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Estimating groundwater contribution to transpiration using satellite-derived evapotranspiration estimates coupled with stable isotope analysis

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The relative importance of groundwater (*GW*) to sustain terrestrial vegetation has been well documented. However, estimating the contribution of various sources to transpiration (T), while important, remains a challenge particularly with respect to understanding its variability in space and time. Furthermore, quantifying *GW* use by riparian vegetation in data scarce regions may prove to be even more challenging. Although, several methods for estimating evapotranspiration (*ET*) at multiples scales exist, these methods rarely offer a way to partition subsurface water contribution to T at scales appropriate for informing management decisions. For this purpose, we present a potentially useful approach to bridging this knowledge gap.

In this study *ET* estimates from the satellite-based surface energy balance system (SEBS) model were coupled with stable isotope analysis, to map and quantify the contribution of *GW* to transpiration (ET_g), along the lower reaches of a perennial river system, in the semi-arid north-eastern region of South Africa. Plant stem, soil, stream and *GW* samples were collected on 3 sampling occasions during the 2016 dry season, which also coincided with a large El Nino induced drought period. δ^2H and δ^{18}O values of the respective samples were measured and analysed.

We found that while *GW* use was prevalent and increased with aridity, overall ET_g was fairly minimal. During the initial stages of the dry season ET_g for the study area was extremely low, approximately 0.10 % of daily *ET* or 0.01 mm d^{-1}. However, as aridity increased, ET_g increased to approximately 10 % of daily *ET* or 0.30 mm d^{-1}. The results of the various investigations undertaken in this study demonstrates the potential of coupling stable isotope analysis with satellite-derived *ET* estimates, as it can be used to provide a cost-effective and spatially representative means to quantify plant water use dynamics. This in turn can prove to be extremely beneficial to water resources managers, as it can be used to facilitate the improved allocation of water resources for human needs and environmental water requirements.