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Spatio-temporal characterisation of short-lived surface-groundwater interactions using streambed thermal signatures

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Streamflow cessation and drying occurs in the majority of the world's river networks, yet the spatio-temporal dynamics of short-lived surface-groundwater interactions are poorly understood. We develop a new method to characterise water flow in variably saturated dryland streambeds based on the depth propagation of the diurnal temperature amplitude ratio. A contrast in thermal signatures between dry or saturated conditions can be used to detect and characterise short-lived stream flow and surface-groundwater interactions. We deployed 10 streambed arrays to measure temperature and pressure time series along a 12 km stretch of a dryland channel where the groundwater is monitored at 4 locations by piezometers located in the alluvium. Analyses of the thermal signatures in conjunction with the pressure records illustrate that short-lived surface-groundwater interactions are complicated and highly variable in space and time. Thermal signatures were used to categorise short-lived surface-groundwater interactions into distinct hydrological regimes: (1) dry channel, (2) surface runoff, (3) pool-riffle sequences, (4) drying pools. Our analyses demonstrates that the rate of redistribution of infiltrated water controls the duration of the pool-riffle sequences regime, which either leads to ephemeral or intermittent stream flow behaviour. This subsurface water redistribution is determined by the hydraulic conductivity of the alluvium, i.e. the heterogeneity of sediments along the channel. Our new approach can be used to investigate how short-lived flow underpins dryland ecology, influences water quality and leads to groundwater recharge.