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Building with nature in wetlands: Plants accelerate soil forming processes of newly deposited fine sediments

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The MarkerWadden building with nature project is a new dynamic and bio-diverse wetland system that will cover 10.000 ha. It is being developed with the deposition of fine sediments in the Markermeer lake (the Netherlands). Problematic is that the process of sediment consolidation and soil forming in the MarkerWadden wetland takes several years. Consolidation may be speed up by technological solutions such as horizontal drainage, however, these measures are invasive and often degrade the natural value of the system. Our current research therefore focusses on exploring alternative approaches that use natural processes, rather than technological solutions, to speed up the sediment consolidation process.

Plants are excellent examples of ecological engineers as they directly interact with the physical components in the sediment and contribute to the natural value of the system. In this research we therefore explored how plants and physical processes effect sediment consolidation and soil forming processes. Specifically, we aim to understand via which mechanisms the fast-growing perennial wetland species Phragmites australis expedite drainage in soft cohesive sediment, and to which extent this process promotes consolidation.

In a controlled climate room, we conducted column experiments with fixed water level. We measured the dynamics of pore pressures at 10 cm depth intervals during a 129-day period in a column with and without plants. Water loss via evaporation and transpiration was measured by water loss from Mariotte bottles and the photosynthetic processes were measured with a LICOR photosynthesis system.

Our results show that Phragmites australis effectively lowered pore pressure between 20-40 cm below the water table and dynamically influenced the pore pressure during day and night times. As a result of this plant activity, the sediments developed into more permeable soils, by increasing the hydraulic conductivity on average from 1.04E-9 m.s-1 (±7.49E-11) in the unplanted column to 2.85 E-9 m.s-1 (±9.78E-11). In the 129 day period, evapotranspiration increased to 7 mm.day-1 with arooting depth to 85 cm.

These results provide crucial information needed for predictive modelling of plants as ecological engineers to speed up soil forming processes in the newly constructed wetlands in the Netherlands.