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ANALYSIS OF THE INFLUENCE OF CHANNELS DISTANCE ON WATER BALANCE CALCULATIONS IN THE LIANG ANGGANG PROTECTED FOREST AREA BLOCK 1

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ABSTRACT

Peatland is an ecosystem that easily catches fire when dry. The highest number of forest fires was found in Banjar Regency, Banjar Regency, and Tapin Regency. One of the factors causing peatland fires in the Liang Anggang Protected Forest, apart from human activity, is the occurrence of drought, where more water is lost than water that enters the land. This study aims to analyze the water balance with the influence of the drought index on peatlands that are fibers and have canals based on the equation in Thompson's study (2014). The data used in the water balance research are monthly rainfall data, and monthly temperature data from 2000 to 2021 obtained from the Class II Meteorological Station Syamsuddin Noor Banjarmasin, then forest intercept is 16.4% based on research from Vernimmen (2007), calculations evapotranspiration (ET0), and storage changes in the unsaturated zone (ΔΘ) with the modified Keech-Byram Drought Index value approach with the condition of the physical properties of fibers peat soil. The highest rainfall occurred in January 2021, 898.7 mm/month. The maximum average evapotranspiration (ET0) occurs in February, with a value of 100.3 mm/month. Based on the calculation of the water balance in the Liang Anggang Protected Forest Block 1, there was a water deficit from July to October, with the peak of the water deficit occurring in September, which was 65.6 mm/month and the peak of the water surplus in February, of 211.8 mm/month.

Keywords: *Interception, Evapotranspiration, Water Balance, Liang Anggang Protection Forest*

1. INTRODUCTION

Peatland is an ecosystem that easily catches fire when dry. According to district/city PNPB data in 2019, it is known that there has been an increase in the total area of land burned in all districts/cities in South Kalimantan from 2017 to 2019. The highest total area of land and forest fires was in Banjar District, followed by Tanah District. Sea, then Tapin Regency. The increasing area of forest and land fires in the province of South Kalimantan is a problem that always occurs every year (Rahmini & Sopiana, 2021). One of the factors that cause fires on peatlands apart from human activity is the occurrence of drought, where more water is lost than water that enters the land. The water balance is closely related to drought. Drought events are caused by rain that is not evenly distributed in land or area. The land fire factor is also caused by a decrease in the groundwater level of peatlands (Fitriati, 2018). This study aims to analyze the water balance with the influence of the drought index on peatlands that are fibers and have canals.

2. THEORETICAL STUDY

Rainfall

Rainfall (mm) is the height of rainwater that falls on a flat area with the assumption that it does not evaporate, does not seep, and does not flow. Rainfall of 1 (one) mm is rainwater as high as 1 (one) mm, which falls (accommodates) on a flat area of 1 m2, assuming nothing evaporates, flows, and seeps. High rainfall in the tropics is generally produced by convection processes and the formation of hot rain clouds. Precipitation is produced by the upward movement of moist air masses (Mulyono, 2014). Rainfall patterns can be used as references for increasing plant productivity (Sofia & Amalia, 2021).

Forest Interception

According to Asdak (2004) in (Putra et al., 2016), interception is a process when rainwater falls on the surface of the vegetation above the ground surface, is held for a while, and then evaporated back into the atmosphere or is absorbed by the vegetation in question. The value of intercepting peat forests was 16.4%. The intercept value is used to calculate the net rainfall that reaches the ground surface. Rainfall intercept losses were calculated for one hectare each of unlogged and logged moist tropical rainforest. The results showed that intercept losses were higher in a logged-over forest (11% of total gross rainfall) than in logged-over forests (6%) (Vernimmen et al., 2007).

Evapotranspiration (ET_0)

Evapotranspiration is a combination of evaporation and transpiration. Rain that reaches the earth's surface is channeled to the surface and subsurface of the reservoir through the surface and/or subsurface runoff. The water stored in the reservoir is then transferred back into the atmosphere through evaporation and transpiration processes (Tachyan & Pangaribuan, 1985).

ET0 is an evapotranspiration condition based on meteorological conditions such as temperature, sunlight, humidity, and wind where there is sufficient water available for plant growth (Fitriati et al., 2015). The FAO Penman-Monteith method was chosen as the method by which the evapotranspiration from this reference surface (ETo) can be determined and as the method which gives consistent ETo values across all regions and climates. The Penman-Monteith formula in 1990 by FAO was later modified and developed into the FAO Penman-Monteith formula (Allen et al., 1998).

$$ET_0 = \frac{0{,}408\Delta R_n + \gamma \frac{900}{(T+273)} U_2 (e_s - e_a)}{\Delta + \gamma(1 + 0{,}34 U_2)}$$

Description:

ET_0 = reference plant evapotranspiration (mm/day)
R_n = net solar radiation over the plant surface (MJ/m^2/day).
T = average air temperature (^{0}C)
U_2 = wind speed at the height of 2 m from the ground surface (m/s)
e_s = saturated water vapor pressure (kPa)
e_a = actual water vapor pressure (kPa)
Δ = the slope of the water vapor pressure curve concerning temperature (kPa/^{0}C)
γ = psychrometric constant (kPa/^{0}C)
.

Water Balance

The water balance is the most important component in the hydrological system. In simple terms, the water balance is the amount of rainwater that falls into the ground minus evaporation and runoff. In other words, the water balance is the relationship between the flow of water into the soil in the form of input and output within a certain time. Water output can be in the form of actual evapotranspiration and surface runoff (Hartanto, 2017).

The volume of rainwater that seeps into the ground will determine whether or not the balance of groundwater conditions is reached. Groundwater balance or sustainability will be achieved if the input of groundwater is equal to the output of groundwater, or in other words, the volume of groundwater withdrawal is equal to the volume of the addition of groundwater discharge (Kurdi et al., 2018).

Good water management can avoid excessive deficits, which in the short term can lead to dry land, which facilitates the occurrence of fires, and irreversible drying and, in the long term, can cause excessive land subsidence. The water balance in peatlands based on research (Thompson et al., 2014) is presented in the following equation.

$$\Delta S = R - I - ET_0 \pm \Delta\theta$$

description:
ΔS = reservoir change (mm)
R = rainfall (mm)
I = interception (mm)
ET_0 = evapotranspiration (mm)
$\Delta\Theta$ = unsaturated zone storage change (mm)

3. METHOD

This research was conducted in the Liang Anggang Protected Forest Block 1, Liang Anggang District, Banjarbaru City, and Gambut District, Banjar Regency, South Kalimantan. There are two types of data needed, namely primary data and secondary data. Primary data was obtained directly in the field, namely photographic documentation and soil samples at the study site. Secondary data were obtained from third parties or intermediary media, namely rainfall data and temperature data obtained from the Class II Meteorological Station Syamsuddin Noor Banjarmasin. Forest intercept was used with a value of 16.4% based on Vernimmen's research (2007), calculation of evapotranspiration (ET0) using the FAO Penman-Monteith method, changes in storage of unsaturated zones was approximated by the modified KBDI drought index, and water balance calculations using the Thompson method (2014).

4. RESULT AND DISCUSSION

Rain Analysis

The daily rainfall data used in this study were taken from the Class II Meteorological Station Syamsudin Noor Banjarmasin. The data used is daily rainfall data every year from 2000 to 2021, as shown in Table 1.1 below.

Table 1. 1 Monthly Rainfall From 2000 to 2021

Year	Bulanan												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual Rainfall**
2000	392,5	292,6	425,7	122,3	126,2	186,8	156	142,1	74,5	184,5	346,7	410,7	**2860,6**
2001	356,9	208,6	261,8	132,6	132,6	75,9	21,3	17	104,7	162,5	256,3	363,2	**2093,4**
2002	263,8	550,9	133,4	211,9	50,2	98	47,1	41,6	110	170,5	264,6	655,7	**2597,7**
2003	263,8	550,9	133,4	211,9	50,2	98	47,1	41,6	110	170,5	264,6	655,7	**2597,7**

Year	Bulanan												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual Rainfall**
2004	626,1	375,1	303,2	126,9	228,3	80	90,1	0	32,6	51,7	289,6	415	**2618,6**
2005	268,8	271,8	332,5	129,5	230,4	49,7	18,8	49,3	36,1	176,5	203,2	284,4	**2051,0**
2006	547,4	372,9	347,7	181,5	184,6	201,7	12,4	58,4	38,8	0	120,2	347,1	**2412,7**
2007	371	539,1	480,2	473,3	147,3	205,3	158,8	66	19,8	102,9	330,8	354,8	**3249,3**
2008	253,1	318,8	421,2	275,3	85,4	196	267,6	99,4	87,7	212,6	441,4	437,9	**3096,4**
2009	317,8	159,8	138,6	255,1	185,9	55,5	65,7	25,6	21	103,1	400,1	226,5	**1954,7**
2011	517,2	248,6	295,9	181,3	262,9	72,2	78,7	46,4	43,5	160	194,6	639,3	**2740,6**
2012	220,6	155,7	263,6	402,8	126,3	162,3	144,5	27,1	32,3	165,8	337,5	463,2	**2501,7**
2014	279,1	299,7	295,2	213,9	211,3	194,2	75,3	19,7	15	0	52,1	300,1	**1955,6**
2015	338,7	502,7	79,8	274,3	157,8	107,2	44,8	45	0	29,2	83,5	474,4	**2137,4**
2016	383,2	350,1	329,1	333,1	292,3	212,8	129,3	80,5	155,2	200,6	448,7	328,4	**3243,3**
2017	384,8	264,3	172,5	236,6	266,1	208,9	138,7	98,5	116,4	102,5	377,2	390,8	**2757,3**
2018	279,8	473,8	552,5	212,1	44,4	152,4	56,3	64	16	113,2	217,9	608,5	**2790,9**
2019	293,2	326,2	328,4	308,5	84,2	171,5	9,4	26,7	2,6	57,7	91	325	**2024,4**
2020	457,8	532	264,5	59,2	175	126,8	79,2	115,1	109,7	173,2	351,7	500,9	**2945,1**
2021	898,3	417,6	166	213,6	199,6	222,3	63,8	161,8	121,7	144,8	283,9	327,6	**3221,0**
Average	**385,7**	**360,6**	**286,3**	**227,8**	**162,1**	**143,9**	**85,2**	**61,3**	**62,4**	**124,1**	**267,8**	**425,5**	**2592,5**

Based on Table 1.1, in August 2004, October 2006, October 2014, and September 2015, there was no rain. The lowest rainfall occurred in September 2019 at 2.6 mm/month, and the highest rainfall occurred in January 2021 at 898.7 mm/month. Rainfall data for 2010 and 2013 were not recorded at the BMKG online, so data analysis was not included.

Interception

Precipitation that reaches the ground surface will move as runoff or infiltration. Water that infiltrates into the soil increases soil moisture or continues to water.

Table 1. 2 Interception Value Approach Based on Dense Forest Simulation.

Land Use	Interception Value Approach (%)
Forest	16,4
Open Field	0

Based on Table 1.2, the intercept value approach for the Liang Anggang Protected Forest Area with an area of 960 hectares is assumed to be all dense forest, and the value of the intercept is 16.4%.

Evapotranspiration Analysis (ET_0)

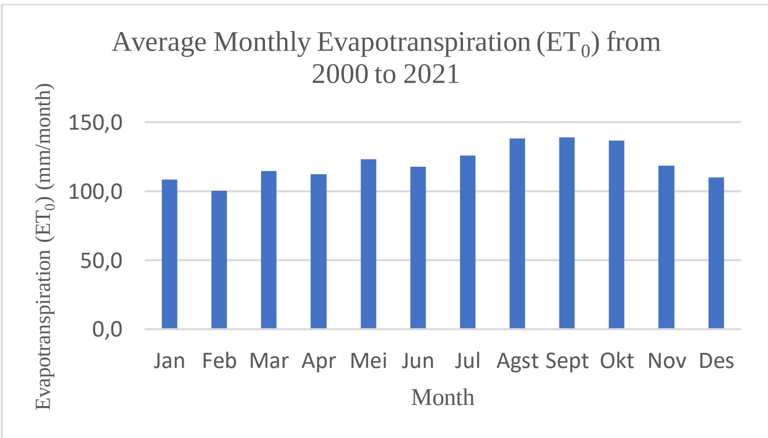
The meteorological data used in the Evapotranspiration (ET0) calculation was obtained from the BMKG Syamsudin Noor Station during the period 2000 to 2021, and the meteorological data used consists of data on minimum temperature, maximum temperature, average temperature, average humidity, maximum wind speed, and duration of sunlight. The method used in calculating Evapotranspiration (ET0) is the Penman-Monteith method.

The evapotranspiration value (ET0) used in data analysis is the monthly evapotranspiration value, which is obtained from the daily evapotranspiration value multiplied by the number of days in that month.

Table 1.3 (ET_0) Monthly Average from 2000 to 2021

Year	Evapotranspirasi Tahunan												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Et0**
2000	107,0	106,3	116,4	115,4	127,0	112,2	127,9	132,8	134,0	126,5	118,7	115,6	**1439,9**
2001	113,2	89,5	114,4	114,6	127,5	121,5	136,1	140,2	139,6	126,3	109,2	111,5	**1443,6**
2002	116,7	100,0	117,8	117,1	133,1	130,8	134,2	151,5	142,8	135,8	116,5	103,6	**1500,0**
2003	115,5	102,0	118,1	117,3	133,2	131,2	134,8	150,7	143,3	134,2	116,9	104,0	**1501,2**
2004	109,4	102,4	113,5	116,9	125,4	131,0	126,9	164,5	143,2	149,5	118,9	106,2	**1507,8**
2005	104,5	99,3	114,1	107,4	114,1	119,0	129,1	135,0	156,4	122,0	108,7	104,5	**1414,0**
2006	104,2	101,8	112,4	106,4	119,3	106,0	127,0	145,2	145,5	157,0	129,7	122,2	**1476,7**
2007	108,2	96,6	114,2	110,2	117,1	106,4	114,0	125,8	135,1	128,9	111,2	110,2	**1377,8**
2008	109,8	104,6	112,8	111,7	130,2	116,9	115,8	121,8	128,2	120,1	111,3	101,3	**1384,5**
2009	105,5	101,2	121,2	119,3	128,9	129,2	138,5	151,6	157,9	141,9	122,9	111,1	**1529,3**
2011	113,5	103,2	113,7	112,2	123,6	135,8	141,6	149,6	137,3	143,2	124,2	105,4	**1503,2**
2012	109,7	103,8	116,6	118,8	130,0	122,2	116,1	134,4	147,4	138,7	119,2	108,7	**1465,4**
2014	100,6	98,2	109,1	110,3	119,5	111,9	114,6	123,0	139,4	155,8	127,1	106,6	**1416,1**
2015	96,2	86,9	112,7	98,7	113,7	109,8	132,4	150,2	155,0	160,1	131,5	117,8	**1464,9**
2016	117,7	102,4	116,0	115,3	122,7	112,5	119,5	130,3	118,6	117,6	112,4	110,8	**1395,8**
2017	108,2	96,2	108,0	113,1	116,6	109,4	117,2	120,3	122,0	122,9	107,6	107,4	**1348,8**
2018	108,7	101,0	109,0	112,5	123,4	115,2	119,6	132,3	139,6	131,9	114,4	109,1	**1416,6**
2019	112,0	109,2	113,3	113,1	124,6	111,5	131,8	146,9	152,1	149,1	133,6	120,4	**1517,7**
2020	114,4	108,0	117,6	115,0	121,4	117,3	118,3	128,3	117,7	128,9	115,7	108,3	**1410,9**
2021	96,2	89,5	115,1	100,3	113,5	108,7	130,6	138,0	140,5	146,6	125,9	114,4	**1419,5**
Average	**108,5**	**100,1**	**114,3**	**112,3**	**123,2**	**117,9**	**126,3**	**138,6**	**139,8**	**136,9**	**118,8**	**109,9**	**1446,7**

Based on Figure 1.1, it can be seen that the maximum average evapotranspiration value is in September, with a value of 138.7 mm/month, while the minimum average ET0 value is in February, with a value of 100.3 mm/month.



Gambar 1. 1 Graph of Average Monthly (ET_0) from 2000 to 2021

Unsaturated Zone Storage Changes (ΔΘ)

Changes in the storage of unsaturated zones in this study were approximated by the modification of the KBDI drought index (Keech-Byram Drought Index) with the physical properties of fiber peat soil (Novitasari et al., 2019). The drought index is the main tool for detecting, monitoring, and evaluating drought events which shows the level of class or degree of drought because the level of drought in an area will differ from one another.

Table 1. 3 Average Monthly Drought Index from 2000 to 2021

Average Monthly Drought Index												
T/B	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2000	34,8	91,8	110,5	216,7	324,3	298,5	332,4	278,6	363,6	349,3	209,0	139,8
2001	108,4	134,6	219,3	269,1	324,9	334,5	372,8	382,3	389,2	331,1	279,7	219,3
2002	144,3	77,2	219,3	259,7	324,2	363,2	344,0	382,3	360,8	336,1	280,3	64,3
2003	138,9	77,2	221,8	260,7	324,4	363,8	354,7	385,4	361,4	335,5	279,3	63,7
2004	47,9	107,2	141,0	260,7	257,7	324,8	385,4	392,4	390,0	252,9	252,9	61,6
2005	114,2	159,2	203,2	198,2	257,7	328,9	376,4	386,8	390,7	355,6	268,1	212,5
2006	104,6	126,2	114,8	174,8	297,1	274,6	331,4	380,3	369,5	393,0	365,8	273,8
2007	219,3	62,1	86,6	83,3	236,3	260,6	277,7	321,1	365,9	344,9	265,0	212,8
2008	219,3	253,3	93,6	206,0	263,9	296,4	284,8	300,9	325,6	318,3	108,8	81,2
2009	99,9	233,9	248,9	283,4	312,2	342,7	364,7	363,8	381,4	351,6	273,4	173,8
2011	122,8	104,9	194,1	223,1	265,8	329,0	347,6	370,1	380,3	371,1	280,7	178,5
2012	135,8	253,4	278,5	250,8	280,6	294,8	325,7	360,5	384,8	363,2	293,1	202,5
2014	146,9	221,3	219,8	258,2	289,1	298,1	336,6	380,5	395,4	397,2	396,1	331,9
2015	261,3	82,9	252,1	281,9	305,1	342,9	371,3	381,6	393,3	398,3	389,0	261,5
2016	186,9	233,4	224,5	237,3	263,9	280,6	311,6	349,1	343,4	318,2	238,0	217,4
2017	234,6	211,8	247,3	280,3	296,4	293,8	297,1	330,0	367,6	349,1	287,2	191,5
2018	199,3	190,0	96,1	201,5	338,9	364,7	346,3	381,0	381,6	370,7	329,6	176,2
2019	173,1	219,4	201,3	257,4	318,6	317,9	368,0	388,3	396,4	390,6	377,5	327,8
2020	194,4	111,5	240,0	316,5	329,3	340,4	355,8	351,1	361,6	350,1	282,2	179,6
2021	89,7	138,7	237,3	267,9	319,4	318,5	328,3	355,9	328,8	337,8	288,5	233,8
Average	**148,8**	**154,5**	**192,5**	**239,4**	**296,5**	**318,4**	**340,6**	**361,1**	**371,6**	**350,7**	**287,2**	**190,2**

Based on Table 1.4, the highest average drought index value occurred in September at 371.6 with an extreme drought index class, and the lowest drought index value occurred in January at 145.1 with a low drought index class.

Water Balance

The water balance is the relationship between the inflow (water entering the system) and the outflow (water leaving the system). Inflow is obtained from the analysis of rainfall that falls on the land, while outflow consists of the analysis of evapotranspiration (ET0), interceptions, then added or subtracted by changes in storage of the unsaturated zone (ΔΘ). The water balance can be said to be experiencing a surplus if the result of the equation is positive and is said to be experiencing a deficit if the result of the equation is negative.

Table 1. 4 Water Balance with Interception 16,4%

Year	Interception Water Balance 16,4%											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2000	229,8	215,8	274,3	116,7	106,8	43,4	61,1	-54,2	31,0	35,7	47,4	172,2
2001	165,0	111,4	202,6	61,7	55,2	-20,2	-64,5	-104,4	-30,2	-36,1	61,9	135,4
2002	35,8	297,1	143,7	112,4	-7,4	17,2	-97,7	-66,5	-61,8	-8,5	51,8	241,1
2003	189,3	303,1	146,1	110,7	-8,3	17,4	-87,6	-74,2	-64,4	-9,6	51,2	242,0
2004	398,6	273,2	177,8	114,8	80,7	23,8	24,3	-143,5	-107,4	-228,6	134,2	66,5
2005	180,7	178,4	214,7	10,9	159,8	10,1	-49,0	-75,2	-104,3	3,1	-18,6	89,1
2006	255,4	236,3	171,9	116,5	175,1	64,8	-45,6	-32,8	-105,8	-109,6	-37,8	87,8
2007	150,5	203,2	317,0	288,4	171,9	110,9	53,5	-20,9	-66,9	-53,0	97,1	143,1
2008	110,9	205,7	83,7	241,1	15,0	99,6	114,2	-7,6	-23,8	64,7	57,0	253,4
2009	188,8	169,6	14,6	142,0	74,7	-33,9	-41,2	-115,3	-108,3	-69,0	139,2	-10,9
2011	271,7	86,3	231,9	76,7	153,0	9,1	-39,0	-72,8	-76,3	-4,7	-40,9	338,3
2012	38,2	150,7	136,5	201,2	21,1	49,8	51,7	-72,9	-82,3	-6,9	98,0	194,7
2014	105,5	258,7	175,3	106,7	102,6	77,2	-6,6	-60,9	-109,0	-143,7	-79,1	85,9
2015	109,2	152,7	130,8	155,7	52,3	35,8	-58,4	-92,6	-129,7	-108,1	-64,1	158,5
2016	122,0	235,1	149,1	184,7	158,0	94,7	23,2	-29,0	5,6	27,9	179,3	153,5
2017	235,8	101,2	78,3	132,6	141,6	86,0	19,3	6,3	20,2	-53,8	149,8	135,0
2018	146,8	287,2	257,3	173,1	67,6	59,9	-77,8	-32,3	-123,6	-49,6	33,3	235,6
2019	135,9	217,0	146,3	208,4	17,6	51,9	-61,7	-96,8	-134,4	-98,8	-67,7	110,0
2020	141,1	255,0	232,3	20,7	57,7	22,7	-24,7	-32,1	-3,8	6,8	116,5	222,7
2021	573,0	298,9	125,9	96,1	113,0	85,2	-39,7	50,8	-35,5	8,1	83,5	125,5
Average	189,2	211,8	170,5	133,6	85,4	45,3	-17,3	-56,3	-65,6	-41,68	49,6	159,0

Based on Table 1.5, the average monthly water balance with an interception of 16.4% experienced a deficit from July to October and experienced a peak surplus in February at 211.8 mm/month.

5. CONCLUSION

Based on the results of the analysis, the average monthly rainfall from 2000 to 2021, the highest, is in December, which is 425 mm/month. At the same time, the lowest was in August at 61.3 mm/month. After calculating the water balance analysis with an intercept value of 16.4%, there was a water shortage or water deficit from July to October, with a water deficit value of 17.3 mm/month, 56.3 mm/month, respectively 65.6 mm/month, 41.68 mm/month, and the highest excess of water or surplus occurred in February at 211.8 mm/month.

In analyzing the availability of water, some data is needed from the local BMKG station, so attention must be paid to data that is not recorded or is blank and damaged. Apart from carrying out a calculation analysis, it is also necessary to carry out a survey directly to the field to ascertain the type of peat soil and conditions in the field.

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