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Learning from Nature – Mapping of Complex Hydrological and Geomorphological Process Systems for More Realistic Modelling of Hazard-related Maps

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Introduction
Hydrological or geomorphological processes in nature are often very diverse and complex. This is partly due to the regional characteristics which vary over time and space, as well as changeable process-initiating and -controlling factors. Despite being aware of this complexity, such aspects are usually neglected in the modelling of hazard-related maps due to several reasons. But particularly when it comes to creating more realistic maps, this would be an essential component to consider.
The first important step towards solving this problem would be to collect data relating to regional conditions which vary over time and geographical location, along with indicators of complex processes. Data should be acquired promptly during and after events, and subsequently digitally combined and analysed.

Study area
In June 2009, considerable damage occurred in the residential area of Klingfurth (Lower Austria) as a result of great pre-event wetness and repeatedly heavy rainfall, leading to flooding, debris flow deposit and gravitational mass movement. One of the causes is the fact that the meso-scale watershed (16 km^2) of the Klingfurth stream is characterised by adverse geological and hydrological conditions. Additionally, the river system network with its discharge concentration within the residential zone contributes considerably to flooding, particularly during excessive rainfall across the entire region, as the flood peaks from different parts of the catchment area are superposed.

First results of mapping
Hydro(geo)logical surveys across the entire catchment area have shown that
- over 600 gravitational mass movements of various type and stage have occurred. 516 of those have acted as a bed load source, while 325 mass movements had not reached the final stage yet and could thus supply bed load in the future. It should be noted that large mass movements in the initial or intermediate stage were predominately found in clayey-silty areas and weathered material, where the fluvial bank erosion only plays a minor role as an initiating factor. On the other hand, fluvial bank erosion does appear to be a cause of smaller mass movements in their final stage which develop spontaneously, most noticeably in regions of gravel-rich soils (coarse-grained) and of shallow weathered material (several decimetres).
- numerous marks of surface runoff were found over the entire catchment area to a greatly variable extent and intensity. In the more eastern parts of the catchment, these signs can be linked especially to anthropogenic concentrated inputs of surface discharge e.g. drainage system of streets. Their spread is limited, but usually associated with huge erosion channels of up to 2 m depth. In the western parts of the catchment, however, signs of surface discharge are more commonly found in forests. Depending on their location, they can be a result of an up-hill infiltration surplus in areas of fields and pastures, or an infiltration surplus in the forest itself. In many places, rapid interflow through biologically-created macropores takes place, which often re-emerges at the surface in the form of return flow. In general, it is noticeable that marks of surface runoff often terminate at the scarps of landslides, which were not caused by fluvial bank erosion. The excess water produces a strong local saturation of the ground, which gives a higher landslide-susceptibility of the embankment.

Future work

Based on the acquired field knowledge, it was possible to distinguish areas of different heterogeneities/homogeneities of the dominant process chains for several micro-scale parts of the catchment area. Subsequently, conceptual slope profiles should be derived from the detailed field data, and these should include information of the dominant and complex process systems. This forms an essential starting point in order to be able to realistically consider relevant hazard-related processes as part of process-oriented modelling.