20 (1) (2023) 31-36

JURNAL GEOGRAFI
https://journal.unnes.ac.id/nju/index.php/JG

Distribution of Drought on Agricultural Land in Palabuhanratu District Sukabumi Regency

Ayu Handayani*, Hafid Setiadi

Department of Geography, Faculty of Mathematics and Natural Sciences, University of Indonesia, Indonesia

Article Info

Article History
Submitted 2022-06-04
Revised 2022-07-28
Accepted 2022-11-17

Keywords
Drought, Agricultural Land, Landsat 8, Pelabuhanratu District

Abstract

Drought is one of the natural disasters that causes substantial losses to food crop production, water supply in several important sectors such as industry, settlements, and agriculture. Climate change often causes drought on agricultural land and can indirectly threaten livelihoods and food security. This study aims to analyze the distribution of drought on agricultural land and examine the relationship between physical conditions. Drought monitoring study using remote sensing methods on Landsat 8 OLI imagery with the Normalized Difference Drought Index (NDDI) algorithm is the result of combining two parameters, namely the Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI). The results of the study show the distribution of agricultural land drought in Palabuhanratu District, Sukabumi Regency during 2018-2021 with five classes (normal, mild, moderate, severe, and very severe), and a very severe drought category of 80.78 ha in 2021, followed by 2018 an area of 32.09 ha. The most potential drought areas are in Palabuhanratu District, namely Jayanti Village and Citepus Village.

*Address: Jl. Margonda Raya PondokCina Kota Depok 16424
E-mail: ayu.handayani21@ui.ac.id

DOI 10.15294/jg.v20i1.41285

p-ISSN 2549-3078 e-ISSN 2549-3094

INTRODUCTION

Erratic climate change causes frequent drought natural disasters on agricultural land. Drought can cause significant losses to crop production, supply water in several important sectors such as industry, settlement to agriculture. Drought is a relationship between the availability of water which is far below the need for water both for the necessities of life, agriculture, economic activities and the environment (BNPB, 2007).

Agricultural drought includes a period when there is a decrease in soil moisture which causes crop failure without taking into account surface water resources (Wilhite and Glantz, 1985 in Aini Rista, 2019). The impacts of drought on the agricultural sector include low productivity, crop failure and crop failure, to a decrease in agricultural land area (Ru Minta, 2016; Fathony, 2022). Drought has often occurred in several regions of Indonesia, especially in West Java Province, besides that it occurs almost every year in Indonesia, especially when the dry season arrives. West Java Province is a province known as an agricultural center and ranks third in rice production in Indonesia (BPS Jawa Barat, 2020).

The problem of drought in West Java Province is felt in several regions, including Sukabumi Regency, West Java and Pelabuhan Ratu District, which is one of the sub-districts affected by drought (BNPB Sukabumi, 2019). The threat of drought due to climate influences cannot be avoided, but its impact can be minimized if drought monitoring in an area can be known. Studies on drought monitoring are carried out using remote sensing methods which have been widely applied, one of which in this study is to use the LANDSAT 8 Satellite using the NDDI *(Normalized Difference Drought Index)* developed by Gu et al (2007) used to assess and identify the appropriate drought in an area temporal.

METHODS

Research Location

Research was conducted in 6 villages or sub-districts including Buniwangi Village, Cibodas Village, Cikadu Village, Cimanggu Village, Citarik Village, Citepus Village, Jayanti Village, Palabuhanratu Village, in Palabuhanratu District, Sukabumi Regency, West Java Province. Geographically, Palabuhanratu District is bordered by Cikakak District to the north, Simpenan District to the south, Bantargadung District to the east and Indian Ocean to the west. In this research there are several stages, starting from data collection, data management and data analysis. (Figure 1.)

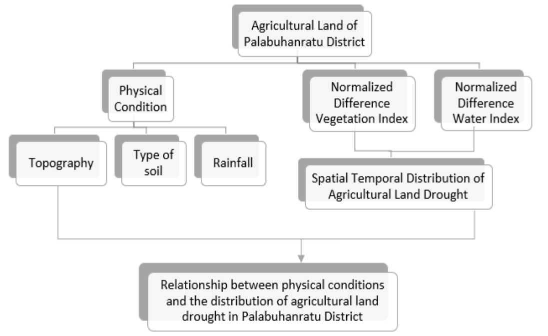

Figure 1. Research Flow Chart

The data used in this research uses some data originating from various sources, including Landsat 8 Path 122 Row 64-65 2018-2021 imagery sources from the Web United States Geological Survey (USGS), topographic maps and topographical maps (DEMNAS) sourced from the Geospatial Information Agency (BIG), rainfall sourced from the Meteorology, Climatology and Geophysics Agency (BMKG).

Data Processing Stages

Geometric Correction

Positions recorded by satellites are not always accurate. This inaccuracy can be seen from a shift in the location of an object in the image from its actual location and before further processing it must go through the geometric correction stage. This geometric correction aims to improve the position of objects in the image due to distortion to their actual position on earth (Ardiansyah, 2015; Fadli 2007).

Image cropping

Image cropping uses the administrative boundary shapefile of Pelabuhan Ratu District. Image cropping and mosaics were performed in ArcGIS software.

Mosaic Citra

Mosaic aims to combine the cropped images.according to the path/row to become an image file according to the administrative boundaries of Pelabuhan Ratu District

Vegetation Index (NDVI)

Analysis *Normalized Difference Vegetation Index* (NDVI), The low NDVI value can be concluded that the area has very low vegetation density, low water absorption capacity which is identified as drought. The following is the formula for the NDVI value (Renza et al., 2010):

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

Information:
NDVI = *Normalized Difference Vegetation Index*
NIR = Infrared wavelength band (Band 5)
RED = Red wavelength band (Band 4)
Moisture Index (NDWI)

Normalized Difference Water Index (NDWI) is an index to measure water molecules that interact in vegetation which is assisted by absorption of sunlight (Chen et., al, 2006 in Aini Rista et al, 2019) The soil moisture index algorithm on the surface was developed by McFeeters in 1996 to identify wetlands with potential for drought. The following NDWI formula is written in the following equation (Gu et al., 2007):

$$\text{NDWI} = \frac{(NIR\ Band - SWIR)}{(NIR\ Band + SWIR)}$$

Information:
NDWI = *Normalized Difference Water Index*
NIR band = NIR band (Band 6)
SWIR = Band that has an Infrared wavelength (Band 5)

Normalized Difference Drought Index (NDDI)

NDDI method combines the greenness of vegetation (NDVI) and land wetness (NDWI) parameters with extract by mask on ArcMap. According to (Gu et al., 2007) NDDI can identify drought better when compared to the *Normalized Difference Vegetation Index* (NDVI) and *Normalized Difference Water Index* (NDWI) alone. Drought conditions are shown with higher values. To get the NDDI value, it can be seen in the following formula:

$$\text{NDDI} = \frac{(NDVI - NDWI)}{(NDVI + NDWI)}$$

Information:
NDVI = Normalized Difference Vegetation Index
NDWI = Normalized Difference Water Index (Wetness Index)

Results of this processor are drought maps using the NDDI method which have been classified into five drought classes, namely normal, mild drought, moderate drought, drought heavy and very heavy. The following is the classification of drought classes using the NDDI method.

Table 1. *NDDI Class Classification*

Index Value	Drought Level
-0.05 – 0.01	Normal
0.01 – 0.15	Mild Drought
0.15 – 0.25	Moderate Drought
0.25 – 1	Severe Drought
> 1	Very Severe Drought

Source: Renza et al., (2010)

RESULTS AND DISCUSSION

NDVI, NDWI and NDDI Analysis for 2011-2020

Transformation *(Normalized Difference Vegetation Index)* in this study was used to determine the level of greenery and vegetation density and its relationship with the drought potential for the annual data sample used. The results showed that the greenness index value of vegetation using the NDVI algorithm in Palabuhanratu District has an index value ranging from -1 to 1 which is divided into five classification classes.

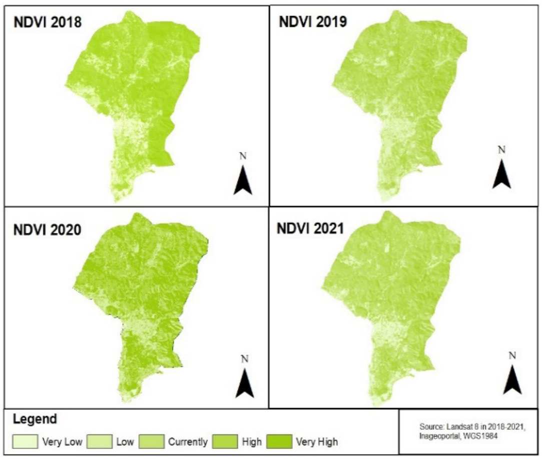

Figure 2. The distribution vegetation index for 2018-2021 in Palabuhanratu District.

From Figure 2. The distribution of vegetation in the very high category in 2018 was 55.7%, followed by 32.3% in 2021. Then the distribution of vegetation which is in the very low category in 2019 is 1.8% followed by 2020 of 1.3%. The distribution of green vegetation seems to have changed, especially in the southern part, in Jayanti Village and Palabuhanratu Village, which are dominated by paddy fields and plantations, which have more significant color changes. The size of the vegetation in the very high category means that the ability to absorb water is high and vegetation that has low ability to absorb water is low which can be identified as drought.

Transformation Normalized Difference Water Index in this study was used to determine the relationship with the potential for drought and to see which areas have more and less moist soil. The results showed that it had an index value ranging from -0.1 to 1 which was divided into six classification classes.

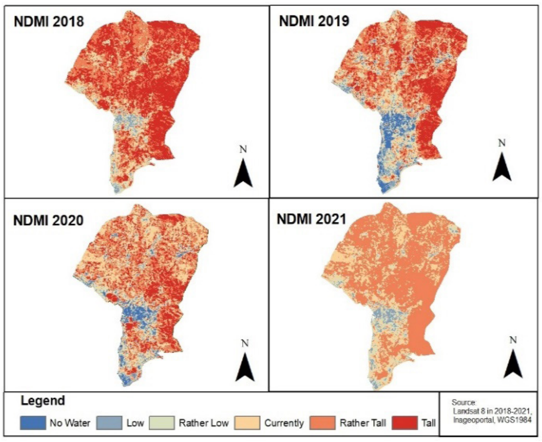

Figure 3. Distribution of the Moisture Index for 2018-2021 in Palabuhanratu District

In Figure 3. Distribution of the Moisture Index changes quite clearly every year, it seems that the humidity is more dominant in 2018 with 45.6%, followed in 2019 with 27.1%. In addition, humidity in the category of no water is found in 2019 at 6.5% followed by 2021 at 3.5%. Moderate humidity levels almost occur in all Palabuhanratu Districts, whereas high humidity levels and non-water only occur in a few areas, the most dominant areas being in Jayanti Village, Palabuhanratu Village and Citepus Village. The lower the spectral transformation value of the humidity index, the drier the region.

The combined NDDI (Normalized Difference Drought Index) transformation of the results of NDVI and NDWI processing in this study is used to determine drought on agricultural land.

Based on Figure 4. Distribution of the drought index has five classes of drought index on agricultural land for four years. The distribution of drought in Palabuhanratu has a relatively high drought potential, from the results of the drought classification that most of the areas spread across Palabuhanratu District experience drought during the dry season, the potential for drought is quite widely spread in the south and west. Then areas that have no potential for drought are in the north and east. From these results the area of the area experiencing drought can be seen in Table 2.

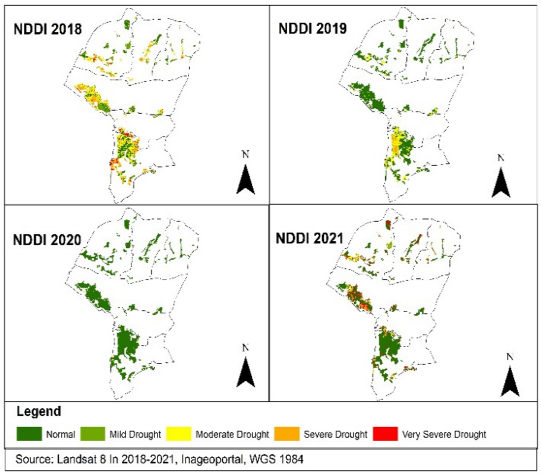

Figure 4. Distribution of the drought index for agricultural land in 2011-2021 in Palabuhanratu District

Distribution of drought on agricultural land for four years has a very severe drought category area of 80.78 ha or 13.5% in 2021 followed in 2018 of 32.09 ha or 5.6%. In 2019 and 2020, as seen from table 1, the drought class does not have such a high potential. The village/ kelurahan area of Palabuhanratu District has a very severe drought in 2021 in Citepus Village covering an area of 33.27 ha followed by Jayanti Village covering 13.56 ha, while in 2018 the very severe drought is in Jayanti Village covering an area of 17.02 ha, and followed by Palabuhanratu sub-district 5.52 ha. Areas of severe drought in 2021 will be in Citepus Village covering an area of 23.61 ha, followed by Cibodas Village 12.05 ha, and in 2018 severe drought will be in Jayanti Village covering an area of 56.16 ha followed by Citepus Village covering an area of 45.15 ha. It can be concluded that the most potential drought distribution is in Palabuhanratu District, namely

Table 2. Area of Drought on Agricultural Land in 2018-2021 in Palabuhanratu District

Class Drought	Year			
	2018	2019	2020	2021
Normal	158,77	458,49	592,05	418,39
Mild Drought	65,04	0,09	0,08	21,04
Modarate Drought	200,15	117,35	7,01	28,09
Severe Drought	114,22	24,38	0,81	51,92
Very Severe Drought	32,09	0,04	0,37	80,78

Jayanti Village and Citepus Village.

Then the results of the drought accuracy test on agricultural land with NDDI obtained an *accuracy* of 0.7 value is acceptable and can be used as an effort to monitor drought areas and drought mitigation and can be developed for making drought maps in other areas. An *accuracy* value of more than 0.5 or 0.7 - 0.8 is acceptable (Hosmer and Lemeshow, 2000; Luqman Aldiansyah 2021).

NDDI Relationship Analysis with Physical Conditions

The distribution of drought on agricultural land can be identified by connecting several parameters of the factors that cause drought, one of which is physical conditions such as altitude, soil type and rainfall. Then to determine the relationship between physical conditions and drought on agricultural land, multiple linear statistical tests were carried out. The results of the multiple linear regression test describe the parameters of physical conditions, one of which is rainfall which has the most influence on the area of distribution of drought on agricultural land, this can be obtained by a regression value of 0.562 or 56.2%, which means that the higher the rainfall, the wider the distribution area of drought. low or weak.

This can be supported by the calculated F test on the regression which obtained a value of 2.570 which is greater than the F table which is 1.53. These values are compared so that it can be concluded that the F table value is smaller than the calculated F, so that all physical condition variables affect drought on agricultural land. In line with the research of Aini Rista et. al (2020), the most dominant physical factor affecting the level of drought is rainfall. Droughts are common in areas with an average rainfall of 82 - 127 mm. While drought is often found in endoaquepts sulphic sedimentary soil types which predominate in the lowland areas and drought is found which has physical characteristics of 0-50 meters above sea level in the lowlands.

CONCLUSIONS

Distribution of NDVI vegetation appears to have changed, especially the southern part in Jayanti Village and Palabuhanratu Sub District which are dominated by paddy fields and plantations which have more significant color changes. The NDWI humidity distribution changes quite clearly every year, high humidity and non-water only occur in a few areas, the most dominant areas are in Jayanti Village, Palabuhanratu Village and Citepus Village.

Distribution of NDDI drought on agricultural land for four years has an area that is in the very severe drought category of 13.5% in 2021 followed in 2018 with 5.6% very heavy category. The most potential drought areas are in Palabuhanratu District, namely Jayanti Village and Citepus Village. Drought on agricultural land can be identified by connecting several parameters to the factors that cause drought, one of which is physical conditions such as altitude, soil type and rainfall. One of the physical conditions that affect rainfall on the area of drought distribution on agricultural land is a regression value of 0.562 or 56.2% meaning that the higher the rainfall, the lower the drought distribution area and vice versa.

REFERENCE

Aini, R. N., Ratna, S., & Adi, W. (2019). Pola Sebaran Kekeringan Lahan Pertanian Kabupaten Serang Dengan Menggunakan Algoritma NDDI. *Prosiding Simposium Infrastruktur Informasi Geospasial, kode makalah: SIIG-008*

Badan Pusat Statistik. (2020). Kecamatan Palabuhanratu Dalam Angka 2020. Diambil dari: *https://sukabumikab.bps.go.id/*

BNPB. (2018). Potensi Bencana di Indonesia. Diambil dari: *https://www.bnpb.go.id/home/potensi.*

Julianto, F. D. (2021). Analisis Sebaran Potensi Kekeringan Dengan Cloud Computing Platform di Kabupaten Grobogan. *Jurnal Ilmiah Geomatika (IMAGI)*, 1(1).

Fathony, A., Somantri, L., & Sugito, N. T. (2022). Analisis Potensi Kekeringan Pertanian di Kabupaten Bandung. *Jurnal Geografi: Media Informasi Pengembangan dan Profesi Kegeografian*, 19(1), 29-37.

Gu, Y., Brown, J. F.,Verdin, J.P. dan Wardlow, B. (2007). 'A five-year analysis of MODIS NDVI and NDWI for grassland drought assessment over the central Great Plains of the United States', *Geophysical Research Letters, 34(L06407) 1–6.*

Luqman, A. D., Wiyono, R. U. A., & Hidayah, E. Akurasi Pemetaan Kekeringan Lahan Pertanian Menggunakan Metode Normalized Difference Drought Index (NDDI) di Kecamatan Wuluhan dan Rambipuji Jember.

McFeeters. Stuart K. (2013). Using the Normalized Difference Water Index (NDWI) within a Geographic Information System to Detect Swimming Pools for Mosquito Abatement: A Practical Approach. *Remote Sensing, 5, 3544–3561.*

Perdana, A. M. P., Pratama, A. Y., Fauzi, A. I., Welly, T. K., & Nurtyawan, R. (2022). Analisis Spasio-temporal Kekeringan Pada Lahan Sawah di Lampung Selatan Berbasis Pengolahan Normalized Difference Drought Index Pada Citra Satelit Landsat 8. *Jurnal Geosains dan Remote*

Sensing, 3(1), 1-9.

Rahman, F., Sukmono, A., & Yuwono, B. D. (2017). Analisis kekeringan pada lahan pertanian menggunakan metode nddi dan perka bnpb nomor 02 tahun 2012 (Studi kasus: Kabupaten kendal tahun 2015). *Jurnal Geodesi UNDIP*, 6(4), 274-284.

Widyastuti, R. (2020). Pola Sebaran Kekeringan di Kecamatan Simpenan Menggunakan Metode SPI (Standardized Precipitation Index). *Jurnal Geosaintek*, 6(1), 19-24.

Renza, D., Martinez, E., Arquero, A., & Sanchez, J. (2010, May). Drought estimation maps by means of multidate Landsat fused images. In *Proceedings of the 30th EARSeL Symposium* (pp. 775-782).

Sholihah, R. I., Trisasongko, B. H., Shiddiq, D., La Ode, S. I., Kusdaryanto, S., & Panuju, D. R. (2016). Identification of agricultural drought extent based on vegetation health indices of landsat data: case of Subang and Karawang, Indonesia. *Procedia Environmental Sciences*, 33, 14-20.

Sukmono, A., Rahman, F., & Yuwono, B. D. (2018). Pemanfaatan Teknologi Penginderaan Jauh untuk Deteksi Kekeringan Pertanian Menggunakan Metode Normalized Difference Drought Index di Kabupaten Kendal. *Jurnal Geografi: Media Informasi Pengembangan dan Profesi Kegeografian*, 14(2), 57-65.

Agus Suprihatin Utomo, A. S. U., M Pramono Hadi, M., & Emilya Nurjani, E. N. (2022). Analisis spasial temporal zona rawan kekeringan lahan pertanian berbasis remote sensing. *Jurnal Ilmiah Sains dan Teknologi*, 11(2), 112-127.