Morphological changes of a gully complex forming on landslide deposits and implications for erosion variability

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Gully complexes are landforms which are initiated by incision of water erosion (gully erosion) and further enlarge by mass movements due to oversteeping gully walls. These rapidly erosion landforms can reach the ridge top and comprise their entire catchment. Gully complexes cause on-site damage such as loss of fertile land and destruction of infrastructure. Off-site damage includes river aggradation and negative effects on aquatic habitats, as large quantities of sediment are supplied from slopes to rivers.
The transition from gullies to gully complexes has been described in many publications. Here the focus is on the erosion variability of a large gully complex eroding into landslide deposits. Morphological changes are assessed on decadal scale during the past 60 years to understand erosion varability in a gully complex.
The gully complex is 1.6km long and has a catchment area of 1.2km^2. The complex is located in the Waipau catchment on the North Island, New Zealand. The study area consists of variably indurated, sheared and crushed mudstone and thin sandstone of Late Cretaceous age. Most of the study area is used for pastoral farming.
Aerial photography taken in 04.1957, 09.1971, 06.1988, 05.2005, and 01.2012 was interpreted to map active and inactive landslides, gullies, and the gully complex itself. Differential digital elevation models were calculated using ERDAS IMAGINE Photogrammetry to estimate topographic changes.
Mapping results for the earlier decades indicate that inactive deep seated landslides cover the western section of the catchment right up to the gully channel. On the steeper eastern slopes small-scale gully erosion and falls occured. Next to an increase of the gully complex over all time slices, a prominent 210m long and 355m wide active slump was evident on the 1988 imagery, which buried the channel of the gully complex by 3-8m. The new gully channel developed 31-45m east of the original channel by undercutting the gully flank. This indicates that the development of gully complexes on unstable slopes are not uni-directional, as landslides deposits are reworked by slumping followed by excavation by water incision. Incision into highly erosion-susceptible materials such as deposits of inactive landslides might be continued until sediment storage is depleted.
These finding might help to develop approaches on gully complex development on erodable landslide deposits, which include the spatial and temporal variability of incision and infill as well as high sediment export rates to appropriately and effectively manage such erosion prone environments.

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