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台湾北部で下刻によって起きた山体の重力変形
Gravitational slope deformation induced by transient waves of incision in northern Taiwan

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At least 11% of the upper Shihmen Reservoir catchment is affected by gravitational slope deformation in the northern part of the Hueshan Mountain Range, Taiwan, where is underlain by Oligocene and Miocene sedimentary rocks and metamorphic rocks. The gravitational slope deformation has occurred as a response to the propagation of new incision waves to palaeosurfaces. Therefore, landscape evolution must be accounted for to predict and to evaluate potential sites of catastrophic landslides, most of which are preceded by gravitational slope deformation. Geomorphic analyses combined with cosmogenic nuclide dating revealed that at least three phases of transient waves of incision have propagated into paleosurfaces with a minimum age of ˜140 ka. Tectonically induced base-level fall triggered the first incision wave around ˜120 to 140 ka, dissecting palaeosurfaces and inspiring gravitational slope deformation. The second incision wave probably driven by global sea-level lowering during last glacial age has reached to the catchment around ˜13 to 15 ka with an enormously rapid incision rate of 20 mm a-1, inducing slope movements. Climate forcing such as increasing monsoonal precipitation during the last glacial-to-interglacial transition may have been another cause of the rapid incision. The third incision wave is apparently associated with a local base level change. The trigger and its initiation are as yet unknown This younger incision made steeper slopes (avg. 39.8 degree), over several tens to a few hundred meters above current river bed. These are small landslide-prone slopes since numerous numbers of smaller landslides are concentrated on the lowest steep part of the river-side hillslopes.

Surface exposure dating on slip surface of an ancient landslide on a dip slope reveals the occurrence of the landslide in the late Holocene epoch, suggesting the development of the deep-seated slope deformation creates suitable conditions in a long-term (in the order of millions of years) for the subsequent landslide activities since the paleosurface has been dissected by the first incision wave. Recent catastrophic landslides had been preceded by gravitational slope deformation of rocks with adverse geological structures, suggesting that major-landslide prone slopes are dip-slopes of alternating beds of sandstone and mudstone at the margins of the paleosurface.

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