Available online at http://iorajournal.org/indx.php/orics/index

**Operations Research: International Conference Series**

e-ISSN: 2722-0974
p-ISSN: 2723-1739

Vol. 2, No. 4, pp. 93-101, 2021

# Analysis of Changes in Green Land Cover of North Minahasa Gold Mine With Landsat 8 Images using the Normalized Difference Vegetation Index

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**Abstract**

Mining is an activity of extracting non-renewable natural resources, including coal, whose management cannot be separated from the company. In realizing mining activities, they must be managed optimally, so it is necessary to supervise and monitor their activities effectively and efficiently. North Minahasa Mining Toka Tindung is a gold mine that has been operating since 2009, with the first gold production in 2011, and has gold reserves of 122 tons at the end of 2020. Toka Tindung has a mining area of 8,986 hectares (400 thousand square km), or 1.3 percent of the planned contract of work which is 741,000 hectares. This research was conducted by monitoring mining land cover using remote sensing technology based on Landsat 8 satellite imagery. related to vegetation. NDVI has a range of values between -1 to +1, the results of the transformation have different percentages of land use. The greater or positive the NDVI value, the better the vegetation density in the area. This study aims to analyze changes in green land cover in the mining area of North Minahasa in 2013 to 2021 based on variations in the greenness of the vegetation index. The results of the study obtained that Variations in the greenery index of vegetation ranged from 0.0 - 0.4 in 2013 and -0.2 - 0.6 in 2021. Where the mining area environment in 2013 had a vegetation class in the form of rocks, vacant land, meadows, shrubs and dense forests and in 2021 had a vegetation class in the form of rocks, vacant land, grasslands, shrubs, dense forests and water. In 2021 it has a vegetation value of -0.2 whose vegetation class is water due to the loss of Ground Cover Vegetation due to digging too deep to form ponds. on the ground surface. Thus the level of vegetation density in the mining area of North Minahasa has changed from 2013 to 2021. The area without vegetation has generally increased. Replacing the green area and the area with vegetation cover, dense green land cover has decreased.

*Keywords:*

## 1. Introduction

Land cover is a physical material appearance on the earth's surface where land cover describes the relationship between natural processes and social processes. Land cover can also provide important information for modeling purposes and for understanding natural phenomena occurring on the earth's surface. Land co ver data are also used in studying climate change and understanding the relationship between human activities and global change (Ardli and Wolff, 2009; Sharma et al, 2018). Accurate land cover information is one of the determining factors in improving the performance of ecosystem, hydrological, and atmospheric models. In addition, land cover also provides basic information in geoscience studies and global change (Sampurno and Thoriq, 2016).

This land cover information can describe the relationship between natural processes and social processes in the form of models of natural phenomena that occur on the earth's surface. Detection of changes in earth's surface objects, especially land cover monitoring, can be done using remote sensing technology (Jianya et al, 2008; Hussain et al, 2013). Remote sensing is one of the technologies used for remote land cover monitoring techniques which will then obtain information on land vegetation cover quickly, accurately and efficiently (Rogan, 2004; Syam et al, 2012).

Vegetation as a constituent of land has a very diverse type. The collection of diverse vegetation will produc e different levels of vegetation density for each land use in an area. The level of vegetation density can be assessed through the use of technology that is currently developing (Bell, 2001; Dassot et al, 2011). Vegetation has unique spectral characteristics so that it can be analyzed in various ways to obtain an index that represents the condition of the vegetation. These technologies are remote sensing technology (remote sensing) and geographic information

systems (GIS). The method of measuring vegetation using satellite imagery utilizes the reflectance of the landscape features.

Research on this land cover has been carried out before, by Aditya in 2020 to analyze changes in the vegetation density index using Landsat Imagery with the results of the NDVI method being 87.82% accurate in 20 13 images and 86.72% in 2018 images (Khairawan et al, 2020). Jan W. Hatulesila in 2019 research to analyze the greenery index value (NDVI) in the spatial pattern of Ambon city, Maliku province with a greenness index value (NDVI) at nine sampling locations of Ambon City green open space for vegetation cover area is 61.58 ha or 58.31%, built area 39.63 ha or 37.52% and vacant land 4.40 ha or 4.17% (Hatulesila et al, 2019). Another study was conducted by Andi T. Waru for Temporal Analysis of Mangrove Forest Change Using Sentinel-2 Satellite Imagery Case Study on Tanakeke Island, Takalar Regency with an overall accuracy of mangrove forest classification results in 2016 and 2019 of 91% and 98%, respectively (Waru et al, 2021).

This study was conducted to analyze land cover changes in the North Minahasa area using the Normalize Difference Vegetation Index (NDVI) method with satellite imagery data used is Landsat 8. in 2013 and 2021. To determine the spatial pattern of gold mining land cover, the variable used is the greenness of the vegetation. Changes in land use that occur in 2013 and 2021 will be seen from land cover patterns and variations in the greenness of the vegetation index.

## 2. Research Methodology

### 2.1. Flowchart of Thought

This research was conducted by looking at the spatial pattern of gold mining land cover in northern Minahasa based on the pattern of land cover changes in 2013 and 2021. In determining the spatial pattern of gold mining land cover the variables used were greenness of vegetation and greenness of non-vegetation. Changes in land use that occurred in 2013 and 2021 will be seen from variations in the greenness of the vegetation index and the greenness of non – vegetation.

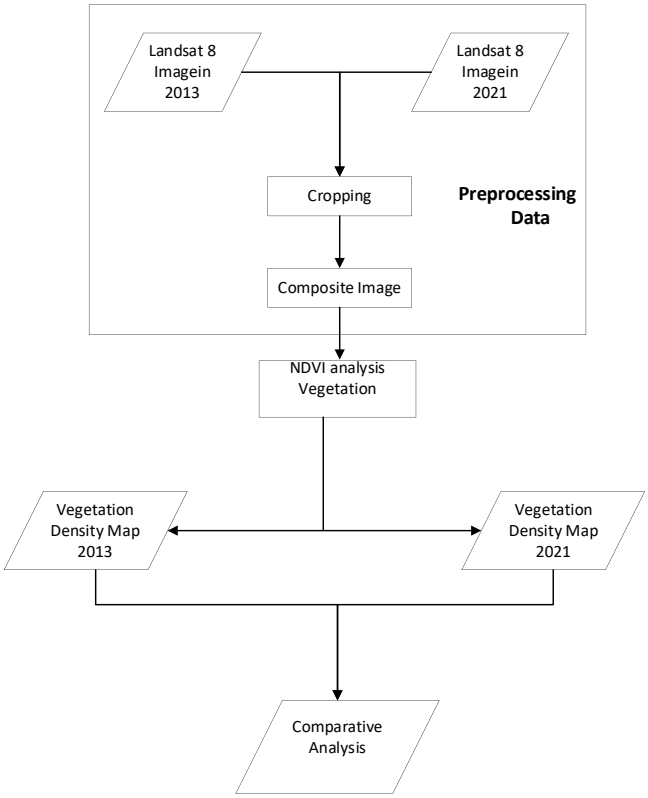


**Figure 1.** Research Steps Flowchart

### 2.2. Data Collection Techniques and Types of Data

Primary data used in the form of Landsat-8 OLI/TIRS imagery path 112 row 05 in 2013 and 2021 downloaded from the US Geological Survey (USGS) website (http://glovis.usgs) .gov/) to get the NDVI value from the date of image recording on November 22, 2013 and August 19, 2021. This research uses software QGIS and software R.

**Figure 2.** Research Locations at (USGS) website (http://glovis.usgs) .gov/) (01035'20" LS and 125007'15" BT)

### 2.3. Data

Processing is carried out to obtain the vegetation index value and the greenness of the vegetation. The first stage is to carry out the preprocessing process, which is image cropping. Image cropping carried out in this study aims to limit and focus the image area according to the research area. In addition, cutting is also to facilitate processing and analysis, generally the size of Landsat 8 image data. The next preprocessing is compiling color composite images. The process of compiling a color composite image is carried out to combine three color channels simultaneously in one display so as to facilitate visual interpretation. Three different Landsat image bands, each of which will be entered into three channels, namely the red channel, the green channel and the blue channel. The combination of these three colors will produce a new image, which is usually the arrangement of bands used in compiling a composite image for a specific purpose, for example to highlight the greenness of plants or to obtain an infrared color image.

**Tabel 1.** characteristics of Landsat 8

| Band | Resolution (meters) |
|---|---|
| Band 1 – Coastal Aeroso | 30 |
| Band 2 – Blue | 30 |
| Band 3 – Green | 30 |
| Band 4 – Red | 30 |
| Band 5 – Near Infrared (NIR) | 30 |
| Band 6 – Short-wave Infrared (SWIR) 1 | 30 |
| Band 7 – Short-wave Infrared (SWIR) 1 | 30 |
| Band 8 – Panchromatic | 15 |
| Band 9 – Cirrus | 30 |
| Band 10 – TIRS 1 | 100 |
| Band 11 – TIRS 2 | 100 |

The next process is to calculate the landsat-8 image to get the value the greenness of the vegetation and the value of the vegetation index. To get the greenness of the vegetation, the process is carried out using the ndvi algorithm. The normalized difference vegetation index (NDVI) is an index that shows the level of density and presence of plants on the surface (Delarizka and

Sasmito, 2016) Then the NDVI value is classified into four levels based on the greenness of the vegetation. The NDVI value to be obtained is between -1 to 1 (Wibowo, 2015). The following NDVI formula is used in Landsat-8 images:

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

$$NDVI = \frac{(Band5 - Band4)}{(Band5 + Band4)}$$

Note: NDVI is normalized difference vegetation index or index of vegetation conditions, NIR is near infrared reflectance or near infrared rays, RED is red reflectance or red light reflection.

**Table 2.** Classification of the level of greenness of vegetation in Landsat-8 images (Nugroho, 2016).

| Value of Vegetation Index Greenness | Level of Vegetation |
|---|---|
| <0.3 | Non-vegetation |
| 0.3-0.4 | Low |
| 0.4-0.6 | Medium |
| >0.6 | High |

## 3. Results and Discussion

Preprocessing of the entire Landsat 8 image data is carried out by cropping the image according to the research area, namely the North Minahasa Toka Tindung gold mine area and making color composite images. The Landsat 8 image band used is selected based on the required band according to the process. The images that have been selected are used as input datasets and output datasets are made as storage media for the resulting images. The Landsat data obtained will be in tar.gz format so it needs to be extracted first, and 14 data will be obtained from each band of Landsat 8 imagery in .tif format along with metadata files.

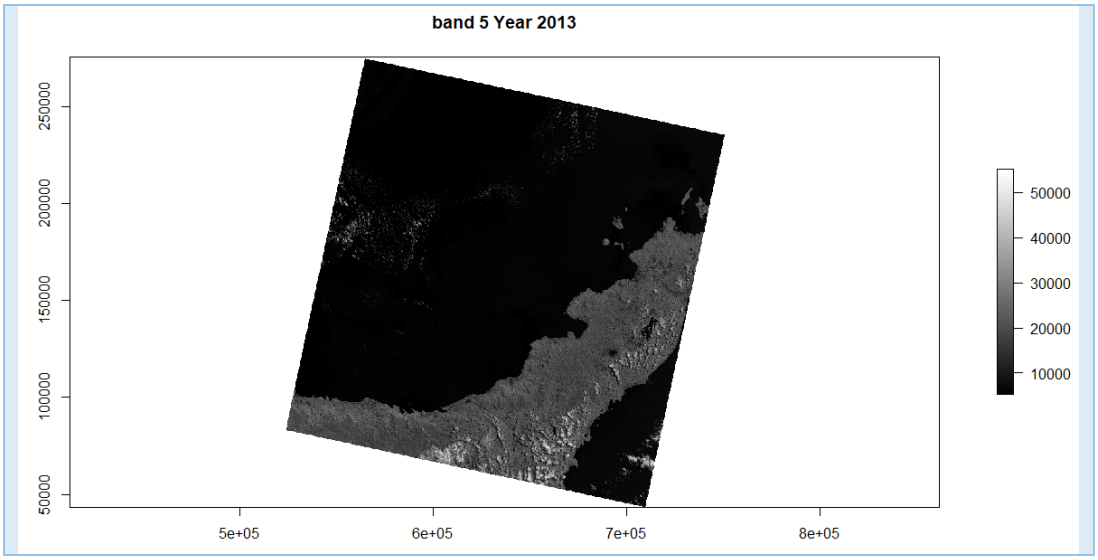


**Figure 3.** An example of one of the image data of band 5 of 2013

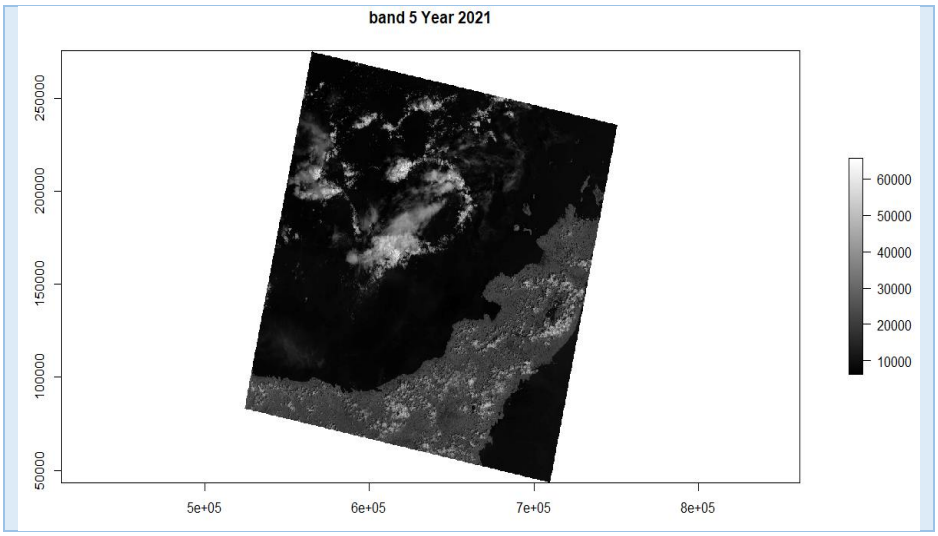


**Figure 4.** An example of one of the image data of band 5 of 2021.

### 3.1. Preprocessing Data

#### a. Satellite Imagery Cropping

One of the preprocessing processes carried out is image cropping. Image cropping carried out in this study aims to limit and focus the image area according to the research area. In addition, cutting is also to facilitate processing and analysis, generally the size of Landsat 8 image data has a large enough size, so this process will also be able to reduce memory capacity during data processing.

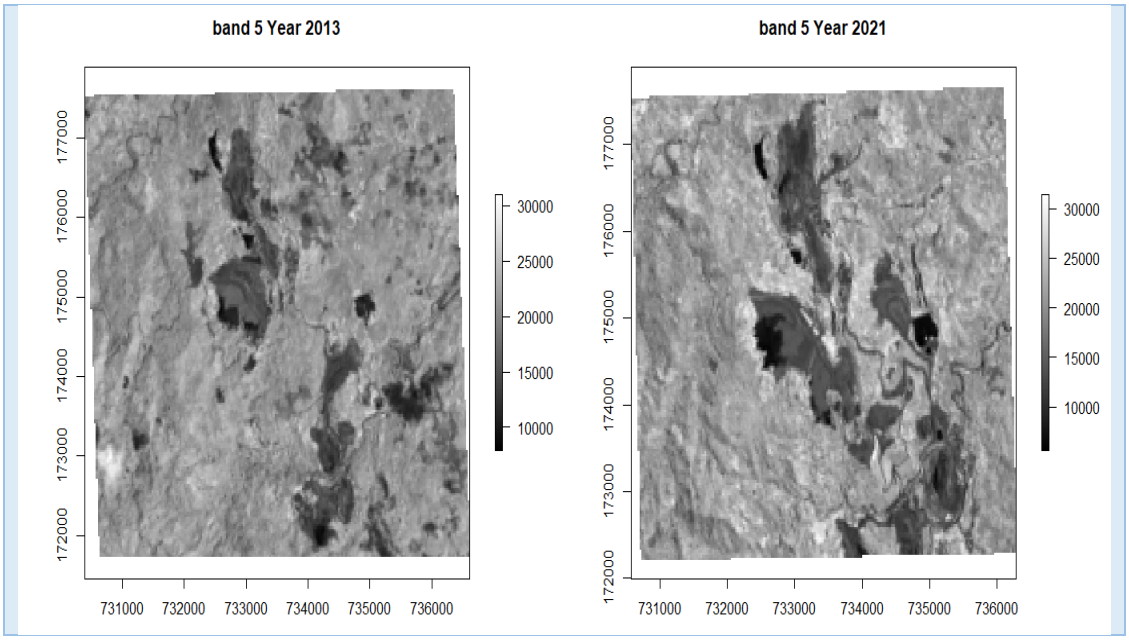


**Figure 5.** Example of land cropping image

#### b. Composite Image Composition

In this research, the composite image that will be used is composite of natural color and Color Infrared (vegetation). According to (TABLE 3), by combining Landsat 8 satellite imagery band 4 – Red to red channel, band 3 – Green to green channel and band 2 – Blue to blue channel for Landsat True color composite. In this study, the results of natural color images from the combination of the three Landsat 8 band images will be used as reference data in comparing and seeing how the original or natural appearance of the area around the tako tindung gold mine, which is the research area. So that it can be seen whether the data from this study are in accordance with the actual conditions.

**Table 3.** Band/Canal

| Applications | CombinationBand |
|---|---|
| Natural Color | 4 3 2 |
| False Color (urban) | 7 6 4 |
| Color Infrared (vegetation) | 5 4 3 |
| Agriculture | 6 5 2 |
| Atmospheric Penetration | 7 6 5 |
| Healthy Vegetation | 5 6 2 |
| Land/Water | 5 6 4 |
| Natural With Atmospheric Removal | 7 5 3 |
| Shortwave Infrared | 7 5 4 |
| Vegetation Analysis | 6 5 4 |

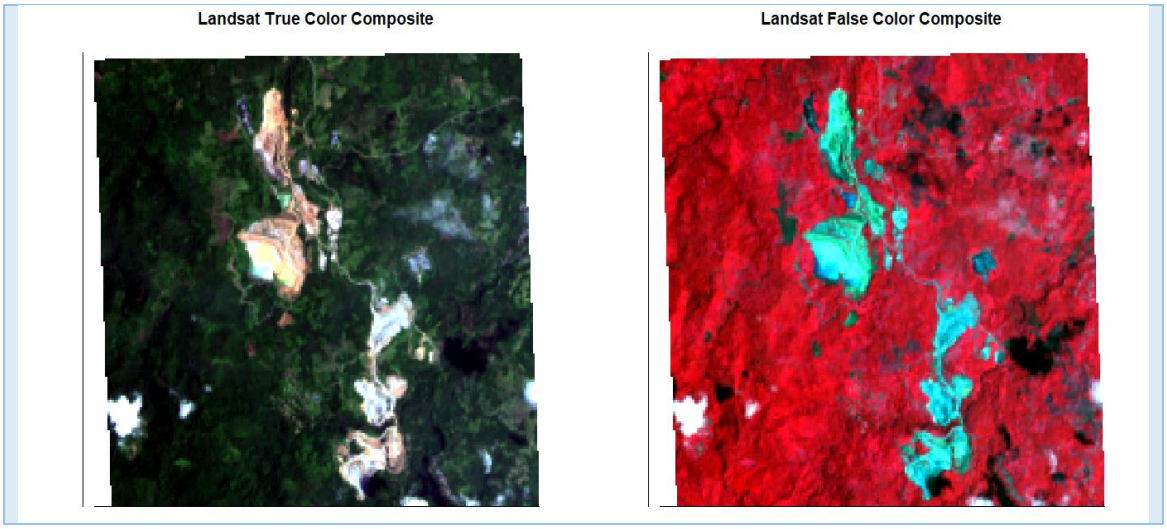


**Figure 6.** Composite Image in 2013

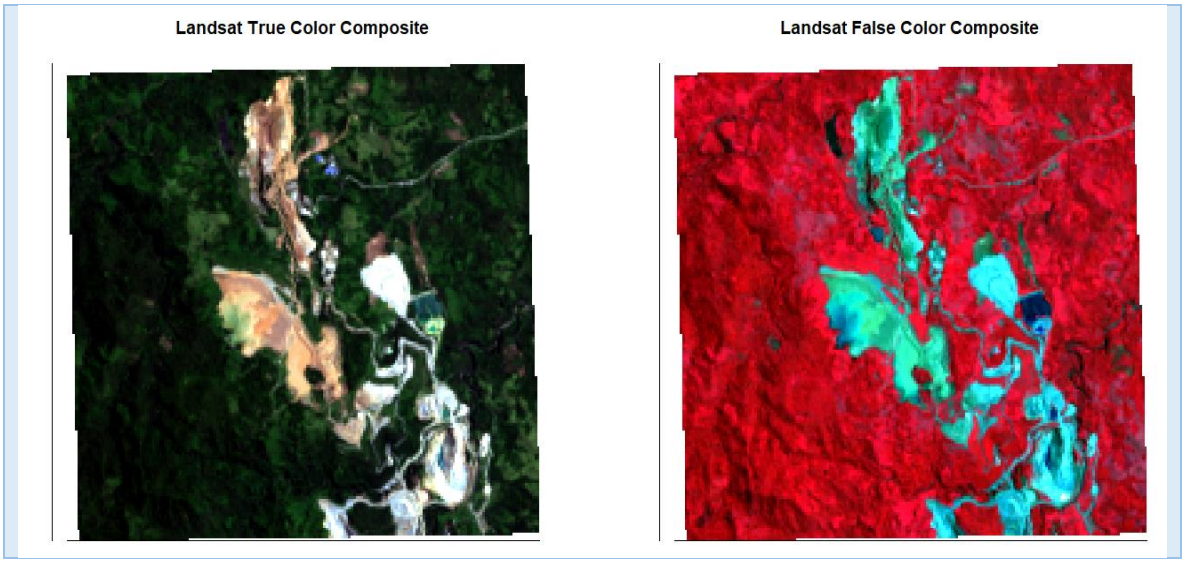


**Figure 7.** Composite Image in 2021

Based on Figure 6 and Figure 7 of the composite image results, namely:

- True Color Composite. This image is a combination of red, green, blue bands. Visible light is depicted naturally.Vegetation is green, bare land and vacant land is brown, and urban structures are white.
- False-color composite. This image is a combination of nearIR, red, green bands. Active vegetation is red, bare and vacant land is green, and urban structures are bluish white

**c. NDVI**

Analysis of changes in the vegetation density index at the Tako Tindung North Minahasa Gold Mine from 2013 to 2021 using the NDVI method with the formula as above. The results of extracting NDVI information are presented in Figure 8 and Figure 9.

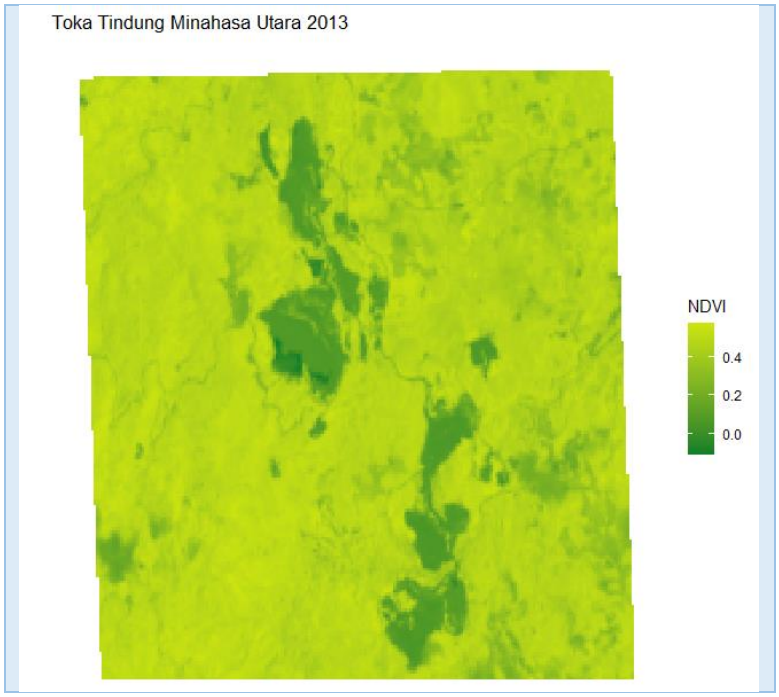


**Figure 8.** Vegetation Index of NDVI Normalization Difference in 2013

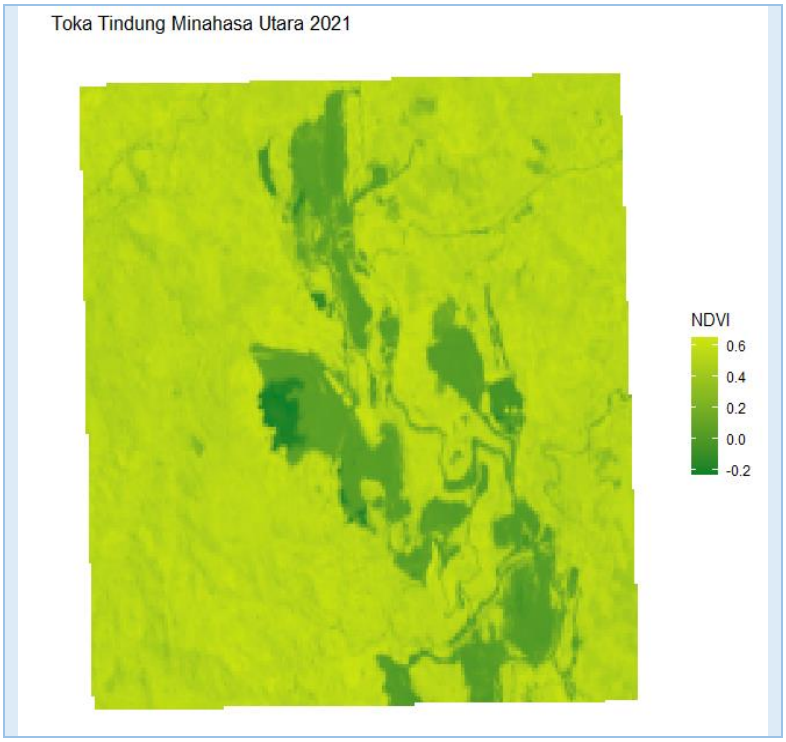


**Figure 9.** Vegetation Index of NDVI Normalization Difference in 2021

This study shows that the results of extracting NDVI information are presented in Figure 8 and Figure 9. It is obtained that Variation the greenness index of the vegetation ranges from 0.0 - 0.4 in 2013 and -0.2 - 0.6 in 2021. Based on the results of the analysis, it is found that the North Minahasa Toka Tindung Gold Mine is distributed

between 4 NDVI classes into four classes based on vegetation density. These classes include cloud and water classes, rock and vacant land classes, meadows and shrubs, and forest classes (Table 4).

**Table 4.** Distribution of objects based on NDVI value

| Distribution area (Class) | NDVI value |
|---|---|
| Clouds and water | < 0 |
| Rocks and vacant land | 0-0.1 |
| Grasslands and shrubs | 0.2-0.3 |
| Forests | 0.4-0.6 |

The results of the next analysis are carried out with the same approach in the 2021 period. The goal is to see changes in NDVI at the North Minahasa Toka Tindung Gold Mine that occurred over a period of 9 years. The results obtained are the area of vegetation density in the mining area of the cloud and water class, rock and vacant land. This shows that the area without vegetation has generally increased to replace mining green areas at the North Minahasa Toka Tindung Gold Mine.

## 4. Conclusion

The results of research at the North Minahasa Toka Tindung gold mine regarding the analysis of changes in the vegetation density index using Landsat images with recording times in 2013 and 2021 obtained, conclusions can be drawn, namely changes in vegetation density in 2013 and 2021 from the results of data analysis processing vegetation density. with the NDVI method on Landsat 8 imagery, changes were found in each existing vegetation density class. The results showed that the variation of the greenery index of vegetation ranged from 0.0 - 0.4 in 2013 and -0.2 - 0.6 in 2021. Where the mining area environment in 2013 had vegetation classes in the form of rocks, vacant land, meadows, shrubs and dense forests and in 2021 has a vegetation class in the form of rocks, vacant land, grasslands, shrubs, dense forests and water. In 2021 it has a vegetation value of -0.2 whose vegetation class is water due to the loss of Ground Cover Vegetation due to excavations that are too deep to form ponds on the ground surface. Thus the level of vegetation density in the mining area of North Minahasa has changed from 2013 to 2021. The area without vegetation has generally increased. Replacing the green area and the area with vegetation cover, dense green land cover has decreased.

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