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Analysis of Drought Index with Theory of Run Statistical Method in Dompu Regency

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Abstract

Indonesia has in recent years experienced severe drought in some areas. Climate change causes temperatures in Indonesia to become hotter and makes rainfall patterns erratic or El-Nino. Indonesia is an agricultural country that makes the agricultural sector as one of the livelihoods for many people, but droughts that occur in several regions in Indonesia result in losses for farmers because the agricultural crops planted have failed harvests, resulting in reduced community income. Dompu Regency is one of the areas experiencing drought. Analysis of the drought index in Manggalewa District using the Theory of Run method with the aim of determining the prediction of the duration of rain for a period of 10 years. The results showed that in the period 2003-2022, the longest drought duration was 11 events that occurred from March 2014 to January 2015 with a deficit value of 430.05 mm from the average normal rain, while the duration of wet months was 12 events that occurred from March 2021 to February 2022. Meanwhile, in the 2023-2032 period, the longest drought duration is 8 months which occurs in February-September 2027, while the worst deficit value occurs in December 2030 to January 2031 of 235.93 mm from the average normal rain, while the duration of wet months is 6 events that occur in August 2025 to January 2026.

Keywords: Hydrology, Drought Index, Theory of Run Method.

INTRODUCTION

In recent years, Indonesia has experienced severe drought in some areas. Climate change is causing temperatures in Indonesia to become hotter and making rainfall patterns erratic (Achyadi et al., 2019; Jaro'ah et al., 2023; Surmaini et al., 2024). Indonesia is an agricultural country that makes the agricultural sector as one of the livelihoods for many people. Still, droughts that occur in several regions in Indonesia result in losses for farmers because the agricultural crops planted have failed harvests, resulting in reduced community income (Duffy et al., 2021; Pratiwi & Suzuki, 2019). One of the areas in NTB experiencing drought is Manggalewa District, Dompu Regency. According to records from the National Disaster Management Agency (BNPB), from 2017 to 2020, 36 drought disasters occurred in NTB Province, 4 of which were drought disasters that occurred in Dompu Regency (BNPB, 2023).

Manggalewa District is one of the sub-districts in Dompu Regency with an area of 176.49 km2. The agricultural sector is the main source of income for most residents in Manggalewa

sub-district. The area of rice fields in 2019 reached 3,030 Ha and dry land covered an area of 9,167 Ha (BPS Dompu Regency, 2022). This study used a statistical method, namely the Theory of Run method (Suhardi et al., 2022; Wang et al., 2020a; Wu et al., 2019a). The use of this method is related to another common problem in the field of hydrology: the lack of data, for example, in the analysis of the chances of a flood or drought (Callegary et al., 2018; Ma et al., 2023; Wang et al., 2020b; Wu et al., 2019b; Zhang et al., 2024).

The authors hope that drought analysis research using this method will obtain a measure of the determinant of dry months based on rain data in previous years. Rain data available in the previous year is then generated using the Thomas Fiering method to predict dry months, which can later be used to plan mitigation measures, anticipate prevention, or reduce the impact of drought. To find out the predicted value of rainfall and the worst deficit value based on the Theory of Run method.

METHODS

At the data collection stage, there are primary data as well as secondary data. Primary data is obtained from data from field surveys, which in this study is not used, while secondary data is data obtained from related agencies in the form of location coordinates along with rainfall data for each sectoral rainfall station in Dompu Regency for statistical parameter calculation activities from 2003 to 2022, which are then determined by influential sectoral rain stations using the Thiessen Polygon method.

The stages of data processing and drawing conclusions in drought analysis in the Manggalewa District area using statistical methods, namely the Theory of Run method. Collect monthly rainfall data from 2003 to 2022. Selecting influential rain stations using the Thiessen Polygon method, Monthly rainfall data consistency test, this rain data consistency test was carried out using the Rescaled Adjusted Partial Sums (RAPS) method for the period 2003 to 2022, Calculation of rain discharge data generation using the Thomas Fiering Model for a period of 10 years (2023 to 2032).

RESULTS AND DISCUSSION

Selection of Influential Rainfall Stations

To determine the rainfall station that affects the research location, the Thiessen Polygon method can be used to find that the station that affects Manggalewa District, Dompu Regency is the Dompu rainfall station.

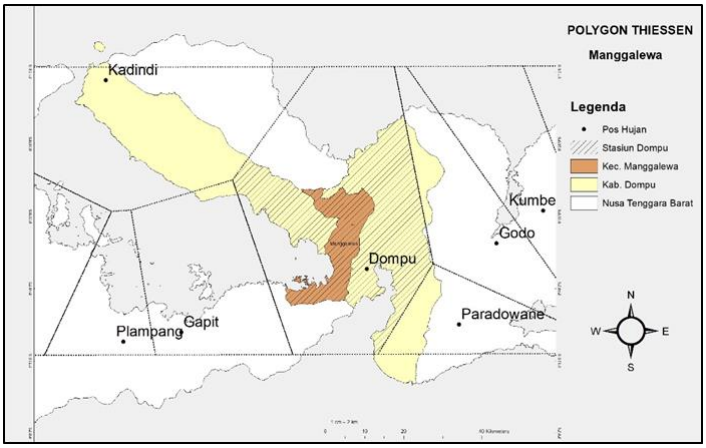

Figure 1. Thiessen's Polygon to Research Site

Rainfall Data

The data used in this study is semi-monthly rainfall data at each rainfall station that affects the study location. The rainfall station data used is the Dompu rainfall station.

THN	JAN I	JAN II	FEB I	FEB II	MAR I	MAR II	APR I	APR II	MEI I	MEI II	JUN I	JUN II	JUL I	JUL II	AGT I	AGT II	SEP I	SEP II	OKT I	OKT II	NOV I	NOV II	DES I	DES II	Jumlah
2003	79.00	167.50	77.75	136.75	137.00	129.57	49.90	22.90	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.91	2.50	17.74	155.80	46.80	134.00	70.00	1253.11
2004	117.50	104.50	65.50	76.47	64.50	131.26	98.25	68.25	11.67	24.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.00	37.00	73.50	36.50	38.00	47.00	1051.58
2005	74.50	92.50	88.12	104.75	175.00	66.00	62.28	42.28	0.00	0.00	12.00	5.00	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	25.00	19.50	18.50	791.90
2006	71.50	52.50	81.65	117.15	72.00	91.00	121.90	47.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	111.50	66.78	832.98
2007	191.96	150.08	128.06	23.22	69.50	27.50	27.00	0.00	5.00	5.00	7.50	7.50	0.00	0.00	0.00	0.00	0.00	0.00	7.87	0.00	116.92	31.91	152.50	97.50	1049.03
2008	78.00	57.11	35.00	49.00	78.00	17.00	14.50	2.00	39.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.50	71.41	75.00	205.00	826.52
2009	118.32	41.00	150.50	125.50	210.50	80.09	100.48	12.50	0.00	0.00	17.00	17.00	13.21	0.00	0.00	0.00	0.00	0.00	26.75	16.75	33.00	122.50	213.50	119.00	1417.60
2010	138.25	49.10	185.47	64.50	167.00	80.00	120.00	93.00	0.00	40.00	2.50	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	87.20	68.70	1114.22
2011	90.50	95.50	78.75	77.17	55.50	71.45	109.65	30.65	24.50	44.76	2.10	4.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.93	6.00	209.62	235.62	1147.10
2012	193.94	87.25	139.94	90.36	165.93	46.50	50.00	41.70	11.05	8.15	3.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.30	49.50	47.26	82.71	132.75	211.75	1382.30
2013	43.00	149.35	62.00	63.25	55.00	24.00	67.00	5.00	12.50	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.50	40.50	96.50	36.50	63.50	73.50	821.60
2014	177.29	95.53	76.14	135.30	140.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	130.33	10.98	766.30
2015	166.52	43.77	121.17	93.73	66.00	117.20	45.65	22.05	52.05	1.35	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.48	46.20	833.36
2016	57.55	47.05	178.08	29.81	56.58	0.00	0.00	0.00	0.00	0.00	0.05	0.45	0.00	0.00	0.00	0.00	0.00	0.00	29.15	11.45	33.55	98.03	205.20	409.60	1156.55
2017	197.51	88.47	147.10	150.20	79.35	119.55	87.71	41.02	23.37	37.11	33.14	1.00	0.00	0.00	0.00	0.00	0.00	0.00	32.50	39.16	153.86	85.06	197.45	62.39	1575.95
2018	114.70	174.20	128.87	40.39	137.59	45.80	121.05	133.65	16.75	15.05	0.00	12.90	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.55	136.65	97.85	103.75	1374.75
2019	73.20	100.80	138.30	77.70	92.85	57.75	70.35	58.55	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	166.23	62.73	898.66
2020	127.45	147.45	155.50	87.00	69.35	94.25	146.25	39.95	37.75	27.95	4.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	33.36	16.97	71.45	86.84	77.30	38.40	1271.21
2021	92.35	141.95	82.25	86.05	68.25	127.15	75.75	72.35	21.70	41.60	36.50	49.10	10.70	0.00	2.80	0.00	0.00	36.70	146.00	62.80	164.70	127.80	129.40	163.00	1738.90
2022	125.05	114.05	85.95	119.55	47.05	31.65	66.05	46.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.60	58.20	0.40	0.60	72.75	59.65	154.80	88.70	1083.50
Jumlah	2328.09	1999.66	2206.09	1747.87	2007.67	1357.72	1433.77	779.30	279.34	268.14	118.19	109.85	27.58	0.00	2.80	0.00	12.60	96.81	383.33	292.47	1214.27	1069.36	2453.11	2199.10	22387.11
Rerata	116.40	99.98	110.30	87.39	100.38	67.89	71.69	38.97	13.97	13.41	5.91	5.49	1.38	0.00	0.14	0.00	0.63	4.84	19.17	14.62	60.71	53.47	122.66	109.96	1119.36

Figure 2. Half Month Rainfall Data Dompu Rainfall Station (mm)

Source: Agency, Meteorology, Climatology, and Geophysics (BMKG) Bima Regency 2022

Rainfall Data Consistency Test

The consistency test of rainfall data was carried out using the Rescaled Adjusted Partial Sums (RAPS) method.

Table 1. Dompu Rain Station Monthly Rainfall Data (mm)

Yrs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des	X_i
2003	247	215	267	73	24	0	0	0	2	20	203	204	1253.11
2004	222	142	196	167	36	0	0	0	0	94	110	85	1051.58
2005	167	193	241	105	0	17	1	0	0	0	30	38	791.90
2006	124	199	163	169	0	0	0	0	0	0	0	178	832.98
2007	342	151	97	27	10	15	0	0	0	8	149	250	1049.03
2008	135	84	95	17	59	0	0	0	0	0	157	280	826.52
2009	159	276	291	113	0	34	13	0	0	44	156	333	1417.60
2010	187	250	247	213	40	5	0	0	0	0	16	156	1114.22
2011	186	156	127	140	69	7	0	0	0	0	17	445	1147.10
2012	281	230	212	92	19	3	0	0	0	70	130	345	1382.30
2013	192	125	79	72	15	0	0	0	0	68	133	137	821.60
2014	273	211	141	0	0	0	0	0	0	0	0	141	766.30

2015	210	215	183	68	53	0	0	0	0	0	0	104	833.36
2016	105	208	57	0	0	1	0	0	0	41	132	615	1156.55
2017	286	297	199	129	60	34	0	0	0	72	239	260	1575.95
2018	289	169	183	255	32	13	2	0	0	0	230	202	1374.75
2019	174	216	151	129	0	0	0	0	0	0	0	229	898.66
2020	275	243	164	186	66	14	0	0	0	50	158	116	1271.21
2021	234	168	195	148	63	86	11	3	37	209	293	292	1738.90
2022	239	206	79	113	0	0	0	0	71	1	132	244	1083.50
Average													1119.36

Source: 2023 Calculation Results

Table 2. Dompu Rain Station Consistency Test

Year	X_i	S_K^*	D_v^2	S_K^{**}	$\lvert S_K^{**} \rvert$
2003	1253.11	133.76	894.52	0.89	0.89
2004	1051.58	65.97	217.63	-0.45	0.45
2005	791.90	-261.48	3418.58	-2.18	2.18
2006	832.98	-547.86	15007.41	-1.91	1.91
2007	1049.03	-618.19	19107.69	-0.47	0.47
2008	826.52	-911.02	41497.97	-1.95	1.95
2009	1417.60	-612.78	18774.95	1.99	1.99
2010	1114.22	-617.91	19090.87	-0.03	0.03
2011	1147.10	-590.17	17414.81	0.18	0.18
2012	1382.30	-327.23	5353.82	1.75	1.75
2013	821.60	-624.98	19529.97	-1.98	1.98
2014	766.30	-978.03	47827.59	-2.35	2.35
2015	833.36	-1264.03	79888.21	-1.91	1.91
2016	1156.55	-1226.83	75255.89	0.25	0.25
2017	1575.95	-770.24	29663.64	3.04	3.04
2018	1374.75	-514.85	13253.43	1.70	1.70
2019	898.66	-735.55	27051.40	-1.47	1.47
2020	1271.21	-583.69	17034.63	1.01	1.01
2021	1738.90	35.86	64.28	4.13	4.13
2022	1083.50	0.00	0.00	-0.24	0.24
Sum			450347.29		
Average	1119.36		22517.36		
n		=	20		
D_v		=	150.06		
$S_K^{**}\min$		=	-2.35		
$S_K^{**}\text{maks}$		=	4.13		
$Q_v = \lvert S_K^{**}\text{maks} \rvert$		=	4.13		
$R_v = S_K^{**}\text{maks} - S_K^{**}\min$		=	6.48		
$Q_y / \sqrt{n}$		=	0.92 < 1.42 (Consistent)		
$R_y / \sqrt{n}$		=	1.45 < 1.60 (Consistent)		

Source: 2023 Calculation Results

Data Generation Model Using Thomas Fiering Model

Calculate semi-monthly average rainfall

The equation used is equation (2.7). Example of calculation at the Dompu rainfall station:

Average for January I:

$$\bar{p}_j = \frac{\sum_{i=1}^{n} p_{ij}}{n} = \frac{\text{Curah hujan Jan I } (2003 + 2004 + \cdots + 2022)}{20} = \frac{2328{,}09}{20} = 116{,}40 \text{ mm}$$

Table 3. Average Score of Dompu Rainfall Station (mm)

Moon		p_j	Moon		p_j
JAN	I	116.40	**JUL**	I	1.38
	II	99.98		II	0.00
FEB	I	110.30	**AUG**	I	0.14
	II	87.39		II	0.00
MAR	I	100.38	**SEP**	I	0.63
	II	67.89		II	4.84
APR	I	71.69	**OCT**	I	19.17
	II	38.97		II	14.62
MAY	I	13.97	**NOV**	I	60.71
	II	13.41		II	53.47
JUN	I	5.91	**DES**	I	122.66
	II	5.49		II	109.96

Source: 2023 Calculation Results

Calculate standard deviation/standard deviation

Standard deviation in January I of 2003:

$(p_{ij} - \bar{p}_j) = 79{,}00 - (116{,}40) = -37{,}40 \text{ mm}$

$(p_{ij} - \bar{p}_j)^2 = (-37{,}40)^2 = 1399{,}08 \text{ mm}^2$

Table 4. Parameter Analysis of Standard Deviation Value in January I

Year	p_{ij}	$(p_{ij} - \bar{p}_j)$	$(p_{ij} - \bar{p}_j)^2$
2003	79.00	-37.40	1399.08
2004	117.50	1.10	1.20
2005	74.50	-41.90	1755.97
2006	71.50	-44.90	2016.39
2007	191.96	75.55	5707.93
2008	78.00	-38.40	1474.89
2009	118.32	1.91	3.65
2010	138.25	21.85	477.24
2011	90.50	-25.90	671.03
2012	193.94	77.54	6011.79
2013	43.00	-73.40	5388.18
2014	177.29	60.89	3707.44
2015	166.52	50.12	2511.83
2016	57.55	-58.85	3463.82
2017	197.51	81.11	6578.08

2018	114.70	-1.70	2.90
2019	73.20	-43.20	1866.61
2020	127.45	11.05	122.01
2021	92.35	-24.05	578.61
2022	125.05	8.65	74.75
Sum	2328.09		43813.39
Average			

Source: 2023 Calculation Results

Calculating the correlation coefficient

Table 5. The value of the correlation coefficient of the Dompu Rainfall Station

Moon		r_j	Moon		r_j
JAN	I	0.39	**JUL**	I	0.79
	II	-0.05		II	0.00
FEB	I	-0.23	**AUG**	I	0.00
	II	-0.15		II	0.00
MAR	I	0.28	**SEP**	I	0.00
	II	0.00		II	0.84
APR	I	0.54	**OCT**	I	0.36
	II	0.65		II	0.80
MAY	I	-0.07	**NOV**	I	0.58
	II	0.35		II	0.56
JUN	I	0.45	**DES**	I	0.24
	II	0.69		II	0.50

Generate rain data

Table 6. Rainfall Data Generation Results of Dompu Rainfall Station (mm)

Month		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
January	I	50.97	91.99	117.31	124.79	104.35	62.11	120.76	92.46	66.80	49.77
	II	150.24	109.15	133.57	86.26	165.54	150.64	33.93	136.45	81.42	175.09
February	I	67.23	180.31	39.93	46.64	47.57	60.27	106.36	159.05	67.29	98.00
	II	38.82	63.81	31.37	100.63	52.59	91.99	75.29	80.01	146.75	27.60
March	I	130.76	188.44	138.34	160.75	61.97	9.80	146.38	118.64	76.94	185.00
	II	123.44	50.43	124.25	59.11	16.97	74.50	111.47	142.33	1.33	46.83
April	I	98.08	64.15	21.13	57.04	11.05	70.37	65.31	22.65	37.20	16.03
	II	78.56	20.75	38.23	19.97	47.19	37.57	34.53	62.48	5.60	62.15
May	I	1.86	27.29	40.84	34.14	17.81	9.46	11.70	0.27	40.28	29.81
	II	0.21	41.20	8.92	23.33	3.39	3.75	5.21	12.94	5.51	38.26
June	I	8.25	3.14	10.02	2.18	4.19	9.23	8.22	9.87	17.53	5.40

	II	15.87	3.32	9.14	0.28	9.32	8.23	6.40	16.56	14.01	2.10
July	I	3.14	2.28	0.06	1.22	0.89	0.24	1.64	2.81	3.86	0.67
	II	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
August	I	0.85	0.65	0.70	0.16	0.36	1.36	0.53	0.77	0.57	0.29
	II	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
September	I	3.48	0.84	3.82	1.17	1.17	2.34	1.72	2.05	0.08	1.22
	II	3.57	2.16	12.52	9.25	2.10	7.66	10.44	10.83	2.14	12.93
October	I	64.79	15.21	35.26	15.34	21.96	53.02	29.84	10.56	3.89	8.61
	II	16.69	6.19	20.92	1.97	25.43	10.24	28.39	0.46	17.23	14.82
November	I	106.54	35.46	103.22	95.02	20.87	86.29	3.28	47.77	107.38	42.50
	II	1.51	41.17	114.27	58.12	73.22	23.82	79.06	96.73	92.91	50.02
December	I	208.28	130.56	189.63	156.94	147.21	108.66	70.65	43.12	77.51	25.65
	II	223.00	14.60	125.52	236.53	145.40	162.29	192.04	44.50	120.27	191.64

Source: 2023 Calculation Results

Drought Analysis with the Theory of Run Method

Average monthly rain

Table 7. Monthly Rain Data of Dompu Rainfall Station for the Period 2003-2022 (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des
2003	247.00	215.00	267.00	73.00	24.00	0.00	0.00	0.00	2.00	20.00	203.00	204.00
2004	222.00	142.00	196.00	167.00	36.00	0.00	0.00	0.00	0.00	94.00	110.00	85.00
2005	167.00	193.00	241.00	105.00	0.00	17.00	1.00	0.00	0.00	0.00	30.00	38.00
2006	124.00	199.00	163.00	169.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	178.00
2007	342.00	151.00	97.00	27.00	10.00	15.00	0.00	0.00	0.00	8.00	149.00	250.00
2008	135.00	84.00	95.00	17.00	59.00	0.00	0.00	0.00	0.00	0.00	157.00	280.00
2009	159.00	276.00	291.00	113.00	0.00	34.00	13.00	0.00	0.00	44.00	156.00	333.00
2010	187.00	250.00	247.00	213.00	40.00	5.00	0.00	0.00	0.00	0.00	16.00	156.00
2011	186.00	156.00	127.00	140.00	69.00	7.00	0.00	0.00	0.00	0.00	17.00	445.00
2012	281.0	230.0	212.0	92.00	19.0	3.00	0.00	0.00	0.00	70.00	130.0	345.0

	0	0	0		0					0	0
2013	192.00	125.00	79.00	72.00	15.00	0.00	0.00	0.00	0.00	68.00	133.00	137.00
2014	273.00	211.00	141.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	141.00
2015	210.00	215.00	183.00	68.00	53.00	0.00	0.00	0.00	0.00	0.00	0.00	104.00
2016	105.00	208.00	57.00	0.00	0.00	1.00	0.00	0.00	0.00	41.00	132.00	615.00
2017	286.00	297.00	199.00	129.00	60.00	34.00	0.00	0.00	0.00	72.00	239.00	260.00
2018	289.00	169.00	183.00	255.00	32.00	13.00	2.00	0.00	0.00	0.00	230.00	202.00
2019	174.00	216.00	151.00	129.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	229.00
2020	275.00	243.00	164.00	186.00	66.00	14.00	0.00	0.00	0.00	50.00	158.00	116.00
2021	234.00	168.00	195.00	148.00	63.00	86.00	11.00	3.00	37.00	209.00	293.00	292.00
2022	239.00	206.00	79.00	113.00	0.00	0.00	0.00	0.00	71.00	1.00	132.00	244.00
SUM	4327	3954	3367	2216	546	229	27	3	110	677	2285	4654
AVERAGE	216.35	197.70	168.35	110.80	27.30	11.45	1.35	0.15	5.50	33.85	114.25	232.70
ST. DEV	63.25	51.34	65.95	69.54	26.41	20.58	3.69	0.67	17.49	51.75	90.36	133.56
SKEWNESS	0.06	-0.22	0.03	0.11	0.36	2.83	2.84	4.47	3.38	2.25	0.14	1.27
KURTOSIS	-0.68	0.22	-0.74	-0.35	-1.53	9.17	7.05	20.00	11.46	6.26	-0.91	2.42

Table 8. Monthly Rain Data of Dompu Rainfall Station for the Year 2023-2032 (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DES
2023	201.21	106.05	254.21	176.65	2.07	24.13	3.14	0.85	7.05	81.49	108.05	431.29
2024	201.15	244.12	238.87	84.90	68.50	6.46	2.28	0.65	3.00	21.40	76.64	145.16
2025	250.87	71.30	262.59	59.36	49.76	19.16	0.06	0.70	16.34	56.18	217.50	315.15
2026	211.04	147.27	219.86	77.01	57.46	2.45	1.22	0.16	10.42	17.31	153.14	393.48
2027	269.90	100.16	78.94	58.24	21.21	13.51	0.89	0.36	3.27	47.39	94.08	292.61
2028	212.75	152.26	84.30	107.94	13.20	17.46	0.24	1.36	10.00	63.26	110.12	270.94
2029	154.69	181.65	257.85	99.84	16.92	14.61	1.64	0.53	12.16	58.23	82.34	262.69
2030	228.91	239.06	260.97	85.13	13.21	26.43	2.81	0.77	12.88	11.02	144.50	87.61

2031	148.22	214.05	78.27	42.79	45.79	31.54	3.86	0.57	2.22	21.11	200.30	197.77
2032	224.87	125.59	231.84	78.18	68.06	7.50	0.67	0.29	14.16	23.43	92.52	217.28
SUM	2103.6	1581.5	1967.7	870.0	356.2	163.3	16.8	6.2	91.5	400.8	1279.2	2613.9
AVERAGE	210.36	158.15	196.77	87.00	35.62	16.33	1.68	0.62	9.15	40.08	127.92	261.40
ST. DEV	37.82	60.04	81.37	37.08	24.95	9.32	1.29	0.34	5.02	24.14	49.43	105.40
SKEWNESS	-0.33	0.21	-0.93	1.63	0.13	0.12	0.40	0.92	-0.22	0.39	0.91	0.03
KURTOSIS	-0.08	-1.25	-1.28	3.74	-1.81	-0.86	-1.11	1.68	-1.41	-1.31	-0.44	-0.34

Surplus/deficit value

1. January 2003:

   $Z_i = X_i - \overline{X} = 247{,}00 - 216{,}35 = 30{,}65\ \text{mm}$ (surplus)

2. April 2003:

   $Z_i = X_i - \overline{X} = 73 - 110{,}80 = -37{,}80\ \text{mm}$ (deficit)

Table 9. Monthly Rainfall Surplus and Deficit Value of Dompu Rainfall Station for the Period 2003-2022 (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des
2003	30.65	17.30	98.65	-37.80	-3.30	-11.45	-1.35	-0.15	-3.50	-13.85	88.75	-28.70
2004	5.65	-55.70	27.65	56.20	8.70	-11.45	-1.35	-0.15	-5.50	60.15	-4.25	-147.70
2005	-49.35	-4.70	72.65	-5.80	-27.30	5.55	-0.35	-0.15	-5.50	-33.85	-84.25	-194.70
2006	-92.35	1.30	-5.35	58.20	-27.30	-11.45	-1.35	-0.15	-5.50	-33.85	-114.25	-54.70
2007	125.65	-46.70	-71.35	-83.80	-17.30	3.55	-1.35	-0.15	-5.50	-25.85	34.75	17.30
2008	-81.35	-113.70	-73.35	-93.80	31.70	-11.45	-1.35	-0.15	-5.50	-33.85	42.75	47.30
2009	-57.35	78.30	122.65	2.20	-27.30	22.55	11.65	-0.15	-5.50	10.15	41.75	100.30
2010	-29.35	52.30	78.65	102.20	12.70	-6.45	-1.35	-0.15	-5.50	-33.85	-98.25	-76.70
2011	-	-	-	29.20	41.7	-	-	-	-	-	-	212.

	30.35	41.70	41.35		0	4.45	1.35	0.15	5.50	33.85	97.25	30
2012	64.65	32.30	43.65	-18.80	-8.30	-8.45	-1.35	-0.15	-5.50	36.15	15.75	112.30
2013	-24.35	-72.70	-89.35	-38.80	-12.30	-11.45	-1.35	-0.15	-5.50	34.15	18.75	-95.70
2014	56.65	13.30	-27.35	-110.80	-27.30	-11.45	-1.35	-0.15	-5.50	-33.85	-114.25	-91.70
2015	-6.35	17.30	14.65	-42.80	25.70	-11.45	-1.35	-0.15	-5.50	-33.85	-114.25	-128.70
2016	-111.35	10.30	-111.35	-110.80	-27.30	-10.45	-1.35	-0.15	-5.50	7.15	17.75	382.30
2017	69.65	99.30	30.65	18.20	32.70	22.55	-1.35	-0.15	-5.50	38.15	124.75	27.30
2018	72.65	-28.70	14.65	144.20	4.70	1.55	0.65	-0.15	-5.50	-33.85	115.75	-30.70
2019	-42.35	18.30	-17.35	18.20	-27.30	-11.45	-1.35	-0.15	-5.50	-33.85	-114.25	-3.70
2020	58.65	45.30	-4.35	75.20	38.70	2.55	-1.35	-0.15	-5.50	16.15	43.75	-116.70
2021	17.65	-29.70	26.65	37.20	35.70	74.55	9.65	2.85	31.50	175.15	178.75	59.30
2022	22.65	8.30	-89.35	2.20	-27.30	-11.45	-1.35	-0.15	65.50	-32.85	17.75	11.30

Source: 2023 Calculation Results

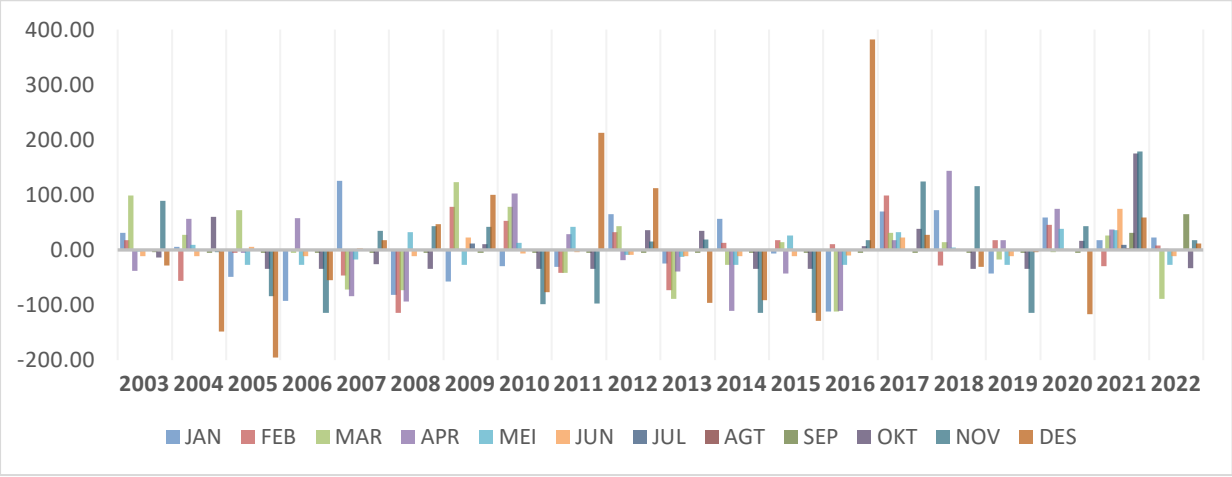

Figure 2. Graph of surplus and deficit of Monthly Rain of Dompu Rainfall Station for the Year 2003-2022 (mm)

Table 10. Surplus and Monthly Rain Deficit Value of Dompu Rainfall Station for the Year 2023-2032 (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des
2023	-9.15	-52.10	57.44	89.65	-33.55	7.81	1.46	0.23	-2.10	41.41	-19.87	169.89
2024	-9.21	85.97	42.10	-2.10	32.88	-9.87	0.60	0.03	-6.15	-18.68	-51.28	-116.24
2025	40.51	-86.85	65.82	-27.64	14.14	2.84	-1.62	0.08	7.19	16.10	89.58	53.75
2026	0.68	-10.88	23.09	-9.99	21.84	-13.88	-0.46	-0.46	1.27	-22.77	25.22	132.08
2027	59.54	-57.99	-117.83	-28.76	-14.41	-2.82	-0.79	-0.26	-5.88	7.31	-33.84	31.21
2028	2.39	-5.89	-112.47	20.94	-22.42	1.14	-1.44	0.74	0.85	23.18	-17.80	9.54
2029	-55.67	23.50	61.08	12.84	-18.70	-1.72	-0.04	-0.09	3.01	18.15	-45.58	1.29
2030	18.55	80.91	64.20	-1.87	-22.41	10.11	1.13	0.15	3.73	-29.06	16.58	-173.79
2031	-62.14	55.90	-118.50	-44.21	10.17	15.22	2.18	-0.05	-6.93	-18.97	72.38	-63.63
2032	14.51	-32.56	35.07	-8.82	32.44	-8.83	-1.01	-0.33	5.01	-16.65	-35.40	-44.12

Source: 2023 Calculation Results

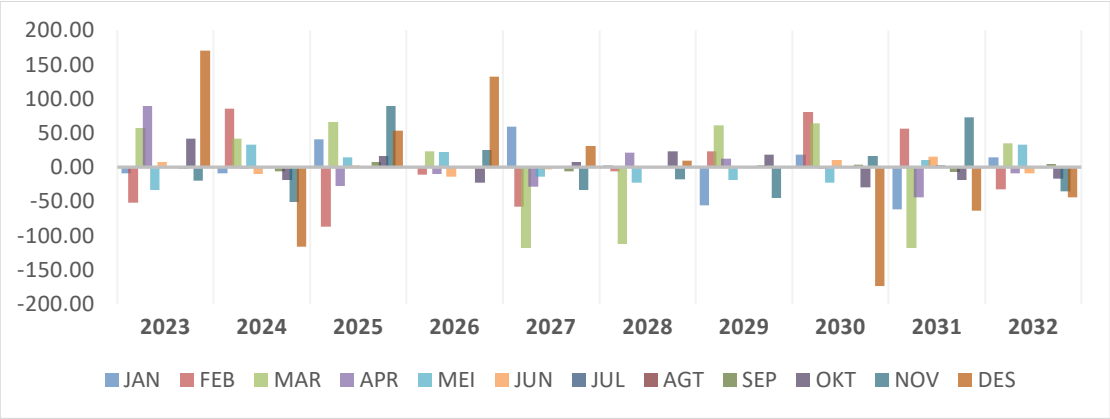

Figure 3. Graph of surplus and deficit of Monthly Rain of Dompu Rainfall Station for the Year 2023-2032 (mm)

CONCLUSION

The research conducted in Manggalewa District, Dompu Regency, utilizing the Theory of Run method and focusing on the Dompu rainfall station reveals several key findings. Firstly, from 2003 to 2022, the district experienced 11 months of drought, spanning from March 2014 to January 2015, resulting in a deficit of 430.05 mm compared to the average normal rainfall. Secondly, during the same period, there were 12 consecutive months of wet weather, lasting from March 2021 to February 2022. Thirdly, projecting forward to the period of 2023 to 2032, the study anticipates 8 months of drought, occurring from February to September 2027. Notably, the most significant deficit is forecasted for December 2030 to January 2031, with a shortfall of 235.93 mm from the average normal rainfall. These findings underscore the importance of understanding and preparing for fluctuations in rainfall patterns in the region for effective water resource management and agricultural planning.

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