An Integrated Modeling System for Assessing the Impacts of Climate Change and Alternative Management Systems in Corn-Based Cropping Systems in the U.S. Cornbelt Region

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Introduction

THE CENTER FOR AGRICULTURAL and Rural Development (CARD) at Iowa State University is building an enhanced integrated modeling system for the Upper Mississippi River Basin (UMRB) and Ohio-Tennessee River Basin (OTRB) regions (Figure 1), in collaboration with scientists at multiple research institutions. The UMRB and OTRB have extensive water quality problems and have been identified as primary source regions of nutrients exported to the Gulf of Mexico, within the overall Mississippi-Atchafalaya River Basin (MARB), which result in the seasonal hypoxic zone in the northern gulf (Figure 1).

The integrated modeling system will be used to evaluate a range of fertilizer, tillage, and other management practices within the context of

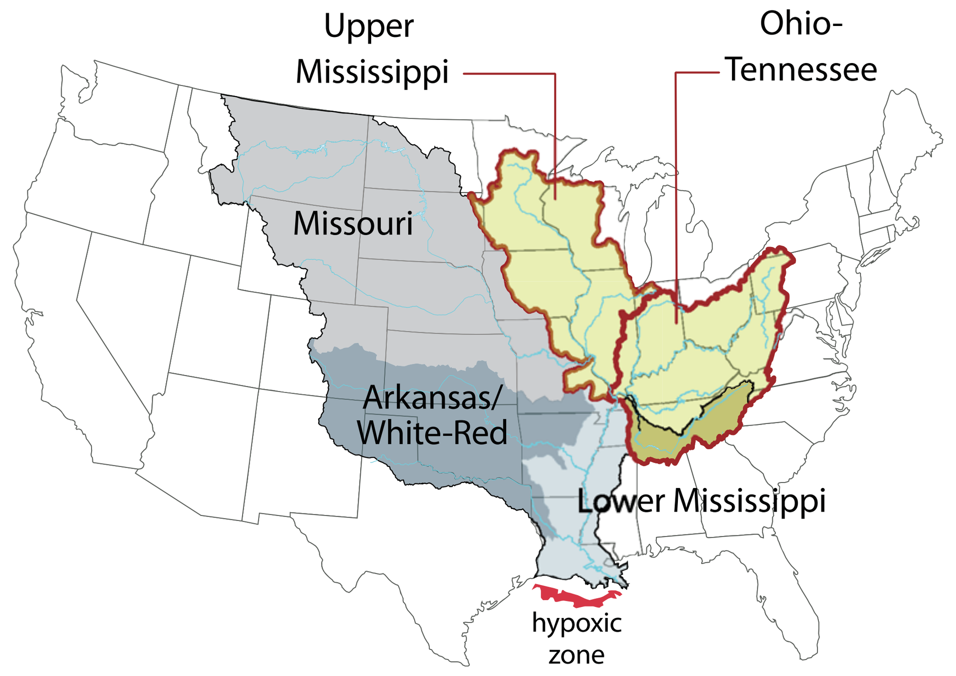

Figure 1. Upper Mississippi River Basin (UMRB) and Ohio-Tennessee River Basin (ORTB) regions

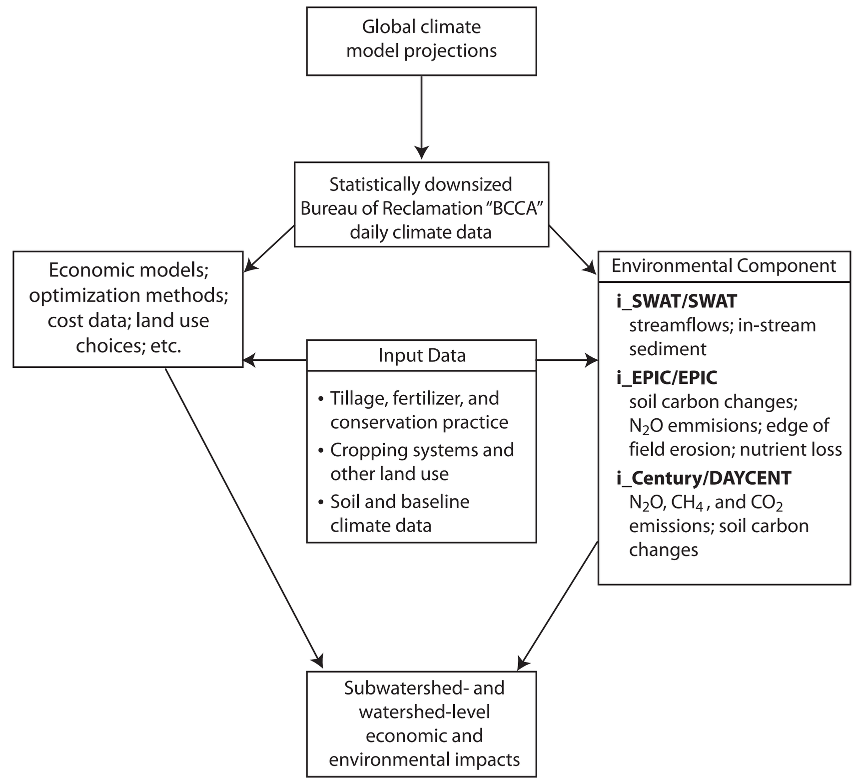

Figure 2. Integrated modeling system

projected climate change and corn production systems (Figure 2) for the CSCAP project. Both economic and environmental impacts will be assessed taking into account relevant cost, soil, and management inputs. The placement of alternative cropping systems and/or management practices on specific landscapes within the three models for both regions will be performed primarily via an interface with an evolutionary algorithm (EA) and corresponding cost data for each management system in the economic component (Figure 2). Downscaled climate change projections will be input into the different models per recommendations posted at sustainablecorn.org for Objective 3 collaborators.

Three environmental models are being incorporated into the modeling system to describe regional soil

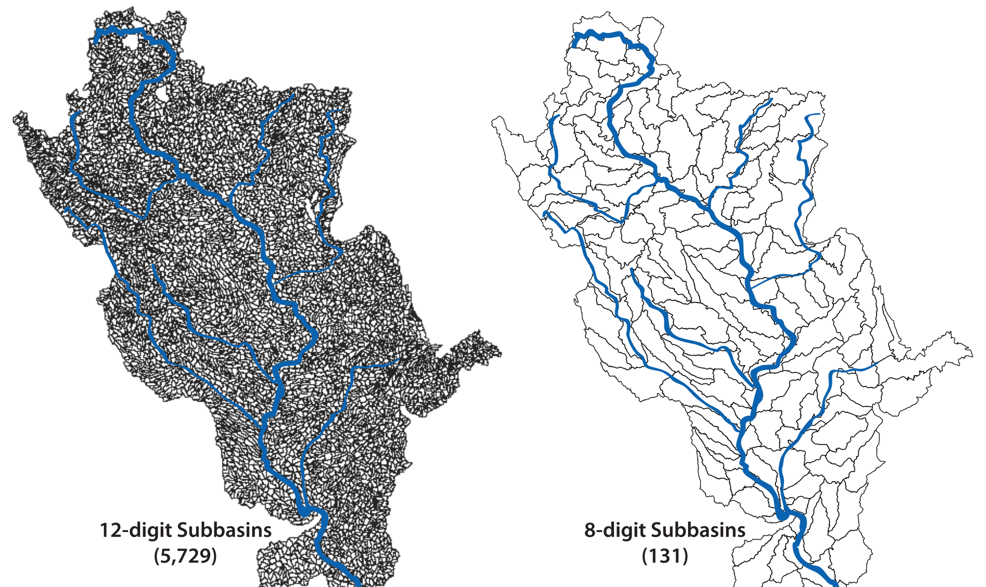

Figure 3. Comparison of UMRB delineations

carbon, greenhouse gas (GHG) emissions, and water quality impacts (Figure 2 and Table 1). One key refinement in the current modeling system development is the delineation of the UMRB and OTRB subwatersheds at the 12-digit watershed level rather than the 8-digit level used for previous modeling studies (e.g., Rabotyagov et al. 2010); see the UMRB comparison shown in Figure 3. This refinement will allow for enhanced targeting of management and cropping scenarios using the Soil and Water Assessment Tool (SWAT) water quality model.

Table 1. Environmental models included in integrated modeling system

Model	Scale	Outputs	Website
Soil and Water Assessment Tool (SWAT)	watershed and river basin	water quantity and quality at the subwatershed- and watershed-levels	swatmodel.tamu.edu/
Environmental Policy Integrated Climate (EPIC)	field	edge-of-field water quality, soil carbon, GHG emissions, and related outputs	epicapex.brc.tamus.edu/
DAYCENT	field	edge-of-field nutrient cycling, soil carbon, GHG emissions, and related outputs	www.nrel.colostate.edu/projects/daycent/

Considerable challenges are encountered in the determination of management and land use assumptions for baseline conditions. For example, county-level tillage survey data must be translated to the watershed-scale for SWAT modeling purposes, which has been performed by Baker (2011); e.g., Figure 4. However, we are then faced with disaggregating this data to the 12-digit subwatershed level for the integrated modeling system. Similar aggregation and disaggregation issues must be contended with for other SWAT input data; e.g., estimates of regional use of subsurface tile drainage (Figure 5). Similar input data issues must also be dealt with for the EPIC and DAYCENT models, and aggregation issues arise when considering regional representation of EPIC and DAYCENT outputs.

Preliminary testing of the SWAT 12-digit UMRB and OTRB models indicates that the models are responding rationally regarding the overall hydrologic balance of the systems. Efforts continue to construct consistent, rational input datasets for all three models, as well as testing of the models for a range of cropping, management, and environmental conditions.

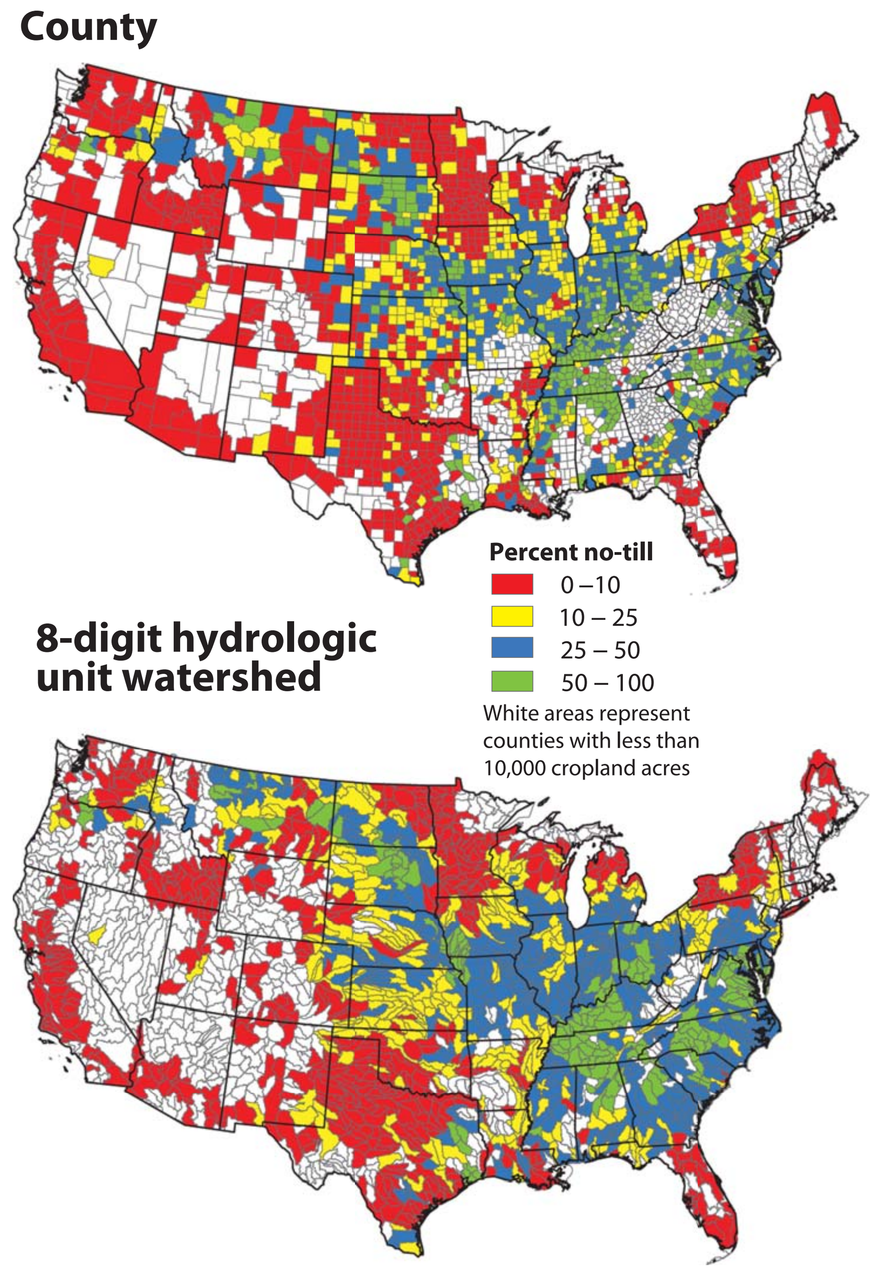

Figure 4. County-level no-till survey data (all crops) aggregated to 8-digit watersheds (Baker, 2011)

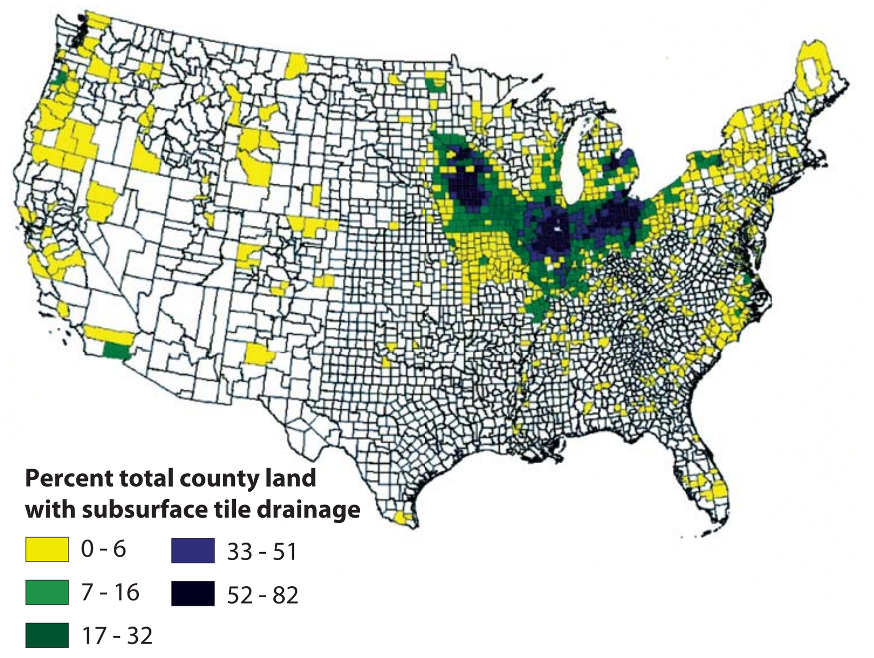

Figure 5. County-level estimates of tile drainage use (Sugg, 2007)

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Acknowledgments

This research is part of a regional collaborative project supported by the USDA-NIFA, Award No. 2011-68002-30190: *Cropping Systems Coordinated Agricultural Project: Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems* (*www.sustainablecorn.org*) and the National Science Foundation, Award No. DEB1010259; *Understanding Land Use Decisions & Watershed Scale Interactions: Water Quality in the Mississippi River Basin & Hypoxic Conditions in the Gulf of Mexico.*

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