Characteristics of Effect of Bank Erosion Countermeasures

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1. Introduction

Riverbank erosion is a natural process that can cause the loss of useful land and endanger the safety of navigation, among others. These processes are essentially dominated by the complicated interaction between flow, sediment transport, and bank material (Duan 2001). Generally, revetment is applied as a method to countermeasure of bank erosion. The revetment can protect the bank directly. However, the dangerous flow characteristics are not improved well by the revetment. On the other hand, it is considered that the dredging of sand bars can modify the dangerous flow characteristics dramatically for a certain period. In this study, computation of surface flow using the governing equation of the horizontal two-dimensional flow averaged with depth of the Sesayap River is performed under the conditions which include the constructions on countermeasure of bank erosion such as revetment, the dredging of sand bars and the combination of them. The effect of countermeasure methods to the hydraulics parameters in the river such as the river stage and velocity will be discussed.

2. Study Area

Figure 1 shows the topography of the Sesayap River at Malinau city. The flow is from left to right. The Sesayap River located at East Kalimantan, Indonesia has 279 km long and catchments area is 18.158 km^2. The channel morphology changes during last five years become very intensive to cause erosion and sedimentation at some river reaches, especially at Malinau city, capital of Malinau district. On April and September 2008, about 100 m long of riverbanks were collapsed and serious damages on the main street of the city were given. A huge sand bar is formed in the middle of river in this segment. These become a serious issue for government to countermeasure this problem.

3. Methods

Numerical simulations for the case of the Sesayap River are performed using horizontal two dimensional flow model whose equations are written in general coordinate system. The purpose of this numerical simulation is to calculate the water velocity and water level in the river under varieties of constructions to countermeasure of local bank erosion. Calculations are performed under four cases. Case 1 is performed under the present condition. Dredging at the central bar is considered in case 2. The revetment at location of bank erosion is installed in case 3. Both dredging and the revetment are considered in case 4. The study area is located in the tidal area. However, the direction of the flow is always from upstream area to downstream area. Hence, the boundary conditions are the discharge for the upstream end and river stages at the downstream end.

4. Results and Discussions

Figure 2a shows the result of the longitudinal profiles of water surface elevation. From this figure, the dredging of sand bars to reduce the concentration of velocity at lee (case 2) produces a significant effect on decreasing of river stage at upstream reach. This result is similar in case 4 and indicates that installing revetment is not influent significantly on the river stage at the upstream area. The use of revetment only as shown in case 3 produces increasing in the river stage at upstream reach. So, this condition will trigger flood with high water level during wet season. Because, as the annual condition of Sesayap River at Malinau, the flood plain area always flooding around 0.5 m. This condition also triggers

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on the possibility of bank failure. Consider to the results on a river stage effect, the dredging method will give the positive effect to reduce flood and reduce the possibility of bank erosion at another river reach.

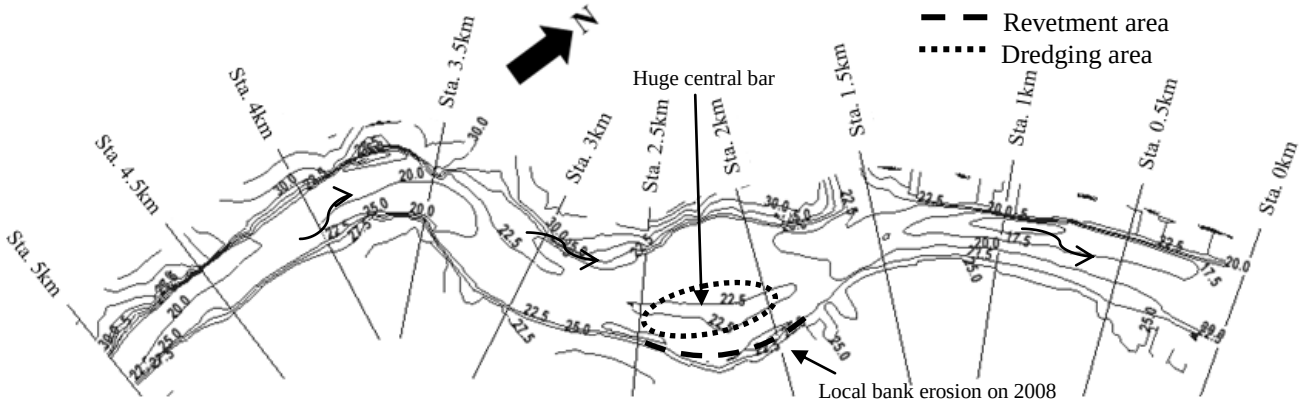

Fig. 1 Topography and cross section station of Sesayap River

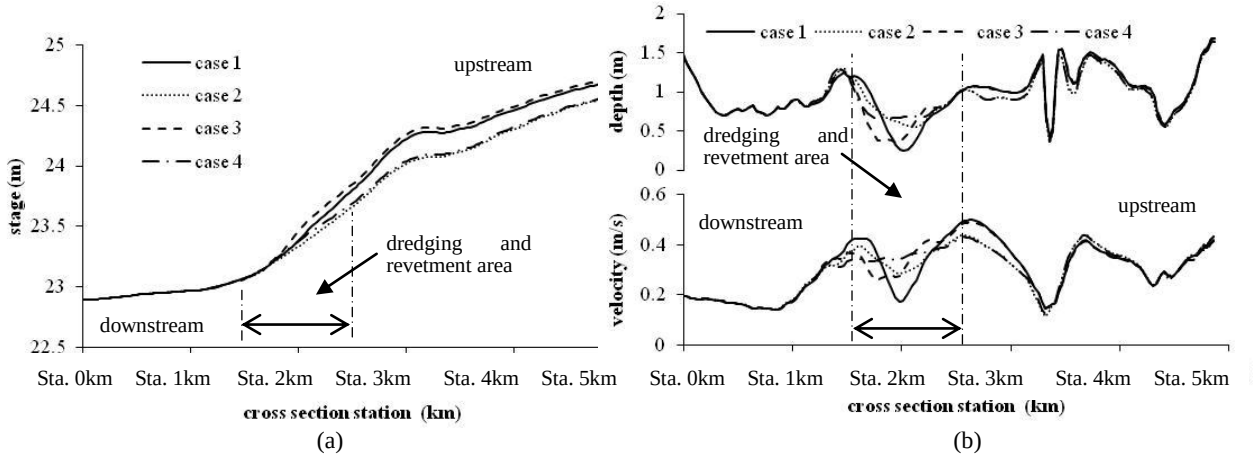

Fig. 2 Longitudinal profile of stage and velocity

The result on velocity and water depth along the bank is shown in Figure 2b. The depth in the river from sta. 2.5 km to sta. 3.5 km was decreased in case 2 and case 4, but in case 3 the velocity was not changed significantly comparing to the presence condition. Furthermore, minimum water velocity of the cases 2, 3 and 4 in the dredging and revetment area is increased comparing to the presence condition. However, maximum water velocity which produces the significant bank erosion is suppressed in cases 2, 3 and 4. As a result, when we consider the both of water surface elevation and water velocity, case 2 and case 4 has an advantage. Furthermore, the difference between case 2 and 4 is very small. If the decrease in the water velocity is enough to suppress the bank erosion, there is a possibility that the revetment t is not necessary.

5. Conclusions

Two-dimensional flow averaged with depth of the Sesayap River is performed. Furthermore, the hydraulic impact of construction to countermeasure of bank erosion is discussed. The dredging of bars is the appropriate choice for the countermeasures of bank erosion of the Sesayap River at Malinau, when we considered the river stage effect. The dredging of sand bars can modify the dangerous flow characteristics dramatically. If the decrease in the water velocity is enough to suppress the bank erosion, there is a possibility that the revetment is not necessary.

6. Reference

Duan, J.G., Wang, S.S.Y., and Jia, Y., “The Applications of the Enhanced CCHE2D Model to Study the Alluvial Channel Migration Processes”, 2001, *Journal of Hydraulic Research*, Volume 39, Issue 5, pp. 469-480