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Research Paper

Recent Analysis of Maximum Rain Period

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Abstract

Control and Handling of Flood Issues No Regardless of optimum infrastructure availability in flood control efforts such as soil walls, irrigation networks, dams, drainage and others. Planning in the design of water structures for flood control needs to use accurate information and data of the population, such as information on the maximum rainfall data of the area with a certain repetition period, it is necessary to calculate the flood discharge of the plan so that it can calculate the capacity of the dam to be built. This study aims to determine the ratio of maximum rainfall using three calculation methods, namely Iway Kadoya, EJ Gumbel and Log Person III. This research was conducted to get an idea of the maximum rainfall with a return period of 2,5,10,15,20, ... 100 years. The location of this research is conducted in Tualang Subdistrict, the data of the period of maximum rainfall is using the data of rainfall observation station in Tualang Subdistrict. Based on the calculation of rainfall design done can be concluded that the calculation of rainfall design with Iway Kadoya method is greater when compared with Log Pearson Type III and EJ method. Gumbel.

Keywords: *Design of rainfall, return period, Iway Kadoya, log Pearson III, EJ Gumbell methods,.*

1. Introduction

The condition of Indonesia is geographically flanked by two oceans and two continents, its territory is an archipelago. The territory of Indonesia lies between the Asian Continent and the Australian Continent and is flanked by the Indian Ocean and the Pacific Ocean, between the two Northern and Southern hemispheres [1]. Geographically Indonesia has a special nature, extending from west to east between 98oBT-141oBT and 6o-11oLU. Most (70%) of Indonesia is an ocean, while its land area consists of approximately 17500 large and small islands, and generally has a mountainous surface, so Ramage [2] calls it a continent maritime. The condition of the region caused a variety of climate in Indonesia. The diversity of this climate occurs due to differences in geographical location and complex topographic conditions [3]. This difference is evident by the different types of rainfall [4] in this region, ie monsoonal, equatorial and local types [5].

Climate is the most important element of Geography in influencing human life [1]. Climate has an important role in the survival of human life.

The most influential climate parameter in Indonesia is the rainfall. Because Indonesia is a tropical climate. Climatic elements such as rainfall are becoming a much-needed resource for the population. But rainfall is also one source of disaster. The high rainfall causes the area to be vulnerable to floods.

Sea breezes and terrestrial winds also have considerable influence in spatial rain variations, especially in archipelagic and peninsula areas in low latitudes, the sea breeze will increase the tendency of cumulus flares and rain splashes during the day in the region mainland [6].

Topographic factors have an enormous influence on spatial rain variations, especially in siak districts, hilly topography conditions and along the Siak river. This area is prone to flood disasters.

Control and Handling of Flood Issues No Regardless of optimum infrastructure availability in flood control efforts such as soil walls, irrigation networks, dams, drainage and others. Planning in the design of water structures for flood control needs to use accurate information and data of the population, such as information on the maximum rainfall data of the area with a certain repetition period, it is necessary to calculate the flood discharge of the plan so that it can calculate the capacity of the dam to be built.

This study aims to determine the ratio of maximum rainfall using three calculation methods, namely Iway Kadoya, EJ Gumbel and Log Person III. This research was conducted to get an idea of the maximum rainfall with a return period of 2,5,10,15,20, ... 100 years. The location of this research is conducted in Tualang Subdistrict, the data of the period of maximum rainfall is using the data of rainfall observation station in Tualang Subdistrict..

2. Methodology

In this study, the data using this primary data is obtained by way of observation/measurement lang-sung in the field. Whereas sec-ondary data is obtained from related agencies or certain bodies in the form of rainfall data.

2.1. Data analysis

The data has been collected and then processed in a calculation to obtain the results of the research which will be taken the conclu-sion from the purpose of this writing. The way the analysis of this study is:

1. Analyzing the rainfall by taking the maximum rainfall data each year.
2. Analyzing the frequency and probability of rainfall by using 3 methods The calculations used in the field of hydrology are Iway Kadoya, EJ Gumbel and Log Person III for various repetition periods.
3. Mapping the results of the calculation of repeated periods of rainfall for the return period of 50 and 100 annual.
4. Compare the results obtained from the three methods, either graphically or spatially.
5. Giving conclusions and suggestions.

3. Literature Review

Re-period is a term often used in the field of water resources, sometimes understood differently by various parties. The fundamental definition of the statistical hydrology of the "repeat period" (Haan, 1977): "Re-period is the time-lapse of occurrence of an occurrence with a certain magnitude or greater." [7]
Rainfall analysis of available rain data can be used with several methods including Normal, normal log, Iway Kadoya, EJ Gumbel and Log Person III. The following are some of the methods used in this study to analyze the probability of rainfall, ie

3.1. Selection of Spread Type

The determination of the type of distribution is required to find a data set suitable for a particular distribution and not suitable for other distribution. To determine the suitability of a certain type of distribution, need to be reviewed in advance the existing provisions, namely:.

1. Calculate the statistical parameters Cs and Ck, to determine the kind of frequency analysis used.
2. The skewness coefficient (Cs) is calculated by the equation:
3.

$$C_s = \frac{n.\sum(X-\bar{X})^3}{(n-1)(n-2).S^3} \text{..(1)}$$

4. The coefficient of precipitation / curtosis (Ck) is calculated by the equation:
5.

$$C_k = \frac{n^2.\sum(X-\bar{X})^4}{(n-1)(n-2)(n-3).S^4} \text{..(2)}$$

Where :

n = amount of data
$\bar{X}$= mean rainfall data (mm)
S = standard deviation (standard deviation)
X = rain data (mm)

When C s> 1.0: Spreads close to Gumbel distribution
When Cs <1.0: The distribution approaches the distribution properties of Log Normal or Log Pearson III
When Cs = 1.0: The distribution is close to Normal distribution

3.2. Iway Kadoya Distribution method analysis

The calculation of Iway Kadoya is described as follows:

$$\xi = c.\,log\,\frac{x+b}{x_0+b} \text{..(3)}$$

Where :

ξ = frequency factor
c = factor Iway Kadoya

log (xo + b) is the average price of log (xi + b with (i = 1, 2, … n) and is denoted by (Xo, b, c dan xo) estimated from the following formulas:

a. First estimated price of Xo:
Log xo = 1/n ∑ logxi...(3).

b. Estimated price b:
b = 1/m ∑ bi ; m = n/10

$$bi = \frac{xs.xt-xo^2}{2xo-(xs+xt)} \text{..................................(4).}$$

c. Estimated price Xo:
Xo = log (xo +b)
= 1/n ∑ log (xi + b)..(5).

d. Estimated pricec:

$$\frac{1}{c} = c.\sqrt{\frac{2}{(n-1)}\sum \log(\frac{xi+b}{xo+b})^2}$$

$$= \sqrt{\frac{2n}{(n-1)}}.\sqrt{x^2-xo^2}$$

$$X^2 = \frac{1}{n}\sum_{i=1}^{n}\{\log(x_1+b)\}^2 \text{.......................................(6).}$$

Where:

Xs = price of observation with the sequence number (m) of the largest
Xt = price of observation with the sequence number (m) of the smallest
n = number of data
m = n/10 : round number (rounded to the nearest number)

Sometimes if the price of b is so small then to simplify the calculation of the price b can be taken b = 0. If all of these constants have been obtained, then the probable rainfall which is in accordance with the arbitrary probability can be calculated by the formula

:Log (x + b) = log (xo + b) + (1/c) ξ…........………(7)

Calculation steps:

1. The first approximate price of xo and b is obtained by the formula
2. Log (xi + b) it can and lox (xo + b) is obtained by the formula
3. {log (xi + b) is computed and X2 is calculated by the formula
4. Using X2 and Xo2, then 1 / c is calculated by the formula
5. The price ξ corresponding to the more probable possibility in the table and the precipitation may be estimated by the formula.

3.3. Gumbel EJ Distribution Analysis

E.J method equation Gumbell is as follows:

$$X_T = \bar{X} + K - S_d \text{..(8)}$$

Where:

X_T= Variable extrapolated ie the amount of rainfall (mm) of the design for a certain repeat period.
X̄ = Average rainfall price (mm))

$$\bar{X} = \frac{\sum_{i=1}^{n} X_1}{n} \text{...(9)}$$

$$S_d = \sqrt{\frac{\sum_{i=1}^{n}(X_i-\bar{X})^2}{n-1}} \text{..(10)}$$

Where:

Sd = standard deviation
$\bar{X}$= average value (mm)
Xi = value of variant to i
n = amount of data

K = frequency factor which is a function of the return period and frequency distribution type.

To calculate frequency factor E.J. Gumbel Type I used the formula:

$$K = \frac{YT - Yn}{Sn} \qquad (11)$$

Where:

YT = *Reduced variate as a return period function*

T = - Ln [- Ln (T - 1)/T]

Yn = Reduced mean as a function of the number data n

Sn = Reduced standard deviation as a function of the number

Substituting the above three equations is obtained:

$$XT = X + \frac{Sx}{Sn}(YT - Yn) \qquad (12)$$

If :

$$\frac{1}{a} = \frac{Sx}{Sn}$$

$$b = X - \frac{Sx}{Sn}.Yn$$

The above equation becomes:

$$XT = b + \frac{1}{a}.YT \qquad (13)$$

Where :

$$C_s = \frac{\frac{n}{(n-1)(n-2)}\sum_{i=1}^{n}(X-\bar{X})^3}{{S_d}^3} \qquad (14)$$

Where:

Cs = skewness coefficient

X = average value

Xi = value of variant to i

n = amount of data

Kurtosis Coefficient:

$$C_k = \frac{n^2.\sum(X-\bar{X})^4}{(n-1)(n-2)(n-3).{S_d}^4} \qquad (15)$$

Where :

Ck = coefficient of kurtosis

X = average value

Xi = value of variant to i

n = amount of data

3.4 Log Person Type III Frequency Distribution Analysis.

The Pearson Type III Log distribution is the result of the transformation of the Pearson Type III distribution by replacing the data into logarithmic value. The Pearson Log Type distribution equation can be written as follows:

$$LogX_1 = \overline{LogX} + (GxS) \qquad (16)$$

Where:

Xt = The amount of rainfall with period t (mm)

$\overline{LogX}$= Mean of logarithm value of X data of observation result

S = Standard Deviation of logarithm value of data X result

The equations used are:

Average value:

$$\overline{LogX} = \frac{\sum Logx}{n} \qquad (17)$$

Standard Deviation :

$$S_d = \sqrt{\frac{\sum_{i=1}^{n}(logX_i - \overline{logX})^2}{n-1}} \qquad (18)$$

Cs = Skew Coefficient

$$C_s = \frac{n\sum_{i=1}^{n}(logX - \overline{logX})^4}{(n-1)(n-2)(S\overline{logX})^4} \qquad (19)$$

Ck = Coefficient of Kurtosis

$$C_k = \frac{n^2\sum_{i=1}^{n}(logX - \overline{logX})^4}{(n-1)(n-2)(n-3)(S\overline{logX})^4} \qquad (20)$$

3.5. Test of Probability Distribution.

The Probability Distribution Test is intended to determine whether the selected probability distribution equation can represent the statistical distribution of the sampled data analyzed (Kamamiana, 2011). This research uses two testing methods that are a Chi-Square test and Kolmogorov Smirnov test.

3.5.1 Chi-Square Test Method (X^2-test)

This test method examines the size of the difference between the observed and expected frequencies and is used to test the vertical deviation, determined by the equation::

$$X^2Hitung = \sum_{i=1}^{n}\frac{((O_J - E_J))^2}{E_J} \qquad (21)$$

Where :

$X^2Hitung$ = The calculated chi-square parameter counts 2

Ej = observed frequency

Oj = the theoretical frequency of class j (expected frequency

a. The steps in using this type of test are as follows:
b. a. sort the maximum daily rainfall data from the smallest to the largest.
c. b. Determine the chance of maximum daily rainfall price Xt with Weibull probability price (Soetopo, 1996: 12):

$$S_n(X) = \frac{n}{N+1}.100\% \qquad (22)$$

Where:

Sn (x) = probability (%)

n = serial number of data series that has been sorted

N = total amount of data

d. Calculate the Xcr price by determining the significance level α = 5% and with the degrees of freedom calculated using the equation:

$$Dk = K - (P + 1) \qquad (23)$$

information :

Dk = Degree of freedom

P = Parameters bound in frequency aggregation

K = Number of distribution classes

= 1 + (3.322 . log n)

3.5.2. Smirnov-Kolmogorov Test Methodv

This suitability test is used to test the deviation horizontally. Smirnov-Kolmogorof fit test, also called non -parametric test, because the test does not use certain distribution function. This test is used to test the largest deviation between the probability of observation (empirical) and the theoretical opportunities.

This test is performed with several steps as follows:

1. Sort the maximum daily rainfall data from the smallest to the largest

2. Plot the maximum daily rainfall price Xt with the probability price, Sn (x) as in the above equation
3. Tests on the suitability of data by using available tables with parameters the number of data (n), level of trust / significant level (α), and Δcr
4. Calculate the maximum difference value between the theoretical distribution and the empirical distribution with the equation :

$$\Delta maks = |P_0 - P_r| \text{..} \quad (24)$$

Where :

Δmaks = The greatest difference between empirical opportunities with Theoretical

Pe = Empirical Opportunities, using equations from Weibull:

$$P = \frac{m}{N+1} \text{..} \quad (25)$$

m = serial number of events, or event ratings

N = number of observation data

PT = theoretical opportunities from the depiction of the data on the distribution paper (distribution equation) graphically, or using the opportunity calculation facility by the wide area under the normal curve in the Table..

5. Compare the value of Δcr and Δmaks with conditions if:
   Δcr >Δmaks then the distribution is not accepted
   Δcr < Δmaks then the distribution is accepted

4. Results and Discussion

Rainfall data

In this research, rainfall data used is Tualang rainfall station data, rain data that have been obtained is analyzed first to get the average rainfall data. Rainfall data can be seen in Figure1.

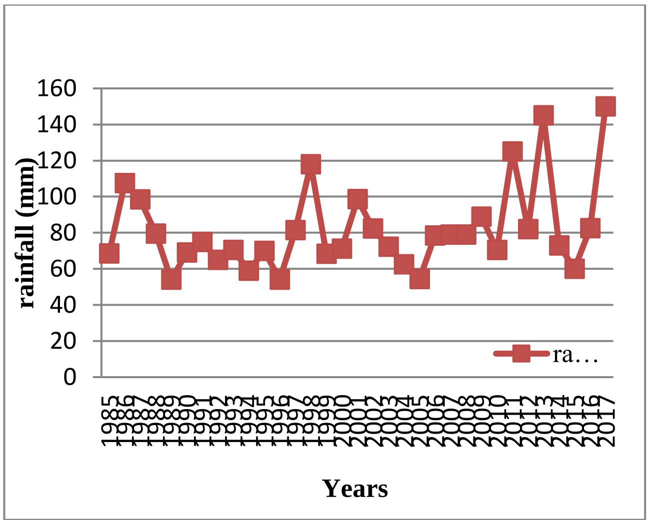

Figure 1. Maximum Daily Rainfall Chart

From Figure 1 it can be seen that the highest rainfall occurred in 2017 with rainfall of 150 mm and the lowest rainfall occurred in 1989, 1996 with 54 mm rainfall

Selection of Spread Type

The determination of the type of distribution is required to find a data set suitable for a particular distribution and not suitable for other distribution. Based on the maximum rainfall data is obtained when the frequency analysis that can be used based on the test requirements Data agitation for the Use of Freon Analysis is Gumbel Distribution, Distribution Log Person II and Iwai Kadoya Distribution.

Analysis of Maximum Rainfall Period

In this study, the maximum rainfall calculation from 1985 to 2017 in Tualang sub-district with a period of 2,5,10,15,20, ... 100 by using Gumbel Distribution method, Log Person II Distribution and Iwai Kadoya Distribution can be seen in table 1.

Table 1: Rainfall Calculation EJ.Gumble Log Person III Design and Iwai Kadoya Distribution No. Probability Time Rainfall Design (mm)

No.	Reader	Probability Time	Rainfall Design (mm)		
	Time	(%)	EJ Gumbel	Log Pearson III	Iwai - Kadoya
1	2	50	77,89	75,85	74,90
2	5	20	101,90	96,45	96,54
3	10	10	117,79	112,20	113,91
4	15	6,667	126,76	119,00	124,74
5	20	5	133,03	126,20	132,78
6	25	4	137,87	133,85	139,21
7	30	3,333	141,80	137,20	144,64
8	35	2,857	145,12	140,64	150,04
9	40	2,5	147,99	144,17	153,40
10	45	2,222	150,51	147,78	156,87
11	50	2	152,77	151,49	160,45
12	55	1,818	154,80	153,31	163,38
13	60	1,667	156,66	155,15	166,38
14	65	1,538	158,37	157,01	168,72
15	70	1,429	159,95	158,90	171,10
16	75	1,333	161,42	160,80	173,53
17	80	1,25	162,80	162,73	176,01
18	85	1,176	164,09	164,69	177,89
19	90	1,111	165,31	166,67	179,80
20	95	1,053	166,46	168,67	181,74
21	100	1	167,55	170,69	183,71

from Table 1 shows the results of calculations using Log Pearson Type III and Iway Kadoya for each return period obtained results that are not much different, while for Iway Kadoya method showed higher results compared with both methods.

The maximum rainfall with high intensity is likely to occur more rarely, for example from the calculation result with the Iway Kadoya method of rain events with intensity of 183,71 mm / day meaning rain with intensity 183,71 mm / day possibly occurrence only once in 100 year period , with an opportunity of 1% (Table 1). Average rainfall period E.J Gumbel, Log Person II and Iwai Kadoya method can be seen in Figure 2.

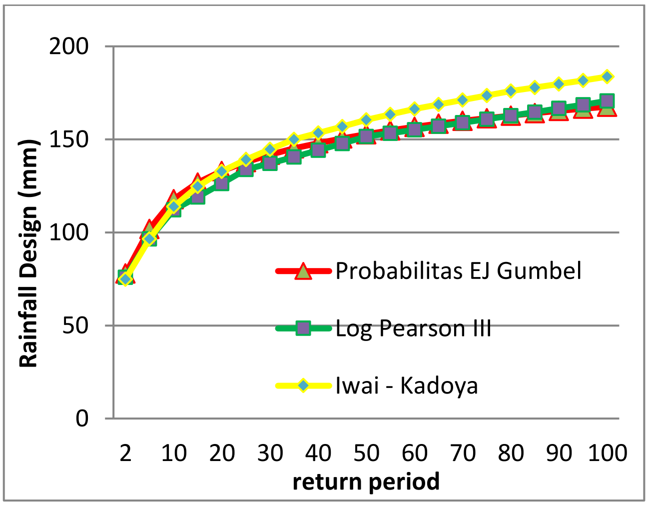

Figure 2. Average Rainfall Grain Chart method E.J Gumbel, Log Person II and Iwai Kadoya

The difference in the value of the larger calculation toward the bigger repeat period can be seen in Figure 2. Based on the results of the calculation of the three methods. EJ.Gumbel method yields

a lower calculation result when compared with calculated value using Log Pearson and Iway Kadoya method.
In order to assess the feasibility of the calculation result with three methods, it is tested the suitability of distribution with significant 5% level with Chi-Square Test and Smirnov-Kolmogorov Test. From the test results than the three methods can be accepted. Thus, when the method can be used for the maximum rainfall period in Tualang District.

5. Conclusions

Based on the calculation of rainfall, the design can be concluded that the result of calculation of rainfall design with Iway Kadoya method is bigger compared to Log Pearson Type III and EJ method. Gumbel.

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