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Environmental impacts on the hydrology of ephemeral streams and alluvial aquifers

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In arid and semi-arid regions alluvial groundwater resources of ephemeral streams are highly important for water supplies and ecosystems. Recent projects have studied processes of indirect recharge in situ and in detail (Dahan et al., 2008; Klaus et al., 2008). Still, little is known about the vulnerability of these aquifers to environmental impacts like surface dam constructions, land-use changes and climatic conditions as well as the time and type of response to such external impacts. With a catchment size of about 30.000 km^2 the Swakop River in Namibia is the largest of the country's twelve major ephemeral streams draining westwards into the Atlantic Ocean. The alluvial groundwater resources have been affected by the construction of two major surface water dams in the upper catchment as well as by abstractions for rural water supply, farming and mining downstream of the constructed dams (referred to as lower catchment). The determination of environmental impacts in the Swakop River catchment is difficult due to scarce hydrometric and water quality data. In order to obtain a better understanding of the hydrological system under changing environmental conditions a spatially distributed environmental tracer approach was applied. A longitudinal profile of groundwater samples was taken within a field study along the alluvial aquifer of the Swakop River. The samples were analysed for stable isotopes (18O, 2H), major ions and trace elements as well as for the residence time indicators CFC and SF6. The combined application of groundwater residence time analysis, stable isotope measurements and hydrochemical characterisation was used in order to associate a time scale with groundwater quality data. This method provides dated information on recharge and water quality before and after dam construction and can be used to detect environmental impacts on the hydrological system. CFC-12 analysis resulted in recharge years ranging from 1950 (0.01 pmol/l) to 1992 (1.4 pmol/l). Seven of 14 groundwater samples represent mainly groundwater recharged before or between the construction of surface water dams (1970 and 1978), the remaining samples represent groundwater recharge after dam construction. The groundwater residence time is generally short (recharge mainly after 1980) in the upper catchment and much higher (recharge mainly before 1980 and before dam construction) in the lower part of the catchment. Combining the age and isotope information shows how the surface water dams modified the pattern of groundwater recharge. The lower catchment has been partly cut off from the upper part in terms of indirect groundwater recharge by floods which means that most large floods originating in the headwaters of the Swakop River do not reach the lower alluvial aquifer anymore. The relationship between groundwater age and groundwater constituents helped to define baselines of hydrological properties (origin of water, recharge altitude) and of hydrochemical composition prior to the construction of dams (and other anthropogenic impacts). The well defined relationship between groundwater age and altitude of the river further helps to assess how fast different segments will be affected by these environmental impacts.

References

Dahan, O., Tatarsky, B., Enzel, Y., Kuells, C., Seely, M., Benito, G. (2008) Dynamics of Flood Water Infiltration and Ground Water Recharge in Hyperarid Desert. Ground Water, Vol. 46, 3. (6-2008), pp. 450-461.

Klaus, J., Kuells, C., Dahan, O. (2008): Evaluating the recharge mechanism of the Lower Kuiseb Dune Area using mixing cell modeling and residence time data. Journal of Hydrology, v. 358, p. 304-316.