Hydrological system analysis in drylands (Abstract Leipzig 2008)

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presented by C. Kuells based on research within the WADE project with contributions from Julian Klaus, Ingo Heidbüchl, Andrea Schmitz and Ofer Dahan

Abstract

In drylands the erratic occurrence and the importance of rare rainfall and flood events limit the availability of relevant hydrological monitoring data. Ecohydrological models require data about hydrological processes and system characteristics. For the Kuiseb ephemeral river and the associated paleo-channel and aquifer system in the Namib desert the application of environmental tracers for deriving such information is presented. Stable isotopes of water (^{18}O and ^{2}H) and of carbon (^{14}C, ^{13}C) and trace gases (SF_6, CFCs) were used to investigate basic hydrological characteristics: the origin and amount of groundwater recharge, past periods of intense and limited recharge, flow velocities in the alluvial aquifer. The case study of the Kuiseb river also demonstrates how environmental tracers may be used to constrain the parameter space of hydrological models.

Flow velocity in the alluvium of the Kuiseb river is fundamental for the water balance and ecohydrological processes. By means of a long term tracer injection and dilution test (1 year) the flow of groundwater could be quantified. The analysis of trace gases provided an independent approach to estimating flow velocities and mean residence times without artificial tracer based on existing atmospheric pollution only. The recharge mechanisms could be studied with inverse mixing models with major ion concentrations. Inverse mixing indicates a lateral groundwater inflow from the basement (Klaus, Kuells & Dahan, 2008). Finally, stable isotope profiles reveal the spatial distribution of recharge along the Kuiseb.

Although the application of environmental tracers can be used for quantification of hydrological processes, evaluation methods are often parametric: they depend on model assumptions. Still, the fact that most applications of environmental tracers represent inverse problems assures that a priori 'unknown' processes causes can be detected.

References

On the Kuiseb river

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Further reading

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Mosegaard, K. and Tarantola, A. (2002) „Probabilistic Approach to Inverse Problems.“ In International Handbook of Earthquake & Engineering Seismology, Part A. New York: Academic Press, pp. 237-265, 2002.

Tarantola A. (2005): Inverse Problem Theory. (PDF), Society for Industrial and Applied Mathematics, Philadelphia 2005, ISBN 0-898-71572-5.

Links

The WADE project homepage

Tarantola, A. (2004): Inverse Problem Theory and Model Parameter Estimation. Philadelphia, PA: SIAM, 2004.