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Original Article

Integration of Normalized Difference Vegetation Index (NDVI) and Soil-Adjusted Vegetation Index (SAVI) to Identify Vegetation Covers on an Oil-Producing Landscape in Kedewan, Bojonegoro Regency

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Abstract. East Java Province is one of the most populous provinces in Indonesia with the second most populous position in Indonesia, the number of regencies and cities in East Java is 28 regions. Meanwhile, Bojonegoro Regency is the tenth most populous area in East Java. Population growth every year, of course, greatly impacts land use in Bojonegoro Regency, including one of its sub-districts, namely the Kadewan Sub-district. The increasing land use that occurs in Kedewan District is not only caused by increasingly dense population growth. However, this is caused by the fact that Kedewan District has an energy source in the form of oil, whose land is used for mining. If mining expands, it cannot be ruled out that vegetation, which is the main source producing oxygen for humans, will decrease. Therefore, it is important to re-analyze the vegetation index in the region. The aim of study is to investigate the integration of Normalized Difference Vegetation Index (NDVI) and Soil-Adjusted Vegetation Index (SAVI) as a tool to identify vegetation covers on an oil-producing landscape. Data collection using mothed observation techniques (non-participant observation) and document study techniques. The results of the study showed that NDVI and SAVI calculations had been carried out, and it was found that the overall density conditions in Kedewan District were classified as having a moderate level of vegetation density. Apart from that, from the calculations and analysis that have been done, the SAVI method is superior to using the NDVI method.

Keywords: Vegetation Index, NDVI, SAVI

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1. Introduction

The population growth in the world occurs so fast every year. According to the United Nations, several countries have very high population growth rates, one of which is Indonesia. Indonesia's population is the fourth most densely populated in the world. Based on the results of the census conducted in 2010, the total population of Indonesia is 237,641,326 million people, while the results of the 2020 census in September, Indonesia's population touched a figure of 270.20 million people. So it is seen that the population of Indonesia has increased by 32.56 million people from 2010 to 2020.

Bojonegoro Regency is the tenth most populous area in East Java. The development population of Bojonegoro Regency until 2020 has increased every year. The population in 2020 it 1,344,038 people. Compared to the population in 2019 of 1,331,077 people, there has been an increase of 12,961 people in 1 year. Population growth every year course directly impacts land use in Bojonegoro Regency, including one of its districts, namely Kadewan Sub-district. Land use is increasing such as settlements, business premises, and public

infrastructure, which will reduce the availability of land. In terms of land use, approximately 40.15% of the total area in Bojonegoro Regency is a state forest area. The proportion of land use includes 73,938 ha of paddy fields, 49,115 ha of dry land, 88,371 ha of forest, 58,100 ha of plantations, and 49,490 ha of others. Developments in the last five years show that the area of paddy fields decreased by an average of around 0.5% per year, dry land area decreased by 0.7 %, and forest land decreased by 3.3% per year (Dinas PERHUTANI Bojonegoro Regency in Murtia, 2014). The increasing land use in Kedewan Sub-district is not only caused by increasingly dense population growth. However, this is also caused by the fact that the Kedewan Sub-district has an energy source in the form of oil. If oil mining is expanded, it cannot be ruled out that oxygen-producing vegetation for humans will decrease. Therefore it is important to re-analyze the vegetation index in the region. Therefore it is important to re-analyze the vegetation index in the region.

One way to get conditional vegetation information can obtain from Landsat 8. Landsat 8 has several advantages, especially regarding the specifications of the bands it has and the length of the spectrum of the captured electromagnetic waves. As is well known, the color of objects in the image is composed of 3 basic colors, namely Red, Green, and Blue (RGB). With the increasing number of bands as constituents of composite RGB, the tones of objects become more varied. Many analysis methods can be used to determine the vegetation index of the area. However, this research focuses on the NDVI method and the SAVI method. Although the two methods are often used in a study, it is still rare to compare the results of analysis using the two methods in a study. According to Sinaga dkk., (2018), in they research on the availability of green open space in the Demak district using the NDVI and SAVI methods, the level of accuracy of the data obtained is better using the NDVI method. In addition, based on (Ariani dkk., 2020) research regarding the estimation of rice productivity levels in Pekalongan regency based on NDVI, SAVI and EVI algorithms, the best accuracy test uses the NDVI method. Therefore, this study aims to find out how the conditional of the vegetation index is in Kadewan Sub-district, Bojonegoro Regency using the NDVI and SAVI methods. The second aim is to compare the results of the vegetation index of the NDVI method and the results of the vegetation index of the SAVI method in the Kedewan Sub-district area.

2. Methods

This research uses quantitative research methods, and then this research uses data collection techniques using two kinds of methods, namely observation and document study. The quantitative approach is one of the scientific inquiry efforts based on the philosophy of logical positivism that operates with strict rules regarding logic, truth, laws, and predictions. Observations used are kinds of non-participant observation. Observation activities are carried out through observing pictures or document recordings. The document study method is carried out by collecting documents that are used as material for analysis. The data used in this study is secondary data, namely documents based on reports. One of the secondary data in this study is raster data and spatial data. This research also will make a land cover map. In the process of making land cover maps, there is an accuracy test process used. This accuracy test process aims to determine the suitability of the map made based on the actual conditions of the research area. In the process of testing the accuracy, the researchers took several sample points that were used to test the accuracy of the land cover map.

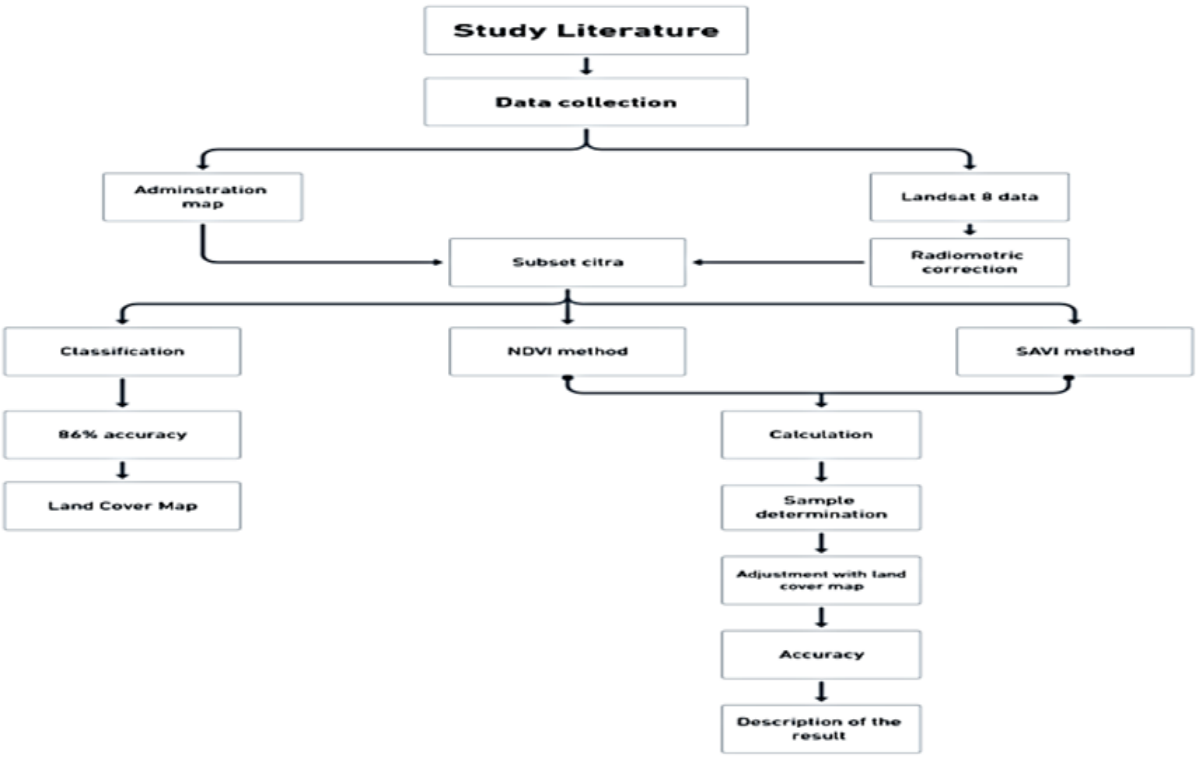

Fig. 1 Research flow chart

This study uses data analysis by comparing two methods it is NDVI and SAVI. The NDVI (Normalized Difference Vegetation Index) method is one of the methods used to determine a measure of the vegetation index in an area. One of the advantages of the NDVI method is that it is able to detect the spatial-temporal vulnerability of plants/vegetation and has a fairly high level of accuracy (Widiyatmoko et al., 2018). The SAVI (Soil Adjusted Vegetation Index) method is another type of vegetation index analysis method in which this SAVI method emphasizes the soil background disturbance in addition to referring to the canopy brightness level. One of the advantages of the SAVI vegetation index method is that it takes into account the background characteristics in the weighting of the vegetation index. The SAVI method itself uses band 4 (NIR) and band 8 (Simarmata dkk., 2021). The results of calculating the vegetation index using the NDVI and SAVI methods will produce several ranges of classification values. Class classification is based on the results of the vegetation index value using the NDVI and SAVI methods, the class classifications for both are the same but only differ in the range of values. The vegetation index class is divided into five classes, namely Non-RTH class, very low, low, medium, high, and very high (Tables 1 and 2).The following is the formula of the NDVI and SAVI methods:

$$NDVI = \frac{NIR-RED}{NIR+RED} \quad \text{.....(1)}$$

$$SAVI = \frac{NIR-RED}{NIR+RED+L} \text{ X } 1 + L \quad \text{.....(2)}$$

Explanation
NDVI = *Normalized Difference Vegetation Index*
SAVI = *Soil-Adjusted Vegetation Index*
NIR = *Band Near Infrared*
Red = *Band Red (NDVI) / Band Shortwave Infrared (SAVI)*
L = *Background Illumination Land (0,5)*

Table 1

Classification of NDVI methods

Class	Density	RTH Type
<0	Non RTH	Body water like a river, etc.
0-0,1	Very low	Settlements, vacant land, and paved or paving roads.
0,1 – 0,5	Low	Land cover vegetation, such as on dirt roads, and empty fields, without being lined with asphalt or paving roads.
0,5 – 0,7	Medium	Vegetation cover lands such as coconut plantations, mixed gardens, grass vegetation, golf courses, and others.
>0,7	High	Dense vegetation such as forests.

Source: Putra (2012)

Table 2

Classification of SAVI methods

Class	Density	RTH Type
-0,3667 - 0,0187	Non RTH	Body water like a river, etc.
0,0187 - 0,1041	Very Low	Settlements, vacant land, and paved or paving roads.
0,1041 - 0,3667	Low	Covered vegetated land, such as empty fields, dirt roads, asphalt paved roads, and paving roads.
0,3667 - 0,5214	Medium	Vegetation cover lands such as coconut plantations, mixed gardens, grass vegetation, golf courses, reeds, and others.
0,5214 - 0,7895	High	Dense vegetation such as forests.

Source: Mahesti., *et al* (2020)

3. Results and Discussion

3.1 Results.

3.1.1 Land cover of Kedewan Districts.

From the results of image data processing in the Kedewan District, it can produce a land cover map. Where the results of the land cover map are generated from the multispectral classification process using the Mahalanobis method. The Mahalanobis Distance method measures the distance between two objects by considering the correlation between objects in the form of vector variables of objects and covariance matrices (Wijaya dkk., 2022). According to (Imburi, 2020) research, in his research entitled "Comparison of Algorithms in the Alos Avnir-2 Image-Based Supervised Classification Method for Mangrove Mapping" results that the Mahalanobis supervised classification method has a better level of accuracy compared to the Density Slicing, Parallepiped, Minimum Distance, Maximum method. The likelihood, and Spectral Angel Mapper. Therefore in this study, the image classification method used is the Mahalanobis Distance method.The image data used for processing the land cover map is Lansad 8 Oli 2022 image data. From the results of was made this land cover map, we can see that the Kedewan District area still has a lot of forest areas and vacant land, and paddy fields. Where the most abundant area in Kedewan District is the forest area with a percentage of 34.5%. For the built-up land area in Kedewan District, this is only 5.5%. From the results of this mapping, we also know that the area of Kedewan District reaches 56 km2.

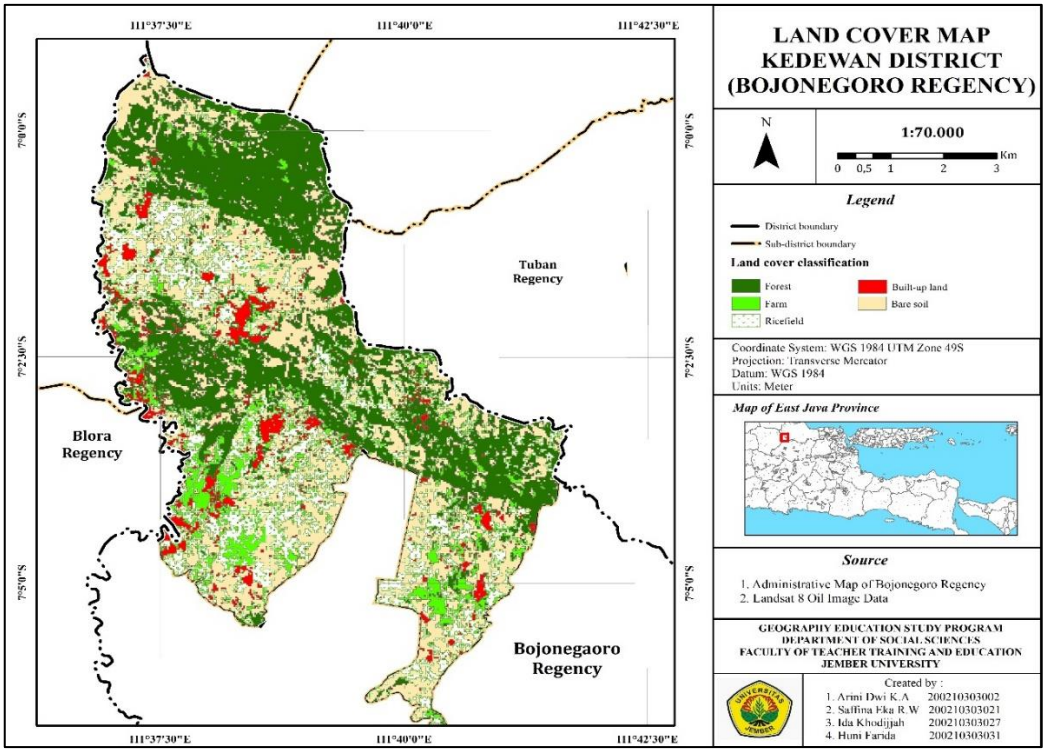

Fig. 2 Land Cover Map of Kedewan Sub-districts

Table 3
The results of the classification and the area of the Kedewan Sub-district

Na.	Land Use Classification	Area (M)	Area (ha)	Area (Km^2)	Percentage (%)
1	Forest	18.910.717	1891	19	34,5
2	Built-up land	3.224.122	322	3	5,5
3	Vacant land	18.340.147	1834	19	32,7
4	Plantation/Garden	5.080.635	508	5	9,1
5	Rice field	1.0212.987	1021	10	18,2
	Total area		5.576	56	100%

3.1.2 Test the accuracy of the land cover map.

A map accuracy test is an attempt to find out how accurate the map that has been made is. In the tests conducted, this study took 50 sample points. From the results of the accuracy test calculations, it was obtained that the interpretation accuracy reached 86%. Therefore this land cover map is good enough for further use. The most errors from the accuracy test conducted were at the location of the rice fields where out of a total of fourteen samples taken, only ten samples were correct. One wrong sample was vacant land, and the other three samples were identified as vacant land. From the producer's side (Producer's Accuracy) and the user's side, the highest total emission error was from the user's side where the total emission error from the producer's side was 63.82%, while that from the user's side was 85.58%.

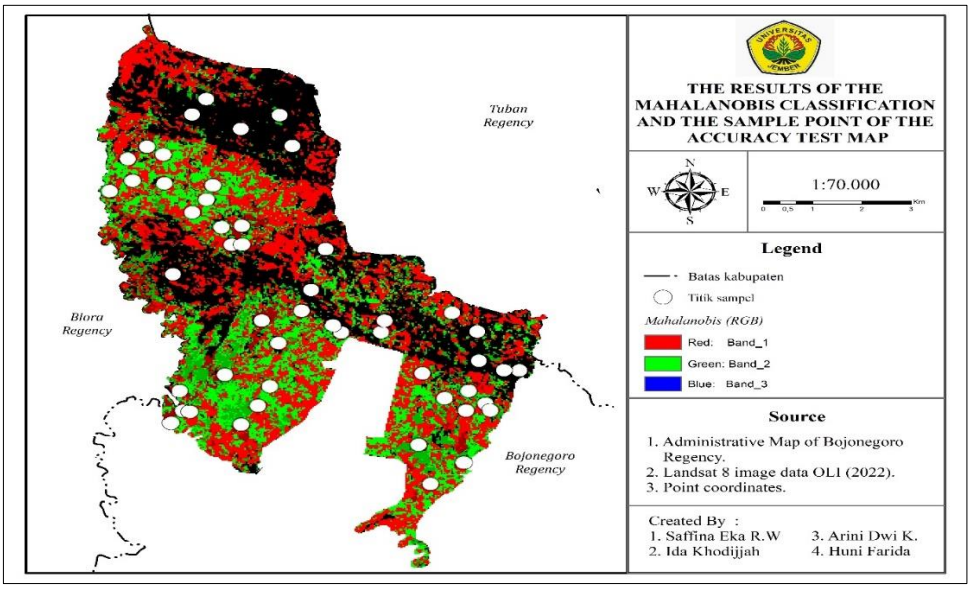

Fig. 3 Location point sample to accurate test

Table 4
Accuracy test error matrix

REPORT CATEGORY	CATEGORIES OF INTERPOLATION RESULTS					ROW TOTALS
	Built-up land	*Vacant land*	*Forest*	*Plantation/ Garden*	*Rice field*	
Built-up land	15					15
Vacant land		5	1			6
Forest			10			10
Plantation / Garden		1		3	1	5
Rice field	1	3			10	14
COLUMN TOTALS	16	9	11	3	11	50

Table 5
Continue from the accuracy test error matrix table

MAPPING ACCURACY				ACCURACY OF INTERPRETATION RESULTS
Producer"s Accuracy	*Omission of errors*	*User's Accuracy*	*Omission of errors*	
15/15 = 100%	0%	15/15=100%	0%	(15+5+10+3+10)/50 = **86%**
5/9 = 55,5%	44,5%	5/6= 83%	17%	
10/11 =90,09%	9,91%	10/10=100%	0%	
3/3 =100%	0%	3/5=60%	40%	
10/11 =90,09%	9,91%	10/14=71,42%	28,58%	

3.1.3 Vegetation index uses NDVI methods

From the calculation of the vegetation index in Kedewan District, the minimum value is 0.124043, while the maximum value is 0.82691. From the values obtained, in general, the classification of the vegetation index in Kedewan District is divided into five classifications. Of the total land area in Kedewan District, this is approximately 55 km2. Almost as a condition, the vegetation index is classified as moderate with a percentage of the total area reaching 71.69%. Thus, the condition of the vegetation in the Kedewan sub-district is mostly in the form of vegetation cover land in the form of plantations, mixed gardens, grass vegetation, and reeds. For the classification of conditions, the vegetation density index is very low, very small, and even less than 1%, which only reaches 0.0010%.

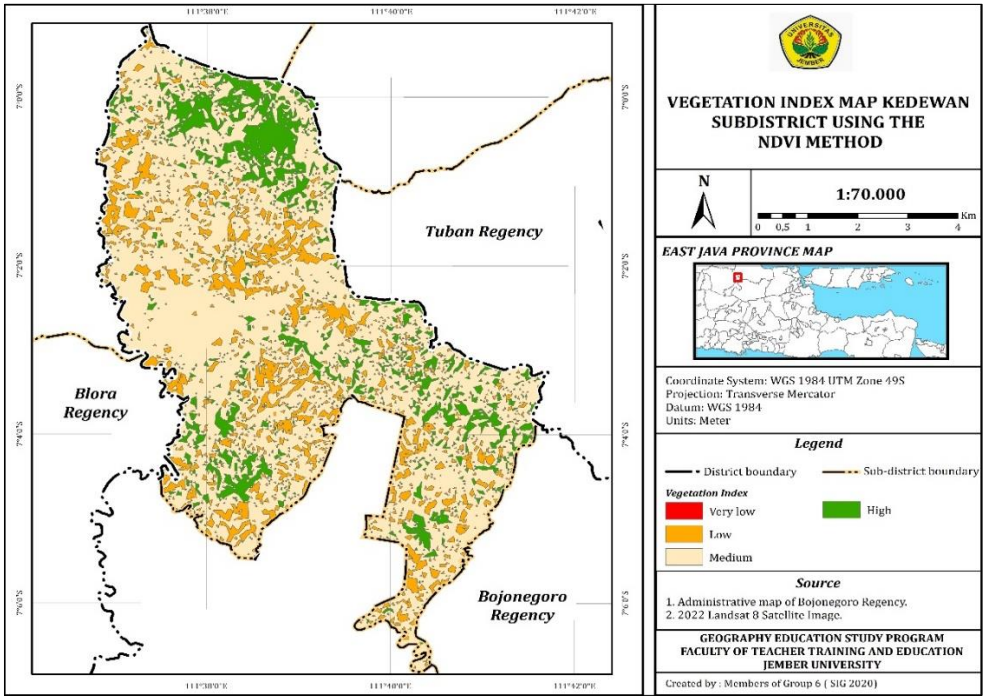

Fig. 4 The vegetation index map uses NDVI methods.

Table 6
Land cover classification results

No.	Classification	Description	Class Name's	Area (M)	Area (Ha)	Area (KM)	Percentage (%)
1	Very Low	Settlements, vacant land, and paved or paving roads.	Built-up land	576	0	0	0,0010
2	Low	Land cover vegetation, such as on dirt roads, and empty fields, without being lined with asphalt or paving roads.	Vacant land	8.270.021	827	8	14,85
3	Medium	Vegetation cover lands such as coconut plantations, mixed gardens, grass vegetation, golf courses, and others.	Grassy vegetation (rice fields and plantations/garden)	39.922.729	3.992	40	71,69
4	High	Dense vegetation such as forests.	Forest	7.496.406	750	7	13,46
Total				55.689.732	5.569	55	100

3.1.4 Vegetation index uses SAVI methods

From the results of calculations using the SAVI Index method, the minimum value is 0.00, while the maximum value is 0.637835. Therefore, according to the classification method, there are only four class classifications, because there are no numbers below 0. So we know that there are no water bodies in this Kedewan District area. From the calculations that have been done, it is found that the medium classification has the largest area, around 54.21% of the total area, so it can be said that in Kedewan District many plantations, mixed gardens, grass, and reed vegetation are found. It is estimated that plantations, mixed gardens, grass vegetation, and Imperata cover an area of 3,021 hectares. From this classification, we also know that built-up land areas such as settlements and roads have the smallest area, which is 0.07% or an area of 4 hectares. From the SAVI method, we also know that there is quite a bit of forest vegetation in Kedewan District, only 1.091% or an area of 61 hectares.

Table 7
Land cover classification results (2)

Na.	Classification	Description	Class Name's	Area (M)	Area (Ha)	Area (Km^2)	Percentage (%)
1	Very Low	Settlements, vacant land, and paved or paving roads.	Built-up land	39.374	4	0	0,07
2	Low	Covered vegetated land, such as empty fields, dirt roads, asphalt paved roads, and paving roads.	Vacant land	24.870.053	2.487	25	44,63
3	Medium	Vegetation cover lands such as coconut plantations, mixed gardens, grass vegetation, golf courses, reeds, and others.	Grassy vegetation (rice fields and plantations / garden)	30.210.206	3.021	30	54,21
4	High	Dense vegetation such as forests.	Forest	608.176	61	1	1,091
Total				**55.727.809**	**5.573**	**56**	**100**

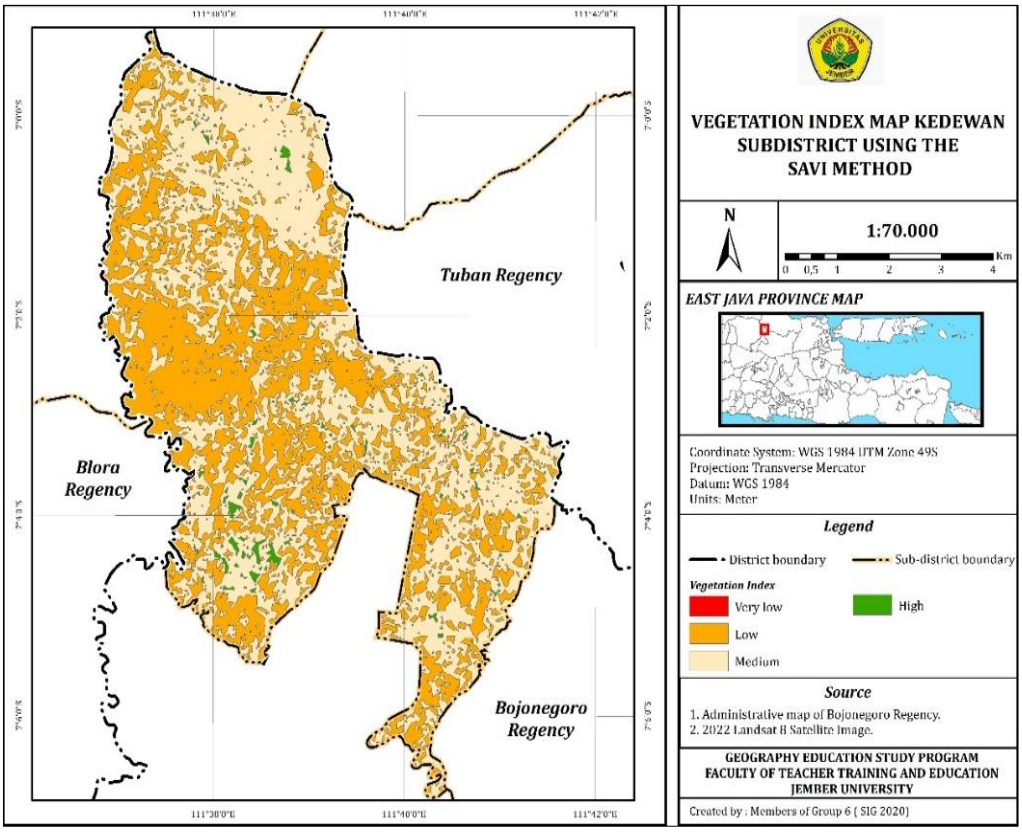

Fig. 5 The vegetation index map uses SAVI methods

3.2 Discussion.

From the calculation of the results of NDVI and SAVI both have quite different results. One of the differences lies in the maximum value generated from the NDVI method and SAVI method where the value is greater using the NDVI method, which is a value of 0.82691 while using the SAVI method the maximum value only reaches 0.637835. And the smallest value is also different, where SAVI has the smallest value of 0 while NDVI has the smallest value of 0.124043. Therefore, the number of areas that have a high-density level is more identified on the area index map using the NDVI method, compared to using the SAVI method.

Table 8

Comparison of NDVI and SAVI methods based on land cover maps

Class Name	Area Percentage(%)		
	Land Cover Map (Mahalanobis)	NDVI	SAVI
Built-up land	5,5	0,001	0,07
Vacant land	32,7	14,85	44,63
Grassy vegetation (rice fields and plantations/ garden)	27,3	71,69	54,21
Forest	34,5	13,46	1,091

From Table 8 we can see that the more appropriate vegetation index value is the vegetation index value using the SAVI method. Where the comparison is a land cover map made with the Mahalanobis classification method. Based on the percentage of area, the SAVI value is closer to the percentage of the land cover map compared to the percentage area of the NDVI method. Therefore it can be said that the vegetation index method using the SAVI method is better than the NDVI method, especially in the built and open land classes. This is because the SAVI method is a method that emphasizes the effect of soil pixels with an emphasis on using the background canopy adjustment factor (Sinaga et al., 2018), so it is quite sensitive to areas with low and very low vegetation. In addition, the SAVI method is also quite good at identifying the residential area, because as we know that most of the roofs in residential areas are made of clay. Meanwhile, for types of vegetation density such as forest, the NDVI method is far superior to the SAVI method as seen from the percentage of the land cover map area.

4. Conclusion

From the results of the NDVI and SAVI calculations that have been made, overall the density conditions in Kedewan District are classified as having a moderate density level. Where this can be seen from the land cover map using the Mahalanobis method, and most of the area is open land areas, rice fields, and gardens. In addition, if you look at the land cover maps that have been made using the Mahalanobis method to identify very low to low-density classes, the SAVI method is superior to using the NDVI method. Meanwhile, to identify high-density classes, the NDVI method is superior to the SAVI method. This study did not test the accuracy of the vegetation index density map for each method, which only compared it with the land cover map that had been made, because it could be material for further research.

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