STUDY OF CISANGKUY RIVER FLOOD AND SEDIMENTATION

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Abstract. In 2020, the Cisangkuy Floodway has operated with the main function of parsing flood discharge from the Cisangkuy River. With the distribution of the discharge, the old Cisangkuy river has changed from its natural condition. Therefore, it is necessary to study the analysis of the river's carrying capacity and changes in the riverbed that occurred with the construction of the Cisangkuy Floodway. The results of the flood model, with a 5-year return flood discharge, in the lower reaches of the Cisangkuy River, there is still flooding in the downstream for a length of 3.55 km. The simulation results of the sedimentation model, after the existence of the Cisangkuy FW using daily discharge data for 2020 for 1 year, show that the sedimentation of the riverbed in the upstream has decreased due to some sediment entering the Cisangkuy Floodway. In the middle, the degradation that occurs is reduced and in the downstream part, the degradation occurs first and then is degraded. The simulation results with the flood discharge compared to the average discharge in a year, it shows that the flood discharge erodes more due to the higher shear stress. Simulation results in the presence of embankments downstream of the Cisangkuy River, resulted in one section of the Cisangkuy river being more degraded.

1.Introduction

In 2020, the Cisangkuy Floodway has operated with the main function of parsing flood discharge from the Cisangkuy River. There is a confluence of 2 rivers, namely the Cisangkuy River which empties into the Citarum River which causes the river discharge to increase in the confluence area. The Cisangkuy floodway is expected to reduce the risk of flooding in several sub-districts, namely Banjaran, Baleendah and Dayeuhkolot districts. However, with the distribution of the discharge, the old Cisangkuy river has changed from its natural condition.

2.Problem Identification

The Cisangkuy Floodway changes the downstream Cisangkuy River from its natural state. The planning carried out does not yet have a morphological study of the Cisangkuy river due to the distribution of the discharge which is quite significant.

3.Overview of the Study

The location of the Cisangkuy Floodway inlet building is located in Tarajusari Village, Banjaran District downstream to the outlet / meeting with the Citarum River which is located in Cibolerang Village, Sangkanurip District, Katapang District, Bandung Regency [4].

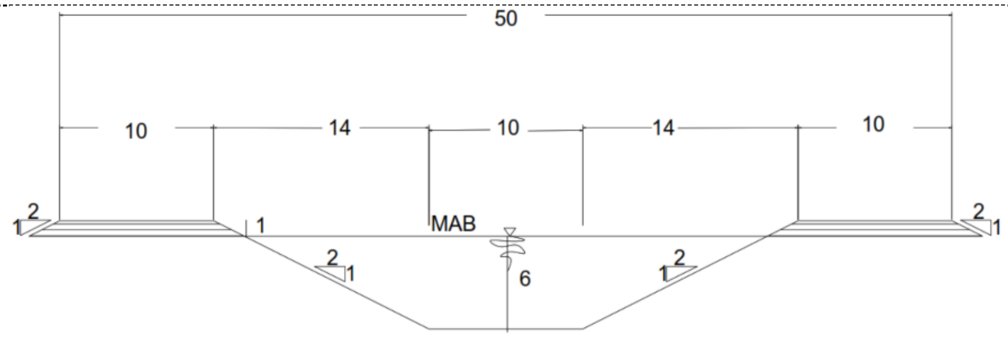

Figure 1. The Floodway's cross section. (Source : Floodway Cisangkuy Final Report)

4.Research Method

To obtain the information needed for modelling, topographical data such as the Digital Elevation Model (DEM) and land cover were collected, then hydrological data such as rainfall data were collected from 16 (Sixteen) rain gauge stations for 10 (ten) years. Topographic and hydrological data were analyzed to obtain a river hydrograph according to the appropriate procedure [5]. Field data in the form of granular materials were also collected.

Numerical model for hydraulic analysis and sediment transport uses a hydrograph as the upper limit, geometric data obtained from shop drawings and field data collected to model riverbed gradations.

The river discharge capacity is obtained by subjecting the model through a number of hydrographs, then further analyzed to obtain the effect on reducing Cisangkuy flood discharge. The morphological changes of the model were obtained by analyzing the sediment transport with daily discharge for 1 year.

5.Result

5.1 Topographic Analysis

Using GIS-based software the area of watershed could be delineated, furthermore the coefficient for Thiessen rainfall area and curve number of said watershed could also be obtained for rainfall area calculation and rainfall abstraction respectively. It is obtained that the area of the watershed is 219.44 km^2, with a curve number of 67.38. Also, the coefficient for Thiessen rainfall area method is presented in the following table:

Table 1. Thiessen coefficient for Cisangkuy Watershed

Station	Thiessen Polygon Area [km^2]	Thiessen Coefficient
Cileunca	88.442	0.403
Kertamanah	69.254	0.316
Cipanas	10.287	0.047
Cisondari	51.114	0.233
Cibeureum	0.342	0.002
Sum	**219.44**	**1.00**

5.2 Hydrologic Analysis

Using rainfall data from 16 (sixteen) stations near the watershed and the result from topographical analysis, hydrologic analysis using Synthetic Unit Hydrograph (SUH) due to the lack of discharge data in the river and in accordance to the procedure for flood discharge calculation [5] the necessary hydrograph needed for hydraulic and sediment transport model analysis could be obtained. The discharge with this return period is taken according to the planned flood discharge in the Cisangkuy river, which is the 5-year return period. The hydrograph for *5 Years* returning period is as follows:

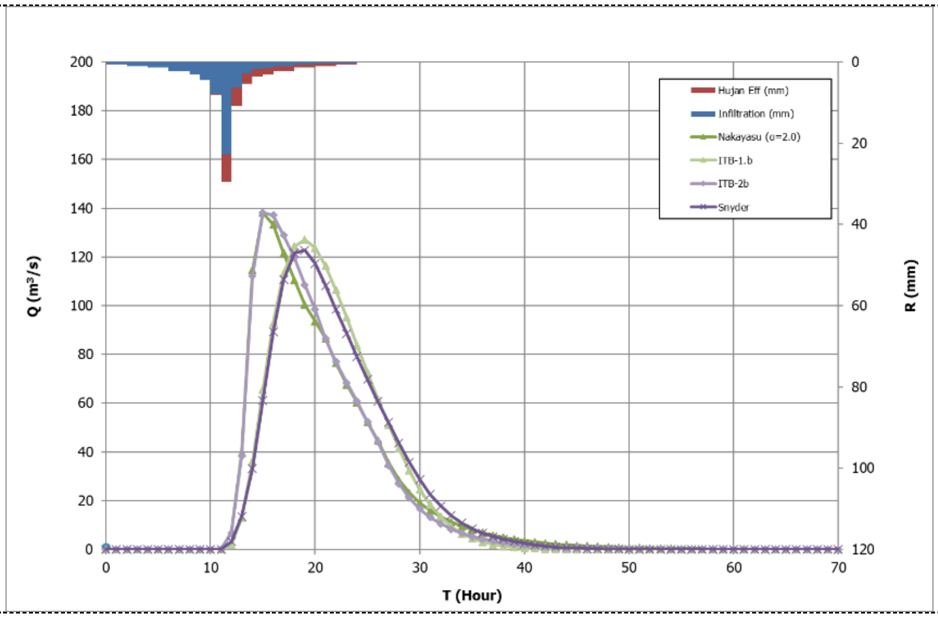

Figure 2 Hydrograph with a return period of 5 years for Cisangkuy River

5.2.1 Simulation Scenario

Simulation for flood events uses hydrograph data hydrologic analysis, the upstream boundary uses a 5-years return period flow hydrograph to simulate flood event in Cisangkuy River.

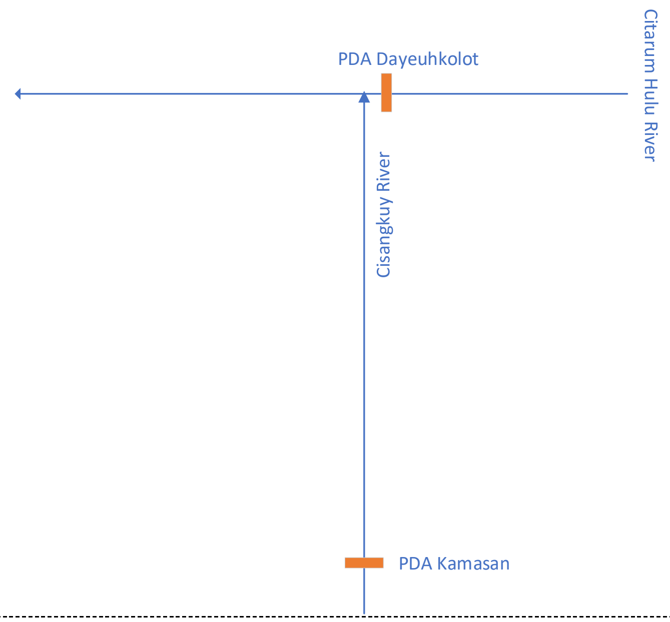

Figure 3 Scenario 1 of Simulation

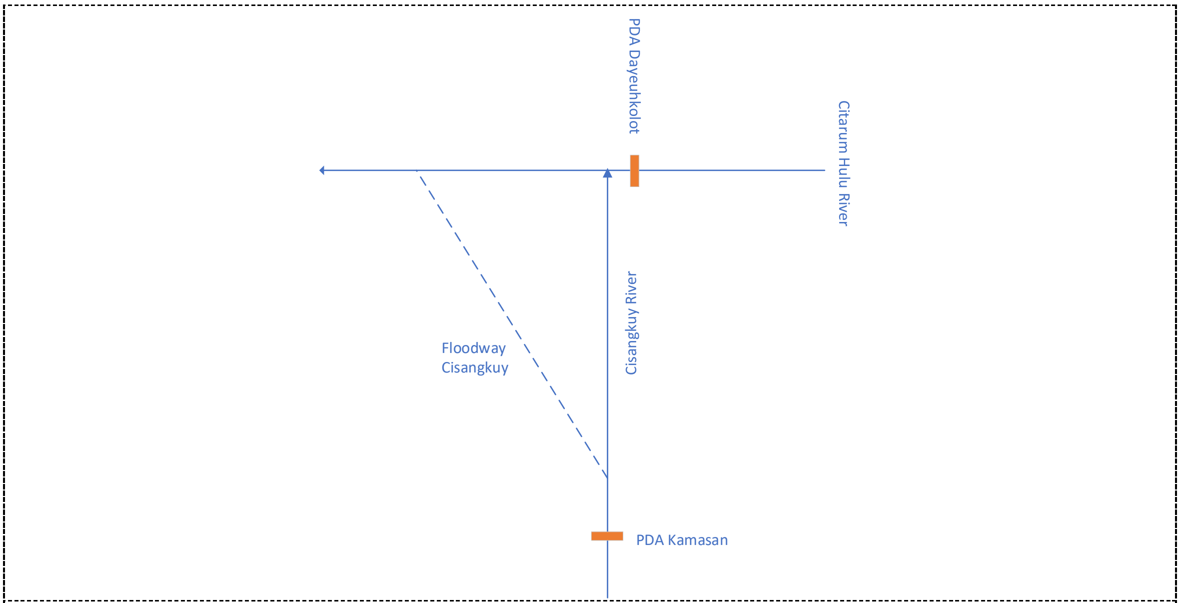

Figure 4 Scenario 2 of Simulation

5.2.2 Hydraulic Model Analysis

Result from the hydraulic model is as follows:

Table 2. Percentage Reduction in Flood Discharge

Cisangkuy River Cross Section	**Water Surface Elevation (m)**		
	Scenario		% Reduction
	1	2	
	Elevation (m)	Elevation (m)	
192	665.83	662.24	65.99%
92	662.61	660.26	49.27%
2	660.65	660.25	4.71%

From the table above, it can be concluded that for the Q5 simulation, in the upstream section of 192, the water level decreased by 65.99% from +665.83 m to +662.24 m. In the middle of the 92 section, the water level decreased by 49.27% from +662.61 m to 660.26 m. Downstream of section 2, the water level decreased by 4.71% from +660.65 to +660.25 m.

5.3 Sediment Transport Model Analysis

Modeling to be carried out for sediment transport is done for several scenarios to get a pattern of morphological changes in the river to the effect of Floodway, different flow and the effect of Embankment on the Cisangkuy River.

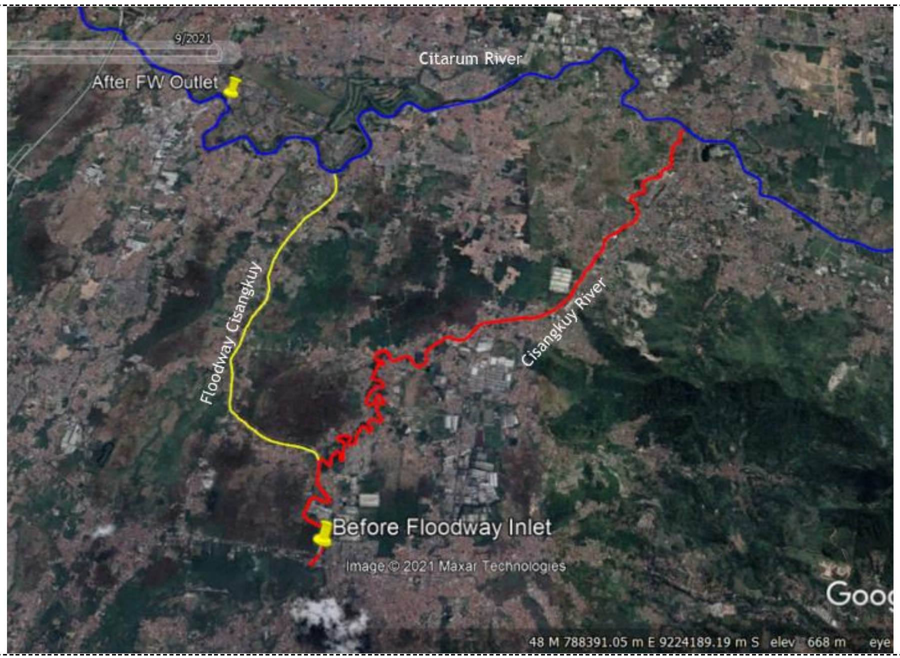

Figure 5 Sediment Sampling Location

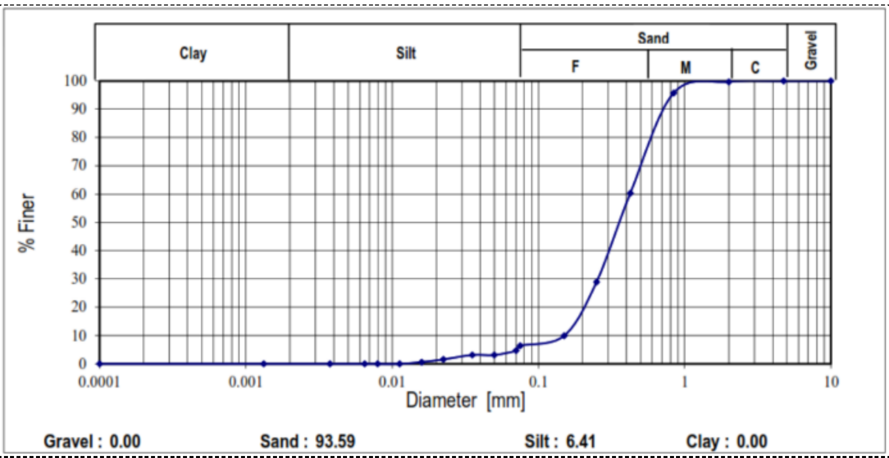

Figure 6 Sediment Sampling Location Before Floodway Inlet

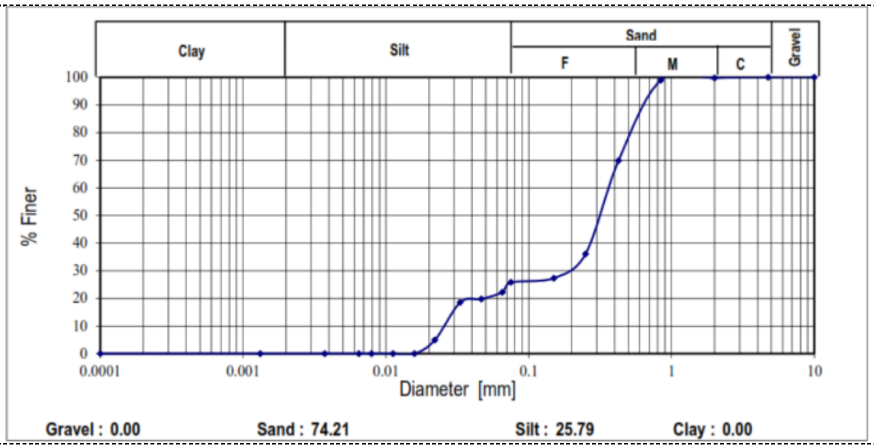

Figure 7 Sediment Sampling Location at After Floodway Outlet

5.3.1 Simulation 1
The modeling that will be carried out for sediment transport is carried out for several scenarios to obtain the pattern of river bed changes. In order to achieve the goal of the sediment transport simulation multiple simulation scenarios is conducted as follows: Scenario 1: This simulation uses Existing Geometry, 1 (one) year daily discharge to see the river response and simulation uses Yang transport function.; and Scenario 2: This simulation uses Existing Geometry with Floodway Cisangkuy Geometry, 1 (one) year daily discharge to see the river response and simulation uses Yang transport function.

To carry out a study on changes in river morphology in the form of aggradation and degradation of the riverbed, the Cisangkuy River studied is divided into 3 (three) parts, namely: the downstream part, the middle part, and the upstream. The results that will be reviewed from the model are changes in river bed elevation, or aggradation and degradation as a form of changes in the morphology of the Cisangkuy River.

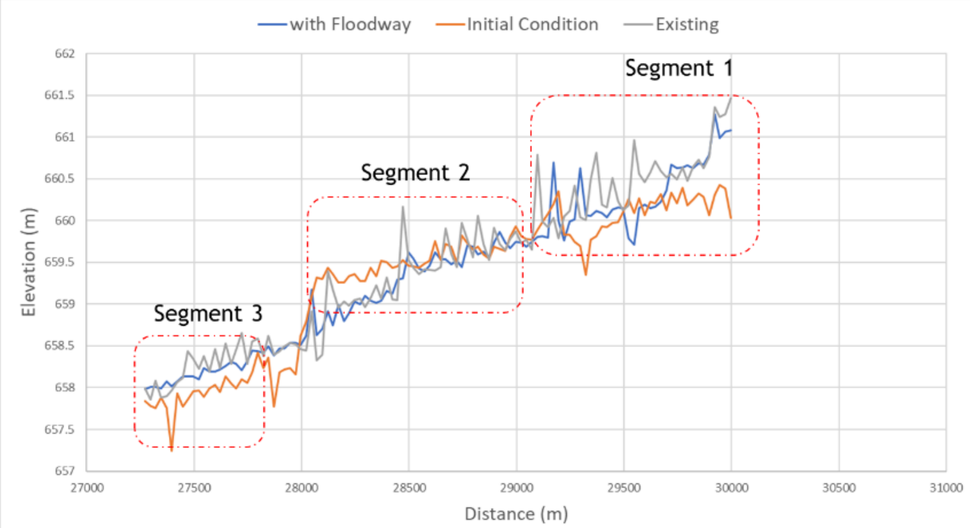

Figure 8. Simulation –1 Upstream invert elevation result.

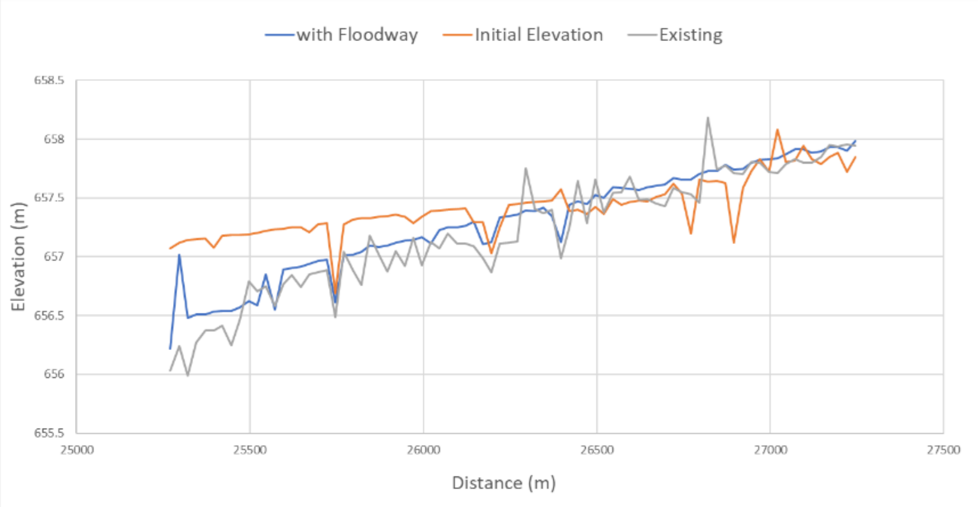

Figure 9. Simulation –1 Middle Stream invert elevation result

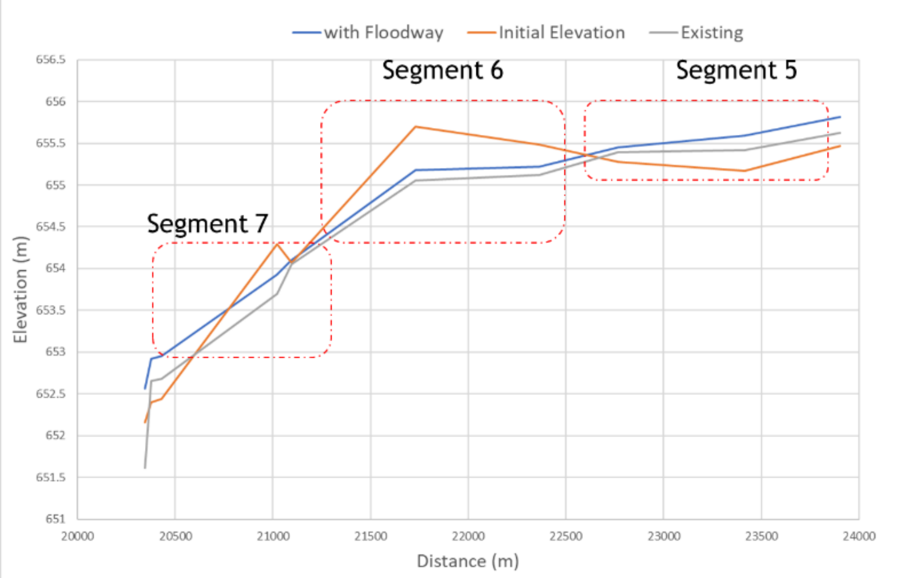

Figure 10. Simulation – 1 Down Stream invert elevation result.

Table 3. Sediment transport simulation – 1 result summary

Location	Segment	Existing			Floodway		
		Max Aggradation	Min Degradation	Average Δ Invert	Max Aggradation	Min Degradation	Average Δ Invert
Up stream	1	2.31	-0.07	0.75	2.06	-0.31	0.56
	2	0.89	-0.99	-0.11	0.61	-0.69	-0.15
	3	0.73	0.00	0.31	0.84	0.00	0.27
Middle stream	4	0.59	-1.15	-0.22	0.62	-0.86	-0.13
Down stream	5	0.25	0.00	0.17	0.42	0.00	0.31
	6	0.00	-0.65	-0.34	0.03	-0.53	-0.25
	7	0.26	-0.59	-0.16	0.52	-0.36	0.27

In Table 3, it can be seen that the pattern of aggradation and degradation in river morphology. At the downstream art degradation occurs if there is a Floodway, where the average degradation that occurs in the upstream area is 1 (one) year is 0.56 for segment 1 and 0.27 for segment 2, while degradation that occurred in this area was 0.15 m in the segment 2. At the middle section from the average model of river morphology changes occur degradation overall. The upstream part it can be seen in this area aggradation tends to occur 0.31 m in segment 5 and 0.27 in segment 7. In segment 6, the degradation occurs 0.25 m.

5.3.2 Simulation 2

In order to achieve the goal of the sediment transport simulation multiple simulation scenarios is conducted as follows: Scenario 1: This simulation uses Existing Geometry, 1 (one) year real daily discharge to see river response and simulation uses Yang transport function; and Scenario 2: This simulation uses Existing Geometry, 1 (one) year real daily discharge without peak flow to see river response and simulation uses Yang transport function.

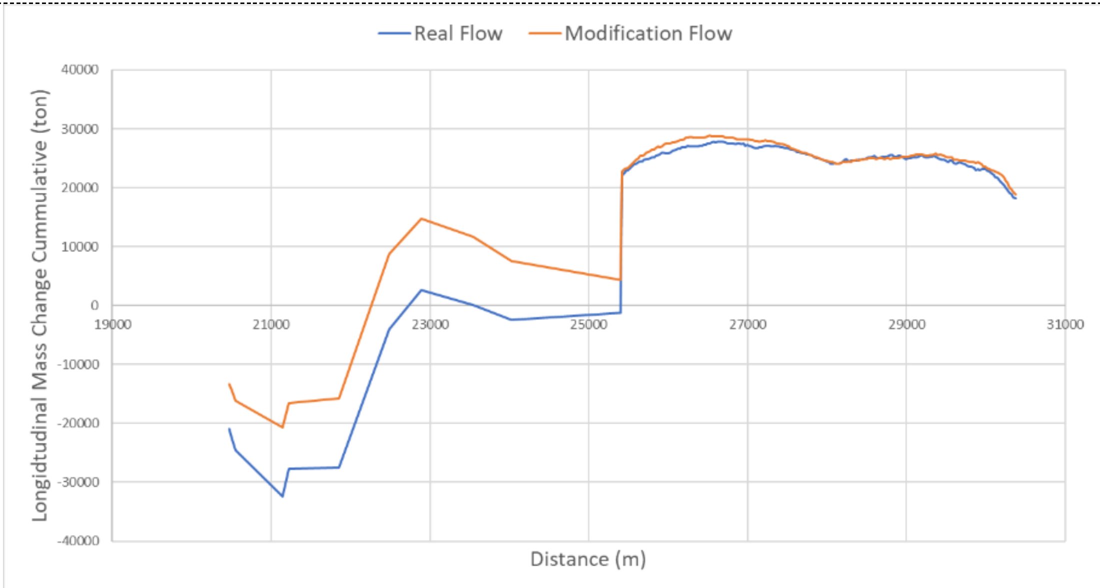

Figure 11. Simulation – 2 Long Mass Cum result.

From the graphic above, it can be seen that before the operation of the Cisangkuy Floodway and with different Peak discharge, it can be seen that if there is a high discharge (107 m3/s), the degradation tends to increase by 36.55%.

5.3.3 Simulation 3

In order to achieve the goal of the sediment transport simulation multiple simulation scenarios is conducted as follows: Scenario 1: This simulation uses Existing Geometry with Floodway Cisangkuy, 1 (one) year daily discharge and simulation uses Yang transport function; and Scenario 2: This simulation uses Existing Geometry with Floodway Cisangkuy Geometry, 1 (one) year daily discharge without peak flow and simulation uses Yang transport function.

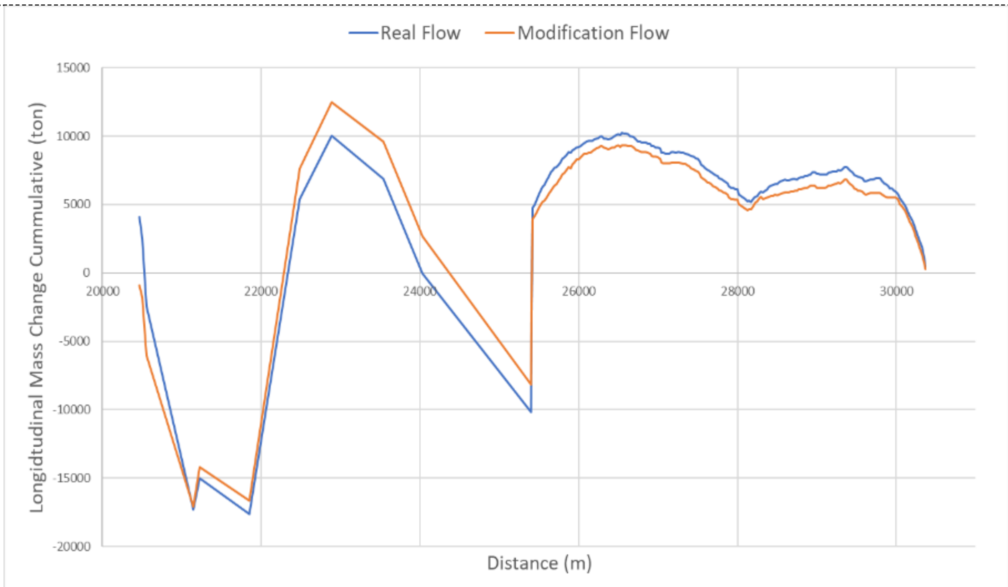

Figure 12. Simulation – *3 Long Mass Cum* result..

From the graphic above, it can be seen that after the operation of the Cisangkuy Floodway, with different peak discharges, it can be seen that if there is a high discharge (107 m^3/s), the degradation will increase by 77.5%.

5.3.4 Simulation 4

This simulation aims to see the response of the river due to the influence of embankment construction on the river downstream Cisangkuy. In order to achieve the goal of the sediment transport simulation, multiple simulation scenarios is conducted as follows: Scenario 1: This simulation uses Existing Geometry with Floodway Cisangkuy, 1 (one) year daily discharge and simulation uses Yang transport function; and Scenario 2: This simulation uses Existing Geometry with Floodway Cisangkuy and embankment along 3.55 km, 1 (one) year daily discharge and simulation uses Yang transport function.

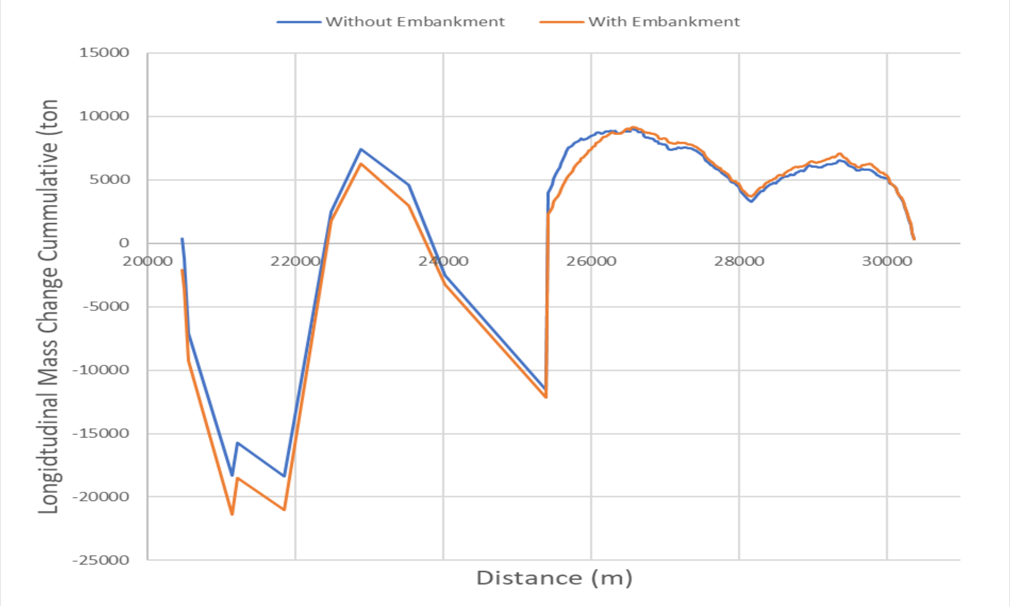

Figure 13. Simulation – 4 Long Mass Cum result..

From the graphic above, it can be seen that with the addition of an embankment along 3.55 km downstream (flood location) with the same daily discharge, river degradation increased = 83.74%.

6. Conclusion

For the Q5 simulation, in the upstream section of 192, the water level decreased by 65.99% from +665.83 m to +662.24 m. In the middle of the 92 section, the water level decreased by 49.27% from +662.61 m to 660.26 m. Downstream of section 2, the water level decreased by 4.71% from +660.65 to +660.25 m. For Sedimentation Simulation, The results of river model for simulation – 1 show that after the floodway operates, the upstream and middle Cisangkuy rivers tend to be degraded and the downstream Cisangkuy rivers tend to occur sedimentation. The results of river model for simulation – 2, it can be seen that if there is a high discharge (107 m^3/s), the degradation in the Cisangkuy River increases by 36.55%. The results of river model for simulation – 3 show that it can be seen that if there is a high discharge (107 m^3/s), the degradation in the Cisangkuy River increases by 77.5%. And, The results of river model for simulation – 4, it can be seen that with the embankment, degradation in the Cisangkuy River increased = 83.74%.

7. References

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Acknowledgments

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