The Groundsill Effectiveness on the Sediment Distribution Along Cipamingkis River in Bogor Regency, West Java

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Abstract. The degradation of Cipamingkis River in Bogor Regency that occurs in the downstream of New Cipamingkis Weir is a main problem that potentially cause damage to the infrastructure built on it. In addition, excavated materials like sand are used for the construction of physical infrastructure. River sand mining can cause a decrease in the riverbed which results in damage to public infrastructure. One of the preventive ways to control decreasing elevation of the riverbed is the construction of groundsill This study analyze the distribution of sediment along Cipamingkis river before and after the groundsill construction and the effect of sand mining on riverbed changes, using MIKE 11 software with discharge data, river topography and river bed grain gradation as the inputs. The simulation shows that without groundsill, the length of the degraded river, aggradation, and the transition area are about 5 km, 3.5 km, and 1.5 km, respectively. After the simulation with two groundsills built downstream of the Cipamingkis Weir, it can be seen that all are changed; the degradation, aggradation, as well as transition area becoming 1.5 km, 3 km, and 1 km. Therefore, It is recommended that the sand mining site be done in the Jonggol Cariu Bridge along 4 km downstream. Sediment transport simulations based on recommended location and capacity of new sand mining site show that the average of riverbed degradation is 0.8 m and 0.6 m.

1. Introduction

The current condition of the Cipamingkis River is damaged downstream. There are many sediment deposits downstream of the river, the river channel is eroded, river cliffs are damaged, some of the soil is cracked and during the dry season there is very little river water. This shows that the upstream and downstream areas show the magnitude of the degradation process. In recent years, especially during the rainy season, the flood discharge in the Cipamingkis River has increased and the river's storage capacity, especially in the downstream part, is insufficient to accommodate the discharge, resulting in part of the dam body being cracked and in the middle of the river very vulnerable to cliff erosion.

Cipamingkis river starting from the Cipamingkis Irrigation Weir downstream, there has been degradation of the riverbed which is marked by the loss of the riverbed layer in the form of coarse grains, while the lower layer in the form of soft clay begins to appear and there is also an influence from the upstream of the weir. This condition is thought to be due to C excavation activities and the decreasing environmental quality in the Cipamingkis watershed.

2. Problem identification.

Problems that occur in the Cipamingkis River are changes in river morphology in the form of bottom erosion and channel wall erosion which result in failure of three main structures on the Cipamingkis River, namely Cipamingkis Weir, Jonggol Cariu Bridge and Cibarusah Bridge. One of the causes is the massive C excavation carried out by the local people.

3. Overview of the study

Utilization of the Cipamingkis River by the community in addition to irrigation is excavation C. Since 1983, there has been an uncontrolled mining of riverbed material to support the construction of the Jakarta - Cikampek toll road. From 1984 until now, the condition of the Cipamingkis River downstream of the Cipamingkis Weir to its estuary in the Cibeet River has been degraded to an average of more than 5 meters (Hanwar, 2007). This degradation resulted in damage to the Cipamingkis Weir, which functions to irrigate ± 7500 ha of irrigated land, so repairs had to be made by adding three stilling basins and a groundsill downstream of the weir.

In 2002, several ground sills that had been built were damaged and destroyed due to degradation and increasing flood discharge. Likewise, in 2007, the ground sill that had been repaired was damaged again due to degradation and flooding.

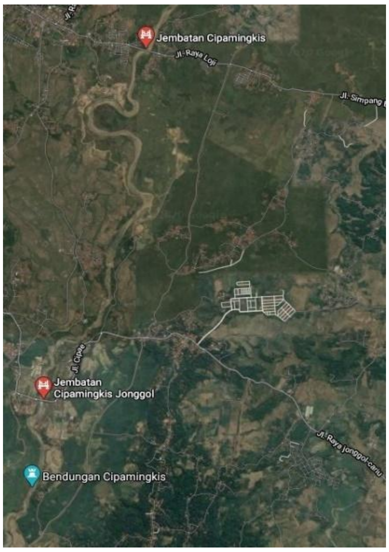

Figure 1. Location of the groundsill construction.

4. Research method

To obtain the information needed for numerical model, namely rain data, discharge data, cross-sectional data and sediment data are needed. Rainfall data used for numerical modeling is 10 (ten) years, observation discharge data at the Cipamingkis Dam, then topographic data for 2017.Topographic and hydrological data were analyzed to obtain a river hydrograph in accordance with appropriate procedure. Field data such as instantaneous discharge, base material, and suspended solids concentrations were also collected. Numerical model for hydraulic analysis and use of sediment transport. Hydrograph as an upstream boundary condition, obtained river geometry data and sedimentation potential from working drawings and field data collected are used to model riverbed grading and sediment ratings curve.

5. Result

5.1. Hydrological analysis

Rainfall data used for hydrological analysis is rain data from Cipamingkis station. From the results of data collection at PJT II, 10 years of data have been obtained from 2007 to 2016. The discharge used for modeling is the discharge that affects changes in the cross-section and flow of a river (dominant to the sediment rate) which is widely known as the dominant discharge. (Andrews, 1980) in (Muneer, A and Md. Musfequzzaman, 2014) defines dominant discharge as a discharge that carries most of the sediment particles as a total charge. ii) Full channel discharge (bankfull) which only fills the river completely and does not overflow. iii) A debit with a return period of 1-2 years. iv) and discharge which shows the best statistical correlation with various river morphological characteristics.

In determining the discharge for the return period of 1-2 years, the discharge calculation is carried out using a Synthetic Unit Hydrograph (HSS) using the Nakayasu and Snyder Alexeyev method based on SNI 2415:2016.

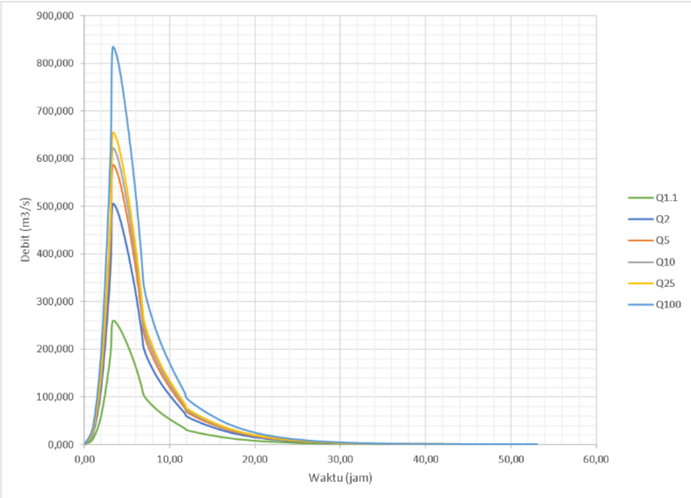

Figure 2. The flood hydrograph of the Nakayasu method.

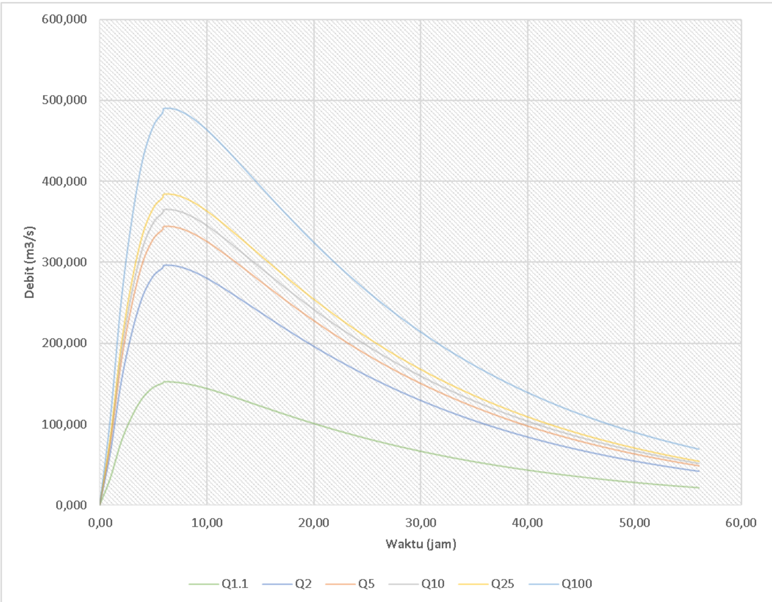

Figure 3. The flood hydrograph of the Snyder method.

After the discharge value is obtained, then a simulation model is carried out with a return period of 1 or 2 years so that the return period discharge can be seen which represents the condition of the bankfull channel. Overview of the simulation results of the 2-year return period full flow discharge model.

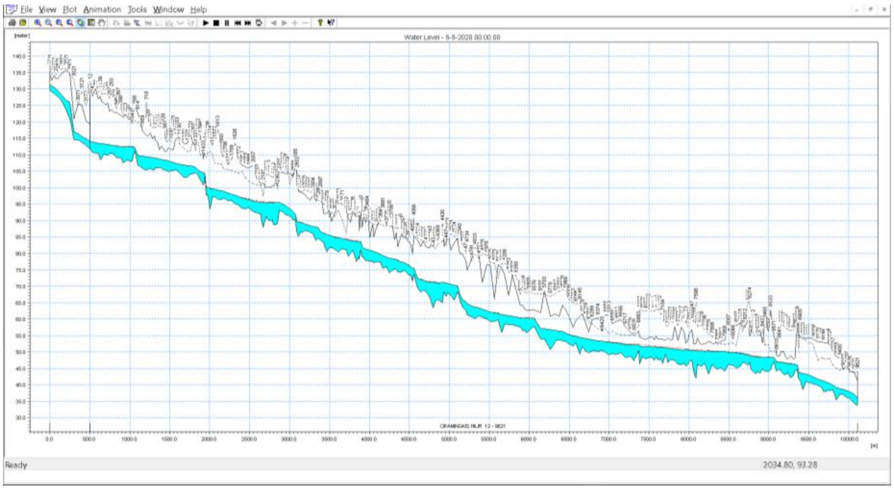

Figure 4. Simulation results for the 2-year return period discharge using the Nakayasu.

5.2 Sediment measurement and river bed material

Sediment measurement to get a graph between river discharge and sediment rate. From the sieve analysis test, the density and gradation of the bottom material of the Cipamingkis River were obtained as well as the value of the diameter of the grain size.

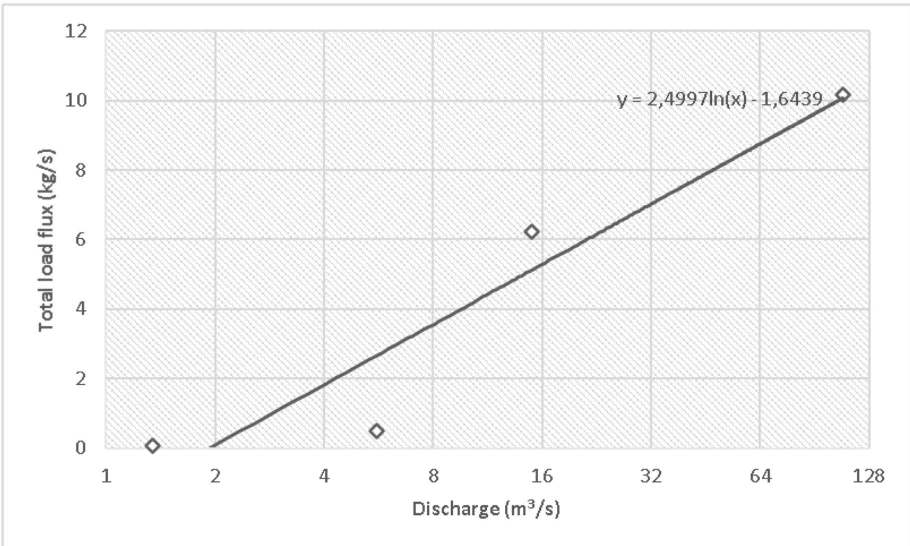

Figure 5. Relation between discharge and sediment rate of total load.

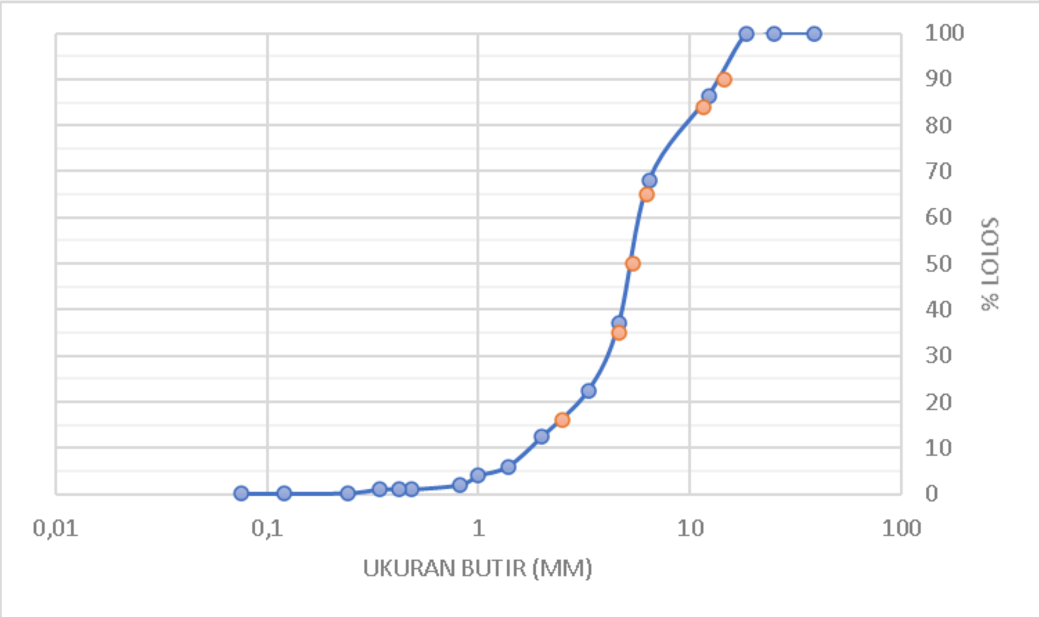

Figure 7. Material gradation of Cipamingkis River.

The grain size diameter taken downstream of the Jonggol Cariu Bridge or in this segment, shows a relatively large grain size condition. The grain size classification of riverbed material with a range of 4 mm -16 mm falls into the type of fine gravel to medium gravel.

Likewise, from the results of field identification, the diameter of the river bed from the upstream of the Cipamingkis Dam to the Cibarusah Bridge appears to have a relatively large diameter.

5.3 MIKE 11 numerical model analysis

Calibration of the model to ensure that the model made can really approach the field conditions. Calibration of the numerical model is carried out by comparing the water level in the field with the results of the numerical model to obtain riverbed roughness parameters that represent field conditions. In this study, the riverbed roughness parameter used is Chezy roughness.

The first step in modeling is the creation of a river network by connecting the cross-sectional and longitudinal-sectional data from the measurement results.

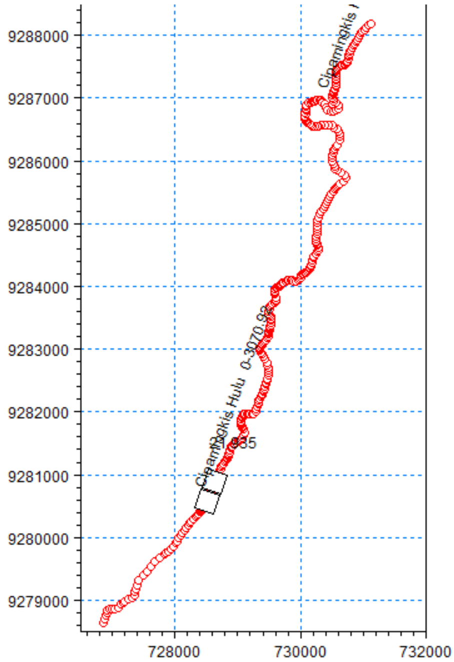

Figure 8. River network Cipamingkis.

After that, it is continued with the input cross section to determine the boundary of the left cliff, the deepest elevation and the boundary of the right cliff. Then, the boundary parameters are determined in the form of discharge as the upstream limit and the rating curve as the downstream limit.

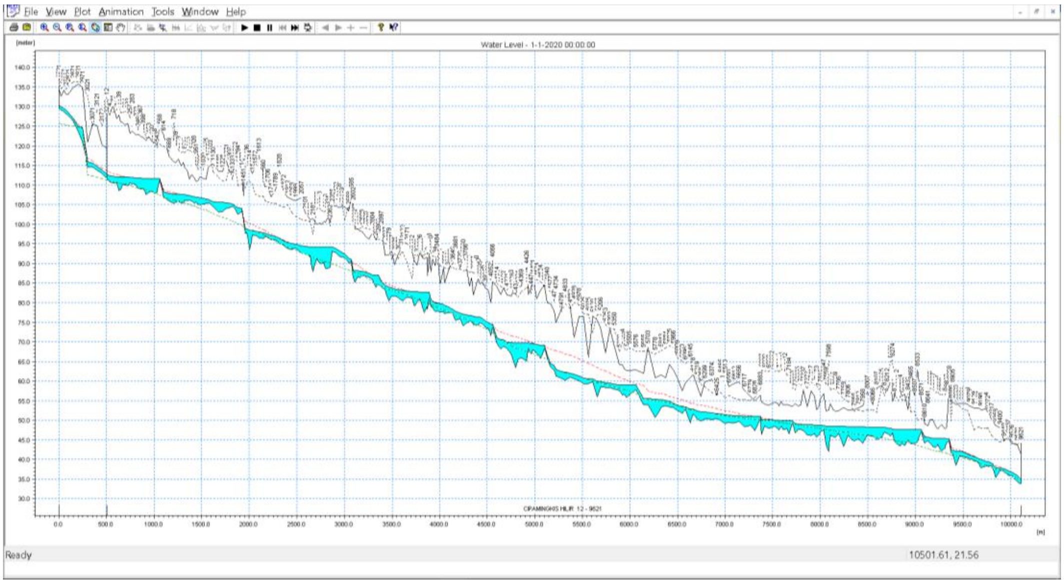

Figure 9. Water level of Cipamingkis River.

The simulation results show the water level profile along the Cipamingkis River channel which is reviewed at a flow rate of 100 $m^{3/s}$.

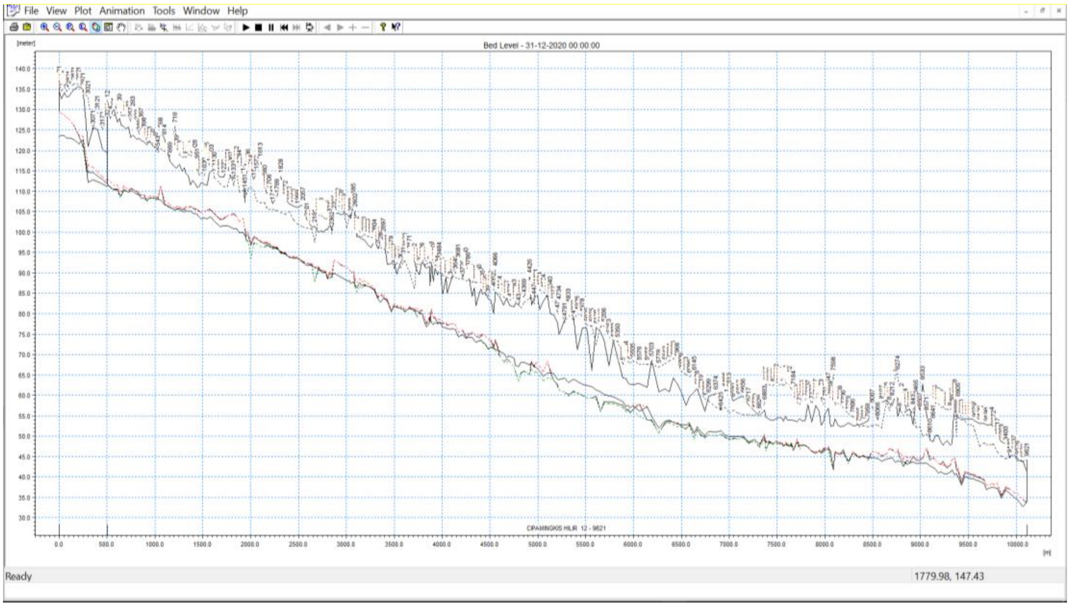

Figure 10. Morphology of the Cipamingkis River without groundsills.

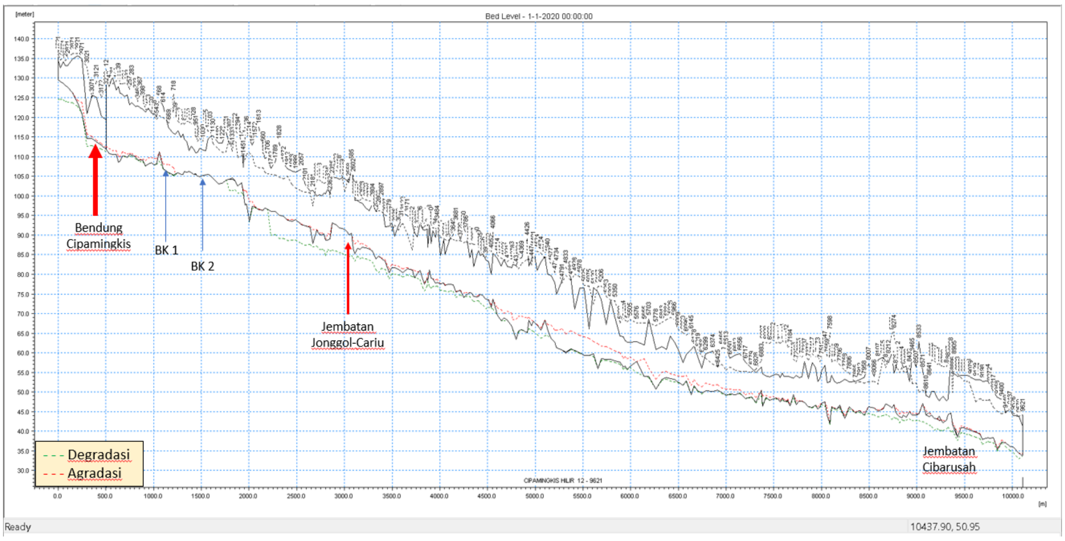

Figure 11. Morphology of the Cipamingkis River with two groundsills.

6. Conclusion

The simulation shows that without groundsill, the length of the degraded river, aggradation, and the transition area are about 5 km, 3.5 km, and 1.5 km, respectively. After the simulation with two groundsills built downstream of the Cipamingkis Weir, it can be seen that all are changed; the degradation, aggradation, as well as transition area becoming 1.5 km, 3 km, and 1 km. Therefore, It is recommended that the sand mining site is done in the Jonggol Cariu Bridge along 4 km downstream. Sediment transport simulations based on recommended location and capacity of new sand mining site show that the average of riverbed degradation is 0.8 m and 0.6 m.

7. References

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