Measurement of a Landslide Dam in Yubama Area from a Helicopter by SfM Using Oblique Photos

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INTRODUCTION

Once a landslide dam is formed, it may cause damage to the downstream area due to debris flood caused by the dam break and, therefore, the area is examined. As regards debris flood, the extent it may reach is anticipated by value analysis [*Shimizu et al.*, 2012]. As the shape of the landslide dam including its height, etc. becomes an important factor for determining the assumed damage area, the shape and position of the dam are measured.

In recent years, a technology called Structure from Motion (SfM) which acquires a 3D profile of an object from digital camera's images from multiple viewpoints has been developed. In existing researches [*Uchiyama et al*., 2014; *Obanawa et al.*, 2014], some trials have been conducted to measure geographical shapes from aerial photos by an unmanned aerial vehicle (UAV) using SfM. In this research, aiming to know shape of landslide dam by helicopter survey conducted after the disaster, SfM is conducted to measure the shape of landslide dam by creating a geographical model (DSM; Digital Surface Model) using oblique photos. The DSM were compared with the results of airborne LiDAR survey (LP) [*Akazawa et al.*, 2017] and the difference image of them was produced, and the accuracy of DSM by SfM was verified.

METHOD

This study targeted the landslide dam in Yubama area formed by the Iwate-Miyagi inland earthquake of 2008. Currently countermeasure construction is being conducted in Yubama area by building a steel cell dam.

As SfM software, commercial software PhotoScan (of Agisoft) which is frequently used in existing researches [*Uchiyama et al*., 2014; *Obanawa et al.*, 2014] is being used. To take the photos, Nikon D7000 equipped with GPS unit (GP-1A, position accuracy 10mRMS) is used.

In the process flow frequently executed in existing researches, photos are taken first, then they are processed by SfM software. In the processing, a 3-dimentional shape of the target is built from photos taken and, to have a geographical coordinate, ground control points is set and geographical data (DSM; Digital Surface Model) is obtained. To set ground control points, a few coordinate values must be already known on the measurement target. However in reality, it is difficult to locally conduct the measurement because roads may have been blocked after the landslide dam is formed. Therefore, setting of ground control points becomes problematic.

In the procedures used for this study, the coordinate data is buried in the photo data by using a camera with GPS unit and it is possible to make a 3-dimentional model equipped with a geographical coordinate without setting the ground control points. In June, 2016, 52 photos were taken from a helicopter, and the DSM was created by SfM. It took 6 hours to create the DSM.

RESULTS

The DSM created by SfM was verified by comparing with the DEM (Digital Elevation Model) created by LP conducted in 2013. **Fig.1** shows an airborne photo when conducting the LP. It shows that the slope was collapsed and the landslide dam has been formed in the area encircled by the red circle. **Fig.2** shows the difference between SfM and LP. There is an area where elevation by SfM is higher. This is because the dam was completed and accretion of sand advanced during approximately three year period when SfM (2016) and LP (2013) were conducted. Similarly, there is an area around the top edge where elevation by LP is higher. This is thought to be the impact of the construction. **Fig.2** shows the longitudinal map and the side lines. By comparing the elevation of the landslide dam's top edge, it is found that the difference of the elevation is 5.8m.

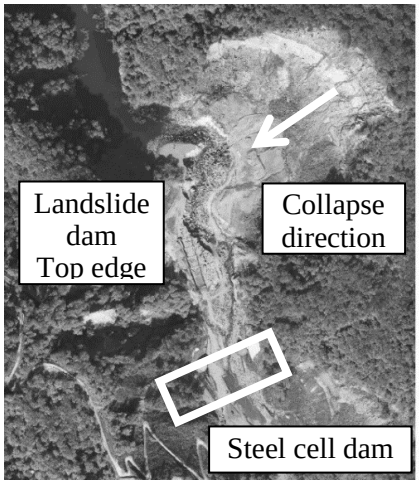

Fig.1 Airborne photo (2013)

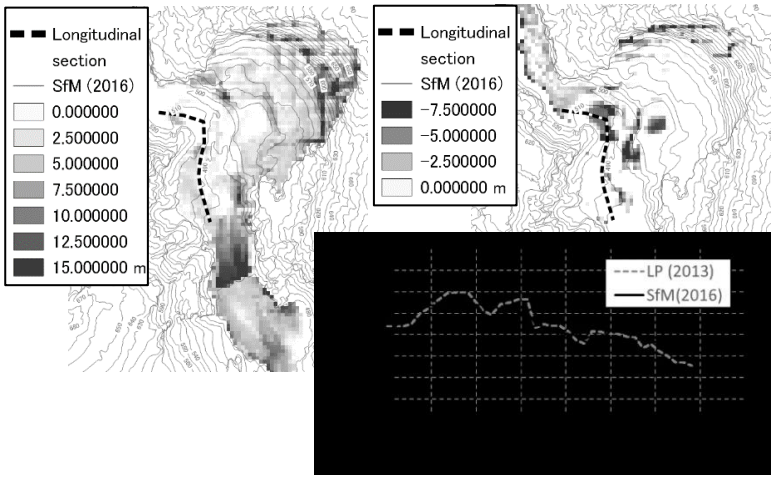

Fig.2 Difference between SfM and LP, and longitudinal map

DISCUSSION AND CONCLUSION

As a result of the SfM method used for this study, it was found that a shape of landslide dam and elevation could be measured at the accuracy of several meters. It is said that the elevation accuracy of LP is 0.3 m, position accuracy of GPS is 10 mRMS and the accuracy of long distance laser distance meter is approximately 10 m [*Uchida et al.*, 2011] and the height of many landslide dams is several tens meter. Therefore, the method of this study has sufficient accuracy for the measurement of the shape made just after a landslide dam is formed.

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