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Using of high resolution morphometric thalweg analyses of dry valleys under woodland to assess land use impact and soil erosion in the late Holocene

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During the Holocene, geomorphic processes have been greatly hindered by the natural vegetation cover in central Europe. On the majority of land surfaces, processes of soil development dominate, hence producing stable geomorphodynamic systems. The removal of trees for timber, the construction of pathways or clear-cuts to enable agriculture creates temporarily or permanently bare soil surfaces which are highly vulnerable to soil erosion. During rainfall events run-off produces erosional forms like rills and gullies on slopes and along the thalweg. The eroded material accumulates as colluvium on the footslopes and as hillslope terraces, and at the outlet of gullies or dry valleys as colluvial fans. Hence, these forms are a topographical legacy of land use and intensive rainfall events in the past. In central Europe, many of these forms are well preserved under woodland. LiDAR data provide an excellent basis to identify, survey, and quantify their spatial distribution by geo-statistical methods. This paper presents automatic morphometric analyses of cross-sections along dry valleys using ArcGIS®. The idea behind this approach is that in cross-section the deposition of sediments leads to a flattening of small valley bottoms from a v-shaped to a u-shaped form while linear erosion deepens the thalweg in a morphometric form different to the natural situation. The study area has a size of about 100 km^2 and is located in the central part of the Palatinate forest of the German-Lorraine Triassic escarpment. The low-mountain range landscape is characterized by steep slopes with an alternation of scarps with exposed bedrock of the Bunter sandstone. In the southern part, agriculture and clear-cuts for timber use were dominant between the 18th to mid-19th century while in the remote northern part the harvest of trees occurred only occasionally. After the automatic generation of cross-sections in a GIS, each profile was analysed and compared to typical natural or erosional forms by geostatistical methods. The spatial distribution of the classified correlation indices represents areas where dissected or natural dry valleys are distributed. The results show that LiDAR data are valuable for automatic morphometric analyses of erosional forms in forested areas to assess land use impact in historical times.