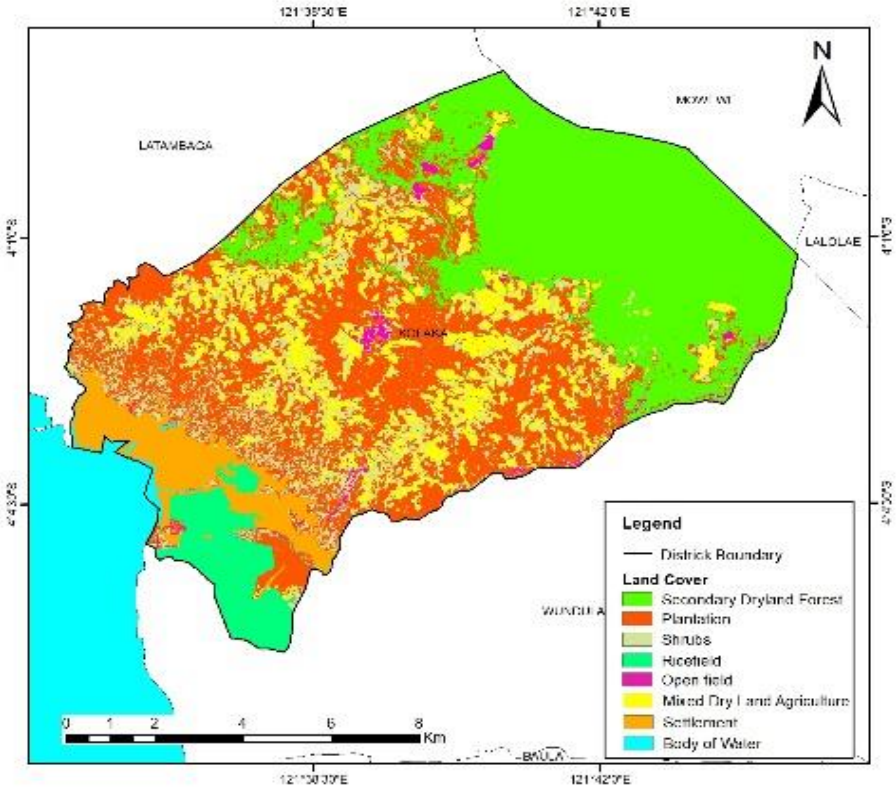

Figure 2. Map of Land Cover in Kolaka Regency 2023

Table 1. Land cover class of 2023

Land cover class	**Area (Ha)**	**Percent**
Secondary Drylan Forest	3974.20	31.84
Open Field	148.66	1.19
Settlement	744.26	5.96
Plantation	3886.87	31.14
Mixed Dry Land Agriculture	1415.62	11.34
Ricefield	613.53	4.92
Shrubs	1641.42	13.15
Body Water	56.22	0.45
Total Area	**12480.79**	**100**

Based on table 1, the most extensive type of land cover is secondary dry land forest covering an area of 3974.20 Ha or 31.84%, plantation land cover covering an area of 3,886.87 Ha or 31.14%, shrub land covering an area of 1,641.42 Ha or 13.15%, mixed dry land agricultural land cover covering an area of 1,415.62 Ha or 11.34%, the residential land cover of 744.26 or 5.96%, paddy field cover of 613.53 Ha or 4.92%, the open land cover of 148.66 Ha or 1.19% and water body land cover of 56.22 Ha or 0.45% of the total area of Kolaka District.

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 then 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**	**Ptc**	**Sw**	**B**	**T**	**Column Total**	**Producer Accuracy**	**User Accuracy**	**Overall Accuracy**
A	7	0	2	0	0	0	1	0	10	100	70	
Hs	0	9	0	1	0	0	0	0	10	100	90	
Pm	0	0	9	0	0	1	0	0	10	81.82	90	
Kb	0	0	0	9	1	0	0	0	10	90	90	
Ptc	0	0	0	0	9	0	1	0	10	75	90	**88.75**
Sw	0	0	0	0	0	10	0	0	10	90.91	100	
B	0	0	0	0	1	0	9	0	10	81.82	90	
T	0	0	0	0	1	0	0	9	10	100	90	
Rows Total	7	9	11	10	12	11	11	9	80			

Information :
A (water body), Hs (secondary dry land forest), Pm (settlement), Kb (plantation), Ptc (mixed dry land agriculture), Sw (rice fields), B (shrubs), T (open land)

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 88.75% with details of the highest Producer Accuracy being in the secondary dryland forest, water bodies and soil classes. open at 100% and the lowest was in the mixed dry land farming class at 75%. Meanwhile, the highest User Accuracy was in the 100% rice field class and the lowest was in the 70% Water Body class.

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 88.75%. 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).

Conclusion

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 based on digital image interpretation using the Maximum Likelihood classification in Kolaka District with the training area obtained 8 land cover classes, namely secondary dry land forest covering an area of 3974.20 Ha or 31.84%, plantation land cover covering an area of 3,886.87 Ha or 31.14%, shrubs covering an area of 1,641.42 Ha or 13.15%, the mixed dryland agricultural land cover of 1,415.62 Ha or 11.34%, the residential land cover of 744.26 or 5.96%, paddy field cover of 613.53 Ha or 4.92%, an open land cover of 148.66 Ha or 1.19% and land cover of The water body covers an area of 56.22 Ha or 0.45% of the total area of Kolaka District.

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