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THE PERFORMANCE EVALUATION OF KAMPUNG BANJAR RETENTION BASIN IN THE PROVINCIAL GOVERNMENT OFFICE AREA OF SOUTH KALIMANTAN IN REDUCING THE FLOOD DISCHARGE IN THE DRAINAGE SYSTEM OF BANJARBARU CITY

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ABSTRACT

Kampung Banjar Retention Basin was built in 2015 to overcome flood entering the drainage system of Banjarbaru urban areas due to the provincial government office area of South Kalimantan. This study aimed at analyzing the performance of Kampung Banjar Retention Basin in controlling the flood discharge flowing to Banjarbaru city. In this study, the rainfall data with an observation period of 17 years were collected from the Meteorology, Climatology, and Geophysics Agency of Banjarbaru (2003-2019) and the climate data with 12-year observation (2008-2019). The potential evapotranspiration was estimated using the Modified Penman method. The analysis method of flood discharge consisted of Hasper's method, Rational method using Mononobe formula, Weduwen method, Nakayasu SUH (Synthetic Unit Hydrograph), ITB 1 SUH, and ITB 2 SUH at some return periods, namely 2 years, 5 years, 10 years, 20 years, 25 years, 50 years, and 100 years, while the analysis of dependable discharge was done using the F.J. Mock method. The result showed that the analysis method of flood discharged selected in this study was Nakayasu SUH. The value of flood discharge using Nakayasu SUH at a return period of 50 years was 42.1 m^3/sec. The 80% dependable discharge (Q_{80}) using the F.J Mock method was around 0.004 to 0.204 m^3/sec and a mean of 0.059 m^3/sec, while the 90% dependable discharge (Q_{90}) was around 0.045-0.120 m^3/sec with a mean of 0.071 m^3/sec. The existence of Kampung Banjar Retention Basin can reduce the peak flood discharge flowing to Banjarbaru city by 67% and it can slow down the peak flood flows from 2 hours to be 6 hours.

Keywords: *Flood Control; Retention Basin; Flood Discharge; Dependable Flow*.

I. INTRODUCTION

The provincial government office of South Kalimantan is located in Banjarbaru city, whereby the topography of the office location is higher than the city center of Banjarbaru. Since the principle of water that flows to lower areas when raining or the excess water from the provincial government office of South Kalimantan will flow to Banjarbaru city center. Besides, Banjarbaru city is the downstream area of the Paring watershed or the watershed that is used for designing the dam for the area around the provincial government office of South Kalimantan. Consequently, if an overflowing river occurs, it can cause a flood in Banjarbaru city.

The provincial government office area of South Kalimantan is also an integrated office area that its spatial planning needs some supporting facilities, such as the area that can be used as a recharge area, for collecting/reducing the surface runoff flowing to Banjarbaru city.

Based on several studies related to drainage system conducted by Lujiutomo (2019); Azwarman (2017); Yamali (2019); Susilowati (2017); and Lubis (2011), it is stated that the puddle occurs due to the drainage system that is broken or not functioning properly. Regarding the previous explanation, this problem required a case study if the construction of a water reservoir or a Retention Basin in the provincial government office area of South Kalimantan could overcome the puddle happening in that area.

Method

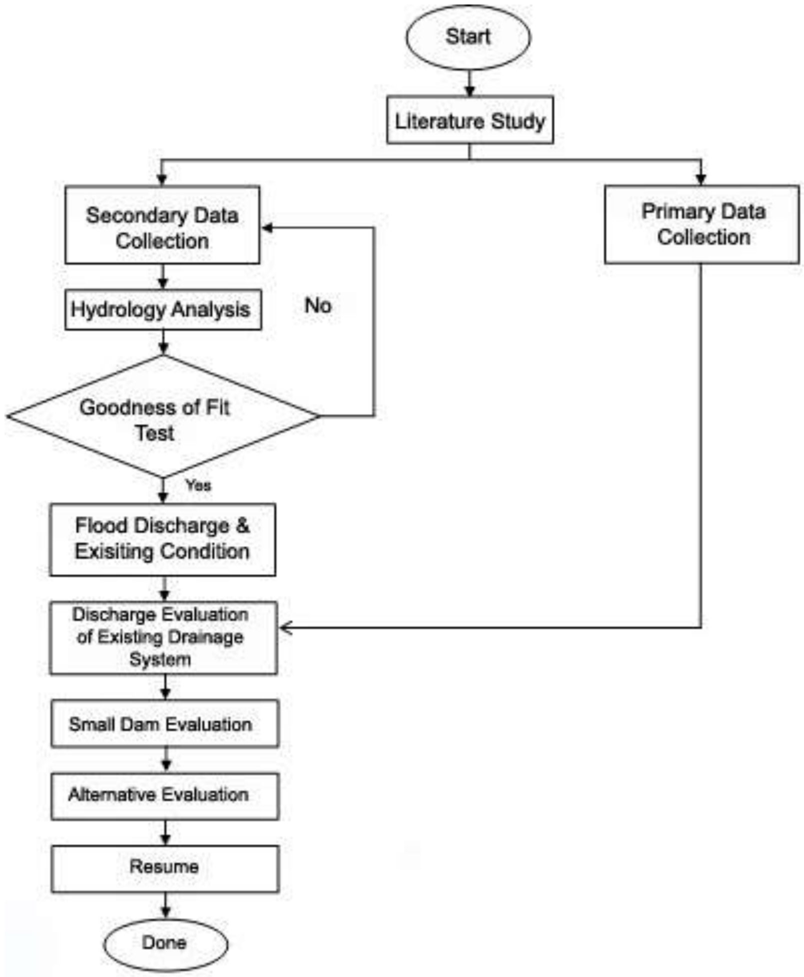

Figure 1 The Path Diagram of the Study

The steps of this research method were as follows:

1. Collecting the required data consisting of rainfall data and topography data. The rainfall data could be obtained from the climatology station of Banjarbaru with an observation period of 17 years, from 2003 to 2019, while the topography data were collected from the measurement result in the field.
2. After all of the data were collected, the next step was analyzing the data. Further rainfall data would be analyzed to analyze the designed-discharge. Meanwhile, the topographic data were analyzed to obtain a topographic illustration of the research location.
3. The designed-flood discharge was analyzed through some steps and the method that was relevant to the regulation.
4. After obtaining the designed-flood discharge, the next step was identifying the puddle areas that occurred in the research location.
5. The next step was identifying the potential Retention Basin to overcome the puddle in the research location.
6. The last step was analyzing the result entirely regarding this study to achieve the objective and conducting a discussion related to the result analysis.

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II. RESULT AND DISCUSSION

The Characteristics of Kampung Banjar Retention Basin

Kampung Banjar Retention Basin is located at the end of the provincial government office area of South Kalimantan. The embankment and the base of this dam were built by using the available soil or it did not use the masonry, such as concrete or stone, with the soil porosity categorized in the semi-porous.

The Technical Data of Kampung Banjar Retention Basin

1.	Maximum Reservoir Capacity at an El. of + 21.5 m	:	6.36 Ha
2.	The Height of Retention Basin from the bottom of the foundation (cut off)	:	7 meters
3.	The Lowest Base Elevation	:	+16.00
4.	The Highest Water Surface Elevation	:	+21.50
5.	The Maximum Reservoir Volume at an El. of + 21.5 m	:	318.180m^3
6.	The Elevation of Embankment	:	+22.00

The Designed-Rain Analysis

There are several types of rainfall data, daily rainfall, monthly rainfall, annual rainfall, and the short-duration rainfall data consist of 5 minutes,10 minutes, 15 minutes, 30 minutes up to 60 minutes. If there short-duration rainfall data are not available, daily rainfall can be used.

Based on the result of the calculation of hourly rainfall distribution above, the net hourly rainfall for some return periods in the location can be seen in Table 2.

Table 1. The Calculation of Net Rainfall

Return Period (Years)	**Design** Rain (mm)	**Flow** Coefficient (C)	**Net Rainfall/** Rn (mm)
2	45.3641	0.8443	38.3016
5	107.3072	0.8443	90.6013
10	131.7024	0.8443	111.1986
20	143.2411	0.8443	120.9409
25	152.0782	0.8443	128.4022
50	153.9100	0.8443	129.9488
100	159.8223	0.8443	134.9407

Table 2. The Recapitulation of the Calculation of the Designed-Flood Discharge Using 6 (six) Methods

Return Period (Years)	**Designed-Flood Discharge (m^3/sec)**					
	Haspers Method	**Rational Mononobe Method**	**Weduwen Method**	**Nakayasu SUH**	**ITB 1 SUH**	**ITB 2 SUH**
2	19.3	5.6	11.3	15.8	12.27	14.29
5	29.4	8.6	18.6	24.1	16.29	18.96
10	36.6	10.7	24.0	30.0	18.88	21.98
20	43.7	12.8	29.4	35.9	21.34	24.83
25	45.3	13.3	30.6	37.2	22.11	25.73

Return Period (Years)	Designed-Flood Discharge (m^3/sec)					
	Haspers Method	Rational Mononobe Method	Weduwen Method	Nakayasu SUH	ITB 1 SUH	ITB 2 SUH
50	51.3	15.1	35.2	42.1	24.48	28.49
100	56.4	16.5	39.1	46.3	26.83	31.23

The watershed used for the calculation of the designed-flood discharge was Paring Watershed. Paring river is the Ampaya river whose downstream located in Banjarbaru city, and the Ampaya river is the creek of Banyuirang. The calculation of flood discharge analysis was conducted in Paring river that was the inlet of the Retention Basin in the Provincial Government Office area of South Kalimantan. The data for the Paring watershed are as follows.

- The area of Watershed = 1.56 km^2
- The Length of Main River = 1.001 km
- The Elevation of Upstream = 28 m
- The Elevation of Downstream = 14 m

The recapitulation of the designed-flood discharge analysis using 6 (six) methods in this study can be seen in Table 3.

The Dependable Discharge Analysis

Dependable discharge is the available discharge for fulfilling certain necessities, such as irrigation, drinking water, etc, for a full year. The risk of failure had also been taken into account. The method for calculating dependable discharge for this study was the F.J. MOCK method. This method was used for calculating the monthly discharge values, soil moisture and groundwater, and groundwater catchment areas.

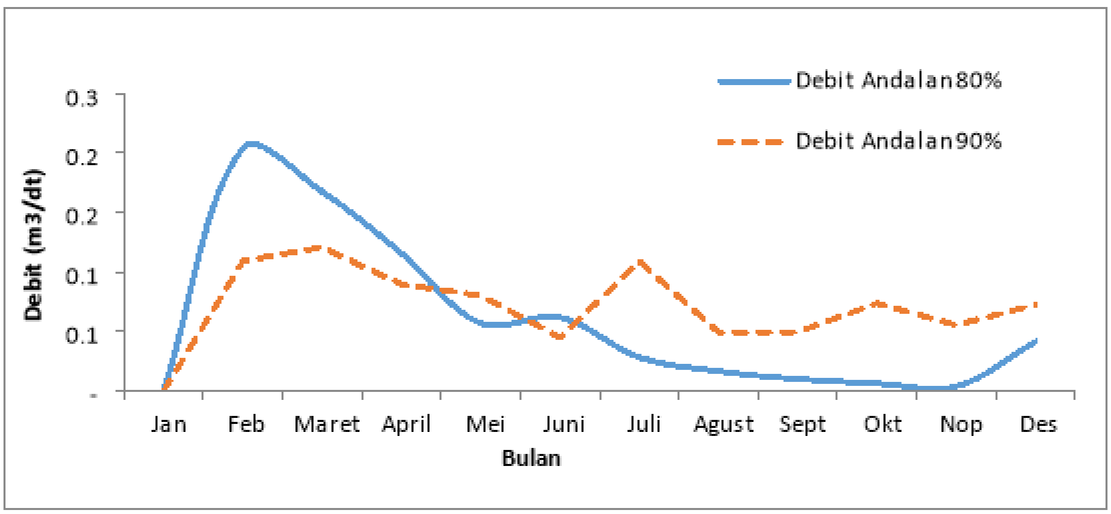

Figure 2. The Graphic of Annual Discharge by FJ. Mock

The Flood Routing at the Retention Basin

The graphic of flow routing in Figure 4 showed that the inflow discharge to the steep slope dam section compared to the outflow discharge from the Retention Basin had a difference of peak discharge of 67%. The curve of inflow discharge to the Retention Basin can be assumed as the discharge flowing to the area of Banjarbaru city without any Retention Basin, while the curve of outflow discharge can be assumed as the discharge flowing to Banjarbaru city with a Retention Basin. Thus, the existence of a Retention Basin could reduce the discharge flowing into the area of Banjarbaru city by 67 %.

Based on the designed-flood discharge analysis and flow routing analysis, it can be inferred that Kampung Banjar Retention Basin can collect the maximum flood discharge and the Retention Basin can function properly.

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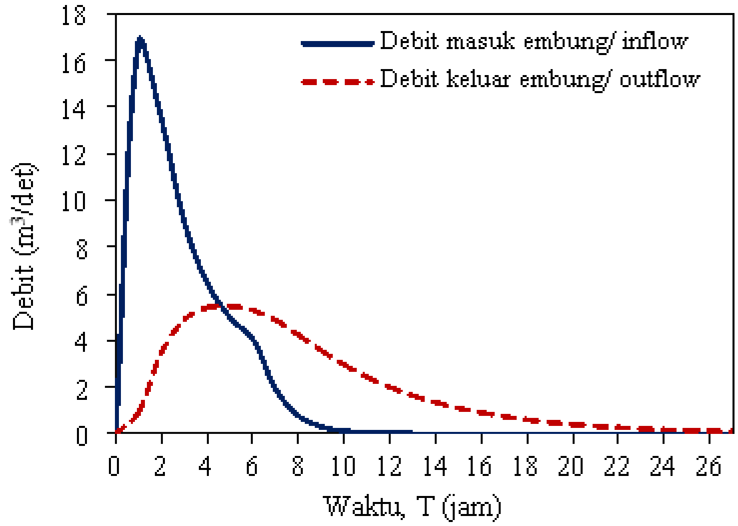

Inflow Discharge - Outflow Discharge
Discharge (m^3/sec) - Time, T (hour(s))
Figure 3. The Discharge Routing of Kampung Banjar Retention Basin

III. CONCLUSION

1. The designed-flood discharge used in the study for the Retention Basin in the provincial government office area of South Kalimantan was the *Nakayasu* SUH method with a return period of 50 years. Selecting the *Nakayasu* SUH method is based on the closest condition to the condition in the field and the return period of 50 years is used for constructing a Retention Basin. The result of flood discharge using *Nakayasu* SUH with a return period of 50 years is 42.1 m^3/sec.
2. The method of dependable discharge for the calculation is F.J. Mock with the reliability level of 80% and 90%. The year for the 80% reliability level is 2003, while the year for the 90% reliability level is 2010. The dependable discharge in 2003 was around 0.004 m^3/sec up to 0.204 m^3/sec with a mean of 0.059 m^3/sec. Meanwhile, the dependable discharge in 2010 was around 0.045 m^3/sec up to 0.120 m^3/sec with a mean of 0.071 m^3/sec.
3. The graphic for the flow routing shows that the inflow discharge to the steep slope dam section compared to the outflow discharge from the Retention Basin has a difference of peak discharge of 67%. The curve of inflow discharge to the Retention Basin can be assumed as the discharge flowing to the area of Banjarbaru city without any Retention Basin, while the curve of outflow discharge can be assumed as the discharge flowing to Banjarbaru city with a Retention Basin. Besides, the existence of a Retention Basin can slow down the peak discharge from 2 hours to be 6 hours. Thus, the existence of a Retention Basin can reduce the peak discharge and the inflow discharge to the area of Banjarbaru city by 67%.

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