Damage Assessment of Flood Safety Embankment of Das Larike, West Leihitu Sub-District, Central MalukuDistrict

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Abstract

Rivers are places and containers as well as water flowing networks starting from springs to estuaries with limited right and left and along its flow by border lines. The river can also be interpreted as part of the earth's surface which is lower than the surrounding land and becomes a place for fresh water to flow into the sea, lake, swamp or to another river. Flooding is an event where land that is usually dry (not a swamp area) becomes inundated by water, this is caused by high rainfall and the topographic conditions of the area in the form of lowlands to concave. Almost every year, precisely in the rainy season, floods occur in several areas in the West Leihitu District, Central Maluku Regency. The research objective to be achieved is to obtain the level of damage to the flood safety embankment in order to obtain a discharge and Budget Plan for the construction of a 200 meter long embankment in the Larike watershed. The methods used are Polygon Thiessen Method, Gumbel Scatter Method, Dr. Mononobe Method, Haspers Method and Levee Damage Analysis. From the calculation study it can be concluded that the damage to the Larike watershed flood safety embankment is at a value of 37.88% then the value of the physical condition of the damage level is 21-40% (moderately damaged), the results of the calculation of the planned flood discharge Q = 534.82 m3 / sec based on the results of the calculation of the cost budget plan of Rp 1,085,137,000.00 (One Billion Eighty Five Million One Hundred Thirty Seven Thousand Rupiah).

Keyterms: Flood, Levee Damage, Discharge, Cost Budget Plan

I. INTRODUCTION

Flooding has become a classic problem in Maluku in general and more specifically in Larike Village, West Leihitu District, Central Malulu Regency. Almost every rainy season, the overflow of water in the Larike watershed always inundates several areas, especially the areas around the river. With this condition, the floods that occur will be enough to disrupt existing life activities. As well as causing material losses for residents. Because flood inundation due to local rains that cause annual floods has an inundation time of two to three days as a result, economic activities are disrupted. To avoid this, river improvement and maintenance are needed, so that it can utilize the river as a drain efficiently. Flooding in the Way Hatu River often occurs because the flood discharge is greater than its capacity. In general, storage is reduced due to fluvial sedimentation on the riverbed which causes the storage to be small, so that flood water eventually overflows. There are also floods caused by the increased discharge, without sedimentation, flooding will still occur. The purpose of planning the Larike watershed flood embankment is to reduce inundation in areas where water overflow occurs, so that losses due to flooding can be reduced. The goal is to increase the capacity of the Larike watershed so that overflows do not occur and are carried out in various ways, namely by improving the cross section, planning embankments, raising existing embankments, planning concrete parapets and strengthening slopes or cliffs that are prone to landslides.

Flooding is defined as the inundation of a place due to the overflow of water that exceeds the capacity of water disposal in an area and causes physical, social and economic losses. Flooding is a seasonal threat that occurs when a body of water overflows from an existing channel and inundates the surrounding area. Floods are the most frequent natural threat and the most costly in terms of both humanity and economy (IDEP, 2007).

Flooding is an event where land that is usually dry (not swampy areas) becomes inundated by water, this is caused by high rainfall and topographic conditions in the form of lowlands to concave areas. In addition, the occurrence of flooding can be caused by surface water runoff (runoff) that overflows and its volume exceeds the drainage capacity of the drainage system or river flow system. The occurrence of floods is also caused by the low infiltration ability of the soil, causing the soil to no longer be able to absorb water. Floods can occur due to rising water levels due to above-normal rainfall, temperature changes, levees/dams that collapse, rapid snowmelt, obstruction of water flow elsewhere.

According to Kodoatie and Sugiyanto (2002), the factors that cause flooding can be classified into two categories, namely natural flooding and flooding by human actions. Natural floods are influenced by rainfall, physiography, erosion and sedimentation, river capacity, drainage capacity and the influence of tides. Whereas flooding due to human activities is caused by human actions that cause environmental changes such as changes in the condition of the watershed, residential areas around the banks, damage to land drainage, damage to flood control buildings, destruction of forests (natural vegetation) and improper planning of flood control systems". Regulation of Public Works and Public Housing Number 28 of 2015 concerning the determination of river boundary lines and lake boundary lines in article 15 reads that for buildings located on riverbanks, the minimum distance of the house from the riverbank is 10 meters from the left and right banks of the river, and if the river is too deep exceeding three meters, the distance from the riverbank is more than 10 meters.

This year's rainy season, which occurred on July 10, 2022, resulted in the Larike watershed flood safety embankment collapsing (damaged / broken) and resulting in, overflowing the river so that it entered the residential areas of residents who live around the river. Therefore, the Government immediately took special care to anticipate further flooding that occurred again and was very disturbing to the community in carrying out their daily activities.

From the background exposure above, it is interesting for researchers to make a scientific study in the form of research with the title Damage Assessment of the Larike Watershed Flood Safety Embankment, West Leihitu District, Central Maluku Regency.

II. METHODS

Research Location

Damage to flood safety embankment in Larike watershed, Larike village, West Leihitu sub-district, Central Maluku district.

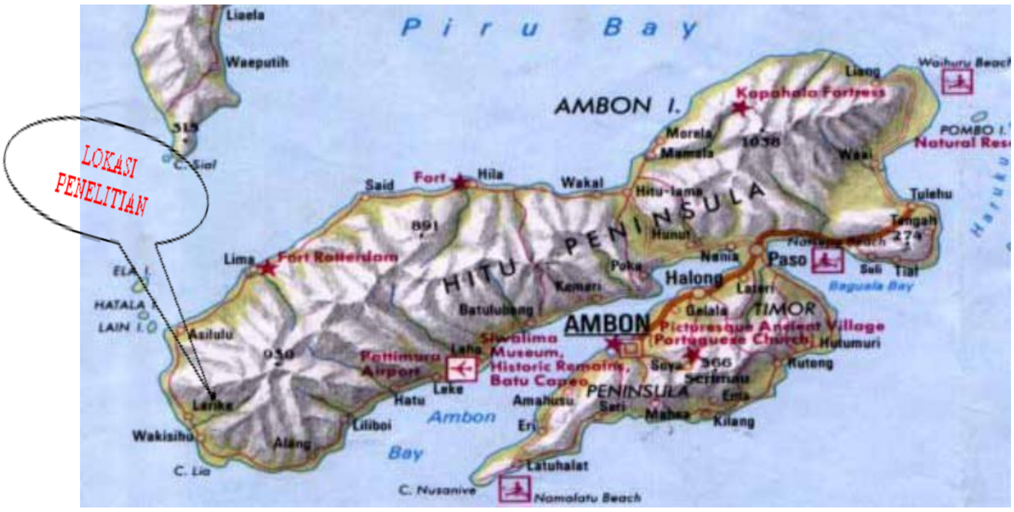


Image 1 Research Location

Data Collection Technique

The data collection techniques used in the research are as follows:

a. Observation

Observation technique means making observations and recording systematically about the symptoms that appear on the object of research.

b. Interview

This interview technique is conducted face-to-face through questions and answers between researchers or data collectors andrespondents or sources or data sources.

c. Document

Document technique in which researchers take research sources or objects from documents or records of events that have passed, either in the form of writings, pictures, or monumental works of a person. Usually taken from diaries, life histories,biographies, regulations and so on.

Types of Data

Based on the source, the data in the data collection technique is divided into two, namely:

a. Primary Data

Primary data is a type of data that is collected directly from the source. Most of it is collected specifically for research projects and can be shared publicly to be used for other research Observations, Surveys, Interviews with local communities and photo documentation of the watershed that is used as the object of research so as to strengthen the truth of the research results and data on damage to the Larike watershed flood safety embankment.

b. Secondary Data

Secondary data is data in data collection techniques that become complementary data, namely:Plan Drawing
Unit Price Analysis
Cost Budget Plan (RAB).Rainfall Data.

Research Variables

a. The independent variable (independent variable) The dependent variable (X) in this study is Damage to flood safetyembankments.

b. The dependent variable (Y) in this study is the evaluation of levee repair.

Data Analysis Method

Data Analysis Method is the phase of the research process in which the collected data is processed to respond to the problemformulation. The method used is:

a. Thiessen Polygon Method

b. Gumbel Scatter Method I

c. Dr. Mononobe Method

d. Metede Haspers

e. Levee Damage Analysis

Research flow chart

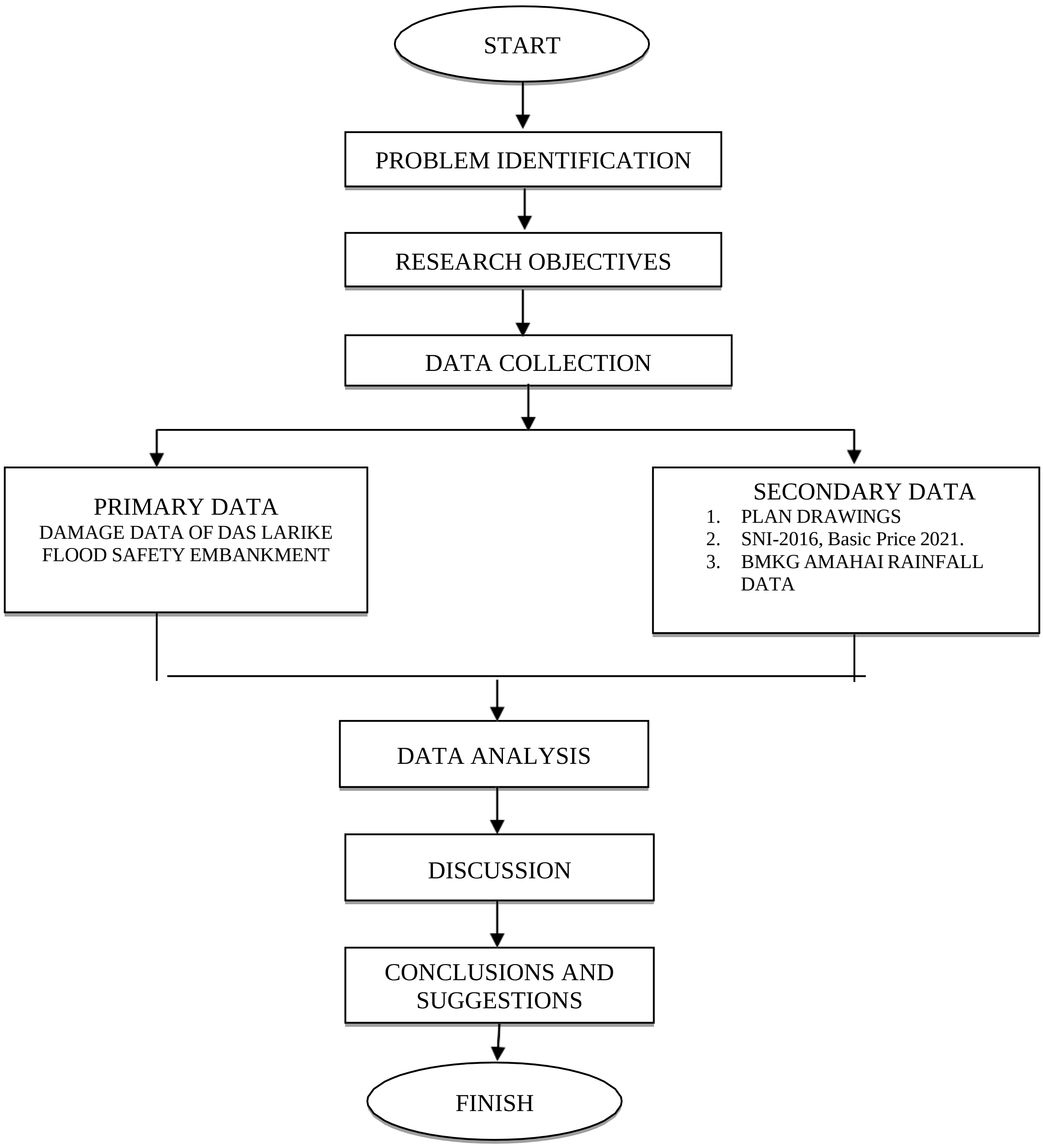


Image 2 Research Flowchart

III. ANALYSIS AND DISCUSSION

Damage Analysis Calculation

Analysis is observing an object's activities by describing the object's composition and reassembling its components for detailedreview or study.

$$\text{Damage Percentage Formula} = \frac{\text{Total length of Damage}}{\text{Total length}} \text{ X100} \qquad (1)$$

$$= \frac{200 \text{ m}}{528 \text{ m}} \text{ x } 100 = 37{,}88 \text{ \%}$$

With the results of the above calculations, the value of the physical condition of the damage level is between 21-40% of themedium damage category.

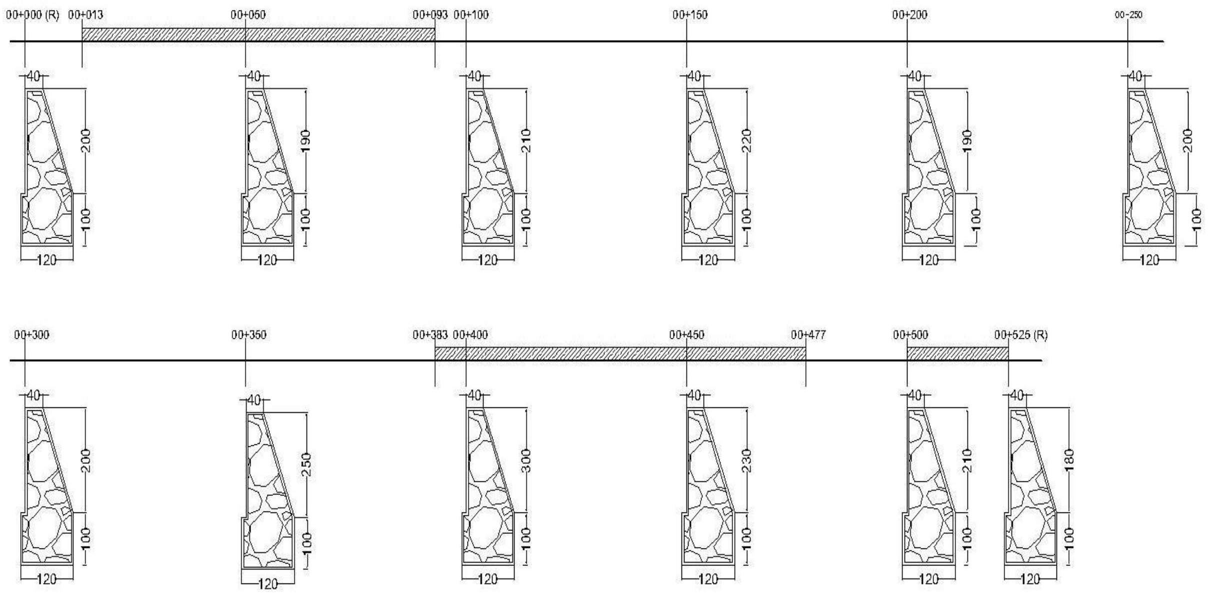


Image 3 Typical dimensions of embankment with length = 528 meters

Table 1 Physical condition of damage to the Larike watershed flood protection embankment, West Leihitu sub-district, CentralMaluku district.

No.	Embankment Building	Conditions	Documentation
1	Segment I, 00+013 - 00+093	Moderately damaged	
2	Segment II, 00+383 - 00+477	Moderately damaged	
3	Segment III, 00+500 - 00+528	Moderately damaged	

Plan Rainfall Calculation

The maximum daily rainfall data used in this analysis is sourced from the BMKG Ambon Meteorological Station with arecording period of 2008 to 2022:

Table 2 Rainfall data

No.	**Year**	**Daily rainfall**
		Maximum (mm/day)
1	2008	190,2
2	2009	143
3	2010	136,2
4	2011	208,3
5	2012	210
6	2013	178,2
7	2014	122,5
8	2015	91
9	2016	121,8
10	2017	106,1
11	2018	106,1
12	2019	195
13	2020	118
14	2021	136,7
15	2022	1131,1

a. Area Rainfall

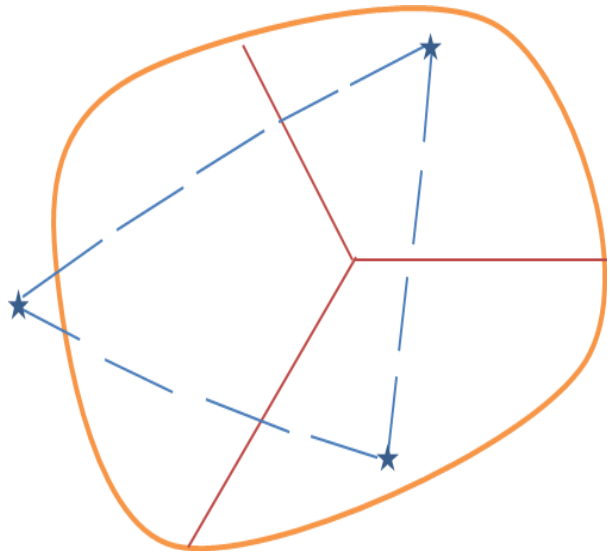


Image 4 Polygon Thiessin Station Post

Unknown:
Effective river channel length (L) = 6.02
kmPost 1 = 70 km² m
Post 2 = 40 km²
Post 3 = 66.24 km²
Total Watershed Area = 176.24 km²

R1, R2, R3 Average Rainfall from 2022 -
2022R1 = 118 mm
R2 = 136.7 mm
R3 = 1131.1 mm

b. Using the Thiessen Polygon method

$$\overline{R} = \frac{A1R1 + A2R2 + AnRn}{A1 + A2 + An} \quad (2)$$

$$\overline{R} = \frac{70x + 118 + 40x\ 136,7 + 66,24x\ 1131,1}{70 + 40 + 66,24}$$

$$\overline{R} = \frac{888652,064}{176,24} = 503,02\ Km/mm$$

c. Frequency Analysis

$$X_T = X + \frac{S}{S_n} \quad (3)$$

$$S = \sqrt{\frac{\sum_{i=1}^{n} (x_1 - x)^2}{n - 1}} \quad (4)$$

The maximum daily rainfall data for 15 years of observation is shown in the table below

Table 3 Maximum rainfall data for the last 15 years

Year	Xi rainfall(mm)	$(\overline{X_i}$-X average$)^2$
2008	1131,1	843005,5435
2009	210	4295,4916
2010	208,3	42964,74966
2011	195	38016,96642
2012	190,2	36176,04
2013	178,2	31755,24
2014	143	20449
2015	136,7	18686,89
2016	136,2	18550,44
2017	122,5	15006,25
2018	121,8	14835,24
2019	118	13924
2020	106,1	11257,21
2021	106,1	11257,21
2022	91	8281
Total	3194,2	1128461,271
Average(X)	212,95	
Standard Deviation(S)	144,46	

Calculate Average value (X)

$$X=\frac{\sum(Xi)}{15}=\frac{3194,2}{15}=212,95$$

$$S=\frac{\sum(Xi-X)^2}{(15-1)}=\frac{1128461,271}{14}=144,46$$

Calculate Frequency Factor (K) and Rainfall Plan (X_T)

With the number of data (n)=15years, the values (S_n) and (Y_n)

Table 4 Sn and Yn values

For 15 years of data		
Sn	1,0206	Reduced average
Yn	0,5128	Reduced deviation

Table 5 Yt values

Return Period T(year)	Reduced Variate(Yt)
2	0,3665
5	1,4999
10	2,2502
50	3,9019
100	4,6001

Then the planned rainfall for return periods of 2 years, 5, 10, 50 and 100 years is calculated with Yt for each return periodand the results of the calculation are listed in:

Table 6 Return Period

Return Period (year)	Yt	Yn	Sn	Frequency factor (kt)	X	S	Rainfall Plan (mm) (Xt)
2	0,3665	0,5128	1,0206	-0,13595	212,95	144,46	193,31
5	1,4999	0,5128	1,0206	0,99745	212,95	144,46	357,04
10	2,2502	0,5128	1,0206	1,74775	212,95	144,46	465,43
50	3,9019	0,5128	1,0206	3,39945	212,95	144,46	704,03
100	4,6001	0,5128	1,0206	4,09765	212,95	144,46	804,9

d. Rainfall intensity

$$I=\frac{R24}{24}*\left(\frac{24}{t}\right)^{2/3} \quad (5)$$

Table 7 Mononobe Method 24-Hour Rainfall

t (hour)	R24				
	R2	R10	R20	R50	R100
	193,31	357,04	465,43	704,03	804,90
1	1546,48	2856,32	3723,44	5632,24	6439,20
2	386,62	714,08	930,86	1408,06	1609,80
3	171,83	317,37	413,72	625,80	715,47
4	96,66	158,68	232,72	352,02	402,45
5	61,86	114,25	148,94	225,29	257,57
6	42,96	79,34	103,43	156,45	178,87
7	31,56	58,29	75,99	114,94	131,41
8	24,16	44,63	58,18	88,00	100,61
9	19,09	35,26	45,97	69,53	79,50
10	15,46	28,56	37,23	56,32	64,39
11	12,78	23,61	30,77	46,55	53,22
12	10,74	19,84	25,86	39,11	44,72
13	9,15	16,90	22,03	33,33	38,10
14	7,89	14,57	19,00	28,74	32,85
15	6,87	12,69	16,55	25,03	28,62
16	6,04	11,16	14,54	22,00	25,15
17	5,35	9,88	12,88	19,49	22,28
18	4,77	8,82	11,49	17,38	19,87
19	4,28	7,91	10,31	15,60	17,84
20	3,87	7,14	9,31	14,08	16,10
21	3,51	6,48	8,44	12,77	14,60
22	3,20	5,90	7,69	11,64	13,30
23	2,92	5,40	7,04	10,65	12,17
24	2,68	4,96	6,46	9,78	11,18

From the results of the calculation of the table above, the maximum rainfall intensity value (I) = 6439.20 mm / hour is taken.

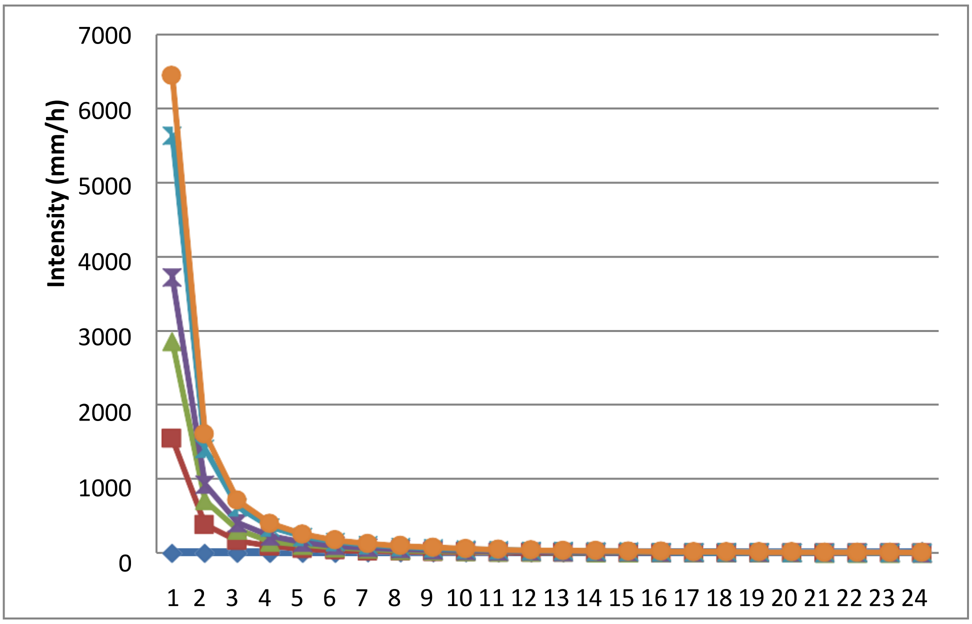


Image 5 IDF Curve Graph

From the IDF curve graph above, the smaller the value of t (hour), the greater the value of rainfall intensity (I)

Calculation of Plan Flood Discharge

To calculate the flood discharge plan, the "Haspers" method was used, and the following data results were obtained:

1.Area of river basin (DPS) (A) = 176.24 km²
2.Effective River Flow Length, (L)= 6.02 km = 6020 meters
3.Elevation Upstream = 590 meters
Downstream = 0 meters

4.River Slope $i = \frac{ElevasiHulu - ElevasiHilir}{PanjangAlurSungai(L)}$

$$i = \frac{590-0}{6020} = 0{,}0980m$$

a. Haspers Method
b. Rain Intensity

Fort<2hours

$$Rt = \frac{tR24}{t+1-0.0008*(260-R24)(2-t)^2}$$

$$Rt = \frac{0{,}84x357{,}04}{0{,}84+1-0{,}0008x(260-357{,}04)x(2-0{,}84)^2}$$

$$Rt = \frac{299{,}91}{0{,}84+1-(0{,}0008x(-115{,}04)x1{,}34)}$$

$$Rt = \frac{299{,}91}{0{,}84+1-(-0{,}123)}$$

$$Rt = \frac{299{,}91}{1{,}963}$$

$$Rt = 152{,}78$$

c. Maximum Rainfall (q):

$$q_n = n3{,}6xt$$

where t is in hours, q(m³/km²/sec)

$$q_n = \frac{152{,}78}{3{,}6x0{,}84}$$

$$q_n = \frac{152{,}78}{3{,}024}$$

q_n=50,52m³/km²/sec

$$Qt = \alpha.\beta.q_n A$$

$$Qt = 0{,}050x1{,}266x50{,}52x167{,}24 = 534{,}82m3/detik$$

Calculation of Embankment Volume (R)

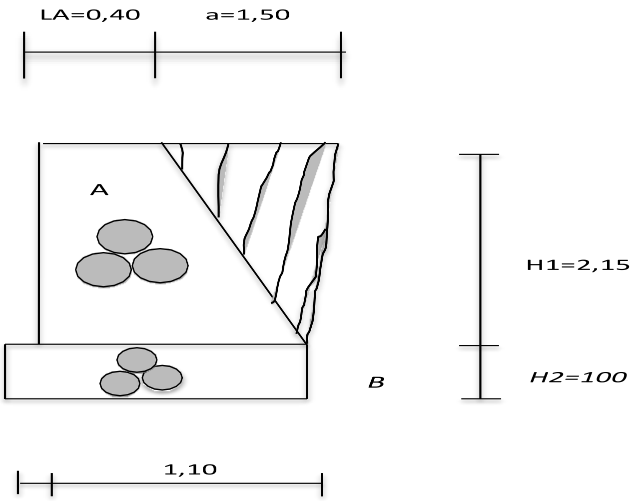
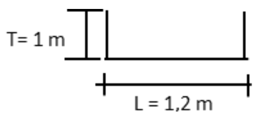
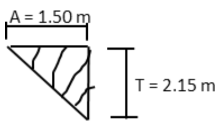


Image 6 Typical Embankment

Description:
Top side width = 0,40
Bottom side width = 1,10
H1 = 2,15
H2 = 1,00
a = 1,50 m
Embankment Length = 200 m

Table 8 Volume Calculation

No.	**Calculations**						**Volume**	**Unit**
1.	**Ordinary Excavation Work**							
		1,2	x	1	=	1,2	1,2	M2
				P	=	200		M
		1,2	x	200	=		**240**	M3
2.	**Ordinary backfill work**							
		0,5	x	1,5	x	2,15	1,61	M2
		P	200					M
		1,61	x	200	=		**322**	M3
3.	**Stone masonry work Camp 1:3**							
a.	Cross section A							

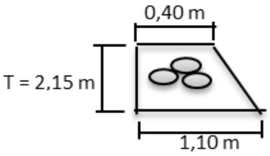
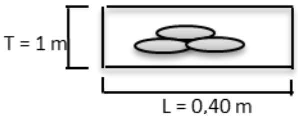
		(0,4	+	1,1)	x	2,15	1,61	M2
			2					
		P	=	20 0				
			1,61	x	200		322	M3
b.	Penamapang B							
		1,2	x	1	=		1,2	M2
		P	=	20 0				M2
		1,2	x	20 0	=	240		
Total Volume A + B =							**562**	M3
4.	**Camp Plastering Work 1:3**							
	0,4	+	0,1	+	2,1 5	=	2,65	M'
	P	=	200	M"	=			
	2,65	x	200		=	**530**		M2
5.	**Pipe Work**							
	Pipe Distance	2	m					
	Length of pipe 1	0,8	m					
	Pipe length 2	1	m					
	Number of pipes	200	:	2	=	100		Ptg
	Pipe Length	6	x	0, 8	+	6	x	
		10, 8						M2

Table 9 Analysis of Unit Price of Work (AHSP)

(T.07 excavation of rocky soil /T.07.a.1 manual method) 1m3 excavation of ordinary soil ≤ 1 m deep					
No.	Description	Unit	Coefficient	Unit Price (Rp)	Total (Rp)
1	2	3	4	5	6
A	Labor				
1	Workers	OH	1,351	125.000	168.875
2	Foreman	OH	0,1351	250.000	33.775
Total Labor Price					202.650
B	Total Labor Price				202.650
C	Common costs and Profits	(	15%	x B)	30.398
D	Unit Price of Work (B+C)				233.048

P. 14.n 1 m3 10 kg - 30 kg masonry, maximum 20% void					
No.	Description	Unit	Coefficient	Unit Price (Rp)	Total (Rp)
1	2	3	4	5	6
A	Labor				
1	Workers	OH	1,1	125.000	137.500
2	Stonemason	OH	0,22	130.000	28.600
3	Foreman	OH	0,11	250.000	27.500
Total Labor Price					193.600
B	Material				
1	River stone / round /oval 10 kg - 30 kg	m³	1,25	471.000	588.750
Total Price of Materials					588.750
C	Total Price of Labor and Materials (A+B)				782.350
D	Common costs and Profits		15%	x (C)	117.353
E	Unit Price of Work (C+D)				899.703

P.04.e Plastering 1.5 cm thick, with type s mortar (equivalent to 1 PC : 3 PP mix)					
No.	Description	Unit	Coefficient	Unit Price (Rp)	Total (Rp)
1	2	3	4	5	6
A	Labor				
1	Workers	OH	0,384	125.000	48.000
2	Stonemason	OH	0,192	130.000	24.960
3	Head mason	OH	0,019	150.000	2.850
4	Foreman	OH	0,019	250.000	4.750
Total Labor Price					80.560
B	Material				
1	Sand tide	m³	0,03	808.000	24.240
2	Portland cement	Kg	7,776	65.000	505.440
Total Price of Materials					529.680
C	Equipment				
Total Equipment Price					-
D	Total Price of Labor, Materials and Equipment (A+B+C)				610.240
E	Common costs and Profits	(	15%	x D)	91.536
F	Unit Price of Work (D+E)				701.776

T.14.a 1 m3 EARTH BUILDING OR REBUILDING LAND					
No.	Description	Unit	Coefficient	Unit Price (Rp)	Total (Rp)
1	2	3	4	5	6

A	Labor				
1	Workers	OH	0,33	125.000	41.250
2	Foreman	OH	0,033	250.000	8.250
Total Labor Price					49.500
B	Material				
Total Price of Materials					-
C	Equipment				
Total Equipment Price					-
D	Total Price of Labor, Materials and Equipment (A+B+C)				49.500
E	Common costs and Profits	(	15%	x D)	7.425
F	Unit Price of Work (D+E)				56.925

P.16.1 m install distilled pipe - distilled					
No.	Description	Unit	Coefficient	Unit Price (Rp)	Total (Rp)
1	2	3	4	5	6
A	Labor				
1	Workers	OH	0,1	125.000	12.500
2	Foreman	OH	0,01	250.000	2.500
Total Labor Price					15.000
B	Material				
1	1 1/2" PVC pipe	M	1,05	535.000,00	561.750
2	Palm fiber	M	0,01	12.000,00	
3	Gravel	m3	0,02	235.000	4.700
Total Price of Materials					4.700
C	Equipment				
1	Tools				-
Total Equipment Price					-
D	Total Price of Labor, Materials and Equipment (A+B+C)				19.700
E	Common costs and Profits	(	15%	x D)	2.955
F	Unit Price of Work (D+E)				22.655

RAB calculation

Table 10 RAB Calculation

ENGINEERING ESTIMATE					
Work Unit	:	Evaluation			
Jobs	:	Flood Safety Wall			
Jobs	:	Way Hatu Flood Safety Wall			
Job Location	:	Hatu Village, Central Maluku Regency			
No.	WORK ITEMS	SAT	VOLUME	UNIT PRICE	PRICE AMOUNT
1	Rock excavation work	M3	240	233.048,00	55.931.520,00
2	Ordinary Urugan Work	M3	322	56.925,00	18.329.850,00
3	Stone masonry 1 PC:3	M3	562	899.703,00	505.633.086,00
4	Camp Plastering Work 1:3	M2	544	701.776,00	381.766.144,00
5	Pipe Work	Ptg	100	22.655,00	2.265.500,00
			A	Total Quantity	963.926.100,00
			B	Contingency(11%x A	106.031.871,00

	C	Total A+B	1.069.957.971,00
	D	Rounded	1.085.137.000,00
Retrieved	One Billion Eighty Five Million One Hundred Thirty Seven Thousand Rupiahs		

IV. CLOSING

Conclusion

The damage analysis of the Larike watershed flood safety embankment is at a value of 37.88%, so the physical condition value of the damage level is 21-40% (moderately damaged), the results of the calculation of the planned flood discharge Q = 534.82 m3 / sec based on the results of the calculation of the cost budget plan of Rp 1,085,137,000.00 (One Billion Eighty Five Million One Hundred Thirty Seven Thousand Rupiah).

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