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"Nutrients and dissolved organic carbon dynamics in response to environmental drivers in a Belgian peatland"

Henrion, Maud ; Anciaux, Elise ; Moore, Angus ; Lambot, Sébastien ; Van Oost, Kristof ; Jonard, François ; Opfergelt, Sophie ; Vanacker, Veerle

ABSTRACT

Peatlands are providing crucial ecological services such as significant carbon storage. These sensitive ecosystems are subjected to degradation due to land use and climate change resulting in carbon emissions. Multiple studies focused on the gaseous carbon fluxes from disturbed peatlands while dissolved carbon fluxes have often been overlooked. However, hydrologic export of carbon can represent up to 30 % of the ecosystem carbon exchanges and is highly variable. We investigated the spatiotemporal variability in dissolved carbon in a peatland located in the Belgian High Fens. The site was previously drained for forestry and is now under passive restoration. These disturbed peatlands are understudied despite their ubiquitous presence in the Ardennes-Eifel region. It is therefore important to understand their actual state and their recovery potential. Our objectives are to: (i) characterize the spatiotemporal variability in dissolved nutrient and carbon concentrations in soil solutes; (ii) investigate the association between soil moisture, redox conditions and nutrient and carbon concentrations; (ii) identify hot-spots or hot-moments in the biogeochemical functioning of peatlands. Soil pore water samplers were installed at five contrasting positions along a toposequence, at three different depths. Soil pore and river waters are collected and analyzed once per month during one year. These water samples are analyzed for their conductivity, pH, major element concentrations, dissolved C, dissolved N, NO3, NH4, Cl, organic carbon aromaticity and Fe(II)/Fe(III) ratio. At the same ...

CITE THIS VERSION

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Nutrients and dissolved organic carbon dynamics in response to environmental drivers in a Belgian peatland

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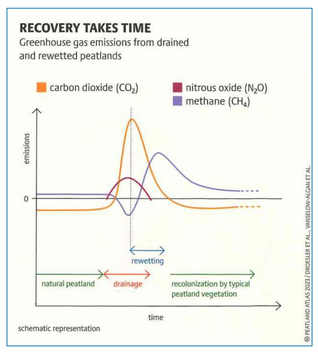
Why should we study peatlands ?

Peatlands provide crucial ecological services such as carbon storage. But they are subjected to **degradation** due to land use and climate change.

Dissolved carbon fluxes in peatlands:

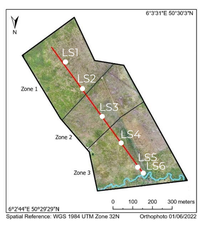
- Often overlooked
- Can represent up to 30% of the ecosystem C exchanges
- Highly variable following perturbations
- Impacted by some key elements



Where is our study site ?

In the natural reserve of the Belgian **Hautes Fagnes**.

- Disturbed through spruce plantations in the 20th century
- Now under passive restoration
- Peat depth ranges between 0.2 and 2 m
- Climatic interest (globally)
- Ecological interest (in Belgium)
- Understudied previously drained temperate peatland



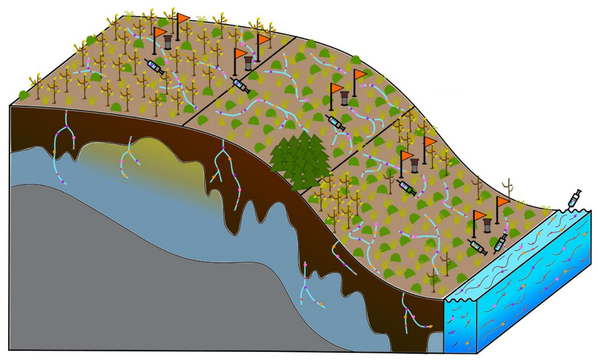
How are we studying nutrients and organic carbon dynamics and their drivers ?

Soil water sampling

What ?
Rhizons

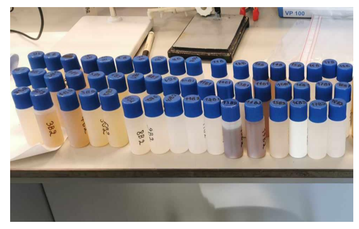
Where ?
- 6 positions on the toposequence
- 2 replicates at each position
- 3 depths (10, 30, 45-90 cm)

When ?
- 1 / month
- Aug 2023 – Sept 2024

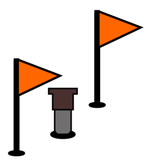


Chemical analyses

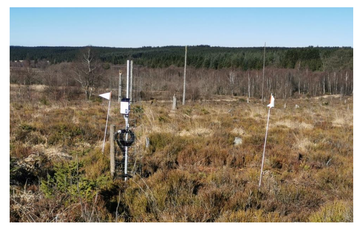
- pH
- Conductivity
- Redox potential
- Ions (NO_3^-, NH_4^+, Cl^-)
- Alkalinity
- Carbon and nitrogen concentration
- Carbon aromaticity
- Fe(II)/Fe(III) ratio
- Major element concentration (Ca, Mg, Na, K, Si, Al, Fe, Mn, S, P)



Water, redox and temperature conditions monitoring



Soil water content **Soil temperature** **Soil electrical conductivity**	*Teros12* sensors	• 5 positions, 2 replicates, 3 depths • Monitoring every 10 min, Oct 2022 - Oct 2025
Water table depth	Piezometers	• 5 positions • Monitoring every 10 min, May 2023 - Oct 2025
Soil redox conditions	*SWAP* probes	• 4 positions, 2 to 4 depths • Monitoring every 30 min, Dec 2023 - Oct 2025



OBJECTIVES

What is the spatiotemporal variability in dissolved nutrient and carbon concentrations in soil solutes ?

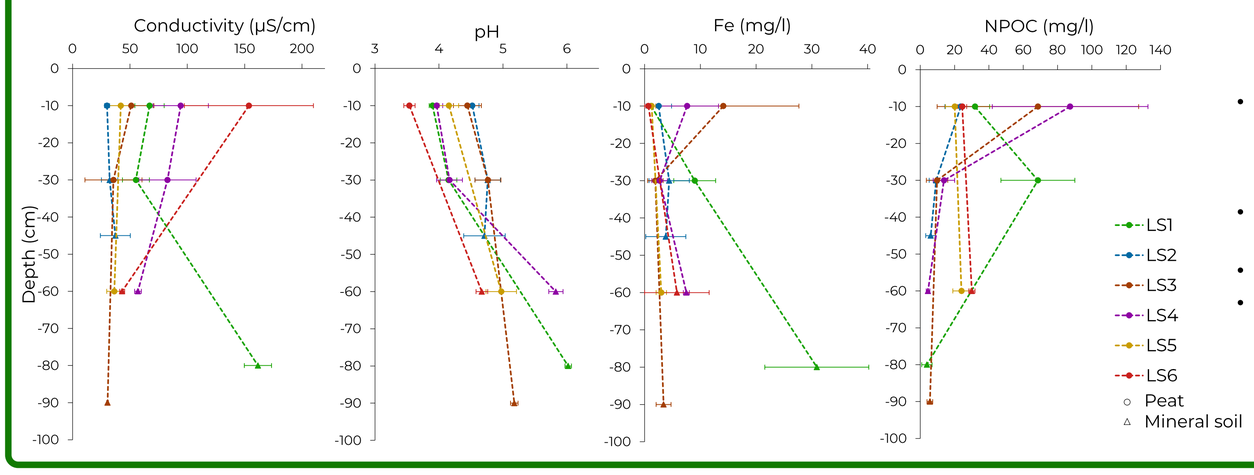
What are the associations between soil moisture, redox conditions and nutrient and carbon concentrations ?

Are there hot-spots or hot-moments in the biogeochemical functioning of this peatland ?

OBJECTIVES

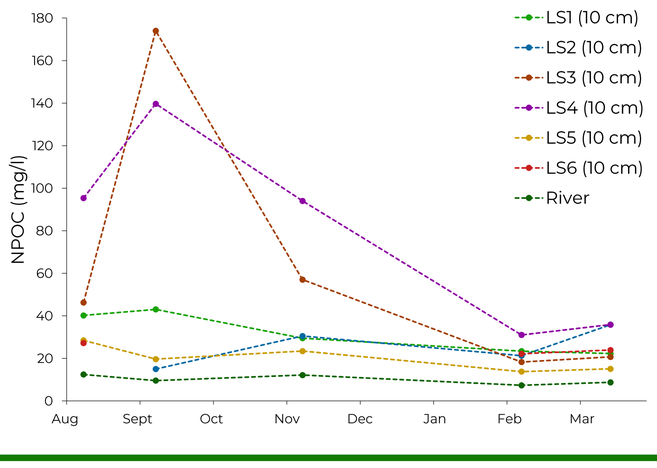
What are the nutrients and dissolved organic carbon spatial and temporal variability ?

Spatial variability in conductivity, pH, iron and carbon



- Soil solute chemistry varies largely in function of topographic position and sampling depth
- Rainfall impacts conductivity in surface
- Low pH in peat
- Higher dissolved organic carbon concentration in peat

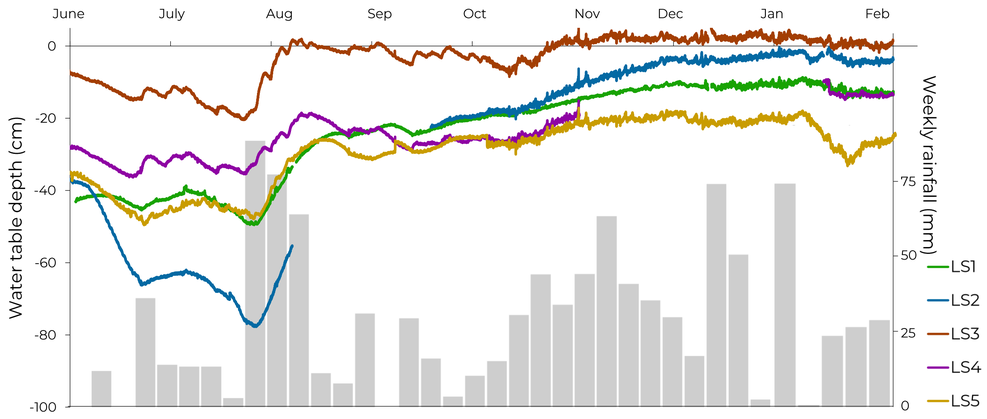
Dissolved organic carbon concentration dynamics



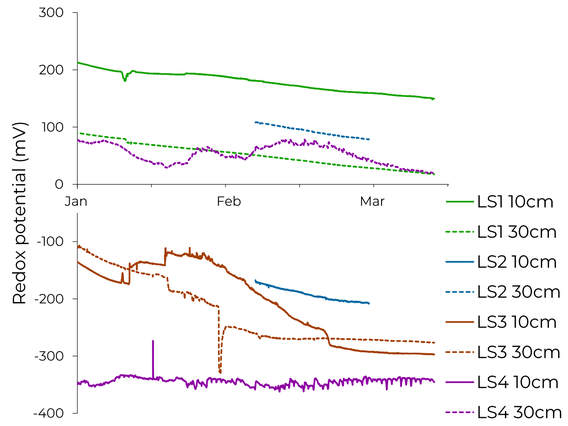
- Dissolved organic carbon concentration decreases during winter
- Higher dissolved organic carbon concentration in the slope

What is the temporal variability of the drivers ?

Water table depth and pluviometry dynamics



Redox potential dynamics



First results

- Meteorological events impact dissolved nutrient and carbon concentrations
- The ground water dynamics impacts the pH and conductivity
- Dissolved organic carbon concentration is correlated to Al and Fe concentration (Pearson correlation of 85% and 27% respectively)

HOT SPOTS ?
- 10 cm LS3 and LS4 (slope): high DOC, N, Fe, Al concentration
- 30 cm LS1 (summit): high DOC, Fe, Al concentration

HOT MOMENTS ?
- September is showing a contrasting behavior
- More are expected in the summer, after a drought event

What are the next steps ?

- Continue the monitoring until September 2024
- Monitor intensively a rewetting event after a drought this summer
- Continue the chemical analyses
- Spectroscopy measurements for carbon aromaticity and Fe(II)/Fe(III) ratio
- Determine the impact of organic carbon-mineral interactions on carbon export
- Compute carbon and nutrient fluxes via hydrological modelling
- Quantify the dissolved carbon export relatively to the gaseous ones

Visit the LandSense project website !

Our research about geophysical peatland characterization: *Henrion et al. 2024*

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