U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Water Quality Assessment of Pesticide Usage for Biofuel Production

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Background and Introduction

- The Energy Independence and Security Act mandates production of 36 billion gallons of renewable fuel by 2022
- Environmentally sustainable feedstock production methods are needed to meet these long-term goals

- First generation biofuel feedstock
  - Edible food sources (sugars, starches, plant oils and fats)
  - High conversion efficiency
  - Limited carbon sequestration benefits
- Second generation sources
  - Cellulosic biomass (wood chips, grasses, crop residue, and biological waste)
  - Lower energy input and water usage than first generation
  - Greater potential carbon sequestration
- Advanced biofuel feedstock sources
  - Algae, photosynthetic bacteria and other potential sources
  - High biomass density and small footprint
  - High water demand

Figure 1: Biofuel feedstock. Top: First-generation sources, middle: second generation sources, bottom: higher-generation sources

- Agricultural pesticide use of over 500 million lbs per year
- Over 16,000 miles of streams and rivers and 370,000 acres of lakes and reservoirs in the U.S. impaired because of pesticides[1]
- EPA recommends determining best management practices (BMPs) to mitigate negative environmental effects from biofuel production, including water quality
- Lack of studies on the water quality impacts of different biofuel feedstock production in the literature
- Different biomass feedstock and BMPs will have different water quality effects, including production and application of fertilizers, pesticides, herbicides and fungicides

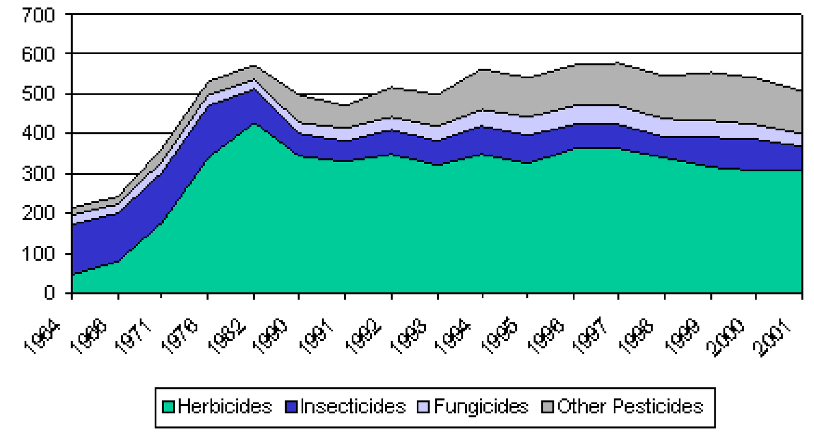

Figure 2: Total Pesticide Use in United States (million lbs)[2]

➢ Need a baseline assessment of water quality impacts of pesticides and herbicides associated with various production techniques

[1]*Biofuels and the Environment: the First Triennial Report to Congress (External Review Draft)*, Environmental Protection Agency, 2011. Washington, DC, EPA/600/R-10/183A.
[2]*USDA website (http://www.ers.usda.gov/Briefing/Agchemicals/pestmangement.htm#pesticide)*

Approach

To understand the water quality impacts associated with pesticide usage for biofuel feedstock production, it will be necessary to develop a calibrated model that can compare different best management practices and feedstock sources. Pesticides are transported through the environment through surface runoff, sorption onto soil particles and erosion, groundwater seepage, atmospheric deposition, and flow within water bodies. During transport pesticides can be degraded biologically. Figure 3 shows a schematic of the hydrologic processes affecting pesticide fate and transport in the environment. The modeling approach must take into account each of these processes to assess the impacts of changes in land use on water quality. The model will require a large database of climate and flow data.

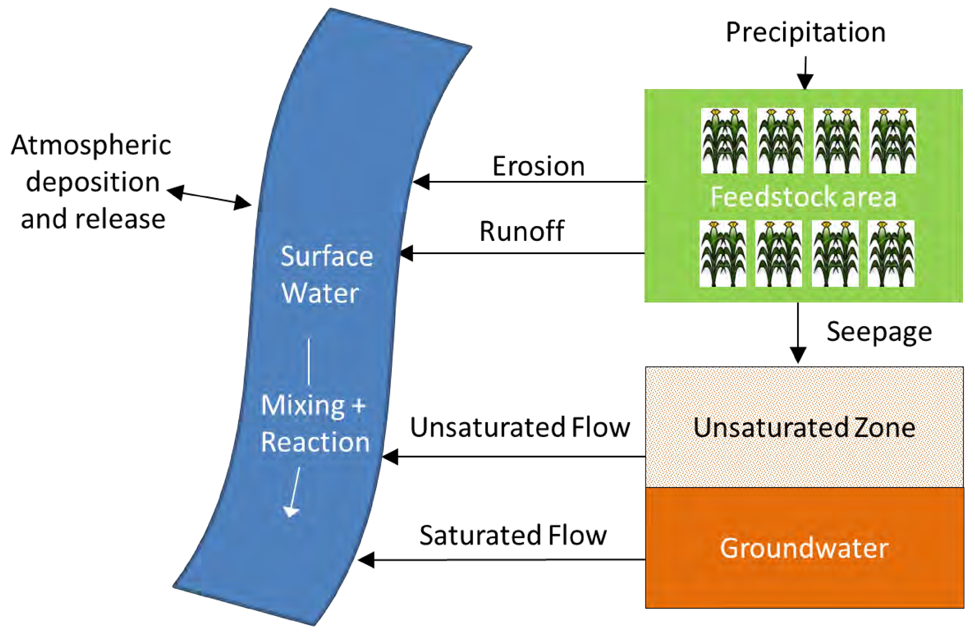

Figure 3: Hydrologic Processes Affecting Pesticide Fate and Transport

Predicting pesticide behavior requires a model that integrates monitoring data for flow, weather, and atmospheric conditions to assess the fate and transport of pesticides in the environment. The Hydrologic Simulation Program Fortran (HSPF) is the standard model for predicting water quality impacts of non-point source pollutants. HSPF is capable of simulating all of the relevant transport processes for this study. This model has a proven track record at assessing the effects of land-use change, reservoir operations, point or nonpoint source treatment alternatives, and flow diversions on water quality.

This research will develop a quantitative approach to estimate the water quality impacts associated with pesticide and herbicide usage associated with different biofuel feedstock production methods. The model will be calibrated and tested at four watersheds in the Upper Mississippi River Basin in the Midwestern United States where significant feedstock production has begun and the necessary data are available. The watersheds appear in Figure 4. At each site, the hydrological and meteorological data from before and after biofuel production will be used to develop a predictive approach for future biofuel production sites. The calibrated model can then be used to weigh the benefits of biofuel production against the negative impacts on water quality.

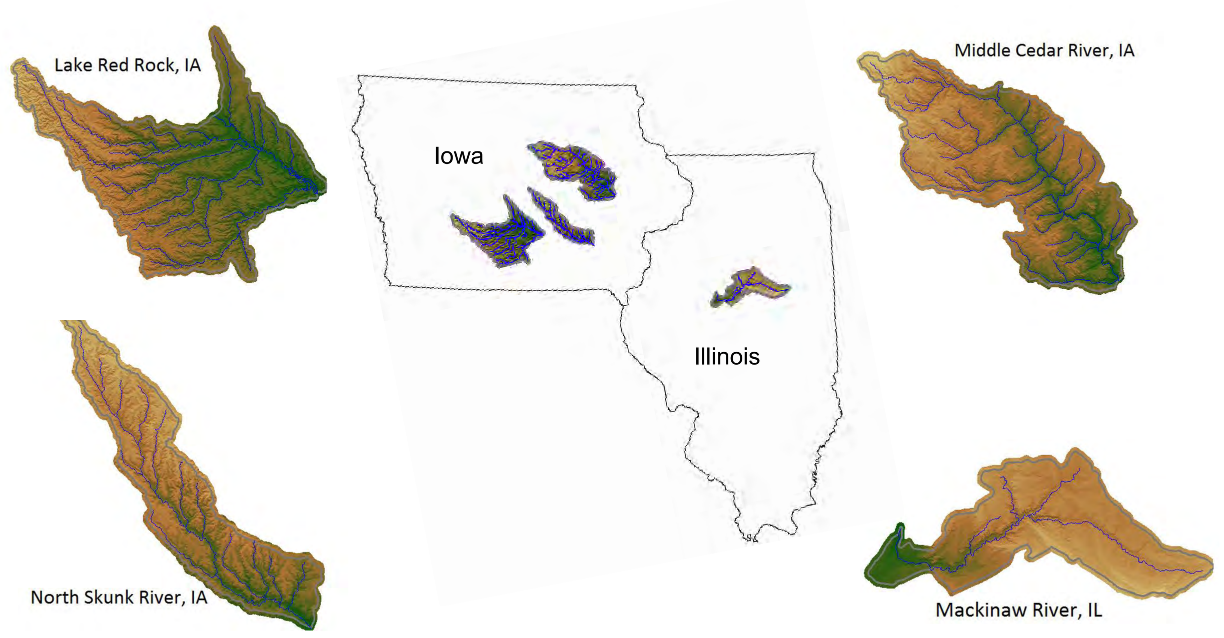

Figure 4: Biofuel Water Quality Impact Study Watersheds

Impact

The results of this study will provide an approach that can be used by policy-makers to weight the potential negative water quality impacts of biofuel production against the potential benefits. The data from the study will be useful to decision-makers and farmers when weighing different BMPs and deciding on land usage. In addition, this research will enhance the general understanding of pesticide fate and transport in hydrologic systems. Finally, with the advancements in computing technology, modeling of large-scale watersheds has become more viable. The results of these studies could have important implications for other water quality modeling applications in the future.

Acknowledgments

EERE Biomass Program

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Accurately predicting water quality impacts of feedstock production is essential for biofuel sustainability.