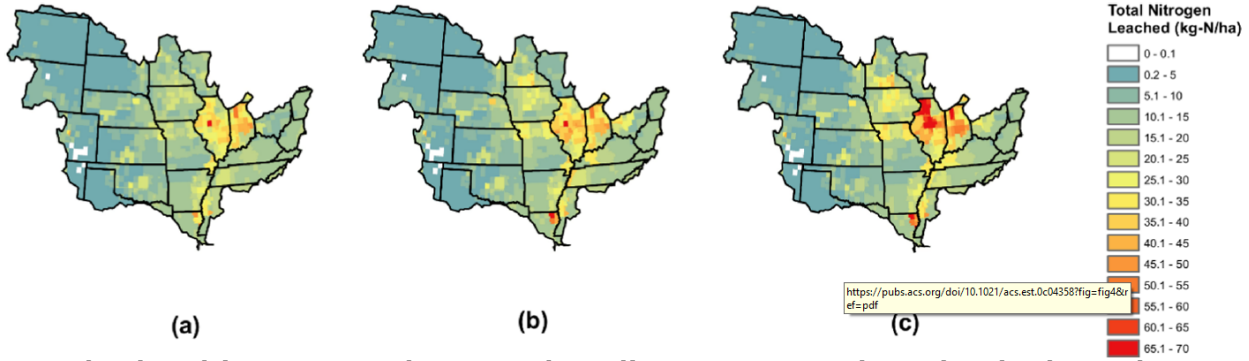
BRC Science Highlight
January 2021

Water Quality Effects of Economically Viable Land Use Change in the Mississippi River Basin under the Renewable Fuel Standard

Objective

Increased biofuel production associated with the Renewable Fuel Standard (RFS2) has driven more land into corn production and caused increased nitrogen (N) loss from the Mississippi Atchafalaya River Basin (MARB) to the Gulf of Mexico. While incorporation of perennial bioenergy crops may reduce these N losses, the extent of these potential benefits depends on the mix of bioenergy crops used and the extent to which these crops displace annual row crops. Here, researchers developed an integrated economic-agricultural model to elucidate the impacts of three different policy scenarios.



Total N leaching rate under RSF1 baseline (a), corn ethanol only (b) and corn + cellulosic ethanol (c) scenarios.

Approach

- Tested three policy scenarios: RFS1 baseline (7.5 billion gallons corn ethanol; prior to RFS2); corn ethanol only (15 billion gallons corn ethanol); and corn + cellulosic ethanol (corn only scenario + 16 billion gallons of cellulosic ethanol).
- Combined economic-biophysical modeling approach using land allocation and N application predictions from the Biofuel and Environmental Policy Analysis Model (BEPAM) to drive simulations in the Integrated BIosphere Simulator-Agricultural Version (Agro-IBIS) and Terrestrial Hydrologic Model with Biogeochemistry (THMB).

Results

- Meeting the 16 billion-gallon cellulosic ethanol mandate would require an increase in agricultural land used for corn production, increased N application, incorporation of corn stover removal, and conversion of idle land (i.e., land not under active crop production) to perennial bioenergy crops.
- Inclusion of corn stover in the cellulosic feedstock scenario increased N leaching both by driving a shift to continuous corn planting (rather than corn-soy rotation) and increased N application to compensate for stover removal.
- Perennial bioenergy grasses have the potential to reduce N loss compared to corn stover. Sensitivity analysis indicated that a perennial grass-only scenario of cellulosic ethanol production (no corn stover) could reduce N loss by 7% relative to the corn + cellulosic ethanol scenario.

Significance

This analysis demonstrates the use of integrated economic and agricultural models to quantify the impact of potential land use changes on MARB water quality.

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