

EGU2020-12214

<https://doi.org/10.5194/egusphere-egu2020-12214>

EGU General Assembly 2020

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Focused groundwater recharge in a dryland environment: hydrometric and isotopic evidence from central Tanzania

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Groundwater, and its replenishment via recharge, is critical to livelihoods and poverty alleviation in drylands of sub-Saharan Africa and beyond, yet the processes by which groundwater is replenished remain inadequately observed and resolved. Here, we present three lines of evidence, from an extensively-monitored wellfield in central semi-arid Tanzania, indicating focused groundwater recharge occurring via leakage from episodic, ephemeral stream discharges. First, the duration of ephemeral streamflow observed from daily records from 2007 to 2016 correlates strongly ($R^2 = 0.85$) with the magnitude of groundwater recharge events observed and estimated from piezometric observations. Second, high-resolution (hourly) monitoring of groundwater levels and stream stage, established in advance of the 2015-16 El Niño, shows the formation and decay of groundwater mounds beneath episodically inundated adjacent streambeds. Third, stable-isotope ratios of O and H of groundwater and precipitation as well as perennial and ephemeral surface waters trace the origin of groundwater to ephemeral stream discharges. The identification and characterisation of focused groundwater recharge have important implications not only, locally, for protecting and potentially augmenting replenishment of a wellfield supplying the capital of Tanzania through Managed Aquifer Recharge but also, more widely, in understanding and modelling groundwater recharge in dryland environments.