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Analysing flow patterns in degraded peat soils using TiO_2 dye

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Dye tracing is a valuable method for studying the flow patterns in soils. However, limited information is available on water flow and solute transport pathways in dark colored peat soils because the frequently used Brilliant Blue FCF dye does not visibly stain the soil. In this study, we were aiming at testing the suitability of Titanium dioxide (TiO_2) as a dye tracer for dark peat soils. The objectives were to quantify the physical properties of different degraded peat soils and visualize the flow patterns. Soil samples were collected from two low-lying fen sites, where the top soil was highly degraded, while lower horizons were less decomposed. Dye tracer experiments were conducted at both sites by applying a TiO_2 suspension (10 g/l) with a pulse of 40 mm. Soil profiles were prepared for photo documentation the following day. It was found that the physical and hydraulic properties of peat were significantly influenced by the degree of peat decomposition and degradation. Higher decomposed and degraded peat soils had a higher bulk density, lower organic matter content and lower porosity. Moreover, higher decomposition and degradation resulted in a lower saturated hydraulic conductivity as long as investigated samples originated from the same site. In addition, degraded peat soils showed less anisotropy than un-degraded peat. It turned out that TiO_2 is a suitable dye tracer to visualize the flow paths in peat soils. Although dye patterns differed within the same plot and between different plots, most of the flow patterns indicated a preferential flow situation. The distribution of TiO_2 in the soil profile, as analyzed from 5 by 5 cm grid cells, compared to the distribution of bromide, which was applied along with the dye confirming the suitability of the dye tracer. Un-decomposed plant structures, such as wood branches and leaves, were identified as the major preferential flow path in un-degraded peat. For degraded peat, bio-pores, such as root and earthworm channels operated as the major transport domain.