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ISSN: 04532198
Volume 62, Issue 09, October, 2020

Flood Management for Banger River Basin in Semarang City, Central Java, Indonesia, Using SWMM

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ABSTRACT— Floods that occur on the north coast of Central Java are generally caused by high rainfall, where water flows from upstream to downstream carrying waste material. In the form of used bottles, plastics, tree branches and others, other so that the presence of garbage will disturb and inhibit the flow of water, the government's efforts to deal with flooding in the city of Semarang by optimizing there are retention ponds in Semarang City, for example, retention ponds in Tawang, Muktiharjo, Tanah Mas and Banger, these pools are useful. to accommodate water and later the water will be disposed of using a pump into the river then heading to the sea, if there is high tide that inundates the roads and houses, the pump is turned on Meanwhile, if the water recedes and does not inundate residential areas, the pump is turned off. The purpose of this study is to formulate a correlation between pumps and retention ponds, the research method used is quantitative by simulating a pool and pump prototype model in the laboratory, field observations using a diver, numerical modeling with the help of SWMM version 5.1 software. flood control using a return period of 50 years, the method used is SWMM. The depth of the pool is 3 meters; the reservoir volume is 406,000 m3. The pump is set to start at a water depth of 2.5 meters, and to stop at a depth of 0.5 meters. Pump capacity 22.34 m3 / s.

KEYWORDS: Flood, Retention Pool, Pump

1. INTRODUCTION

Floods that often occur in the city of Semarang, Central Java in general are caused due to high rainfall so that water is not accommodated in channels or rivers. Why does this happen because channels and rivers become shallower, the causes of shallow rivers and canals are caused by sedimentation, the causes of high sedimentation include environmental damage in the upstream or catchment area and also caused by an imbalance between input and output water in the channel city drainage Inundation areas are currently flooding in several areas including around Ahmad Yani Airport, Karangayu, Krobokan, Bandarharjo, Semarang River, Kali Banger, in Genuk from Kaligawe to the Demak. To reduce the risk and number of flood events, it is necessary to design an appropriate and integrated flood control system and in the planning of flood control systems needed in an area there is an evaluation and analysis that takes into account the flood inundation area or its scope [1]. Flood characteristics in the form of inundation area / coverage, inundation depth and water flow velocity need to be mapped so that they can be a strong basis in flood control planning. [2, 3] City of Semarang there are basically three approaches namely. a. Control of floods that come from watersheds in upstream, b. Local Flood Control, and c. Flood control due to tides or tides [4]. 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 the rising sea level, where the rate of sea level rise recorded at the Tidal Observation Station of Tanjung Emas Port in Semarang is +15 cm / year [5] In addition, the factors of high tides and land subsidence are the main threats in Semarang City [6] Land subsidence is basically a change (deformation) of the land surface vertically downward from a high reference plane [7, 8]. Excisiting conditions of land elevation which are lower than sea level cause the greater rate of land subsidence. Rob floods in Semarang cause damage to road damage, housing, sanitation and other infrastructure but it will also have an impact on the lives of the people especially those directly affected by floods [9]. Problems caused by tidal floods are that the residential areas become slums and the health of many residents is disturbed as for the research objectives are: Knowing the Hydrological Characteristics that are in the Catchment Area banger and making flood control simulations as well as the operation of the Polder system pump.

2. Material and Methods

The research method that will be used is quantitative research in accordance with the conditions in the field. The data used consists of Polder area data, drainage channel capacity, and Pump Capacity, while other data sourced from relevant agencies and has taken measurements. consists of: Rain Data, using the reference of the Tanjung Mas Maritime Rain Station with data series from 2006 to 2018, Text Topographic Data, using the RBI Topographic Map (Rupa Bumi Indonesia), Land Use Data, referring to Regional Regulation No. 5 of 2004 concerning Spatial Planning (RTRW) Semarang City 2000 - 2010, Drainage system data, Land Subsidence Data and Tidal data, using references from the Tanjung Mas Maritime Rain Station. To carry out research activities "Method of Handling Rob Floods in the Banger River Basin in Semarang City Using SWMM [10]. Before conducting a hydrological analysis, first determine the rain station, rain data and catchment area. In the hydrological analysis will discuss the steps to determine the flood discharge plan. Steps to determine the flood discharge plan is to calculate regional average rainfall, plan rainfall, conduct alignment tests to determine methods that meet the distribution test, calculate rainfall intensity and plan flood discharge. Calculate Average Regional Rainfall Using the Thiessen Method. Modeling flood discharge with SWMM also begins with the distribution of catchment areas. The depiction of the catchment area is done by dividing residential areas and roads that are adapted to drainage channels in existing conditions. In addition, the depiction of the catchment area is also determined based on the direction of flow and elevation in the existing concession. At SWMM the main river is represented by conduit. The hydrological model in the Banger River Basin SWMM uses the SCS Unit Hydrograph method while for losses using the SCS Curve Number method [11].

3. Results

Based on checking experiments on the 2 other 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: [12].

Figure 1. Cacthment Area DAS Banger

ISSN: 04532198
Volume 62, Issue 09, October, 2020

Based on the picture above, that the Banger Watershed Catchment Area is indeed only affected by the Maritime Rain Station. So the coefficient for the catchment area is as follows.

Table 1. Area of Effect of Rain Station on the Banger River Basin

	Large Catchment Area (m^2)	Koefisien Thiessen
CA Maritim	5,292,219.80	1.00
Luas DAS Banger	5,292,219.80	1.00

Rain Frequency Frequency analysis in this study uses A Prob software version 4.1 which was developed by Ir. Istiarto, M. Eng., Ph.D staff lecturer at Gajahmada University. Log Pearson III distribution distribution with the smallest maximum difference of 0.090. It was proven in Smirnov-Kolmogorof and Chi-Square test, the distribution of Pearson III Log data was passed [13, 14]. The magnitude of the rain return is as follows:

Table 2. Banger River Basin Rainfall Based on Re-Period.

On birthday	Log Pearson III
2	104
5	131
10	147
20	163
50	182
100	196
200	211
500	229
1000	243

Rain Intensity 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 Flood Discharge Planned Water catchment plan in planning the Banger drainage system it is planned with a Polder system [15, 16]. Pump stations are built to remove water from retention ponds. The plan for retention ponds can be seen in Figure 2.

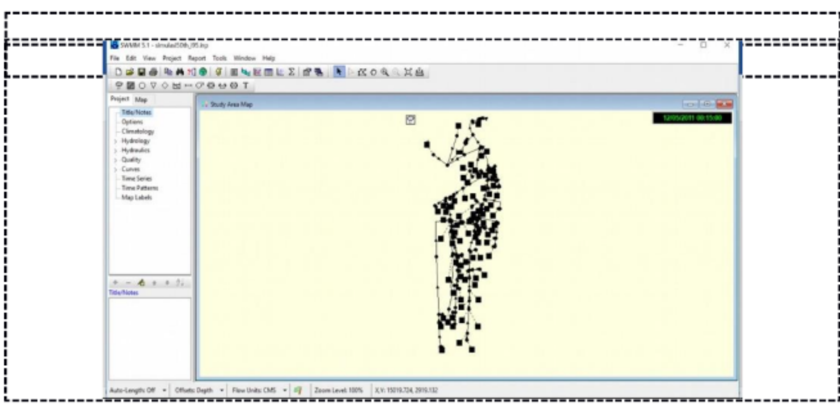

Figure 2. Sub DAS Banger on the SWMM Model

Modeling a Polder Plan in the Banger River Basin, the depiction of the catchment area is done by dividing residential areas and roads that are adapted to drainage channels in existing conditions. In addition, the depiction of the catchment area is also determined based on the direction of flow and elevation in the existing conditions. The polder system in the Banger Watershed is to analyze the capacity of the retention pond plan with pumps. The principle of analysis is that retention ponds are a function of pump capacity [17, 18]. The greater the retention pool reservoir, the smaller the pump capacity needed, vice versa. Based on the results of running SWMM with a 50-year return period and rainfall intensity of 182 mm, the peak flood discharge that enters the pool is 22.34 m3/s with the flood hydrograph shown in Figure 3.

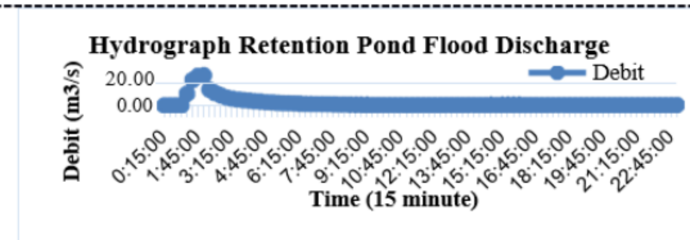

Figure 3. Hydrograph Retention Pond Flood Discharge

With a retention pond area of 13.54 ha, the depth of the pool is 3.0 m and the storage volume is 406,000 m^3. pump capacity of 5 m^3/s. The pump is set to start at a water depth of 2.5 meters, and to stop at a depth of 0.5 meters. Variation of pump capacity of 3x1.5 m^3/s and 1x0.5 m^3/s, pump operating schedule is in Table 5 The pump is set to start at a water depth of 2.5 meters, and to stop at a depth of 0.5 meters from the bottom of the pool. Assuming the pool water depth is 2 meters at the time of pumping [19, 20]. The retention pond in has a 3.0 m pool depth, 23.54 Ha area, and a reservoir volume of 406,000 m^3. The pump required in condition 1 is 5 m^3/s a variation of the pump capacity of 3x1.5 m^3 /s and 1x0.5 m^3 /s the pump operating schedule in Table 3. The pump is set to start at 2.5 meters of water depth, and shut down at a depth of 0.5 meters from the bottom of the pond. Assuming pond water depth is 2 meters at the time of pumping [21, 22, 23].

Table 3. Pump and Pond Operation Schedule

Water Depth (m)	Elevation (m)	Pump discharge (m3/dt)
0	-2,7	0
0,5	-2,2	1,5
1	-1,7	1,5
1,5	-1,2	3
2	-0,7	3
2,5	-0,2	4,5

According to the pump operation schedule, the depth of the pool is maintained so that no overflow / puddle occurs. So that the depth of the pool is obtained as shown in Figure 5, where the water level of the pool remains at a depth of 2.4 m and does not overtake [24].

ISSN: 04532198
Volume 62, Issue 09, October, 2020

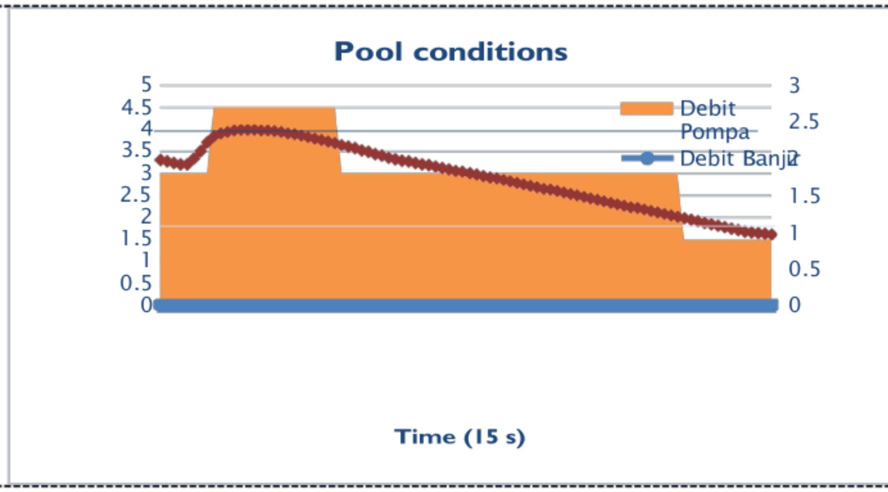

Figure 4. Pond Water Depth Conditions

The pump that is turned on varies at several pond depths. At a pool depth of 0.5 m, start turning on the pump with a capacity of 2 m^3/s. At a depth of 4 m the pump capacity is increased to 2x2 m^3/s, maintained until the water depth at the LS increases up to 5m [25].

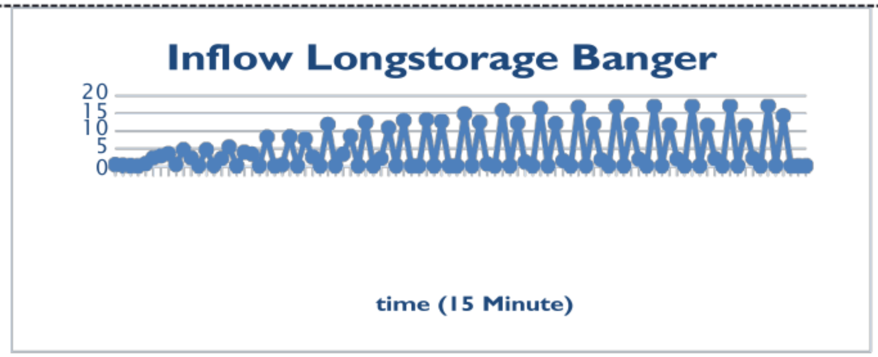

Figure 5. Alternative Pond Water Depth Conditions 1

Table 4. Pump and Pond Operation Sche

Water Depth (m)	**Elevatio n (m)**	**Pump discharge (m^3/dt)**
0	-4.7	0
0.5	-4.2	2
1	-3.7	2
1.5	-3.2	2
2	-2.7	2
0	-4.7	0

The following is the condition of Longstorage Banger water level fluctuation when the pump is operated. In Figure 7 it can be seen that the water level of the pond can be maintained at a depth of 2.3 m and does not overtake.

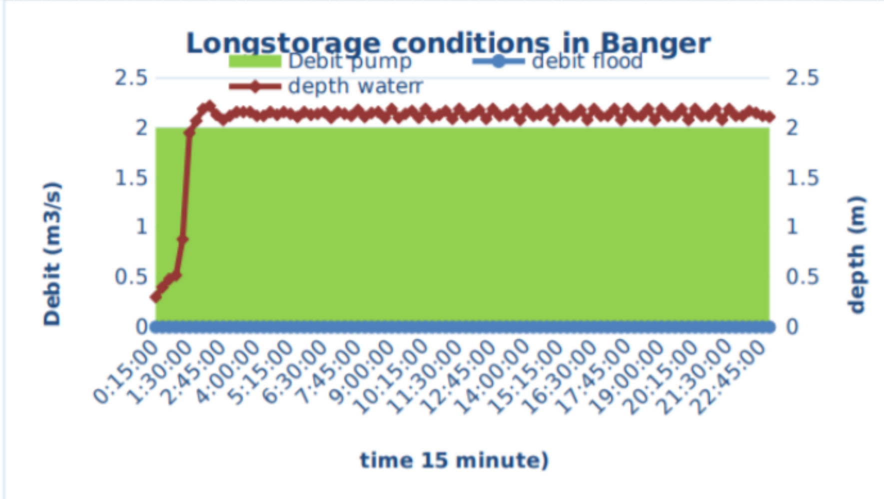

Figure 6. Pond Water Depth Conditions

Pool depth of 3.0 m, area of 5.0 ha, and a reservoir volume of 406,000 m^3. The pump needed in condition pool is 5 m^3/s with a Variation of pump capacity of 3x1.5 m^3/s and 1x0.5 m^3 / s, while flood control efforts according to [20], [26]. With Semarang Indah's long storage, it is 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, long storage. Madukoro was designed using 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's long storage is designed using 4 pumps with a capacity of 1.5 m^3/s. This is in line with flood prevention efforts that have been done by. To bring flood control in the city of Semarang there are basically three approaches namely. Flood control due to high rainfall so that the watershed in Hulu is unable to accommodate it, Local Flood Control due to silting or sedimentation, and Flood Control due to tides or tides.

4. Conclusions

The polder system is the most appropriate treatment for tidal flood control in the Banger watershed, with the concept of isolating sea water flow and controlling water elevation with pumps, channels, ponds, embankments: Catchment area (CA) of the Banger Watershed is only affected by the distribution of rain recorded at the Tanjung Mas Maritime Rain Observing Station in Semarang. With an area of CA equal to the area of the Banger watershed which is 529,222 ha. Based on the recording of the depth of rain at the Maritime Sta, and after analyzing the rain area with the Thiessen method, a planned rainfall with a return period of 50 years is 182 mm, which has been statistically tested with the distribution of the Pearson III log distribution. Based on the results of hydrological analysis using SWMM software, it was found that the inflow of the Banger watershed entering the reservoir was 25.0 m3/s with a 50-year flood return. Variation of pump capacity of 3x1.5 m3 / s and 1x0.5 m3 / s, a pool depth of 3.0 m, area of 5.0 ha, and a reservoir volume of 406,000 m3. The pump needed in alternative condition 4 is 5 m3/s with a variation of pump capacity of 3x1.5 m3/s and 1x0.5 m3/s.

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