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Multi-isotopes systematics to constrain surface water–groundwater interactions in an alluvial plain: the Loire River case

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This work is dedicated to wetlands of the Loire River systems and aims to better understand the global functioning of the system from the hydrological, geochemical, ecological and sociological aspects. The present study, using a coupled hydrological and geochemical (based stable isotopes of the water molecule δ^{18}O & δ^{2}H and Sr isotopes) approach, focuses on the 'Soulangy' site with its secondary anastomosing channels just below the confluence of the Loire and Allier rivers, and also on the 'Dornant' site with two unconnected oxbow lakes 50 km upstream of the confluence. The stable isotopes of water show that the alluvial (or riverbank) aquifer feeds the Loire River during the summer, but, contrary to the classical scheme, is not recharged by the river during flood periods in the winter; the alluvial groundwater thus has a purely local origin from precipitation. The major elements reveal an anthropogenic input of Cl and more importantly of nitrate, especially near farms. The ^{87}Sr/^{86}Sr isotopes identify different groundwater layers in the alluvium, i.e. an upper and a lower alluvial aquifer, and a perched aquifer at Dornant site, that have relatively complex relationships with the surface water. The two main rivers (Loire and Allier) present distinct geochemical characteristics reflecting the different lithologies that they drain upstream. In addition, the secondary channels, lying parallel to the Loire main stream at the Soulangy site, give different geochemical signatures, which shows that they are not fed by the same overflows of the Loire; they are more-or-less well connected to the upper level of the alluvial plain, and a longitudinal study of one of these channels has revealed a Loire River influence progressively replaced by a water contribution from the upper alluvial aquifer. Similarly, the two oxbow lakes at the Dornant site are not supplied by the same water during the summer months. A conceptual scheme of the Loire hydrosystem based on δ^{18}O and ^{87}Sr/^{86}Sr suggests that the isotopic variations of the Loire River can be related to a Massif Central surface-water supply for the Loire and Allier main streams and to a groundwater supply from the alluvial plains.