International Journal of Sustainable Building, Infrastructure, and Environment

ANALYSIS OF FLOOD DISCHARGE OF THE BLORONG RIVER, KENDAL DISTRICT

Dally Apriarso[1], Ilham Kusuma[2], Ikhwanudin[3], Farida Yudaningrum[4]

Faculty of Engineering and Informatics, Universitas PGRI Semarang, Jl. Sidodadi- Timur No.24 Semarang, Central Java 50232, Indonesia

dallyars369@gmail.com, ilhamkusuma943@gmail.com, ikhwan.menur12@gmail.com, faridayudaningrum@upgris.ac.id

Abstrack. The Blorong River is a river in the Brangsong District, Kendal Regency, Central Java Province, which has the potential to be hit by flood disasters almost every year. So conditions like this can cause losses to communities around the Blorong River. Through the research carried out, the aim was to determine the maximum discharge of the Blorong river with a river length of ± 3.3 km. The calculations and analysis applied in this research use quantitative methods. The primary data taken is documentation of the existing conditions of the Blorong river, while the secondary data is rainfall data from Balai Pusdataru Bodri Kuto. Analysis of the planned flood discharge using the Nakayasu HSS method shows that the planned return period flood discharge is Q2 years = 236,500 m^3/s, Q5 years = 276,392 m^3/s, Q10 years = 296,294 m^3/s and Q25 years = 300,180 m^3/s. After comparing it with the results of manual calculations of the existing conditions of the Blorong River using the Manning formula. The solution to the problem of flooding from the Blorong river is to normalize the river, raise the embankment in the STA section which is no longer able to accommodate the planned flood discharge, and also provide regulations so that people do not throw rubbish in the river.

Keywords: Flood Analysis, Flood Discharge, Blorong River

1. Introduction

The Blorong River is a river located in the Brangsong sub-district, Kendal Regency. This river has a watershed capacity of 208.20 km^2 with a river length of 51 km which functions to supply raw water needs for the local community [1]

Kendal Regency is one of the areas in Central Java Province that has the potential to be hit by flood disasters almost every year. Along with changing conditions in the Kendal Regency area, changes in land use and population growth mean that rivers do not function optimally as they should. One of the causes is the overflow of the Blorong River due to a lack of public awareness in disposing of rubbish, especially throwing rubbish into the river and the development of residential areas and the rapid growth of industry causing surface water catchment areas to decrease, not only that, the lack of embankments

in the area is also one of the factors. the most important cause. When the intensity of rain is high, the river cannot accommodate the air discharge, resulting in overflow or flooding

2. Methods

2.1. Arithmetic Mean Method (Algebra)

This algebraic method is a method of finding the average of a rain station as in Figure 1 below;

Figure 1. Rain Station in a Watershed

This method is the simplest for calculating average rainfall in an area. Measurements taken at several stations at the same time are added up and then divided by the number of stations. The rain stations used in the calculation are usually those within the watershed, but stations outside the watershed that are still nearby can also be taken into account. [2]

Expected rainfall is the largest annual rainfall with a certain probability that may occur in an area. In calculating the design rainfall distribution, it can be calculated using several methods, including:

a. Normal Distribution
b. Log Normal Distribution
c. Gumbel Distribution
d. Log Pearson Type III Distribution

Rainfall intensity is the height of rainfall that occurs in a period of time where the water is concentrated, in units of mm/hour . The general nature of rain means that the shorter the rain lasts, the higher the intensity tends to be and the greater the return period, the higher the intensity. The correlation between intensity, duration of rain and frequency of rain is generally expressed in the Intensity - Duration - Frequency curve (IDF = Intensity – Duration – Frequency Curve). Short-term rain data is needed, for example 5 minutes, 10 minutes, 30 minutes, 60 minutes and hours to form an IDF curve. This type of rain data can only be obtained from automatic rain measuring posts. Furthermore, based on short-term rain data the IDF curve can be created [3]

Design flood discharge is the maximum discharge that may occur in an area with a certain probability. In this case, synthetic hydrographs that have been developed in other countries are usually used, where the parameters must first be adjusted to the characteristics of the drainage area under consideration [4], [5]

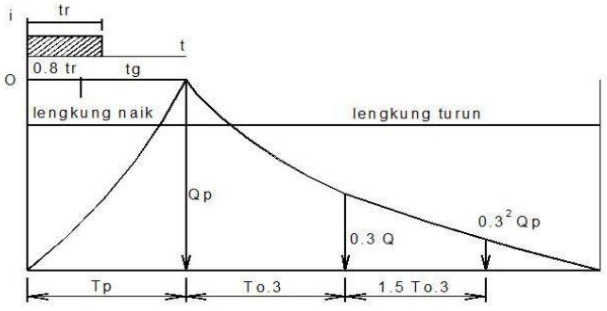

Figure 2. Synthetic hydrograph

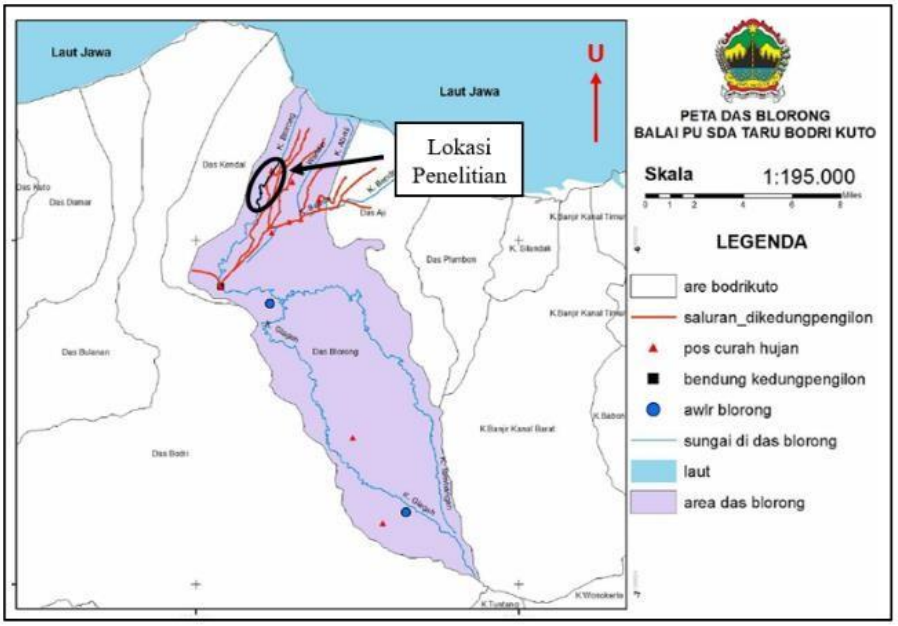

Figure 3. Blorong Watershed Research Location

The research location was carried out in the Blorong River Watershed (DAS) which is administratively included in Brangsong District, Kendal Regency, Central Java Province. Based on the problem boundaries in chapter 1, the river under review is between STA 43 to STA 10. The length of the river under review is ± 3.3 km with relatively gentle topographic conditions. To find out the research location, see Figure 3.

2.2. Types of research

In this research, researchers used quantitative research. Quantitative research means research that uses numbers and statistics in the collection and analysis of data that can be measured. This research was carried out systematically from research preparation, data collection, and hydrological data processing.

2.3. Data source

In a study, a data source is needed as the analytical material used. In this research, the data used consists of primary data and secondary data as follows:

a. Primary Data

Primary data is data that researchers obtain directly from the field. In this research, primary data was obtained from a field survey to see the existing condition of the Blorong river. The data obtained is in the form of documentation of the existing conditions of the Blorong river.

b. Secondary data

Secondary data is data obtained from related agencies and previous research which can be used as a reference in this research. In this research, the secondary data used was obtained from the Public Works Department of Water Resources and Spatial Planning (DINAS PUSDATARU) of Central Java Province.

2.4. Hydrological Analysis

The hydrological analysis carried out in this research with the aim of calculating the planned flood discharge was carried out by:

a. Calculation of annual maximum daily average rainfall using algebraic methods.
b. Calculation of planned rainfall.
c. Calculation of rainwater intensity.
d. Calculation of planned flood discharge.

2.5. Research Flow Chart

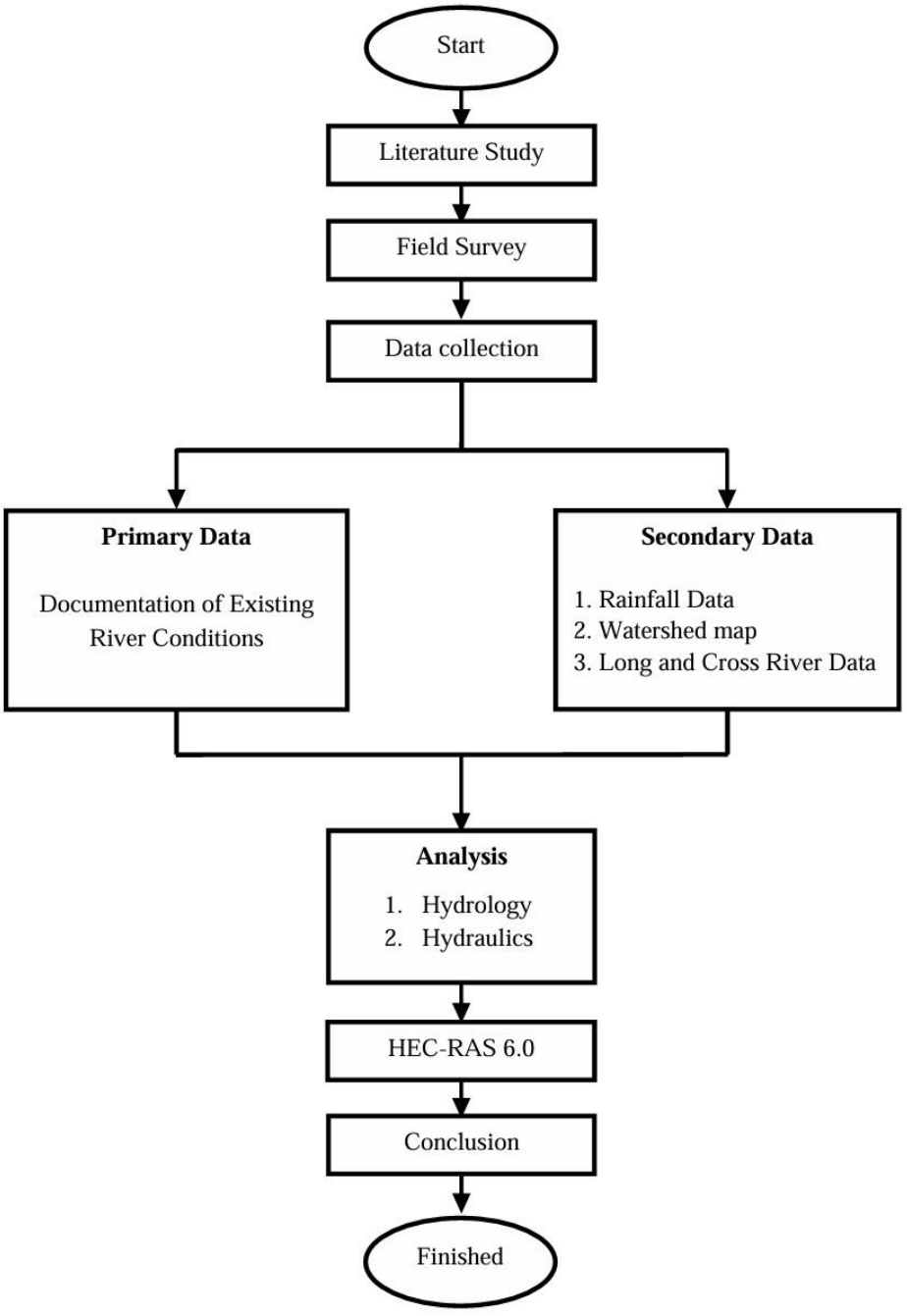

Figure 4. Research Flow Chart

3. Results and Discussion

The hydrological analysis in this research is aimed at calculating flood discharge at return periods of 2, 5, 10 and 25 years in the Blorong River, Kendal Regency.

Table 1. Annual Maximum Rainfall Data at Kaligading Station

Year/Month	Maximum Rain
2013	128,0
2014	98,0
2015	53,0
2016	88,0
2017	82,0
2018	140,0
2019	120,0
2020	113,0
2021	114,0
2022	112,0
Rata-Rata	104,8

Analysis of rainwater frequency distribution and distribution testing, calculation of planned rainfall using the Log Person III method. The return periods used are 2, 5, 10 and 25 years
Next, calculate the planned return period rainfall using the Log Pearson III method as follows.
5 year return period rainfall:

$$\log X_{\square} = \log X + \square_{\square} . \square \log X$$
$$= 2{,}007 + 0{,}8161 \times 0{,}12$$
$$= 2{,}105 \text{ mm}$$
$$X_T = 127{,}350$$

Results of rainfall for return periods 2 to 25 years are in table 2.

Table 2. Planned Rainfall

Return Period (Year)	Precipitation Plan (mm)
2	108,893
5	127,350
10	133,352
25	138,357

The results of calculating the distribution of hourly rainfall and hourly rainfall for the following time can be seen in table 3 below.

Table 3. Calculation Results of Rain Distribution and Hourly Rainfall

Hour to	I	Ratio
1	0,5503	0,5503
2	0,3467	0,1431
3	0,2646	0,1004
4	0,2184	0,0798
5	0,1882	0,0674
6	0,1667	0,0592

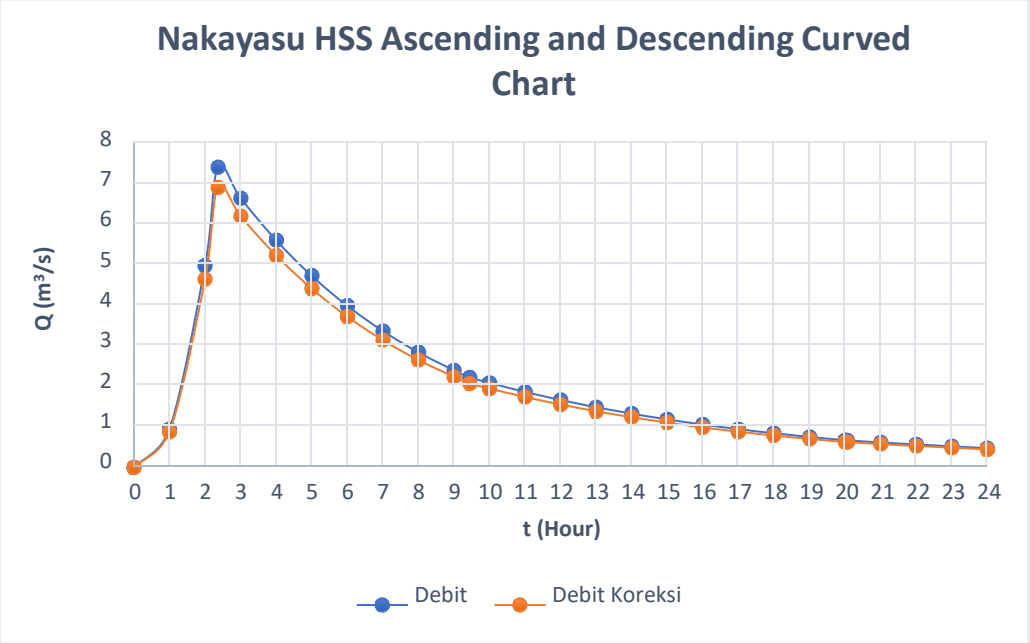

Figure 5. Nakayasu HSS Method Calculation Graph

Based on the graph above, we can see that the discharge curve continues to increase over time until at 2,361 hours the planned flood peak discharge occurs with a volume of 7,423 m³/s, after that the curve slowly decreases over time until it reaches the point of zero discharge volume.

From the method used in calculating the planned flood discharge on the Blorong River, the largest discharge value was selected. Based on table 4, the planned flood discharge can be determined which will be used in the subsequent analysis, namely using the HSS Nakayasu method.

Table 4. Recapitulation of Planned Flood Discharge for Each Method

Periode Ulang (Tahun)	Metode
	HSS Nakayasu
2	236,500
5	276,392
10	296,294
25	300,180

4. Conclusion

Based on the results of rainfall analysis calculations for the last 10 years, the maximum discharge was 303,346 m³/sec, while the smallest discharge was 28,355 m³/sec, and the average discharge of the Blorong River was 113,974 m³/sec.

Suggestion

To prevent flooding in the Blorong River, especially at points on the river that are unable to accommodate flood discharge, there must be further treatment regarding this problem, especially

repairing infrastructure at sections that can no longer accommodate flood discharge, by raising the section to prevent it from rising or rising. air flow that can cause flooding.

Acknowledgements
Special thanks go to the Chancellor of PGRI University Semarang. Thanks were also expressed to the Dean of the Faculty of Engineering, Coordinator of the Civil Engineering Study Program, Chair of the LPPM PGRI University Semarang. And thanks are also expressed to the Departments and Agencies who have helped with the data needed for research and the preparation of the journal.

References

References

[1] bpusdataru, "DAS Blorong," Balai PSDA Bodri Kuto, 2021. [Online]. Available: https://bpusdataru-bk.jatengprov.go.id/index.php/informasi-sda/sungai/daerah-aliran-sungai/das-blorong. [Accessed 23 January 2024].

[2] E. Q. Ajr and F. Dwirani, " Determining Rain Stations and Rainfall using the Thiessen Polygon Method in Lebak Regency.," *Journal of Environment and Natural Resources*, vol. 2, no. 2, p. 139– 146, 2019.

[3] Suripin, Sistem Drainase Perkotaan yang Berkelanjutan, Yogyakarta: Penerbit Andi, 2004.

[4] R. Wigati and S. Soedarsono, "Analisis Banjir Menggunakan Software HEC-RAS 4.1. 0 (Studi Kasus Sub DAS Ciberang HM 0+ 00-HM 34+ 00).," *Fondasi: Jurnal Teknik Sipil*, vol. 5, no. 2, 2016.

[5] Qariatullailiyah., " Analysis of the Effect of Storage on Flood Control and Raw Water Supply in the Kemuning-Sampang River Basin (DAS).," Institut Teknologi Sepuluh November, Surabaya, 2015.