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Salinization sources and management strategies in South Africa

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Irrigation practices of various kinds are used in farming all over the world. Especially in cases of over-irrigation and inadequate drainage, evaporation losses can be high and lead to accumulation of minerals in the soils. Water uptake in crops is driven by osmosis, and as such it is reduced or diminished when salt concentrations in the soil water increase. Today, approximately 10 % of irrigated land worldwide has faced diminished production due to salinization, and losses increase every year. There is also concern that global warming can deteriorate production further due to increased evaporation, which should be considered in the light of increasing crop demands with population growth. There is therefore pressing concern to study effects and measures on a global scale.

Continental to global scale hydrological models have emerged in recent years as tools for flood forecasting and estimation of dynamic water fluxes. HYPE is a catchment-based model that simulates rainfall-runoff as well as water quality processes. Recently, an application was developed based on HYPE that covers almost the entire globe, World Wide HYPE (Arheimer et al., 2019). This tool also has great potential for future global assessments of soil salinization under different scenarios.

In this work, a salinization routine was developed in HYPE, whereby salt components follow all main natural hydrological pathways as well as irrigation using groundwater or river flow as a water source. Equilibrium reactions, complexation and cation exchange determine the distribution between dissolved and solid states in the soil. A semi-arid catchment in South Africa with salinization issues (the Crocodile River, Mpumalanga province) was chosen for code development, calibration and verification. Evaluations were based on comparison of simulated and observed mineral concentrations in rivers and groundwater. The model was also tested for all of South Africa.

Detailed analyses of the soil salinity processes were carried out for the Crocodile River catchment. Results show the sensitivity of salinization to hydrological parameters such as recession coefficients, infiltration capacities and macropore flow. This will guide future calibration of the World Wide HYPE model setup. Assessment of the major processes and sources of salinization is performed, and mitigation strategies such as irrigation control and drainage management are tested. Possible regionalization of parameters for global salinization modeling is also suggested based on the results.

Arheimer, B., Pimentel, R., Isberg, K., Crochemore, L., Andersson, J. C. M., Hasan, A., and Pineda, L. (accepted). Global catchment modelling using World-Wide HYPE (WWH), open data and stepwise parameter estimation, *Hydrol. Earth Syst. Sci*, <https://doi.org/10.5194/hess-2019-111>, in press, 2019