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# Catchments Under Change: Assessing Impacts and Feedbacks from New Biomass Crops in the Agricultural Midwestern USA

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In order to meet the challenges of future change, it is essential to understand the environmental response to current conditions and historical changes. The central Midwestern US is an example of anthropogenic change and environmental feedbacks, having been transformed from a natural grassland system to an artificially-drained agricultural system. Environmental feedbacks from reduced soil residence times coupled with increasing crop fertilization have manifested as a hypoxic zone in the Gulf of Mexico. In an effort to address these feedbacks while meeting new crop demands, large-scale planting of high-yielding perennial biomass crops has been proposed. This could be detrimental to both human and environmental streamflow users because these plants require more water than do current crops. The lowest natural flows in this shallow groundwater-dependent region coincide with the peak of the growing season, thus compounding the problem. Therefore, for large-scale biomass crop production to be sustainable, these tradeoffs between water quality and water quantity must be fully understood.

To better understand the catchment response to current conditions, we have analyzed streamflow data in a central Illinois agricultural watershed. To deal with future changes, we have developed an integrated systems model which provides, among other outputs, the land usage that maximizes the benefit to the human system. This land use is then implemented in a separate hydrologic model to determine the impact to the environmental system. Interactively running the two models, taking into account the catchment response to human actions as well as possible anthropogenic responses to the environment, allows us to examine the feedbacks between the two systems. This lets us plot the trajectory of the state of the system, which we hypothesize will show emergent internal properties of the coupled system. Initial tests of this modeling framework show promise that this may indeed be the case. External economic forcings were applied to the human system, resulting in greatly-reduced streamflow due to a large percentage of the watershed planted with the new crops. The anthropogenic response to this environmental feedback was an imposed minimum flow requirement in the integrated model, which resulted in a new optimized land use that improved environmental conditions, but not to the previous state. Further refinement of this experiment will provide thresholds, both where crop types change, and where environmental damage becomes evident. Preliminary results revealed added complexity, as tributary and mainstem subcatchments do not respond equally, even in this homogenous region; thus the spatial context also becomes important.