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(Semi-)Automated landform mapping of the alpine valley Gradental (Austria) based on LiDAR data

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Alpine valleys are typically characterised as complex, hierarchical structured systems with rapid landform changes. Detection of landform changes can be supported by automated geomorphological mapping. Especially, the analysis over short time scales require a method for standardised, unbiased geomorphological map reproduction, which is delivered by automated mapping techniques.

In general, digital geomorphological mapping is a challenging task, since knowledge about landforms with respect to their natural boundaries as well as their hierarchical and scaling relationships, has to be integrated in an objective way. A combination of very-high spatial resolution data (VHSR) such as LiDAR and new methods like object based image analysis (OBIA) allow for a more standardised production of geomorphological maps. In OBIA the processing units are spatially configured objects that are created by multi-scale segmentation. Therefore, not only spectral information can be used for assigning the objects to geomorphological classes, but also spatial and topological properties can be exploited.

In this study we focus on the detection of landforms, especially bedrock sediment deposits (alluvion, debris cone, talus, moraine, rockglacier), as well as glaciers. The study site Gradental [N 46°58'29.1"/ E 12°48'53.8"] is located in the Schobergruppe (Austria, Carinthia) and is characterised by heterogenic geology conditions and high process activity. The area is difficult to access and dominated by steep slopes, thus hindering a fast and detailed geomorphological field mapping. Landforms are identified using aerial and terrestrial LiDAR data (1 m spatial resolution). These DEMs are analysed by an object based hierarchical approach, which is structured in three main steps. The first step is to define occurring landforms by basic land surface parameters (LSPs), topology and hierarchy relations. Based on those definitions a semantic model is created. Secondly, a multi-scale segmentation is performed on a three-band LSP that integrates slope, aspect and plan curvature, which expresses the driving forces of geomorphological processes. In the third step, the generated multi-level object structures are classified in order to produce the geomorphological map. The classification rules are derived from the semantic model. Due to landform type-specific scale dependencies of LSPs, the values of LSPs used in the classification are calculated in a multi-scale manner by constantly enlarging the size of the moving window. In addition, object form properties (density, compactness, rectangular fit) are utilised as additional information for landform characterisation. Validation of classification is performed by intersecting a visually interpreted reference map with the classification output map and calculating accuracy matrices.

Validation shows an overall accuracy of 78.25 % and a Kappa of 0.65. The natural borders of landforms can be easily detected by the use of slope, aspect and plan curvature. This study illustrates the potential of OBIA for a more standardised and automated mapping of surface units (landforms, landcover). Therefore, the presented methodology features a prospective automated geomorphological mapping approach for alpine regions.