Failure and dynamic process of Luhu landslide inferred from the geologic investigation, numerical modeling and seismic signals

Che-Ming Yang1,2, Wei-An Chao1,2, Jyh-Jong Liao1,2, and Yii-Wen Pan1,2

1Department of Civil Engineering, National Chiao Tung University, Hsinchu 30010, Taiwan (stanleyyangcm@nctu.edu.tw)
2Disaster Prevention and Water Environment Research Center, National Chiao Tung University, Hsinchu 30010, Taiwan (stanleyyangcm@nctu.edu.tw)

Luhu landslide occurred at April 13 2018 and locates in Luhu village, Miaoli county, Taiwan during intermittent rainfall. A sequence of rockfall events has been documented also by the local government in early April. Frequent rockfalls and gully erosion possibly resulted failure of a deep-seated landslide (DSL). The estimated maximum thickness, collapsed area and volume of the landslide are about 60 m, 65,000 m$^2$ and 2 million m$^3$, respectively. The purpose of this study is to clarify the failure mechanism and dynamic process of Luhu landslide, which is practically critical case to understanding the susceptibility of deep-seated landslide without direct triggered factors (thereafter uses the term 'non-triggered DSL'), including earthquake and intense rainfall. Study site is a steep anaclinal slope consisting of thick sandstone, interbedded of sandstone and shale. Multi-temporal ortho-images and digital elevation (surface) models from 1980 to 2019 are collected for geological investigation and geomorphological interpretation. The study area contains three sub-regions: the north, the northwest and the west slopes. The slope failure occurred repeatedly inside the north and the northwest slopes in the early stage. Gully erosion in the west slope progressed to a landslide in early April first and expanded to cover the DSL failure in the northwest slope eventually, blocking the Luchang River and forming a natural dam. In order to further investigating landslide dynamics, seismic records generated by landslide are collected from the broadband seismic network. A series of time-frequency analysis shows that the spectral power distributed in a wide frequency range. Low-frequency seismic signals, which are generated by the unloading/reloading cycle of landslide mass, would be helpful for force history inversion. We propose that the relative high-frequency (HF) signals contains the information about the small block particles interacting with the topographic barriers. The automatic scheme of HF signal detection was adopted to find out the activity of collision/impact of rock block, which can be an indicator of increasing instability. Aforementioned results combined with numerical simulations provide not only the better understanding of failure mechanism of Luhu landslide but also crucial for the identification of non-triggered DSLs and their hazard assessment.