

Surface structure as a control for gully complex development in the Mackey`s block, North Island, New Zealand

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Gully erosion occurs on many steep, erosion-prone slopes. While most research focusses on gully formation by water erosion, gullies can also enlarge by mass movement processes. In New Zealand, such process combinations are named gully complexes. While concepts on gully complex development are available, material variability - other than lithology - is not included. In this study, development of gullies and gully complexes is analyzed by focusing on properties of the initial surface into which gullies and gully complexes erode to relate gully orientation and erosion intensity to surface structure.

The study area consists of 12 headwater catchments in the Mackey`s Block, North Island, New Zealand. Bedrock consists of Cretaceous-aged, highly crushed and sheared mudstones and sandstones. Deforestation by European settlers at the beginning of the 20th century for pastoral farming was followed by reforestation for wood production from the 1980s. Sequential aerial photographs from 1939 to 2005 were interpreted to map mass movements and the development of gullies. Digital elevation models were extracted from aerial photography from 1957 to 2002 using ERDAS to relate surface structure to gully orientation and erosion intensity.

Mapping results indicate that prior to a severe gully erosion phase, which started shortly before the first aerial photography in 1939, the surface structure is characterized by (revegetated) small gullies, deep-seated landsliding with double ridges, and shallow flows. Deep (few meters to 15m) gullies complexes incised at the toe of mass movement bodies and eroded upslope. Such gullies developed oversteepened sidewalls, which in turn initiate extensive mass movements at the gully walls. Erosion intensity increased suddenly, where gullies destabilized mass movement deposits. Above the deep gully complexes, shallow (about 1 -2m deep), hundreds of meter long gully arms extended along boundaries of mass movements. These results indicate that next to morphometric parameters (slope, catchment size), material type, vegetation change, and moisture conditions, the development of gully complexes is also controlled by surface structure.

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