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Characterization of nested water supplies in a mid latitude/altitude peatland using long-term monitoring data before and after restoration. The case study of the Frasne peatland (Jura Mountains, France)

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Peatland hydrology forms, together with vegetation cover and carbon dynamics, a sensitive interconnected three-pillar system, which furnishes essential ecosystem services from the local (specific biodiversity, interaction with the watershed) to the global scale (carbon and fresh water storage). The present study focuses on the hydrological function of the Frasne peatland, and especially investigates how restoration of water supplies can be used to mitigate climate change effects on peatland hydrology and sustainability.

In this perspective, the Forbonnet bog, belonging to the Frasne peatland complex (300 ha; French Jura Mountains; 46.826 N, 6.1754 E; 850 m a.s.l) is monitored in the framework of the French observatory of peatland (SNO Tourbières) since 2008. The site, restored in 2015 (European program "Life Tourbières"), is located in a wide karstifed syncline overlain by moraine deposits. Between 2009 and 2019, mean annual precipitation and air temperature were respectively 1618 mm and 7 °C.

In order to identify and model water supply and transfers at the ecosystem scale, this study combines a range of hydrological, geochemical and reservoir modeling approaches. This enabled us to propose a conceptual scheme of the hydrological functioning that implies a nested organization of 3 water origins:

(1) The superficial reservoir (acrotelm) featuring a low mineralization, has a fast (daily) reactivity to precipitation, suggesting a strong dependence to direct atmospheric inputs. In addition, the outlet discharge shows a complex relation with the water level of this layer, highlighting a threshold effect where the saturation degree of the acrotelm seems to be involved.

(2) Five years of outlet discharge and electrical conductivity (EC) monitoring highlight a seasonal pattern. During low flow periods (June-Oct.) EC is positively correlated with rainfall recharge of the previous winter (Nov.-May). Furthermore, the bog water budget is loss-making when only considering the topographical watershed. Considering the geological context, these elements

argue for groundwater inflows from the surrounding karst aquifer likely occurring at the base of the bog, throughout the permeable or discontinuous moraine layers. Vertical EC profiles show that these inflows supply the mineralized water deep reservoir of the bog.

(3) The monitoring of the restoration effects (by backfilling of drainage channels) through panpipe piezometers suggests that lateral seepage from the neighboring wooded, more elevated and mature peatlands supplies a transitional peat reservoir.

Moreover, spatial (horizontal and vertical) and temporal EC variability argue for advective water transfers through the bog.

This work supports the interest in monitoring over the long-term (several and contrasted hydrological years) for constraining hydrological processes. The three water supplies delineated could have contrasted responses to climate change and then impact both biological and carbon cycles. This work also highlights the importance to integrate hydrological processes beyond the ecosystem scale, to consider climate change and anthropogenic pressure effects on the regional hydrology that probably interact with peatlands in mountainous environments. In this perspective, the current hydrological monitoring is nowadays combined with isotopic ($\delta^{18}O$ and $\delta^{2}H$) evaluation to refine this conceptual scheme and quantify the contribution of the 3 identified water flow paths.