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Water Resources Conservation on Cidurian Upstream as Flood Reduction in Cidurian River

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ABSTRACT

Flood always happen in every heavy rain at Serang District and Tangerang District. Flood is caused by overflow from Cidurian River. That makes gives a very detrimental impact to the local community activities. Not a few villages and infrastructure in Serang District and Tangerang District is disrupted by flood. Flood is occurred from 2010 up to now. Based on the data of the BBWS-Cidanau-Ciujung Cidurian River, increase of fllod discharge occured from 2010 up to now. Improvement of flood discharge is estimated by changes in land cover conditions. For anticipation of these conditions, the need for a concerted effort to stifle the flow rate of the surface. The effort made is mechanically conservation by making dam. With the reduction effort of this conservation are expected to reduce flooding in the Serang District and Tangerang District.
KEYWORDS: Flood, flood discharge, mechanical conservation, Cidurian River

INTRODUCTION

Flood became a natural phenomenon that occurs almost routinely each year. Almost all districts of the city in Banten Province there are dots flood-prone. Floods can occur naturally or is caused by human error. Wild logging in upper watersheds will impact fatal to the survival of ecosystems and the forest environment and will have an effect on the increase in the rate of runoff.

An increase in the maximum discharge in Cidurian river occurs reach 600%. From the results of the recording shows that the maximum debit debit Cidurian River from 2002 up to the year 2009 of 236.92 m^3/sec. While from 2010 up to now increases to 1,214.05 m^3/sec. It is estimated that the impact of any change in the existing land cover Watershed of Cidurian[1].

Closures of land use in watershed Cidurian and surrounding areas covering 12 types i.e., secondary forest land, forest plants, agricultural settlements, plantations, dry land, dry land agricultural mix, rice fields, shrubs, ponds, open land, surface water and the airport. The condition of changing land closure is forest crops, orchards, neighborhoods, bushland and open land. Cidurian forest plants decreased by 26% after the year of 2006. Broad plantations decreased by 9% after the year 2003. Extensive settlements experienced growth from 2000 up to 2003 amounting to 16.7%, while in 2003 up to 2006 amounted to 13.7%, dry land farming mixed has decreased from 2000 to 2006, but the increase occurred in 2009[2].

Based on these conditions need for water resource conservation efforts to reduce the flow rate that will have an impact on the continuity of forest ecosystems and the environment at the same time can prevent disaster for the downstream area.

METHODS

This study operates on the reduction of flood discharge in river Cidurian with mechanical method (Dam). Dam is planned as a flood control and as ground water storage[3]. Broad river basin study region is 322.742 km2.

The rain data used in this paper from 1998 until the year 2013, topographic map, map of soil types and soil permeability from BBWS-Cidanau-Ciujung-Cidurian. For a map of land cover in the study area obtained from the office of Citarum Watershed Management Area by 2014.

To determine the average rainfall of the region is using the Thiessen Polygon method. Debit flood plan using Synthetic Hydrograf Nakayasu Units[4]. Calculation of the volume of the spooler required reducing flood discharge method Flood Routing with spillway[4].

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ANALYSIS

The method used in calculating the average rainfall of the region is the Thiessen Polygon[5]. To calculate the average rainfall regions using the formula:

$$R_{ave} = \sum_{i}^{n} \frac{A_n}{A} R_n + \sum_{i}^{m} \frac{A_m}{A} R_m$$

A_n = Influence Area of Rain Station (Ha)
A = Total area of watershed (Ha)
R_n = High of rainfall (mm)

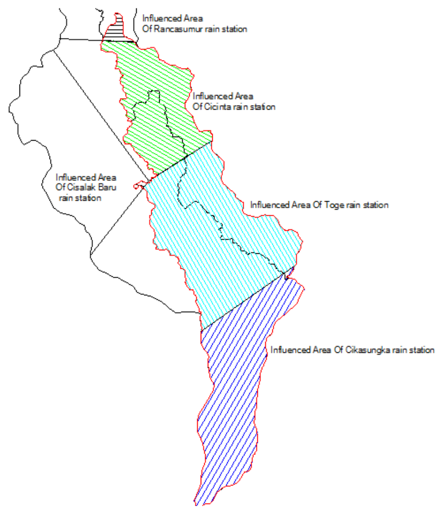

Figure 1. Influenced Area of Thiessen

Table 1. Calculation of Precipitation Using Thiessen Method

No.	R (mm)
1	187,00
2	139,13
3	135,00
4	133,00
5	129,47
6	110,78
7	92,90
8	89,81
9	88,89
10	75,81
11	73,75
12	68,34
13	59,93
14	58,81
15	53,60
16	38,93

The calculation of precipitation is using a Log Pearson Type III [5]. The formula as follows:

$$\mathbf{LogRt} = \overline{\mathbf{LogR}} + \mathbf{K.Sd}$$

LogRt = is the flood discharge value of some specified probability
$\overline{LogR}$ = Is the average of the *log R* discharge values
Sd = Is the standard deviation of the *log R*-values
K = Is a frequency factor. The frequency factor *K* is a function of the skewness coefficient and return period and can be found using the frequency factor table.

Table 2. Calculation of precipitation plans with Log Perason Type III method

Rain of Year	R (mm/24 hour)
2	89.06
5	125.86
10	151.18
25	182.51
50	205.77
100	228.87

The type and area of each land cover in the study area can be seen in table 3

Table 3. The Wide of Each Type Of Land Cover

Type of Land Use	Wide (Ha)
Primary terrestrial forest	1399,11
Secondary terrestrial forest	2458,46
Crops forest	3172,25
Plantation	4341,38
Settlement	1196,55
Dryland farming	6411,49
Dryland mixed farming	9936,65
Paddy field	2978,06
TOTAL	**32274,81**

The magnitude of the coefficient stream in the area of study is calculated based on the slope of the land and soil type as in the following table 4.

Tabel 4. Calculation Of Stream Coefficient (C).

Type of Land Use	Wide (Ha)	C	C x A
Primary terrestrial forest (>20%)	1,399.11	0.38	531.66
Secondary terrestrial forest (8% - 20%)	2,380.56	0.29	698.30
Secondary terrestrial forest (>20%)	197.00	0.38	74.80
Crops forest (<8%)	1,948.23	0.24	467.58
Crops forest (8% - 20%)	534.95	0.32	171.18
Crops forest (>20%)	950.83	0.42	399.35
Plantation (<8%)	4,101.24	0.24	984.30
Plantation (8% - 20%)	240.14	0.32	76.84
Settlement	1,196.55	0.40	478.62
Dryland farming (<8%)	2,241.77	0.24	538.02
Dryland farming (8% - 20%)	4,169.72	0.32	1,334.31
Dryland mixed farming (<8%)	7,201.85	0.24	1,728.44
Dryland mixed farming (8% - 20%)	2,604.57	0.32	833.46
Dryland mixed farming (>20%)	130.23	0.39	51.22
Paddy field	2,978.06	0.31	923.20
TOTAL	**32,274.81**		**9,291.35**
C ((C x A)/ Total Area)		**0.288**	

(Source: Land use map 2014 From BPDAS Citarum Ciliwung dan *Google Earth* 2016 and analysis)

Based on the area, the magnitude of the coefficient stream in the area of study is about 0.288. Calculation of flood discharge using Hydograf Nakayasu. The formula as follows:

$$Q_p = \frac{C.A.R_o}{3.6(0.3T_p + T_{0.3})}$$

Q_p = Function of peak discharge (m³/sec).
R_o = Unit rainfall (mm).
C = Watershed characteristic coefficient.
A = Peak discharge of watershed area (km²)
T_p = Time lag (hour).
$T_{0.3}$ = Time required to discharge reduction up to 30% peak discharge
(Source: soemarto [4])

Characteristic of watershed and rainfall

- Watershed area (A) = 322,70 km².
- Length of main river (L) = 69,20 km.
- Precipitation (R_o) = 1 mm.
- Characteristic coefficient watershed (α) = 3
- Stream coefficient = 0,288

Table 5. Recapitulation of the flood discharge using Nakayasu method.

Year Flood	Discharge (m³/sec)
2	126.20
5	178.35
10	214.23
25	258.63
50	291.58
100	324.32

RESULTS

The magnitude of the reduction of flood discharge in river Cidurian is amounting to 150 m³/dt. The magnitude of these reductions based on conditions on the field. Serang District and Tangerang District predicted the flood would happen if discharge in Weirs Rancasumur ≥ 150 m³/dt. Therefore it needs to be done with mechanical conservation efforts to stifle the flow rate of the surface.

Conservation with mechanical in this paper is to manufacture dam. In addition to controlling floods, dam also serves as a place of saving water that will make the increase of the ground water [6]. In this study, dam is planned as a flood control and saving the ground water. In this study, the making of dam based on flood discharge 5 year plan (Q5). The amount of the required dam is a calculation result needs spool volume. The magnitude of the volume of the spooler required reducing flood discharge calculated by search flood (flood routing). The search method of the flood (flood routing) that is used is the search through flood reservoirs.

I – Q = Ds / Dt

I (rt2) ΔT – (Q1+Q2)/2. ΔT = S2 – S1

(I1 + I2). ΔT/2 + (S1- Q1. ΔT/2) = (S2 + Q2. ΔT/2)

Where:

I_1 , I_2 = Inflow t_1 , t_2

Q_1 , Q_2 = Outflow t_1 , t_2

S_1 , S_2 = Storage Volume whent_1 , t_2

(Source: Soemarto, 1999)

Try with the spooler is 1,172, 000 m ² ≈ 117.20 Ha, pelimpah 40 m wide.

Table 6. The connection between outflow (Q5) and storage.

Elevation	H	S	S/Δt	Q2	S2	S1
m	*m*	*m3*	*m3/sec*	*m3/sec*	*m3/sec*	*m3/sec*
1,00	0,00	0	0	0	0,000	0,000
1,20	0,20	234400	130	6,118	133,281	127,163
1,40	0,40	468800	260	17,304	269,096	251,792
1,60	0,60	703200	391	31,789	406,561	374,772
1,80	0,80	937600	521	48,943	545,360	496,417
2,00	1,00	1172000	651	68,400	685,311	616,911
2,20	1,20	1406400	781	89,914	826,290	736,376
2,40	1,40	1640800	912	113,305	968,208	854,903
2,60	1,60	1875200	1042	138,432	1110,994	972,562
2,80	1,80	2109600	1172	165,183	1254,591	1089,409

Description:

S : Storage (depth x area)

H : Depth of water above spillway.

Q2 : Discharge use storage, Q2 = 1.71 x B x H^ (3/2) (m³/sec).

Q1 : Discharge not use storage (m³/sec).

Δt : Time Interval (take 30 minute).
S1 : S/Δt - Q
S2 : Q + S1

Tabel 7. Discharge calculation after with storage (Q2).

T	Q1	Q (average)	S1	S2	H	Q2
(minute)	*(m^3/sec)*	*(m^3/sec)*	*(m^3/sec)*	*(m^3/sec)*	*(m)*	*(m^3/sec)*
0	0,000					0,000
30	0,170	0,085	0,000	0,085	0,001	0,004
60	0,944	0,557	0,081	0,638	0,006	0,029
90	2,645	1,794	0,609	2,403	0,014	0,110
120	5,555	4,100	2,293	6,393	0,026	0,293
150	9,929	7,742	6,099	13,841	0,044	0,635
180	16,009	12,969	13,206	26,175	0,068	1,202
210	24,023	20,016	24,974	44,990	0,097	2,065
240	34,188	29,106	42,925	72,031	0,133	3,306
270	46,716	40,452	68,724	109,176	0,175	5,011
300	61,809	54,262	104,165	158,427	0,243	8,189
330	79,653	70,731	150,238	220,969	0,336	13,340
360	100,404	90,029	207,629	297,658	0,445	20,314
390	124,200	112,302	277,344	389,646	0,577	30,007
420	151,169	137,684	359,639	497,324	0,734	43,006
450	166,314	158,741	454,317	613,059	0,900	58,355
480	173,274	169,794	554,704	724,498	1,057	74,380
510	176,874	175,074	650,118	825,192	1,199	89,746
540	178,352	177,613	735,445	913,058	1,324	104,215
570	178,135	178,244	808,843	987,087	1,427	116,627
600	176,450	177,293	870,460	1047,752	1,513	127,303
630	173,428	174,939	920,450	1095,389	1,579	135,686
660	169,139	171,283	959,703	1130,986	1,629	142,156
690	163,617	166,378	988,830	1155,208	1,663	146,669
720	156,872	160,244	1008,539	1168,784	1,682	149,198
750	149,944	153,408	1019,586	1172,994	1,688	149,982
780	143,283	146,614	1023,012	1169,626	1,683	149,355
810	136,918	140,101	1020,272	1160,372	1,670	147,631
840	130,836	133,877	1012,742	1146,619	1,651	145,068
870	125,024	127,930	1001,550	1129,480	1,626	141,876

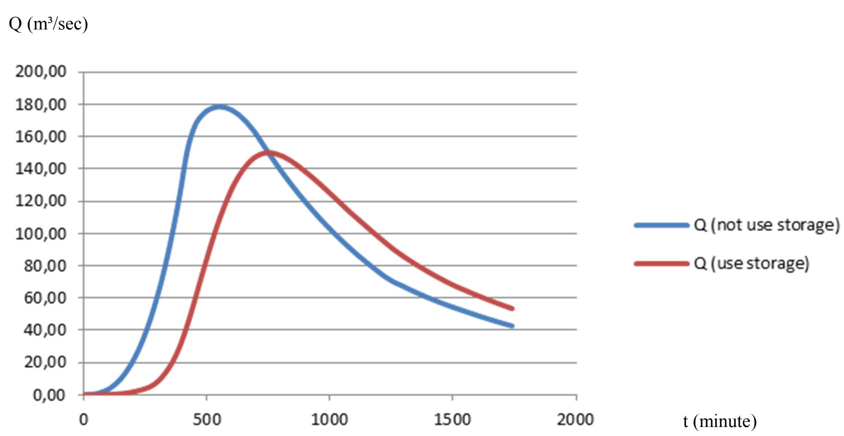

Figure 2. The results of the flood discharge deduction with the storage

The flood search results showed that with storage of 1,978,106.22 m³ can reduce flood discharge period of 5 year (Q5) 178.352 m³/sec be 149,982 m³/sec. When the storage volume made dam lying scattered in the area of study, if a dam:

- Areas : 3 Ha
- Depth : 5 m
- Volume : 150.000 m³
- Sum of dam : 1.978.106,22 m³/150,000 m³
  : 13,187 ≈ 13 dam.

Tabel 8. Recapitulation of the flood discharge deduction with the storage

No.	Discharged use storage(m³/sec)	Volume of demand(m³)
1.	149.982	1.978.106,22 m³ (13 dams)

CONCLUSION

To reduce discharge in Cidurian River, spool volume required is 1,978,106.22 m³. Conservation of water resources with a mechanical can reduce the flood discharge of 16%.

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