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Quantitative analysis of anthropogenic relief features: automated mapping of charcoal kiln sites from high-resolution ALS data

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High-resolution digital elevation data from airborne laser scanning (ALS) allow for identification and mapping of so far unknown small-scale relief features that are hidden by forest cover. Especially as a result of historic land use, small anthropogenic landforms can occur, e.g., remains of charcoal kilns on sites that were used for charcoal production or ridge and furrow systems in former farmland areas. Mapping such relief features and analyzing their spatial distribution patterns can help to understand past land-use systems and their effects on landscapes. To efficiently detect and quantify small-scale relief features from high-resolution DEMs for larger areas, (semi-) automated mapping routines are required.

In order to describe the number and spatial distribution of historic charcoal kiln sites in the area around Cottbus, Germany, we developed a GIS-based routine for the detection and mapping of kiln remnants from ALS elevation models with a resolution of 1 or 2 meters. The method is based on a template matching algorithm, using a combination of morphometric parameters, and is implemented within ArcGIS. The mapping results could be validated against a comprehensive database of kiln sites and diameters recorded from archaeological excavations in the forefield of the opencast mine Jänschwalde and from manual digitization of kiln remnants from Shaded Relief maps for the Jänschwalder Heide and the Tauersche Forst, north of Cottbus.

A considerably high number of charcoal kiln sites could be detected in ALS data, and the diameters of the identified charcoal kilns are remarkable large in the area. For the Jänschwalder Heide, more than 5000 kiln sites in an area of 32 km2 were detected by manual digitization, with 1355 kiln sites that are wider than 12 m. These relatively large kiln sites could be mapped with detection rates that are close to those of manual digitization using the automated mapping routine. Detection quality was improved by the combination of several morphometric parameters used for template matching, as compared to a mapping based on elevation values only. In comparison to manual digitization, a combination of the described detection routine and a manual removal of falsely detected sites can considerably facilitate the mapping and distribution analysis of kiln sites or other small-scale relief features.