**Title**

Detecting local surface motion of pas­tures on peat soils using laser scanning technology

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**Abstract**

Subsidence can be observed at various locations in the Netherlands. While it can be due to both shallow and deep subsurface processes, the shallow subsidence is mainly a result from compaction, oxidation and/or groundwater drainage. Moreover, for grasslands on organic soils, in particular pastures on drained peat soils, the vertical position of the ground level is subject to significant temporal variability. Temporal scales of the vertical motion are expected to vary between days and centuries, and spatial scales between millimeters and kilometers. Unfortunately, performing precise, reliable, and representative geodetic measurements of shallow subsidence processes is very difficult for soils, as fixed benchmarks do not exist. Here we propose an insitu measurement procedure for grass-covered soils using laser scanning, both terrestrial and airborne, using a vertically fixed reference platform. We show that for terrestrial laser scanning (TLS) it is possible to detect changes in the vertical position of soils with a systematic error of up to 2.6 mm and a standard deviation of 0.4 mm. Given a predefined level of significance of 훼 =0.05 (confidence level of 95%) and a detectability power of 훾 =90%, we achieve a minimal detectable vertical deformation (MDD) of 21.1 mm in our study area. We show that the results are influenced by the grass density and length, the incidence angle of the laser beam, as well as other settings of the laser scanner. We find that the parameter settings of the method for estimating soil surface, and subsequently the subsidence, has an influence on the results and related statistics. For airborne laser scanning (ALS), using a precisely leveled reference platform, we find that the quality of elevation estimates is still limited, requiring further considerations on the design of data acquisition surveys and the reference platforms. Our results demonstrate the ability of laser scanning technology for investigating shallow subsurface motion of grass-covered soils relative to a benchmark on a local scale. Based on the quality assessment, the detection of vertical ground level change is better understood in terms of time and probability. In future research, the factors affecting terrestrial laser scanning technology to accurately identify soils affected by vegetation, environment, and device condition, should be further studied.