Report as of FY2006 for 2005IA79B: "Improving water quality in Iowa rivers: cost-benefit analysis of adopting new conservation practices and changing agricultural land use"

Publications

Project 2005IA79B has resulted in no reported publications as of FY2006.

Report Follows

IWC final Report
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June 2007 (for report period March 1 2006—February 28, 2007)

Problem and Research Objectives

The objective of this project was to assess water quality improvements and costs of alternative policy scenarios for the state of Iowa. The water quality measures of interest were nitrogen, phosphorus, and sediment. Our study fully assessed different conservation policies in the state by modeling adequately the spatial heterogeneity of land characteristics and the interactions between land use decisions at the micro level and watershed dynamics. Nonpoint source pollution due to agricultural activities is a vital issue for the State. It is difficult to overstate the importance of these issues to the environment and land managers, given the importance of agriculture in Iowa, and the large number of impaired waters in the state. This project provided a first assessment of the overall impact on in-stream water quality of large scale conservation policies that included several practices simultaneously. The results from our project would be particularly valuable for effective, science-based water quality management in the state of Iowa.

Methodology

Micro-unit-based economic models and data on land use and conservation practices are combined with a watershed-based hydrological model (Soil and Water Assessment Tool, SWAT) to estimate the costs of obtaining water quality changes from the hypothetical placement of conservation practices. The main procedures involved in the project include: estimate the costs of conservation practices, identify the location of conservation practices, calculate the cost of alternative conservation policies, estimate the water quality consequences of the policies, and finally assess the cost and benefit of the policies.

The SWAT executions, including the input and output data, are managed with the interactive SWAT (i_SWAT) software (http:// www.public.iastate.edu/~elvis).

Principal Findings and Significance

During the first year of the project, we finished investigating the costs and benefits of improving water quality in Iowa under two policy objectives. In the first scenario we assessed the impact of a program designed to improve water quality in Iowa on carbon sequestration, and in the second scenario we calculated the water quality impact of a program aimed at maximizing carbon sequestration. Our results indicate that the amount of benefits depends on what indicators are used to measure water quality. Our results also suggest that the term “improving water quality” can mean different things for different people. This is because the responses of different water quality indicators to conservation efforts can be quite different. For more detailed analysis, please see Secchi et al. (2007, **Choices**).

In the second year of the project, we obtained additional funding from a coalition of organizations, namely the Iowa Farm Bureau, the Iowa Corn Growers' Association, the Iowa Soybean Association, and the Leopold Center for Sustainable Agriculture. As a result, we were able to do a much more thorough analysis of the research problem than otherwise possible. In particular, we were able to gather detailed cost data for major conservation practices used in Iowa. Equally importantly, we were able to set up and use an algorithm that optimized the set of conservation practices and their location in the landscape.

As a result of the augmented project, we gathered county-level data for some major conservation practices with regard to their costs and coverage. A database of county average cost is established for terraces, grass waterways, land retirement, sediment control basins, grade stabilization structures, filter strips, wetland restoration, riparian buffers, contour buffer strips, and nutrient management. We also obtained a state wide estimate of total costs for major conservation practices currently implemented in Iowa.

In the search for cost-effective conservation policies, we considered three different types of nutrient targets: reducing phosphorus loadings by 40%, reducing nitrate loadings by 25%, and a goal of reducing both phosphorus (by 40%) and nitrate (by 25%). The evolution algorithm was used to search for the least cost of reaching the targets. Focusing on nitrates exclusively without any regard to phosphorus levels led to an increase in total phosphorus loadings in 8 out of 13 watersheds. The total statewide gross cost of reducing nitrates was about $472 million annually. For the phosphorous target, the total gross cost was estimated to be almost $613 million a year. Implementing the phosphorous target would simultaneously result in a statewide reduction in nitrate loadings of over 31%. This means that meeting the target of a 40% reduction in phosphorous would also meet the target of a 25% reduction in nitrogen.

Our results indicated that conservation practices that are efficient for erosion and phosphorous control are not in general efficient for nitrogen control. In general, conservation practices that have been implemented on the ground tend to focus on erosion control. Based on this, our recommendation is that to reduce nitrogen pollution in the waterways, measures that directly target nitrogen might be necessary. This has implications for policies that are designed to alleviate the hypoxic problem in the Gulf of Mexico. Our results also indicate that the cost-effective measures are different across different watersheds. The message for stakeholders in the watersheds is that they should gain a good knowledge of their watersheds before adopting any control policies that have been proving to be promising in other watersheds. Finally, a clear result from our analysis is that targeting different pollutants will mean different land use options. Thus, the needs of stakeholders in the watersheds should be identified before any policy discussions take place. While our results indicate that targeting phosphorous would also achieve the nitrate goal in our scenarios, we think it is highly likely that this particular result will not hold as more practices are considered and a more thorough search is conducted through the genetic algorithm.

For the Raccoon watershed, where the calibration and validation of the SWAT is focused on for this project, we conducted an additional study to assess alternative targeting policies. We use SWAT, along with transfer coefficients, to assess alternative principles of allocating nutrient load reduction in the Raccoon River watershed in central Iowa. Delivery coefficients have long been used in economic analysis of policies that seek to address environmental problems like water pollution. However, the derivation and validity of delivery coefficients have not been examined carefully by empirical analyses. In this study, we derived estimates of delivery coefficients and then evaluated them as a bridge between complex water quality models and economic policies. Specifically, delivery coefficients were first derived from the simulation results of SWAT. Nutrient reduction responsibilities were then allocated to subwatersheds based on the delivery coefficients using four allocation principles. We found that the allocations achieved outcomes that differed from intended water quality targets by less than ten percent in most cases. For the least cost allocation with homogeneous cost, potential cost savings, relative to uniform allocation, were about the same magnitude as the divergence between outcomes and targets. However, cost savings significantly outweighed the deviation from water quality targets when cost was heterogeneous across the subwatersheds.