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Landslide induced by the Typhoon Morakot in Shiaolin village, Taiwan

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Typhoon Morakot induced Shiaolin landslide, which killed 439 people in the south of Taiwan on 9 August 2009 (National Disasters Prevention and Protection Commission, 2009). The cumulative rainfall reached to 1676.5 mm in about 3 days, when the Shiaolin landslide occurred. That was about one day after the peak of rainfall intensity. The landslide occurred on a dip slope, which is underlain by late Miocene to early Pliocene sedimentary rocks consisting of silt shale, massive mudstone, and sandstone. These beds, which trend NW-SE and dip at 20-25° to SW, are located on the east limb of a syncline trending NNE-SSW and plunging to SSW.

The landslide was 3 km long, 0.8 to 1.5 km wide, with an apparent friction angle of 14°. It started as a slide upslope and transformed into debris avalanche downslope. The source area was the upper third of the landslide and is divided into major southern part and the minor northern part, which are separated by E-W trending joints. Interpretation of topography before the landslide suggests that the source area showed hummocky surface, which is indicative of the gravitational slope deformation before the event. In addition, water coming out from the source area precipitated calcite on the stream bed, indicating that calcite contained in the rocks is once dissolved by the groundwater. This dissolution should have occurred also before the landslide and deteriorated the rocks, which are gravitationally deformed.

The debris avalanche was a large bulk of mostly rock debris deriving from the southern major part. The start time of the landslide was close to 06:16 AM and the end time of the landslide was estimated to 06:17 AM with a velocity of 24.4 to 34.9 m/s, which is estimated from the information of eyewitness and the seismic record of this landslide. The seismic record is further processed and analyzed. The results indicate that the major frequency content of the landslide vibration was near 0.9 Hz. The debris avalanche crossed the flat terraces below the source area and pushed out or buried the village below the terrace. It buried the narrow river channel with about 80 m width and then ran up the opposite slope, making a 60 m high landslide dam, which breached at 07:00 AM, on 9 August (Shieh et al., 2009) and flooded the village area. The debris consisted of fragments of mudstone, shale and sandstone, and interestingly they had clayey materials at the bottom. These clayey materials had no swelling clay minerals and is assumed to have played an important role for the transportation.