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Modelling greenhouse gas balances of bogs in Germany based on vegetation types and water levels

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An important share of the greenhouse gas (GHG) emissions of many European and South-East Asian countries is originating from degraded peatlands. However, only the GHG balances of a few sites can be measured directly, as these measurements are both cost- and labour-intensive. Therefore, reliable methods for upscaling peatland GHG balances to a larger scale are necessary. Ideally, such upscaling methods use readily available data and also allow for the assessment of scenarios and implemented restoration measures.

In this study, we focused on unused and extensively used bogs in Germany and collected a dataset of published annual balances of carbon dioxide (CO_2) and methane (CH_4) from bogs within Germany and the surrounding temperate Europe. Each site was assigned to one of eight vegetation types, which are based on a clustering of the German federal biotope type classification to enable later upscaling based on this data. The relationships of the annual CO_2 and CH_4-balances to vegetation type, mean annual water level and temperature were then analysed with mixed effects modelling.

As expected, wet extensive grassland had relatively high CO_2 and low methane emissions, while semi-natural bogs showed a small CO_2-uptake but higher methane emissions. Most degeneration stages showed an intermediate behaviour. Noteworthy are the comparatively low CH_4 emissions of recently rewetted sites with sparse vegetation and of wet unused forested areas. Due to very little available data, the uncertainties of GHG emissions from some vegetation types are large. For very wet vegetation types such as semi-natural *Sphagnum*-dominated sites, water levels did not improve the GHG emission estimates compared to solely using vegetation data. For dryer sites such as wet extensive grassland, incorporating water levels significantly improved the estimation of both CO_2 and CH_4 fluxes.

The results are broadly in line with previous findings and provide a basis for future upscaling to a German-wide estimation. In some cases, knowledge on water levels after having taking restoration measures will still improve the estimation of GHG exchange. The most severe data shortage occurred for recently rewetted sites with sparse vegetation and wet unused forested bogs as well as subalpine and alpine peatlands.