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Seasonal, long-term, and short-term deformation in the Central Range of Taiwan induced by landslides

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Seasonal movement of GPS stations is often attributed to hydrological loading and other environmental factors. For the first time we observe seasonal motion associated with slow-moving landslides. Eight of 26 continuous GPS (cGPS) sites in the Central Range of Taiwan show long-term landslide-induced motion at rates of ~3–15 mm/yr, ~20%–60% of their tectonic interseismic velocities. The directions of movements after heavy rains and in the wet season are consistent with the slope directions derived from a high-resolution elevation model constructed by airborne Light Detection and Ranging (LiDAR). Long-term and seasonal interseismic motions are modulated by slow-moving landslides as well. Estimates of interseismic crustal strain can be biased if surface processes are not taken into account. Preliminary analyses indicate that rainfall and topography play strong roles in the occurrence of landslides. Discrimination between surface processes and motion that has a tectonic origin is the key to natural hazard assessments.

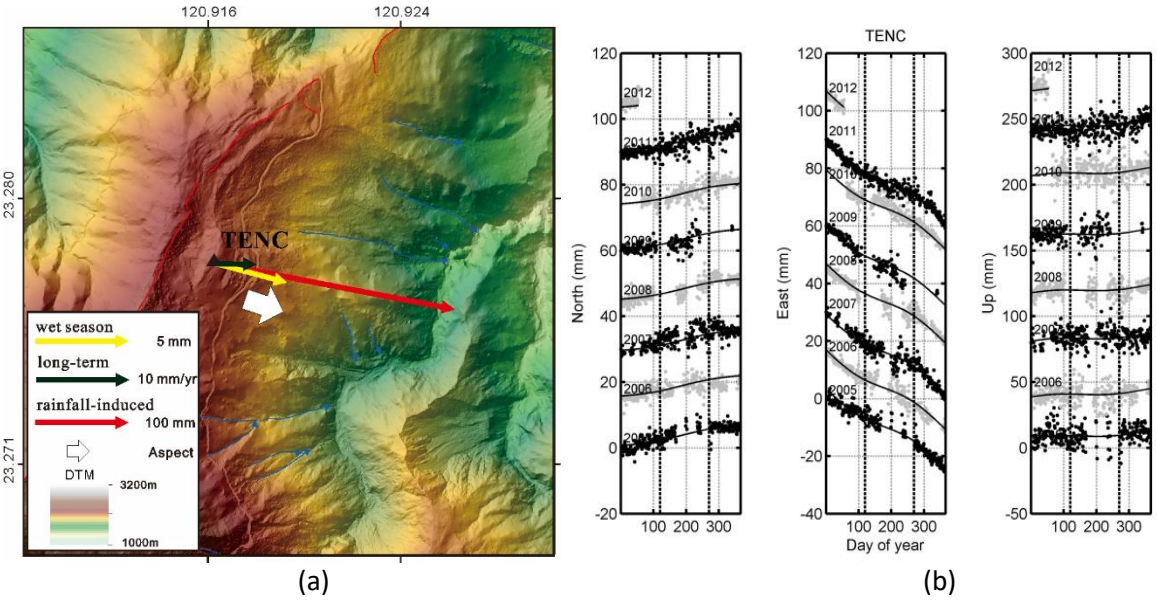

Figure 1: Topography and time series of station positions in TENC. DTM—digital terrain model. (a): Topography derived from LiDAR (1 m × 1 m). Red lines are fault scarps; blue lines indicate gullies. Red vector indicates GPS displacements of the largest rainfall-induced landslide during the Typhoon Morakot. Black vector indicates landslide-induced long-term linear rates and yellow vector indicates additional motion in the wet season. White vector denotes aspect of slope derived from LiDAR. (b): GPS time series

of north, east, and up components. We add a constant offset, and switch color between black and gray every year for better visualization. Solid line is the model with a landslide- induced long-term linear rate and periodic annual motion.