Remote sensing application to monitoring mine landuse changing in limestone/dolomite

Y M Anaperta, A Octova, R Maiyudi, D Y Feldi

Mining Engineering Department, Faculty of Engineering, Universitas Negeri Padang, Prof Hamka Street, Padang 25131, Indonesia

Abstract. This research was conducted to monitoring mine landuse Changing in Limestone/Dolomite at PT. Bakapindo in Jorong Durian, Kenagarian Kamang, Kamang Magek District, Agam Regency, West Sumatra Province. This research was carried out through visual interpretation of remote sensing data. The remote sensing data used is the Landsat imagery 8 Oli in 2018 which will be classified by the Supervised Classification method. Based on the results of the Landsat imagery 8 Oli processing with the observation years of 2013, 2016 and 2018 it was found that the mine area in 2013 was 12.53 hectares, in 2016 the area was 13.1678 hectares and in 2018 14.7586 hectares. Based on the results of the Landsat imagery processing in the observation years of 2013, 2016 and 2018, that for the mine area each year the observation changes. In the period of 2013 to 2016, the mining area increased by 0.6378 hectares and in 2016 to 2018 it increased by 1.0806 hectare.

1. Introduction

PT. Bakapindo is one of the private companies in the field of limestone and dolomite mining located in Jorong Durian Kenagarian Kamang Magek, Agam Regency. The area controlled by PT. Bakapindo is 60 hectares, and 15 hectares have obtained production permits. So far, PT Bakapindo does not have a special section on land mapping. So far the mapping needs have been given to mapping consultants outside the company. Mapping at PT Bakapindo is usually only used for mapping the progress of the mine, but does not map how land changes occur from year to year. Therefore, a land change mapping is carried out from 20013, 20016 and 2018 to find out the land changes that have occurred at PT Bakapindo. Mapping these land uses uses identified through visual interpretation of remote sensing data. The remote sensing data used is Landsat imagery 8 Oli in 2018.

2. Literature Review

2.1 General study

2.1.1 Location of Regional Performance

PT. Bakapindo is between 0° 12’ 11.0” – 0° 12’ 21.30” LS and 99° 52’0” to 100° 33’0” LU with an altitude of 900 m above sea level. The mine location is approximately ± 10 km from the center of Bukittinggi city with a travel time of around 20 minutes.
2.1.2 Geology and Stratigrafi

The rock formations found in this area can be classified into Pratersier (old age) which consists of surface sedimentary rocks, sediments, metamorphic, volcanic and instructions. Stratigrafi PT. Bakapindo which is an order of limestone hill location has two layers, which are thick layers of limestone and clay layers that line the rock surface. This clay coating is not too thick, which is around ± 0.5 - 2 meters which is overgrown with various kinds of plants which are mostly dominated by ferns, nails, and pandanus.

2.2 Theoretical Review

2.2.1 Interpretation of Remote Sensing Images

Interpretation of remote sensing images is a way of studying aerial photographs or images with the intention of identifying objects. Image interpretation can be done in two ways, namely visual interpretation and digital interpretation [2]. The image identification process is carried out in three stages: detection, Identification, Analysis.

2.2.2 Visual Interpretation

Visual interpretation is the introduction of spatial characteristics of objects based on the elements of remote sensing imagery. Interpretation of remote sensing images based on the classification system aims to group or segment homogeneous features of the earth's surface with qualitative techniques. The principle of recognition of the identity and type of object depicted in the image is based on the characteristics / attributes of objects in the image. The characteristics of the objects depicted in the image are identified using 8 (eight) elements of interpretation, hue / color, size, shape, texture, pattern, shadow, location, and association of object appearance.

2.2.3 Digital Interpretation

Interpretations carried out with the help of computers, the interpretation process starts from image processing (pre-processing which includes image corrections), reconstruction of image sharpening images, to object classification, namely detecting classes or types of objects in the image, classification object [4].

2.2.4 Image Classification

Image processing techniques by grouping pixels into a number of classes, so that each class has unique and specific patterns or spatial distributions that reflect an object or useful information according to the requirements [5]. Classification is divided into two types of techniques, Supervised Classification and Unsupervised Classification.

2.2.5 Interpretation Accuracy Test

The results of image interpretation need to be verified through an accuracy test process. The stages of classification accuracy testing are done by the confusion matrix method. In the process of mapping / land cover classification, the acceptable value of accuracy is 85% or 0.85 (Anderson, 1976). Accuracy of analysis is made in several classes of X which are calculated by making a matrix of confusion matrix calculations [6].

The confusion matrix formula:
The accuracy of all classification results:

\[ KH = \frac{\text{The number of object in all classes}}{\text{The number of all object}} \]  

(2)

2.2.6 ENVI (Ironment for Visualizing Images)

ENVI (The Environment For Visualizing Image) is a raster data processing software (Image) owned by ITT Exelis company. This software processor was first introduced in 2005 and until now ENVI has launched various generations and versions. ENVI is very easy to use because the appearance is not too complicated. ENVI version 5.1 which is the latest version, ENVI has a full desktop display which is a form of development from the previous ENVI (ENVI Classic).

3. Method

This study analyzes the changes in the open land area of limestone and dolomite mines of PT. Bakapindo using remote sensing applications, namely Landsat imagery satellite. The object of this research is the change and expansion of the mining area of PT. Bakapindo for 2013, 2016 and 2018. The research is expected to be used as material for consideration in carrying out post-mining open land reclamation, especially PT. Bakapindo. The tools used in the study are a computer set, Envi 5.1 Software, ArcGIS 10.1 Software, Garmin Handheld GPS, Camera digital.

4. Results and Discussion

4.1 Analysis of Mine Land Cover in 2013, 2016 and 2018

Analysis of changes in mine land cover in this study was carried out in three years of observation, namely in 2013, 2016, and 2018. Based on visual interpretation of remote sensing data, information on mine land cover area was obtained in each year of observation.

a. Coverage Area of 2013 Mining Land

\[ MA = \frac{X_{cr} \text{Pixel}}{X_{cr} \text{Pixel} + X_0 \text{Pixel} + X_{co} \text{Pixel}} \]  

(1)
Based on the results of the image interpretation described in the previous sub-chapter, in 2013 the mine land cover area at PT. Bakapindo is 12.53 hectares. Classification results of Landsat imagery 8 oli in 2013 is presented on a map.

![Figure 2. 2013 Mining Land Distribution Map](image)

Table 1. Data of the 2013 Observation Classification Results

| No | Land           | Class | Area (ha) |
|----|----------------|-------|-----------|
| 1  | Dense forest   | 1     | 13,152    |
| 2  | Mine Land      | 2     | 12.53     |
| 3  | vegetation     | 3     | 35,826    |
|    | **Total area** |       | **61,508**|

b. Area of Mine Land Cover in 2016

Based on the data overlay and map of PT. Bakapindo, in 2016 the mining area was 13,1687 hectares.

![Figure 3. 2016 Mining Land Distribution Map](image)

Table 2. Data of the 2016 Observation Classification Results

| No | Land   | Class | Area (ha) |
|----|--------|-------|-----------|
| 1  | Dense forest | 1     | 18,9905   |
| 2  | Mine Land  | 2     | 13,1687   |
| 3  | vegetation | 3     | 29,3229   |
|    | **Total area** |       | **61,4821**|

c. Coverage of Mining Land in 2018

Based on the data overlay and map of PT. Bakapindo. In 2018 the area of mine land obtained from the results of image processing was 14.7586 hectares.
Table 3. Data of the 2018 Observation Classification Results

| No | Land         | Class | Area (ha) |
|----|--------------|-------|-----------|
| 1  | Dense forest | 1     | 24,250    |
| 2  | Mine Land    | 2     | 14,758    |
| 3  | vegetation   | 3     | 22,597    |
|    | Total area   |       | 61,607    |

4.2 Analysis of Changes in Mine Land in 2013, 2016 and 2018

Analysis of changes for the three years of observation 2013, 2016 and 2018 was carried out by overlaying the map each year of observation.

Table 4. Data of the 2013, 2016, 2018 overlaying the map

| No | Land         | Class | Area (ha) |
|----|--------------|-------|-----------|
| 1  | Dense forest | 1     | 18,990    |
| 2  | Mine Land    | 2     | 13,168    |
| 3  | vegetation   | 3     | 29,322    |
|    | Total area   |       | 61,482    |

4.3 Accuracy Test (Ground check)

To find out the level of accuracy of the results of image interpretation, when classifying, a classification accuracy test must be carried out. The classification accuracy test is done by calculating the matrix of error calculations on each land use resulting from image interpretation. The sample points on land use are taken for field validation tests of 65 sample points. This sample was taken randomly at each type of land use which spread throughout the image.

Figure 4. 2018 Mining Land Distribution Map

Figure 5. Point of Accuracy Sample Test
Based on the results of a field survey of 65 samples, the corresponding sample points produced were 53 sample points and 12 did not match the sample points. The point of the sample that is not suitable in the field is in the form of mining land which has turned into a body of water and vegetation.

4.4 calculation of the accuracy test of the interpretation of mine and non-mining land uses landsat imagery using the confusion matrix method

| Survey results | Classifcation results | 1 | 2 | Total | Commission object | Ma(%) |
|----------------|-----------------------|---|---|-------|-------------------|-------|
| 1. Mining      |                       | 53| 0 | 65    | 12                | 81.53 |
| 2. Non-mining  |                       | 0 | 12|       | 12                |       |
| Total KH       |                       | 53| 53|       | 12                | 81.53 |
| Commission object |                   | 12| 12|       |                   |       |

5. Conclusions

Based on the research that has been done, it can be concluded that based on the results of the processing of Landsat imagery 8 Oli images with the observation years 2013, 2016 and 2018, the mine land area in 2013 was 12.53 hectares, in 2016 the area was 13.1678 hectares and 2018 as many as 14.7586 hectares. Based on the results of the Landsat imagery processing in the observation years of 2013, 2016 and 2018, that for the mine area each year the observation changes. In the period of 2013 to 2016 the mining area has increased by 0.6378 hectares and in 2016 to 2018 it has increased by 1.0806 hectares.

Acknowledgments

We thank to PT Bakapindo for the permission to do this research.

References

[1] Anderson, J.H.E., Roach J.T., & R. Wittmer. 1976. A Land Use And Land Cover Classification System For Use With Remote Sensor Data. Geological Survey Professional Paper 964. United States Government Printing Office : Washington.
[2] Hardjowigeno, S. Dan Widiatmaka.. Kesesuaian Lahan dan Perencanaan Tataguna Tanah. Jurusan Tanah Fakultas Pertanian, IPB. Bogor. (2001)
[3] Rahmawaty, Restorasi Lahan Bekas Tambang Berdasarkan Kaidah Ekologi. (2002)
[4] Lillesand, T. M. dan R.W. Kiefer. Penginderaan Jauh dan Interpretasi Citra. (1990)
[5] Purwadhi, Sri Hardiyanty Dan Sanjoto, Tjaturahono Budi,.Pengantar Interpretasi Citra Penginderaan Jauh. LAPAN-UNNES.(2008) (7)
[6] Sutanto. Penginderaan Jauh Jilid I. Gajah Mada University Press: Yogyakarta.(1986)
[7] Purwadhi Sri Hardiyanti F, Interpretasi Citra Digital. PT Gramedia Widiasarana Indonesia: Jakarta. (2001)
[8] Ardiansyah. Pengolahan citra penginderaan jauh menggunakan ENVI.5.1 danENVI LIDAR. Labsig Inderaja. Bogor. (2005)
[9] Sutanto. Penginderaan Jauh Jilid I. Gajah Mada University Press: Yogyakarta.(1986)
[10] Purwadhi Sri Hardiyanti F, Interpretasi Citra Digital. PT Gramedia Widiasarana Indonesia: Jakarta.(2001)
[11] Purwadhi Sri Hardiyanti F, dkk. Aplikasi Penginderaan Jauh Sistem InfomasiGeografis Untuk Pengembangan Wilayah. Polimedia Publishing : Jakarta Selatan.(2015)
[12] Lillesand, T. M. dan R.W. Kiefer. Penginderaan Jauh dan Interpretasi Citra. (1990)
[13] Sutanto. Penginderaan Jauh Jilid I. Gajah Mada University Press: Yogyakarta.(1986)