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Continuous radon measurements in upper catchments to determine soil water retention

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Perennial rivers flow all year, even during long periods of drought. From baseflow separation analysis, it is known that approximately 10 to 40% of the total discharge during dry periods is derived from the adjacent riverbanks and the regional groundwater in the lowland areas of rivers. However, these amounts do not even constitute half of the total discharge. This suggests that other reservoirs within the catchment hold water from wetter seasons and release them slowly during the rest of the year. While the volume of small alluvial deposits in mountain valleys and the groundwater can only account for a fraction of the 'missing' discharge components, the soil cover has a large capacity to store and release water, but is often neglected in traditional hydrogeological studies.

Hydrogeochemical tracers are often used to determine the contributions from upper catchment reservoirs; however, sampling intervals are often too large to show all of the process involved in the stream flow generation process.

^{222}Rn is a naturally produced radioactive isotopic tracer that is commonly used to quantify groundwater discharge to streams, rivers, and wetlands. Traditional sampling and analysis techniques are usually confined to point measurements taken at a specific time. However, it is difficult to constrain short- or medium-term processes occurring at the groundwater-surface water interface using single measurements. We have developed a new technique to extract dissolved gases from surface water, which allows continuous ^{222}Rn and CO_2 measurements. The technique is ideal for determining the time scales for the contribution of groundwater discharge and interflow to upper catchment creeks.

The first results from the continuous measurement techniques in combination with continuous electrical conductivity measurements and weekly sampling for major ion chemistry, stable isotopes, DIC and Si in a small headwater catchment in Australia (Lyrebird Creek Catchment, Victoria, Australia) show that direct continuous measurements capture variations in runoff processes and related chemistry changes in short-time scales ($<$2 days) that cannot be observed with weekly sampling. Major ion chemistry indicates that surface runoff dominates to more than 90% the total runoff during the peaks of major rain events and a recovery to 'normal' flow conditions ranges from 2 to 5 days. Radon activities are generally high in the creek water (range from 1000 to 3000 Bq/m3) and the continuous measurement of ^{222}Rn and CO_2, however, indicate that most of this water derives from interflow, rather than surface runoff.

Continuous measurements add the missing link to understanding the temporal variability of catchment response. The first results from this study show that more investigations in continuous chemical tracer measurements are needed to extend water flux calculations to nutrient transport behaviour and fluxes with changing flow conditions.