

## **The 2011 Zen Garden Landslides: Trigger and causal factors**

### **ABSTRACT**

The Zen Garden Resort and its surrounding area are part of the "Kundasang Landslide Complex" and were experiencing reactivation of old landslides on 10 April 2011. Consequently, more than 80 room units of the resort, ten buildings, homes, and local roads were destroyed, uplifted, and damaged as well as disrupted day traffic. About 500m in length and 200m in width of the slope area were slides for 25m. The vertical fall movement in the head section of the landslide is 25m. There is no direct relationship between the 2015 Ranau earthquake and with earlier rotational clay slide of the 2011 Zen Garden Resort landslide. The causing and triggering factor for landslides are generally varied and are always characterized as region-specific and site-specific. Thus, this study was conducted to unravel the triggering and causal factors for the rotational clay slide of the 2011 Zen Garden Resort landslide. The methodology consists of desk study, remote sensing study, geological mapping, geodynamic mapping, laboratory, and data analysis. This study found that the landslides were triggered by prolonged moderate to occasional heavy rainfall. The causal factors are divided into natural factors (tectonic uplift, weak materials, weathered materials, sheared or jointed materials, adversely oriented mass discontinuity or structural discontinuity, and contrast in permeability) while the artificial factor consists of excavation of the slope or its toe, cut and fill, subterranean erosion/ piping, irrigation or water leakage from utilities and deforestation or vegetation removal.