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Investigation of groundwater recharge in arid environments through continuous monitoring of water fluxes within the unsaturated zone

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For groundwater resources management in arid environments the rate of aquifer replenishment due to groundwater recharge is one of the most important factors and unfortunately also one of the most difficult to derive with sufficient accuracy. In general, the potential evaporation by far exceeds the precipitation limiting groundwater recharge.

Unsaturated zone processes play a key role in groundwater recharge as the thickness of the unsaturated zone in arid areas may reach several thenth of meters, compared to millimeters or centimeters of assumed groundwater recharge per year. This indicates the complexity of the problem. Overcoming the field capacity along the infiltration path to initiate downward movement on such a long distance to the groundwater table would require the recharge of tenths or even hundreds of years. Also, precipitation is highly variable in space, time, and intensity and may be followed by hot and dry conditions leading to an alternation of downward and upward movement of water.

For this study, field sites in the Kingdom of Saudi Arabia (located app. 200km SW of Riyadh) were selected that represent typical settings for potential groundwater recharge in arid regions, i.e. sand dune areas and wadi beds. In the field campaign vibro-coring techniques applying direct-push technologies (Geoprobe 7720DT) were used to retrieve undisturbed soil sampling down to depths of about 15 m in the unsaturated zone. The drilled boreholes were consequently used for the installation of specially designed flat cable TDR sensors that provide continuous monitoring of the soil moisture content in high vertical resolution. In addition, temperature sensors were installed to monitor temperature fluctuations in the unsaturated zone.

We present data on the analyses of soil samples as well as on the measured water content evolution over time as determined by the TDR flat band cables. Results show, that significant changes in water content occurred within the observation time indicating the potential for groundwater recharge even under the arid conditions encountered at the field sites.

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