Simulation Plan Hydraulic Polder Banger System on the Flood of Rob City of Semarang

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Abstract: Flood is a common problem that occurs in some parts of Indonesia, especially in densely populated areas such as in urban areas, The cause of the flood itself can occur due to various things both natural and human. Flood that occurred in Semarang Central Java, in general is caused by several problems among them due to the increase in discharge, base silting of river body and river narrowing due to sedimentation, Catchment area and also caused by the imbalance between the incoming water, water coming out on city drainage channels, Another problem that often arises is the tide of the sea (Rob) in some parts of the territory that are subscribed to a puddle due to rob. Furthermore, the frequency of rainfall was analyzed by Log Pearson Type III method, Gumbel and Haspers, then calculated flood discharge plan with Rational method, Weduwen, and Haspers. From the results of flood discharge planning analysis, to find out runoff used flood discharge when re-5 years, with rainfall from Gumbel method R5 = 130.473 mm with Q5 average = 102.677 m3 / dt From the calculation shows that there is an increase of flood water level that can no longer be accommodated by Banger times. The research method is done by hydraulic simulation of robotic flood of Semarang city by comparing field data and simulation through Catchment area variation, through storage variation, pump variation and through monitoring / observation of water elevation For 100% storage while 50% Retention Pool and long storage 0.25%.

1 INTRODUCTION

Semarang is one of the areas that prone to the flood. The main problem faced in Semarang is the problem of the flood with a long pool. In addition, the problem of drainage systems with reduced function and capacity, increased drainage load due to land conversion, saltwater intrusion, decreased soil elevation symptoms, sea level rise as a result of global warming, less optimal operation and maintenance and law enforcement which is still low. To overcome this problem required flood control strategy with various techniques and technology.

In this activity, many flood simulation simulations are performed on existing drainage and river systems with numerical models. The simulation scenario starts with studying the existing condition, the normalization of the groove and the elevation of the embankment, the manufacture of polder technology to the offshore draft. The location of the research was conducted in several watersheds from upstream to downstream (estuary and offshore) and certain locations that experiencing floods and puddles around the city of Semarang. that until now cannot be overcome.

The coverage of the current flooding area has been widespread in some areas including the estuary of Kali Plumbon, Kali Siangker around Achmad Yani Airport, Karangayu, Kerobokan, Bandarharjo, along the road in Mangkang, Tugu Muda area - Simpang Lima to Kali Semarang, banger times, in Genuk from Kaligawe to the Demak border (City Government of Semarang, 2011). The main problem of Semarang City drainage system is sea level rise as the result of the global warming and land subsidence. In addition, due to the decrease of the drainage/flood capacity caused by sedimentation, garbage, illegal building, increased drainage load due to land conversion that is not followed by the return of recharge and catchment function, operation and maintenance is not optimal and law enforcement (law enforcement) still weak (Wahyudi, 2010).

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Some parts of the Semarang area are lowlands and some of them are lower than the sea level, then this area receives rainwater flow from upstream, local rain and tidal water. Some simple polder system has been applied in the city of Semarang including feather drain subsystem, Tanah Mas, and Tawang. Some simple polder system has been applied in the city of Semarang including feather drain subsystem, Tanah Mas, and Tawang. However, the system has not been optimally functioned because of the problem of retention pond capacity, channel condition and pump capacity, and institutional management of the polder system. In addition, due to land subsidence and sea level rise in the North Coast of Central Java, although there is no rain, in some areas in the north of Semarang are inundated by seawater at high tide called ROB. When the rainfall is high, the puddle area has a more expansive area. Losses resulting from the flood/puddle of rob the longer the increase over time namely damage to residential buildings, factories, residential areas, environments and other infrastructure Global warming is indicated to be the cause of sea level rise. When the atmosphere warms up, the ocean surface layer will also warm up, so the volume will expand and raise the sea level (Nguyen et al., 2016).

Changes in sea level affect the life in coastal areas and can drown some land through estuaries, river networks and drainage.Changes in sea level affect the life in coastal areas Another cause of tidal flooding in Semarang City is land subsidence. Based on the measurement and analysis of land acquisition in the area around the Port of Tanjung Emas an average of 6.5 cm per year (Wahyudi, 2007).

In order to improve the condition and to anticipate the possibility of increasing complexity of flood / puddle problem, it is necessary to study the phenomenon of the sea tide elevation increase and land subsidence, modeled mathematically and physically as the basis for drafting / handling of robot handling concept Then the need to study similar cases in some overseas advanced cities are more experienced in handling, so as to develop an implementation polder system especially in the city of Semarang.

1.1 Problems

- Flood control with polder system in some locations is still less optimal so that floods still occur.
- Soil subsidence is slowly occurring in some polder subsystems due to uncontrolled groundwater extraction and has resulted in the topography of the terrain at that location to be lower than the flood waters so that in that location floods and puddles are still occurring.

1.2 Research Purposes

The purposes of the study is to get a good formula for the strategy of handling and managing the good and efficient time of Banger Watershed. Then what needs to be done is collecting data compartment with experimental data below.

- To know the characteristics of Retention Pond
- To know Banger Polder Channel Capacity
- Formulate the Banger Polder System

1.3 Literature Review

Polder is an urban drainage handling system by isolating the area served (catchment area) to the entry of water from outside the area, either in the form of overflow or subsurface flow (culvert and seepage), and control the flood water level inside system according to plan. Properties of Polder System include:

- The polder region is well-defined, where water from outside the area should not enter, only rainwater and sometimes seepage water, in the area itself collected.
- In polders there is no free surface flow as in natural water catchment areas, but is equipped with a control building at its disposal (with a drain or pump) to control outflow.
- Water faces in polders (surface water or subsurface water) are not dependent on the water surface in the surrounding area and are assessed by land elevation, soil properties, climates, and plants. The polder system component consists of These are 1) Mobile embankment and / or sea defense, or other insulation construction 2) Field drainage system 3) Conveyance system 4) Storage pond and outfall system 5) Water body recipient waters (Segeren, 1982)

Based on the definition can be concluded that the object of the polder system is an area with the following characteristics: 1) Isolated as a unit of hydrological system that is not affected by the surrounding system, 2) Surface water and ground water can be controlled in such a way, 3) Areas that are in natural condition are often inundated (flood area).The polder system is a closed water system with embankment elements, pumps, conduits, retention pools, landscape arrangements, municipal water installations. This Polder system must work a unified system and integrated with a more macro drainage master plan (Wahyudi, 2012).

Polder system is a way of handling flood with physical building, including drainage system, retention pond, embankment that surrounds the area, as well as pump and / door of water, as an integral water management unit (Pusair, 2007). Construction of polder system can not be done individually, but need to be planned and implemented in an integrated, adjusted to the spatial plan of the region and the water system in a macro. The combination of pump capacity and retention ponds should be capable of controlling the water level in a polder area and not negatively impacting the drainage system on a macro basis. Completeness of physical facilities for polder system include: embankment for insulation with seawater, drains, retention ponds (tank) and pumps (Rosdianti, 2009)

The concept of a polder system is a concept of closed water system using seepage embankments and sluice gates so as to be the right solution in overcoming the problem of flooding and inundation in low areas (Wahyudi et al., 2017). In addition to flooding from the sea, this system can also protect the area in the embankment from floods due to rain through a system of watering management (Mah et al., 2011)

The polder system is built to prevent water from flowing back into the system by using the pump in case of rain. Water expenditure in the system can be done by gravity when the water level in the river is lower than in the system (Taborda & Riberio, 2015). Based on the definition can be concluded that the object of the polder system is an area with the following characteristics: a. Isolated as a unit of hydrological system that is not affected by the surrounding system, b. Surface water and ground water can be controlled in such a way, c. Areas that are in natural condition are often inundated (flood area).

There are several disadvantages of the polder system: 1) In the drainage is done by pumping, this is due to natural conditions, 2) High operational costs compared to the gravity system. 2) If the pump condition is disrupted then the pump can not operate so the reservoir pump must be provided. 3) Cleaning should be routine

1.4 Sea Level Rise

Global warming affects the weather, sea level, beach, agriculture, wildlife and human health. When the atmosphere warms up, the ocean surface layer will also warm up, so the volume will expand and raise the sea level. Changes in sea level will greatly affect coastal life. A 100 cm increase would drown the Netherlands, 17.5% of Bangladesh, and many islands. When the high oceans reach the mouth of the river, floods due to high tides will increase inland.

1.5 Land Subsidence

Indication of land subsidence in Semarang can be known from several data sources. Based on measurement and data of land subsidence in the hilly area in Semarang city is smaller than the decrease in coastal area. From field observations of land subsidence in the former swamps and ponds showed a decline the largest, for example in Tanah Mas housing, Tanjung Mas Beach, with a decrease between 5.5 - 7.23 cm per (Marfai & King, 2008).

2 RESEARCH METHODOLOGY

The data collection used in this study consisted of primary and secondary data. Primary data is data obtained directly from the object of research in the field or can be an interview to the parties concerned. While the secondary data is obtained from related institutions that have the completeness of the data as needed eg topographic map, flood discharge data, land use map, drainage network system data, tidal data and sea water waves and data of land subsidence (landsubsidence).

3 RESULTS AND DISCUSSION

3.1 Catchment Area Polder Banger

Polder Banger has a catchment 675 ha area, located in East Semarang, has a river length of 13,326 km This Polder has its equipments which include retention pond area of 9.8 Ha and 5 pumps with capacity of 2 m3 / sec. When the retention pond is still a natural reservoir. The Kali Banger Polder System has an infrastructure component comprising (Mondel, 2009) Northern dike (North Artery Dam Arrangement), protecting the Kali Banger Polder area from sea level, Eastern dike (East Flood Canal Flood) protecting the Polder area from the East Flood Canal River, Dam Banger River (Pembangunan Bendung K.Banger) that closes the flow connections from the Polder region to rivers and seas, currently where temporary shutdowns are located downstream near the pumping station Pumping station is enabled to control the water elevation because the Polder area is covered by a weir, Retention basin (Retention Pond) is used for system water level control polder before pumping.

Water elevation in the retention pool is controlled -2 m MSL natural retention pool of large polder banger that is 9.6 ha using 5 pumps with capacity of 2 m^3/ s.

Figure 1 Catchment area polder Banger.

The boundary embankments around the Banger polder basin are as follows:
1. north: Java Sea
2. south: Jl. Brigadier Katamso;
3. west: Kali Baru and Kali Semarang;
4. east: East Flood Canal Levee

Folder-based analysis with scale of 1.5000 in wide catchment area of banger 675 ha

3.1.1 Rainfall Analysis

The intensity of rain is the rainfall that occurs during a period of time when the water is concentrated. The general nature of the rain is the shorter the rain the intensity tends to be higher and the greater the repetition period the higher the intensity (Suripin, 2004)

To find the polder effectiveness measured by the polder's ability to control flooding. The first step is to find the average rainfall. one of the calculation of rainfall intensity is using Mononobe method. As seen in Equation (1).

$$I = \frac{R24}{24} + \frac{(24)^{4/5}}{10} \quad (1)$$

Where, I is the rainfall intensity (mm / hour), R24 is an annual maximum annual rainfall for the year t reset (mm) and tc referes to concentration time (hours).

Rain depth is determined by Hyeteograph calculation using Alternating Block Method (ABM) method. From the value of Hyeteograph can be obtained Rain Effective with the formula as presented in the equation. (Triatmodjo, 2008).

$$Pe = \frac{(P-0,25)\,2}{P+0,85} \quad (2)$$

Where, Pe is an effective rain depth (mm), P is the rain depth (mm) and S is for maximum water potential retention by soil, which is mostly due to infiltration (mm).

Based on the rainfall analysis, the analysis of rainfall frequency using Log Pearson Type III, Gumbel and Haspers method, Flood discharge plan with Rational method, Weduwen, and Haspers. From the results of flood discharge planning analysis, to find out the runoff used flood discharge when re-5 years with rainfall from Gumbel method R5 = 130.473 mm.

3.1.2 Flood Debit Analysis Plan

In the case study on the flood problem of Kali Banger Kota Semarang, it begins with secondary data collection related to location and inventory of rainfall data and data of existing condition of Banger River. Furthermore, the analysis of rainfall frequency using Log Pearson Type III, Gumbel and Haspers method, then calculation of flood discharge plan with Rational, Weduwen and Haspers method. From the results of flood discharge analysis of the plan, to find out the runoff used flood debit when re-5 years with rainfall from Gumbel method R5 = 130.473 mm with Q5 average = 102.677 m^3/dt. From the calculation shows that there is an increase in flood water level that can no longer be accommodated by Kali Banger. To know the runoff used flood discharge when re-5 years with rainfall. From the calculation results show that the increment of flood water level that is no longer able to be accommodated in banger times, and briefly the calculation of flood analysis Concluded the design flood discharge obtained certain periods for example for Q5th the discharge used is 130.473 m^3/dt

Tabel 1: Flood discharge design.

Return Period Year's	Q Average Design (m^3/dt)
2	96.56
5	102.67
10	120.33
20	128.44
25	131.28
50	138.52

Flood debit analysis at Banger times is summarized in graph (rating-curve) which shows the relationship between flood discharge (m^3/dt) and time (hours). Where the maximum discharge (Qmax-5th) was obtained for 102.677 m3 / dt.

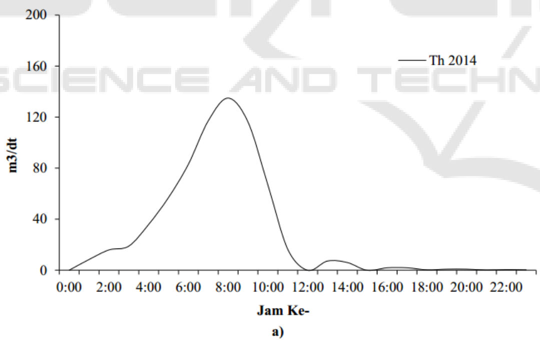

Figure 2: Flood of Banger times.

3.1.3 Hydrograph Unit Analysis

The first step to find out the correlation model of catchment area, water storage, pump capacity in polder system is data collection of rainfall data obtained, conducted hydrological analysis resulting in flood discharge plan, which then processed again to find the amount of flood routing which result is used to determine elevation of embankment. Hydrological analysis for retention pool planning includes four activities:

- Incoming flow (inflow) that fills the flood retention pool plan to determine the capacity and dimension of the embankment
- Pool retention count.
- Outflow (outflow) to determine the amount of water that comes out.

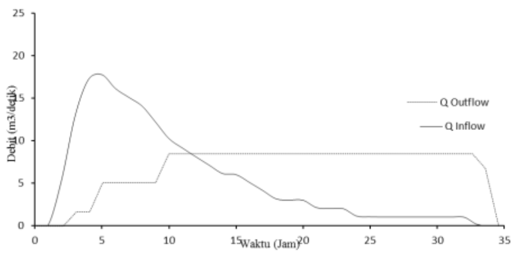

Figure 3: Graph of Inflow and Outflow (with pump) on Banger polder.

3.1.4 Simulation the Effectiveness of Discharge and Pump

The highest flood discharge called inflow will be compared to the highest plan pump capability called outflow. This comparison is called the effectiveness and can be seen the percentage of performance of each polder. The effectiveness of the pump with the formula as in Equation 3 below.

$$Efektifitas = \frac{Q_{outflow}}{Q_{inflow}} \times 100\% \qquad (3)$$

The effectiveness of pumps obtained in Kali banger Polder. That is, after the construction of Polder Kali Semarang, the amount of water discharge into the drainage network system can be minimized The effectiveness of pumps obtained in Polder Banger sebsebsar 56% That is, after the builder Polder Banger, the amount of water discharge into the drainage network system can be minimized by 56% .

3.1.5 Hydraulic Simulation Plan Polder Banger Laboratory

This simulation compares field data with the experiment through variations of Catchment area, storage variation, pump variation and monitoring and water elevation observation for this simulation comparison between storage of retention pool and longe storage. For storage 100% while Retention Pool 50% and Lang storage 0.25%.

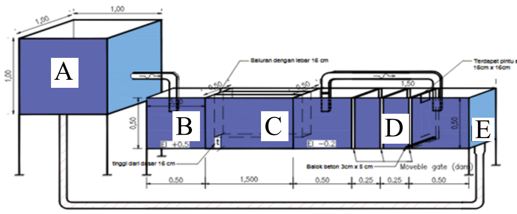

Figure 3: Scheme of Banger hydraulic polder simulation. (A: Water reservoir; B: Catchment Area; C: Lang storage; D: Pump; E: The Sea).

4 CONCLUSION

Flood and Rob occurred in the city of Semarang due to the phenomenon of sea level rise and land subsidence. Polder system to isolate seawater flow and control water elevation with pumps, conduits, ponds, embankments and weirs or gates. To overcome this phenomenon must know the capacity of Tonson, Pump and channel.

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