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The Handling of Tidal Flood (Rob) with polder system

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Abstract - Rain often causes inundations in the area of Semarang. Currently,drainage system in the area of East Semarang is strongly influenced by the presence of tidal water. It causes the social and economic losses due to the inundation of rob that floods the northern coast of Central Java. Therefore, some studies are necessary to overcome the problem of flood and rob that exist. The mitigations of tidethat get on the land (called rob) are also needed. To remove the flood of East flood canal Normalization (BKT), Tenggang River and Sringin River, pumps with detention pond are required. Modeling designis done by using HEC-RAS application program for modeling river water flow, and RiverAnalysis System (RAS), which is created and developed by Hydrologic Engineering Center (HEC). The appropriate flood control and handling systems are polder systems, with the infrastructure components of sea dams utilized as protection against tide (rob) towards the mainland of Tenggang River watershed and Sringin River watershed. The rainwater expenditure falling in the watershed uses pumps and detention ponds.

Keywords: *Polder, Drainage City, Dam*

1. Preface

Flood and rob often hit the city of Semarang. The flood is caused by many problems, such as:the rivers in Semarang which cannot accommodatethe volume of water coming from the upper stream if the rainfall is high, the reduction of river cross section due to sedimentation, and the habit of people throwing garbage carelessly while tidal flood is a flood which water comes from the sea. Tidal flood is a flood caused by sea tidal, thus it floods the land. The tidal flood is also known as inundation flood. It often strikes or occurs in areaswhich surface is lower than sea level. Because of the overflowing of sea water that reaches the land, this tidal flood water has clearer color than the usual floods.
Some characteristics of tidal flood include:
1. It occurs when the sea water is tidal
2. The water color is not too muddy
3. It does not only happenin the rainy season
4. It usually occurs in the areas that have lower land than the oceans.

Those are some characteristics of the tidal flood. When there is an area affected by the flood and has the same characteristics as mentioned above, it may be the tidal flood. Then, what causes the tidal flood? However, a flood can be caused by several things, as well as this tidal flood. Even though we know beforehand that the tidal flood is caused by the sea water tide, there must be something happens behind it that causes the flood.

Flood and rob impacts in Semarang, especially in Genuk District have negative effect on socio-economic condition and public health.
The location of rob and flood area that will be overcome with polder system

Figure1. The Location of East Semarang Polder

The decrease of river capacity and urban drainage channels is caused by sedimentation, the clogging of watercourses in riverbanks and the numbers of (illegal) buildings on riverbanks and river bodies. Several flood mitigations have been undertaken, including the construction of the Jatibarang dam, the repair of the West Flood Canal, the plan of East Flood Canal development, the construction of pump house and retention pond in Semarang, as well as the construction of Banger Polder.

RTRW study with Semarang Drainage Master Plan and the Water Resources (SDA) Management Plan of Jratunseluna Riveris indispensable. Based on the flood mitigation experience in Semarang and other areas, it can be concluded that the polder system will be suitable for overcoming flood and rob (Mondel & Budinetro, 2010).

If the community around polder can participate in maintaining the existence of the polder and utilize it well, the condition becomes the hope of all parties. Community-based polder management can be done because of the efficient financing of the polders' operation and maintenancewithout burdening the people's economy. However, the construction needs to be supported by the government because of the high cost of development and technology. East Semarang is a crowded populated area with many environmental problems. It is the area that is often flooded and robs with the very low soil bearing capacity, causing a decrease of soil levelevery year. The problems of floods or inundation that occur in the area of East Semarang are caused by:

1) The inundation caused by heavy rain. Flood prone areas are settlements and industrial areas. In the polder area of East Semarang, there are railway networks, as well as large and small industries
2) The increase of sea level due to tidal conditions that reach the mainland called rob

To be able to overcome the problems caused by flood and rob, some destinations need to be achieved, as follow;

1) Analyzing the hydrograph flood in various repeated periods by a particular method.
2) Analyzing the flood and rob area to know the areas affected by flood and rob disasters.

2. Literature Review

Kali Banger Polder is a small polder system that covers an area of approximately 600 hectares. This polder area is a flood-prone area caused by the high sea tidal and heavy rains. Based on the previous research, this area also has land subsidence problems, with the decreasing rates ranging from 9 to 15 cm per year (Wahyudi, S. Imam et al, 2012A).

Event that can lead to the failure of the polder drainage system is heavy rain or high sea level elevations, but it may also occur due to some failures e.g. failure of the weir structure. Anticipation of technical failure can be done with good inspection and maintenance management (Boulet, 2009)

Planning and design of a good green urban infrastructure can adapt to climate change such as the increasing of tidal levels, the rising of flood peaks and the decreasing of soil level. The impacts of climate change can reduce urban resilience because of the increasing of flood frequency, the decreasing of people's health condition and the decreasing of region's socio-economic development(Mondel and Budinetro, 2010).

Determining the polder infrastructure dimension including the capacity of pump and the volume of the storage pond; designing and constructing cover dam or sea dam equipped with flood disposal pumps are key tasks in flood and rob handling. The improvement of rivers that include in the polder region is the second stage of polder construction. The final stage is the arrangement of urban infrastructure in polder areas such as roads and sanitation systems (Ankum, 2002).

The method to estimate the peak surface flow rates is commonly used rational method. This method is very simple and easy to use, but it is used for small size areas only (Suripin, 2004).

$$Q = 0{,}278 \cdot C \cdot I \cdot A \qquad (1)$$

Q is the highest discharge for the repeated periods of t year (in m^3/s). A is the total area of the rain stream (in km^2). I is the rain intensity (in mm/h). C is the flow coefficient.

Channel capacity evaluation is intended to review the ability of existing drainage channels with the occurring design flood discharge. Basically the discharge that can be passed by drainage can be done by using the formula of Manning (Suhardjono, 2015).

$$Qsal = Vsal \times Asal \qquad (2)$$

$$V = \frac{1}{n} \times R^{2/3} \times I^{1/2} \qquad (3)$$

Qsal is the discharge (in m3/s). Vsal is the flow velocity in the channel (in m/sec). Asal is the total wet cross-sectional area (in m2). Q is the discharge (in m3/sec). A is the total wet cross-sectional area (in m2); R is the hydraulic radius (in m). I is the bottom slope of the channel, and is the coarseness coefficient of Manning.

The inundation observation that occurs due to the tides of river is done by simulating the modeling using HEC-RAS program. HAS-RAS is an application program for modeling river water flow, River Analysis System (RAS) which is created and developed by Hydrologic Engineering Center (HEC), which is part of Institute for Water Resources (IWR), under the US Army Corps of Engineers (USACE).

This program is a program designed to run one-dimensional and two-dimensional hydraulic calculations for river network/natural or artificial channel (Hendrasari, 2015). One of the features in HEC-RAS version 5.01 is an additional feature for two-dimensional analysis. Hence, it can be used to model the inundation distribution due to overflow. HEC-RAS River 5.01 version has four components of one dimensional river system analysis and one component of two-dimensional river system analysis consisting of:

a. Steady flow calculation
b. Unsteady flow calculation

c. Sediment transport
d. Water quality

Polder system is a handling of urban drainage by isolating the area served (catchment area) against the entry of water from outside the system either in the form of overflow (runoff) or subsurface flow and controlling the height of flood water level in the system in accordance to the plan (Al Falah, 2000 in Nugroho, 2012).

The Polder system is an integrated handling of flood with several important elements, including a circular dam which protects from sea tidal, a pumping station that is useful to control water elevation and retentionponds for temporary storage of water which is then flowed to the water receiving trunk (Herman Mondeel & Hermono S Budinetro, in Nugroho, 2012).

Flood analysis onaccommodatingpond is done by the formula (Limantara, 2010):

$$\left(\frac{I_1 + I_2}{2}\right) * \Delta t + \left(S_1 - \frac{O_1}{2}\Delta t\right) = \left(S_2 + \frac{O_2}{2}.\Delta\Delta\right) \quad (4)$$

I1 is the inflow at t1, I2 is the inflow at t2, At is the time interval between t1 and t2, O1 is the outflow at t1, O2 is the outflow at t2, S1 is Storage at t1 and S2 are Storage at t2.

The calculation of tidal flood searches on Polder uses the flood tracing principle in accommodating pond to review Polder's planned capabilities.

3. Research Methods

3.1. Data Collection

The flood and rob mitigation activities were conducted with the following methodologies:

1) Secondary data collection; the field review was conducted as a first step of the activity to find out the initial environmental/current condition of the buildings and conduits in East Semarang polder system. These data include hydro meteorological data, topographic data, land use maps and soil type maps as well as geological and fracture maps.
2) Field review, the identification of channel and supporting building required; the field review was conducted as a first step of the activity to find out the initial environmental/current condition of buildings and conduits in the East Semarang polder system. The identification is done to understand the location of the study and identify the initial problems obtained in the field as well as to see the possible solutions proposed by the community in the inundation location. Identification was done to estimate the dimensions of the buildings and channels by using a particular form. The investigation of location data in each building was done with the help of GPS tools and the availabletopographic maps. The purpose of channels and buildingsidentification is to know the coordinate points of the channel/river, river dam and existing infrastructure building.

The data used in the research was in the form of primary data and secondary data. Primary data was obtained by observation and direct measurement in the field. Primary data used was consisted of existing drainage channel data (dimension, outlet, direction of flow, condition of existingsediment). Observation field was conducted and to get the data. Secondary data is data obtained or sourced from related agencies.

3.2. Data Processing

To evaluate the capacity of the river, the calculation phases consisting of several stages were done. They were:

1) Calculating and determining the elevation height at the time of the tide in accordance to the observation data.
2) Conducting Linear Regression analysis, to see the relationship of river water level in the upstream, downstream and center in accordance to the results of observation and Station data. From the result equation of linear regression analysis, the profile of river water level was known. The result of the water level from the linear regression equation analysis was used as calibration on the water level profile, the model simulation result of HECRASv5.01 program.
3) Calculating the design rainfall by Log Person Type III Method
4) Analyzing of distribution conformity test
5) Calculating the planned flood discharge of the river with HSS Nakayasu Method.
6) Inputting the data in HEC-RAS program in the form of tidal data, planned flood discharge, river geometry
7) Running HEC-RAS program to analyze the modeling of river water level profile and inundation.

4. Conclusions and Recommendation

Conclusions

The results of the study from East Semarang Polder are as follows:

1) Flood hydrograph analysis uses SCS method with repeated period of 1000 years, 100 years, 50 years, 25 years, 20 years, 10 years 5 years and 2 years
2) The shape of the rob retaining dam is planned to be attached to the East Flood Canal (left) and Babon River (right).

Recommendation

For the researchers, it is recommended to do further study so the utilization of polder can be optimized and can be used directly for the surrounding community. The involvement of the community and public awareness to participate in the operation and maintenance of polder system are needed thus the maintenance costs are not solely from the government, but there is a breakthrough for the public or private sector involvement to take part in the operation.

Bibliography

Engineers, C.o., 2010. *Hydrologic Engineering Center's River Analysis SystemUser's Manual*. Washington, DC: U.S. Army.

Hendrasari, E. 2015. *Kajian PenangananGenangan Pada Sub Sistem DrainaseJangkok Kota Mataram*.

Mondel, H., & Budinetro, H., 2010. *The Banger Polder in Semarang*. Semarang: CRBOM Small Publication.

Nugroho, V. T. K. 2012. *Evaluasi SistemPolder Kota Lama dan BandarharjoSemarang Terhadap PengendalianBanjir Dan Rob*. Tesis. Tidak Dipublikasikan. Surakarta: Universitas Sebelas Maret.

Suhardjono. 2015. *Buku Ajar DrainasePerkotaan*. Jurusan Teknik Pengairan. Malang: Universitas Brawijaya.

Suripin. 2004. *Sistem Drainase Perkotaan YangBerkelanjutan*. Yogyakarta: Andi Offset

Susilowati, 2006. *Analisis Perubahan TataGuna Lahan dan Koefisien LimpasanTerhadap Debit Drainase Perkotaan*. Surakarta: Jurusan Teknik Sipil UNS