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Modelling the Hydrologic Regime of Arid Inland Wetlands: Non-linear Relationship Between Root-uptakes of Water and Underground Water Table

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Abstract: Wetlands remaining in the arid inland river landscapes of northwestern China suffer degradation and their resilience and ability to continue functioning under hydrologic and land use changes resulting from climate change may be significantly inhibited. Information on the desert-oasis wetlands, however, is sparse and knowledge of how ecological functioning and resilience may change under climate change and water-resource management is still lacking. Research in oasis wetland areas of the Northwestern China identified linkages between subsurface flow, plant transpiration, and water levels. In this study, we present an ecohydrological analysis of the energy and water balance in the wetland ecosystem. A process-based stochastic soil moisture model developed for groundwater-dependent ecosystems was employed to modelling the interactions between rainfall, water table fluctuations, soil moisture dynamics, and vegetation, and to investigate the ecohydrology of arid inland wetlands system. Field measured groundwater levels, vertical soil moisture profiles, soil water potentials, and root biomass allocation and transpiration of pioneer species in the wetlands were used to calibrate and validate the stochastic model. The parameterized model was then running to simulate the probability distributions of soil moisture and root water uptake, and quantitative descript the vegetation–water table–soil moisture interplay in the hypothesized scenarios of future. Our analysis suggested the increasing rates of water extraction and regulation of hydrologic processes, coupled with destruction of natural vegetation, and climate change, are jeopardizing the future persistence of wetlands and the ecological and socio-economic functions they support. To understand how climate change will impact on the ecohydrological functioning of wetlands, both hydrological and land use changes need to be considered in future works.

Keywords: Wetland ecosystem, groundwater, soil moisture dynamics, water balances, Heihe River Basin