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Constructing stage discharge relationship with numerical simulation including hydraulic resistance

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A flood risk assessment has implemented with an inundation map or with other simulated results; e.g., a rainfall-runoff simulation. In order to conduct the flood risk assessment, it is usual that the case with maximum floods are subject for discussion. At the same time, it is usual that observed data of the maximum floods are not available, since the maximum floods has not experienced, or observation have not conducted. Estimation of the discharge values are not simple, since the river flow at the targeted cross section are affected by river shape, or roughness changes. Both of them are sensitive with different flow stage.

The present study discusses about constructing the stage discharge relationship with numerical simulation. For this purpose, the author implements the 2-D depth integrated flow simulation including the flow resistance. The flow resistance is one of the traditional studies of the sediment hydraulics. It deals with the changing of resistance with different micro-scale bed forms as the bed shear stress changes. Similar with the one by Engelund (1966), the relationship with grain shear stress and total shear stress are constructed in qualitative manner by Kishi and Kuroki (1973). It is useful to obtain the bed roughness with different flow stage. The author implements the changes of the roughness in the 2-D depth integrated flow simulation and obtains the flow field in actual river flow in order to obtain the discharge values.

The authors conducted the numerical simulation in steady flow condition. In order to construct the stage-discharge relationship based on the results, 10 different cases with appropriate ranges of stage were conducted. The domain of the simulation is 5 times longer than the width of the targeted section. In order to construct the initial condition, bathymetry data in the one point in 5 m with the laser technique, and sediment size distribution at the different location; e.g., at center of flow, top of the dune and etc., were obtained. The calculated results were compared with observed flow field by float measurements and other non-contact current meter. The results indicate that the numerical stage-discharge relationship shows some good agreements and few disagreements with the one created based on observation. For example, at the water stage which represents the dune I, the simulated results are similar with observed. However, at the stage of dune II, simulated velocity shows smaller velocity than observed. As Hirai (2015) suggested, shape of micro-bed form classified as Dune II is unstably changes between Dune and flat bed. Therefore, velocity at the stage is sensitively changes as well. From this aspect, the authors concluded that not only the numerical simulation but also field measurement are necessary in order to construct

good stage-discharge relationships, in particular if the shear stress at the targeted discharge involves the Dune II.