Analysis of Sombe River Flood Discharge, Porame Village, Sigi Regency

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ABSTRACT

This research was conducted in the village of Porame, Sigi Regency, which was conducted from March to August 2017. The Sombe river basin is one of the rivers in the Porame Village, Kab. Sigi, Central Sulawesi Province, which empties into the Palu River, has a length of 10.54 Km and a watershed area of 53.95 Km^2. High rainfall intensity and uncontrolled land-use changes in the Sombe Watershed Area cause flooding problems, which can ultimately cause a lot of damage. For planning flood control, river safety, and various water structures in the river it is necessary to conduct a hydrological analysis to obtain the magnitude of the flood plain. In this study frequency analysis and Empirical methods are used, namely the Rational, Hasper and Melchior Methods, counting from 10 to 200 years. The calculation of the Sombe River flood discharge used rainfall data at the Porame station, with the recording period from 2005 to 2016 and using a 1: 50,000 scale topographic map. The results of the design flood discharge analysis for each method with various repeat periods obtained the Rational Method that gets the largest value of Flood Discharge that is 663,548 m3 / s; then, the Frequency Analysis Method gets the smallest value 133,057 mm.

Keywords — Sombe River, Frequency Analysis, Rational Methods

INTRODUCTION

Sombe River is a branch of a tributary that sits on the Palu River. At the time of the rainy season with high rainfall intensity resulting in flooding that the discharge exceeds the cross-section of the river. In general, the characteristics of the Sombe watershed, which includes its shape, topography, soil type, and land use, are possible to flood in conditions of high rainfall. It can be seen from the Sombe River Basin (DAS), which is a hilly and mountainous area that facilitates water that falls directly into a runoff. A river flow consists of three important components of flow, namely surface runoff, intermediate runoff, and baseflow. The three components will cause a discharge in the river.

Land-use changes that lack control, where the upstream forest becomes bare due to felling of trees, which is then replaced with other production plants that do not absorb water, consequently the upstream plants that function as interception no longer function, and this condition raises problems include rain falling directly into runoff which increases the volume of surface runoff rapidly causing an increase in downstream flooding.

Along with the development of hydrology, many calculation methods use rain data to determine the design flood discharge. In choosing the right method used to determine the amount of flood discharge, the design of a watershed is very difficult because the method uses certain assumptions and coefficients. Therefore the calculation of design flood discharge using river discharge data is very rarely used. Often there are deviations in the value of the discharge that will be compared with river discharge data, so there is a need for in-depth research studies.

Given the frequent flooding due to rain with high intensity. Based on this background, the author tries to research the form of articles, on the Sombe Watershed with the title "Analysis of Flood Discharge in the Sombe River Basin Design (DAS) Porame Village, Sigi Regency."

METHODOLOGY

This research was carried out in Porame Village, Sigi Regency, starting from March to August 2017. The research tools and materials for measuring flood discharges used simple tools namely pimpong balls, meter roll, and stopwatch. Procedure research is a scientific way to obtain data with specific purposes and uses; data obtained through research are empirical data (observable) with valid, reliable, and objective criteria.

RESULT & DISCUSSION

The calculation method is carried out with various methods depending on the available data and the characteristics of the available data. Experience and importance so that the steps and determination of the calculation are done:

Frequency Analysis with Normal Distribution Method, Normal Log Method, Pearson Type III Log Method, Gumbel Method.

The distribution suitability test uses the Chi-Square Method, Kolmogorov Smirnov Method.

Flood Discharge Plan Using Methods:

- Rational Method

  Rational methods can describe the relationship between discharge and the amount of rainfall for watersheds (DAS) with this method specifically for calculating flood discharges with an area of watersheds below 300 km^2.

- Hasper Method

  The Hasper Method, in particular, calculates flood discharges with Watershed Areas below 300 km ^{2}.

- Melchior Method

  The Melchior method is recommended to calculate the flood discharge for a Watershed Area greater than 100 km^2.

Subsequent daily discharge data will be selected to determine the maximum annual daily discharge for further analysis into a flood plan data for a specific re-period, which will then be processed into a planned flood discharge.

The steps in the hydrological analysis are as follows: Determine watersheds (DAS) and their extent. Determine the maximum daily discharge each year from the daily discharge data from the headwaters to the confluence of the Sombe and Lewara rivers. Calculates the maximum daily debit that represents a watershed. Analyze flood discharge plans with a T year return period. Calculates plan flood discharge based on the design flood discharge above on T year return period. The results will be compared with the results of the flood design calculation of the three methods, namely: Rational Method, Haspers Method, and Melchior Method.

Before determining the watershed, first, determine the location of the sub-watershed that must be reviewed. From this sub-watershed location downstream, then the boundary of the river basin is determined by drawing an imaginary line connecting the point that has the highest contours to the left and right of the river being reviewed.

From the topographic map, the width of the Sombe River basin is 53.95 Km^2.

Table 1. Maximum Daily Rainfall Data of Porame Station

Year	The month of the Year												Rh Total (mm)	Rh Maks. (mm)
	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agst	Sep	Okt	Nov	Des		
2005	-	-	-	-	-	-	-	-	-	5,50	30,70	12,90	49,10	30,70
2006	15,10	60,10	22,20	27,50	12,00	5,70	22,60	10,50	38,20	12,50	33,20	28,00	287,60	60,10
2007	21,40	9,90	31,40	45,50	18,70	9,70	32,60	0,50	3,90	1,00	24,00	38,10	236,70	45,50
2008	23,40	64,00	8,20	20,00	61,70	31,00	20,00	14,40	21,00	55,50	68,10	24,90	412,20	68,10
2009	8,20	12,80	82,70	19,20	13,10	22,30	2,20	1,00	38,60	0,00	26,50	22,40	249,00	82,70
2010	45,70	60,00	51,60	29,00	28,10	24,10	35,00	60,50	18,20	89,00	29,20	23,10	493,50	89,00
2011	18,00	13,20	26,50	81,80	25,30	22,80	76,00	32,20	48,00	21,80	30,30	47,90	443,80	81,80
2012	16,90	12,50	16,30	43,80	10,40	15,50	20,00	14,00	9,00	9,00	35,60	28,10	231,10	43,80
2013	39,70	8,80	11,80	26,70	17,20	48,00	20,20	28,40	23,00	18,60	10,40	18,20	271,00	48,00
2014	17,00	85,80	26,80	55,20	40,70	56,50	43,20	20,00	53,90	12,80	9,40	53,70	475,00	85,80
2015	23,40	21,30	25,20	24,10	3,00	32,70	50,00	40,90	20,00	12,70	31,50	24,70	309,50	50,00
2016	24,00	29,80	35,10	28,10	20,80	51,70	76,30	25,00	4,20	97,20	10,00	20,50	422,70	97,20

Source: Sulawesi River Basin Office, III, Central Sulawesi, 2016.

Calculation of Flood Discharge

To calculate or estimate the magnitude of flood discharges that will occur in various return periods with good results can be done by analyzing the flow data from the river in question. Because the relevant flow data is not available, than in the calculation of flood discharge will be used several methods, namely: Rational Method, Haspers Method, Melchior.

Flood Discharge Rational Method Design

The Rational Method can describe the relationship between the discharge and the amount of rainfall for a watershed with an area of up to 300, as follows: the calculation of flood discharge plans for the rational method:

Table 2. Flood Discharge Rational Method Design

No	Period Repeat (year)	A (km2)	Rt (mm)	L (km)	I_0 (km)	C	W (km/jam)	tc (jam)	I (mm/jam)	Qt (m3/dtk)
1	10	53.950	95,709	10,454	0,074	0,750	15,136	0,691	42,466	477,296
2	25	53.950	108,889	10,454	0,074	0,750	15,136	0,691	48,314	543,026
3	50	53.950	117,660	10,454	0,074	0,750	15,136	0,691	52,205	586,765
4	100	53.950	125,650	10,454	0,074	0,750	15,136	0,691	55,750	626,610
5	200	53.950	133,057	10,454	0,074	0,750	15,136	0,691	59,037	663,548

Flood Discharge Haspers Method Design

Calculation of design flood discharge for Haspers Method This method can be used with the condition that the watershed area <300 km^2.

Table 3. Results of Flood Discharge Hasper Method Design

No.	Period Repeat T	R24 (mm)	R (mm)	Qn (m3/km2/det.)	Q m3/det.
1.	10	95,709	57,279	11,159	262,012
2.	25	108,889	65,072	12,677	297,660
3.	50	117,660	70,245	13,684	321,324
4.	100	125,650	74,949	14,601	342,842
5.	200	133,057	79,302	15,449	362,756

Flood Discharge Melchior Method Design

The Melchior method is used to estimate the design flood discharge for watersheds that cover more than 100 km^2.

Table 4. Calculation of Flood Discharge for the Melchior Method Design

Parameter	IF YOU RE-DO				
	10	**25**	**50**	**100**	**200**
R_T (mm)	95,709	108,889	117,660	125,650	133,057
A (km^2)	53,950	53,950	53,950	53,950	53,950
L (km)	10,454	10,454	10,454	10,454	10,454
I	0,063480	0,063480	0,063480	0,063480	0,063480
F (km^2)	96,133	96,133	96,133	96,133	96,133
T_0 (jam)	7,000	7,000	7,000	7,000	7,000
βR (m^3/det./km^2)	8,900	8,900	9,000	9,010	9,000
$βR_0$ (m3/det./km2)	4,259	4,846	5,295	5,661	5,988
A	0,750	0,750	0,750	0,750	0,750
Q_0 (m^3/det.)	**172,332**	**196,064**	**214,237**	**229,039**	**242,272**
T (jam)	2,652	2,652	2,605	2,570	2,542
V (m'/det.)	1,218	1,250	1,272	1,289	2,143

Conclusion on the Results of Calculation of Flood Discharge Plan

Based on the results of the calculation of debits with 3 (three) different methods, it can be seen that there are differences in the results of calculations from the three methods. Based on security considerations and the uncertainty of the amount of discharge floods that occur in these areas, then among the three methods available, the rational method is used.

With the knowledge of the design flood discharges that will be used for flood protection planning, which is used as an important foundation in determining various civil works that must be carried out in the framework of business.

Table 5. Comparison of Results of Calculation of Flood Discharge

Re-Period (year)	Flood Discharge Plan (m³/det.)		
	Rational	**Haspers Method**	**Melchior Method**
10	477,296	262,012	172,332
25	543,026	297,660	196,064
50	586,765	321,324	214,237
100	626,610	342,842	229,039
200	663,548	362,756	242,272

CONCLUSIONS

The results of calculations with three methods of flood discharge design Sombe Watershed, namely the Rational, Haspers and Melchior methods show that the Rational method has the largest design flood discharge with a 200 year return period 663,548 m3 / s, so that in this study the flood discharge used is the Rational method, with safety factor considerations in planning flood control and for planning other water structures. In planning water structures in the Sombe River Basin, it should refer to the design flood discharge value of the measured (AWLR) flow data. If river discharge data is not available, then in determining the design flood discharge value can be done by processing rainfall data using several methods and using the largest discharge value. That each river ideally has an Automatic water Leaver Recorder (AWLR) tool.

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