

CIHEULANG RIVER FLOOD ANALYSIS IN CARINGIN DISTRICT SUKABUMI REGENCY

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ABSTRACT

This study aims to study and analyze the intensity of rainfall, flood discharge and flood control of the Ciheulang River in Caringin District, Sukabumi Regency. The method used is a statistical and empirical model analysis approach including the distribution of Log Pearson Type III, Intensity Duration Frequency and rational methods. Based on the results of the study, it is known that (1) The intensity of rainfall in the Ciheulang river in Caringin District, Sukabumi Regency in a 2 year period is 7.999 mm/second, a 5 year period 9, 215 mm/second, a 10 year period 9,922 mm/second, a 25 year period 10,736 mm/second, period of 50 years 11.297 mm/second and period of 100 years 11.825 mm/second; (2) Ciheulang river flood discharge in Caringin District, Sukabumi Regency for a 2 year period is 38.424 mm/second, a 5 year period 44,266 mm/second, a 10 year period 47,664 mm/second, a 25 year period 51.574 mm/second, a 50 year period 54.269 mm/second and period of 100 years 56,807 mm/second; (3) Control of flooding that occurred in the Ciheulang river in Caringin District, Sukabumi Regency is carried out by reducing and overcoming runoff that occurs due to planned flood discharges with various return periods, through alternative structural efforts, including: making/raising flood embankments using revetments, gabions river channel.



KEYWORDS

Flood Discharge Analysis
Rational Method
Ciheulang River



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1. Introduce

Floods or inundation in a residential or urban area still occur in many cities in Indonesia [1] [2] [3]. Inundation is not only experienced by urban areas located in the lowlands, it is even experienced by areas located in the highlands [4] [5]. Flooding or inundation in an area occurs when the system that functions to accommodate the inundation is not able to accommodate the flowing discharge [6] [7]. There are several possibilities for inundation in an area, namely decreased system capacity and increased water flow rate [8] [9].

The occurrence of flooding/overflow can be distinguished by several types, namely the discharge is too large or the capacity of the river flow is reduced [10]. This can occur due to natural phenomena or due to carelessness of human activities in carrying out river management/management for various purposes. In line with the rate of development of the community, especially those who live and carry out activities around floodplains, the problems caused by floods are increasing from time to time and require attention and efforts to overcome them properly [11].

The most dominant cause of flooding is the conversion of land that was previously green open space or forest area into a built space, especially housing as the population continues to grow [12]. The government's efforts to control flooding, especially with the structural method, will be outpaced by the level of watershed damage due to changes in land use, which results in increased flooding even though water infrastructure has been built at a very high cost. It can be likened mathematically to flood control in an arithmetical manner, but flood disasters are a geometric series [13].

Ciheulang River is a sub-watershed of Cicatih-Cimandiri which is an agricultural center area in Caringin District, Sukabumi Regency. This is a factor causing flooding, because most of the

rain that falls on the surface flows into the river quickly and downstream there is a narrowing of the lip. the river so that the volume of water exceeds the capacity, in the end the water overflows out of the river.[11] The narrowing that occurs is due to sedimentation carried by the flow, the impact of this flood causes losses in several villages, especially the downstream part of the river which includes inundating access roads and people's houses around the river flow, damage to settlements, damage to agricultural land.

To reduce the risk of flood damage around the Ciheulang River, flood control efforts are needed. Planning for flood control in a sub-watershed can be carried out properly if the planned flood discharge is known. In analyzing the peak flood discharge, rainfall data and discharge data are needed. However, not all watersheds and sub-watersheds have good rainfall and discharge data.[14]

Based on the problems posed in this study, the general objectives of this research are: (1) To study and analyze the intensity of rainfall in the Ciheulang River in Caringin District, Sukabumi Regency; (2) To study and analyze the flood discharge of the Ciheulang River in Caringin District, Sukabumi Regency; (3) To study and analyze how to control floods that occur in the Ciheulang river in Caringin District, Sukabumi Regency.

2. Method

Below is the research flow which is described in the form of a Flowchart diagram:

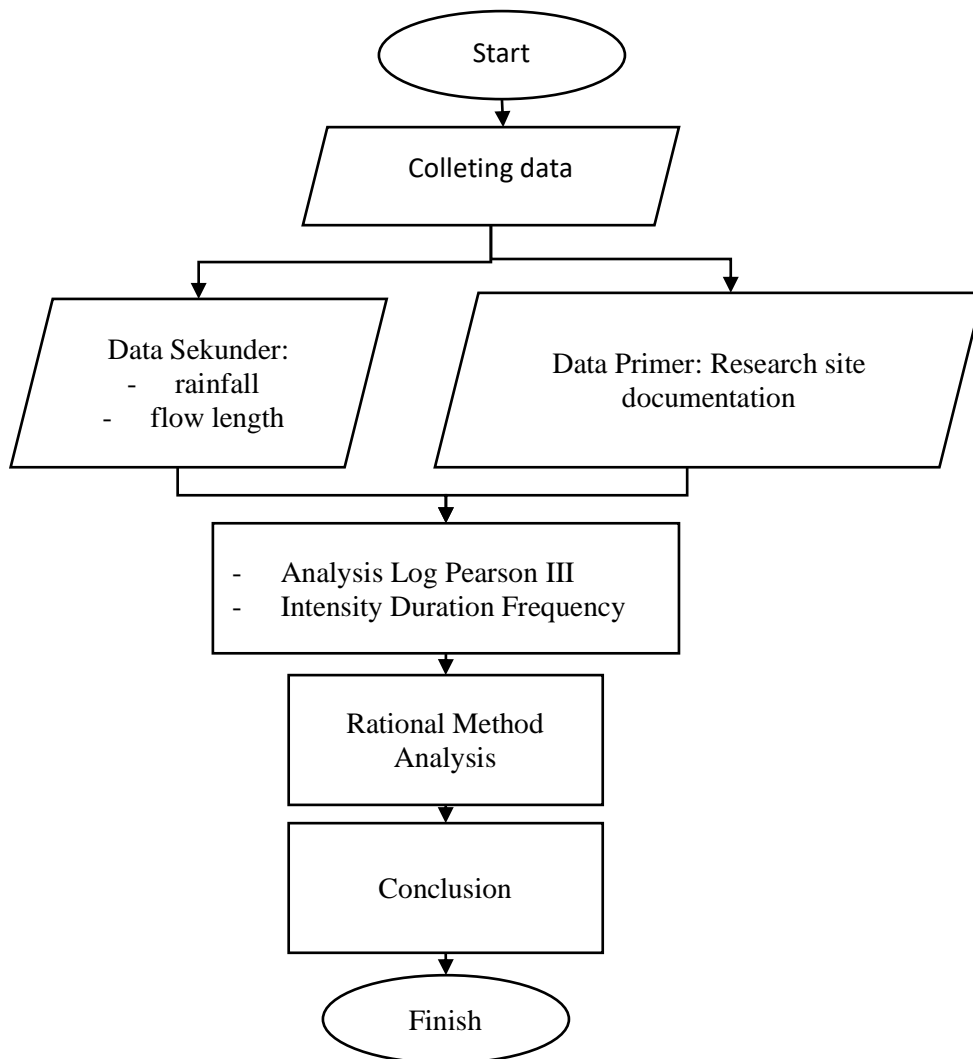


Fig 2.1 Research Flowchart

The research location is in Caringin District, Sukabumi Regency with the coordinates of the position at 6045'52"S and 106020'04"E. The administrative map of the Sub-watershed in Sukabumi can be described as follows:

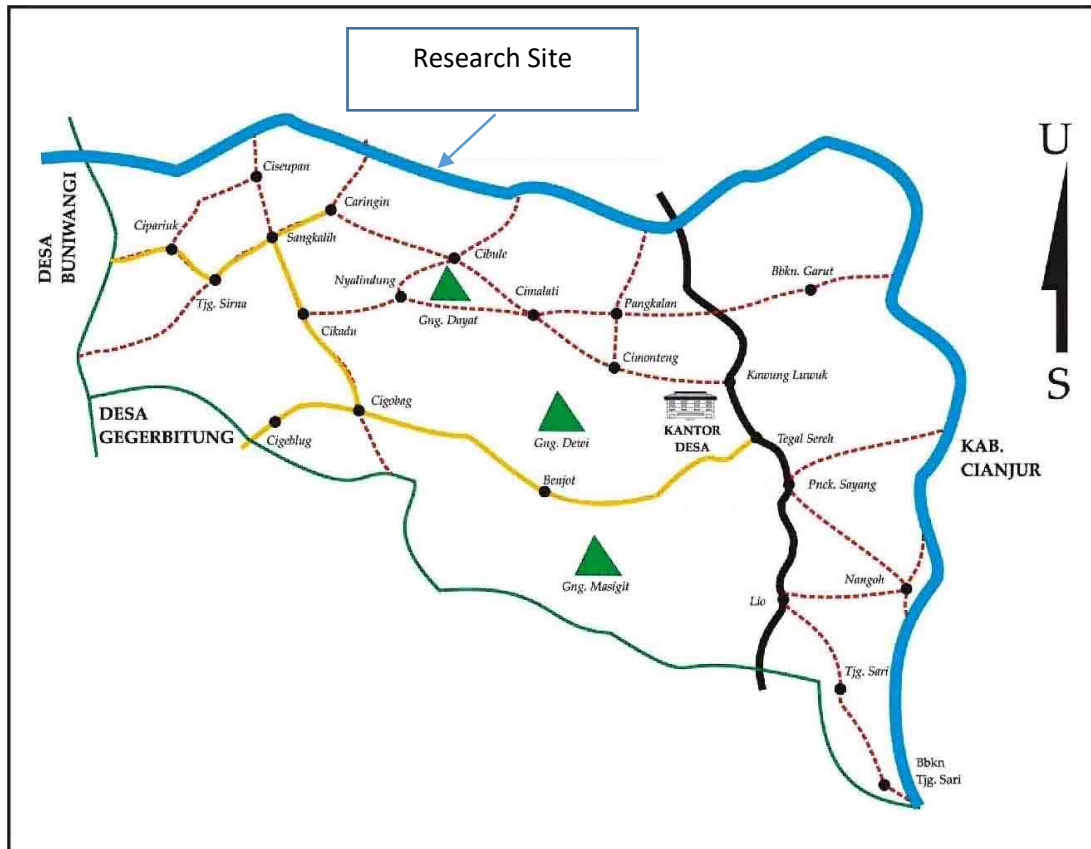


Fig 2.2 Research Site Map

The watershed that crosses Sukabumi district is the Cicatih-Cimandiri watershed with an area of 52,979 ha or 530 km² of the Cicatih watershed. The Ciheulang sub-watershed is the largest area that reaches 30% of the total area of the sub-watershed or 15,911 ha. Next is the order of the sub-watersheds which have the largest to the smallest area: Cicatih upstream with an area of 9,939 ha, Cipalasar with an area of 9,306 ha, Cileuleuy with an area of 9234 ha and Cikembar which is a downstream area with an area of 8,589 ha. In this study, the focus is on the Ciheulang sub-watershed that crosses the Caringin . sub-district.

The methodology used in this study is a quantitative descriptive method, namely the method of calculation and elaboration of the results of processing field data from the location being reviewed.

The type of data in this study consists of primary data and secondary data. Primary data is data obtained by field observations and measurements and analysis. In general, the definition of primary data is data obtained from the first source/data source or data collected by researchers directly through research objects such as site visits and this data is usually not processed. The researcher looks at the condition of the housing area and the condition of the river profile.

Secondary data is data that supports research and provides an overview of things that include research. Secondary data collection is obtained through agencies that are involved in this problem, such as journals, literature books, internet and the data used. In general terms secondary data is data obtained from a second party, secondary data in this study include rainfall data, river flow area data, area and flow maps.[15]

The analysis in this study uses an analytical approach to existing statistical and empirical models, namely:[16]

- Performing an analysis of rainfall using the Log Pearson III distribution method. Analysis of rainfall is intended to calculate the maximum rainfall intensity in a certain return period. By knowing the maximum rainfall intensity, the flood discharge capacity can be calculated. The steps for processing the maximum daily rainfall data are using the Log Pearson Type III method.[17]
- Determine the value of k (Pearson Type III Log distribution characteristics), using a table based on the value of g and the return period T_r . To determine the value of k with a return period and a certain value of g, interpolation can be carried out on the values in the Pearson Type III Log distribution characteristic table.
- Depictions of the daily rainfall identity curve with a certain return period on the IDF (*Intensity-Duration-Frequency*)
- Calculate the planned flood discharge using the formula:

$$Q_p = C.I.A \text{ 3.1 Rational Method Formula}$$

Q = debit in m³/dt; c = surface runoff coefficient, which is < 1; i = rain intensity; A = rain catchment area. For flow coefficient c , if it is not measured directly in the intended flow field, then it can be used to estimate the value of the coefficient c empirically based on the results of the study.[15]

3. Results and Discussion

This study aims to determine the amount of planned rainfall that occurs in the Ciheulang River, Caringin District, Sukabumi Regency, Daily rainfall data for the last year is required at the nearest rain gauge station. The data used are 2011 rainfall data. As explained in chapter II, the determination of effective rainfall starts from finding the average maximum rain obtained from the BMKG, so that data such as table 3.1 is obtained below.

Table 3.1 Rainfall on the Ciheulang River

No.	Month	2016	2017	2018	2019	2020	Average Rainfall
1	January	220	406	349	364	544	377
2	February	327	405	250	468	386	367
3	March	455	209	593	313	748	464
4	April	365	190	223	374	324	295
5	May	322	128	233	158	343	237
6	June	192	185	113	10	138	128
7	July	292	97	0	11	25	85
8	August	151	34	0	7	80	54
9	September	280	102	103	10	55	110
10	October	352	276	75	66	239	202
11	November	376	332	351	95	179	267
12	December	462	196	317	584	395	391
Total		3794	2560	2607	2460	3456	2.975
Avarage		316	213	217	205	288	248

Source: Data Processing Results, 2021

Based on table 3.1 above, it is found that the highest maximum daily rainfall is 248 mm and the lowest average maximum daily rainfall is 54 mm..

Rain intensity is one of the parameters to determine the flood discharge of rainwater. Calculation of rainwater intensity is based on maximum daily rainfall data at rain recording stations on the Ciheulang River, Caringin District, Sukabumi Regency. The maximum daily rainfall data from each rain station is processed into the design maximum daily rainfall using the Log Pearson type III . method. In simple terms the Pearson Type III distribution density function is as follows:

$$X_t = X_i + K_T.S_i$$

Which is:

X_i = Data to- i

S_i = Standard deviation

C_s = Skewness coefficient

K_T = The nature factor of the Pearson Type III distribution, which is a function of the amount of C_s shown in the table.

Based on the above equation, it can be calculated design rain for various return periods. This design rain can be seen in Table 3.2 below.

Table 3.2 Rain Design Various Periods Repeat

repeatedness	X	Log Xi	Si	Cs	KT	Log Xt	Hujan Rancangan (Xt)
2	247,95	2,3	0,073	0,044	0	2,300	199,526
5	247,95	2,3	0,073	0,044	0,842	2,361	229,861
10	247,95	2,3	0,073	0,044	1,282	2,394	247,506
25	247,95	2,3	0,073	0,044	1,751	2,428	267,808
50	247,95	2,3	0,073	0,044	2,054	2,450	281,801
100	247,95	2,3	0,073	0,044	2,326	2,470	294,984

Source: Data Processing Results, 2021

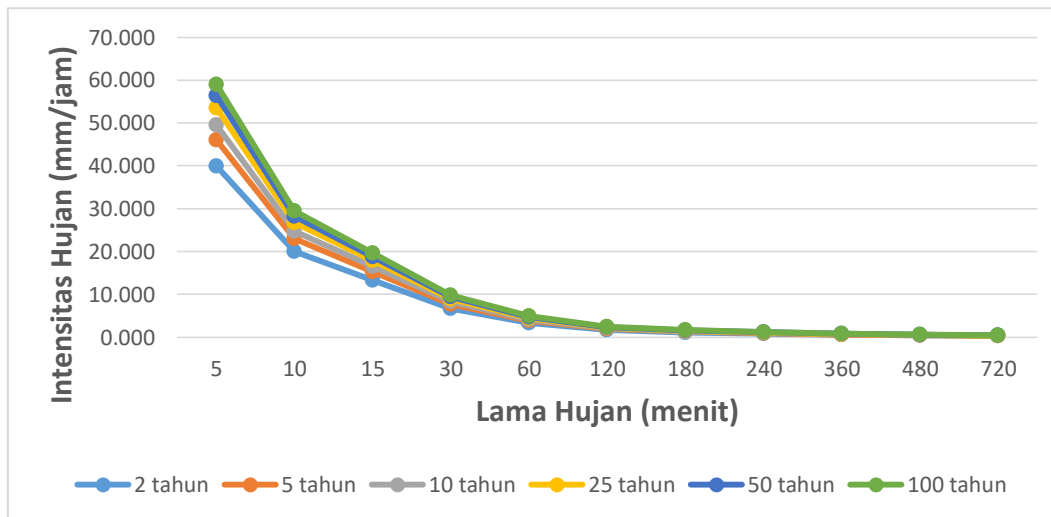
Rain intensity is one of the parameters to determine the flood discharge of rainwater. [13] Calculation of rainwater intensity is based on maximum daily rainfall data at rain recording stations on the Ciheulang River, Caringin District, Sukabumi Regency. Furthermore, the maximum rain data is processed into an equation of rain intensity by using a Menobe and obtained a curved curve of rain intensity, this can be seen in table 3.3 dan Fig 3.1:

Table 3.3 Rainfall Intensity (mm/hour) For Various Return Periods

Rainfall Intensity (mm/hour) For Various Return Periods						
T (Minute)	2 Years	5 Years	10 Years	25 Years	50 Years	100 Years
5	39,905	45,972	49,50	53,56	56,36	59,00
10	19,953	22,986	24,75	26,78	28,18	29,50
15	13,302	15,324	16,500	17,854	18,787	19,666
30	6,651	7,662	8,250	8,927	9,393	9,833
60	3,325	3,831	4,125	4,463	4,697	4,916
120	1,663	1,916	2,063	2,232	2,348	2,458
180	1,108	1,277	1,375	1,488	1,566	1,639
240	0,831	0,958	1,031	1,116	1,174	1,229

360	0,554	0,639	0,688	0,744	0,783	0,819
480	0,416	0,479	0,516	0,558	0,587	0,615
720	0,277	0,319	0,344	0,372	0,391	0,410
rata-rata	7,999	9,215	9,922	10,736	11,297	11,825

Source: Data Processing Results, 2021



Source: Data Processing Results, 2021

Fig 3.1 Chart of Rain Intensity on the Ciheulang River, Caringin District, Sukabumi Regency

Based on the Intensity Duration Frequency (IDF) curve, it can be seen that the intensity of rainfall in the Ciheulang sub-watershed area, Carangan sub-district in the 2-year repeat period was 7.999, 5 year return period 9,215, 10 year return period 9,922, 25 year return period 10,736, 50 year return period 11,297, 100 year return period 11,825. From the Intensity Duration Frequency (IDF) curve, it can be seen that high rainfall intensity lasts for a short duration. This shows that heavy rains generally last for a short time, but not heavy rains (drizzle) last for a long time. This is in accordance with Suripin's statement that the general nature of rain is the shorter the rain lasts, the intensity tends to be higher and the greater the return period, the higher the intensity. Interpretation of the Intensity Duration Frequency (IDF) curve is needed to determine the design flood discharge using the rational method.[18]

The results of the analysis in the form of rain intensity with a certain duration and return period are connected into an Intensity Duration Frequency (IDF) curve. The IDF curve illustrates the relationship between two important rain parameters, namely the duration and intensity of rain which can then be used to calculate peak discharge using the rational method [19] [20]. This is in accordance with the statement of Sosrodarsono and Takeda (2013), who said that the Curvature Intensity Duration Frequency (IDF) was used in calculating peak discharge with a rational method to determine the average rainfall intensity from the selected concentration time.[21]

Based on the data obtained above, it can be calculated the peak discharge in the Ciheulang River, Caringin District, Sukabumi Regency with the rational method for certain return periods. The duration of rain with a certain intensity is the same as the time of concentration and the runoff coefficient remains constant as long as the rain occurs. This is in accordance with Wanielista's statement, stating that to use the rational method, rainfall occurs with a fixed intensity within a certain period of time at least equal to the concentration time and the runoff coefficient is

considered constant for the duration of the rain.[22] The peak discharge in the Ciheulang River, Caringin District, Sukabumi Regency in more detail can be seen in the table below:

Table 3.4 Flood Discharge in the Ciheulang River
Caringin District, Sukabumi Regency

Kala Ulang	C	I (mm/jam)	A (km)	Q (m/detik)
2	0,8	7,999	21,6	38,424
5	0,8	9,215	21,6	44,266
10	0,8	9,922	21,6	47,664
25	0,8	10,736	21,6	51,574
50	0,8	11,297	21,6	54,269
100	0,8	11,825	21,6	56,807

Source: Data Processing Results, 2021

Based on the calculations above, it can be stated that the peak discharges of 2, 5, 10, 25, 50, and 100 years obtained can be used as basic materials for planning flood control buildings, where a flood control building is built that can accommodate the peak discharge of a water flow so that it can save costs and time in the implementation of development projects. It is known that the Ciheulang sub-watershed area in Caringin District, Sukabumi Regency is an area that is prone to landslides and floods, especially during the rainy season. Rainfall, river length, river slope and area in a watershed (Watershed Area) are some of the factors that affect the occurrence of floods also affect the stability, security and viability of a population that exists in these areast.[21]

Floods are one of the natural phenomena that often cause disasters, especially if there is high rainfall [23]. These conditions have an impact on the emergence of puddles in an area that can harm the community. One of the causes of flooding is the overflow of river water caused by river discharge that exceeds the river's capacity in conditions of high rainfall and inundation in flat lowland areas which are usually not flooded. In addition, there are several other factors that cause flooding, namely high rainfall and for a long period of time, blockage of water flow due to poor waste management. It can also be due to the drainage of water from the river which is not able to accommodate large rainwater discharges so that it overflows and inadequate drainage to accommodate runoff runoff. In residential areas that are densely packed with buildings, it can cause the water absorption area into the soil to decrease and due to population density there is also a decrease in land level.[24]

If the flood disaster is not responded to properly, the resulting losses will increase every year. Therefore, it is necessary to monitor flood discharge in the Ciheulang sub-watershed, Caringin sub-district, which has the potential to become a flood area.

In the hydrological cycle, rainwater that falls from the atmosphere falls to the earth's surface and is then captured by vegetation or man-made surfaces, some of it evaporates, infiltrates and is stored in the basin, if the basin is full then the water will run over the land surface and merge into tributaries and eventually become the main river flow. Runoff from the upstream watershed enters the river quickly resulting in an increase in river discharge, if the discharge entering the river is greater than the capacity of the river, overflow and flooding will occur. Rain that falls in a watershed will turn into a river flow, influenced by meteorological factors such as intensity, duration and distribution of rain as well as watershed characteristics, namely area and shape, topography and land use of the watershed.[25]

Based on rainfall, changes in land use and topography, the condition of the research location can be known, Is it a drought-prone area or is it prone to flooding. The current hydrological conditions in Sukabumi Regency are generally characterized by increasing extreme events such as floods and droughts with high levels of contamination in water bodies such as rivers. The water crisis is also getting worse, especially before and during the dry season, which is anticipated to experience serious water scarcity due to acute population pressure and poor land use change conditions. It is estimated that as an impact that needs to be observed from changes in land use on a large scale is a decrease in rainfall and the hydrological regime.[26]

Ciheulang river flood control in Caringin District, Sukabumi Regency is carried out to reduce and overcome runoff that occurs due to planned flood discharges with various return periods, through alternative structural measures, including: construction/raising of flood embankments using revetments, gabions in the river channel due to narrow bank conditions downstream and condition of the river area which has become part of the infrastructure consisting of transportation roads, residential areas, agricultural land, etc. so that it is not possible for countermeasures to use land

4. Conclusion

Based on the results of research and data analysis, several conclusions can be drawn as followst:

- The intensity of rainfall on the Ciheulang River in Caringin District, Sukabumi Regency for a 2 year period is 7.999 mm/second, a 5 year period 9, 215 mm/second, a 10 year period 9,922 mm/second, a 25 year period 10,736 mm/second, a 50 year period 11.297 mm/s and a period of 100 years 11.825 mm/second.
- Ciheulang river flood discharge in Caringin District, Sukabumi Regency for a 2 year period is 38,424 mm/second, a 5 year period 44,266 mm/second, a 10 year period 47,664 mm/second, a 25 year period 51.574 mm/second, a 50 year period 54.269 mm/second seconds and a period of 100 years 56.807 mm/second.
- Control of flooding that occurred in the Ciheulang river in Caringin District, Sukabumi Regency is carried out by reducing and overcoming runoff that occurs due to planned flood discharges with various return periods, through alternative structural measures, including: making/raising flood embankments using revetments, gabions in the river channel.

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