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ANALYSIS OF DROUGHT INDEX IN THE GAMBUT SUB-DISTRICT, SOUTH BORNEO, FOR WILDFIRE PEATLAND MITIGATION

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ABSTRACT

In mid-2019, smog almost covered all areas in South Kalimantan. Banjar regency is one of the regencies in South Kalimantan Province with the most fires in 2019. One of the most burned subdistricts of Banjar Regency is Gambut Subdistrict. Analyzing the drought index for drought danger mitigation that triggers wildfire peatlands is necessary. This drought index research aims to investigate the magnitude of the drought index in the Gambut Subdistrict that causes land fires.

The analysis method is data collection, namely rainfall data for 20 years (2001-2020) and maximum daily temperature data, which is then processed using several stages of analysis by Keetch Byram Drought Index (KBDI) model modification for wetlands and modification KBDI for peatlands. This method is used to determine the level and duration of drought that occurs over a period of 20 years. This study also requires observation of data fire point and water table data for the calibration process of sensitivity of the model used.

The results of the analysis based on the calculations that have been done can be concluded that the magnitude of the drought index that occurs in the Peat Censure of South Kalimantan for peatlands has an extreme drought index that occurs from July to November 2014 2015, and 2019 with the number of fires as much as 210, 357, and 233 based on water table observations as long as the results are obtained that by maintaining the water table no more than 40 cm will prevent the occurrence of drought that causes flammable land.

Keywords*:* drought index KBDI modification, water table, hotspot, Gambut Subdistrict

1. INTRODUCTION

In mid-2019, the smog almost covered the entire area in South Kalimantan. One of the causes of this haze is forest and land fires that occurred in Gambut District. Gambut District has an area of 129.3 km^2 with a strategic location between the Banjarmasin and the Banjarbaru (BPS, 2021). From the fires that occurred in the District of Gambut, it is necessary to analyze the drought index to determine how high the drought level is. It can use rainfall data to identify the magnitude of the drought index and how to overcome land drought in Gambut District, which causes fires.

2. LITERATURE REVIEW

2.1. Peatland Fire

Peat fires are classified as bottom fires or what can be called ground fires (Usup, 2015). In a bottom fire, the fire will spread erratically below the surface because it is not affected by the wind. The fire will burn the organic matter contained in the peat by smoldering so that only white smoke can be seen above the surface (Treat *et al.*, 2013).

Since this type of underground fire occurs underground and only the smoke rises to the surface, extinguishing it will be difficult. Complete fire suppression in peatland will only succeed if the burning peat layer is flooded with water. To achieve the condition of the flooded peat soil layer, a very large amount of water is needed, such as using a stuck pump or waiting for heavy rain naturally to extinguish a fire (Adinugroho *et al.*, 2004).

2.2. Drought

The impact of global warming causes the dry season to be longer and the rainy season to be shorter, but the intensity of the rain will be greater. As a result of global warming in various regions during the dry season, droughts will last for a long time, and the problem of water deficits is becoming more complex. The rainy season will be shorter, but the intensity of the rain will increase; this means that the rainfall will be high in a short period. High rainfall, when it falls to the earth, will cause an increase in run-off, which causes flooding to increase, and the capacity of the stored flow to become a dependent flow decreases. As a result, during the dry season, there are fewer water reserves in steady streams, and things like this will significantly affect the drought that occurs (Sulwi, Monika, and Suska-malawska, 2017).

2.3. KBDI Drought Index

The KBDI calculation method is simple (Keetch and Byram, 1968). It was modified for tropical conditions (Taufik, Setiawan, and van Lanen, 2015) and peatland conditions (Novitasari *et al.*, 2019). It is because only three variables are needed to calculate the value of the fire hazard level, namely:

a. Average annual rainfall from local/local weather station
b. Daily rainfall
c. Maximum temperature

The calculation method of this method is based on the following equation:

$$KBDI_{p,t} = KBDI_{p,t-1} + DF_{p,t} - RF_{p,t} \quad ...(1)$$

Where $KBDI_{p,t}$ is today's drought index, $KBDI_{p,t-1}$ is the previous day's drought index, $DF_{p,t}$ is the Drought Factor, and $RF_{p,t}$ is effective rainfall. The rainfall factor value (*RFt*) be calculated using annual rainfall. The Data more than 5.1 mm/day is considered a subtraction in the drought index and is determined using the following equation:

$$RF_t = \begin{cases} (R_t - 5,1),\ R_t \geq 5,1\ \text{mm/day}, \\ \text{first rainy day} \\ R_t,\ R_{t-1} \geq 5,1 mm/\quad day \\ \text{day the second day and the next rainy day} \\ 0,\ R_t < 5,1\ \text{mm/} \end{cases} \quad (2)$$

Where R_t (the daily rainfall at t) and R_{t-1} (the daily rainfall at t-1). For tropical conditions and for a, b, and c, the coefficients are as follows:

$$DF_t = (w_c - KBDI_{t-1}) \frac{(ae^{(bTm+1,5552)} - c)10^{-3}}{1+10,88e^{(-0,001736R_0)}} \quad (3)$$

Where DF_t is the dryness factor (mm), *wc* is the available water field capacity in the layer (mm), $KBDI_{t-1}$ is moisture deficiency (KBDI at t – 1), T_m (the daily maximum air temperature in ^oC), *t* is the increase (days), R_0 (the average annual rainfall in = mm), *a* and *c* are coefficients affected by the average annual rainfall (R_0), *b* is coefficients affected by evapotranspiration.

Table 1. Climate Variables for Tropical Wetlands and Peat Conditions

Parameter	Tropical Wetlands	Tropical Peatlands due to El Nino
T_m [^oC]	26,67	26,67
R_0 [mm]	2540	1650
a	0,4982	0,3614
b	0,0905	0,0905
c	4,27	3,10
w_c	203	400

Source: (Novitasari *et al.*, 2019)

Table 2. KBDI Drought Index Class Modified for Tropical Peatland Conditions

Class	KBDI Index	KBDI Index in Tropical Peat
Low	0-100	0-200
Medium	101-150	201-300
High	151-175	301-350
Extreme	>175	>350

Source: (Novitasari *et al.*, 2019)

The water table 400 mm below the surface is considered to be the cause of the maximum drought index and has a potential fire risk for peat ecosystems (PP No 150, 2000; PP No 57, 2016; Putra *et al.*, 2018; Novitasari *et al.*, 2019). A water level of 0 mm, or water level above the soil surface, is stated as ideal peat in conditions that are always waterlogged. Based on the new *wc* values for peatland conditions, the KBDI class values are modified for peatland conditions. The drought index class is classified into four levels, as presented in Table 2.2 (Novitasari et al., 2019).

3. RESEARCH METHODOLOGY

3.1. Research Location

The research was conducted at the location of Jl. Ahmad Yani Km. 17, Malintang, Gambut District, Banjar, South Kalimantan. Precisely in front of BPTD XV South Kalimantan Province (Barakat Banjar Gambut Terminal).

Figure 1. Research Area

3.2. Research Methods

The stages in the research process are shown in the following flow chart:

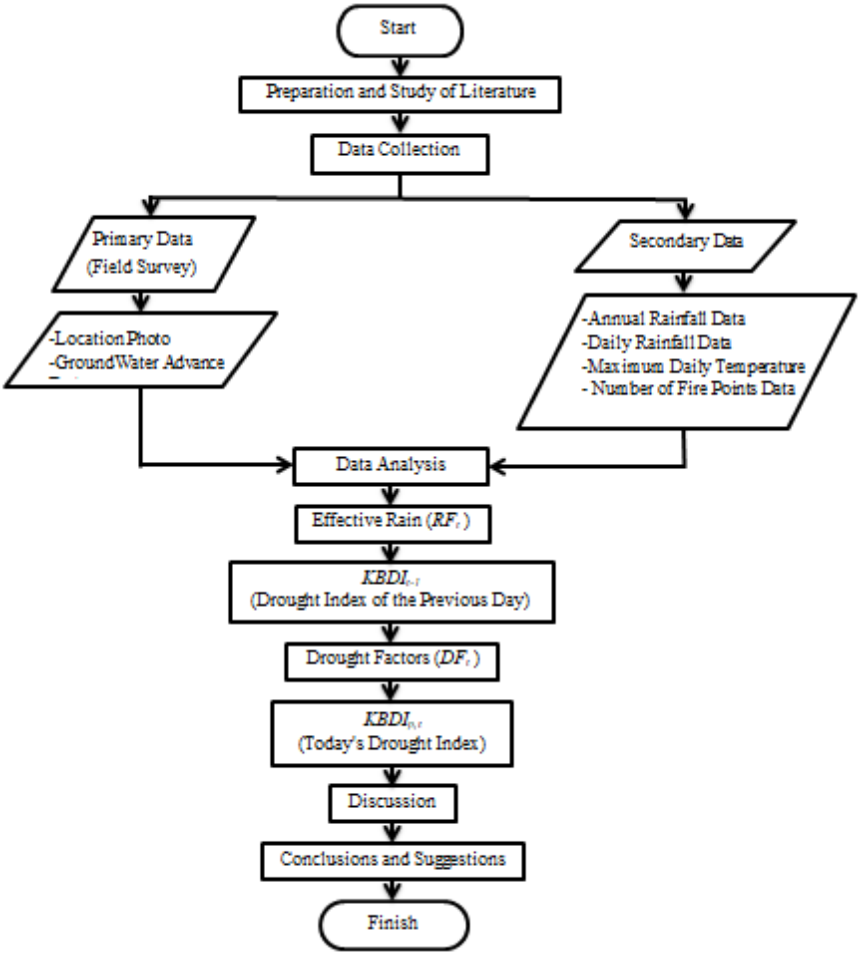

Figure 2. Research flow chart

4. RESULTS AND DISCUSSION

4.1. Rainfall Data

The maximum daily rainfall data used in this study is located in Banjarmasin City, South Kalimantan Province. The data obtained consisted of daily maximum rainfall data every year from 2001 to 2020. The data was obtained from the online BMKG Syamsudinoor Meteorology Station Banjarmasin (BMKG, 2022).

4.2. Hotspot Data

Data on the number of hotspots was obtained from the Global Forest Watch online site in the history of fire warnings in Banjar Regency, South Kalimantan, from 2012 to 2020. From 2012 to 2020, the most hotspots were recorded in June, July, August, September, October, and November. And the most annual hotspots in 2015 amounted to 357 hotspots. This coincided with the occurrence of El Nino in Indonesia (Global Forest Watch (GFW), 2021).

4.3. The water table data

The water table was obtained from the results of measurements using the Solinst Levelogger Junior Edge Model 300. Data were collected using a 2-inch pipe with a length of 1.2 meters which was planted into peat soil as deep as 1 meter. Measurements are carried out 2 to 3 times a week in hot weather conditions and not after rain. This measurement is carried out for two months and is carried out in the wet month or during the rainy season.

4.4. Keetch-Byram Method (KBDI) Drought Index Analysis

Analyzing the magnitude of the land drought index in this study for 20 years (2001–2020) using daily rainfall data. From the daily rainfall data, which is subtracted by 5.1 mm based on the KBDI formula, effective rain data is obtained.

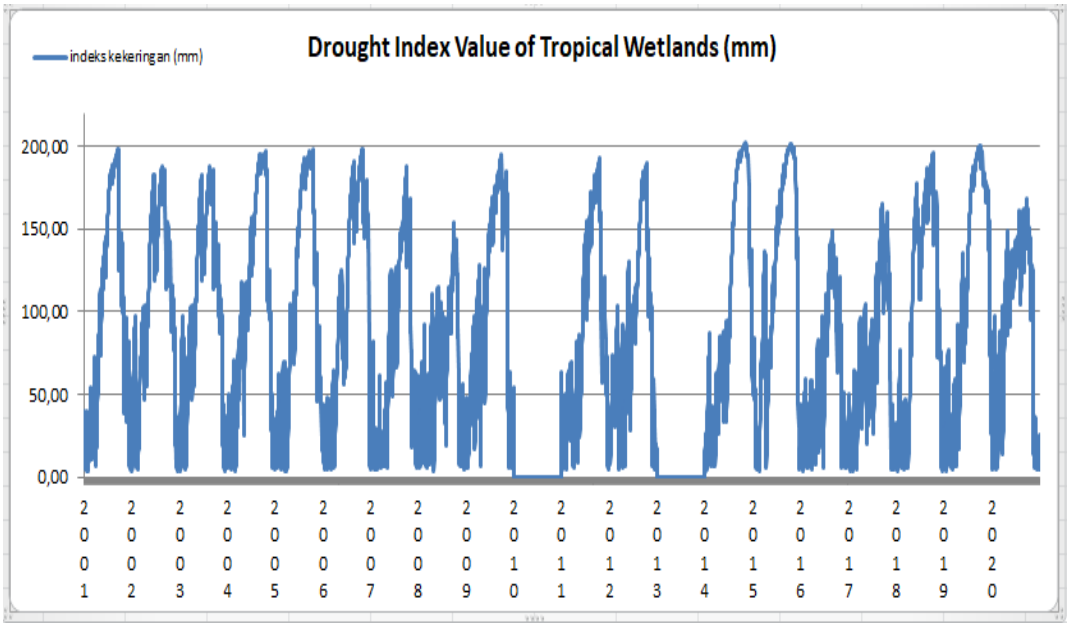

Figure 3. Drought Index Value of Tropical Wetlands

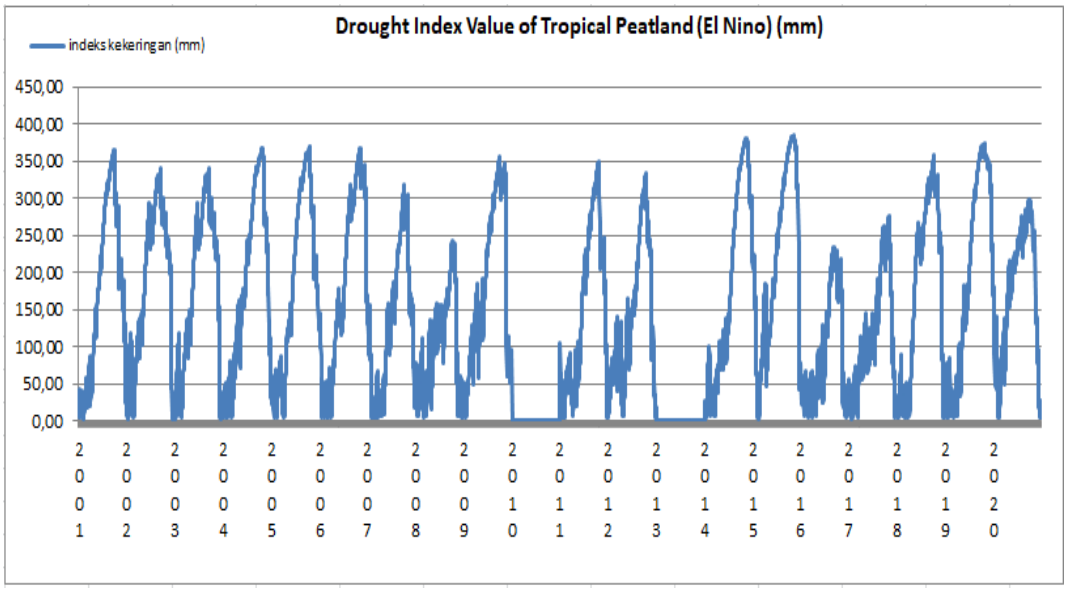

Figure 4. Drought Index Value of Tropical Peatland Conditions

4.5. Intercourse Between Drought Index and Hotspots

The data on the distribution of hotspots has been analyzed, and it is known that the year with the most hotspots was then correlated with the drought index in the same year, where the correlation between the number of hotspots and the drought index can be seen in Figure 5 below.

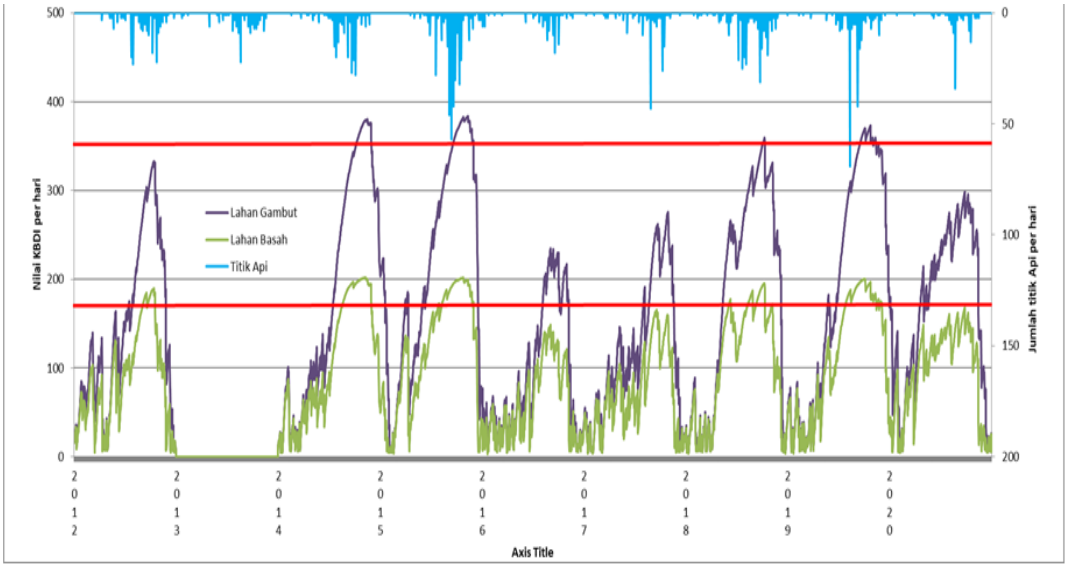

Figure 5. Relationship between Drought Index and Hotspots.

Hotspots occur when drought levels are at an extreme scale. This shows that when the area is dry (extreme drought index), the number of hotspots detected is large, but on a low drought index scale, there are few hotspots or even none at all. This shows that the fire point, which indicates a fire, has an inclination that is not fixed.

The water table 400 mm below the surface is considered to be the cause of maximum drought and potential fires for peat ecosystems. The 0 mm water level or the water level above the soil surface is defined as peat with ideal conditions that are always flooded. Based on the wc value, the value of peatland conditions, and the KBDI class value for peatland conditions.

5. CONCLUSIONS

From the results of the analysis and calculations, it can be concluded as follows:

1. The magnitude of the drought index that occurred in the Peatlands of South Kalimantan using the modified Keech Byram Drought Index (KBDI) method for peatlands for 20 years from 2001 to 2020 has a high drought index that occurred from July to November in 2014, 2015, and 2019.
2. Based on land fire data from Global Forest Watch and drought index data, it was found that the extreme drought index was 892 days for 20 years, days from July to November, which can cause fires to occur in 2014 as many as 101 incidents, in 2015 there were 106 incidents, and in 2019 there were 110 incidents, which occurred in tropical peatland conditions due to El Nino. As for tropical wetlands, in 2014, there were 56 incidents; in 2015, there were 76 incidents; and in 2019, there were 61 incidents.
3. One way to overcome the drought in peatlands that causes fires is to maintain the water table like the original peatland condition, namely land that is inundated or maintains a water table of no more than 40 cm according to regulation no.150 of 2000 and regulation no. 57 of 2016. Based on field observations, it was found that in the research area in 2021, from April to June, the daily water table data was around 10.29 cm; this is supported by the absence of land fires in 2021.

REFERENCES

Adinugroho, W. C. *et al.* (2004) *Panduan Pengendalian Kebakaran Hutan dan Lahan Gambut*. Bogor, Indonesia: Wetlands International - Indonesia Programme.

BMKG (2022) *Data Hujan Online*. Jakarta. Available at: http://dataonline.bmkg.go.id (Accessed: June 30, 2022).

BPS (2021) *Kecamatan Gambut Dalam Angka 2021*, *Badan Pusat Statistik*. Kecamatan

Gambut, Kabupaten Banjar, Kalimatan Selatan, Indonesia. Available at: https://banjarkab.bps.go.id/publication/download.html?nrbvfeve=MWMzMjRkYTE1NGEzOGY2Nzg4MjJkYzZk&xzmn=aHR0cHM6Ly9iYW5qYXJrYWIuYnBzLmdvLmlkL3B1YmxpY2F0aW9uLzIwMjEvMDkvMjQvMWMzMjRkYTE1NGEzOGY2Nzg4MjJkYzZkL2tlY2FtYXRhbi1nYW1idXQtZGFsYW0tYW5na2EtMjAyMS5odG1s&t.

Global Forest Watch (GFW) (2021) *https://www.globalforestwatch.org/*.

Keetch, J. J. and Byram, G. M. (1968) *A Drought Index for Forest Fire Control*. USA.

Novitasari, N. *et al.* (2019) "Drought Index for Peatland Wildfire Management in Central Kalimantan, Indonesia During El Niño Phenomenon," *Journal of Disaster Research*, 14(7), pp. 939–948. doi: 10.20965/jdr.2019.p0939.

PP No 150 (2000) *Peraturan Pemerintah tahun No. 150 Tahun 2000 tentang Pengendalian Kerusakan Tanah untuk Produksi Biomassa*.

PP No 57 (2016) *PP No 57 Tahun 2016 tentang Perubahan PP No 71 Perlindungan dan Pengelolaan Ekosistem Gambut*.

Putra, E. I. *et al.* (2018) "Referensi Tinggi Muka Air Tanah Bagi Pencegahan Kebakaran Gambut di Indonesia," in *Prosiding Seminar Nasional Hari Air Dunia*, p. 66.

Sulwi, M., Monika, M. and Suska-malawska, M. (2017) "Long-term fi re effects of the drained open fen on organic soils," 43(1), pp. 11–19. doi: 10.1515/aep-2017-0002.

Taufik, M., Setiawan, B. I. and van Lanen, H. a. J. (2015) "Modification of a fire drought index for tropical wetland ecosystems by including water table depth," *Agricultural and Forest Meteorology*. Elsevier B.V., 203(Fire Drought Index), pp. 1–10. doi: 10.1016/j.agrformet.2014.12.006.

Treat, C. C. *et al.* (2013) "Modelling the effects of climate change and disturbance on permafrost stability in northern organic soils," *Mires and Peat*, 12(Zoltai 1993), pp. 1–17.

Usup, A. (2015) *Sistem Pencegahan dan Pengendalian Kebakaran berbasis Masyarakat untuk kawasan Hutan dan Lahan Gambut Tropis di Provinsi Kalimantan Tengah, Indonesia*. Palangkaraya.