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Potential and challenges of Terrestrial Full-Waveform Laser Scanning for monitoring purposes in mountainous areas

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Terrestrial Laser Scanning (TLS) has developed itself to a leading technology in 3D data acquisition of real-world scenes, especially in the industrial environment. The latest generation of TLS systems, similar to airborne sensors, records the sampled waveform of the echoes of the emitted laser pulse (full-waveform TLS). Thus, extracting multiple echoes and derivation of several reflecting surfaces becomes possible.

This technology is also applicable in various geomorphic environments. However, the geometry of the observation setting is notably different than in the case of ALS: the angle of incidence, the orientation of the surface of natural objects (like trees stems, leaves, bush) to the laser beam may reach high angles that are uncommon in processing of ALS. Unlike in the industrial application, in geomorphology this property may cause difficulties in the processing and in the interpretation of the acquired data. The canopy may also cover larger parts of the field of measurements. Furthermore, the targeted accuracy is at the limit of current technology and achieving cm-accuracy over large horizontal distances is a challenge with respect to instrumentation set-up and measurement configuration.

The geomorphic targets that evolve in relatively short time like slopes, scree, eroding rock surfaces are especially suitable to test this methodology. To detect these changes, repeated TLS measurements are planned. The question to be solved is whether the co-georeferencing and the achieveable data accuracy can be enough to reveal the changes caused by geomorphic processes.

In this sense, TLS technique has great advantages producing a multi-target point cloud, so the differentiation of canopy cover from the geomorphic surface is more likely. It is of particular interest to investigate the practicability of full-waveform TLS data in mountainous environments: one the one hand because TLS campaigns are way cheaper to provide a DTM and can be adapted more flexibly to the in-situ conditions with multiple scanning positions. Furthermore, the retrieval of physical parameters (like back-scatter cross section) from full-waveform data is highly desirable.

We focused both on analysing the advantages and drawbacks of using full-waveform TLS data for monitoring in principle and on giving empirical evidence for our conclusions. For the latter, high relief test sites in Montafon (Vorarlberg, Austria) were chosen. The post-glacial oversteeepened valley slopes partly consisting of talus/scree slope are prone to mass movements of various scale. Also some fluvial incision due to increased precipitation events or snow melting in the scree slope is expected to be detected by this technique.

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