Rainfall Analysis in Flood Prone Areas in Binjai City

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Abstract. High rainfall is one of the main factors in flooding, especially if drainage is not functioning optimally, so it is necessary to carry out rainfall analysis to determine the maximum rainfall in an area which can be taken into consideration in drainage planning. The flood-prone areas that will be analyzed are Binjai City, Jalan Soekarno Hatta using the frequency analysis method: normal, log normal, log person III and Gumbel. The analysis uses 18 years of rainfall data with a return period of 50 years. The results obtained were Normal 1017.857 mm, log normal 917.211 mm, log person III 763.160 mm, and Gumbel 1412.4255 mm. From these results, the gumbel method frequency analysis has the most extreme value. For further analysis, a chi square goodness-of-fit test or Smirnov-Kolmogorov test can be carried out to determine which distribution analysis values are suitable to support channel dimension planning in the Soekarno Hatta area.

Keywords: Rainfall, Frequency Analysis, Binjai City

1 Introduction

Rain is a form of precipitation in which the process begins with the condensation of water vapor in the atmosphere into heavy water droplets which then fall to land. The elements contained in rain are rain intensity, rain duration, rain height, rain frequency and area. Rain can be measured with manual and automatic rainfall gauges, usually the tool is placed at a rain station where from the rain gauge, information is obtained about the amount of rain that falls in an area ([4] Rahmadani, 2023).

These data are better known as rainfall data. Rainfall data is always used for analysis which influences discharge planning in determining channel dimensions. Rain is often the cause of floods because of the high intensity of rain and the channels that are not functioning optimally. Where flooding is an event that cannot be known when it will occur, but can be predicted and the risk of occurrence can be minimized. Flooding is still a problem that needs special attention and handling ([3] Rahmadani, 2022). Usually flooding is an event caused by the inability of the canal to accommodate, hold or drain the water in it, so that the water level rises and overflow occurs which inundates the surrounding area.

Channels should be properly designed so that they function optimally because bearing in mind their function is to drain, drain, dispose or divert water which is generally defined as an effort

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made to minimize excess water originating from rain, seepage or irrigation water in a field so that the function of the land is not disturbed. due to excess water ([5] Suripin, 2004).
The city of Binjai is located in North Sumatra Province, has an area of ± 90.23 km^2 with a population of 2,435,252 people in 2020 with a density of 9,522.22 people/km^2 , consisting of 21 sub-districts and 151 urban villages. Geographically, Binjai City is located at 3°31' 40" – 3°40'2" North Latitude and 98°27'3" – 98°32'32" East Longitude and is located 30 m above sea level ([1] Binjai City in Figures, 2022). Soekarno Hatta Road in Binjai City is an area prone to flooding, especially during the rainy season. The thing that requires special attention regarding flooding in this area is that this area is not close to a river flow but is very prone to flooding due to overflow from the drainage or it can also be said that the drainage capacity is unable to store rainwater resulting in overflow. So from this it is necessary to do a rainfall analysis.

2 Method

In this study the method used is descriptive evaluative method, namely a study method that evaluates objective conditions on Soekarno Hatta Street, Binjai City by displaying the conditions that are currently the object of study with the aim of accurately describing rainfall conditions at the study location, more precisely to make a detailed picture. systematic.
This study uses a secondary data collection method, namely rainfall data for the city of Binjai, especially Jalan Soekarno Hatta in the East Binjai sub-district. Data obtained from BMKG and Binjai City Website ([1] Binjai City in Figures). The data used spans 18 years, from 2005 to 2022. The data obtained is then analyzed using the Normal, Log Normal, Log Person III, and Gumbel methods and compared with applicable standards.

3 Results and Discussion

Observational Area
Binjai City is a lowland area with an average elevation of ±30 meters above sea level. Binjai consists of 5 (five) sub-districts namely, (1) South Binjai District, (2) Binjai Kota District, (3) East Binjai District, (4) North Binjai District, and (5) West Binjai District. The following Figure 1 presents the percentage of area by sub-district (%) in Binjai City.

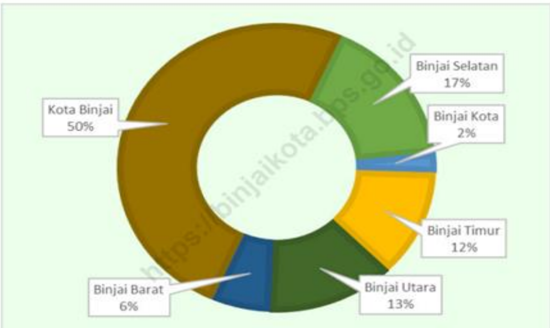

Fig 1. Area Presentation

The area to be analyzed is the East Binjai sub-district in Table 1.

Table 1 . Region Data

Matter	Information
Observational Area	Soekarno Hatta Street
Subdistrict	East Binjai
Starting Point	Royal Pet Shop Binjai Coordinates (3.6087 North Latitude, 98.5014 East Longitude)
End Point	Bandrek Heri 's house Coordinates (3.6089 N, 98.5162 E)
Long	1.8 Km

Hydrological Aspect

In the hydrological analysis, some information regarding hydrological phenomena is displayed which provides information about the amount of rainfall, temperature, evaporation, length of sunlight, wind speed, river discharge, and water level ([5] Suripin, 2004).

Climate City of Binjai

Binjai City is a tropical climate with 2 seasons, namely the rainy season and the dry season. These two seasons are usually marked by the number of rainy days in each month of the season ([1] Binjai City in Figures, 2022).

Rainfall

Table 2 presents rainfall data for the East Binjai sub-district which will be analyzed. Rain data is displayed in the form of monthly rain data in millimeters (mm). The data was obtained from Binjai City in Figures on the Binjai City website for 18 years from 2005 to 2022.

Table 2. Monthly Rainfall

Year	**Month**											
	JAN	**FEB**	**MAR**	**APR**	**MEI**	**JUNI**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DES**
2005	92	17	48	97	161	121	134	27	213	200	300	**311**
2006	48	119	134	103	97	180	127	150	208	227	**375**	204
2007	146	112	60	112	**426**	87	147	99	226	96	178	74
2008	18	30	69	82	36	X	55	85	120	**165**	155	85
2009	182	63	**354**	135	208	72	256	211	319	248	157	126
2010	97.5	37	67	88	227	221	144	216	50	217	**365**	72
2011	214	75	227	71	75	147	136	219	109	**369**	163	9
2012	122	127	119	262	**436**	92	121	137	283	267	191	73
2013	331	251	59	126	192	74	85	96	178	**423**	209	266
2014	37	46	26	45	**482**	123	80	247	293	323	69	274
2015	268	28	87	189	172	33	46	242	109	220	**350**	166
2016	57	208	17	110	230	132	124	65	268	**381**	80	58
2017	206	87	251	211.5	110	117	53	240	272	163	230.5	**350**
2018	177	137	116	258	216	171	148	52	130	**315**	114	184

2019	**1535**	76	52	186	258.5	65	177	39.5	416	340.5	313.5	292
2020	111	73.5	60	238.5	342.5	211.5	208.5	104.5	202	**346.5**	182	331.5
2021	199	17	93	204	171	161	107	226	189	185	**356**	149
2022	190	188	122	127	204	151	190	257	266	274	**504**	417

From the rainfall in Table 2 it can be seen that the amount of rain that occurs is not uniform. Then an analysis is needed to provide significant results in the effort to plan water structures in order to minimize regional flooding. The rain data can be analyzed by selecting the monthly maximum rain data. The data is attached in Table 3.

Table 3. Maximum Rainfall

Year	Max Rainfall (mm)	Year	Max Rainfall (mm)
2005	311	2014	482
2006	375	2015	350
2007	426	2016	381
2008	165	2017	350
2009	354	2018	315
2010	365	2019	1535
2011	369	2020	346.5
2012	436	2021	356
2013	423	2022	504
Amount		7843.5	
X Average		435.75	

From these data, it can be seen that the highest rainfall value of 18 years was in 2019 with a rainfall of 1535 mm^3 . By using the overall maximum rainfall data, a total rainfall of 7843.5 mm^3 and an average of 437.75 mm^3 can be obtained.

The comparative data on rainfall and rainy days by sub-district in Binjai City, 2021 is in Figure 2 below:

Fig 2. Comparison of Rainfall and Rainy Days

Figure 2 shows that East Binjai sub-district experienced 10 rainy days with a total of 171.42 mm [3.] This data is for events in 2021. When compared to other sub-districts, south binjai and west binjai, the East Binjai sub-district is included in the lowest rainfall group which is almost the same as the data north starlight but larger than city starlight. That way it means that rainfall is not the main cause of flooding in the area, and it is possible that the flooding was caused by inadequate drainage. For this reason, further analysis is needed by calculating the return period with frequency analysis.

Frequency Distribution Analysis

Rain frequency is the probability that the amount of rain will be equaled or exceeded, while the return period is a hypothetical period or time in which rain with a certain amount will be equaled or exceeded. The purpose of frequency analysis is related to the magnitude of extreme events related to the frequency of their occurrence through the application of the probability distribution. The hydrological data analyzed are assumed to be independent and randomly distributed and stochastic ([5] Suripin, 2004). Frequency analysis is usually based on the statistical nature of past event data to obtain the probability of rainfall in the future along with frequency analysis of normal distribution, log normal, log person III and Gumbel.

Normal Distribution

The normal distribution is also called the Gaussian distribution, which has a symmetrical view of the vertical axis and is shaped like a bell ([6] Triatmodjo, 2006). The normal distribution can be written in terms of mean and deviation ([5] Suripin, 2004).

Table 4. Analysis of Normal Distribution Rainfall

Year	Max Rainfall (Xi)(mm)	(Xi-X)	$(Xi-X)^2$
2005	311	-124.75	15562.56
2006	375	-60.75	3690563
2007	426	-9.75	95.0625
2008	165	-270.75	73305.56
2009	354	-81.75	6683063
2010	365	-70.75	5005563
2011	369	-66.75	4455563
2012	436	0.25	0.0625
2013	423	-12.75	162.5625
2014	482	46.25	2139063
2015	350	-85.75	7353.063
2016	381	-54.75	2997563
2017	350	-85.75	7353.063
2018	315	-120.75	14580.56
2019	1535	1099.25	1208351
2020	346.5	-89.25	7965563
2021	356	-79.75	6360063
2022	504	68.25	4658063
Amount	7843.5		1370718

From the data in Table 4, the average daily rainfall is 435.75 mm, with a standard deviation (Sd) of 283.955. For return periods, 2, 5, 10, 20, and 50 year return periods are used as shown in Table 5.

Table 5. Analysis of Normal Distribution Return Period Rainfall

Repeat Period (T)	KT	Xi	sd	Rainfall (X_H) (mm)
2	0	435.75	283,955	435.75
5	0.84	435.75	283,955	674,272
10	1.28	435.75	283,955	799,212
20	1.64	435.75	283,955	901,436
50	2.05	435.75	283,955	1017.857

Information
KT : Gaussian Reduction Value
Xi : Average Rainfall (mm)

The value of KT in each repeat period is obtained from the Gauss Reduction variable value table ([5] Suripin, 2004). Which here for the largest return period analyzed is the 50 year return period with a Gauss Reduction value of 2.05, an average rainfall of 435.75 mm and Sd 283,955 obtains a maximum rainfall value (X_T) of 1017,857 mm.

Log Normal Distribution

The Log Normal distribution is carried out in almost the same way as the normal distribution, the difference is that the Log Normal distribution will be used if the values of the random variables do not follow the Normal distribution, but the logarithm values meet the normal distribution. The Log Normal distribution is usually described by the mean and standard deviation ([6]Triatmodjo, 2006). The following is Table 6 for the analysis of Log Normal rainfall distribution.

Table 6. Log Normal Distribution Rainfall Analysis

Year	Max Rainfall (Xi)(mm)	Log Xi	Log Xi-Log X	(Log Xi-Log X)^2
2005	311	2,493	-0.101	0.0102
2006	375	2,574	-0.020	0.0004
2007	426	2,629	0.036	0.0013
2008	165	2.217	-0.376	0.1416
2009	354	2,549	-0.045	0.0020
2010	365	2,562	-0.031	0.0010
2011	369	2,567	-0.027	0.0007
2012	436	2,639	0.046	0.0021
2013	423	2,626	0.033	0.0011
2014	482	2,683	0.089	0.0080
2015	350	2,544	-0.050	0.0025
2016	381	2,581	-0.013	0.0002
2017	350	2,544	-0.050	0.0025
2018	315	2,498	-0.095	0.0091
2019	1535	3,186	0.592	0.3509
2020	346.5	2,540	-0.054	0.0029
2021	356	2,551	-0.042	0.0018
2022	504	2,702	0.109	0.0118
Amount	7843.5		46,688	0.5499

X average	435.75	2,594

From the data in Table 6, ∑ (Log Xi-Log X) $^{2 \text{ is obtained}}$ of 0.5499 mm, value Standard Deviation (Sd) 0.179851 and a Log X value of 2.593. Table 7 below provides information on the results of the analysis of rainfall with return periods of 2.5, 10, 20 and 50 years for the frequency analysis of the Log Normal distribution.

Table 7. Analysis of Normal Log Return Period Rainfall

Repeat Period (T)	KT	LOG X	LOG X_T	Sd	Rainfall (X_H) (mm)
2	0	2.593775	2.593775	0.1798511	392.4413
5	0.84	2.593775	2.74485	0.1798511	555.7119
10	1.28	2.593775	2.823984	0.1798511	666.7825
20	1.64	2.593775	2.888731	0.1798511	773.9816
50	2.05	2.593775	2.96247	0.1798511	917.2117

Table 7 shows the results of the analysis with a 50 year return period, with a Log X value of 2.593775, Log X_T 2.96247, and standard deviation (Sd) 0.1798511 produces a maximum rainfall value (X_T) of 917.2117 mm.

Distribution of Log Person III

In the Log Person III distribution, there are parameters that are the core for conducting analysis, namely the mean value, standard deviation and slope. In the Log Person III distribution, if the slope coefficient is equal to zero, then the distribution returns to the Log Normal distribution. The following Table 8 results of the analysis of rainfall distribution of Log Person III.

Table 8. Analysis of Rainfall Distribution Log Person III

Year	Max Rainfall (Xi)(mm)	Log Xi	Log Xi-Log X	$(\text{Log Xi-Log X})^2$	$(\text{Log Xi-Log X})^3$
2005	311	2,493	-0.101	0.0102	-0.001031
2006	375	2,574	-0.020	0.0004	-0.000008
2007	426	2,629	0.036	0.0013	0.000045
2008	165	2.217	-0.376	0.1416	-0.053281
2009	354	2,549	-0.045	0.0020	-0.000090
2010	365	2,562	-0.031	0.0010	-0.000031
2011	369	2,567	-0.027	0.0007	-0.000019
2012	436	2,639	0.046	0.0021	0.000096
2013	423	2,626	0.033	0.0011	0.000035
2014	482	2,683	0.089	0.0080	0.000711
2015	350	2,544	-0.050	0.0025	-0.000123
2016	381	2,581	-0.013	0.0002	-0.000002
2017	350	2,544	-0.050	0.0025	-0.000123
2018	315	2,498	-0.095	0.0091	-0.000870
2019	1535	3,186	0.592	0.3509	0.207826
2020	346.5	2,540	-0.054	0.0029	-0.000158
2021	356	2,551	-0.042	0.0018	-0.000076

2022	504	2,702	0.109	0.0118	0.001283
Amount	7843.5	46,688		0.5499	0.154184
X Average	435.75	2,594			

Information

G : Slope coefficient

For ∑ (Log Xi-Log X) [3] obtained value 0.154184mm, with X mean 435.75 mm, then can calculated n value of slope coefficient (G). Calculation of the value of G using the formula $\frac{n\sum_{i=1}^{n}(Xi-X)^3}{(n-1)(n-2)S^3}$. With the number of years (n) = 18 years, then G = 1.753897; Sd = 0.179851 and Log X = 2.593775.

Table 9 provides information on the results of the return analysis of Log Person III rainfall analysis.

Table 9. Analysis of Return Period Rainfall Distribution of Log Person III

No.	Repeat Period (T)	KT	LOG X	Log X_T	Sd	Rainfall (XT) (mm)
1	2	0.132	2.593775	2.617515	0.179851	414.4910
2	5	0.856	2.593775	2.747727	0.179851	559.4063
3	10	1.166	2.593775	2.803481	0.179851	636.0352
4	20	1,448	2.593775	2.854199	0.179851	714.8241
5	50	1,606	2.593775	2.882616	0.179851	763.1601

Table 9 shows the results of the rainfall analysis, which with a 50-year return period the value of Log X is 2.593775, Log X_T 2.882616, and standard deviation (Sd) 0.1798511. The n value of maximum rainfall (X_T) is 763.1601 mm.

Gumble Distribution

The Gumbel distribution is usually always used to analyze maximum data or extreme data from flood data. The following is Table 10 of the results of the Gumbel distribution rainfall analysis.

Table 10. Analysis of Gumbel Rainfall Distribution

No.	Year	Max Rainfall (Xi)(mm)	(Xi-X)	$(Xi-X)^2$
1	2005	311	-124.75	15562.5625
2	2006	375	-60.75	3690.5625
3	2007	426	-9.75	95.0625
4	2008	165	-270.75	73305.5625
5	2009	354	-81.75	6683.0625
6	2010	365	-70.75	5005.5625
7	2011	369	-66.75	4455.5625
8	2012	436	0.25	0.0625
9	2013	423	-12.75	162.5625
10	2014	482	46.25	2139.0625
11	2015	350	-85.75	7353.0625
12	2016	381	-54.75	2997.5625
13	2017	350	-85.75	7353.0625
14	2018	315	-120.75	14580.5625

15	2019	1535	1099.25	1208350563
16	2020	346.5	-89.25	7965.5625
17	2021	356	-79.75	6360.0625
18	2022	504	68.25	4658.0625
Amount		7843.5		1370718.125

From the maximum rainfall data, the value ∑ (Xi-X) ^{2} = 1370718.125 mm, X mean = 435.75 mm and Sd = 283.955063 are obtained. The return period is carried out at the return period of 2, 5, 10, 20 and 50 years. Table 11 provides information on the results of the Gumbel distribution return period rainfall analysis.

Table 11. Analysis of Gumbel Return Period Rainfall Distribution

Repeat Period (T)	Y_{Tr}	Yn	Sn	X	Sd	K	Rainfall (X_H) (mm)
2	0.3668	0.5035	0.9883	435.75	283,955	-0.138	396.4738
5	1.5004	0.5035	0.9883	435.75	283,955	1.008	722,176
10	2,251	0.5035	0.9883	435.75	283,955	1.768	937.8359
20	3.1993	0.5035	0.9883	435.75	283,955	2.727	1210298
50	3.9028	0.5035	0.9883	435.75	283,955	3.439	1412426

Y_{Tr}, Yn, Sn and K values were obtained from tables sourced from sustainable urban drainage systems (2004). for the 50 year anniversary, the value of Y_{Tr} : 3.9028 ; Yn : 0.5035 ; Sn : 0.9883; and K : 3.439 yields mark bulk Rain maximum (X_H) : 1412.426 mm.

As for the results bulk Rain plan maximum period birthday 2, 5, 10, 20 and 50 years for fourth method analysis frequency shown in Table 12.

Table 12. Summary of Maximum Planned Rainfall Analysis

Birthday Period (T) Years	Normal(mm)	Log Normal (mm)	Log Person III (mm)	Gumbel (mm)
2	435.75	392.4413	414,491	396.4738
5	674.2723	555.7119	559.4063	722,176
10	799.2125	666.7825	636.0352	937.8359
20	901.4363	773.9816	714.8241	1210298
50	1017858	917.2117	763.1601	1412426

From the data in Table 12 it can be seen that the largest value of the maximum planned rainfall analysis is the Gumbel method for the 50 and 20 year return periods with values of 1412,425 mm and 1210,298 mm, while for the Log Person III method the maximum planned rainfall values are recorded in the return period. 50 years is 763.1601 mm. In the Log Normal method 917.2117 mm and Normal 1017.858 mm.

The following Figure 3 represents picture graphs of maximum rainfall and return period for the four methods.

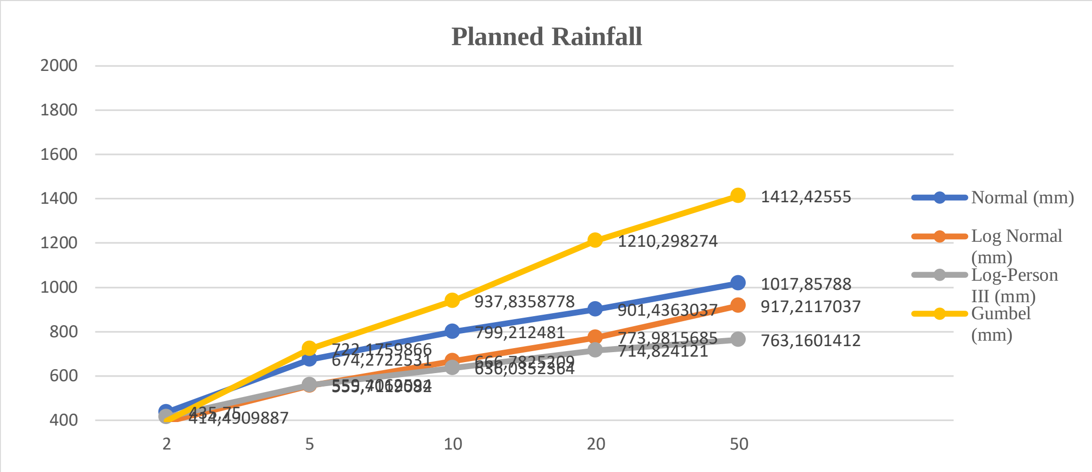

Fig 3. Graph of Maximum Rainfall and Repeat Period

From the graph above it is clear that the 20 and 50 year return period gumbel method has the highest value for the analysis of return period frequency.

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Figure 2 shows that East Binjai sub-district experienced 10 rainy days with a total of 171.42 mm [3.] This data is for events in 2021. When compared to other sub-districts, south binjai and west binjai, the East Binjai sub-district is included in the lowest rainfall group which is almost the same as the data north starlight but larger than city starlight. That way it means that rainfall is not the main cause of flooding in the area, and it is possible that the flooding was caused by inadequate drainage. For this reason, further analysis is needed by calculating the return period with frequency analysis.

Frequency Distribution Analysis

Rain frequency is the probability that the amount of rain will be equaled or exceeded, while the return period is a hypothetical period or time in which rain with a certain amount will be equaled or exceeded. The purpose of frequency analysis is related to the magnitude of extreme events related to the frequency of their occurrence through the application of the probability distribution. The hydrological data analyzed are assumed to be independent and randomly distributed and stochastic ([5] Suripin, 2004). Frequency analysis is usually based on the statistical nature of past event data to obtain the probability of rainfall in the future along with frequency analysis of normal distribution, log normal, log person III and Gumbel.

Normal Distribution

The normal distribution is also called the Gaussian distribution, which has a symmetrical view of the vertical axis and is shaped like a bell ([6] Triatmodjo, 2006). The normal distribution can be written in terms of mean and deviation ([5] Suripin, 2004).

Table 4. Analysis of Normal Distribution Rainfall

Year	Max Rainfall (Xi)(mm)	(Xi-X)	$(Xi-X)^2$
2005	311	-124.75	15562.56
2006	375	-60.75	3690563
2007	426	-9.75	95.0625
2008	165	-270.75	73305.56
2009	354	-81.75	6683063
2010	365	-70.75	5005563
2011	369	-66.75	4455563
2012	436	0.25	0.0625

2013	423	-12.75	162.5625
2014	482	46.25	2139063
2015	350	-85.75	7353.063
2016	381	-54.75	2997563
2017	350	-85.75	7353.063
2018	315	-120.75	14580.56
2019	1535	1099.25	1208351
2020	346.5	-89.25	7965563
2021	356	-79.75	6360063
2022	504	68.25	4658063
Amount	7843.5		1370718

From the data in Table 4, the average daily rainfall is 435.75 mm, with a standard deviation (Sd) of 283.955. For return periods, 2, 5, 10, 20, and 50 year return periods are used as shown in Table 5.

Table 5. Analysis of Normal Distribution Return Period Rainfall

Repeat Period (T)	KT	Xi	Sd	Rainfall (X_H) (mm)
2	0	435.75	283,955	435.75
5	0.84	435.75	283,955	674,272
10	1.28	435.75	283,955	799,212
20	1.64	435.75	283,955	901,436
50	2.05	435.75	283,955	1017.857

Information

KT : Gaussian Reduction Value

Xi : Average Rainfall (mm)

The value of KT in each repeat period is obtained from the Gauss Reduction variable value table ([5] Suripin, 2004). Which here for the largest return period analyzed is the 50 year return period with a Gauss Reduction value of 2.05, an average rainfall of 435.75 mm and Sd 283,955 obtains a maximum rainfall value (X_T) of 1017,857 mm.

Log Normal Distribution

The Log Normal distribution is carried out in almost the same way as the normal distribution, the difference is that the Log Normal distribution will be used if the values of the random variables do not follow the Normal distribution, but the logarithm values meet the normal distribution. The Log Normal distribution is usually described by the mean and standard deviation ([6]Triatmodjo, 2006). The following is Table 6 for the analysis of Log Normal rainfall distribution.

Table 6. Log Normal Distribution Rainfall Analysis

Year	Max Rainfall (Xi)(mm)	Log Xi	Log Xi-Log X	$(\text{Log Xi-Log X})^2$
2005	311	2,493	-0.101	0.0102
2006	375	2,574	-0.020	0.0004
2007	426	2,629	0.036	0.0013
2008	165	2.217	-0.376	0.1416
2009	354	2,549	-0.045	0.0020
2010	365	2,562	-0.031	0.0010
2011	369	2,567	-0.027	0.0007

2012	436	2,639	0.046	0.0021
2013	423	2,626	0.033	0.0011
2014	482	2,683	0.089	0.0080
2015	350	2,544	-0.050	0.0025
2016	381	2,581	-0.013	0.0002
2017	350	2,544	-0.050	0.0025
2018	315	2,498	-0.095	0.0091
2019	1535	3,186	0.592	0.3509
2020	346.5	2,540	-0.054	0.0029
2021	356	2,551	-0.042	0.0018
2022	504	2,702	0.109	0.0118
Amount	7843.5		46,688	0.5499
X average	435.75		2,594	

From the data in Table 6, ∑ (Log Xi-Log X) $^{2\text{ is obtained}}$ of 0.5499 mm, value Standard Deviation (Sd) 0.179851 and a Log X value of 2.593. Table 7 below provides information on the results of the analysis of rainfall with return periods of 2.5, 10, 20 and 50 years for the frequency analysis of the Log Normal distribution.

Table 7. Analysis of Normal Log Return Period Rainfall

Repeat Period (T)	KT	LOG X	LOG X $_T$	Sd	Rainfall (X_H) (mm)
2	0	2.593775	2.593775	0.1798511	392.4413
5	0.84	2.593775	2.74485	0.1798511	555.7119
10	1.28	2.593775	2.823984	0.1798511	666.7825
20	1.64	2.593775	2.888731	0.1798511	773.9816
50	2.05	2.593775	2.96247	0.1798511	917.2117

Table 7 shows the results of the analysis with a 50 year return period, with a Log X value of 2.593775, Log X $_T$ 2.96247, and standard deviation (Sd) 0.1798511 produces a maximum rainfall value (X_T) of 917.2117 mm.

Distribution of Log Person III

In the Log Person III distribution, there are parameters that are the core for conducting analysis, namely the mean value, standard deviation and slope. In the Log Person III distribution, if the slope coefficient is equal to zero, then the distribution returns to the Log Normal distribution. The following Table 8 results of the analysis of rainfall distribution of Log Person III.

Table 8. Analysis of Rainfall Distribution Log Person III

Year	Max Rainfall (Xi)(mm)	Log Xi	Log Xi-Log X	(Log Xi-Log X)^2	(Log Xi-Log X)^3
2005	311	2,493	-0.101	0.0102	-0.001031
2006	375	2,574	-0.020	0.0004	-0.000008
2007	426	2,629	0.036	0.0013	0.000045
2008	165	2.217	-0.376	0.1416	-0.053281
2009	354	2,549	-0.045	0.0020	-0.000090
2010	365	2,562	-0.031	0.0010	-0.000031
2011	369	2,567	-0.027	0.0007	-0.000019

2012	436	2,639	0.046	0.0021	0.000096
2013	423	2,626	0.033	0.0011	0.000035
2014	482	2,683	0.089	0.0080	0.000711
2015	350	2,544	-0.050	0.0025	-0.000123
2016	381	2,581	-0.013	0.0002	-0.000002
2017	350	2,544	-0.050	0.0025	-0.000123
2018	315	2,498	-0.095	0.0091	-0.000870
2019	1535	3,186	0.592	0.3509	0.207826
2020	346.5	2,540	-0.054	0.0029	-0.000158
2021	356	2,551	-0.042	0.0018	-0.000076
2022	504	2,702	0.109	0.0118	0.001283
Amount	7843.5	46,688		0.5499	0.154184
X Average	435.75	2,594			

Information

G : Slope coefficient

For ∑ (Log Xi-Log X) ^{3} obtained value 0.154184mm, with X mean 435.75 mm, then can calculated n value of slope coefficient (G). Calculation of the value of G using the formula $\frac{n\sum_{i=1}^{n}(Xi-X)^3}{(n-1)(n-2)S^3}$. With the number of years (n) = 18 years, then G = 1.753897; Sd = 0.179851 and Log X = 2.593775.

Table 9 provides information on the results of the return analysis of Log Person III rainfall analysis.

Table 9. Analysis of Return Period Rainfall Distribution of Log Person III

No.	Repeat Period (T)	KT	LOG X	Log X_T	Sd	Rainfall (XT) (mm)
1	2	0.132	2.593775	2.617515	0.179851	414.4910
2	5	0.856	2.593775	2.747727	0.179851	559.4063
3	10	1.166	2.593775	2.803481	0.179851	636.0352
4	20	1,448	2.593775	2.854199	0.179851	714.8241
5	50	1,606	2.593775	2.882616	0.179851	763.1601

Table 9 shows the results of the rainfall analysis, which with a 50-year return period the value of Log X is 2.593775, Log X_T 2.882616, and standard deviation (Sd) 0.1798511. The n value of maximum rainfall (X_T) is 763.1601 mm.

Gumble Distribution

The Gumbel distribution is usually always used to analyze maximum data or extreme data from flood data. The following is Table 10 of the results of the Gumbel distribution rainfall analysis.

Table 10. Analysis of Gumbel Rainfall Distribution

No.	Year	Max Rainfall (Xi)(mm)	(Xi-X)	$(Xi-X)^2$
1	2005	311	-124.75	15562.5625
2	2006	375	-60.75	3690.5625
3	2007	426	-9.75	95.0625
4	2008	165	-270.75	73305.5625
5	2009	354	-81.75	6683.0625
6	2010	365	-70.75	5005.5625

7	2011	369	-66.75	4455.5625
8	2012	436	0.25	0.0625
9	2013	423	-12.75	162.5625
10	2014	482	46.25	2139.0625
11	2015	350	-85.75	7353.0625
12	2016	381	-54.75	2997.5625
13	2017	350	-85.75	7353.0625
14	2018	315	-120.75	14580.5625
15	2019	1535	1099.25	1208350563
16	2020	346.5	-89.25	7965.5625
17	2021	356	-79.75	6360.0625
18	2022	504	68.25	4658.0625
Amount		7843.5		1370718.125

From the maximum rainfall data, the value $\sum (Xi\text{-}X)^2$ = 1370718.125 mm, X mean = 435.75 mm and Sd = 283.955063 are obtained. The return period is carried out at the return period of 2, 5, 10, 20 and 50 years. Table 11 provides information on the results of the Gumbel distribution return period rainfall analysis.

Table 11. Analysis of Gumbel Return Period Rainfall Distribution

Repeat Period (T)	Y_{Tr}	Yn	Sn	X	Sd	K	Rainfall (X_H) (mm)
2	0.3668	0.5035	0.9883	435.75	283,955	-0.138	396.4738
5	1.5004	0.5035	0.9883	435.75	283,955	1.008	722,176
10	2,251	0.5035	0.9883	435.75	283,955	1.768	937.8359
20	3.1993	0.5035	0.9883	435.75	283,955	2.727	1210298
50	3.9028	0.5035	0.9883	435.75	283,955	3.439	1412426

Y_{Tr}, Yn, Sn and K values were obtained from tables sourced from sustainable urban drainage systems (2004). for the 50 year anniversary, the value of Y_{Tr} : 3.9028 ; Yn : 0.5035 ; Sn : 0.9883; and K : 3.439 yields mark bulk Rain maximum (X_H) : 1412.426 mm.

As for the results bulk Rain plan maximum period birthday 2, 5, 10, 20 and 50 years for fourth method analysis frequency shown in Table 12.

Table 12. Summary of Maximum Planned Rainfall Analysis

Birthday Period (T) Years	Normal(mm)	Log Normal (mm)	Log Person III (mm)	Gumbel (mm)
2	435.75	392.4413	414,491	396.4738
5	674.2723	555.7119	559.4063	722,176
10	799.2125	666.7825	636.0352	937.8359
20	901.4363	773.9816	714.8241	1210298
50	1017858	917.2117	763.1601	1412426

From the data in Table 12 it can be seen that the largest value of the maximum planned rainfall analysis is the Gumbel method for the 50 and 20 year return periods with values of 1412,425 mm and 1210,298 mm, while for the Log Person III method the maximum planned rainfall values are recorded in the return period. 50 years is 763.1601 mm. In the Log Normal method 917.2117 mm and Normal 1017.858 mm.
The following Figure 3 represents picture graphs of maximum rainfall and return period for the four methods.

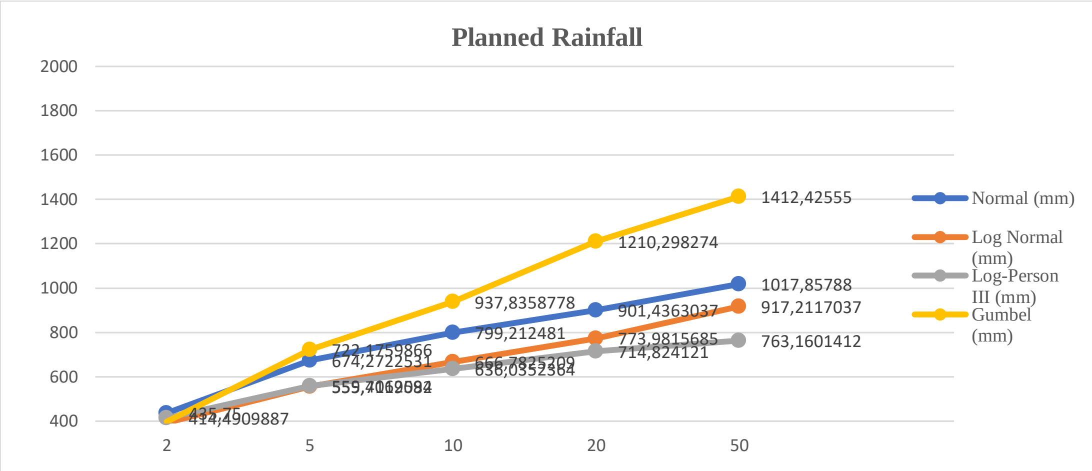

Fig 3. Graph of Maximum Rainfall and Repeat Period

From the graph above it is clear that the 20 and 50 year return period gumbel method has the highest value for the analysis of return period frequency.

4 Conclusion

From study analysis bulk rain on Jalan Soekarno Hatta, District East Binjai, Binjai City can concluded that from fourth method analysis frequency the analysis Gumble method with 50 year anniversary period own mark bulk Rain maximum i.e. 1412.42555 mm. Frequency analysis results fourth method This can tested compatibility with chi square method or the Smirnov-Kolmogorov Test. Where this fit test is useful to determine the best frequency distribution analysis that can be used as a follow-up analysis in planning drainage dimensions. Therefore, it is better to continue the analysis with a fit test to get a match between the distribution of data based on observations and theoretically based data.

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