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# Statistical assessment of soil surface roughness for environmental applications using photogrammetric imaging techniques

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Micro scale soil surface roughness is a crucial parameter in many environmental applications. Recent soil erosion studies have shown the impact of micro topography on soil erosion rates as well as overland flow generation due to soil crusting effects. Besides the above mentioned, it is widely recognized that the backscattered signal in SAR remote sensing is strongly influenced by soil surface roughness and by regular higher order tillage patterns. However, there is an ambiguity in the appropriate measurement technique and scale for roughness studies and SAR backscatter model parametrization. While different roughness indices depend on their measurement length, no satisfying roughness parametrization and measurement technique has been found yet, introducing large uncertainty in the interpretation of the radar backscatter.

In the presented study, we computed high resolution digital elevation models (DEM) using a consumer grade digital camera in the frame of photogrammetric imaging techniques to represent soil micro topography from different soil surfaces (ploughed, harrowed, seedbed and crusted) . The retrieved DEMs showed sufficient accuracy, with an RMSE of a 1.64 mm compared to high accurate reference points,. For roughness characterization, we calculated different roughness indices (RMS height (s), autocorrelation length (l), tortuosity index (TB)).

In an extensive statistical investigation we show the behaviour of the roughness indices for different acquisition sizes. Compared to results from profile measurements taken from literature and profiles generated out of the dataset, results indicate,that by using a three dimensional measuring device, the calculated roughness indices are more robust against outliers and even saturate faster with increasing acquisition size. Dependent on the roughness condition, the calculated values for the RMS-height saturate for ploughed fields at 2.3 m, for harrowed fields at 2.0 m and for crusted fields at 1.2 m. Results also indicate a strong directional dependency of the RMS-height, showing that for the same fields were roughness was measured perpendicular to the tillage direction, the RMS-height saturates at few centimeters, indicating a higher order dependency of the calculated roughness indices from the tillage pattern and not with single soil clods or aggregates. An additional variogram analysis approved this scale dependency. Indeed, the calculated variograms reveal a statistical independency of the height values at shorter distances.

In this presentation we will show the efficiency of the proposed method and its applicability to environmental studies, especially for microwave remote sensing studies. We will highlight the statistical analysis and discuss the results in terms of their representativeness.