Flood Control in Areas of Cisumdawu Toll Road Section 3 at Galudra Village, Sumedang Regency.

Arsyadin Abil Fada[1], David Setiawan, Muhamad Tisna, Piki Abdurahman,
R.H.B Ash Siddiq

Abstract: *Flooding is a problem that often occurs in urban and rural areas. Flooding can be caused by an overflow of drainage flow that exceeds its capacity. In 2019, Galudra Village, Sumedang Utara Subdistrict flooding happened, the cause of the flood was indicated since the Cisumdawu development project, based on observations in fields, the flood caused by the overflow of local drainage flows that caused inundation of 20-50 cm which inundated the paddy field and Galudra Village area. From the results of the hydrological analysis, it was found that the Catchment Area at the study site was divided into 2, with each area of Subcatchment 1 being 283.1 ha and the area of sub-catchment 2 being 414.9 ha. With extreme rain period of 2 years (R2) of 91.05 mm and an extreme rain period of 5 years (R5) is 107.59 mm. From the results of SWMM modeling, it is found that the most effective flood control is by bypassing the channel and enlarging the downstream channel dimensions in the form of a trapezoid.*

Keywords*: Flood, Galudra Village, Drainage Channel, SWMM.*

I. INTRODUCTION

Flooding happens in urban areas is caused by existing drainage capacity cannot accommodate runoff (Kodoatie and Sugiyanto). In a watershed, the reduction of green absorption areas has reduced the ability to function as an environmental buffer zone (Dr. Ir. Suripin). In 2019, Galudra Village, Sumedang Utara Subdistrict flooding happened, the cause of the flood was indicated since the Cisumdawu development project, based on observations in fields, the flood caused by the overflow of local drainage flows that caused inundation of 20-50 cm which inundated the paddy field and Galudra Village area. The flood was triggered by a decrease in an absorption area in catchment areas due to increasing population, activities and land requirements, so that happens interventions in urban activities on conservation areas and green open spaces (Hasan et al.). Based on these conditions, it is necessary to research the management of flood control so that there is no assumption about the Cisumdawu toll road construction project which is causing bad development for Galudra Village.

[1] *Departement of Civil Engineering, Widyatama University, Indonesia*
Email: abil.fada@widyatama.ac.id, david.setiawan@widyatama.ac.id, Muhamad.Tisna@widyatama.ac.id, piki.abdurahman@widyatama.ac.id, raden.herdian@widyatama.ac.id

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

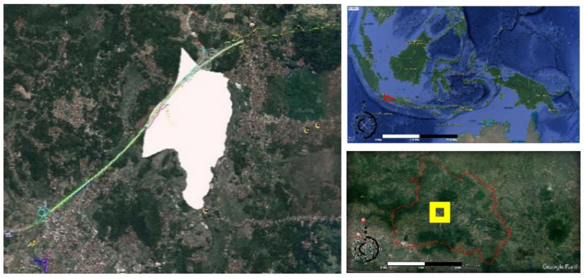


Figure 1: Galudra Village Location

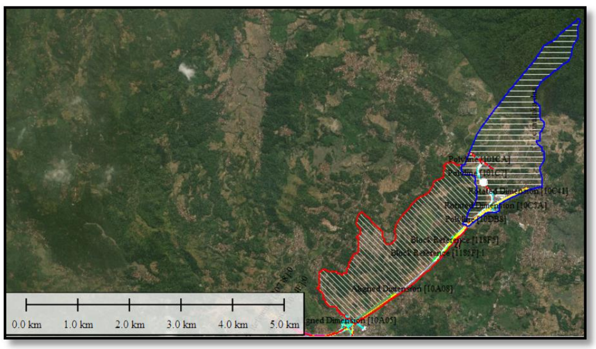


Figure 2 Sub catchment in Study Area

II. LITERATURE REVIEW

1.1 Average Rainfall with Polygon Thiessen Method

The rainfall needed for the flood control plan is the average rainfall in the whole area not the rainfall at a certain point. This rainfall is called regional rainfall and is expressed in mm (Sosrodarsono, 1993, p.27)

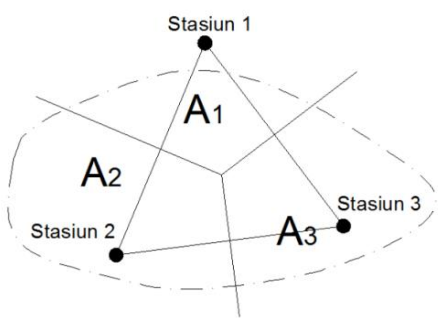


Figure 3 Methode Polygon Thiesen

$$P_n = \frac{A_n}{A}$$

With :

P_n = Theisen coefficient

A_n = The area represented by the measurement stations

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

A = Overall area (Km^2)

$d = P_1.d_1 + P_2.d_2 + ... + P_n.d_n$

With :

d = Regional maximum rainfall

P_n = Thiessen's coefficient

d_n = Rainfall height measured from the measurement station

1.2 Frequency Distribution

The types of frequency distributions that used in this research are:

a) Normal Distribution
b) Lognormal Distribution
c) Pearson Log Distribution III
d) Gumbel distribution

Normal distribution

$$X_T = \overline{X} + K_T S$$

With:

$$S = \sqrt{\frac{\sum_{n-1}^{n} (X-\overline{X})^2}{n-1}}$$

With :

X_T = the expected value,

$\overline{X}$ = the average value,

S = the standard deviation,

K_T = frequency factor

Log Normal Distribution

$$Y_T = \overline{Y} + K_T.S$$

With :

Y_T = the estimated value

$\overline{Y}\ (\overline{Y} = \log \overline{X})$ = the average value

S = standard deviation

K_T = frequency factor

Log Person III Distribution

$\log X_T = \log \overline{X} + K.S$

Gumbel Distribution

$$X_{Tr} = b + \frac{1}{a} Y_{Tr}$$

With,

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

$a = \frac{S_n}{S}$ dan $b = \overline{X} - \frac{Y_n S}{S_n}$

Where ;

Y_n = Reduced Mean depending on the number of samples/data

S_n = Reduced Aviation standard which also depends on sample/data n.

1.3 Rainfall Intensity

From the rainfall period then determined the intensity of rainfall per hour with the assumption that the duration of rain is 6 hours. To get the rainfall intensity Mononobe formula is used

$$I = \frac{R_{24}}{24}\left(\frac{24}{T}\right)^{\frac{2}{3}}$$

Where:

I = Rainfall Intensity (mm/hr)

T = Rainfall Duration Time (hr)

R24 = Maximum Rainfall in 24 hour (mm)

1.4 Hydroloical Design Criteria for Retenton Pond.

Determination of the return period for retention pond design based on the catchment area and city typology based on PU Permen No.12 / PRT / M / 2014 concerning the Implementation of the Urban Drainage System (Science).

Table 1 Return Period for Retention Pond Design

City Typology	Catchment Area (ha)			
	<10	10-100	100-500	>500
Metropolis	2 yr	2-5 yr	5-10 yr	10-25 yr
Big City	2 yr	2-5 yr	5-10 yr	5-20 yr
Small City	2 yr	2-5 yr	2-5 yr	5-10 yr

Source: (Menteri Pekerjaan Umum)

Based on table, its determined that for the Catchment area with 100-500 ha in the small city is used 2-5 year return period design.

1.5 SWMM

Storm Water Management Model (SWMM) is a dynamic simulation model of the relationship between rainfall and runoff. This model is used to simulate single or continuous events over a long period, both in the form of runoff volume and water quality, especially in an urban area.

In modeling using SWMM there are parameters used in data processing, these parameters are:

Table 2 Parameter – Parameter Pengolahan Data SWMM

No	Fixed Parameter	Free Parameter
1	Rainfall	%Imperv
2	Area	Channel Width
3	Elevation	Channel Height
4	Width	Channel Shape
5	Infiltration	
6	%Slope	
7	N-Imperv	

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

No	Fixed Parameter	Free Parameter
8	N-Perv	
9	Dstore Imperv	
10	Dstore Perv	
11	%Zero Imperv	

Source: (Rossman)

III. METHOD

The steps in this research process are as follows:

1) Collecting survey data and secondary data. The data required include:
   a) A map of the earth's shape
   b) Rainfall data from 2 climatology Station, there are Jatimulya station and Paseh station. With a length of observation duration of 16 years each.
2) Data analysis

The intended analysis is as follows:

a) Determine the Sub catchment area from a map.
b) Rainfall analysis using the Thiessen method.
c) Statistical parameters which are parameters used in data analysis of a variable. Then do the distribution type selection to get the appropriate distribution
d) Flood Modeling with Storm Water Management Model (SWMM).

IV. RESULT AND ANALYSIS

1.6 First Modeling Scenario

In this first scenario, there is an existing modeling that aims to equate the modeling conditions with conditions in the field. In this scenario, parameters are also arranged so that the results of the modeling approach the actual conditions. The parameters set in this scenario are;

1) % Impervious = 50 (dense urban settlement)
2) Roughness = 0.01 (concrete lining channel)
3) 2 year rainfall period

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

International Journal of Psychological Rehabilitation, Vol.24, Issue 07, 2020
`Issn: 1475-7192

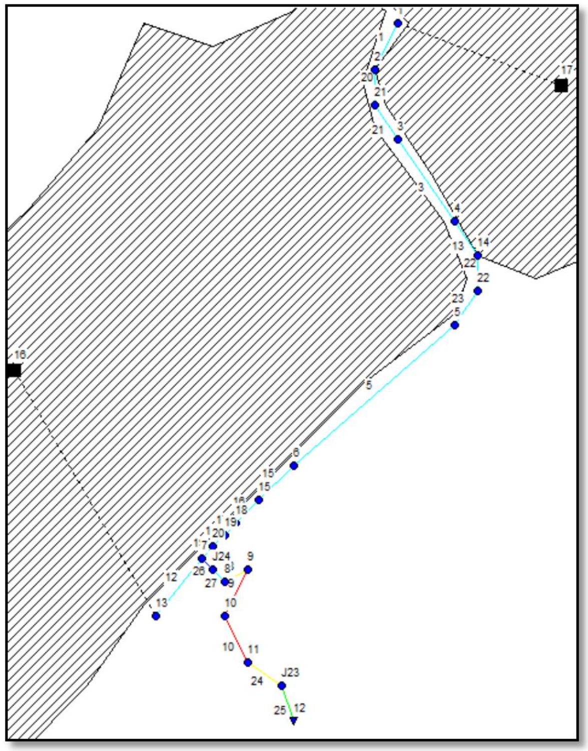


Figure 4 Channel Condition (link) Result on the First Scenarios

The first scenario modeling showed a channel in red indicating that the existing channel capacity is not able to accommodate water discharge, while a channel in green indicates that the channel is still able to accommodate water discharge. The results obtained are as follows:

1) Link 9, 10 and 11 at second hours there was an overflow due to the channel being unable to accommodate the water discharge. The channel is located in the village area of Galudra.

2) At Link 9,10 and 11 there was an overflow as high as 20 cm.

3) According to fields data, it can be said that this modeling is appropriate.

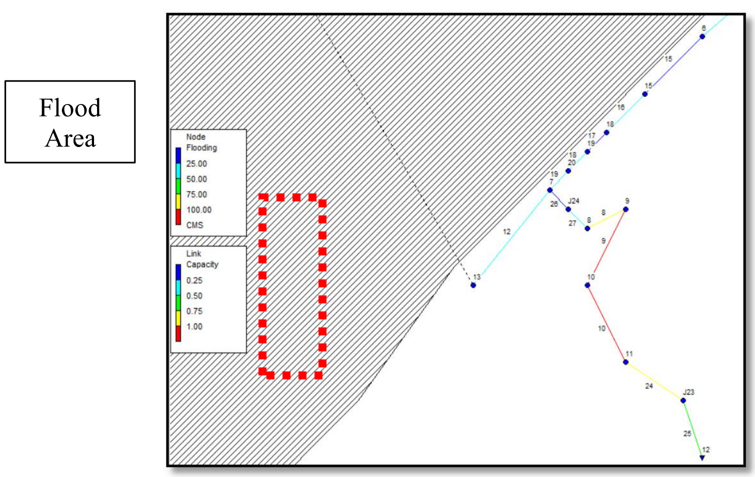


Figure 5 The results of SWMM modeling first scenario.

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

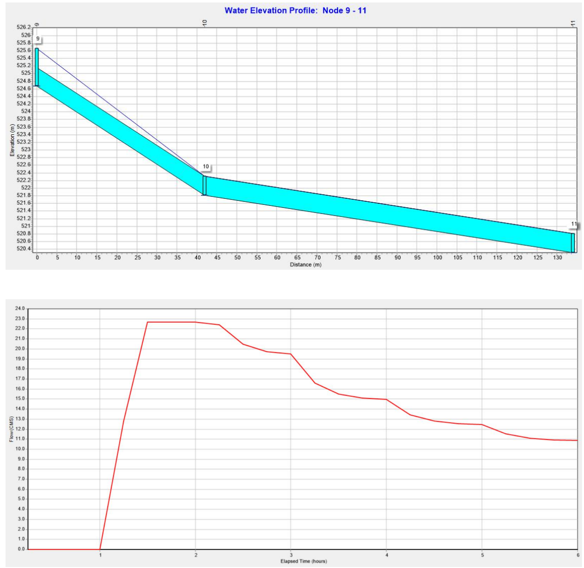


Figure 6 Long section and Discharge on the channel that occurs overflow

Figure 7 ***Flood conditions in one of the houses of citizens at Galudra village***

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

Figure 8 ***Flood conditions in paddy fields in the village of Galudra***

1.7 Second Modeling Scenario

In this second scenario the modeling is carried out by enlarging the dimensions of the channel, which was previously 0.50 x 0.50 meters (square) to be enlarged into a trapezoidal shape with a bottom width 1.00 meters and 1: 1 of slope and 2 yearly rain.

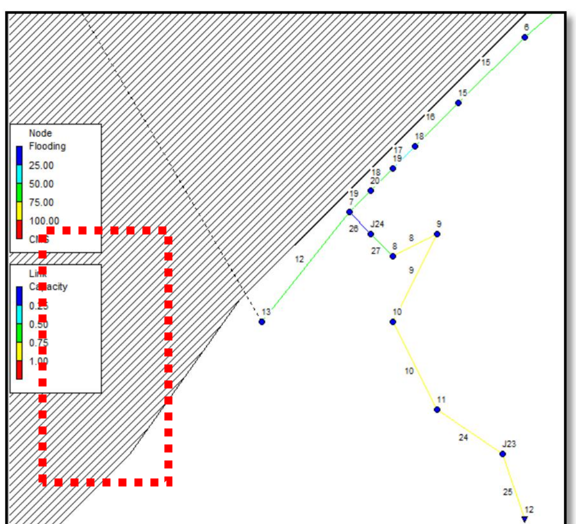


Figure 9 The results of SWMM modeling second scenario.

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

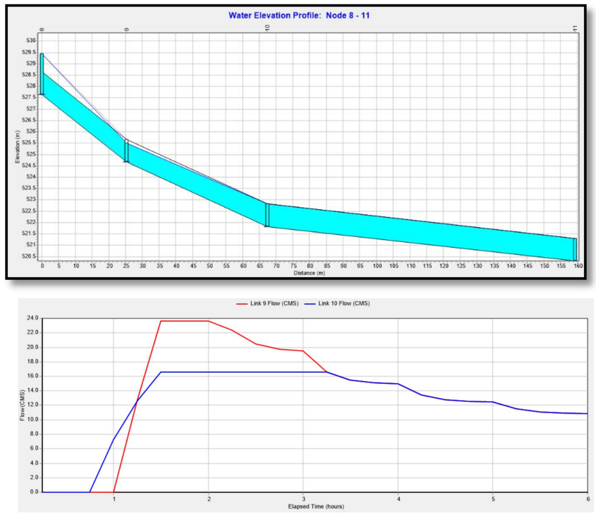


Figure 10 Long section and Discharge on the channel Link 9 and 10 that occurs overflow

1.8 Third Modeling Scenario

In this scenario, input from first Sub catchment is not calculated. By connecting the drainage channel that was previously entered into the culvert with the channel across. These changes by hoarding the left side of the road, to be the basis for the placement of channels that pass over the culvert. And the dimensions of the exciting channel are enlarged to the size as in scenario 2.

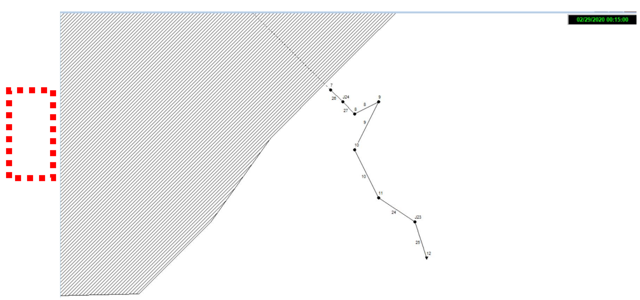


Figure 11 The results of SWMM modeling third scenario.

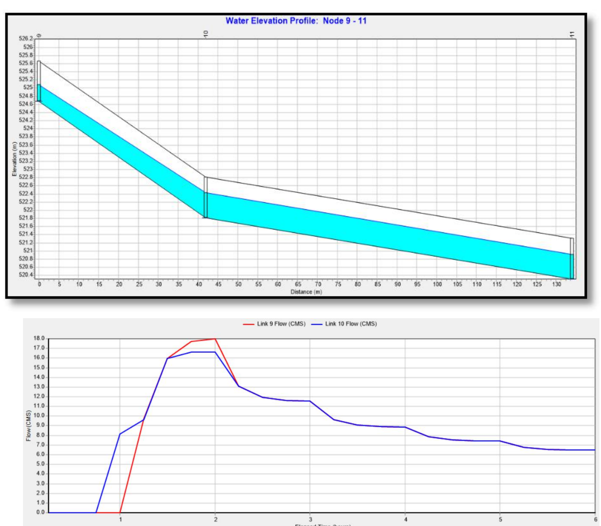


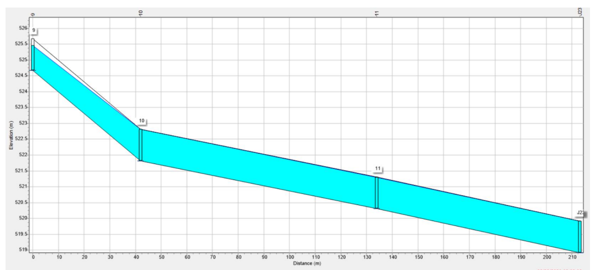
Figure 12 Long section and Discharge on the channel Link 9 and 10 in the third scenario

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

In this third scenario the canal is seen still yellow which indicates that in channels 9 and 10 there is no overflow of water but the condition is critical. However, in this scenario the peak discharge at Node 10 has decreased to 1.64 m^3 / s. From scenario 2 and 3 the same result is obtained that there is no overflow in the channel but the channel is in critical condition. However, when viewed from the ratio of incoming flow to the channel, scenario 3 is more effective. In scenario 2 the peak discharge in channel 9 is 25.5 m^3 / s and in channel 10 it is 16.7 m^3 / s, whereas in scenario 3 the peak discharge in channel 9 decreases to 18 m^3/s and channel 10 becomes 16.5 m^3 /s

1.9 Fourth Modeling Scenario

This fourth scenario modeling is the same as scenario 3, but it uses 5 year rain period.



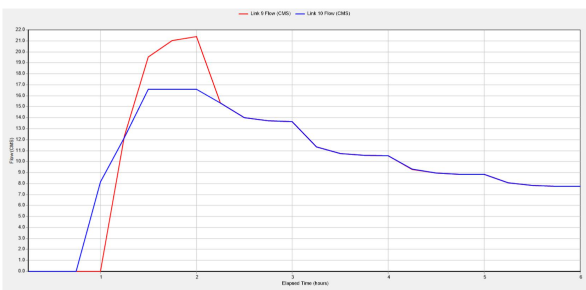


Figure 13 Long section and Discharge on the channel Link 9 and 10.

In this scenario seen in channel 9, 10 does not overflow but the channel is in critical condition. This indicates that the dimensions of the channel can accommodate up to 5 yearly flood discharges.

V. CONCLUSION

The conclusions of this study are:

1) The Catchment area at this study site is divided into 2 sub-catchments with each area of sub-catchment 1 being 283.1 ha and the area of sub-catchment 2 being 414.9 ha.

2) Based on the Hydrology analysis obtained extreme rain with a return period of 2 years (R2) of 91.05 mm and a return period of 5 years (R5) is 107.59 mm.

3) Based on the Minister of Public Works Regulation No. 12 of 2014 that for small cities with a catchment area of 100-500 ha, rainfall returns from 2-5 yrs are used to calculate the discharge.

4) From the simulation results, it is found that the third scenario is the most effective way to control flooding in Galudra Village,

5) The reason why the trapezium channel was chosen because in the Galudra Village there is still a large area of rice fields making it possible to make a larger trapezium channel. Also from a technical standpoint, making and installing is easier compared to box culverts that require truck access roads.

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

VI. REFERENCES

[1] Dr. Ir. Suripin, M. Eng. "Drainage." Sustainable Urban Drainage System, 2004.

[2] Hasan, Fuad, et al. "STUDY OF CIMANYAR RIVER FLOW RESPONSE TO VARIOUS RAIN EVENTS." *Jurnal Ilmiah Teknologi Infomasi Terapan*, 2020, doi:10.33197/jitter.vol6.iss1.2019.322.

[3] Kodoatie, Robert J., and Sugiyanto. "Floods, Some Causes and Control in Environmental Perspectives." *Pustaka Pelajar. Yogyakarta.*, 2002, doi:10.1016/j.npg.2013.07.003.

[4] Ministry of Public Works. *Peraturan Menteri Pekerjaan Umum Republik Indonesia Nomor 12/PRT/M/2014 Penyelenggaraan Sistem Drainase Perkotaan*. 2014, pp. 1–18.

[5] Rossman, L. A. "STORM WATER MANAGEMENT MODEL USER'S MANUAL Version 5.1." *EPA/600/R-14/413b, National Risk Management Laboratory Office of Research and Development. United States Environmental Protection Agency, Cincinnati, Ohio.*, no. September, 2015, p. 352, http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100N3J6.TXT.

[6] Sosrodasono, Suryono. *Hydrology for Irrigation*. PT Pradnya Paramita. Jakarta. 1973.

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019