EGU22-2000, updated on 24 May 2022
https://doi.org/10.5194/egusphere-egu22-2000
EGU General Assembly 2022

Assessment of soil erosion induced by different tillage practices through multi-temporal geomorphometric analyses

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One of the main environmental threats to sustainability and crop productivity in the agricultural sector is soil erosion. For the mitigation of this problem in agricultural fields, no-till management is considered a key approach. The measurement of soil erosion is particularly challenging, especially when surficial morphological changes are relatively small. Conventional experiments are commonly time-consuming and labour-intensive in terms of both field surveys and laboratory methods. However, the Structure from Motion (SfM) photogrammetry technique has enhanced the experimental activities by enabling the temporal evolution of soil erosion to be assessed through detailed micro-topography. This work presents a multitemporal quantification of soil erosion, using SfM through Uncrewed Aerial Vehicles (UAV) survey for understanding the evolution of no-till (NT) and conventional tillage (CT) in experimental plots. Considering that plot-scale soil surface (mm grid size) by several orders of magnitude, it was necessary to minimise SfM errors (e.g., co-registration and interpolation) in volumetric estimates to reduce noise as much as possible. Therefore, a methodological workflow was developed to analyse and identify the effectiveness of multi-temporal SfM-derived products, e.g. the conventional Difference of Digital Terrain Models (DoDs) and the less used Differences of Meshes (DoMs), for soil volume computations. To recognise the most suitable estimation method, the research validated the erosion volumetric changes calculated from the SfM outputs with the amount of soil directly collected through conventional runoff and sediment measurements in the field. This study presents a novel approach for using DoMs instead of DoDs to accurately describe the micro-topography changes and sediment dynamics. Another key and innovative aspect of this research, often overlooked in soil erosion studies, was to identify the contributing sediment surface, by delineating the channels potentially routing runoff directly to water collectors. The sediment paths and connected areas inside the plots were identified using a multi-temporal analysis of the sediment connectivity index for achieving the volumetric estimates. The DoM volume estimates

showed better results with respect to DoDs and a mild overestimation compared to in-situ measurements. This difference was attributable to other factors (e.g., the soil compaction processes) or variables rather than to photogrammetric or geometric ones. The developed workflow enabled a very detailed quantification of soil erosion dynamics for assessing the mitigation effects of no-till management that can also be extended in the future to different scales with low-costs, based on SfM and UAV technologies.