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EVALUATION OF FLOOD HANDLING AT SEMINYAK WAY II, IN THE TUKAD MATI DRAINAGE SUB-SYSTEM

I Gusti Ngurah Kerta Arsana [1], Mawiti Infantri Yekti [2], Dewa Ayu Utari Winandari [2]

1) Environmental Engineering, Faculty of Engineering, Udayana University, Badung Regency
2) Civil Engineering, Faculty of Engineering, Udayana University, Badung Regency

Correponding email [1] :
kertaarsana64@gmail.com

Abstract. Flood is a natural phenomenon that often occurs in several areas of Badung Regency. Losses result in damage to buildings, roads, and other public facilities. Floods are caused by a more sloping land topography, changes in land use to dense settlements, and soil conditions. This study aims to deal with flooding by evaluating the existing canal on Jalan Kunti II Seminyak. The method used for testing data consistency is the RAPS (Rescaled Adjusted Partial Sums) method. The distribution used is Log Person Type III. Testing of frequency distribution used the Smirnov – Kolmogorov Test and the Chi-Square Test. Analysis of rainfall intensity using the Mononobe formula. Calculation of planned flood discharge (Q) uses the Rational method, Nakayasu method, and theoretical discharge control for 2, 5, 10, and 25-year return periods with the existing channel capacity. The result of the analysis shows that the theoretical discharge with a return period has met of planned flood discharge so that the drainage on Jalan Kunti can accommodate the planned flood with a return period of 10 years. Where the drainage capacity of Jalan Kunti is 0,412 m^3/second & 0,461 m^3/second. The drainage ditch with a capacity of 200 m^3/second to Tukad Mati has not been able to accommodate the planned flood discharge for the 25-year return period of 242.33 m^3/second. The Tukad Mati channel for the existing Q 675,825 m^3/second has been able to accommodate the flood discharge Q at the 25-year return period of 314.49 m^3/second.

Keywords: Channel Capacity, Channel Dimensions, Flood

1. INTRODUCTION

Floods require attention and handling from both the government and the community. According to [1], Floods are events where river flow overflows as a result of water that is above its storage capacity so that it overflows and forms puddles on the plains or lower surrounding areas. Floods occur due to rising water levels due to rainfall exceeding its normal limits, changing temperatures, dams or embankments breaking, fast melting of snow, or obstructed water flow in other places [2]. Besides that, the causes of flooding are also due to other factors such as the condition of the rain catchment area, the duration of rain entities, and the land cover of certain areas. Broadly speaking, flooding occurs due to the contribution of the physical conditions of certain areas, including land topography which is more sloping compared to other land areas. Another cause was put forward by [3] that one of the reasons for flooding was the siltation of the canal due to garbage and sedimentation. In addition, changes in land use are also related to a decrease in the ability of the soil to absorb water, so it also has an impact on increasing runoff to the surface. Sedimentation/siltation at the mouth of the river is also one of the causes of flooding.

Drainage has the meaning of draining, draining, removing, or diverting water. In general, drainage has a definition, namely a series of water structures with the function of reducing or removing excess water from a certain area or land, so that the land can function properly and optimally. Drainage also means an attempt to control

the quality of groundwater salinity [4]
The existence of drainage becomes very important in life. Drainage has the function of reducing the amount of excess water in certain areas so that the area or land can function optimally, controlling soil erosion, and damage to buildings and roads, controlling water to the surface to improve flood areas, and controlling excess rainwater so that no flood disaster occurs. However, the reality on the ground is that several drainages have failed to function so water that cannot be accommodated by the drainage itself causes overflow to inundate residential areas and roads [5]. Various factors are the cause of the failure of the drainage function, such as landfills, silt or sediment deposits, urban growth, industrial development, and others. When the drainage is no longer able to accommodate discharge when it floods, it can be said that the drainage has a problem. Drainage failure causes flooding which greatly affects human activities [6].

Badung Regency is located at 08º14'01" - 08º50'52" South Latitude and 115º05'03" -115º26'51" East Longitude, has several areas that are prone to flooding and inundation, especially in Kuta District which has an area of 17.52 km^2. One of the causes of flooding in Kuta District is the condition of Tukad Mati whose watershed passes through most of the Kuta District area. In January 2018, Jl. However, in observations made in 2020-2021 during the rainy season between December-January, based on a field survey the depth of inundation on Kunti II Street during the rainy season is approximately 20-30 cm or an adult's calf with an inundation duration of 2-3 hours. This stagnant water occurs because the flow of water from the sewer is blocked from flowing into Tukad Mati.

The lack of arrangement in the Tukad Mati sub-drainage greatly affects runoff in the surrounding area as happened on Kunti II Street. In addition, the elevation of the tertiary channel with the Tukad Mati sub-drainage is very small. As well as Kunti II Street which was flooded, it is a basin area, so when the intensity of rainfall is high enough, runoff will occur on the road. As well as the lack of public awareness in maintaining cleanliness also had a major impact on the inundation that occurred on Kunti II Street. In addition, even though there have been countermeasures from the government by increasing the capacity and quality of drainage downstream of the Tukad Mati sub-system drainage channel, inundation still occurs on Kunti II Street.

This study aims to evaluate the extent to which the ability of the existing drainage sections on Kunti II Street, the sewer and Tukad Mati to cope with annual flooding and to calculate the dimensions of the drainage containers on Kunti II Street, the sewer, and Tukad Mati so that they can accommodate the planned flood discharge so that it can provide solutions/input to overcome the flood and can be used as a reference in planning drainage channels.

2. METHODS

The research method carried out uses a quantitative method or the method used in the description of the actual phenomenon according to the conditions in the field with the stages of data collection, data analysis, and interpretation of the results of the analysis [7]. In addition, to test the power consistency using the RAPS (Rescaled Adjusted Partial Sums) method. For distribution using Log Person Type III. Frequency distribution testing uses the Smirnov-Kolmogorov Test and Chi-Square. For analysis of rainfall intensity using the Mononobe formula. Calculation of the planned flood discharge or Q using the Rational method, the Nakayasu method, and evaluation of the total capacity of the existing canal with its theoretical discharge control lies in the return periods of 2, 5, 20, and 25 years with the existing canal capacity.

3. RESULTS AND DISCUSSION

In determining the amount of planned flood discharge, what must be done first is to analyze data from rainfall obtained from the nearest station around Seminyak. These stations are Sanglah Station and Ngurah Rai Station. Rainfall analysis data is a daily maximum span of 19 years, namely from 2001 to 2019 which was obtained through the Meteorology, Climatology and Geophysics Center for Region III Denpasar. Considering that the number of rain stations is limited to the scope of the study, the calculation of the average rainfall for the area is carried out using the Algebraic average method. This method is carried out using measurements at several stations at the same time and can only be used if the rainfall occurs in a homogeneous watershed and the yearly variation is not large enough. In calculating the average maximum daily rainfall, a total of 2468.35 mm was obtained.

In addition, a test was carried out on the consistency of rain data using RAPS (Rescaled Adjusted Partial Sums) which was applied to the calculated results at Sanglah Station and Ngurah Rai Station. The results of calculations at the Sanglah station are that the $Q/\sqrt{n}$ value is smaller than the critical $Q/\sqrt{n}$ value with a significant level of 90% ($0.40 < 1.10$) and the $R/\sqrt{n}$ value is smaller than the critical $R/\sqrt{n}$ value ($0.85 < 1.34$) and the results of calculations at Ngurah Rai Station, namely the $Q/\sqrt{n}$ value is smaller than the critical $Q/\sqrt{n}$ value with a significant level of 90% ($0.40 < 1.10$) and the $R/\sqrt{n}$ value smaller than the critical $R/\sqrt{n}$ value ($0.99 < 1.34$). Based on these calculations, the data shows that it is consistent.

Next, the selection of the frequency distribution is carried out based on the results of calculating the sloping coefficient (Cs) and peaking coefficient (Ck). Based on the selection conditions for the appropriate type of distribution or frequency distribution, where (Cs) = 0.53 and (Ck) = 5.50, so that no distribution complies with the applicable frequency distribution requirements, the conclusion uses the Log Person Type III method. Use of the Log Person Type III method to analyze planned rainfall by taking 2,5,10,25 return period. The calculation results are described according to the following table:

Table 1. Calculation Results of Log Person Type III

T (Return Period)	Frequency (K)	Log Xt	X design rain (mm/day)	Rounding off
2	0.000	2.099	125.621	126
5	0.842	2.196	157.215	157
10	1.270	2.246	176.206	176
25	1.751	2.302	200.300	200

To prove whether the results calculated using the Log Person Type III method can be used or not, a test must be carried out with the Smirnov – Kolmogorov test which shows that the distribution distribution using the Log Person Type III method is acceptable or not. This can be proven by the magnitude of the value greater than (0.3075 > 0.29) which has a degree of confidence of 5%.

In addition, in determining the equation for the probability distribution it has been chosen so that it can represent a statistical distribution for the analysis of sample data. The formula used is the formula cited by [8] in his book. The results of testing the value of the Log Person Type III distribution using Chi-Square can be described in Table 2 below.

Table 2. Testing the value of Log Person Type III distribution using Chi-Square

Probability	Expected Frequency	*Observed Frequency*	(Ef-Of)	$(Ef\text{-}Of)^2$
P≤1.99	3,8	2	1,8	3,24
1.99<P≤2.07	3.8	4	-0.2	0.04
2.07<P≤2.15	3.8	2	1.8	3.24
2.15<P≤2.23	3.8	8	-4.2	17.64
2.23<P≤2.311	3.8	3	0.8	0.64
Total	19	19		24.8

Based on the results of the tabulation above, the calculated X^2 is 24.8 / 19 = 1.305 with X^2hit < X^2cr (1.305 < 5.991) meaning that the distribution using Log Person Type III is acceptable. After the tabulation results are obtained, a rainfall analysis is determined with the results of the design rain calculations at various return periods as shown in table 3 below.

Table 3. Design Rain for Various Return Periods

No	Return Period (T)	Rain Plan (mm)
1	2	126
2	5	157
3	10	176
4	15	200

The calculation of rainfall intensity uses the mononobe formula proposed by Ishiguro [9] with the following calculation results:

Table 4. Calculation of Rainfall Intensity (mononobe)

	R24			
t	R2	R5	R10	R25
(hour)	75.373	94.329	105.724	120.180
1	44.078	55.164	61.828	70.282
2	11.457	14.338	16.070	18.268
3	8.037	10.058	11.273	12.814
4	6.398	8.007	8.974	10.201
5	5.403	6.762	7.579	8.615
6	4.723	5.911	6.624	7.530
7	4.223	5.285	5.924	6.734
8	3.838	4.803	5.383	6.119
9	3.530	4.418	4.951	5.628
10	3.277	4.101	4.597	5.225
11	3.065	3.836	4.300	4.888
12	2.885	3.610	4.047	4.600
13	2.729	3.415	3.828	4.351
14	2.592	3.244	3.636	4.133
15	2.471	3.093	3.467	3.941
16	2.364	2.958	3.316	3.769
17	2.267	2.838	3.180	3.615
18	2.180	2.728	3.058	3.476
19	2.101	2.629	2.947	3.350
20	2.028	2.538	2.845	3.234
21	1.962	2.455	2.752	3.128
22	1.900	2.378	2.666	3.030
23	1.844	2.307	2.586	2.940
24	1.791	2.241	2.512	2.856

Apart from being in table form, a curve depicting the IDF graph with various return periods 2,5,10,20 is displayed below:

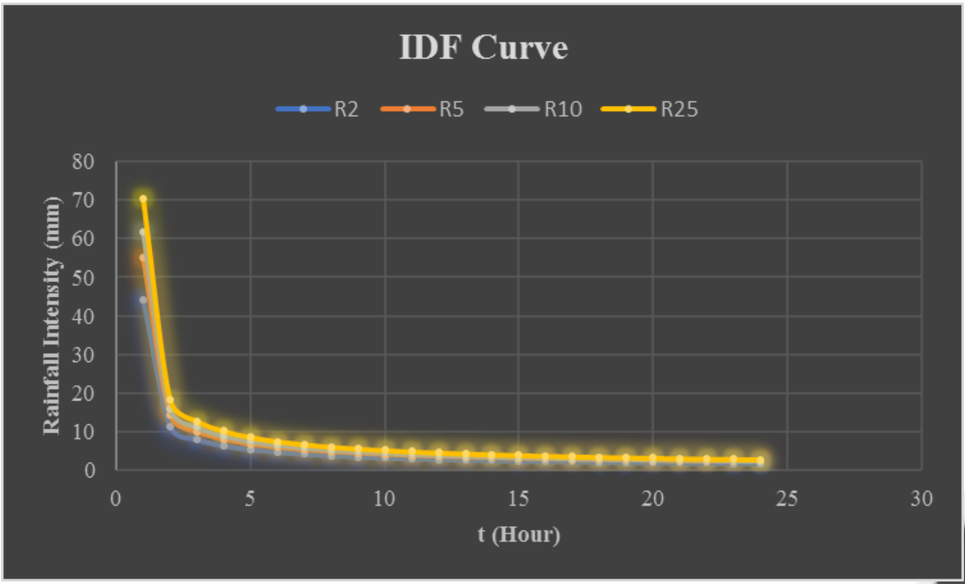

Figure 1. DF Graph with Various Return Periods

After knowing the value of the intensity of rainfall, the drainage calculation is carried out on Jalan Kunti II by determining the area of the drainage area, the length of the channel, the difference in height, and the slope of the channel is calculated according to the conditions in the field. Based on the existing conditions of the drainage canal on Jalan Kunti II Seminyak, the method used in estimating concentration time is the formula from Kirpich [10]. This formula is used because there is no watershed above the surface of the land that enters the end of the Jalan Kunti II drainage canal.

$$tc = \left(\frac{0.87 x L^2}{1000 x S} \right)^{0.385} \quad (1)$$

Information :
tc = concentration time (hours)
L = length of main channel from upstream to channel (m)
S = Average main channel slope (%)

The capacity of the existing canal is calculated based on the dimensions of the existing canal obtained from field survey results by dividing the canal into field segments with the channel code SKT, SKB where the canal is used to mark the canal on Jalan Kunti. Then proceed with calculating the discharge (Q) of the sewer (sub-drainage of Tukad Mati), and the discharge (Q) of Tukad Mati. For these drainage channels use a return period of 5 and 10 years, while the Tukad Mati sub-drainage uses a return period of 5 and 10 years, and the Tukad Mati channel uses a return period of 10 and 20 years. Here the author describes in tabular form contained in the table below:

Table 5. Existing Channel Dimensions

Channel Code	B	H	A
SKT	0.7	0.8	0.56
SKB	0.7	0.9	9.63

Table 6. Calculation of Channel Length, Channel Slope,
Time of Concentration, and Rain Intensity Return Period 5 Years

Channel Code	L (m)	S	Tc (Hour)	I (5 years)
SKT	166	0.00060	0.984	55.057
SKB	176	0.00057	1.052	52.630

Table 7. Calculation of Channel Length, Channel Slope,
Time of Concentration, and Rain Intensity Return Period of 10 Years

Channel Code	L (m)	S	Tc (Hour)	I (10 years)
SKT	166	0.000602	0.984	70.277
SKB	176	0.0005681	1.052	67.179

In addition, calculations are made on the design flood discharge (Q) using the Rational Method. For a watershed consisting of the same land use, the value of C (coefficient of runoff) is chosen to be 0.8. This means that 80% of rain runoff enters the drainage canal and only 20% seeps into the ground. In other words, most types of ground cover use concrete and asphalt pavements. The description, the author presents in table form is as follows:

Table 8. Calculation of Theoretical Water Discharge Return Period 5 Years

Channel Code	I (5 years)	A (km^2)	C	Qt 5 years (m^3/s)
SKT	55.057	0.0027	0.8	0.033
SKB	52.630	0.0181	0.8	0.212

Table 9. Calculation of Theoretical Water Discharge Return Period 10 Years

Channel Code	I (5 years)	A (km^2)	C	Qt 10 years (m^3/s)
SKT	70.277	0.0027	0.8	0.042
SKB	67.179	0.018098	0.8	0.040

The capacity of the existing canal is calculated based on the dimensions of the existing canal obtained from field survey results, by dividing the canal into field segments with the channel code SKT, SKB where the canal is to mark the canal on Jalan Kunti. Where the existing Q of SKT and SKB is 0.421 m^3/sec and 0.461 m^3/sec which is greater than the Q of 5-year and 10-year plan floods (OK). The results of the largest design flood Q analysis in the sewer channel with the Nakayasu method are at t = 3.131 and Q25 Year is 242.33 m^3/second. The results of the design flood analysis in the sewer channel using the Nakayasu method obtained results with Q2 Years = 151.98 m^3/sec, Q5 Years = 190.20 m^3/sec, Q10 Years = 256.08 m^3/sec and Q25 Years = 242.33 m^3/sec. The results of the Planned Flood Discharge in the sewer with the Nakayasu Method are described more clearly in the following table:

Table 10. Planned Flood Discharge of the Nakayasu Method

Return Period	Water Discharge Plan (m^3/s)
T = 2 years	151.98
T = 5 years	190.20
T = 10 years	209.03
T = 25 years	242.33

In analyzing flood control, the planned flood discharge in the sewer to deal with T = 25-year floods is the planned flood discharge calculated using the Nakayasu method of 242.33 m³/s. So the discharge capacity (Q) that can be flowed by the studied exhaust channel is 200.598 m^3/second < 242.33 m^2/second from Q25 Years (NOT OK).

Distinguish between river floods and floods in drainage channels in flood analysis. For floods in the drainage canal, the analysis process uses the ratio formula, while for floods in the river use the Nakayasu unit hydrograph analysis. The results of the largest design flood Q analysis in Tukad Mati with the Nakayasu method are at t = 3 and Q25 Year is 314.49 m^3/second. The results of the design flood analysis in the Tukad Mati Nakayasu Method obtained results with Q2 Years = 197.24 m^3/second, Q5 Years = 246.84 m^3/second, Q10 Years = 276.66 m3/second and Q25 Years = 314.49 m^3 /second.

The analysis for controlling the Tukad Mati flood uses the planned flood discharge to overcome the T = 25-year flood using the Nakayasu method of 314.49 m³/s. The complete results are listed in table 10 below:

Table 11. Planned Flood Discharge of the Nakayasu Method

Return Period	Water Discharge Plan (m^3/s)
T = 2 years	197.24
T = 5 years	246.84
T = 10 years	276.66
T = 25 years	314.49

So the discharge capacity (Q) that can be flowed by the Tukad Mati canal under study is 675.825 m^3/second > 314.49 m^3/second from Q25 Years (OK).

4. CONCLUSION

Based on the results of the discussion above, it is concluded that:

1. The results of the analysis show that the drainage channel on Jalan Kunti II with a theoretical discharge with a return period has fulfilled the flood discharge requirements for the planned return period of 10 years where the drainage capacity on Jalan Kunti is SKT 0.412 m^3/s & SKB 0.461 m^3/s, drainage ditches with a capacity 200.598 m^3/sec to Tukad Mati has not been able to accommodate the planned flood discharge for the 25 year return period of 242.33 m^3/sec. In the Tukad Mati channel for the existing Q 675.825 m^3/sec, it has been able to accommodate the flood discharge Q for the 25th year return period of 314.49 m^3/sec.
2. On the drainage on Jalan Kunti II, Tukad Mati. Theoretical discharge with a return period is sufficient. In the Sewer Channel, the existing cross-sectional capacity is not sufficient for the Q plan. The solution that can be implemented is the need to increase flood control in the upstream part of the Tukad Mati watershed. As well as the need for public awareness in maintaining cleanliness is expected to overcome flooding on Jalan Kunti II.

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