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# Effect of Water Balance in Arafuru Retention Pond due to Buah River Water Level Changes

Deni Harison[1] and Achmad Syarifudin[2]

[1,2]Civil and Environment Engineering Faculty,

Universitas Bina Darma

Indonesia



**Abstract— The study was conducted to examine the effect of changes in water level in the Buah River on the balance of water retention in the Arafuru pond using the HEC-RAS ver.4.1.0 program.**

**The data used is based on rainfall data analysis, namely the value of rainfall rainfall simulation results from the Buah River Basin (DAS) with the main river length of 7.93 km, there are many meanders and river wall reinforcement has been built.**

**The results showed that the Buah River with Arafuru retention contained areas where the water ran off, namely at station 3+000 which was 0.90 m both on the right and left of the channel cliff. 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 of the Buah river which resulted in changes in air balance and the effect of opening and closing the floodgates ( closing gate) in the Arafuru pond.**

**Keywords—The Buah river; Flood discharge; IDF curve; HEC-RAS program; Water balance**

## I. Introduction

In hydrology, rain is an important input component in the hydrological process. Analysis of rain data in the review of hydrological planning aspects is used as an approach in estimating the amount of flood discharge that occurs in a watershed. The approach to estimating flood discharge that occurs from rain data is carried out if the watershed concerned is not equipped with an Automatic Water Level Recorder (AWLR) water gauge. To obtain the amount of rain that can be considered as the actual depth of rain that occurs throughout the watershed, it is necessary to have a number of rain stations that can represent the amount of rain in the watershed.

Water resource problems such as drought, flooding, and difficulties in utilizing water resources in the city of Palembang, especially in urban areas. Almost at the beginning of the dry season, residents' wells and almost all rivers or streams of water as well as under and reservoirs experience a sharp decrease in water volume. On the other hand, during the rainy season, some of the Buah Watershed experience problems with flooding due to scouring and sedimentation from the Buah river, as well as factors that change land function which causes water to not seep into the ground.

Flood is a disaster that often strikes an area in Indonesia, especially urban areas so that it 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 (DAS) of a complex hydrological system to predict hydrological events that will occur such as floods. (Sri Harto, 1993).

There are 4 (four) major rivers that cross the city of Palembang, namely the Musi River, Komering River, Ogan River, and Keramasan River. The main river of the 4 (four) major rivers mentioned above is the Musi river which has an average width of 504 meters and a maximum width of 1,350 meters around Kemaro Island. (Syarifudin, A, et al, 2018). The city of Palembang as the capital of the province of South Sumatra has 108 tributaries consisting of 21 sub-watersheds, but only 18 sub-watersheds in the city of Palembang which empties directly into the Musi river, namely the Rengas Lacak, Gandus, Lambidaro, Boang, Sekanak, Wendung, Lawang Kidul sub-watersheds. , Fruit, Juaro, Batang, Sei Lively, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju. (Department of PUPR of Palembang city, 2018)

HEC-RAS itself is a software program that can model unsteady flow with a 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. (Baitullah, 2014) . 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. (Baitullah, 2014).

## II. RESEARCH METHODS

### 2.1 Tools and Materials

The tools and materials using 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 the rainfall intensity intensity (IDF) curve is made and calculate 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. (Baitullah, 2016).

### 2.2 Research methods

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. (Baitullah, 2016)

In the hydraulic analysis, the water level profile is calculated using some data on the design flood discharge and drainage channels in the Jakabaring Sport City (JSC) main channel to obtain a water level profile. In this analysis also used the application program HEC-RAS 4.1.0. After getting the direct runoff discharge, the results of the calculations on the existing channel are simulated using HEC-RAS 4.1.0. (Baitullah, 2016)

### 2.3 Process and Data Analysis

To Procesing of the data as follows:

- 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. 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.
- Design Flood Discharge Analysis

  Calculating the design flood discharge using the rational equation method previously determined the intensity of rain, time of concentration and runoff.
- Hydraulic Analysis

  This analysis is carried out by calculating the planned flood discharge using the rational formula
- The HEC-RAS program version 4.1.0 (open source) is used for modeling the Jakabaring Sport City (JSC) Main Channel to determine the ability of the trough/channel body to accommodate flood discharge within a certain return period.

### 2.4 Research preparation

This research was conducted using a laboratory approach method with various variations in the flow rate, flow rate and time. The standard channel (flume standard), most of its components are made of glass and have important parts, namely:

- The aqueduct, the main place in this experiment, to drain the water. In the form of water flume with a size of 4.00 x 20 x 15 meters. This channel has transparent walls for easy to observed phenomena of the scoring depth,
- A reservoir that functions to accommodate water that will be flowed into the channel or out,
- Water pump, used to pump water so that it can be distributed along the gutter,
- Discharge faucet, functions to regulate the discharge that comes out of the pump. Has a discharge scale of 6-9 range,
- The tilt adjustment wheel, located upstream and downstream of the channel, can be manually turned to adjust the desired bed slope. This bed slope adjustment wheel has a scale for maximum positive bed slope + 3.0% and maximum negative bed slope - 1.0%.

## III. RESULTS AND DISCUSSION

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.

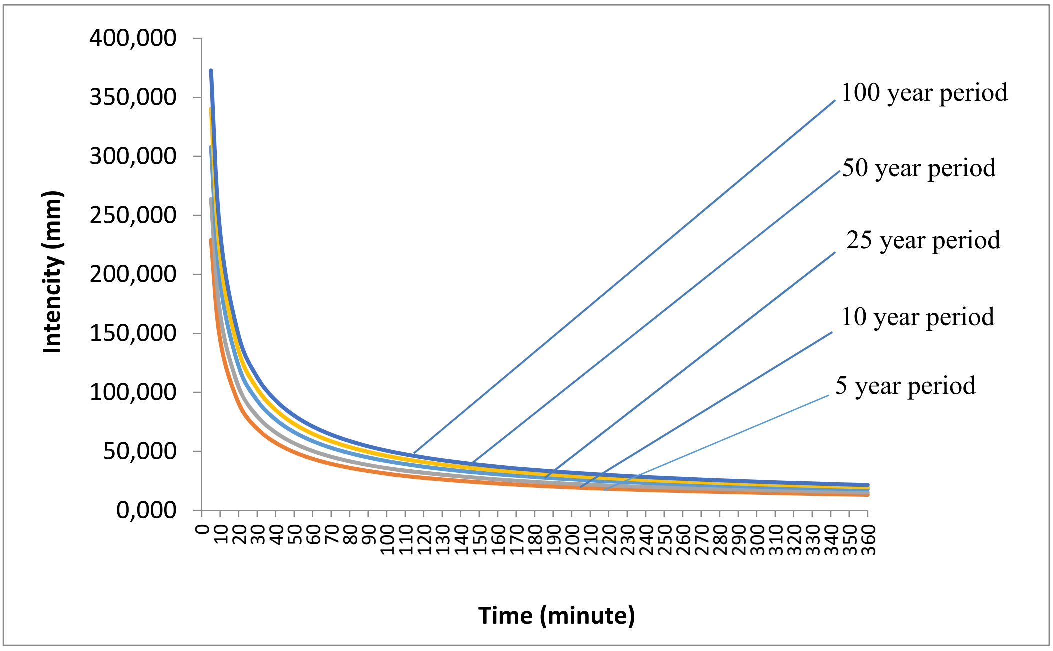


Fig. 1. Intencity Duration Frequency - Curve

### 3.1 Buah river discharge

To calculate the runoff discharge (Q) using the Rational Formula and the results of discharge value are as in table 1.

TABLE I. EXPERIMENTAL RESULTS IN THE LABORATORY

| 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 |

### 3.2 Simulation Results

After all 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/channels and its effect on the presence of the Kiwal retention pond can be seen as shown in the image below:

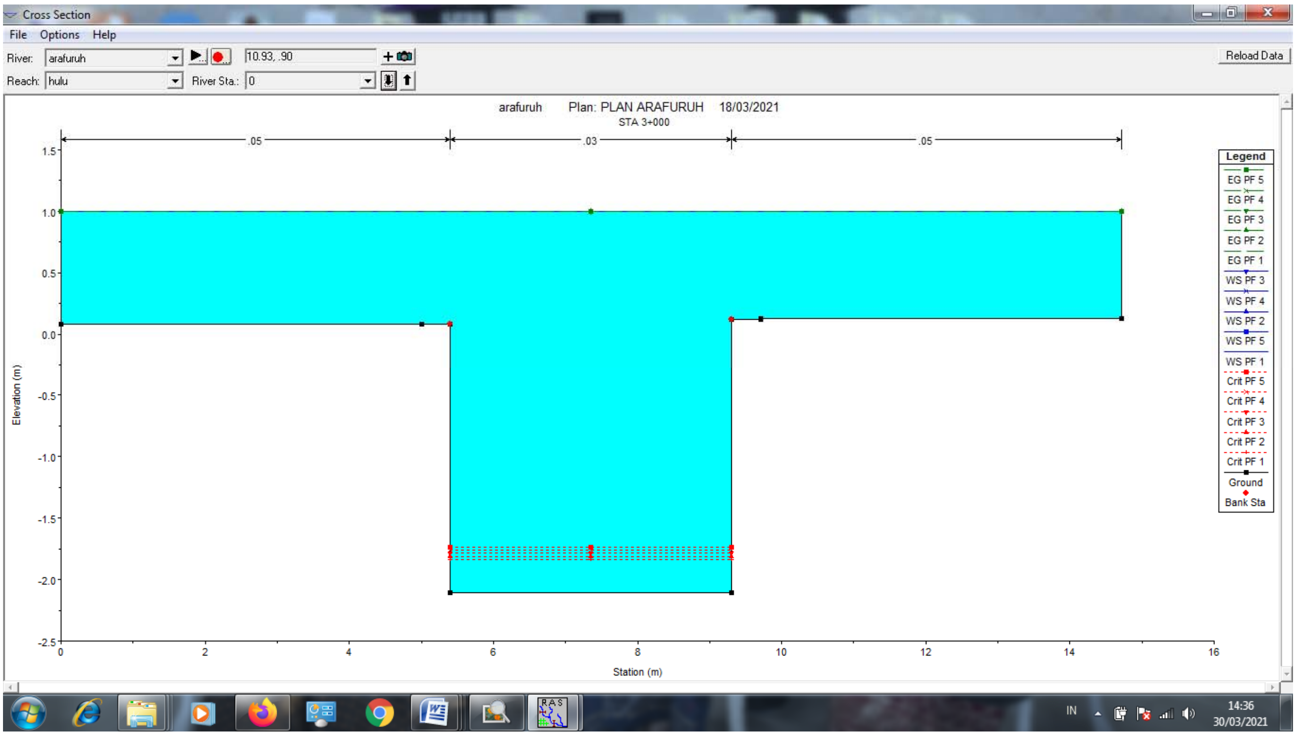


*Fig. 2.* The pattern of water flow movement in the Buah river Sta.3+000

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 flow balance in the Arafuru retention pond.

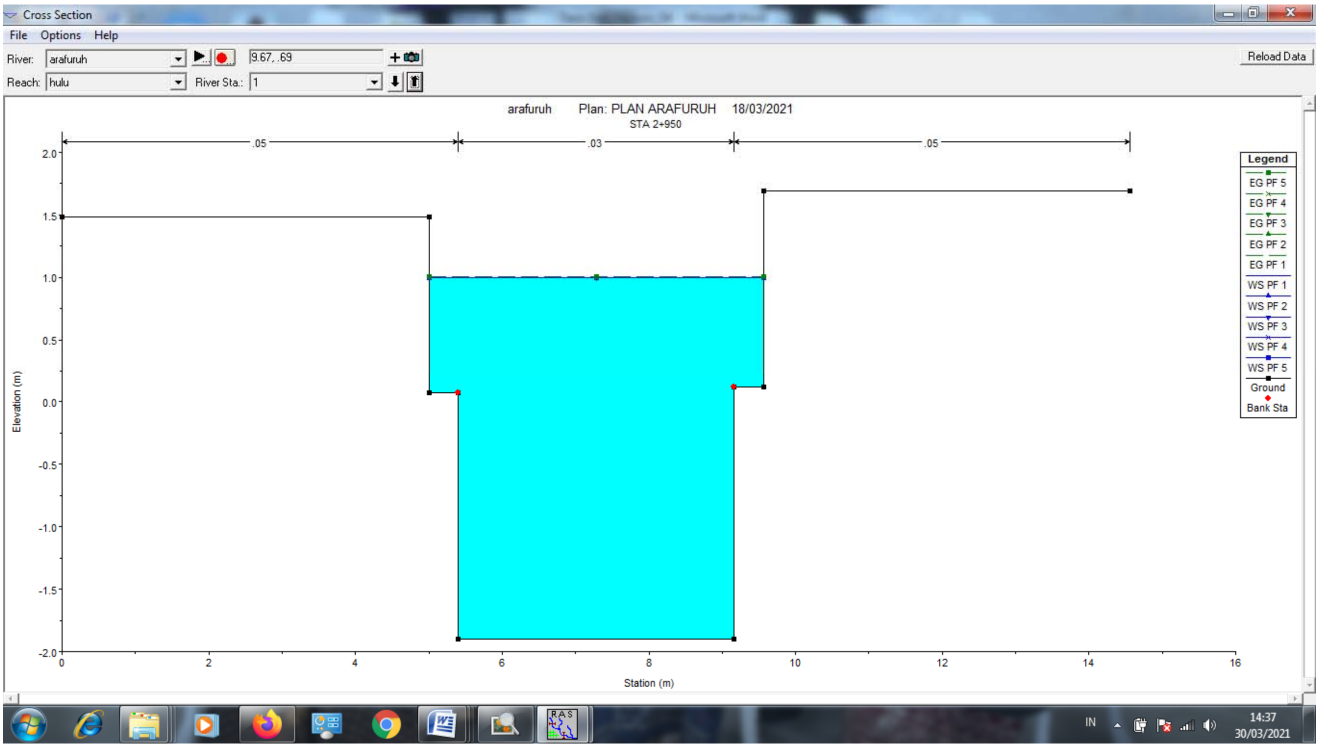


*Fig. 3.* The pattern of water flow movement in the Buah river Sta.2+950

In Figure 3. at Sta.2+950, there is no visible water level rise in the river at that station. This means that at Sta 2+950 there is no overflow that affects the Arafuru retention pond.

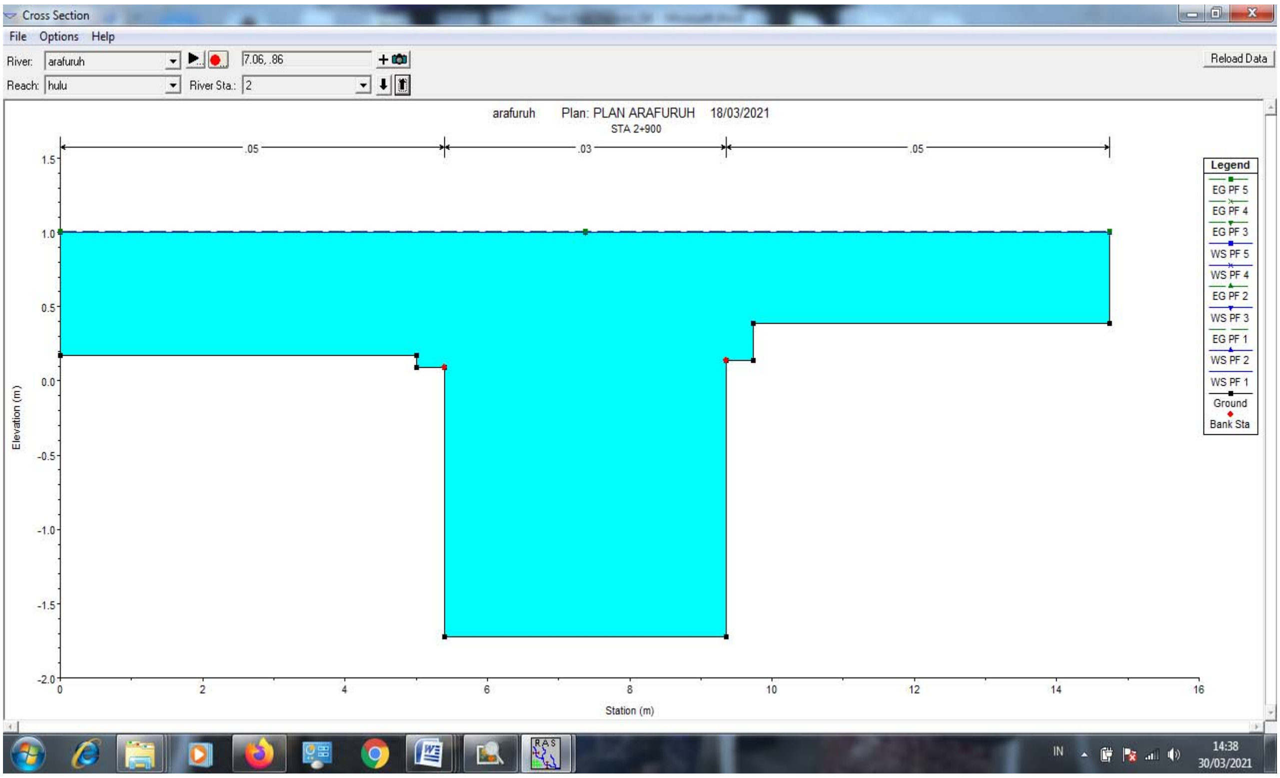


*Fig. 4.* The pattern of water flow movement in the Buah river Sta.2+900

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 flow balance in the Arafuru retention pond.

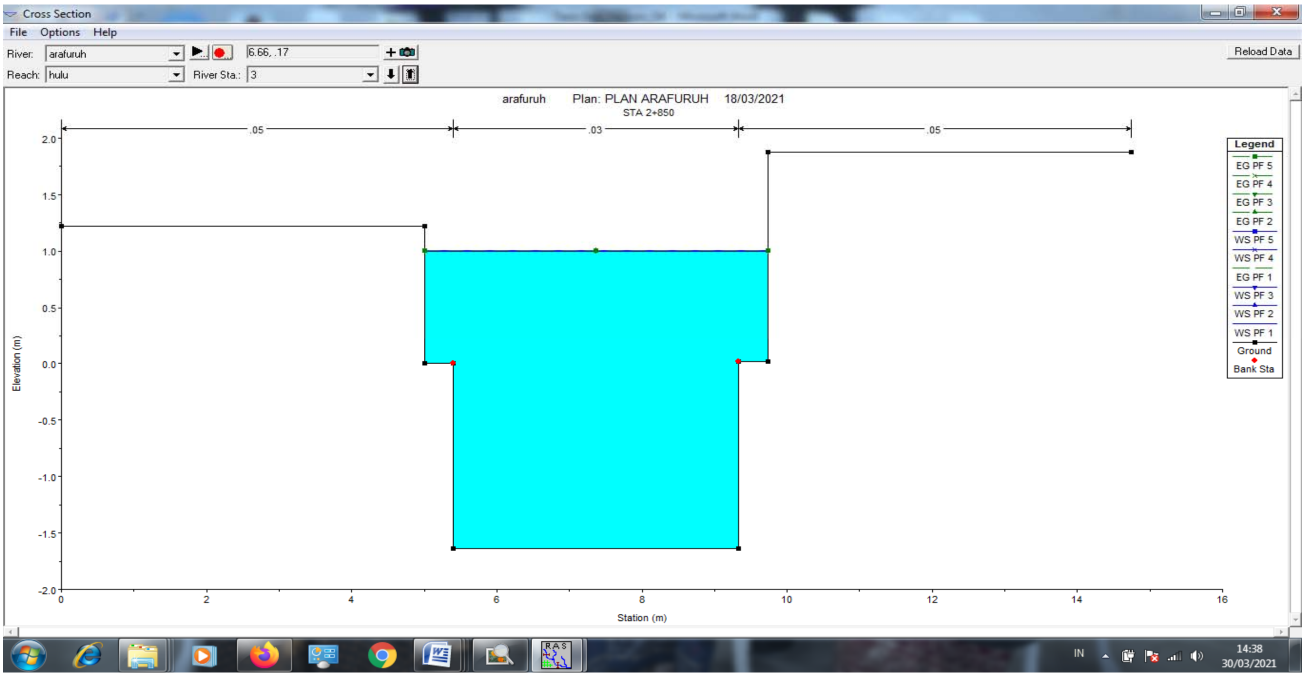


*Fig. 5.* The pattern of water flow movement in the Buah river Sta.2+850

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 which will affect the flow balance in the Arafuru retention pond.

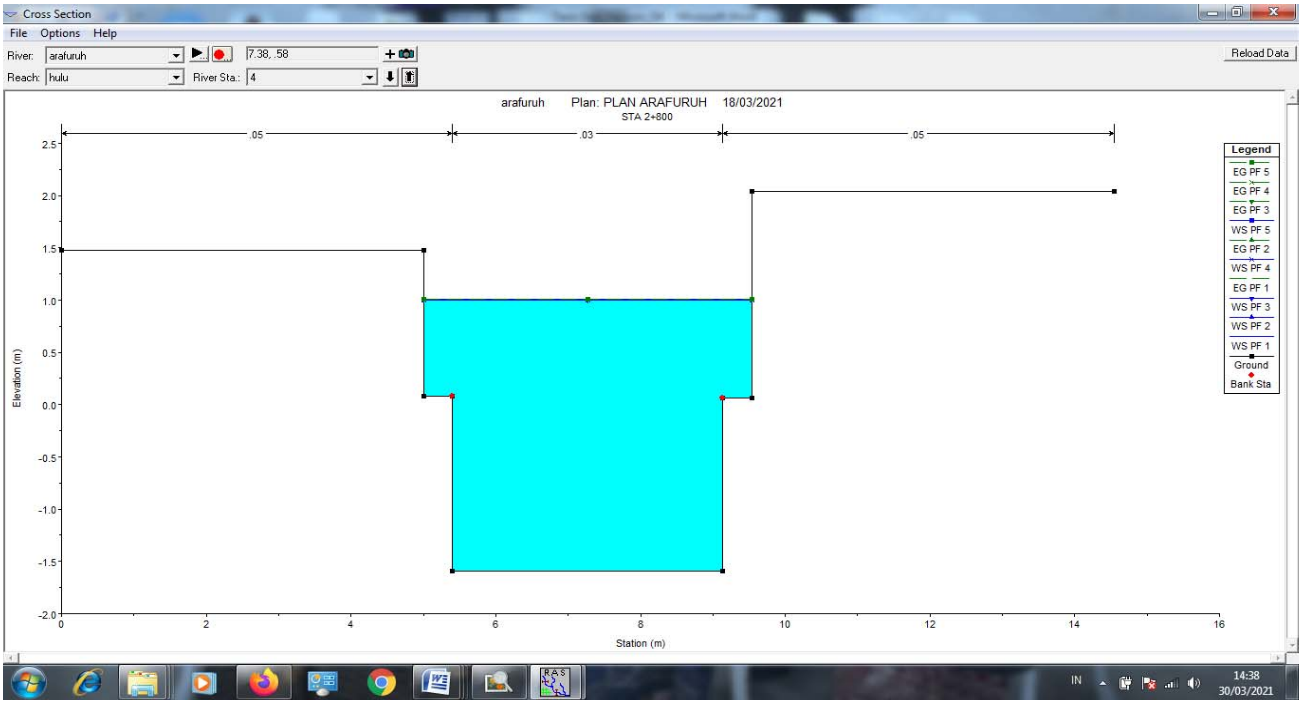


*Fig. 6.* The pattern of water flow movement in the Buah river Sta.2+800

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 balanced condition.

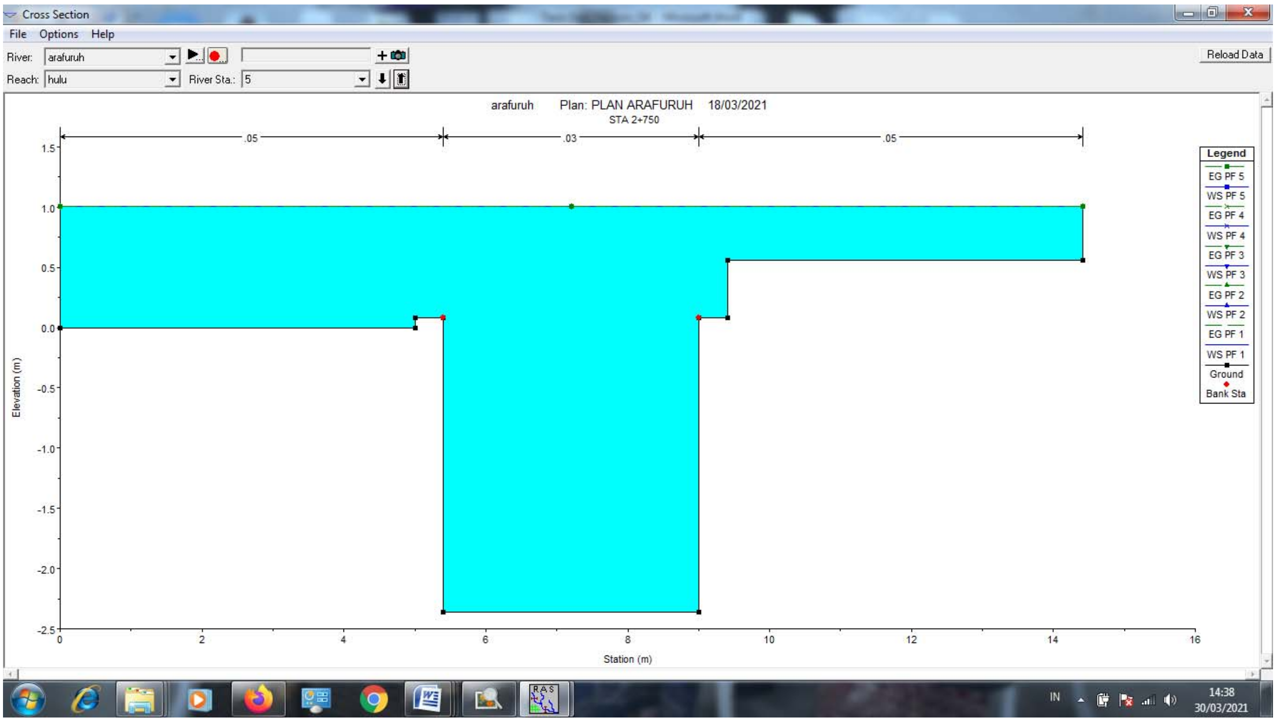


*Fig. 7.* The pattern of water flow movement in the Buah river Sta.2+750

In Figure 7. below is a picture of the situation 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.

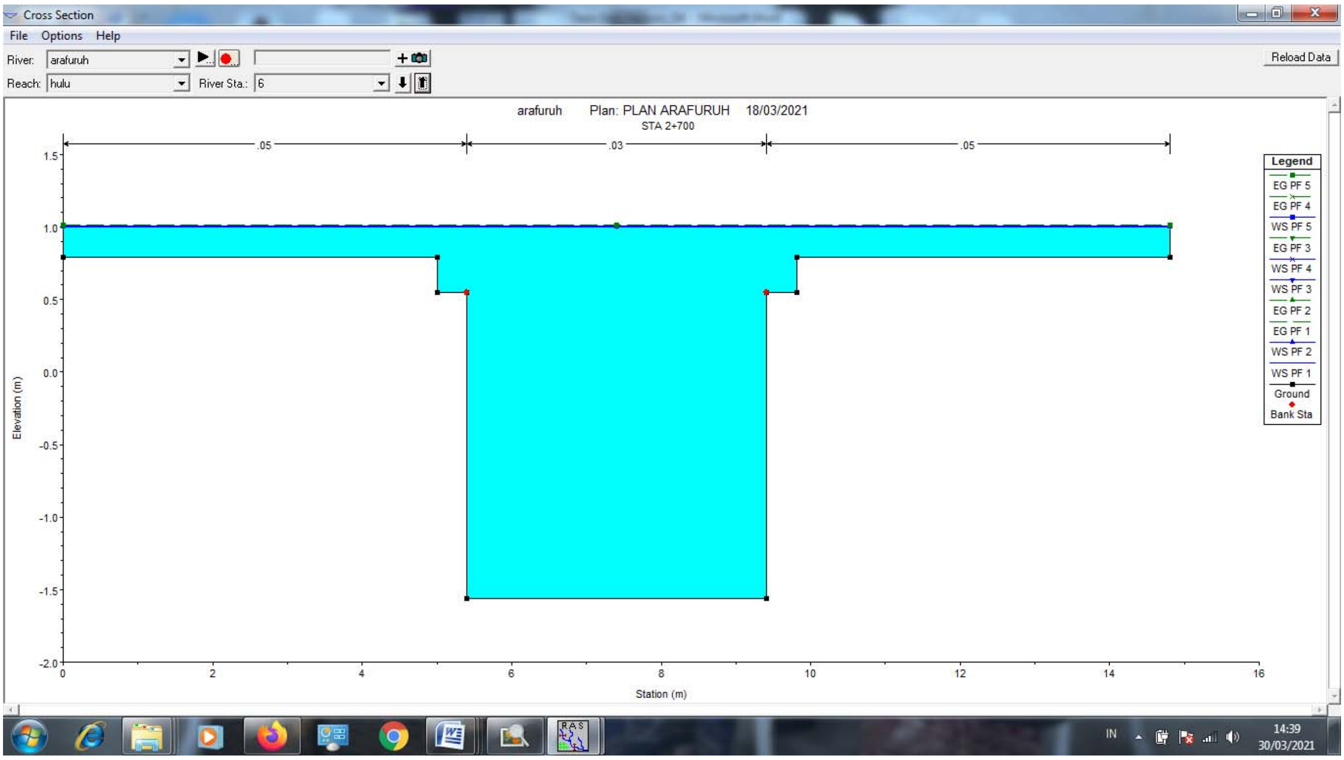


*Fig. 8.* The pattern of water flow movement in the Buah river Sta.2+700

In Figure 8. as shown below, there is a decrease in the water level at station 2+700, it is possible that this condition affects the water level in the Arafuru retention pond.

## IV. CONCLUSION

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. 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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