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The Impact of Sepaku Semoi Dam Construction on the Reduction of Tengin River Flow with the HEC-HMS Model

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Abstract

Flooding is a common hydrometeorological disaster in Indonesia, particularly in river basins. One of the most frequently affected watersheds is the Sepaku Watershed (DAS Sepaku), where the frequency and intensity of floods have increased in recent years. To mitigate future flood risks, reservoir routing analysis is conducted as a preventive measure. A key strategy to reduce flooding is dam construction. In response, the Central Government, through the Ministry of Public Works and Public Housing, has undertaken the Sepaku Semoi Dam project in Penajam Paser Utara Regency. This dam is designed to provide a raw water supply of approximately 2,500 liters per second, mitigate flooding, and support tourism. This study examines flood discharge at the Sepaku Semoi Dam using the HEC-HMS model with the reservoir routing method. The modeling process aims to generate accurate flood discharge calculations, assess the impact of storage capacity on peak flood discharge, and evaluate the overall effects of dam construction. The reservoir routing analysis results indicate a 74.34% flood reduction for a 1,000-year return period (Q1000). Meanwhile, the outflow discharge for a 50-year return period (Q50) is 105.7 m³/s, below the Tengin River's downstream capacity, demonstrating the dam's effectiveness in flood control.

Keywords*: Dam; Flood; Watershed; Design Flood; Overtopping*

1. Introduction

The Sepaku Semoi Dam is a homogeneous earthfill dam constructed by damming the Tengin River. The dam's structural parameters, measured from its foundation, include a height of 25 meters, a length of 450 meters, a width of 6 meters at its crest, an upstream slope ratio of 1:3.5, and a downstream slope ratio of 1:3.0. The dam's normal water level (MAN) is positioned at an elevation of +15.073 meters above sea level, while the high water level (MAB Q1000) is at an elevation of +17.053 meters above sea level. The flood water level is measured at an elevation of +17.053 meters above sea level. The maximum flood water level (MAB QPMF) is +18.913 meters above sea level, and the maximum crest elevation of the dam is +20.073 meters above sea level.The Sepaku Semoi Dam is used to meet the raw water demand of ±2,500 liters/second and to reduce the annual flooding that often occurs in the Sepaku watershed. Geographically, the dam is situated at 01° 32' 24" LS and 116° 24' 11" E, while administratively, it is located in Tengin Baru Village, Sepaku Subdistrict, Penajam Paser Utara District, East Kalimantan (see Figure 1).

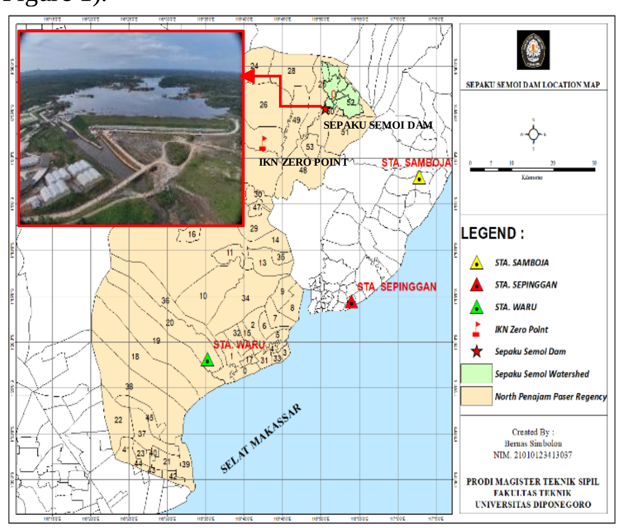

Figure 1. Location of the Sepaku Semoi Dam.

Flooding is one of the most common hydrometeorological disasters in Indonesia, especially in the Sepaku watershed. In recent years, the intensity and frequency of flooding have increased in several parts of

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Indonesia, including Tengin Baru village and the Sepaku subdistrict. The Sepaku watershed experienced frequent flooding before the dam, resulting in the overflow of the Tengin River inundating residential areas and becoming an annual problem for residents. This is corroborated by information from the National Disaster Mitigation Agency (BNPB), which recorded approximately 31 flood events that affected the Penajam Paser Utara district between 2010 and 2020. On February 18, 2020, BNPB reported a flood in Tengin Baru village that inundated about 115 families or 379 people and damaged a bridge. http://www.viva.co.id/ragam/round-up/1263917-sama-dengan-jakarta-calon-ibu-kota-baru-rawanbanjir?page=1

It is believed that the flooding in Tengin Baru village is caused by a combination of factors, including heavy rainfall intensity, extended rainfall duration, climate change, environmental degradation, and the lack of adequate flood control infrastructure.The impact of flooding has resulted in significant losses, both material and immaterial, including infrastructure damage, economic losses, disruption to daily activities, and negative health impacts. One potential solution that has been proposed to help mitigate the risk of future flooding is the construction of dams, which aim to reduce the impact of floods (Teknika Cipta Konsultan, 2019).

The purpose and objective of this research is to obtain the design flood discharge at the DTA of Sepaku Semoi Dam with different return periods (Q50, Q100, Q500, Q1000 & QPMF) and to analyze the impact of the construction of Sepaku Semoi Dam on the reduction of Tengin River discharge.

2. Materials and Methods

2.1 Hydrological Analysis

The hydrological analysis process involves processing data on rainfall, watershed, slope, and land use.These factors influence the maximum rainfall, conveyance coefficient, time of concentration, rainfall intensity, and design flood discharge (Nurdianyoto, 2019).When conducting flood discharge analysis in ungauged catchments, rainfall data is a critical component. The limited number of surface rain gauge stations in many regions of Indonesia poses a significant challenge in providing spatially reliable rainfall data (Wahyuni et al., 2020). In this study, GPM rainfall data is utilized to calculate the rainfall schedule employed in the design flood discharge calculation. The Global Precipitation Measurement (GPM) satellite constellation, an international network of satellites, provides global rain and snow observations, with a 2-4 hour data collection frequency. It offers wider coverage than the TRMM (Tropical Rainfall Monitoring Mission) data (Goddard Space Flight Center Greenbelt, 2013). Prior to analysis, GPM satellite rain data is compared with ground station rain data to assess data quality. To ensure the quality of the GPM satellite rain data obtained, the data evaluation is first carried out using the correlation coefficient parameter between the ground station rain data and the GPM rain data by creating an NSE matrix and the correlation coefficient.The correlation coefficient value can be calculated using the following equation (Sanjaya et al., 2022).

$$r = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum (X_i - \bar{X})^2 \cdot \sum (Y_i - \bar{Y})^2}} \quad (1)$$

where r is the correlation coefficient, $\bar{X}$ is the mean value of the random variable X, Xi is the value of the ith variable X, $\bar{Y}$ is the mean value of the random variable Y, Yi is the value of the ith variable Y. And to find the NSE criterion value, you can use the criteria in Table 1.

Table 1. Nash-Sutcliffe Efficiency Criteria (Jarwanti et al., 2021)

NSE Value	Interpretation
NSE > 0,75	Good
0,36 < *NSE* < 0,75	Meet
NSE < 0,36	Does not meet

2.2 Design Rainfall Analysis

Frequency analysis is the process of determining the relationship between the magnitude of extreme events and the frequency of their occurrence using probability analysis. There are several types of distributions that can be used to analyze design rainfall, including Normal, Log Normal, Log Pearson Type III, and Gumbel (Sudarmin, 2017). The calculation of rainfall schedules can be performed using Hydrognomon software, a tool designed for the management and analysis of hydrological data, including design rainfall analysis. Within Hydrognomon, the Pythia module is employed for statistical analysis of time series data, and the GPM Maximum Yearly Daily Rainfall (HHTM) values are entered into the software. The final output is the design rainfall with various return periods up to R1000th (Amri et al., 2024). Additionally, the PMP is calculated using the Hersfield method. The design rainfall is also used as input to the HEC-HMS software to calculate the design flood discharge.

2.3 Design Flood Discharge Analysis

In addition to the design rainfall used as input, the hourly rainfall distribution is required for the design flood discharge calculation. This hourly distribution is a temporal distribution (the amount of rain at any given time to the nearest day, hour, or even minute), not a spatial distribution. The hourly rainfall used to calculate the flood discharge is a modification of the rainfall distribution model that is arranged in a clapper (Febriani et al., 2024).

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2.4 HEC-HMS

HEC-HMS can simulate hydrologic processes such as water loss, runoff transformation, open channel routing, meteorological data analysis, rainfall-runoff simulation, and parameter estimation (Tassew et al., 2019). HEC-HMS is a numerical mathematical model packaged in a computer program that consists of various methods for simulating the behavior of watersheds, channels, and water control structures. The model was developed by USACE-HEC to predict the performance of a watershed system. In this study, a multi-basin approach was used to calculate the design flood discharge and water availability, which was chosen because of its wide coverage. The calculation process was performed using HEC-HMS software (US Army Corps of Engineers, 2001).

The primary components of the HEC-HMS system include the following: (1) a basin model, (2) a meteorological model, (3) control specifications, (4) time series data, (5) paired data, and (6) terrain data. In this particular instance, the data input process is executed within the aforementioned components of HEC-HMS. The procedure initiates with the delineation of the watershed area to obtain a map. The outputs issued from the HEC-HMS modeling results are in the form of planned flood discharge, peak flood discharge, and flood reduction (Sahu et al., 2020).

The following data are required: watershed maps, soil type maps, and land use maps. The Sepaku Semoi watershed is dominated by scrub forest, plantations, and mixed dryland agriculture. Based on the available land use map, the area of the Sepaku Semoi watershed is 63.48 km². The percentage values of soil types and land cover are presented in Tables 2 to 3, and the land use map can be seen in Figure 2.

Table 2. Soil Types in the Sepaku Semoi Watershed.

No.	Domsoi Type	Soil Type	HSG	Area (Km²)	Percentage (%)
1	Qc	Sand	A	37,41	58,93
2	Ao	Sandy Clay Loam	A	26,07	41,07
	Total Land Area			63,48	100

Table 3. Summary of land use in the watershed Sepaku Semoi

No.	Land Cover of the Sepaku Watershed	Area (Km²)	Percentage (%)
1	Thicket	10,28	16,19
2	Forest Plantation	2,62	4,12
3	Plantation	19,37	30,52
4	Mixed Dryland Farming	22,94	36,13
5	Open Land	1,22	1,92
6	Transmigration	7,06	11,11
Total Land Cover		**63,48**	**100**

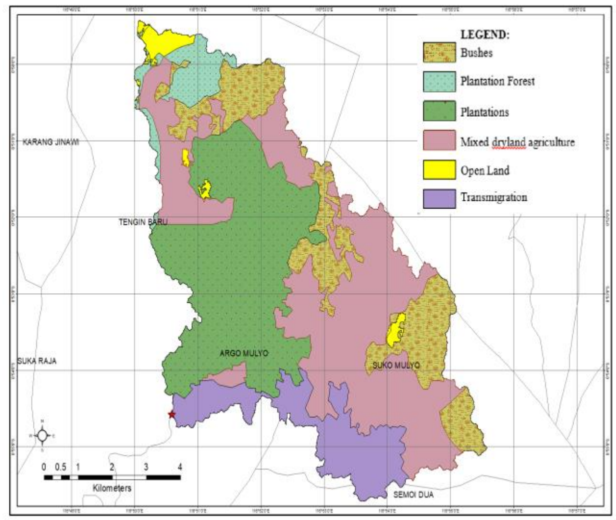

Figure 2. Land Use Map of Sepaku Semoi Watershed

2.5 Reservoir Routing Analysis

Reservoir tracing is a procedure for determining the time and discharge (flood hydrograph) at a point of flow. The purpose of flood tracing is to determine the characteristics of floods entering a reservoir in the context of flood control (Triatmodjo, 2008).

The utilization of the HEC-HMS model, employing the reservoir routing method, has emerged as a prominent approach in the study of flood forecasting in reservoirs. This model serves as a prototype, mirroring actual natural conditions. The primary objective of this model is to expeditiously derive flood runoff calculations and to discern the impact of alterations in storage capacity on peak flood runoff conditions. The validity of a model is contingent upon the incorporation of inputs that accurately represent actual conditions. These inputs exert a significant influence on the model's capacity to approximate actual conditions. The model inputs of particular relevance include watershed characteristics, such as curve number (CN), initial abstraction (IA), slope values, design rainfall, dam dimensions, and other characteristics (Limbong & Wulandari, 2022).

The objective of flood tracing past the spillway is to ascertain the relationship between discharge and reservoir water level elevation, commencing from the

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spillway sill elevation. The flood tracking is predicated on the continuity equation as follows (Soemarto, 1995):

$$I - O = \frac{ds}{dt} \quad (2)$$

When expressed in time, it can be formulated with the equation**:**

$$S_{t+1} - S_t = \frac{(It+I_{t+1})\Delta t}{2} - \frac{(Ot+O_{t+1})\Delta t}{2} \quad (3)$$

Or

$$\left[\frac{(I_i+I_{i+1})}{2}\right] + \left[\frac{S_t}{\Delta t} - \frac{O_t}{\Delta t}\right] = \left[\frac{S_t}{\Delta t} + \frac{O_t}{\Delta t}\right] \quad (4)$$

If

$$\left[\frac{S_t}{\Delta t} - \frac{O_t}{\Delta t}\right] = \Psi \text{ dan } \left[\frac{S_t}{\Delta t} + \frac{O_t}{\Delta t}\right] = \Phi \quad (5)$$

Then,

$$\left[\frac{(I_i+I_{i+1})}{2}\right] + \Psi = \Phi \quad (6)$$

Where I_t is the inflow hydrograph at the beginning of time Δt, I_{t+1} is the inflow at the end of time Δt, O_t is the outflow hydrograph at the beginning of time Δt, S_t is the storage at the beginning of time Δt, S_{t+1} is the storage at the end of time Δt.

2.6 Research Methods

In this study, the necessary supporting data were obtained from BWS Kalimantan IV in the form of secondary data. The data included (1) rainfall data, (2) bending capacity (H-V-A curve), (3) dam technical data, and (4) GPM satellite rainfall data for the last 23 years; (5) a soil type map, obtained from DSMW version 1974; (6) land use, obtained from Geospatial Information Agency (BIG) 2019; and (7) DEMNAS data (Kalimantan River Basin IV, 2023).

In conducting this research, it is essential to adhere to a systematic sequence of steps to minimize variation and ensure the analysis achieves study results that align with the research objectives.The collection of detailed data is imperative to support the research.The research steps commence with the comparison of daily rainfall data from ground stations with GPM satellite rainfall data utilizing correlation coefficients.The evaluation results that meet good correlation criteria and satisfactory NSE are employed to rectify the rainfall data until the error value is ascertained. Rainfall data undergoes rigorous scrutiny using RAPS consistency tests and outlier tests.Satellite rainfall data that successfully passes these rigorous evaluations is then subjected to detailed analysis. This analysis involves calculating the influence coefficient area of the selected grid rain stations to obtain the maximum annual daily rainfall (HHMT).The HHMT value is then entered into Hydrognomon to obtain the planned rainfall.

Daily rainfall data is first converted to hourly rainfall data. Then, it is converted to daily discharge using the HEC-HMS application. The planned flood discharge is analyzed with the HEC-HMS application using the SCS method. The planned flood discharge is used for reservoir flood routing through spillways. Based on the flood routing results, the peak inflow and outflow discharges and the flood reduction percentage are obtained. The overall research steps are illustrated in Figure 3.

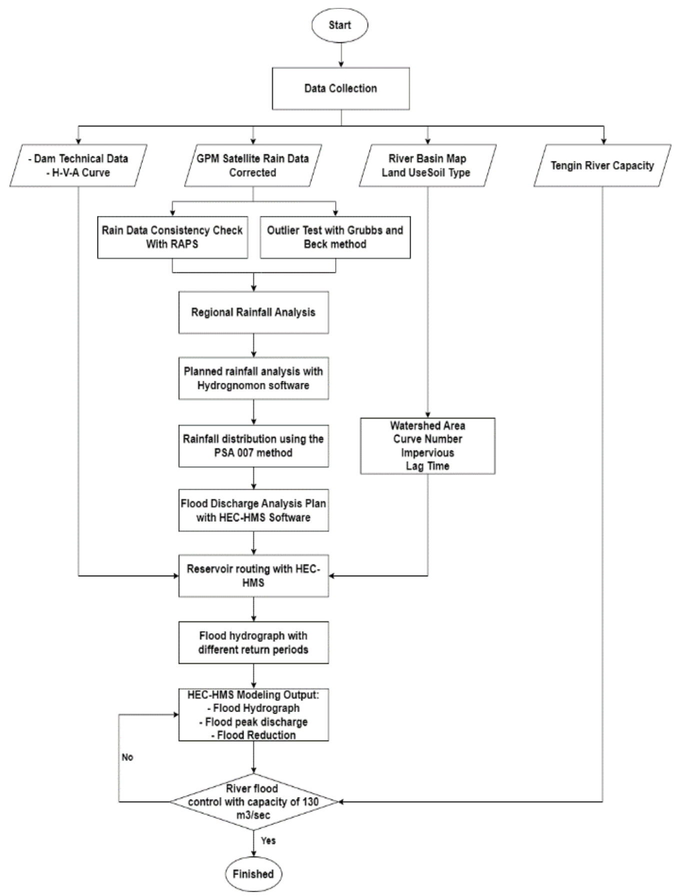

Figure 3. Research Flow Chart.

The data processing steps are as follows :

Rain Data Test

The initial step in this study is to ascertain the feasibility of utilizing rainfall data. This is achieved by statistically testing the corrected satellite rainfall data to ensure its suitability for further analysis. The data tests performed include data consistency tests using the Rescaled Adjusted Partial Sums (RAPS) method and outlier tests using the Grubbs and Beck method.

Regional Rainfall

The following stages are carried out for regional rainfall: (a) To obtain the maximum CH, data from two

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station grids are calculated based on the date of occurrence at each station, then multiplied by the area affecting the Sepaku Watershed. The result is the Annual Maximum Daily Rainfall (HHMT) value in the Sepaku Watershed area. (b) In the analysis of rainfall frequency, the amount of planned rainfall can be determined manually by applying the Gumbel, Normal, Log Normal, and Log Pearson Type III methods. (c) The frequency distribution suitability test is carried out manually using the Chi-Square Method (X²).

Rainfall schedule using Hydrognomon software

In this case study, the following steps are taken in the calculation of rainfall schedules: (a) First, the average CH rainfall value of the region is obtained. Then, the calculation is analyzed in Hydrognomon software by searching for the value of rainfall schedules with different return times. (b) Subsequently, the CH frequency analysis can calculate the amount of design rainfall by applying Hydrognomon software to the Gumbel method, Normal, Log Normal, and Log Person Type III. The suitability test of frequency distribution is performed with Hydrognomon software using the Smirnov-Kolmogorov test method and the Chi-square method (X²). The results of the analysis of the frequency of rainfall schedules for different return times are then recapitulated. Finally, several types of distributions are compared, and a method is selected, where the smaller critical value is selected for further analysis.

Flood tracing using the software HEC-HMS

Through hydrological modeling in this program, the amount of inflow, outflow, and timing of inflow-outflow in a watershed can be determined. The main stages of flood modeling using HEC-HMS software include collecting data on rainfall, land use, soil type, and DEM; creating a watershed model; determining parameters such as Curve Number (CN), Initial Abstraction (Ia), and Lag Time; inputting planned rainfall data into the model; running simulations to obtain planned flood discharges and flood hydrographs; and validating the model by comparing simulation results with historical data.

3. Results and Discussion

3.1 Rain Data Analysis

Conducting a rainfall analysis necessitates the consideration of data availability and quality to ensure the reliability of the results. The process involves the selection of maximum daily rainfall at each observation station, the correlation with satellite rain stations, the correction and verification of rainfall data, regional rainfall analysis, frequency analysis, and distribution suitability testing. In this study, three observation rain stations are situated in proximity to the dam site, and their coordinates are delineated in Figure 4.

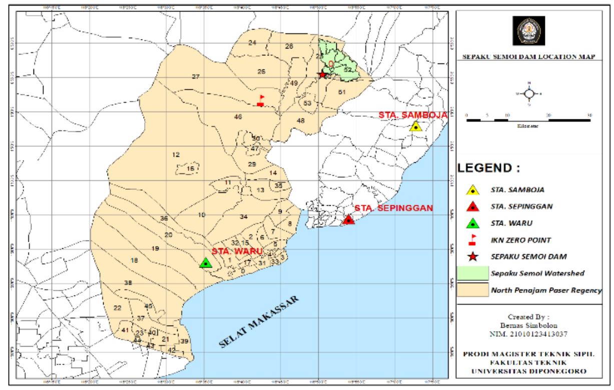

Figure 4. Coordinate map of Groundstation Rain Post.

As illustrated in Figure 4, there are several problematic conditions at the observation rainfall station around the dam. Namely, there is a lack of data availability at STA. Samboja, STA. Sepinggan, and STA. Waru. In addition, the three stations are located outside the watershed, which does not affect the Sepaku watershed. Therefore, the rainfall analysis was conducted using GPM satellite rainfall data. The boundaries of the GPM satellite rainfall data and its grid coordinates are delineated in Figure 5.

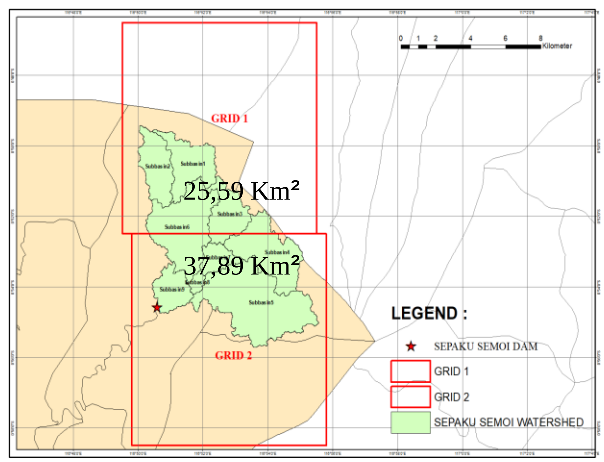

Figure 5. GPM Satellite Grid Boundary.

The results of the calculation of the correlation coefficient value and the NSE value between satellite rain data and ground station rain data can be found in the description of Table 4.

Table 4. Correlation coefficient value of ground station with GPM satellite

Rainfall	Correlation Coefficient			NSE		
	Samboja	Sepinggan	Waru	Samboja	Sepinggan	Waru
GRID 1	0,67	0,91	0,90	-0,49	0,57	0,19
GRID 2	0,68	0,91	0,90	-0,47	0,58	0,22

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The results of the analysis presented in Table 4 indicate a strong correlation between satellite rain data and ground station rain data, as evidenced by the significant positive correlation coefficients (r) > 0.6 observed for STA. Samboja, STA. Sepinggan, and STA. Waru. This finding suggests a high degree of concordance between the GPM satellite rain data and the ground station rain data. Given the observed value of the correlation coefficient between satellite rain data and ground station rain data, which exceeds 0.6, it is imperative to undertake further analysis to ascertain the probability value of each variable. The outcomes of the error value of the three rain data are then compared, and the smallest difference value is identified for incorporation into the data correction process. (3) The Sepinggan rain post is the basis for correcting GPM daily rain because it has a high level of correlation and NSE.

3.2 Regional Rainfall Analysis

Rainfall data that has passed the inspection test is then used to calculate a regional rainfall analysis based on the influence of each grid in Sepaku DTA. The influence of grid 1 and grid 2 can be obtained from the description of Figure 5. The following results of the influence area of each selected grid are listed as shown in Table 5.

Table 5. Area of Influence of Each Grid

Rain Station	Area (Km^2)	Coefficient	Data Availability
GRID 1	25,59	0,40	2001 - 2023
GRID 2	37,89	0,60	2001 - 2023
Total Area of Influence	**63,48**	**1**	

The calculation of the coefficient of the area of influence of the Grid CH Region rain station for the annual maximum daily precipitation (HHMT) from 2001 to 2023 can be found in the description of Table 6.

Table 6. Recapitulation of annual maximum daily precipitation

Year	HHMT (mm)	Year	HHMT (mm)
2001	96,73	2013	105,00
2002	255,59	2014	106,08
2003	117,16	2015	94,32
2004	117,14	2016	83,38
2005	104,90	2017	185,14
2006	140,53	2018	175,32
2007	97,64	2019	134,72
2008	98,95	2020	84,54
2009	55,08	2021	106,09
2010	178,51	2022	137,27
2011	135,09	2023	80,56
2012	118,68		

Based on Table 6, the annual maximum daily rainfall (HHMT) value is used as an input to the Hydrognomon component to obtain the design rainfall value.

3.3 Rainfall Analysis

The design rainfall value employed in this study is the Log Pearson-III distribution, a determination that is supported by the findings of the distribution test. The distribution test results, as indicated in Table 7, exhibit the smallest deviation value. The distribution test methods utilized in this study are the Smirnov-Kolmogorov and Chi-square methods, both of which are generated from the Hydrognomon software.

Table 7. Distribution test results for various return times using Hydrognomon

No.	Return Period	Rainfall Plan (mm) Normal	Gumbel	Log-Normal	Log Pearson III
1	2	122,105	114,964	115,037	113,793
2	5	158,678	153,382	153,837	151,682
3	10	177,796	178,818	179,077	178,026
4	25	198,182	210,956	210,571	212,800
5	50	211,352	234,799	233,803	239,815
6	100	223,180	258,465	256,882	267,805
7	200	234,039	282,044	279,994	296,990
8	500	247,178	313,153	310,808	337,703
9	1000	256,393	336,665	334,424	370,309
Test Smirnov - Kolmogorov (a=5%)	D Maks	0,156	0,094	0,093	0,086
	D Critical	0,275	0,275	0,275	0,275
	Results	**Accepted**	**Accepted**	**Accepted**	**Accepted**
Test Smirnov - Kolmogorov (a=1%)	D Maks	0,156	0,094	0,093	0,086
	D Critical	0,330	0,330	0,330	0,330
	Results	**Accepted**	**Accepted**	**Accepted**	**Accepted**
Test Chi-Square (a=5%)	x^2	10,130	4,913	3,870	0,739
	x^2 Critical	7,815	7,815	7,815	7,815
	Results	**Rejected**	**Accepted**	**Accepted**	**Accepted**
Test Chi-Square (a=1%)	x^2	10,130	4,913	3,870	0,739
	x^2 Critical	11,341	11,341	11,341	11,341
	Results	**Accepted**	**Accepted**	**Accepted**	**Accepted**

The distribution test results for various return times for the Gumbel, Log Normal, and Log Pearson III distributions demonstrated a successful outcome in passing the Smirnov-Kolmogorov and Chi-square tests. The distribution that was utilized for the rainfall schedule was the Log Pearson III distribution, as it exhibited the minimum Dmax value in comparison to the other distributions.

The probable maximum precipitation (PMP) analysis for the Sepaku Dam is guided by the guidelines outlined in SNI 7746 of 2012, which details the procedures for analyzing probable maximum rainfall calculations using the Hershfield method (National Standardization Agency, 2012). The Hershfield method

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is a statistical procedure employed to estimate maximum precipitation values, particularly in scenarios where meteorological data are scarce. The PMP calculation in the Sepaku Semoi watershed yielded a result of 432.37 mm.

3.4 Hourly Rainfall Distribution Patterns

The purpose of the hourly rainfall distribution analysis is to estimate the percentage of the total rainfall that falls each hour. The hourly rainfall intensity distribution pattern used in this case study refers to PSA 007. The results of the planned rainfall intensity distribution at the Sepaku Dam catchment area over 6 hours are shown in Table 8.

Table 8. Hourly Rainfall in the 1st hour to 6th hour time duration (mm)

Hours	Plan Rain Intensity (mm)									
	2	5	10	25	50	100	200	500	1000	PMP
1	5	6	7	9	10	11	12	14	15	21
2	13	17	21	26	31	36	41	47	53	85
3	81	106	121	143	156	171	187	209	226	297
4	7	10	14	18	24	29	34	41	47	85
5	5	6	7	9	10	11	12	14	15	21
6	5	6	7	9	10	11	12	14	15	21

3.5 Modeling of Plan Flood Discharge

In this case study, the parameters or characteristics of the watershed are determined using the SCS Curve Number pattern by implementing an overlay on the land use map, soil type map, and DEM map of the Sepaku Semoi Dam watershed. The parameter values obtained from the overlay results, including Curve Number (CN), Initial Abstraction (Ia), and Impervious (I) values, are shown in Table 9.

Table 9. Loss Parameter Value of Sepaku Dam DTA

No.	SUB DAS	CN	IA	I
1	Subbasin1	46,22	59,11	5,00
2	Subbasin2	54,41	42,57	5,00
3	Subbasin3	48,44	54,08	5,00
4	Subbasin4	54,83	41,85	5,00
5	Subbasin5	68,40	23,46	13,01
6	Subbasin6	46,09	59,42	5,00
7	Subbasin7	54,84	41,84	5,00
8	Subbasin8	47,48	56,19	5,37
9	Subbasin9	61,16	32,26	14,00

The integration of land use and soil type maps facilitates the determination of parameter loss values for the Sepaku Dam catchment area. These values are subsequently entered into the HEC-HMS component to assess the design flood discharge through simulations with varying return periods.The modeling results for the planned flood discharge using HEC-HMS with these parameters illustrate the maximum discharge value at the 6-hour time position for different return periods. The analysis of the planned flood discharge and the flood discharge hydrographs for various return periods are illustrated in Figure 6.

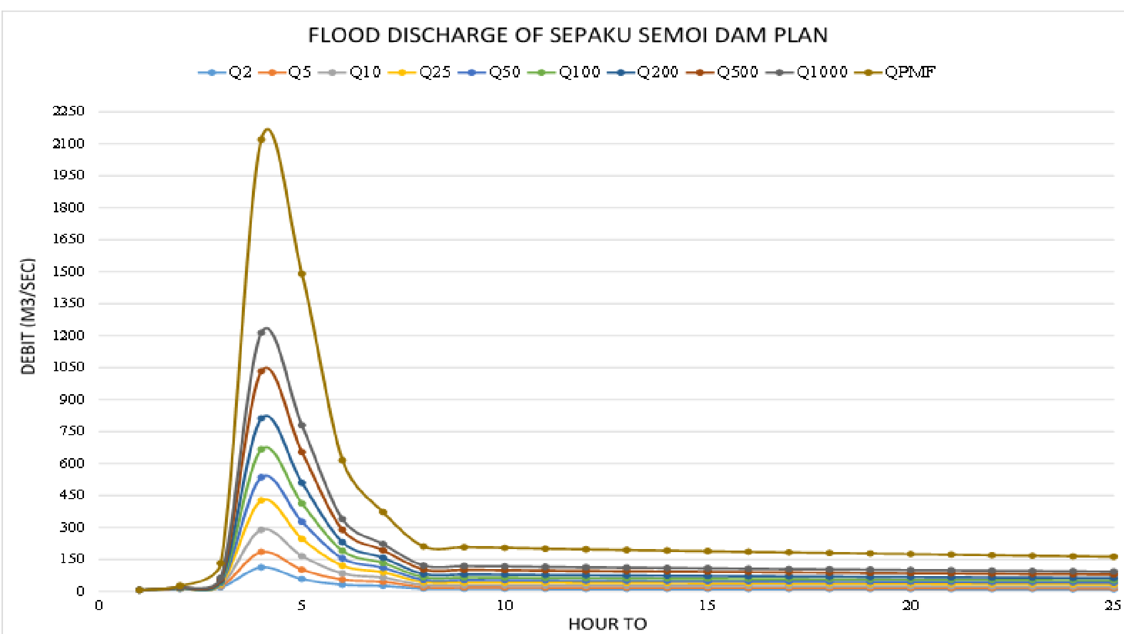

Figure 6. Hydrograph of planned flood discharge.

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3.6 Flood Tracing (Routing)

The results of the Hec-HMS simulation were utilized to assess the planned flood discharge modeling, yielding the inflow and outflow discharge values at various return periods. The flood tracking results indicate that this dam can significantly reduce floods at various return periods. The flood reduction percentage for the Sepaku Semoi Dam is demonstrated in Table 10.

Table 10. Reduction of flood discharge at Sepaku Semoi Dam at each return period

No.	Repeat Time	Peak Inflow	Peak Outflow	Peak Flood Elevation	Flood Reduction
	(Year)	m³/dt	m³/dt	m	%
1	**2**	112,40	12,70	15,30	88,70
2	**5**	**184,70**	28,60	15,50	84,52
3	**10**	289,30	45,40	15,60	84,31
4	**25**	426,90	75,70	15,80	82,27
5	**50**	535,50	105,70	16,00	80,26
6	**100**	666,40	**140,30**	16,20	78,95
7	**200**	811,80	181,10	16,40	77,69
8	**500**	1032,60	247,40	16,70	76,04
9	**1000**	1213,40	311,40	**16,90**	**74,34**
10	**PMF**	2119,90	679,70	18,10	67,94

The flood routing results in the Sepaku Semoi Dam catchment area, as shown by the HEC-HMS application. These results indicate that the peak discharge of Q1000 is at an elevation of +16.90, which is below the MAB (technical data) of +17.073, with a flood reduction percentage of 74.34%. The discharge for the Q50 return period is 105.70 m³/s, while the capacity of the Tengin River is 130 m³/s. Therefore, the reservoir discharge for the Q50 recurrence period is smaller than the river capacity.

The routing results before the dam existed show that floods occurred at a Q5 return period with a discharge of 184.70 m³/s. After the dam was constructed, floods occurred at a Q100 return period with a discharge of 140.30 m³/s. This indicates that the calculated discharge is less than the capacity of the Tengin River, so the discharge from the dam does not cause downstream flooding.

4. Conclusion

Based on the flood routing results using the HEC-HMS application, the planned flood discharges for different return periods are as follows: Q2 year at 112.40 m³/s; Q5 year at 184.70 m³/s; Q10 year at 289.30 m³/s; Q25 year at 426.90 m³/s; Q50 year at 535.50 m³/s; Q100 year at 666.40 m³/s; Q200 year at 811.80 m³/s; Q500 year at 1032.60 m³/s; Q1000 year at 1213.40 m³/s; and QPMF at 2119.90 m³/s. The construction of the Sepaku Semoi Dam has had a significant impact on reducing the Tengin River's discharge. Before the dam was built, the Q5 return period discharge caused flooding. However, after the construction of the dam, only the Q100 return period discharge caused flooding. This demonstrates the dam's effectiveness in mitigating flood risks.

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References

Amri, S., Roza Syofyan, E., Wahyuni, F., & Kurniawan, J. (2024). Analisis Run-Off Menggunakan Cara Manual dan Software *Hydrognomon* pada DAS Batang Lembang. Jurnal Teknik Sipil ITP, 11(1). https://doi.org/10.21063/JTS.2024.V1101.046-55

Badan Standardisasi Nasional. (2012). *SNI 7746:2012* Tata Cara Perhitungan Hujan Maksimum Boleh Jadi Dengan *Metode Hershfield*.

Balai Wilayah Sungai Kalimantan IV. (2023). Laporan Rencana Tindak Darurat Bendungan Sepaku Semoi.

Febriani, I., Sriyana, I., & Suharyanto, S. (2024). Evaluasi Kemampuan Bendungan Logung dalam Mereduksi Banjir Akibat Perubahan Curah Hujan dan Tata Guna Lahan. TEKNIK, 45(1), 117–127.

Goddard Space Flight Center Greenbelt, M. 20771. (2013). Global Precipitation Measurement (GPM) Science Implementation Plan. NASA. Greenbelt, Maryland.

Jarwanti, D. P., Suhartanto, E., & Fidari, J. S. (2021). Validasi Data Curah Hujan Satelit TRMM (Tropical Rainfall Measuring Mission) dengan Data Pos Penakar Hujan di DAS Grindulu, Kabupaten Pacitan, Jawa Timur. Jurnal Teknologi Dan Rekayasa Sumber Daya Air, 1, 772–785.

Limbong, B., & Wulandari, D. A. (2022). *Reservoir Routing* di Waduk Greneng, Blora Dengan Model HEC-HMS.

Nurdianyoto, I. (2019). Analisis Hujan-Debit Banjir menggunakan Model HEC-HMS Sub DAS Sadar Kabupaten Mojokerto.

Sahu, S., Pyasi, S. K., & Galkate, R. V. (2020). *A review of the HEC-HMS rainfall-runoff simulation model*. *International Journal of Agricultural Science and Research*, *10*(4), 183–190.

Sanjaya, S., Yudianto, D., Adidarma, W., & Fitriana, F. (2022). Studi Pemanfaatan Curah Hujan Bulanan Satelit GPM di Kawasan Bandung Raya dengan Validasi Silang Monte Carlo.

Soemarto, C. D. (1995). Hidrologi Teknik (Edisi ke-2). Erlangga. Jakarta.

Sudarmin, M. A. (2017). Analisis Debit Banjir Rancangan dan Kapasitas Pelimpah Bendungan Way Yori. Tugas Akhir. Jurusan Sipil, Fakultas Teknik, Universitas Hasanuddin, Makassar.

Tassew, B. G., Belete, M. A., & Miegel, K. (2019). Application of HEC-HMS model for flow simulation in the Lake Tana basin: The case of Gilgel Abay catchment, upper Blue Nile basin, Ethiopia. Hydrology, 6(1), 21.

Teknika Cipta Konsultan, P. (2019). Laporan Akhir Review Desain dan Sertifikasi Desain Bendungan Sepaku Semoi.

Triatmodjo, B. (2008). Hidrologi Terapan, Beta Offset. Yogyakarta. Hal, 195–273.

US Army Corps of Engineers, H. E. Center. (2001). H. M. S. H.-H. U. manual. (2001). Hydrologic Modeling System HEC-HMS User's Manual CPD-74A.

Wahyuni, S., Hambali, R., & Fahriani, F. (2020). Evaluasi Ketelitian Data Curah Hujan Satelit GPM Terhadap Data Curah Hujan Permukaan. *Evaluation of the Accuracy of GPM Satellite Rainfall Data on Surface Rainfall Data)* Pertemuan Ilmiah Tahunan (PIT) HATHI-37. Universitas Bangka Belitung, 1083–1094.

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