Hydraulic Reponses to River Bank Improvement in the Mekong, Cambodia

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Introduction

There are many sediment-related issues occurring in the Mekong River, especially the river bank erosion. Farm, road and residual lands near the riverbanks have been damaged by bank erosion, resulting in loss of lives and properties. In Cambodia, for example, bank erosion is considered as a hazardous event which occurred frequently along the river; especially Mekong River. This study is conducted by using the HEC-RAS model for computing water surface and velocity profile which are the compulsory information for the design of river bank stability scheme. The aim of this research is to analysis the hydraulic responses to different types of river bank protection which are popular in the Lower Mekong River, Cambodia. It consists of two specific objectives: (1) evaluation of HEC-RAS in simulating hydraulic conditions of a river reach in the Mekong's part of Cambodia and (2) analysis of hydraulic responses to different scheme of river bank improvement.

Material and Methods

The study is conducted along the Lower Mekong River parallel to the National Road No 1 in the Ksom Village, Banteay Dek Commune, Kean Svay District, Kandal Province (Figure 1). The river segment is about 4 km. Being change into commercial, the area is facing a serious problem of riverbank erosion which caused by the great change in river flow conditions. Likewise, the National Road No. 1 is much closed to the eroded riverbank; hence the Department of Waterways of Ministry of Public Works and Transport (MPWT) has decided to construct the riverbank protection in order to prevent more serious problem caused by the riverbank. The mathematical model in HEC-RAS is based on the digital elevation terrain model in a single coordinate system, realized from the topographic survey carried out in the study area in 2015 by MPWT, from the Shuttle Radar Topography Mission resolution (SRTM) with the resolution of 30 m.

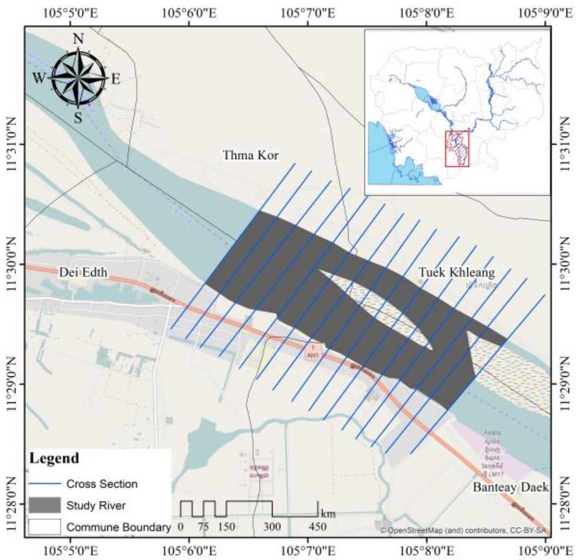

Figure 1 Location map of the study area

The discharge and water level data at upstream boundary was obtained from a hydrological monitoring station; the discharge data is available from 2008 to 2009 with the irregular time step; hence, it is necessary to conduct the analysis on a monthly basis. Moreover, the observed discharge and water level data was obtained from the previous studies which were conducted along the Lower Mekong River with the approximate length of 50 km (Sun, 2017). Likewise, to assign the Manning roughness, first we need to define vegetation characteristics for the common study area through the river then it was calibrated based on the Manning's Value Criteria from HEC-RAS.

Model calibration defined as the procedure of adjustment of parameter values of a model to reproduce the response of reality within the range of accuracy specified in the performance criteria (Refsgaard and Henriksen, 2004). The model was calibrated with data between January and December, 2008 and validated with data between July and December, 2009. Furthermore, in order to analyse the performance of the model in the calibration and validation phase some measures are used, graphical comparisons and statistical tests. Graphical comparison includes the time series plots of observed versus simulated water levels. For the statistical tests, two error indicators were considered. They are Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE).

Results and Conclusions

After a dozen of simulations, the different values of Manning's n for the main channel and for the overbank are applied. The resulting water level at the upstream compared to the Reach 920 for the period: January-December 2008, which ensure the best fit to the observed water levels. As a result, the model gives better results for n = 0.03 which yields the maximum of the HEC-RAS model performance. The values of the model errors after the calibration process for 2008 were RSME = 5.3 cm, MAE = 4 cm and MAPE = 0.9%. Hence, there is generally strong agreement between observed and simulated water level at the upstream of the study river and it is evaluated as good performance rating. The validation was performed for the period of six months from July to December 2009. After the calibrated Manning's n value (n = 0.03) was used to simulate the model in the aforesaid period, the values of the model errors after the validation process were RSME =8 cm, MAE=4.7 cm, and the MAPE=1.07 %. Somehow, there is also generally strong agreement between observed and simulated water level at the upstream of the study river and it is still evaluated as good performance rating.

The results of the HEC-RAS model calibration and validation were satisfied as the statistical indicator were in the acceptable range. Thereafter, this calibrated model was used to assess an impact assessment in the river by introduced the new cross section with three common used riverbank protection (concrete n = 0.013, gabion n = 0.027 and riprap n = 0.042); and to make the velocity mapping. After simulation, it can be seen that there was a higher flow at right side than the left side of the river and this is because of the water depth at the right side are deeper (Figure 2); also, the flow direction is direct to the right side to the river along with the bigger water force then it caused the bank erode. However, after the bank protections among the three-riverbank protection aforesaid have been construct the velocity will only change slightly with changes less than 0.01 m/s compared to the existing condition of the river (Figure 3). Although the overall change in flow velocity in not significant (-1.10% to +9.56%), the localized change is up to +51.72% (Table 1). Overall, the improvement of the riverbank will not cause much effect on the velocity in the river as well as the riverbank in the upstream and downstream.

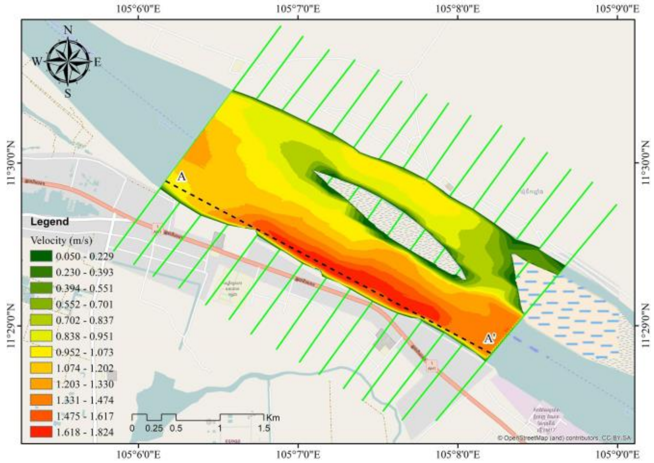

Figure 2 Velocity map of the baseline simulation

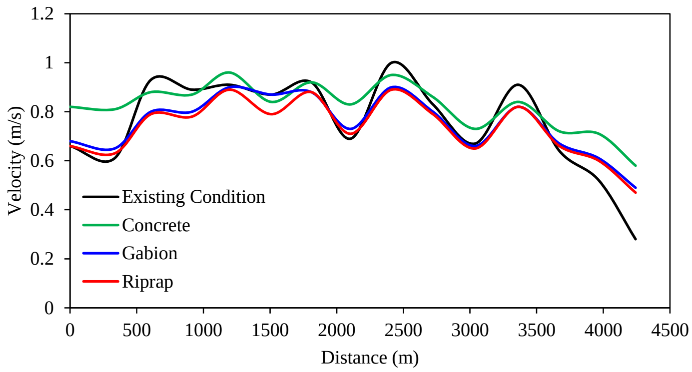

Figure 1 Longitudinal profile of flow velocity for different riverbank protection

Table 1 Changes in flow velocity

Type of Revetments	Minimum change (%)	Maximum change (%)	Mean change (%)
Concrete	-8.33	51.72	9.56
Gabion	-16.25	42.86	1.14
Riprap	-17.72	40.43	-1.10

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