



Vegetation Index Assessment Modeling Using Remote Sensing And Soil Surveying The Slope of Argopura Mountain: a Case Study in Kalianan Village, Krucil District, Probolinggo Regency

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ABSTRACT

Vegetation is a form of soil with a density level in each region that is influenced by other land factors such as rainfall, soil conditions, and water. Density levels can be analyzed either manually in the field or using remote sensing technology. Field observations have weaknesses, one of which is that the time used for a wide area > 1 ha requires > 2 days. The use of remote sensing technology has the advantage of being able to cover large areas in a short time with a modeling system. The research uses a data exploration modeling method with an NDVI approach to calculate the analysis of Landsat 8 image bands. NDVI is calculated based on bands 4 (red) and 5 (near-Infrared). The research results show that in 2017, Kalianan Village, Krucil District, had a vegetation index dominated by dense and very dense density classes. In 2022, the vegetation index of Krucil Village will be dominated by medium- and low-density classes. The differences that occur in 2017 and 2022 could occur due to the deforestation of land for tourism and residential areas.

INTRODUCTION

Land is a natural resource needed by living creatures to fulfill their living needs (Basuki et al., 2024). There is a close relationship between land and living things. Human land use is closely related to changes in the land surface. Land changes by humans are used for transportation, development, and other changes that support the continuity of human life. These changes also have an impact on changes in vegetation density (Asgari et al., 2020; Basuki et al., 2021). Vegetation is a constituent of land, with variations and classifications regarding different densities in each region. Vegetation describes how much land has been utilized by the

community. Vegetation diversity is influenced by the types of plants on land (Quigley et al., 2020).

Vegetation density interacts with one plant and other plants. Vegetation has an important role in maintaining the ecosystem (Basuki, Bambang Hermiyanto, et al., 2023; Quigley et al., 2020). The dense vegetation conditions make an area very suitable for habitation. This is related to the suitability of temperature and easy access to food ingredients such as vegetables. Population growth is one of the factors underlying land changes and changes in vegetation density (Mulyani et al., 2020; Soetriono et al., 2023). Analysis of land cover by vegetation density can be done using satellite imagery. Satellite imagery is the result of remote sensing sensors that utilize electromagnetic waves to transmit image data from land. Analysis can use satellite imagery from Landsat 8. Interpretation using satellite 8 imagery can use the Normalized Difference Vegetation Index (NDVI) method (Basuki, Hermiyanto, et al., 2023). The data obtained was obtained by using near-infrared calculations with the radiation emitted by plants (Jia et al., 2014).

The NDVI (Normalized Difference Vegetation Index) method is an image transformation with spectral sharpening to analyze things related to vegetation density (Andriani et al., 2018; Munyati & Sinthumule, 2021). From the use of NDVI, land use and land degradation can be seen from year to year (Yanti et al., 2020). One of the analyses carried out to observe changes in vegetation density levels is observing vegetation in the Mount Hyang Argopuro area. Mount Hyang Argopuro is a mountain that has great potential for changing vegetation. This is caused, in part, by fires that often occur in mountainous areas (Latifah., 2018). Identification of vegetation density can be done using NDVI by utilizing imagery from Landsat 8 (Basuki, Sulistiawati, et al., 2023). Kalianan village, Krucil subdistrict, and Probolinggo district are an area at the foot of Mount Argopura to the north that has the potential for changes in vegetation that can disrupt climate change. This research aims to assess vegetation indices using remote sensing modeling, especially in Kalianan village, Krucil subdistrict, and Probolinggo district, part of the slopes of Mount Argopura, in 2017 and 2023.

METHODS

Location and Time

The research was carried out in Kalianan village, Probolinggo district, East Java province, and in the laboratory of land resources and climate science, Faculty of Agriculture, Jember University. Kalianan Village is one of the villages in Krucil sub-district, Probolinggo Regency, on the slopes of Mount Argopuro. This village is located at coordinates 7° 54' 57.11" S and 113° 30' 43.69" E, with an altitude of between 1000 and 1300 meters above sea level and an area of 1,328.62 ha (Fig 1). From the map, it can be seen that Kalianan village to the north is Plaosan village, to the south is Bermi village, to the west is Watupanjang village, and to the east are the Argopuro mountains. The research was conducted in January–July 2023.

Method of Collecting Data

The data collection technique used in this research involves acquiring image data from Landsat 8 OLI/TIRS C2 L1 temporally in 2017 and 2022. Primary data collection is in the form of satellite images downloaded via the official USGS (United States Geological Survey) website, <https://www.usgs.gov/>, by considering the percentage of cloud cover. The images used in this research are band 4 (red) and band 5 (near-infrared) (Gumma et al., 2011; How Jin Aik et al., 2021; Nurrochman et al., 2020; Sampurno RM, 2016).

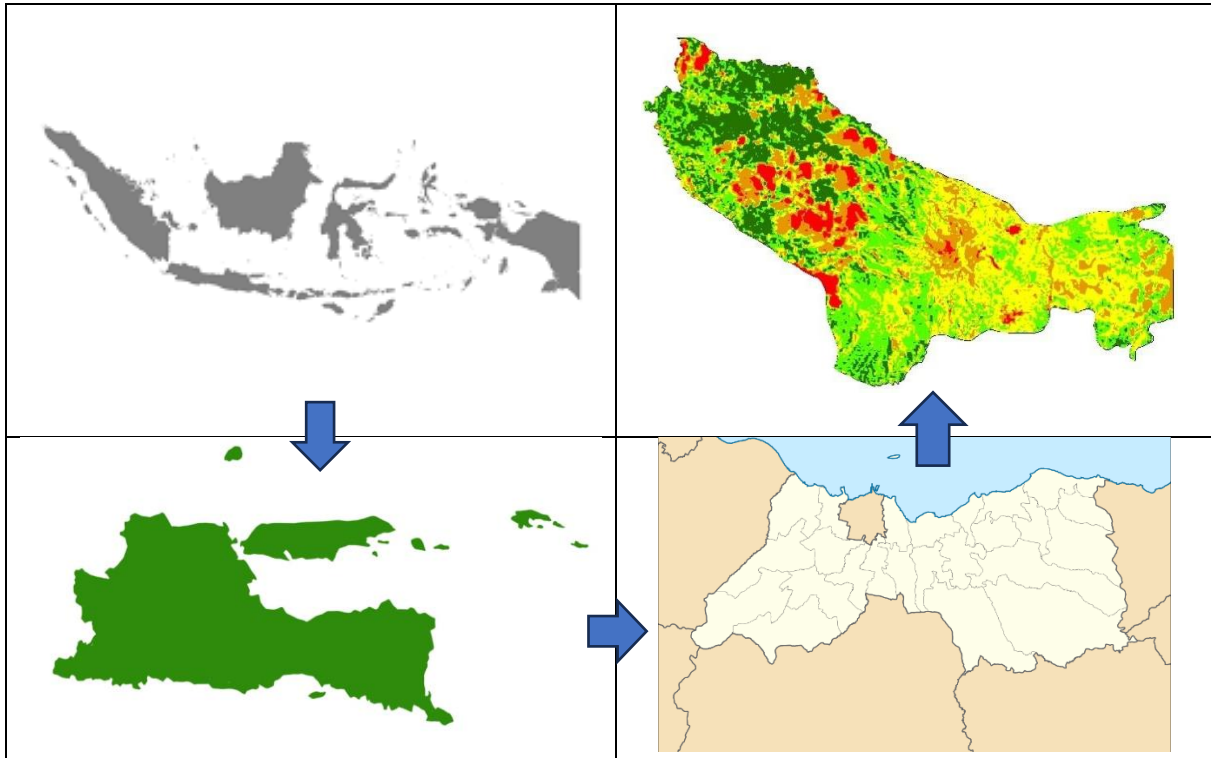


Fig 1. Research location

Data Analysis

The method used to assess vegetation density uses a remote sensing approach and land survey. Data analysis is divided into several stages of activity, including collecting Landsat 8 imagery in 2017 and 2022. The Landsat image data is cut according to the research area, especially in Kalianan Village, Krucil District, and Probolinggo Regency (Fig 2). The results of the cuts in the research area are analyzed by the Normalized Difference Vegetation Index (NDVI) with the formula:

$$\text{NDVI} = (\text{NIR} - \text{RED}) / (\text{NIR} + \text{RED})$$

(Mahboob et al., 2019; Yang et al., 2017)

The results of NDVI identification are classified according to the colors that appear and are divided into 5 classes, including no vegetation, low vegetation, moderate vegetation, dense vegetation, and very dense vegetation (Munyati & Sinthumule, 2021; Ramadanningrum et al., 2020; Yu et al., 2021). The NDVI classes and wavelengths for vegetation density (Table 1).

The results of identifying vegetation density as an effort to determine the truth were carried out by a field survey as an effort to determine the level of accuracy of the truth in the field.

Table 1. NDVI values and vegetation density

No	Plant density	NDVI
1	Vegetation is very dence	0,36 – 1,00
2	Dense vegetation	0,26 – 0,35
3	Moderate vegetation	0,16 – 0,25
4	Low vegetation	-0,04 – 0,15
5	Not vegetated	-1 – -0,03

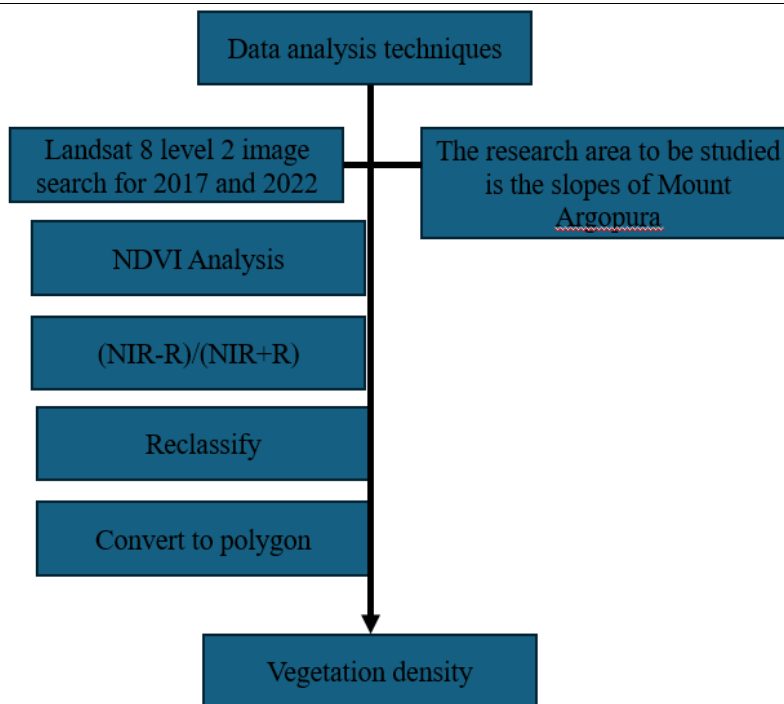


Fig 2. Research flow for analyzing vegetation density data

RESULTS AND DISCUSSIONS

Land cover is closely related to the use of natural resources by humans that occurs on a plot of land. The increase in human activity has made it possible to trigger accelerated changes in the land use index (Rahman et al., 2024).Vegetation is an algorithm applied to satellite images that is used to determine aspects of vegetation density, or, in more practical terms, the vegetation index. The vegetation index is a mathematical transformation that includes several channels simultaneously to produce a new image that is more representative when representing aspects related to vegetation (Setiawati et al., 2024). Maps of vegetation density levels and their extent in Kalinan Village, Krucil District, in 2017 and 2022 can be seen in Figures 1 and 2. Vegetation density levels were obtained using NDVI algorithm calculations using ArcGIS 10.8

using band 5 and band 4 Landsat 8 images. Density map Vegetation in Kalianan Village, Krucil District, and Probolinggo Regency in 2017 can be seen in Figure 3.

The NDVI values used are divided into 5 classes, namely No Vegetation, Low Vegetation, Medium Vegetation, Dense Vegetation, and Very Dense Vegetation. From the results of data management from Satellite Image 8, 2017, it shows that the vegetation density value of Kalianan village, Krucil sub-district in 2017 was dominated by dark green and light green. These two colors themselves identify the level of vegetation density as very dense and dense. The area of each class can be seen in Table 2.

Table 2. Values of Vegetation Density, NDVI and Area in Kalianan Village, Krucil District, 2017

No	Plant density	NDVI	Color	Area (ha)
1	Vegetation is very dence	0,36 – 1,00	Dark green	1.777,58
2	Dense vegetation	0,26 – 0,35	Light green	1989,41
3	Moderate vegetation	0,16 – 0,25	Yellow	1523,36
4	Low vegetation	-0,04 – 0,15	Orange	665.31
5	Not vegetated	-1 – -0,03	Red	953,51

Table 3. Values of Vegetation Density, NDVI and Area in Kalianan Village, Krucil District, 2022

No	Plant density	NDVI	Color	Area (ha)
1	Vegetation is very dence	0,36 – 1,00	Dark green	367,68
2	Dense vegetation	0,26 – 0,35	Light green	1131,61
3	Moderate vegetation	0,16 – 0,25	Yellow	2199,84
4	Low vegetation	-0,04 – 0,15	Orange	1975,44
5	Not vegetated	-1 – -0,03	Red	1234,15

The vegetation index value is a numerical measure that describes the density or health of vegetation in a certain area based on analysis of satellite imagery or spectral data. One of the most commonly used vegetation indices is the Normalized Difference Vegetation Index (NDVI) (Astuti & Arsana, 2023). In the table above, it can be seen that the density of vegetation in Kalianan village, Krucil sub-district, in 2017 was dominated by the very dense density class with an area of 1777.581417. The NDVI value of this very dense density class is 0.36 to 1.00. Meanwhile, the Meeting vegetation density class, with an area of 198.412281, has an NDVI value of 0.26 to 0.35. This shows that the vegetation density results in Kalianan village, Krucil sub-district, in 2017 are still in good condition. A good vegetation index level can indicate that the area is still in a stable ecosystem condition and also has supporting agricultural potential. This can be influenced by several factors that support environmental conditions in increasing

the level of vegetation density, including water availability, a supportive climate, and minimal land conversion.

Based on Figure 3, it can be shown that there is a difference in vegetation density in 2022 compared to vegetation density in 2017. Vegetation has experienced a change in density from being dominated by green to being dominated by yellow to orange. The dominance of yellow to orange indicates that the vegetation density in Kalinan Village in 2022 will be dominated by medium- to low-density levels. This can be explained through the data on the vegetation density area of Kalinan Village in 2022 in Table 3. In Table 3 above, it can be seen that the vegetation density in Kalianan village, Krucil sub-district, in 2022 is dominated by the medium density class with an area of 2199.84 ha. The NDVI value of this medium-density class is 0.16 to 0.25. Meanwhile, the vegetation density class is low in Area 1975.44 ha has an NDVI value of -0.04 to 0.15. This shows that the vegetation density results in Kalianan village, Krucil subdistrict, in 2022 have changed from 2017. Many factors cause a reduction in vegetation density in an area.

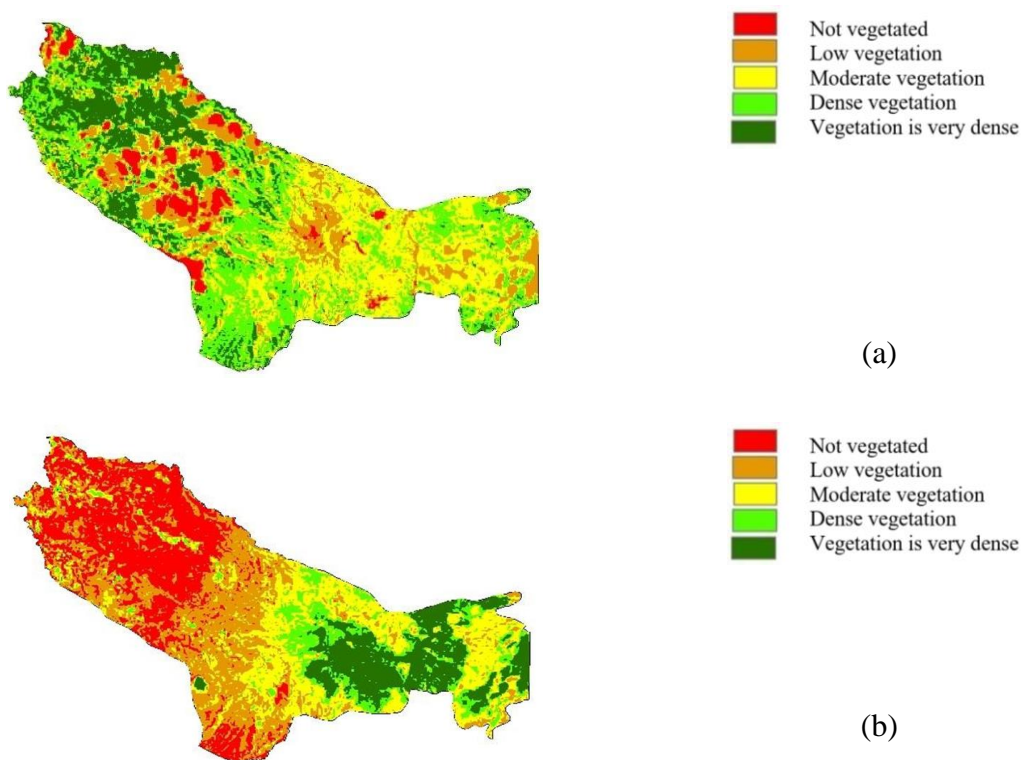


Fig 2. Vegetation Density Map of Kalinan Village, Krucil District, 2017 (a) and 2022 (b)

The differences in the results found in 2017 and 2022 have very significant differences. This can be seen from the description in Table 2 and Table 3. In 2017, the resulting vegetation density level was classified as being in good condition, dominated by dense and very dense vegetation levels. Meanwhile, in 2022, vegetation density levels were found to be dominated by rare and very rare vegetation density levels. The review of density change factors was carried out via Google Earth in Kalinan Village, Krucil District. From the results of this review, it cannot be said significantly what factors cause changes in vegetation density (Basuki & Sari,

2024; Soetrisno et al., 2024). The results of the interpretation through conditions seen on Google Earth are the possibility of deforestation for certain purposes, such as tourism and others. Apart from that, the conversion of land into residential areas may also be one of the factors causing changes in vegetation density in Kalinan Village.

CONCLUSIONS

Based on the results of the practicum activities, several conclusions were obtained, as follows:

1. The vegetation density in Kalianan Village, Krucil District, in 2017 was dominated by very dense and dense density classes, which indicated that the vegetation density of Kalianan Village was in good condition.
2. The vegetation density in Kalianan Village, Krucil District, in 2022 was dominated by the medium-density class with an area of 2.199.84 ha and the low-density class with an area of 1.975.44 ha.
3. The cause of the decrease in vegetation density in Kalianan Village, Kurcil District, is likely the deforestation of land for tourism and residential purposes.

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