**STABLE WATER ISOTOPES IN LANDSCAPES: MONITORING, MODELLING AND BIG DATA OPPORTUNITIES TO RESPOND TO CURRENT CHALLENGES UNDER ENVIRONMENTAL CHANGE**

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Quantifying water cycling through landscapes is of crucial importance for a sustainable management of land and water resources. Climate change and associated extremes (droughts, floods) are increasingly altering the water balance and magnitude of fluxes across different compartments of landscapes (that is atmosphere, surface water, groundwater, soilwater, plant water). The application of stable water isotopes developed from a specialist sub-field to major data source for innovation in hydrology. Further, over the past decade, the widespread availability of laser spectroscopy has facilitated an explosion in acquisition of stable water isotope data from catchment systems all over the world. As a result, it is now possible to record all relevant landscape compartments in terms of their isotopic composition at high temporal (<1 hr) and spatial resolution (<1 m2). Characterising the spatial and temporal variability of stable isotopes in different water fluxes and store has given profound insights into a wide range of hydrological processes at spatial scales spanning hillslopes, small to large catchments and the entire globe. These include the dominance of “young” water in the age distributions of stream flow, the importance of transpiration as a global hydrological flux and the large volumes of “old” storage involved in mixing processes prior to stream flow generation. Further, enhanced data analysis, modelling, big data and open data resulted in a step change in our understanding of hydrological systems.

This contribution will briefly highlight major breakthroughs underpinning our current understanding. However, it will also look at how integration of such data in different models (e.g. stochastic, conceptual and process-based) is helping constrain quantitative characterisation of a geographically diverse range of surface water systems. In particular, such models can increasingly resolve the importance of ecohydrological interactions and their influences on surface waters. I will show examples of how we can use such isotope data to test hypotheses about complex multi-scale hydrological processes e.g. mixing interactions between various storage, fluxes and ages, but also how they are a mean to help calibration and/or testing of Machine Learning (ML) approaches for hydrological modelling and forecasting.

In the current context of increasing pressure on water resources and quality globally, the advancement of quantitative studies of the functioning of landscapes and catchments using stable water isotopes remains urgent and extremely timely being a prerequisite to securing water supplies to sustain ecosystem growth, recharge of groundwater resources and maintaining river flows.