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Locating the rock hazard and understanding its physical process using seismic signals

Jui-Ming Chang[1], Wei-An Chao[2,3], and Hongey Chen[1,4]
[1]Department of Geosciences, National Taiwan University, Taiwan
[2]Department of Civil Engineering, National Chiao Tung University, Taiwan
[3]Disaster Prevention and Water Environment Research Center, National Chiao Tung University, Taiwan
[4]National Science and Technology Center for Disaster Reduction, Taiwan

Rock hazard is a common geohazard event that occurs in the orogenic mountain belt and often causes the destruction of road and casualties. The steep topography, fractured bedrock and frequent earthquakes favor to happen. Those are usually fast and unpredictable, leading a lack of direct observation of physical process. Recent seismological studies highlighted the rock hazard induced seismic signals could improve understanding of its dynamics. This study focuses on the three provincial highways that cross the Taiwan Island from east to west. The regions along the highways have the complexity in tectonic structure and extreme climate-forced erosion, causing the hazard frequently occurred. In order to understanding seismic features and physical process of rock hazard, we conducted a series of seismic analyses using the seismic records collected form regional seismic network for ten events, which were reported by the government agency. Four of them have the video recordings, which would be helpful to understanding the relationships between physical process (falling, rolling, bouncing and fragmentation), movement type (fall, topple, slump, slide, avalanche or complex) and seismic features. We developed the hybrid method of determination of geohazard event location (GeoLoc) that combines the cross-correlation-based method and the amplitude-attenuation-based approach. We apply the GeoLoc scheme to locate the events recorded by the seismic station with epicentral distance ranging from 2 to 56 kilometers (km) and it helps to reduce the location error. The leading seismic signals of the mass detachment linked to the crack propagation or slope response can be observed, and we also found that the seismic feature caused by fragment of rock block exhibits the higher frequency than the seismic signals corresponding to impaction of rock particles. Our results highlight the possibility of the seismic technique for locating rock hazards distributed along highways in a regional scale and further understanding its physical process. The aforementioned results would be helpful to build the near-real-time monitoring system along the highways for hazard mitigation of events.