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Accuracy analysis of digital elevation models on different scales for Northern Chile

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Digital elevation models (DEMs) show an increasing importance for many geoscientific applications. Resolution and accuracy have a direct influence on geoscientific computations like landform classifications and hydrologic modelling results. Nowadays, several worldwide DEMs are available, as well as DEMs representing regional or local extents. These DEMs are derived by several different methods, such as laser scanning, photogrammetry and radar. Thus, it is important to analyse the accuracy of these DEMs and the relation of errors to specific landforms, e.g. steep slopes.

The study area of these analysis is the northern part of Chile. The region has a hyper arid climate and is one of the driest areas on earth. The relief is characterized by large height differences and a diverse topography. Accurate topographic information is necessary for numerous applications, such as sediment transport estimation, hydrologic analysis and studies on plant distribution.

Numerous worldwide available datasets were evaluated (ALOS World 3D – 30m v2.1, ASTER GDEM v3, TanDEM-X WorldDEM™ - 12m & 90m, SRTM v3 - 30m & 90m), as well as DEMs derived from stereo satellite imagery from Spot 6/7 and Pleiades satellites. These datasets were evaluated against data points of the Geoscience Laser Altimeter System (GLAS) instrument aboard the NASA Ice, Cloud, and land Elevation (ICESat) satellite by using root mean square error (RMSE) and normalized median absolute deviation (NMAD). The association of errors to specific landform elements was analysed by assigning these errors to landforms from the topographic position index (TPI) based on the TanDEM-X WorldDEM™ - 12m dataset.

Results show general higher accuracies of the TanDEM-X WorldDEM™ - 12m (RMSE: 2.3 m, NMAD: 0.8) in comparison to all other worldwide available datasets (mean RMSE: 6.2 m, mean NMAD: 4.2) in particular in flat landscapes. In rougher terrain, e.g. ridges, lower accuracies are detected for all DEMs. DEMs derived from stereo satellite imagery show a varying accuracy (mean RMSE: 3.7 m, mean NMAD: 2.2) also depending on the topography covered by the scene. These results are further proven by datasets of terrestrial laser scanning and UAV-based photogrammetry surveys of areas with steeper slopes. Comparable differences were detected in hydrologic analysis based on the different DEMs.

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