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STUDY OF POTENTIAL FLOOD RUNOFF USING HYDROLOGICAL ANALYSIS AND HYDRAULIC SIMULATION ON RIVERS IN URBAN AREAS, CASE STUDY ON WAY PISANG RIVERS, LAMPUNG PROVINCE

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ABSTRACT

Every region in Indonesia, especially those around rivers that develop to urban areas is always faced with the problem of flooding in every rainy season. Flood disasters ranging from mild to large (flash floods) will have an impact on community activities and often result in property losses and even fatalities. To be able to anticipate the impact of flooding, a method is needed to estimate the amount of flood discharge and the potential for overflow that will occur in the area around the river. One method that can be used is hydrological analysis and hydraulics simulations, where hydrological analysis will obtain the amount of flood discharge at each repeat event, while hydraulics simulations can obtain data on potential flood discharges that will inundate the area around the river if no prevention and control measures are taken good and measurable countermeasures. In this study, to determine the return flood discharge, the Nakayasu method was used with river characteristics according to the data obtained, while the hydraulics simulation used HECRAS software. The results of hydrological analysis and hydraulics simulations show that for a 10-year return flood discharge of 323.01 m^3/s, there is the potential for an overflow of 14.5 km with an inundation area of 15,314 m^2 and a flood discharge for a 20-year return period of 376.43 m^3/s. potential for overflow along 14.6 km with inundation area of 17,441 m^2.

Keywords: flood, nakayasu, HECRAS.

1. INTRODUCTION

Every region in Indonesia, especially those around rivers that develop to urban areas is always faced with the problem of flooding in every rainy season. Flood disasters ranging from mild to large (flash floods) will have an impact on community activities and often result in property losses and even fatalities.

Flood is an event where land that is usually dry (not swampy area) becomes inundated by water, this is caused by high rainfall and the topography of the area in the form of lowlands to sunken areas. In addition, the occurrence of flooding can also be caused by overflow of surface water (runoff) and its volume exceeds the capacity of the drainage system or river flow system. The occurrence of floods is also caused by the low infiltration capacity of the soil, causing the soil to no longer be able to absorb water. Floods can occur due to rising water levels due to above normal rainfall, changes in temperature, broken embankments/dams, rapid snowmelt, and obstruction of water flow elsewhere (Ligal, 2008).

Some efforts that can be made to reduce the impact of flooding in a watershed are to carry out reforestation activities (for the upstream part), normalization activities in order to increase the river's carrying capacity (for the middle part) and the construction of flood dams and retention ponds. (For downstream).

Normalization activities in order to increase the river's capacity are usually relatively easy to carry out if the conditions on the right and left of the river are still sufficient for widening and deepening the river.

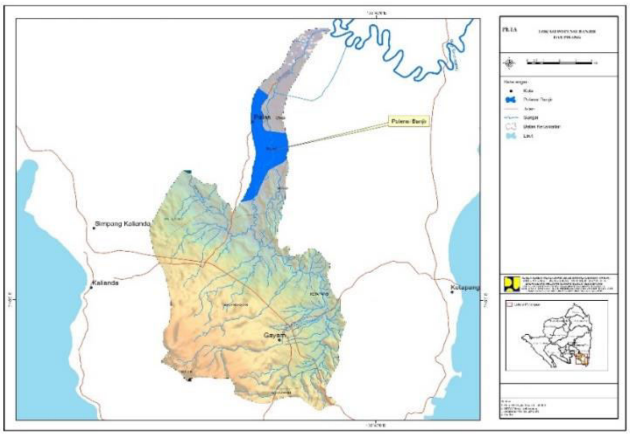

Figure-1. Location of potential floods in the way Pisang watershed.

For rivers that cross developing and urban areas, normalization activities in order to increase river capacity will experience difficulties and even cause more complex social problems, because in many places in urban areas people live right on the right and left sides of the river, not even a few who built buildings jutting into the river room. This research will be carried out at the Way Pisang River location which is administratively located in the South Lampung Regency, Lampung Province which has a classification of river segments as natural rivers, developing rivers and urban rivers.

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2. METHOD

To achieve the expected goals, this research will be carried out in several stages of implementation methods as follows”

a) This research begins by conducting a literature study and literature review related to the subject in the research, so that novelty can be found in this study referring to the results of previous research;
b) The next stage is the collection of secondary data in the form of: Hydrological data; Flood incident data; Watershed Map and River Length Map; Rain Post Location Map and Land Use Map. The data will be collected from relevant agencies that have the authority to manage the data;
c) After secondary data collection activities are carried out, primary data collection will be carried out in the form of river situation measurement data, river longitudinal cross-section data and river cross-sectional data based on the results of topographical measurements;
d) Based on the primary and secondary data that have been collected, hydrological analysis and modeling will be carried out in the form of calculation and modeling of the design flood discharge for each return period of 10, 20, 50 and 100 years;
e) The next stage of activity is to carry out modeling of the existing river capacity using the HEC-RAS program application based on the data parameters from hydrological analysis and modeling and river geometry measurement data.

3. RESULT AND DISCUSSIONS

a) Long of Way Pisang River

Based on the results of data collection on the measurement of the Way Pisang River it is known that the Way Pisang River Length is 27.32 km.

b) Area of Way Pisang Watershed

Based on the results of data collection and measurements on the Way Pisang watershed map has an area of 155.34 km^2.

c) Land Use of Way Pisang Watershed

Based on the map of the Way Pisang watershed in 2007 and 2019, the following types of land use can be identified:

Table-1. Way Pisang Watershed Land Use in 2020.

No	Land Use	Area (km^2)	%
1	Thicket	1.04	0.67
2	Forest	13.78	8.87
3	Residential	5.37	3.46
4	Dry land agriculture /gardens	125.79	80.98
5	Sawah	9.35	6.02
	Total	155.34	100

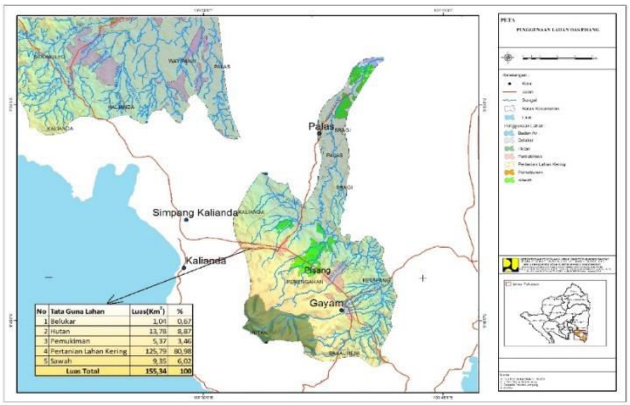

Figure 2. Land use of way Pisang watershed.

d) Rainfall Observation Post Around the Way Pisang Watershed

Based on the results of data collection and analysis there are 4 (four) Rainfall Observation Posts around the Way Pisang watershed as can be seen in Table-2 below.

Table-2. Rainfall Observation Post around the Way Pisang Watershed.

No	Name of Post	LS	BT	Data Availability
1	PH030 - Klaten	5˚44’4.5562”	105˚41’33.0431”	2008-2020
2	PH 031 - Purwodadi	5˚40’58.700”	105˚40’28.4000”	2008-2020
3	R 021 - Pasuruhan	5˚44’42.500”	105˚40’35.3000”	2008-2020
4	R 233 - Palas	5˚36’4.1000”	105˚41’44.8000”	2008-2020

e) Distribution of Rain Observation Posts in the Way Pisang Watershed

Based on the results of GIS analysis data, it can be seen the distribution of Rainfall Observation Post locations in the Way Pisang watershed as can be seen in Figure-3.

f) Extent of Effect of Rain Observation Post on Way Pisang Watershed

Based on the results of GIS analysis data collection, the area of influence of each Rainfall Observation Post in the Way Pisang watershed is as follows:

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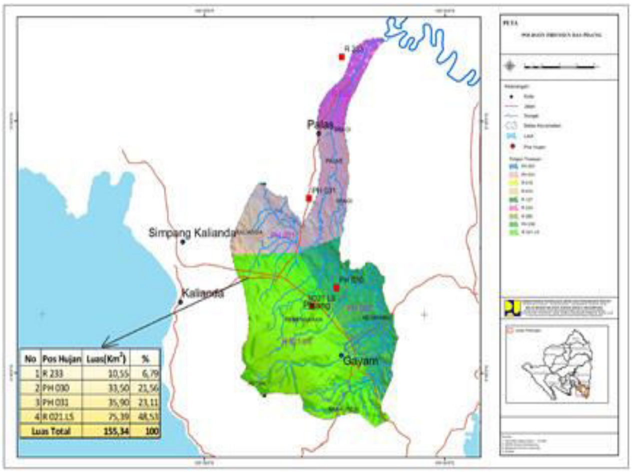

Figure-3. Map of the distribution of rain posts in the way Pisang watershed.

Table-3. Extent of effect of rain observation post on Way Pisang watershed.

No	Name of Post	Area (km^2)	% Area
1	PH030 - Klaten	33.5	21.566
2	PH 031 - Purwodadi	35.9	23.111
3	R 021 - Pasuruhan	75.39	48.532
4	R 233 - Palas	10.55	6.792
	Total	155.34	100

g) Way Pisang Surface Runoff Coefficient

Based on the type of land cover in Way Pisang River Basin, it can be seen that the drainage coefficient values in the Way Pisang River Basin are as follows:

Table-4. Runoff coefficient of way Pisang watershed in 2020.

No	Land Use	Area (km^2)	%		C	L.C
1	**Forest**		**1.04**	**0.67**	**0.03**	**0.33**
2	Residential		13.78	8.87	0.5	8.09
3	Rice fields		5.37	3.46	0.15	4.71
4	Dry land agriculture / gardens		125.79	80.98	0.2	18.75
5	Thicket		9.35	6.02	0.07	0.2226
	Total	**155.34**	**100**			**32.09**
	C Average					**0.207**

Table-5. Average flow coefficient based on the way Pisang land use land use in 2020.

Period	Runoff coefficient (C)							
	2	5	10	20	25	50	100	Average
Rain	0.701	0.579	0.527	0.487	0.480	0.452	0.430	
TGL	0.207	0.207	0.207	0.207	0.207	0.207	0.207	
Average	0.454	0.393	0.367	0.347	0.343	0.329	0.318	0.364

h) Design Flood of the Way Pisang Watershed

By using the Nakayasu unit hydrograph, it can be seen that the Way Pisang River Design Flood according to the time of return is as follows:

Table-6. Way Pisang watershed design flood in 2020.

Period	Design Flood in 2020 (m^3/s)
KU-2 year	186.87
KU-5 year	269.77
KU-10 year	323.01
KU-20 year	376.43
KU-25 year	388.13
KU-50 year	435.12
KU-100 year	480.58

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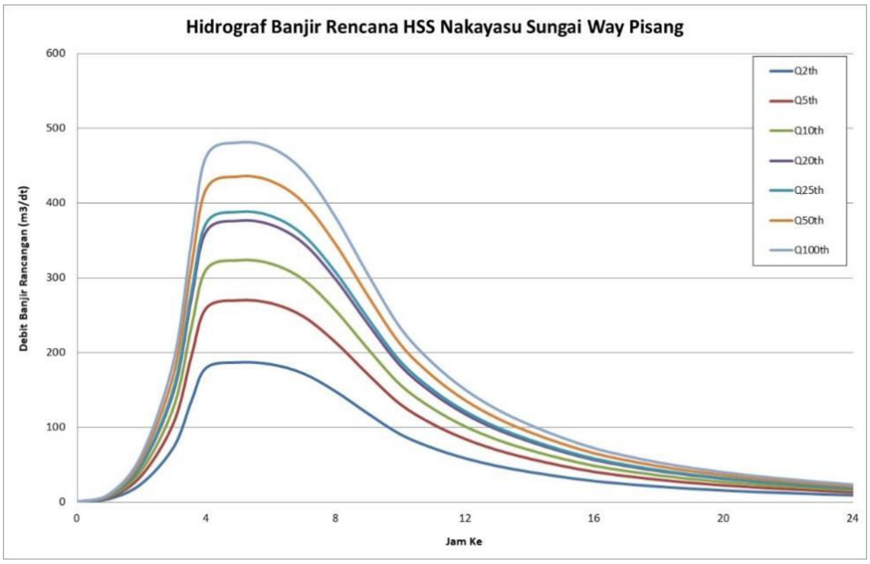

Figure-4. Way Pisang watershed design flood in 2020.

i) Way Pisang River Hydraulics Modeling

The hydraulics modeling that will be carried out in this study is modeling using HEC-RAS software with the parameters used are river geometry data from topographic measurements and planned flood discharge parameters in accordance with the return calculations that have been calculated in the Plan Flood Discharge modeling in the previous discussion.

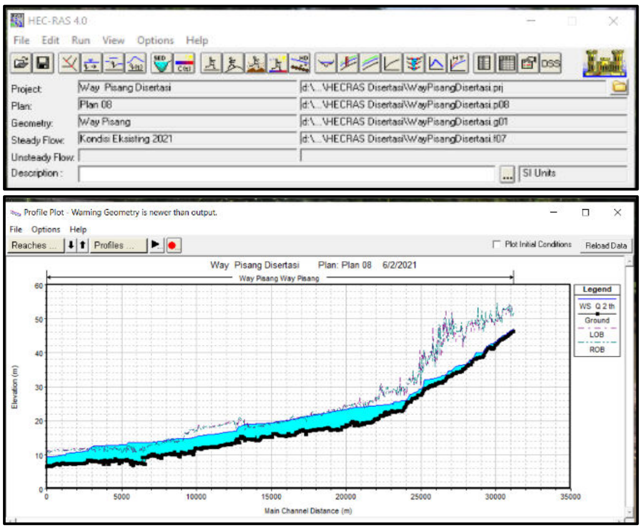

Figure-5. Way Pisang river long section model.

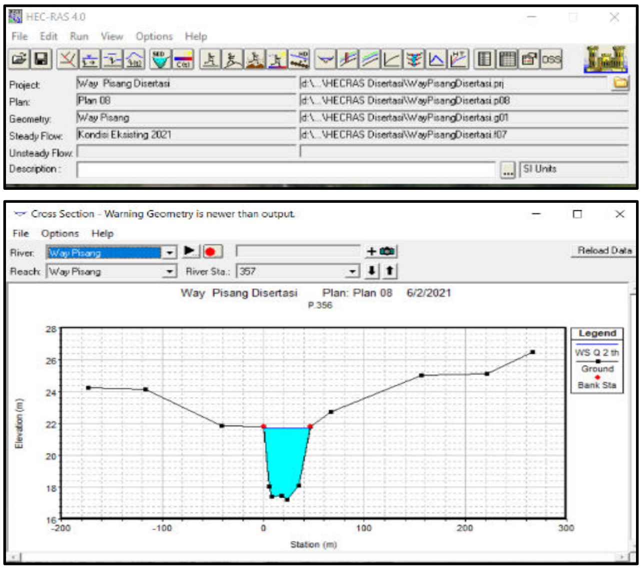

Figure-6. Way Pisang river cross section model.

4. CONCLUSIONS

The existing condition of the Way Pisang River in the planned flood discharge flow for Q10 years (323.01 m^3/s) experiences overflow/overtoping along 14.5 km, the average flood water level elevation is 1.05 m and the potential for inundation is 15,314 m^2, while in the planned flood discharge flow for Q20 years (376.43 m^3/s), the Way Pisang River section which experienced overflow/overtoping along 14.6 km with an average flood water level elevation of 1.19 m, potential for inundation of 17,441 m^2.

REFERENCES

[1] Anggun Citra Putrinda. 2012. Surface Flow Coefficient in Sekampung Watershed, Lampung Province 1995-2010.

[2] Anik S. 2007. Study of Alternative Flood Management (Case Study of Ladapa River in Gorontalo Regency).

[3] National Standardization Agency, 2016, Procedure for Calculation of Planned Flood Discharge, Indonesian National Standard SNI 2415: 2016

[4] Balai Besar Wilayah Sungai Mesuji Sekampung. 2015. Pattern of Water Resources Management in Seputih-Sekampung River Basin.

[5] Balai Besar Wilayah Sungai Mesuji Sekampung. 2018. Document of Water Resources Management Plan for Seputih-Sekampung River Basin.

[6] Balai Besar Wilayah Sungai Mesuji Sekampung, 2018, Way Pisang River Riparian Zone Study.

[7] Bambang Istijono. 2015. Development of Environmentally Friendly Flood Control (Case Study: Batang Anai Flood Control, West Sumatra).

[8] Bayu Akbar Krisnamukti H, dkk. 2015. Study on Flood Control of the Alopohu River System, Gorontalo Regency, Gorontalo Province.

[9] Departemen Kehutanan. 2009. Peraturan Direktur Jenderal Rahabilitasi Lahan dan Perhutanan Sosial Nomor: P.04/V-SET/2009 about Guidelines for Monitoring and Evaluation of Watersheds.

[10] Deputi Bidang Sarana dan Prasarana, Direktorat Pengairan dan Irigasi. 2008. Flood Management Policy in Indonesia.

[11] Dessy Rosliani, dkk. 2013. Study on Optimizing Channel Design for Flood Control in Upper Citarum.

[12] Dhani Pratama, dkk. 2014. River Cross-sectional Capacity Normalization Study (Case Study of the Engkulik River in Sintang District).

[13] Dhani Pratama, dkk. 2015. River Cross-sectional Capacity Normalization Study (Case Study of the Engkulik River in Sintang District).

[14] Dibyosaputro Suprapto. 1984. Flood Susceptibility and Hazard Survey of the Kudus Prawata Welahan Area, Central Java. Indonesia. Thesis, ITC, Enschende, Netherlands.

[15] Fajar Yulianto, dkk, 2009, Ciliwung River Flood Overflow Simulation Model in Kampung Melayu – Bukit Duri Area Jakarta, Indonesia;

[16] Fungky Pramana, Anis Saggaff, Febrian Hadinata. 2020. An Analysis of a Design Flood Discharge in the Developmental Palnning of the Lematang Weirr.

[17] Garindra Gustianto. 2016. Flood Mitigation Efforts by Repairing the Lamong River Channel in Gresik.

[18] Gustave SP. 2013. Analysis of Design Flood Discharge Using a Hydrograph of Measured Units in the Upper Progo River Basin.

[19] Hartono Himawan. 2015. Alternative for Deli River Flood Handling With Water Tunnel Model.

[20] Heldy S, dkk. 2017. Analysis of the Effect of Land Use Changes on Flood Discharge in the Downstream Area of the Angke River Flow.

[21] Hendra, 2020, Floods Flooded Dozens of Houses in Sragi, South Lampung, and Lampung Province.

[22] Iin Widiatni Widyaningsih. 2008. The Effect of Land Use Changes in the Keduang Watershed Viewed from the Hydrological Aspect.

[23] Jeffier Andrew, dkk. 2014. Analysis of Ranoyapo River Flood Discharge Using HSS Gama I and HSS Limantara. Methods.

[24] Jien Liu, Hong Xiao, Pengzhi Lin, Chuanxing Zhou, Wei Wang. 2021. Effect of Vertical Velocity Profile approximations on estimate of Dam Breach discharge using surface velocity.

[25] Kementerian Pekerjaan Umum dan Perumahan Rakyat. 2015. Regulation of the Minister of Public Works and Public Housing Number 28/PRT/M/2015 concerning Stipulation of Riparian Zone and Lake Riparian Zone.

[26] Kinanti JD. 2019. Heavy rain pours Bandar Lampung Floods inundate the front road of Rajabasa Terminal, Tribunnews.

[27] Leena Karrasch, Britta Restemeyer, Thomas Klenke, The Flood Resilience Rose: A Management tool topromote transformation toward flood resilience.

[28] Lilik Ariyanto, 2021, River Engineering and All it's Potential, Sulur Pustaka.

[29] M Bagus Ansori, dkk. 2015. Kalidawir Flood Control Study.

[30] M Ridhwan. 2012. Flood Area Modeling in Jambi City.

[31] M Rogger, dkk. 2017. Land use change impacts on floods at the catchment scale: Challenges and opportunities for future research:

[32] Maimun S, dkk. 2018. Storage Capacity Analysis and Determination of the Location of Damage to the Aih Tripe River, Gayo Lues Regency, Pamungkas SB, 2020.

[33] Pamungkas SB. 2020. One Area Submerged by Floods in Early 2020, Lampost.

[34] PM Kundu, dkk. 2011. The impact of land use change on runoff and peak flood discharges for the Nyando River in Lake Victoria drainage basin, Kenya.

[35] Riman. 2012. Analysis of Flood Discharge in Watersheds for Design and Evaluation of Water Capacity Buildings.

[36] Saputra B. 2019. Floods in Bandar Lampung Teak Houses of Kalibalau Kencana Residents Broken, Tribunnews.

[37] Sebastian Ligal. 2008. Flood Prevention and Management Approach. Journal of Civil Engineering Dynamics. 8: 162-169.

[38] Shang-Shu Shih, Po-Chih-Chen, Identifying tree characteristic to determine the blocking effect of water cobveyance for natural flood management in urban rivers.

[39] Sunil Kute, dkk. 2014. Flood Modeling of River Godavari using HEC-RAS.

[40] Sutomo D. 2019. Hundreds of Hectares of Rice Fields in Palas, South Lampung, Flooded, Tribunnews.

[41] Thair Sharif Kayyun, Dheyaa Hamdan Dagher. 2018. Potential Sediment within a Reach in Tigris River.

[42] Wouter V, dkk. 2003. Model of the effects of a flood in the Dender catchment, based on a risk methodology.

[43] Yulyana Aurdin. 2014. The Effect of Land Use Change on Flood Hydrograph Characteristics.