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Topsoil removal as a method of fen restoration that helps to prevent elevated methane emissions and surface water eutrophication

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Natural peatlands produce peat, because the decomposition rate of organic matter is lower than the primary productivity. Thanks to this unique property, peatlands provide many vital ecosystem services to people, such as carbon sequestration and nutrient storage. At the same time, peat-forming mires are among the habitat types most threatened worldwide due to human activities. Temperate fens are probably the most transformed peatland types due to the drainage for agriculture. Lowering of the watertable, which is a result of drainage, allows oxic mineralisation of peat, which releases carbon back to the atmosphere and nutrients to surface waters at a rate much faster than they were bound in the past. Degradation of the vast majority of peatlands in developed countries and its negative consequences, is the reason why ecological restoration of those ecosystems is implemented. The most commonly used method of ecological restoration of peatlands is rewetting. However this method has been criticised from climate change perspective, due to the periodic significant increase in methane emissions. Moreover, its application on highly degraded peatlands causes mobilisation of nutrients, which pollute surface waters. Second method used in fen restoration, is removal of degraded topsoil. However, our knowledge about the effectiveness of this method in restoring peatland ecosystem services, including greenhouse gas balance and nutrient cycling, is very limited and based on indirect reasoning. The main objective of the presented research was to evaluate the effectiveness topsoil removal, in comparison with rewetting, as a fen restoration method in terms of the perspectives to re-establish natural nutrient cycling and greenhouse gas balance.
The study area was located in central Poland within the Całowanie Fen. The site is a typical example of peatland development, but also of its degradation due to human influence within the European Lowland. Research was connected to a restoration project, which included a topsoil removal over 2 ha of severely degraded peatland. Within and around this area permanent plots were established, including: topsoil removed plots, control plots on degraded peat, reference ones in fen remnants within old peat-cuts and experimentally rewetted plots, which allowed comparison of both restoration methods. Within the above methane emissions were measured each month, with the static chamber method, over two vegetation seasons. At the same time nutrient and main cations concentrations were monitored in sub-surface pore water.
The results proved that topsoil removal, in contrast to rewetting, can reduce nutrient concentration in the soil solution after restoration and does not increase methane emissions (in comparison with degraded situation). However, if the overall global warming potential of both restoration methods is to be compared the impact of mineralisation of the removed topsoil has to be included and as a result the restoration of fens with topsoil removal, can actually be less favourable for climate that their rewetting.