Identifying of the relationship between lineament density and vegetation index at Tumpangpitu Mining Area, East Java, Indonesia

Cite as: AIP Conference Proceedings **2278**, 020006 (2020); https://doi.org/10.1063/5.0014701
Published Online: 26 October 2020

Haeruddin and Januar Fery Irawan

Identifying of The Relationship Between Lineament Density and Vegetation Index at Tumpangpitu Mining Area, East Java, Indonesia

Haeruddin[1, a)] and Januar Fery Irawan[1]

[1]*Faculty of Engineering, University of Jember, Jl. Kalimantan 37 Jember, INDONESIA*

[a)]Corresponding author: haeruddin@unej.ac.id

Abstract. Tumpangpitu Mining Area was in Banyuwangi Regency, East Java, Indonesia. This area has potential of mineral resources, forests, plantations and agriculture. The potential for mineral resources was developed into the Tumpangpitu mining area. Geological structures as a controller of mineral resource potential can be observed through satellite imagery using lineament analysis. Furthermore, the lineament can be tested for its effect on land cover diversity through analysis of the vegetation index. Utilization of satellite imagery such as Landsat-8 and SRTM DEM can be used to determine the lineament and vegetation index. In this case, Landsat-8 is useful for knowing the vegetation index, while SRTM DEM can be used to determine lineament of the morphology and geological structures. The spatial characterization of lineament was obtained by measuring lineament density (intersection, number, and length) using modified Segmen Tracing Algorithm (mSTA). The measurement of vegetation index was processed using NDVI (Normalized Difference Vegetation Index). In this case, the vegetation index has a range of -0.48 to 0.87, with a mean of 0.48. This indicates that the study area was dominated by dense vegetation, especially on the northern part in the study area. Lineament density which includes intersection, number, and length of lineament have a positive correlation with vegetation index value. Thus, it could be concluded that the greater lineament density in a zone, the greater of the vegetation index.

INTRODUCTION

Tumpangpitu Mining Area is located in Banyuwangi Regency, East Java, coordinately around 8° 35'20" S and 114° 01' 08" N. This area is an area that has quite diverse potential, starting from the potential of mineral resources, forests, plantation, and agriculture. Potential mineral resources were then developed into an Tumpangpitu mining area. The existence of geological structures as controllers of the existence of potential mineral resources can be observed through satellite imagery using line analysis. Furthermore, the presence of the lineaments can be tested for their influence on the diversity of land cover through analysis of the vegetation index.

Straightness is an elongated formation that is assumed to occur due to geological processes and can be identified through remote sensing. Straightness is used to determine geological features and morphological conditions, rock unit boundaries and fracture zones. Straightness extraction research is widely used in fields such as straightness and its relation to groundwater potential, geothermal energy, and metal mineralization. In addition, research on the relationship of morphological straightness with vegetation index is also interesting to study.

Vegetation index in general has been widely used in soil science applications to monitor and characterize the earth's vegetation using satellite imagery. Vegetation index is an optical measurement of vegetation cover, leaf chlorophyll composition, leaf area, canopy cover and canopy architecture. Vegetation index does not measure the physical quantity of vegetation, but can represent an assessment of the number of biophysical and biochemical variables in the vegetation area (Yunus, 2017). As for the existence of the lineament will continuously affect the existence of vegetation patterns around the zone. Specifically, vegetation patterns such as aligning the same

Climate Change and Sustainability Engineering in ASEAN 2019
AIP Conf. Proc. 2278, 020006-1–020006-8; https://doi.org/10.1063/5.0014701
Published by AIP Publishing. 978-0-7354-4008-1/$30.00

vegetation type can be formed by the alignment that controls the groundwater flow and produces various types of soil with a strong weathering process (Wang et al, 2013). Thus, the distribution of vegetation is expected to correlate with the presence of lineaments.

The development of remote sensing technology has now developed quite rapidly. This technology can even be applied to analyze vegetation, morphological features, the presence of mineral resources, and others. Satellite image technology is widely favored in earth research because it has several advantages, which can cover large areas and can observe the same area over and over again. In this study, the satellite images used are Landsat-8 imagery and SRTM DEM. Landsat-8 satellite imagery is used to determine the vegetation index. SRTM DEM can be used to determine morphological alignment and geological structure.

REGIONAL GEOLOGY OF TUMPANGPITU MINING AREA

Tumpangpitu Mining Area in Banyuwangi Regency has been around since 1997 by PT. Hakman Platina Metalindo (HPM) then the company was replaced by PT. Indo Multi Niaga (IMN) in 2006, then on July 19, 2012 the mining authority was held by PT. Bumi Suksesindo (BSI) to date. The three companies are companies that hold power over the Seven Hill Project, where Mount Tumpangpitu is a protected forest area that has been converted into a mineral mining area.

Tumpangpitu is located along a NW-SE–striking structural corridor covering an area of 12 × 5 km. This structural corridor hosts several Cu-Au-Mo mineralized tonalitic porphyries, each with varying degrees of metal enrichment. We have constructed type sections through Tumpangpitu based on intrusive and breccia crosscutting relationships, supported by radiometric dating. This work has provided the first comprehensive geological model for the deposit (Harrison, 2015). Tumpangpitu berada di southern mountains arc denngan intrusive rocks (Figure 1).

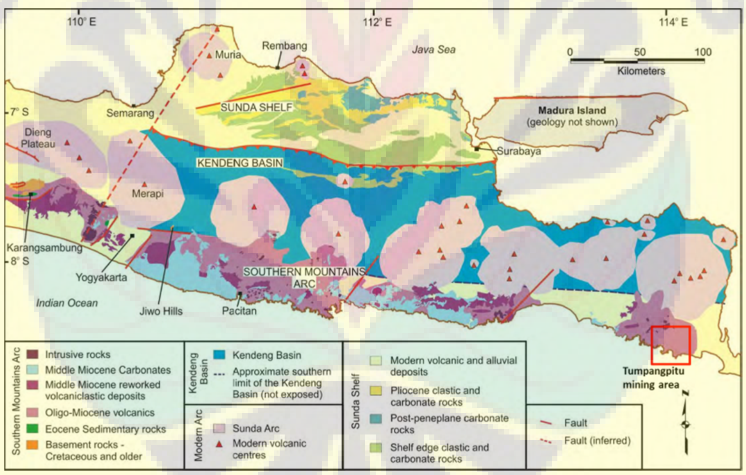

FIGURE 1. Geology of Tumpangpitu mining area, East Java (Smyth et.al. 2007)

MATERIALS AND METHODS

The data were used in this study include satellite magery (Landsat-8 and SRTM DEM). Landsat-8 imagery was used to determine the vegetation index in the Tumpangpitu mining area. In this study, landsat-8 images were obtained from www.earthexplorer.usgs.gov, which was acquired on March 29, 2018 with path/row 117/66. In addition, the ASTER GDEM data was used to determine the lineament density analysis in the study area. The data could be downloaded at www.earthexplorer.usgs.gov, having a 30m × 30m (1 arc second) resolution.

Data processing consists of automatic lineament extraction using modified Segment Tracing Algorithm (mSTA), and vegetation index analysis using Normalized Difference Vegetation Index (NDVI). Detail information about mSTA method was addressed in Saepuloh et al (2018). This method was developed from STA in Koike et al. (1994) and Koike et al (2001). In this case, SRTM DEM was used to find lineament in the study area. Before that, the SRTM DEM was changed to become a multishaded relief, then continued with lineament extraction using mSTA. After the lineamet was obtained, then it was continued by determining the lineament density.

In vegetation index analysis, Landsat-8 satellite image data is corrected by the atmospheric correction then proceed to know the vegetation index. The first step is to change DN (Digital Number) to reflectance. The NDVI formula is as follows:

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

Information:
NIR = Near Infrared band on corrected images
RED = Red band on corrected image.

The results of calculating lineament density and vegetation index then proceed with determining the spatial correlation of these values. Furthermore, a cross-sectional example is given to determine the relationship between lineament density and vegetation index in the study area.

RESULT AND DISCUSSION

Landsat-8 used in this study is Landsat-OLI (band 5 and band 4), where band 5 and 4 are SWIR and red, respectively. This data was processed to produce a vegetation index that can describe the condition of vegetation in the study area. While the SRTM DEM data used shows that the study area has an elevation of 0-900 m. This data was processed so as to produce lineament density that describes the geological structure in the study area.

Lineament Density Extraction

Before lineament extraction, the imagery was made multishaded relief. The light azimuth was 0º-180º and 180º-360º, respectively, with a lighting interval of 30º. The inclination angle was 50º-70º with an interval of 10º. So that the two multishade relief of DEM images were produced as shown in Figure 2. These two lighting aims to provide a relief effect that makes it easier to compare the results of lineament extraction.

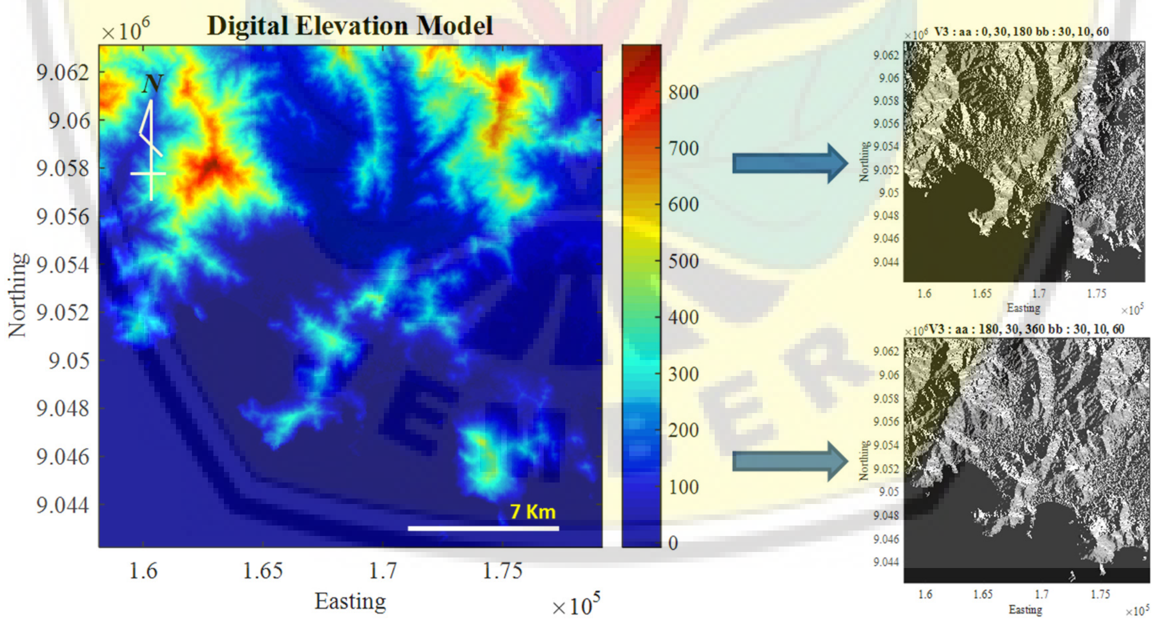

FIGURE 2. DEM SRTM image in Tumpangpitu mining area, East Java

Automatic lineament extraction process using the modified Segment Tracing Algorithm (mSTA). The results was obtained as in Figure 3. Lineament extraction was done on each multishaded relief image of SRTM DEM.

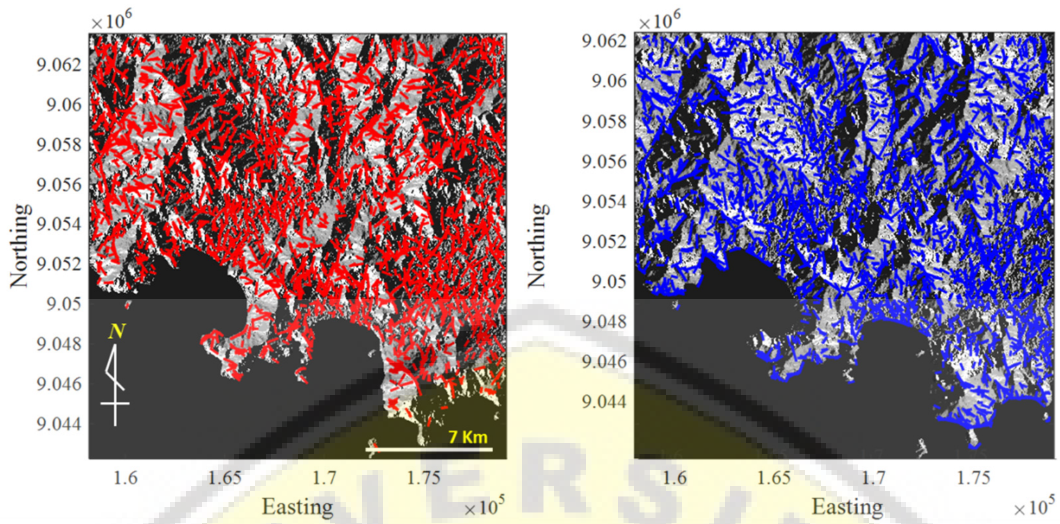

FIGURE 3. Lineament Extraction using mSTA for multishaded relief of SRTM DEM: (a) 0º-180º, (b) 0º-180º

Furthermore, the grouping process aims to eliminate the overlaying line segments. The grouping process in this study consists of two step (correction and combination step. The correction step aims to eliminate line segments that overlay on the multishaded relief SRTM DEM. The combination step, lineament derived from two multishaded rerief DEM SRTM images, then merged into one, and the overlay line segments were deleted. Ther result lineament in combination step was showed in Figure 4. The results of lineament extraction at the combination step indicate the general direction of NE-SW and NW-SE. This lineament would be used as material to determine the lineaments density that are scattered in the Tumpangpitu Mining Area, East Java.

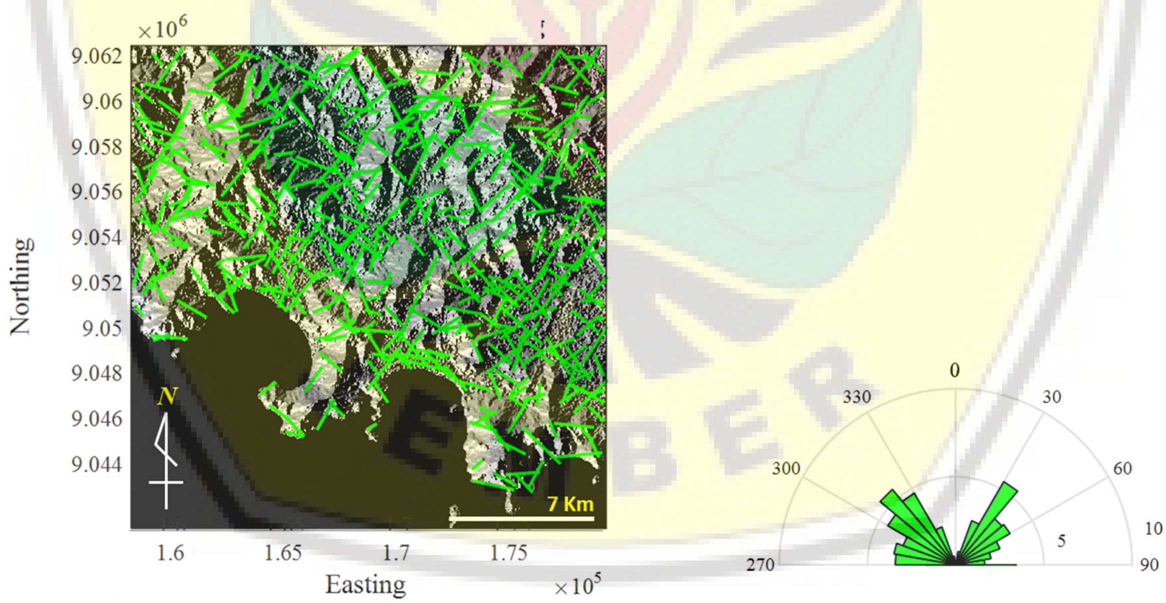

FIGURE 4. (a) Lineament extraction from combination step, (b) general direction of lineament

Lineament density was based on the number of intersections between lineaments, the number of lineaments, and the total length of lineaments in each grid (where the grid size of 1km × 1km). The results of this density were shown in Figure 5 which shows the blue color for areas with low density, while areas with high density were marked in red. At the intersection density between lineaments, it was found that the high density in the middle part, and spread over several points. The number and total lenght of lineaments were found that the density is evenly distributed in several regions, especially in the eastern part.

Furthermore, the density of intersections between lineaments has 0 to 10 1/km^2, with an average of 0.57 1/km^2. While the lineament length density is spread from 0 to 4.6 km/km^2, with an average of 1.17 km/km^2. The number of lineament density has values from 0 to 9 1/km^2, with an average of 2.39 1/km^2. The lineament density results could be seen in Figure 5.

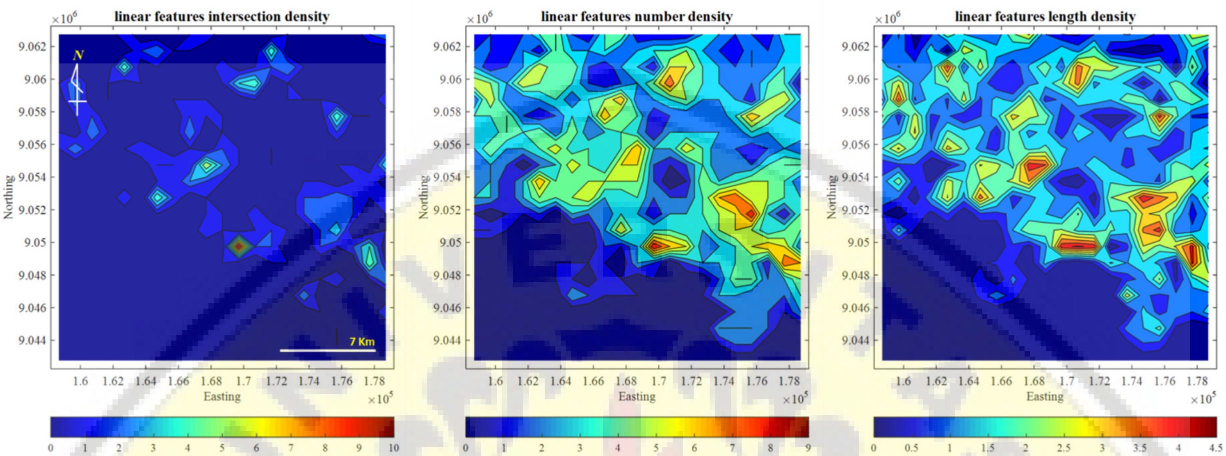

FIGURE 5. Lineament density at Tumpangpitu mining area, East Java

Analysis of Vegetation Index using NDVI

NDVI calculation on Landsat-8 satellite imagery (bands 5 and 4) was done after the satellite imagery was corrected, so that a good vegetation index value could be obtained. Vegetation index was the amount of vegetation greenness value obtained from digital signal processing of NIR and RED band reflectance values. The aphenomenon of red light absorption by chlorophyll and reflection of near-infrared light by mesophyll tissue contained in the leaves would make the brightness values received by the satellite sensors on these bands would be very different. At the non-vegetation areas, including water, residential areas, and areas with damaged vegetation, would not show a high ratio value (minimum). Conversely, in the area of dense vegetation with healthy conditions, the ratio of the two bands would be very high (maximum). The results of NDVI processing in Tumpangpitu Mining Area was shown in Figure 6.

Based on Figure 6, it was known that NDVI values range from -0.58 to 0.87. In this case, the picture in blue shows the smallest NDVI value, while the red color shows the highest NDVI value. NDVI values range from -0.58 to 0 indicate non vegetation areas, most areas without vegetation are sea areas. NDVI values 0-0.5 were medium vegetation and residential areas, while areas with NDVI values more than 0.5 were forest. If observed in more detail, the mainland research area is dominated by forest areas.

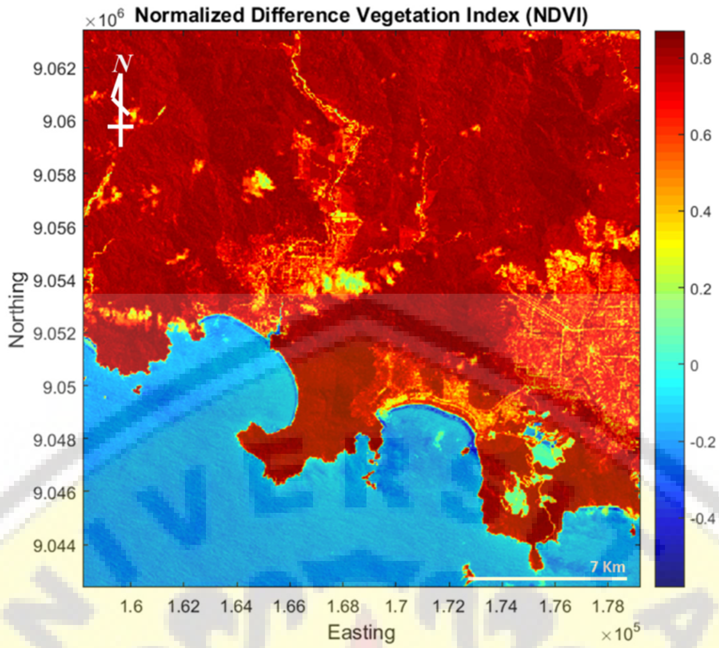

FIGURE 6. NDVI at Tumpangpitu mining area, East Java

Relationship of Lineament Density and Vegetation Index

The calculation results it was known that the average value of the vegetation index was 0.49 with a pixel count of 491401. While the lineament density consists of 441 grids. So in determining the spatial relationship between lineament density and vegetation index based on the number of grids and pixels. The statistical results of vegetation index and lineament density could be seen in Table 1.

TABLE 1. Descriptive statistics of vegetation index and lineament density

Parameter	NDVI	Lineament Density		
		Intersection	Number	Length
Count	491401	441	441	441
Mean	0.4876	0.56689	2.3946	1.173
Minimum	-0.5817	0	0	0
Maximum	0.8705	10	9	4.5975
Variance	0.0031	1.2506	4.094	1.2028
Std. of Dev.	0.0557	1.1183	2.0234	1.0967

Relationship between lineament density and vegetation index could be determined by looking at the lineament density and vegetation index. As an illustration, one point was taken at the study areas, 176085 E, 9056935 N, then a cross section was made at the location in the North-South and West-East directions (Figure 7).

Based on Figure 7, it was known that for cross section A-B vegetation index values with average of 0.8 although there are three points that have a minimum value. The minimum value was located in the eastern part, where in the area has a low lineament density. For C-D cross section, it was known that the south has a very low vegetation index value and the lineament density, because the area is the sea. Whereas to the northern part was an area with dense vegetation with high lineament density at several points. From this illustration, it could be seen that the lineament density value was directly proportional to the vegetation index value.

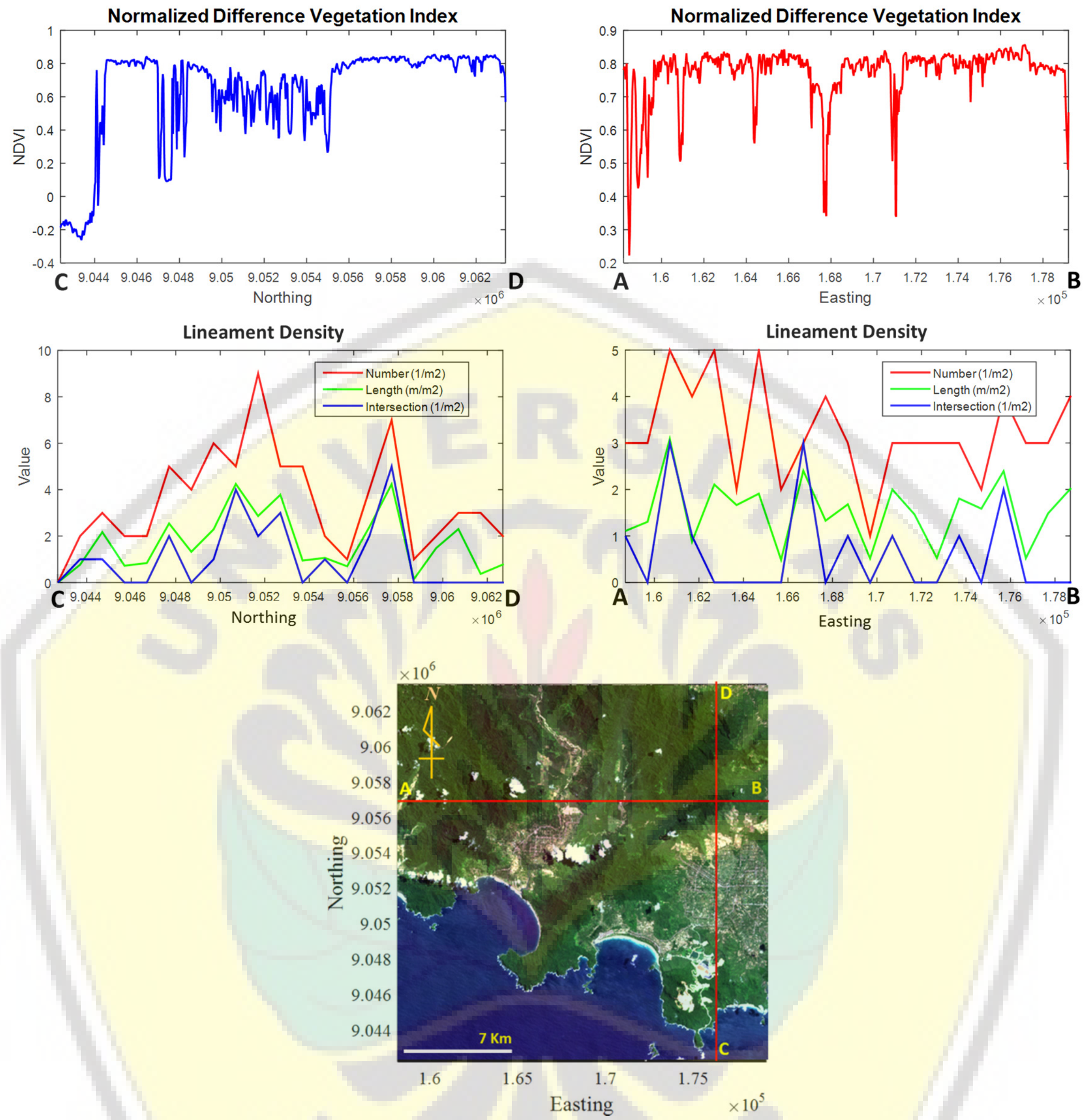

FIGURE 7. Example of cross section to show relationship between lineament density and vegetation index at Tumpangpitu Mining Area, East Java

CONCLUSION

Utilization of Landsat-8 SRTM DEM effectively describes the relationship between lineament density and vegetation index at the Tumpangpitu Mining Area, East Java. The Vegetation index has a range of -0.48 to 0.87, with a mean of 0.48. This indicates that the study area is dominated by dense vegetation, especially on the northern part of the study area. Lineament density which includes intersection, number, and length of lineament have a positive correlation with vegetation index value. Thus, it could be concluded that the greater lineament density in a zone, the greater of the vegetation index. Furthermore, these results could be used to determine mineral resources, with an indication that minerals were carried through geological structures which were seen in morphological lineament that were directly proportional to dense vegetation.

ACKNOWLEDGMENTS

The authors thank to University of Jember for providing aquipment and financial supports to this research.

REFERENCES

1. R. Harrison and A. Maryono, *Tumpangpitu Porphyry-High Sulfidation Epithermal Deposit,* Tujuh Bukit Project, Indonesia–Geology, Alteration, and Mineralization: Red Metals Symposium, Centre of Excellence in Ore Deposits (CODES), University of Tasmania, Australia (2012).
2. A. Saepuloh, H. Haeruddin, M. N. Heriawan, T. Kubo, K. Koike, and D. Malik, Geothermics, **72**, 142–155 (2018).
3. K. Koike, S. Nagano, and M. Ohmi, Computers & Geosciences, **21**, 1091–1104 (1995).
4. K. Koike, R. Kouda, and T. Ueki, Bull. of the Geol. Surv. of Japan, **52**, 405–423 (2001).
5. H. R. Smyth, R. Hall and G. J. Nichols, The Geol. Soc. of America, **436**, 199 (2008).
6. L. Wang, B. Tian, A. Masoud, and K. Koike, J. of Earth Science, **24**, 282–296 (2013).
7. M. Yunus, "Pengukuran nilai Enhanced Vegetation Index (EVI) menggunakan kamera Raspberry Pi dengan antarmuka web server LAMPP", M.Sc. thesis, Institiut Pertanian Bogor, 2017.