Teleconnections in the global water system, their impacts on local water resources, and opportunities for addressing them in IWRM

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Abstract

Food security is increasingly constrained by water scarcity, while at the same time agriculture and food production contribute to the overexploitation and degradation of water resources in more and more regions of the world. Integrated water resources management (IWRM) has been promoted as response to the growing pressures, but its (not always successful) implementation has been focused on catchments and river basins, not accounting for growing external pressures on water resources.

This thesis starts by providing an improved global water assessment, integrating the full blue and green water resources and their agricultural productivities and the interdependencies with land use. Based on that, it assesses the growing external pressures on local water resources, via so-called teleconnections, associated with global change and globalization. Three main teleconnections in the global water system are mapped and analyzed for their impacts across regions: i) atmospheric moisture transport and moisture recycling, which transmit the hydrological effects of land cover changes to downwind regions, ii) trade with agricultural commodities and associated imports and exports of virtual water, and iii) foreign direct investments in agricultural land and their impacts on local water resources in the target countries.

The geographical focus of this thesis is on Sub-Saharan Africa (SSA), a hotspot of water scarcity and food insecurity, which also holds large potential for sustainable agricultural intensification. The three teleconnections can affect local water resources (and hence also food security) in SSA e.g. via impacts of i) deforestation on downwind precipitation in water scarce rainfed regions in West Africa, ii) food imports by European countries on consumptive water use in water scarce West African export regions, iii) foreign direct investments in agricultural land on river discharge in East African "water towers". Water scarcity in SSA differs significantly from that in the MENA (Middle East – North Africa) region, which has a much lower degree of freedom to achieve water and food security through local IWRM.

By combining the results of different large- and meso-scale simulation models with national and local data, this thesis generates new globally consistent, yet context-specific information on the impacts ("footprints") of teleconnections on local water resources. It demonstrates that water scarcity and food insecurity can be significantly aggravated by external drivers as transmitted through these teleconnections. With that, it provides a basis for recommendations on how to address these teleconnections in Integrated Water Resources Management (IWRM), for turning them into opportunities for sustainable production and consumption. Opportunities for doing so include e.g. the integration of i) water-related teleconnections in spatial planning, ii) virtual water as an active component of IWRM, and iii) FDI into strategies for improving agricultural water productivity in target countries.