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Inundation Prediction Model Based on Land Use in Krukut Watershed

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ABSTRACT

Purpose: Flooding is a problem in urban areas, particularly in the Krukut watershed. The causative factors are changes in land use, increased land conversion from dry land to watertight built-up land, and reduced water catchment areas. Various efforts to control inundation have been made, but the location of inundation has not been significantly reduced. As a result, a model is required to predict the occurrence of inundation so that it can be anticipated. This study will discuss a mathematical model for predicting inundation in the Krukut Watershed by considering rainfall, land use, and the drainage system.

Design/methodology/approach: Researchers gathered inundation data from trusted social media from 2010 to 2020, rainfall data from 2003 to 2018 from the Universitas Indonesia Campus station, and land use data from Citra Landsad in 2019. SPSS was used to analyze the data.

Findings: The analysis results show a solid positive correlation with the variable Building Open Area impermeable to inundation. According to the research findings, the inundation area is 0.17 km2. Compared to the EPA SWMM modeling results, the result is 0.21 km2 with a return period of 25 years, with an overall accuracy of 90,91% and a kappa accuracy of 67%. It means that the applied model produces an acceptable level of truth.

Paper type: Research paper

Keywords: *Building Open Space, EPA SWMM, Inundation, Land Use, SPSS*

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I. INTRODUCTION

A Watershed is a land area serving as an ecosystem unit for rivers and their tributaries. Its purpose is to naturally accommodate, store, and drain water that falls from the sky into lakes or seas. The land boundary is a topographic separator, and the sea boundary extends to irrigation areas still affected by land activities (Water Resources Law No.7/2004).

The Krukut watershed is located on the east side of the Ciliwung watershed, bordered on the west by the Grogol watershed and the Pesanggrahan watershed. It is connected to the West Flood Canal and has an area of 73.53 km^2, a river length of 32.2 km, a river bed elevation of +81.80 asl, a downstream elevation of +2.85 asl, and an estimated width of 3 to 10 meters. The sequence is divided into three sections based on its topography: upstream in Ratu Jaya in the municipality of Depok, middle in the South Jakarta Administrative City, and downstream in the West Flood Canal (BKB) in the Central Jakarta Administrative City.

Inundation disaster is an issue in urban areas, particularly in the Krukut watershed in DKI Jakarta. Extreme rains, increased land use conversion into open spaces of watertight buildings, narrowing of river banks, and reduced rainwater catchment areas all contributed to this incident. This incident has profoundly impacted the last ten years, from 2010 to 2020. The incidence increases along the Krukut River at 29 points out of 10 sub-districts, with an average inundation height of around 25 cm.

Efforts to address floods from structural and non-structural perspectives have been implemented by widening the cross-section of rivers and reservoirs. It aims to increase flow capacity while decreasing inundation frequency (Anita, 2013). However, several efforts to reduce the risk of flooding are challenging to implement, particularly in urban areas, because they will clash with politics and require a large budget for relocating settlements. As a result, other efforts are required to enable it to be carried out in cities, including managing rainwater runoff at its source.

As more urban land is developed into watertight built-up land, flooding occurs. The water that cannot be accommodated will raise the runoff coefficient and lower storage volume during the rainy season. It is all a result of the insufficient drainage capacity of a catchment area and the challenge of acquiring land within the context of normalizing and enlarging the river cross-section (Hassan et al., 2022).

Considering the dynamics of the growth of hydrological studies, particularly flooding, and inundation in metropolitan areas, the study is currently leading to spatial-based studies. Some spatial research is inextricably linked to the role of Geographic Information Systems (GIS) as a supporting tool. Furthermore, its function is to provide a type of modeling of a hydrological occurrence, such as flooding and inundation in metropolitan settings (Rajabifard et al., 2003).

According to Asdak (2002), land use changes will impact the overall ecological system, including hydrology in the watershed area. The influence of these changes on a wide scale alters the behavior of river water. River water output increases dramatically during the rainy season, while it is pretty low during the dry season.

Climate, soil (topography, soil, geology, geomorphology), and land use contribute to the discharge of a river in a watershed, according to Seyhan (1990). According to Saputro et al. (2018) and Mardhatillah & Yulianti (2020), land use, with varying land use types, influences surface runoff. According to Yasa et al. (2020), surface runoff is influenced by infiltration, which is affected by soil texture, vegetation type, land use, soil temperature, and rain intensity. According to Spatial Planning Law No. 26 of 2007, a minimum green space area of a city is 30% of its total area.

According to the Center for Research and Development of Settlements, Agency for Research and Development of the Ministry of Public Works, the goal is environment-based urban drainage, TRAP (Accommodate, Absorb, Flow, Maintain) (Ecodrainage).

Recommended minimum return period (years) for planned floods for flood control projects, according to the Center for Water Resources Research and Development's design criteria for flood control buildings in 2002, rivers for urban areas with a population of more than 2 million people use a Planned Return Period of 25 years.

During the rainy season, a rise in land conversion from catchment regions to built-up areas or impermeable construction open spaces in a watershed in urban areas may cause an increase in inundation events, particularly in the Krukut watershed, which has nearly inundated events each year.

As a result, the Prediction Model for the Area of Inundation estimates the occurrence of inundation in a watershed based on land use and cover. The predictor variables are Water Open Area, Building Open Area, and Vegetation Open Area, also known as independent variables. The region of inundation is the subject of this modeling, also known as the dependent variable.

This study aims to develop a predictive model for inundation and identify characteristics that influence inundation occurrence based on land use. At the same time, the benefit of this research is that it provides data for predicting flooding areas in the Krukut watershed.

This prediction model is projected to serve as the foundation for calculating flooding events in the Krukut watershed, allowing these events to be predicted in the future.

II. METHODS

This study was carried out in the Krukut Watershed using land cover data for 2019 available from the United States Geological Survey (USGS) website (http://earththexplorer.usgs.gov/). Land cover data at the research site is based on recognized areas using the ArcGIS 10.6.1 software's area of interest tools, which are backed by field data, Google Earth maps, and high-resolution satellite imagery.

Visual interpretation and knowledge analysis of the characteristics of the distribution of land cover in the Krukut watershed reveal five classes of land cover: Water Open Area (represented in blue), Building Open Area (described in yellow), Grass Open Area (represented in light green), Ground Open Area (designated in golden brown), and Vegetation Open Area (represented in dark green). Secondary data, mainly hydrological and hydraulic analysis data, were gathered indirectly by researchers via intermediary media and documented.

The Campus of Universitas Indonesia rainfall station provided 16 years of rainfall data (2003–2018) for the researchers to analyze. The dependent variable in this study is the inundation area, referred to as the dependent variable (Y), with area units gathered over the last ten years (2010-2020) at the research site. 1) is the independent variable in this study or as an independent variable with an area unit. 2.) Building Open Area (X1), 3.) Water Open Area (X1) (X2). 3). Grass Open Area, (X3), 4). Ground Open Area (X4), 5). Vegetation Open Area (X5) is the area in km2 units.

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III. RESULTS AND DISCUSSION

Based on the inundation events from 2010 to 2020 from various trusted social media, the researchers created an inundation map as described in Figure 1.

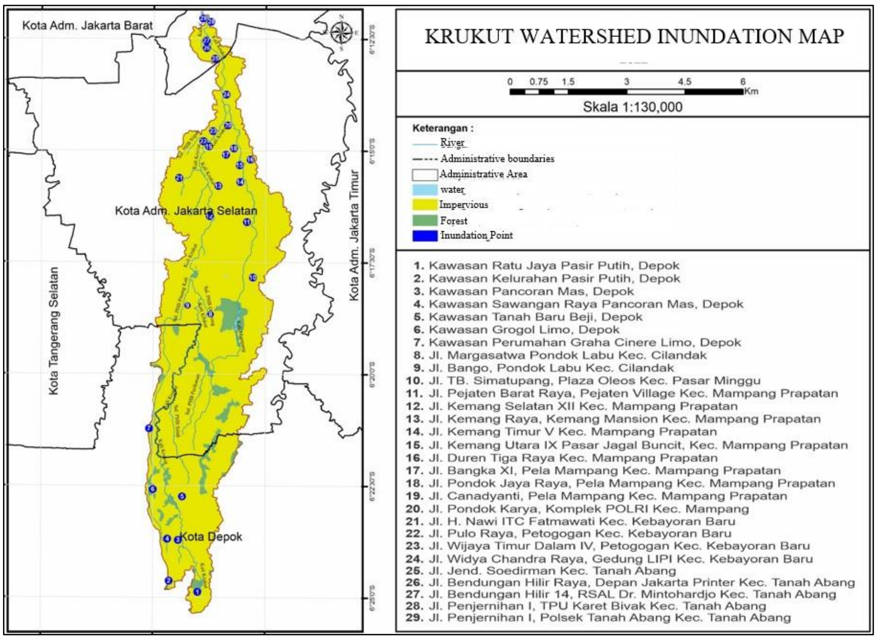

Figure 1. Krukut Watershed Inundation Map

The Thiessen Polygon method was used to calculate the amount of rainfall in the Krukut Catchment Area based on data collected over 16 years (2003–2018). This method uses the region the station in question represents as a weighting factor when determining the average rainfall. This method is thought to be superior to the average algebraic method. It helps figure out the average rainfall of a watershed for regions with few stations, and the rain is not equally distributed, even though it cannot yet provide the exact weight (Ningsih, 2012). Testing rain data within the context of hydrological analysis requires that the data be stationary (unchanging), consistent, and homogeneous.

The researcher used a frequency distribution fit test to determine the most appropriate distribution pattern (Statistical Parameter test, MAPE test, RMS test, Sminrov Kolmogorov test, Chi-Square test). The Log Pearson Type III approach is best for distributing the available data, according to the findings of the difficulties that have been run. It has the lowest error degree when every test satisfies the standards listed in table 1 below.

Table 1. Rainfall Period Plan for Krukut Watershed, University of Indonesia Campus Station

Return Period	*Normal*	*Log-Normal*	*Pearson III*	*Log Pearson III*	*Gumbel*
100	*171.17*	*179.73*	*179.70*	*189.02*	*189.44*
50	*165.03*	*170.89*	*171.10*	*177.18*	*177.18*
25	*158.20*	*161.57*	*161.94*	*165.25*	*164.82*
10	*147.64*	*148.13*	*148.57*	*149.03*	*148.16*
5	*137.72*	*136.54*	*136.90*	*135.94*	*134.98*
2	*118.77*	*116.85*	*116.83*	*115.52*	*115.07*

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The duration of rainfall determines the intensity of rain over 24 hours. The results of these computations are then used to create an IDF (Intensity Duration Frequency) curve. Using various curve graphs based on rain data from the Rainfall Station, the intensity of rainfall over 24 hours is determined.

Only the maximum daily rainfall (mm/24 hours) observed in a single year is available to calculate this flood plan. Hence, the researcher conducted the analysis using the Mononobe formula. As part of the architecture for flood calculation, the rainfall hydrograph for flood calculation stations is distributed over six hours to determine critical rainfall. The following table depicts the distribution of precipitation based on the Mononobe Method (within 6 hours).

Table 2. Table of rain distribution in Krukut watershed Mononobe method (in 6 hours)

Mononobe	*Tr=2*	*Tr=5*	*Tr=10*	*Tr=25*	*Tr=50*	*Tr=100*
	115.52	*135.94*	*149.03*	*165.25*	*177.18*	*189.02*
0.067	*7.79*	*9.17*	*10.05*	*11.15*	*11.95*	*12.75*
0.100	*11.59*	*13.64*	*14.95*	*16.58*	*17.78*	*18.97*
0.550	*63.57*	*74.81*	*82.01*	*90.94*	*97.51*	*104.02*
0.143	*16.52*	*19.44*	*21.32*	*23.64*	*25.34*	*27.04*
0.080	*9.23*	*10.86*	*11.90*	*13.20*	*14.15*	*15.10*
0.059	*6.81*	*8.02*	*8.79*	*9.74*	*10.45*	*11.15*

The Krukut Watershed's land usage in 2019 is divided into 12 sub-watersheds that are organized from upstream to downstream, including the Water Catchment Area: Mampang Depok, Salak, Perikanan, Danyong, Pinang Kali, Elnusa, Palm, Asem, Nipah, Mampang, Benhil, and Sungai Krukut are the following: 4. According to tables 3 and 4 below, the percentages of land cover classifications for open water area (1.67%), building open space (92.54%), and vegetation open space (5.79%) are as follows:

Table 3. Land Use in the Krukut Watershed in 2019

Classification	*Area (km^2)*	*Percentage (%)*
Water open area.	*1.45*	*1.67*
Building open area	*68.05*	*92.54*
Grass open area.	*0*	*0*
Ground open area.	*0*	*0*
Vegetation open area.	*4.03*	*5.79*
Total	*73.53*	*100*

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Table 4. Land use classification of the Krukut inlet catchment area in 2019

No	Sub Watershed	Water Open Area (km2)	Building Open Area (km2)	Vegetation Open Area (km2)
1	WCA Mampang Depok	0.0169	0.5065	0.2206
2	WCA Salak	0.0877	2.5553	0
3	WCA Perikanan	0.0892	2.5614	0.1219
4	WCA Danyong	0.0016	0.5135	0.0006
5	WCA Pinang Kali	0.1675	5.9758	0.3408
6	WCA Elnusa	0.0007	0.4588	0
7	WCA Palm	0.0056	1.6238	0
8	WCA Asem	0.0039	2.1263	0.0039
9	WCA Nipah	0,0053	1.6188	0
10	WCA S.Mampang	0.5778	29.4002	2.3828
11	WCA Benhil	0.0078	0.6983	0
12	WCA S.Krukut	0.4891	20.0093	0.9591

The analytical technique of the 25-year plan is used to calculate the probability of flooding the area. The researchers produced calculation results that revealed that the termination was overwhelming with an assumption of an average high inundation of 25 cm after considering the existing drainage capacity. The spanning area in km^2 units was calculated by the researchers using the following calculations in Table 5 below:

Table 5. Probability of inundation area of Krukut watershed return period of 25 years

No	Sub Watershed	Existing DrainedCapacity (m^3/sec)	QTR_{25} (m^3/sec)	YTR_{25} (m^3/sec)	Conversion of the assumption 25 cm (Km^2)	YTR_{25} (Km^2)
1	2	3	4	5= (4-3)	6	7 = (5*6)
1	WCA Mampang Depok	14.62	23.62	9.01	0.0000695	0.0006
2	WCA Salak	12.07	111.52	99.45	0.0000695	0.0069
3	WCA Perikanan	22.20	112.63	90.43	0.0000695	0.0063

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4	*WCA Danyong*	*6.55*	*22.41*	*15.86*	*0.0000695*	*0.0011*
5	*WCA Pinang Kali*	*16.37*	*263.15*	*246.78*	*0.0000695*	*0.0172*
6	*WCA Elnusa*	*9.62*	*20.02*	*10.41*	*0.0000695*	*0.0007*
7	*WCA Palm*	*8.83*	*70.86*	*62.04*	*0.0000695*	*0.0043*
8	*WCA Asem*	*8.05*	*92.82*	*84.77*	*0.0000695*	*0.0059*
9	*WCANipah*	*12.07*	*70.65*	*58.58*	*0.0000695*	*0.0041*
10	*WCA S.Mampang*	*134.68*	*1,299.52*	*1,164.84*	*0.0000695*	*0.0810*
11	*WCA Benhil*	*14.12*	*30.47*	*16.35*	*0.0000695*	*0.0011*
12	*WCA S.Krukut*	*238.03*	*879.87*	*641.84*	*0.0000695*	*0.0446*

The 2019 land coverage data and the chance of overlapping are utilized for data analysis with statistical approaches such as the Correlation Regression Test. The data were analyzed and interpreted using the SPSS software.

Table 6. Model Development

No	*Sub Watershed*	*Water Open Area*	*Building Open Area*	*Grass Open Area*	*Ground Open Area*	*Vegetation Open Area*	*Inundation*
		(km^2)	*(km^2)*	*(km^2)*	*(km^2)*	*(km^2)*	*(km^2)*
		X1	*X2*	*X3*	*X4*	*X5*	*YTR25*
1	*WCA Mampang Depok*	*0.016916*	*0.506475*	*0.000000*	*0.000000*	*0.220570*	*0.000626*
2	*WCA Salak*	*0.087691*	*2.555297*	*0.000000*	*0.000000*	*0.000000*	*0.006912*
3	*WCA Perikanan*	*0.089229*	*2.561434*	*0.000000*	*0.000000*	*0.121911*	*0.006285*
4	*WCA Danyong*	*0.001577*	*0.513475*	*0.000000*	*0.000000*	*0.000555*	*0.001102*
5	*WCA Pinang Kali*	*0.167464*	*5.975758*	*0.000000*	*0.000000*	*0.340835*	*0.017151*
6	*WCA Elnusa*	*0.000725*	*0.458753*	*0.000000*	*0.000000*	*0.000000*	*0.000723*
7	*WCA Palm*	*0.005621*	*1.623760*	*0.000000*	*0.000000*	*0.000000*	*0.004312*
8	*WCA Asem*	*0.003882*	*2.126307*	*0.000000*	*0.000000*	*0.003882*	*0.005892*

9	*WCA Nipah*	*0.005294*	*1.618779*	*0.000000*	*0.000000*	*0.000000*	*0.004071*
10	*WCA Sungai Mampang*	*0.577785*	*29.400151*	*0.000000*	*0.000000*	*2.382791*	*0.080956*
11	*WCA Bendungan Hilir*	*0.007760*	*0.698285*	*0.000000*	*0.000000*	*0.000000*	*0.001136*
12	*WCA Sungai Krukut*	*0.489098*	*20.009349*	*0.000000*	*0.000000*	*0.959134*	*0.044608*

Table 7. Research Description

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Inundation (YTR25)	*12*	*.000626*	*.080956*	*.01448117*	*.024275001*
WOA (X1)	*12*	*.000725*	*.577785*	*.12108683*	*.200278873*
BOA (X2)	*12*	*.458753*	*29.400151*	*5.67065192*	*9.237591343*
Grass OA (X3)	*12*	*.000000*	*.000000*	*.00000000*	*.000000000*
Ground OA (X4)	*12*	*.000000*	*.000000*	*.00000000*	*.000000000*
VOA (X5)	*12*	*.000000*	*2.382791*	*.33580650*	*.702213138*
Valid N (listwise)	*12*				

Table 8. Correlation between variables

Relationship between Variables			*Pearson Correlation*	*Relationship Level*
Water Open Area	➡	*Inundation*	*0.966*	*Very Strong*
Building Open Area	➡	*Inundation*	*0.994*	*Very Strong*
Vegetation Open Area	➡	*Inundation*	*0.982*	*Very Strong*
Building Open Area	➡	*Water Open Area*	*0.984*	*Very Strong*
Vegetation Open Area	➡	*Water Open Area*	*0.924*	*Very Strong*
Building Open Area	➡	*Vegetation Open Area*	*0.965*	*Very Strong*

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As the table above shows, all independent factors are significantly associated with inundation.

Table 9. Research Hypothesis Testing Results

Hypothesis	Analysis	Test			Conclusion
		T- Statistics	Sig.	Description	
H1	Water Open Area	< 2	>0,05	Not Significant	Rejected
H2	Building Open Area	>2	<0,05	Significant	Accepted
H3	Grass Open Area	< 2	>0,05	Not Significant	Rejected
H4	Ground Open Area	< 2	>0,05	Not Significant	Rejected
H5	Vegetation Open Area	< 2	>0,05	Not Significant	Rejected

Hence, the variable influencing inundation is Building Open Area (X2), with a p-value of 0.05 and T Statistics > 2. Then, every variable with a p-value greater than 0.05 is removed from the model.

The correlation between the independent variables Water Open Area, Building Open Area, and Vegetation Open Area based on the relationship level table Pearson Product Moment has a strong positive relationship (> 0.9). The relationship between independent variables and inundation is also very strongly positive. However, after testing the classical assumptions, it can be seen that only the Building Open Area has a significant effect on the t statistic (> 2) and the p-value (> 0.05). The other variables had no impact, so a stage 2 regression was carried out with the results described in Table 10 below:

Table 10. Correlation Coefficient / Pearson Product Momen

		Inundation (YTR_{25})	Building Open Area (X_2)
Inundation (YTR_{25})	Pearson Correlation	1	1.000**
	Sig. (2-tailed)		0.000
	N	11	11
Building Open Area (X_2)	Pearson Correlation	1.000**	1
	Sig. (2-tailed)	0.000	
	N	11	11

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation becomes stronger if the magnitude of the Pearson product-moment correlation variable Building Open Area approaches 1 or -1. The table above demonstrates that the association between Building Open Areas and Inundation is positive, with a Pearson 1 correlation r value of more than zero and a p-value less than 0.000 0.05.

The increasing value of R Square and adjusted R Square, which approaches one, indicates the strength of the independent variable in explaining the dependent variable, which in this case is inundation. The R Square

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score of 0.988, when combined with the Adjusted R Square value of 0.988, suggests that the independent variable can strongly explain the dependent variable.

Table 11. Model Summary

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate
1	0,994[a]	0,988	0,987	0,002803996

a. Predictors: (Constant), R.T.B (X_2)
b. Dependent Variable: Genangan (YTR_{25})

Because the regression has a Sig F value of 0.05, the ANOVA table indicates it is legitimate. It can also display a comparison of FCount and FTable of 814.435. Researchers obtain a result of 4.96 by putting FTable in the numerator with df1 = 1 (number of independent variables) and df2 (number of samples - number of independent variables -1) = 10. As a result, FCount > FTable.

Tabel 12. Anova

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	0,006	1	0,006	814,435	,000[b]
	Residual	0,000	10	0,000		
	Total	0,006	11			

a. Dependent Variable: Genangan (YTR_{25})
b. Predictors: (Constant), R.T.B (X_2)

The normality test determines whether data or variables are normally distributed. The data spread along the diagonal line, and the histogram forms a bell looking upwards, indicating that the standardized residuals are normally distributed.

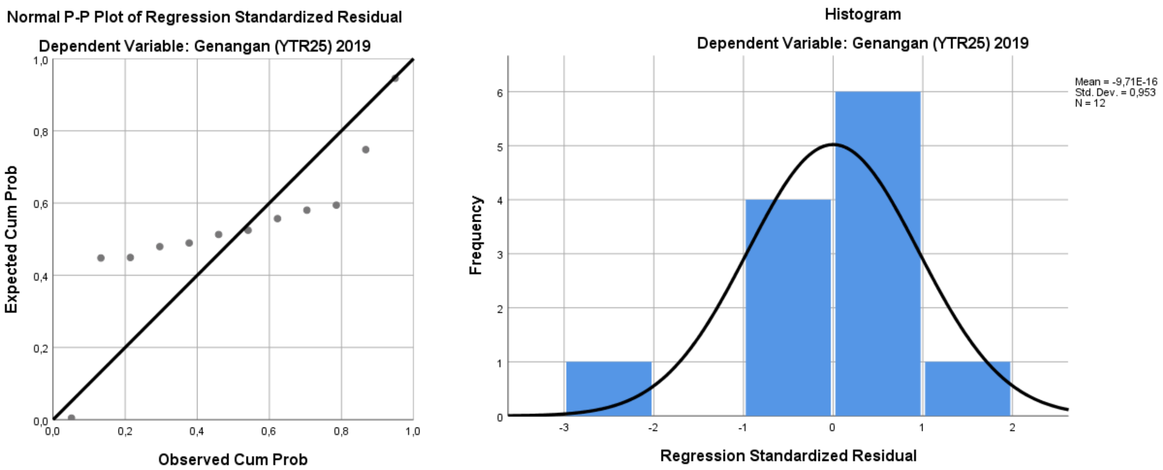

Figure 2. Normality and Histogram Test

The T-test was used to determine how much the independent variables of the Building's Open Area influence the dependent variable of inundation separately, with a confidence level of 95% or alpha = 0.05. If T Count > T Table and the T Table value is (alpha; n-k) = 0.05 and the df value is 6, then the T Table is 1.943. The computed T value is more than 1.943. According to Ghozali (2011: 101), the value of Sig. 0.05 influences the dependent variable in part (Y).

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Table 13. Coefficients

	Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-0,00033	0,001		-0,343	0,739		
	R.T.B (X_2)	0,00261	0,000	0,994	28,538	0,000	1,000	1,000

a. Dependent Variable: Genangan (YTR_{25})

The regression equation may be seen in the equation table below after passing all of the classical assumption tests, the T-test, and the F-test, indicating that they meet the requirements as a model.

Table 14. Prediction Model Equation

Parameter	R^2	Prediction Model Equation				
Inundation TR_{25}	0.987	=	-0.0003	+	0.0026	Building Open Area

A. Discussions

Rain, increased land conversion from water catchment regions to Building Open Areas, and a reduction in water catchment areas in a river basin can all affect an increase in inundation. The proportion of the building's open space area is 92.54% at the research site, whereas the percentage of the water catchment area is 7.46%. According to Law No. 26 of 2007 on spatial planning, the water absorption area should be 30%. As a result, the location of this research is still not optimal for carrying out existing laws, and inundation is unavoidable.

In the Krukut river basin, land conversion from permeable to impervious land is one element contributing to an increase in the frequency of inundation. This fact can be explained by the fact that there is a very high positive association between inundation and impervious events, implying that actions to control inundation at the study site are required.

The resulting equation model can estimate the flooding area = -0.0003 + 0.0026 Building Open Space. The researchers anticipate that an inundation event with an area of 0.17 km2 will occur in the 25-year return period plan with an RTB area of 68.04 km2.

B. Validation Analysis

Researchers obtain the accuracy degree of the quantitative model output using the accuracy evaluation test stage. The model findings are in the form of areas and location points suspected of having the potential for flooding, which are compared to the results of field checks conducted in each catchment area with the assistance of the SWMM EPA Program. The mathematical evaluation uses a contingency or error matrix (confused/error matrix) and Kappa analysis. Figures 3, 4, and Table 12 show the findings of the EPA SWMM simulation.

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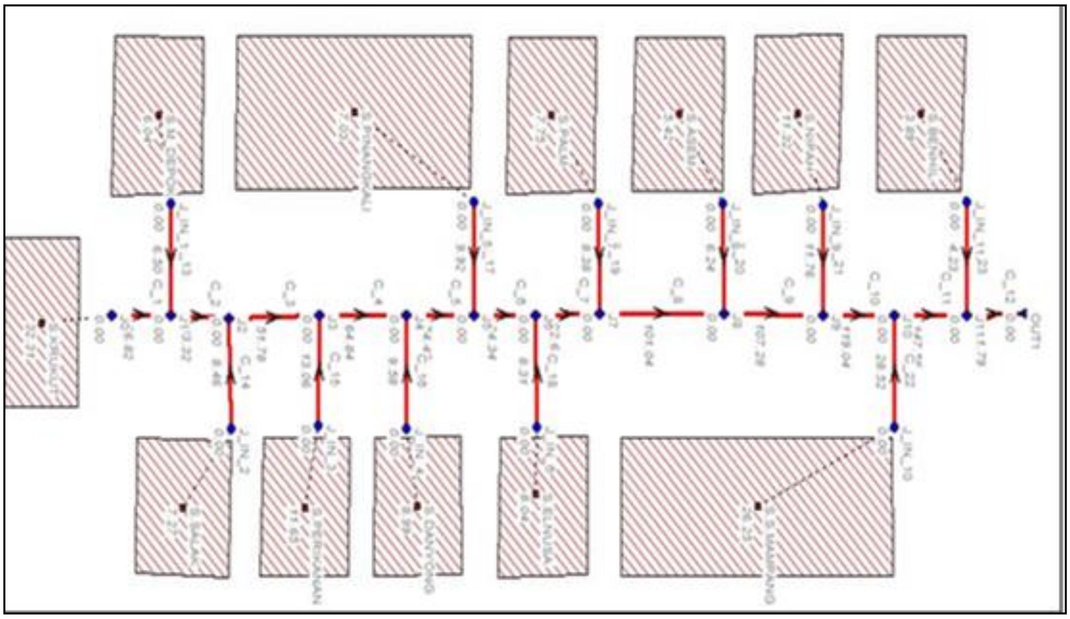

Figure 3. Krukut Watershed Situation Map

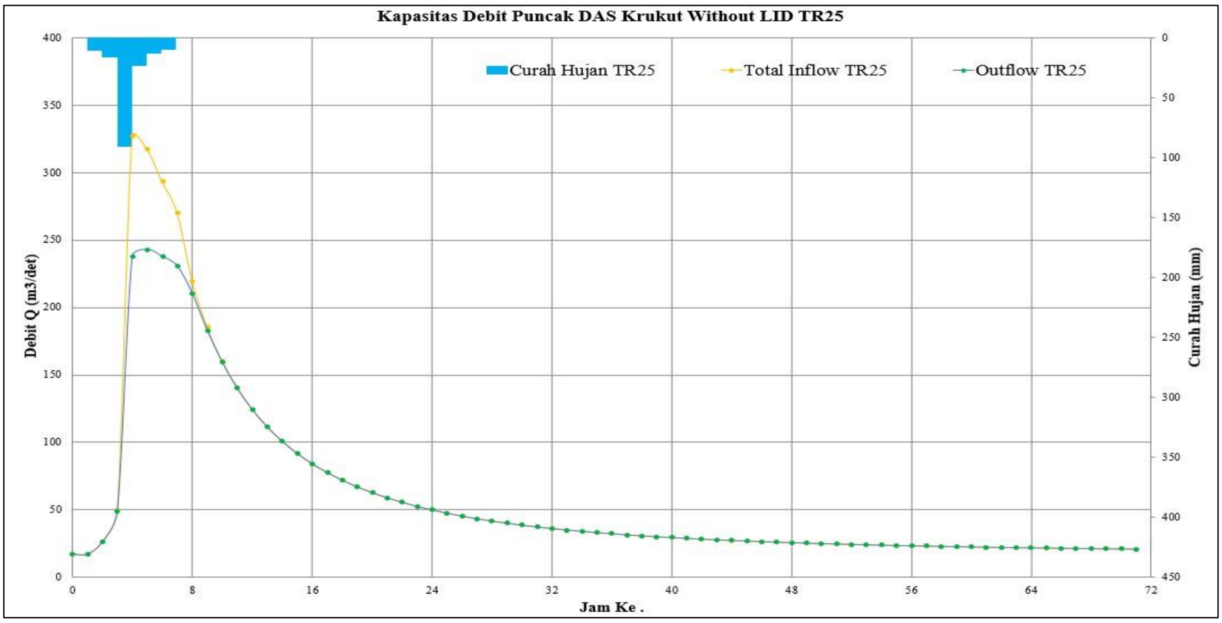

Figure 4. Krukut Watershed Peak Discharge Capacity

Table 15. Simulation Results of Inundation Events at QTR 25

Parameter	*Results of Running EPA SWMM*
Intensity (mm/hour)	*165.25*
Flooding loss (m^3)	*840,894.00*
Flooding loss (m^3/sec)	*104.51*

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Infiltration loss (mm)	*4.021*
Node Flooding	*J0,J3,J4,J-In-2, J-In-3, J-In-4, J-In-5, J-In-7, J-In-8, J-In-9.*
Runoff Peack (m3/sec)	*310.27*
Inundation Prediction (Ha)	*21.02*

Table 13 compares model data findings to the results of field inspections, error matrices, and model accuracy evaluation results.

Table 16. Comparison of model and field data

No	*Sub-System*	*Potential Inundation Category*	
		Model Data	*Field Data*
1	*WCA Mampang Depok*	*Potential*	*No Potential*
2	*WCA Salak*	*Potential*	*Potential*
3	*WCA Perikanan*	*Potential*	*Potential*
4	*WCA Danyong*	*Potential*	*Potential*
5	*WCA Pinang Kali*	*Potential*	*Potential*
6	*WCA Elnusa*	*Potential*	*No Potential*
7	*WCA Palm/Pelita*	*Potential*	*Potential*
8	*WCA Asem*	*Potential*	*Potential*
9	*WCA Nipah/Ciragil*	*Potential*	*Potential*
10	*WCA Sungai Mampang*	*Potential*	*No Potential*
11	*WCA Bendungan Hilir*	*Potential*	*No Potential*
12	*WCA Sungai Krukut*	*Potential*	*Potential*

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Table 17. Error matrix of model results against field data

		Field Data		Σ1
		B	T	
Model Data	B	12	0	12
	T	2	8	10
Σ2		14	8	22

Note: B = Potential Inundation Category, T= No Potential Category, Σ1= Number of Row, Σ2= Number of Column.

Table 18. Assessment of Modeling Result Accuracy Evaluation

No	Evaluation	Potency (%)	No Potency (%)
1	UA	54,55	63,64
2	PA	45,45	36,36
3	OA	90,91	
4	K	0,67	

UA= User's accuracy; PA = Producer's accuracy; OA= Overall accuracy; K= Kappa Coefficients

The overall accuracy was 90,91%, while the kappa accuracy was 0.67, or 67%. As a result, the outcome of this study modeling can produce an appropriate level of truth.

IV. CONCLUSIONS

The researchers came to numerous conclusions as a consequence of their examination and discussion:
1. The occurrence of inundation has a solid positive link with converting land into open space for buildings. Inundation incidents will occur during the rainy season.
2. According to the research on the data prediction model for the occurrence of inundation in the Krukut watershed, the element that has the most significant influence on the event of inundation is the 92.54% rise in land conversion into open space for structures. As a result, researchers provide projections for the inundation area = -0.0003 + 0.0026 Building Open Area. At the 25-year return period, inundation is 0.17 km2.
3. The EPA SWMM modeling findings over 25 years reveal a peak discharge of 310.20 m3/s and an inundation of 104.51 m3/s, covering an area of 0.21 km2.
4. This study's model was evaluated and found to have an overall accuracy of 90,91% and a kappa accuracy rating of 67%. It signifies that the model used generates a reasonable amount of truth.

Based on the findings of this study's inundation identification, the following recommendations can be made:
1. Change in built-up land is an important aspect to consider in the context of urban growth. It mainly concerns since the higher the built-up area, the more the equilibrium of the local drainage system will be thrown off, especially when it rains.
2. More emphasis should be paid to technical approaches of inundation management in city governance, such as utilizing open spaces as catchment areas or incorporating the LID idea.

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