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Change detection using terrestrial laser scanning in steep terrain and complex surface geometry – Survey planning, data processing and validation

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Terrestrial laser scanning for detection of geomorphic change is still a young technique without established procedures. Complex surface geometry and large areas (10^4 m^2) require multi-scan-station surveys and pose new challenges for consistent point cloud co-registration. Uncertainties in DEMs derived from terrestrial laser scanning are much larger than the measurement uncertainty of the laser scanner. They arise from a number of factors specific to the workflow used. The quality assessment of this type of data is difficult because higher quality check data is usually not available. We show the workflow used for repeat surveys of a 300 m long debris flow channel using 10 scan stations and investigate the importance of various factors on the uncertainty in the resulting DEM. Our research shows that the point cloud co-registration is the most important factor influencing the quality of a DEM. But the same time this is the most difficult step in the workflow. We propose a novel method for the assessment of point cloud co-registration quality based on topographically corrected standard deviation of elevation. We provide guidelines for survey planning, data acquisition, processing and validation specific to terrestrial laser scanning.