Geophysical Research Abstracts
Vol. 16, EGU2014-4012-2, 2014
EGU General Assembly 2014

Deuterium labeling of soil water movement in the Cuvelai-Etosha Basin, Namibia

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Groundwater recharge estimations in semi-arid areas are challenging, especially in developing countries such as large parts of Sub-Saharan Africa, where data is generally scarce. Due to high heterogeneity in soil characteristics, vegetation and land use as well as spatially and temporally highly variable rainfall, precise site studies are necessary in order to characterize processes and quantify groundwater recharge rates. The stable isotope deuterium, ^2H has been shown to be particularly suitable for such investigations. In this study, a field experiment using deuterium as an artificial tracer (^2H_2O, 70% deuterated water) was conducted to characterize movement of water during and after a synthetic rain event.

The study was carried out in the framework of the project SASSCAL (Southern African Science Service Centre for Climate Change and Adaptive Land Management) in the Niipele catchment of the Cuvelai-Etosha Basin in Namibia at two locations differing in both soil and vegetation type: A forest site dominated by *terminalia sericea*, *baikiaea plurijuga*, *burkea africana* and *acacia erioloba* with deep pure sand soil and a shrub-/woodland site characterized by smaller *burkea africana, borchemia discolor* and *acacia erioloba* on a dark loamy sand soil underlain by a thick layer of calcrete. At both locations, soils were first saturated to trigger typical rainy season conditions and avoid immediate evaporation of the deuterated water. Subsequently, 500 ml of ^2H_2O was applied homogenously over a 0.25 m^2 test plot at 25 cm depth. Finally, a 10 mm artificial rain event was applied onto the plot.

Soil samples were collected every 10 cm to a maximum depth of 2.5 m with an Eijkelkamp hand auger after 1, 2, and 5 (respective 10) days. From these, soil water is extracted in the laboratory and subsequently analyzed for deuterium concentrations using a Picarro L2120-i cavity-ringdown (CRD) water vapor analyzer after vaporization. Additionally, grain size distribution, water content and bulk density are determined in the lab.

Results demonstrate how the artificially applied deuterium distributes after a rain event of 10 mm. Both up- and downward movement of the applied deuterium could be tracked analyzing the isotopic composition of the soil profiles. Whilst the deuterium front at the sand forest site travelled towards a depth of more than 1.5 m, the peak at the loamy sand/calcrete woodland site only reached the calcrete layer at 1.2 m. Deeper infiltration into the calcrete layer was not observed. Soil sampling will be repeated at the same plots to investigate the travel depth of the deuterium front after the rainy season to enable the quantification of groundwater recharge at a site level.