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The Use of the HEC-RAS Program in Kampung Sawah Village, Martapura City, Indonesia

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Abstract
The flood incident with the overflow of the Komering river i n the city area of Martapura to be precise in the Tanjung Kemala Village area, Kampung Sawah village, East OKU sub-district, Martapura which resulted in several rice fields and settlements being affected by flooding or inundation which was very detrimental to the community. The floods were also caused by floods sent from South OKU district and the overflow of the Komering river where 1,093 hectares of rice fields were recorded in 16 flood-affected districts.
The research approach is through topographic surveys, long section and cross section as well as simulation with the HEC-RAS program as a medium to see in detail the phenomenon, especially the water level that occurs in the existing canal (prototype). on the cross-section and long section of the channel in the area.
The results showed that the magnitude of the flood discharge (Q) that occurred in the channel of Kampung Sawah village, Martapura sub-district, East OKU district was 14,403 m^3/s and the movement of the water level in each cross section along the 2,745 km channel in the village area of Kampung Sawah, Martapura sub-district, East OKU all overflow as at the starting point of the channel (P_0) of +/- 0.5 meters; P_5 of +/- 2.50 meters; P_{10} of 2.50 meters; P_{15} of 3.00 meters; P_{20} of 4.00 meters; P_{25} of +/- 4.00 meters; and at $P_{27.45}$ by 5 meters.

***Keywords**: Floods, Discharge, HEC-RAS Program, Overflow*

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I. INTRODUCTION

Based on Law Number 37 of 2003, the area of East Ogan Komering Ulu (OKUT) district is 3,370 km², geographically, east OKU is located at 103º 40'– 104º 33' East Longitude and 3º 45'– 4º 55' South Latitude, where most of the territory consists of lowlands and flat hills except in the Martapura sub-district area and its surrounding areas which are hilly[1].

The district area of the East Ogan Komering Ulu (OKUT) can be classified topographically into flat areas (Pelnelplain Zone), low-lying areas (Pielmont Zone), and parts of it are mountainous areas with varying elevation heights, namely between 42 meters to the highest elevation reaching 87 levels above the sea level and slope varies between 0-2% and 2-15%. Flat areas are found in Belitang and Buay Madang districts, while growing areas are in parts of Martapura District[1].

There is the Komering river in the East OKU district, one of the rivers in the province of South Sumatra, Indonesia. The Komering River is also a tributary of the Musi River, or often known as Batanghari Sembilan which means Nine Great Rivers. The Komering River is also the second longest river in South Sumatra province after the Musi River[1].

The physiography of East OKU district is part of the Barisan Mountains Zone and the Basin Zone. The Barisan Mountains Zone is characterized by volcanic cones, undulating mountains and hills formed by intrusive rocks of andesite-granite composition, pyroclastic and tertiary sedimentary rocks, while the Basin Zone is characterized by low undulating plains and sloping landscapes formed mostly by river allulvial sediments and in some where there are tertiary sedimentary rocks and local swamp deposits as well as reef limestone. This deterioration in environmental quality is mainly indicated by, among other things, illegal logging of forests for ponds, plantations and residential areas that do not pay attention to the principles of environmental sustainability and the occurrence of water turbidity at the mouths of the Komering river[2].

Based on data from BPS, East OKU in figures (2022) the Komering River flows in the southern part of the island of Sumatra which has a tropical rainforest climate. The average annual temperature is around 24°C. The warmest month is October, with an average temperature of around 26°C, and the coldest is January, around 22°C. The average annual rainfall is 2902 mm. The wettest month is November, with an average of 435 mm of rainfall, and the driest is August, with an average of 83 mm. The Komering sub-watershed is one of the nine Musi sub-watersheds and is located in the southern part of the island of Sumatra with an area of 915,375,820 ha.

The Komering Sub-Watershed is one of the priority sub-watersheds that requires immediate action, because in line with the development of society in the Komering Sub-watershed area, various living arrangements are changing rapidly in line with various community needs [3].

Based on the identification results of the Musi Watershed Management Center [4], the condition of the river area and land shows that the upstream part of the Komering Sub-watershed has experienced disturbance or deterioration in the quality of its ecosystem and environment.

The upstream area of the Komering Sub-Watershed is divided into 12 sub-sub-watersheds, which are administratively located in the South OKU Regency area (19 sub-districts), and hydrologically, the river channels in the upstream area of the Komering Sub-watershed flow into the Komering Sub-watershed[5]. Based on the identification results, the drainage pattern of the upstream Komering Sub-watershed river channels generally includes a fine to moderate dendritic pattern [6]. This pattern, when linked to a river flow system (drainage system), can accelerate the movement of water runoff and facilitate soil erosion in the upstream Komering Sub-watershed. In detail the flow patterns in the upstream Komering Sub-Watershed area[6-7].

II. METHODOLOGY

2.1 Research location

The research was carried out through a location survey approach, including topographic surveys, longitudinal and cross section profiles of the Komering River channel and carrying out numerical analysis using the HEC-RAS ver. 6.1.0. using an numerical combined with empirical approach, including hydrological analysis and hydraulics analysis, then simulation was carried out using the HEC-RAS program. Hydrological analysis to determine the design rainfall with a certain return period and get a picture of the Intensity Duration Frequency (IDF) curve as well as channel hydraulics analysis to calculate flood discharge and then a simulation is carried out with the help of the HEC-RAS program.

Of course, before the analysis is carried out with the program, secondary data is collected, namely collecting references related to the research and primary data collection, namely by carrying out a topographic and hydrodynamic survey of the flow in the Komering River which enters the channel in the Water Catchment Area as in the map in Figure 1.

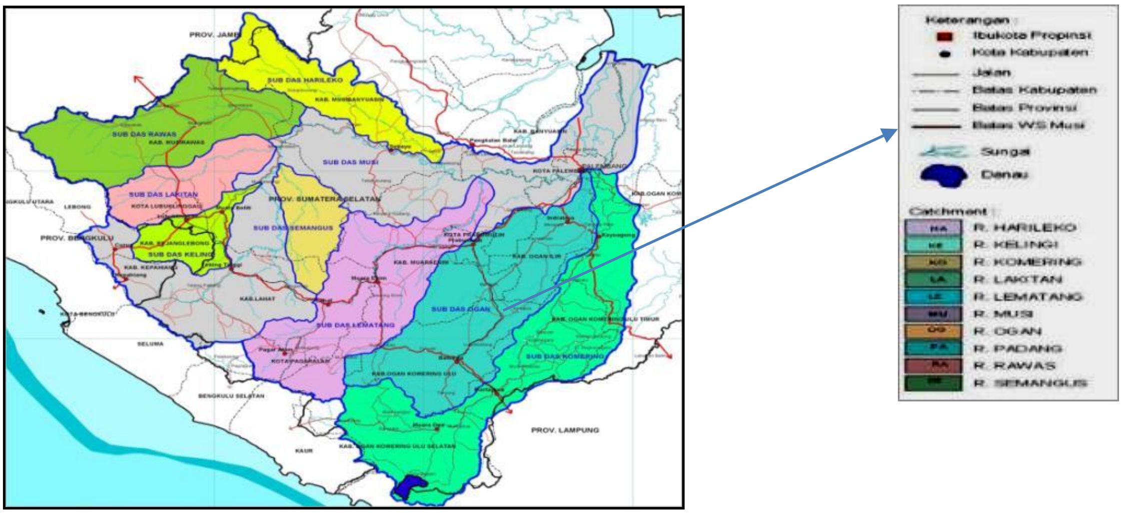

Figure 1: Administrative Map of Research Location

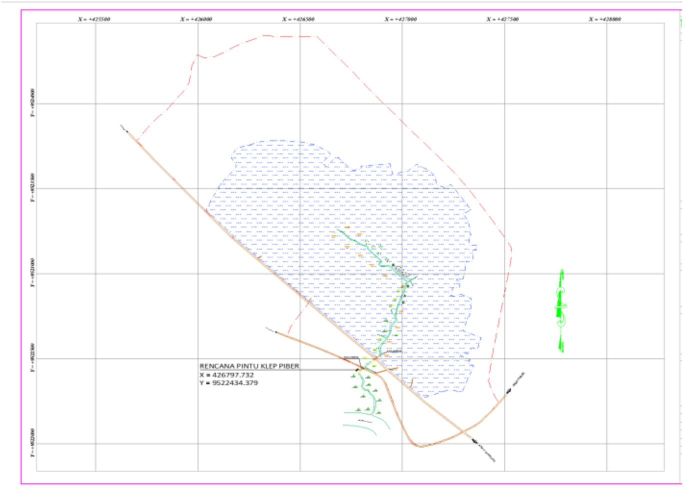

Figure 2: Map of the East Kozering OKU River Area (WS)[2].

Figure 3: Kampung Sawah area, Tanjung Kemala village, Martapura sub district, East OKU district

According to Baitullah[9] and Istiarto[10], simulations with the HEC-RAS 4.1.0 program have been useful in knowing the longitudinal profile of rivers, maximum water elevations and flow velocity. A part from that, with this model it is also possible to modify the appearance of the channel to obtain a channel appearance that can anticipate the planned flood flow. The modeling that will be discussed consists of 3 (three) studies, namely the existing model, water gate and pump system.

2.2 Materials and tools

The materials used in this research include collecting rainfall data to analyze rainfall with a certain return period, topographic surveys to obtain images of the cross section and long section of the river/channel of Kampung Sawah village.

The recorded rainfall is subjected to frequency analysis with certain return periods and will produce a rainfall frequency intensity curve (IDF-Curve) and calculate the planned discharge for each specific return period. The duration of the rainfall observation data is the last 10 years using the Gumbell Method or Pearson Log Type III frequency analysis. Economically, determining the return period considers construction costs as an effect of the size of the return period determined. The resulting Benelfit Cost Ratio (BCR) is as balanced as possible. The calculated costs can include the economic risk factors of the protected area as constituent components. Determination of retention pond reuse is based on city typology and watershed area as follows:

Table 1: Determining Time of Return Rainfall Period

No	Typology	Watershed Area (ha)			
		< 10	10-100	100-500	>500
1	Metropolitan	2 th	2,5 th	5-10 th	10-25 th
2	Big City	2 th	2,5 th	2,5 th	5-20 th
3	Medium/Small Cities	2 th	2,5 th	2,5 th	5-10 th

HEC-RAS 4.1.0 program to predict water overflow in channels based on the results of cross-sectional surveys and longitudinal channel profiles.

III. RESULTS AND DISCUSSION

3.1. Modeling Results

The results of hydrodynamic modeling are water surface elevation, velocity and several other hydraulic parameters. By carrying out hydrodynamic modeling, the water level in each channel segment will be known, so that segments that are not filled with water or overflowing will be known. By knowing which segments are experiencing water shortages, the next steps can be taken, either by building reservoirs or by improving channels. Hydrodynamic modeling can also create plans in combination with building controls such as flood pumps and water gates.

Hydrodynamic modeling with HEC-RAS can also compare plans between existing conditions and design conditions, so that the influence of design on changes in water level can be known. In modeling existing conditions, simulations were also carried out without including input from the source. This is intended to check whether the existing system can accommodate the load from its own watershed. The results of modeling the existing discharge conditions and the planned simulation conditions can be seen in Figure 4 below.

3.2 Return Period

According to Syarifudin, A[7], the extent of the water catchment area at the research location still contains several areas for water absorption, so the return period used in this research was determined as a return period of 10 years. The return period used in the design is 10 years with a rain intensity of 60.9973 mm.

Table 2: Analysis of Design Rain Analysis Results

Return Period (T)	Design Rainfall Frequency Analysis (mm)			
	Normal	Log Normal	Log Pearson Type III	Gumbel
5	188.601	139.711	237.467	193.508
10	205.512	153.019	274.053	221.775
25	221.655	166.901	331.270	257.487
50	235.107	179.428	382.308	283.980
100	245.869	190.123	441.209	310.281

Source: Analysis results, 2024

Based on the results of the rainfall frequency analysis, the ones that meet the design rainfall are based on Log Normal distribution with return periods of 5, 10, 25, 50 and 100 years respectively.

Table 3: Design Rainfall

Return Period (T)	YT	R_{24}
5	2.145	139.711
10	2.185	153.019
25	2.222	166.901
50	2.254	179.428
100	2.279	190.123

By using the Mononobe formula and design rainfall with Log Normal Distribution, the rainfall intensity is obtained as in table 3.

Table 4: Rainfall intensity with various return periods

T (Year)	R_{24} (mm)	I (mm/jam)
5	114	45,0343
10	155	60,9973
25	182	71,8987
50	212	83,5867
100	218	86,1431

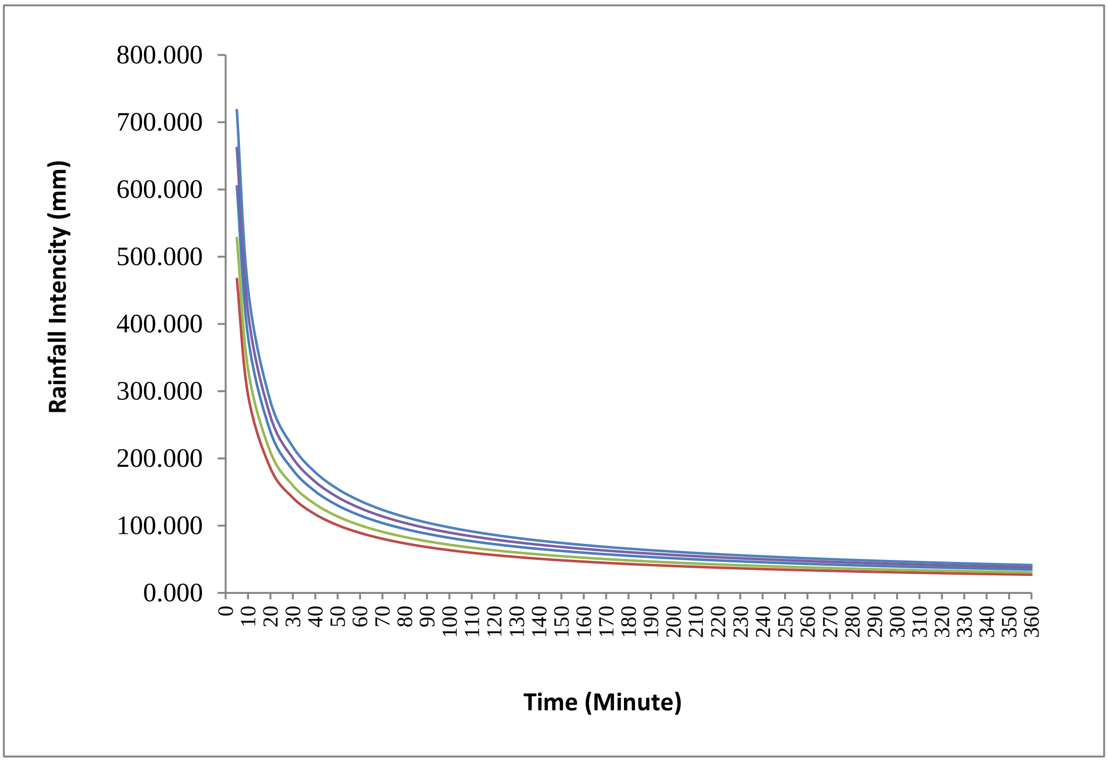

Figure 4: ***Intencity Duration Frequency*** **(IDF) Curve**

3.3 Simulation Results

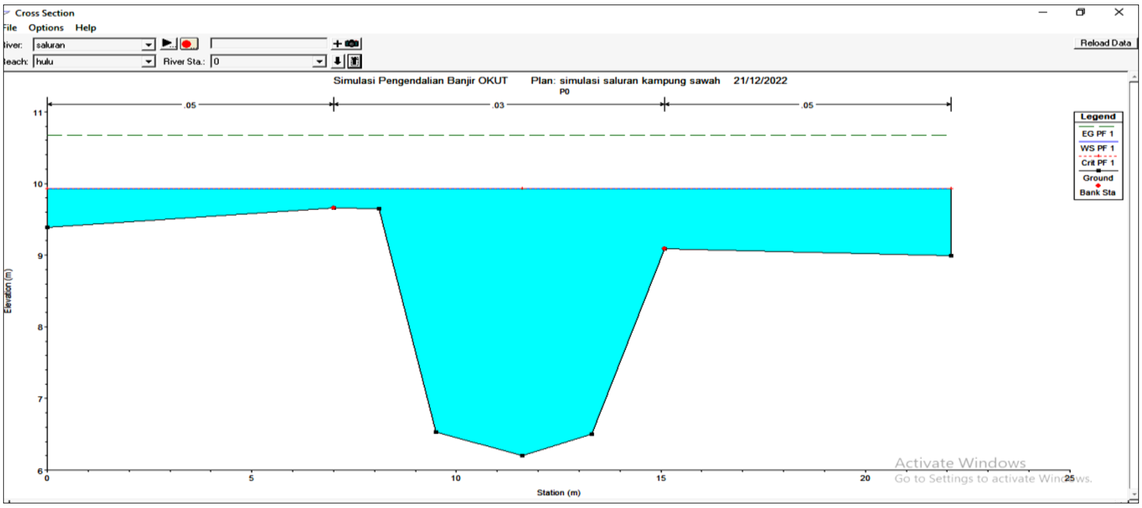

Figure 5: Simulation results at point P_0 (start of channel) (Source: simulation results, 2024)

It can be seen in figure 5. as above that at point P_0 (beginning of the channel) there is an overflow of the flow with a height of +/- 0.50 meters. This is possible that at the beginning of the channel the overflow is usually not that big but the further the distance upstream the overflow usually occurs hight.

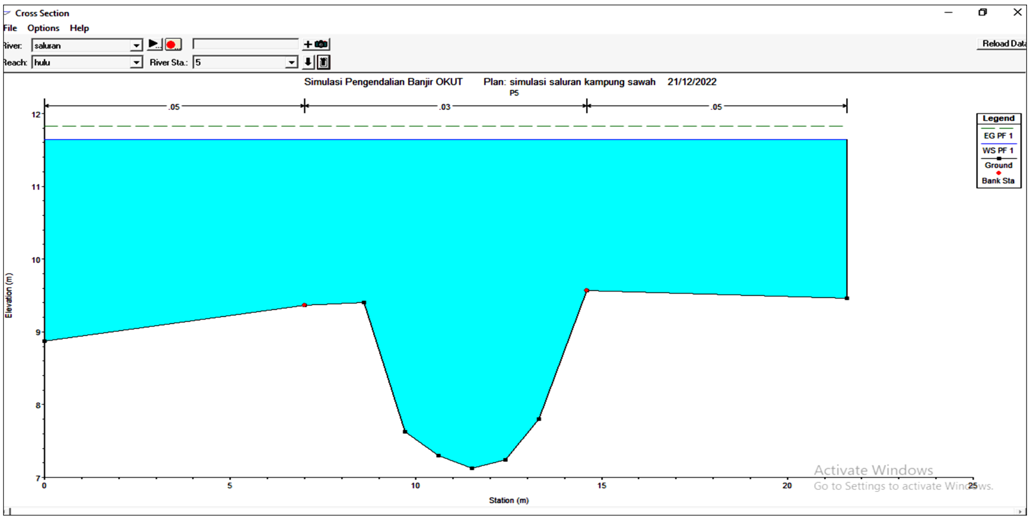

Figure 6: Simulation results at point P_5 (0+500) (Source: simulation results, 2022)

In figure 6. at the point P_5 (0+500), the water overflow that occurs increases, namely by 2.50 meters. Usually the overflow is not very high, but the further upstream the channel is, the overflow usually occurs to high.

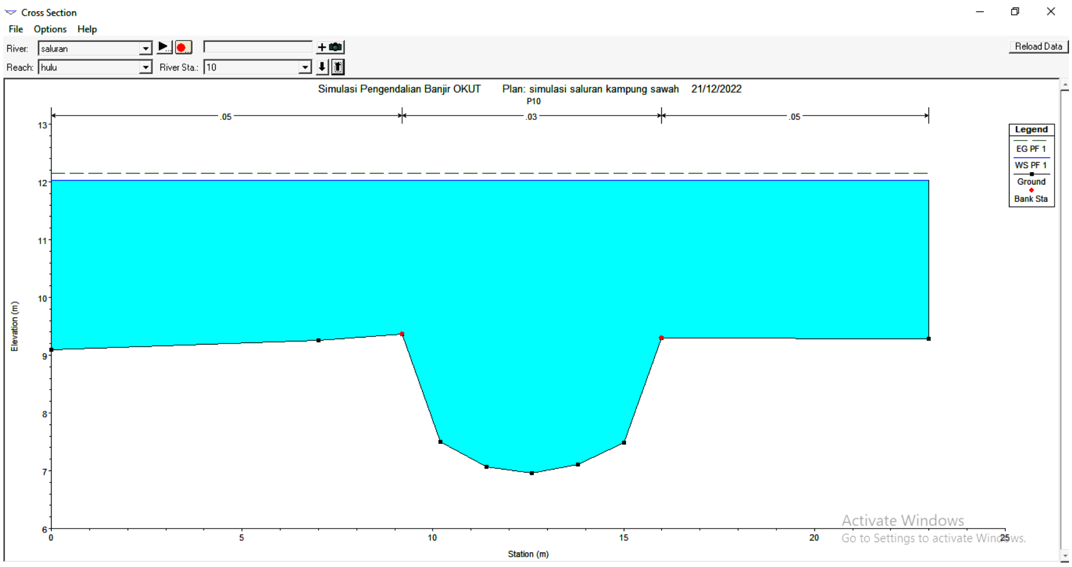

Figure 7: Simulation results at point P_{10} (1+000) (Source: simulation results, 2022)

In figure 7. It can be seen that at point P_{10} (1+000) there is a flow overflow with a height of almost 3.00 meters, meaning that the further you go upstream, the higher the water overflow that occurs.

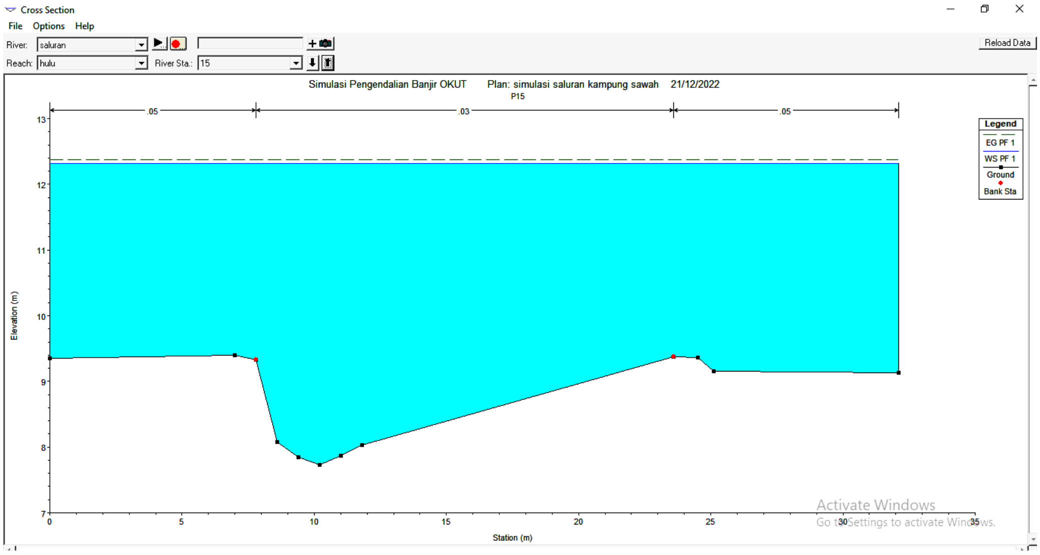

Figure 8: Simulation results at point P_{15} (1+500) (Source: simulation results, 2022)

In figure 8. Precisely at point P_{15} (1+500) there is also an overflow of the flow with a height of 3.00 meters, meaning that the further upstream the movement of flow on the channel surface also occurs, the higher it is.

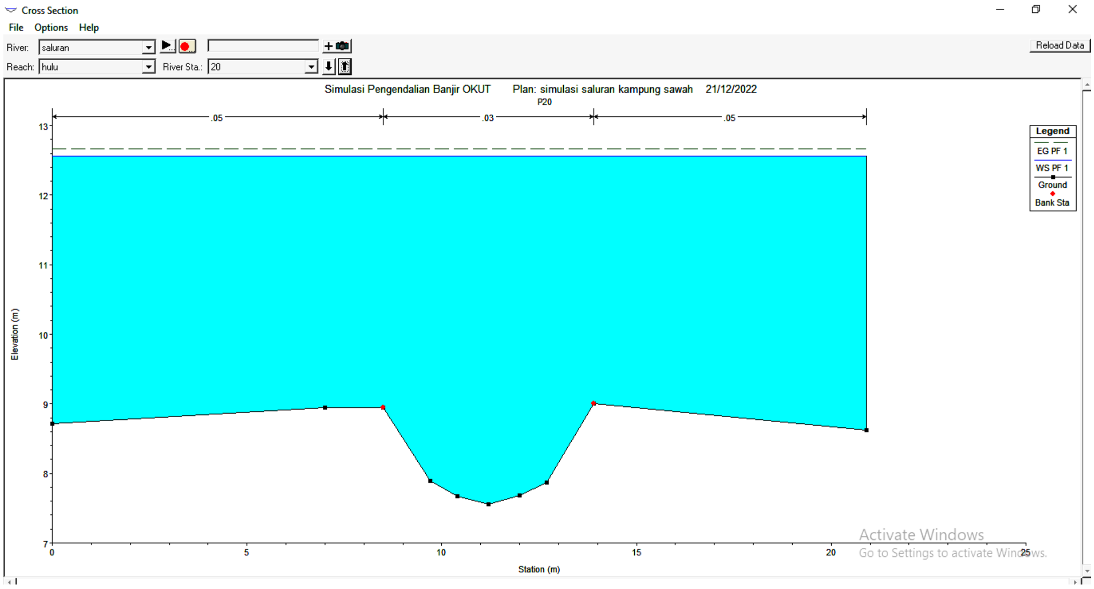

Figure 9: Simulation results at point P_{20} (2+000) (Source: simulation results, 2022)

In figure 9. At point P_{20} (2+000) there is also higher water overflow with a height range of almost 4.00 meters, meaning that the further upstream you go, the higher the overflow in the channel at point P_{20} occurs.

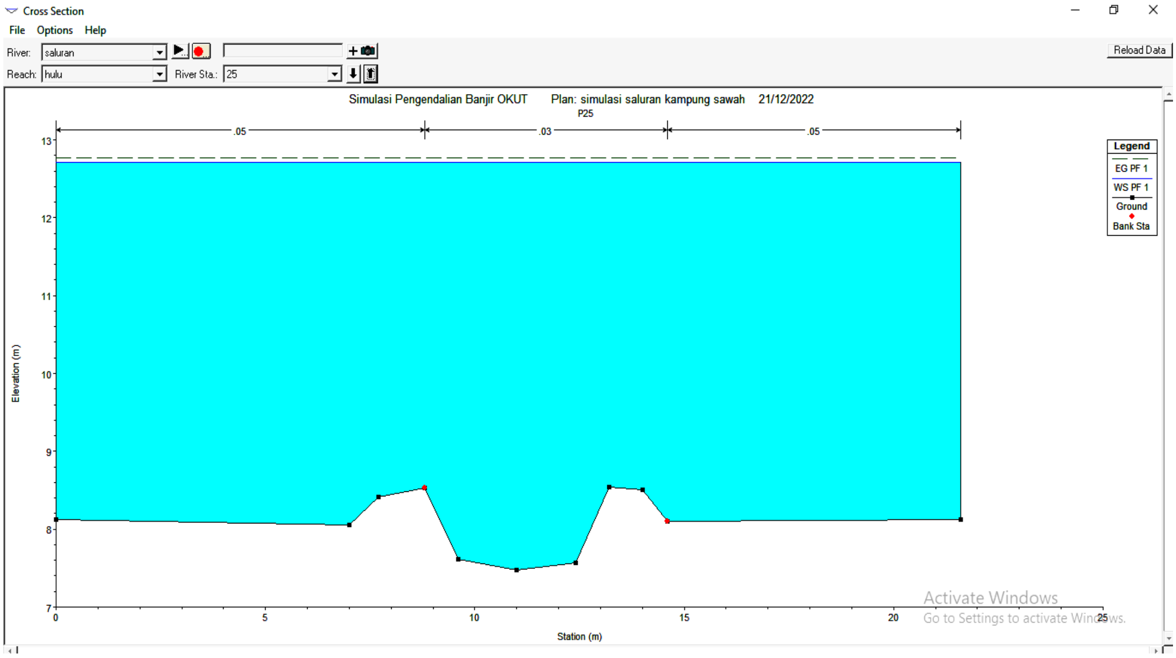

Figure 10: Simulation results at point P_{25} (2+500) (Source: simulation results, 2022)

In figure 10. At point P_{25} (2+500) there is also an overflow of water with a height of almost 4.00 meters, meaning that in the cross section of channel P_{25} (2+2500) the further upstream the change in water level occurs, the more it increases.

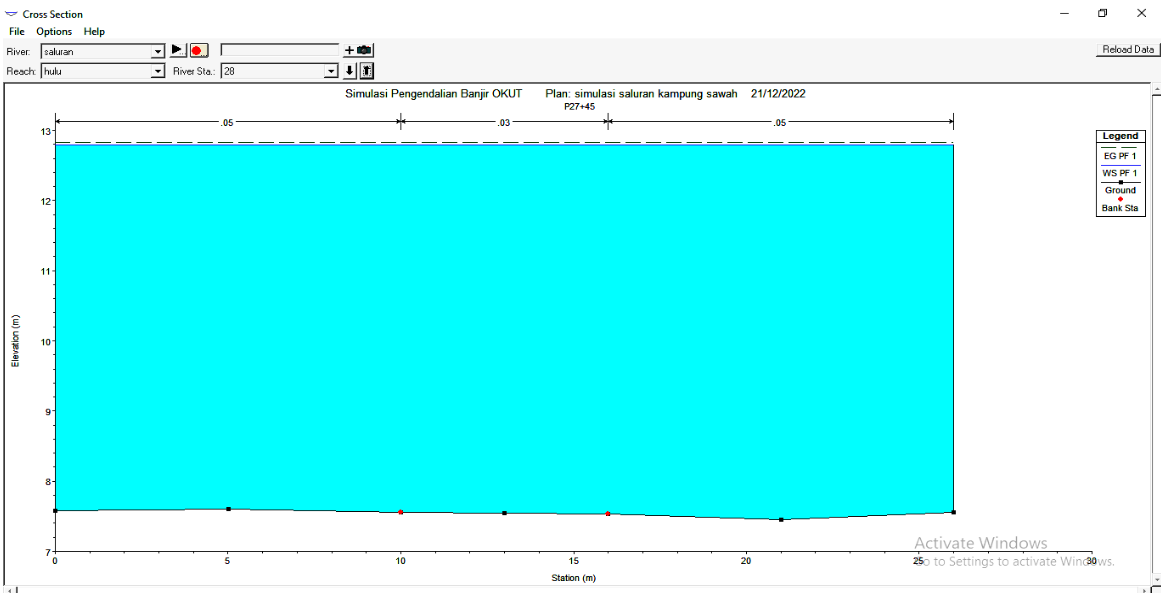

Figure 11: Simulation results at point $P_{27.45}$ (2.7+450) (Source: simulation results, 2022)

In Figure 10. at point $P_{27.45}$ (2.7+450) it is almost certain that water overflow has occurred with a height of almost 5.00 meters, meaning that in the 2.745 km long channel in the rice field village area there has indeed been an overflow and inundation. which resulted in a flood disaster in the area.

IV. CONCLUSION

From the results of modeling simulation analysis with the HEC-RAS program and flood tracing in the Kampung Sawah area channel, Martapura, it can be concluded as follows:

1. The flow capacity or flood discharge (Q) that occurs in the channel in the Kampung Sawah area, Martapura subdistrict, East OKU Regency is 14,403 m^3/sec with a slowdown in the flow in the channel which will move back into the Komering river due to the backflow. water) from the Komering river.
2. Simulation results of water level movements in each cross section along the 2,745 km channel in the Kampung Sawah village area, Martapura sub-district, East OKU Regency, all of which overflow occurs as at the starting point of the channel (P_0) of +/- 0.5 meters ; P_5 is +/- 2.50 meters; P_{10} of 2.50 meters; P_{15} of 3.00 meters; P_{20} of 4.00 meters; P_{25} of +/- 4.00 meters; and at $P_{27.45}$ for 5 meters.

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