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Monitoring of Flash Floods Using Image-Based Techniques

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Introduction

In Japan, several restoration of rivers has been implemented due to degradation of river ecosystem and significant morphological changes, which caused by various factors such as, dam construction and a channelization. In attempt to guide and confine the river channel, it is important to manage river system for effective and safe movement of flow and sediment using a different flood control structures such groynes and crib spurs (Seigyu). These structures are installed at an angle to the flow to divert the river flow path from critical zones (Fig. 1). Groynes and traditional structures are made of gravel, rock, wooden piles, bamboo casing, and cribs (Yossef & Vriend, 2011).

"Seigyu" is one of traditional river structures in Japan, used to restoring and maintaining riverbanks. The constructed material used in this structure, made of wood, stone and bamboo (MASCARENHAS, COPPE-UFRJ and BRAZIL 2011). Many studies have investigated the flow characteristics around groynes (Uijttewaal, 2005) and case similar to Seigyu. The flow characteristics around groynes occurred with turbulent flow due to varies parameters such discharge rate velocity and bed roughness parameters (Ouillon & Dartus, 1997). In this paper, we measured the surface flow velocity distributions around seigyu structure to obtain flow patterns using large-scale particle image velocimetry (LSPIV). To see the capability of structure for provided a better flow filed for protection and restoration. Finally, the predicted results based on image techniques are calibrated with the measured velocity by using propeller.

Fig. 1 Seigyu structure located at the right bank of Kizu River

Method and Materials

The installed seigyu structures are located in Kizu River, a tributary of the Yodo River in central part of Japan. The bed material of Kizu River can be classified as a typical sandy river sourced from weathered granite. The corresponding basin of this river is 1,596 km^2. There are five completed dams in the Kizu River System, Murou, Shourenji, Hinachi, Takayama, and Nunome dams, which caused riverbed and banks degradation due to reduction of sediments supply and peak discharge rate, (Kantoush and Sumi 2016, Choi, 2014). Kantoush and Sumi have monitored the surface flow velocity and sediment transport rate downstream of Murou and Nunome dams (Kantoush et al. 2011). The LSPIV method used to extract surface flow velocity by detecting the movements of flow over each pixel with space and time at sequent frames. The obtained flow fields are two dimensional surface flow velocities. The image based techniques demonstrate in many applications such dam discharge operation, bed channel stabilization and early warning system which required high performance to estimate of flow velocity period and discharge rate with time (Kantoush et al. 2012). In this research, we used drone to captured videos at height of 25 –50 meter vertically to surface flow with 4096 x 2160 pixels resolutions and 23.98 frames per second.

Results

Figure 2 shows the flow patterns during the recession of the flood measured on 5 May 2018. The seigyu is able to deflect the flowing water away from the critical zone on the right bank. The interface between the structure and the main flow show the flow behaviour takes place more sufficiently around the structure and the space between selected range in merged and sub-merged condition. A large surface flow velocity induced between Seigyu structures can be seen in case of flood recession phase, which caused riverbed degradation in critical zone. Figure 4 shows velocity colour map calculated from the video image using

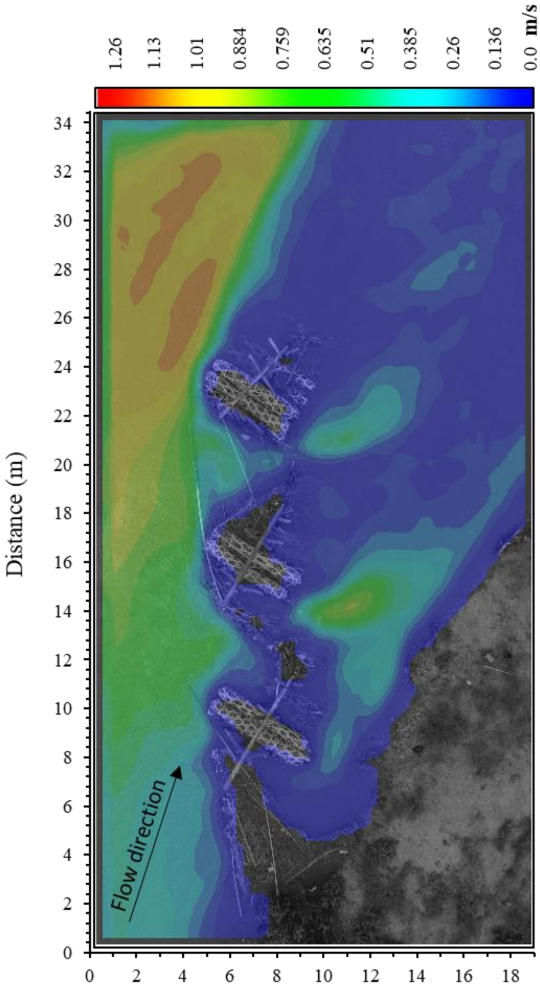

Fig. 2 velocity color map around Seigyu during submerged condition on regular floods.

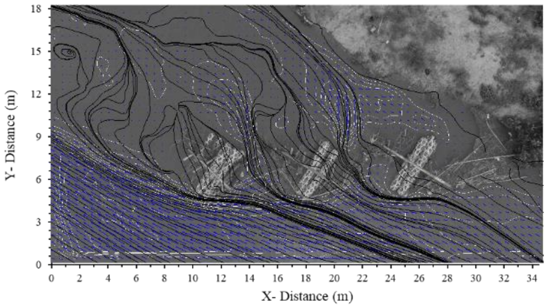

Fig. 3 Streamline and velocity vectors for measured flood on 5 May 2018

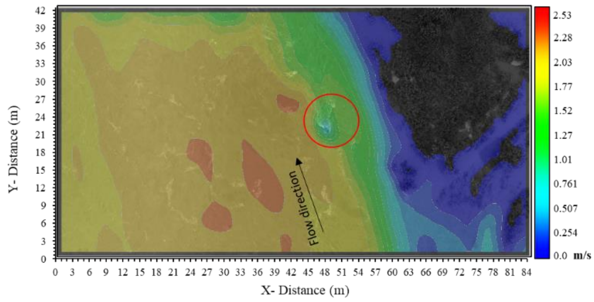

Fig. 4 velocity color map around Seigyu during merged condition on large floods.

LSPIV techniques during the peak floods 29 July 2018. Consequently, the result present the estimated averaged velocity collected from 781 frames with time lag between each frames was 0.033 sec. In case of flood recession seigyu, the eroded riverbed will be reduced based to the velocity profile and water level, which can observed in figure 4.

Conclusion

The LSPIV method can successively showed velocity distribution with spatial and temporal resolution. Although, this structures should be arranged and close the space between each seigyu to prevent riverbed and increase the stability of structures during regular floods.

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