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ANALYSIS OF THE DROUGHT DISTRIBUTION OF THE PALMER DROUGHT SEVERITY INDEX (PDSI) METHOD IN THE IRRIGATION JURANG SATE ON LOMBOK RIVER BASIN

by
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Abstract

The problem of drought during the long dry season becomes routine in Indonesia, but the handling of prevention and prevention is very slow so that it becomes a prolonged problem that is not resolved. Drought has a relationship with the balance between demand and water supply for various purposes. Irrigation area (DI) Jurang Sate is divided into two, namely: In the Upper Sate Jurang (4095 Ha) and Downstream Jurang Sate (6383 Ha). The availability of water in the Jurang Sate Irrigation Area (DI) can be obtained from Jangkok Weir, Sesaot Feeder Weir, Keru Feeder Weir, Jurang Sate Weir. The analysis conducted was: i) Thiessen Polygon Analysis, ii) Analysis of Regional Rainfall, iii) Analysis of Area Evaporation, and iv) Analysis of Drought in the PDSI Method. Based on the drought analysis, it was found that the drought index value in the Irrigation Area (DI) The satay gap occurred in August to October which needed further water regulation because the Jurang Sate Irrigation Area (DI) had water coming from water structures in the form of weirs namely Jangkok weir, Sesaot feeder Weir, Keru Feeder Weir and Jurang Sate Weir.
Keyword: Jurang Sate; PDSI, Drought; Lombok River Basin

INTRODUCTION

The problem of drought during the long dry season becomes routine in Indonesia, but the handling of prevention and prevention is very slow so that it becomes a prolonged problem that is not resolved (Pratama, 2014). Drought has a relationship with the balance between demand and water supply for various purposes. The Lombok River Basin (WS) is a National Strategic WS consisting of 52 Utility Watersheds (DAS). The 52 watersheds there are 12 watersheds that are connected through high level divertion channels that stretch from western Lombok to southern Lombok. In the 12 watersheds there are 1 main Irrigation Areas that are irrigated, namely the Irate Sate Irrigation Area (DI).

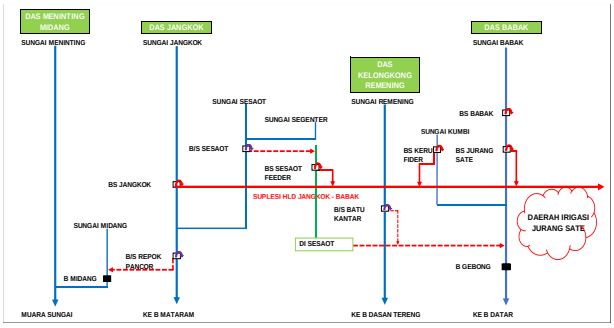

Figure A. Water Flow Scheme to Irrigation Jurang Sate

METHODS

1. Research Location

The research location is in the Irrigation Area (DI) Jurang Sate located in the districts of Pringgarata, Jonggat, Praya, Praya Timur, Praya Barat Daya in Central Lombok Regency, West Nusa Tenggara Province. The area of Irrigation Area (DI) of Jurang Sate is divided

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into two, namely: In the Upper Jurang Sate (4095 Ha) and Lower Jurang Sate (6383 Ha). The availability of water in the Jurang Sate Irrigation Area (DI) can be obtained from Jangkok Dam, Sesaot Feeder Dam, Keru Feeder Dam, Jurang Sate Dam.

Table A. Main Buliding Data releated to Irrigation area of The Jurang Sate

No	Headwork	Autority	LS	BT	X	Y	Watershed
1	Jangkok DAM	Masonry	8°3'29"	116°14'4.3"	415757	9056473	Jangkok (HLD)
2	Sesaot Feeder DAM	Province	8°32'42.4"	116°14'16.1"	416120	9055556	Jangkok (HLD)
3	Sesaot DAM	Province	8°32'25.9"	116°14'39"	416819	9055884	Jangkok (HLD)
4	Keru Feeder DAM	District	8°34'25.98"	116°15'55.56"	419166	9052180	Babak (HLD)
5	Jurang Sate DAM	Masonry	8°35'19.86"	116°16'29.34"	420202	9050527	Babak (HLD)

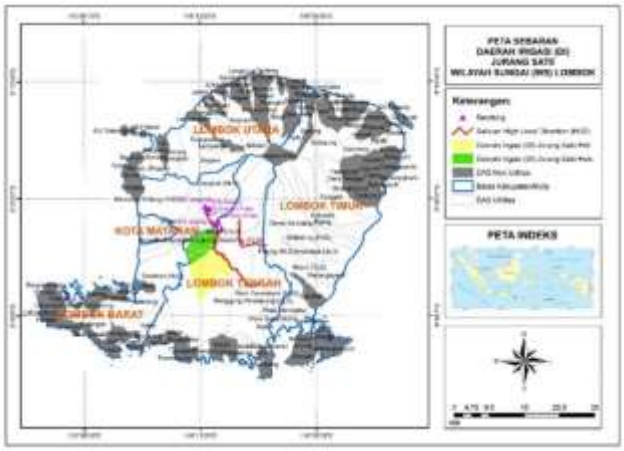

Figure B. Map of the Distribution of Irrigation Areas (DI) of the Jurang Sate in Lombok River Basin

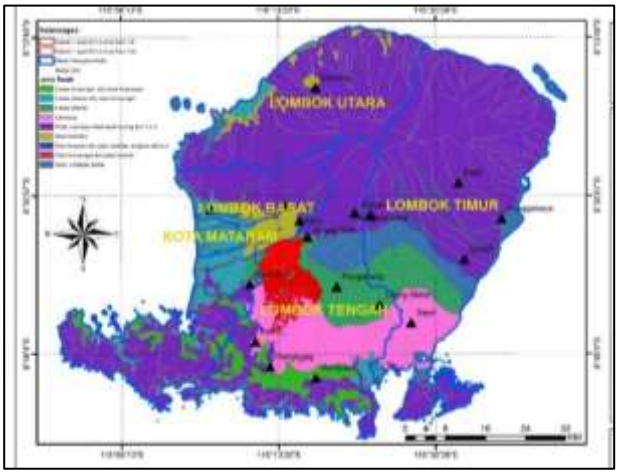

Figure C. Map of Distribution of Soil Types in the Lombok River Basin

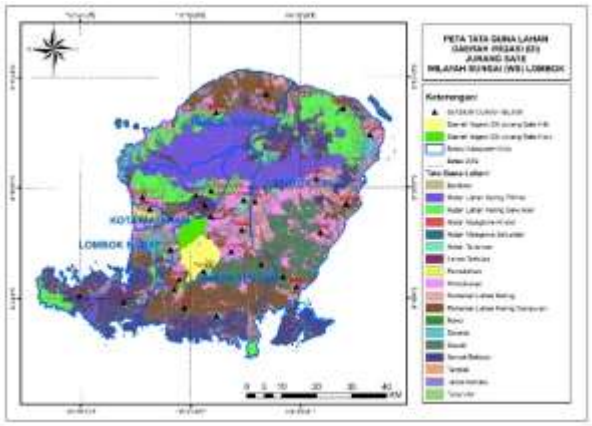

Figure D. Map of Land Use in the Lombok River Basin

2. Analysis

The analysis of this study begins by determining the rainfall station that affects the Irrigation Area (DI) to be analyzed.

2.1. Analysis Polygon Thiessen

Thiessen Polygon analysis was performed using ArcGIS software. In this analysis a rainfall station selection will be carried out which has an influence on the rainfall in the Irrigation Area (DI) Jurang Sate (Upstream and Downstream).

2.2. Analysis Rainfall Region

After obtaining the regional rainfall station used, the calculation of the regional rainfall using the Isohyet method with the Inverse Distance Weighted (IDW) interpolation with the input of the Normal Probability of Rainfall value (50%).

2.3. Analysis Evaporation Region

Evaporation Analysis is done using Evaporation data at the nearest station, the Pengga CR Station. Pengga CR is located in the Dodan River Basin.

2.4. Drought Calculation Method

Langkah perhitungan metode *PDSI* adalah:

The calculation steps for the PDSI method are:

a. Calculate water storage capacity (Water Holding Capacity)
b. Calculates the difference between P and ET

If (P-ET)> 0, a rainfall surplus occurs (wet month period)
If (P-ET) <0, there is a rainfall deficit (dry period)

c. Calculate the amount of cumulative rainfall deficit in APWL (Accumulated potential Water Loss)
By adding up the numbers (P-ET) for months that have a potential evapotranspiration more than the negative rainfall (P-ET).
APWL = - $\sum 1^{n}$ x (P-ET) neg
APWLi = APWLi-1 + (P-ET) neg
If P> ET, this data series is broken APWL = 0

d. Calculate soil moisture
In the wet months (P> ET), the value of ST = Sto (WHC)
In the dry months (P <ET), in this month the monthly ST is calculated by the formula:
ST = Sto x e ^ (- (APWL / STo))
With:
ST = Moisture content of the soil in the root area (mm)
Sto = Moisture content of soil in field conditions (mm), Sto referred to in this formula is the value = WHC
e = Navier's number (e = 2.718)
AWL = Cumulative amount of rainfall deficit (mm)

e. Calculate the change in soil moisture content (ΔST)
Changes in soil moisture content (ΔST) per Monthly can be obtained by subtracting soil moisture (ΔST) in the Monthly concerned with (ST) in the previous Monthly (ΔST = STi - STi-1) then a negative value causes the soil to become dry.

f. Calculating Actual Evapotranspiration (ETa)
In the wet month (P> ET), the value of ET = ET
In the dry months (P> ET), the value of ETa = P - ΔST

g. Calculating Deficits (Moisture Deficiency)
D = ET - ETa
With:
D = deficit (mm / Monthly)
ET = Potential Evapotranspiration (mm / Monthly)
ETa = Actual evapotranspiration (mm / Monthly)

h. Calculating Surplus (Moisture Strength)
S = (P-ET) - ΔST
With:
S = Surplus (mm / Monthly)
P = Rainfall (mm / Monthly)
ET = Potential Evapotranspiration (mm / Monthly)
ΔST = Change in Soil Moisture (mm / Monthly)

i. Calculating Runoff (Ro)
Shows the amount of water flowing at the ground surface. Calculate it 50% multiplied by the surplus value.

j. Calculate potential soil moisture fill (PR)
PR = WHC - ST

k. Calculate soil moisture fill (R)
Filling of soil soil occurs if the ST in the previous month is smaller than the ST in the month, adding the ST value becomes the soil moisture filling.
R = ST - STj-1
With:
R = Filling in soil
ST = Moisture content of soil in the month of the month
STj-1 = Moisture content of soil in the previous month's work

l. Calculate potential soil moisture loss (PL)
PL = ET - ΔST

m. Calculate soil moisture loss (L)
L = ST j-1 - ST

n. Determination of the coefficient
The coefficient in question is to determine the value of CAFEC (Climatically Appropriate for Exiting Condition). The values of the coefficients above are determined by the formula:

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Evapotranspiration coefficient
α = AE / ET
Moisture filling coefficient into the soil
β = R / PR
Runoff coefficient
γ = Ro / S
The coefficient of soil moisture loss
δ = L / PL
Approach to climate weighting
K = ((ET + R)) / ((P + L))

o. Determination of CAFEC (Climatically Approprite for Existing Condition) value
Determine the CAFEC evapotranspiration value
ET = α x ET
Determine replenishment of moisture into CAFEC soil
R = β x PR
Determine the CAFEC runoff value
Ro = γ x Ro
Determine the loss of soil moisture CAFEC
L = δ x PL
Determine the loss of CAFEC's presipiration
P = ET + R + Ro - L

p. Determination of periods of lack or excess rain (d)
d = P - P

q. Determination of absolute value (D)
D = Average value d

r. The second approach to the value of the factor K (k)
K '= 1.5 log 10 (((PE + R + Ro) / (P + L) + 2.80): 25.4 / D + 0.5
DK '= D x k

s. Climate Character as a weighting factor (K)
K = (D x K ') / (∑1 x D x K) x K'

t. t. Moisture anomaly index (Z)
Z = d x K

u. Palmer Drought Index
X = (Z / 3) x (j-1) + ΔX
AX = (Z / 3) x h - 0.103 (Z / 3) _ (j-1)

3. RESULT AND DISCUSSION

3.1. Analysis Polygon Thiessen Rainfall

Figure D. Map of Polygon Thiessen Analysis in the Lombok River Basin

Results of rainfall analysis using polygon thiessen are presented in the following table:

Table B. Results using Polygon Thiessen in the Irrigation Area (DI) of Jurang Sate on the Lombok River Basin

No	Irrigation Name	Irrigation Area (Ha)	Station ARR	ARR Station Area (Ha)	Percentage of Irrigation Area	Percentage of Total Irrigation Area
1	Jurang Sate Hulu	2667.15	ARR Kuripan	831.70	31.18%	9.94%
			ARR Bertais	582.75	21.85%	6.96%
			ARR Jurang Sate	1252.69	46.97%	14.97%
2	Jurang Sate Hilir	5703.11	ARR Batujai	3113.29	54.59%	37.19%
			ARR Kuripan	981.86	17.20%	11.72%
			ARR Pengga	510.85	8.96%	6.10%
			ARR Pengadang	753.04	13.20%	9.00%
			ARR Jurang Sate	344.87	6.05%	4.12%
	Total	8370.26		8370.26		100%

Based on the results of the analysis of polygon thiessen in the Jurang Sate Irrigation Area, the station used for Regional Rainfall Analysis with the Isohyet Interpolation Inverse Distance Weighted (IDW) method is 6 Stations. The ARR stations, namely ARR Kuripan, ARR Bertais, ARR Jurang Sate, ARR Batujai, ARR Pengga, and ARR Pengadang.

3.2. Probability Rainfall Data

Based on the results of Polygon Thiessen rainfall data are obtained as follows:

Table C. Probability Rainfall Data (Normal) for the Rainy Season (October - March)

No	ARR	Rainfall (mm)					
		Oct	Nov	Dec	Jan	Feb	Mar
1	ARR Batu Jai	4.78	79.21	160.60	209.22	124.23	153.96
2	ARR Bertais	29.90	200.62	154.96	168.78	115.30	128.00
3	ARR Jurang Sate	41.00	162.38	228.10	215.14	228.00	241.70
4	ARR Kuripan	14.30	174.70	194.09	149.10	135.70	122.75
5	ARR Pengadang	7.60	185.30	218.90	214.00	193.17	208.40
6	ARR Pengga	12.50	81.50	194.90	197.80	143.40	156.20

Table D. Probability Rainfall Data (Normal) for the Rainy Season (April - September)

No	ARR	Rainfall (mm)					
		Apr	May	Jun	Jul	Ags	Sep
1	ARR Batu Jai	81.79	5.42	0.00	2.30	0.50	2.00
2	ARR Bertais	115.70	48.40	8.40	2.00	0.00	10.80
3	ARR Jurang Sate	131.20	36.80	6.40	3.10	0.00	0.00
4	ARR Kuripan	114.21	28.61	3.40	0.00	0.00	1.20
5	ARR Pengadang	128.84	8.10	4.70	0.00	0.80	1.90
6	ARR Pengga	94.10	14.40	10.90	0.80	1.80	1.50

Analysis Polygon Thiessen Analysis

Figure D. Polygon Thiessen Analysis Map in the Lombok River Basin.

The results of the Evaporation Analysis using polygon thiessen are presented in the following table:

Table E. Results of Climate Analysis using Polygon Thiessen in the Irrigation Area of Jurang Sate River on Lombok River Basin

No	Station ARR	ARR Area (Ha)	Station CR	CR Area (Ha)	Percentage of Irrigation area
1	ARR Kuripan	15767.16	CR Sekotong	1206.98	7.66 %
			CR Pengga	14560.18	92.34 %
2	ARR Bertais	8439.13	CR Kopang	2265.94	26.85 %
			CR Pengga	6173.20	73.15 %
3	ARR Jurang Sate	8148.47	CR Kopang	7884.45	96.76 %
			CR Pengga	264.02	3.24 %
4	ARR Batujai	11394.25	CR Kopang	428.72	3.76 %
			CR Pengga	10965.54	96.24 %
5	ARR Pengga	5343.04	CR Pengga	5343.04	100 %
6	ARR Pengadang	9527.79	CR Kopang	9513.45	99.85 %
			CR Pengga	14.34	0.15 %
	Total	58619.84		58619.84	

3.3. Analysis Water Holding Capacity (WHC)

WHC analysis of the PDSI method was conducted at 6 Rainfall Stations in the Lombok River Basin. Following are the results of the WHC analysis at the 6 Rainfall Stations:

Table C. WHC Analysis on 6 ARR Stations

No	ARR	WHC Value
1	ARR Batu Jai	88.11
2	ARR Bertais	100.85
3	ARR Jurang Sate	122.41
4	ARR Kuripan	138.02
5	ARR Pengadang	212.98
6	ARR Pengga	103.94

3.4. Palmer Drought Severity Index (PDSI) Drought Analysis Method

The results of the Drought Index Analysis at 6 Rainfall Stations (ARR) in the Lombok River Basin are as follows:

Table D. Recapitulation of Drought Index Value at Rainfall Station (ARR) in the Lombok River Basin

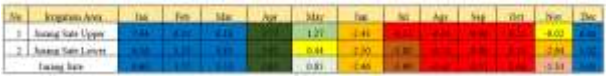
Table E. Color Information for PDSI Dryness Index (modification) Color Description:

Drought Index	Color Weather	Color Properties
≥ 4.00	Ectreme Wet	
3.00 – 3.99	Very Wet	
2.00 – 2.99	Rather Wet	
1.00 – 1.99	Little Wet	
0.50 – 0.99	Beginning of the Wet	
0.49 – (-0.49)	Normal	
(-0.50) – (-0.99)	Beginning of The Dry	
(-1.00) – (-1.99)	Little Dry	
(-2.00) – (-2.99)	Rather Dry	
(-3.00) – (-3.99)	Very Dry	
≤ (-4.00)	Extreme Dry	

Analisis Kekeringan di Daerah Irigasi (DI) Jurang Sate

Berdasarkan analisis Isohyet didapatkan bahwa hasil analisis kekeringan adalah seperti tabel berikut ini:

Table E. Analysis of Drought in the Jurang Sate Irrigation Area



Based on the Isohyet analysis it was found that the results of the drought analysis are as the following table:

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CONCLUSION

Based on the drought analysis, it was found that the drought index value in the Irrigation Area (DI) The satay gap occurred in August to October which needed further water regulation because the Satay Irrigation Area (DI) had water coming from water structures in the form of weirs namely Jangkok weir, Weir Sesaot feeder, Bendung Keru Feeder and Bendung Jurang Sate.

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collection.

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