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Uncertainty in parameterisation and model structure affect simulation results in coupled ecohydrological models

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Abstract. In this paper we develop and apply a conceptual ecohydrological model to investigate the effects of model structure and parameter uncertainty on the simulation of vegetation structure and hydrological dynamics. The model is applied for a typical water limited riparian ecosystem along an ephemeral river: the middle section of the Kuiseb River in Namibia. We modelled this system by coupling an ecological model with a conceptual hydrological model. The hydrological model is storage based with stochastical forcing from the flood. The ecosystem is modelled with a population model, and represents three dominating riparian plant populations. In appreciation of uncertainty about population dynamics, we applied three model versions with increasing complexity. Population parameters were found by Latin hypercube sampling of the parameter space and with the constraint that three species should coexist as observed. Two of the three models were able to reproduce the observed coexistence. However, both models relied on different coexistence mechanisms, and reacted differently to change of long term memory in the flood forcing. The coexistence requirement strongly constrained the parameter space for both successful models. Only very few parameter sets (0.5% of 150 000 samples) allowed for coexistence in a representative number of repeated simulations (at least 10 out of 100) and the success of the coexistence mechanism was controlled by the combination of population parameters. The ensemble statistics of average values of hydrologic variables like transpiration and depth to ground water were similar for both models, suggesting that they were mainly controlled by the applied hydrological model. The ensemble statistics of the fluctuations of depth to groundwater and transpiration, however, differed significantly, suggesting that they were controlled by the applied ecological model and coexistence mechanisms. Our study emphasizes that uncertainty about ecosystem structure and intra-specific interactions influence the prediction of the hydrosystem.

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