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Rising Tides, Shifting Gases: Impacts of Salinization on Peatland Ecosystems

MARTYNA GLODOWSKA[1], QUINTEN STRUIK[1], JOSE PARANAIBA[1], THOMAS GREMMEN[2] AND GIJS VAN DIJK[2]

[1]Radboud University
[2]B-WARE

Presenting Author: glodowska.m@gmail.com

The Intergovernmental Panel on Climate Change (IPCC) projected that the global sea level will rise up to 110 cm by 2100 in response to increased temperatures, ocean warming, and the melting of glaciers. These consequences of climate change will lead to the intrusion of seawater and the salinization of freshwater ecosystems, especially low-lying coastal zones, such as the Netherlands. Despite numerous models and predictions, very few studies have tested the effects of salinization of freshwater peatlands and coastal wetlands on ecosystem functioning. The consequences of seawater intrusion and the effect of salinization on microbial activity and biogeochemical processes remain unknown. Increasing salinity is expected to strongly affect the carbon cycle and change the patterns in both methanogenic and methanotrophic activities and consequential greenhouse gas emissions. Still, the mechanisms behind these processes remain elusive, and available studies report contradictory results. Since peatlands are known to significantly contribute to total global methane emissions, it is crucial to understand how future salinization will affect these emissions.

Besides salinity, seawater intrusion introduces sulfate into the ecosystem, potentially stimulating heterotrophic sulfate reduction and/or anaerobic methane oxidation coupled with sulfate reduction, an important sink of methane in marine ecosystems. Furthermore, sulfate-reducing bacteria might compete for the organic carbon, decreasing the pool of bioavailable carbon and subsequently preventing methanogenesis and methane release. To understand the changes in biogeochemical processes triggered by seawater intrusion with a special focus on sulfur and carbon cycling, we are using experimental ditches in a long-term (seven years) field experiment in a freshwater peatland North of Amsterdam (Polder Westzaan). Sediment cores are collected once every season for one year to capture seasonal changes in oxic and anoxic layers as well as the redox transition zone of freshwater and brackish peatland ditches. With a multidisciplinary approach combining solid-state and pore-water chemistry, gas analysis, metagenomics, metatranscriptomics, and untargeted metabolomics we aim to provide a comprehensive study explaining the effect of seawater intrusion on the biogeochemistry of freshwater peatland.