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Towards semantic interoperability in digital geomorphological mapping

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Geomorphological maps are important devices for environmental planning, natural hazard assessment as well as for soil and landscape studies. Usually, such maps are derived from digital terrain models (DTMs) by applying either cell-based classification or object-based image analysis (OBIA). In our research we focus on the OBIA approach. Basically, OBIA involves the following two tasks: Firstly, segmentation is employed where the cells of the DTM are aggregated into digital terrain objects based on homogeneity. Secondly, the terrain objects are classified by applying rule sets. Since OBIA provides a well-suited framework to integrate expert knowledge, especially for the development of classification rules, it has recently gained much attention in earth sciences.

However, the problem is that geomorphological units such as landforms and landform elements are defined and mapped differently, depending on the domain knowledge and the intention of the user. Due to the lack of standardized semantic labels and classification rules transferability of automated geomorphological mapping approaches as well as comparison of classifications for different areas is limited. Still, semantic interoperability in OBIA-based geomorphological mapping is far from being solved.

In order to achieve semantic consistency in OBIA-based geomorphological mapping we propose a general methodology that supports the user in assigning standardized geomorphological meaning to DTMs. The methodology consists of the following steps: Initially, definitions about the landforms of interest are acquired from literature and domain ontologies. Due to semantic heterogeneity of definitions clear concepts of landforms are developed in the next step. These concepts at least include the semantic core of each landform, i.e. its shape, size and context. Then, we perform semantic modeling as a strategy to formalize and structure the semantic content of the landform concepts. The semantic landform model indicates for each landform the set of terrain object parameters that should be used for the creation of interoperable classification rules in OBIA software. Through DTM segmentation characteristic patterns of terrain objects are generated. Once characteristic objects are delineated in the digital realm, the extracted rules can finally be applied to map each object to the landform concept to which it comes closest.

The proposed framework increases the objectivity and transferability of OBIA-based geomorphological mapping. In a wider sense the outcomes of the presented research could contribute to laying the scientific foundations towards semantic interoperability in object-based mapping of any kind of features from multidimensional and multi-scalar field representations such as DTMs and satellite images.