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Land Cover Classification Using Sentinel 2A Image in Lore Lindu National Park Area, Central Sulawesi

(Klasifikasi Tutupan Lahan menggunakan Citra Sentinel 2A di Kawasan Taman Nasional Lore Lindu, Sulawesi Tengah)

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ABSTRACT

Land cover within Lore Lindu National Park is undergoing a continuous transformation driven by both natural processes and anthropogenic pressures. Accurate mapping and classification of land cover types are critical for informed conservation planning and sustainable ecosystem management. This study aims to assess the effectiveness of Sentinel-2A satellite imagery combined with the supervised Maximum Likelihood Classification (MLC) method in delineating land cover types within the Lore Lindu National Park, Central Sulawesi. The research was conducted from August to December 2023 and involved four primary stages: image pre-processing through layer stacking, land cover classification, field verification (ground truthing), and accuracy assessment. The classification results yielded an Overall Accuracy (OA) of 83.75%, indicating a high level of reliability. A total of fifteen distinct land cover classes were identified, with secondary dryland forest occupying the most significant proportion of the area (approximately 80.60%), followed by primary dryland forest, plantation areas, and smaller fractions of rice fields, mining zones, and water bodies. These findings underscore the utility of Sentinel-2A imagery, in conjunction with the Maximum Likelihood algorithm, as a dependable tool for land cover mapping in tropical protected environments. The results provide a valuable spatial basis for developing targeted conservation strategies and enhance the understanding of landscape dynamics within the park.

KEYWORDS: ***Land Cover, Lore Lindu National Park, Maximum Likelihood Classification, Sentinel-2A Imagery, Supervised Classification***

INTISARI

Tutupan lahan di kawasan Taman Nasional Lore Lindu terus mengalami transformasi yang dipengaruhi oleh dinamika alami maupun aktivitas antropogenik. Pemetaan dan identifikasi jenis tutupan lahan secara akurat menjadi langkah krusial dalam merencanakan upaya konservasi

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yang efektif. Penelitian ini bertujuan untuk mengevaluasi efektivitas citra Sentinel-2A yang dikombinasikan dengan metode klasifikasi terarah Maximum Likelihood dalam pemetaan jenis tutupan lahan di wilayah Taman Nasional Lore Lindu, Sulawesi Tengah. Penelitian dilaksanakan pada periode Agustus hingga Desember 2023 melalui empat tahapan utama, yaitu: pra-pemrosesan citra dengan teknik layer stacking, klasifikasi citra, verifikasi lapangan (ground truthing), dan penilaian akurasi. Hasil klasifikasi menunjukkan nilai Overall Accuracy (OA) sebesar 83,75%, yang tergolong dalam kategori baik. Sebanyak lima belas kelas tutupan lahan berhasil diidentifikasi, dengan hutan sekunder lahan kering mencakup area terluas (sekitar 80,60%), diikuti oleh hutan primer lahan kering, areal perkebunan, serta kelas-kelas minor lainnya seperti sawah, area tambang, dan badan air. Temuan ini membuktikan bahwa citra Sentinel-2A yang dikombinasikan dengan pendekatan Maximum Likelihood merupakan metode yang andal dalam pemetaan tutupan lahan di kawasan lindung tropis, serta mendukung strategi pengelolaan ekosistem yang lebih efektif.

KATA KUNCI: Citra Sentinel 2A, Klasifikasi Terbimbing, Kemungkinan Maksimum, Taman Nasional Lore Lindu, Tutupan Lahan.

INTRODUCTION

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

Pressure on the land used will have an impact on land use which will lead to land conversion. On the other hand, land use is a human activity carried out on land to meet certain needs. 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 that continues to experience significant changes from year to year. Changes in land use mainly occur in the conversion of agricultural land from rice fields to non-rice fields which experience a decrease and increase in built-up land (Hidayat & Noor, 2020 ; Suni, Fitra, et al., 2023).

The development of land cover changes in an area can be analyzed by utilizing remote sensing data in the form of multitemporal satellite imagery. The use of remote sensing technology is one way to quickly find out changes in land use. 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 a growing population and increasing demands for a better quality of life (Suni, et al., 2023).

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Remote sensing is defined as obtaining information about an object without physical contact with the object. Remote sensing obtains information by detecting and measuring object changes, which are influenced by surrounding optical conditions, 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, et al., 2020 ; Budiputra, 2021).

Remote sensing can cover a large area 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, resulting in results that can be explained in terms of accuracy (Safitri & Giofandi, 2019).

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 specific 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 the appearance class of a particular object. This determination is based on the analyst's knowledge of the area in the image related to the land cover area. The pixel value in the sample area is then used by computer software as a key to identify other pixels. Areas that have similar pixel values will be included in the specified class (Ghebrezgabher et al., 2016).

The Sentinel 2 MSI satellite is a satellite owned by 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 local time with the aim of obtaining results with minimal cloud cover and appropriate sunlight (Segarra et al., 2020).

The development of land cover changes in an area can be analyzed by utilizing remote sensing data in the form of multitemporal satellite imagery. The use of remote sensing technology is one way to quickly determine land use changes (Muhati et al., 2018; Suni, et al., 2023).

The implications of population growth around the area have an impact on land needs, including agriculture, housing, services, and transportation facilities will affect changes in land cover every year in the Lore Lindu National Park area. According to Kaimuddin (2008), he said that forest area encroachment is currently often found in areas directly bordering forest areas, due to the increasingly limited land used for agricultural and plantation cultivation, pressure on forest areas is increasing.

Based on these conditions, it is necessary to conduct research on land cover analysis in the Lore Lindu National Park area which aims to obtain the latest information on the class and extent of land cover to support conservation policies and efforts in dealing with the rate of decline in forest area functions in the Lore Lindu National Park area.

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This is important for the development, management, and control of area functions, as well as the implementation of control measures to reduce the rate of decline in area functions in the future. In addition, this information is very important in providing good insight into the current conditions of land cover and prevention and providing information for management agencies to make the right decisions regarding management strategies, such as patrols, development of management plans, and future planning.

RESEARCH METHODS

Study site

This research was conducted for six months from July to December 2023 in the Lore Lindu National Park area with conservation area status. Lore Lindu National Park is located in Central Sulawesi Province, located in two districts in 13 sub-districts, and has 72 buffer villages. The two districts are Sigi Regency, Lore Lindu National Park covering an area of 118,220.8 hectares (54.8%), and Poso Regency covering an area of 97,512.9 hectares (45.2%) (Figure 1).

The Lore Lindu National Park area has 8 types of ecosystems and is dominated by lower mountain ecosystems. Geographically, the Lore Lindu National Park area is located at coordinates 119° 90'-120° 16' East Longitude and 1° 8'-1° 3' South Latitude.

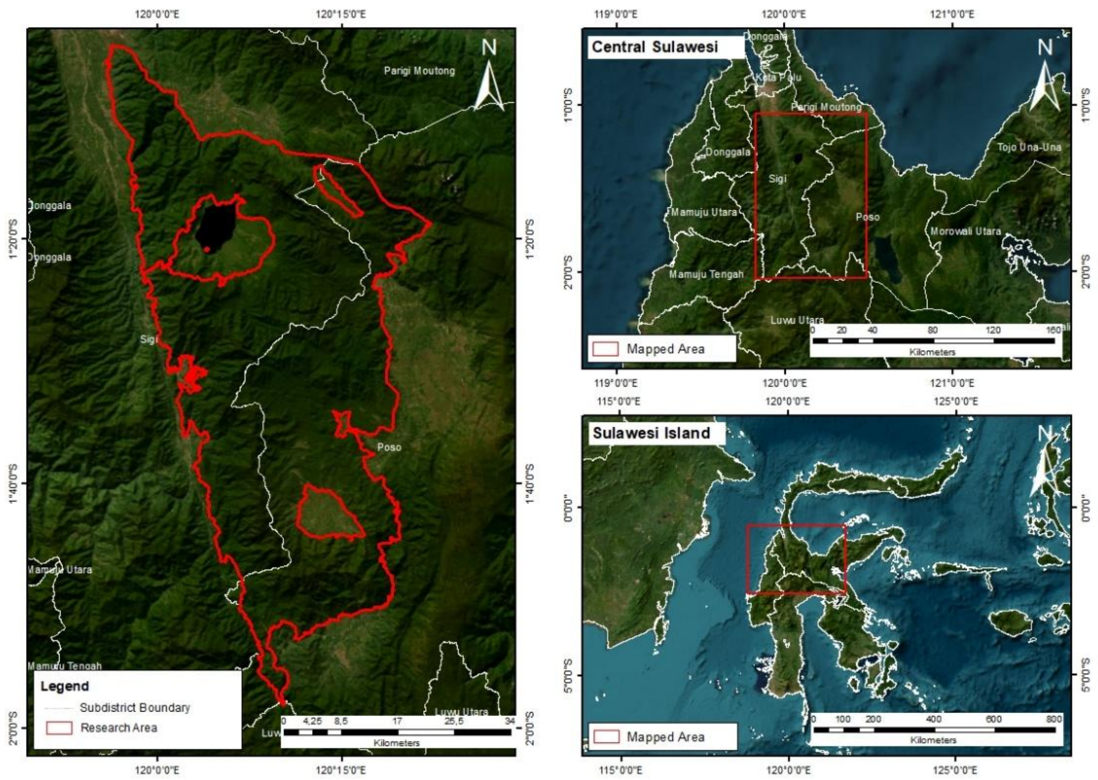

Figure 1. Location Map

Tools and materials

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The materials used are secondary data in the form of Sentinel-2A imagery from the Copernicus Open Access Hub (https://scihub.copernicus.eu, accessed December 2023) covered in July - December 2023 sourced from Copernicus, Google Earth satellite imagery, and a 1:50,000 scale Indonesian Earth Map in 2023. The tools used are a laptop with 32 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, resulting in 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 supervised classification is that it is a remote-sensing image classification method that uses training sample data to determine the class of an object. This method assumes that the data for each class is normally distributed and identifies the class that has the highest probability for a particular pixel ((Lillesand et al., 2015: Septiani, 2019). This study uses supervised classification with maximum likelihood classification. Supervised classification considers variance-covariance in class distribution, so it can provide more accurate classification results, especially for normally distributed data (Richards & Jia, 2006).
3. Field Survey (Ground Check). A field survey was conducted to check and identify land cover classes, taking 75 random coordinate point samples using Handheld GPS by considering the land cover class after performing image analysis on the ArcGIS 10.8 application.
4. Accuracy Test. The results of this study used the Confusion Matrix ≥ 80% method. Accuracy calculations were carried out by comparing data obtained from the classification results (Maximum Likelihood) with the results of field checks. According to Akhbar et al., (2013) the accuracy criteria in ranking are as follows 80% (very good) and 60-70% (good). Accuracy was assessed by comparing classified results with ground truth data through a confusion matrix analysis. 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

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mapping accuracy is determined by using a classification accuracy test referring to Hanifa & Suwardi, (2023) with the formula:

$$Overall\ Accuracy = \frac{D}{N} * 100\% \quad \ldots\ldots (1)$$

Information:
D = total correct row values that have been added diagonally
N = total values tested in error.

RESULTS AND DISCUSSION

Land Cover Classification

The results of the Sentinel-2A image classification using the Maximum Likelihood method show that the Lore Lindu National Park area is dominated by forest cover, especially the secondary dryland forest and primary dryland forest classes. Based on the data in Table 1, secondary dryland forest is the largest type of land cover with an area of 73,876.25 hectares or 80.60% of the total area. This dominance is also visually depicted on the classification results map (Figure 2), where the light green color representing this class dominates most of the national park area.

Table 1. Land cover class of 2023

Class	Area (ha)	Percentage
Primary dryland forest	21,916.40	10.16
Secondary dryland forest	73,876.25	80.60
Secondary swamp forest	274.49	0.13
Settlement	16.81	0.01
Plantation	13,934.34	6.46
Rice fields	30.62	0.01
Mining	15.95	0.01
Dryland farming	604.45	0.28
Mixed dryland agriculture	702.75	0.33
Swamp	112.44	0.05
Savannah	1,618.83	0.75
Shrubs	1,674.95	0.78
Swamp bush	141.14	0.07
Open land	630.35	0.29
Water	169.89	0.08
Total Area	**215,719.65**	**100**

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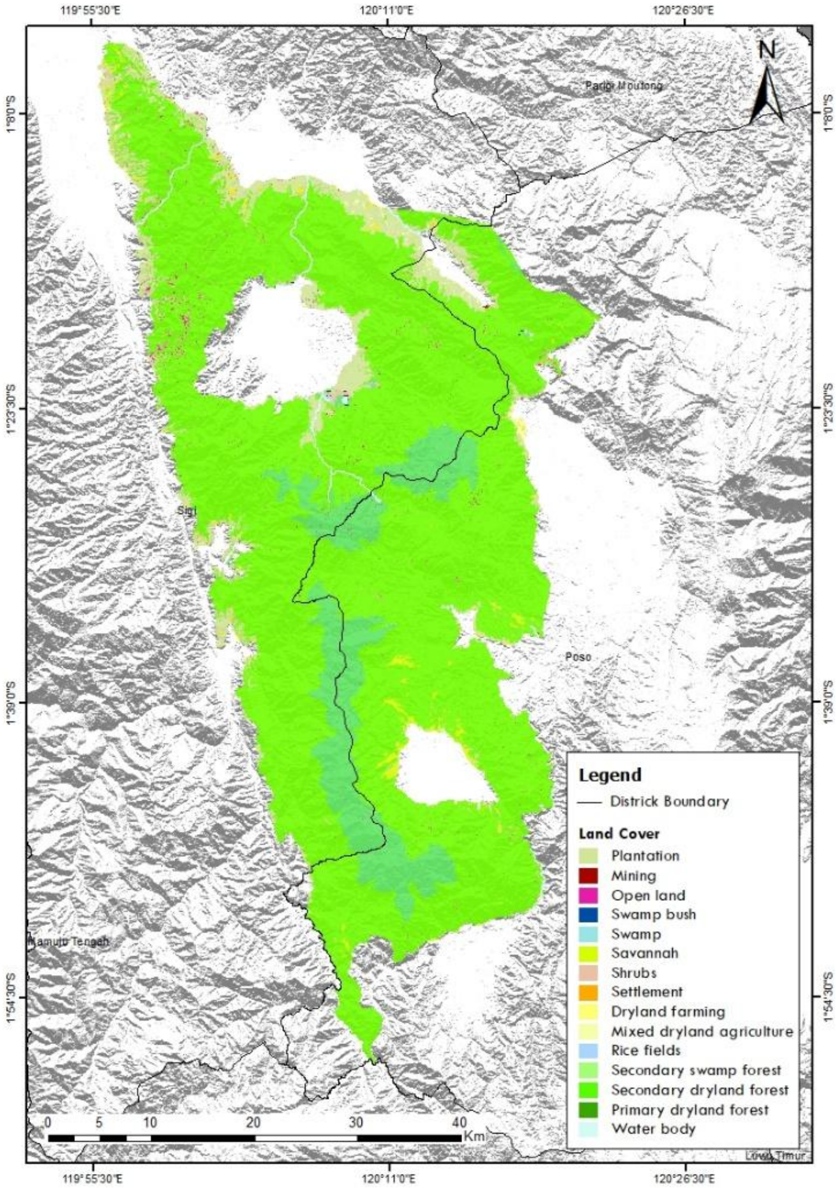

Figure 2. Map of Land Cover in Lore Lindu National Park 2023

The primary dryland forest class is in second place with an area of 21,916.40 hectares or 10.16% of the total area. The dark green color on the map shows the distribution of this class which tends to be in areas that are more difficult to reach geographically. This indicates that the area is likely not to have experienced significant anthropogenic disturbance and still maintains good ecological conditions. The difference in proportion between primary and secondary forests reflects the natural regeneration or rehabilitation process due to previous disturbances, either in the form of illegal logging, encroachment, or forest fires.

The plantation class is in third place with an area of 13,934.34 hectares or 6.46%, which is shown in light brown on the map. The existence of plantations indicates land use pressure from

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human activities around and within the buffer zone of the national park. This activity has the potential to affect the integrity of the conservation area if not managed sustainably. Other land cover types such as shrubs (0.78%), savanna (0.75%), mixed dryland agriculture (0.33%), open land (0.29%), and dryland agriculture (0.28%) each cover a small proportion. However, the distribution of these classes indicates land fragmentation and the potential for conversion of forest cover to other forms of land use. Several classes with very small areas such as settlements (0.01%), rice fields (0.01%), and mining (0.01%) reflect anthropogenic activities that are still limited but have the potential to develop if there is no supervision and control. Meanwhile, the presence of water bodies (0.08%), swamps (0.05%), and scrub swamps (0.07%) indicates the presence of aquatic ecosystem elements that, although small in proportion, are important in terms of biodiversity and ecosystem services.

Overall, the land cover distribution pattern shows that Lore Lindu National Park still has a strong forest cover dominance. However, the presence of non-forest activities, both permanent such as settlements and plantations, and temporary such as agriculture, indicates the need to strengthen area management, especially in buffer zones and areas with high accessibility.

The distribution pattern and comparison of the area between land cover classes indicate that the Lore Lindu National Park area generally still maintains its forest ecosystem function. However, the dominance of secondary forests over primary forests indicates significant historical degradation. In addition, the distribution of non-forest classes, although small, indicates the potential for fragmentation and disturbance that needs to be mitigated through strengthening zoning, monitoring, and community-based conservation approaches.

Accuracy Test

Accuracy assessment was performed to validate the classification results 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 (Yanuar et al., 2018). 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 (Suni et al., 2023).

Several cover classes such as settlements (0.01%), mining (0.01%), and rice fields (0.01%) show very small proportions. This is in line with the conservation function of national parks that limit human activities, but still indicate human intervention that is spread on a small scale. The existence of open land, swamp, and savannah classes which are low in number also deserves to be observed as areas that have the potential to change along with the dynamics of land use.

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Table 2. Supervised Classification Accuracy Test Results

Land Cover	SF	PF	P	Sh	Sv	MA	OL	DF	SS	WB	SB	Sw	S	RF	M	Column Total	Producer Accuracy	User Accuracy	Overall Accuracy
SF	8	1	0	1	0	0	0	0	0	0	0	0	0	0	0	10	88,89	80	**82,67**
PF	1	9	0	0	0	0	0	0	0	0	0	0	0	0	0	10	90	90	
P	0	0	8	0	0	1	0	1	0	0	0	0	0	0	0	10	81,82	80	
Sh	0	0	0	9	1	0	0	0	0	0	0	0	0	0	0	10	81,82	90	
Sv	0	0	0	1	8	1	0	0	0	0	0	0	0	0	0	10	80	80	
MA	0	0	0	0	1	8	0	1	0	0	0	0	0	0	0	10	72,73	80	
OL	0	0	1	0	0	0	8	0	0	0	0	0	1	0	0	10	80	80	
DF	0	0	0	0	0	1	0	9	0	0	0	0	0	0	0	10	81,82	90	
SS	0	0	0	0	0	0	0	0	8	2	0	0	0	0	0	10	72,73	80	
WB	0	0	0	0	0	0	0	0	1	9	0	0	0	0	0	10	81,82	90	
SB	0	0	0	0	0	0	0	0	1	0	8	1	0	0	0	10	80	80	
Sw	0	0	0	0	0	0	0	0	0	0	1	8	1	0	0	10	88,89	80	
S	0	0	0	0	0	0	0	0	0	0	0	0	9	0	1	10	75	90	
RF	0	0	0	0	0	0	0	0	1	0	1	0	0	8	0	10	100	80	
M	0	0	0	0	0	0	2	0	0	0	0	0	1	0	7	10	88	70	
Rows Total	9	10	9	11	10	11	10	11	11	11	10	9	12	8	8	150			

Information: SF (secondary dryland forest), PF (primary dryland forest), P (plantation), Sh (shrubs), Sv (savannah), MA (mixed dryland agriculture), OL (open land), DF (dryland farming), SS (secondary swamp forest), WB (water body), SB (swamp bush), Sw (swamp), S (settlement), RF (rice fields), M (mining)

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The classification accuracy test produced an Overall Accuracy (OA) value of 82.67%, approaching the minimum standard for classification accuracy according to the USGS (85%). This value indicates that the classification carried out is quite accurate and can be used as a basis for decision making, considering that classification with an OA value > 80% is already classified as very good according to the criteria (Akhbar et al., 2013).

The class with the highest producer accuracy is rice fields (100%), followed by primary dryland forest (90%) and water body (88.89%). This shows that satellite imagery can recognize the spectral characteristics of rice fields and water areas very well. In contrast, mixed dryland agriculture showed the lowest producer accuracy (72.73%), possibly due to the vegetation spectrum being similar to other types of land such as plantations and shrubs, so they are often confused. In terms of user accuracy, the highest was achieved by several classes such as primary dryland forest, shrubs, dryland farming, water body, and settlement (each 90%). However, the mining class showed the lowest user accuracy (70%), which may be due to the small area size or spectral overlap with open land and agriculture.

CONCLUSIONS

The use of Sentinel-2A imagery with the Maximum Likelihood supervised classification method has proven effective in identifying and mapping land cover in Lore Lindu National Park. The classification results successfully differentiated 15 land cover classes with an overall accuracy of 82.67%. The dominance of secondary dryland forests (80.60%) compared to primary forests (10.16%) indicates a natural regeneration process after anthropogenic disturbances such as illegal logging or land clearing. Although the proportion of non-forestry classes such as plantations (6.46%), agriculture, and open land is relatively small, their distribution indicates spatial pressure in the buffer zone that has the potential to cause ecosystem fragmentation. Several classes showed high accuracy, such as rice fields (100%) and primary forests (90%), but there was still confusion in the classification of classes with a similar spectrum, such as settlements, mining, and open land. This indicates the need for improvement in training data selection and the possible integration of additional higher-resolution data to improve spatial and thematic accuracy. Overall, this study shows that Sentinel-2A imagery plays a strategic role in providing reliable spatial data to support decision-making in planning, management, and conservation of the area. These findings support the strengthening of community-based zoning and conservation approaches in anticipating pressures on the ecological functions of Lore Lindu National Park, while providing a scientific basis for formulating land conversion control policies.

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REFERENCES

Akhbar, Basir, M., Elim Somba, B., & Golar. (2013). AR4-50 model, The extraction of spectral values into remote sensing image data-based land use class. *Agrivita*, *35*(3), 255–262. https://doi.org/10.17503/Agrivita-2013-35-3-p255-262

Budiputra, A. R. (2021). Analisis Kerapatan Vegetasi di Kabupaten Magelang Menggunakan Citra Landsat 8 Bermetode NDVI (Normalized Difference Vegetation Index). *Jurnal Sosial Teknologi*, *1*(11), 1.332-1340. https://doi.org/10.59188/JURNALSOSTECH.V1I11.231

Derajat, R. M., Sopariah, Y., Aprilianti, S., Taruna, A. C., Aria, H., Tisna, R., Ridwana, R., & Sugandi, D. (2020). Klasifikasi Tutupan Lahan Menggunakan Citra Landsat 8 Operational Land Imager (OLI) di Kecamatan Pangandaran. *Jurnal Samudra Geografi*, *3*(1), 1–10. https://doi.org/10.33059/JSG.V3I1.1985

Ghebrezgabher, M. G., Yang, T., Yang, X., Wang, X., & Khan, M. (2016). Extracting and analyzing forest and woodland cover change in Eritrea based on landsat data using supervised classification. *The Egyptian Journal of Remote Sensing and Space Science*, *19*(1), 37–47. https://doi.org/10.1016/J.EJRS.2015.09.002

Hanifa, H., & Suwardi, S. (2023). Identifikasi Tingkat Kerawanan Tanah Longsor Di Ajibarang Banyumas Menggunakan Metode Skoring. *Jurnal Tanah Dan Sumberdaya Lahan*, *10*(1), 97–103. https://doi.org/10.21776/UB.JTSL.2023.010.1.10

Hidayat, M. A., & Noor, A. (2020). Pengaruh pertumbuhan ekonomi terhadap alih fungsi lahan di kota samarinda. *Inovasi*, 16(2), 299-308. doi: 10.30872/jinv.v16i2.8256

Kaimuddin, K. (2008). Analisa Perambahan Kawasan Hutan terhadap Kebocoran Carbon dan Perubahan Iklim (Studi Kasus Desa Bantimurung Kecamatan Bone-bone Kabupaten Luwu Utara). *Jurnal Hutan dan Masyarakat*, 3(2), 8217.

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote Sensing and Image Interpretation*. John Wiley & Sons.

Muttaqin, S., & Aini, Q. (2011). Analisis perubahan penutup lahan hutan dan perkebunan di Provinsi Jambi Periode 2000-2008. *Studia Informatika: Jurnal Sistem Informasi* 4(2).

Muhati, G. L., Olago, D., & Olaka, L. (2018). Land use and land cover changes in a sub-humid Montane forest in an arid setting: A case study of the Marsabit forest reserve in northern Kenya. *Global Ecology and Conservation*, *16*, e00512. https://doi.org/10.1016/J.GECCO.2018.E00512

Rahmatsyah, M. S., Juliani, R., dan Tampubolon, T. (2020). Fisika Kelautan. Media Sains Indonesia.

Richards, J. A., & Jia, X. (2006). *Remote Sensing Digital Image Analysis: An Introduction*. Springer.

Septiani, R., Citra, I. P. A., & Nugraha, A. S. A. (2019). Perbandingan metode supervised classification dan unsupervised classification terhadap penutup lahan di Kabupaten Buleleng. *Jurnal Geografi: Media Informasi Pengembangan Dan Profesi Kegeografian*, 16(2), 90-96. doi: 10.15294/jg.v16i2.19777

Safitri, Y., & Giofandi, E. A. (2019). Pemanfaatan Citra Multi Spektral Landsat Oli 8 Dan Sentinel-2a Dalam Menganalisis Degradasi Vegetasi Hutan Dan Lahan (Studi Kasus : Cagar Alam Rimbo Panti, Pasaman). *Jurnal Swarnabhumi : Jurnal Geografi Dan Pembelajaran Geografi*, *4*(2), 115. https://doi.org/10.31851/SWARNABHUMI.V4I2.2950

Segarra, J., Buchaillot, M. L., Araus, J. L., & Kefauver, S. C. (2020). Remote Sensing for Precision Agriculture: Sentinel-2 Improved Features and Applications. *Agronomy 2020, Vol. 10, Page 641*, *10*(5), 641. https://doi.org/10.3390/AGRONOMY10050641

e-ISSN : 2746 – 7155
p-ISSN : 1978 – 4996

Suni, M. A., Fitra, R. A., Fahrul, M., & Umar, H. (2023). Land Cover Classification Using Sentinel 2A Image in Kolaka Subdistrict, Kolaka Regency, Southeast Sulawesi. *Jurnal Riset Multidisiplin Dan Inovasi Teknologi*, *1*(02), 145–153. https://doi.org/10.59653/JIMAT.V1I02.267

Suni, M. A., Mappatoba, C. A., & Basoka, M. D. (2023). Identification of Landslide Susceptibility Level in Buffer Village Lore Lindu National Park Using Scoring Method. *International Journal of Multidisciplinary Approach Research and Science*, *1*(02), 221–236. https://doi.org/10.59653/IJMARS.V1I02.96

Suni, M. A., Muis, H., & Arianingsih, I. (2023). Spatial Modeling of Changes in Land Cover of Limited Production Forests in Kulawi Subdistrict Sigi Regency Central Sulawesi Province. *Jurnal Ilmiah Geomatika*, *29*(1), 55–56.

Van Noordwijk, M., Mulyoutami, E., Sakuntaladewi, N., & Agus, F. (2008). *Swiddens in transition: shifted perceptions on shifting cultivators in Indonesia*. Occasional Paper no.9. World Agroforestry Centre. Bogor. 49 p.

Yanuar, R. C., Hanintyo, R., & Muzaki, A. A. (2018). Penentuan Jenis Citra Satelit Dalam Interpretasi Luasan Ekosistem Lamun Menggunakan Pengolahan Algoritma Cahaya Tampak. *Jurnal Ilmiah Geomatika*, *23*(2), 75. https://doi.org/10.24895/jig.2017.23-2.704

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