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Long-term rewetting of fen peatlands alters the response of water tables to rainfall and temperature

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Fens belong to the most threatened ecosystems in Europe. Maintaining a high water table through rewetting is an effective measure to rehabilitate many of their ecosystem functions. However, the impact of meteorological factors such as relative humidity, precipitation and air temperature on water storage and its dynamics is still unclear especially for rewetted fens in the temperate regions. Here, we quantify the impact of meteorological factors on water table dynamics comparing a drained and a rewetted fen in North-East Germany, using multiple linear regression with data from continuous high-resolution (temporal) water level monitoring and weather stations. We found that a 1-degree rise in daily maximum air temperature causes a drop of about 4 mm in the water table in the drained and degraded fen but only a drop of around 2 mm at the rewetted site, mainly through evapotranspiration. Higher minimum relative humidity limits evapotranspiration and is, thus, negatively associated with water table elevation at both sites. Precipitation contributes to recharge, causing the water table to rise almost six times higher at the drained site than at the rewetted site. We attribute the differential impacts of meteorological factors on water table dynamics to (1) differences in vegetation, which acts as surface control and (2) differences in soil properties. We found that for the depths at which the groundwater fluctuates, the peat of the rewetted fen has a higher specific yield compared to the drained fen, causing the water table to rise or recede at smaller rates. A period of 20 years of rewetting was sufficient to form a new layer of organic matter with a substantial fraction of macropores providing water storage capacity and thereby changing water table response. Our study underlines the importance of long-term rewetting and meteorological factors for peatland restoration. Continuous monitoring of water table and vegetation development in rewetted fens is advisable to ensure long-term success, especially under climate change conditions.

The updated versions of the papers on which this abstract is based can be found at (1) https://www.frontiersin.org/articles/10.3389/feart.2021.630469/abstract and (2) https://www.sciencedirect.com/science/article/pii/S0048969720351007