Assessment of Landslide Recurrence by Onsite Monitoring - Incidence of Hung-Yeh Landslide -

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INTRODUCTION

Typhoon Meranti brought 651.5 mm of rain in four days to Hung-Yeh Village in Taitung County, Taiwan starting from September 12, 2016, which triggered a 7.8-ha landslide with approximate volume of 40,000 m^3 of debris that damaged 39 housings, 3 public buildings, and local traffic system (**Fig. 1**).

A magnitude 5 earthquake trembled the entire Taitung County on October 6, 2016 followed by Typhoon Aere, which brought 1009.5 mm of rain within a week. Earthquake and intensive rainfall further deteriorated the landslide and resulted a 1.8-ha expansion on landside scarp. People from Hung-Yeh Village were immediately evacuated.

Emergency relief task forces were immediately dispatched to help restore public facilities. Research team was also called up by government officials to install boreholes and monitoring system, which includes rain gauge, inclinometers, and water-level sensors. Check dam as well as gully control structures are currently under construction to prevent landslide from worsening.

Fig. 1 Disaster caused by September 12 2016 landslide

Therefore, the objective of this study is to assess the likelihood of landslide recurrence and the feasibility of control structures by analyzing data from inclinometers, water-level sensors as well as numerical simulations under different scenarios.

METHOD

Total of five boreholes was installed on site. Core samples from each borehole were taken for mechanical property analysis, which includes cohesion, angle of repose, and ultimate stress. Dual-axis inclinometer was inserted into borehole casting and took the readings from ground level to the bottom of borehole, and the measurement depths ranged from 22 m to 76 m. Rain gauge was installed in the vicinity of the landslide site with a data logger attached to automatically log the rainfall events.

Water-level sensor was placed in the borehole casting to continuously record groundwater levels every 10 minutes. It was then retrieved for data readout every month.

Digital elevation model was created using Unmanned Aerial Vehicle (UAV) scan and topography field survey immediately after emergency relief. Digital Elevation Model (DEM) has been constantly updating during the construction of gully control. The DEMs were then used for numerical simulations. FLO-2D model (O'Biren, 2009) was used to simulate the extent of debris-flow affecting areas under different rainfall scenarios, which included 25- and 200-yr storm recurrence intervals.

RESULTS AND DISCUSSION

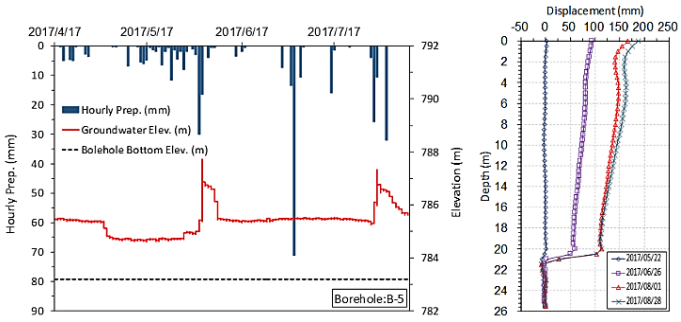

Fig. 2 Groundwater elevation readings from B-5

Results from groundwater-elevation readings indicated groundwater levels changed rapidly and synchronized with rainfall particularly for B-2, B-3, and B-5 that constituted the entire landslide scarp section. Core samples taken from these boreholes also indicated the existence of rock fractures. Inclinometer readings from B-5 (**Fig. 2**) showed a 18.8-cm displacement in downslope direction in three months.

Numerical simulation assessment of debris-flow affecting areas at different rainfall scenarios is still undertaken while gully control and check dam construction continuously alters the landslide landscape. It will provide update information to both government agency and construction company when refinement of restoration project is needed.

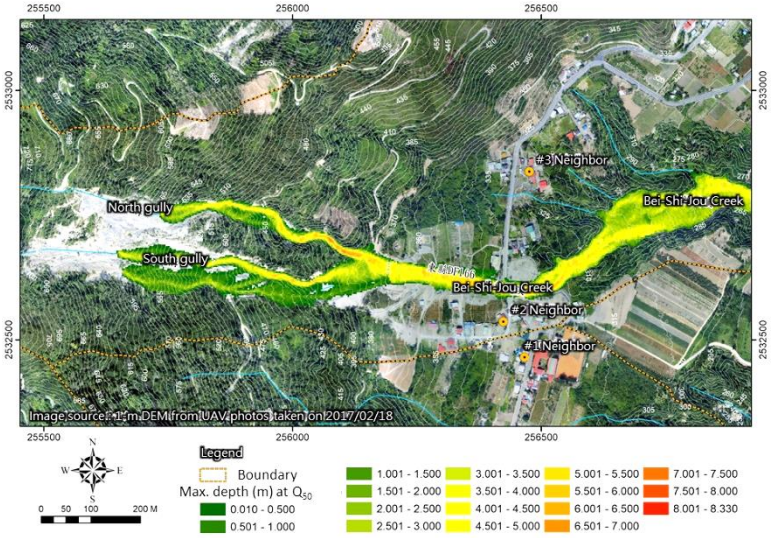

Fig. 3 Numerical simulation of debris-flow affecting

CONCLUSIONS

Onsite monitoring is currently undertaken while 2017 rain season just begins for less than a week. Typhoons are expected to affect Taiwan as usual. Field survey, geologic assessment, inclinometer readings, and groundwater level readings all suggests the causes of 0912 landslide were mainly due to continuous, heavy rainfall and existing rock fractures. Likelihood of landslide recurrence is expected. We hope that check dam and gully control structures currently under construction can help minimize the scope of disaster.

Keywords: Landslide, Field monitoring, Assessment of landslide recurrence