Current Progress of Development of an Integrated Sediment Disaster Simulator and Application in the Brantas River Basin, Indonesia

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Abstract

Sedimentation is the main problem in reservoirs and dams in Brantas river basin. They are suffering from severe watershed erosion and heavily load of volcanic ash ejected from the eruption of Mt Kelut, one of the most active volcanoes in Indonesia. The function of those reservoirs to especially control flood is declined due to severe sedimentation that reduce its storage capacities.

The Wlingi reservoir is significantly affected by recurrent volcanic activities of Mt. Kelud.. Mt. Kelud is one of the most active volcanoes in Indonesia, occurred two major eruption in 1990 and 2014. The latest eruption of Mt. Kelud occurred on 13 February 2014. After 2014 eruption, the capacity of Wlingi and Lodoyo reservoirs decreased dramatically just 46% (from 4,83 MCM in 2013 to 2.20 MCM in 2014) and 46% (from 2.72 MCM to 1.33 MCM) (Hidayat, *et al.*, 2017).

To analyze the impact of volcanic eruption disaster on reservoir sedimentation an integrated numerical model of sediment is required. The FUJIYAMA model is an integrated model of sediment production, sediment supply and sediment and runoff model in the unit channels and unit slopes. The model seems suitable for mountainous basin. The main objective of this research is to Development of an Integrated Sediment Disaster Simulator using The FUJIYAMA model.

1. Introduction

Sedimentation of the reservoir is one of the main problems in the Brantas River Basin. The Wlingi reservoir, which is part of a reservoir system in the Brantas Basin, has lost its storage capacity rapidly. The decrease in reservoir storage capacity affects water allocation for energy generation, irrigation and raw water fulfillment during the dry season and flood control capability in the rainy season. Sedimentation is caused by sediment flood from river tributaries which are drained from the slope of Mt. Kelud volcanoes.

2. Development of the integrated model

This study is conducted in the Wlingi watershed, an upper region of the Brantas River Basin, Indonesia as shown in **Fig.1**.

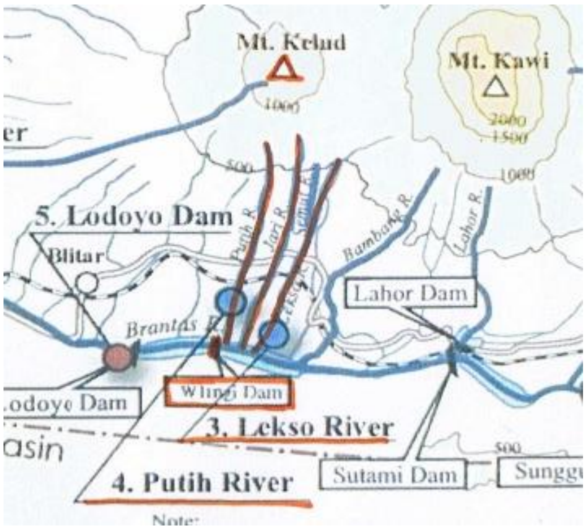

Fig.1 Map of the target basin.

Sediment production is defined as the process by which fresh sediment is generated and deposited near channels. Sediment production, especially in mountainous watershed, produced sediment deposits and forms talus cones. Talus cone are eroded, especially during floods. This process can be termed as a sediment supply process, defined as the movement of the produced sediment from outside to within channels. Finally, the sediment transport process is defined as the movement of sediment by water flow within channel systems (Yamanoi and Fujita, 2015). To predict and analyze the impact of volcanic eruption disaster on reservoir sedimentation an integrated numerical model of sediment is required. The FUJIYAMA model is an integrated model of sediment production, sediment supply and sediment and runoff model in the unit channels and unit slopes. The model was applied to an actual watershed located in the Japanese central mountainous region. The model will be applied to Wlingi watershed to develop of an integrated sediment disaster simulator.

3. Application

An integrated sediment runoff model was developed by combining sediment production, sediment supply and sediment transport sub-process models into a single basin model that was composed of unit channels and unit slopes.

Fig. 2 Upstream sediment deposit

The model will apply to the actual basin using metrological data in 2012-2017. The temperature and solar radiation data will obtain at the observation station at the Wlingi Dam. The rainfall data were observed at the rainfall gauge near the target basin. The unit slopes and unit channel were extracted using the 30 m mesh DEM data from SRTM of NASA. The inclination of each channel will obtained by dividing the difference of elevation between the upstream end and the downstream end of the unit channel by its length. The length of gullies and the width of valley will obtained by measuring from an aerial photograph. The grain size distribution of the riverbed material and produced sediment will obtained by field sampling and laboratory testing.

GRASS-GIS was employed for data processing. First, the positional information for unit channels and unit slopes was extracted from the DEM (digital elevation model) by GIS processing. The locations of the bare slopes will determined from aerial photos, and the locations of the bare slopes of the unconsolidated pyroclastic flow deposit layer were extracted by overlaying geologic maps on the unit-channel network. Next, using topographical and meteorological data, the sediment production rate and the timing of production were calculated and transferred to the sediment supply model. Third, the simulation of sediment transport was conducted using the simulation results for the sediment supply rate.

4. Current Progress

The current research progress is on the preparing 30 m DEM data from SRTM and processing using GIS, collecting rainfall observation data from 2012-2017 from rain stations in the study area, field sampling and perform laboratory tests of The grain size distribution of the riverbed material and produced sediment and measuring the flow length and width river from aerial photograph. After all the data and GIS processing is complete, we will proceed calculation of the sediment production using the FUJIYAMA model.

Fig. 3 Discussion on the developing model

Fig. 4 Typical depth of deposited sediment

Fig. 5 Field survey to the upstream tributary Brantas watershed

5. References

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