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STUDY OF FLOOD DISPOSAL BASED ON STEADY FLOW ANALYSIS WITH HECRAS ON CAMPUS I OF LAMBUNG MANGKURAT UNIVERSITY, BANJARMASIN

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ABSTRACT

The city of Banjarmasin, especially northern Banjarmasin, which is a lowland located at an average altitude of 0.16 m below sea level, so that when the sea water is high, it flows into residential areas to the ULM Campus I area. In this study, the flood discharge method used is the Rational method with a return period of 2, 5, 10, 25, 50 and 100 years. After the flood discharge was found, the analysis of the longitudinal and transverse sections of the Prince river was then modeled using Steady Flow Analysis on HECRAS according to the return period of the rain. Simulation results using Steady Flow Analysis on HECRAS which are close to the design flood discharge are station 12 with discharge times of 2, 5,10, 25, 50 and 100 years respectively, namely 41.18 m^3/s, 55.33 m^3/s , 64.47 m^3/s, 74.74 m^3/s, 83.92 m^3/s, 92.33 m^3/s, so that the design flood discharge can be used for further calculations and used as a reference in the construction of hydraulic buildings.

Keywords**:** **Flood Discharge, Cross Section Analysis, Steady Flow Analysis.**

1. INTRODUCTION

Background

In mid-January 2021 floods hit South Kalimantan. The city of Banjarmasin, especially northern Banjarmasin which is a lowland located at an average height of 0.16 m below sea level, so that when the sea water is high, it will reach residential areas and flow to the Campus I ULM area. The puddle of water that submerged the ULM Campus occurred for several days so that the roads to the building and classrooms became limited. Campus I ULM is crossed by small rivers, Campus land built on wetlands, ineffective infiltration wells and due to tides. In addition, the occurrence of flood inundation can also be caused by runoffthatoverflows and its volume exceeds the capacity of the drainage system or river flow system.

2. THEORITICAL STUDY

Hydrological Analysis

analysis in the form of calculations of the frequency of rainfall, several distributions of rainfall frequencies that are widely used in hydrological analysis there are four types, namely:

1. Normal Distribution

   Calculation of normal distribution is as follows.

$$P(X) = \frac{1}{\sigma\sqrt{2\pi}} \exp^{\left(\frac{-(x-\mu)^2}{2\sigma^2}\right)}, -\infty < x < \infty$$

   Description :

   P(X) = Normal probability density function (ordinary curve normal)

   X = Continuous random variable

   μ = Average value

   X σ = Standard deviation of X value

2. Log Normal Distribution

$$(X) = \frac{1}{X\,\sigma\sqrt{2\pi}} \exp^{\left(\frac{-(Y-u_y)^2}{2\sigma y^2}\right)}$$

$$Y = \text{Log } X$$

   Description :

   P(X) = Log Normal probability

   X = variant value of observations

   μY = population mean value Y

3. Gumbel Distribution

   Distribution calculation is as follows

   $X_t = \bar{x} + S \cdot K$

   Description :

   X = average sample price

   S = variant value of observations X

4. Pearson Type III Log Distribution

   Calculation of the Pearson Type III distribution uses the following formula.

   $\text{Log Xt} = \log \bar{x} + K$

   Description :

   log X = average sample
   S = standard deviation price
   G = slope coeffient
   S = standard of deviation of variation value
   K = probability factor

Analysis of Design Flood Discharge

method of calculating flood discharge used is the Rational method. The formula for the Rational method is presented as follows.

$Q_p = 0{,}278 \,.\, C.I.A$

Description:

Qp = Peak discharge (m^3/sec)
C = runoff coefficient
I = rain intensity with the same duration as the time of flood concentration (mm/hour)
A = watershed area (km^2)

Analysis of Design Flood Discharge with Steady Flow Analysis on HECRAS

Steady Flow Analysis on application The HECRAS is an analysis of constant flood discharge in the HECRAS by entering design flood discharge data with a return period and longitudinal and transverse section data on the river.

2 METHOD

In this study, the data used is rainfall data in the city of Banjarmasin from the Banjarmasin Climatology Station. The data obtained are daily rainfall data for the years 2005-2009 and 2011-2021. The steps of this research method are;

1. Analyze the frequency of rain using the Normal distribution, Log Normal, Gumbel and Log Pearson Type III

2. From the results of the calculation of the frequency of rainfall with four distributions, it is found that the selected rainfall for the design flood discharge using the rational method

3. Analyzing the longitudinal and transverse cross sections of the river by taking measurements using a waterpass

4. Simulating Steady Flow Analysis using HECRAS from the data that has been obtained previously.

Research Data

Location The research location for flood inundation maps due to tides on Campus I ULM Banjarmasin is located on Jalan Brigadier General H. Hasan Basry Kayu Tangi, kec. North Banjarmasin, Banjarmasin City, South Kalimantan Province. Primary data is topographic data and secondary data is hydrological data.

3 RESULTS AND DISCUSSION

Rainfall data from 2005-2009, and 2011-2021 at the Banjarmasin climatology station can be seen in Table 1 below.

Table 1. Rainfall Recapitulation of Banjarmasin Climatology Station

No	Years	Rainfall(mm)
1	2005	62.2
2	2006	80
3	2007	109.3
4	2008	145
5	2009	105.2
6	2011	113
7	2012	92.4
8	2013	23.5
9	2014	118.2

No	Years	Rainfall(mm)
10	2015	117.5
11	2016	98.9
12	2017	111.8
13	2018	112.1
14	2019	70.5
15	2020	122.1
16	2021	249

Source: Banjarmasin Climatology Station

After 16 years of rainfall data are found, the next step is to calculate the frequency distribution with four distributions.

1. Normal Distribution

The normal distribution has a Gaussian variable value and is adjusted to the return period of rain. The normal distribution has a Gaussian variable value and is adjusted for the return period of rain.

2. Log Normal Distribution

Distribution The log normal distribution is not much different from the normal distribution because it also has a Gaussian variable value and is adjusted to the return period of rain.

3. Gumbel Distribution

Distribution In Gumbel distribution The estimated rainfall data for Gumbel distribution can be seen in Table 2.

4. Distribution of Log Pearson Type III

In the distribution of log Pearson Type III, rainfall data is multiplied by Log then subtracted by Xrt of rainfall.

The recapitulation of rainfall forecasts for Normal, Log Normal, Gumbel and Log Pearson Type III distributions with return periods of 2, 5, 10, 25, 50 and 100 years is presented in Table 2 below.

Table 2. Recapitulation of Rainfall Estimates with Normal Distribution, Log Normal, Gumbel and Log Pearson Type III

NO.	Repead Period (T)	RAINFALL(mm)			
		FREQUENCY DISTRIBUTION METHOD			
		NORMAL	LOG NORMAL	GUMBEL	LOG PEARSON TYPE III
1	2	216.338	216.338	103.959	108.169
2	5	256.012	216.516	151.683	163.340
3	10	276.794	216.610	183.283	202.697
4	25	297.104	216.702	223.207	250.307
5	50	313.163	216.774	252.824	295.748
6	100	326.388	216.834	282.180	339.301

After finding all the rainfall in accordance with the distribution, the next step is to test the distribution suitability with the chi-square distribution and Smirnov Kolmogorov distribution. The requirements for the chi-square compatibility test are $X^2 < X^2Cr$ in Table 3. Furthermore, the Smirnov Kolmogorov with the critical ∆P conditions ∆P maximum can be seen in Table 8 which is presented as follows.

Tabel 3. Chi-Square Fit Test Recapitulation

Frequency Distribution	X^2	X^2cr	Description
Normal	13.38	5.991	Rejected
Log Normal	9.63	5.991	Rejected
Gumbel	8.19	5.991	Rejected
Log Pearson Type III	3.38	5.991	**Received**

Tabel 4. Smirnov Kolmogorov Fit Test Recapitulation

Frequency Distribution	∆P max	∆P kritis	Description
Normal	0,206	0,34	**Received**
Log Normal	0,37	0,34	Rejected

Gumbel	0,62	0,34	Rejected
Log Pearson Type III	0,11	0,34	**Received**

Based on the Chi-Square compatibility test and the Smirnov Kolmogov test, the frequency distribution that both passed the test and met the requirements was the Log Pearson Type III, so it was concluded for further calculation analysis using the planned rainfall distribution Log Normal Type III. Rainfall The selected plan can be seen in Table 5 which is presented as follows.

Tabel 5. Preferred Rainfall

Repead Period (T)	**Frekuency Distribution**
	LOG PEARSON TYPE III (mm)
2	108.169
5	163.340
10	202.697
25	250.307
50	295.748
100	339.301

Design Flood Discharge

Method of calculating flood discharge used is the Rational method, with rainfall intensity using the Mononobe formula for 24 hours of rain in accordance with the planned rainfall that has been calculated. An example of calculating the intensity at the 1st hour can be seen as follows.

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

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

$t = 0{,}3467$ hours

Then calculate the discharge according to the planned rainfall for the 2-year return period

$I = 108{,}17$ x $0{,}3467$

$I = 37{,}500$ mm

After the rain intensity is calculated until the 24th hour, it is continued by calculating the flood discharge using the maximum hour. An example of a calculation for a 2 year anniversary can be seen as follows.

$Q_p = 0{,}278 \cdot C.I.A$

$Q_p = 0{,}278 \text{ x } 0{,}8 \text{ x } 37{,}500 \text{ x } 3{,}98$

$Q_p = 33{,}19 \text{ m}^3/\text{sec}$

The calculation of flood discharge for return periods of 2, 5, 10, 25, 50, and 100 years is presented in Table 10 as follows.

Tabel 6. Flood Discharge Rational Method

Period	**Flood Discharge**
Repead Period (T)	**Rational Method (m^3/s)**
2	33.19
5	50.12
10	62.20
25	76.81
50	90.75
100	104.12

Analysis of Design Flood Discharge with Steady Flow Analysis on HECRAS

After the design flood discharge data and the longitudinal and transverse river section data have been calculated, they are then modeled using Steady Flow Analysis on HECRAS. The first thing to do is the process of entering cross section each Prince River station which is divided into 13 stations according to the data values. The process of inputting the cross section can be seen in Figure 3.then fill in the design flood discharge according to the return period and the slope of the river. Next is the running process by filling in the plan and short ID. In this study, a design flood discharge was simulated based on Steady Flow Analysis at 2, 5, 10, 25, 50, and 100 year return periods, which can be seen in Figure 1 below.

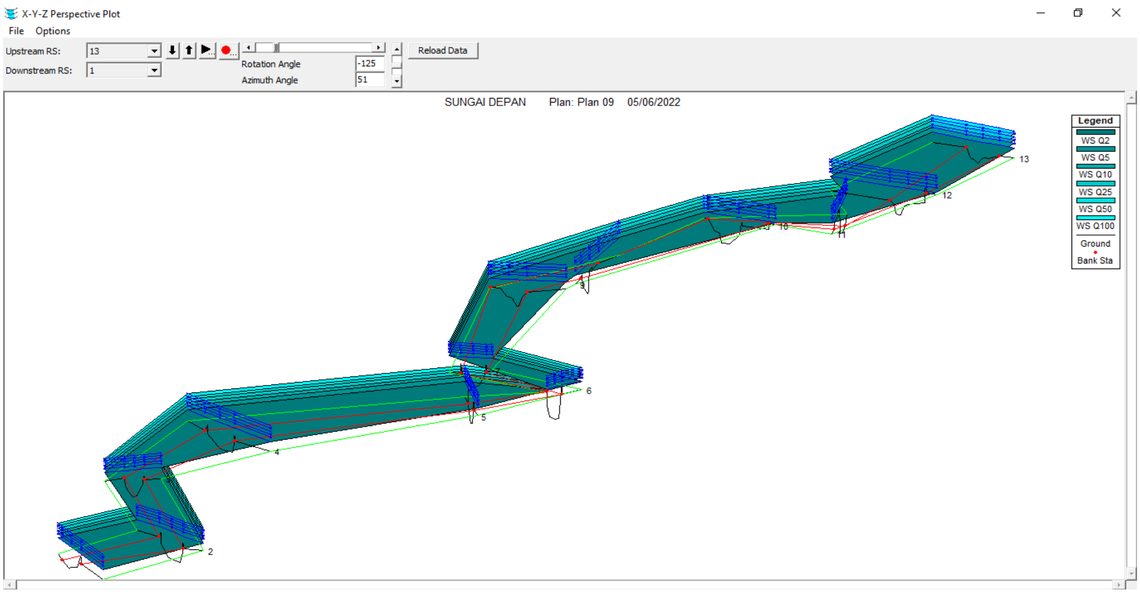

Figure 1. Inundation Simulation Results based on Steady flow

The results output profile based on Figure 1 can be seen in Figure 2 presented as follows.

Profile Output Table - Standard Table 1

File Options Std. Tables Locations Help

HEC-RAS Plan: Plan 09 River: SUNGAI DEPAN

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
RUAS 1	13	Q2	33.19	5.88	7.98		8.05	0.000184	1.34	29.17	25.00	0.35
RUAS 1	13	Q5	50.12	5.88	8.44		8.52	0.000148	1.43	40.70	25.00	0.33
RUAS 1	13	Q10	62.20	5.88	8.74		8.83	0.000135	1.50	48.07	25.00	0.32
RUAS 1	13	Q25	76.81	5.88	9.07		9.17	0.000125	1.58	56.35	25.00	0.31
RUAS 1	13	Q50	90.75	5.88	9.36		9.47	0.000119	1.66	63.74	25.00	0.31
RUAS 1	13	Q100	104.12	5.88	9.63		9.75	0.000114	1.72	70.51	25.00	0.31
RUAS 1	12	Q2	33.19	5.33	8.01		8.04	0.000078	0.84	41.18	30.40	0.21
RUAS 1	12	Q5	50.12	5.33	8.47		8.51	0.000073	0.93	55.33	30.80	0.21
RUAS 1	12	Q10	62.20	5.33	8.76		8.81	0.000069	0.99	64.47	30.80	0.21
RUAS 1	12	Q25	76.81	5.33	9.10		9.15	0.000067	1.06	74.74	30.80	0.21
RUAS 1	12	Q50	90.75	5.33	9.40		9.46	0.000065	1.12	83.92	30.80	0.21
RUAS 1	12	Q100	104.12	5.33	9.67		9.74	0.000063	1.17	92.33	30.80	0.21
RUAS 1	11	Q2	33.19	5.02	7.99		8.04	0.000087	0.98	36.47	21.85	0.24
RUAS 1	11	Q5	50.12	5.02	8.45		8.51	0.000096	1.15	46.87	23.00	0.26
RUAS 1	11	Q10	62.20	5.02	8.74		8.81	0.000096	1.26	53.55	23.00	0.26
RUAS 1	11	Q25	76.81	5.02	9.06		9.15	0.000096	1.38	61.04	23.00	0.27
RUAS 1	11	Q50	90.75	5.02	9.35		9.45	0.000096	1.47	67.73	23.00	0.27
RUAS 1	11	Q100	104.12	5.02	9.62		9.73	0.000096	1.56	73.86	23.00	0.28
RUAS 1	10	Q2	33.19	5.27	7.94		8.03	0.000226	1.33	25.59	20.40	0.36
RUAS 1	10	Q5	50.12	5.27	8.39		8.50	0.000199	1.50	34.72	20.40	0.35
RUAS 1	10	Q10	62.20	5.27	8.67		8.80	0.000187	1.60	40.57	20.40	0.35
RUAS 1	10	Q25	76.81	5.27	8.99		9.14	0.000177	1.71	47.14	20.40	0.35
RUAS 1	10	Q50	90.75	5.27	9.28		9.44	0.000170	1.80	53.00	20.40	0.35
RUAS 1	10	Q100	104.12	5.27	9.55		9.72	0.000165	1.88	58.37	20.40	0.35
RUAS 1	9	Q2	33.19	5.22	7.96		8.00	0.000122	0.92	37.59	31.00	0.25
RUAS 1	9	Q5	50.12	5.22	8.42		8.47	0.000099	1.01	51.83	31.00	0.24
RUAS 1	9	Q10	62.20	5.22	8.72		8.77	0.000091	1.07	60.94	31.00	0.23
RUAS 1	9	Q25	76.81	5.22	9.05		9.11	0.000084	1.13	71.17	31.00	0.23
RUAS 1	9	Q50	90.75	5.22	9.34		9.41	0.000080	1.19	80.30	31.00	0.23
RUAS 1	9	Q100	104.12	5.22	9.61		9.68	0.000077	1.25	88.66	31.00	0.23
RUAS 1	8	Q2	33.19	5.32	7.90		7.99	0.000254	1.51	24.72	20.60	0.40

Total flow in cross section.

Figure 2. Profile Output

Based on output profile in Figure 5, it can be observed that the simulation results from the Steady Flow Analysis of flood discharge that are close to the design flood discharge are at station 12 for each return period in sequence, namely 41.18 m3/s, 55.33 m3/s, 64 ,47 m^3/s, 74.74 m^3/s, 83.92 m^3/s, 92.33 m^3/s.

4 CONCLUSIONS

Based on the results of the above analysis, it can be concluded that:

1. The design flood discharge on the Prince River at the return period of 2, 5, 10, 25, 50 and 100 years in a row is 33.19 m^3/s, 50.12 m^3/s, 62.20 m^3/s, 76.81 m^3/s, 90.75 m^3/s, and 104.12 m^3/s.
2. Simulation results using Steady Flow Analysis on HECRAS which are close to the design flood discharge are station 12 with discharge times of 2, 5,10, 25, 50 and 100 years respectively, namely 41.18 m^3/s, 55.33 m^3/s , 64.47 m^3/s, 74.74 m^3/s, 83.92 m^3/s, 92.33 m^3/s, so that the design flood discharge can be used for further calculations and used as a reference in the construction of hydraulic buildings.

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