Estimation of Changes in The Water Level of The Buah river with HEC-RAS Program

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Abstract

This study aims to analyze of flood hazard of water level changes in the Buah River with the HEC-RAS software program. Buah river is one of the river flow directly into the Musi River. The Buah River has a length of 7.93 km, part of which has been built with the retaining walls with concrete structures. While Some of the walls are made of ordinary soils.
The results showed that at station 3+000 of the Buah river there was flooding due to an overflow of water as high as 0.90 m both on the left and right side of the river channel. At stations 2+750 to 2+800 there was a decrease in water level ranging from 0.70 m to 0.80 m, while at station 2+700 there was a decrease in the water level as high as 0.20 m at station 2+700, the overflow was not too high but still flooded to this area.

Keywords: IDF curve, HEC-RAS program, Flood Hazard, Water level fluctuation

I.INTRODUCTION

A river or open channel is a channel where water flows with a free water level. In an open channel, for example a river (natural channel), the flow variable is very irregular with respect to time and space. These variables are the cross section of the channel, roughness, bottom slope, curvature of the flow rate and so on [1]. A river is a long channel on the surface of the earth where water flows from rain and is always touched by the flow of water and is formed naturally [2].
The complexity of the river system can be seen from the various components of the river, for example the shape of the river flow and branching, river bed form, river morphology, and river ecosystem. The river branch will resemble a river tree starting from the first order to the nth order river. The river bed formation, when examined at a glance, is very difficult to identify and characterize. The shape of the meander groove is influenced by the longitudinal slope of the landscape, the type of river bed material, and the vegetation in the area [3]. The biggest benefit of a river is for agricultural irrigation, raw materials for drinking water, as a drainage for rainwater and waste water, and it has the potential to become a river tourism object. In Indonesia, there are currently 5,950 watersheds.
Palembang City itself has 108 tributaries. There are 4 major rivers that cross the city of Palembang, namely the Musi River, Komering River, Ogan River, and Keramasan River. Of the 4 major rivers above the Musi River, the largest river with an average width of 504 meters and a maximum width of 1,350 meters is located around Kemaro Island [4].
Based on the division of the river area there are 21 sub-watersheds, but only 18 sub-watersheds in the city of Palembang which empties directly into the Musi river in the city of Palembang, namely the Rengas, Lacak, Gandus, Lambidaro, Boang, Sekanak, Bendung, Lawang Kidul, Buah, Juaro, Batang, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju [5].

The urban drainage system which always experiences flooding in Palembang every year, among others, is the Buah river basin. The Buah River, with the main river being 7.93 km long, has many meanders and a river wall reinforcement has been built. The Buah watershed, with an area of 10.79 km2, is generally a residential, industrial and swampy area. The Buah Watershed is one of the 33 flood-prone areas in Palembang City. This is because, until now the Buah Watershed does not yet have pumping facilities. As a result, the Sapta Marga, Sekojo, and Urip Sumoharjo areas, which flow into the Buah watershed are also frequently flooded [5].

The simulation uses a program with different conditions, namely existing conditions, normalization of river flows, cut-off, retention ponds, a combination of a pump system and the construction of embankments, showing that there are seven inundated areas in the existing conditions. After the flood management simulation with normalization and cuttings has been carried out, the runoff height has decreased to 0.11 m in the downstream part of the river. Another flood management simulation is the construction of a retention pond that can reduce runoff height by up to 0.9 m in the area where the retention pond is built. Combined simulation with a pump system with a capacity of 11 m^3/sec and 4 m^3/sec in the lower reaches of the Buah river can reduce runoff by up to 0.22 m. The height of the embankment reaches 0.68 m in the Buah sub-district [6].

HEC-RAS is a program that can model unsteady flow with one-dimensional view with more accurate geometric modeling because the approach points for modeling river cross sections can be made more than some other one-dimensional unsteady flow programs that are often used. Thus, the depiction of each cross section of each profile using the HEC-RAS program will be closer than before [7] .

Simulation with HEC-RAS aims to determine the longitudinal profile of the river, maximum water level elevation, and flow velocity. In addition, with this model, it is also possible to modify the appearance of the channel to get a channel view that can anticipate the planned flood discharge. The model that will be discussed consists of 3 studies, namely the existing model, the sluice gate and the pump system [7].

Floods are disasters that often hit especially urban areas so that they can harm human activities and other living things. The first step in predicting flooding is by hydrological modeling. The hydrological model is a simple description of the watershed of a complex hydrological system to predict hydrological events that will occur such as floods [8].

II.RESEARCH METHODS

The materials and tools used in this study were to collect rainfall data to analyze rainfall with a certain return period covering a return period of 2 years, 5 years, and 10 years, after which the intensity of rainfall was calculated for the first time the concentration time was calculated. Then a rainfall frequency intensity (IDF) curve is made and calculates the planned discharge for each certain return period.

The HEC-RAS 4.1.0 program was carried out to predict the overflow of water in the channel/river at each cross-section based on the results of the survey of the cross-section and the longitudinal profile of the river [7].

This research was conducted using an empirical approach, including hydrological analysis and hydraulics analysis, then simulation was carried out using the HEC-RAS program. Hydrological analysis to determine the design rain with a certain return period and get a picture of the IDF (Intensity Duration Curve) 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 4.1.0 software program [7].

In the hydraulic analysis, the water level profile is calculated using some data on the design flood discharge and Buah drainage system to obtain a water level profile. In this analysis also used the application program HEC-RAS. After getting the direct runoff discharge, the results of the calculations on the existing channel are simulated using HEC-RAS [7].

After the data is collected, it is processed as follows:

a) Rainfall analysis is analyzed using frequency analysis, then the selection of frequency distribution with the normal distribution method, normal log, pearson type III log, and gumbel.
b) Then the suitability test to determine the difference in discharge from the calculation results. Conformity test using chi-squared and rainfall intensity with Smirnov-Kolmogorov
c) Design Flood Discharge Analysis
d) Calculating the design flood discharge using the rational equation method which previously determined the intensity of rain, time of concentration and runoff.
e) Hydraulic Analysis
   This analysis is carried out by calculating the planned flood discharge using the rational formula
f) The HEC-RAS program version 4.1.0 is used for modeling the Buah river to determine the ability of the trough/channel body to accommodate flood discharge within a certain return period.

III. Result and Discussion

3.1. Intencity Duration Frequency Curve

The results of the calculation of the intensity of rain for each return period in a span of 10 minutes. So that IDF curves can be made with the help of Ms. Excel. The following is the shape of the IDF curve from the rain intensity data that has been obtained which is shown in Figure 1.

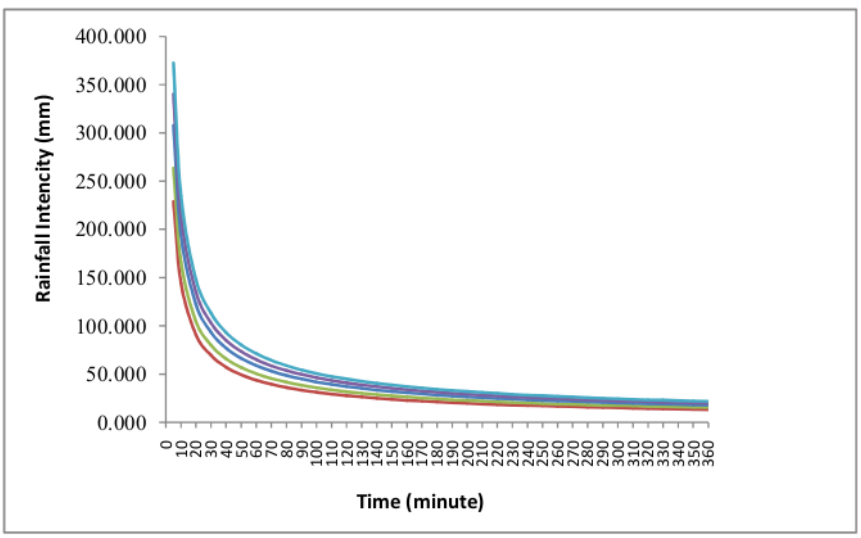

Fig. 1. IDF (Intencity Duration Frequency) Curve

3.2. Buah river discharge

To calculate the runoff discharge using the Rational Formula. The results are as in table 1.

Table 1. The results of the calculation of runoff discharge

Return Period (years)	C	I (mm/jam)	A (km^2)	Q (m^3/det)
2	0.5864	257.1460	8.458	9.84
5	0.5864	296.2446	8.458	11.34
10	0.5864	345.6414	8.458	13.22
20	0.5864	382.2866	8.458	14.63
50	0.5864	418.6661	8.458	16.02

3.3. Simulation Results

After all the data is entered into the HEC-RAS Program, then it is run and the data results are seen. Each return period discharge is seen in each cross section.
The pattern of water level movement in the Buah river/channeland its effect on the existence of the Arafuru retention pond can be seen as shown below:

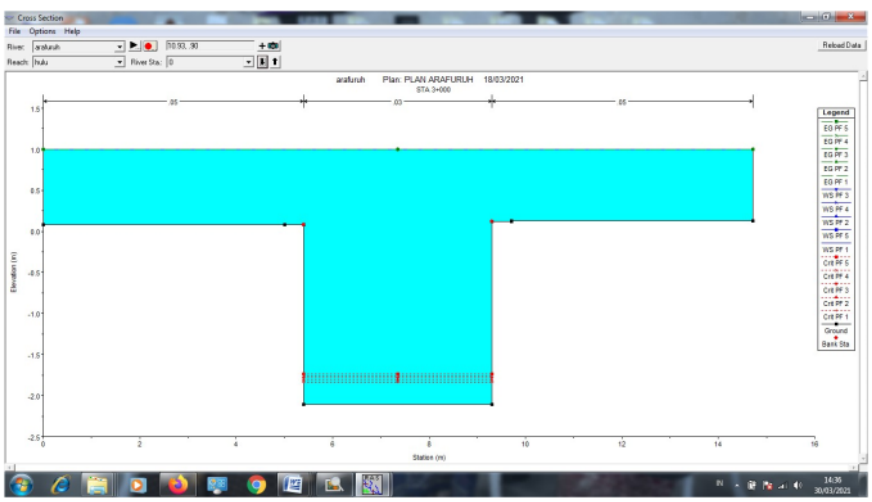

Fig. 2. Pattern of water flow movement in the river Sta. 3+000

In Figure 2. it can be seen that at Sta.3+000 there was an increase in the water level in the river of approximately 0.90 m. This means that at Sta 3+000 there is an overflow which affects the fluctuation of water level in the Arafuru retention pond.

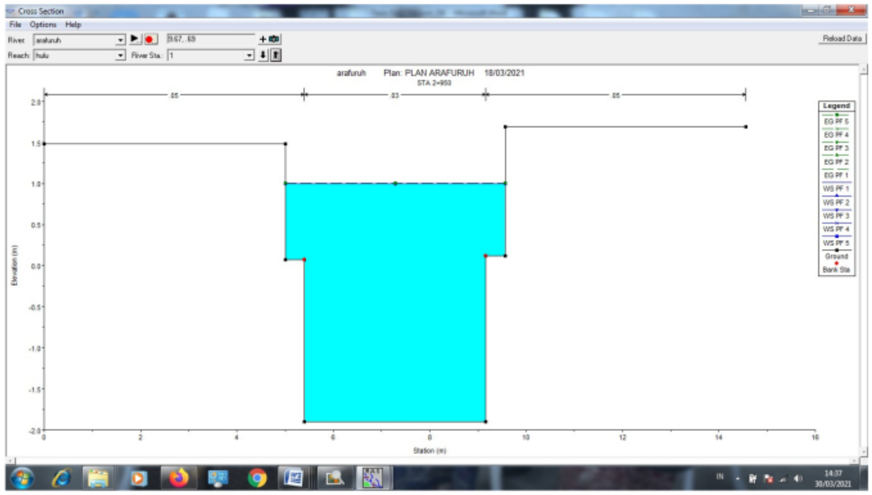

Fig. 3. Pattern of water flow movement in the river Sta. 2+950

In Figure 3. at Sta.2+950 there is no water level rise in the river at that station. This means that at Sta 2+950 there is no overflow where there is not affects to the Arafuru retention pond.

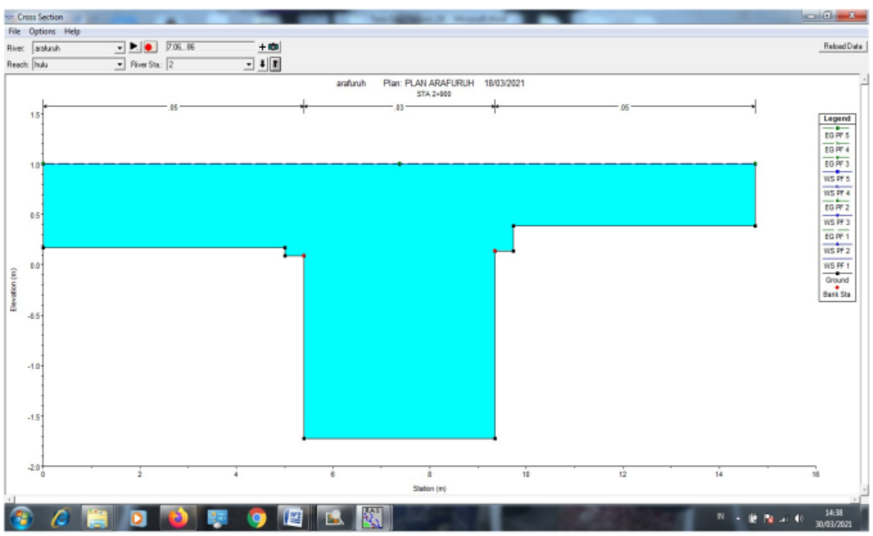

Fig. 4. Pattern of water flow movement in the river Sta. 2+900

In figure 4. seen at Sta. 2+900 there is a rise in water level in the river of approximately 0.80 m. This means at Sta. 2+900 overflow occurs which will affect the water fluctuation in the Arafuru retention pond.

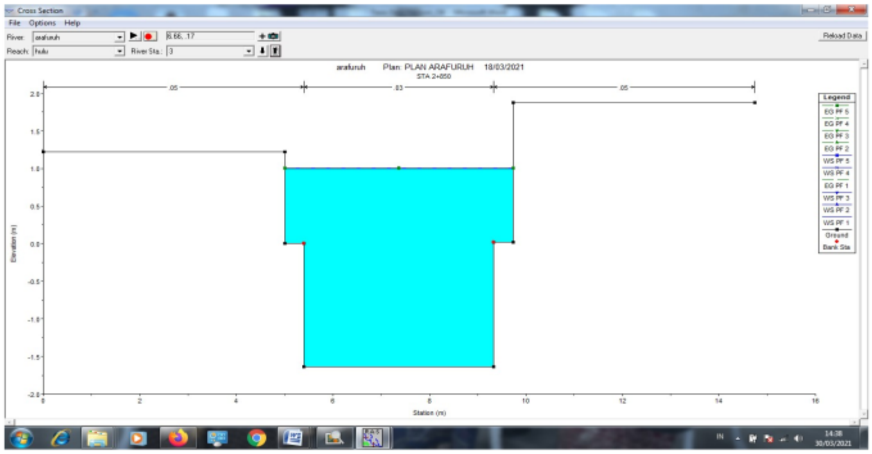

Fig. 5. Pattern of water flow movement in the river Sta. 2+850

In figure 5. seen in Sta. 2+850 there is no water level rise in the river. This means at Sta. 2+850 there is no overflow that will affect the water balance in the Arafuru retention pond.

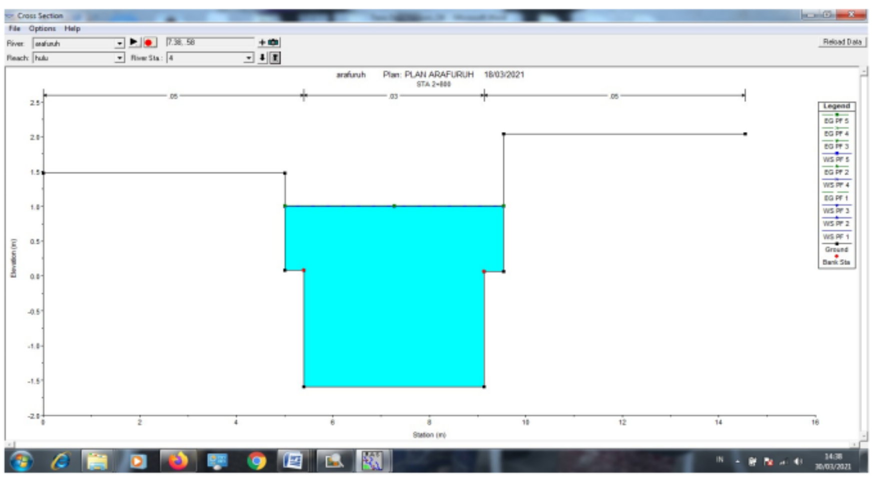

Fig. 6. Pattern of water flow movement in the river Sta. 2+800

In figure 6. it can be seen at Sta.2+800 that there is no increase in the water level in the river, even it tends to decrease to 0.5 m. This means that at Sta 2+800 there is no overflow so that the Arafuru retention pond is in a euilibrium or balanced condition.

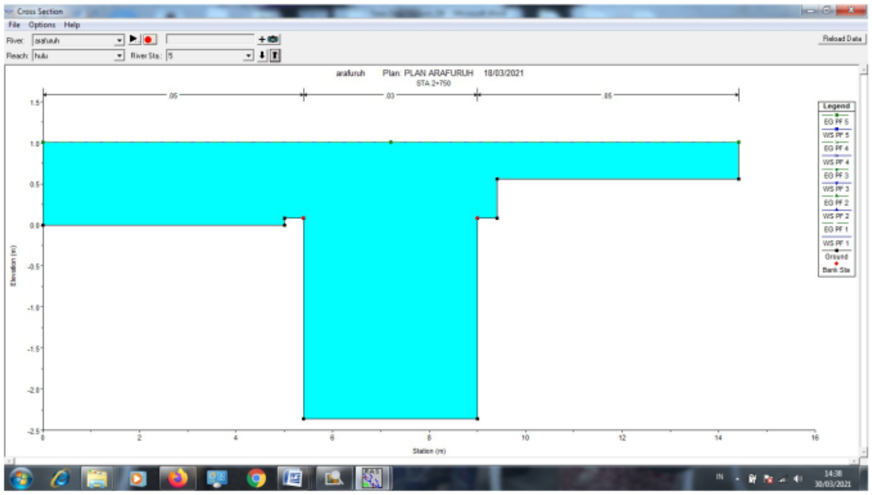

Fig. 7. Pattern of water flow movement in the river Sta. 2+750

In figure 7. the situation of fluctuation in the Buah river at station 2+750 where the condition is that the water level in the Buah river again rises at station 2+750, so that the increase in water level at this station affects the conditions in the Arafuru retention pond. Under these conditions, flooding occurred in the area at sta 2+750 as high as 1.00 m.

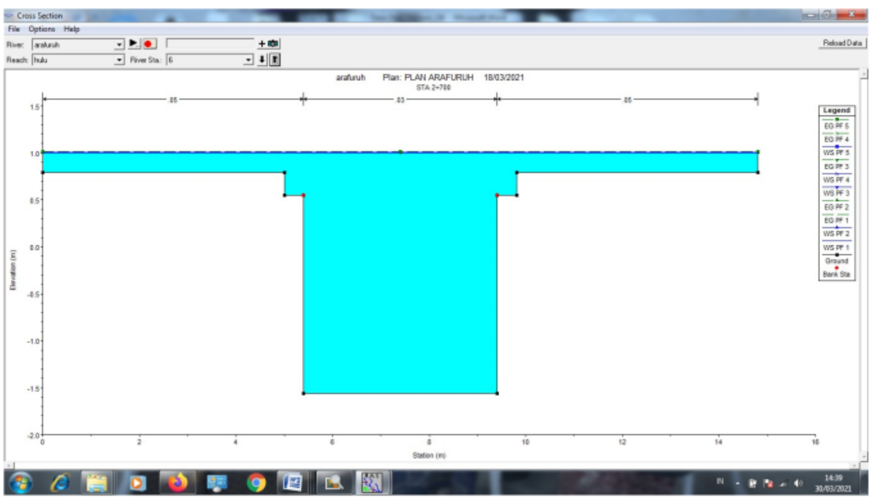

Fig. 8. Pattern of water flow movement in the river Sta. 2+700

In figure 8. as shown, there was a 0.20 m drop in water level at station 2+700, the overflow was not too high level on the river/channels but still flooded.

IV. CONCLUTION

In the Buah River, which has the Arafuru retention pond, there is an area where the water overflows, namely at station 3+000, which is 0.90 m both on the right and left of the channel/river bank protection. At stations 2+750 to 2+800 there was a decrease in the water level ranging from 0.70 m to 0.80 m, while at station 2+700 there was an increase in the water level of the Buah river. This is due to the effect of opening and closing the flap gate in the Arafuru pond.

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