

Economic and Environmental Modeling of Bioenergy Production – Policy Impacts on Water Quality

Authors: Kelsie Ferin, Jia Zhong, Weiwei Wang, Andy VanLoocke, Madhu Khanna

Bioenergy feedstocks can provide many potential ecosystem services but also pose many tradeoffs and challenges. Key examples include the tradeoff of provisioning energy and bioproducts, reducing carbon emissions and reducing nitrogen run-off from cropland versus competing for land with food and or natural habitat. Current production systems, in particular annual croplands, are major contributors to nitrogen pollution in surface waters and a driver for the Gulf of Mexico Hypoxic Zone. Therefore, opportunities exist to improve water quality and provide other ecosystem services by growing energy crops on cropland, but balancing these with food and feed production and costs of feedstock production remains a challenge. A predictive, policy oriented approach is required to accurately investigate these tradeoffs at scale.

This poster will describe our proposed research to conduct an integrated set of experiments that combine economic and ecosystem modelling approaches to aid in assessing tradeoffs between current production systems and advanced bioenergy systems. Our approach will combine BEPAM (Biofuel and Environmental Policy Analysis Model) economic model and Agro-IBIS (Integrated Biosphere Simulator – Agricultural Version) agroecosystem model with state-of-the-art spatial mapping of land characteristics in the Central and Eastern US. The BEPAM model is a multi-market, dynamic, open economy model that integrates the fuel sectors in the US, including agricultural and forestry sectors. Agro-IBIS is a process-based agro-ecosystem model that simulates the physical cycling of carbon, nitrogen, water and energy in managed and unmanaged systems. Both models have been used separately to quantify economic and water quality impacts of bioenergy production. The key advancement in the current project is to use the models together to constrain and increase the complexity and breadth of modeling capabilities.

The poster will present our findings using the BEPAM and Agro-IBIS models. Specifically, it will show the land types and locations where energy crops can be produced economically to meet demands posed by a biofuel mandate determined using BEPAM. It will also show the findings from the Agro-IBIS models on the implications of converting cropland to varying levels of energy crop production on nitrate run-off and hypoxia in the Gulf of Mexico. We will describe proposed integrated systems approach to link the two models and discuss the implications of our findings for the design of policy to meet both energy production and ecosystem service provision goals simultaneously.