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Isotopes as tracers of groundwater circulation in a peat land

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Like all wetlands ecosystems, the bio-diversity of peatlands is strongly fragile as it is requiring very specific wet conditions. In the past 20 years, increasing efforts were engaged to restore degraded wetlands, to create new wetlands and to manage wetlands sustainably in order to assess their multiple benefits. Engaging specific actions to restore and preserve wetlands require an important knowledge on the water cycle in such systems. In this study, we use chemical and multi-isotopic approaches to trace the fluxes of water and dissolved element in a peatland and for the drainage network. Aims are to evaluate the origin of dissolved elements and possible anthropogenic impacts through Li, Sr, O and H isotope systematics. This approach clearly demonstrated its effectiveness for improving our understanding of the hydrological functioning of this wetland ecosystem.

Water circulation and mixing were traced using strontium and lithium isotopes. The use of Ca/Na ratios coupled with Sr isotopes constraint the end-members and mixing calculations support that in the site, Sr-isotope signatures of water could be explained solely by mixing Sr from water/rock interactions (the rainwater after run-off, basalts and carbonate weathering) without involving any other process. As no carbonate outcrops occur in the area, the carbonate end-member is allocated to the use of Ca-amendment. Lithium contents in the water fluctuate significantly and δ^7Li are extremely variable reaching values up to +1226‰.This extremely enriched ^{7}Li signature of the groundwaters was explained by an external input due to Ca-amendment, used in local agriculture. The main results are that at least three strong groundwater fluxes with distinct chemical and isotopic signatures supply water to the peatland and water volume flowing out is almost negligible as low δ^7Li are observed in the stream draining the area.

We therefore applied B isotopes to complement the investigation of δ^7Li. The δ^{11}B values increase between rivers draining basalts (around 0%¸) and the springs bordering the peatland (δ^{11}B > 25%¸). Peatland groundwaters have intermediate δ^{11}B values in the range 7.8 to 19.4‰ range accompanied by an increase in the Ca contents between the river draining basalts and water in the peatland. Regarding the δ^{11}B versus chloride as conservative element, the isotope ratio decrease with no variation in the Cl content from rain water to river draining basalts (as indicator of water rock interaction), then increase with slight increase in the Cl content in the groundwater in the peatland and end with large increase in δ^{11}B and Cl contents in the springs (as indicators of fertilizer inputs). Cross interpretation of δ^{11}B and δ^7Li confirms the role of water rock interaction and present day fertilizer inputs in the river draining basalts and in the springs bordering the peatland. However, B isotopes do not support the extremely enriched ^{7}Li signature of the groundwaters in the peatland as representative of an input due to present day Ca-amendment used in local agriculture. Thus this study opened a new field for B-Li isotope investigations in hydro-systems through their capability to trace present vs. day-past activities.