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ANALYSIS OF CIPELANG RIVER STRORAGE CAPACITY REGENCY SUMEDANG

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ABSTRACT

Rainy season flooding: Ujung Jaya Regency experiences flooding almost every year, this annual flood phenomenon causes material losses. The research aims to analyze the capacity of the Cipelang River which is located in Sumedang Regency. The Cipelang River is part of the Cimanuk Watershed (DAS) with an area of around 130.70 km², which has several tributaries such as Ciandana, Cicacaban, and Cipanassaat. The methods used in this research include collecting hydrological data, topographic analysis, and evaluating land use around the river. Rainfall and river flow data were taken from the nearest meteorological station to determine water storage potential. Results of analysis of existing river storage capacity and flood discharge. The maximum capacity of the Cipelang river is 409,002 m3/s. Nakayasu HSS method planned discharge using river watershed discharge occurs in the 100 year anniversary period. However, time periods of 2,5,10,25,50 years are considered safe. The results of comparing the planned discharge of the Hasper method with the discharge of the river catchment did not occur. So the most suitable method to use is the hasper method, land use which is dominated by irrigated rice fields and gardens also contributes to water management in this watershed. It is hoped that this research can provide recommendations for better water resource management and flood risk mitigation in the area. These findings are important to support sustainable infrastructure development and maintain ecosystem balance in the Sumedang Regency area.

Keywords: *Rain , River, Discharge, Capacity, Flood*

1. INTRODUCTION

Rain torrential [1]in the region Sumedang north make three villages in the District Kertajati , Regency Majalengka experience flood [2]. Rain around four hours [3][4] , as well as delivery water from area Congean , Regency Sumedang , creating the villages of Palasah , Kertawinangun , and Pakubeureum , District Kertajati submerged flood . The water level reaches 80 cm during the day Sunday at 17.30 WIB. Hundreds House submerged flood [5] in Leuwi Awi, Cipelang Village and Ujungjaya Village , District Ujungjaya , Regency Sumedang , February 11 2024. Water accompanied soaking mud House inhabitant caused by a break embankment [6]Cipelang River . Sufficient rainfall tall result Cipelang River embankment broken-down . Monday 12 February 2024. Total available around 220 housing units submerged residents flood with number of civilian victims affected [7] around 220 families or around 700 people , West Java BPBD noted There is about 1,300 houses affected residents .

Increasing incident flood [8] in three year become One incident flood in a year allegedly consequence from change use land upstream of the river [9]. The more reduced area absorption Rain [10], [11]and direct flow to the River causes river No capable accommodate existing debits until overflowing and flooding areas on the banks of the river [12]. Formulation problem in study This is How many big capacity accommodate [13]Cipelang River in Ujung Jaya Village, Ujung Jaya District , Regency Sumedang, West Java and how much large incoming debit to the River of Consequences bulk it rained . As for goals from study This is know capacity accommodate the Cipelang River in Ujung Jaya Village, Ujung Jaya District , Regency Sumedang, West Java. and find out incoming debits to the River of

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Consequences bulk Rain . The research aims to analyze the storage capacity of the Cipelang River, benefits of research as material consideration for agency related nor public around in prevention disaster flood nor alert and responsive emergency disaster flood . Scope of problem study This is review only carried out in the Cipelang River , Ujung Jaya Village, Ujung Jaya District , Regency Sumedang, West Java, no do simulation mitigation disaster flooded or not do calculation sediment and water quality.

2. LITERATURE REVIEW

2.1. Analysis Hydrology

Hydrological analysis not only requires the volume and height of rain, but also the distribution of rain over time and place. In hydrological analysis and planning, the characteristics of rain are carefully reviewed, including:

a. Intensity I, is the rate of rain or water height per unit of time, for example mm/minute, mm/hour, or mm/day.
b. Length of time (duration) t, namely the length of time during which rain falls in minutes or hours.
c. Rain height d, namely the amount or depth of rain that occurs during the duration of the rain, is expressed in terms of the thickness of the water above the surface in mm.
d. The frequency of events is usually expressed in terms of a return period T, for example once every 2 years.
e. Area is the geographical area of the rain distribution area.

2.2. Analysis Frequency and Probability

Frequency analysis is an analysis of the recurrence of an event, both the number of frequencies per unit of time and the return period. To analyze planned rainfall, existing hydrological data from an event consists of several theories that suggest similarities regarding the analysis. The planned rainfall calculation uses rainfall data with a certain return period which is calculated using 4 frequency distribution methods, namely:

1. Normal Distribution
2. Log Normal Distribution
3. Log Pearson Distribution III
4. Gumbel Distribution

Frequency distribution is used to determine the relationship between the magnitude of extreme hydrological events such as floods and the number of events that have occurred so that the probability of extreme events over time can be predicted [14]. Data analysis carried out using the four methods includes the average, b deviation coefficient of variation, skewness coefficient and kurtosis coefficient.

2.3. Testing Compatibility Distribution

The results obtained for. of these four methods, then a suitability test was carried out using the Smimov-Kolmogorov method or non-parametric suitability test. This suitability test is used to determine the design rainfall values from the four frequency distribution methods that are most suitable for use at the research location.

2.3.1. Square Test

$$X^2 = \sum_{i=1}^{G} \frac{(Ef - Of)^2}{Ef} \quad \ldots (1)$$

Condition: Mark X^2 must < from X^2 CR

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2.3.2. Smirmov Kolmogorov test

The Smimov-Kolmogorov goodness-of-fit test is often called a non-parametric goodness-of-fit test because the test does not use a specific distribution function..

Condition: Δ max < Δ critical

2.4. Rainfall Intensity

Formula Mononobe :

$$I = \frac{R_{24}}{24} * \left[\frac{24}{t}\right]^{\frac{2}{3}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where :

$I \quad = Intensitas\ curah\ hujan\ \left(\frac{mm}{jam}\right)$
$R_{24} = Curah\ hujan\ maksimum\ dalam\ 24\ jam\ (mm)$
$t \quad = lamanya\ curah\ hujan\ (jam)$

2.5. Planned Flood Discharge

Rational Method

$$Q = 0.278 \text{ X } C \text{ X } I \text{ X } A \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$I = \frac{R_{24}}{24} * \left[\frac{24}{t_c}\right]^{\frac{2}{3}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$t_c = \left(\frac{0{,}87xL^2}{1000xS}\right)^{0{,}385} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

Where :

$Q \quad = debit\ maksimum\left(\frac{m^3}{detik}\right)$
$A \quad = luas\ DAS\ (Km)^2$
$C \quad = koefisien\ limpasan$
$I \quad = intensitas\ curah\ hujan\ selama\ waktu\ konsentrasi\ \left(\frac{mm}{jam}\right)$
$R_{24} = curah\ hujan\ maksimum\ harian\ 24\ jam\ (mm)$
$t_c \quad = waktu\ konsentrasi\ (jam)$
$L \quad = panjang\ saluran\ utama\ dari\ hulu\ ke\ hilir\ (km)$
$S \quad = kemiringan\ rata - rata\ saluran\ dalam$

2.6. Dimensions Channel

The cross-sectional shape of the channel used is a trapezoidal shape, the capacity of the channel is determined by the area being irrigated. In general, the bottom width of the channel (b) is taken to be greater than or equal to the depth of the channel (h), with the aim of preventing silting in the channel when water flows through the channel. In this study, an open channel type with a trapezoidal shape was used.

Flow velocity (V) can be calculated using the Manning Formula, namely:

$$V = \frac{1}{n} * R^{\frac{2}{3}} * S^{\frac{1}{2}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

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Where :

V = Flow speed (m/sec)
R = Hydraulic radius (m)
A = wet cross-sectional area (m^2)
P = Wet perimeter (m)
n = Manning roughness coefficient
S = Slope of the channel bottom
b = Channel width (m)
m = Slope of the embankment (1 vertical : m horizontal)
h = Water height (m)

2.7. Channel Capacity

The channel capacity calculation can be estimated by the amount of runoff on a piece of land or based on the planned discharge. Channel capacity is influenced by two factors, namely cross-sectional area and flow speed. The flow velocity is determined by the slope of the channel, the hydraulic radius (the quotient between the cross-sectional area and the channel parameters) and the roughness coefficient of the channel.

2.8. Slope Channel (S)

The slope of the channel bed is generally determined by the topography of the land or the desired height and end of the channel. The slope of the channel bed depends on the material forming the channel. The formula used to calculate the slope of the channel is Robert Manning's formula, namely:

$$S = \left(\frac{Q}{(A*R)^{2/3}}\right)^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Continuity formula:

$$Q = A \cdot V \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where :

A = Wet cross-sectional area of the channel (m2)
V = Flow speed in the channel (m/sec)
R = Hydraulic radius of the channel (m)
M = Slope of the Talud
n = Manning roughness coefficient
h = Water height in the channel (m)
S = Slope of the channel bottom
Q = Flow rate (m3/sec)

2.9. Hydraulic Radius.

The hydraulic radius is the ratio between the area of the channel's wet reservoir and the channel's perimeter. The formula used is:

$$R = \frac{A}{P} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where :

R = hydraulic radius (m)
A = Wet cross-sectional area of the channel (m2)
P = Wet perimeter of the channel (m)

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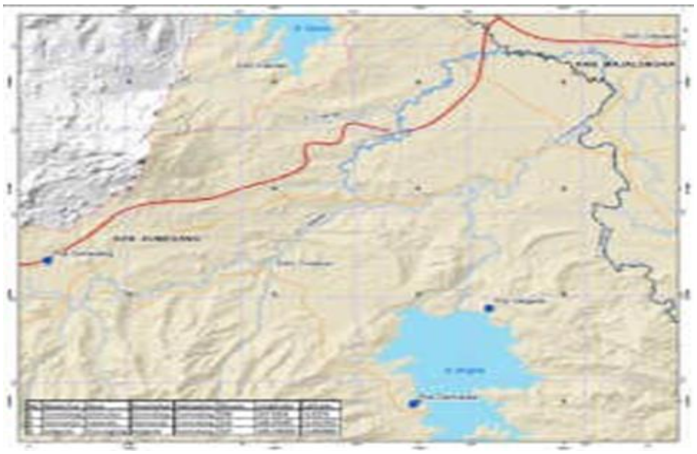
3. METHODOLOGY

The research methodology for analyzing the storage capacity of the Cipelang River in Sumedang Regency involves several systematic steps designed to collect and analyze hydrological data and the physical characteristics of the river. The initial stage of research began with identifying problems related to the storage capacity of the Cipelang River, including the potential for flooding and irrigation needs in the surrounding area. Stage two data collection was carried out in two categories, namely Primary data Survey of the study location to obtain direct information regarding the physical condition of the river, including channel dimensions, cliff slopes and geological conditions, Secondary data in the form of rainfall data from the nearest meteorological station for the relevant period. River flow discharge data and land use information around the Cipelang watershed, which includes land use for agriculture, settlements and green areas. The third stage is hydrological analysis with rainfall calculations, using the algebraic average method to determine regional rainfall, frequency distribution applying the Log Pearson III and Gumbel methods to analyze rainfall distribution, the Distribution Fit Test uses the Chi-Square and Smirnov-Kolmogorov methods to ensure the accuracy of the distribution model used. The fourth stage of hydraulic analysis is calculating channel capacity discharge, calculating existing channel capacity based on channel dimension data, calculating planned flood discharge: using rational methods to determine the flood discharge that can be accommodated by the channel. The fifth stage is evaluation and recommendations



Source : BBWS Cimanuk – Cisanggarung Hydrology Unit

Figure 1. Map of the Cipelang watershed

3.1. Analysis Rainfall Distribution

For get appropriate distribution with existing data from BMKG and BBWS Cimanuk stations Cisanggarung , then done analysis distribution frequency . Election distribution Rain calculated with using statistical data parameters , that is use analysis frequency Normal method , Log Normal method , Log Pearson III, and Gumbel. Then value obtained customized with condition from each distribution .

3.2. Rainfall Analysis Plan

Bulk data available rain analyzed follow Normal, Log Normal, Gumbel distribution for determined bulk Rain plan . Based on results calculation type distribution rain , rainfall Rain plan calculated according to type selected distribution . Then , bulk Rain plan calculated For know bulk Rain plans that occur in various period repeat 2 years , 5 years , 10 years , 25 years , 50 years and 100 years . Calculation results This used For flood discharge calculation plan .

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3.3. Flood Discharge Analysis Plan

Flood discharge plan on research This will analyzed with use method method Weduwen , Haspers and HSS Nakayashu . Determination method on study This is Because wide area shelter rain at the location For study this is under 1000 km2. Calculation of flood discharge plan This will obtained flood discharge plans happen in period birthdays 2 years , 5 years , 10 years , 25 years , 50 years and 100 years in the river Cipelang . Flood discharge value This will used in calculation profile flood water level .

3.4. River Storage Capacity Analysis

Analysis capacity River storage is needed For identify is dimensions cross section river the capable flow the planned debit . Then analysis capacity this is also done For determine elevation flood water level .

4. RESULTS AND DISCUSSION

4.1. Rainfall Analysis Plan

Station observations reviewed is stations located within the research area . Remember very varied rain type from One place to place else , then for large areas , review Rain No can describe rain nearby . In terms of This needed rain The area obtained from the average bulk rain Some stations the gauge inside around the area

4.2. Analysis Distribution Rainfall Data Frequency

Estimated flood discharge use Hasper and Melchior's method produces flood different designs . With thereby need is known mark which method is best used . There are 4 methods For do analysis distribution bulk data frequency Rain that is Normal Distribution , Log Normal Distribution , Gumbel Distribution , and Log Pearson Type III Distribution . After do analysis distribution frequency furthermore Bulk data suitability test was carried out Rain to type spread

Calculation bulk Rain calculated plan happen in period birthdays 2 years , 5 years , 10 years , 25 years , 50 years and 100 years . Calculation bulk Rain plan calculated based on bulk data Rain for 13 years started from 2012 to 2023. Data used originate from BBWS Cimanuk Cisanggarang .

Table 1. Recapitulation Analysis Frequency

Period	Probability P=(1/2 Tr)x 100%	Gumbel (mm)	Normal Logs (mm)	Pearson Log III (mm)
2	50	91,238	106,409	99.126
5	20	136,243	119,949	123,253
10	10	164,546	138,147	134.117
25	4	197,528	173,074	143,952
50	2	226,826	201,833	149,258
100	1	253,156	222,199	153,354

Source ; The calculation results

4.3. Planned Discharge Analysis

The calculations have been made done the planned debit is obtained various times again , with various method period birthdays 2 years , 5 years , 10 years , 25 years , 50 years , and 100 years . Calculation of flood discharge plans on studies capacity river Cipelang Ujung Jaya Village is counted with use Weduwen Method , Hesper Method, Hss Method Nakayashu , Election method This done Because watershed area at the location studies planning is 69.45 km2 and one method For calculate flood discharge plan with watershed area is less from 100 km2 and less of 300 km2.

Table 2. Weduwen Method

Period	Rn	Time	β	qn	α	A (Km2)	Qn (m3/ sec)
2	91,238	5.0	0.791	10,488	0.732	69,450	793,942
5	136,243	5.0	0.791	10,488	0.732	69,450	1185.570
10	164,546	5.0	0.791	10,488	0.732	69,450	1431.856
25	197,528	5.0	0.791	10,488	0.732	69,450	1718,866
50	226,826	5.0	0.791	10,488	0.732	69,450	1973,814
100	253,156	5.0	0.791	10,488	0.732	69,450	2202,937

Source ; The calculation results

Table 3. Hesper Method

Period	α	β	A	qt	Qi
2	0.502	0.977	69.45	3,763	128,078
5	0.502	0.977	69.45	5,620	191,255
10	0.502	0.977	69.45	7,971	271,267
25	0.502	0.977	69.45	8,148	277,286
50	0.502	0.977	69.45	9,356	318,414
100	0.502	0.977	69.45	10,442	355,376

Source ; The calculation results

Table 4. Recapitulation of Q Values for Hss Method Nakayashu

Period	t (hours)	Rn	Q
2	4	91,238	163,366
5	4	136,243	243,949
10	4	164,546	294,626
25	4	197,528	353,682
50	4	226,826	406.142
100	4	253,156	453,287

Source ; The calculation results

Table 5. Recapitulation of Q Values

Period	Weduwen (m3/s)	Haspers (m3/s)	HSS Nakayashu (m3/s)
2	793,942	128,078	163,366
5	1185.570	191,255	243,949
10	1431.856	271,267	294,626
25	1718,866	277,286	353,682
50	1973,814	318,414	406.142
100	2202,937	355,376	453,287

Source ; The calculation results

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Flood discharge plan period T 's birthday calculated with enter coefficient rainwater runoff , coefficient reduction area For bulk watershed rainfall , intensity Rain maximum , watershed area and bulk Rain plan For period T 's birthday .

Profile flood water level in planning reinforcement cliff river Cipelang in Ujung Jaya village calculated with use method stages standard (*standard step method*) based on flood discharge data plan period repeat 2,5,10,25,50 and 100 years River speed data was obtained from survey to field .

Analysis capacity shelter from flood discharge calculation plans that use the Weduwen , Haspers and HSS Nakayashu Methods , will taken amount of debit with period 2 year anniversary namely 793,942 m3/ second . From the results condition existing shelter river seen that *overtopping* already start occurs in debit with period 2 year anniversary as shown in table 5 as following .

Table 6. Comparison Q River Capacity with Q Weduwen Method Plan

Period	L	I	n	B	H	A	P	R	V	Q Capacity	Q Plan	Condition
2	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	793,942	Overflow
5	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	1185,570	Overflow
10	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	1431,856	Overflow
25	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	1718,866	Overflow
50	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	1973,814	Overflow
100	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	2202,937	Overflow

Source ; The calculation results

Table 7. Comparison of Q River Capacity with Q Planned by Haspers Method

Period	L	I	n	B	H	A	P	R	V	Q Capacity	Q Plan	Condition
2	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	129,078	Safe
5	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	191,255	Safe
10	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	271,267	Safe
25	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	277,286	Safe
50	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	318,414	Safe
100	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	355,376	Safe

Source ; The calculation results

Table 8. Comparison of Q River Capacity with Q Plan of the Nakayashu HSS Method

Period	L	I	n	B	H	A	P	R	V	Q Capacity	Q Plan	Condition
2	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	163,366	Safe
5	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	243,949	Safe
10	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	294,626	Safe
25	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	353,682	Safe
50	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	406,142	Safe
100	151.4	0.02	0.03	6,545	7.63	49.9	21,805	2,291	8,191	409,022	453,287	Overflow

Source ; The calculation results

4.4. River Storage Capacity

River capacity obtained with method multiply wide cross section wet with speed Genre . Speed every cross section calculated use Manning's formula with mark roughness 0.03 for channel nature . Carrying capacity maximum (Bank Full Capacity) Cipelang River varies between 78,315 – 409,002 because happen narrowing channel consequence erosion along channel .

Calculation Cross section River River Cipelang at PL1 Point

- Slope (I) : 0.02

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- River Width (B) : 6,545 m
- Depth (H) : 7.63 m
- Slope River Wall (M) : 12.0448 m
- Manning Coefficient : 0.03

Manning coefficient is used of 0.03 because is channel experience new clean and taken mark the maximum .

- Cross- sectional area Wet
  A = b . H
  A = 6.545 x 7.63
  A = 49,938 m2
- Around wet
  P = b + 2. H
  P = 6.545 + 2 x 7.63
  P = 21.805 m
- Fingers hydraulic
  R = A/P
  R = 49.938 / 21.805
  R = 2.290225
- Speed Genre
  V = 1/ nx R^2/3 x I^1/2
  V =1/0.03 x 2.290225^2/3 x 0.02^1/2
  V = 8.190539 m/ sec
- River Discharge
  Q = A x V
  Q = 49.938 x 8.190539
  Q = 409,002

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

1. Cipelang River Watershed own area 69.45 Km2
2. Maximum capacity river Cipelang amounting to 409,002 m3/ sec .
3. From third method the can concluded that method Weduwen not enough worthy used Because results comparison planned discharge capacity exceed storage discharge capacity .
4. Results of the planned debit calculation for the HSS Nakayasu Method with river watershed discharge occurs in periods 100 years anniversary . However periods 2,5,10,25,50 years considered safe .
5. Comparison results of planned discharge method hasper with catch discharge river No happen runoff . Then the most suitable method used is method hasper

5.2. Suggestion

1. Based on research that has been done can given solution to disaster floods in Ujung Jaya Village, Ujung Jaya Village, Ujung Jaya District , Regency Sumedang with did it dredging river to get it reduce shallow and can return function river as controller flood For anticipating increased water discharge
2. Making Embankment right left Can done For prevention runoff moment happen Rain torrential .
3. Study more carry on related method flood discharge calculation design based on various aspects and criteria reason flood can inputed in overcome flood runoff.

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