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Basin-scale analysis of hillslope-channel coupling in a cuesta landscape (Swabian Alb, SW-Germany)

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Since the quantitative revolution in geomorphology in the mid 20th century, fluvial dynamics and hillslope processes are generally studied independently from each other. However, the connectivity between geomorphological process domains is a major control of sediment flux in geomorphic systems. The few existing studies that focus hillslope channel coupling are mainly limited to highly active mountain ranges in alpine regions and/or the processes after extreme events.

Hillslope–channel coupling is an emergent, scale-dependent phenomenon, which is highly sensitive to environmental changes and leads to system transience. Existing classifications for hillslope-channel couplings are nearly all qualitative and dealing with the questions of scale and type of the contact zones, as well as with the direction of change. Therefore, the quantitative understanding of hillslope-channel coupling in less active environments is rather limited.

This study focuses on the hillslope-channel coupling in the Fils catchment (Swabian Alb, SW Germany). The Swabian Alb is a typical jurassic cuesta landscape with back eroding rivers in front of the escarpments, generating deeply incised valleys. The steep slopes are consisting of unstable marls and clays and are affected by numerous landslides.

The major aim of the study is to investigate the spatial distribution of landslides with different degrees of hillslope channel coupling at the catchment scale.

The analysis is based on a high resolution 1m * 1m DEM and an existing landslide inventory for the Fils catchment. The landslides are visually classified from hillshades and by fieldwork according their degree of connectivity to the fluvial system, using a modified classification created by Korup (2005) for the alpine region. Adjoint catchments are hydrologically calculated from the DEM to compute the spatial statistical distribution of the landslides in relation to the river. River long profiles and valley cross-sections are generated to analyse the impact of landslides on the fluvial system.

The distribution of the coupled landslides shows a spatial concentration in those channel sections, which are characterized by high relief and low valley widths. Besides these coherences the geology seems to have a strong effect on the spatial distribution and the strength of the coupling. While the hillslope channel coupling seems to have influence on the valley cross sections, the river long profile does not show any effects.