CIVED Journal of Civil Engineering and Vocational Education

EISSN: 2622-6774
Vol 11 No.1 March 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Analysis of River Capacity Rainfall on The Watershed in Village Galapuang Ulakan Region

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Received 25th Feb 2024; Revision 22th March 2024; Accepted 31th March 2024

ABSTRACT

Natural phenomena that occur often cause disasters and losses for the community and cause some losses both from social, financial, education and so on. Therefore advances in the world of construction and technology in the scope of water here play a very important role in analyzing a disaster that occurs, one of which is flooding. Based on the method used in this research is descriptive quantitative where the analysis is carried out by modeling the cross-sectional capacity of the watershed using the help of HEC-RAS software with a case study of river capacity analysis for rainfall in the watershed in Nagari Kampuang Galapuang Ulakan with a river stem length of 19 km and an area of river 115 km² the analysis interview process was carried out directly to the local community affected by the incident and resulted in a conclusion explaining that the Batang Ulakan Watershed can reach its maximum discharge in just 2 hours 6 minutes 25 seconds. To achieve a peak discharge of 9.51 m³/s from its normal discharge. And during the 25 to 50 year planned rainfall return period, the cross-sectional capacity data found that the geological conditions which have elevations that are not much different between the river sections and residents' settlements have little difference, resulting in the Batang Ulakan Watershed section, Nagari, Galapuang Village, on average, overflowing as high as 0.447 m in each of the Batang Ulakan Region Watershed in the Galapuang Village

Keywords: *Hydraulic Engineering; Centre-River Analysis Systeme (HEC-RAS)*

INTRODUCTION

A river is a gathering place for water that comes from rain that falls in its catchment area and flows at its own rate. The river is a natural drainage that has a river network with cross-sections, has a rain catchment area, and is called a River Watershed (DAS) (Siregar, 2004).

Water in a watershed is a water flow that experiences a natural hydrological cycle. During the hydrological cycle, namely the never-ending journey of water from the sea surface to the atmosphere, then to the land surface, and back again to the sea, the water will be retained (temporarily) in rivers, lakes/reservoirs, and the soil so that it will be used by humans. or living creatures. Rainfall at a certain time in an area results in an increase in water discharge in the river basin which has the effect of overflowing river water into community settlements which are contoured at the same elevation as the lip line of the river basin.

Flooding is excessive flow or inundation that comes from a river or other body of water and causes or threatens damage. Floods are indicated by water flows that exceed the carrying capacity of river banks/embankments, thereby inundating the surrounding area (Mustofa/BPDAS, 2011). Flood disasters are natural events that occur in river basins that overflow due to high rainfall factors that are not balanced by good water channels or poor water drainage. Floods also cause loss of property for residents and can also cause loss of life and damage to the ecosystem. In recent years the overflow of river water into community settlements is a problem that needs to be paid attention to and addressed for the sake of community comfort when the rainy season increases.

Many factors cause flood disasters, generally, two main factors cause flood disasters, namely floods caused naturally and floods caused by human activity. Floods caused by humans are related to human activities and needs, which are primarily meant in the form of the need for space for residence. The need for space will ultimately trigger a change in land use from vegetation to built-up land. On built-up land, the flow value is greater than the use of vegetated land, thus triggering floods.

Factors that cause natural flooding include rainfall, physiographic influences, erosion and sedimentation, river capacity, inadequate drainage capacity, and the influence of tides. Flood disasters, apart from being a result of ecosystem damage or unprotected environmental aspects, are also caused by high rainfall as a natural phenomenon. Rainfall greatly influences the amount of water flowing into rivers. The rainfall used in hydrological analysis is the average regional rainfall for the entire area concerned. Rainfall is expressed in mm.

The role of the world of Civil Engineering in helping the environment, the community here helped research one of the areas affected by the overflowing river water. Therefore, the author researched "Analysis of River Capacity on Rainfall in Watersheds in Village Galapuang Ulakan Region".

METHOD

Research Location.
Nagari Kampuang Galapuang Ulakan is in Ulakan Tapakis District, Padang Pariaman Regency, West Sumatra Province. Nagari area: 1.25 square kilometers or 3.22 percent of the area of Ulakan Tapakis District. It is 1 kilometer from the sub-district capital, 18 kilometers from the district capital, and 41 kilometers from the provincial capital.

Data Sources
In the calculation to determine the flood discharge in the Ulakan River Watershed (DAS). Nagari Kampung Galapuang. Ulakan District uses several data, namely as follows:

1. River geometry data
   Geometry data was obtained by taking measurements in the field and using DEMNAS map data and location maps from Google Earth which were later processed using Arc-GIS software.
2. Rainfall and river discharge data Rainfall and river discharge data obtained are recorded at each rainfall station in the river basin area that will be reviewed.

Research Variables
According to Silean (2018: 69) states "Research variables are concepts that have various values or have varying values, namely a characteristic, characteristic or phenomenon that can show something that can be observed or measured whose value is different or varies. ”

1. The variables used in this research are: rainfall, flood discharge, river cross-section using HEC RAS 5.0.1
2. Operational variable according to Sugiyono (2015, p. 38) is an attribute or nature or value of an object or activity that has certain variations that have been determined by researchers to be studied and then drawn conclusions. Definitions of research variables must be formulated to avoid errors in data collection. So based on the variables above, the description of the operational variables in this research is:
   a. Rainfall, rainfall can be interpreted as the amount of rainwater that falls in a certain area in a certain unit of time. The amount of rainfall is the volume of water collected on a flat surface in a certain period (daily, weekly, monthly, or annually).
   b. The planned flood discharge uses the Nakayasu method, which is used to estimate the magnitude of flood discharge that will occur in an area when there is high rainfall.
   c. HEC-RAS is a one-dimensional model of permanent and non-permanent flow (steady and unsteady one-dimensional flow model) (Istiarto, 2014). HEC-RAS is also able to calculate subcritical and supercritical flow water surface sections. This system contains 3 components of one-dimensional hydraulic analysis, namely calculating the cross-section of the water surface for a steady flow, unsteady flow and sediment transport calculations.

Research Procedures

1. Hydrological analysis
2. River cross-section analysis using HEC-RAS
3. Input River Geometry Data
4. Input Flood Discharge Data
5. Perform RUN Application

RESULTS AND DISCUSSION

After processing the data from the flow path map in the Batang Ulakan watershed, the data processing results obtained in the table 1.

Table 1: Thiessen Polygon Calculation

STATION NAME	=	138,33	KM²	KOEFISIEN		
ST. VII KOTO SUNGAI SARIK	=	90,93	KM²	W1	=	0,6573
ST. SICICIN	=	21,84	KM²	W2	=	0,2402
ST. SINTUK	=	25,56	KM²	W3	=	1,1703

With the data above we can continue calculating average rainfall using the formula stated ithe previous chapter. Coefficient at each station:

1. St. VII Koto Sungai Sarik : 90,93/138,33 = 0,6573
2. St. Sicicin : 21,84/138,33 = 0,2402
3. St. Sintuk : 25,56/138,33 = 1,1703

Rain Plan

Planned rainfall can be calculated using the formula attached to the previous chapter. Namely at the return period of 2 years, 5 years, 10 years, 25 years, 50 years.

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a. Average rainfall

$$\frac{\sum \log R}{n} = \frac{\sum \log 880{,}75}{10} = 1{,}944 \text{ mm}$$

b. Standard Deviation Data

$$\sqrt{\frac{\sum(\log(R) - \log(R))^2}{n-1}} = \sqrt{\frac{\sum(\log(1{,}944) - \log(1{,}944))^2}{10-1}} = 0{,}205 \text{ mm}$$

c. Skewness coefficient

$$CS = \frac{N \sum \log(R) - \log(R)^3}{(n-1)\times(n-2)\times(std\ (\log(R)^3}$$

$$CS = \frac{N \sum \log(R) - \log(R)^3}{(n-1)\times(n-2)\times(std\ (\log(R)^3} = 0{,}288 \text{ mm}$$

d. Rain Design Data (RT)

Log t = Log R + std (log)).G

1. For repeat period 5 year
   = (1,944 mm +0,205 mm) x 0,830
   = 1,783
   = RT 10^{logt}
   = $10^{1,783}$
   = 60,67 mm

2. For repeat period 10 year
   = (1,944 mm +0,205 mm) x 1,301
   = 2,795 mm
   = RT 10^{logt}
   = $10^{2,795}$
   = 623,73 mm

3. For repeat period 25 year
   = (1,944 mm + 0,205 mm) x 1,849
   = 3,973 mm
   = RT 10^{logt}
   = $10^{3,973}$
   = 9397,23 mm

4. For repeat period 50 year
   = (1,944 mm +0,205 mm) x 2,159 = mm
   = RT 10^{logt}
   = $10^{4,621}$
   = 39810,717 mm

a. Rain Design Data (RT)

It is assumed that only 90% of the rain occurs with an average of 4 consecutive hours of rain with a division of 10% to 40%.

I5 = $60{,}67 \text{ mm} \times 90\% \times 40\%$

= 21,84 mm/jam
I10 = 623,73mm × 90% × 40%
= 224,542 mm/jam
I25 = 9397.23mm × 90% × 40%
= 3382,92 mm/jam
I50 = 39810,717 mm × 90% × 40%
= 14331,85 mm/jam

Nakayasu HSS Planned Flood Discharge

Known data:
Watershed area (A) : 115 Km^2
River length : 19 Km
A : for 2 regular streams
R0 : 1mm
C :2,06

Calculations are carried out in this way: For L > 15 Km

1. Time between rain and peak discharge Tg (L > 15 Km)
   Tg = 0.4 + 0.058 x L
   Tg = 0.4 + 0.058 x 19 Km
   = 1,502 Hours
2. Rainy time
   Tr = 0.55 x Tg
   Tr = 0.55 x 1.502 hours
   = 0.826 Hours

3. Time to reach the peak (Tp)
   Tp = Tg + (0.8 x Tr)
   Tp = 1.502 + (0.8 x 0.826)
   = 2,162 Hours

Table 2: Nakayasu Method Plan Flood Discharge Calculation

T (O'clock)	Qt (m3/s)	Q CORRECT (m3/s)	Information
0	0	0	Q Up
1	0,507631855	0,1066	
2	2,679296994	0,5629	
2,16	3,230	0,6786	Qp
3	0,207	0,0436	Q Down 1
4	0,062	0,0131	
5	0,019	0,0039	
6	0,006	0,0012	
6,47	0,00	0,0000	
7	0,00	0,0000	Q Down 2
8	0,00	0,0000	
9	0,00	0,0000	
10	0,00	0,0000	

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11	0,00	0,0000	
11,82	0,00	0,0000	
12	0,00	0,0000	Q Down 3
13	0,00	0,0000	
14	0,00	0,0000	
15	0,00	0,0000	
16	0,00	0,0000	
17	0,00	0,0000	
18	0,00	0,0000	
19	0,00	0,0000	
20	0,00	0,0000	
21	0,00	0,0000	
22	0,00	0,0000	
23	0,00	0,0000	
24	0,00	0,0000	
Amount Q (M3/S)	6,711	1,410	
VLL (M3)	24159,64	5075,55	
TLL (MM)	0,210	1,0000	

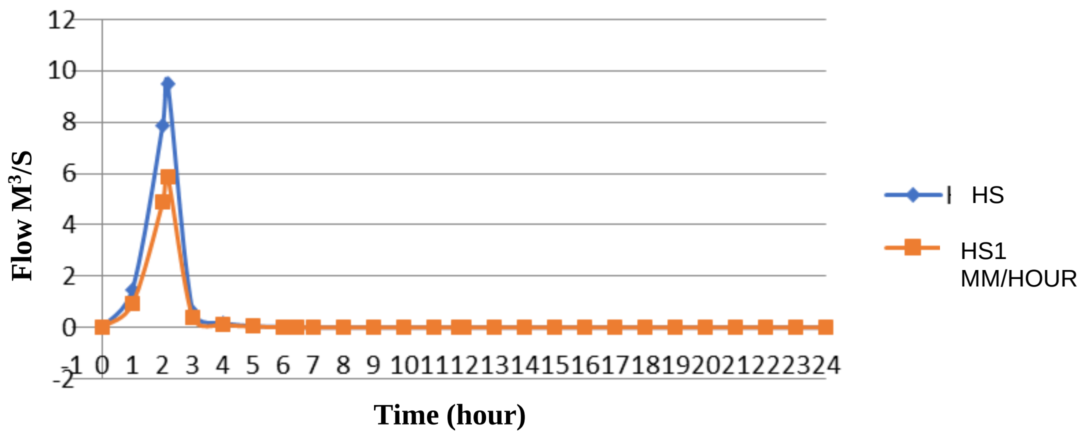

Figure 1: HSS graph of Nakayasu DAS Kampuang Galapuang

CONCLUSION

From the results of the flood discharge analysis, the plan explains that the Batang Ulakan watershed can reach maximum discharge in just 2 hours 6 minutes 25 seconds. To achieve a peak discharge of 9.51 m³/s from the normal discharge. During the planned rain return period of 25 years to 50 years, the cross-sectional capacity data obtained shows that the geological conditions which have elevations that are not much different between the river cross-section and the residents' settlements have a slight difference, resulting in the cross-section of the Batang Ulakan Nagari Kampung Galapuang watershed on average overflowing as high as 0.447 m in each Batang Ulakan Time (Hour) ng Galapuang watershed.

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EISSN: 2622-6774
Vol 11 No.1 March 2024
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