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Using very-high resolution 4D proximate soil sensing to quantify soil loss at plot-scale during a cropping season (East-Flanders, Belgium)

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Structure-from-Motion (SfM) photogrammetry is now being widely used in geosciences in order to quantify changes in surface morphology that are the result of geomorphic processes. In soil erosion research, the quantification of sheet and rill erosion in cropland remains a challenge for multiple reasons. First, the loss and accumulation of soil and sediment caused by sheet and rill erosion causes only minor topographical changes within a cropping season and thus requires capturing the surface morphology accurately at very-high resolutions. Second, the identification of sheet erosion may be biased by micro-elevation changes of the soil surface due to the settling of the surface after sowing, or due to fluctuations in temperature and moisture. And third, crop growth limits the duration for which monitoring is possible, as it rapidly makes the soil surface invisible when photographed from above. Here, we present a case study of the quantification of soil erosion at plot-scales using SfM-photogrammetry and discuss the technical challenges in very-high resolution 4D monitoring campaigns. Our study was done parallel to measurements of sediment yield at experimental plots (testing the effect of recent agronomic innovations for maize and potatoes on erosive-prone soils for the Interreg 2 Seas project Triple C; East-Flanders, Belgium). Collecting images was done at about 7 m above the ground using a photograph camera (16MP Panasonic Lumix DMC-GM5) attached to a telescopic pole. As ground control points, stakes were inserted in the soil (30 cm) and their position was measures using a total station. Following every rainfall event, the experimental plots were surveyed and processed into Digital Surface Models (DSMs) using Photoscan (Agisoft). The ground resolution of the DSMs is about 2-4 mm, with an XYZ-accuracy for change detection of about 1.5 cm. Early results show clear patterns of erosion and sedimentation consistent with field observations. For the potato field, the soil loss corresponds to 3 Mg per hectare after two rainfall events cumulating at 45 mm. A good correspondence exists between the quantified topographical changes and the sediment yield from the plots.