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A multiparameter method for analysis of likely causes of the Maoxian rainfall-triggered landslide

Zelang Miao (1,2), Shuai Chen (1,2), Lixin Wu (1,2)

(1) School of Geosciences and Info-physics, Central South University, Changsha, China, (2) Key Laboratory of Metalogenic Prediction of Nonferrous Metals and Geological Environment Monitoring (Central South University) Ministry of Education, Changsha, China

A rainfall-triggered landslide on 24 June 2017 devastated a small village of Maoxian in the northwestern China, causing more than dozens of deaths. This study explores a multiparameter approach to explore the mechanical causes of this event. To this end, a series of parameters derived from satellite observations were utilized. This study indicates that several events collectively caused the event.

Digital elevation model from SRTM shows that the slope of the bare land is between 20∼70 degrees, which provides a natural precondition for landslide occurrence. A bare land was detected from an optical image, captured by GF2 with a spatial resolution of 2m per pixel. The exposed surface was mainly covered by limestone that has negative effects on the normal growth of plants in the area, due to its high hardness, low nutrients content and potential heavy metals pollution. Although the limestone has a high stability, historical earthquakes in this region, particularly the 7.9 magnitude Wenchuan earthquake happened on 12 May 2008, gradually damaged the stability of the bare land and created surface cracks and fissures that provide channels for water seepage. The post-disaster field surveying finds clear yellow elongated areas with a leached appearance. Compared to the vegetated area, the bare land is more conducive for the downward seepage, which in turn further damage the bedrock. Beyond that, a severe summer drought, retrieved from precipitation data from ECMWF, hit the region 11 months before the occurrence of the destructive landslide. The drought is also a contributing cause of landslides, as it could change the geotechnical strength and sliding force. These factors deepened the surface cracks and crevasses created by earthquakes, which reduced the triggering threshold of landslide. The continuous rain during 18 June to 24 June 2017 finally induced the landslide. Thus, we can conclude that internal factors (i.e. fault, slope and rock type) and external factors (i.e. earthquake, vegetation cover and extreme climate change) mutually caused the Maoxian rainfall-triggered landslide of June 2017.

The Maoxian rainfall-triggered landslide shared similar geohazard mechanism with several drought-wet related landslides occurred in the region previously. For instance, the phenomenon of severe drought occurring before landslides was both identified in Guanling (Guizhou) landslide of May 2010, Guanling (Guizhou) landslide of June 2010 and Baoshan (Yunan) landslide of September 2010. These findings have implications for mechanical-hydrologic interactions that link landslide movement with extreme events, such as abrupt climate change and earthquake. Additionally, this study provides real cases to confirm the finding by Diandong Ren: ‘gravity field measuring satellites indicat that the larger geological environment of the region is becoming increasingly unstable’.