Sumatra Journal of Disaster, Geography and Geography Education June, 2023. Vol.7. No.1. pp. 35-40
Disaster, Geography, Geography Education http://sjdgge.ppj.unp.ac.id/index.php/Sjdgge
ISSN : 2580 - 4030 (Print) 2580 - 1775 (Online), Indonesia

COMPARISON OF PCA (PRINCIPAL COMPONENT ANALYSIS) AND BAND RATIO METHODS USING LANDSAT 9 IMAGES FOR LAND COVER VISUALIZATION MAPPING (Case Study: Lubuk Begalung District, Padang City)

*Sri Kandi Putri[1] dan Fahrezy Maulana Haz[1], Mentari Dian Pertiwi[2], Naf'an Arifian[3]

[1]Study Program of Penginderaan Jauh dan Sistem Informasi Geografis, Universitas Negeri Padang - Indonesia
[3]Geography Departement, Universitas Negeri Padang - Indonesia
[3]Nautical Technology Study, Merchant Marine Polytechnic of West Sumatera - Indonesia
Email: srikandi_25@fis.unp.ac.id

*Corresponding Author, Received: April 12, 2023. Revised: May 10, 2023. Accepted: June 06, 2023

ABSTRACT: Identification of land cover using satellite imagery through supervised and unsupervised classifications has been successfully carried out in various locations. This study aims to assess the accuracy of Landsat-9 OLI imagery by identifying land cover by observant the spectral responses of settlements, industrial buildings, rice fields, forests, wetlands, and open land using Principle Component Analysis (PCA) and Band Ratio methods. The success of land cover mapping was evaluated statistically using a confusion matrix. The acceptable level of accuracy is 85% with a Cohen's kappa coefficient greater than 0.8. The results showed that the PCA and Band Ratio methods were not successful in mapping land cover at the study site because the accuracy level of both was at the specified moderate level. PCA has 80.5% accuracy with 0.75 kappa better than Band Ratio (80.5% accuracy, 0.76 kappa). The level of spectral sensitivity in industrial buildings and open land on PCA is much better than Band Ratio. However, in the residential and rice fields the Band Ratio is much better at detecting than PCA.

Keywords: *Land cover, Iimage classification, Band ratio, PCA*

1. INTRODUCTION

The study of changes in land use and land cover is very important, especially regarding the loss of vegetation cover in an area. These changes can be attributed to several anthropic and natural factors such as floods, climate change, and deforestation [1]. Change detection is a process of identifying a phenomenon or object by observing it at different times [2]. Remote sensing products can be used to detect changes in land cover, in this study it was applied in the Lubuk Begalung sub-district.

There are many methods and techniques for classifying data from remote sensing products, such as supervised and unsupervised classification methods, but the method used in this study uses Principal Component Analysis (PCA) and Band Ratio. According to [1], that the PCA method shows the best capacity to limit vegetation cover with infrared composition compared to the NDVI method which is less accurate. Meanwhile, according to [3], Band ratio is the division between x and y bands which aims to highlight water objects, vegetation and the boundary between land and sea. *This study aims to compare the better method between PCA and Band Ratio*.

The high frequency of spatial changes in urban areas, along with the large mix of surface materials in each map category produce a distinctive urban spectral response that makes most of the urban categories separable in the image [4]. However, those variances of urban spectral response also resemble the familiar curves of vegetation, soil, rock, and water

2. METHODS

This research was conducted in 2022 in Lubuk Begalung Sub-district, which is located at 100º 21' 11" East Longitude and 00º 58' 4" South Latitude.

Data and Equipment

The data used in this study are:

Num	Data Name	Source
1.	Landsat 9 imagery level 2	USGS
2.	Road and river network data	RBI BIG
3.	Lubuk Begalung sub-district administrative data	Bappeda Kota Padang

The equipment used in this study are:

Num	Equipment	Function
1.	GPS Essential	Specify the location coordinates
2.	Software ArcGis 10.4	Processing spatial data
3.	Software Microsoft Office	Data processing
4.	Asus Laptop A456U	Data processing
5.	Office stationery	To write and take notes

The flowchart of this research can be seen in Figure 1 below.

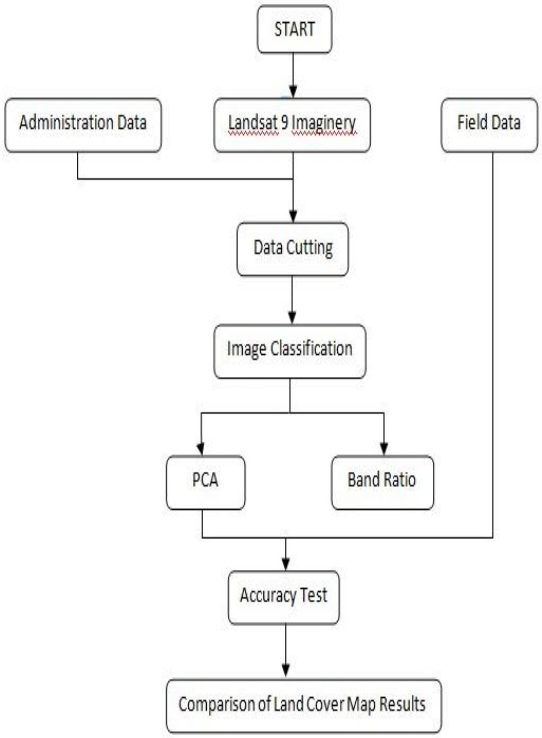

Fig. 1 Research Flowchart

2.1 Landsat 9

Landsat 9 carries two instruments: Operational Land Imager 2 (OLI-2) and Thermal Infrared Sensor 2 (TIRS-2). Specifically, Landsat 9 will replace Landsat 7 in orbit thereby continuing to provide 8 days out-of-phase imagery with Landsat 8 [5]. Landsat 9 is needed to obtain data consistent enough with Landsat 8 to allow comparisons of the detection and quantification of global soil changes. Landsat 9 will downgrade 14-bit data from OLI-2, compared to 12-bit data from OLI, leading to increased observations of darker areas, such as coastal waters [6]. The characteristics of the wavelength and spatial resolution of Landsat 9 imagery can be seen in full in Table 1.

Table 1 Landsat 9 Image Characteristics 9

No.	Bands	Wavelength (micrometers)	Resolution (meters)
1.	Band 1 - Coastal aerosol	0.43 - 0.45	30
2.	Band 2 - Blue	0.45 - 0.51	30
3.	Band 3 - Green	0.52 - 0.60	30
4.	Band 4 - Red	0.63 - 0.68	30
5.	Band 5 - Near Infrared (NIR)	0.84 - 0.88	30
6.	Band 6 - SWIR 1	1.56 - 1.66	30
7.	Band 7 - SWIR 2	2.10 - 2.30	30
8.	Band 8 - Panchromatic	0.50 - 0.68	15
9.	Band 9 - Cirrus	1.36 - 1.39	30
10.	Band 10 - Thermal Infrared (TIRS) 1	10.30 -11.30	100
11.	Band 11 - Thermal Infrared (TIRS) 2	11.50 -12.50	100

Source : Masek et al., 2020

2.2 Image Cropping

Image cropping was carried out using administrative data of Lubuk Begalung Sub-district sourced from Bappeda (Board of Development Planning, Research and Regional Development) agency of the City of Padang. One common way to classify digital numbers or pixels from images that have similar characteristics is by using Per-Pixel Analysis (PPA) [7]. This method assumes that every object on the earth's surface has a different spectral reflectance

2.3 Principal Component Analysis (PCA)

PCA is the process of transforming the spectral values in the image to reduce data redundancy [8]. PCA calculates a new variant called the principal components which is the result of a linear combination of the original variance. PC1 will contain the data with the largest percentage of variance and PC2 will contain the second largest percentage of variance, and so on until the last PC will only contain disturbances [9]. The input from PCA is in the form of image statistical data which will be compiled in the form of a matrix to get the eigen value and eigen vector to rotate the original data [10].

2.4 Band Ratio

The Band Ratio method is a method of dividing the Digital Number (DN) value of a band with the DN value of another band to clarify the appearance of an area or object on the earth's surface that is difficult or cannot be seen by a single band [11].

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And Band ratio is also often used for image processing in reducing interference with spectral values that affect objects on the earth's surface [3]. So, this method aims to increase the difference in the spectral values of each band to reduce the effect of masking.

2.5 Confussion Matrix

This matrix is used to see the level of truth of the results of data processing on land cover by testing the accuracy of sampling coordinate points in the field.

Table 2 Confussion Matrix

Klasifikasi				∑ Baris	User's Accuracy
	Objek 1	Objek 2	Objek 3		
Objek 1	X_{i1j1}	X_{i1j2}	X_{i1j3}	$\sum X_{i1}$	$X_{i1j1}/\sum X_{i1}$
Objek 2	X_{i2j1}	X_{i2j2}	X_{i2j3}	$\sum X_{i2}$	$X_{i2j2}/\sum X_{i2}$
Objek 3	X_{i3j1}	X_{i3j2}	X_{i3j3}	$\sum X_{i3}$	$X_{i3j3}/\sum X_{i3}$
∑ Kolom	$\sum X_{j1}$	$\sum X_{j2}$	$\sum X_{j3}$	N	
Producer's Accuracy	$X_{i1j1}/\sum X_{i1}$	$X_{i2j2}/\sum X_{i2}$	$X_{i3j3}/\sum X_{i3}$		

Source: Stehman dan Foody, 2019

Producer's accuracy is the accuracy seen from the map maker's side, while user's accuracy is the accuracy seen from the map user's side [12]. However, the overall accuracy test is the level of truth of the data from the classification processing results compared to the data in the field

3. RESULTS AND DISCUSSION

3.1 Result of PCA and Band Ratio Methodes

The results of the PCA analysis are eigenvector loadings. High eigenvector values indicate information on the presence of land cover targets. The positive (+) and negative (-) signs on the eigenvector indicate the brightness level of the hue in the PC image [8]. From data processing, 6 classes have been classified, including rivers, trains, industrial buildings, rice fields, forest wetlands and open land, as shown in Figure 2.

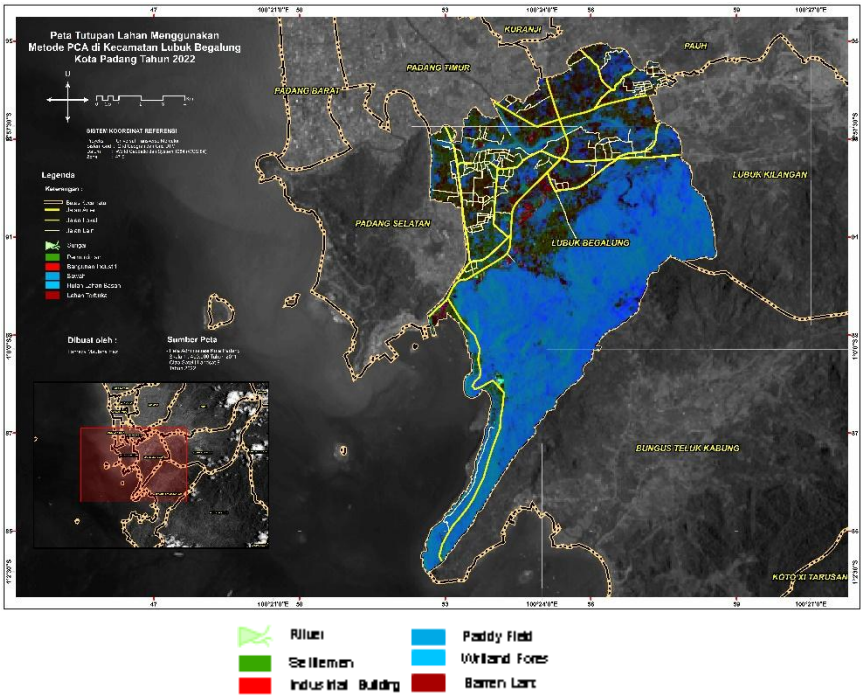

Fig. 2 The land cover map uses the PCA method

Judging from the results of the PCA combination on channel 4-3-2 in Table 2, it shows that PC1 has positive eigenvector loadings for all channel bands. Meanwhile, PC2 has a high and opposite eigenvector, namely on channel 2 (0.83) and channel 3 (-0.4). PC3 actually also has high eigenvector loadings on channel 3 (0.71), but only contains 0.10% of the total spectral data variance. PC1 and PC3 display bright DN values to display land cover in residential areas, industrial buildings and open land. While PC2 displays the highest and lowest DN values to distinguish urban areas, vegetation and geological rocks in open land.

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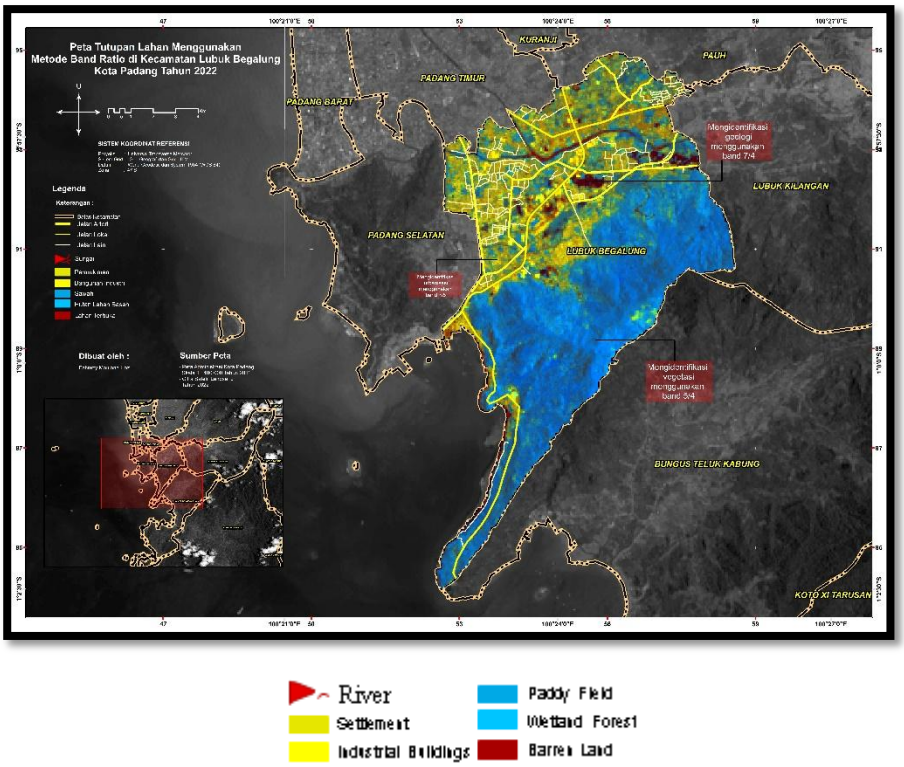

Fig. 3 The land cover map uses the Band Ratio method

The ratio is carried out on several bands, namely band 5 is rationed to band 4 (band ratio 5/4) to get the spectral reflectance value in vegetation, then band 7 is compared to band 5 (band ratio 7/5) to get the spectral reflectance value in urban areas (urban), and band 7 is rationed to band 4 (band ratio 7/4) to obtain the spectral reflection value on the ground (geological rock). The results of these ratios are composited in RGB 5/4, 7/5, and 7/4 to clarify the appearance of an object in land cover.

3.2 Accuracy Test

Accuracy test techniques carried out by using the Confusion Matrix or comparing it from the results of land cover classification data processing with the results of field observation samples.

Table 3 PCA Method Confusion Matrix

Land Cover	Field Assessment						
	Settlement	Industrial Building	Paddy Field	Wetland Forrest	Barren Land	River	**Total**
Settlement	4	0	2	0	0	0	6
Industrial Building	2	4	0	0	0	0	6
Paddy Field	2	0	4	0	0	0	6
Wetland Forrest	0	0	0	6	0	0	6
Barren Land	0	0	1	0	5	0	6
River	0	0	0	0	0	6	6
Total	8	4	7	6	5	6	36
Producer Accuracy %	50.0	100.0	57.1	100.0	100.0	100.0	
User Accuracy %	66.7	66.7	66.7	100.0	83.3	100.0	
Overall Accuracy %	80.5						
Kappa Coefficient	75.5						

From matrix table 3 shown that the percentage level of the overall accuracy results reaches 80.5% with a kappa coefficient value of 75.50 on the PCA method.

Table 4 Band Ratio Method Confusion Matrix

Land Cover	Field Assessment						
	Settlement	Industrial Building	Paddy Field	Wetland Forrest	Barren Land	River	**Total**
Settlement	6	0	0	0	0	0	6
Industrial Building	4	2	0	0	0	0	6
Paddy Field	1	0	5	0	0	0	6
Wetland Forrest	0	0	0	6	0	0	6
Barren Land	2	0	0	0	4	0	6
River	0	0	0	0	0	6	6
Total	13	2	5	6	4	6	36
Producer Accuracy %	46.2	100.0	100.0	100.0	100.0	100.0	
User Accuracy %	100.0	33.3	83.3	100.0	66.7	100.0	
Overall Accuracy %	80.5						
Kappa Coefficient	76.7						

Meanwhile results of the matrix table 3.3 which obtained from the band ratio processing, show that the results of the percentage level of overall accuracy is 80.5%. Therefore it is same as PCA method, but the kappa coefficient value of 76.7 higher than PCA method.

4. CONCLUSIONS

Result it can be concluded that the best method for land cover mapping is the band ratio with a kappa coefficient of 76.7% compared to a PCA of 75.5%. Even so, the level of spectral sensitivity in industrial buildings and open land on PCA is much better than the band ratio. However the band ratio is much better at detecting land cover of the settlement and paddy fields.

5. SUGGESTIONS

Suggestions that can be given for further research for better implemented are:

1. Using a much more detailed spatial resolution image to detect land cover so that the results obtained are much more accurate.
2. Increase the number of sample points in the field for each land cover classification.
3. Pay attention to coherence in taking sample points on land cover, so that there is no bias in the reflection of the spectral values of the image.

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