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Close Areal Sensing for measuring temporal and spatial change of soil surface conditions

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Runoff and sediment generation are complex and highly variable processes that often cannot be explained satisfactorily by the general erosion factors such as landform, rainfall intensity, soil type and crop management. The spatial and temporal variability of erosion responses highly depends on the soil surface conditions such as soil roughness, residue/plant cover and soil crusting. The main objective of this study was to investigate how high-resolution image data can be used for extracting and monitoring spatially explicit information on soil surface conditions. To this end, we extensively utilize Close Areal Sensing (CAS) systems as a new way for deriving quantitative information on the temporal and spatial change of soil surface conditions at the plot scale. Replicated field-experiments have been established in two consecutive years in Denmark. Winter wheat is grown on two different soil types each under conventional or reduced tillage. We monitored a range of climatic and soil conditions by means of sensors, as well as runoff and sediment yield during runoff seasons. Extremely high-resolution imagery is being collected by a CAS platform (DJI Matrice 100). The sensors used are a Zenmuse X5 (RGB) and MicaSense RedEdge (multispectral) camera. Automated algorithms are currently being developed for describing the soil surface conditions and treatment differences at different time-steps. We derive spatial metrics for surface roughness using variograms, deviation between pixel elevations of different time-steps and point-cloud distributions for characterizing surface runoff connectivity in the plots. For the residue/plant cover the plots are divided into three classes; bare soil, plants and dead plant material. Their distribution patterns in different treatments are successfully captured based on reflectance values using supervised classification. The extent of soil sealing and crusting is determined by comparing reflectance patterns with locally measured infiltration rates and penetration resistance of the surface layer.