Analysis of Urban Whale Drainage Capability Pekanbaru to the Maximum Intensity of Rainfall

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Abstract. Drainage becomes an essential tool in an urban area. A city can be said neat and orderly if its drainage facility can accommodate any existing water discharge, either from rain or the flow of household disposal. Jalan Pope Pekanbaru is the connecting road between Tuanku Tambusai road and Arifin Achmad street. Pope road condition is very strategic then Pope street becomes one of business area in Pekanbaru. This study aims to determine the capacity of the drainage channel of the city of Pekanbaru whales against the intensity of rainfall in the city of Pekanbaru. The method used is direct survey sampling to the field then analysing precipitation, frequency and probability of rain by using four types of distribution used in the field of hydrology that is Normal Distribution, Normal Log Distribution, Log Person Distribution III and Gumbel Distribution type 1, rain intensity with mononobe method. Because short-term data is not available, Calculates the discharge plan and the drainage channel. Based on the results of the 5-year Planet Bit Flow analysis using the Gumbel type 1 method of 247.53 m / s, the flow of existing drainage (Q) is 0.6245 m / sec, while the peak flood flow (Qp) is m / seconds

Keywords: Intensity of rainfall, flood discharge

1. Introduction

Drainage becomes an essential tool in an urban area. A city can be said neat and orderly if its drainage facility can accommodate any existing water discharge, either from rain or the flow of household disposal. Proper drainage should have no garbage, water flow is smooth and does not overflow when it rains. Drainage conditions like this are rarely found in Pekanbaru City. Most drainage in Pekanbaru City is currently a lot of garbage and also often overflowing. One flow drainage that experienced problems in the flow of water is along Jalan Paus Pekanbaru. At the time of the rainy season at some point there is a blockage so that the drainage does not flow smoothly, this is caused by the amount of plastic waste contained in it. Also, the rarity of this drainage is carried out by the government as the responsible party to create the garbage in this drainage to accumulate. Also, the traders who close the drainage for access to the street to sell also cause the drainage is clogged. When the heavy rains of wastewater contained in this drainage overflowed up to the highway (Tribun pekanbaru, 2016). Improper management of household wastewater is one of the factors causing slums in an urban area, where it should be a separate household waste water drainage system with environmental drainage channels (Putri, 2018).

Street Paus Pekanbaru is a connecting road between Tuanku Tambusai road and Arifin Achmad street. Street Paus condition is very strategic then Pope street becomes one of business area in Pekanbaru. Therefore the Pope's path became one of the select investors to invest, and this is evidenced along the way Pope many shops, supermarkets, housing, gas stations, hotels and others. Systematically increasing population density, the volume of water passing through the water channel
also increases because of the reduced water absorption area. The actual channel width is 0.6 m wide, 0.8 m high, 0.2 m full guard with right straight irregular channel type. Due to the development of the most affected areas is the drainage planning, among others, is the amount of rainfall intensity in the drainage area and how the land use in the drainage area. If we know the intensity of large rainfall and small absorption area, then the drainage dimension is planned more significant and vice versa.

Analysis of rainfall data is intended to obtain the quantity of rainfall and statistical analysis required in the calculation of the design debit. The rainfall data used for the design debit calculation is the rain that occurs in the water flow area at the same time. The rainfall required for the preparation of a water use design and flood control design is the average rainfall in the entire area concerned, not rainfall at a particular point. This rainfall is called rainfall area and expressed in mm (Sosrodarsono, 2003). Control and Handling of Flood Issues No Regardless of maximum 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 region with a specified repetition period, it is necessary to calculate the flood discharge plan so that it can calculate the drainage capacity to be built (Soehardi, 2018). This study aims to determine the capacity of the drainage channel of the city of Pekanbaru whales against the intensity of rainfall in the city of Pekanbaru.

2. The Review

In drainage channel planning the return, the period is used depending on the channel function and the rain catching area to be dried. In general, the use of the re-planning period for Channel channel is one year return period; the tertiary channel is two year return period, secondary channel is five year return period, the primary circuit is ten year return period.

The pre-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.” Analysis of rainfall distribution from available rain data can be done by several methods such as Normal Distribution, Normal Log Distribution, Pearson III Log and Gumbel Distribution Type1. The following are some of the distributions used in this study to analyse the probability of discharge planning, ie.

**Normal Distribution:** In normal hydrological distribution, analysis is often used to analyse the frequency of rainfall, statistical analysis of the distribution of annual rainfall, average annual discharge. Normal distribution or normal curve is also called a Gauss distribution.

**Log Method Normal:** Standard Log Distribution, is the result of the transformation from a Normal distribution, that is by convert variant $X$ into X variant logarithmic value. The formula used in the calculation of this method is as follows:

$$Y_t = \bar{X} + K_t \cdot S_x$$

Where,
- $X_t$ = the amount of rainfall that may occur in the return period $T$ year (mm / day)
- $\bar{X}$ = Average Rainfall observation result (mm / day)
- $S_x$ = Standard deviation
- $K_t$ = Standard variable for birthday period

**Gumbel Distribution Type I:** is used for maximum data analysis, eg for flood frequency analysis

**Pearson Log Distribution Type III:** Gumbel Distribution Type III Used in the hydrological analysis, especially in the review of maximum data (flood) and minimum (minimum discharge) with extreme
values. The form of distribution of Pearson Log type III is the result of the transformation of Pearson type III distribution by substituting variant to logarithmic value. Log distribution of Pearson III has a coefficient of skewness or $C_s \neq 0$. After selection of spreading type is made then the next procedure is to look for rainfall plan of return period 2, 5, 10, 25, 50, and 100 years (Soewarno, 1995).

**Rainfall Intensity:** The intensity of rainfall is the height of rainfall that occurs at a time when the water concentrates. This rainfall intensity analysis can be processed from rainfall data that has occurred in the past. According to Dr Mononobe if the existing rainfall data is only daily rainfall.

**Design Debit With Rational Method:** Debit plans for urban areas are generally desirable for immediate drainage of water, to avoid significant water puddles. To fulfil this purpose, the channels must be made sufficiently to the design debit.

3. **Method**

In this study the data using this primary data obtained by way of observation / direct measurement in the field of street whales Pekanbaru. While secondary data collected from related agencies or certain bodies in the form of rainfall data.

The method used is survey direct sampling to the field and then collected by analyzing rainfall by taking the maximum rainfall data each year, explaining the frequency and probability of precipitation by using four types of distribution used in the field of hydrology that is Normal Distribution, Log Distribution Normal, Distribution Log Person III and Gumbel kind of distribution 1. Conduct calculation of rain intensity with mononobe method. This is because short-term data is not available, only maximum daily rainfall data. Calculate the area of the puddle/flood area. Calculate the discharge plan, which is the sum of the discharge of rainwater with the release of dirty water. Calculate the drainage channel drainage. Then analysed whether the drainage channel capacity is enough to accommodate the discharge plan or not. If not, it is necessary to plan a new drainage channel to obtain conclusions and suggestions.

4. **Result and discussion**

In this research, rainfall data used is Pekanbaru Pekanbaru station rainfall data, rain data that has been obtained is analysed first to get the average rainfall data. Rainfall data can be seen in Figure 1.

![Figure 1. Maximum Daily Rainfall Pekanbaru](image)

From Figure 1 above, the average rainfall data for the city of Pekanbaru is 213.37 mm
4.1 Analysis of frequency and probability of rainfall

In this study, the calculation of rains is done by ranking first rainfall data from 2012 to 2016 from the most significant data to the smallest. From the calculation results obtained the value of the frequency of rainfall using Normal distribution method, lognormal, Log Pearson Type III and Gumbel Type I. For the return period of 2.5, 10, 25, 50 and 100 years for the four methods can be seen from in table 1 below:

| No | Tahun | \( \bar{x} \) | Sx | Distribution Normal | Log distribution Normal | Distribution Pearson Type III log | Distribution Gumbel Type I |
|----|-------|---------|----|---------------------|------------------------|-----------------------------|------------------------|
| 1  | 2     | 213,37  | 32.29 | 0.00                | 213.37                 | 213.37                      | 208.99                 |
| 2  | 5     | 213.37  | 32.29 | 0.84                | 240.49                 | 240.49                      | 247.53                 |
| 3  | 10    | 213.37  | 32.29 | 1.28                | 254.70                 | 254.70                      | 273.04                 |
| 4  | 25    | 213.37  | 32.29 | 1.71                | 268.58                 | 268.58                      | 292.31                 |
| 5  | 50    | 213.37  | 32.29 | 2.05                | 279.56                 | 279.56                      | 306.66                 |
| 6  | 100   | 213.37  | 32.29 | 2.33                | 288.60                 | 288.60                      | 321.49                 |

Based on table 1 shows that From the above four methods obtained maximum rainfall frequency value is using Gumbel Type I method.

4.2 Analysis of rainfall intensity

To determine the concentration of rainfall using Dr Mononobe if the existing rainfall data is only daily rainfall. In this research, the maximum rain used is five years period rainfall from Gumbel type I method that is 247,530 mm/sec = 18,477 mm/hr

4.3 Design Debit With Rational Method

Debit plans for urban areas are generally desirable for quick drainage, the magnitude of design debits can be calculated = 1.724m³/second

4.4 Channel Debit Analysis

The existing channel discharge has a square-sectional cross section:

From the above drainage section it can be seen that : b = 0.6 m , h = 0.8 m , High Cycle = 25% h = 0.25x 0.8 = 0.2 m , roughness number (n) type of rock channel, straight irregular in good condition = 0.030 , basal slope = 0.005 , rectangular cross section means talud t = 1: 1, so b = h , Area of cross section (A) = , Wet circumference (P) = 3h , Hydraulic radius (R) = 0.333h.
Flow rate = 0.9765 m/sec
Existing drainage debit = 0.625 m$^3$/sec

Channel Debit Analysis Plan

The existing channel discharge has a square-sectional cross section:

![Figure 3. Drainage section to be planned](image)

From the above mentioned drainage section it can be seen that: $b = 0.8$ m, $h = 1.2$ m, High Cycle = 25% , $h = 0.25 \times 1.2 = 0.3$ m, Roughness (n) type of rock channel, straight irregular in good condition = 0.030 , Tilt base line = 0.005 , rectangular cross section means talud t = 1:1, so $b = h$ , cross section $(A) =$, Wet circumference $(P) = 3h$, Hydraulic radius $(R) = 0.333h$

Flow rate = 1.2796 m$^3$/sec
Debit Drainage Plan = 1.43 m$^3$/sec

From the above calculation, it is found that the flow of existing drainage flow (Q) is 0.6245 m/sec, while the peak flood flow (Qp) is 1.428 m/sec, so it can be estimated that the blood flow cannot be accommodated by drainage channel capacity there is. So it can be re-planned with a larger drainage size than the previous drainage.

5. Conclusion

Based on the results of the Flood Flood Analysis Plan (Q) 5 years using Gumbel method the author made as a debit comparison to determine the channel function. The current drainage flow discharge (Q) is 0.6245 m/sec, while the peak flood flow (Qp) is 1.428 m/sec, so it can be estimated that the existing drainage capacity can not accommodate the blood flow. It is necessary to change the size of the drainage section from 0.8 m width to 1.2 m. Another solution is that residents still maintain cleanliness and perform work every month to clean up the sediment and garbage in the channel.

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