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Water erosion as a cause for agricultural soil loss: modeling of dynamic processes using high-resolution ground based LiDAR measurements

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Soil erosion by rainfall and water flow is a frequent natural geomorphic process shaping the earth's surface at various scales. Conventional agrotechnical methods enhance soil erosion at the field scale and are at the origin of the reduction of the upper soil layer depth. This reduction is expressed in two aspects: decrease of soil depth, mainly due to erosion, and the diminution of soil quality, mainly due to the loss of fine material, nutrients and organic matter. Rain events, not even the most extremes, cause detachment and transport of fertile soil rich in organic matter and nutrients away from the fields, filling and plugging drainage channels, blocking infrastructure and contaminating water sources.

Empirical, semi-empirical and mechanistic models are available to estimate soil erosion by water flow and sediment transport (e.g. WEPP, KINEROSS, EUROSEM). Calibration of these models requires data measured at high spatial and temporal resolutions. Development of high-resolution measurement tools (for both spatial and temporal aspects) should improve the calibration of functions related to particles detachment and transport from the soil surface. In addition, despite the great impact of different tillage systems on the soil erosion process, the vast majority of the models ignore this fundamental factor.

The objective of this study is to apply high-resolution ground-based LiDAR measurements to different tillage schemes and scales to improve the ability of models to accurately describe the process of soil erosion induced by rainfall and overland flow. Ground-based laser scans provide high resolution accurate and subtle geomorphic changes, as well as larger-scale deformations. As such, it allows frequent monitoring, so that even the effect of a single storm can be measured, thus improving the calibration of the erosion models.

Preliminary results for scans made in the field show the potential and limitations of ground-based LiDAR, and at this point qualitatively can differ between soil tillage practices.