

Characterizing landslide dam breach geometry conducted by field landslide dam overtopping failure experiment

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INTRODUCTION

Global climate change has resulted in sediment falling into the river, which will block river and form landslide dams. When flood infiltrates the dam, its structure will become weaker and be prone to failure (Stansby, 1998). Generally, outburst flooding into downstream area results in significant damage and loss of human life, property and infrastructure. It is difficult to delimit the process of landslide dam failure, which includes drowning, hydraulic jump, piping, seepage, strong vertical erosion, discontinuous mass collapse and head cutting. In addition, upstream and downstream hydrological condition, materials characteristic and status all affect the breach form and its mechanism (Xu et al., 2013). Most researches proposed by laboratory experiments are on small scale homogeneous dams, very few large scale experiments have been conducted in recent years (Wu, 2011).

METHOD

A prototype natural dam overtopping failure experiment, which was held in Landao Creek, Huisun, Taiwan. The experiment channel length is 450 meters, width is 25 meters, and the average slope is 9 degrees. An artificial landslide dams were built to approach a hydrological analysis of a dammed lake, and discuss characteristics and phenomenon of landslide dam failure process, such as variations of outburst velocity, development of breach geometry, and topography change after dam break.

To investigate the development of landslide dam breach geometry, we proposed a dimensionless breach shape parameter (L) to distinguish the characteristics of landslide dam breach. L equals $((T_{down}-L_{down})/L_{down}-(T_{up}-L_{up})/L_{up})$, T_{up} is top section width of upstream dam breach, L_{up} is lower section width of upstream dam breach, T_{down} is top section width of downstream

dam breach, and L_{down} is lower section width of downstream dam breach.

Two artificial landslide dams were built with length of 28 meters, width of 10 meters and height of 2.5 meters. The distances are 16.2 and 32.4 meters in Case A and Case B, respectively. Besides, the dam height in Case C, 3.3 meters high, is different from Case B. In each case, before and after landslide dam failure, 3D Model was built by Lidar topographic measurement, and was combined with photography system to observe the dam breaching phenomenon. On the other hand, water level loggers were set up to identify the hydrological process. (Fig. 2)

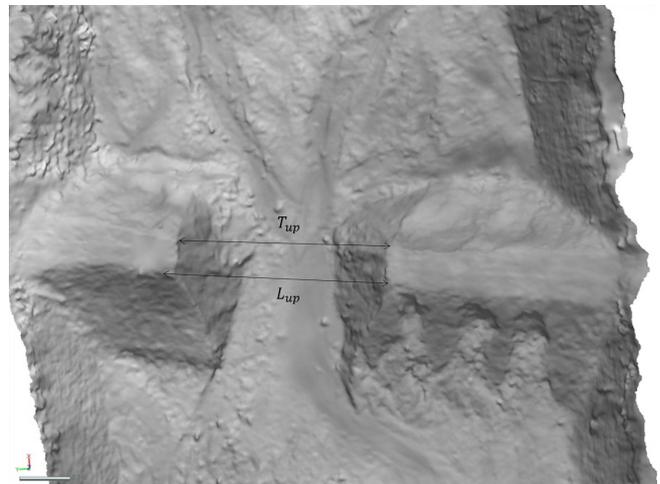


Figure 1. T_{up} is top section width of upstream dam breach, L_{up} is lower section width of upstream dam breach.

CONCLUSION

The results indicate that the dam failure process can be divided into two stages from the top view and side view. First, from top view, the flood flows through the dam crest causing head erosion and forming a narrow upstream, wide downstream channel. Second, the breach shape affected by contraction of outflow develops into wide upstream, narrow downstream channel. From side view, the development of breach geometry can be

divided into three distinct stages. First, the breach shape appears as an inverted triangle caused by vertical erosion. Then, the erosion process evolves gradually from vertical degradation to lateral horizontal erosion after approaches to the foundation or datum plane. In the final stage, the mass collapses from breach sidewalls and transforms from a parabolic to trapezoidal shape. Then, the breach shape and size are affected significantly by breach shape parameter L , which represent the breach characteristics influenced. The value of L is 0.17 in Case A, 0.12 in Case B, and -0.11 in Case C. When the interval between two dams increases, it will decrease the influence of upstream outburst to downstream dam. When the dams become bigger, the reservoir volume will rise, it will increase the influence of upstream outburst to downstream dam, even change the development process of breach geometry. In Case C, L is negative, represents that the failure process maintains in first stage from top view. In addition, the experiment results of average final breach width B are found to be in

the range of $2.0 \leq B/H \leq 3.0$, where H is the dam height, in agreement with the research of Chinnarasri and Wongwises (Chinnarasri et al., 2004), who proposed it as $1.5 \leq B/H \leq 3.0$.

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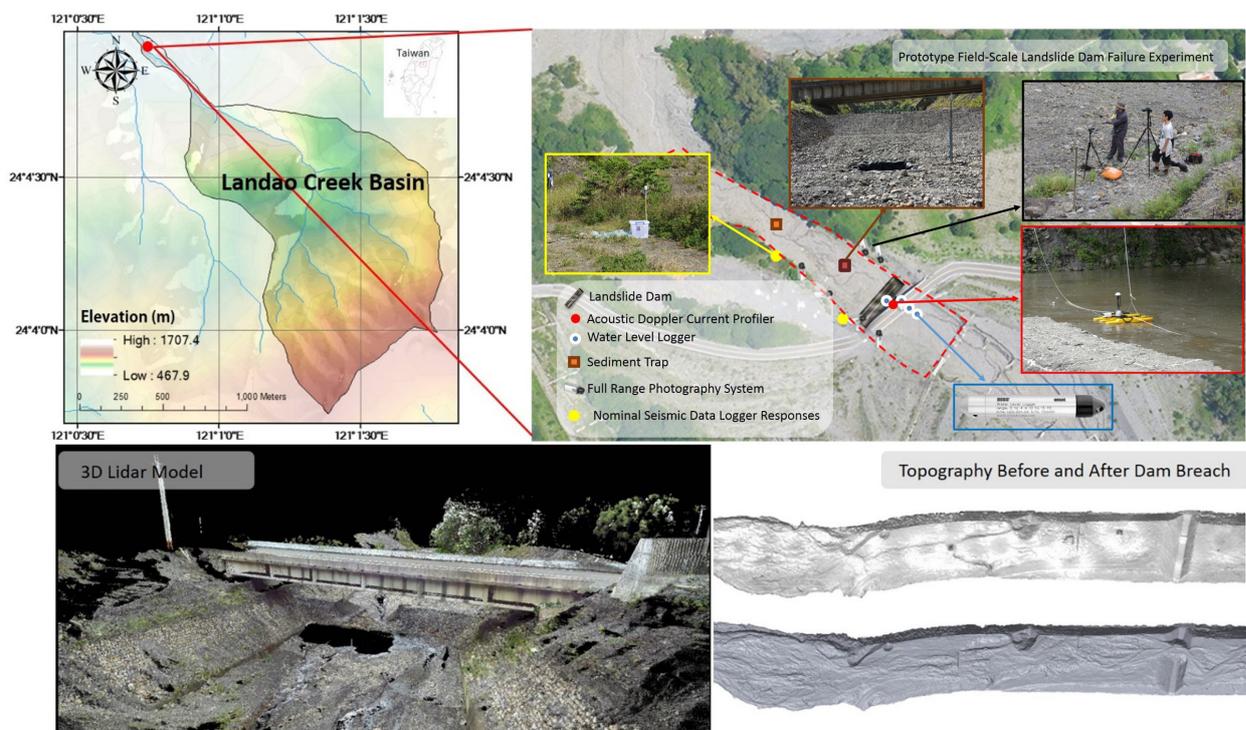


Figure 2. Location, experiment setting and 3D Lidar topography model of landslide dam failure experiment.

KEYWORDS

breach shape; development of breach geometry; breach shape parameter