Media Komunikasi FPIPS
Volume 21, Number 1, April 2022, pp. 93-98
DOI: http://dx.doi.org/10.23887/mkfis.v21i1.43546
Open Access: https://ejournal.undiksha.ac.id/index.php/MKFIS/index

Comparison of Vegetation Index Method to Detect Drought in Bondowoso Regency, East Java

Yuda Aulia Aziz[1], A Sediyo Adi Nugraha[1*]

[1] Universitas Pendidikan Ganesha, Singaraja, Indonesia

*e-mail: adi.nugraha@undiksha.ac.id

Article history: Received 14 January 2022; Accepted 31 March 2022; Available online 01 April 2022

Abstract

Drought in Bondowoso County has the potential to occur sustainably with diverse topographic variations. This study aims to determine drought conditions by using a vegetation index with a multi-temporal Landsat 8 OLI image from January-July 2021. The vegetation index methods used are SAVI (Soil Adjusted Vegetation Index), EVI (Enhanced Vegetation Index), and NDVI (Normalized Difference Vegetation Index). The three vegetation indices were chosen because they provide different vegetation sensitivities. The results showed that all three vegetation indices provided a slight difference inaccuracy. SAVI has an accuracy result of 86%, EVI with 14% accuracy, and NDVI has 80% accuracy. The difference in accuracy results from the condition of Bondowoso Regency with a variety of vegetation. Temporally also showed that SAVI is more sensitive to vegetation information, especially in areas close to clouds, than in EVI and NDVI. It can be concluded that SAVI can provide drought information better than EVI and NDVI.

Keywords:
Drought; NDVI; SAVI; EVI

1. Introduction

Drought, according to BPBD, is a condition in which a region, land, or community experiences a lack of water so that it cannot meet its needs (Jeyaseelan, 2003; Nugraha, 2016). Drought can be caused because a region does not experience rain or drought for a long time or rainfall below average so that the water content in the soil is reduced or even non-existent. Drought usually occurs because the people of an area or region have not managed existing water resources properly or lack water resources infrastructure. Lack of water sources can also be the cause of this disaster.

Another cause of this drought is low vegetation, or it can be called the lack of vegetation in a region or deforested land. Bald vegetation means that water that soaks into the ground (infiltration) will undoubtedly be reduced because the function of the roots themselves absorbs and stores water from rain. The water stored in the roots can be used as a backup when the dry season has arrived (Inarossy & P, 2019).

When the dry season comes, areas with few trees will have little water reserves that can make drought hit the region (Iryanthony dkk., 2019). With the problems that have been explained, the study aims to find out the ability of 3 vegetation indexes such as SAVI (Soil Adjusted Vegetation Index), EVI (Enhanced Vegetation Index), and NDVI (Normalized Difference Vegetation Index) by

using Landsat 8 to detect drought in January to June 2021. This comparison is expected to provide a role in the utilization of the vegetation index to identify drought with the vegetation index of land or region.

2. Method

2.1 Study Area

Bondowoso Regency is one of the districts in East Java Province located to the east of Java Island and known as the horseshoe area. Bondowoso Regency has an area of 1,560.10 km2 which is geographically located at coordinates between 113°48′10" - 113°48′26" BT and 7°50′10" - 7°56′41" LS (Coopersmith, 2016). With the southern boundary with Jember Regency, North Situbondo, East Situbondo and Banyuwangi, West Probolinggo and Situbondo. It has 23 sub-districts in the region with a focus on research areas in Wringin, Bondowoso, Binakal, Pakem, Tapen, Wonosari, Tlogosari, Tangerang, Grujugan, Tamanan and Tegal Ampel.

2.2 Remote Sensing Data

Data using Landsat 8 OLI with a resolution of 30x30 meters can be accessed through the following link https://earthexplorer.usgs.gov/ where the image is downloaded between January to June 2021.

2.3 Soil Adjusted Vegetation Index (SAVI)

SAVI is an algorithm with a higher sensitivity to vegetation than NDVI and is a development of the use of red bands and infrared bands (Ar Huete, 1988). The algorithm for SAVI is shown in equation (1). Where NIR and Red can be obtained from Landsat image. L is Constanta is 0.5

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

2.4 Enhanced Vegetation Index (EVI)

The enhanced vegetation index is an 'optimized' vegetation index designed to improve vegetation signals with better sensitivity in areas with high biomass and better vegetation monitoring through canopy background signal separation and reduced atmospheric influence (A. Huete dkk., 2002). The algorithm of EVI is shown in equation (2).

$$EVI = G\ \frac{NIR - RED}{NIR+(C1xRED)-(C2xBlue)+L} x\ (1 + \mathrm{L}) \quad \text{.....(1)}$$

2.5 Normalized Different Vegetation Index (NDVI)

NDVI is the resulting value of vegetation index processing from satellite images of infrared canals and red canals that show the chlorophyll concentrations of leaves that correlate with vegetation density (Marantika & Sudaryatno, n.d.). In addition, NDVI is used as a derivative of vegetation proportions to obtain Land Surface Emissivity values in temperature transformation, which is done with a formula (A. Huete dkk., 2011). NDVI Algorithm is shown in equation (3).

$$NDVI = \frac{NIR - RED}{NIR+RED} \quad \text{.....(3)}$$

3. Result and Discussion

The comparison of the three vegetation index methods shows similarities but also differences. In SAVI and NDVI have almost similar distribution results, but in SAVI, the results become different. EVI provides more sensitive information on vegetation conditions, especially in densely populated areas. SAVI and NDVI show the reverse results caused by the use of applications when performing algorithm inputs. As a result, the NDVI look greener, and the SAVI shows the result of no vegetation (Figure 1). It is similar to Nugraha [10] that using several comparison algorithms to find out drought is ineffective because each algorithm has its sensitivity. In the processing of EVI, there is a significant difference compared to SAVI and NDVI. The user influenced the difference in entering the formula to obtain the best results with the EVI Algorithm, but the processing results still showed that the region was no vegetation.

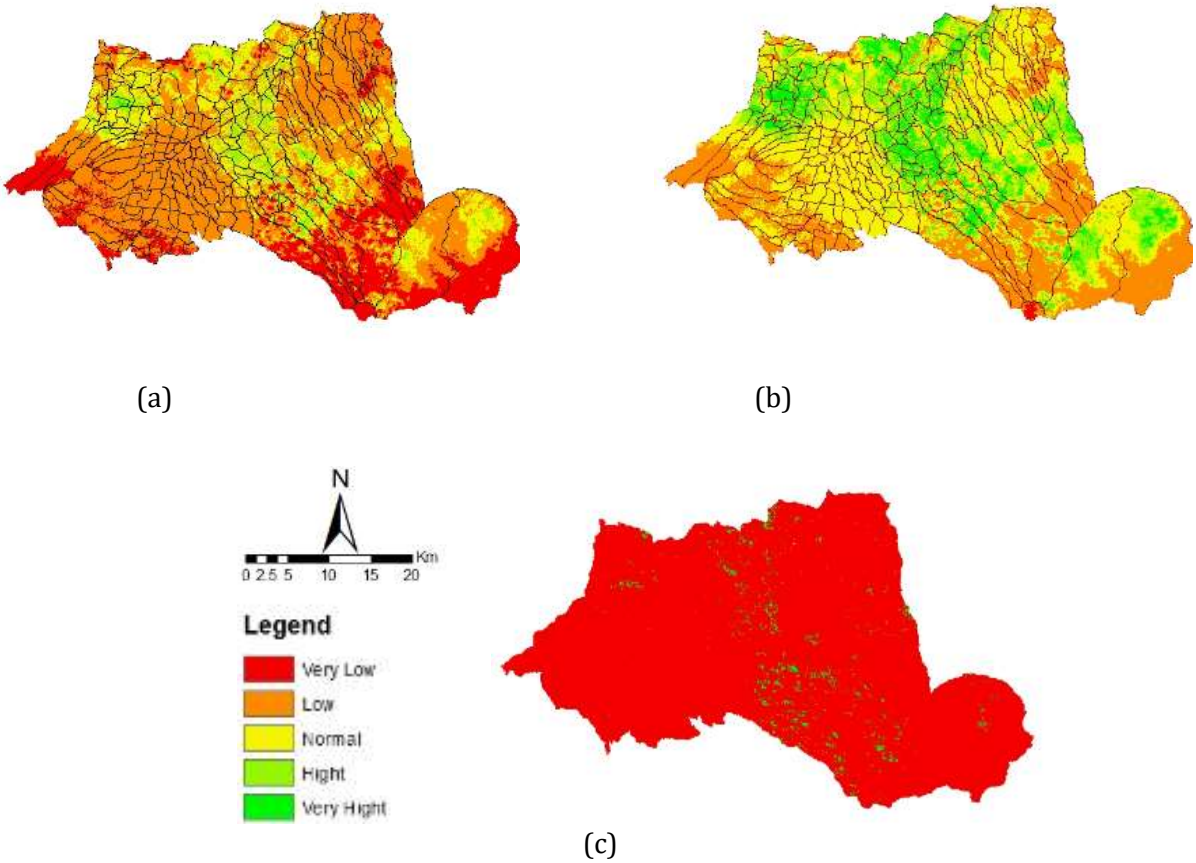

Fig. 1. Vegetation Index from Landsat in June 2021 of (a) SAVI, (b) NDVI, and (c) EVI

The processing results for all three algorithms prove that using SAVI and NDVI methods is more accessible to apply than EVI. In addition, obstacles occur in the recording of Landsat images from January to May. In Bondowoso Regency, there are many cloud appearances so that only June can be used to compare the results of appearances for drought identification. The distribution of the three vegetation index results will then be conducted validation and accuracy tests with the table matrix method developed by Congalton (R.G Congalton & Green, 2008; Russell G. Congalton, 1991).

The distribution of each algorithm varies extensively, judging from the SAVI algorithm of the distribution of regions or regions with the classification of typical vegetation is highest with a score in table matrix. The total sample is 17 compared to other classifications with shallow

vegetation is 6, low vegetation is 8, typical vegetation being 17, vegetation high is 12, vegetation very high is 7, with all sample numbers numbering 50. While the NDVI algorithm also takes 50 samples, where very low is 9, low is 9, typical vegetation is 11, high is 10, and very high vegetation with the number 11. Then the EVI algorithm with a sample number of 50 with the following vegetation distribution Low vegetation is 25, and high vegetation is 25. Judging from the distribution pattern of all the algorithms used is also seen the sampling area by paying attention to the type of soil wherein Bondowoso more regosol with an area reaching 782.82 Km2 or equivalent to 50% of the area of Bondowoso regency wherewith the soil there is rice, palawija, tobacco, and sugarcane. A classification with three algorithms shows that land with high vegetation is still abundant in the Bondowoso area. Distribution of table matrix shown in Table 3, 4, dan 5.

Table 3
SAVI Matrix Table

SAVI	Very Low	Low	Normal	High	Very High	Total Rows	Producer Accuracy (%)
Very Low	5	0	1	0	0	6	100
Low	0	7	1	0	0	8	100
Normal	0	0	14	3	0	17	92
High	0	0	1	11	0	12	82
Very High	0	0	0	1	6	7	100
Total Colom	5	7	17	15	6	50	
User Accuracy (%)	83	88	82	92	86		

Overall Accuracy = (5+7+14+11+6)/50 = 86%
Sumber: data Processing, 2021

Table 4
EVI Matrix Table

EVI	Very Low	Low	Normal	High	Very High	Total Rows	Producer Accuracy (%)
Very Low	2	7	10	4	2	25	100
Low	0	0	0	0	0	0	-
Normal	0	0	0	0	0	0	-
High	0	0	0	0	0	0	-
Very High	0	0	8	12	5	25	71
Total Colom	2	7	18	16	7	50	
User Accuracy (%)	8	0	0	0	20		

Overall Accuracy = (2+0+0+0+5)/50 = 14%
Sumber: data Processing, 2021

Table 5
NDVI Matrix Table

NDVI	Very Low	Low	Normal	High	Very High	Total Rows	Producer Accuracy (%)
Very Low	9	0	0	0	0	9	100
Low	0	6	1	2	0	9	100
Normal	0	0	6	5	0	11	86
High	0	0	0	10	0	10	53
Very High	0	0	0	2	9	11	100
Total Colom	9	6	7	19	9	50	
User Accuracy (%)	100	67	55	100	81		

Overall Accuracy = (9+6+6+10+9)/50 = 80%
Sumber: data Processing, 2021

Field activities prove that appearances on the EVI tend to be more errors, such as drought results and appearances on the ground tend to have vegetation. Based on the results of field surveys from all three algorithms showed that the approaching SAVI was appropriate. The drought conditions of the three algorithms that dry areas / no vegetation is dominated by vacant land or rice fields that do not have rice (Figure 2).

(a) (b) (c)

Fig. 2. Field Survey (a) High Density, (b) Medium Density, and (c) Low Density

4. Conclusion

Bondowoso area is still much dense vegetation, so the occurrence of drought is very small judging from the percentage of accuracy tests that have been conducted where the results of SAVI accuracy tests score 86%, while EVI can be 84% and NDVI gets a score of 80%. So in determining drought, using the SAVI vegetation index is the suitable method to choose from the percentage of

accuracy tests. It is expected that the use of vegetation index can be compared with different algorithms such as Land Surface Temperature (LST) in the future.

References

Congalton, R.G, & Green, K. (2008). Assessing The Accuracy of Remotely Sensed Data: Principles and Practices (2nd Edition). *CRC Press, Taylor and Francis Group*.

Congalton, Russell G. (1991). A review of assessing the accuracy of classifications of remotely sensed data. *Remote Sensing of Environment*, *37*(1), 35–46. https://doi.org/10.1016/0034-4257(91)90048-B

Coopersmith, J. (2016). Lisa Gitelman. Paper Knowledge: Toward a Media History of Documents. *The American Historical Review*, *121*(4), 1248–1249. https://doi.org/10.1093/ahr/121.4.1248

Huete, A., Didan, K., Leeuwen, W. V., Miura, T., & Glenn, E. (2011). *MODIS Vegetation Indices. Land Remote Sensing and Global Environmental Change.* Springer.

Huete, A., Didan, K., Miura, T., Rodriguez, E. P., Gao, X., & Ferreira, L. G. (2002). Overview of the radiometric and biophysical performance of the MODIS vegetation indices. *Remote Sensing of Environment*, *83*(1), 195–213.

Huete, Ar. (1988). A soil-adjusted vegetation index (SAVI). *Remote Sensing of Environment*, *25*(3), 295–309. https://doi.org/10.1016/0034-4257(88)90106-X

Inarossy, N., & P, S. Y. J. (2019). Klasifikasi Wilayah Risiko Bencana Kekeringan Berbasis Citra Satelit Landsat 8 Oli Dengan Kombinasi Metode Moran ' s I dan Getis Ord G * (Studi Kasus : Kabupaten Boyolali dan Klaten). *Indonesian Journal of Computing and Modeling*, *2*(2), 36–54.

Iryanthony, S. B., Hakeem, A. R., Rahmadewi, D. P., & Artikel, S. (2019). Strategi Pengelolaan Kekeringan Masyarakat Sub DAS Bompon di Lereng Kaki Vulkanik Pegunungan Sumbing. *Jurnal Geografi*, *16*(1). https://doi.org/10.15294/jg.v16i1.10896

Jeyaseelan, A. T. (2003). Droughts & floods assessment and monitoring using remote sensing and GIS. *Satellite Remote Sensing and GIS Applications in Agricultural Meteorology*, 291–313.

Marantika, E. P., & Sudaryatno. (n.d.). *Hubungan Antara Nilai Spektral Dengan Tekstur Tanah Pada Data Digital Citra Alos Avnir-2 Sebagian Kabupaten Purworejo, Jawa Tengah*. Universitas Gadjah Mada.

Nugraha, A. S. A. (2016). *Pemanfaatan Citra Penginderaan Jauh Multi-Tingkat Untuk Pemetaan Perubahan Kekeringan (Kasus di Provinsi Jawa Timur)*. Universitas Gadjah Mada.