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How accurate can we be? – An evaluation of airborne digital elevation models in a high mountain environment

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Stereoscopic airborne remote sensing is able to generate high-resolution digital elevation models (DEMs) in remote areas or areas of extreme terrain. This information can be used to analyze the relevant structures (monotemporal) and processes (multitemporal) which define a landform. High mountain environments receive a large amount of attention due to their sensitivity to climatic factors and the dynamics and relevance of occurring processes.

In order to assess and quantify geomorphological structures and processes in high mountain environments the absolute accuracy of the available DEMs has to be known. This study assesses the absolute vertical accuracy of DEMs generated by the High Resolution Stereo Camera – Airborne (HRSC-A), the Leica Airborne Digital Sensor 40 (ADS40) and the analogue stereoscopic camera system RC30 for the same area. The study area is located in the Turtmann Valley, Valais, Switzerland and depicts a glacially and periglacially formed hanging valley stretching from 2400m to 3300m a.s.l.

The photogrammetrically derived DEMs are evaluated against geodetic field measurements and an airborne laser scan (ALS). Traditional global and local accuracy measures such as the root mean square error (RMSE), standard deviation (SD) and absolute mean error (AME) are used to describe the vertical quality of the DEMs. The error distributions are additionally checked for normal distribution. All DEMs show non Gaussian error distributions and therefore according robust statistical measures (Median, Normalized Median Absolute Deviation and several quantiles) are found to describe the accuracy of the DEMs ideally.

The results show that the ADS40 camera system performs best in high mountain environments with complex terrain. The biggest systematic and random errors were identified for the HRSC-A system. As to be expected the vertical accuracy of the DEMs depends strongly on the inclination of the sampled terrain but the sensor systems perform differently in steep areas.

The outcome of this study shows the level of detail to which airborne stereoscopic DEMs can be reliably used in geomorphological analysis of high mountain environments. The accuracy information is especially crucial when quantifying structures and processes. The results can also be used to optimize the further application of the mentioned sensor systems.