The Boone River Watershed Modeling Framework:

A Common Land Unit (CLU) Approach for Constructing Model Simulation Scenarios

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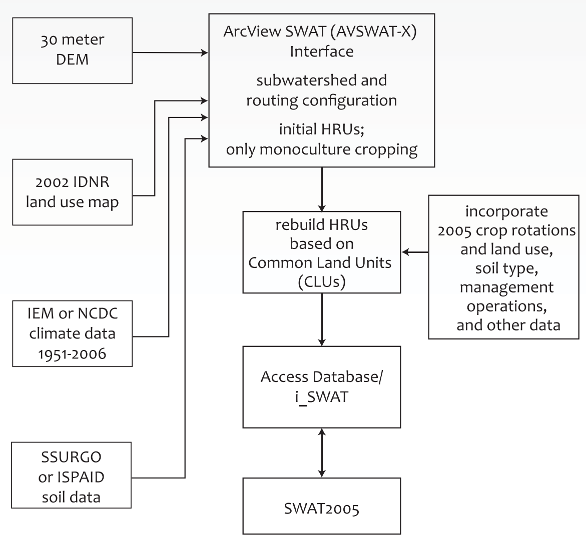
Introduction

THE BOONE RIVER watershed (BRW) covers over 237,000 ha in six north central Iowa counties and is one of 131 8-digit watersheds that are located in the Upper Mississippi River Basin (UMRB). The watershed is characterized by extensive tile drainage, intensive corn and soybean production, and intensive livestock production, including annual output of roughly 480,000 swine. Nitrate and other nutrient losses result in elevated in-stream pollutant levels and contribute to downstream pollution problems, including the seasonal Gulf of Mexico hypoxic zone. In response, an integrated environmental-economic modeling system is being developed for the watershed that will allow evaluation of alternative management and cropping system practices as well as biofuel and other pertinent scenarios.

Modeling System

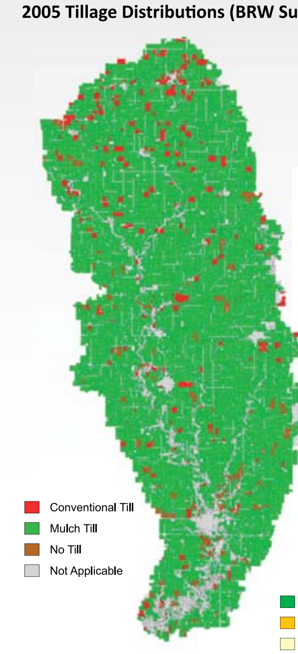
THE SCHEMATIC SHOWS the process of building simulations with the Soil and Water Assessment Tool (SWAT) model (Gassman et al., 2007) within the environmental component of the modeling system. The hydrologic response units (HRUs) are reconstructed on the basis of land use and other data collected at the Common Land Unit (CLU) level. The land use and tillage maps show the distribution of those practices based on a CLU-level survey performed in 2005 for the 16,000+ CLUs in the BRW. The CLU data is aggregated to create nearly 2,800 HRUs for the BRW simulations; these data are managed with other required input data with an Access database and the interactive SWAT (i_SWAT) software, for the SWAT2005 simulations performed for this study.

Schematic of BRW Modeling System Environmental Component

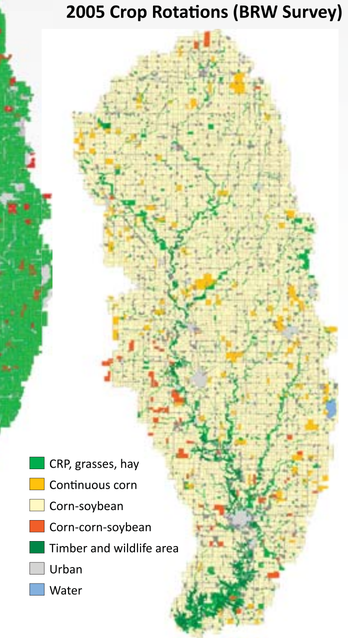


The economic model generates estimates of cropping systems and management practices at the CLU level for several alternative corn prices. Farmers' choices among alternative rotations are compared versus the 2005 baseline data. The effects of crop prices, rotation effects on corn yields, and nitrogen fertilizer impacts on corn yields are directly accounted for in the economic model. For each corn price level under consideration, the outcome of the economic model is the prediction of the rotation and tillage choices associated with each year in rotation, for each CLU of the study area.

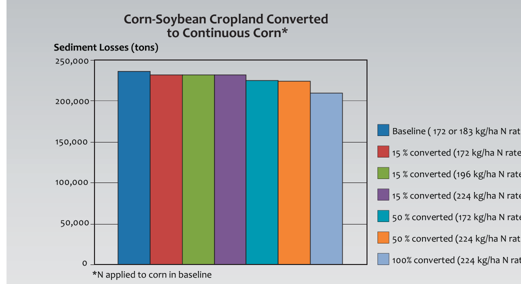
2005 Tillage Distributions (BRW Survey)

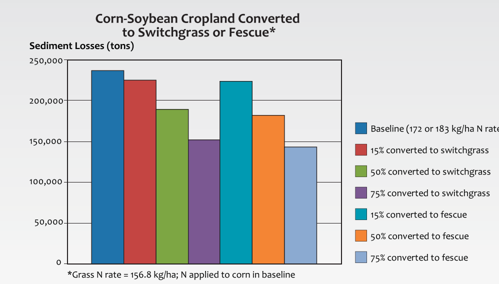


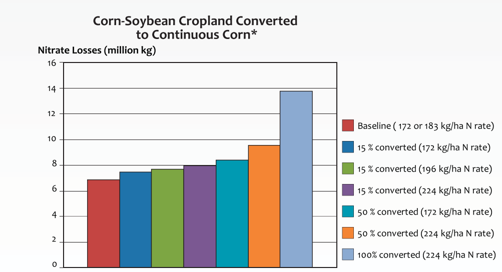
2005 Crop Rotations (BRW Survey)

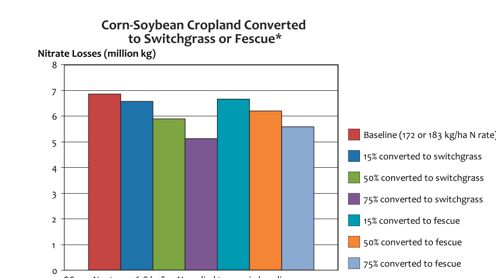


Example Scenario Results









EXAMPLE BRW SCENARIO nitrate and sediment loss results are shown in the four sets of bar charts (following calibration of SWAT2005). The scenarios represent conversions of baseline corn-soybean cropland into continuous corn, switchgrass, or fescue, which reflect biofuel or expanded perennial grass scenarios (warm season versus cool season). Conversion of corn-soybean to continuous corn resulted in nitrate loss increases of 9% to 100% while the expansion of fertilized perennial grasses resulted in nitrate decreases of 3% to 26%. Sediment was predicted to decrease by 2% to 11% for the increased continuous corn scenarios versus decreases of 5% to 39% predicted when the perennial grasses were introduced.

Conclusions

THESE RESULTS SHOW that the model is very sensitive to increases in fertilized continuous corn, that corn residue provides an erosion benefit as compared to soybean residue, and that both nitrate and sediment losses would be expected to decrease with increased fertilized perennial grasses. The large increases in nitrate loss for the continuous corn scenarios show potentially much greater impacts than some field studies (e.g., Bakhsh and Kanwar, 2007). Thus, further testing is required to ensure that the SWAT2005 nitrogen cycling and loss components are being adequately simulated. Future scenarios will incorporate the interface between the economic model and the environmental component.

References

Bakhsh, A. and R.S. Kanwar. 2007. Tillage and N application rates effect on corn and soybean yields and NO3-N leaching losses. *Trans. ASABE* 50(4): 1189-1198.
Gassman, P.W., M. Reyes, C.H. Green, and J.G. Arnold. 2007. The Soil and Water Assessment Tool: Historical development, applications, and future directions. *Trans. ASABE* 50(4): 1211-1250.

Acknowledgment

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