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Integrating project knowledge and models: The next step in developing a Payment for Ecosystem Services scheme for the Big Creek watershed

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Abstract:

The team developed a spatially targeted conservation planning scheme to foster water quality decision making in central Iowa's Big Creek watershed. The scheme is foundational to the potential development of a Payment for Ecosystem Services (PES) for the watershed. Big Creek watershed is an ideal Iowa location for this project because of the proximity of ecosystem service providers (farmers) to a large number of beneficiaries (water users).

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Budget:
$35,000 for year one

Q Can we use existing land use and biophysical data and emerging GIS-based planning tools to provide efficient conservation planning for Iowa?

A The research team answered this question by combining knowledge of Iowa Nutrient Reduction Strategy-approved practices with existing GIS data layers and tools, scenario development, and economic analysis.

ECOLOGY

Background

There is an increasing social demand for a broader suite of ecosystem service outcomes from the agricultural landscape. Research has shown that both the public and farmers are inclined to support the expansion of such services. The challenge is to develop a robust way to link the providers of ecosystem services (farmers) with their beneficiaries (users of ES). A spatially targeted Payment for Ecosystem Services (PES) approach for Iowa can provide a timely and appropriate way to meet this challenge.

The objectives of this project are to:

- Integrate data and knowledge from numerous, highly complementary studies on land use practices that blend agricultural production and conservation goals to parameterize natural resource decision-making models for Big Creek watershed; and
- Enhance ongoing, on-the-ground action within the Big Creek watershed through scenario development, landscape visualization, comparative estimation, and monetarization of ecosystem services using models.

Approach and methods

Project investigators evaluated the potential of a spatially targeted PES approach to enhance water quality in Big Creek watershed in central Iowa. This watershed lies directly north of the Des Moines metropolitan area, which has approximately 500,000 residents. Big Creek Lake provides important flood protection for the city of Des Moines. Coupled with the surrounding 1,500-acre Big Creek Lake State Park, the lake is a valuable recreational resource in central Iowa.

However, both flood control and recreational services may be jeopardized by land use within the watershed. Over 80 percent of Big Creek area is in row-crop corn and soybean agriculture, and there are two confined animal feeding operations (CAFOs) in the watershed. The lake has been on the Environmental Protection Agency's 303(d) list of impaired waters since 1998 for *E. coli* contamination from multiple sources. In addition, there are concerns about sediment and nutrient pollution from upstream.

The team used geospatial data to parameterize and adapt the GIS-based

Agricultural Conservation Planning Framework (ACPF). Using this tool, they systematically evaluated the watershed at the field level, indicating locations where specific conservation practices would be most appropriate in terms of biophysical vulnerabilities. Coupled with financial and economic data, they prioritized high-risk fields and developed alternative land management scenarios designed to evaluate land use tradeoffs associated with efficient and cost-effective ecosystem service production. They identified fields at high risk for runoff (phosphorus, sediment, and *E. coli*) and nitrate leaching, coupled with low opportunity costs to locate parcels with high biophysical vulnerability and low opportunity cost – fields of critical priority and opportunity.

Results and discussion

The primary output from the ACPF consists of mapped distributions of opportunities for conservation practices within the watershed, which were visualized as alternatives for watershed management. Alternative land use scenarios focused on three conservation practices: (1) cover crops, (2) nutrient removal wetlands, and (3) saturated buffers. These practices were chosen based on their bacterial, nutrient, and sediment removal efficiencies, as well as their identified appeal to farmers in the watershed. Alternative land use scenarios were evaluated for anticipated ecosystem service outcomes and costs specifically related to enhanced water quality. These alternatives were designed to identify stakeholders' conservation priorities and preferences, and to guide opportunities to identify areas of the landscape best suited for the production of ecosystem services.

Project results suggest that large reductions in nitrate loss (i.e., 48 percent) at the watershed level can be made through coordinated placement of conservation practices on high-contributing parcels with limited removal (i.e., 2 percent) of cultivated acres. The result points to at least one critical environmental outcome (nitrate reduction), without a significant change in watershed scale land use.

For example, one alternative land use scenario with 20 wetland complexes (703 acres), cover crops (45,000 acres), and 66 saturated buffers (12.9 perennial stream miles) removed less than 2 percent of cultivated area and reduced nitrate loss by an estimated 48 percent, exceeding the Iowa Nutrient Reduction Strategy goal for enhancing water quality. Estimated cost of installation was $7.05 million and annual costs were estimated at $3.53 million. Not an insignificant investment, yet it is one tied to a distinct performance level and an outcome that current conservation spending cannot claim. Nevertheless, a significant amount of money is invested each year in Iowa for conservation purposes; e.g., nearly $235 million of federal money was spent in the state of Iowa in 2014 for new and ongoing conservation programming. This program demonstrates a performance-oriented approach to spending those dollars more efficiently. These project results are being used by staff at the Iowa Department of Agriculture and Land Stewardship (IDALS) and Iowa Department of Natural Resources (IDNR). These data help spatially identify and prioritize conservation efforts in Big Creek watershed.

Conclusions

PES schemes provide social infrastructure that formalizes an existing relationship between watershed level ecosystem service providers (farmers) and ecosystem service beneficiaries (e.g., local and/or regional surface and groundwater users, watershed

recreationalists, regional wildlife enthusiasts). The core of PES is a mechanism that allows downstream ecosystem service beneficiaries to make direct, contractual, and/or conditional payments to landowners/farmers. In return, they adopt land use practices that secure desired/demanded and measurable ecosystem service outputs. The market-oriented characteristics of PES schemes provide multi-stakeholder incentives that:

- encourage farmers to adopt multifunctional management perspectives and actions;
- dictate that agencies routinely and comprehensively measure ecosystem service outcomes;
- promote the inexpensive availability of data; and
- strengthen public understanding of ecosystem service principles and elevate the role of farmers in providing food, fiber and fuel, and also environmental quality.

Spatially targeted conservation approaches can, and should, target and prioritize parts of the landscape based on biophysical parameters and cost parameters. Spatial targeting using both biophysical parameters and cost parameters represents an important step forward in identifying parts of the landscape that deliver the greatest gains in ecosystem service outcomes at the lowest economic cost; this is a key principle in adopting a PES framework. Current frameworks and tools can be adapted to include costs.

Impact of results

The overarching goal of this project was to further the development of an effective and enduring PES framework in Iowa. Recent papers in academic journals discussed the conceptual ideas behind PES to promote expanded environmental performance markets for landowners/farmers. The researchers conducted a case study of the Big Creek watershed and developed the key components necessary for the emergence of new markets for environmental quality in Iowa. This work likely is the first of its kind in Iowa that goes beyond the conceptual level. It provides a technical blueprint, case study showcasing the publically available data required, demonstrating cutting-edge analytical tools and outlining the stakeholder demand analysis that are required for any PES to succeed. If PES is to have a place in Iowa's agricultural economy, this work will prove pioneering.

In the future, the research team and IDALS staff will continue to explore PES approaches in this watershed by conducting a "willingness to pay" survey of ecosystem service beneficiaries (e.g., area surface and groundwater users, watershed recreationalists, regional wildlife enthusiasts). This will further the development of an effective and enduring PES framework in Iowa.

The long-term outcomes of this research will help to guide the development of cost-effective and accessible economic tools and opportunities for Iowa farmers who coproduce commodities and contribute to ecosystem service provision (e.g., enhanced water quality, recreational opportunities, wildlife habitat, etc.). These new economic opportunities and the institutional coordination that emerge from them are poised to affect future conservation policy in Iowa. This research also is an important step toward providing Iowans with a new opportunity to participate in land use decisions to affect future conservation policy in Iowa and purchase a desired agricultural outcome. These actions will promote a shared-systems perspective (encompassed in supply and demand dynamics) that is sustained by multiple stakeholder partnership.

Education and outreach

Methods and results from this project were shared at several conferences aimed at the scientific community and agricultural conservation personnel from governmental and nongovernmental organizations. Among them were the:

- Soil and Water Conservation Society Annual Meeting, 2016;
- U.S. Meeting – International Association of Landscape Ecologists, 2016;
- 4-Nations Agriculture and Biodiversity Conference, 2015; and,
- World Conference – International Association of Landscape Ecologists, 2015.

The project has thus far generated one outreach publication (Zimmerman 2016) with other publications planned.

Leveraged funds

This project fueled a significant amount of leveraged resources including a Ph.D. student fellowship award as well as federal, state, industry, and private foundation research funds. Ph.D. candidate Emily Zimmerman showcased this research and was awarded a Plant Sciences Institute Fellowship to supplement her research assistantship. The project also leveraged assistantship support and tuition for Zimmerman from USDA McIntire-Stennis and three semesters of teaching assistantships from the ISU Department of Natural Resource Ecology and Management. Preliminary data, as well as analytical techniques developed as part of this project, were used to secure $530,000 in additional research funding from these funding sources:

- Walton Family Foundation. Economic evaluation of the watershed scale pairing of cover crops and two-stage ditches using water and soil data. 2017-2020. $300,000;
- Iowa Nutrient Reduction Center. Development to Achieve Iowa Nutrient Reduction Center Goals. 2017-2019. $130,000; and,
- Indiana Corn Marketing Council/ Indiana Soybean Association. Indiana Watershed Initiative (IWI): Quantifying Water Quality Responses from the Watershed-Scale Pairing of Cover Crops and the Two-Stage Ditch. 2015-2016. $100,000.

The Iowa Department of Natural Resources dedicated a significant amount of staff time to provide guidance for data acquisition and tool and survey calibration. The People, Land-Use and Society Lab (Co-PI Tyndall) and the Landscape Ecology and Sustainable Ecosystem Management Lab (PI Schulte Moore) provided various in-kind support for general overhead, equipment, and miscellaneous funds for this project.

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