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On the importance of including vegetation dynamics in hydrological simulation under climate change: A case study in the Jing River Basin

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The role of catchment vegetation within the hydrological cycle and its impact on hydrological processes has long been a topic of research within hydrology. A key element in quantifying the hydrological impact of climate change is the relationship between catchment vegetation and runoff, which continues to be a productive area of research within hydrology. However, the parameterization of vegetation composition and distribution as a dynamic component is insufficient in stand-alone hydrological modeling studies. Dynamic global vegetation models (DGVMs) are able to simulate transient structural changes in major vegetation types but do not simulate runoff generation reliably. A biosphere hydrological model (LPJH) coupling a prominent DGVM (Lund–Postdam–Jena model referred to as LPJ) with a stand-alone hydrological model (HYMOD) may simulate both vegetation dynamics and runoff generation reasonably. This study applies the LPJH model to the Jing River basin, a tributary of the Yellow River, with the objective of analyzing the role of vegetation in the hydrological processes at this semi-arid basin and evaluating the impact of vegetation change on the hydrological processes under climate change. The results show that the LPJH model gives reasonable hydrological simulation in terms of runoff. It is shown that changing climate conditions in terms of co2, temperature, precipitation, and the combination changes of these variables would result in actual evapotranspiration and runoff changes. Theses changes are mainly attributable to changes in transpiration driven by vegetation dynamics, which are not simulated in stand-alone hydrological models. Therefore, the composition and distribution of vegetation are of fundamental importance for evapotranspiration and runoff generation, especially under climate change. The percent of impact from each climate variable is also explored by using the LPJH model, which gives an overall view of climate change impact on hydrological processes and helps for river basin management under climate change. The LPJH model potentially provides a powerful tool for simulating vegetation response to climate changes at basin scale in the biosphere hydrological cycle.