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Drainage Channel Evaluation and Budget Plan for Sumeith Pasinaro – Watui Road Section, West Seram Regency

Hamkah[1], Sulastry Kakaly[2], Alfredo Yefta Hattu[3]

1, 2, 3 Civil Engineering Department, Ambon State Polytechnic, Ambon, Indonesia

Corresponding Author Email: aldohattu@gmail.com

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ABSTRACT

The drainage channel on the sumeith pasinaro - watui road section which certainly affects activities in this area because of frequent landslides that cause inundation and runoff, so that the drainage channel cannot accommodate rainwater discharge. In the evaluation of the drainage channel of the sumeith pasinaro - watui road section, the aim is to find the runoff discharge, to be able to plan the dimensions of the channel and then analyze how much budget is needed in the evaluation of the drainage channel. The research method used is the method of collecting and analyzing data used is primary data and secondary data which is then analyzed using the Log Person III and Gumbel methods based on hydrological and hydrological analysis then evaluating the existing channel with the amount of discharge plan then estimating the cost budget plan with AHSP 2022. Based on the results of the calculation of runoff discharge on the Sumeith Pasinaro - Watui road section is 0.337 m³ / sec and for channel discharge is 0.066 m³ / sec so it is found that the drainage channel cannot accommodate runoff discharge. So that in the re-planning of drainage dimensions with a length of 250 m, a channel top width of 2 m, a channel bottom width of 1.5 m, and a channel height of 1.1 m with a channel discharge of 0.372 m³/det it is found that the new channel dimensions can accommodate runoff discharge. And the value of the Cost Budget Plan based on the new dimensions amounted to IDR. 492.594.000.00

1. INTRODUCTION

The Sumeith Pasinaro - Watui village road is a road section located in Elpaputih District, West Seram Regency. The Sumeith Pasinaro - Watui Village road was built with the aim of facilitating access to travel from Sumeith Pasinaro village to Watui village and connecting other mountain villages in Elpaputih District, West Seram Regency or vice versa has not been functioning properly. The drainage channel on the road section on the Sumeith Pasinaro - Watui section that occurs certainly greatly affects transportation activities.

Damage to the drainage channel is caused by erosion at the bottom of the channel and also a channel covered by an avalanche as high as 60 cm. points that experience problems such as damage to drainage channels include channel can be seen in Figure 1 dimensions at STA 00 + 950 with a channel length of 250 m, channel height of 0.8 m, channel top width of 1.2 m and channel bottom width of 0.70 m which cannot accommodate water discharge especially in the rainy season and also sediment that is clogged in drainage channels which causes drainage to not function properly.

In overcoming inundation and runoff, the solution needed is to evaluate the channel and then follow it with a re-planning of the appropriate drainage cross-sectional dimensions to create comfort for local residents, In addition, it is also necessary to calculate the Budget Plan (RAB) on the dimensions of the drainage channel as an estimate for the relevant agencies in order to renovate the drainage channel.

Figure 1. Scouring of drainage channels

2. LITERATURE RIVIEW

2.1. Definition of Drainage

Drainage is a system created to address the problem of excess water, both above ground and below ground. Excess water can be caused by high rain intensity or long duration of rain. In general, drainage is defined as the study of efforts to drain excess water in an area [1]. Drainage is the conveying, draining, disposing of, or diverting of water. In general, drainage is defined as either [2].

2.2. Purpose of Drainage

Drainage has an important purpose in its development, which is to reduce and remove excess water from an area so that the land can function optimally in accordance with its use.

2.3. Hydrological Cycle

Hydrology is the study of the intricacies and travel of water on the earth's surface. Hydrology is studied by people to solve water-related problems, such as water management, flood control, and waterworks planning. Hydrology is usually reserved more for inland water problems. This means that hydrology is usually not intended for calculations that have to do with sea water [3].

Runoff discharge is the volume of rainwater per unit time that does not experience infiltration so that it must be drained through drainage channels. The coefficient used as a parameter is part of the rainwater that must be channeled through the drainage channel because it does not experience absorption into the soil (infiltration). to calculate the discharge of rainwater runoff using the rational method, can be calculated using the equation (1):

$$Q = 0.278\ C\ I\ A \quad (1)$$

2.4. Hydraulics Analysis

The hydraulics analysis consists of analyzing the cross section of the natural river, calculating the concentration time, rainfall intensity, water flow discharge and planning the dimensions of the new channel with reference to the calculation data. The results of the dimensions are then drawn compared to the dimensions of the natural channel, and then conclusions can be drawn. From the conclusion, suggestions can be given from the study and planning to be followed up into a channel that can accommodate water discharge [4].

In drainage plans, the uniform flow formula is used, assuming that the permanent water velocity is continuous throughout the break [5].

2.5. Types of Cross Sections

There are 4 generally recognized types of naming:

1. Trapezoidal Shape
   This form serves to accommodate and channel rainwater runoff that has a large discharge.
2. Square Shape
   Accommodating and channeling rainwater runoff with a large discharge is the main function of this square-shaped water channel.
3. Triangular Shape
   Triangular channels are only used in certain conditions only to accommodate and channel rainwater runoff with a small discharge.
4. Semicircular shape
   This form of channel only serves to channel rainwater waste that has a small discharge.

2.6. Channel Dimension Calculation

As for the equation in calculating channel dimensions, you can use the manning formulation method, can be expressed by equation (2):

$$A \left[\frac{1}{n}\right] \left[\frac{(b+mh)h}{b+2h\sqrt{1+m^2}}\right]^{2/3} . S^{1/2} \quad (2)$$

Description:

$$V = 1/n.\ R^{\frac{1}{2}}.S^{\frac{2}{3}} \quad (3)$$

$$Q = A.V = A(1/n\ .R^{\frac{1}{2}}.\ S^{\frac{2}{3}}) \quad (4)$$

$$R = A/P \quad (5)$$

$$A = (b+mh)h \quad (6)$$

$$P = b+2h\sqrt{1+m^2} \quad (7)$$

2.7. Frequency Analysis

Frequency analysis is a statistical analysis, namely by looking at past rainfall data which will be calculated by probability analysis to determine the possibility of future rainfall so that drainage design can be planned properly which is expected to accommodate rainwater in the future. Analysis of rainfall frequency and planned rainfall discharge with several different time periods (return period) with a range of 1 - 50 years) [6]. The methods used are Gumbel Distribution, and Log Person type III.

2.8. Chi - Square Distribution Test

Chi-square or chi squared is a type of non-parametric comparative test performed on two variables, the data scale of the two variables is nominal or ordinal. The chi squared test can be calculated in equation (8):

$$X^2 = \sum_{i=1}^{G} \frac{(\mathrm{Of}-\mathrm{Ef})^2}{Ef} \quad (8)$$

2.9. Cost Budget Plan (RAB)

RAB or short for Cost Budget Plan is the science of estimating the costs required for each activity in a construction project to obtain the total amount of costs that will be required for work completion [7].

3. METHODOLOGY

3.1 Research Location

The research location as shown in Figure 2 is located on the Sumeith Pasinaro - Watui Road Section, Elpaputih District, West Seram Regency, Maluku Province at STA 00+950.

Figure 2. Research location

3.2 Data collection and analysis

In general, data collection is obtained directly from the research site and from various reading literature, the data collected is divided into: (1) primary data: existing data of drainage channels, land use, topography, (2): rainfall data and basic price.

Data collection techniques are carried out by directly observing the research location, in this case the researcher obtains direct data or information, and library techniques, which are carried out by reading, reviewing and recording various literature or reading materials that are in accordance with the subject matter. In this study there is an analysis used to calculate runoff discharge, planning the dimensions of the drainage channel, and calculating the cost budget plan (RAB) of the channel.

3.2.1 Evaluation of drainage channels using the : Normal, log normal, log person type III, and gumbel.
3.2.2 The distribution suitability test was chosen using : Chi-square test method
3.2.3 Calculating the cost budget plan (RAB) with the AHSP 2022 method

4. RESULTS AND DISCUSSION

4.1 Hydrological Analysis

The rainfall data used is daily rainfall data for 10 years (2014 - 2023) obtained from BWS Maluku Province. From the results of the calculation of statistical parameters, it will be concluded that what distribution is suitable for the data.

Maximum rainfall in the last 10 years can be seen in the table below with the highest rainfall in 2022 with maximum daily rainfall of 309.4 mm can be seen on Table 1.

Table 1. Maximum rainfall data

NO	YEAR	CH MAXIMUM
1	2014	100.1
2	2015	100.1
3	2016	78.5
4	2017	107
5	2018	114
6	2019	95
7	2020	125.9
8	2021	121.3
9	2022	309.4
10	2023	135.7

4.2 Frequency analysis

Using the maximum rainfall, a frequency analysis was conducted to determine the likelihood of rainfall with future return period values. By finding the average value, standard deviation, coefficient of variation, skewness, and kurtosis. Then based on the conditions obtained, the method for determining the value of the return period is the log person type III and Gumbel method.

Table 2. Analysis of planned rainfall using Log Person Type III distribution

Return period (Y) year	Kt	Log XT	XT (mm)
2	-0.319	2.026	106.054
5	0.592	2.172	148.477
10	1.293	2.284	192.446
25	2.230	2.435	272.081
50	2.941	2.549	353.960
100	3.655	2.664	460.905

Based on Table 2 obtained rainfall for a period of 2 years - 100 years using the log person type III method.

Table 3. Analysis of planned rainfall using Gumbel distribution

Return period (Y) year	YTR	K	XT (mm)
2	0.3065	0.844	184.092
5	1.4999	2.101	266.547
10	2.2504	2.891	318.401
25	3.1255	3.813	378.864
50	3.9019	4.630	432.508
75	4.3117	5.062	460.822
100	4.6001	5.366	480.748

Based on Table 3 obtained rainfall for a period of 2 years - 100 years using gumbel method.

4.3 Chi – square test

Based on the chi-squared distribution test using maximum rainfall, the chi-squared test results for the log person type III method $X^2 = 7$, while the gumbel method $X^2 = 11$.

Table 4. Chi – square test results

Frequency Distribution	X2	X2cr
Log Person III	7	7.378
Gumbel	11	7.378

4.4 Runoff discharge analysis

Channel calculation

Channel length: 250 m

Channel bottom slope: 0.002 m/m

4.4.1 Calculating the drainage area (A)

$A_{total} = A1 + A2$

$= 1100\ m^2 + 25000\ m^2$

$= 26100\ m^2$

$= 0.0261\ km^2$

4.4.2 Rain Intensity

To calculate the estimated concentration time, Kirpich's empirical formula can be expressed by equation (9):

$$Tc = 0.0195\ L^{0,77}.\ S^{-0,385} \quad (9)$$

$$Tc = 0.0195\ 250^{0,77} \times 0.002^{-0,385}$$

$$= 15 \text{ minutes}$$

After getting the concentration time, the next step is to calculate the rain intensity can be expressed by this equation (10):

$$I = \frac{R_{24}}{24}\left(\frac{24}{T_c}\right)^{2/3} \quad (10)$$

$$I_{10} = \frac{192{,}446}{24} \times \left(\frac{24}{15/60}\right)^{2/3} = 168{,}117 \text{ mm/ hours}$$

4.4.3 Determining the coefficient value (C)

The value of the conveyance coefficient is known based on observations at the research location, determined based on the character of the land surface in the observed area, namely land use conditions based on Table 5.

Tabel 5. Table coefficient C

No	Land description/surface character	Coefficient C
1	**Pavement** Asphalt and Concrete	0.70 – 0.90
2	**Park, Cemetery Forest**	0.10 – 0.25

Coefficient can be expressed by equation (11):

$$C = \frac{C1xA1 + C2xA2}{A1+A2} \quad (11)$$

$$C = \frac{0.9\ x\ 1100 + 0.25\ x\ 25000}{1100+25000}$$

$$= 0.277$$

4.4.4 Run off discharge calculation

$Q = 0.278\ C\ A\ I$

$= 0.278 \times 0.277 \times 0.0261 \times 168.117$

$= 0.337\ m^3/det$

4.5 Analysis of existing channel discharge

Channel calculation

$A = (B + mh)h$
$= (0.70 + 1 \times 0.6) \times 0.6$
$= 0.780\ m^2$

$P = B + 2h\sqrt{1+m^2}$
$= (0.70 + 2 \times 0.6 \times \sqrt{1+1^2}$
$= 2.397$ m

$R = A/P$
$= 0.780/2.397$
$= 0.325$ m

$V = \frac{1}{0.25} \times R^{2/3} \times S^{1/2}$
$= \frac{1}{0.25} \times 0.325^{2/3} \times 0.002^{1/2}$
$= 0.08463$ m/sec

$Q_s = A \times V$
$= 0.780 \times 0.08463$
$= 0.06601\ m^3/sec$

Difference between channel discharge and runoff discharge

Q check = Q runoff - Q channel
= 0.337 – 0.066
= $0.271\ m^3/sec$

It is known that the channel discharge capacity is smaller than the plan discharge ($Q_{ah} > Q_s$). So that the right type of cross section is needed in order to accommodate the discharge of water flow.

4.6 New drainage channel plan

New channel dimensions:

B = Channel bottom width (m)
= 1.5

h = Water level (m)
= 1.1

m = sloping side of the channel (m)
= 1

$A = (B + mh)h$
$= (1.5 + 1 \times 1.1) \times 1.1$
$= 2.860\ m^2$

$P = B + 2h\sqrt{1 + m^2}$
$= (1.5 + 2 \times 1.1 \times \sqrt{1+1^2}$
$= 4.611$ m

$R = A/P$
$= 2.860/4.611$
$= 0.620$ m

$V = \frac{1}{0.25} \times R^{2/3} \times S^{1/2}$
$= \frac{1}{0.25} \times 0.620^{2/3} \times 0.002^{1/2}$
$= 0.130$ m/sec

$Q_s = A \times V$
$= 2.860 \times 0.130$
$= 0.372\ m^3/sec$

Difference between Runoff Discharge and Plan Discharge
Q check = Q Plan - Q runoff
New Channel = 0.372 – 0.337 = 0.035 m^3/sec …….Ok
From the above analysis, it is known that the new cross-sectional dimensions can accommodate runoff discharge in Figure 3.

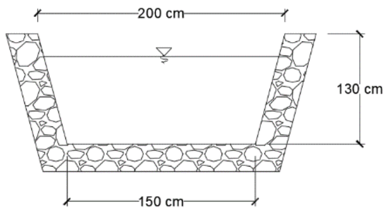

Figure 3. New channel dimensions

4.7 Cost Budget Plan (RAB)

Table 6. Quantity and price list

Description	Unit	Estimated quantity	Total price (IDR)
Excavation for drainage ditches and waterways	M^3	787.50	41.128.916,11
Stone masonry with mortar	M^3	218.75	420.649.790,77

Based on Table 6. obtained a total estimated price of IDR. 443.778.706.88 for drainage work.

Table 7. Recapitulation of estimated price of work

No. Division	Description	Total Price of Work (IDR)
3	Drainage	443.778.706,88
(A) Total Price of Work (including General Costs and Profit)		443.778.706,88
(B) Value Added Tax (VAT) = 11% x (A)		48.815.657,76
(C) Total Work Price = (A) + (B)		492.594.364,64
(D) Circulated		492.594.000,00
Amount: Four hundred ninety two million five hundred ninety four thousand rupiahs		

Based on Table 7, the total budget plan for the drainage channel work for the Sumeith Pasunaro - Watui road section is IDR. 492.594.000.00.

Channel length = 250 m
Channel width = 1,5 m
Channel height = 1,1 m
Budget Plan Cost/m $= \frac{\text{total cost}}{channel\ length}$
$= \frac{492.594.000.00}{250\text{ m}}$
= IDR 1.970.376.00

5. CONCLUSION

Based on the results of research and discussion regarding the Evaluation of the Sumeith Pasunaro - Watui Road Drainage Channel, it can be concluded as follows: Based on the calculation obtained water runoff discharge of 0.337 m^3 / second. Then for the dimensions of the drainage channel plan with a length of 250 m, the dimensions are obtained: the top width of the channel is 2 m, the width of the channel base is 1.5 m and the channel height is 1.1 m. and based on the calculation of the cost budget plan (RAB) the costs incurred for the construction of a drainage channel with a length of 250 m amounted to IDR. 492.594.000.00.

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NOMENCLATURE

A	channel wet cross-sectional area (m^2)
B	channel bottom width (m)
h	water height in the channel (m)
m	channel slope (m)
P	wet cross-sectional area (m)
Qs	channel discharge (m^3)
R	hydraulic radius of the channel (m)
S	channel bed slope (m/m)
V	flow velocity (m/sec)
A_{total}	drainage area (km^2)
C	runoff coefficient
Tc	concentration time (minutes)
I	rainfall intensity (mm/h)
Q	debit plan (m^3)
X^2	chi-square value