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ANALYSIS OF PACINAN RIVER NORMALIZATION CONSIDERING RIVER MOUTH CONSTRICTION USING HEC-RAS SOFTWARE

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ABSTRACT

The Pacinan River in the Veteran Road area, spanning 1,392 meters, plays a crucial role as the main drainage channel. However, over time, it has encountered issues such as pollution, siltation from sedimentation, and narrowing due to construction. The reduced capacity of the river has caused rainwater not to flow improperly, leading to flooding around roads and residential areas. This study aims to analyze the normalization of the Pacinan River to prevent overflow using HEC-RAS software. The analysis includes hydrological aspects, such as rainfall frequency analysis and planned flood discharge using rational method for recurrence intervals of 2, 5, 10, and 25 years, as well as hydraulic analysis covering river cross-sections and dredging volumes through 1D Unsteady Flow simulations. The research results indicate that the planned flood discharge values for recurrence intervals of 2, 5, 10, and 25 years at the Pacinan River range from 1,28 m³/s to 2,15 m³/s. Based on HEC-RAS simulations, the depth of the Pacinan River before normalization ranged from 0,89 to 1,7 meters, with a cross-sectional width between 2,8 and 27,8 meters. After normalization was performed without changing the river's cross-sectional width, the river depth increased to between 1,83 and 1,86 meters.

Keywords: *River Normalization, Estuary Narrowing, HEC-RAS, Pacinan River*

1. INTRODUCTION

The Pacinan River, located in Banjarmasin City, has a length of 1,392 meters and an average width ranging from 0 to 20 meters. It serves as one of the primary drainage channels along Veteran Road. However, land-use changes, population growth, and construction activities have led to various issues such as pollution, sedimentation, and river narrowing. These conditions have reduced the river's capacity, increasing the risk of flooding when water discharge rises, particularly during the rainy season. Therefore, analyzing the normalization of the Pacinan River is essential to mitigate the risk of overflow along Veteran Road due to estuary narrowing.

2. THEORITICAL STUDY

Frequency Analysis

Frequency analysis is a method used to estimate the likelihood of a hydrological event occurring based on historical data, serving as a reference in hydrological planning. This approach aims to anticipate various potential future scenarios. In the field of water resources, frequency analysis is applied to predict extreme events such as heavy rainfall, design floods, and droughts.

Design Flood Discharge

Design flood discharge refers to the estimated maximum flow rate that may occur in a river or channel, calculated based on a specific return period. This value is used as a reference in the design of hydraulic structures to ensure they can accommodate potential flood volumes within the designated return period. One of the methods for determining design flood discharge is the rational method, which is expressed by the following general equation:

$Q = 0{,}278.C.I.A$

Where:

Q = peak discharge generated by rainfall with a specific intensity, duration, and frequency (m^3/s)

I = rainfall intensity (mm/h)

A = catchment area (km^2)

C = runoff coefficient

River Normalization

River normalization is an effort to restore and enhance the river's function to an optimal condition. This process includes removing sediment deposits and deepening the river channel to increase its water-holding capacity.

River Estuary Narrowing

River estuary narrowing refers to a condition where the width or area of a river estuary is reduced compared to its original state. Several factors contribute to this phenomenon, including sediment accumulation leading to shallowing and infrastructure development, such as residential construction along riverbanks.

HEC-RAS Application

HEC-RAS is a software tool that integrates various features, including a graphical

interface, hydraulic analysis, data management and storage, graphical visualization, and report generation. To analyze river profiles using HEC-RAS, several input data are required, such as longitudinal river profiles, cross-sections, flow discharge, and Manning's roughness coefficient for the river cross-section.

3. METHOD

Research Location

This study is conducted on the Pacinan River, which flows along the Sungai Bilu area, Gadang Subdistrict, Central Banjarmasin District, Banjarmasin City, South Kalimantan.

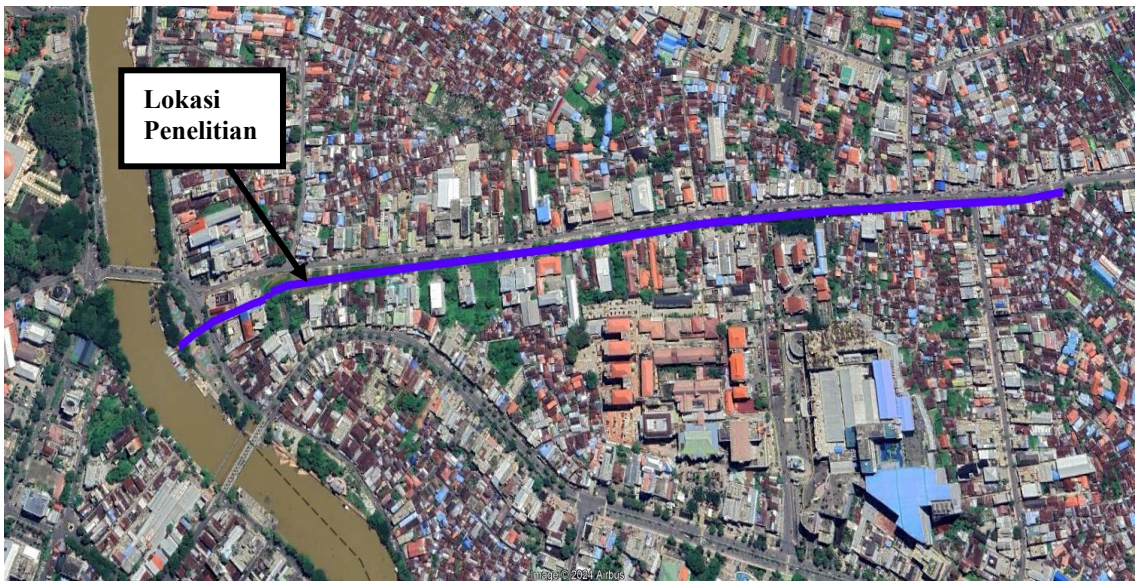


Figure 1. Pacinan River Location

Research Procedure

The initial step involves collecting primary data, including field observations and direct data acquisition, such as photographic documentation, river flow velocity measurements, river depth measurements, and interviews with local residents. Once primary data is obtained, the process continues with the collection of secondary data, including maximum rainfall data from the Class II Meteorological Station Syamsudin Noor Banjarmasin, watershed area data, and tidal observation data. The next stage involves hydrological and hydraulic data analysis, covering frequency analysis, design flood discharge analysis, and cross-sectional analysis.

4. RESULT AND DISCUSSION

Frequency Analysis

Based on statistical parameter calculations, the distribution type that meets the requirements is the Log Pearson III distribution. The calculation process for rainfall frequency analysis using the Log Pearson III distribution follows the procedure below:

a. Transform the annual rainfall data of n values X_1, X_2, …, X_n into $Log\ X_1$, $Log\ X_2$, ..., $Log\ X_n$.

b. Calculate the mean value:

$Log\ \bar{X} = \frac{97,834}{49} = 2,00$

c. Calculate the standard deviation:

$S_{Log\ \bar{X}} = \sqrt{\frac{0,593}{49-1}} = 0,11$

d. Calculate the skewness coefficient:

$C_s = \frac{49\ x\ (0,03892)}{(49-1)(49-2)(0,11)^3} = 0,615$

Design Rainfall

Based on the frequency analysis calculation data, the distribution that meets the requirements is the Log Pearson III distribution, with a Cs value of 0,615. Subsequently, the design rainfall is calculated with return periods of 2, 5, 10, and 25 years as a calculation for the Pacinan River's design flood discharge.

Design Flood Discharge

The method used to determine the design flood discharge is the Rational Method. This method considers the area, rainfall, and runoff coefficient to calculate the maximum water discharge that can occur within a certain period. The following are the results of the Pacinan River's design flood discharge calculation for return periods of 2, 5, 10, and 25 years.

Table 1.1 The Result Of The Pacinan River Design Flood Discharge Calculation

Concentration Time (Hour)	Rain Intensity (mm/hour)				Maximum Flow Rate (m^3/second)			
	2	5	10	25	2	5	10	25
0,50	53,053	66,782	76,467	89,392	1,28	1,61	1,84	2,15
1	33,538	42,217	48,340	72,997	0,807	1,015	1,163	1,359
2	21,127	26,595	30,452	45,986	0,508	0,640	0,732	0,856
3	16,123	20,296	23,239	35,094	0,388	0,488	0,559	0,653
4	13,309	16,754	19,184	28,969	0,320	0,403	0,461	0,539

Concentration Time (Hour)	Rain Intensity (mm/hour)				Maximum Flow Rate (m^3/second)			
	2	5	10	25	2	5	10	25
5	11,470	14,438	16,532	24,965	0,276	0,347	0,398	0,465
6	10,157	12,786	14,640	22,108	0,244	0,308	0,352	0,412
7	9,165	11,537	13,210	19,948	0,220	0,277	0,318	0,371
8	8,384	10,554	12,085	18,249	0,202	0,254	0,291	0,340
9	7,751	9,757	11,172	16,871	0,186	0,235	0,269	0,314
10	7,225	9,095	10,414	15,727	0,174	0,219	0,250	0,293
11	6,781	8,535	9,773	14,759	0,163	0,205	0,235	0,275
12	6,399	8,054	9,223	13,927	0,154	0,194	0,222	0,259
13	6,066	7,636	8,743	13,203	0,146	0,184	0,210	0,246
14	5,774	7,268	8,322	12,567	0,139	0,175	0,200	0,234
15	5,514	6,941	7,948	12,002	0,133	0,167	0,191	0,223
16	5,282	6,649	7,613	11,496	0,127	0,160	0,183	0,214
17	5,073	6,385	7,311	11,041	0,122	0,154	0,176	0,206
18	4,883	6,147	7,038	10,628	0,117	0,148	0,169	0,198
19	4,710	5,929	6,789	10,252	0,113	0,143	0,163	0,191
20	4,552	5,730	6,561	9,907	0,109	0,138	0,158	0,184
21	4,406	5,546	6,351	9,590	0,106	0,133	0,153	0,179
22	4,272	5,377	6,157	9,297	0,103	0,129	0,148	0,173
23	4,147	5,220	5,977	9,026	0,100	0,126	0,144	0,168
24	4,031	5,074	5,810	8,773	0,097	0,122	0,140	0,163

Existing Cross-Section Analysis Using HEC-RAS Software

The existing cross-section analysis aims to determine the capacity of a cross-section to accommodate the design flood discharge for a predetermined return period.

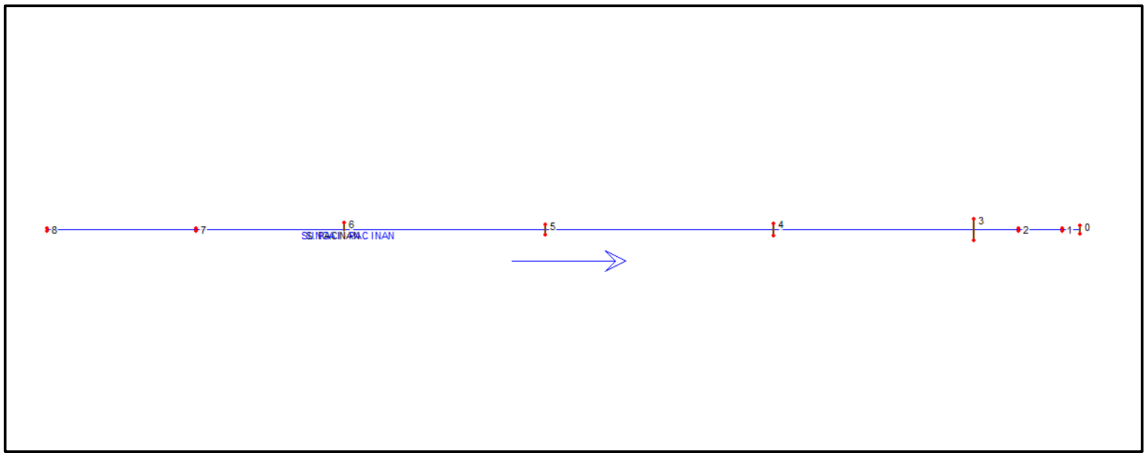


Figure 2. Pacinan River Geometry

Following analysis using HEC-RAS software, it was found that several river cross-sections are unable to accommodate the design flood discharge for each return period. Therefore, normalization is necessary in the form of river dredging and increasing the

elevation of river embankments along the Pacinan River to ensure the design discharge can be contained. The following is a comparison of river cross-sections and depths before and after normalization in the upstream, middle, and downstream sections.

Table 1. 2 Comparison of Existing Cross-Sections of the Pacinan River

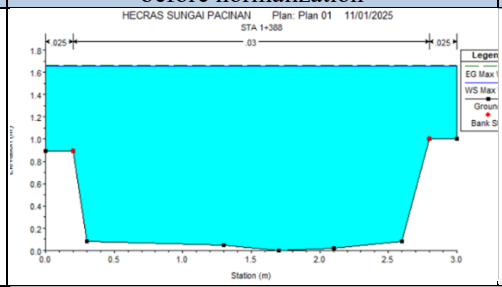
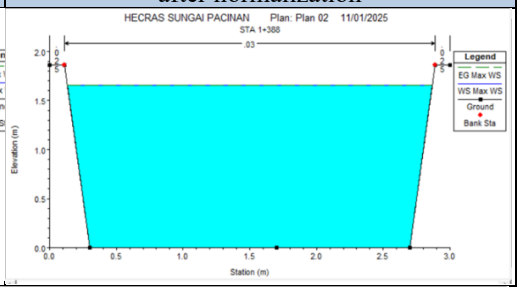
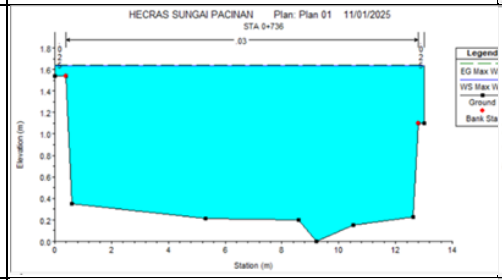
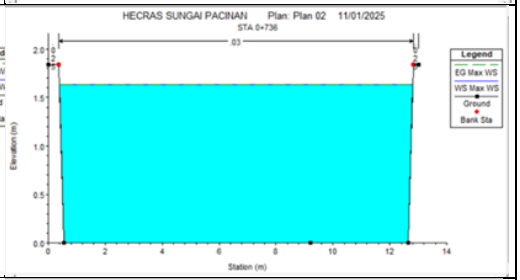
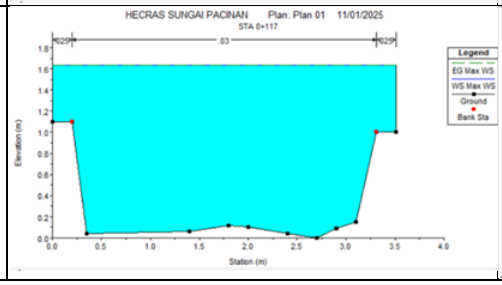
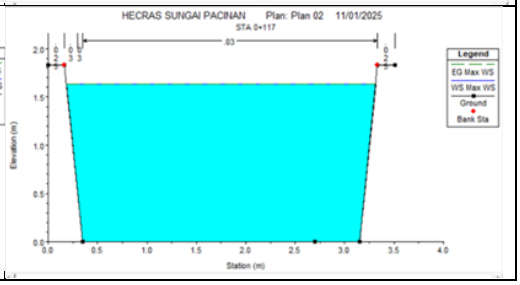
Pacinan River Return Period 2 Years		
	before normalization	after normalization
Upstream		
middle		
Down stream		

Table 1.2 above shows a comparison of the dimensional changes between the existing cross-section and the cross-section after normalization, which involved dredging at each cross-section. The most significant change is in the upstream section, where the river was unable to accommodate the 2-year return period flood discharge before normalization. However, after normalization, the river can accommodate the flood discharge without overflowing

5. CONCLUSION

The conclusions that can be drawn from this research are as follows:

1. Hydrological analysis using maximum rainfall data from the last 49 years with the Log Pearson III distribution shows that the design flood discharge for return periods

of 2, 5, 10, and 25 years are 1.28 m^3/s, 1.61 m^3/s, 1.84 m^3/s, and 2.15 m^3/s, respectively.

2. Based on HEC-RAS program simulations, the depth of the Pacinan River before normalization ranged from 0.89-1.7 m with a cross-sectional width of 2.8-27.8 m. After normalization, without altering the river's cross-sectional width, the resulting river depth ranged from 1.83-1.86 meters.

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