Methods for Handling Rob Floods in the Banger River Basin in Semarang City

Ikhwanudin, S I Wahyudi and Soedarsono

Civil Engineering Department, Universitas Sultan Agung Semarang
Corresponding author: ikhwan_menur@yahoo.com

Abstrak. In the area of North Semarang often occurs tidal floods. The current government has dealt with the flooding of Rob by making dykes on the north coast of Semarang. There is a method of handling tidal flooding by making a retention pool, Longstorage equipped with a pump if there is a flood the water is stored in a retention pond then the water is pumped into the river. The purpose of this study is to formulate a correlation between pumps and retention ponds. Alternative flood control using the count of 50 years. The method used is using HEC-HMS. There are three alternatives used in the simulation: 1st alternative pond with an area of 3.8 m$^2$ and a storage volume of 114,000 m$^3$, with inflow of 31.4 m$^3$/s in this alternative the capacity of pump is 30 m$^3$/s, second alternative pool with an area of 4.7 m$^2$ and reservoir volume of 142,000 m$^3$, with inflow of 31.4 m$^3$/s, with pump capacity of 27 m$^3$/s. third alternative ponds with an area of 5.0 m$^2$ and a reservoir volume of 150,000 m$^3$, with inflow of 31.4 m$^3$/s. In this alternative a pump with a capacity of 25 m$^3$/s used.

Keywords: Rob flood, retention pool, pump

1. Introduction

Floods that occur on the coast of Semarang are generally caused by uncontrolled flowing water in rivers and drainage channels, which is caused by increased discharge and siltation and narrowing of river bodies, sedimentation. Causes of high sedimentation include environmental damage in the upstream or catchment area. The area of flood inundation is now increasingly expanding in several areas including around the estuary of the Plumbon River, Siangker River around Ahmad Yani Airport, Karangayu, Krobokan, Bandarharjo, Kali Banger, in Kali River Genuk from Kaligawe to the Demak, Global warming is one of the reasons for the occurrence of rob because of rising earth temperatures which cause sea level rise usually which is affected by tides is the coastal area rise over the past 25 years the rate of sea level rise is still unknown, because several studies show different results, [1] To reduce the risk and number of events flooding is needed system planning proper and integrated flood control. (Kodoatie, 2013), In this study flood discharge is calculated by the HEC-RAS program with rain intensity various re-period plans. The HEC-HMS program is a computer program to calculate rain transfer and routing processes in a watershed system. This software was developed by the Hydrologic Engineering Center (HEC) of the US Army Corps of Engineers. As for the hydraulic analysis using the HECRAS program. Data entered for this program is cross section data along river, river lengthwise profile, river hydraulics parameters (bottom roughness and cliffs river), river building parameters, and river flow discharge (planned discharge), and height water level at the river mouth [2].

In addition to flooding caused by high rainfall there are also other problems that often arise, namely the presence of tides (Rob) in several parts of the Central Java pantura region Even so, the government...
has tried to prevent water from tidal flooding into community settlements. One of the causes of this tidal flood is sea level rise, where the rate of sea level rise recorded at the Tanjung Emas Port Tidal Observation Station in Semarang is 5.43 cm/year [3].

Besides that, the factors of high tides and land subsidence are the main threats in the city of Semarang [4]. Land subsidence is basically a change (deformation) of the land surface vertically downward from a high reference field [3].

Existing conditions of land elevation which are lower than sea level cause the greater rate of land subsidence. Rob floods in Semarang caused damage to infrastructure and residential areas while also impacting the lives of people, households and individuals simultaneously [5]. The problem caused by tidal flood is productive land is no longer functioning properly, damage to public infrastructure and increasing conditions in slums. To overcome this problem, the Semarang City Government chose the Polder Banger drainage system. Indications of land subsidence in Semarang can be known from several data sources. Based on measurements and data of land subsidence in hilly areas in the city of Semarang is smaller than the decline in coastal areas. From field observations, land subsidence in former swamps and ponds showed the greatest decline, for example in the Tanah Mas housing complex, Tanjung Mas Beach, with decreases between 5.5 - 7.23 cm per year [5, 6, 7].

Based on the description in the background above, the problem was formulated, among others: when the rainfall is high, the banger catchment area often floods, if the tide (rob), the water will flood the houses of residents around the banger, while The objectives to be achieved from this research are: to find out the hydrological characteristics of the banger catchment area, to Make a simulation and operation of the banger pump system

2. Method of analysis
The research method that will be used is quantitative research in accordance with the conditions in the field.

2.1 Hydrological Analysis Method
Before conducting a hydrological analysis, first determine the rain station, rain data and catchment area. In the hydrological analysis will discuss steps to determine the flood discharge plan. The steps to determine the flood discharge plan are: calculate regional average rainfall, rainfall plan do the alignment test, to determine the method that meets the distribution test, to determine the method that meets the distribution test, calculate the intensity of rain and flood discharge plans: Calculation of Regional Average Rainfall Using the Thiessen Method, Rain Frequency Analysis: Normal method, Normal Log Method, Pearson Log Method III, Gumbel Method, Rain Data Alignment Test. Alignment Test Method: Match test with Chi Square Distribution Test, Smirnov test – Kolmogorov and Rain Intensity.

2.2 Analysis Method Discharge Flood Plans
Modeling flood discharge with HEC_HMS also begins with the division of watersheds into sub-watersheds. The depiction of the sub-watershed is carried out in a way: dividing residential areas and roads that are adapted to drainage channels in the existing conditions. other than that, the drawing of the sub-watershed is also determined based on the direction of flow and elevation in the existing concession. At HEC-HMS the main river is represented by reach. The hydrological model in the Banger Watershed HEC-HMS uses the SCS Unit Hydrograph method whereas for losses or losses using the SCS Curve Number method [8].

3. Results and Discussion

3.1. Analysis Hydrology

3.1.1 Regional Rainfall Distribution(area DAS). Based on checking experiments on the other 2 closest stations, namely Karangroto and Pucanggading using the Thiessen method with the help of ArcGIS
10.5 software resulting division of sections and area of influence of rain stations on each section using the Thiessen method: from the calculation using the catchment area Thiessen method as follows:

Table 1. Extent of rain station influence on Banger River Basin.

| Area                  | Catchment Area (m²) | Thiessen Coefficient |
|-----------------------|---------------------|----------------------|
| CA Maritim            | 6,750,000.00        | 1.00                 |
| Large DAS Banger      | 6,750,000.00        | 1.00                 |

Table 2. Regional maximum rainfall at the Maritim Rain Station.

| No | Year | Date       | Maximum Rainfall (mm) |
|----|------|------------|-----------------------|
| 1  | 2006 | 28 January | 156                   |
| 2  | 2007 | 6 November | 78                    |
| 3  | 2008 | 19 February| 96                    |
| 4  | 2009 | 25 December| 105                   |
| 5  | 2010 | 11 December| 169                   |
| 6  | 2011 | 2 January  | 89                    |
| 7  | 2012 | 4 February | 96                    |
| 8  | 2013 | 23 February| 135                   |
| 9  | 2014 | 23 January | 121                   |
| 10 | 2015 | 13 February| 119                   |
| 11 | 2016 | 11 April   | 74                    |
| 12 | 2017 | 28 October | 99                    |
| 13 | 2018 | 17 February| 139                   |

Table 3. Banger River Basin rainfall based on re-period.

| Return Period | Rainfall (mm) | Return Period | Rainfall (mm) |
|---------------|---------------|---------------|---------------|
| 2             | 104           | 100           | 196           |
| 5             | 131           | 200           | 211           |
| 10            | 147           | 500           | 229           |
| 20            | 163           | 1000          | 243           |
| 50            | 182           |               |               |

3.1.2. Rain Frequency Analysis. Frequency analysis in this study using A Prob software version 4.1 which has been developed by Ir. Istiarto, M.Eng., Ph.D staff lecturer at Gajah Mada University. Based on the analysis, it can be concluded that the rain data alignment test meets the distribution requirements of the distribution of Log Pearson III with the smallest maximum difference of 0.090. Proven in the Smirnov-Kolmogorof and Chi-Square test. the distribution of Log Pearson III data was declared passed The magnitude of the rain return is as follows:

Table 3. Banger River Basin rainfall based on re-period.

Based on the results of the analysis obtained concentration time for 1 hour, so the hyetograph used is a 1 hour rain hyetograph.

3.2. Analysis of Flood Discharge Plans

3.2.1. Design Basin Analysis. In the planning of the Banger drainage system it is planned with a Polder system. Pump stations are built to remove water from retention ponds. The plan for retention ponds can be seen in Figure 1.
3.2.2. Modeling a Polder Plan in the Banger River Basin. The depiction of the sub-watershed is done by dividing residential areas and roads that are adapted to drainage channels in existing conditions. In addition, the drawing of the sub-watershed is also determined based on the flow direction and elevation in the existing concession. The retention pond in Alternative 1 has a 3.0 m depth, 3.8 Ha area, and the storage volume is 114,000 m$^3$. In the HEC-HMS model the peak flood discharge that enters the pool is 34.1 m$^3$/s. The pump needed is 30 m$^3$/s, with a pump capacity variation of 6x5 m$^3$/s, schedule pump operation in Table 4. The pump is set to start at 2.5 meters water depth and turned off at a depth of 0.5 meters from the bottom of the pond. Assuming the depth of the pool water is 2 meters at the time of pumping.

**Table 4.** Pump operation schedule and alternative pool 1.

| Pump  | Capacity (m$^3$/dt) | Elevation | Depth |
|-------|---------------------|-----------|-------|
|       | on  | off | on   | off |
| Pump 1 | 5   | 0.5 | -1.5 | 2.5 | 0.5 |
| Pump 2 | 5   | 0.5 | -1.0 | 2.5 | 1.0 |
| Pump 3 | 5   | 0.5 | -0.75 | 2.5 | 1.25 |
| Pump 4 | 5   | 0.75 | 0.25 | 2.75 | 2.25 |
| Pump 5 | 5   | 0.75 | 0.25 | 2.75 | 2.25 |
| Pump 6 | 5   | 0.75 | 0.25 | 2.75 | 2.25 |

*Source: Analysis, 2019*
Figure 2. Inflow, outflow, and alternative pump Schedule 1.

The retention pond in alternative 2 has a depth of 3.0 m, an area of 4.7 ha and the storage volume of 142,000 m$^3$. In the HEC-HMS model the peak flood discharge is 34.1 m$^3$/s. The pump needed in alternative condition 2 is 27 m$^3$/s, with variations in pump capacity of 3x5 m$^3$/s and 3x4 m$^3$/s. Pump operating schedule in Table 5. The pump is set to start at 2.5 meters water depth, and turned off at a depth of 0.5 meters from the bottom of the pond. Assuming the depth of the pool water is 2 meters at the time of pumping.

Table 5. Pump operation schedule and alternative pool 2.

| Pump   | Capacity (m$^3$/dt) | elevation | Depth |
|--------|---------------------|-----------|-------|
|        |                     | on | off   | on | off |
| Pump 1 | 5                   | 0.5| -1.5  | 2.5| 0.5 |
| Pump 2 | 5                   | 0.5| -1.0  | 2.5| 1.0 |
| Pump 3 | 5                   | 0.5| 0.5   | 2.5| 2.5 |
| Pump 4 | 4                   | 0.75| 0.75  | 2.75| 2.75 |
| Pump 5 | 4                   | 0.75| 0.75  | 2.75| 2.75 |
| Pump 6 | 4                   | 0.75| 0.75  | 2.75| 2.75 |

Source: Analysis, 2019

Figure 3. Inflow, outflow, and alternative pump Schedule 2.
The retention pond in alternative 3 has a 3.0 m deep pool, 5.0 Ha wide, and reservoir volume of 150,000 m$^3$. In the HEC-HMS model the peak flood discharge that enters the pool is 34.1 m$^3$/s. The pump needed in alternative condition 3 is 25 m$^3$/s, with variations in pump capacity of 4x5 m$^3$/s and 2x2.5 m$^3$/s. Pump operating schedule in Table 6. The pump is set to start at 2.5 meters water depth, and turned off at a depth of 0.5 meters from the bottom of the pond. Assuming the depth of the pool water is 2 meters at the time of pumping.

| Pump  | Capacity (m$^3$/d) | Elevation | Depth |
|-------|-------------------|-----------|-------|
|       |                   | on       | off   | on   | off |
| Pump 1| 5.0               | 0.5      | -1.5  | 2.5  | 0.5 |
| Pump 2| 5.0               | 0.5      | -1.25 | 2.5  | 0.75|
| Pump 3| 5.0               | 0.5      | 0     | 2.5  | 2.0 |
| Pump 4| 5.0               | 0.5      | 0.5   | 2.5  | 2.5 |
| Pump 5| 2.5               | 0.75     | 0.75  | 2.75 | 2.75|
| Pump 6| 2.5               | 0.75     | 0.75  | 2.75 | 2.75|

*Source: Analysis, 2019*

**Figure 4. Inflow, Outflow, and Alternative Pump Schedule 3**

The banger watershed control model is carried out by considering the area of area catchment but also considering the existing conditions so that 3 alternative retention ponds with different area and volume are made using 6 alternative pumps 1 with a capacity of 30 m$^3$/s, alternative 2 pump capacity is 27 m$^3$/s while alternative 3 pump capacity is 25 m$^3$/s, while flood prevention efforts according to lina damayanti (2017) (9). With the results of the planned flood discharge, Semarang Indah's long storage was designed using 5 pumps with a capacity of 3 m$^3$/s and 2 existing pumps with a capacity of 0.6 m$^3$/s, for Madukoro long storage, it was designed to use 3 pumps with a capacity of 1.2 m$^3$/s and 2 existing pumps with a capacity of 0.6 m$^3$/s, and Tawang Sari long storage is designed to use 4 pumps with a capacity of 1.5 m$^3$/s.

This is in line with flood prevention efforts that have been done by Th.Dwiyati Wismarini (2011) (10) to bring flood control in the city of Semarang there are basically three approaches namely. Flood control coming from the watershed in Hulu, Local Flood Control, Flood control due to tides or tides.

**4. Conclusions**

Based on the results of the analysis above, that the hydrological characteristics and the flood mitigation simulation model can be concluded as follows:
a) Based on the recording of the depth of rain at Sta Maritim, and after analyzing the rain area using the thiiessen method, a planned rainfall with a 50 year return period of 182 mm, statistically tested distribution of the Pearson III log distribution.

b) Based on the results of the hydrological analysis using the HEC-HMS software, it was found that the inflow of the Banger watershed entering the reservoir was 34.1 m$^3$/s, with a 50 year flood return. The maximum alternative maximum pump capacity that can be installed in the Banger River Basin polder system is 30 m$^3$/s with the smallest alternative pool area of 3.8 Ha Alternative 1 has a 3.0 m depth, 3.8 Ha area, and the storage volume is 114,000 m$^3$ In the HEC-HMS model the peak flood discharge that enters the pool is 34.1 m$^3$/s. The pump needed is 30 m$^3$/s, alternative 2 it has a depth of 3.0 m, an area of 4.7 ha and a storage volume of 142,000 m$^3$. In the HEC-HMS model the peak flood discharge is 34.1 m$^3$/s. The pump needed in alternative condition 2 is 27 m$^3$/s, in alternative 3 has a 3.0 m deep pool, 5.0 Ha wide, and reservoir volume of 150,000 m$^3$. In the HEC-HMS model the peak flood discharge that enters the pool is 34.1 m$^3$/s. The pump needed in alternative condition 3 is 25 m$^3$/s

5. References
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