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ECODRAINAGE SYSTEM EVALUATION AND CONTROL OF FLOODS IN JOMBANG DISTRICT, EAST JAVA

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ABSTRACT

Jombang sub-district is the most densely populated sub-district because it is located in the middle of Jombang district and is also the center of government. Because it is a densely populated area, resulting in many changes in land use, green land for absorption has turned into a watertight area. The results of the analysis from this aspect indicate that several channels in Jombang District are not able to accommodate the design flood discharge. The calculation of the height of rain design in this study used the Log Person type III method with a return period of 5 years, which resulted in the design rainfall of 157 mm. The results of the analysis show that there are 8 channels out of 74 that are unable to accommodate the design flood discharge. After planning the infiltration wells, a different number was obtained for each road. For Jalan Sentot Prawirodirjo, there are 8 infiltration wells with a reduction power of 51.62%.

Keywords: *ecodrainage, floods, infiltration wells*

1. Introduction

Flood is a form of natural phenomenon that occurs due to high rainfall intensity where there is excess water that is not accommodated by an area's drainage network. This condition has an impact on the emergence of inundation in the area which can harm the community [1].

Drainage is one of the basic facilities designed as a system to meet community needs and is an important component in urban planning (especially infrastructure planning). The urban drainage system is a component of urban infrastructure that is closely related to spatial planning. Flood disasters that often hit most regions and cities in Indonesia are caused by chaotic spatial planning [2].

2. Material and Methods

Planning was carried out in Jombang District, Jombang Regency. Starting from January 2019 to March 2019. The data used in this study are rainfall data for the last 10 years, research location data, drainage network maps, and existing drainage data.

2.1 Description ot the Research Location

Jombang District is one of the sub districts located in Jombang Regency. The area of Jombang sub district is around 36,40 km^2, divided into several parts of land including industry, factories, settlements and rice fields.

2.2 Data Analysis

Hidrological data analysis

Calculating the average rainfall using the Polygon Thiessen method and calculating the value of rain intensity using the Mononobe equation and performing frequency analysis by calculating statistical parameters and then using the selected distribution based on the Chi Square and Smirnov-Kolmogorov test.

Figure 1. *Polygon Thiessen* image
Source: Analysis Results, 2014

Design flood discharge analysis

Analize the design flood discharge using the Rational method, the Haspers method, the Nakayasu Hydrograph Synthesis Unit (HSS) and the HSS Gama I. The four methods are the Rational method that will be used in this study.

Infiltration well analysis

Analysis of infiltration wells in this study using the method according to Sunjoto. According to Sunjoto (1998), the volume and efficiency of infiltration wells can be calculated based on the balance of water that enters the well and water that seeps into the ground [3]. The sunjoto equation can be written as follows:

Water Discharge Entering absorption wells

$$Q_{sumur} = \frac{Q}{FK}\left(1 - e^{\frac{FKT}{\pi r^2}}\right)$$

Absorption well capacity

$V_{sumur} = ¼. \pi. R^2. H$

Infiltration well discharge

$Q_{resap} = F. K. H$

Time to infiltrate into the ground

$t_{resap} = V_{sumur}/Q_{sersp}$

time to fill infiltration wells

$T_{isi} = V_{sumur}/Q_{sumur}$

Where :

K = Soil permeability coefficient (cm / s)
F = Geometry factor
H = depth of infiltration well (m)

D = Diameter of infiltration well (m)

3. Result and Discussion

Hydrological analysis is used to determine the design rainfall and the results of processing rainfall data using frequency analysis obtained by Log Person III as follows:

Table 1. Results of Calculation of the Rain Plan with a certain return period

Time again	Pr (%)	Cs	G	Log Xrerata	S	Log X	X (mm)
5	20	0,826	0,830	1,973	0,137	2,197	157,398
10	10	0,826	1,301	1,973	0,137	2,201	158,854
25	5	0,826	1,818	1,973	0,137	2,208	161,435

Source: Calculation Results, 2020

The results of the discharge recapitulation using the rational method can be seen in the table below:

Table 2. Recapitulation of flood discharge for the 5 year return period

No.	Duct Code	Road Name	Qhs (m^3/sec)
1	S.LBK.M	Jalan Dewi Sartika	0,29572
2	S.LBK.R	Jalan Empu Kanwa	0,12028
3	S.LBK.Y	Jalan Imam Bonjol	0,06062
4	S.LBK.LK	Jalan Pattimura Gang 3A	0,22878
5	S.LBK.PO	Jalan R.E. Martadinata	0,08104
6	S.LBK.IU	Jalan Raden Wijaya	0,08330
7	S.LBK.EW	Jalan Sentot Prawirodirjo	0,24001
8	S.LBK.QK	Jalan Teuku Cik Ditiro	0,04952

Source: Calculation Results, 2020

One of the objectives of applying the infiltration stream is to reduce surface runoff so as to avoid excessive surface runoff that can cause flooding. The amount of surface runoff that can be reduced through infiltration wells depends on the volume and number of infiltration wells.

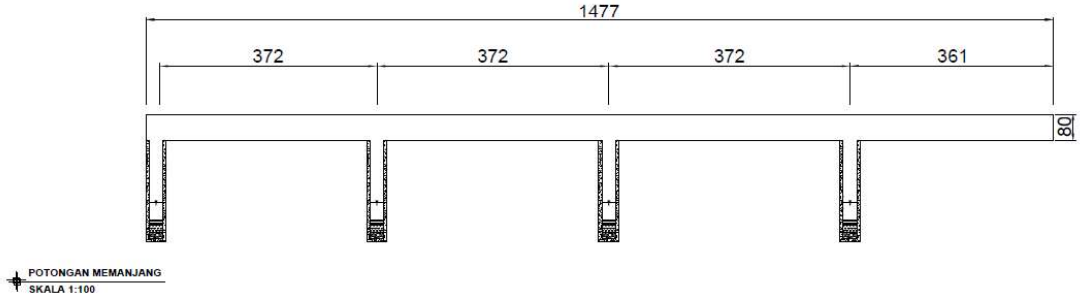

Figure 2. Design of infiltration wells
Source: Analysis Results, 2014

To determine the need for infiltration wells in an area, it can be seen from the flood discharge and flood runoff volume in that area.
Planning data:
Assume the diameter of the well (D) = 0.5 meters
R = 0,25 m
K = 1,5 x 10^{-4} (m/detik)
F = 5.5 x r
= 5,5 x 0,25
= 1,375 m
Q_{atap} = 0,7132 m^3/detik
H $= \frac{Q}{FK}\left(1 - e^{\frac{FKT}{\pi r^2}}\right)$

$= \frac{0,7132}{1,375 .1,5 \times 10-4}\left(1 - 2,78^{\frac{1,375 .1,5 \times 10-4 .75,77}{3,14 .0,0625}}\right)$

H = 23,12 meter
The water depth of the well is very high. If the groundwater level is at a depth of 23.12 meters from the ground level, then the infiltration well needs to be turned into a series system where each well with H = 3.Then the number of wells required for the series system is:
n = 23,12/3 = 7,70 ~ 8 buah
This means that with 8 infiltration wells on Jalan R.E Martadinata, it can store groundwater reserves and reduce flood discharge by 0.00236 m3 / second, or it can reduce flood discharge by around 97.17%.

Efficiency = Qsumur / Qeks x 100%
Efficiency = 0.08104 / 0.0834 x 100%
= 97.17%

From the results of calculations using the Sunjoto method (1998) above, it can be concluded that the number of infiltration wells of 8 units can reduce flooding by 97.17%. The discharge reduction is able to reduce the surface runoff load to infiltrate the soil layer as groundwater reserves.

4. Conclusion

Based on the results of data processing and data analysis, the following conclusions can be drawn:

1. The largest flood discharge in Jombang District is located in the S.LBK.M channel, which is equal to 0.29572 m3 / second.
2. The results of calculations using the Sunjoto method (1998) show that there are 8 infiltration wells on Jalan R.E Martadinata.
3. The existence of 8 infiltration wells can reduce the volume of flooding by 97.17%.
4. Infiltration wells were chosen because they are considered more effective and efficient, because they are also widely used in ecodrainage solutions in Indonesia.

References

[1] Harjadi, *Pengelolaan Daerah Aliran Sungai*, 2007.
[2] Suripin, Sistem Drainase yang Berkelanjutan, Yogyakarta: Andi, 2004.
[3] Sunjoto, Peningkatan, kinerja drainase untuk penanganan banjir menggunakan sumur resapan, 1998.
[4] Andi, Prastowo. 2010. Menguasai Teknik Teknik Data Penelitian Kualitatif. Yogyakarta: Pustaka Pelajar

[5] BR, Sri Harto. (1993). Analisis Hidrologi. Jakarta: Gramedia Pustaka Utama.
[6] Ligal, S. 2008. Pendekatan Pencegahan dan Penanggulangan Banjir. Jurnal Dinamika Teknik Sipil Vol:8, No.2. Juli 2008.
[7] Rachmawati, Azizah. 2010. Aplikasi SIG (Sistem Informasi Geografis) untuk Evaluasi Sistem Jaringan Drainase di Sub Das Lowokwaru Kota Malang. Jurnal Rekayasa Sipil. Vol:4. No.2. 2010
[8] Soewarno. 1995. Hidrologi Aplikasi Metode Statistik untuk Analisa Data. Bandung: Nova.
[9] Subarkhah, Imam. 1980. Hidrologi untuk Perencanaan Bangunan Air. Bandung: Idea Dharma.
[10] Sohardjono. 1984. Drainase. Malang: FTUB.