Transitional DEM Merging – A semi-automatic approach for creating contour lines derived from merged DEMs of different sources and quality

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Abstract:

The use of VGI and OpenGeodata in the production of topographic base maps can often lead to problems of depiction due to inferior or heterogeneous data quality (see Goodchild et. al. 2012, Heipke 2010, Hajek et. al. 2019). But not only vector data such as the OpenStreetMap database but also raster data in the form of digital elevation models (DEM) are affected. Freely available DEMs with (almost) worldwide coverage such as SRTM play a major role in the production of topographic maps as they are easily obtainable and have relatively homogeneous data quality. However, for the application of large scale maps (> 1:50,000) the low resolution of these DEMs (SRTM = approx. 30m) becomes a problem, since the accuracy is no longer sufficient for the production of scale-adequate generalized contour lines. As a solution, state-specific Open Governmental Data can be obtained. These DEMs often cover only one national territory, but in most cases provide higher resolutions. In cross-border topographic representations, different DEMs would thus have to be merged in order to seamlessly display contour lines and generated relief shading, for example. However, this process often leads to depiction problems in the transition area.

The boundaries between different elevation models lead to incorrect representation of calculated contour lines. Edged contour lines occur due to different resolutions and general accuracy of the DEMs. The merging of two different contour line datasets without preparation of the base data can lead to a large manual effort. This paper describes a method to semi-automatically seamlessly merge DEMs of different sources and quality. Calculated contour lines as well as relief shading can be generated error-free in sequence. The method thus allows the use of best available quality elevation models in the production of large scale topographic maps covering border areas.

The method presented in this paper is based on the further development of the process described in the article "Large Scaled Topographic Mapping and Issues in Depicting VGI and Open Data" (Hajek et. al. 2021). In this previous paper, parts of the method were presented that are used to create smooth transitions of elevation information for slope-dependent generalization of contour lines. A modification of the process to generate a transition raster is also applied in this following paper.

The process is mainly based on raster manipulation using tools from the open source library GDAL. The command lines required for the method are combined in a PHP script and can thus be run (partially) automated.

A transition band is placed over the boundary region of the elevation models to be connected. This is calculated by a weighted average of the overlapping raster pixels based on a transition factor. Irregularities can thus be smoothed and the two DEMs are interwoven.

However, when merging data sets of different resolutions, it should be noted that this leads to generally inhomogeneous representations of elements generated from the DEM. For example, contour lines based on high resolution elevation models are more accurate and give better information about the terrain than contour lines calculated from low resolution DEMs. The latter can appear "over-smoothed", especially in comparison, and there is a risk of conveying a falsely flat

and smooth impression of the terrain. These disadvantages of this method must therefore be weighed against the advantages of using homogeneous global elevation models.

The method is not only used when combining high-resolution with low-resolution DEMs. Even DEMs of the same or similar resolution can cause problems when merging at the boundary due to different sources. This paper also tests whether merging two "equivalent" elevation models of different origins with the indicated method can avoid visible depiction problems in the border region.

"Transitional DEM Merging" is a tool for handling different qualities and/or sources of raster data which are to be expected when using Open Geodata. The method can be used for the creation of worldwide topographic web maps due to its (semi-) automatic approach. The tool thus serves to increase the depiction quality of large-scaled topographic maps based on Open Data.

References

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