JURNAL BANGUNAN, KONSTRUKSI & DESAIN

Vol.3 No.3 September 2025

E-ISSN : 3021-7547
Website: http://jbkd.ft.unand.ac.id

FLOOD STORAGE CAPACITY ANALYSIS OF BATANG MAHAT RIVER FOR DAM PLAN AT GUNUNG MALINTANG SUB-DISTRICT

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Manuscript Received : 9 Agustus 2025. Accepted: 8 September 2025. Published : 9 September 2025.

ABSTRACT

Gunung Malintang Sub-district is the largest Sub-district in Pangkalan Koto Baru District, Lima Puluh Kota Regency, West Sumatera Province. With an area of 249.43 km2, Kenagarian Gunung Malintang occupied 35.03 % of Pangkalan Koto Baru District's total area. Crossing by a major river, Batang Mahat river, made this area hit by floods frequently which brings loss to the local community. Building dams is one of the solution for controlling the flood problems. As we know, dams could be a storage for the excessive water during floods, and it could also be a water resource during the dry season. For the reasons mentioned above, it is necessary to analyze the flood area on the location where the dams would build. The aim of this research is to calculate the discharge of probable flood (flood routing) using Muskingum method,and to estimate the storage capacity of the basin on the proposed construction site using relationship curve between elevations – storage area – storage volume. From the flood routing calculation of the probable flood for 100 year of return period, the inflow discharge 325,0911 m3/s and the outflow discharge is 165,6724 m3/s. The peak flood discharge occured at 3 rd hour. So the probable storage balance based on inflow – outflow discharge is 13,773,771.82 m3 in volume. From the storage capacity determination, using topographic analysis obtained 4.467.693,43 m2 in storage area and 30.213.084,779 m3 for storage volume. The dead storage capacity placed on the elevation +156 m above msl. The conclusions of the study indicates that the dead storage capacity meets the probable storage balance from flood routing. Which means that the design dam could be constructed at the elevation +156 m.

Keywords : flood routing, storage area, storage volume, Batang Mahat river

1. INTRODUCTION

Gunung Malintang Sub-district with the area of 249,43 km^2 is Sub-district which has the largest area in Pangkalan Koto Baru District, Lima Puluh Kota Regency, Sumatera Barat Province. This area equal to 35,03 % of Pangkalan Koto Baru District's total area (BPS

DOI : https://doi.org /10.25077/jbkd.3.3.124-134.2025

Kabupaten Lima Puluh Kota, 2021). One of a major river, Batang Mahat river, flows through the district. And as the main water resource for the locals, it plays an important roles to the lives of many people.

Batang Mahat river, which has 76,22 km in total length, is the main river that supplies water for the hydroelectric power plant (PLTA) of Koto Panjang, Kampar, Riau. With the watershed area of 772,87 km2 this river is capable of carrying a large amount of discharge. In rainy season, the water discharge which flows through the river would exceed the river's channel capacity and could cause flood. And Kenagarian Gunung Malintang is the area which affected by flood the most. Flood hits the area almost every year and off course, it makes a big loss for the local society. Due to the frequent flood problems, the urgent action is needed to overcome it.

One of the sollutions for the flood problems is by building a dam. The aims of a dam construction is to accomodate the excessed water discharge when the the peak discharge occurs, and as the main water resource for the local needs when the water discharge reach it's lowest value during the drought. To get the precise dam planning, calculations and analysis of the exact size of the flood are required.

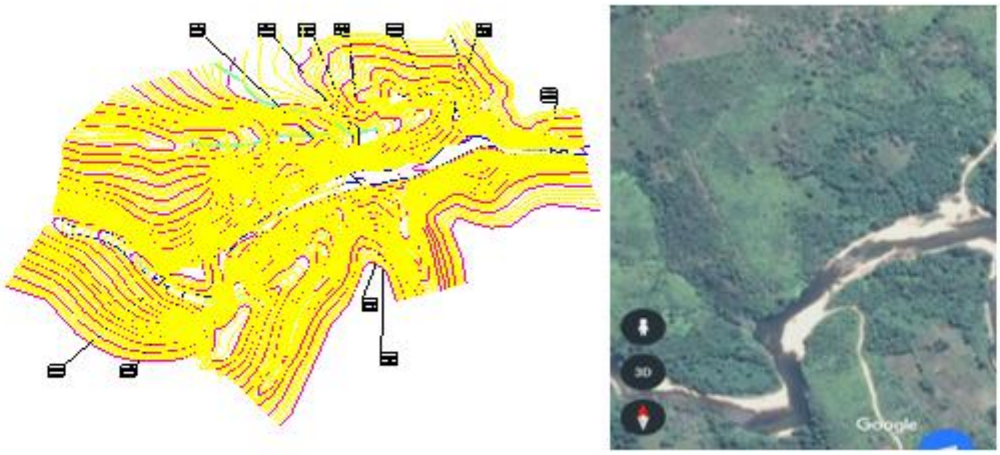


Figure 1. Topographic Maps and The Proposed Construction Site

Figure 1 above is the research location, the proposed construction site for the planned reservoir.

The research about flood in Batang Mahat river has conducted in 2023 (Junaidi et al., 2023). Some parts of the river are prone to flooding because of the narrowing of the river's cross section.The research was aimed to find out things that can causes flood in Batang Mahat river. Cause of flooding was analized using HEC-RAS 6.2 program application with the steady flow simulation. The results showed that the capacity of the river's channel could not accommodate Q50 discharge. The simulations also showed that the widdening of cross sections of the river in Batu Kisok decreased the water level in the upstream.

The flood routing of Bendo dam in Kali Keyang river has been analized in the research which conducted in 2022 (Meda, 2022). Flood routing analysis was aimed to conduct a review of the dam safety. Bendo dam constructed with 71 m in height, equivalent to elevation of +224 msl. This research implied that maximum elevation for Q100 was +222,742 msl, Q1000 discharge elevation +222,916 msl and QPMF discharge elevation equal to +223,334 msl. So the existing Bendo dam construction still able to accommodate the flood plans.

Storage capacity analysis also conducted to Biringire reservoir in Pangkajene Regency. To accommodate the water requirements in the Tonasa V factory area and the use of former soil mining locations, a research was conducted to calculate the storage capacity of the Biringere reservoir (Erwin et al., 2023). The former soil mining land has an area of 183.919 m^2. The results showed that the reservoir's capacity equal to 22.205,39 m^3, with an area 6.331,36 m^2 at elevation +38,5 msl.

Buayan subdistrict which located in Kebumen Regency, is a potensial area to be developed as a seservoir. The potensial place spotted in Rogodadi village. A study aimed at calculating the storage capacity of the proposed reservoir in Rogodadi, Rogodadi reservoir (Suharyanto & Subagyo, 2022). The study obtained 21.033,74 m^3 for storage capacity based on water needs and 22.869 m^3 for the water availability. With 3 m for the dam height, the reservoir could accommodated 21.000 m3 as the design capacity.

Musi river, which flows accross Palembang city, causes flooding frequently. The river with a large influence of tides causes flooding in several areas of Palembang city. For this reason, a study was carried out to find out which areas were inundated by flooding due to the overflow of the Musi River (Marlina, 2022). Using HSS SCS-CN method and Snyder method obtained a flood inundation area of 112,469 km2 which is equivalent to 28% of the total area of Palembang City. Run-off flows up to 0,97 m/s in maximum velocity and made inundation 1,4 to 3 m in depth.

Aside from flood management, water storage capacity calculations could also be used to meet the water resource requirements of local residents. For example, research on the storage capacity of the Danau Asam reservoir. The research aimed to calculate reservoir storage capacity in order to provide water resource requirements of Kotawaringin Barat's residents. The analysis found that the reservoir has a capacity of 391.842,72 m^3, which could meet the water needs of 35.397 residents of Kotawaringin Barat (Zevri, 2021).

Based on background of the study and the literature review, this research aim is to calculate probable flood for Batang Mahat river, to determine the water yield of the basin in Kenagarian Gunung Malintang, the area and the storage capacity (volume) of water which can be yield from the basin that caused by the flood. With the estimation of the area and the quantity of water from the flood of Batang Mahat river, it can estimates the area of required reservoir could be and can be follow-up by building the dam construction for the reservoir at the proposed site plan to provides the domestic purposes.

2. RESEARCH METHODOLOGY

The study started with rainfall data analysis to measure the probable rainfall. The rainfall data series uses in the study range from year 2006 to 2021, which means consist of 16 years of data. We were using four methods of frequency distribution; Normal, Log Normal, Gumbel and Log Pearson Type III, then compare it to the distributions selection requirement. From the probable rainfall we could estimate the rain intensity using Mononobe method (Tambaru, 2024).

$$I = \left(\frac{R_{24}}{24}\right) \times \left(\frac{24}{t}\right)^{2/3} \quad (1)$$

The equation above is the formula for estimating rainfall intensity, Mononobe equation. Where I refered to raninfall intensity in mm/day, R24 refered to probable daily rainfall in mm, and t for time in hours.

When the flood discharge defined, probable flood hydrograph calculated with Units Hydrograph. The results from Units Hydrograph method were the basic data for flood routing analysis. Flood routing analysis delivered the rate of inflow and outflow discharge of the basin. As it is known that the inflow and outflow, also storage capacity would affect the reservoir performance (Sahfitri & Prijono, 2021).

Storage capacity determination used topographic map in the proposed site for the construction. While estimating the area for each elevation on the site used Auto-CAD software. The equation below is the formula for the calculations.

$$V_x = 1/3 \times Z\left[Fy + Fx + \sqrt{Fy + Fx}\,\right] \quad (2)$$

Where Fx and Fy are the area for Y axis and X axis contour in m^2, and Z is the height differences between contours in m. Vx symbol represent contour volume with m^3 in units. In measuring the area of Fx and Fy value using Auto CAD application.

3. RESULTS AND DISCUSSIONS

Calculating process started with rainfall processing data. Tha rainfall datas used here were from two precipitation stations, Suliki Station and Tanjung Pati Station. The rainfall analysis using Arithmatic Method. Table 1 shows the rainfall data we used for the next stages in research process.

Table 1. Maximum Rainfall of Reference Stations

No	Year	Max. Rainfall		Xi
		Suliki	Tj. Pati	
1	1994	88	95	91.5
2	1995	55	95	75
3	1996	97	92	94.5
4	1997	52	60	56
5	1999	57	90	73.5
6	2000	68	90	79
7	2001	77	60	68.5
8	2002	66	97	81.5
9	2005	62	60	61
10	2006	74	86	80
11	2007	67	63	65
12	2008	107	75	91
13	2009	72	100	86
14	2010	65	145	105
15	2011	140	70	105

No	Year	Max. Rainfall		Xi
		Suliki	Tj. Pati	
16	2012	68	125	96.5
17	2013	67	120	93.5
18	2014	73	70	71.5
19	2015	79	75	77
20	2016	82	71	76.5
	Total			1627.5
	Average			81.375

The rainfall datas processed with statistical analysis. From the existing statistical parameters, the type of frequency distribution is selected using the criteria as in the table belows.

Table 2. Conditions for Selecting The Frequency Distribution Method

No	Type of Freq. Dist.	Conditions		Calc. Results		Information
1	Normal	$C_s \approx 0$		Cs =	0,0590	Not qualified
		$C_k \approx 3$		Ck =	2,7386	
2	Log Normal	$C_s = C_v{}^3 + 3\,C_v$	0,1370	Cs =	-0,2856	Not qualified
		$C_k = C_v{}^8 + 6\,C_v{}^6 + 15\,C_v{}^4 + 16\,C_v{}^2 + 3$	3,0334	Ck =	2,9514	
3	Gumbel	$C_s = 1{,}14$	1,14	Cs =	0,0590	Not qualified
		$C_k = 5{,}4$	5,4	Ck =	2,7386	
4	Log Pearson III	$C_s \neq 0$		Cs =	-0,2856	Approaching requirements
		$C_k = 1{,}5\,C_v{}^2 + 3$	3,0031	Ck =	2,9514	

Table 2 shows that the frequency distribution type that is suitable according to the conditions is Log Pearson III. For the next process, the design rainfall for various return periods (25-year, 50-year, 100-year return period) are calculated with Log Pearson III method.

Table 3. Design Rainfall Results of Log Pearson III

Return Period	Ktr	Log X	S Log X	Log Xt	Xt
25	1,6747	1,9044	0,0753	2,0304	107,2611
50	1,9371	1,9044	0,0753	2,0502	112,2516
100	2,1673	1,9044	0,0753	2,0675	116,8216

The Table 3 above shows the results of design rainfall analysis with Log Pearson III method.

Then the data from the frequency distribution was tested with goodness of fit test, Smirnov-Kolmogorov method. The data analysis is tabulated as follows (Table 4).

Table 4. Goodness of Fit Test With Smirnov-Kolmogorov Method

Year	Xi	Xi Ranked	m	P(x)	P(x<)	(Xi-X)/S	P'(x)	P'(x<)	D
1994	1,9614	1,7482	1	0,0476	0,9524	0,7576	0,0526	0,9474	0,0050
1995	1,8751	1,7853	2	0,0952	0,9048	-0,3897	0,1053	0,8947	0,0100
1996	1,9754	1,8129	3	0,1429	0,8571	0,9438	0,1579	0,8421	0,0150
1997	1,7482	1,8357	4	0,1905	0,8095	-2,0754	0,2105	0,7895	0,0201
1999	1,8663	1,8543	5	0,2381	0,7619	-0,5063	0,2632	0,7368	0,0251
2000	1,8976	1,8663	6	0,2857	0,7143	-0,0899	0,3158	0,6842	0,0301
2001	1,8357	1,8751	7	0,3333	0,6667	-0,9128	0,3684	0,6316	0,0351
2002	1,9112	1,8837	8	0,3810	0,6190	0,0898	0,4211	0,5789	0,0401
2005	1,7853	1,8865	9	0,4286	0,5714	-1,5819	0,4737	0,5263	0,0451
2006	1,9031	1,8976	10	0,4762	0,5238	-0,0173	0,5263	0,4737	0,0501
2007	1,8129	1,9031	11	0,5238	0,4762	-1,2154	0,5789	0,4211	0,0551
2008	1,9590	1,9112	12	0,5714	0,4286	0,7260	0,6316	0,3684	0,0602
2009	1,9345	1,9345	13	0,6190	0,3810	0,3999	0,6842	0,3158	0,0652
2010	2,0212	1,9590	14	0,6667	0,3333	1,5517	0,7368	0,2632	0,0702
2011	2,0212	1,9614	15	0,7143	0,2857	1,5517	0,7895	0,2105	0,0752
2012	1,9845	1,9708	16	0,7619	0,2381	1,0646	0,8421	0,1579	0,0802
2013	1,9708	1,9754	17	0,8095	0,1905	0,8824	0,8947	0,1053	0,0852
2014	1,8543	1,9845	18	0,8571	0,1429	-0,6655	0,9474	0,0526	0,0902
2015	1,8865	2,0212	19	0,9048	0,0952	-0,2379	1,0000	0,0000	0,0952
2016	1,8837	2,0212	20	0,9524	0,0476	-0,2755	1,0526	-0,0526	0,1003
								Dmax	0,1003

By using the 5% confidence level with DO value = 0.29 while the calculation of the goodness of fit test shows Dmax = 0.1003. It can be concluded that the results of the frequency distribution analysis are acceptable because 0.1003 < 0.29.

The design rainfall is used to calculate the rainfall intensity (Mononobe method). Continued by calculating synthetic unit hydrograph Nakayasu method. Both rainfall intensity and synthetic unit hydrograph results is used to flood routing analysis.

The flood routing analysis was using Muskingum method, to calculate the reservoir outflow hidrograph provided inflow hidrograph and the outflow characteristics (Heru, 2022). Storage capacity described the water volume that fills the basin. As the inflow hydrograph changes, the reservoir contents will also change .

The result from flood routing analysis data revealed calculations of inflow and outflow rate. The data showed below is the recapitulation of flood routing for probable flood discharge for 25-year (Q25), 50-year (Q50) and 100-year (Q100) return period.

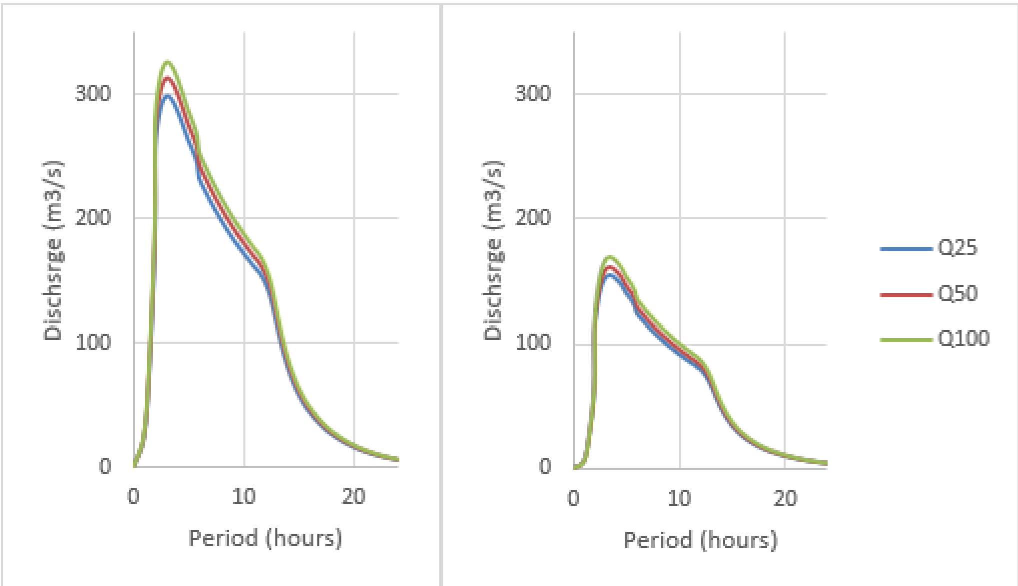
Table 5 below shows inflow and outflow in Batang Mahat river in different return periods of discharge from hours to hours.

Table 5. Flood Routing for Various Flood Plans

Period	**Inflow and Outflow Hydrograph**					
	25-year		**50-year**		**100-year**	
T (Hour)	I	O	I	O	I	O
0	0.0000	0.0000	0.0000	0,0000	0.0000	0.0000
1	24.5252	4.9050	25.6663	5.1333	26.7112	5.3422
1.5	80.3479	23.9177	84.0863	25.0305	87.5097	26.0495
2	182.1185	62.1350	190.5918	65.0260	198.3514	67.6734
2.032	256,9489	109.6677	268.9039	114.7702	279.8517	119.4428
2.5	288.8024	139.9841	302.2394	146.4971	314.5444	152.4614
3	298.4859	152.1139	312.3735	159.1913	325.0911	165.6724
3.5	296.3707	154.7896	310.1598	161.9915	322.7873	168.5866
4	287.8111	152.4008	301.2020	159.4915	313.4648	165.9849
4.572	274.4650	146.9926	287.2350	153.8316	298.9291	160.0946
5	263.7770	140.5842	276.0496	147.1251	287.2884	153.1150
5.5	253.2600	135.0606	265.0433	141.3445	275.8340	147.0991
5.842	244.2335	129.8899	255.5969	135.9332	266.0029	141.4675
6	232.9916	124.7530	243.8319	130.5574	253.7590	135.8727
6.5	223.4206	119.2414	233.8157	124.7894	243.3350	129.8699
7	214.7235	114.4393	224.7139	119.7638	233.8626	124.6397
7.5	206.6403	110.0396	216.2546	115.1593	225.0589	119.8478
8	199.0502	105.9349	208.3114	110.8637	216.7923	115.3773
8.5	191.8867	102.0734	200.8145	106.8225	208.9903	111.1716
9	185.1079	98.4253	193.7204	103.0047	201.6073	107.1983
9.5	178.6849	94.9715	186.9985	99.3902	194.6117	103.4367
10	172.5951	91.6982	180.6254	95.9646	187.9792	99.8716
10.5	166.8202	88.5945	174.5817	92.7165	181.6895	96.4912
11	161.3434	85.6511	168.8502	89.6362	175.7246	93.2855
11.5	156.1498	82.8599	163.4150	86.7151	170.0680	90.2455
12	148.3565	79.6392	155.2591	83.3446	161.5801	86.7378
12.5	136.1703	74.7082	142.5059	78.1841	148.3077	81.3672
13	116.8680	66.9481	122.3054	70.0630	127.2848	72.9154
13.5	97.5813	56.9140	102.1215	59.5620	106.2791	61.9870
14	82.0076	47.6275	85.8231	49.8435	89.3173	51.8728
14.5	69.5621	40.1549	72.7986	42.0231	75.7624	43.7340
15	59.5893	34.1777	62.3618	35.7679	64.9007	37.2241
15.5	51.5725	29.3831	53.9720	30.7502	56.1694	32.0021
16	45.2683	25.5569	47.3745	26.7460	49.3033	27.8349
16.5	39.7541	22.4367	41.6038	23.4806	43.2976	24.4366
17	35.0110	19.7235	36.6399	20.6412	38.1316	21.4815
17.5	30,7735	17.3582	32.2053	18.1658	33.5165	18.9054
18	27.3346	15.3144	28.6064	16.0270	29.7710	16.6795
18.5	24.2800	13.6031	25.4096	14.2360	26.4441	14.8155

Period	Inflow and Outflow Hydrograph					
	25-year		50-year		100-year	
19	21.5667	12.0829	22.5701	12.6451	23.4890	13.1599
19.5	19.1566	10.7327	20.0479	11.2320	20.8641	11.6893
20	17.0159	9.5333	17.8076	9.9769	18.5326	10.3830
20.5	15.1144	8.4680	15.8176	8.8619	16.4616	9.2227
21	13.4254	7.5217	14.0500	7.8716	14.6220	8.1921
21.5	11.9251	6.6811	12.4799	6.9920	12.9880	7.2766
22	10.5925	5.9345	11.0853	6.2106	11.5366	6.4635
22.5	9.4088	5.2713	9.8465	5.5166	10.2474	5.7412
23	8.3573	4.6823	8.7462	4.9001	9.1023	5.0996
23.5	7.4234	4.1590	7.7688	4.3525	8.0851	4.5297
24	6.5939	3.6943	6.9006	3.8661	7.1816	4.0235

Flood routing calculation's result showed that the discharge of flood peak occured at the 3-rd hour with inflow rate Q_{100} = 325.0911 m^3/s and outflow rate Q_{100} = 165.6724 m^3/s. The result of flood routing presented in inflow - outflow curve below.



(a) (b)

Figure 2. Inflow Curve (a) and Outflow Curve (b) In Various Return Period

By substracting the inflow and outflow rate for 100 years of return period, we found the probable water balance for the basin. The storage made 159.4187 m^3/s in discharge, so the volume capasity is 13,773,771.82 m^3.

Since the proposed construction site located on elevation +133.22 to +176.847 m above msl, so storage capacity estimation, both area and volume capacity, calculated based on the elevation mentioned above.

Table 6. Calculations for Cumulative Storage Area

Elev. (m)	Area (m^2)		Fx+Fy (Area, m^2)	Cum. Area (m^2)
	Fx	Fy		
133.22	678,797.863	13,096.979	691,894.842	691,894.842
133.843	678,396.355	12,887.841	691,284.196	1,383,179.038
134	678,783	13,153	691,936	2,075,115.038
134.401	678,974.416	13,210.839	692.185.255	2,767,300.293
135.089	678,352.102	12,910.224	691,262.326	3,458,562.619
141.01	678,965.54	13,235.863	692,201.403	4,150,764.022
168.667	678,766.959	13,213.523	691,980.482	4,842,744.504
168.94	678,765.057	13,220.707	691,985.764	5,534,730.268
174.471	678,831.098	12,971.885	691,802.983	6,226,533.251
176.847	678,834.717	12,958.262	691,792.979	6,918,326.230

Table 6 is the recapitulation of storage area calculation which analyzed by using elevation data and the X (Fx) and Y (Fy) axis area of each elevation at the reasearch location. Where the Fx+Fy is the addition of X area and Y area. The cumulative area showed on the fifth column. The results for storage area calculation showed that the largest area that made by flood inundation is 692,201.403 m^2, placed on the elevation +141,01 msl.

Based on the results of storage area, the storage volume could be estimated at the proposed construction site. The results for the storage volume analysis presented in the **Table 7**.

Table 7. Calculations for Cumulative Storage Volume

Elev. (m)	Z (m)	Vol. (m^3)	Cum. Volume (m^3)
133,22	0	0	0
133,843	0,623	287.484,414	287.484,414
134	0,157	108.673,075	396.157,489
134,401	0,401	370.118,163	766.275,652
135,089	0,688	793.590,190	1.559.865,842
141,01	5,921	8.196.245,626	9.756.111,468
168,667	27,657	44.665.549,132	54.421.660,600
168,94	0,273	503.874,541	54.925.535,141
174,471	5,531	11.484.252,309	66.409.787,450
176,847	2,376	5.481.397,549	71.891.184,999

Table 7. shows that the largest volume obtained by the basin at the proposed construction site is 44,665,549.132 m^3 at elevation +168,667 msl. Refers to the results from **Table 6**. and **Table 7**., the relationships between elevation – storage area – storage volume can be displays as the curve like showing below.

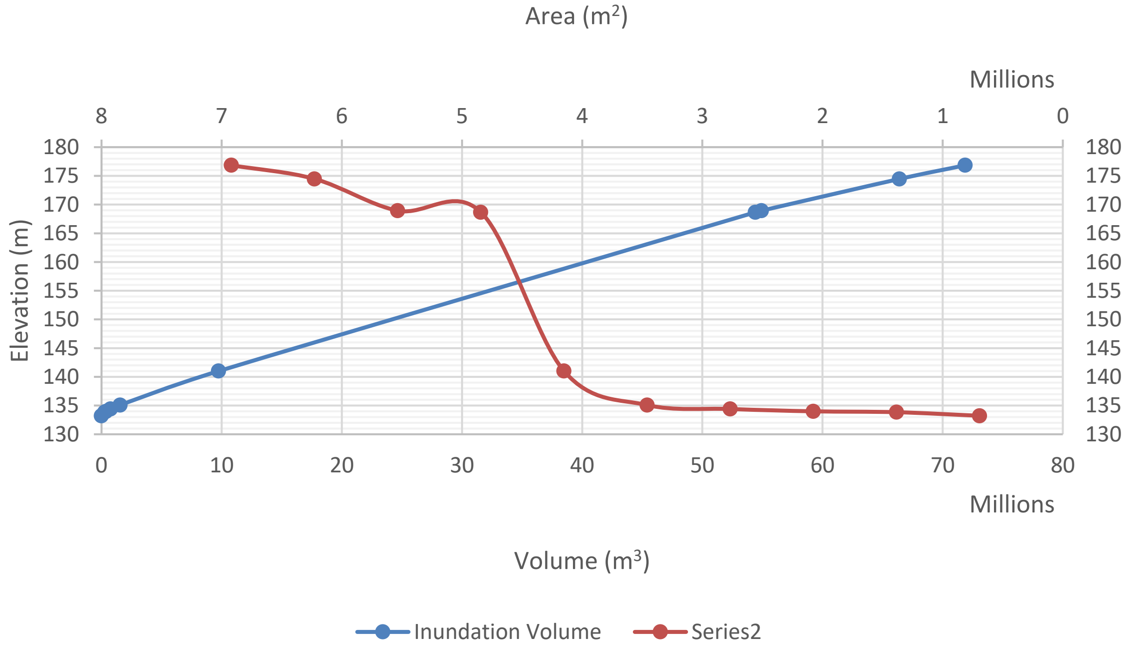


Figure 3. Relationship Curve Between Elevation – Storage Area – Storage Volume

From the curve above, the relationships between elevation, storage area and storage volume for proposed site, dead storage is at elevation +156 m above mean sea level with storage area 4.467.693,43 m^2 and storage volume 30.213.084,779 m^3.

Refers to inflow – outflow calculation results revealed the discharge rate of the flood is 159.4187 m^3/s which leads to volume rate 13,773,771.82 m^3 . Meanwhile, the dead storage calculations at the proposed site is 30.213.084,779 m^3 in volume. From this study it can be concluded that the dam can be built at an elevation of +156 m above msl.

4. CONCLUSIONS

According to the objectives of this study, to obtain flood routing in Kenagarian Gunung Malintang and to define the the area and volume of inundation in the proposed dam constrution site. From flood routing analysis obtained the inflow and outflow caused by probable flood for 100 years of return period are 325.0911 m^3/s and 165.6724 m^3/s. Based on the inflow and outflow rate found the probable storage water balance is 13,773,771.82 m^3. Whereas the area of the dead storage is 4.467.693,43 m^2 with 30.213.084,779 m^3 in volume storage capasity takes place on the elevation +156 m above mean sea level. the study concluded that the capacity of the dead storage is sufficient for the volume that made by probable flood revealed in flood routing.

The research conclusions found out that the location at an elevation of +156 m above msl can be used as a location for the design dam for reservoir plan so that it can prevent flooding and become the main water source for Gunung Malintang residents.

ACKNOWLEDGEMENTS

This publication is supported by Department of Civil Engineering, Sekolah Tinggi Teknologi Payakumbuh. We also would like to thank all the friends and colleages who has assisted on this study.

REFERENCES

BPS Kabupaten Lima Puluh Kota. (2021). Kabupaten Lima Puluh Kota Dalam Angka (BPS Kabupaten Lima Puluh Kota (ed.); 2021st ed.). BPS Kabupaten Lima Puluh Kota.

Erwin, R., Yuliana, A., Musa, R., Mallombasi, A., & Umar, M. H. (2023). Analisa Kapasitas Tampungan Perencanaan Embung Biringere Semen Tonasa Kabupaten Pangkajene Kepulauan. Jurnal Ilmiah Mahasiswa Teknik Sipil, 5(2), 197–207. https://jurnalftlama.umi.ac.id/index.php/JILMATEKS/article/view/757/477

Heru, H. (2022). Pengaruh Tampungan Awal Waduk Dolog Terhadap Retensi Debit Banjir Kota Semarang Timur. Jurnal Profesi Insinyur, 3(1), 20–29. https://doi.org/https://doi.org/10.23960/jpi.v3n1.76

Junaidi, J., Daoed, D., & Syandriaji, D. (2023). STUDY ON THE CAUSES OF FLOODING IN BATANG MAHAT, LIMA PULUH KOTA REGENCY, WEST SUMATERA. Journal of Applied Agricultural Science and Technology, 7(2), 142–159. https://doi.org/https://doi.org/10.55043/jaast.v7i2.161

Marlina, A. (2022). Analisis Genangan Banjir dengan Simulasi Model 2 Dimensi di Sungai Musi Kota Palembang. Jurnal Teknik Sipil UNPAL, 12(1), 21–28. https://jurnal.unpal.ac.id/index.php/tekniksipil/article/view/698

Meda, R. A. (2022). Analisa Penelusuran Banjir Pada Waduk Untuk Keamanan Bangunan Bendungan Bendo [Universitas Islam Indonesia]. https://dspace.uii.ac.id/bitstream/handle/123456789/41643/17511219.pdf?sequence=1

Sahfitri, R., & Prijono, S. (2021). ANALISIS KAPASITAS TAMPUNGAN DAN KINERJA WADUK UNTUK MEMENUHI KEBUTUHAN AIR TANAMAN NANAS DI PT. GREAT GIANT PINEAPPLE. Jurnal Tanah Dan Sumberdaya Lahan, 8(1), 135–148. https://doi.org/10.21776/ub.jtsl.2021.008.1.17

Suharyanto, I., & Subagyo, S. (2022). PENGHITUNGAN KAPASITAS VOLUME TAMPUNGAN EMBUNG ROGODADI KABUPATEN KEBUMEN. CivETech, 4(1), 20–29. https://doi.org/https://doi.org/10.47200/civetech.v4i1.1103

Tambaru, T. (2024). ANALISIS KAPASITAS TAMPUNGAN EMBUNG SERBAGUNA KALEPADANG UNTUK MEMENUHI KEBUTUHAN AIR BAKU PENDUDUK KECAMATAN BONTOHARU. Selodang Mayang, 10(1), 61–72. https://doi.org/https://doi.org/10.47521/selodangmayang.v10i1.358

Zevri, A. (2021). ANALISIS KEBUTUHAN KAPASITAS TAMPUNGAN EMBUNG DANAU ASAM DI KABUPATEN KOTAWARINGIN BARAT. Jurnal Sumber Daya Air, 17(2), 83–94. https://doi.org/https://doi.org/10.32679/jsda.v17i2.719