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Drivers of actual evapotranspiration and runoff in East Africa during the mid-Holocene: assessments from an ecosystem model

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Understanding the evolution and response of the hydrological cycle under changing climate is of vital importance for human populations all around the world. Especially so in regions like East Africa, where society largely depends on the availability of water and the hydrologic conditions are highly sensitive to changes in the distribution and amount of precipitation. In this endeavor, studying past hydrological changes provides us realistic scenarios and data to better understand and predict the extent of the future hydrological changes. However while studying the past, paleovegetation, which plays a pivotal role in the paleo-hydrological cycle, is difficult to determine from fossil pollen records as pollen data can provide very limited information on spatial distribution and composition of the vegetation cover. Here ecosystem models driven by paleo-climate conditions can provide spatially-extensive information on the coupled dynamics of past vegetation and hydrological measures such as actual evapotranspiration (AET), potential evapotranspiration (PET) and runoff. In this study, we looked at AET and runoff estimates of an ecosystem model as these are important elements of water transfer in the hydrological cycle and critical for water balance calculations. We applied the ecosystem model, LPJ-GUESS, for present-day with data from Climatic Research Unit CRU TS3.20 climate dataset, and for mid-Holocene (6 kyrs BP) with data from an atmosphere-ocean coupled global climate model EC-Earth. Climate data for both periods were downscaled to a 10 arc min resolution in order to better resolve the impacts of the complex topography on vegetation distribution, AET and runoff. Comparison of the simulated AET and runoff values for East Africa, show similar patterns as annual AET estimates for the period 1961-1990 by Food and Agriculture Organization of the United Nations (FAO), and with the observed runoff data from Cogley (1998), respectively. Comparison of simulated present-day and mid-Holocene AET values suggests an increase in AET over north-eastern parts of East Africa, especially over Sudan region and Kenyan Rift during the mid-Holocene whereas a decrease in AET during the mid-Holocene over south-southeastern parts of East Africa. On the other hand, comparison of simulated present-day and mid-Holocene runoff values suggests an increase of runoff in north-eastern parts, especially along the East African Rift and decreased runoff in the southern parts of East Africa during the mid-Holocene.