Study on the generation of digital inundation water surface elevation model by using SfM/MVS technique -- A case of flood inundation and natural dam

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Flood disaster around Kinu River associated with Kanto-Tohoku heavy rainfall on September 2015 caused severe damages around Joso City and Shimotsuma City, Ibaraki Prefecture. In this disaster response, drainage of inundation water by using pumper played an important part. When a lot of natural dams were generated by landslides or deep-seated slope collapse associated with the Mid Niigata prefecture Earthquake in 2004, the Iwate-Miyagi Nairiku Earthquake in 2008, and the Kii Peninsula flood disaster by Typhoon Talas (1112) in 2011, etc., pumping drainages were performed. It is important to grasp quickly the inundation water condition for drainage planning for these natural dam and evaluation of risk of dam burst.
Previous methods of estimation of inundation depth for a short period after inundation are followings: 1) Inundation area and inundation water surface elevation are estimated by manual interpretation of aerial photo or video, and then inundation depth is calculated from a difference between inundation water surface elevation and ground elevation before inundation. 2) Inundation depth is calculated from a difference between pre- and post-digital elevation model (DEM) by airborne LiDAR (ex. Konami et al.). Aerial photo of the method 1) is taken with comparative ease although it is affected by weather. Although the method 2) is enable to estimate precisely the inundation water volume, it is affected by weather and it needs many time on the measurement and analysis. On the other hand, SfM (Structure from Motion)/MVS (Multi-View Stereo) technique has advancing recently. This technique is able to generate quickly digital surface model (DSM) from plural aerial photos. Therefore, I tried to generate a digital inundation water surface elevation model (DWEM) from aerial photos by using SfM/MVS technique and to estimate a general inundation depth.
The aerial photos in this study are vertical photos with 60% over-lap and 30% side-lap taken from airplane. Also, this method has some preconditions and issues. In terms of generation of DWEM, the preconditions are 1) the bottom of inundation water is not taken, and 2) inundation water surface has not moving, wave, moving shadow of cloud, and halation. In case of flood inundation, structures over the inundation water or suspended materials on the inundation water are impeditive. In case of natural dam, there is possibility that DWEM cannot be generated under the influence of surrounding trees or suspended materials on the inundation water. In terms of estimation of inundation depth, the shape of collapsed soil under the inundation water surface is only presumed because it is not able to estimate in case of natural dam. In this presentation, I will report the composition result between the inundation depths estimated by this study and inundation depths estimated by previous method or inundation depths measured by field survey.

Keywords: SfM/MVS, digital inundation water surface elevation model, inundation depth, flood inundation, natural dam