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Evaluation of Drainage System for Inundation Problems at Subdistricts of Lowokwaru Malang City

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ABSTRACT

Malang is a city in East Java with the level of development of rapid settlement areas, the region has grown in areas of land rainwater. The consequence of this development is the emergence of some new inundation in urban areas, one of them in Subdistrict Lowokwaru. Carrying amount inundation problems that occurred during 2018 in the Subdistrict Lowokwaru 4 times. Largely due to the drainage conditions are not maintained and are filled with trash and sediment. The conditions resulted in reduced sewer capacity and are not able to drain rainwater discharge and wastewater. Evaluation of drainage system in Subdistrict Lowokwaru include hydrological analysis is data consistency test, data homogeneity test, average rainfall analysis, the maximum daily rainfall plan analysis, the goodness of fittest, rain intensity distribution analysis, and rain intensity curve analysis. Also, hydraulics analysis and evaluate sewer capacity. The analysis showed that there are 21 sewers in condition without sediment that capacity is insufficient and 23 sewers in conditions with sediment are not met or sewer capacity is not technically eligible. It is necessary for a handling plan as an attempt to deal with the sewer capacity to drain the runoff discharge.

KEYWORDS: Inundation, Subdistrict Lowokwaru, Malang City, Drainage Systems, Sewers

1. INTRODUCTION

Malang became one city in East Java with the rapid rate of development, one aspect of the rapidly growing residential area, where the whole corner of the city of Malang is emerging a new residential area and shop. The region is growing in some places, both in the hills and in the area of natural water reservoirs (retarding basin). The area that originally serves as a conservation area that can absorb/accommodate while rainwater is now changed into the area woke up. The consequence of this development is the emergence of some new inundation in urban areas, even on the road.

Subdistrict Lowokwaru is one area that often occurs puddle. Data from Kota Malang Dalam Angka 2018 the carrying amount of inundation problems occurred during 2017 in the Subdistrict Lowokwaru 4 times. Largely due to the drainage conditions are not maintained so many sewers are filled with trash and sediment. The conditions resulted in reduced sewer capacity and are not able to drain rainwater discharge and wastewater. Land-use change is an awakened area that also results in lower catchment areas and rainwater.

The problem of this research is how the technical condition of the drainage system at the location of inundation in Subdistrict Lowokwaru. While the purpose of this study was to evaluate the technical condition of drainage sewers in locations that occur inundation in Subdistrict Lowokwaru by calculating hydrology, discharge runoff and sewer capacity.

2. METHODOLOGY

This study uses a survey approach, while according to the level of explanation is a descriptive study. This is done to describe the condition of the drainage system performance as well as the influence and develop handle strategies appropriate to the issues raised. Stages of the activities carried out are observation, data collection, analysis, and interpretation of data to determine an indication of the problem as a basis for determining the ideal solution as well as set standards and correlation.

The data used is the data that is both qualitative and quantitative. Sources of qualitative data based on information from respondents who becomes the object of research. While quantitative data in the form of numbers or count are processed based on information from the public, institutions, the management board and the results of field observations obtained during the research process.

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3. STUDY AREA

The research location is in the Subdistrict of Lowokwaru Malang city located in the northern city of Malang and adjacent to the Subdistrict Karangploso Malang. Subdsitrict Lowokwaru has an altitude between 200-499 meters above sea level with slopes on the plateau is quite varied, in some places a plain area with a slope of 2-5%, while the hills of the valley section average slope of 8-15%.

The drainage system in Subdistrict Lowokwaru generally used the river as a sewer for final discharge. In Malang city is traversed by five (5) major rivers namely: Brantas River, Amprong River, Bango River, Metro River, and Sukun River. As for the Watershed is divided into three parts, namely:

1. Metro Watershed
2. Brantas Watershed
3. Bango Watershed

Division of Watershed in the Subdistrict Lowokwaru can be seen in Figure 1.

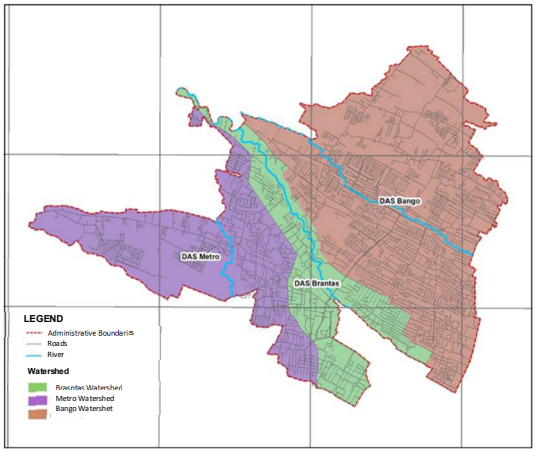

Fig. 1: Watershed Map in the Subdistrict Lowokwaru

4. RESULTS AND DISCUSSION

4.1 Hydrology

Rainfall data used is the data maximum precipitation affecting the five weather stations with the research site over the past 10 years.

Table 4.1 Maximum Daily Rainfall Data Each Weather Station

No.	Years	Weather Station (mm)			
		Karangploso (ST.1)	Dau (ST.2)	Sukun (ST.3)	Ciliwung (ST.4)
1	2008	104	110	130	95
2	2009	69	110	108	73
3	2010	68	144	178	186
4	2011	91	85	83	113
5	2012	108	97	169	138
6	2013	77	85	101	97
7	2014	105	100	134	125
8	2015	67	65	170	96
9	2016	97	94	122	64
10	2017	93	105	132	104
Average		**88**	**100**	**133**	**109**

Source: BMKG Karangploso Malang, 2019

The analysis of these data consistency and homogeneity of the data for accuracy and ensure that data is not contained significant deviations.

- Average rainfall analysis

The analysis was calculated using the Thiessen Polygon method, the analysis is done from the calculation Thiessen coefficient obtained by dividing each area influence rainfall station (Figure 2).

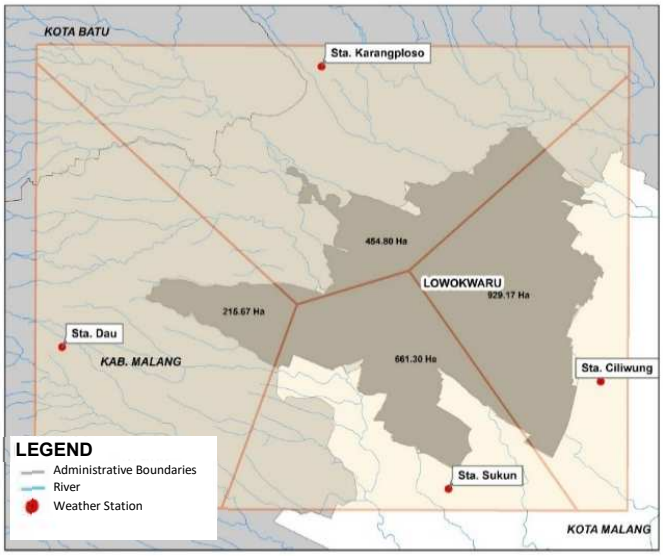

Fig. 2: Map Thiessen Polygon Subdistrict Lowokwaru

- The maximum daily rainfall plan analysis

The maximum daily rainfall plan analysis is done by using two methods: Method Gumbel and Log Person III. From this method were analyzed Goodness of fit test using the Chi-square test and Smirnov-Kolmogorov test thus concluded that the appropriate distribution is the Gumbel method.

- Rain intensity distribution analysis

Results distribution Gumbel method then calculate the rainfall intensity analysis by 3 methods: Van Breen, Bell, and Hasper Weduwen Method. Calculation Result elected rain intensity distribution is Van Breen Method of calculation with the PUH 5 years for the secondary sewer.

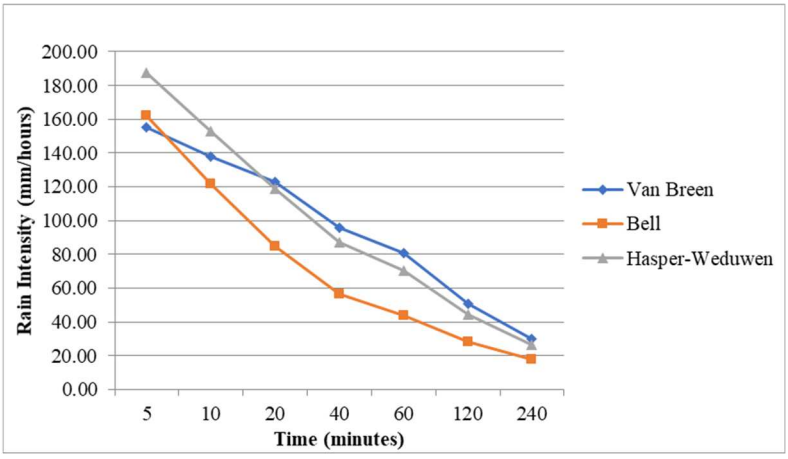

Fig. 3: Comparison Graph of Rain Intensity PUH 5 Years

- Rain intensity curve analysis

Rain Intensity Curve Analysis using a method Talbot, Sherman and Ishiguro. The calculation of the three methods has a method that has the greatest rainfall intensity arch.

Table 4.2 Difference in Rain Intensity of the Talbot, Sherman, and Ishiguro Methods for PUH 5 Years

t (minutes)	I (mm/hours)	I Talbot	I - I Talbot	I Sherman	I - I Sherman	I Ishiguro	I - I Ishiguro
5	165,47	161,44	4,03	199,69	34,22	197,50	32,03
10	140,87	147,65	6,78	148,37	7,50	151,48	10,61
20	127,46	126,11	1,35	110,25	17,21	113,94	13,52
40	97,27	97,62	0,35	81,92	15,35	84,37	12,90
60	81,62	79,63	1,99	68,85	12,77	70,36	11,26
120	50,31	51,28	0,97	51,16	0,85	51,17	0,86
240	30,19	29,95	0,23	38,01	7,82	36,93	6,74
Total	693,19		15,70		95,72		87,93
Average			***2,24***		13,67		12,56

Source: Analysis, 2019

Talbot method was chosen as a rain intensity formula because has a delta (A) smallest and can give optimum results. So that the formula used to calculate the amount of rain intensity using the equation:

$$I = \frac{8864,48}{t + 52,55}$$

4.2 Hydraulics

- Analysis of Existing Debit

Hydraulics analysis is used to determine the ability of the sewer to accommodate the runoff discharge. The analysis is done based on existing data obtained from the primary data and secondary data. The primary data is a length, the width of the base, the width of the surface, the depth of the sewer, and sediment.

Calculation of sewer discharge conducted with two types of conditions that the sewer conditions without sediment and with sediment. Sewer discharge is obtained from the calculation of flow velocity multiplied by the channel cross-sectional area.

- Discharge rainwater runoff analysis

Discharge rainwater runoff is influenced by land use in the catchment area, the variables that influence is runoff length, runoff slope, manning coefficient, assumption of water velocity in a sewer, drainage time, selected rainfall intensity PUH 5 years, and drainage coefficient.

- Wastewater discharge analysis

Subdistrict Lowokwaru drainage system is a mixed drainage system between rainwater and wastewater. Based on the number of residents in the catchment area as well as the extent of the need of clean water per person per day plus non-domestic water needs, it can be calculated the amount of wastewater into the sewer.

- Evaluation of drainage system capacity

Evaluation of the capacity of the drainage system is reviewed based on the total discharge amount of rainfall-runoff and wastewater discharge on existing conditions and then compared to sewer discharge. Evaluation of the capacity of the drainage system needs to be done to determine whether the condition of the existing sewer is still in accordance with the requirements or necessary for the development.

The evaluation results indicate the sewer capacity there are 21 sewers in condition without sediment that capacity is insufficient and 23 sewers in conditions with sediment are not met or sewer capacity is not technically eligible. It is necessary for a handling plan as an attempt to deal with the sewer capacity to drain the runoff discharge.

- Alternative Treatment

Based on the evaluation result in conditions with sediment to maximize sewer capacity and reduce the inundation, it needs to dredge sediment and calculated sewer dimensions based on the rainwater runoff.

5. CONCLUSION

According to analysis carried out on the evaluation of drainage system for inundation problems at Subdistricts Lowokwaru, it can be concluded as follows:

a. Sewer problems in the Subdistrict Lowokwaru form of sewer blockage due to garbage, sediment at the bottom of the sewer, and sewer inlet which is higher than the road.
b. Based on the evaluation result of the sewer there are 21 sewers in condition without sediment that capacity is insufficient and 23 sewers in conditions with sediment are not met or sewer capacity is not technically eligible.
c. The handling plan is in the form of cleaning and dredging of trash and sediment, as well as the calculation of the ideal sewer dimensions to drain the discharge runoff accordingly.

6. ACKNOWLEDGMENT

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7. REFERENCES

[1] Asdak, C. 2003. Hidrologi dan Pengelolaan Daerah Aliran Sungai. Gajah Mada University Press. Yogyakarta.
[2] Chow, V.T. 1997. Hidrolika Saluran Terbuka. Erlangga. Jakarta.
[3] Masduki, H.S. 1988. Perencanaan Sistem Drainase Perkotaan. Institut Teknologi Bandung. Bandung.
[4] Suripin. 2004. Sistem Drainase Perkotaan yang Berkelanjutan. Andi Offset. Yogyakarta.
[5] Sostrodarsono dan Takeda, 1987. Hidrologi untuk Pengairan. PT. Pradnya Paramita. Jakarta.