Hydrological modeling on multiple scales in a data scarce catchment in East Africa

Introduction
The Kilombero floodplain in Tanzania is one of the focal areas of the “GlobE - Wetlands in East Africa” project which emphasizes on reconciling future food production with environmental protection in East African wetlands. The project covers multiple hydrological scales from the plot scale up to the regional scale in the countries Kenya, Rwanda, Tanzania and Uganda. This study concentrates on wetland-catchment interactions in Kilombero Valley which is envisaged as large scale rice production area in the forthcoming years. We are analyzing historical, current and future water availability and distribution inside the catchment and its inherent wetland.

Modeling concept
- Different models on catchment - wetland scale:
  1. Point scale: Hydrus 1D
  2. Flood model: HEC-RAS
  3. Hydrological models: SWAT and SWATgrid
  4. Hydrochemical model: PHREEQC
- Changing land use patterns require distributed hydrological modeling to simulate future water availability (SWAT/SWATgrid)
- Integration of global change scenarios (land use and climate) on catchment scale will be conducted

Conclusions
- The shallow groundwater level at wetland scale responds quickly to precipitation, sub-surface flow and flooding
- The Kilombero wetland is characterized by a groundwater-surface water system with decreasing influence of the Kilombero river from the fringe position
- Results on plot scale show impact of soil cultivation of the upper two layers on soil physical properties and soil moisture dynamics
- Climate station data is scarce in time and space on catchment scale therefore different data sources have to be used

Workflow

Experimental design wetland scale
Plot scale experiments at three different hydrological regimes of the wetland transect:
- agricultural field trials (paddy rice)
- hydrological instrumentation (soil moisture, gw-level)
- soil analysis (nutrients + physical properties)

Research Area

First results wetland scale
- Strong groundwater-surface water interaction
- Mixed and spatially heterogenous groundwater-surface water impact on soil saturation during the rainy season
- Application of Hydrus 1D model to simulate soil moisture dynamics at the transition period between dry and wet season at the experimental center position.
- Soil moisture dynamic is controlled by soil properties and land use during the dry season as well as during the transition periods (dry-wet and wet-dry) and is controlled by flooding during the rainy season
- Modeling results were good with R² of 0.92 and Nash-Sutcliffe Efficiency of 0.9
- The calculated error of the water balance was < 1%

Authors:
K. Näsch 1, S. Beuel 1, B. Diekkrüger 1, G. Gabiri 1, C. Leemhuis 1, A. Müller 1, M. Ziegler 1
1University of Bonn, Department of Geography, Mecklenhner Allee 166, 53115 Bonn, Germany
2University of Bonn, Department of Geology, Nussallee 8, 53115 Bonn, Germany
3University of Applied Sciences Mecklenburg-Vorpommern, Department of Water and Waste Management, Breitscheidstr. 2, 28194 Magdeburg, Germany
Contact: Kristian.Naescher@uni-bonn.de