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Sediment Transport and Channel Morphological Change of Ayeyarwady River near Mandalay City

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1. INTRODUCTION

Many of the large rivers in Asia, namely, the Brahmaputra, Ayeyarwady, Thanlwin, Mekong and Yangtze, begin on the Tibetan Plateau and close to mountain ranges. The flux of river-borne sediment to the nearshore and oceans is of importance for understanding river behavior. Milliman and Syvitski (1992) compiled existing data and calculated that these large rivers in the region carry about 8 % of the total suspended load that reaches the global oceans. Among these rivers, the Ayeyarwady River is the least well known and scientific investigation on sediment transport is very limited. In this study, sediment transport characteristics and sediment related problems in the Ayeyarwady River Basin are introduced first and the channel morphological change is discussed using horizontal two dimensional bed deformation analysis.

2. AYEYARWADY RIVER AND SEDIMENT RELATED PROBLEMS

The Ayeyarwady River in Myanmar is the largest river. It is the major river transportation route and contributes to the Myanmar economy. The length, the average width and the drainage area are 2170 km, 1200m and 413710 km^2, respectively. It ranks fifth in the world in terms of sediment load (265 million ton per year) and fourth in terms of dissolved load; this published sediment flux is estimated using a 19^{th}-century data set. Combined Ayeyarwady - Thanlwin annual averages of 697 km^3 of water, 365 million ton of sediment material, and 162 million ton of dissolved material. The increasing of the number of dam constructions along the Yangtze and Yellow rivers in China has substantially reduced the sediment load, such that the Ayeyarwady may now rank as having as high as the third-largest sediment load in the world after the Amazon and the Ganges-Brahmaputra.

3. CHANNEL MORPHOLOGICAL CHANGE OF THE AYEYARWADY RIVER

The seasonal and spatial rainfall patterns of the Ayeyarwady River basin are strongly affected by the southwest monsoon. According to the rainfall records from 1988 to 1997, 92 % of the annual rainfall was observed during the southwest monsoon season between May and October. The rainfall amount in the study area is lower than that in the rest of the country. As the discharge in river follows closely the pattern of rainfall, the discharge varies substantially between seasons. The temporal change of water discharge and water level at Sagiang station (near Mandalay) is as shown in Fig.1. The data is provided from the Department of Meteorological and Hydrology.

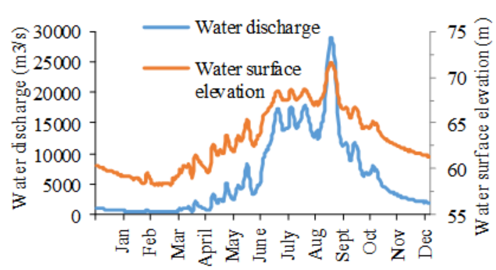

Fig.1 Hydrograph and water surface elevation at Sagaing station

As a result of the high magnitude production of sediment and decrease in the water discharge, braided channels are easy to be formed. Braided channels are very unstable channels temporally. Hence, bed deformation is very active in braided channels and it is very difficult to control the bed geometry to keep the navigable flow depth. The river is classified as braiding channel around Mandalay City and its planform varies a lot as shown in Fig.2.

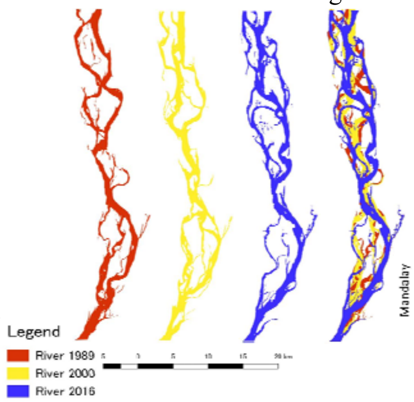

Fig. 2 Planform changes of the Ayeyarwady River

4. NUMERICAL ANALYSIS

Horizontal two dimensional bed deformation analysis is conducted. The governing equations are written in the boundary fitted general coordinate system. Dikes are treated as the emerged rigid bed area. Numerical computations were conducted for two cases such as with dike and without dike. The computational domain, 25 km, and the location of dikes with construction year is shown in Fig. 3. Hydraulic conditions used in the numerical simulation are shown in Table 1.

5. RESULTS, DISCUSSION AND CONCLUSION

The computed results on horizontal distribution of depth averaged water velocity vectors are shown in Fig.4. The bed is eroded and the water depth in the main channel become deeper near dikes. The increase in the water surface level makes the navigable depth deeper. However, it causes the increase in the flood risk. Hence, the dikes which are not worked well to keep navigation channels must be removed. Some of the dikes are set in the bifurcated channel on the bar and sedimentation is accelerated around the dike. It works well to suppress the development of bifurcated channel and increase in the water discharge in the main channel.

Dikes which are installed by Ministry of Transport, have been used in this river near Mandalay to keep navigation channel. However, the location and the shapes of the dikes are decided on the basis of engineer's experience. So, bed deformation analysis is performed to verify the effect of dikes. Setting of these dikes are very important to keep the spatiotemporal stability of the main channel. Near Mandalay city, the position of the main channel changes significantly in the upstream of it overtime, however, the position of the main channel does not change near the city. It is considered that some of the dikes suppress the temporal change of position of the main channel.

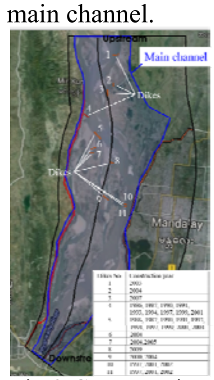

Table 1. Hydraulic conditions

Parameters	Values
Upstream water discharge (m^3/s)	30000
Downstream water level (m)	66.85
Averaged longitudinal slope	0.00019
Mean diameter of bed material(m)	0.002
Manning's roughness coefficient	0.035
Averaged non-dimensional shear stress	0.728
Time of conducted computation	24 weeks

Fig.3 Computational domain and location of dikes

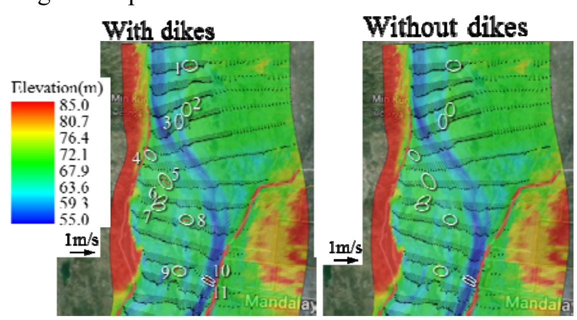

Fig.4 Computed velocity profiles for both cases

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