Peatland Hydrology shapes Dissolved Silicon Dynamics across Peat Profiles

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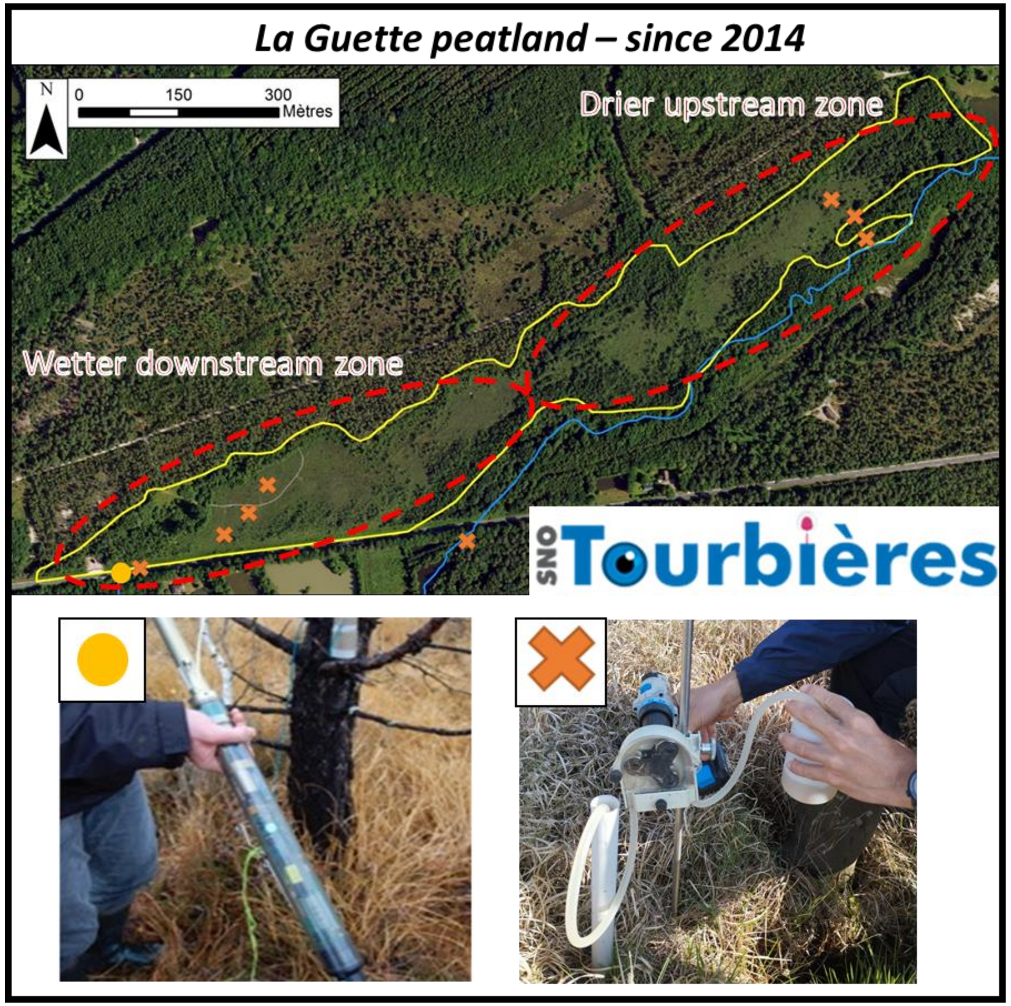
2026 SNO Observil Steering Committee
Tuesday, 16th June 2026

From Peatland to Pond: Silicon Cycling across Two Wetland Ecosystems



✖ Hydrochemical monitoring stations (C)

● Hydrological monitoring stations (Q)

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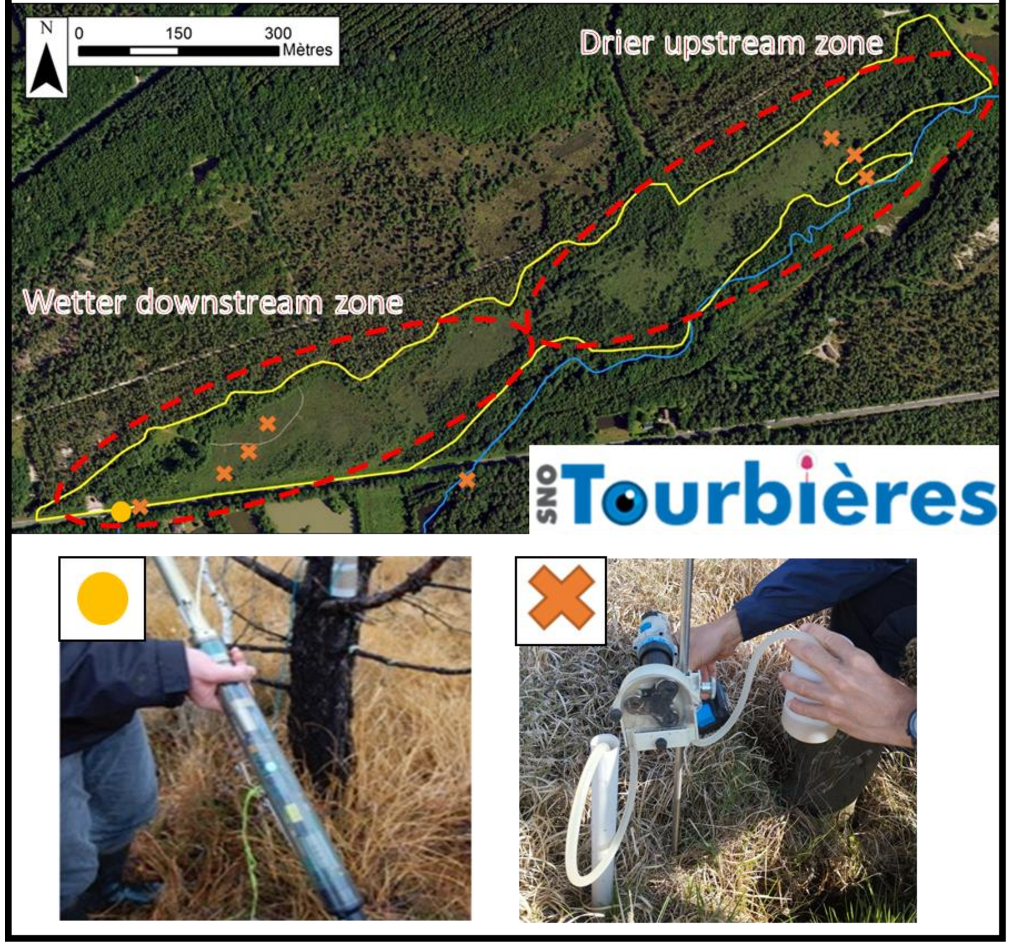
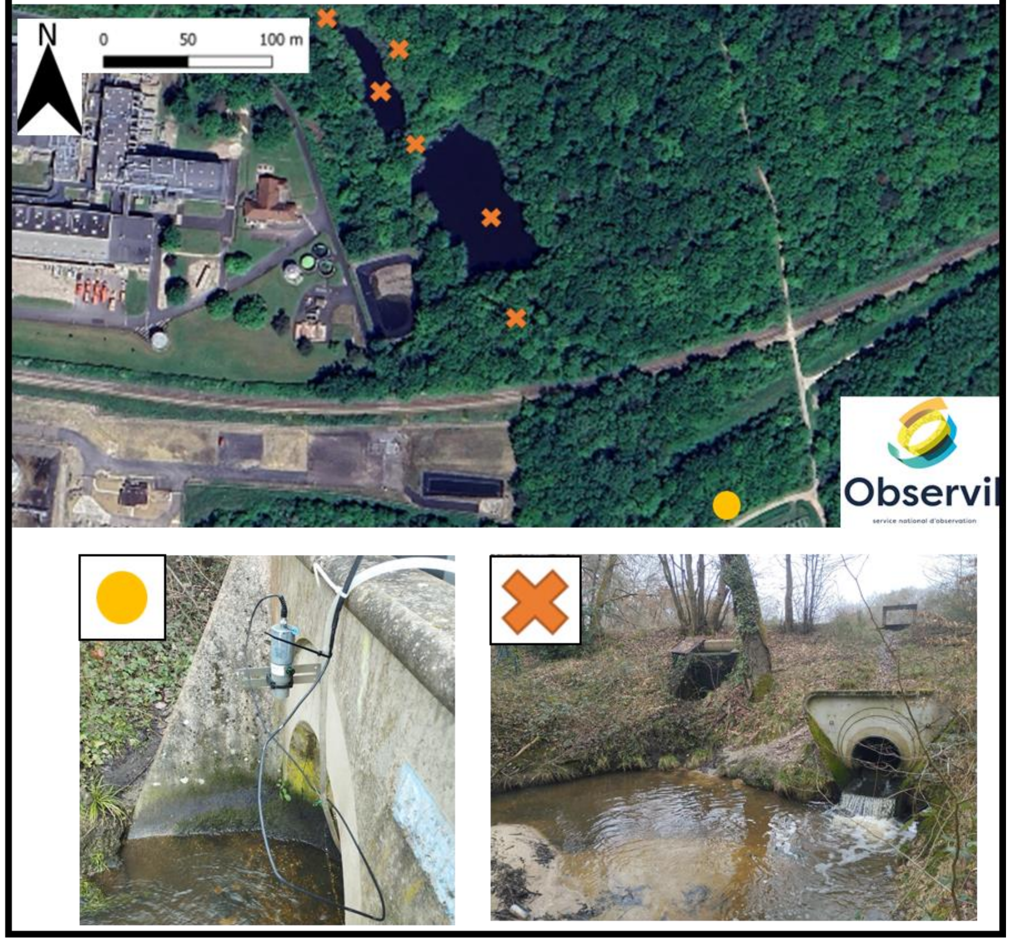
La Guette peatland – since 2014



La Beulie pond (Egoutier watershed) – since feb. 2025



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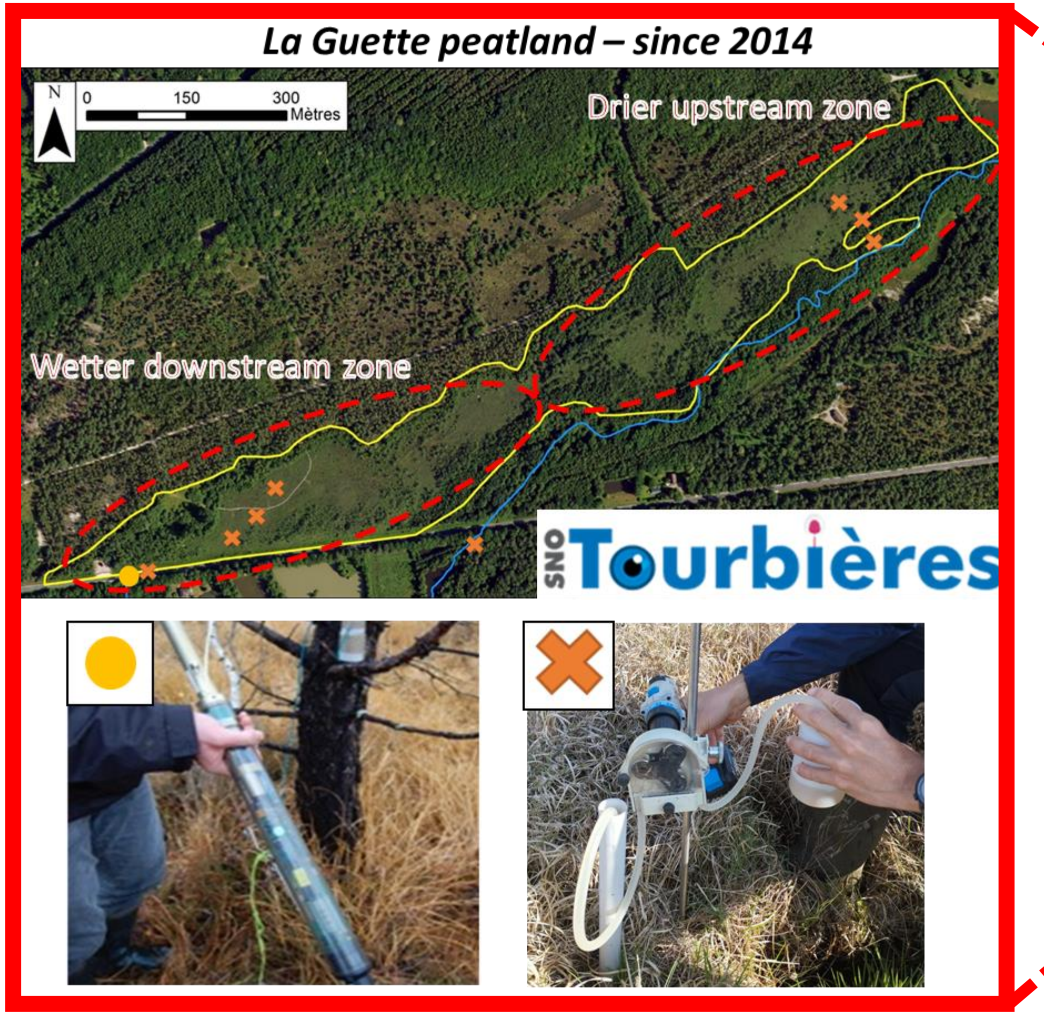

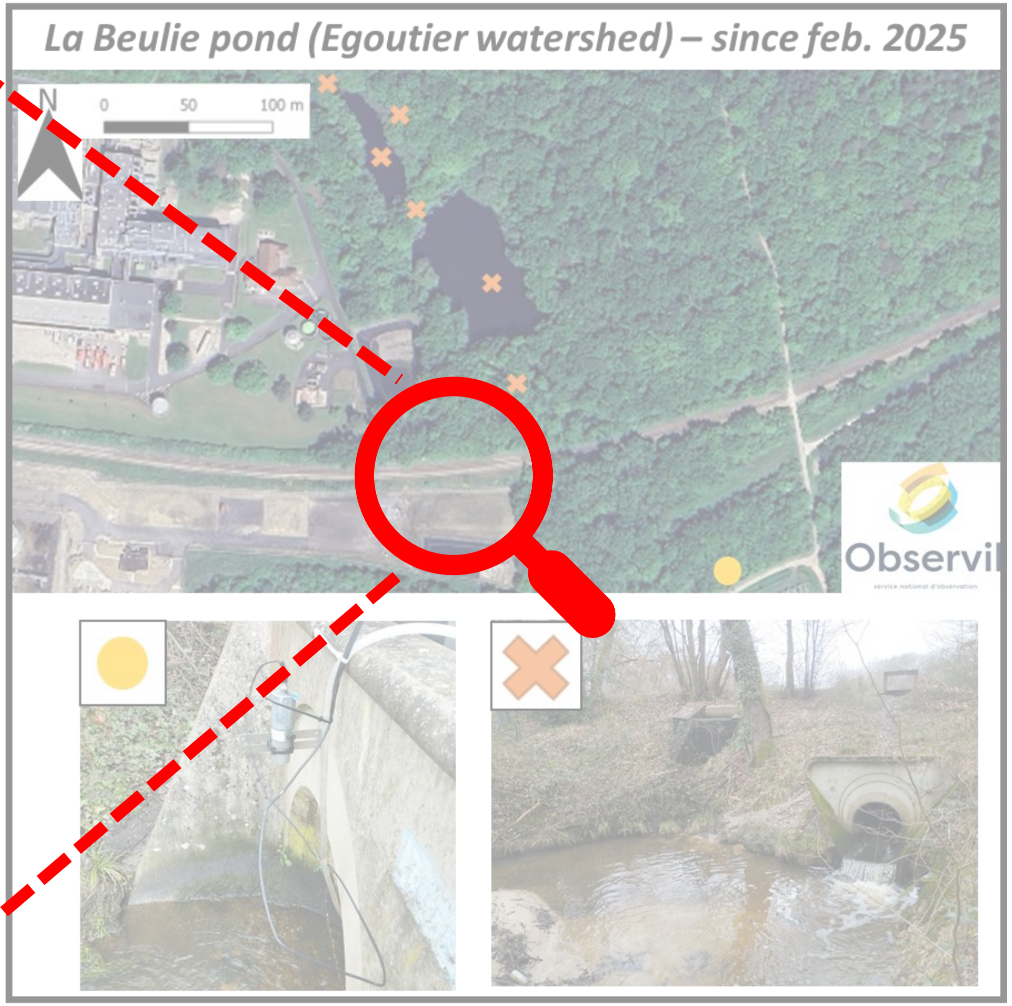

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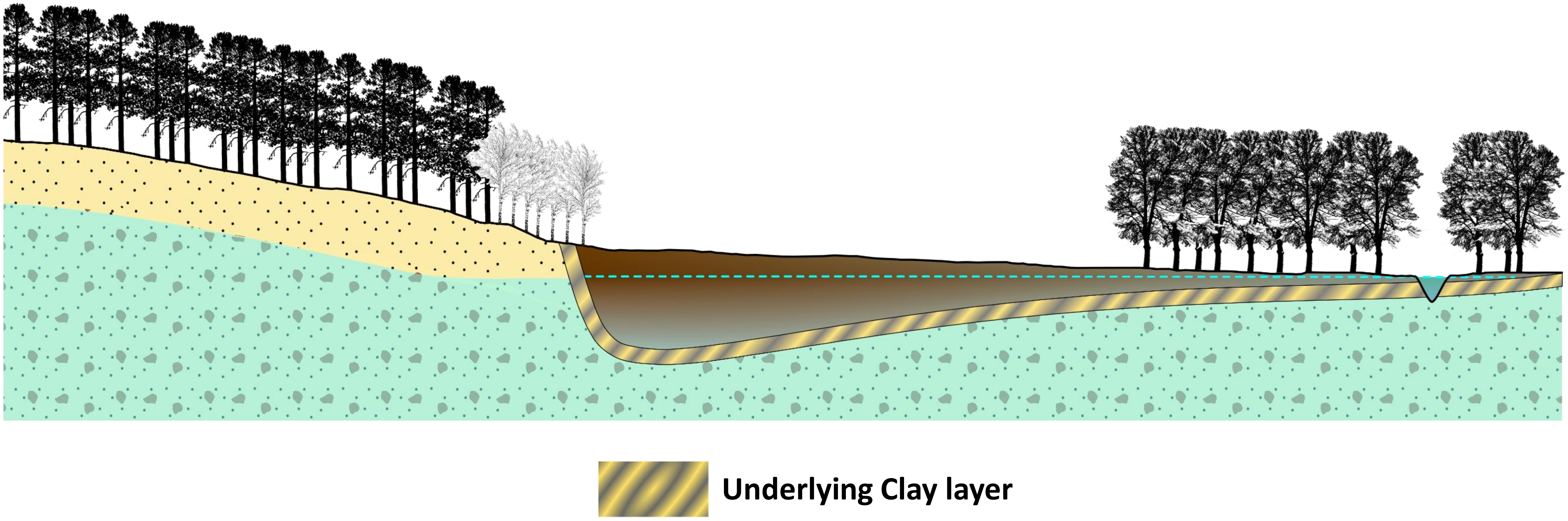
What Lies Beneath the Peat?
A Geophysical Investigation

Initial Conceptual Model



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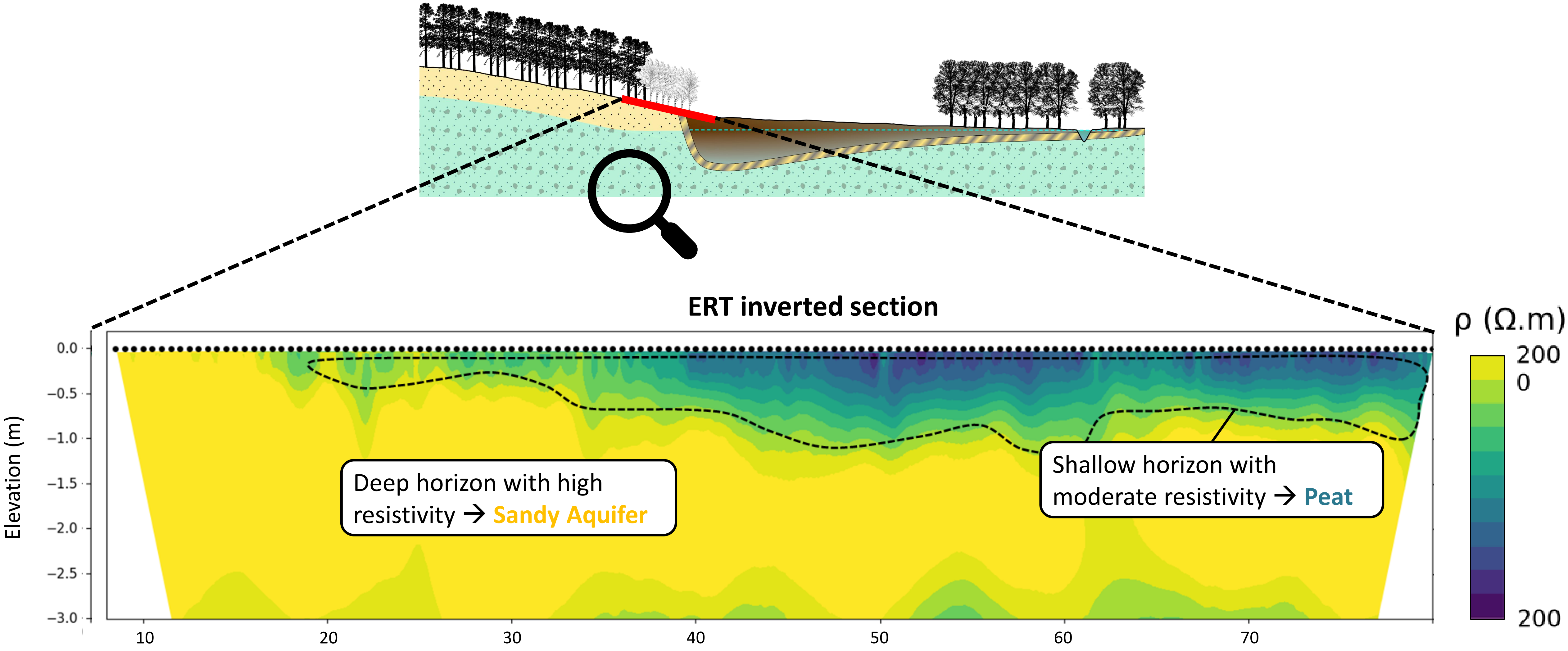

What Lies Beneath the Peat?
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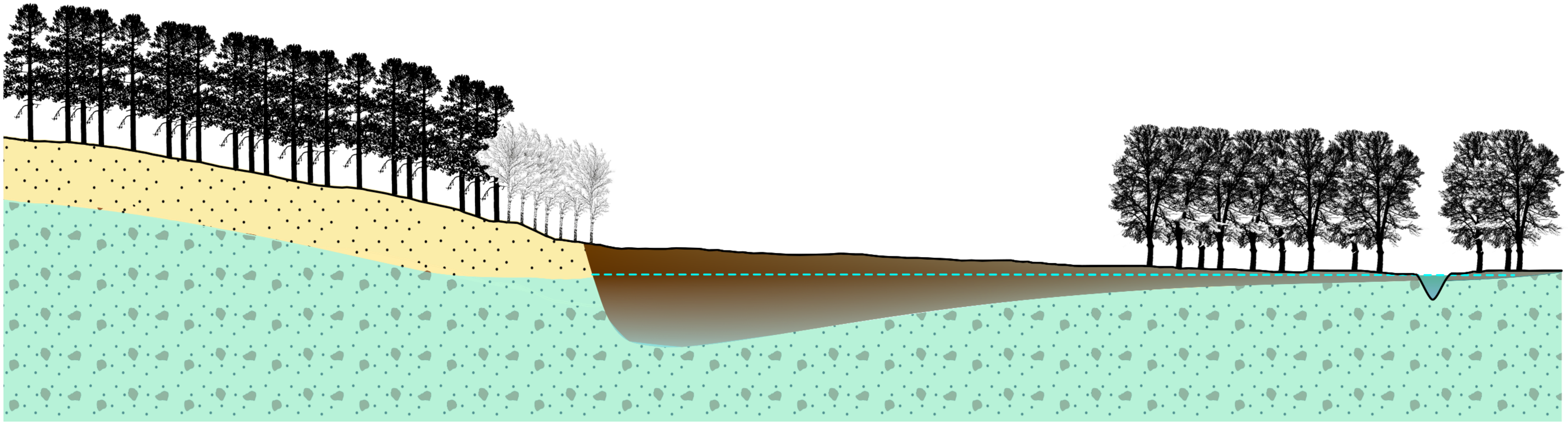
Revised Conceptual Model



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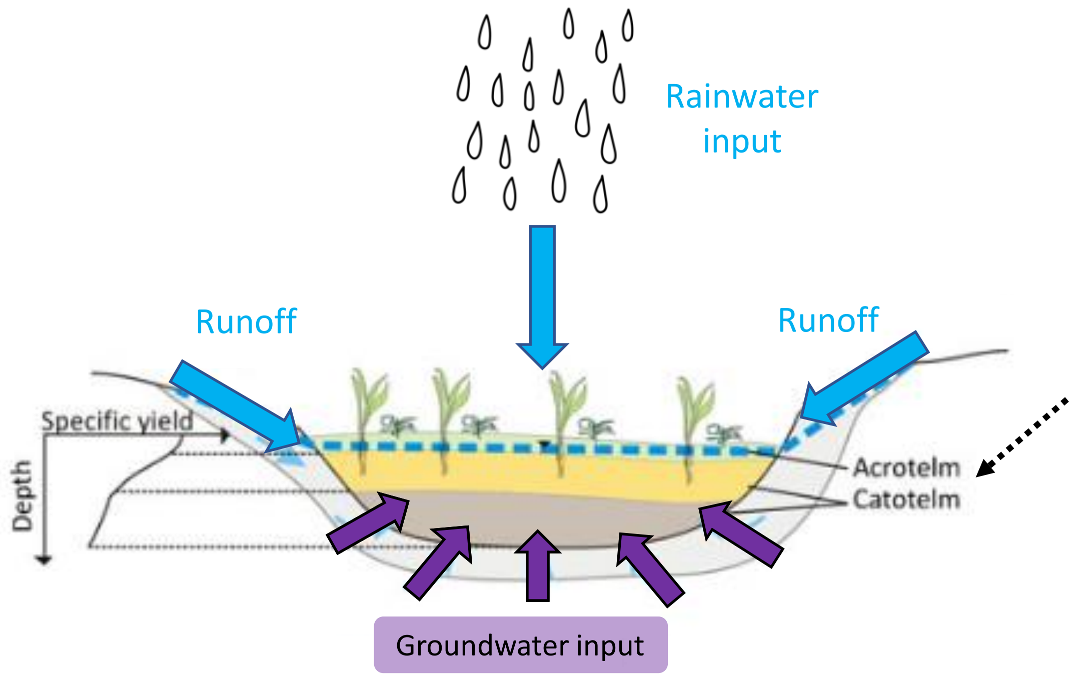
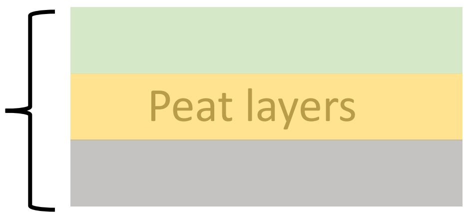
Peatlands: Groundwater-Dependent Ecosystems



Adapted from Bertrand et al., 2012



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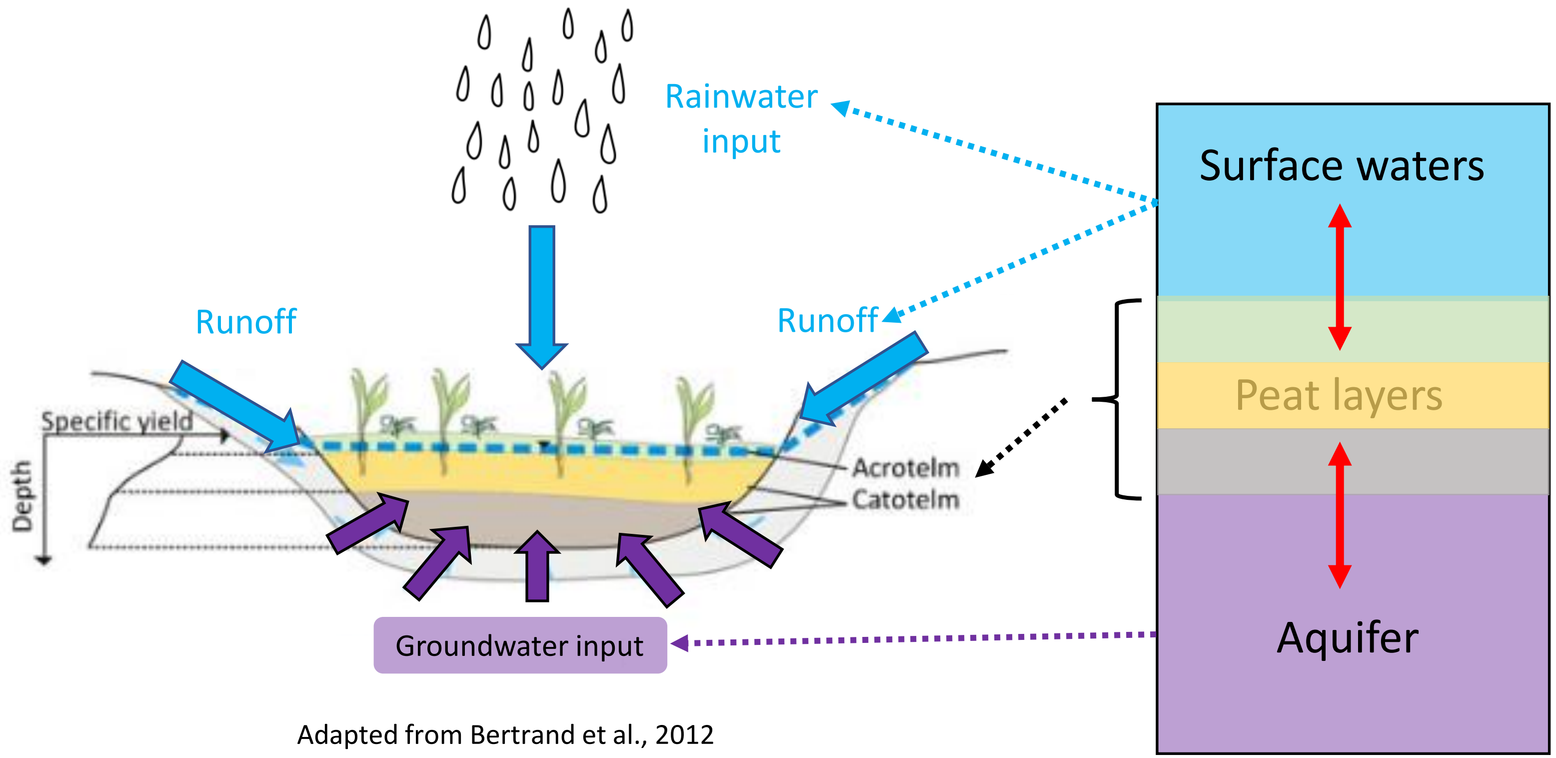

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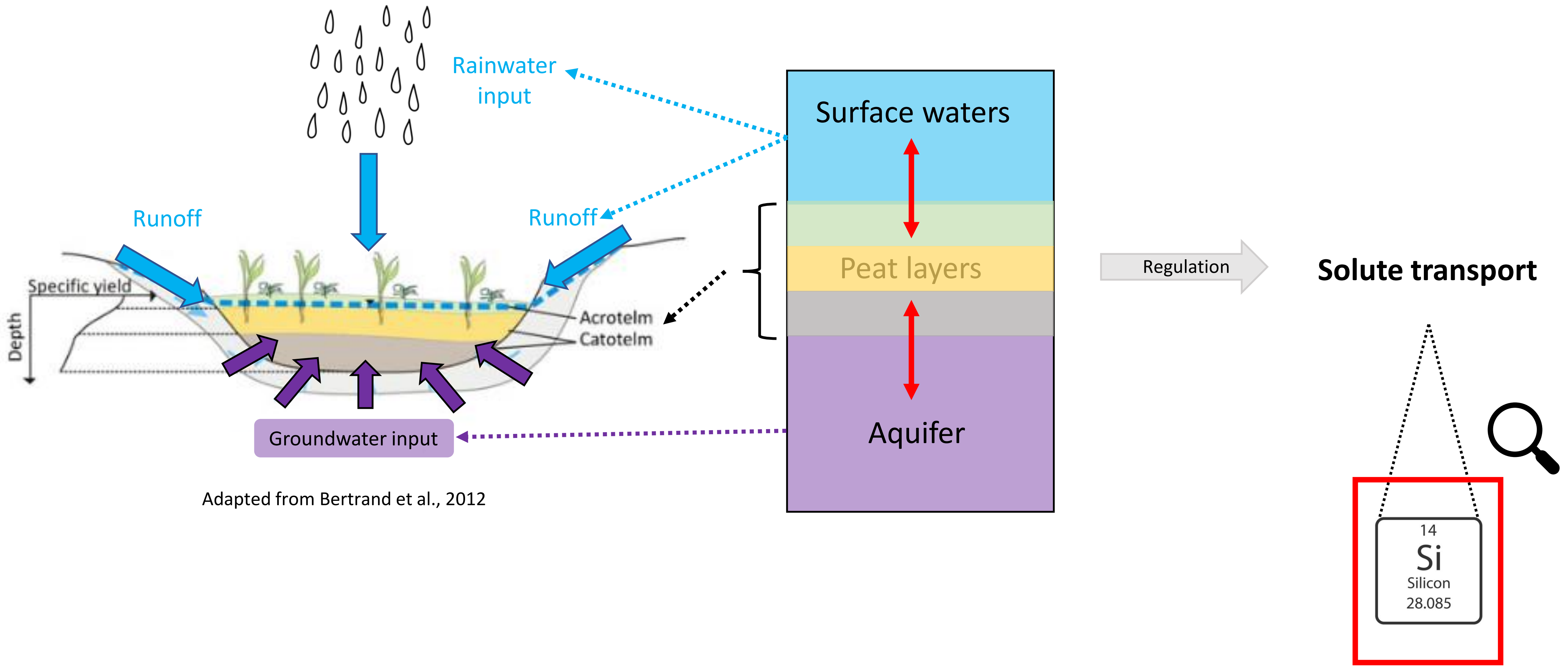

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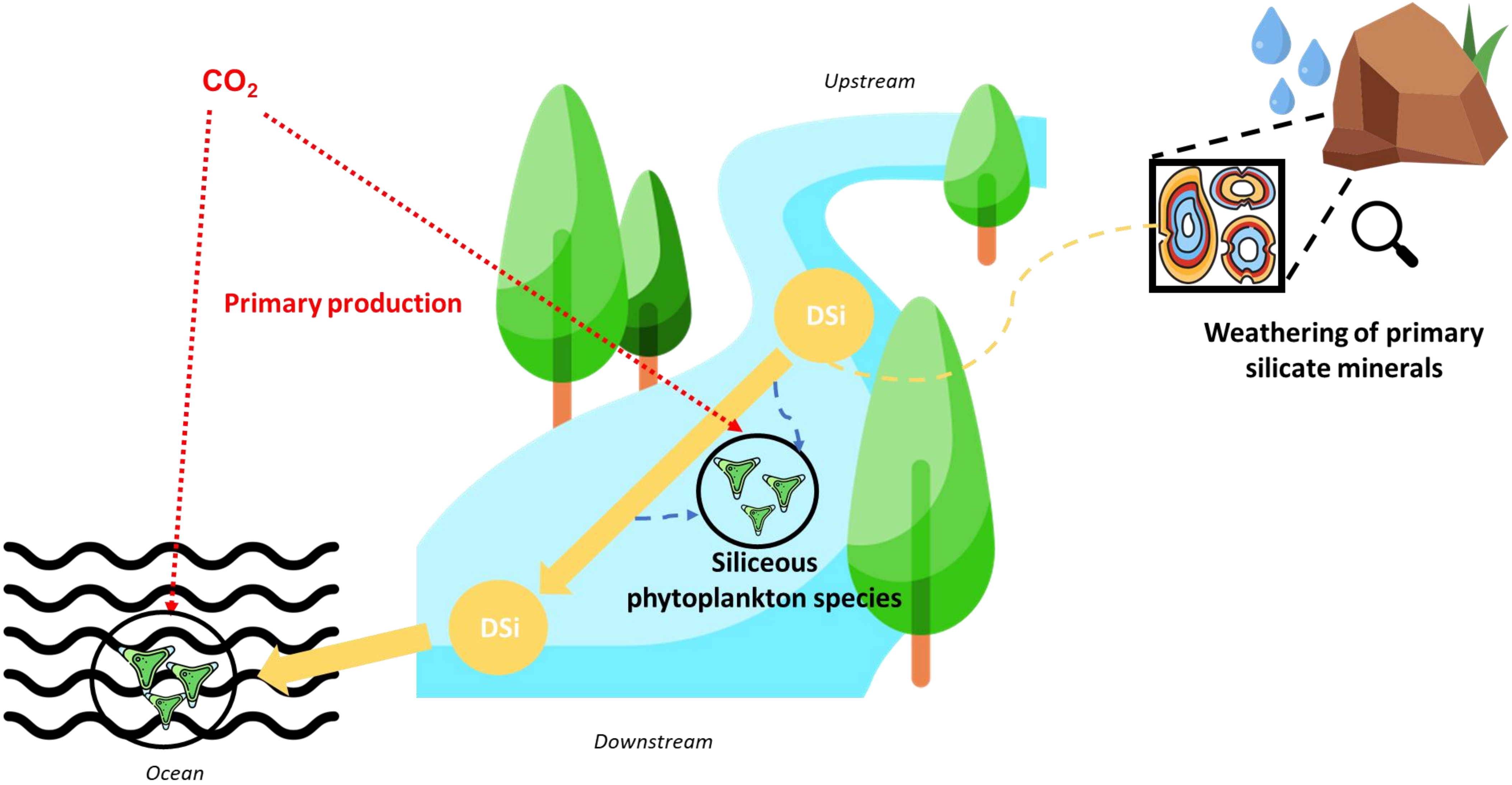
Coupling of the Silicon and Carbon cycles
The importance of quantifying DSi exports



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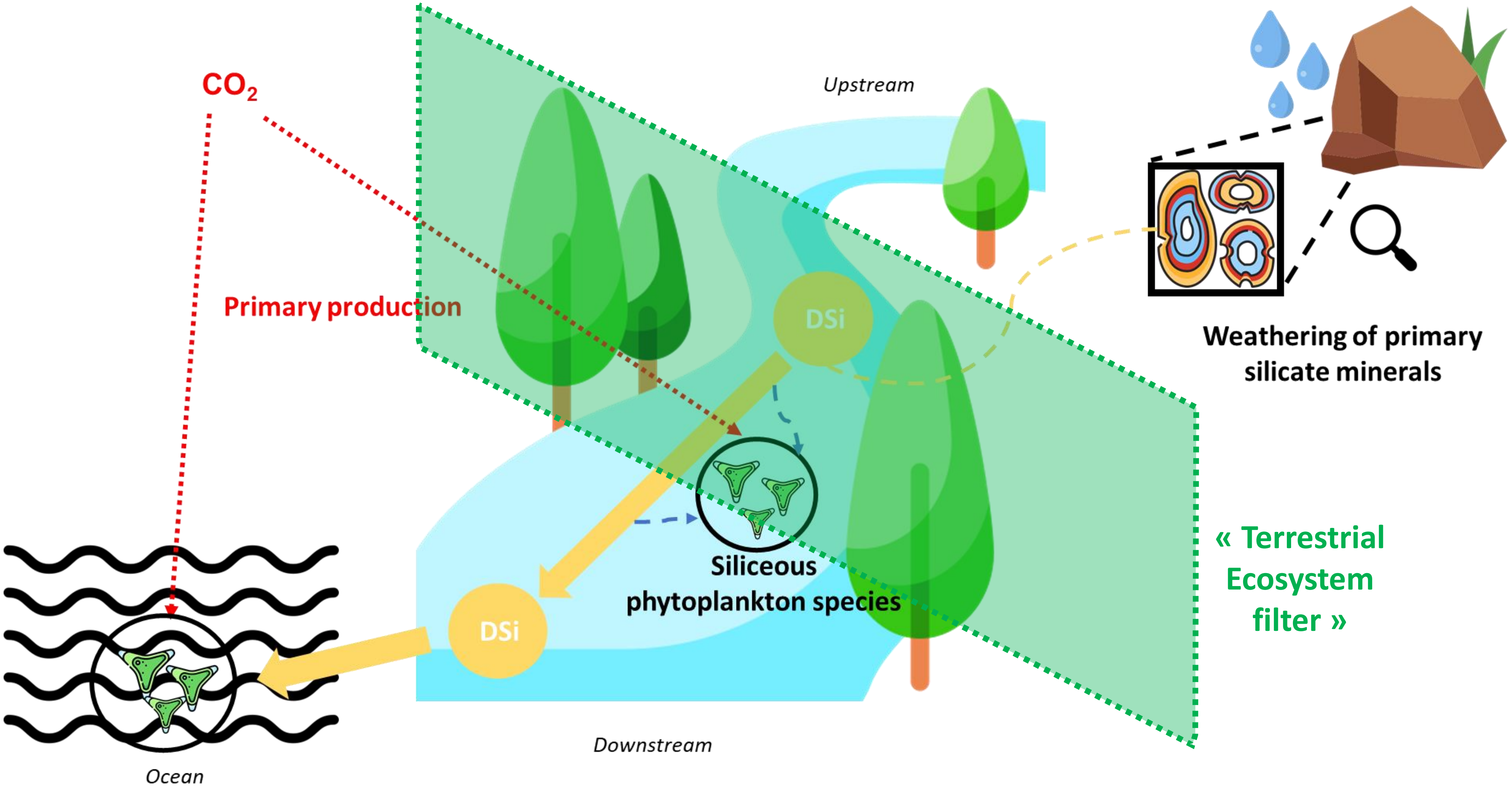

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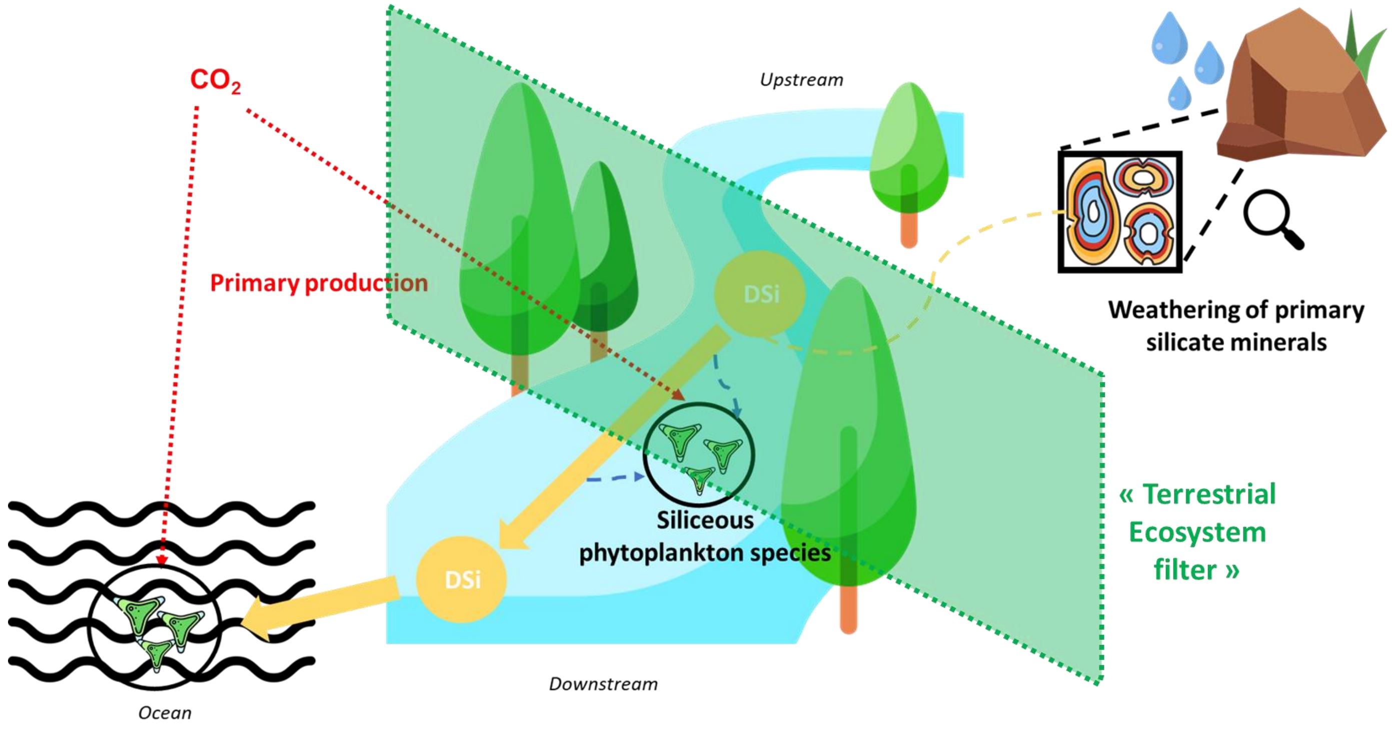

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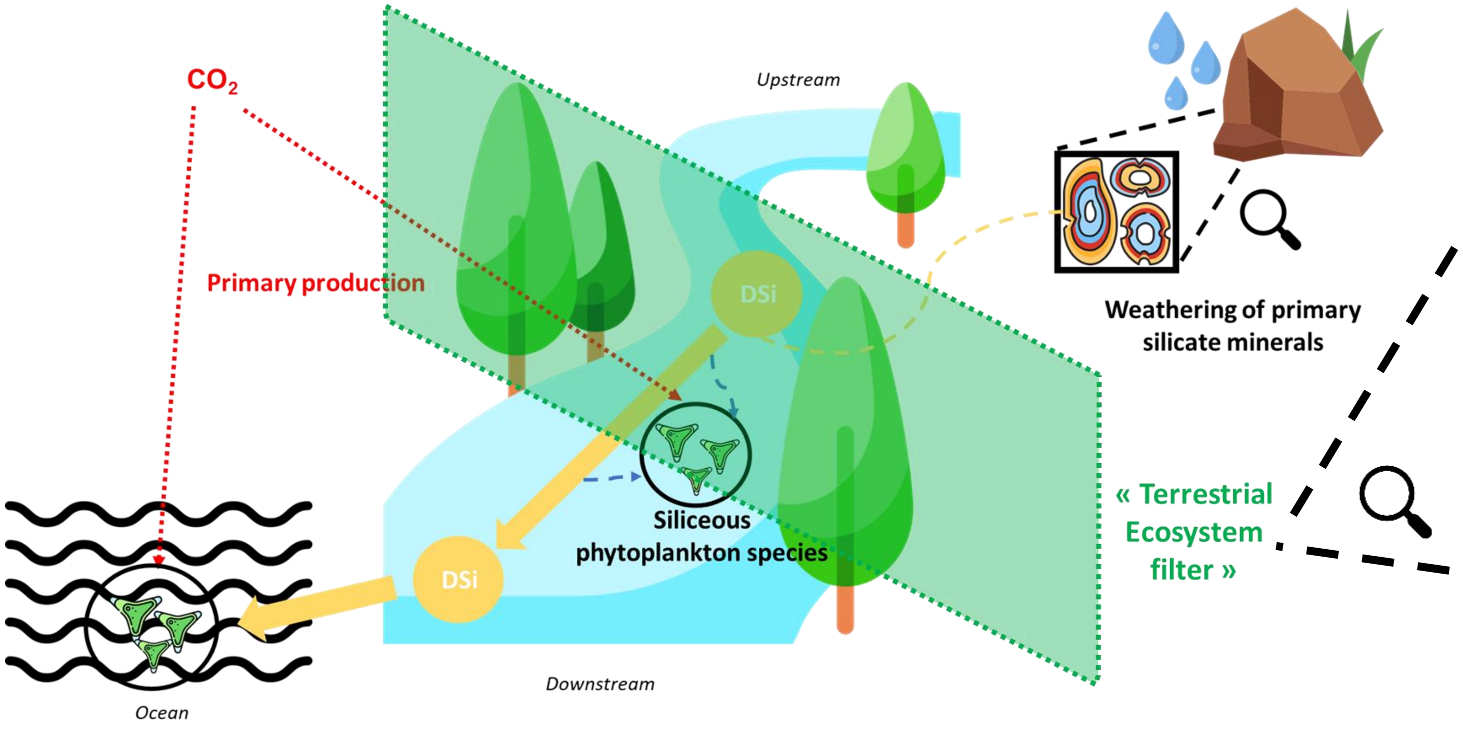

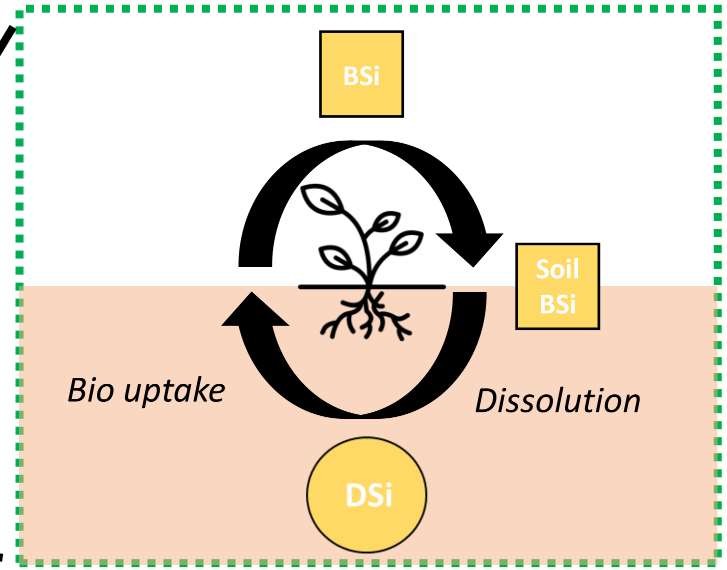

Production
Retention
Dissolution

Coupling of the Silicon and Carbon cycles
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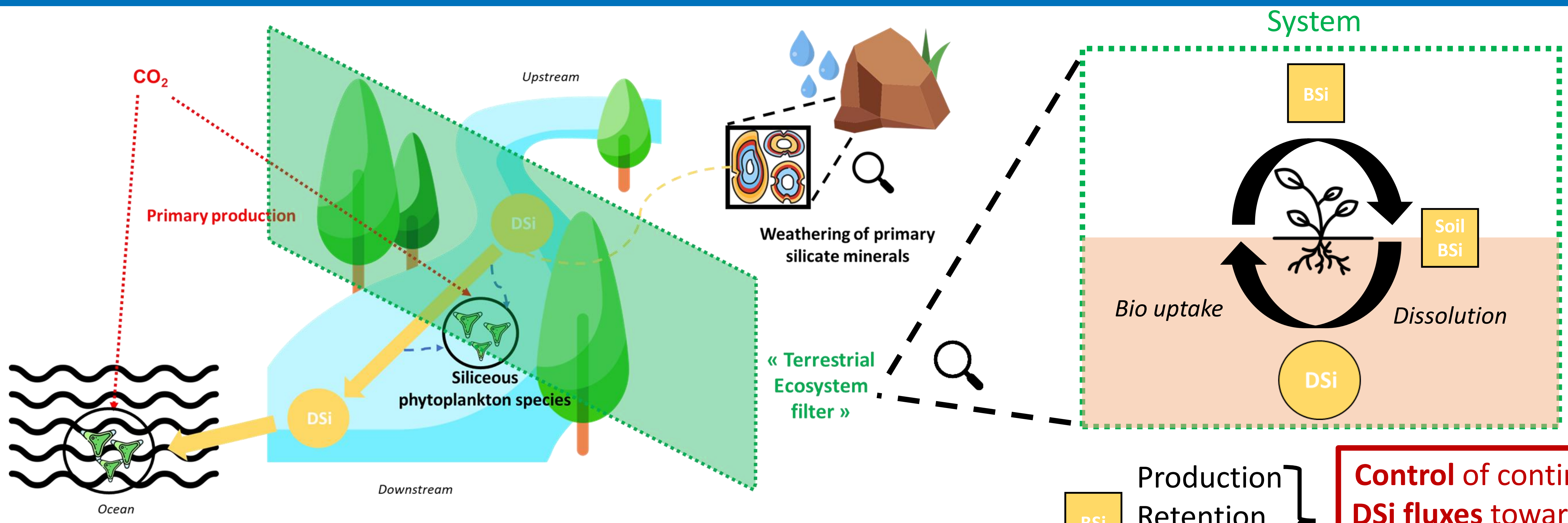
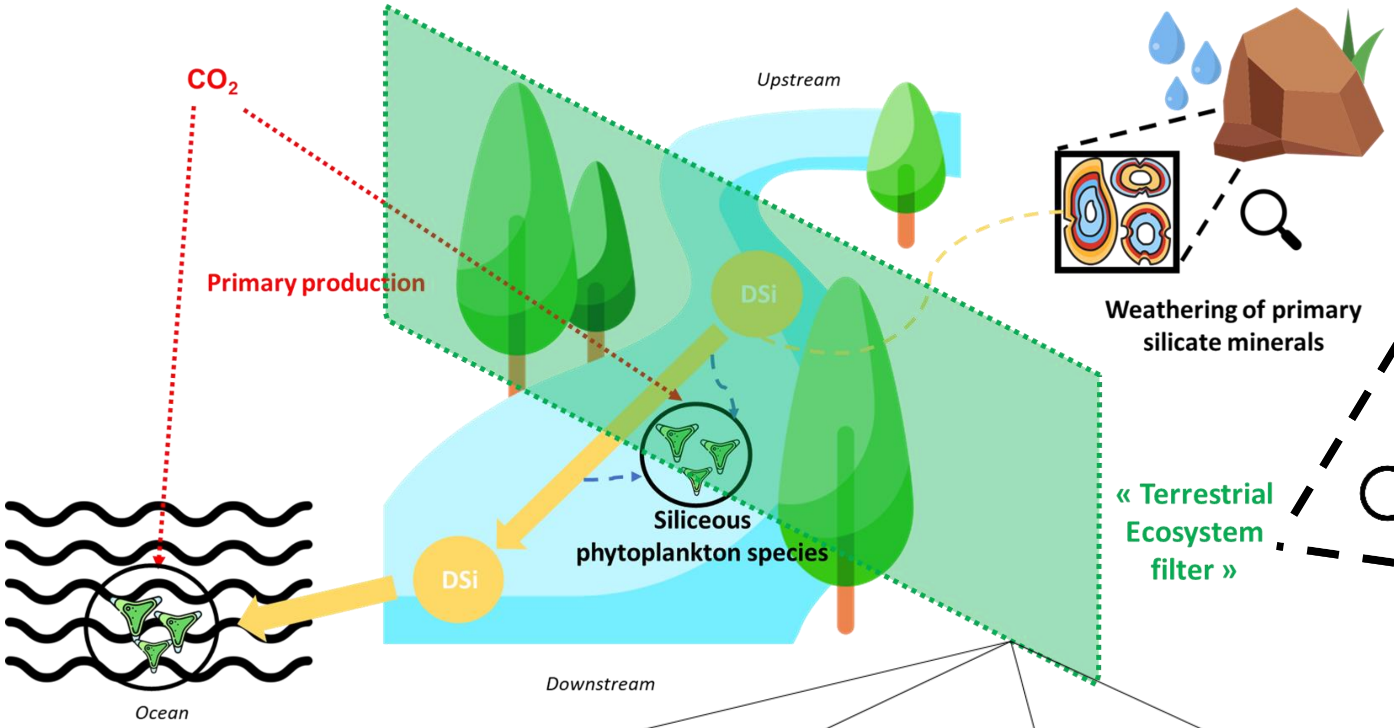


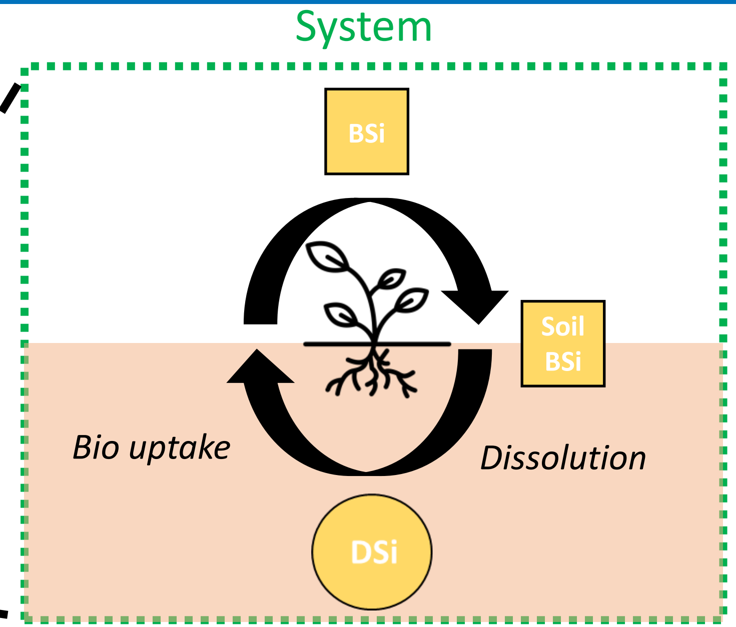
BSi: Production, Retention, Dissolution

Control of continental **DSi fluxes** towards the oceans

Regulation of the C cycle at the **local** and **global** scale

Coupling of the Silicon and Carbon cycles
The importance of quantifying DSi exports





Grasslands	Temperate forests	Equatorial forests	**Wetlands**
✔	✔	✔	**?**
Blecker et al., 2006	Bartoli et al., 1983	Alexandre et al., 1997	

BSi: Production, Retention, Dissolution → **Control** of continental **DSi fluxes** towards the oceans

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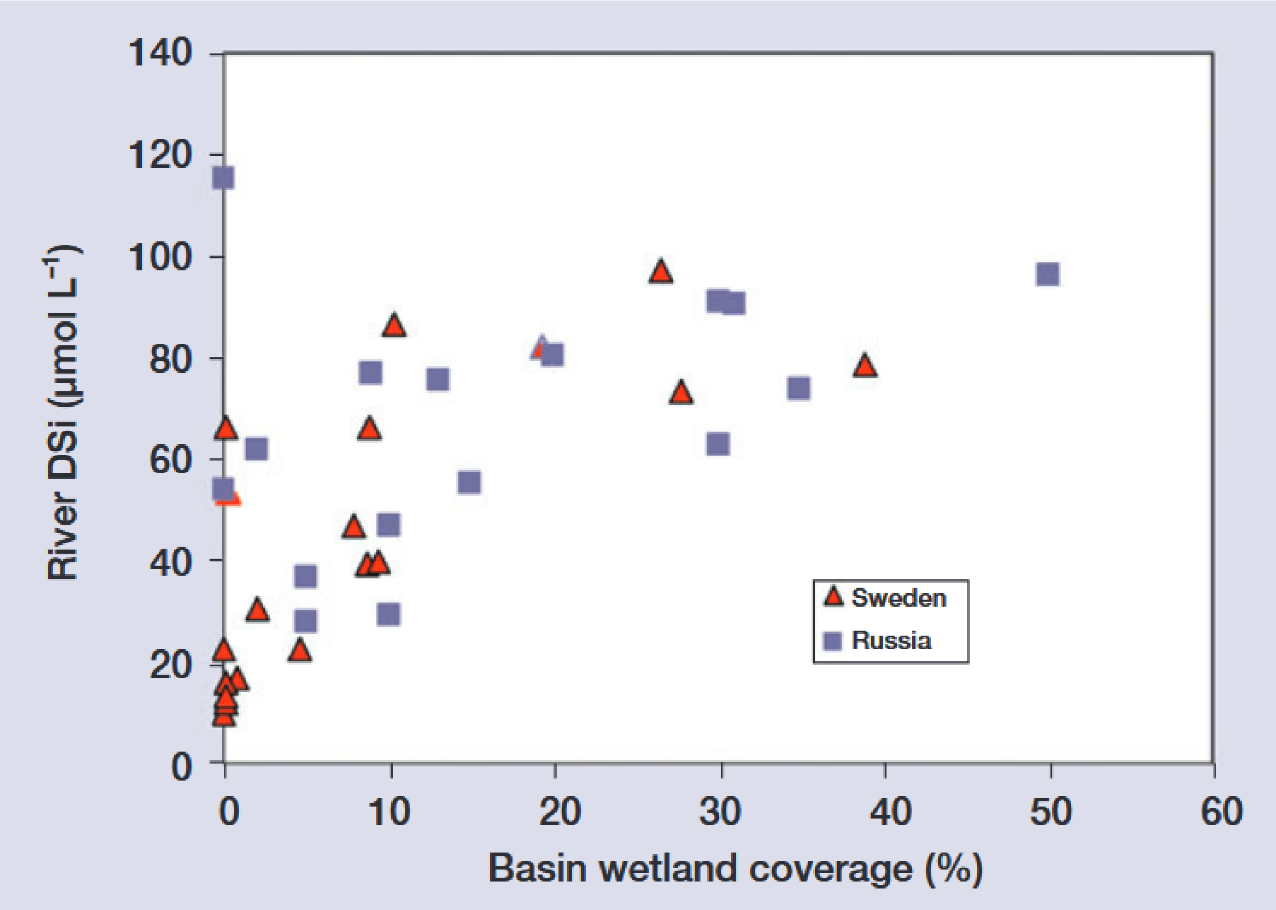
Wetlands: Key Actors in DSi exports



Struyf & Conley, 2009

The greater the wetland coverage in the basin, the higher the DSi exports

Understanding **local** peatland hydrology is essential to assess the role of peatlands as filters controlling **continental** Si exports

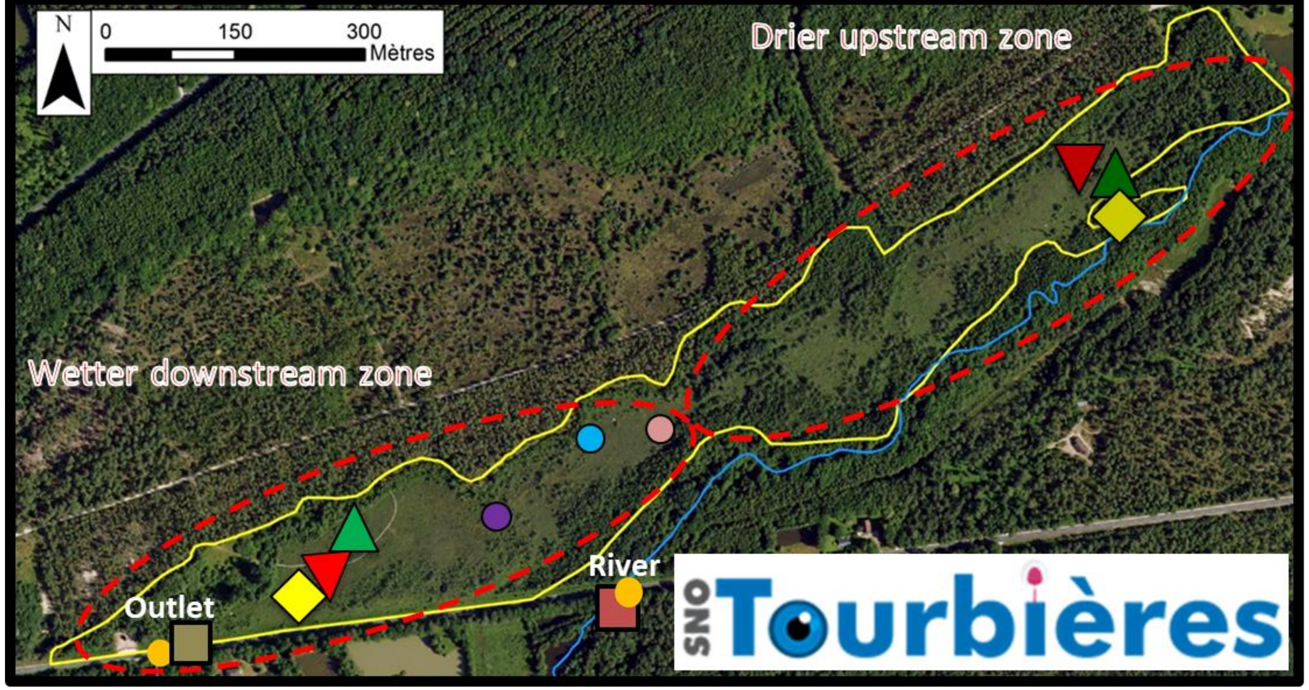
How does peatland hydrology shape the dissolved silicon dynamics within a temperate peatland system ?

What is the relative contribution of local and regional hydrological controls to the functioning of a temperate lowland peatland ?

Materials and Methods

La Guette Peatland

- **Climate:** sub-oceanic (degraded oceanic) climate characteristic of the central and northern plains
- **Lithology:** Sandy clays
- **Vegetation:** Molinia caerulea, Ericaceous shrubs, Sphagnum spp
- **pH**≈4.5
- **Mean/Max peat depth:** 0.80 m/1.80m



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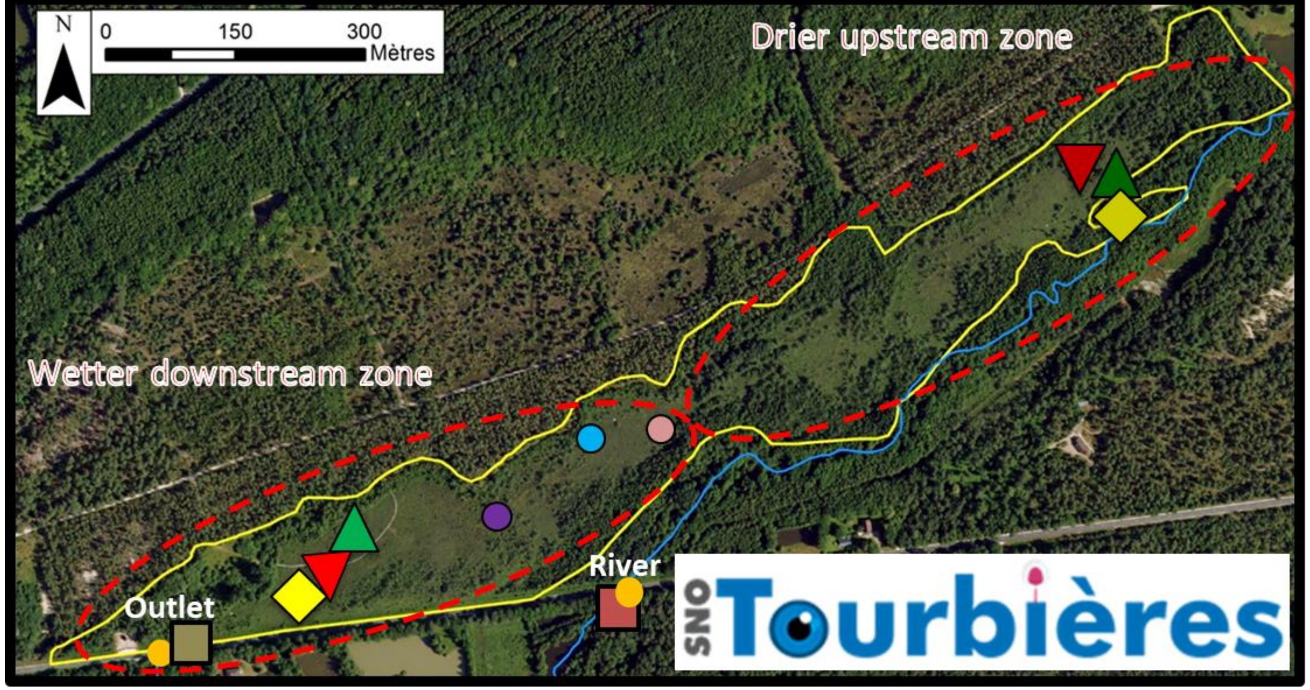

- **Monitoring Period:**

Hydrochemistry

Cations: since 2014

DSi: since 2021

$\delta^{30}Si$: since March 2025

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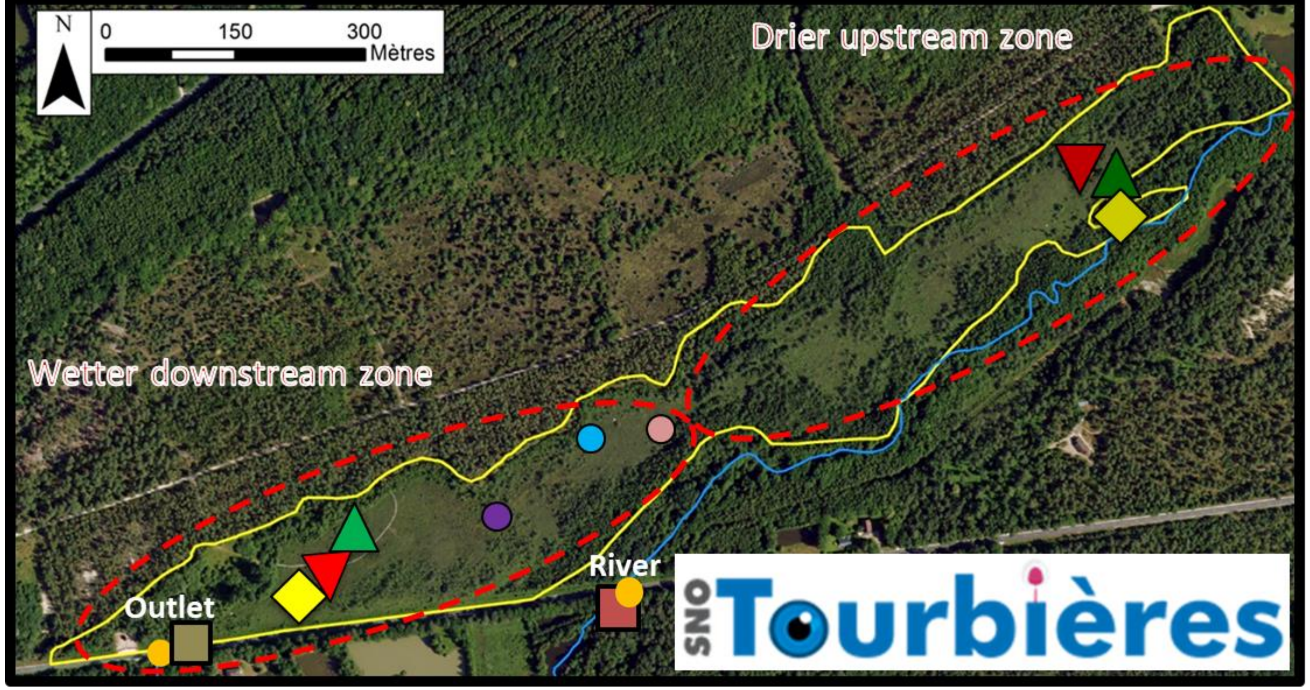

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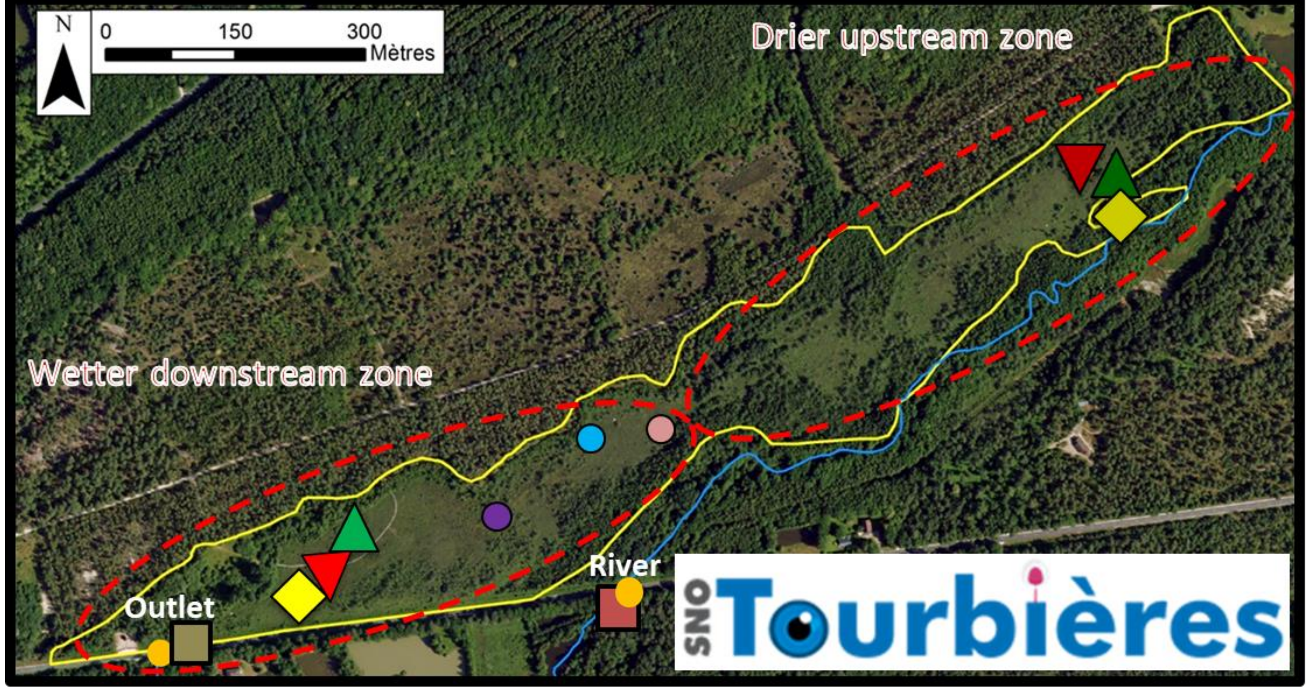

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Discharge (Q): since 2011

- **Sampling Frequency:** monthly

- **Number of Sampling Stations:** 8

Upstream
Downstream

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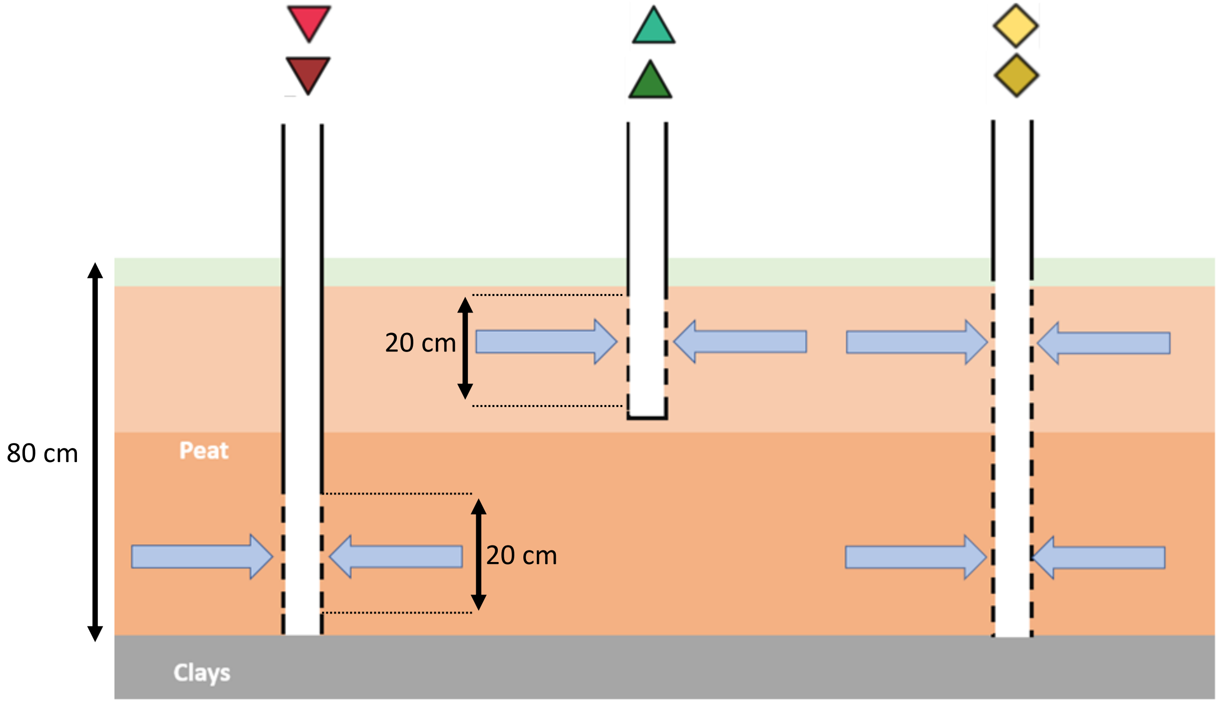
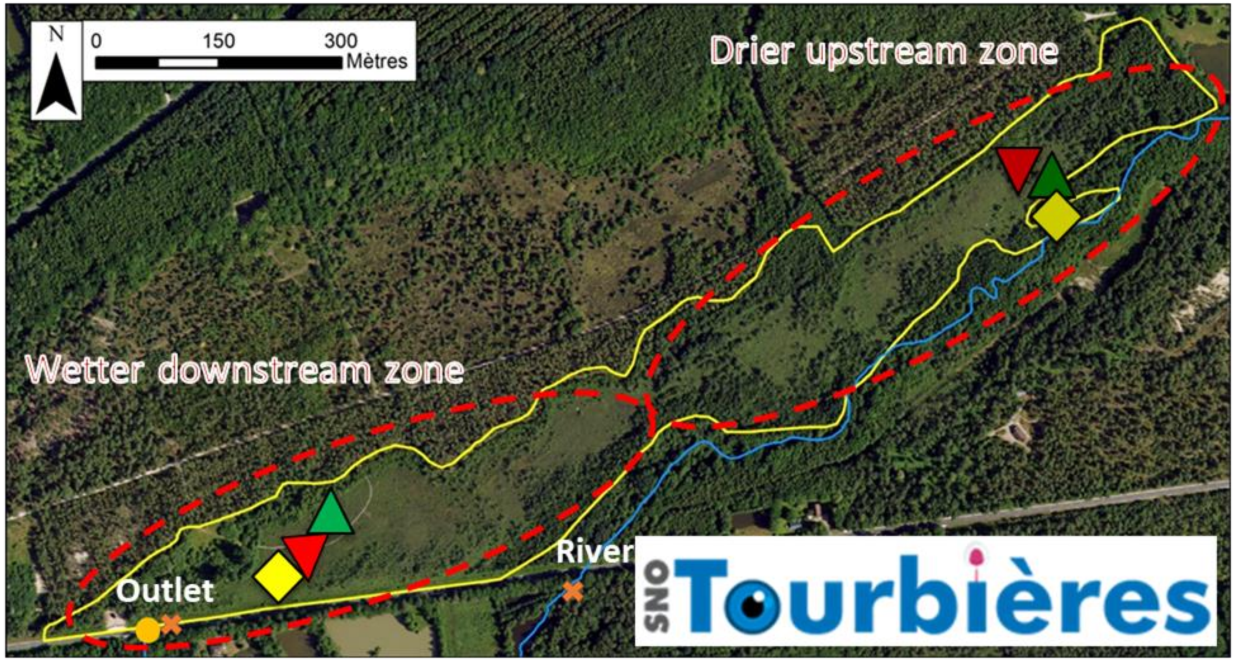
Decoupling Surface and Deep Peat Layer Processes



Set up in January 2025



JUNON

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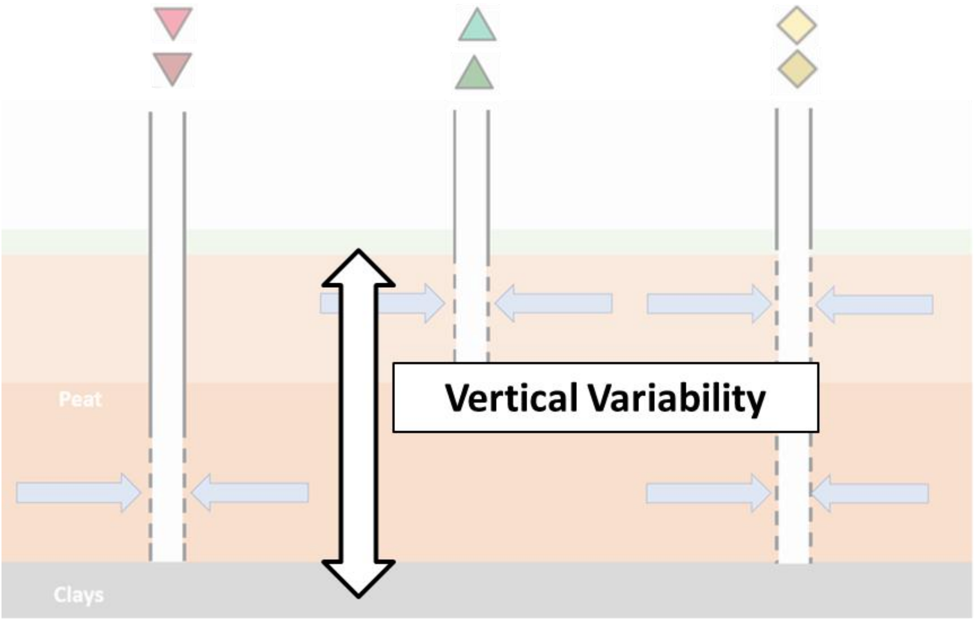

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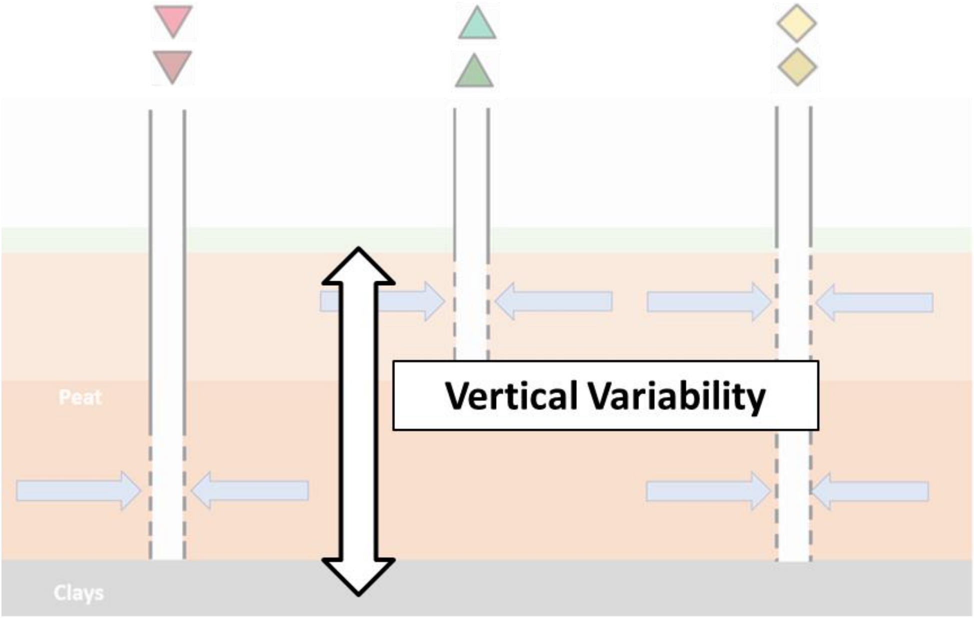

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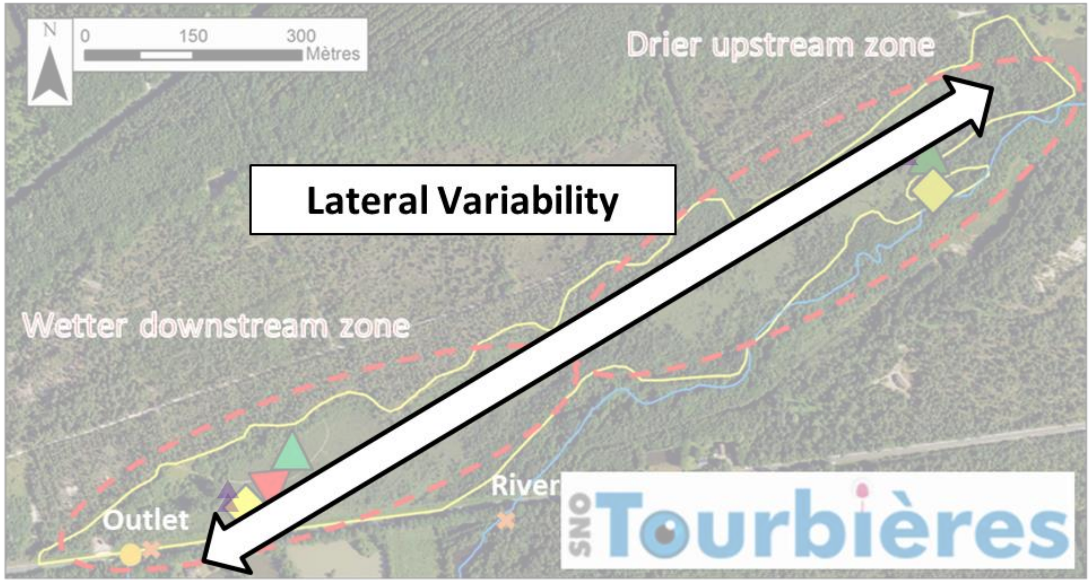

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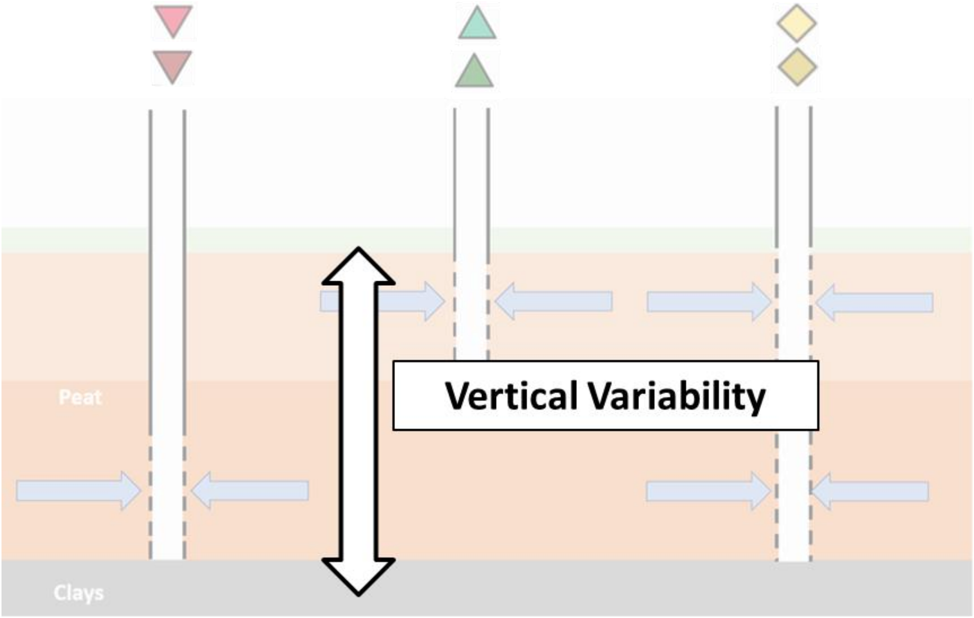

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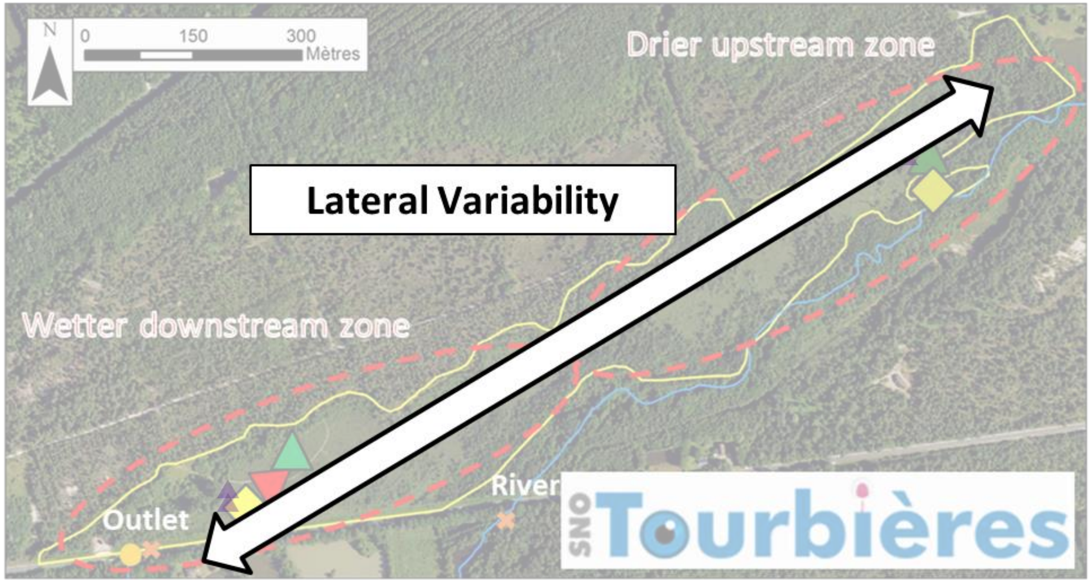
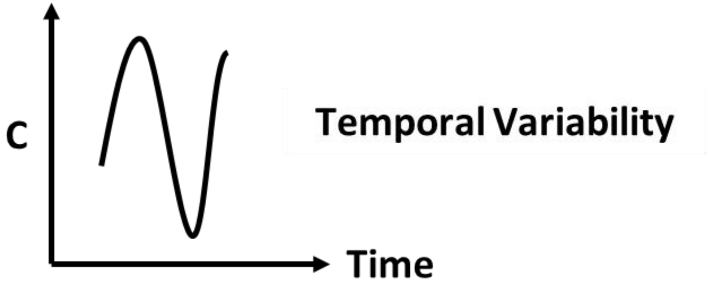
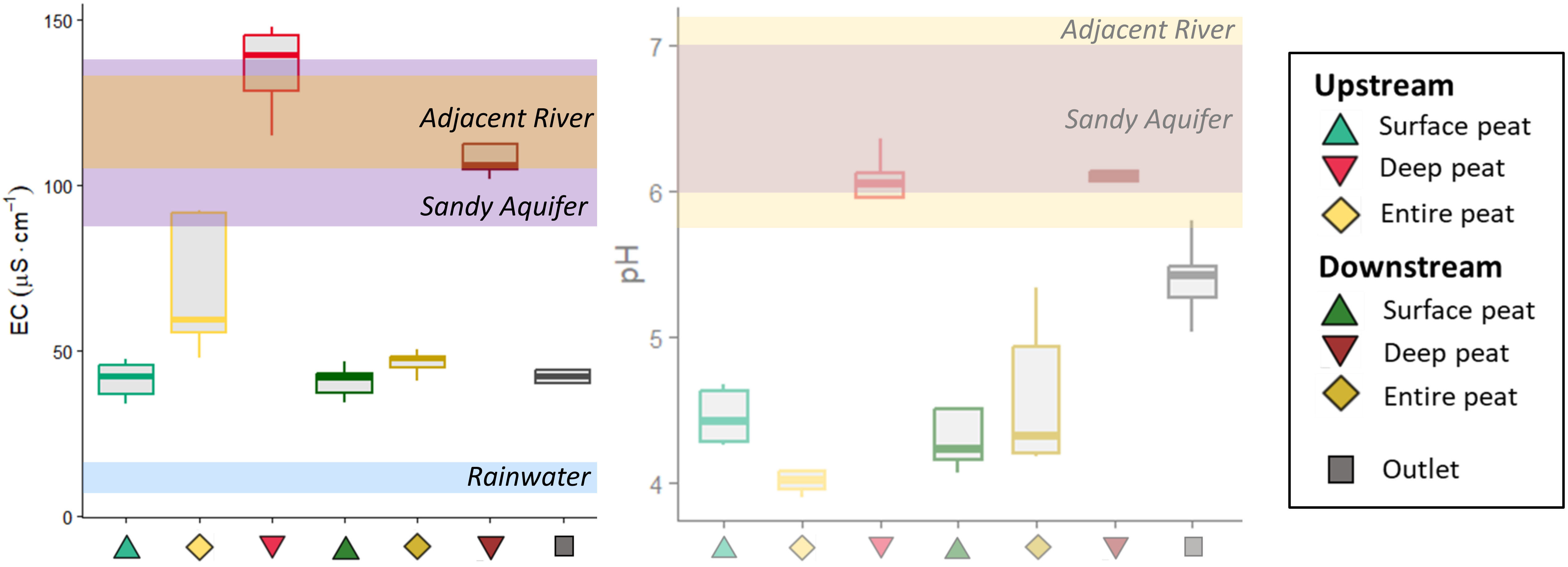




Qualitative Discrimination of Solute Sources
Conductivity & pH Signatures



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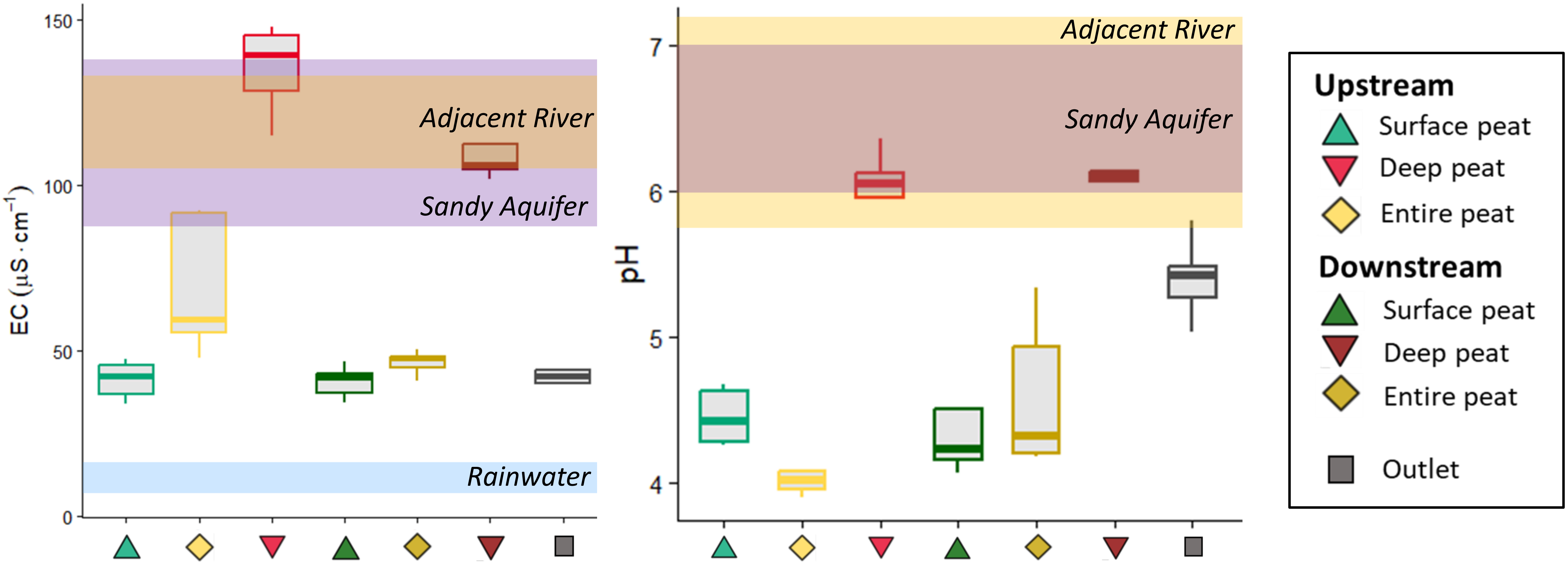
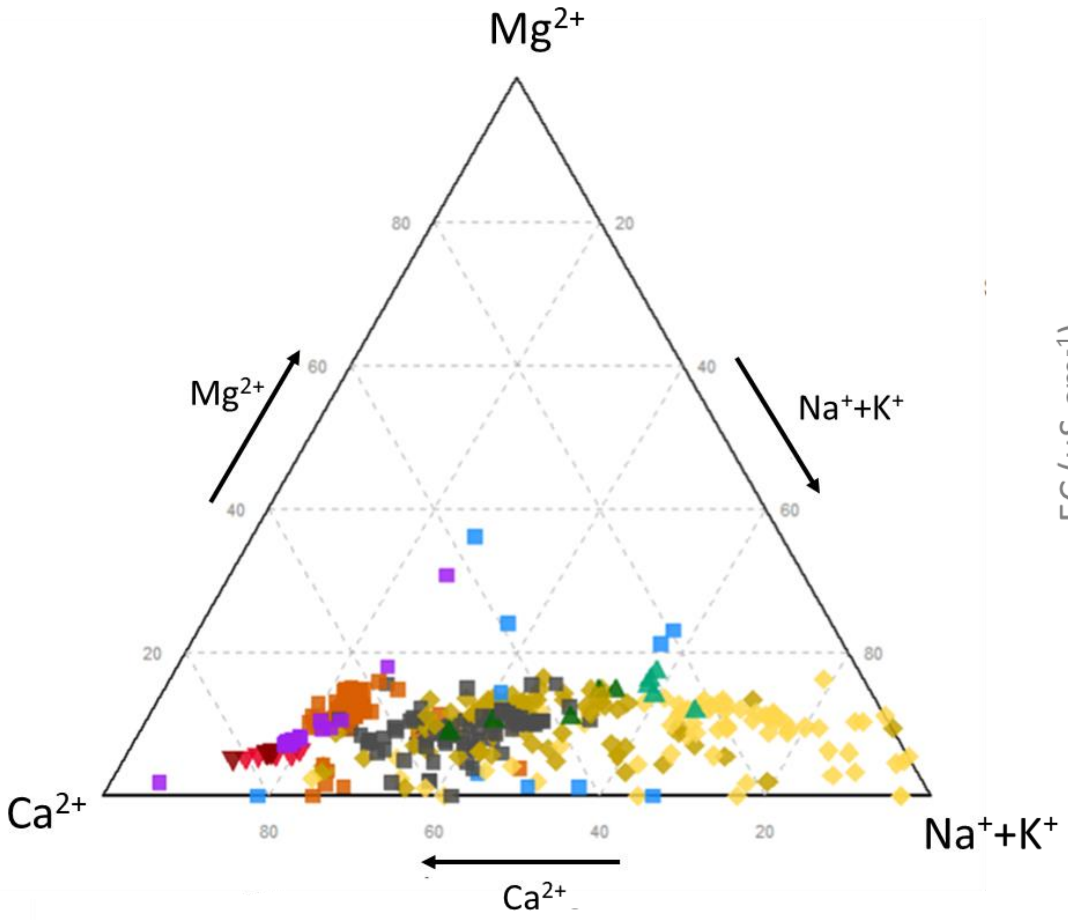
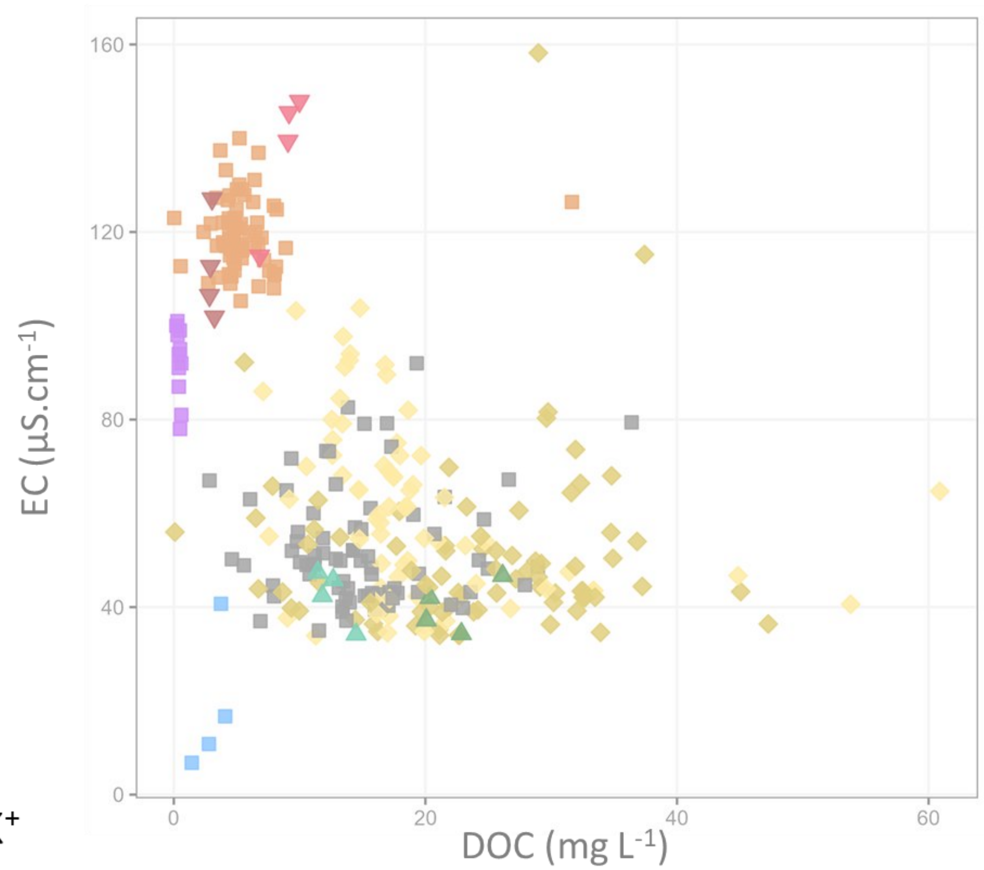
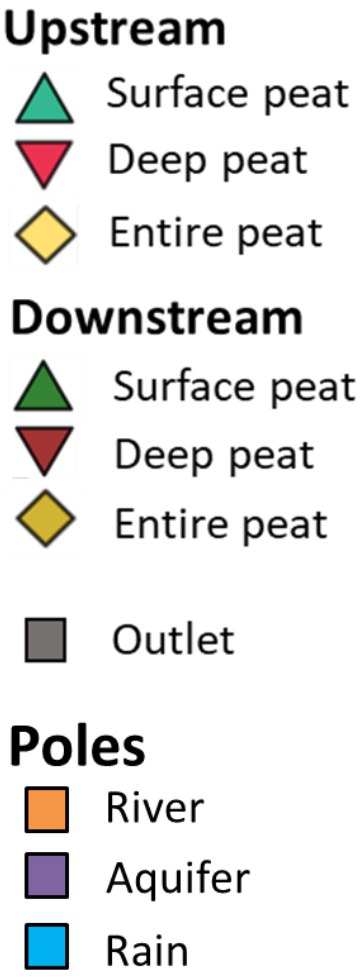


Qualitative Discrimination of Solute Sources
Piper & EC vs DOC Diagrams







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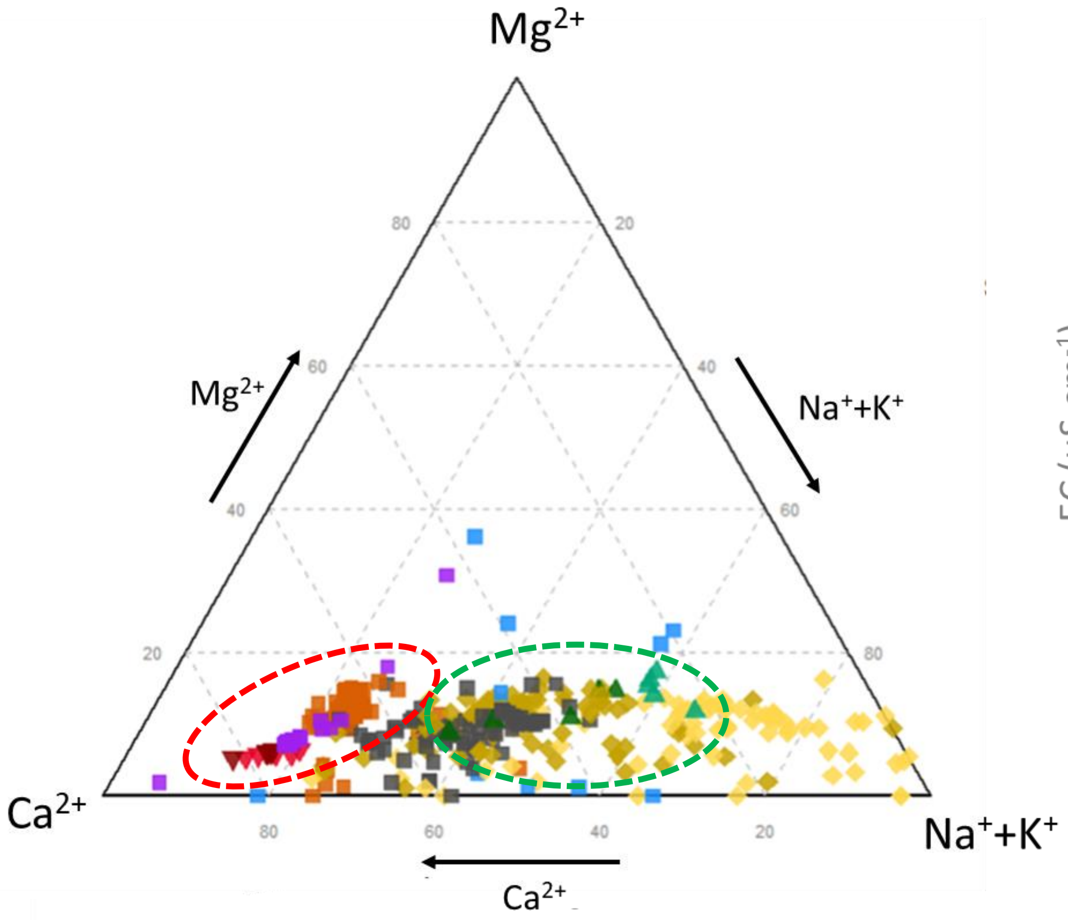

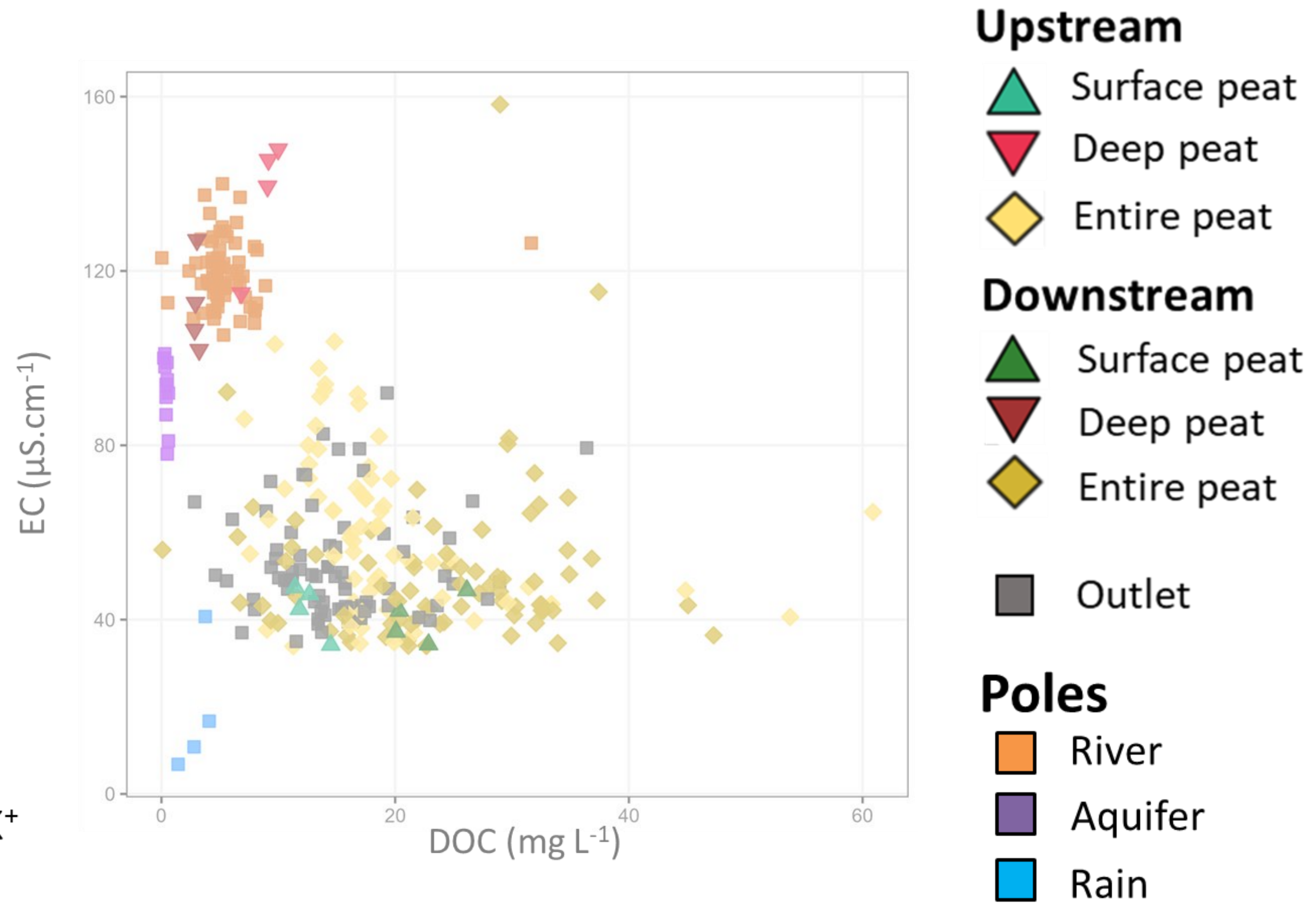

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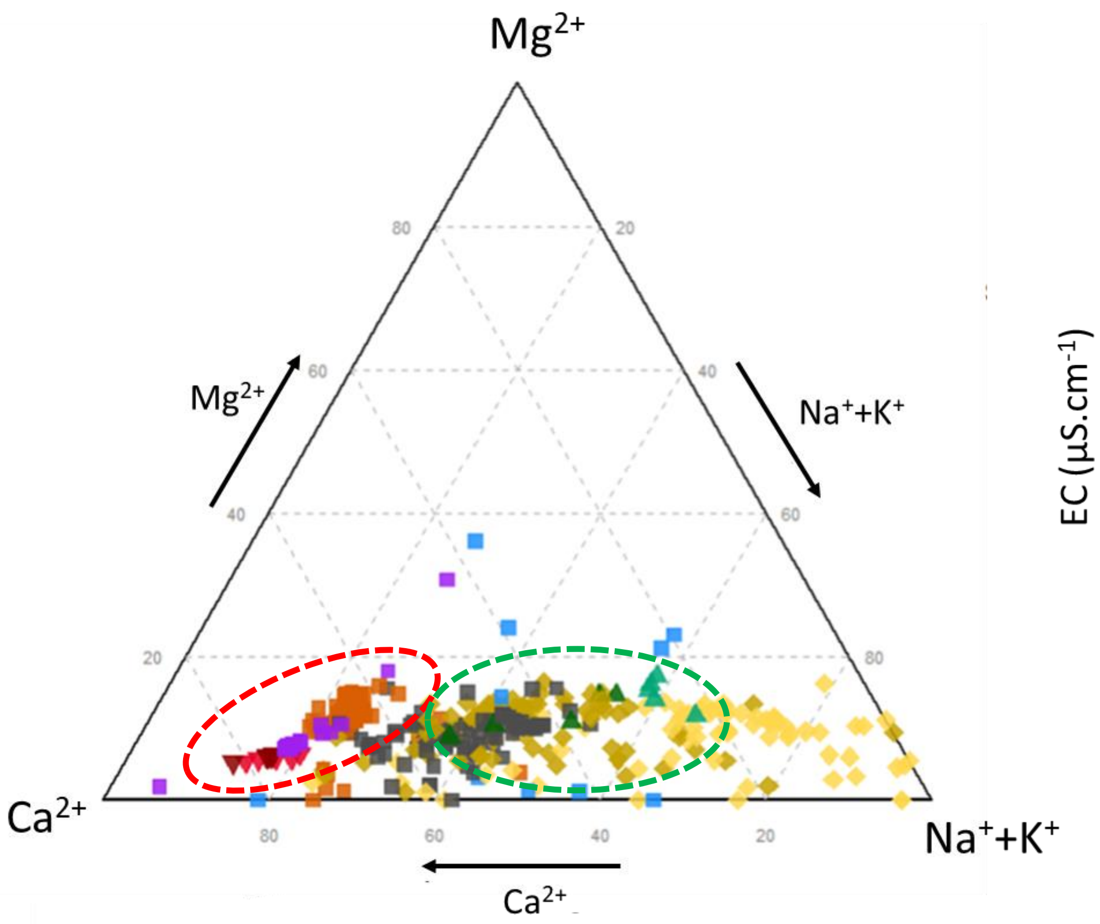

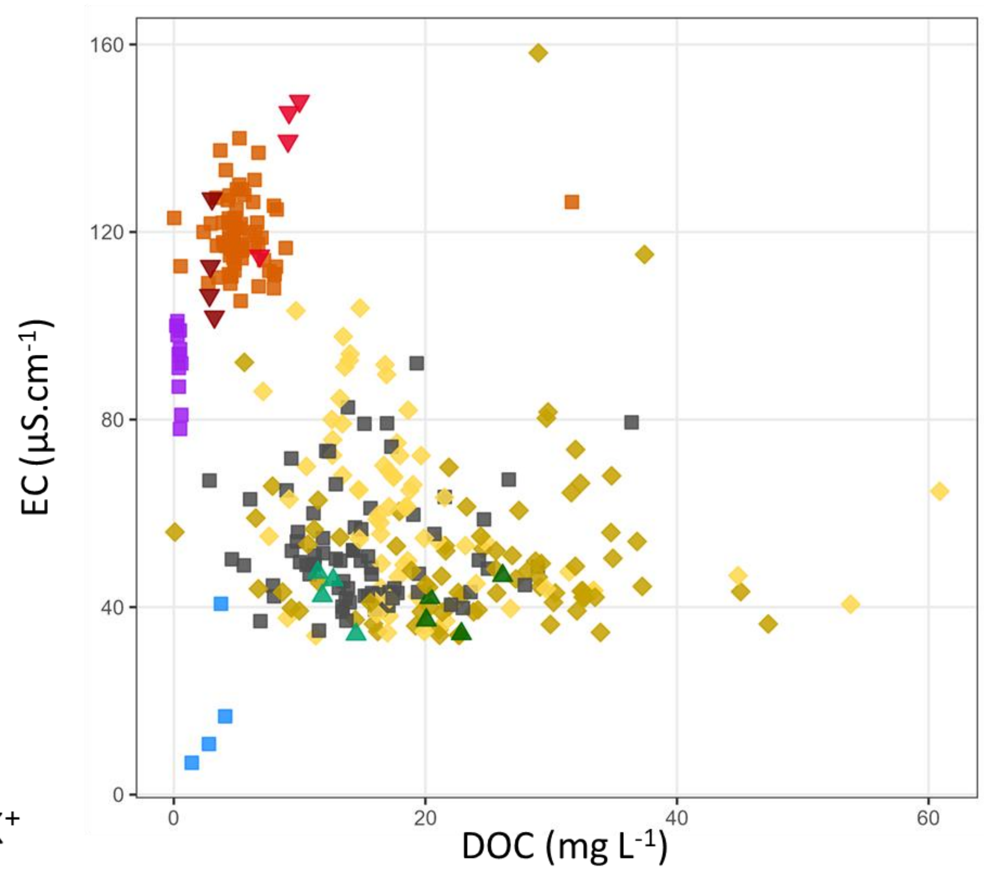

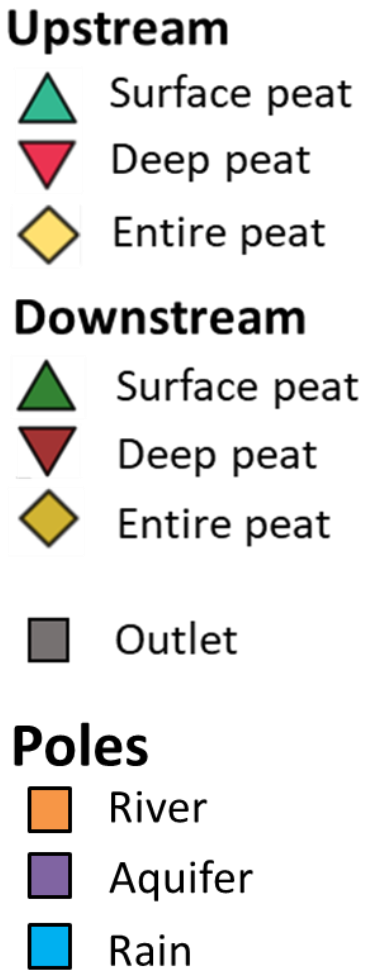

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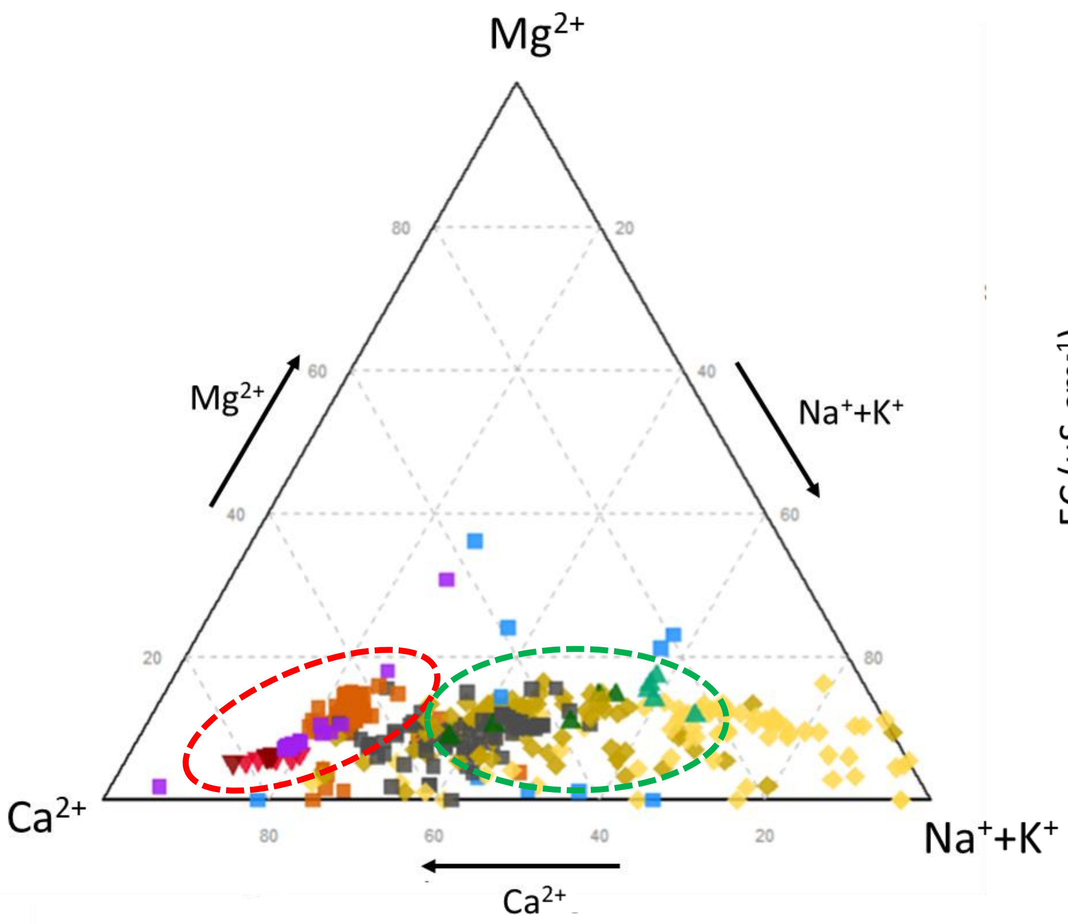
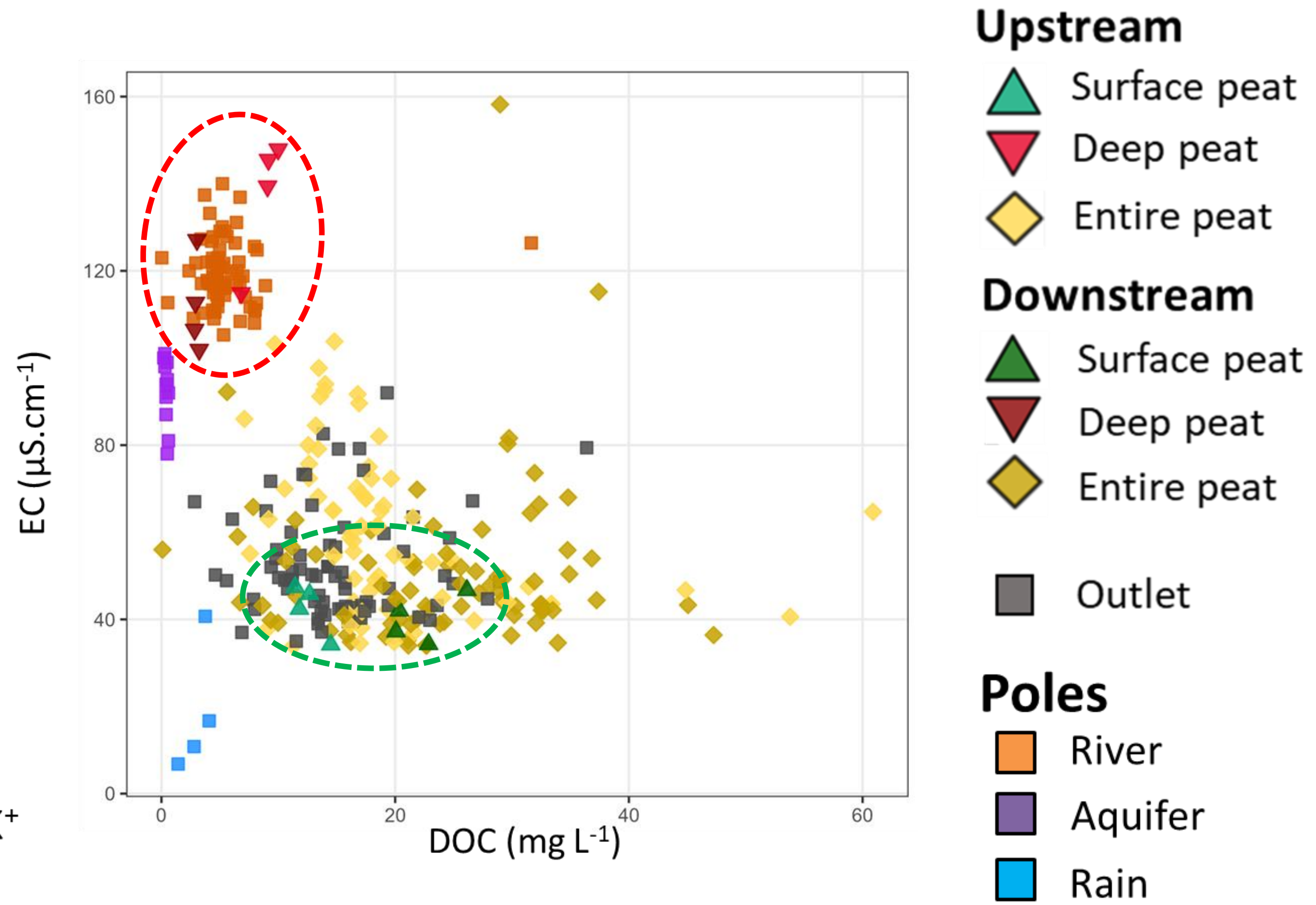
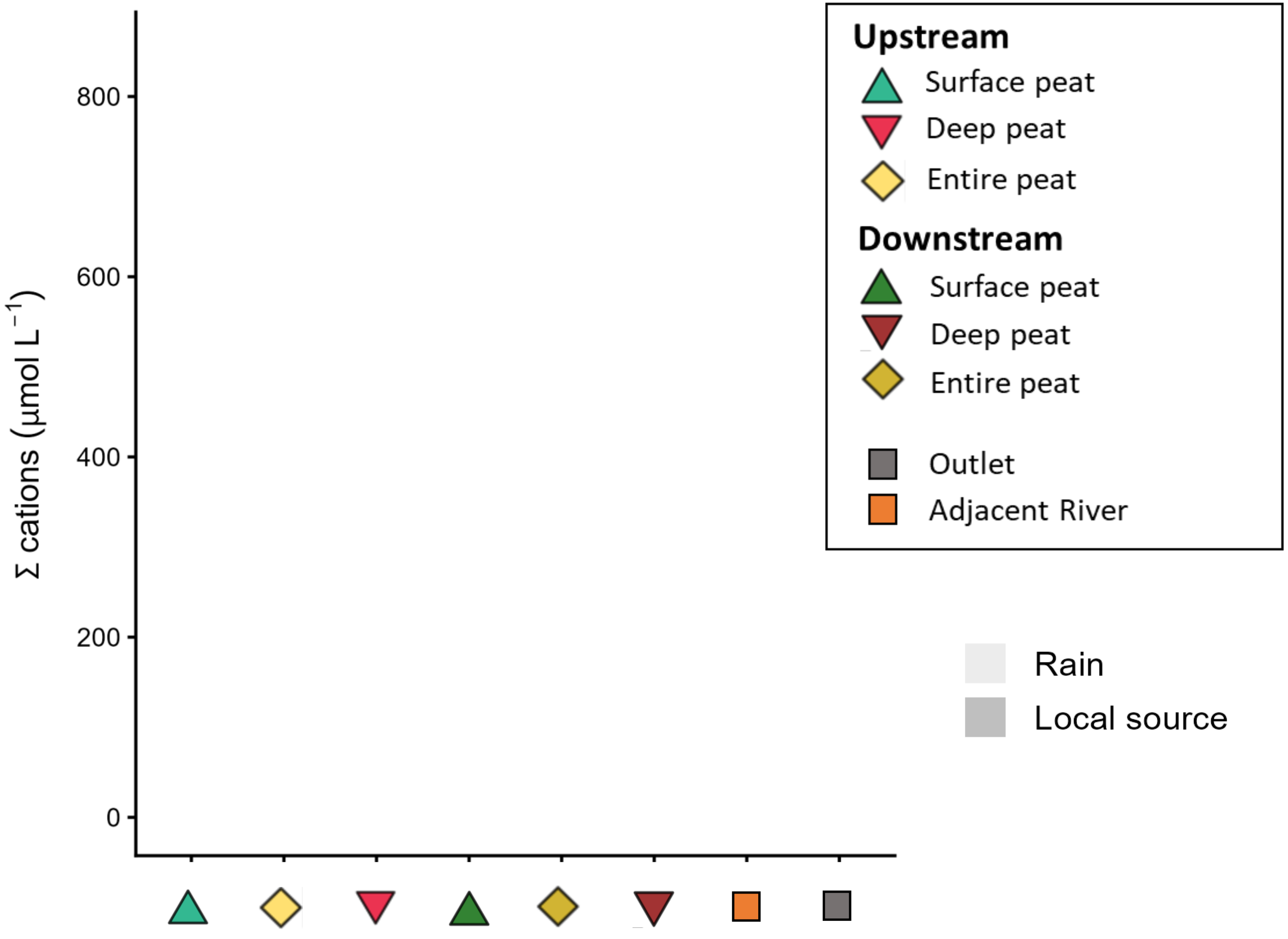




Quantitative Discrimination of Solute Sources
The “Forward Method” (Stallard et al., 1980)



Correction from atmospheric inputs

$$[X^*] = [X_{sample}] - [Cl^-]_{sample} \left(\frac{[X]_{rainwater}}{[Cl]_{rainwater}}\right)$$

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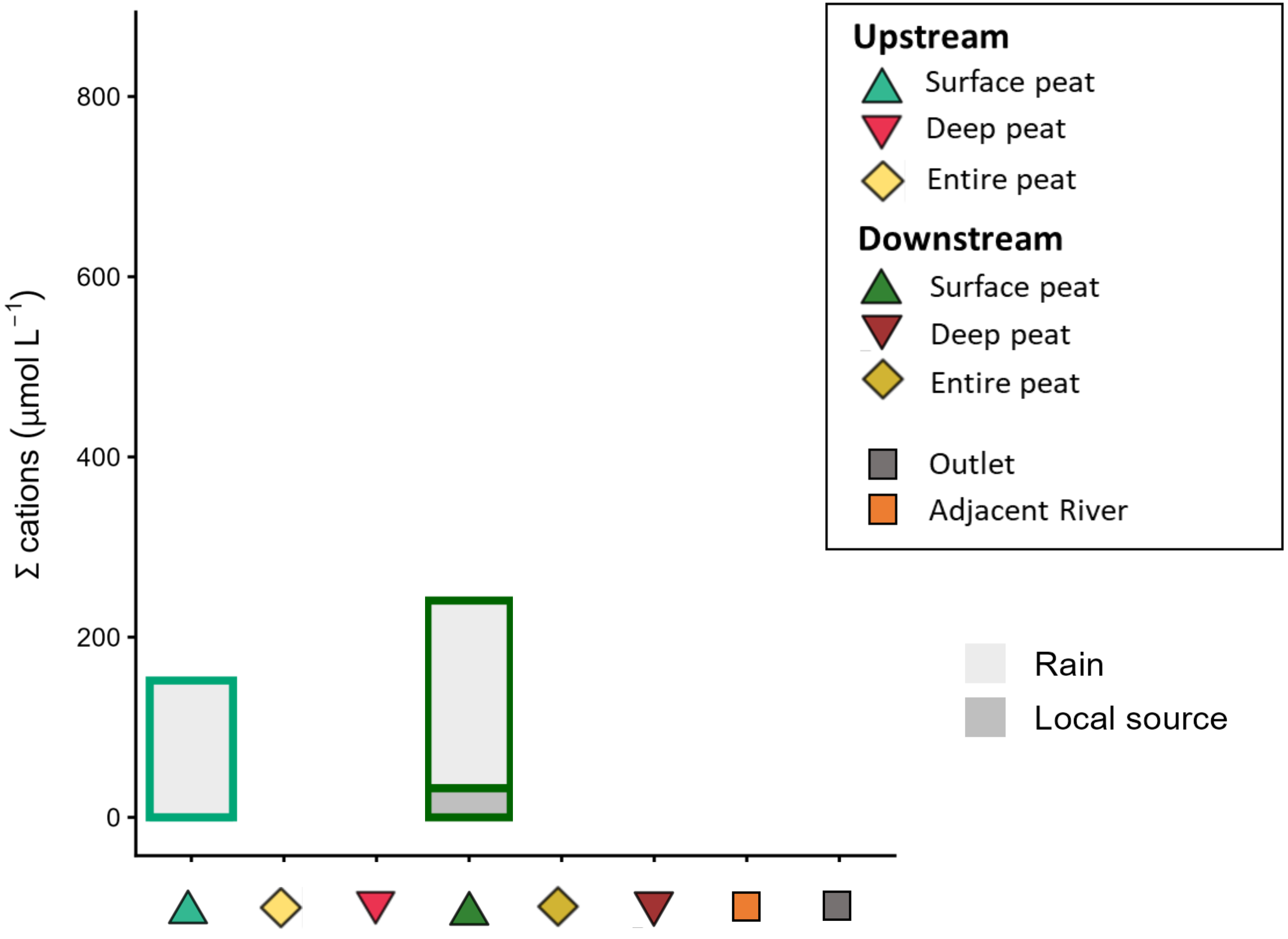

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Peat layer	Rainwater contribution	Local source contribution
Surface	94%	6%

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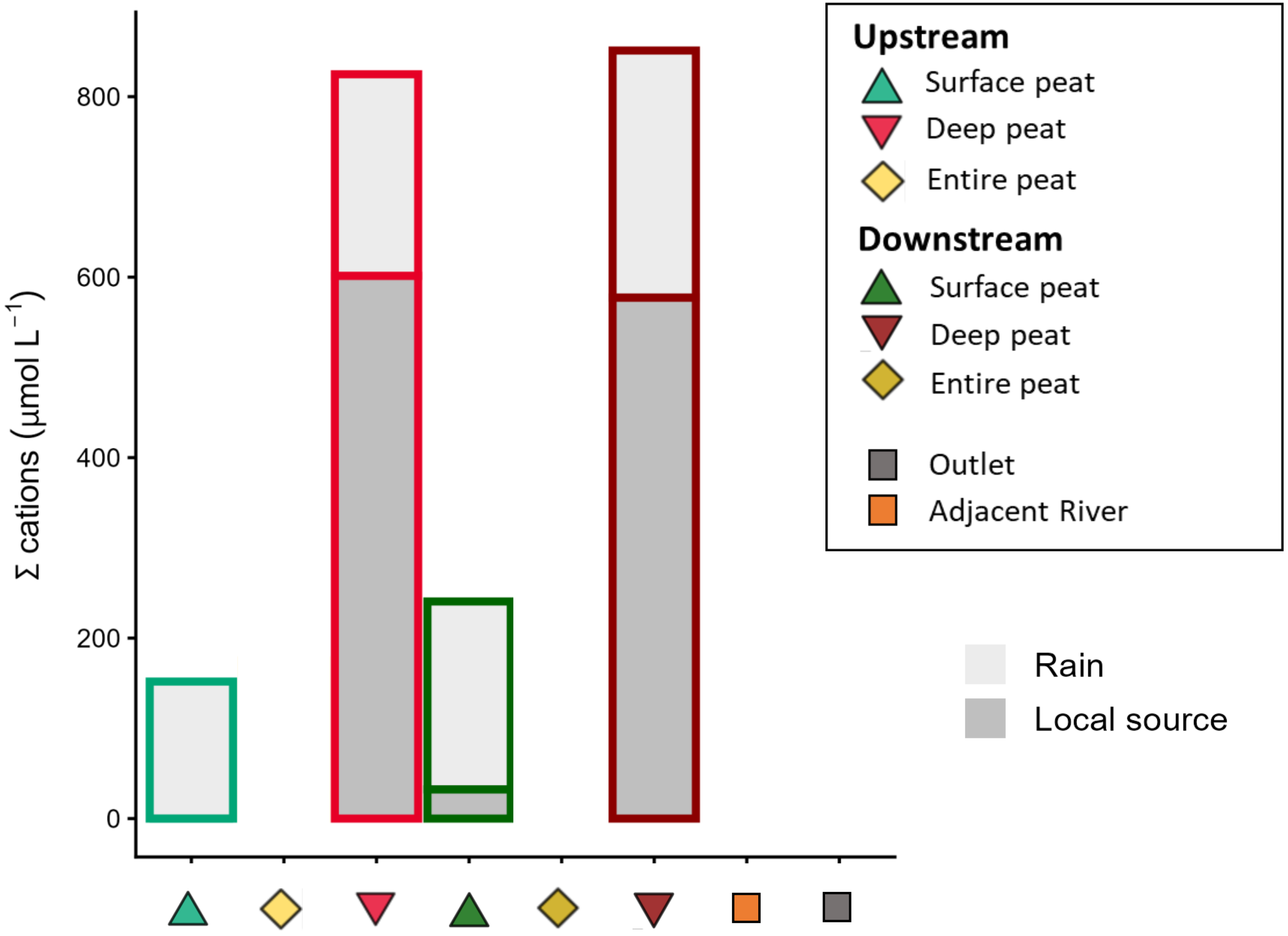

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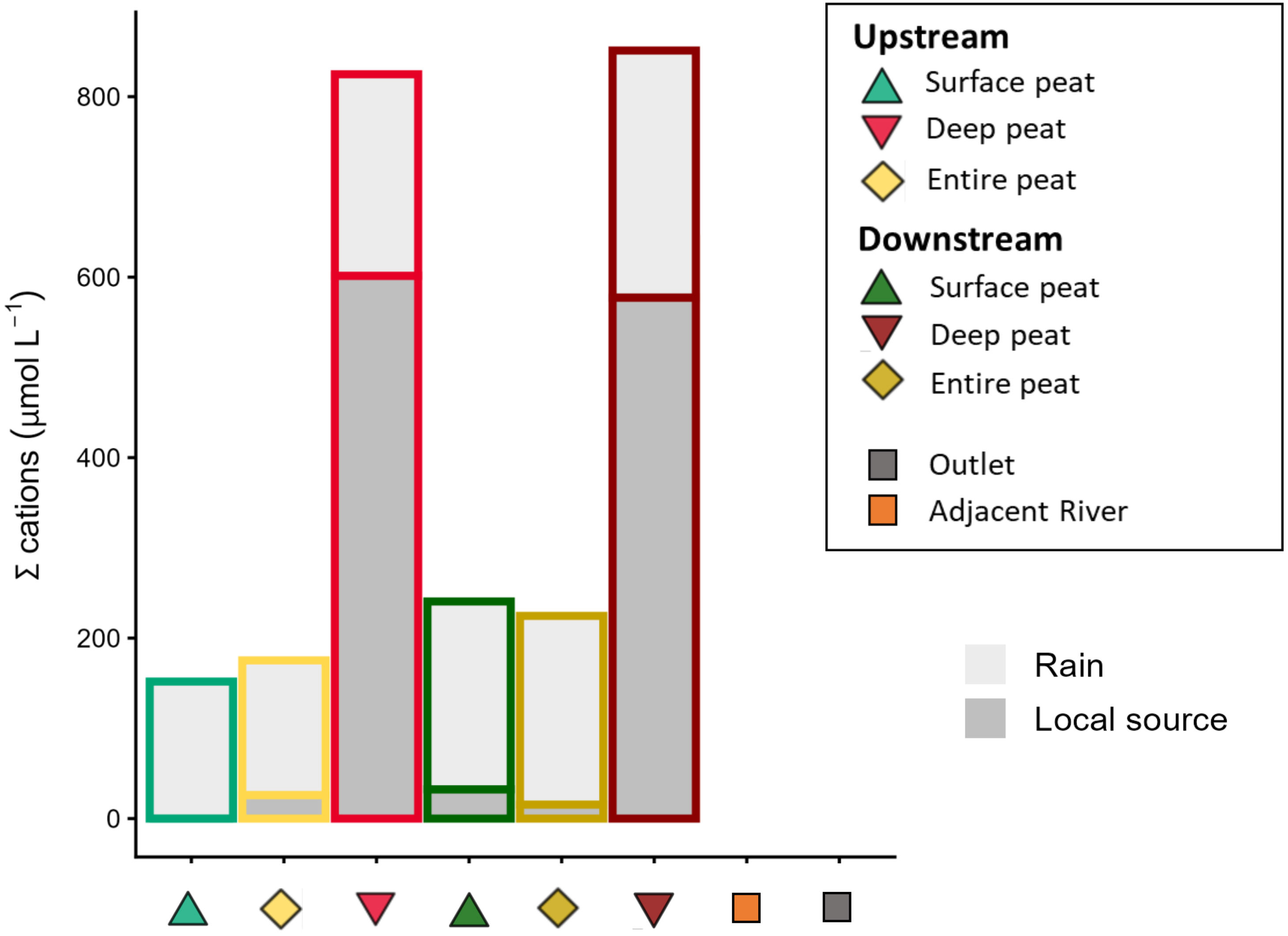

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Deep	35 %	65%
Entire	97%	3%

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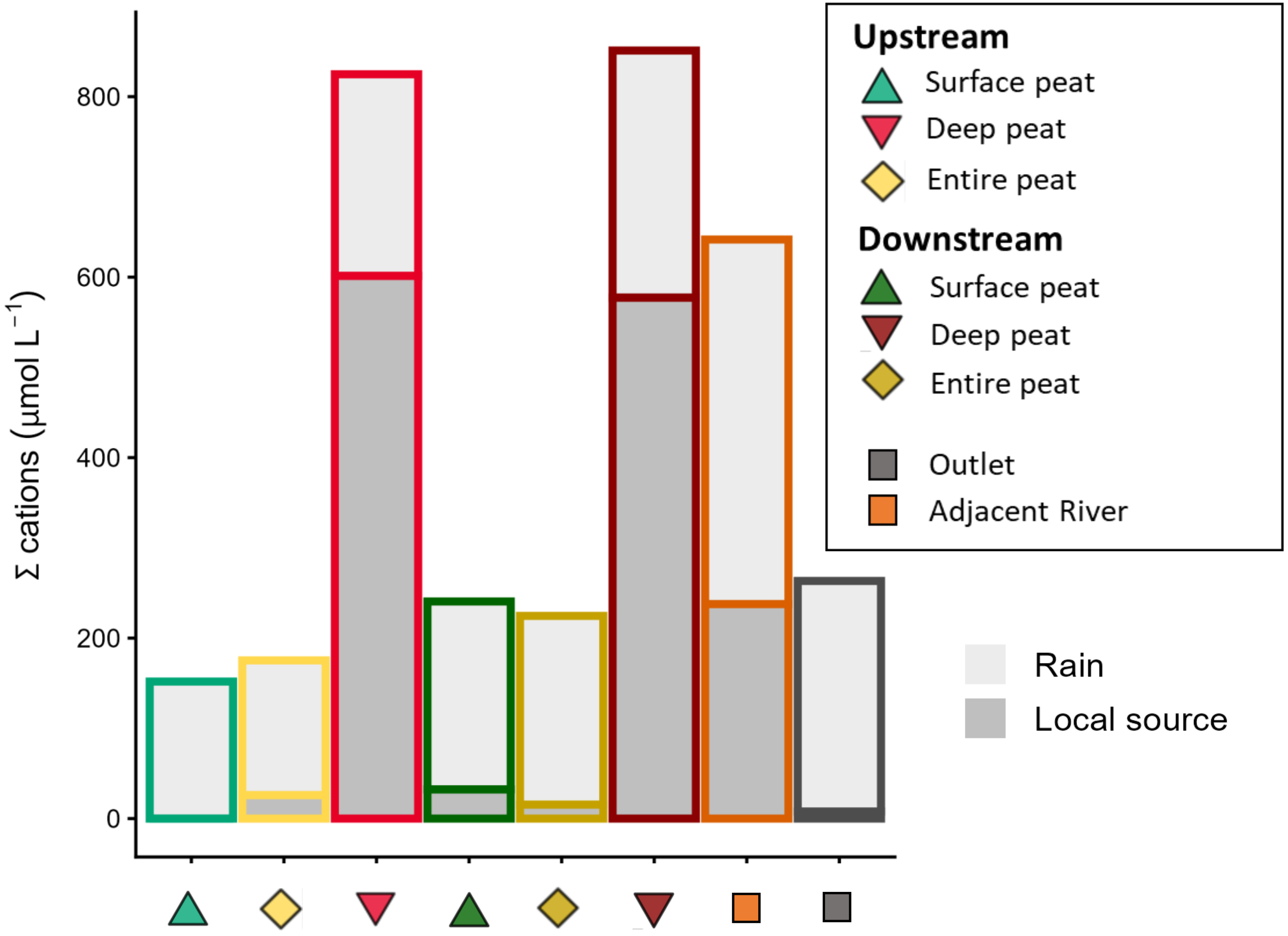

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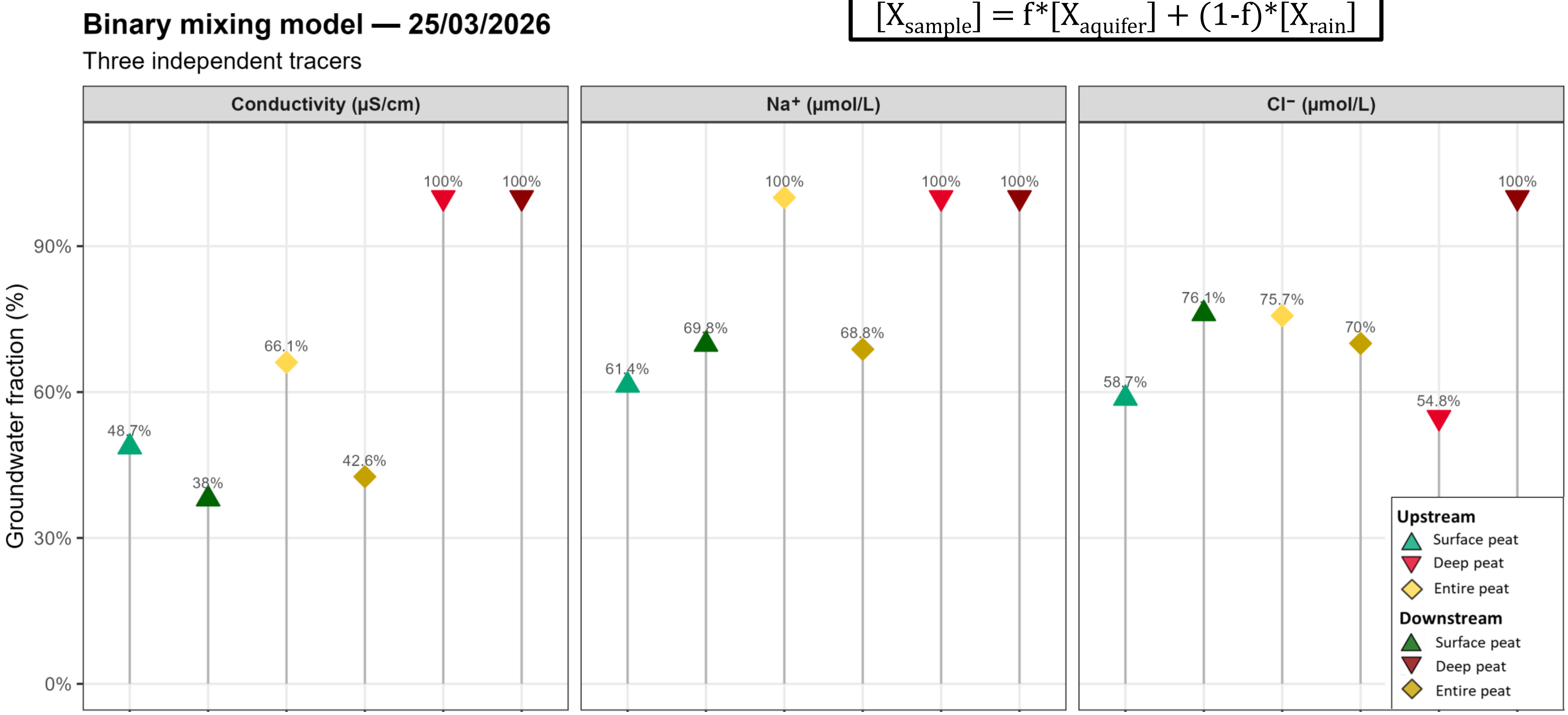
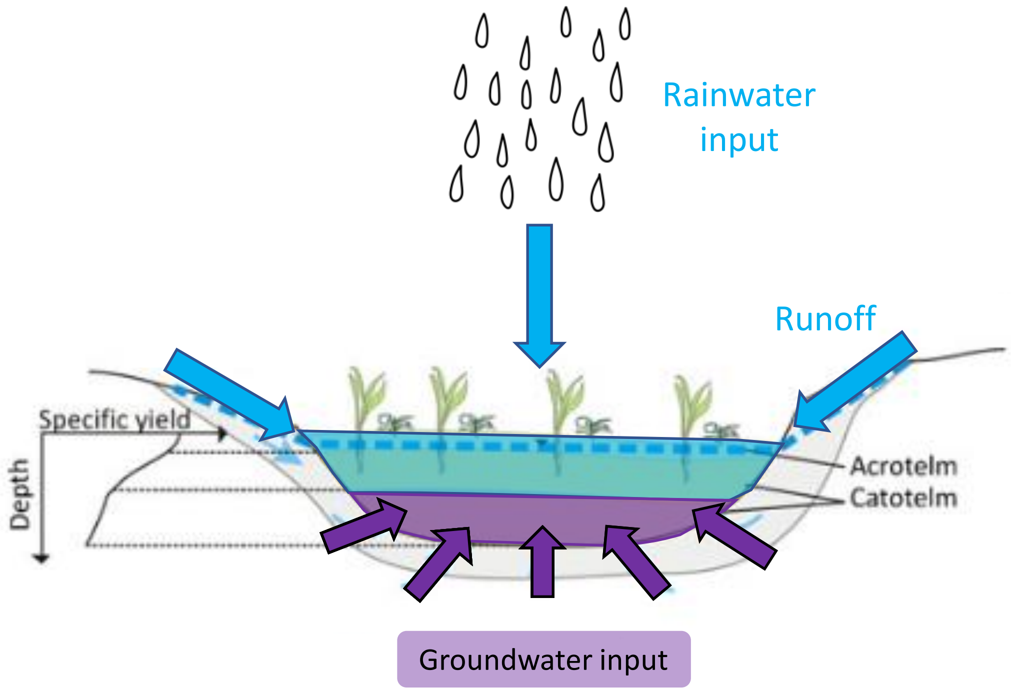
Quantitative Discrimination of Solute Sources
Binary Mixing Model

$$[X_{sample}] = f^*[X_{aquifer}] + (1\text{-}f)^*[X_{rain}]$$



Two Reservoirs, Two Sources



Adapted from Bertrand et al., 2012

The geochemical approach reveals **two contrasted reservoirs**:

- a **surface** reservoir dominated by **rainfall** input
- a **deeper** reservoir fed by **aquifer** contribution

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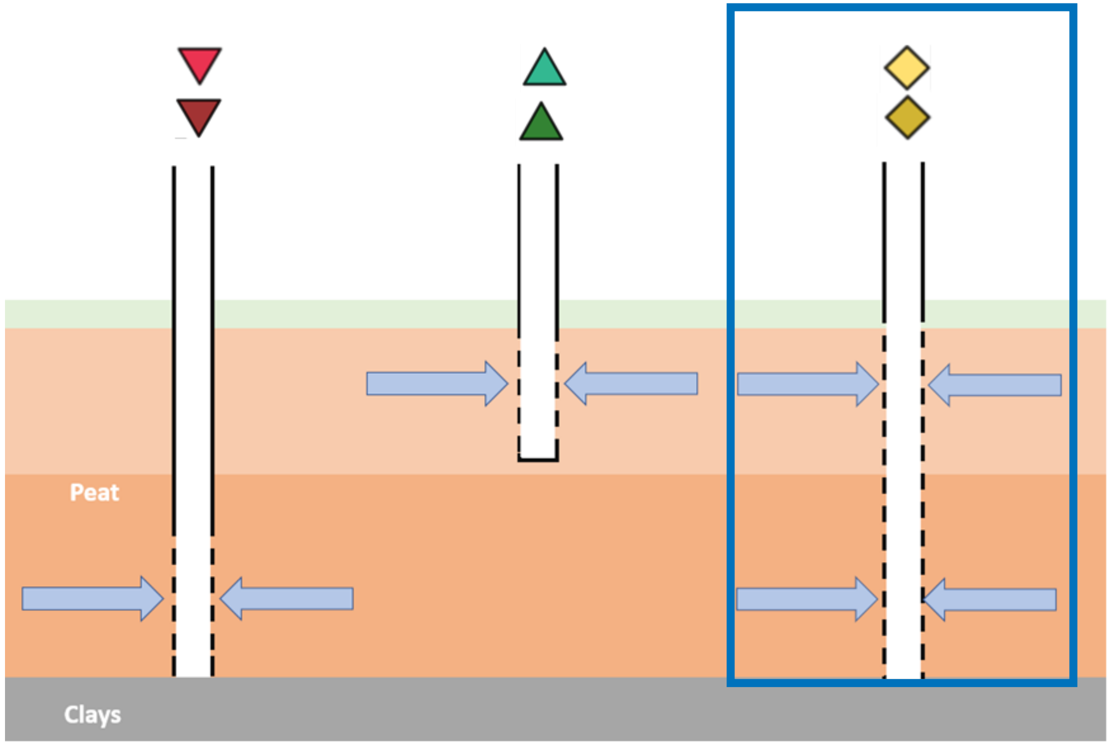
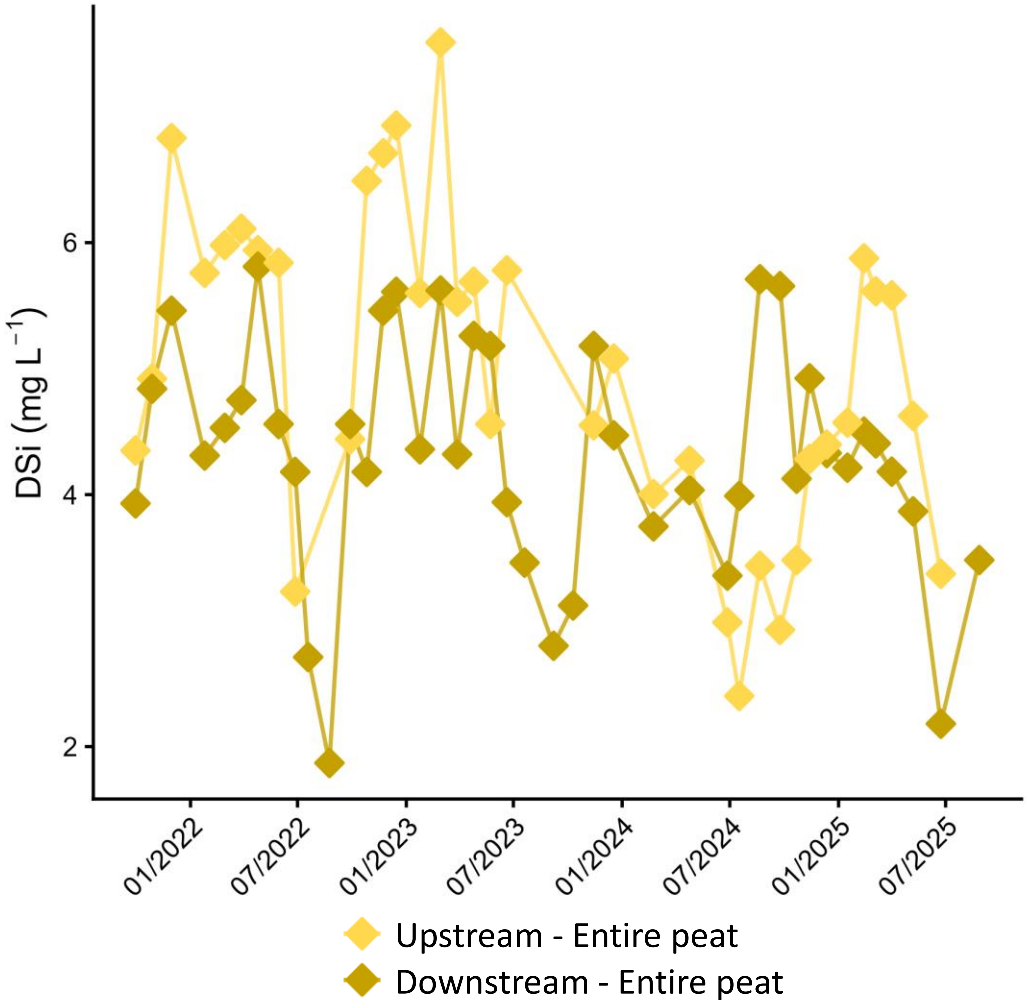
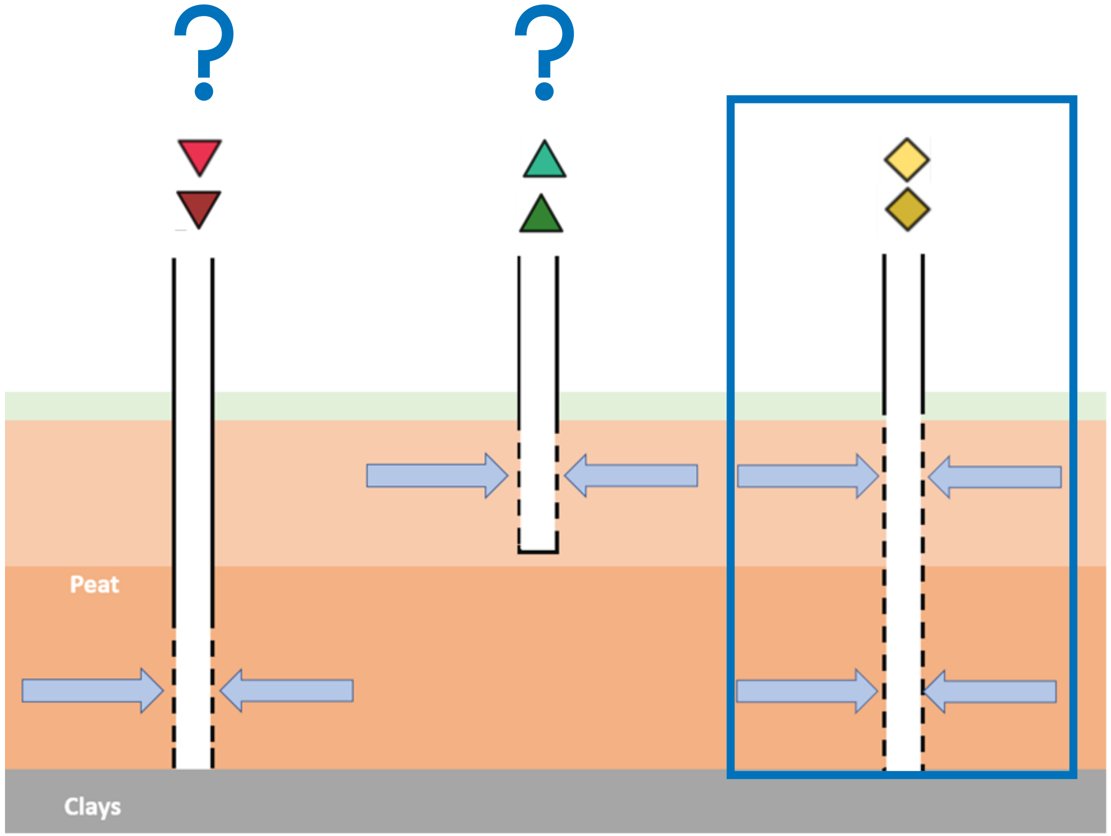
Identification of Key Reservoirs Controlling DSi Dynamics



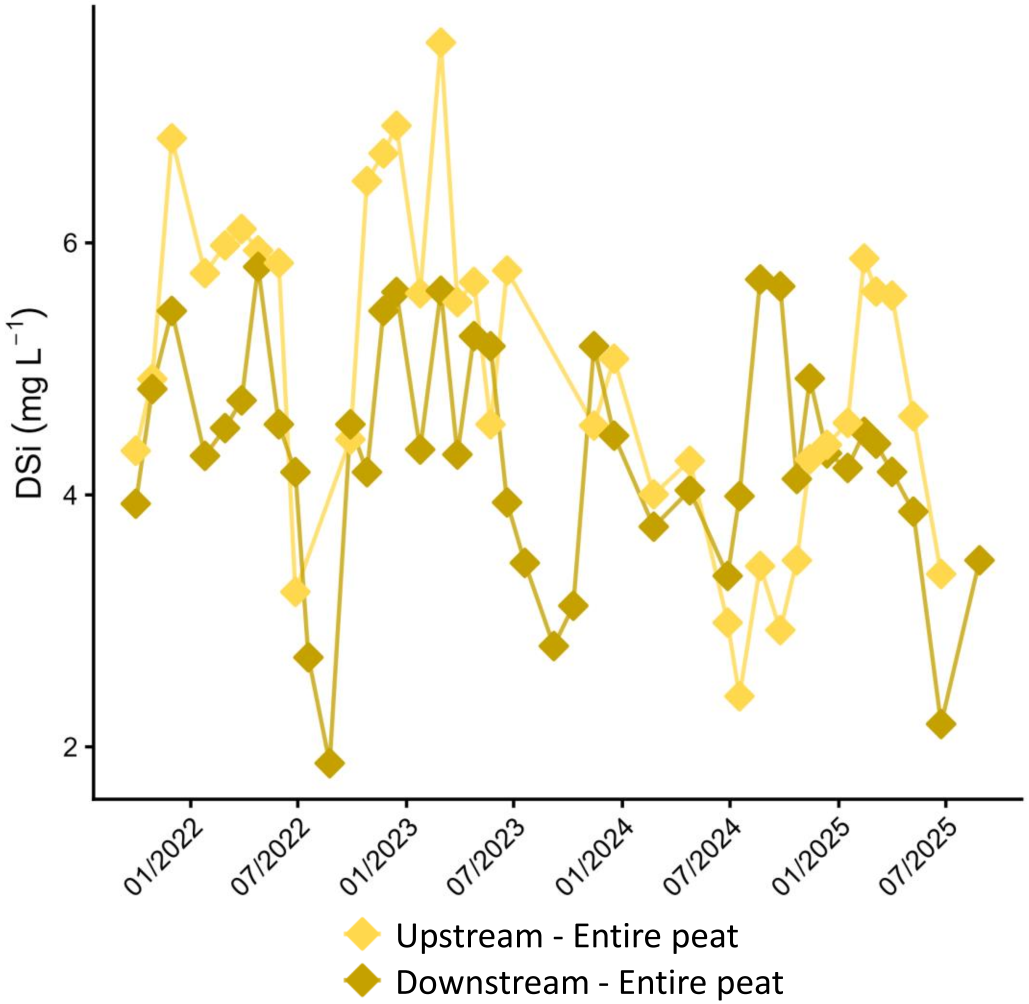
Set up in January 2025



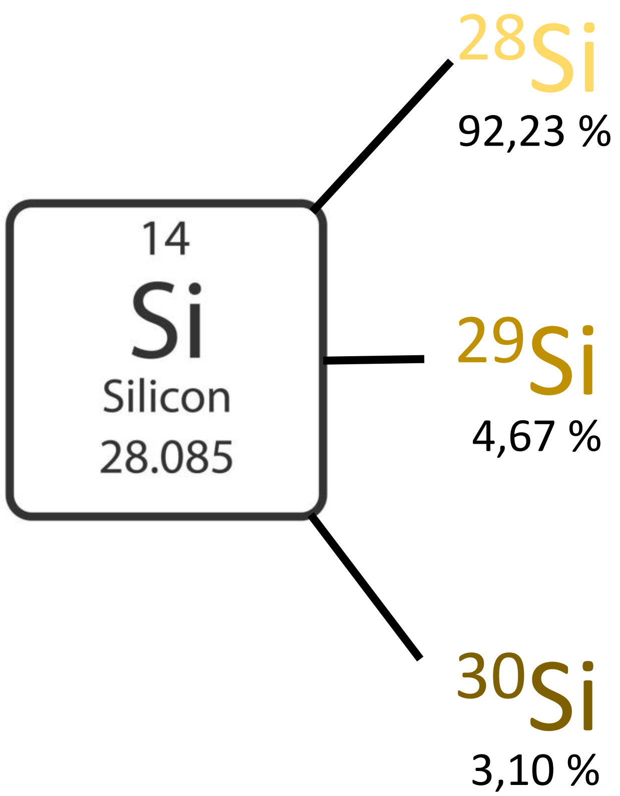
Identification of Key Reservoirs Controlling DSi Dynamics



Set up in January 2025



DSi-δ^{30}Si Relationships to Disentangle Biological and Hydrological Controls on DSi Dynamics



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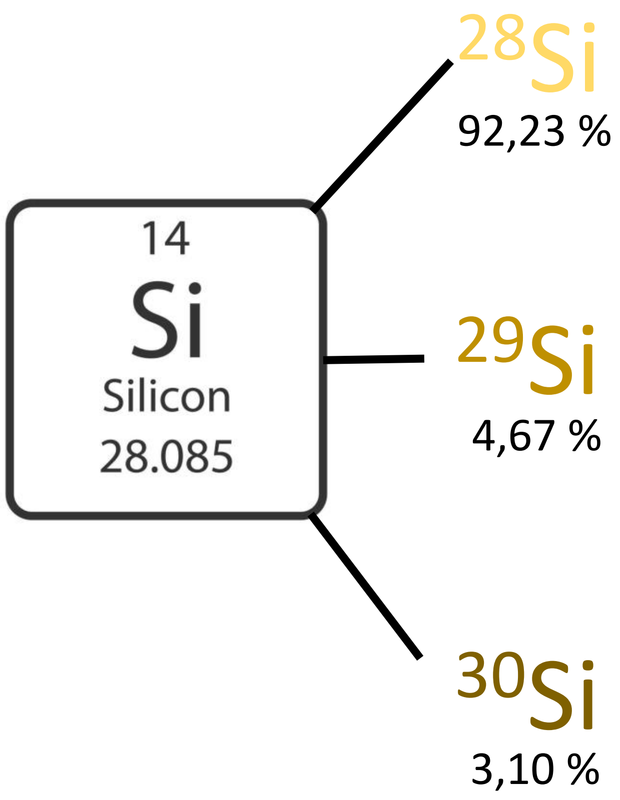
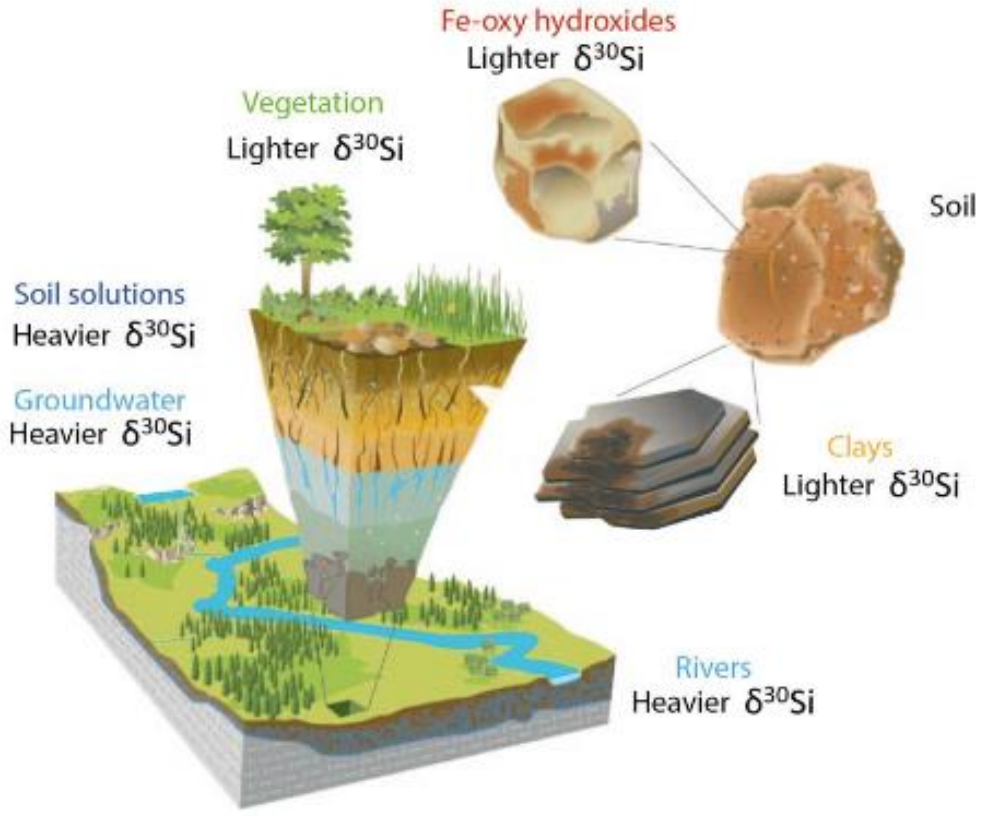
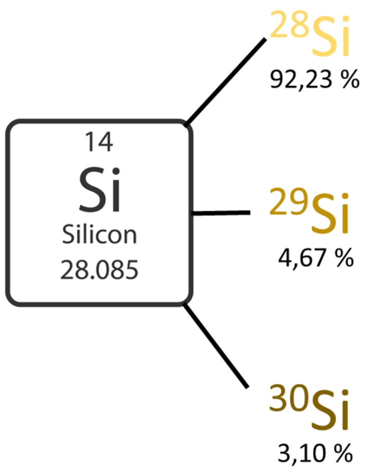
DSi-δ^{30}Si Relationships to Disentangle Biological and Hydrological Controls on DSi Dynamics

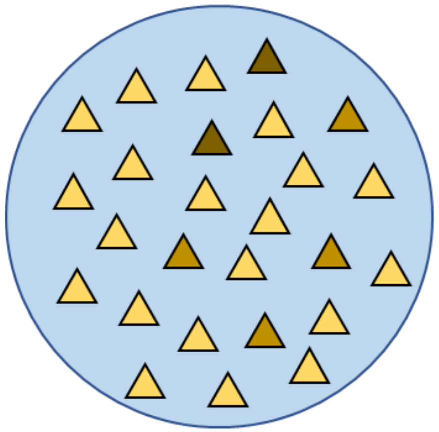




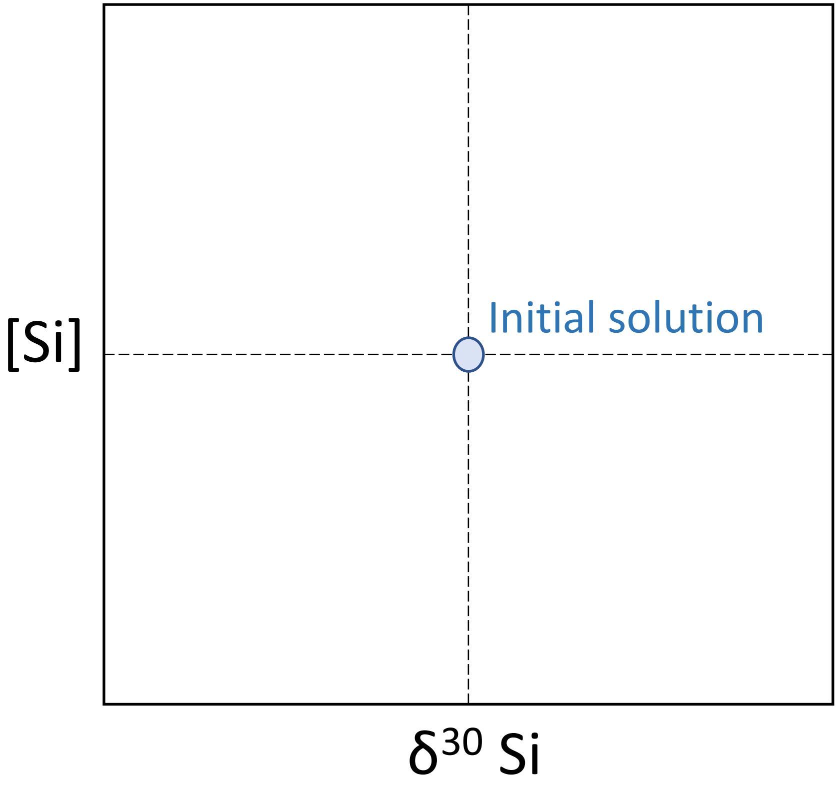
Silicon in the Critical Zone
(Adapted from López Urzúa, 2025)

DSi-δ^{30}Si Relationships to Disentangle Biological and Hydrological Controls on DSi Dynamics





Initial solution



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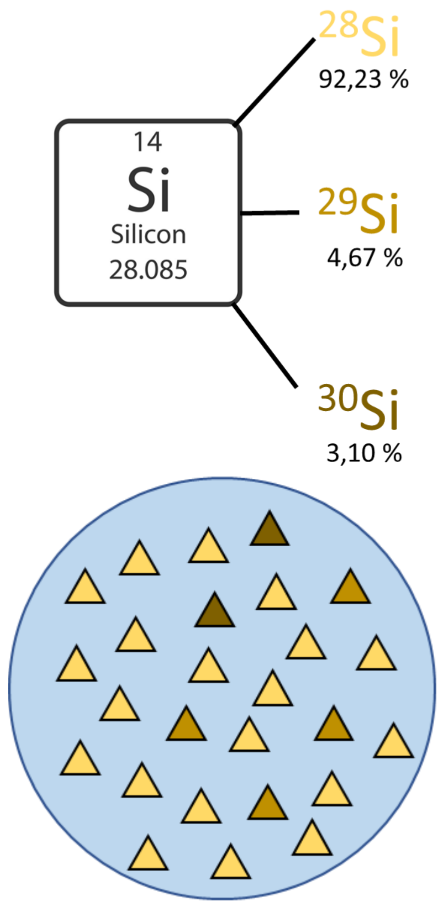

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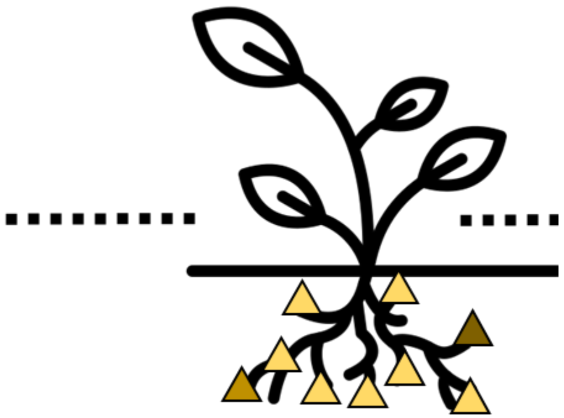

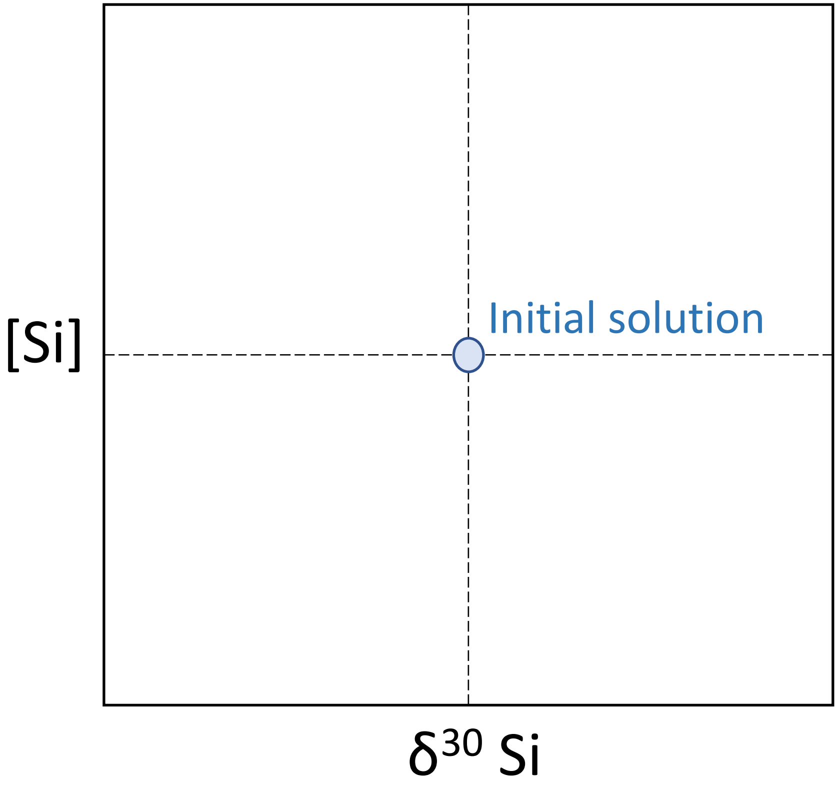

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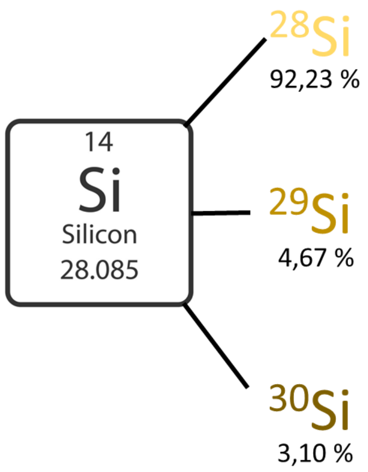
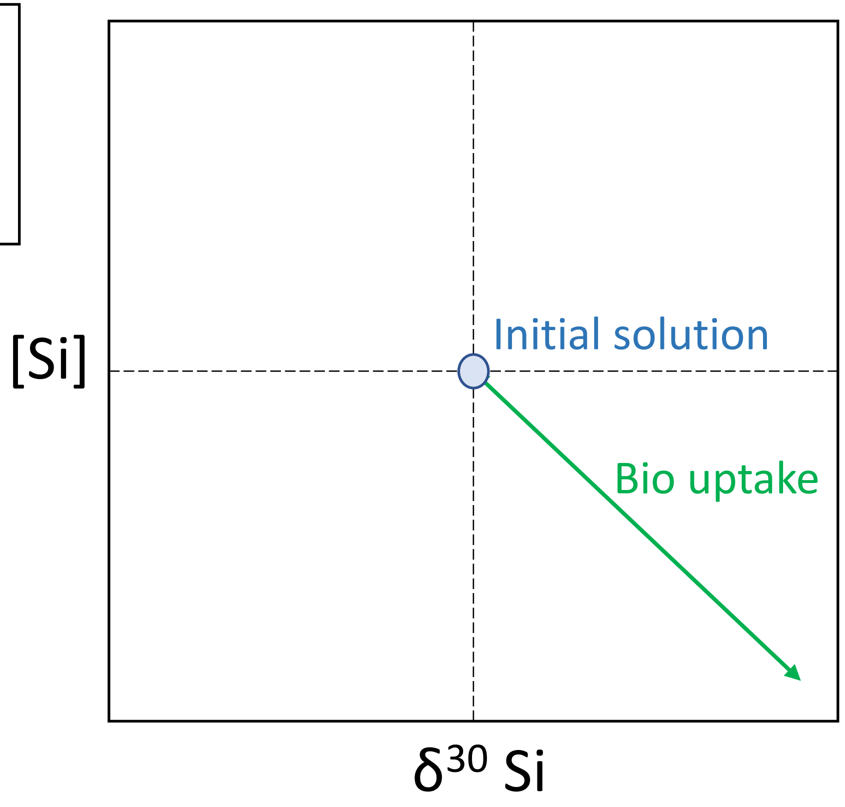
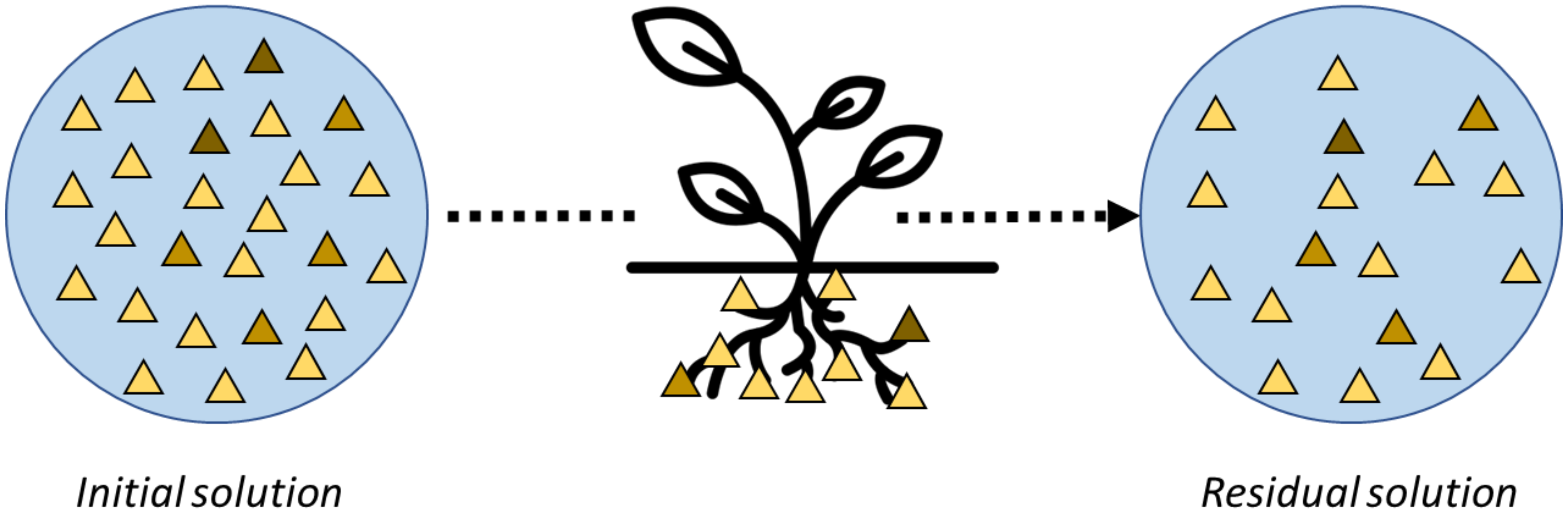


$$\delta^{30}\mathrm{Si}(‰) = \left(\frac{{}^{30}\mathrm{Si}/{}^{28}\mathrm{Si}_{\mathrm{sample}}}{{}^{30}\mathrm{Si}/{}^{28}\mathrm{Si}_{\mathrm{standard}}} - 1 \right) \times 1000$$





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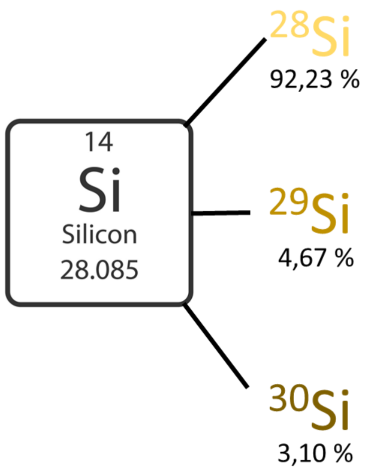

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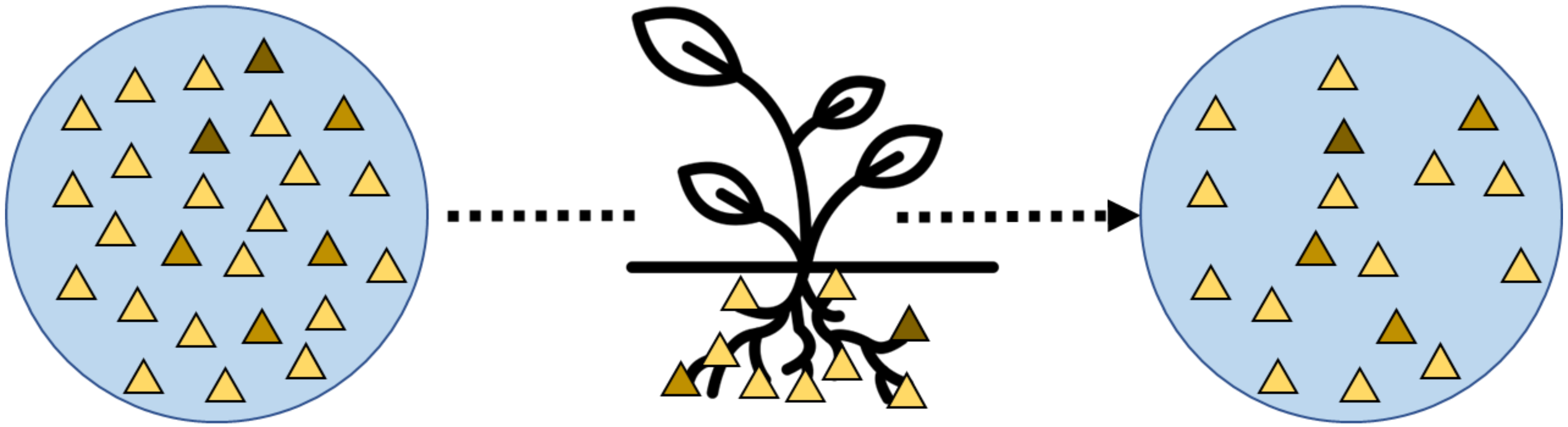
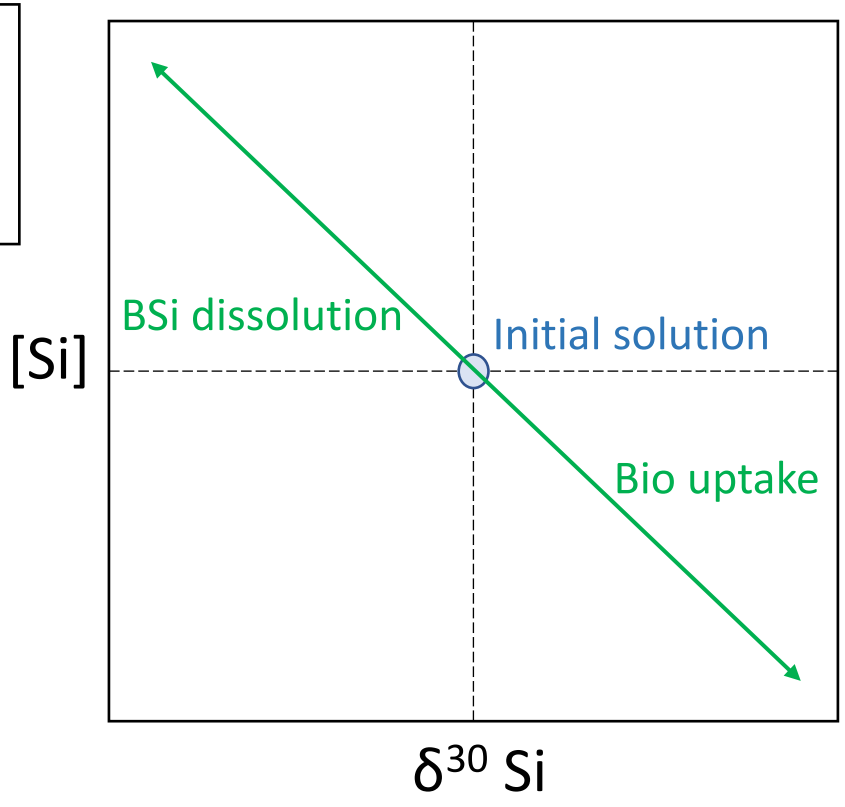


Initial solution

Residual solution



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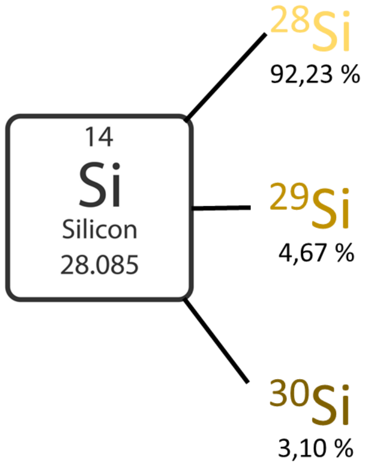

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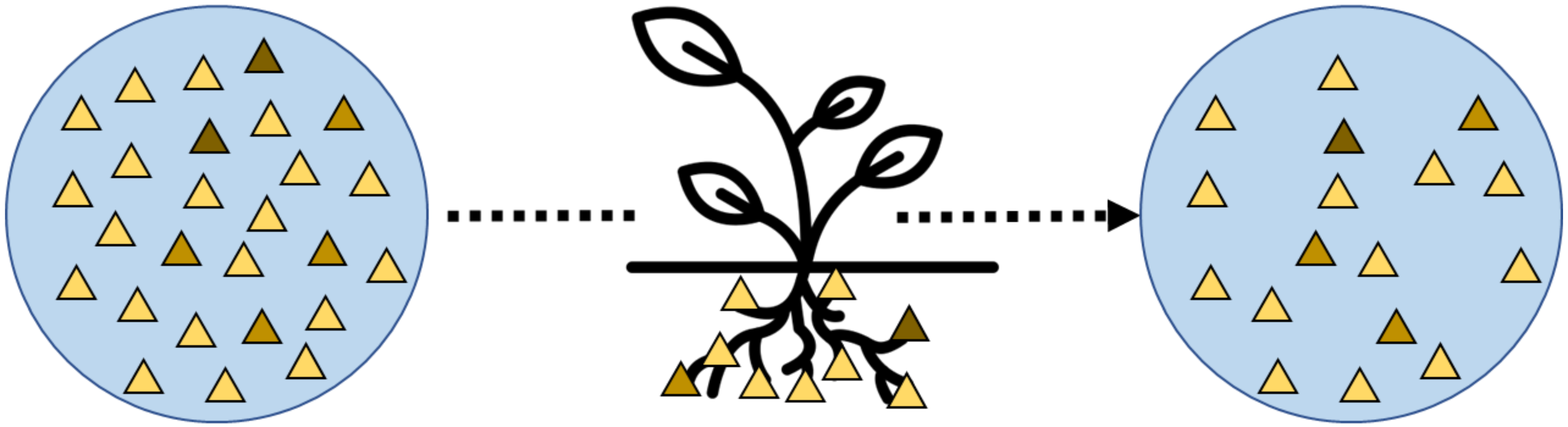

Initial solution

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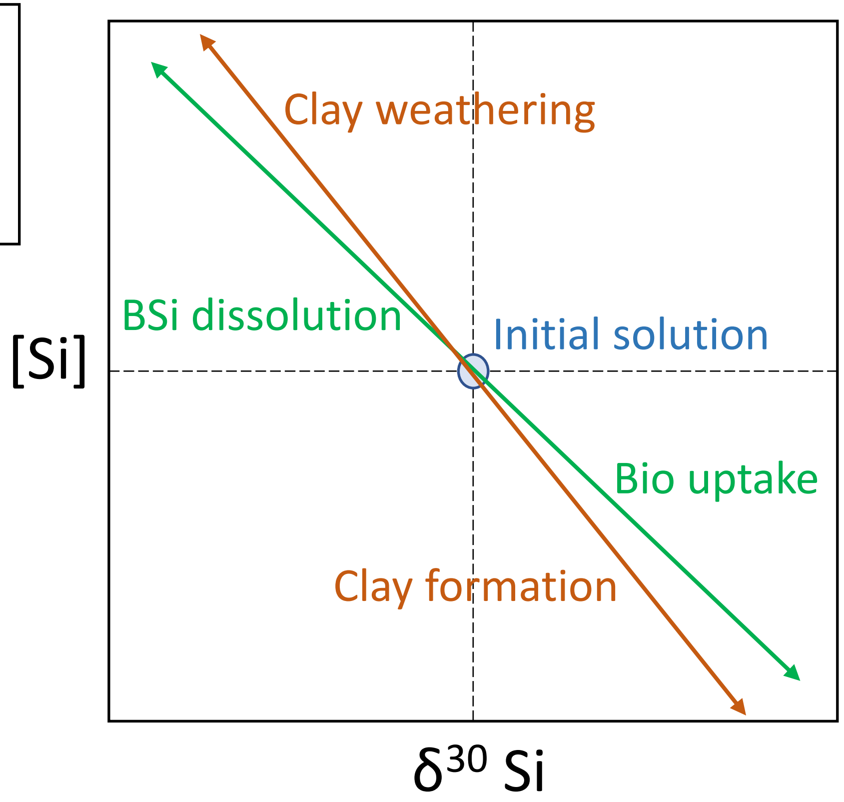
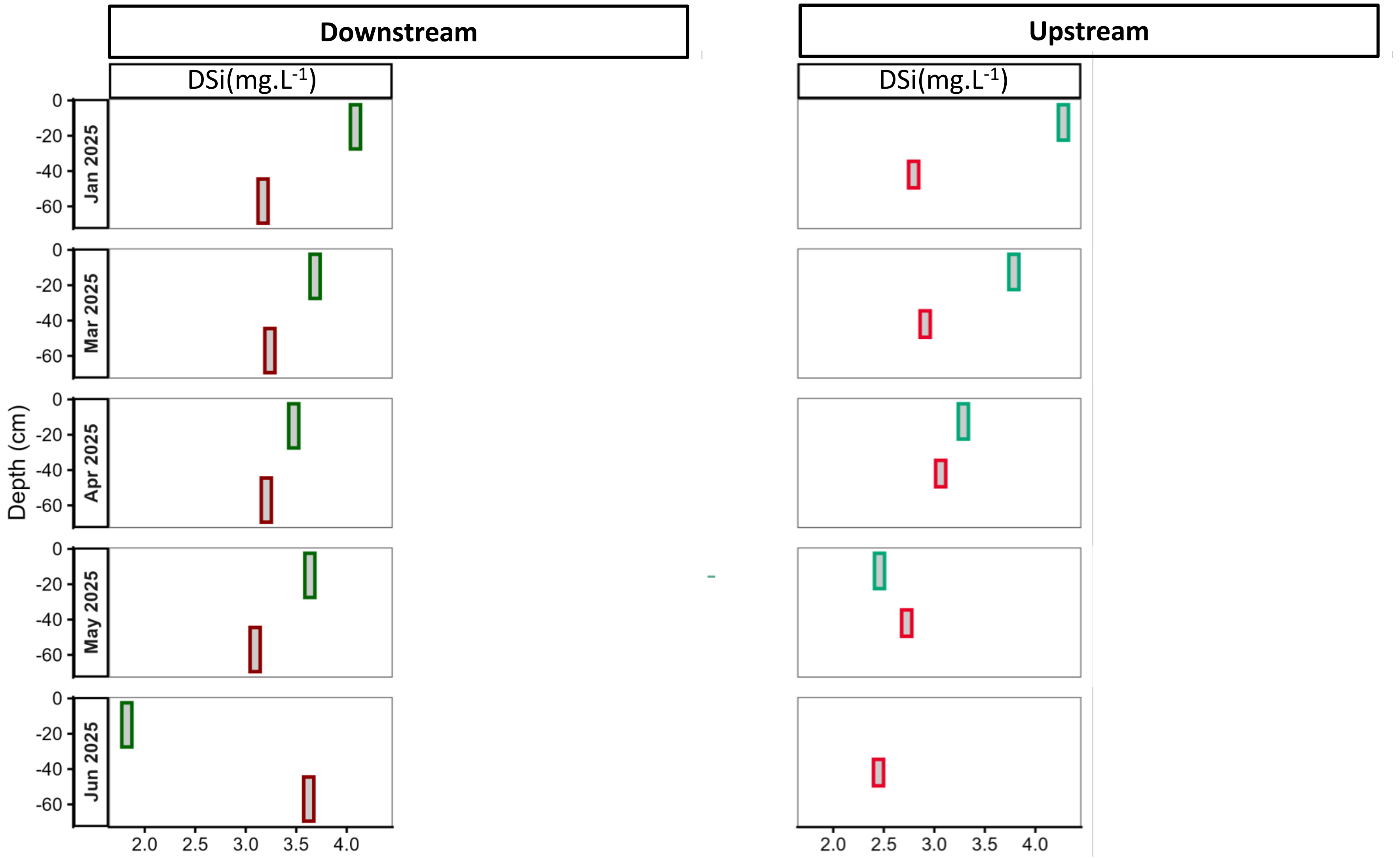


Identification of Key Reservoirs Controlling DSi Dynamics



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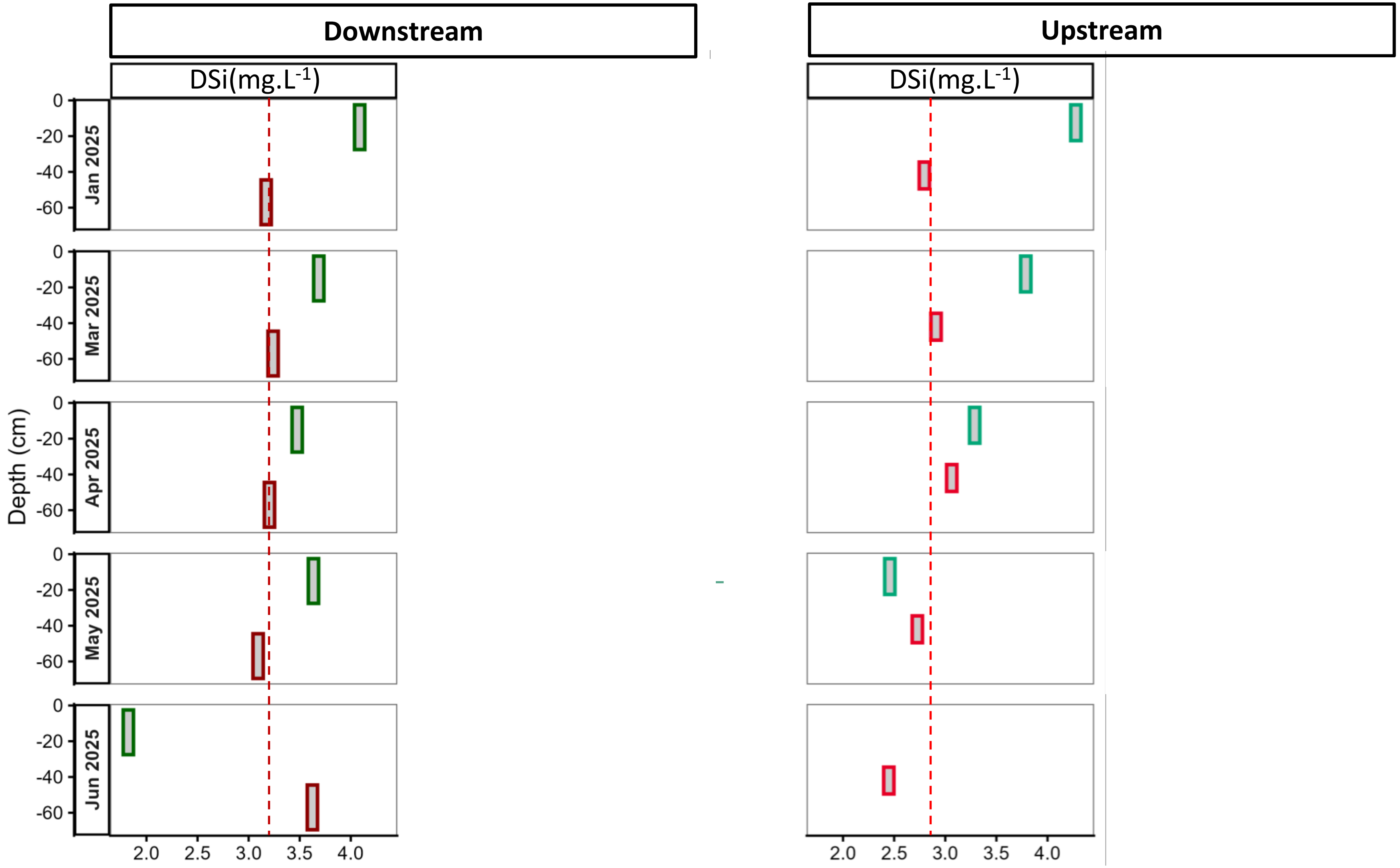
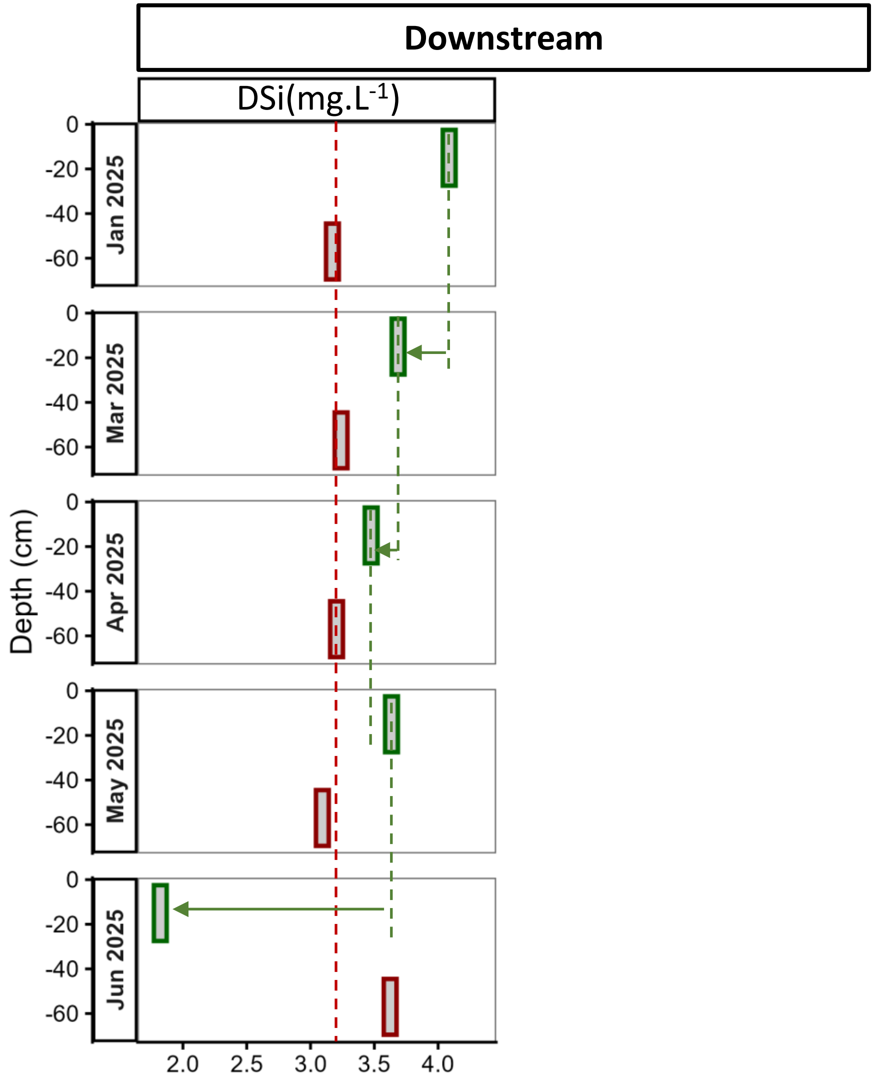
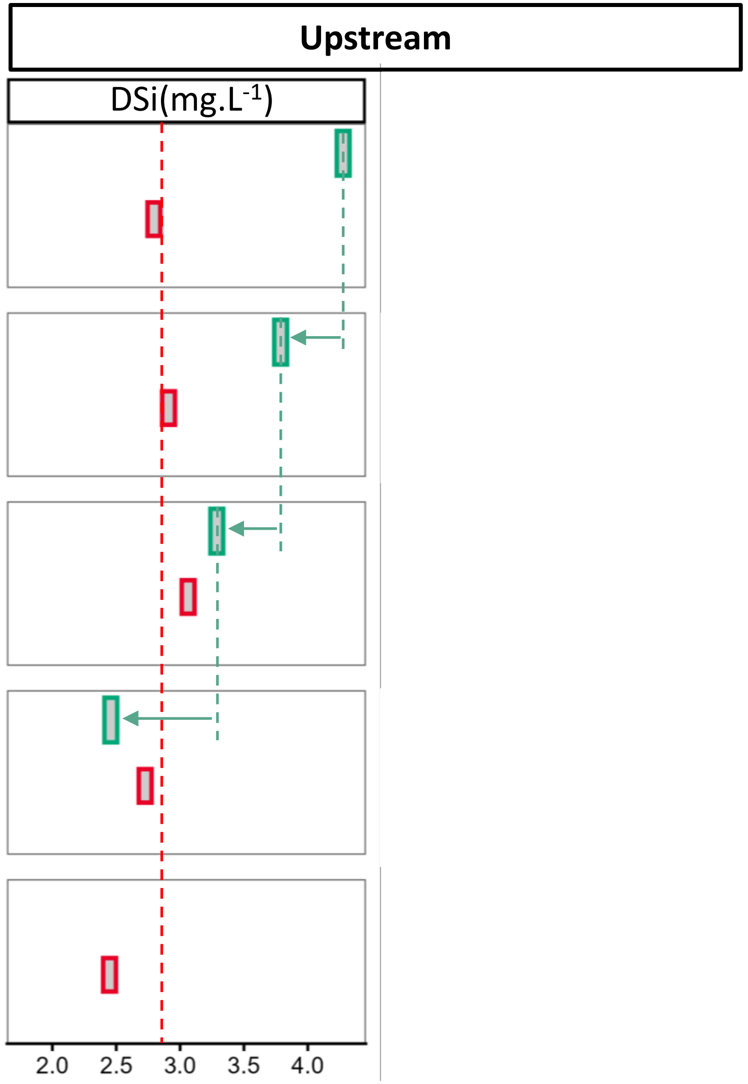


- **Minimal** DSi Fluctuations in the **Deep Peat Layer**

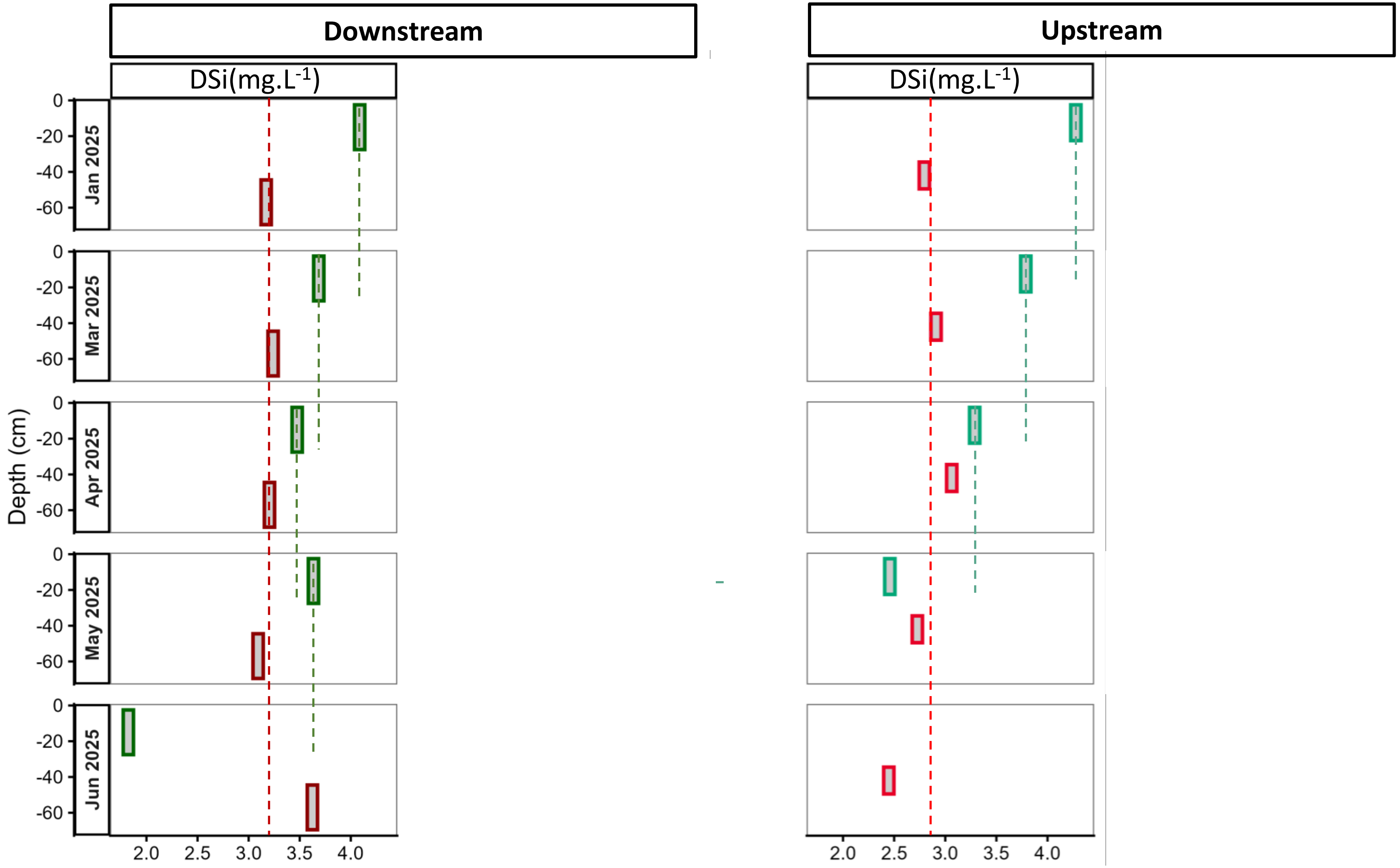
Identification of Key Reservoirs Controlling DSi Dynamics



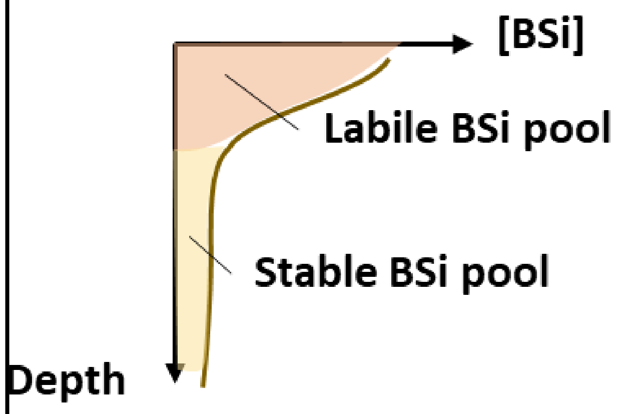


- **Minimal** DSi Fluctuations in the **Deep Peat Layer**
- **Strong** DSi Fluctuations in the **Surface Peat Layer**

Identification of Key Reservoirs Controlling DSi Dynamics



- **Minimal** DSi Fluctuations in the **Deep Peat Layer**
- **Strong** DSi Fluctuations in the **Surface Peat Layer**
- DSi concentrations **peak** in the **Surface Peat Layer**



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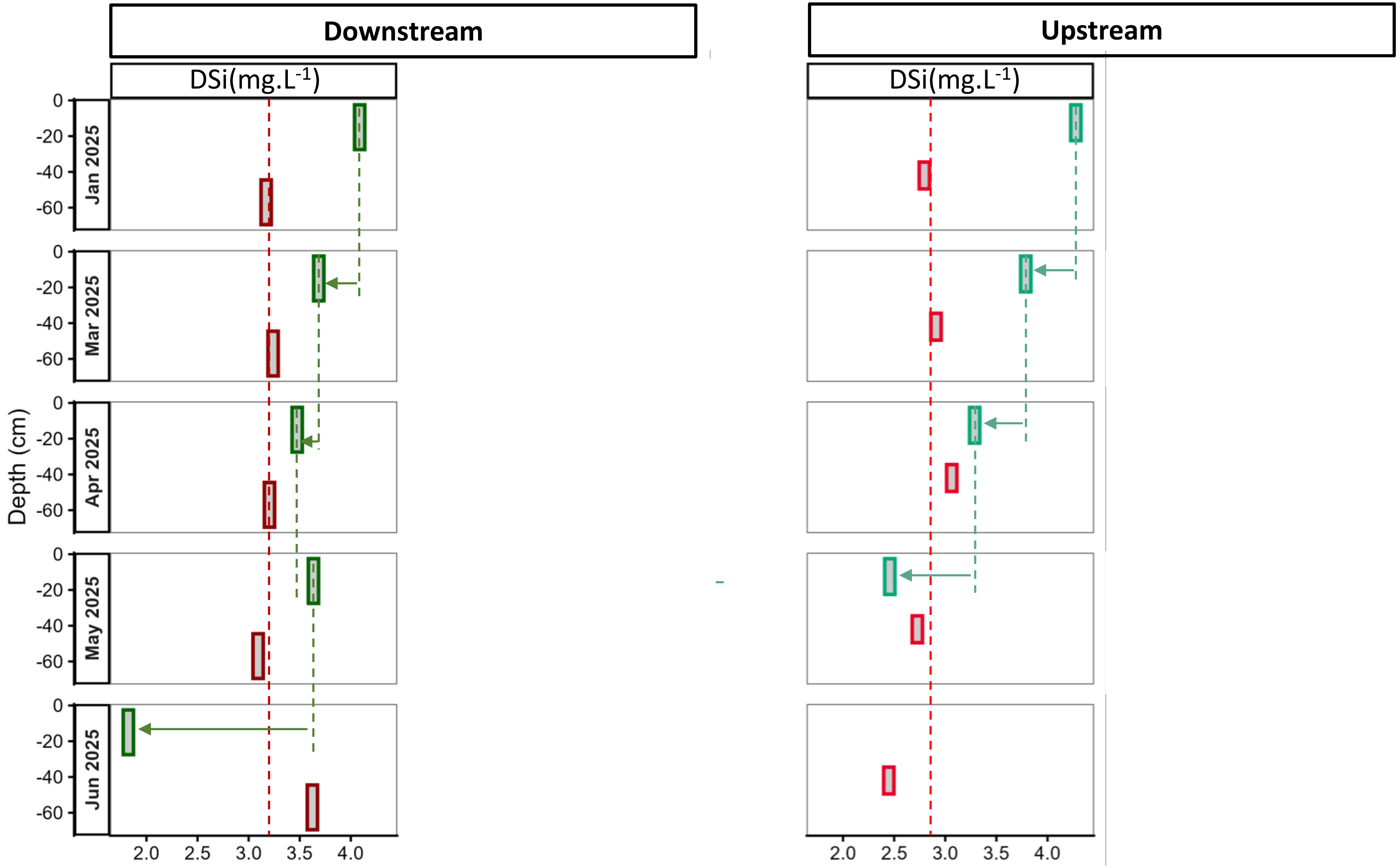
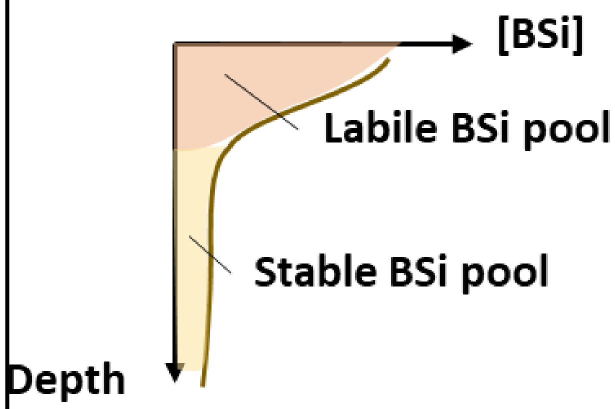
Identification of Key Reservoirs Controlling DSi Dynamics



- **Minimal** DSi Fluctuations in the **Deep Peat Layer**
- **Strong** DSi Fluctuations in the **Surface Peat Layer**
- DSi concentrations **peak** in the **Surface Peat Layer** and show a **progressive decline** throughout the **Spring** period



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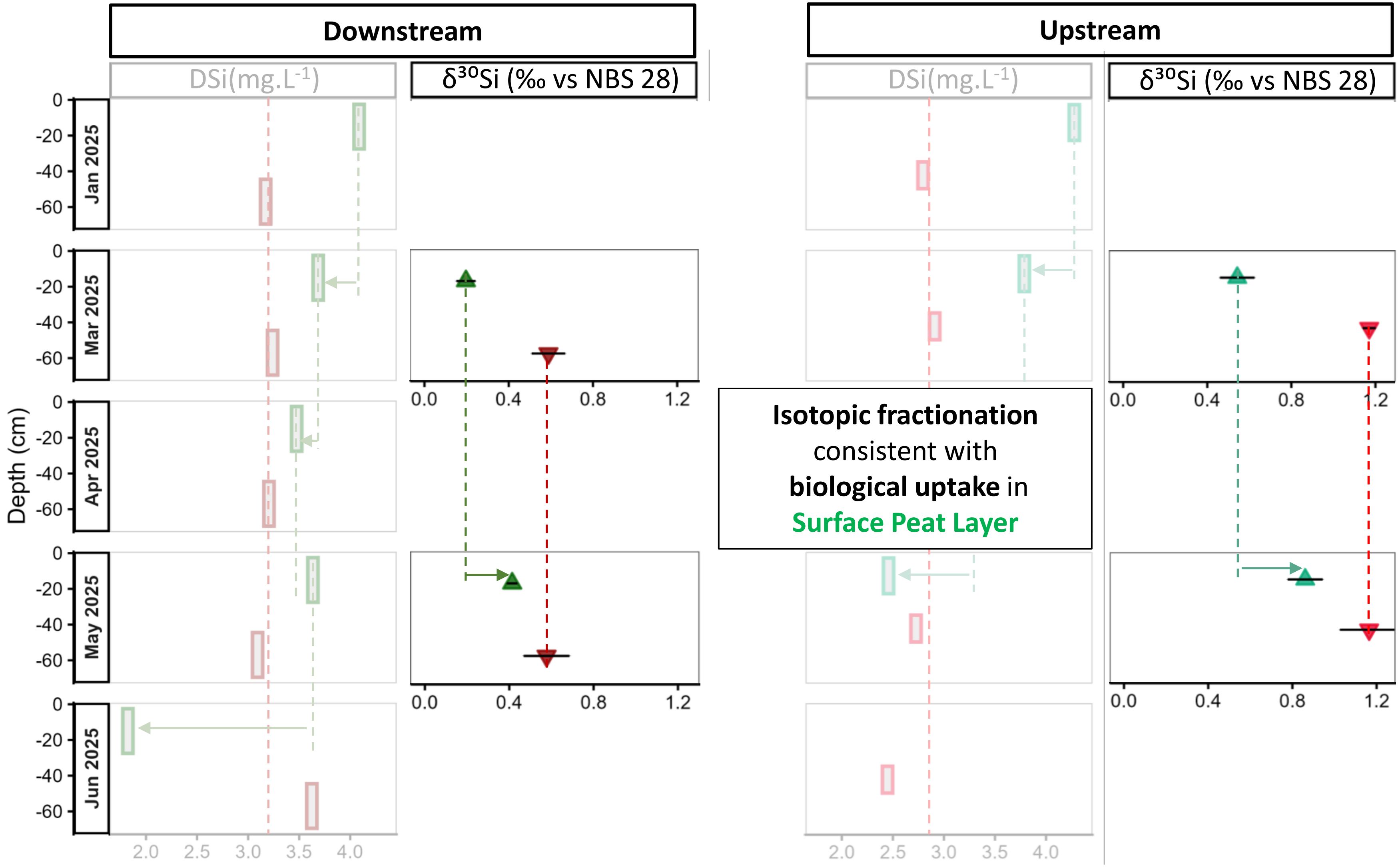

Isotopic fractionation consistent with **biological uptake** in **Surface Peat Layer**

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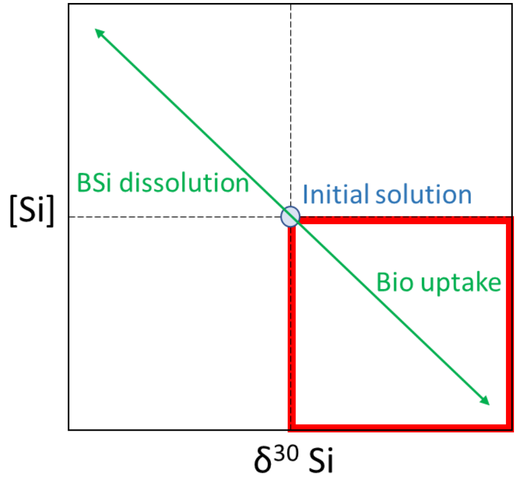

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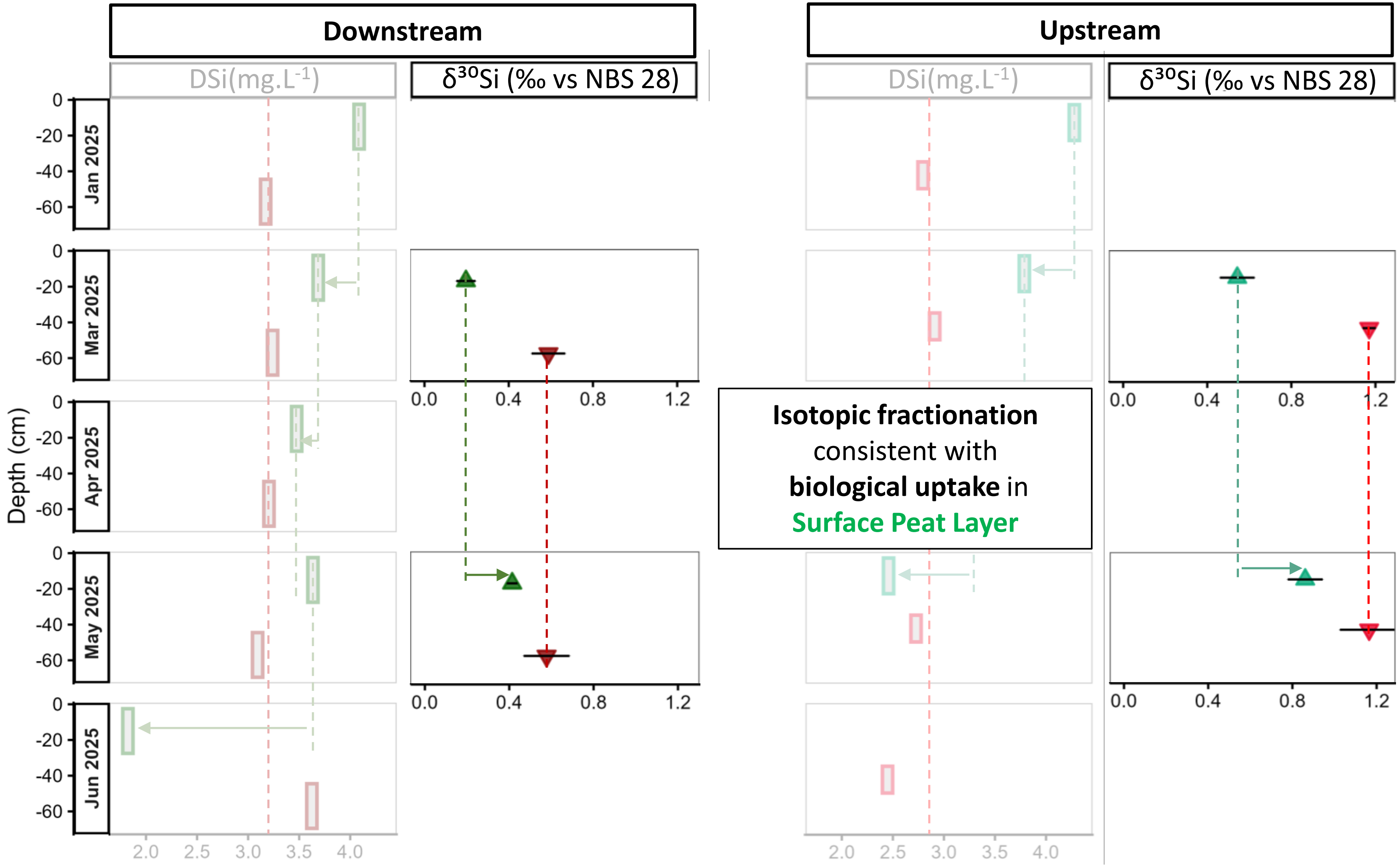

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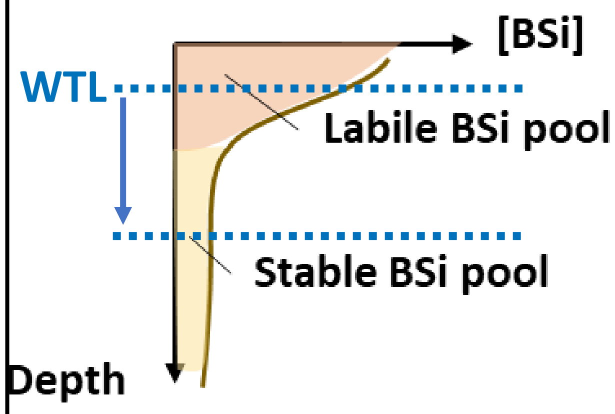
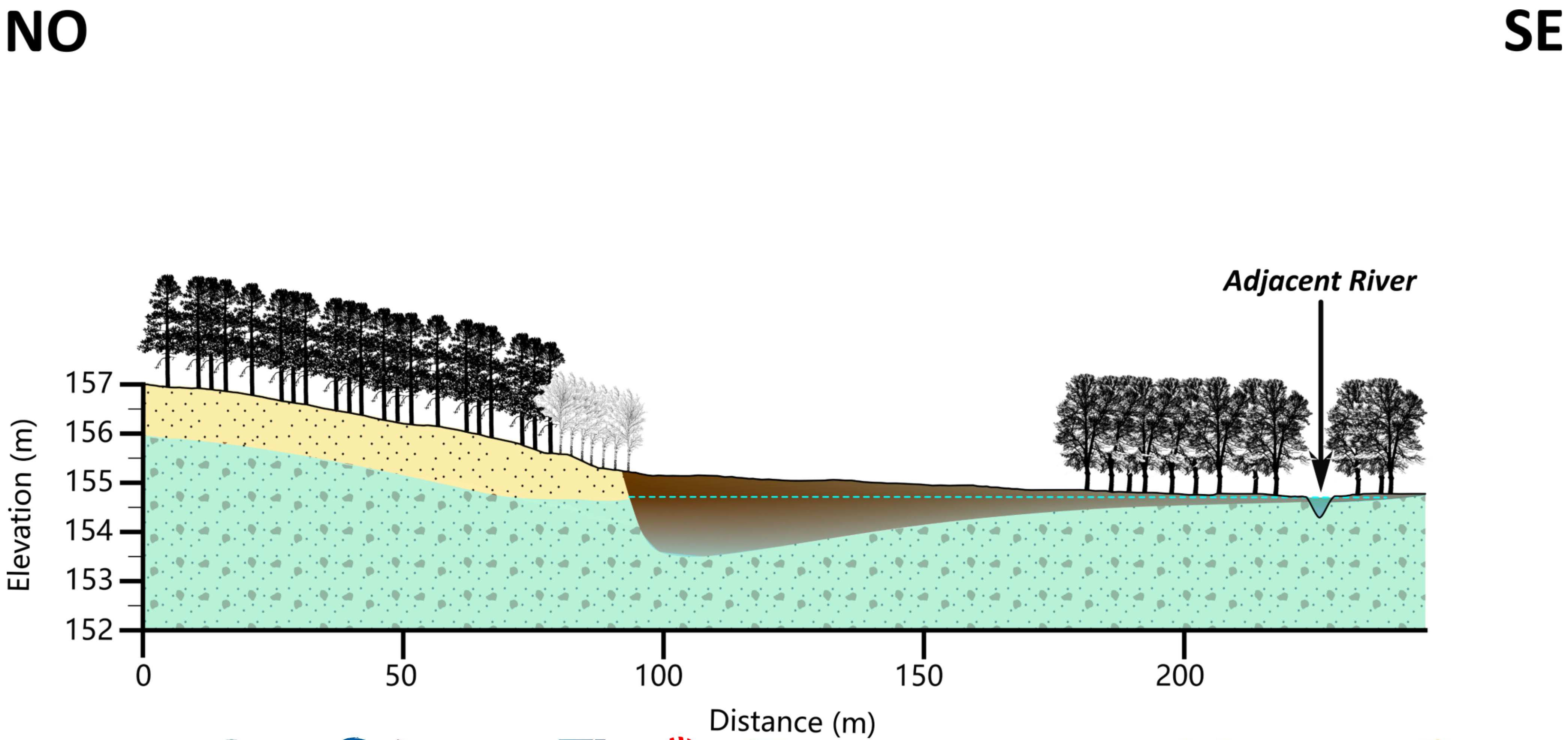


From Water Flow to Silicon Cycling: A Peatland Conceptual Model



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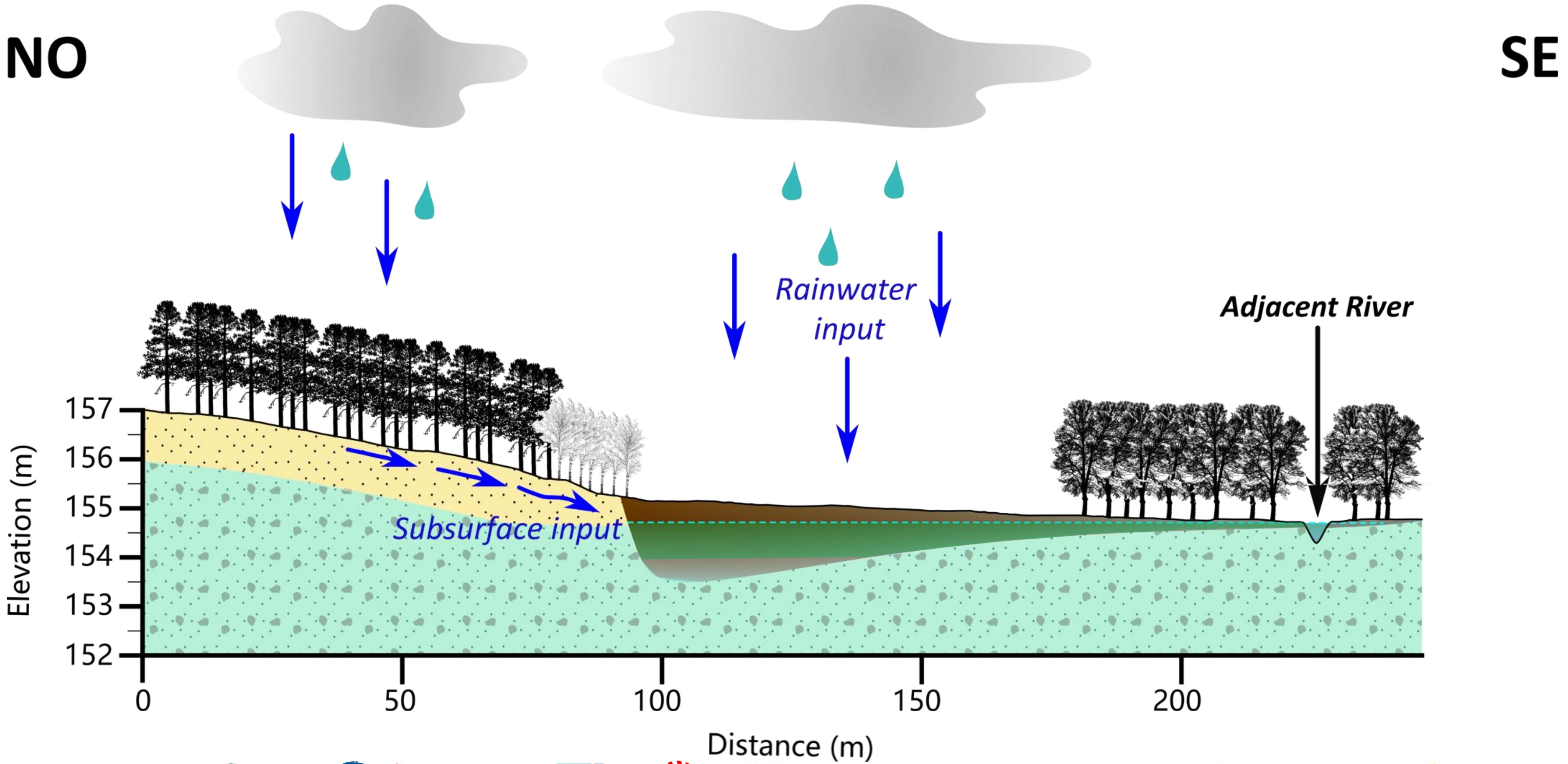
From Water Flow to Silicon Cycling: A Peatland Conceptual Model



OSUC Université d'ORLÉANS ISTO LPC2E IPGP CNRS JUNON SNO Tourbières Observil

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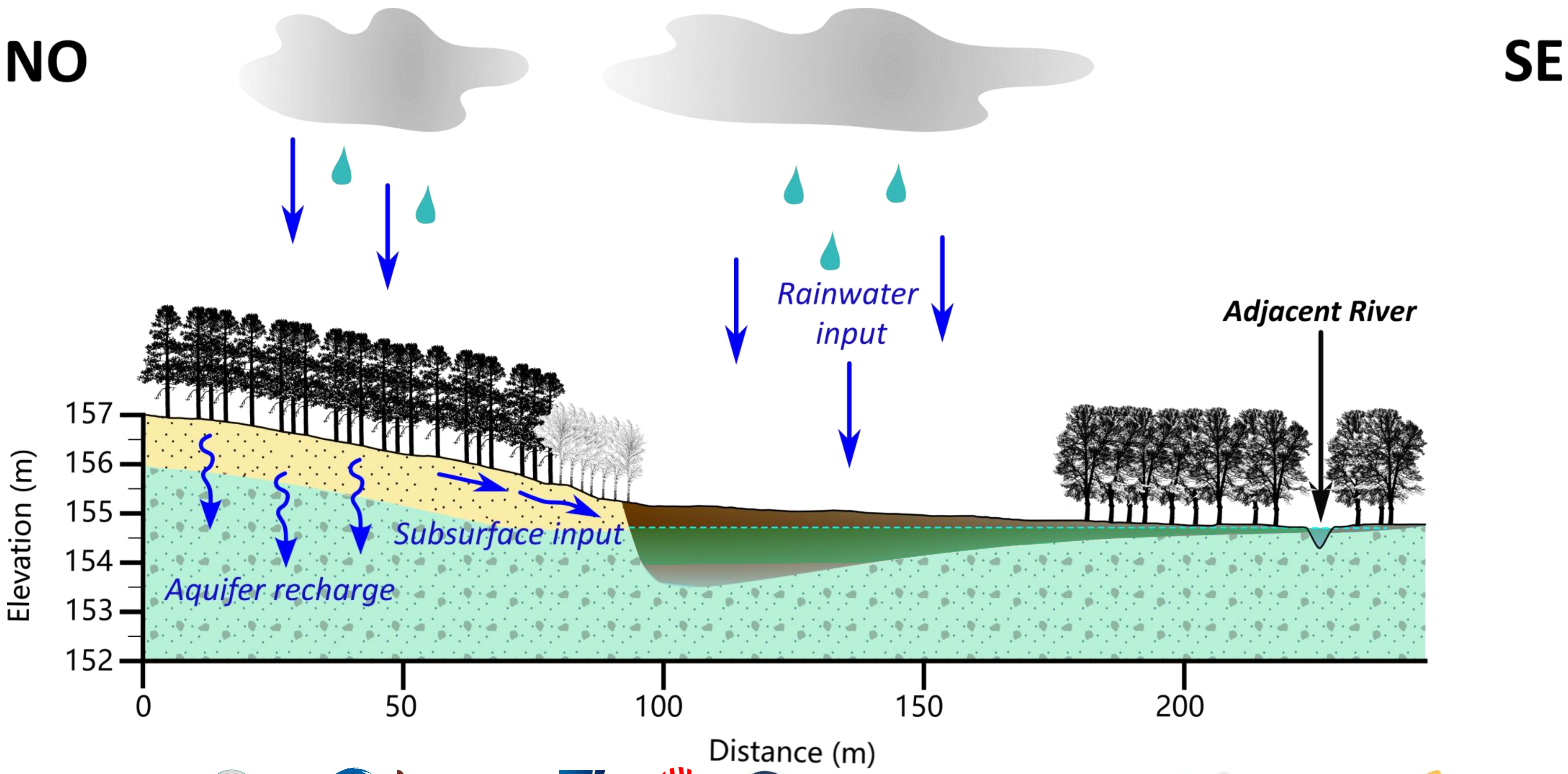

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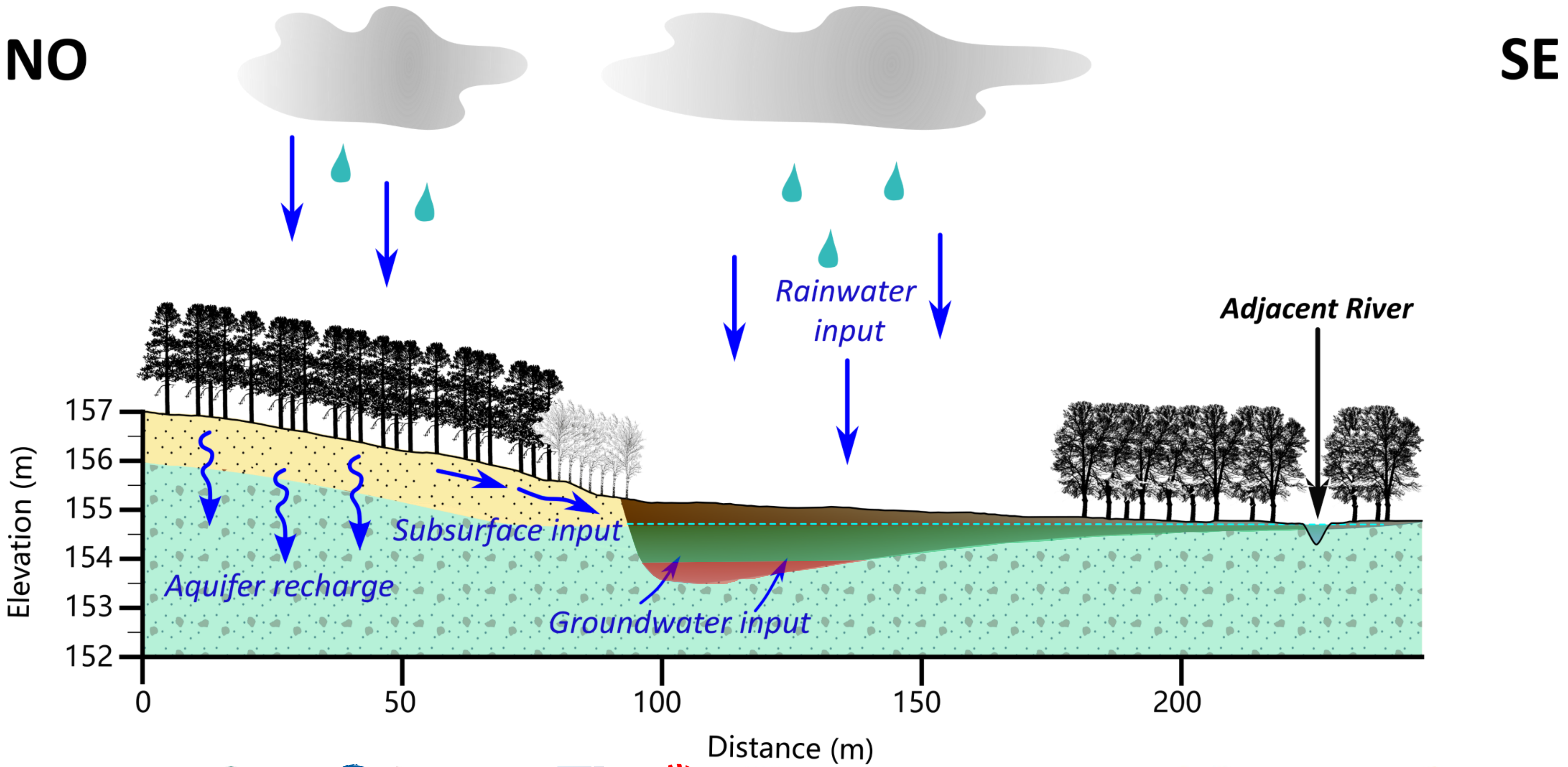

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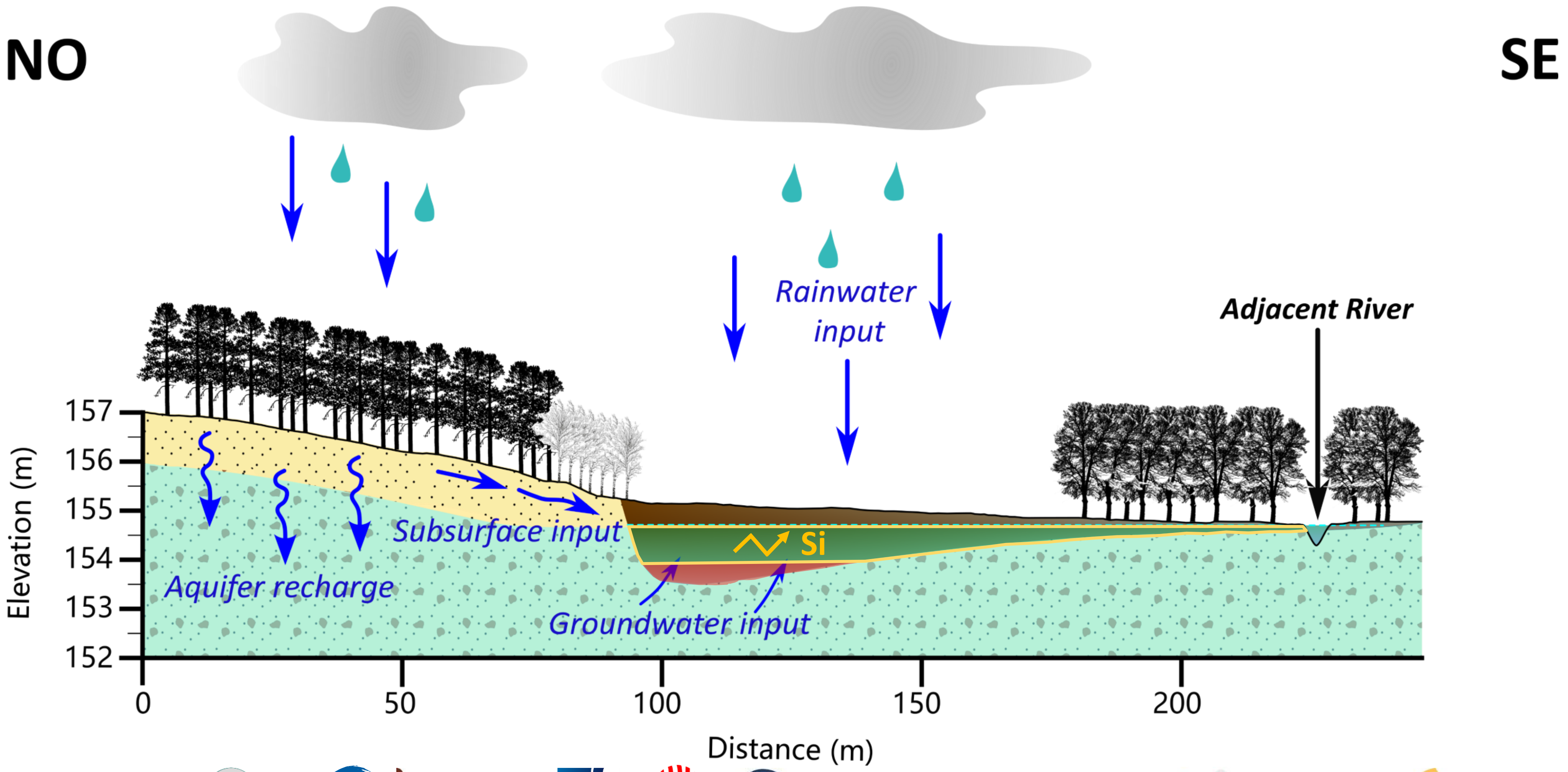
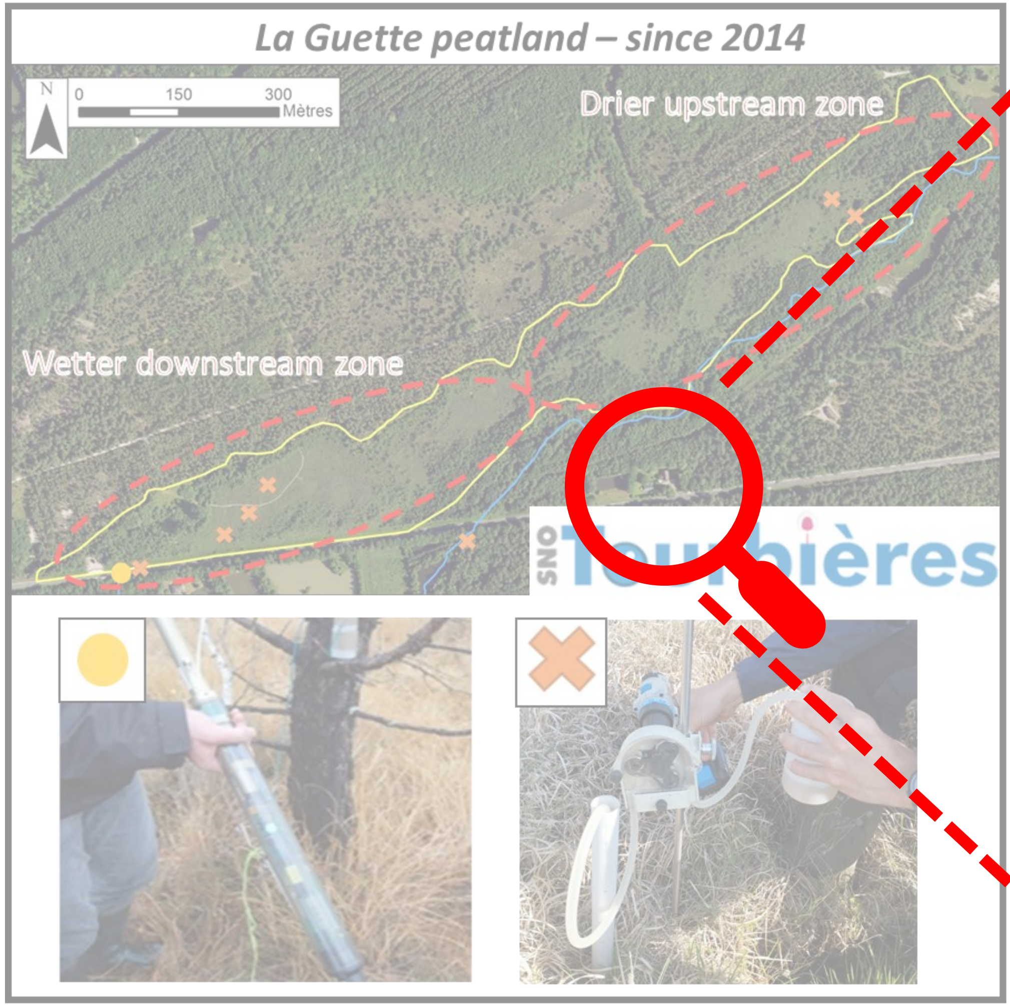
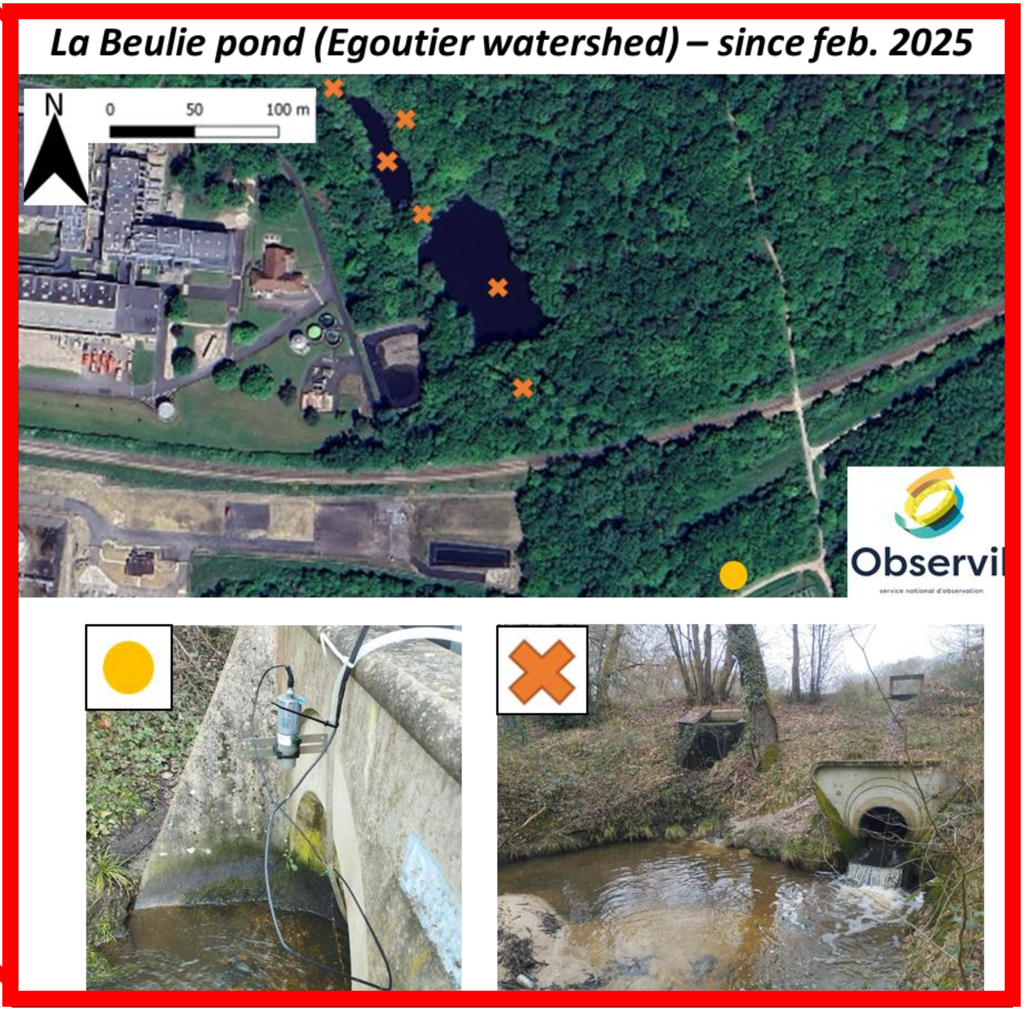


Does Biology Drive Summer DSi Retention in La Beulie Pond ?
A Mass Balance Approach





Hydrochemical monitoring stations (C)

Hydrological monitoring stations (Q)

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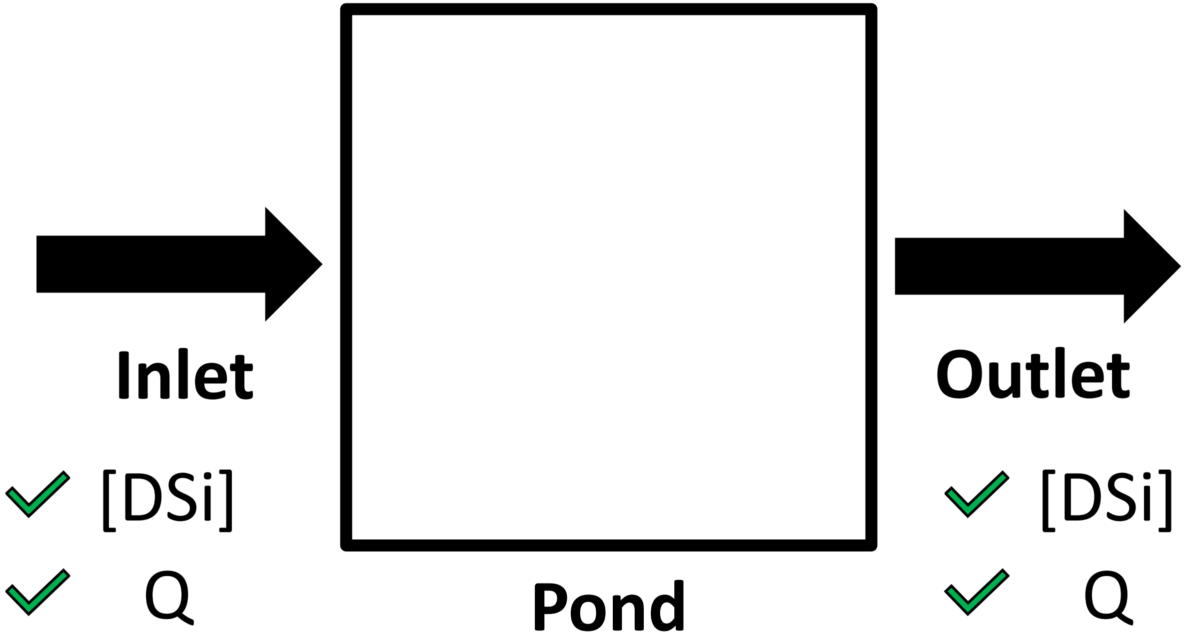

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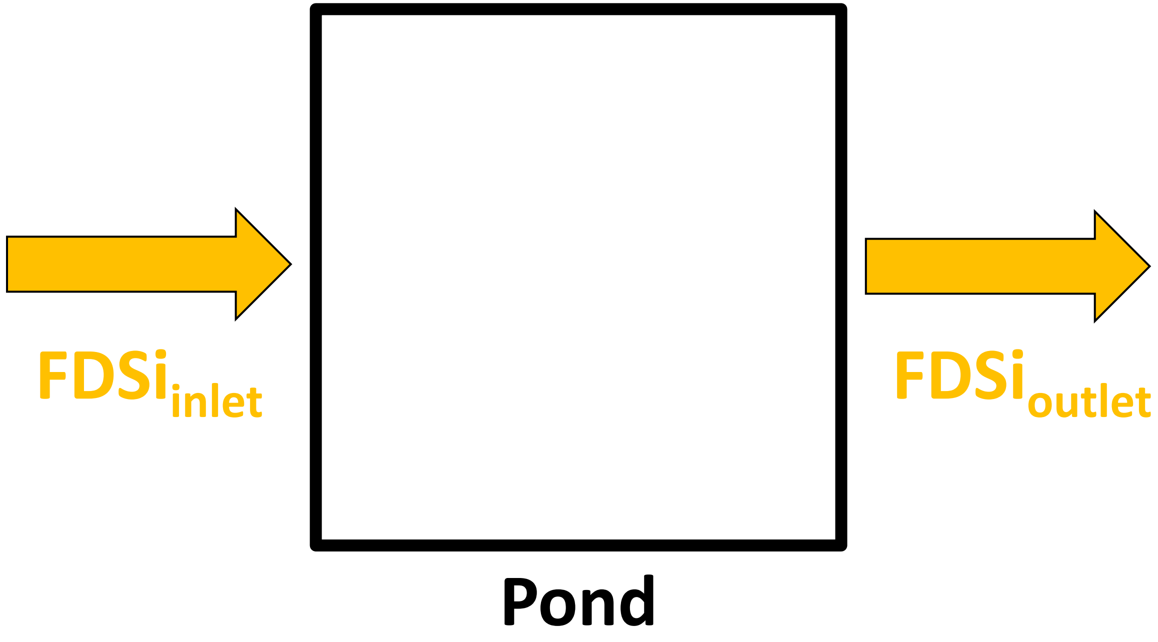

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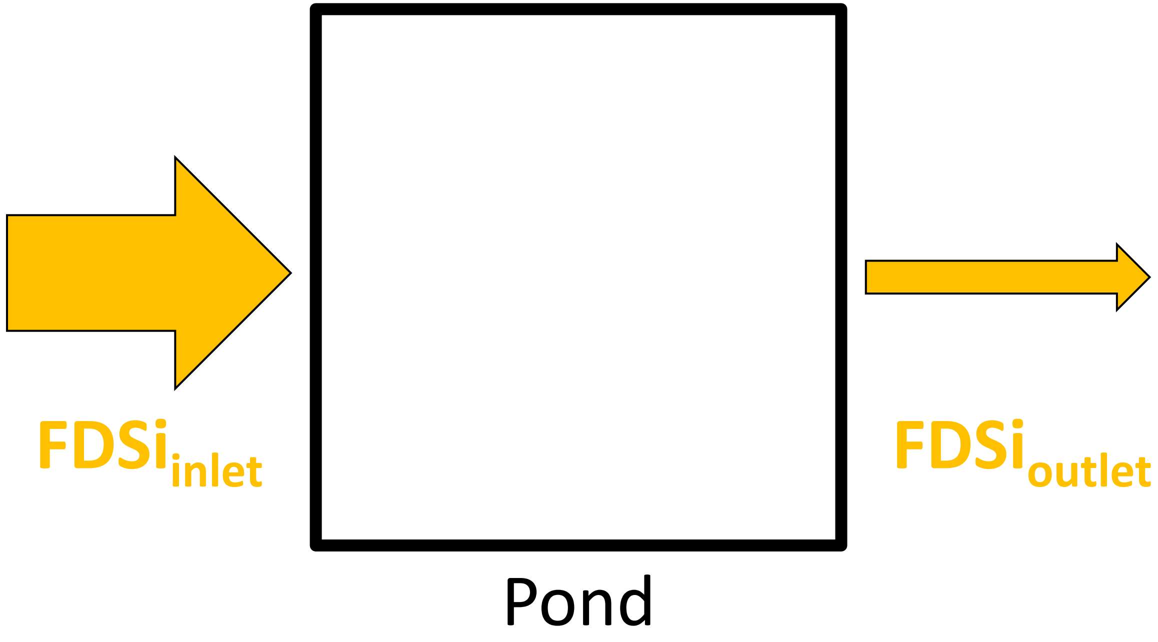

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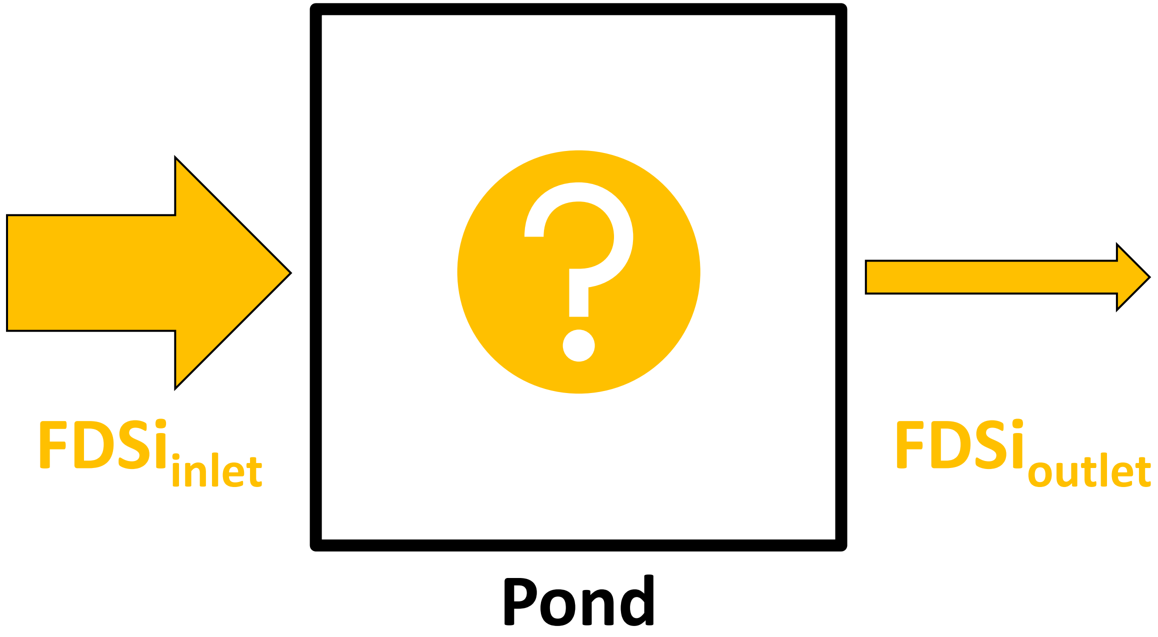

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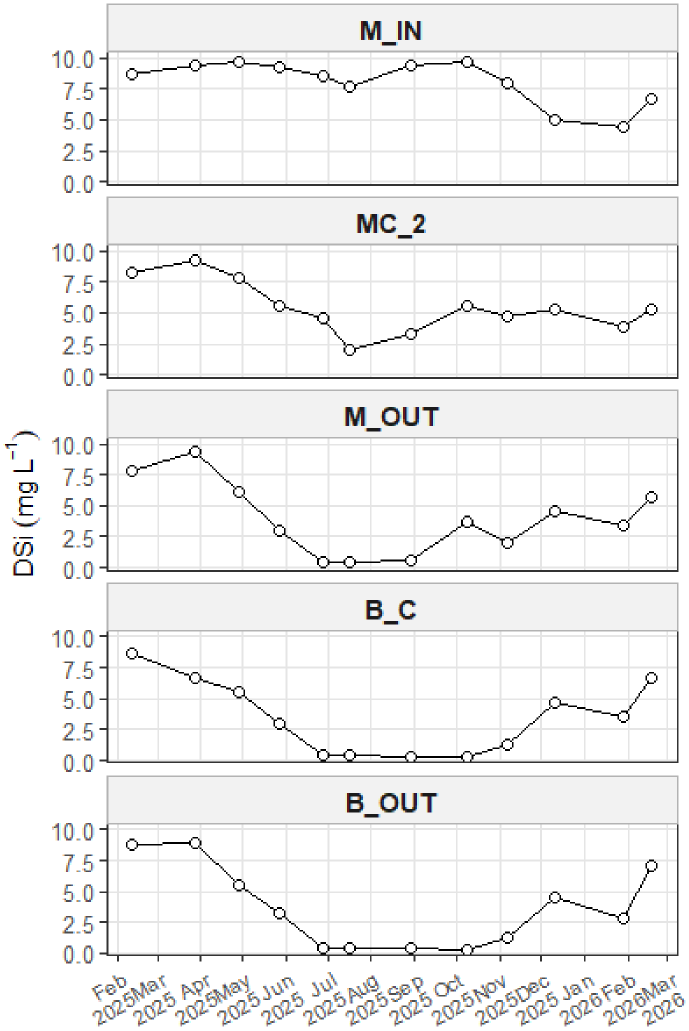
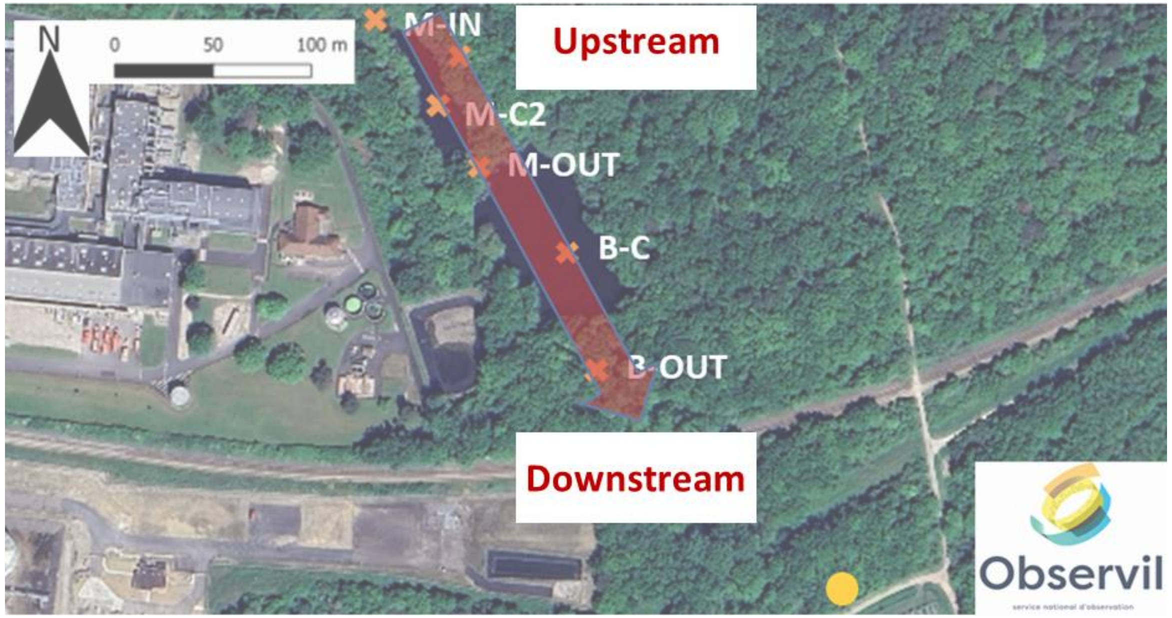


Upstream

Downstream



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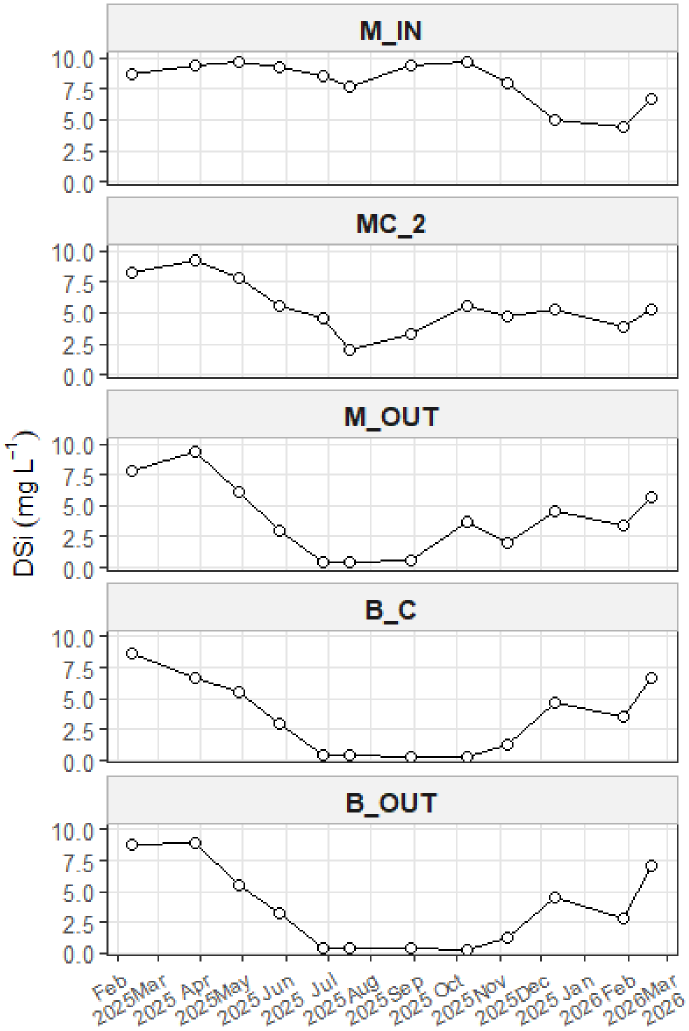
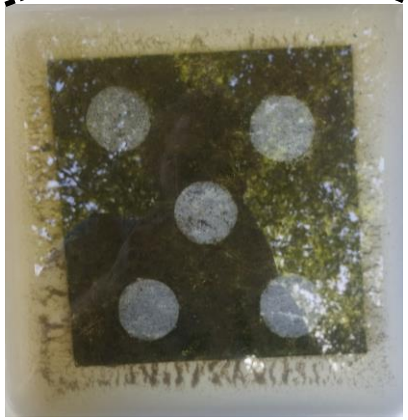


Upstream

Downstream

Monitoring of diatom communities

+ $\delta^{30}Si$



Peatland Hydrology shapes Dissolved Silicon Dynamics across Peat Profiles

Thank you for your attention !

Louis-Marie Le Fer

louis-marie.le-fer@univ-orleans.fr

PhD student, University of Orléans - OSUC / ISTO