Zooming in on CO_2 emissions of adaptive peatland management

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Abstract

Financial compensation for the reduction of greenhouse gas emissions would enhance the implementation of adaptive peatland management strategies. To broker such deals, high spatio-temporal resolution impact assessments are needed. The added value of the SOMERS method for such endeavors was tested. SOMERS was shown better suited to assess the impacts of adaptative strategies on CO_2 emissions than previous methods based on empirical relations with groundwater tables. The method can be further refined by considering seepage conditions.

Introduction

Previously, an integrated impact assessment with the RE:PEAT tool on the Tygron Geodesign Platform (TGP) demonstrated that pressurized field drains and/or higher water levels could enhance the sustainable management of a Dutch peatland polder, but none of the stakeholders would be able to singlehandedly cover the implementation costs (Van Hardeveld et al., 2020). However, if a financial bonus would be granted for the reduction of greenhouse gas emissions, the implementation of pressurized field drains and/or higher water levels would become feasible. To broker such deals, integrated impact assessments with high spatio-temporal resolution are needed, as well as more certainty regarding the impacts of the adaptations on greenhouse gas emissions.

In recent years, many scholars have focused on methods to estimate greenhouse gas emissions from peat soils. For instance, Van den Akker et al. (2008) derived CO_2 emissions from soil subsidence assessments which reflected an empirical relation with the average lowest annual groundwater table, and Couwenberg et al. (2011), Tiemeyer et al. (2020) and Evans et al. (2021) all used empirical relations between mean annual groundwater tables and CO_2 emissions. Although all these relations show that in general, higher groundwater tables lead to less CO_2 emissions, the magnitude of the emissions estimates varies.

To contribute to a better understanding of peatland CO_2 emissions, a group of Dutch scientists is developing SOMERS (Subsurface Organic Matter Emission Registration System), an estimation method which is more sophisticated than mere regression formulas of groundwater statistics. They combine monitoring results of multiple Dutch peatland sites with detailed Hydrus-2D modelling to assess the potential aerobic microbial respiration rate of peatland parcels on a daily basis (Boonman et al. 2021). The first version of SOMERS allows users to access their results and estimate CO_2 emissions for a range of settings, using a lookup table with soil type, ditch water level and parcel width as variables. The question this paper seeks to answer is: what is the added value of the SOMERS method for impact assessments of adaptive peatland management strategies?

Methods

The SOMERS method was compared to an adaption of the method of Van den Akker et al. (2008) that was used in the RE:PEAT tool (Van Hardeveld et al. 2019). For this comparison, the lookup table of the SOMERS method was reconstructed as a mapping tool with high spatio-temporal resolution on the TGP. Both methods were used to assess the impacts of three management strategies in Polder de Ronde Hoep, an agricultural peatland polder of 11.9 km² near Amsterdam: (1) current surface water levels, maintained at 30 cm below the ground surface along the border of the polder, and 10 cm below the ground surface in the center of the polder, (2) raised surface water levels, maintained everywhere at 10 cm below the ground surface, and (3) pressurized field drains which maintain the groundwater table at 30–40 cm below the ground surface.

Results

For the strategy with current surface water levels, the average CO_2 emission assessed by the SOMERS method (8,8 10^3 kg ha^{-1} yr^{-1}) and the RE:PEAT tool (8,5 10^3 kg ha^{-1} yr^{-1}) differed only slightly. The strategy with raised water levels revealed more pronounced difference, with the SOMERS method estimating 4,7 10^3 kg ha^{-1} yr^{-1} and the RE:PEAT tool 3,1 10^3 kg ha^{-1} yr^{-1}. In both strategies, differences were most pronounced at some parcels in the north and along the southern border with strong downward seepage conditions. The strategy with pressurized field drains resulted in the lowest emission estimates, ranging from 3,9 10^3 kg ha^{-1} yr^{-1} according to the SOMERS method to nothing at all according to the RE:PEAT tool.

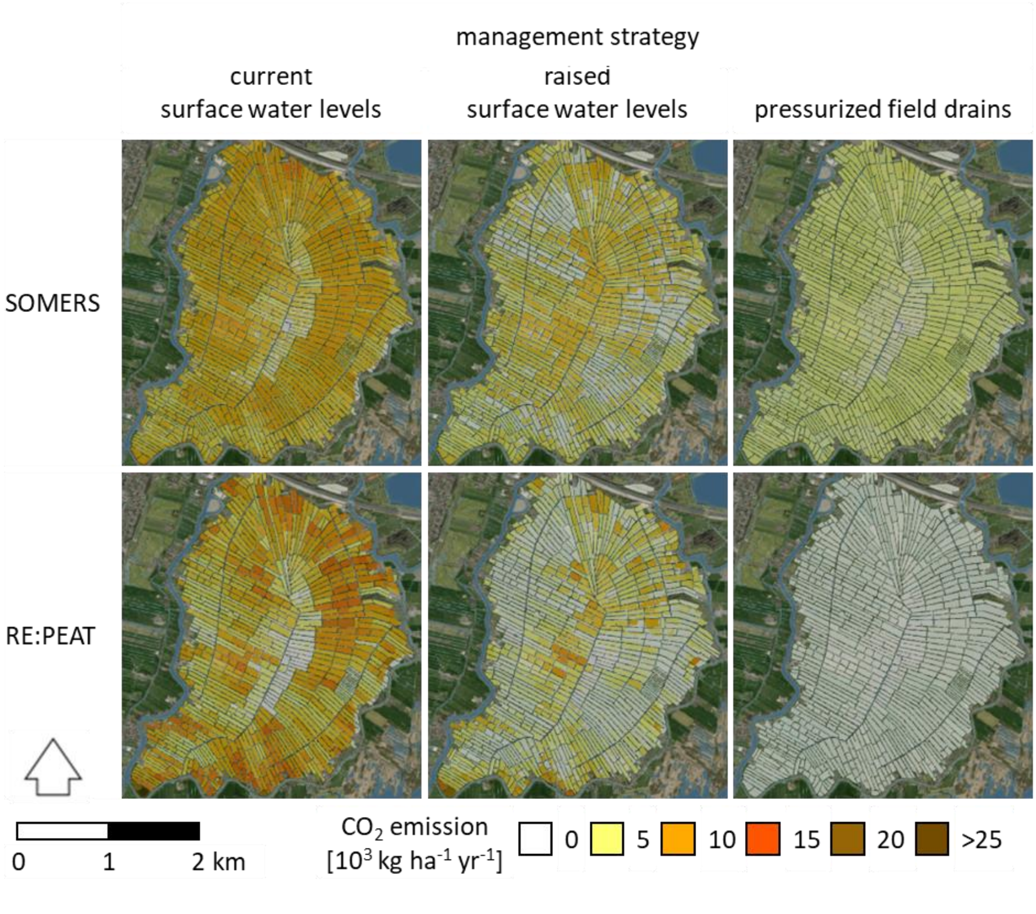

Figure 1 CO2 emissions in the research area resulting from the three management strategies.

Discussion

Polder de Ronde Hoep is a polder with marked downward seepage. Therefore, lowest annual groundwater tables are relatively low compared to similar polders with less seepage, i.e., the conditions which reflect the original empirical relation of the Van den Akker method. In the RE:PEAT tool, the slope of the empirical relation of the Van den Akker method was adjusted, so that estimated soil subsidence in the current situation would better match the recorded long term soil subsidence in polder de Ronde Hoep. As a result, groundwater tables at 30–40 cm below the ground surface result in zero soil subsidence and therefore, zero CO_2 emission. This does not match with emission measurements at monitoring sites with similar conditions. The SOMERS method, which is derived from these measurements, is far more trustworthy on that account. In fact, as many stakeholders involved in policy processes commented on the unlikeliness of the results, the SOMERS method has now replaced the previous method to assess CO_2 emission in the RE:PEAT tool. However, further refinements regarding seepage conditions are still needed. Assessments based on the potential aerobic microbial respiration rate are very well suited to consider the full range of these conditions. Therefore, the next version of the SOMERS method might very well be of even more added value for impact assessments of adaptive peatland management strategies.

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