Retention Pond and Pump Station as an Alternative To Flood Management In Bengawan Jero Irrigation Area

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Abstract. Water is the source of life to all living organisms. But in a very large volume, water can be problematic to life. One of problems generated by a large volume of water is flood disaster. River, as a water source, is one of natural resources with multifunction to human beings. Some areas in Indonesia have increasing flood intensity as the rainy season comes. Retention pond and pump station is one solution to dealing with flood puddle occurring in area. One of areas experiencing flood routinely annually is Bengawan Jero Irrigation Area (D.I. Bengawan Jero). The design of retention pond and pump station in DI Bengawan Jero was calculated using flood flow rate with repeated period of 10 years. From the result of rainfall data processing with repeated period of 10 years using Nakayasu method, it could be found $Q_{planned}$ of 7.37 m³/s at hour 1. The storage volume needed to deal with flood in the Retention Pond in Bengawan Jero Irrigation area is 3.909 m³, using 2 pumps with capacity of 2.5 m³/s. From hydrograph analysis, it could be concluded that the use of retention pond and pump station can control the peak flow rate by suppressing or cutting the flood peak to occur.

1. Introduction
Bengawan Jero Irrigation Area is located in Lamongan Regency area and a little in Gresik Regency, East Java Province. Flood occurs in this area in certain period. Considering topographical condition and land use, Bengawan Jero area can be classified into three parts: 1) Bengawan Jero Barat with medium declivity and relatively smooth gravitation flow is appropriate to agricultural purpose. This location lies in the west part of Sukodadi-Karanggeneng Street. 2) Bengawan Jero Dalam with lower declivity is allocated for tambak (embankment) and a little part for farming in MT 3. Puddle occurs in this area in certain period. This location lies in the east of Sukokadi-Karanggeneng Street through the south of Kuro bordered with low dike from Kuro and K. Glagah through K. Clanggang. 3) Bengawan Jero Luar is located in the east part of Bengawan Jero Dalam, exactly in the east of K. Glagah- K. Clanggang. As aforementioned, flood problem in Bengawan Jero Dalam area needs special attention and thereby is interesting to study, so that the author
wants to give recommendation to the related authority concerning the flood management scenario in Bengawan Jero Irrigation Area.

2. Experimental
2.1 Hydrological Analysis
Evy Harmani[1] found that the hydrograph analysis shows that the use of retention pool in fact can control the peak flow rate by suppressing or cutting the flood peak to occur. Doddy Yulianto’s [2] study also concluded that the result of analysis showed that the combination of retention pool and infiltration well can store runoff volume with flood flow rate repeated period f 10 years. This system infiltrates again the water into aquifer layer all at once. Hydrological analysis is needed to find out the hydrological characteristics of Bengawan Solo River irrigation area. Data of rainfall was processed into the planned rainfall data to be analyzed later into the planned flood flow rate: a) Data of regional rainfall used based on rainfall data recording existing in Bengawan Jero River Flow Area. b) Hydrographic analysis on flood based on annual rainfall, using Q 5 year and Q 10 year, with Nakayassu Synthetic Unit (HSS) Method.

2.2 Hydraulic Analysis
After finding out the flow rate of flood, simulation was conducted using HEC-RAS 4.1.0 2010 software to find out the profile of water surface and river’s storage capacity. The result of simulation constituted layout of flood distribution occurring along the channel, so that the location affected with flood in Bengawan Jero River can be found.

3. DISCUSSION AND CONCLUSION
3.1. Hydrological Analysis
3.1.1 Rainfall Analysis
To determine regional rainfall, Thiessen Polygonal method was used between the closest stations in Bengawan Jero River Flow Area (DAS Bengawan Jero). The closest station of DAS Bengawan Jero plotted for this method was Sembung Rain Station. Data of rain refers to Investigative Survey and Rehabilitation Design report for Bengawan Jero Irrigation area in drainage (continuation) in 2016. Hydrographic chart used in planned flow rate Q 5yr and Q 10 yr can be developed. Hydrograph chart of Planned Flood can be seen in Figure 1.
Figure 1. Chart of Planned Flood Hydrograph

Figure 1 shows the peak flow rate of flood at Q 5 years, 5.298 m3/s at hour 1. Meanwhile the peak flow rate at Q 10 yr is 7.37 m3/s at hour 1.

3.2. Hydraulic Analysis using HRC-RAS Modeling

To find out the hydraulic behavior phenomenon in a river/stream flow, simulation or numerical analysis is required to describe both existing and planned conditions of channel. The analysis is conducted using HEC RAS 4.1.0 2010 numerical modeling. HEC RAS is designed to simulate one-dimension steady flow and unsteady flow. The profile of water surface during flood can be found using HEC RAS software. In this research the analysis was conducted using unsteady flow; the analysis involved existing and planned ability of channeling the planned flood flow rate. The procedure of modeling is as follows:

1. Starting HEC RAS
2. Developing new projects including:
   a. On HEC –RAS main window, select menu File, then New Project
   b. Select Directory and folder wanted or make new folder by clicking Create Folder, writing folder name, click OK (to save all HEC-RAS files).
   c. Then name the Project/title and file name, click OK
   d. Select SI (simulation) unit and continue the steps of input geometric data, input background image of Blawi River, develop river plot, input cross section, defined border condition, and run the modeling program

3.3. Hydraulic Analysis on Existing Condition of Blawi River in DI Bengawan Jero Irrigation Area

The analysis on Capacity of Blawi River plane in Bengawan Jero Irrigation Area is conducted on the existing condition of river aiming to find out the maximum flowing capacity in each of river segments. This analysis was conducted using planned flow rate Q 5yr (Q5) and Q10 yr (Q10). The result of analysis on Bengawan Jero River condition can be seen from the profile of water surface:
Figure 2. Existing Longitudinal Plane of Blawi River in DI Bengawan Jero with planned flow rate Q 2 year (Ramification of Blawi River – Estuary Downstream)

Figure 3 shows that the elevation of Blawi River in Bengawan Jero Irrigation Area in some stationing develops flood puddle. This research conducts a more specific review on Bengawan Jero Dalam River (in the analysis, it is called Blawi 2). The river shows the raise of water flow rate of 0.4m. This flow rate is planned periodically with Q10 years in the attempt of coping with flood occurring in Blawi River in long term. From the result of simulation on planned flow rate Q10 year, it can be found the difference of flood depth, indicating that the longer (more year) the simulation is done, the deeper and the wider is the flood puddle. The difference can be seen in the Table 2.

Table 1. Puddle Width

| NO | PLANNED FLOW RATE | PUDDLE WIDTH (M²) |
|----|-------------------|-------------------|
| 1  | Q10 Yr            | 766.11            |

3.4. A Study on Flood in Bengawan Jero Dalam Irrigation Area

Having found out the existing result of HEC-RAS, a study should be conducted on the flood occurring in Bengawan Jero Irrigation Area because the location often encounter flood almost annually. It can be seen from the Map of Flood-Vulnerable Area as shown in Figure 3.
Figure 3. Map of Potentially Vulnerable-Flood Area

Figure 4 shows that the flood occurring in Bengawan Jero Dalam is due to high flood flow rate and too low land elevation compared with river elevation, with runoff of 0.4 m. So, Bengawan Jero Irrigation Area will encounter flood annually if no attempt is taken such as repairing the channel, retention pool and pump. Therefore, an alternative to flood management is needed in the area. The design of retention pond and pump house can be seen in figures 4, 5, and 6.

Figure 4. Top View of Retention Pool
4. CONCLUSION
The conclusion of research is Storage volume needed in Retention Pond to cope with flood in Bengawan Jero Irrigation Area is 3,909 m³, using 2 pumps with capacity of 2.5 m³/s.

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