P-ISSN : 2598-1277
E-ISSN : 2621-3966

JOURNAL OF GREEN SCIENCE AND TECHNOLOGY

ANALYSIS OF DRAINAGE CHANNEL CAPACITY IN CIREMAI RAYA LARANGAN SUB-DISTRICT OF CIREBON CITY

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ABSTRACT

The perumnas gunung area is one of the areas in the Larangan sub-district, Harjamukti Subdistrict, Cirebon City, whose drainage system greatly disturbs the activities of the population in Cirebon City because when heavy rain causes the high volume of water in the drainage so that it comes out to the highway and is very disturbing it can also cause congestion. To solve the problem of inundation and flooding, it requires maximum rainfall data, population density data and hydraulic data from direct observation at the research location. From the rainfall data, the intensity of the rainfall is calculated, then the standard deviation is calculated to get the return period value using the Gumble formula. From the calculation of the Return Period, the calculation of the flood discharge is carried out using a rational method and calculating the discharge of the existing channel. Calculation of the capacity of the existing channel discharge is carried out by calculating the discharge of rainwater and discharge of household wastewater. From the calculation of Hydrology and Hydraulics, the value of Rainfall Intensity is 46.632 mm / day, the overall channel discharge = 0.603 m3 / s, the calculation of the total discharge from household wastewater and rainwater discharge for the 2-year return period is 0.0076 m3 / s. . From the calculation results, the authors conclude that the dimensions of the existing canal can still accommodate the flow of rainwater and household wastewater. The solution to overcome flood inundation on Jalan Ciremai Raya, it is necessary to normalize the drainage channel so that the drainage channel can function properly.

Keyword: *channel, discharge, intensity.*

I. INTRODUCTION

The development of settlements at this time can be said to be quite large and the increasing population activity will be disrupted if one time a flood occurs because it greatly affects the drainage system and the community must also realize the importance of the drainage system. The development of a residential area which is alleged to be the cause of flooding and inundation in the surrounding environment. This is due to the development of urbanization which has led to changes in land use. The purpose of this research is to calculate the capacity / capacity of drainage channels due to rainfall and due to household wastewater.

II. LITERATURE REVIEW

2.1. Rain Intensity

Drainage is one of the basic facilities designed as a system to meet community needs and is an important component in urban planning (especially infrastructure planning). Drainage is one of the elements of general infrastructure needed by the city community in order to lead a city life that is safe, comfortable, clean, and healthy. Drainage is a system for removing clean water and wastewater from residential, industrial, agricultural, road bodies and pavement surfaces. others, as well as the distribution of excess water in general, in the form of rainwater, waste water or other dirty water that comes out of the area concerned, either above or below the ground surface, into water bodies or into artificial infiltration structures. For the research stage, it is carried out as follows:

1. Survey the research location is on the road Ciremai raya, the village of ban, the city of Cirebon.
2. Calculate Chatman Area
3. Looking for rainfall data from the nearest rainfall station with a minimum data of 10 years
4. Survey of population density in the village of ban, the city of Cirebon
5. Survey the location of drainage channels on Jalan Ciremai Raya, Kelurahan Ban, Cirebon City.
6. Calculating daily rainfall intensity
7. Calculating the probability of the return period of planned Rainfall using the Gumble formula
8. Calculation of the discharge of the existing drainage channels (existing)
9. Calculation of the debit plan in the research location
10. Rational method plan discharge calculation
11. Calculation of the consequences of household wastewater
12. Calculation of the feasibility of channel capacity due to rainfall and due to household waste.

III. METHODOLOGY

3.1. Research Methodology

Based on the research objectives, a research framework can be drawn up as in the following chart.

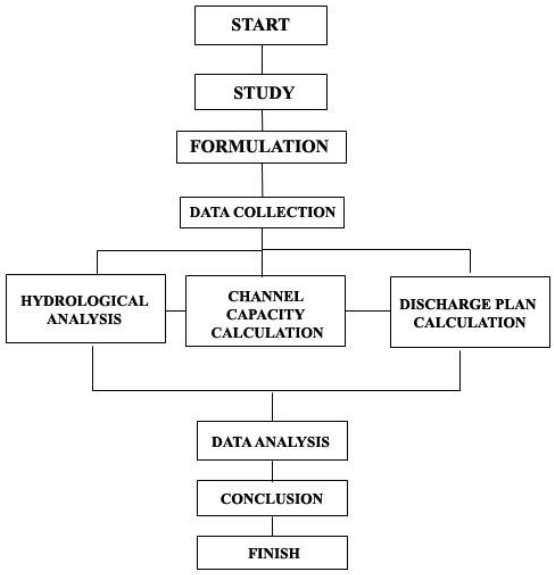

Figure 3.1. Research Methodology

3.2. Problem Solving

3.2.1. Rainfall

Rainfall data used in this study used rain data for 15 years from the Cimanuk-Cisanggarung BBWS rainfall station.

Table 3.1. Rain Data for 15 years

NO	Year Max	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	RH Max
1	2005	73,80	54,10	75,10	90,90	31,40	18,00	47,30	43,90	42,00	28,50	15,80	78,60	90,90
2	2006	61,80	85,60	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	78,60	85,60
3	2007	72,90	61,50	45,20	24,60	40,70	22,10	31,60	0,00	0,00	54,70	80,80	87,50	87,50
4	2008	152,50	60,80	51,50	54,20	32,50	32,60	0,00	15,20	0,00	54,70	80,80	87,50	152,50
5	2009	13,00	57,20	57,60	18,20	14,80	54,20	0,90	0,00	0,00	0,00	132,30	40,20	132,30
6	2010	48,20	98,60	51,20	62,00	54,90	29,20	51,60	53,80	107,30	47,10	74,40	83,50	107,30
7	2011	55,40	103,50	101,20	46,50	13,10	12,20	6,30	0,00	0,00	51,30	49,60	79,80	103,50
8	2012	54,00	186,00	100,80	40,50	36,00	8,00	0,70	0,00	0,00	14,00	20,10	69,10	186,00
9	2013	73,80	133,00	107,50	46,00	56,00	45,00	59,00	2,00	39,00	2,00	37,00	80,00	133,00
10	2014	165,50	78,10	107,50	46,00	56,00	45,00	59,00	2,00	39,00	2,00	37,00	80,00	165,50
11	2015	180,00	78,20	78,70	77,80	48,50	0,40	0,59	8,30	0,00	0,00	14,30	105,00	180,00
12	2016	78,00	133,00	100,00	46,50	43,00	52,60	14,60	103,50	45,00	61,60	54,20	97,50	133,00
13	2017	138,00	140,00	26,00	38,50	69,00	44,00	0,00	0,00	51,00	65,50	55,00	21,20	140,00
14	2018	20,00	103,00	210,00	103,00	0,00	7,00	0,00	0,00	0,00	0,00	110,00	110,00	210,00
15	2019	140,00	140,00	130,00	60,00	46,00	0,50	0,50	0,00	0,00	0,00	7,00	155,00	155,00

Rainfall calculation using the Gumbel method. The formula used in calculating rainfall intensity is:

I = (R 24)/24 × (24/t)^m ……………………..[1]

where :
I = Rainfall Intensity
t = duration of rain (hour)
m = constant (2/3)
R24 = maximum rainfall in 24 hours (mm)

3.2.2. Existing Channel Discharge

Existing channel discharge calculation aims to determine the amount of discharge that can be flowed by the channel, so that the hydraulic analysis can be controlled whether the channel is still functioning properly or not.

To calculate the channel discharge using the balance formula, which is as follows:

A = b x h ……………………………………[2]

P = b + 2 (h) …………………………………..[3]

R = A / P ……………………………………[4]

Q = 1/n A x R 2/3 x S ½ ………………………[5]

3.2.3. Calculation of Discharge Plan Rational Method

In this study, the method of calculating the discharge plan uses the Rational Method, this method is used to determine the amount of flood discharge in planning drainage channels for small catchments (<40 Ha).

Qt = 0.00278 .C.I. A …………………………..[6]

Where :
Qt = flood discharge plan
C = flow coefficient
I = rainfall intensity
A = area of waterhsed

3.2.4. Discharge Calculation Due to Households

In this study, the method of calculating debit due to household uses the following formula:

Total population = Ag x Population Density …..[7]

→ Where, Ag = Drainage area

Average amount of water distributed by households

→ = 120/(1000 x 3600 x 24)

Amount of wastewater flow

→ Q waste = 0.75 x Average amount of water distributed by households x total population x 1.5 …………………………………..[8]

Total discharge obtained

→ Qtotal = Q flood + Q waste ……………[9]

Drainage channel capacity requirements are as follows:

If → Q total < Q Channel (so the channel doesn't need to be enlarged)

3.2.5. Calculation of the Feasibility of Channel Capacity Due to Rainfall

The number of rainy days in one year from existing rainfall data, then for a 2 year return period, is multiplied by two.

Calculating the intensity of rain for a 2 year return period, then calculating the discharge due to rainfall using a rational method.

3.2.6. Calculation of Household Discharge Result for 2 Years Return Period

In calculating the debit due to the household, a large number of population is planned in the next 2 years.

3.2.7. Return Period Total Debit Calculation

Calculation of the total discharge for the return period of rainfall and household waste.

Q total = Qrain + Qwaste ……………………[10]

IV. RESULT AND DISCUSSION

4.1. Rainfall Analysis

The calculation of rainfall intensity uses the following formula:

I = (R 24)/24 × (24/t)^m ……………………[11]

Where :
I = Rainfall Intensity
t = length of rainfall (hours)
m = constant (2/3)
R24 = maximum rainfall in 24 hours (mm)

The following shows how to calculate Rain Intensity in 2005.

I = 90,90/24 × (24/60)^(2/3)

I = 2,056 mm/day

The results of calculating the intensity of rain from 2005 to 2019 are shown in the table.

Table 4.1. Rainfall Intensity

No	Year	Daily Average	Rain Intensity
1	2005	90,900	2,056
2	2006	85,600	1,936
3	2007	87,500	1,979
4	2008	152,500	3,449
5	2009	132,300	2,992
6	2010	107,300	2,426
7	2011	103,500	2,34
8	2012	186,000	4,206
9	2013	133,000	3,008
10	2014	165,500	3,742
11	2015	180,000	4,07
12	2016	133,000	3,008
13	2017	140,000	3,166
14	2018	210,000	4,749
15	2019	155,000	3,505
Total Rain Intensity (mm/day)			46,632

source: calculation result

4.2. Analysis of Average Rainfall Gumbel Method

In this study, the process of calculating the planned rainfall uses the Gumbel Method. The results of the calculation of the gumbel method show the Rainfall Plan for the Return Period T year, as follows:

Table 4.2. Rainfall Plan

Return Period	Rainfall Plan (mm)
2	132,023
5	174,245

source: calculation result

4.3. Existing Debit Calculation

Existing channel discharge calculations are shown in the table below:

Table 4.3. Existing Channel Discharge

Station	B	H	A	P	R	S	n	Q	Detail
0 + 000	0,5	0,6	0,300	1,700	0,176	0,0030	0,020	0,258	Stone Masonry
0 + 050	0,50	0,60	0,300	1,700	0,176	0,0030	0,020	0,258	Stone Masonry
0 + 100	0,50	0,60	0,300	1,700	0,176	0,0030	0,020	0,258	Stone Masonry
0 + 150	0,50	0,60	0,300	1,700	0,176	0,0030	0,020	0,258	Stone Masonry
0 + 200	0,60	0,65	0,390	1,900	0,205	0,0030	0,015	0,495	Concrete
0 + 250	0,60	0,65	0,390	1,900	0,205	0,0030	0,015	0,495	Concrete
0 + 300	0,60	0,65	0,390	1,900	0,205	0,0030	0,015	0,495	Concrete
0 + 350	0,60	0,80	0,480	2,200	0,218	0,0030	0,015	0,635	Concrete
0 + 400	0,60	0,80	0,480	2,200	0,218	0,0030	0,015	0,635	Concrete
0 + 450	0,60	0,80	0,480	2,200	0,218	0,0030	0,015	0,635	Concrete
0 + 500	0,60	0,80	0,480	2,200	0,218	0,0030	0,015	0,635	Concrete
0 + 550	0,60	0,80	0,480	2,200	0,218	0,0030	0,015	0,635	Concrete
0 + 600	0,60	0,80	0,480	2,200	0,218	0,0030	0,015	0,635	Concrete
0 + 650	0,74	1,15	0,851	3,040	0,280	0,0030	0,015	1,329	Concrete
0 + 700	0,74	1,15	0,851	3,040	0,280	0,0030	0,020	0,997	Stone Masonry
0 + 750	0,74	1,15	0,851	3,040	0,280	0,0030	0,020	0,997	Stone Masonry
Q Average								0,603	

source: calculation result

4.4. Calculation of Discharge Plan Rational Method

Qt = 0,00278 x C x I x A
= 0,00278 x 0,40 x 46,632x 0,304
= 0,0157 m3/s

4.5. Calculation of Debt Due to Household

Drainage area (Ag) = 30,4 Ha,
Total population = Ag x Population density
= 30,4 Ha x 270 orang/Ha
= 6.019 people

The average amount of water distributed to households is 120 liters/person/day

= 120/(1000 x 3600 x 24)
= 0,0000014 m3/s

Then the waste water generated is about 75% of the average water that is channeled to the area, so the total waste stream for the area is:

Qwaste = 0,75 x 0,0000014 x 6.019 x 1,5
= 0,0095 m3/s

Then the total discharge is obtained, namely:

Qtotal = Qrain + Qwaste
= 0,0157 + 0,0095
= 0,0252 m3/s

If → Q total < Q Channel (so the channel doesn't need to be enlarged)

→ 0,0252 < 0,603 (qualified)

4.6. Calculation of the Feasibility of Channel Capacity Due to Rainfall

Calculation of the Return Period of Rainwater Discharge, then shown in the table.

Table 4.4. Return Period of Rainwater Discharge

No	Period	Max Daily Rainfall	Average	Rain Intensity	Discharge (Q)
1	2	132,023	140	1,697	0,0679
2	5	174,245	140	2,239	0,0896

source: calculation result

4.7. Due to Household Waste

In calculating the debit due to the household, a large number of population is planned in the next 2 years. Namely as follows:

The total population using the channel in the next 2 years is 6019 people.

= 0,93 % x 6019 x 2
= 112 people

So the population for the next 2 years is:

= 6019 + 112
= 6131 people

Qwaste = 0,75 x 0,0000014 x 6131 x 1,5
= 0,0097 m3/s

Furthermore, for the calculation of the return period is shown in the table below.

Table 4.5. Calculation Of The Return Period

No	Return Period	Year	Total Population	Household Waste
1	T2	2020	6131	0,0097
2	T5	2023	6299	0,0099

source: calculation result

4.8. Return Period Total Debit Calculation

The calculation of the total discharge for the return period of rainfall and household waste will be shown in the table below:

Table 4.6. Total Discharge For The Return Period

No	Return Period	Rain Discharge	Household Waste Discharge	Total Discharge
1	T2	0,0679	0,0097	0,0776
2	T5	0,0896	0,0099	0,0995

source: calculation result

V. CONCLUSION AND RECOMENDATION

5.1. Conclusion

From the results of hydrology and hydraulics calculations that have been carried out, the authors draw conclusions, as follows:

1. The amount of rainfall intensity is 46.632 mm/day
2. The total flowrate is 0.603 m3/s
3. The amount of rainwater discharge from the Rainfall data from 2005 to 2019 is 0.0157 m3/s.
4. The amount of household waste water discharge in the 2-year return period is 0.097 m3/s.
5. The amount of rainwater discharge and household wastewater discharge in the 2-year return period is 0.0776 m3/s
6. Based on the results of existing discharge calculations, the drainage channel is still sufficient to accommodate rainwater discharge and household wastewater discharge.
7. Inundation that occurs in the research location is due to sedimentation in the drainage channel section and the presence of garbage, which impedes the flow of water in the drainage channel.

5.2. Recomendation

As suggestions from researchers, are as follows:

1. Authorities will immediately carry out normalization of drainage channels.
2. There is a need for outreach to the surrounding community to provide guidance on the importance of drainage channels.
3. Appeal to the surrounding community to always keep the environment clean, so that garbage does not enter the drainage channel which will inhibit the flow of water being channeled, causing puddles/flooding.

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