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Land cover or climate? In search of dominant factors inducing groundwater recharge and fen hydrology in European scale

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Groundwater recharge plays the crucial role in development and stability of fens. It was hypothesized that the mid- and late-Holocene acceleration of fens' development in Europe could have been induced by changes in land cover: decreasing areas of forests resulting from the expanding agriculture have enhanced groundwater recharge by decreasing evapotranspiration and interception and promoting infiltration. However, regardless human-related changes of the landscape, recorded climatic fluctuations could also be considered as drivers of changing groundwater recharge that affects fen stability and development. Nowadays, when up to 90% of European wetlands is considered degraded, assessing vulnerability of groundwater recharge to changing landscape and climate is of the crucial importance for setting fen restoration and management strategies.

Main goal of our study was to assess the magnitude of changes in groundwater recharge estimation resulting from modelled changes of the landscape and climatic features in >300 fens located in Poland, Germany, The Netherlands, Sweden, UK and Norway. In our approach we (1) delineated the most probable extents of catchments of particular fens analysed, (2) assumed hypothetical and the most probable changes of land cover within these catchments, (3) assumed the most probable ranges of climatic changes in each of the catchments including historical reconstructions (Holocene) and future projections (A1B scenario, CSIRO:MK3 and UKMO:HADCM3 GCM-RCM ensembles), (4) developed, tested and calibrated automatic, GIS-based groundwater recharge calculation algorithm to be applied in the study, (5) calculated groundwater recharge in multiple probable combinations of landscape and climatic conditions and (6) performed statistical analysis in order to reveal whether the climate or landscape changes were the dominant factors that could have probably influenced groundwater recharge in catchments of fens analysed.

We revealed that in the case of 80% of fens analysed, groundwater recharge in the catchment-scale was strongly related to climatic features whilst in the remaining 20% only the specific combination of climatic and landscape features results in changing groundwater resources. We also revealed that groundwater recharge in certain fens did not change much in variable modelled landscape-climatic conditions which may be considered a prerequisite of fens resilience towards hydrological stressors such as changing groundwater resources. Results of our study allowed the conclusion that although groundwater resources in fen's catchments are variably vulnerable to changing landscape and climatic features in their regions, managing and restoring fens should always account for stability of water supply, and require a catchment-scale approach anticipating landscape and climatic changes.