Does size matter in peatland open-water pool biogeochemistry ?

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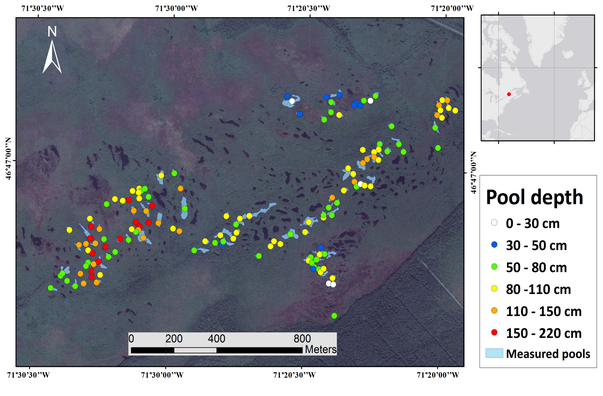
Context

Open-water pools are common features in boreal peatlands but their biogeochemistry is poorly known. We studied C, N and P biogeochemistry in open-water pools of a sub-boreal peatland in Québec, Canada. We assessed the relationship between pool physical characteristics and biogeochemistry, and quantified the temporal evolution of C, N and P concentrations in pools of different size (area and depth) over a growing season.

Study site and methodology

Grande plée Bleue, an undisturbed ombrotrophic peatland, covers 1500 ha. More than 650 pools are scattered on the southern part of the peatland. Vegetation is dominated by Ericaceae (*Kalmia* sp. and *Vaccinium* sp.) and black spruce (*Picea mariana*) over mats of *Sphagnum* sp.

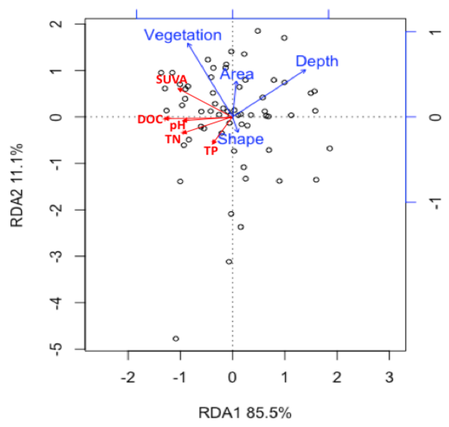


1 - Chemistry controls. 62 of the 650 pools were sampled once mid-summer in 2016. Water samples were taken 20 cm sub-surface with a 2 m perch, at full extension. Dominant vegetation was estimated in the immediate surrounding of the pools.

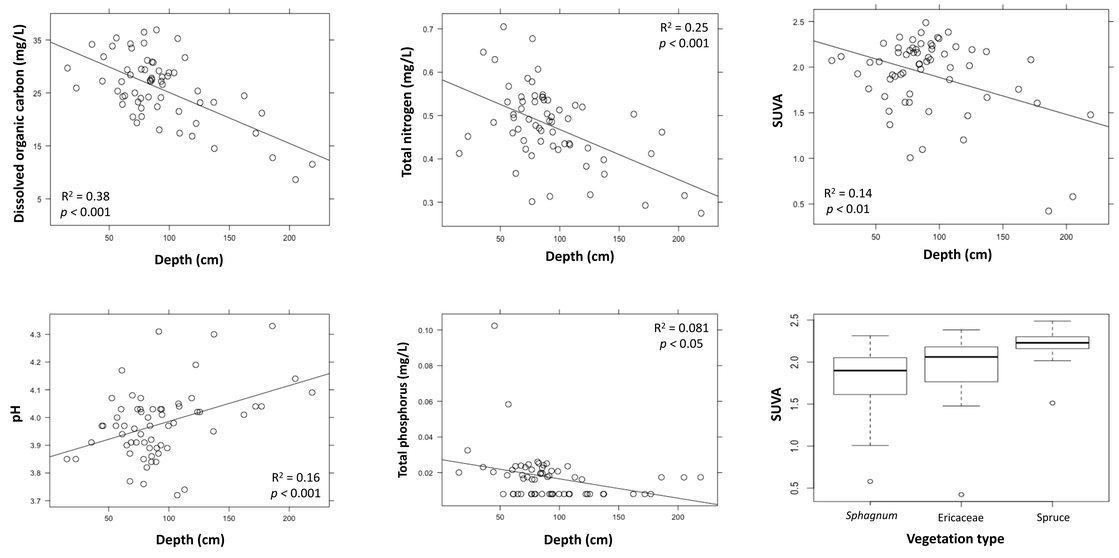
Redundancy analysis was performed to assess how and which of the pool's physical characteristics had an influence on water chemistry.

2 - Seasonal evolution. Nine pools in 3 groups, selected to represent the average size and extremes in both depth and area, were surveyed 10 times over the 2016 growing season (mid-May to late October).

1. Pool chemistry controls



- 36.3% of the variance in pool chemistry is explained by the physical characteristics.
- Depth drives the first RDA axis.
- Depth and vegetation are the only controlling factors of water chemistry (ANOVA, $p < 0.01$).
- **Depth is the main control on water chemistry.**
- SUVA is mostly driven by Vegetation.



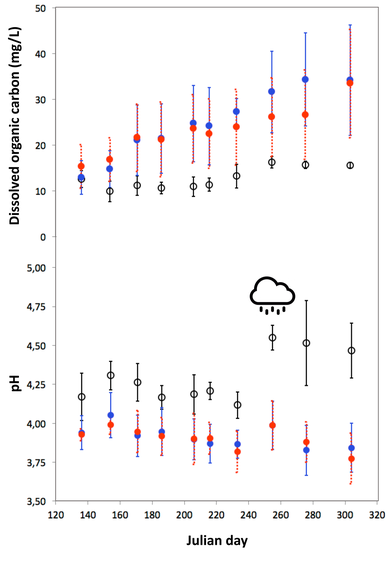
Significant relationships between physical characteristics and pool chemistry SUVA being correlated to vegetation, an ANOVA ($p < 0.01$) and post-hoc tests showed significant higher SUVA in pools dominated by spruces: DOC is less labile.

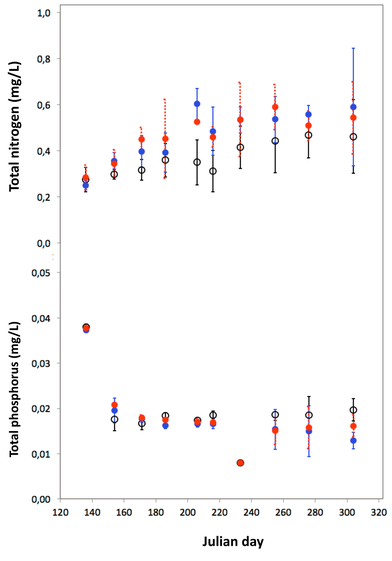
2. Seasonal evolution of pool chemistry

- Consistent with the RDA results, **depth** seems to be controlling water chemistry over the summer. Deeper pools are less productive.
- Over the season, 91-97% of TDN was DON and N:P ratio averaged 30:1 in all pools, indicative of P-limitation.

On the graphs :

- **Shallow and small pools are in red**
- **Shallow and large pools are in blue**
- **Deep and small pools are in black**





Implications

- C and N evolution over time and their relationship with depth suggest higher productivity in shallower pools: **size (depth) does matter.**
- Foreseen climate change and induced water-level change will lead to modification in pools biogeochemistry.
- This study being one of the first to focus on peatland open-water pool biogeochemistry, further investigations on hydrology will eventually lead us to better understand the relationship between pools and the surrounding peat and vegetation.

Acknowledgements

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Grande plée bleue map was produced by Philippe Major.