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Landscape evolution in relation with occurrence of gravitational slope deformation and catastrophic landslides

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The Central Range of Taiwan is an example of a tectonically active orogen. The topography of a mountainous catchment of the Dahan River in northern side of the Central Range exhibits V-shaped inner valleys where landsliding is the dominant process of hillslope erosion and bedrock rivers are incising into the landscape. We take two approaches including (i) the study of present day morphostructural features of gravitationally deformed slopes and (ii) the study of the relationship between the gravitational slope deformation and fluvial incision to research the linkage of gravitational slope deformations, catastrophic landslides, and landscape evolution for the prediction of potential sites of future landslides. Mapped deep-seated gravitational slope deformations and scars of rainfall-induced rock/debris avalanches imply that their distributions are closely related to three series of convex slope breaks relating to the rejuvenation of topography by a three-phase fluvial incision leaded by three series of knickpoints migration. Many shallow rock/debris avalanches have occurred below the lowest slope break. By contrast, majority of gravitational slope deformations have occurred at the margins of the highest slope break around the paleosurface remnants, suggesting that the rejuvenation caused debuttressing of hillslopes and subsequent stress-release led to large scale slope destabilization, resulting in gravitational slope deformations. Catastrophic landslides in many locations deem to be preceded by gravitational slope deformation of rocks with adverse geological structures, many of which are buckling of alternating beds of sandstone and mudstone, and toppling of argillite and slate. The gravitationally deformed slopes change the topography and remain for a long time, and commonly accompany with some other types of mass movements (e.g. debris flows, rock/debris avalanches, and rockfalls). The results suggest that landslides are strongly controlled by geomorphology and geology and their potential sites can be specified from the view point of landscape evolution.