

## 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. 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 (Fig. 1).

The landslide was 3 km long, 0.8 to 1.5 km wide, with an apparent friction angle of 14°. 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, X-ray diffraction (XRD) analysis indicated that calcite is contained in the rocks and it was dissolved by the groundwater so that the rocks had been deteriorated before the landslide, providing the basic causes for the gravitational deformation and landslide.

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 6:16 AM and the transportation velocity was estimated to be 24.4 to 34.9 m/s on the basis of eyewitness and the seismic record of this landslide. It crossed the flat terraces 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 7:00 AM, on 9 August (Shieh *et al.*, 2009) and flooded the village area. Interestingly, the debris had clayey materials at the bottom. This clayey materials had no swelling clay minerals and is assumed to have played an important role for the transportation.

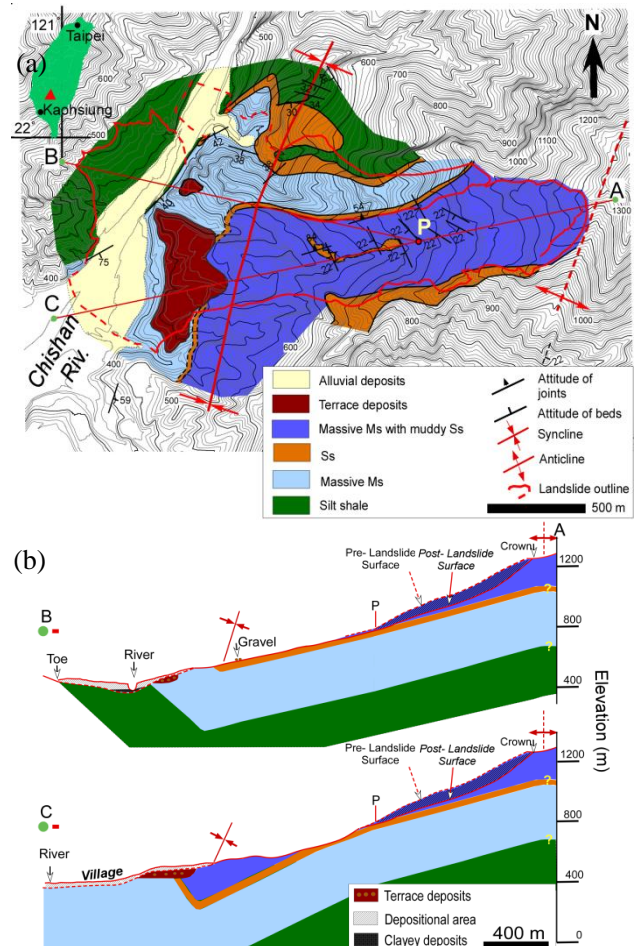


Fig. 1. (a) Geological map of the Shiaolin landslide area, (the contour lines indicate the pre-landslide topography) and (b) geological cross section.