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Research paper

Analysis of precipitation characteristics in Palembang city

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Abstract

Geographically, Palembang is located at 2°59′27.99″S 104°45′24.24″E. The area of Palembang city is 400.61 km², with an average height of 8 meters above sea level. The climate of Palembang is a tropical climate with relatively humid winds, with wind speeds ranging from 2.3 km/hour to 4.5 km/hour. Annual precipitation ranges from 2,000 mm to 3,000 mm. This research was conducted in Palembang city. The purpose of this research is to analyze the precipitation characteristics according to the rainfall data in Palembang city. The aim of this research is to determine the analysis of precipitation intensity using the Mononobe method to obtain Intensity-Duration-Frequency (IDF) values. Based on the results of calculating the precipitation intensity using the mononobe method, a value of 38.60465 mm/hour with a duration of 60 minutes over a return period of 10 years can be classified as very heavy rain. From the IDF curve, the character of the rain shows that heavy rains last only for a short duration, this shows that heavy rains last for a short time and conversely heavy rains can last for a long time.

Keywords: *Climate; Precipitation; Precipitation Characteristics; IDF Curve.*

1. Introduction

Changes in Earth's climate conditions on a global scale due to the effects of greenhouse gases have impacted regional and local weather and climate extremes in Indonesia. The real impact of climate deviation conditions (extreme weather conditions) is increased precipitation intensity, flash floods, local storms/tornadoes, pickaxe, increased urban temperatures, drought and landslides. Rainfall data is very important for technical planning, especially for hydraulic buildings, which is why rainfall data is needed every year. Much of the study of rainfall data is carried out by inference with the aim of modeling and forecasting rainfall. Precipitation modeling studies have been carried out, among others, by Hanum et al. (2015), Deidda& Puliga (2005) and Hafid (2013) which model precipitation according to a certain distribution.

Geographically, Palembang is located at 2°59′27.99″S 104°45′24.24″E. The area of Palembang city is 400.61 km², with an average height of 8 meters above sea level. The climate of Palembang is a tropical climate with humid, relative winds, wind speed varies from 2.3 km/hour to 4.5 km/hour. Annual precipitation ranges from 2,000 mm to 3,000 mm. Air humidity ranges from 75 to 89% with an average solar radiation of 45%. The topography of the land is relatively flat and low. The soil type of Palembang city is alluvial, clayey and sandy, located in the youngest layer. Only a small part of the city's territory is located at a relatively high level. Most of the land is a swampy area, so during the rainy season the area is flooded

The amount of rain resulting from measurements with a rain gauge over a period of time (years) can be used to determine the nature (characteristics) of precipitation in a location. Therefore, the author wants to conduct research related to "Analysis of Precipitation Characteristics in Palembang City". The purpose of this research is to analyze the precipitation characteristics according to the rainfall data in Palembang city. The aim of this research is to determine the analysis of precipitation intensity using the mononobe method to obtain Intensity-Duration-Frequency (IDF) values.

2. Research methodology

2.1. Study zone

The study area in this research is a precipitation observation station consisting of three rainfall stations, namely Plaju, UNSRI Bukit and Kenten stations in Palembang City.

2.2. Data gathering

In this research, there is a method of collecting data regarding what will be discussed. Including the following:

1) Comments

Using rainfall data, as well as the Palembang city area.

2) Surveys

By directly visiting the research location and recording the necessary data.

The data obtained in this research are:

1) Primary data

Primary data is additional data obtained directly when carrying out a survey on the place to be studied. The primary data consists of:

a) The number of rain stations in Palembang city is 6 stations.

- Kenten station, Palembang city
- Plaju station, Palembang city
- UNSRI Bukit Station, Palembang City

2) Secondary data

Secondary data supports data provided by agencies related to on-site issues. Secondary data consists of:

- Rainfall data

The required rainfall data are the maximum daily rainfall data for 5 years of observation obtained from the class 1 climatological station, South Sumata.

3. Results and discussion

3.1 Analysis of rainfall data

In this research, the data which is the main input in the calculation of average precipitation is the rainfall data from three stations, namely Kenten station, Plaju station and UNSRI Bukit Kota Palembang station. The rainfall data used corresponds to the maximum rainfall data for the last 5 years in the city of Palembang.

Table 1: Maximum Precipitation Data (Mm) at Kenten Station, Palembang City

Thn	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des
2018	30	68	75	70	26	75	23	30	34	97	74	78
2019	17	65	81	54	34	40	45	1	15	75	25	76
2020	25	91	63	76	68	41	30	36	34	76	59	60
2021	34	70	14	22	79	80	22	19	52	67	32	85
2022	48	82	50	55	83	20	33	42	113	83	55	54

Sumber : BMKG Kelas 1, Sumatera Selatan.

Table 2: Maximum Precipitation Data (Mm) at PlajuStation, Palembang City

Thn	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des
2018	51	56	75	72	35	54	13	17	52	33	82	61
2019	29	69	89	47	108	40	36	0	5	85	42	19
2020	39	85	85	71	135	X	X	X	26	69	37	46
2021	64	99	26	70	69	90	111	70	65	8	41	29
2022	44	87	49	37	89	14	44	59	124	82	35	60

Sumber : BMKG Kelas 1, Sumatera Selatan.

Table 3: Maximum Precipitation Data (Mm) at UNSRI Bukit Station, Palembang City

Thn	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des
2018	28	24	22	28	56	33	20	31	75	50	120	118
2019	87	64	83	106	55	41	48	0	8	56	48	105
2020	31	86	52	67	70	68	16	33	30	50	79	54
2021	42	36	77	48	32	71	59	75	45	36	80	30
2022	80	52	44	59	88	100	56	80	76	52	12	45

Sumber : BMKG Kelas 1, Sumatera Selatan

To obtain the average value of the maximum daily precipitation in the calculations to see the characteristics of this rain, existing methods are used. The calculation method used is the algebraic average method, with the following description:

1) Algebraic averaging method

To determine the average daily maximum rainfall, the data needed are the maximum rainfall per year at each rainfall station. The average values of daily maximum precipitation can be seen in the table below:

Table 4: Maximum Precipitation Calculation Data (Mm)

Incident		Kenten Rain Post Max Rainfall (mm)	Rain Post Max Rainfall Rate (mm)	UNSRI Bukit Rain Post Max Rainfall (mm)	Average Daily Maximum Rain (mm)
No.	Year				
1	2018	97	82	120	99,7
2	2019	81	108	106	98,3
3	2020	91	135	86	104,0
4	2021	85	111	80	92,0
5	2022	113	124	100	112,3

a) Determination of return time

Rain characteristics show that some heavy rains have a certain return period. The expected return period for the channel follows the standards in force as in the following table:

Table 5: Return Time Based on City Topology and Drainage Area

City Typology	Painting Area (Ha)			
	< 10	10 - 100	100 - 500	> 500
Metropolis	2 year	2 - 5 year	5 - 10 year	10 - 25 year
Big city	2 year	2 - 5 year	2 - 5 year	5 - 20 year
Medium/Small Cities	2 year	2 - 5 year	2 - 5 year	5 - 10 year

Sumber : SIMANTU PUPR

b) Distribution of type III people diaries

Type III per capita distribution is used in hydrological analysis, especially in the analysis of maximum (flood) and minimum (minimum flow) data with extreme values. The Log Person Type III distribution form is the result of transforming the Person Type III distribution by replacing the variance in logarithmic values. The following is a calculation table for the Type III log method using Excel.

Table 5: Calculation of Type III People Diary Method

Thn	X_i	$\log X_i$	$\log \bar{X}$	$\log X_i - \log \bar{X}$	$(\log X_i - \log \bar{X})^2$	$(\log X_i - \log \bar{X})^3$
2018	99,7	1,99855	2,00452	-0,00597	0,00004	0,00000
2019	98,3	1,99270	2,00452	-0,01182	0,00014	0,00000
2020	104,0	2,01703	2,00452	0,01252	0,00016	0,00000
2021	92,0	1,96379	2,00452	-0,04073	0,00166	-0,00007
2022	112,3	2,05051	2,00452	0,04599	0,00212	0,00010
		10,02258			0,00411	0,00003
Sx	0,03204					
Cs	0,4					

After obtaining the Cs value, proceed to calculate the logarithmic value of planned precipitation with a return period of T years with K prices obtained based on the Cs value:

Table 6: Predicted Rainfall for the Year Period Log Person Type III Distribution Method

Return Period	$\log \bar{X}$	K	Sx	$\log X_t$	X_t
2	2,00452	-0,0660	0,03204	2,00240	100,55415
5	2,00452	0,816	0,03204	2,03066	107,31489
10	2,00452	1,317	0,03204	2,04671	111,35507
25	2,00452	1,880	0,03204	2,06475	116,07802
50	2,00452	2,261	0,03204	2,07696	119,38781
100	2,00452	2,615	0,03204	2,08830	122,54624

c) Intensity – duration – frequency (IDF) calculation

2) Mononobe method

Precipitation intensity is the amount of precipitation that occurs during a period of time when water is concentrated. This analysis of precipitation intensity can be processed using rainfall data that occurred in the past. Precipitation intensity is the amount of rain in a certain unit of time expressed in mm/hour. According to Dr. Mononobe if the available rainfall data only concerns daily rainfall. Here is a table of the results of the IDF calculation in minutes using the mononobe method:

Table 7:IDF Calculation Results for the Mononobe Method

Duration (minutes)	PeriodeUlang (tahun)					
	2	5	10	25	50	100
5	182,71902	195,00410	202,34559	210,92776	216,94205	222,68130
10	115,10577	122,84488	127,46973	132,87616	136,66493	140,28043
15	87,84214	93,74819	97,27761	101,40349	104,29486	107,05400
20	72,51209	77,38743	80,30090	83,70674	86,09351	88,37113
45	42,23010	45,06943	46,76620	48,74971	50,13974	51,46620
60	34,86018	37,20399	38,60465	40,24200	41,38944	42,48441
120	21,96054	23,43705	24,31940	25,35087	26,07371	26,76350
180	16,75903	17,88582	18,55918	19,34634	19,89797	20,42437
240	13,83427	14,76441	15,32026	15,97005	16,42541	16,85995
300	11,92201	12,72359	13,20260	13,76257	14,15499	14,52946

Based on the calculation results above with hourly duration over a 5 year return period, it can be classified as very heavy rain because the precipitation intensity obtained was > 20 mm/hour: So from the results of the above calculation by calculating the intensity using With the mononobe method, the IDF graph is obtained as follows:

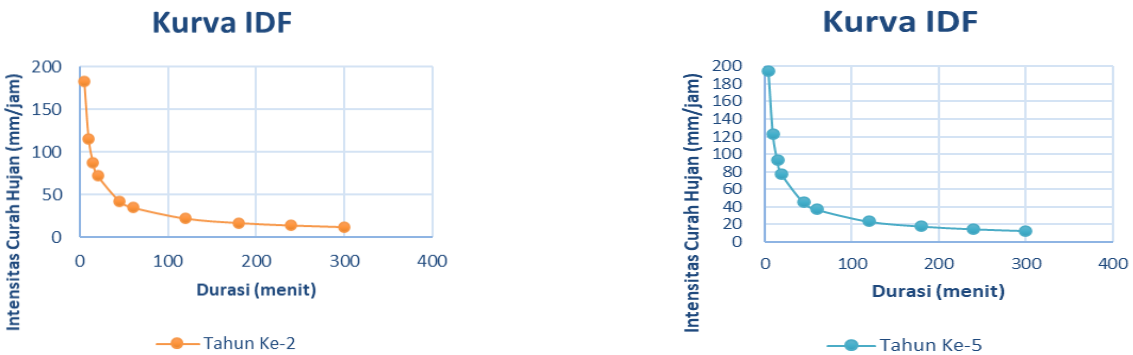

Fig. 1: Intensity-Duration-Frequency (IDF) Curve at 2 Years and 5 Years of Performance.

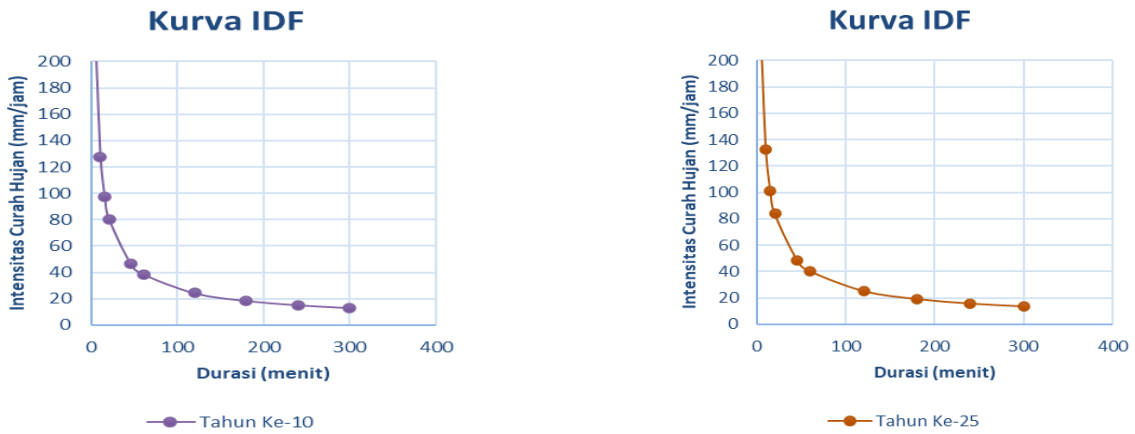

Fig. 2: Intensity-Duration-Frequency (IDF) Curve for 10- and 25-Year Returns.

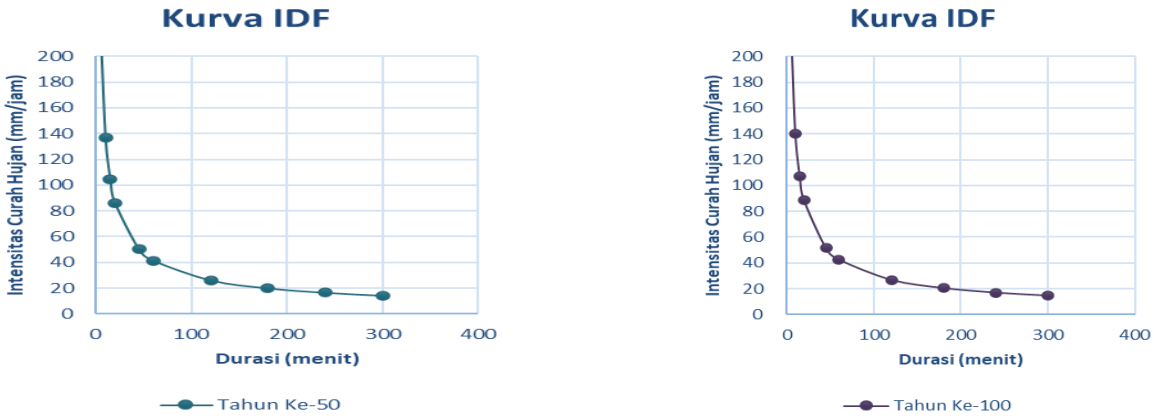

Fig. 3: Intensity-Duration-Frequency (IDF) Curve for 10- and 25-Year Returns.

Based on several figures 1, 2 and 3, it can be seen that: The IDF curve represented/formed from the calculation results has a relationship between the variable X (duration) and the variable Y (intensity) in the form of A negative relationship is indicated by the value of the slope of the curve. The relationship between the variables X and Y is said to be negative if the changes in the variable.

4. Conclusion

1) The standard deviation obtained from the type III person diary method is 0.03204 with an average precipitation value obtained of 2.00452.
2) In the IDF calculation of intensity for a duration of 60 minutes over a return period of 5 years, we obtain a value of 37.20399 mm/hour.
3) The results of calculating the precipitation intensity using the Mononobe method with a duration of 60 minutes over a return period of 10 years were obtained as 38.60465 mm/hour, which can be classified as very heavy rain, while with a duration of 180 minutes over a period of 10 years, During the return period of the year it was obtained at 18.55918 mm/hour and can be classified as heavy rain.
4) Precipitation intensity The Mononobe method is used as a reference to form the IDF curve. From the IDF curve, the character of the rain shows that heavy rains only last for a short duration, this shows that heavy rains last for a short time and conversely heavy rains can last for a long time.

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