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Rainfall-runoff modelling of the Okavango River catchment to assess impacts of land use change on runoff and downstream ecosystems

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The competition between human water use and ecosystem water use is one of the major challenges for water resources management at the global scale. We analyse the situation for the Okavango River basin of southern Africa. The Okavango River is representative for many large rivers throughout the developing world in that it is ungauged and poorly studied. The Okavango basin – spanning over Angola, Namibia and Botswana – represents a multi-objective problem in an international setting. Economic benefits of agricultural development and conservation of ecosystem services call for opposed actions.

A semi-distributed rainfall-runoff model of the Okavango catchment is set up using the Soil and Water Assessment Tool (SWAT). The model is sufficiently physically based to simulate the impact on runoff of extent of agricultural use, crop types and management practices. Precipitation and temperature inputs are taken from datasets covering large parts of the globe. The methodology can thus easily be applied for other ungauged catchments. For temperature we use the ERA-Interim reanalysis product of the European Centre for Medium-Range Weather Forecasts and for precipitation the Famine Early Warning Systems Network data (FEWS-Net). Tropical Rainfall Measurement Mission (TRMM) data resulted in poor model performance compared to the FEWS-Net data.

Presently, the upstream catchment in Angola is largely pristine and agriculture is basically restricted to dry land subsistence farming. But economic growth in Angola is likely to result in agricultural development and consequent impacts on catchment runoff. Land use scenarios that are simulated include large scale irrigated agriculture with water extractions from the river and the shallow aquifer. Climate change impacts are also studied and compared to land use change impacts.

The downstream part of the basin consists of the large Okavango Wetlands, which are a biodiversity hotspot of global importance and, through tourism, an important source of economic income for Botswana. A second hydrological model simulating flow through the wetlands is used to study the impact of catchment runoff changes on the hydrology and ecology of the wetlands.

The final goal of the project is to demonstrate the relation between economic benefits of water abstractions in the upstream and downstream environmental impact. Furthermore the results will provide a basis for defining adequate compensations for upstream stakeholders who forego benefits of agricultural intensification to ensure the conservation of downstream ecosystem services.