Geophysical Research Abstracts
Vol. 13, EGU2011-7641, 2011
EGU General Assembly 2011

Vulnerability of agricultural production in the Inner Niger Delta to water resources management under climate variability and change

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A key pattern in most tropical and sub-tropical river basins is the strong seasonality of the flow regime. Especially in densely populated lowland areas the flow regime governs the water availability for human use. During the rainy season large lowland areas are inundated and the additional water surfaces of these wetlands increase evapotranspiration and groundwater recharge. However, these conditions change totally during the dry season. The study area, the Inner Niger Delta (IND), situated in an arid region in West Africa, is an example of such a wetland. The IND is a network of tributaries, channels, swamps, and lakes providing vital habitats supporting livelihoods in fishing, farming, and stock farming. These floodplains support the highest livestock density in Africa, and are increasingly threatened by a variety of external and internal pressures, such as climate variability as well as unsustainable uses. Food production in the IND is closely related to wetland inundation and of outmost importance for the livelihood of approximately one million people inhabiting the wetland region. The extent of the temporary inundated area ranges between 10,000 and 30,000 km^2 and is one important indicator for food security. It highly depends on rainfall volumes and intensities of the monsoon in the mountainous headwater region.

Assessing the vulnerability of the socio-ecological system of the IND to climate variability, droughts, water and land management is subject of this study. This requires adequate representation of natural processes, particularly the processes of wetland inundation and release. Process-based modeling of wetlands in catchments, especially in large-scale river basins, is still a challenge, and integration of riparian zones in catchment modeling is even more challenging because of the complex interactions and feedbacks between hydrology, vegetation and soils in wetlands.

For this purpose an inundation module was implemented in a semi-distributed eco-hydrological model. Moreover, a reservoir module was developed and integrated into the hydrological model in order to account for the impacts of different reservoir management strategies in the upstream catchment. On the one hand the integrated model is used to investigate the impacts of climate variability and change on inflow patterns and inundation processes in the wetland, and on the other hand it is used to study possible adaptation and mitigation strategies in terms of reservoir management. The results show that beside climate change the reservoir management of existing and planned reservoirs has an important effect on the inflow to the IND and therefore on food production.