Oral presentation for Session HS5.5: Drought, Water Scarcity and Food Security: Forecasting, warning and natural resources management

Water scarcity and distribution in sub-Saharan Africa; Impact of local spatio-temporal variability in meteorological data on estimating stream flow at basin scale

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Abstract:

The growing demand for food and biomass will increase the pressure on water resources and ecosystems. This may be in conflict in realizing Millennium goals: reduction of poverty and hunger and environmental sustainability. There is a need, in particular in Africa, to increase the productivity and eco-efficiency of agricultural systems to meet future global demands. However, quantitative information is lacking on where and how to realize it. Therefore, the availability and distribution of water resources should be made explicit at regional and continental levels and further be quantitative over time (dry and wet seasons). Water resources are often considered in terms of mean annual river flows. In Africa, river flows change often dramatically from one season to the next. As a result actual water scarcity may be overlooked as mean river flows mask seasonal water shortages, like in the headwaters of the Limpopo basin. Knowledge on the seasonal variability in meteorological data on estimating stream flow at basin scale is needed.

Measures, for instance water harvesting, are options to improve agricultural production, but the effect on the river basin scale is still unknown. The analysis focuses on the use of GIS data, hydrological tools and models to study water resources for Africa, needed to investigate in which regions it is feasible to increase agricultural production and/or productivity. The underlying question is to understand the real spatio-temporal water availability or water scarcity. Increased production requires more water, thus it reduces the water resources. The effect of increasing productivity levels and measures to improve crop water availability and water use efficiency on the water resources are examined. Possibilities for using surplus water in downstream areas of the basin can then be quantified.

The objective is to demonstrate tools that quantify the space-time variation in water availability and water use in a river basin. River flows in a basin depends on hydrological and topographical conditions from the upstream catchment. They are estimated with the aid of the one-dimensional groundwater model SIMFLOW. The model simulates the rather complex process of rainfall-runoff involved in such a manner that it is sufficiently accurate without requiring too much input data and computer time. Being physically based it can be used in situations with changing hydrological conditions.

The required data for the modelling approach is handles within a GIS framework. The analysis will be carried out for entire Africa, using grid cells of approx 9*9 km. We used the HydroSHEDS data (Hydrological data and maps based on SHuttle Elevation Derivatives at multiple Scales), which provides hydrographical information in a consistent format for regional applications. Stream networks and sub-basins are identified to carry out the flow routing. Other required data is land use, soil data, drainage resistances and agricultural water

requirements. For the meteorological data the CRU data has been used. To test the model we applied it to the Limpopo river basin (about 415 000 km²), situated in Mozambique and upstream parts in Zambia, Botswana and South Africa. For the gauge near Beitbridge along the South-African and Zambian border measured and calculated discharges were compare. There are differences, but the lower and higher flows are modelled quite well. Furthermore human interventions like projected land use changes were calculated and will be presented. Solutions are needed to make the transition from a water scarce to water secure situation. Small-scale water solutions, like water harvesting, are a major key to increase agricultural productivity. In some regions large-scale irrigation schemes can be developed, but large schemes are costly and slow to develop. In other regions the use of wetlands or groundwater are considered to bridge dry periods.