



Application of Terrestrial Laser Scanning for Measuring Soil Roughness at Meso-scale

Milutin Milenković, Norbert Pfeifer, Philipp Glira, and Camillo Ressel

Vienna University of Technology, Department of Geodesy and Geoinformation (GEO), Vienna, Austria
(Milutin.Milenkovic@geo.tuwien.ac.at)

Soil roughness is a dynamic property of bare-soil surfaces. It affects infiltration and runoff during a rain event, regulates wind erosion rates, and also influences the backscattered energy of radar signals. In geophysical modeling, this soil parameter is considered to be related to local surface features like tillage structure, soil aggregates and particles, and therefore, it is typically described through its regional stochastic properties. Since soil roughness elements range from millimeter to several centimeters in size, high-resolution 3D measurements are required to determine these stochastic parameters accurately. Measurements by a terrestrial laser scanner (TLS) provide precise, high-density 3D information which can match these requirements. However, the resolution and precision of these TLS measurements decrease with range. Therefore, special TLS acquisition settings are required already for investigating soil roughness at meso-scale, i.e. from ca. 10m to 50m. Such information about soil roughness, for example, will soon be required for SAR products of the incoming Sentinel-1 mission, with pixel spacing expected to be 10m-25m in the high-resolution, multi-look mode.

This work focuses on estimating an effective area that can be surveyed by a single TLS scan at the resolution of a few millimeters under different soil roughness conditions. To answer this, a field experiment was conducted where two soil roughness patterns were scanned: oriented- and isotropic-roughness. The roughness patterns were prepared on a 3m x 3m rectangular plot in the Botanical Garden of the University of Vienna. The measurements were performed from several scan positions using an amplitude-modulated continuous-wave TLS. The instrument has a specified precision below 1mm, a small beam divergence (0.22mrad), and a sampling interval of 1.6mm at 5m range. Additionally to these TLS measurements, a small sub-area (0.5m x 1m) was surveyed by a triangulating laser scanner. This instrument has a precision of one order of magnitude better than the used TLS scanner, and its ground sampling distance during the survey was below 1mm. This second data set served as reference for the roughness evaluation.

The above measurement setup showed that with 4 TLS scans, it is possible to cover a 3m x 3m area with a digital elevation model (DEM) of 2mm grid size, i.e. 4mm resolution. When only one scan is used, the same quality DEM can be reconstructed up to 2.6m range. These findings are then used to discuss the potential of TLS for soil roughness measurements at meso-scale.