JOURNAL OF WORLD CONFERENCE
VOLUME 3 | NUMBER 2 | MARCH 2021
Available online at http://proceedings.worldconference.id.
ISSN: 2656-1174 (online)

Hydraulic Analysis of The Upper Segment of Cileungsi River, Bogor District Using Hecras 5.0.7 Program

Acep Hidayat, Febrianto Tri Prasetyo
Faculty of Engineering
Civil Engineering Study Program
Mercu Buana University Bekasi
Jl. Raya Kranggan No.6, Bekasi, Indonesia
acep_hidayat@mercubuana.ac.id, febriantopep@gmail.com

Abstract

Regional Flow of the River Cileungsi has extensive DAS 266 , 15 km^2 and a length of 39.11 km, crossing the district of Bogor and Bekasi. Downstream of the Cileungsi River is the Bekasi Hulu River which is the confluence of the Cileungsi River and Cikeas River . With the condition of land-use land DAS Cileungsi the first form forests changed into land estates and settlements led to discharge runoff were high and result in the occurrence of flooding in the summer rain . Flood prevention efforts are planned by making a dam . Analysis profiles flow conducted by using software HEC-RAS 5.0.7, Planning control flooding river Cileungsi using debit flood plan Q25th which amounted to 1271.45 m^3 / sec and Q50th which amounted to 1376.99 m^3 / sec. In the results of simulation of unsteady flow with HEC-RAS can be concluded that the control of flooding with the manufacture of a dam on the upstream river Cileungsi , already managed to overcome the flow of water excess in the upper reaches of the river

Keywords
DamKeywords, Flood, HEC-RAS

1. Introduction

1.1. Research Backgorund

Bogor Regency is one of the areas in West Java province that has relatively high rainfall and also has a very varied topography, which is a mountainous area in the south bordering Sukabumi and Cianjur regencies, to lowland areas in the north that borders with Tangerang Regency, South Tangerang City, Depok City, Bekasi Regency / City, because the high level of rainfall in the Bogor Regency area causes rivers in this area to have a high enough potential for water disasters in lowland areas.

One of the rivers in Bogor Regency that is prone to causing disasters is the Cileungsi river, which has an impact on flood disasters in Bekasi City, the Cileungsi river is the upstream of the Upper Bekasi river which is dammed by the Bekasi Dam, where if the flood occurs due to the discharge of water sent from the upper reaches of the Cileungsi River and the river Cikeas which is quite high.

The Cileungsi River is one of the rivers in the Bogor Regency area, which stretches across Bogor Regency in the north with a length of its main river 39.11 km from the district. Sukamakmur, which is located in Bogor Regency, until it empties at the Bekasi Dam. This river accommodates the flow of water from the Cileungsi watershed which has an average annual rainfall of less than 2,500 mm / year.

There are various problems encountered along the Cileungsi river flow. Among them are changes in the designation of protected forests and green open spaces around the Cikeas River and Cilungsi River converted into buildings, housing and industry, then in the upstream segment, there is no flood control building so that high water discharge causes flooding in the downstream segment, namely the Bogor and Bekasi border areas. Based on this, it is necessary to carry out an impact analysis of the construction of flood control facilities / infrastructure in the Cileungsi River to plan the appropriate treatment conditions.

1.2. Identification of Problem

Based on the above problems, problems that exist in the Cileungsi River can be identified, including:

1. There are no flood control facilities / infrastructure upstream, so that when the water discharge is high, it will cause flooding in the downstream area of the river.

VOLUME 3 | NUMBER 2 | MARCH 2021
Available online at http://proceedings.worldconference.id.
ISSN: 2656-1174 (online)

2. Changes in the designation of protected forests and green open spaces around the Cikeas and Cilungsi River are converted into buildings, housing and industry, this has contributed to the increase in surface runoff, resulting in the existing river storage capacity being unable to accommodate flood discharge.

2. Literatur Riview

2.1. General Riview

Flood control is part of the management of water resources more specifically to control flood discharge, generally through flood control dams, or improvement of the carrier system (river, drainage) and prevention of potential damage by managing land use and flood plains. (Kodoatie, Robert.J., dan Roestam, 2005)

The implementation of this flood control effort is carried out by normalizing the river. Flood control planning is carried out as an effort to optimize channel capacity and minimize discharge through rivers and channels so that river water does not overflow at flood-prone points.

2.2. Hydrological Analysis

The hydrological analysis in this study is intended to estimate the magnitude of the design flood discharge with a certain return period in the observed area. The design discharge calculation is done by transferring the design rain to the design discharge. The steps for calculating the design discharge by transferring the design rain are as follows:

a. Calculating the mean watershed rainfall.
b. Perform design rainfall calculations , which will be calculated with a return period of 25 years and 50 years using the Log Pearson III distribution method.
c. Conducting a Distribution Suitability Test, using the Chi-Square and Smirnov Kolmogorov methods.
d. Perform design discharge calculations.

In the calculation of the flood discharge plan there are several methods / theoretical approaches, in this study using one method (Nakayasu) without having to compare the results of calculations using other methods. This is because in carrying out the hydraulic analysis, the amount of planned flood discharge will be used as input data to determine the modeling results with running unsteady flow mode.3. Results and Discussion

3. Research Methods

3.1. Study Area Location

Watershed Cileungsi is located between 106˚1 '- 107 ˚ 103' East Longitude and 6 ˚ 19 '- 6 ˚ 47' South Latitude with a watershed area of 266.15 Km2. The area that is passed by the Cileungsi River which has a length of 39.11 Km from downstream to upstream is Kec. Rawa Lumbu, Kec Bantar Gebang, Kec, Cileungsi, Kec. Gunung Putri, Kec. Klapa Nunggal, Kec Citeureup, and Kec. Sukamakmur located in Bogor Regency. And for this study it is located in one of the upstream segments of the Cileungsi River, namely in the area of Dayeuh Village, Cileungsi District.

3.2. Diagram Alir

In order for this research to be structured, the flow of thought in the research of the Cileungsi River Hydraulic Analysis with HEC-RAS 5.0.5 is shown in the flow image below:

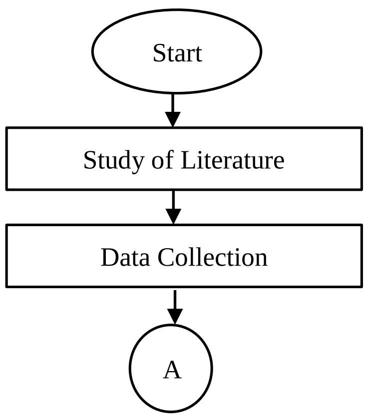

Figure 1. Flowchart

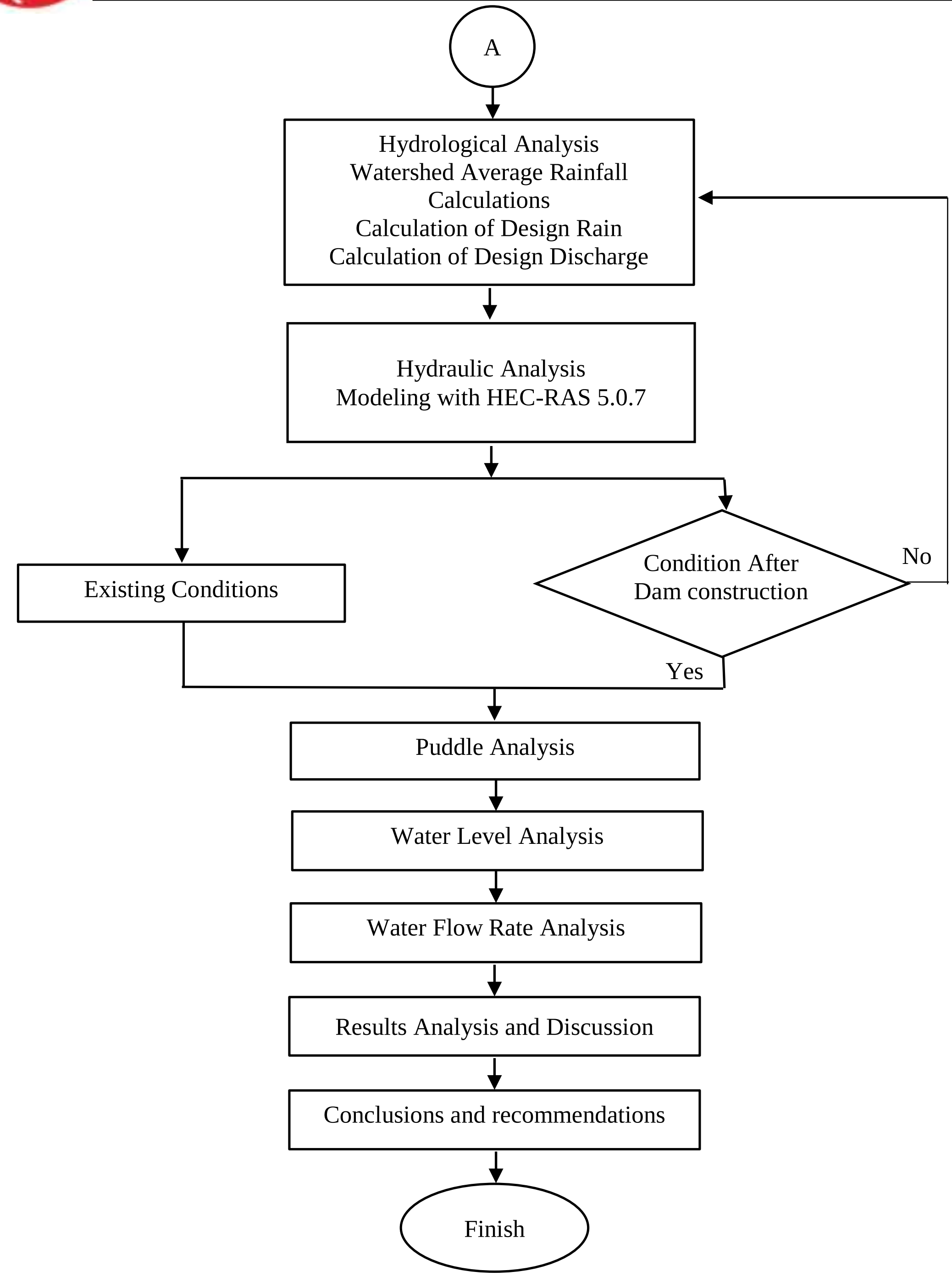

Figure 2. Flowchart

3.3. Necessary Data

In the preparation of this study, supporting data is needed, both primary and secondary data. In general, the data needed in this study are:

1. Topographic data rainfall data and watershed area are used to analyze the design flood discharge.
2. River characteristics data used to analyze the discharge flow of the Cileungsi River using HEC-RAS 5.0.7. In this analysis the authors used 2015 data.(Permatasari, A., Suprijanto, H., & Dermawan, 2015)

4. Results and Analysis

4.1. Hydrological Analysis

1. Calculation of Average Watershed Rainfall and Design Rainfall

Because in this study only rainfall data was obtained from one rain station, namely the Citeko Meteorological Station, from that station the maximum annual daily rainfall data were taken, without using the Thiessen Polygon method.

JOURNAL OF WORLD CONFERENCE
VOLUME 3 | NUMBER 2 | MARCH 2021
Available online at http://proceedings.worldconference.id.
ISSN: 2656-1174 (online)

Table 1. Frequency of Maximum Rainfall at Citeko Meteorological Station

Month	Year									
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
January	56	123	69	54	44	63	69	146	37	46
February	69	114	35	51	74	47	105	123	129	59
March	83	63	58	88	44	26	111	47	36	36
April	58	37	59	41	29	58	52	110	69	79
Mei	74	32	67	71	80	67	80	11	37	43
June	37	27	5	58	37	36	51	69	10	31
July	49	36	4	45	22	95	22	47	0	32
August	3	70	7	37	39	17	24	28	84	4
September	70	35	20	38	48	48	28	18	54	63
October	35	60	11	23	42	41	68	20	81	73
November	69	78	46	37	37	64	57	37	43	27
December	119	66	69	25	54	20	46	55	52	72
Xi (mm)	119	123	69	88	80	95	111	146	129	79

Source: Online Data BMKG

Furthermore, the calculation of the design rainfall with the Log-Pearson III distribution method, from the maximum rainfall data, the following calculation results are obtained.

Table 2. Pearson Type III Log Distribution.

No.	Xi	Log Xi	(Log Xi - average Log X)	(Log Xi - average Log X)^2	(Log Xi - average Log X)^3	(Log Xi - average Log X)^4
1	69.0000	1.8388	-0.1659	0.0275	-0.0046	0.0008
2	79.0000	1.8976	-0.1071	0.0115	-0.0012	0.0001
3	80.0000	1.9031	-0.1017	0.0103	-0.0011	0.0001
4	88.0000	1.9445	-0.0603	0.0036	-0.0002	0.0000
5	95.0000	1.9777	-0.0270	0.0007	0.0000	0.0000
6	111.0000	2.0453	0.0406	0.0016	0.0001	0.0000
7	119.0000	2.0755	0.0708	0.0050	0.0004	0.0000
8	123.0000	2.0899	0.0852	0.0073	0.0006	0.0001
9	129.0000	2.1106	0.1058	0.0112	0.0012	0.0001
10	146.0000	2.1644	0.1596	0.0255	0.0041	0.0006
Total	1039.0000	20.0475	0.0000	0.1043	-0.0008	0.0019

Log Average X	=	2.0047
Standard Deviation (S . Log X)	=	0.1076
CS	=	-0.0884
CK	=	-1.3082

Source: Calculation

2. Distribution Suitability Test

Table 3. Calculation of the Chi-Square Test for the Pearson Type III Log Distribution.

P(%)	Cs	G	Log X	X (mm)
20	-0.0884	0.8688	2.0983	125.3928
40	-0.0884	0.2964	2.0367	108.8057
60	-0.0884	-0.2815	1.9744	94.2854
80	-0.0884	-0.8649	1.9117	81.5927

Examination of the suitability test is dim aksudkan to know a truth frequency distribution hypothesis.

No.	Value Limit Sub Class				Amount of Data Oi	Ei	$(Oi - Ei)^2$	$(Oi - Ei)^2$ / Ei
1	X		<	81.593	3.000	2.000	1.000	0.500
2	81.593	<	X	< 94.285	1.000	2.000	1.000	0.500
3	94.285	<	X	< 108.806	1.000	2.000	1.000	0.500
4	108.806	<	X	< 125.393	3.000	2.000	1.000	0.500
5	X		>	125.393	2.000	2.000	0.000	0.000
	Jumlah :				10.000	10.000	4.000	2.000

Source: Calculation

The critical value for the Chi-Square distribution is obtained α = 5% and degrees of freedom DK = 5 - (2 + 1) = 2 For DK = 2 and α = 5% get X^2 count = 5.991, then X^2 count <X^2 table then Ho is accepted.

Table 4. Calculation of the Chi-Square Test for the Pearson Type III Log Distribution.

Year	X	Log X	G	M	S_n (X)	Pr	Px (X)	D I P_X (X) - S_n (X)
1995	69.00	1.839	-1.541	1.000	0.091	0.941	0.059	0.032
1996	79.000	1.898	-0.995	2.000	0.182	0.815	0.185	0.003
1997	80.000	1.903	-0.944	3.000	0.273	0.809	0.191	0.082
1998	88.000	1.944	-0.560	4.000	0.364	0.695	0.305	0.059
1999	95.000	1.978	-0.251	5.000	0.455	0.590	0.410	0.044
2000	111.000	2.045	0.377	6.000	0.545	0.374	0.626	0.080
2001	119.000	2.076	0.658	7.000	0.636	0.278	0.722	0.086
2002	123.000	2.090	0.791	8.000	0.727	0.232	0.768	0.040
2003	129.000	2.111	0.983	9.000	0.818	0.160	0.840	0.022
2004	146.000	2.164	1.483	10.000	0.909	-0.014	1.014	0.105
							D Maks.	0.1054

Log Average X	=	2.0047
Standard Deviation (S)	=	0.1076
D Max.	=	0.1054
N (Amount of Data)	=	10
α (Degree of Confidence)	=	5%
D Critical	=	0.4090

The calculation is carried out until the last data, then obtained Δ max of 0.1054 with N = 10 and the value of α = 5% from the table, it is obtained that Δ is critical of 0.4090. Since Δ max <Δ is critical, the equality of distribution is acceptable.

3. Debit Plan Calculation

The calculation of the planned flood discharge uses the Nakayasu synthetic hydrograph method.

River Data:

1. Koef. Flow (C) = 0.60
2. Length of the Main River (L) = 39.11 km
3. Watershed area (A) = 226.15 km^2
4. R0 = 1.00 mm (unit rain)

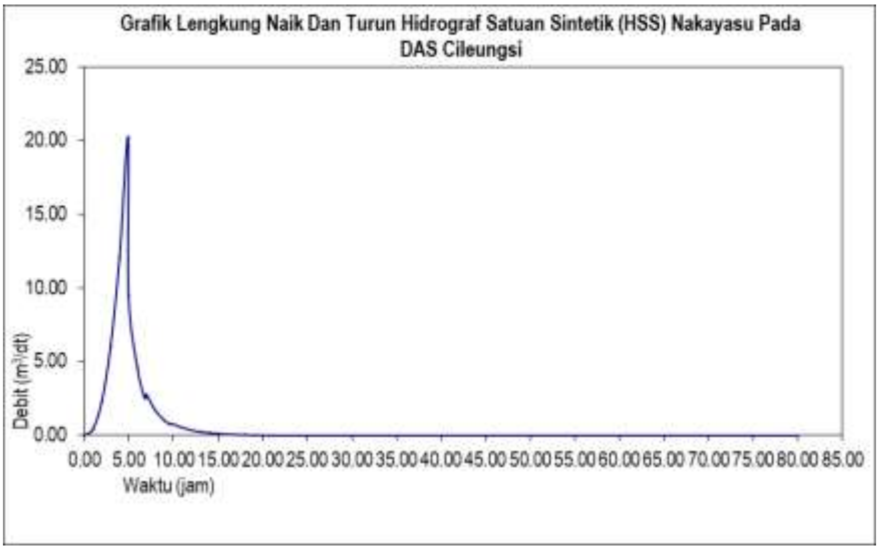

Figure 3. Up and down curve graph of Nakayasu synthetic hydrograph (HSS) in the Cileungsi watershed

Table 5. Design Flood Discharge.

No.	Return (Year)	Design Flood discharge (m^3/dtk)
1	2	831.7056
2	5	1028.9660
3	10	1147.6720
4	20	1249.9314
5	25	1271.4517
6	50	1376.9945
7	100	1465.5368

Source: Calculation

4.2. Hydraulics Analysis

1. HEC-RAS Model Simulation

HEC-RAS is an application program for modeling flow in rivers, the River Analysis System (RAS), created by the Hydrologic Engineering Center (HEC) which is a division within the Institute for Water Resources (IWR), under the US Army Corps of Engineers (USACE). HEC-RAS is a one-dimensional model of permanent and non-permanent flow (steady and unsteady one-dimensional flow model). The HEC-RAS has four components to the one-dimensional model:

1) Permanent flow water level profile count,
2) Non-permanent flow simulation,
3) sediment transport count, and
4) Water quality count.

One important element in HEC-RAS is that the four components use the same geometry data, the same hydraulic counting routine, and several hydraulic design features that can be accessed after a successful water level profile calculation. In this study, the HEC-RAS model simulation conducted is a flood model simulation.

2. Channel System Schematic

The schematization used in this modeling is limited to sections that have been surveyed for cross-sectional measurements, namely cross-sections and longitudinal sections. for this Hec-Ras modeling presented the Cileungsi River which has a length of 39.11 Km. from upstream to downstream, however in this modeling only 200 m long river is simulated. from the upstream, can be seen in Figure 4.2. on the CrCls peg. 388.

Figure 4. Cileungsi River System Schematic

3. Simulation Results of Existing Conditions and Conditions of The 25 Year Return Dam Plan

Flood simulation results using hydrograph loads for a 25 year return period in the existing conditions and conditions of the dam plan. From the simulation results of the Cilungsi River, it is concluded that for a 25 year return period in the existing conditions the water level upstream at a maximum condition reaches 40.89 m. and the water level downstream reaches 27.15 m. The water discharge in the existing condition reaches 23,030.28 m3, while with the dam the water level upstream at the maximum condition reaches 43.52 m. and the water level downstream reaches 24.41, the discharge is reduced by 666.07 m3 / s. However, the peak discharge time is shifted by 5 hours.

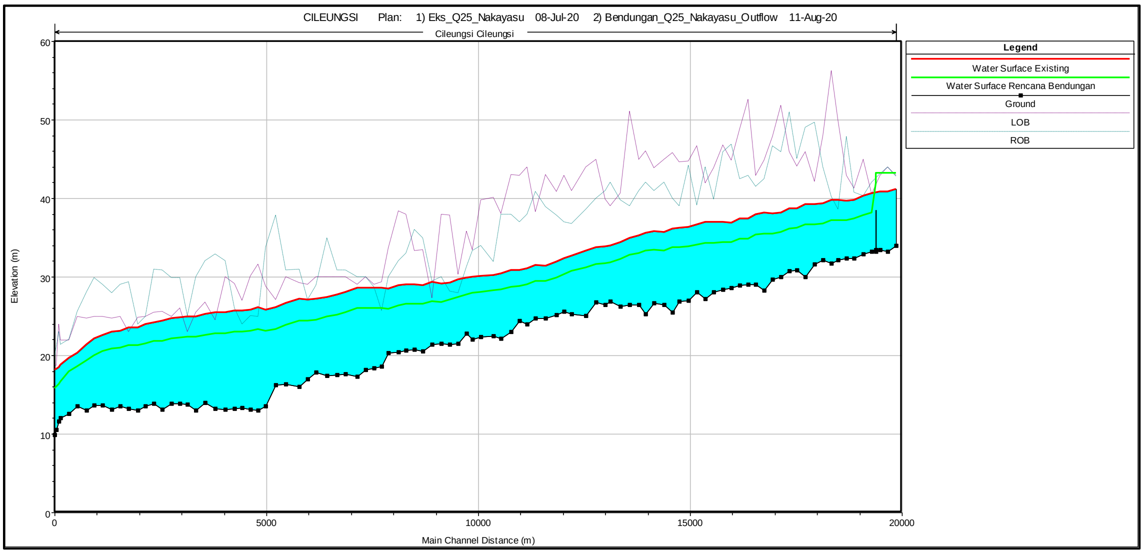

Figure 5. Results of Existing Running and Dam Plan Q25.

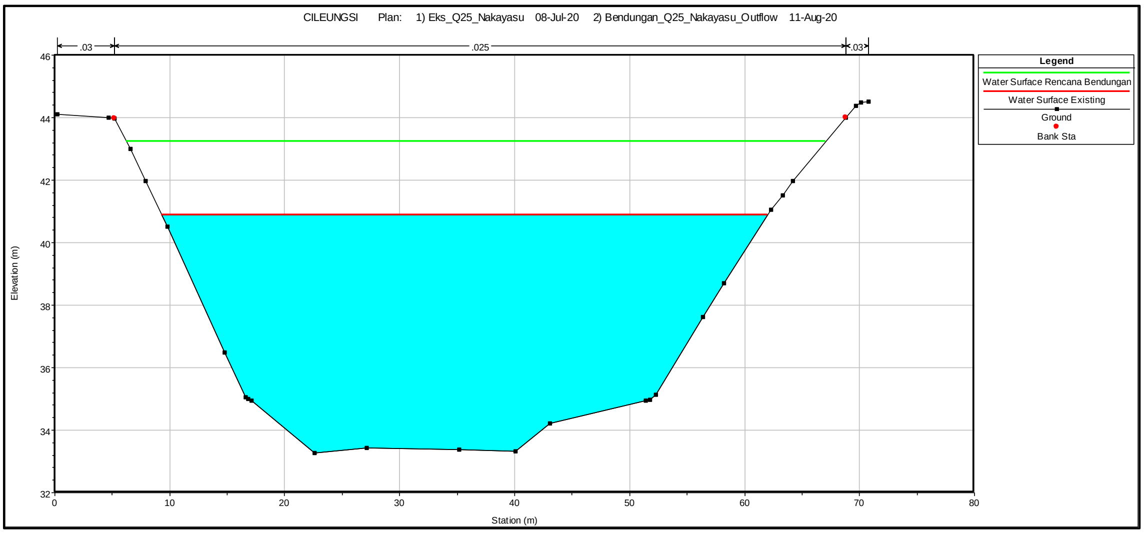

Figure 6. Results of Existing Running and Dam Plan Q25 (CrCls.384).

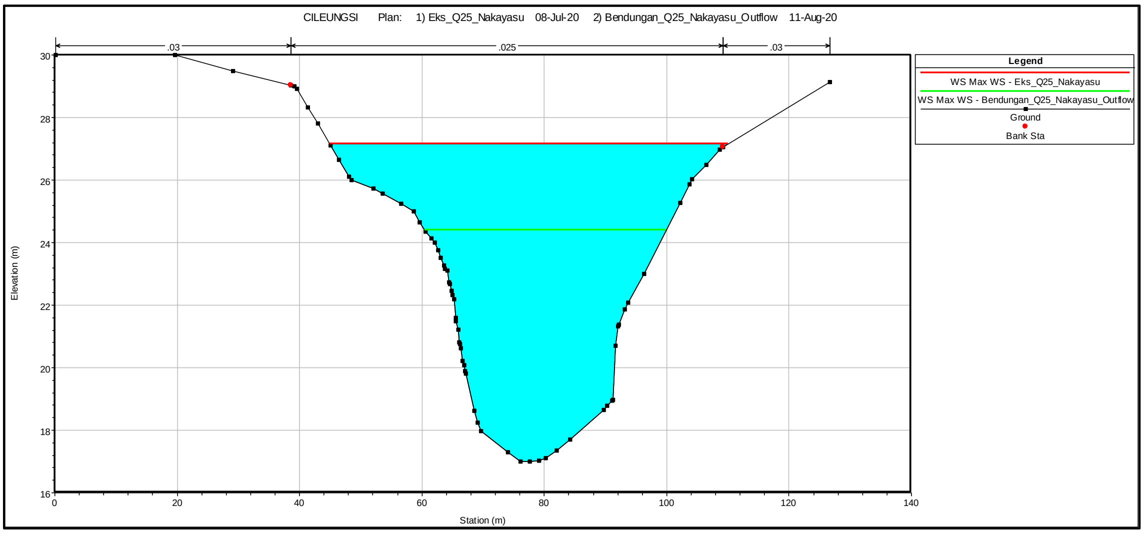

Figure 7. Existing Running Results and Q25 Dam Plan (CrCls.116).

4. Simulation Results of Existing Conditions and Conditions of the 50 Year Return Dam Plan

Flood simulation results using hydrograph loads for a 50 year return period in the existing conditions and conditions of the dam plan. From the simulation results of the Cilungsi River it was concluded that for a 50 year return period in the existing conditions, the water level upstream at a maximum condition reached 41.21 m. and the water level downstream reaches 27.54 m. The water discharge in the existing condition reaches 24,593.29 m3, while with the dam the water level upstream at the maximum condition reaches 43.82 m. and the water level downstream reaches 25.56, the discharge is reduced by 610.96 m3 / s. However, the peak discharge time is shifted by 5 hours.

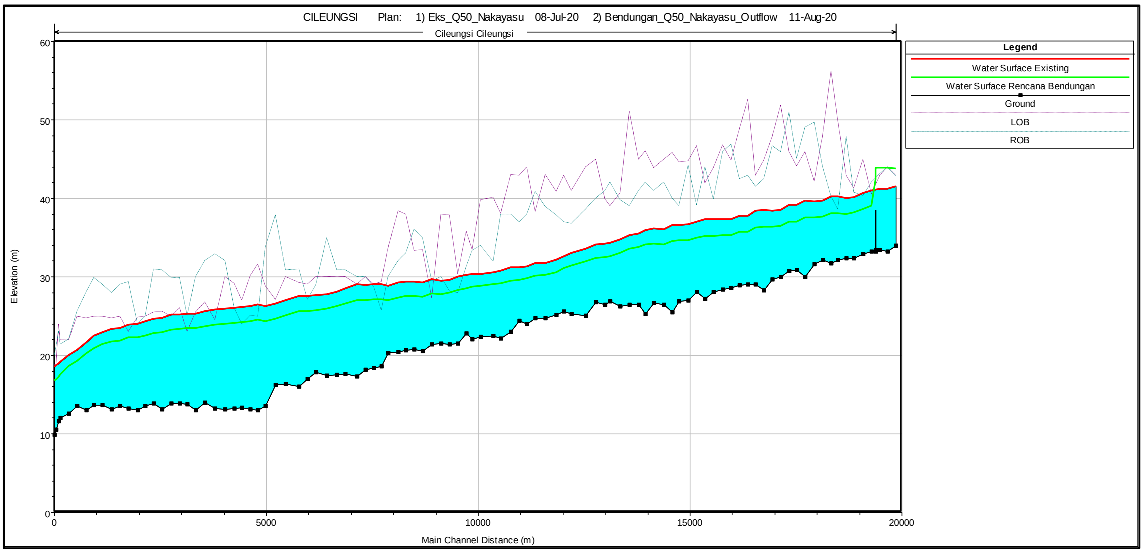

Figure 8. Running Results Ex isting and Dam Plan Q50.

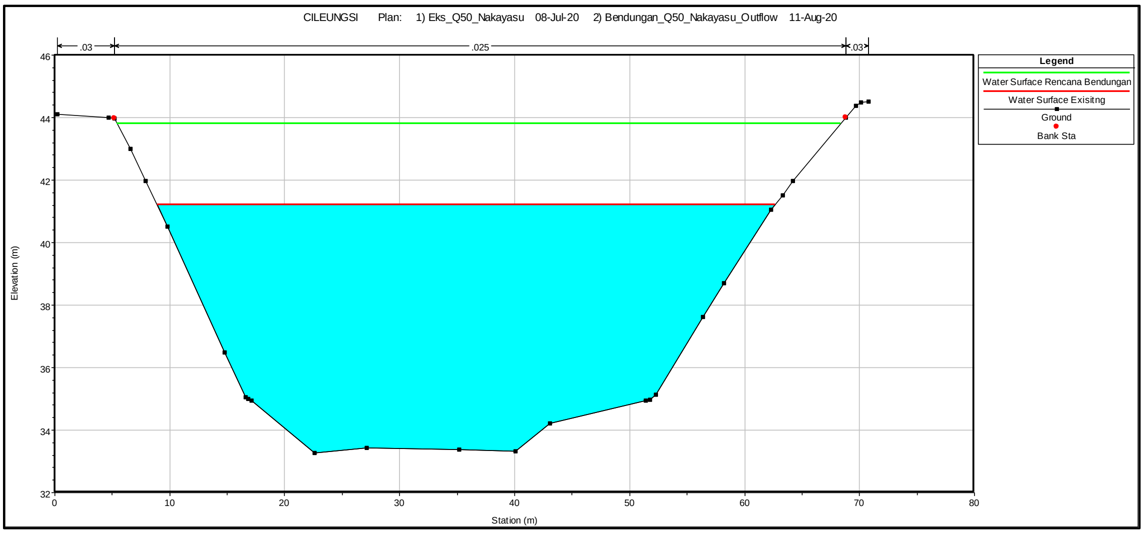

Figure 9. Results of Existing Running and Dam Plan Q50 (CrCls.384).

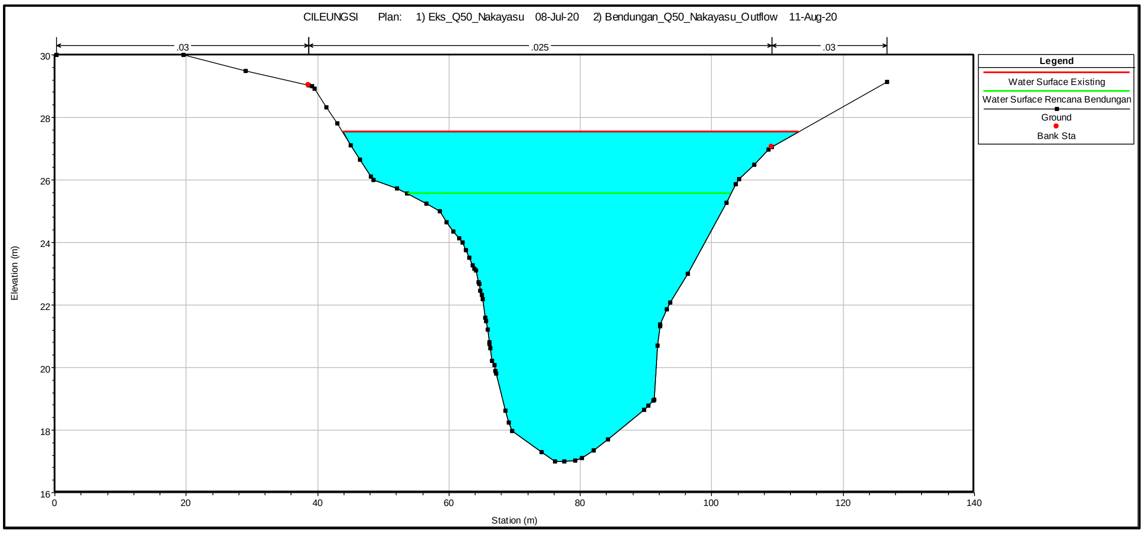

Figure 10. Existing Running Results and Dam Plan Q50 (CrCls.116).

5. Conclussion and Suggestions

Based on the results of calculations and analysis carried out in the previous chapter, several conclusions can be drawn as follows:

1. The results of the design flood discharge hydrological analysis using the Nakayasu Method on the Cileungsi River obtained a discharge of:
   831.71 m3 / s (2nd time),
   1,028.97 m3 / s (5th return),
   1,147.67 m3 / s (10th birthday),
   1,249.93 m3 / s (20th return),
   1,271.45 m3 / s (25th birthday),
   1,376.99 m3 / s (50th birthday),
   1,465.54 m3 / s (100th reset).
2. The flood prevention efforts on the Cileungsi River are planned in the form of building a dam in the upper reaches of the Cilungsi River, assuming the height of the dam is 40 m.
3. With the dam:
   a. at the flood discharge design Q25 year the water level upstream increased by an average of 2.25 m and the water level downstream decreased by an average of -2.41 m.
   b. at the flood discharge design Q50 year the water level upstream increased by an average of 2.49 m and the water level downstream decreased by an average of -1.84 m.
   c. In the existing conditions, the design flood discharge of Q25 in the Cileungsi River reached 1,261.47 m3 / s with the design flood discharge dam reduced to 595.4 m3 / sec.
   d. in existing conditions with the design flood discharge Q50 in the Cileungsi River it reached 1,376.99 m3 / s with the design flood discharge dam reduced to 766.03 m3 / sec.

This means that the presence of a dam on the Cileungsi River is quite effective in overcoming flooding due to the too high water discharge in the downstream of the Cileungsi River.

1. In addition to the above conclusions, some suggestions can be made, including:
   In supporting efforts to control floods in the Cileungsi River, it is necessary to include efforts to protect and organize the river area. In view of the high population growth in the riverbank area, it is also necessary to have firmness from government officials and the community in managing residential areas, especially for settlements located along river boundaries, so that river bodies do not narrow.
2. Further studies are needed for flood management in the Cileungsi watershed by non-structural means that can be carried out by improving land use in the upstream area.

References

Kodoatie, Robert.J., dan Roestam, S. (2005). *Pengelolaan Sumber Daya Air Terpadu*. Andi.

Permatasari, A., Suprijanto, H., & Dermawan, H. (2015). Studi Perencanaan Tanggul dan Dinding Penahan Untuk Pengendalian Banjir di Sungai Cileungsi Kabupaten Bogor Jawa Barat. *Jurnal Ilmiah*.