Geophysical Research Abstracts, Vol. 7, 09864, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09864

The importance of soil moisture content in eco-hydrological modelling of groundwater-fed alluvial wetlands

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The occurrence and distribution pattern of vegetation in wetlands is to a large extent controlled by the site hydrology. The available water and water quality are important site factors, and are in turn influenced by the size and the interactions between the different water fluxes, i.e. groundwater, surface water and rainfall/evapotranspiration. Eco-hydrological models link the distribution of plant species and vegetation types to hydrological variables and water quality. Often, relations between vegetation and hydrological variables are based on a statistical analysis for a certain area. Also, most wetland studies focus on groundwater levels instead of soil moisture content in the root zone, although this is a more direct indicator of water available to plants. This limits the transferability of vegetation-hydrology relationships and the predictive power of the eco-hydrological model. In this research, soil moisture content and groundwater levels are measured in an alluvial groundwater-fed wetland for a period of two years. Groundwater levels and soil moisture content are modelled with the physically-based two-dimensional HYDRUS-2D model that simulates water flow in variably saturated media by numerically solving the Richards‘ equation. The aim of the study is to establish whether root zone conditions can be inferred from groundwater levels by comparing time series and by investigating the effects of changes in the regional hydrological system on both types of hydrological variable. The study site is a wetland along the river Dijle displaying a typical microtopography with natural high levees close to the river and a floodplain depression further from the river. The hydrology is highly dynamical with groundwater amplitudes ranging from 1.5 metres close to the river to 0.5 meters in the floodplain depression. A previous eco-hydrological study of the area has established that the distribution of vegetation is best explained by average groundwater level and groundwater amplitude. A transect was selected from levee to depression along the main groundwater flow direction and crossing several vegetation zones. Measurements indicate soil moisture content in the root zone remains close to saturation when groundwater levels drop down to 60 cm below surface due to capillary rise in the fine-textured soils. This effect probably explains the wide ranges in groundwater levels associated with vegetation types in the area compared to the ranges in groundwater level found for the same vegetation types in other areas. The HYDRUS-2D model was calibrated and validated with the two-year measured data and proved to be capable of describing the groundwater dynamics and soil moisture content variation along the transect and over the seasons. The model was used to calculate the effect of a scenario of decreasing groundwater seepage on groundwater level and soil moisture content. The SEV (Sum Exceedance Value) was calculated to translate both changes in groundwater level and soil moisture content in shifts in the vegetation zonation along the transect. Results show a different response if groundwater levels or soil moisture content changes are used. This demonstrates the importance of incorporating soil moisture content in eco-hydrological studies in order to predict more reliably the response of vegetation to changes in the hydrological boundary conditions.