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Object-based mapping of drumlins from DTMs

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Until recently, landforms such as drumlins have only been manually delineated due to the difficulty in integrating contextual and semantic landform information in per cell classification approaches. Therefore, in most cases the results of per cell classifications presented basic landform elements or broad-scale physiographic regions that were only thematically defined. In contrast, object-based analysis provides spatially configured landform objects that are generated by terrain segmentation, the process of merging DTM cells to meaningful terrain objects at multiple scales. Such terrain objects should be favoured for landform modelling due to the following reasons: Firstly, their outlines potentially better correspond to the spatial limits of landforms as conceptualised by geoscientists; secondly, spatially aware objects enable the integration of semantic descriptions in the classification process.

We present a multi-scale object-based study on automated delineation and classification of drumlins for a small test area in Bavaria, Germany. The multi-resolution segmentation algorithm is applied to create statistically meaningful objects patterns of selected DTMs, which are derived from a 5 m LiDAR DEM. For the subsequent classification of drumlins a semantics-based approach, which uses the principles of semantic modelling, is employed: initially, a geomorphological concept of the landform type drumlin is developed. The drumlin concept should ideally comprise verbal descriptions of the fundamental morphometric, morphological, hierarchical and contextual properties. Subsequently, the semantic model is built by structuring the conceptualised knowledge facts, and by associating those facts with object and class-related features, which are available in commonly used object-based software products for the development of classification rules. For the accuracy assessment we plan an integrated approach, which combines a statistical comparison to field maps and a qualitative evaluation based on expert consultation.

The study on drumlins should demonstrate the applicability of the object-based approach for the extraction of specific landforms from DTMs in a multi-scale framework. The provision of meaningful spatial modelling units and the straightforward way for the integration of semantics make object-based analysis superior to field-based methods. However, an explicit representation of geomorphological knowledge – as for example in the form of a semantic model – prior to landform classification is a prerequisite for effective mapping. Such an approach allows the user to delineate and map drumlins in a way that is close to the human cognition of landforms. Once most of the drumlins are recognized by the developed classification system, those objects can further be investigated with respect to their morphometry and morphology in order to improve the understanding of glacial processes.