THE POTENTIAL FOR INCORPORATING ECONOMICS INTO A DECISION SUPPORT TOOL

Decision Support Tools (DSS) have become an increasingly powerful tool in conservation and planning efforts, especially for erosion prevention and mitigating sediment flow to water bodies. However, until now, only limited economic information has been incorporated into the tools; as such the incorporation of economic data will assist with evaluating more fully the costs and benefits of potential conservation actions, and provide more complete answers to concerns about the effectiveness of BMPs.

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Institute of Water Research
Michigan State University

The Potential for Incorporating Economics into a Decision Support Tool

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Great Lakes and Ohio River Division,

US Army Corps of Engineers

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PREFACE

Decision Support Tools (DSS) have become an increasingly powerful tool in conservation and planning efforts, especially for erosion prevention and mitigating sediment flow to water bodies. However, until now, only limited economic information has been incorporated into the tools; as such the incorporation of economic data will assist with evaluating more fully the costs and benefits of potential conservation actions, and provide more complete answers to concerns about the effectiveness of BMPs.

This paper is intended to provide a background of economics for conservation and different types of economic data and potential for incorporation into the DSS. The paper also provides a summary of a one-day workshop that gathered information from presentations/discussions of experts about the use of DSS, and current efforts to incorporate economics into the DSS for improving conservation decisions.

The Institute of Water Research at Michigan State University would like to thank Jan Miller of the U.S. Army Corps of Engineers, Tom Crane of the Great Lakes Commission, Frank Lupi of Michigan State University, and the U.S. Geological Survey (USGS) (through grant/cooperative agreement USGS Award No. G14AP00032) for their support of the workshop, and additional appreciation to all of the participants who provided insightful information and valuable discussions at the Workshop which led to the preparation of this paper.

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Director

The Potential for Incorporating Economics into a Decision Support Tool

White Paper

May 2015

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The Potential for Incorporating Economics into a Decision Support Tools

Contents

1. INTRODUCTION

Excessive soil erosion and sediment delivered to surface water impair aquatic life and habitats, limit opportunities for recreation, impact human health, and increase the costs of water supply and navigation dredging. Nutrient and soil losses through erosion also affect farm operation and production. These on-site and off-site environmental effects of soil erosion have economic consequences to both farmers and society[1]. Estimates of the economic costs of soil erosion have been reported for several countries (see Telles et al. 2011 for details). In the United States, the combined off-site and on-site cost of soil erosion from agriculture was estimated at about $44 billion at 1992 price levels (the equivalent of $74 billion at 2014 price levels), of which approximately 60 percent is on-site costs associated with a reduction in soil productivity (Pimentel et al., 1995).

In the US, while more than 50 years of conservation efforts and billions of dollars (USDA, 2006) have been spent toward working with landowners and farmers to reduce soil erosion and sedimentation through implementation of best management practices (BMPs), there is still a continuing loss of soil and non-point source (NPS) pollution problems associated with soil erosion in surface water bodies. This raises concerns among resource planners and policy makers about the effectiveness and outcomes of BMP implementation. The public, as taxpayers, need to be informed of the benefits of conservation spending, especially those off-site benefits. In addition, with higher crop prices, farmers/producers are also facing a decision whether to place their land in conservation and/or retire their land from conservation for high value crop production. As such, there is a significant need for information about the economic costs and benefits of conservation at all levels of decision-making.

With advances in technology and a better understanding of soil sciences, decision support tools have become an increasingly powerful tool in conservation and planning efforts. However, complete economic information has not been fully incorporated into the tools; the incorporation of economic data will assist with evaluating more fully the costs and benefits of potential conservation actions, and provide more complete answers to concerns about the effectiveness of BMPs. The U.S. Army Corps of Engineers (USACE), under the Great Lakes Tributary Model program (GLTM), developed tributary models and web-based tools to assist resource planners and local stakeholders to reduce sedimentation. One example is the Great Lakes Watershed Management System (GLWMS) modeling efforts previously supported by the USACE. Currently, GLWMS is able to prioritize agricultural areas that contribute sediment and other NPS pollutants to the Great Lakes and their tributaries, evaluate potential impacts of land use changes, and predict soil loss and runoff from a watershed to a waterbody.

[1] On-site effects of soil erosion occur within a physical farm unit (e.g., loss of top soils and nutrients) and results in lower soil quality and productivity. Off-site effects are those soil erosion impacts on the surrounding environment, such as sedimentation damage to wetlands and habitats, accumulations up river and channels, and loss of reservoir storage.

The Institute of Water Research (IWR), supported by the USACE and the Great Lakes Commission (GLC), organized a one-day workshop to discuss the potential for incorporating economic information into decision support tools. The workshop convened a total of 20 experts in the areas of economics, conservation, and technology who have experience using decision support tools (see Appendix), and presented case studies of current conservation activities and the development and use of such tools, including the GLWMS.

The following section provides an overview of how economic analyses are used in conservation policy. Section 3 highlights information provided in the workshop presentations and discussions, while Section 4 presents challenges for incorporating the economic information into decision support tools. Finally, Section 5 provides a summary of conclusions and the recommendations for next steps.

2. BACKGROUND

2.1 Economics and Conservation Policy

Economic information has been used in policy analysis to help support and/or guide many policy decisions, including those related to conservation. Several types of economic analyses are often used, including impact analysis, cost-benefit analysis, and cost effectiveness analysis. Impact analysis is useful when resource managers want to understand the impacts of implemented policies on the local economy (e.g., employment). Cost-benefit analysis helps resource managers select an option that maximizes the net benefit of resource uses. And finally, cost-effectiveness analysis is used to find the option that meets policy targets at the least cost. Both cost-benefit analysis and cost effectiveness analysis reflect the economic efficiency of resource allocation under conditions of scarcity. Therefore, sound choices in policy necessitate an understanding of all the components related to economic benefits and costs for investment options.

The Natural Resources Conservation Services (NRCS), the lead agency responsible for conservation efforts on farmland, considers economic information an integral component in establishing conservation planning decisions. The agency utilizes economic information and applications to support conservation decision planning at several levels, including, the use of economic consequences of alternative conservation actions to help inform NRCS customers of conservation implementation options; and the use of economics to satisfy the goal of maximizing environmental benefits per dollar expended in a selected conservation program.

2.2 Estimating Costs and Benefits of Conservation

Information on economic costs and benefits is vital for determining the effectiveness of conservation programs, especially when facing limited resource allocation. Identifying what information to include in the economic analysis requires knowledge of all economic costs and benefits associated with conservation activities. Costs of BMPs implementation are those related to design, construction, operation, maintenance and monitoring. These engineering unit costs are quite straightforward to estimate, while only partial benefits associated with BMPs can be captured through market prices, such as increase in yields as a result of soil productivity improvement.

Many economic benefits from conservation are not captured in market transactions; examples include the benefits of environmental improvement that enhance habitat for wildlife and improve recreation activities. These types of benefits can be estimated by various methods to capture the "value" of nonmarket goods. Examples of empirical studies which estimate the non-market benefits of conservation, especially related to soil erosion and sediment reduction, can be found in various studies (please refer to Ribaudo, 1992; Huszar and Piper, 1986; Feather et al.1999; Hansen et al. 2002). In addition, Hansen and Ribaudo (2008) used the benefit transfer approach to estimate the off-site benefits to downstream communities (including households, industries, and municipalities) as a result of upstream water quality improvements. The estimated values can be viewed as prices that people, businesses, and government agencies would be willing to pay for a 1-ton reduction in soil erosion.[2]

Although conservation costs (e.g., implementation costs) are relatively easy to identity, many conservation plans do not fully identify the associated economic costs, such as opportunity costs or forgone benefits from taking cropland out of production. Naidoo et al. (2006) identified economic costs of conservation planning as consisting of everything that landowners/farmers must sacrifice to implement conservation practices. These costs include acquisition, management, transaction, damage, and opportunity costs. The range of costs varies depending on the type of conservation practice; therefore, resource managers must consider the relevant costs associated with the conservation practice of interest. Similar to costs, benefits of conservation can be classified as private or public benefits and/or on-site and off-site benefits. Details and examples of costs and benefits are shown in Table 1.

Benefit and cost information can be useful in BMP implementation and support decision making at various levels. For example, when adopting BMPs at the individual farm level, in addition to any risks associated with switching practices, a farmer would also consider whether private net benefits would increase. Several studies have identified, and attempted to quantify, costs and benefits of BMPs and have found some common challenges when performing the economic

[2] The per-ton benefit values are available on the Economic Research Services (ERS) web site at www.ers.usda.gov for the 2,111 8-digit Hydrologic Unit Code (HUC) watersheds within the contiguous 48 States. Although the estimated values lack specific details, overall they are useful for a broad policy analysis.

assessment. Although there is a need for using models to quantify impacts of BMPs, existing models lack comprehensive economic information; therefore, it is difficult to quantify the total impact of BMPs. For example, Uri (1998) identified types of cost and benefit information for his economic assessment of conservation tillage adoption, including yields, expected output prices, and inputs used in production (labor, fertilizer, pesticides, seeds, and machinery). Bracmont et al. (2004) compared benefits and costs of BMP implementation on water quality improvement as a result of sediment and phosphorus reductions. Several off-site benefits (e.g., wildlife habitat improvement, aesthetics) were not captured in their analysis due to limited data availability.

Yuan et al. (2002) and Zhou et al. (2009) used models to help in the analyses of cost effectiveness of alternative BMPs. Yuan et al. (2002) used a model called AnnAGNPS[3] to assess the impacts of several BMP combinations on sediment yields from cropland in the Mississippi Delta watershed and analyzed the cost-effectiveness of BMPs for three tillage systems. Zhou et al. (2009) investigated cost-benefits of conservation management practices (tillage systems and conservation structures) on sediment reduction in eastern Iowa using the Water Erosion Prediction Project (WEPP) model, which estimates annual sediment yield. Overall costs were based on the production costs, costs of establishment and maintenance of conservation structures, yield return, and the value of eroded soil. Off-site costs were also included in the analysis.

[3] AnnAGNPS (Annualized Agricultural Non-Point Source Pollution Model) is a computer model developed to predict non-point source pollutant loadings within agricultural watersheds (more details http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/?cid=stelprdb1042468)

<u>Table 1</u> Cost and Benefit Categories – Examples for BMP Evaluations

	Cost	Benefit
Private	Private costs associated with implementation of conservation practices, and are primarily incurred by a landowner. *Examples:* - Production costs due to adopting conservation practices (e.g., such as implementation costs, operation and maintenance (O&M) and replacement costs) - Reduction of income due to taking farmland out of production	Private benefits accrue to a landowner and are generally not shared with the public. *Examples:* - Increased revenue from increases in crop yields and/or quality improvements of agricultural products as a result of soil and water improvements after implementing conservation practices - Reduced production costs (e.g., input uses on farm production)
Public	Public costs are associated with implementation of conservation practices and are incurred by taxpayers through conservation programs. *Examples:* - Increasing the public cost's share of implementing conservation practices such as CRP (Conservation Reserve Program), EQIP (Environmental Quality Incentives Program) WHIP (Wildlife Habitat Incentive Program) - Creation of negative externalities[4] with a community or the public in general due to undesired landscape or downstream flow changes	Public benefits are either shared with a land owner with his or her community/society in general or they are enjoyed entirely by the public. *Examples:* - Enjoying a beautified landscape as a result of trees/plants planted by a landowner - Restoring wildlife habitats and biodiversity as a results of conservation practices implemented by a land owner

Continued (next page)

[4] Externalities can be viewed as costs (negative externalities) or benefits (positive externalities) that are generated by someone (usually unintentionally) which affect unrelated third parties who are not engaged in the direct market transactions.

Table 1 (continued)

	Cost	Benefit
Onsite	Onsite costs of implementation that are directly associated with the land unit where conservation practices are applied. *Examples:* - Increasing expenditures due to implementation of conservation practices (e.g., installation, operation and maintenance costs) Losing revenue from land production due to placing land in a conservation practice (forgone income)	The benefits realized on the physical land unit where the conservation practices implemented. *Examples:* - Maintaining, restoring, or increasing productivity by protecting the soil from erosion as well as conserving water - Increasing crop yields resulting in increased income and offset of conservation costs to producers - Decreasing production costs (e.g., some conservation practices may save the farm operation time, fuel, and machine wear, use less fertilizer and fewer chemical inputs). - Increasing wildlife visits, enhanced local air quality, and improved opportunities of recreation use
Offsite	Offsite costs are those costs incurred outside of the immediate project area (cross-effects impacting non-targeted resources). *Examples:* - Impacting/disturbing nearby wildlife habitats	Sometimes when conservation practices are implemented they reduce the transportation of major pollutants to nearby and down-stream, and thus provide various offsite economic benefits. *Examples:* - Enhance water-based recreation uses by reducing pollutants in water bodies (~Improve water quality) - Reduce potential damage from sediment accumulation in drains, ditches, plug culverts, lakes, reservoirs, ponds - Improve reservoir storage capacity - Reduce sediment dredging costs - Reduce drinking water treatment costs - Restore/improve wildlife habitats - Provide recharge to aquifers to maintain flows - Increase property values - Reduce downstream floods and storm damages - Regulate/provide sinks for greenhouse gases

Sources: Adapted from USDA-NRCS- Natural Resource Economics Handbook 2012 and Cattaneo et al 2005.

2.3 NRCS – BMPs Costs

Cost payments from the NRCS can be described as the typical costs for implementing a conservation activity on a farm. These costs include the installation, operation, and maintenance of the conservation activity. A more detailed definition of cost payments can be found in the following equation (NRCS, 2009):

Total Implementation Cost = (Materials + Equipment/Installation + Mobilization + Acquisition of Technical Knowledge + Administration/Permit) + (First year of: Operation/Maintenance + Foregone Income + Risk)

Each state has a definition of cost payments developed for their own use based on a typical scenario on an annual basis. According to the NRCS (2009), "a typical scenario describes the most commonly used inputs and costs associated with a practice or activity installation in a typical setting for a geographic area. The typical scenario is the basis for cost data development." More than one typical scenario may be developed, as variations in types of materials used, economies of scale, labor costs, and other factors may result in large differences. If an activity is to be implemented over multiple years, the costs can be amortized over the timespan of that activity.

When it comes to transferring money to producers, NRCS will typically pay a proportion of the cost, otherwise known as a payment rate, to help producers offset the cost of implementing a practice. Payment rates vary according to the program in which the producer is enrolled, with the rate varying from seventy-five percent to one-hundred percent. Examples of payment programs from the NRCS include EQIP (Environmental Quality Incentives Program), WHIP (Wildlife Habitat Incentive Program), and AMA (Agricultural Management Assistance).

With estimated implementation costs being developed by each state on an annual basis, in order for cost payments to reflect real-world costs incurred by producers, the NRCS thus helps ensure cost data integrity. States must develop their own quality assurance plan, which includes a review of processes, a listing of cost elements, and methods. Guidance must also be in place on how to conduct the process of cost data updates, which often takes place throughout the year as data becomes available.

3. WORKSHOP PRESENTATIONS AND DISCUSSIONS

This section provides a summary of workshop presentations, and highlights the main issues for incorporating economic information into decision support tools.

3.1 Workshop Presentations

Several workshop participants (including, Jon Bartholic and Glenn O'Neil of IWR-MSU; Jan Miller of USACE and Tom Crane of the GLC; Scott Sowa of TNC and Steven Miller of MSU-AFRE) provided presentations of case studies focused on the decision support tool development and their uses to assist conservation planning (e.g., targeting, measuring and evaluating conservation activities). Overall, economic and cost data has been incorporated, to a limited degree, into the decision support tools used in planning efforts. The following highlights a number of examples from the workshop presentations:

The GLTM has developed two types of sediment modeling: site specific tributary modeling and web-based tools (see appendix for details). The tributary models rely heavily on technology, thus requiring technical expertise in sediment modeling, and are much more site specific. Web-based tools are more user friendly and are more appropriate for watershed level planning. The web-based tools can be used for tracking and targeting outcomes while working with producers on BMP implementation at the landscape level. Linking changes in sediment reduction in a landscape and relating them to downstream environmental improvement (i.e. water quality) is needed.

IWR presented about GLWMS, including the HIT tool, and their applications. Specifically, HIT calculates the total and rate of erosion and sediment loadings, as well as the amount of sediment or erosion reductions when applying BMPs. This tool allows users to compare sediment/erosion reduction costs to the amount of sediment/erosion reduction (dollar per ton of reduction). However, only partial costs (i.e., NRCS-BMPs standard cost) are provided for in the tool. It is anticipated that the full economic costs of conservation could be identified and built into the GLWMS.

The economic component of BMPs with enterprise budgets (EB) was presented by Steven Miller. Farmers can input their farm operation costs and income data into a spreadsheet and calculate their cost and return on a per acre basis. It may be beneficial to expand EB to include BMP costs and benefits options for farm operators, as a means to increase BMP adoption. Farmers and resource managers would benefit by knowing the full costs and benefits, including the economic risks associated with BMP implementation. This could also facilitate discussions between resource managers and farmers about making changes to conservation policies and encourage the adoption of BMPs on farmlands.

The Nature Conservancy's (TNC) presentation focused on using adaptive management approaches to inform management of agricultural non-point source pollution at the watershed level, and provided a good use of economic analysis to complement the policy goals. TNC works with stakeholders to set achievable conservation goals, then select the most cost effective BMPs to meet those goals. There are four phases to TNC's planning strategies:

- Phase 1 – relate the health of biological communities to water quality;
- Phase 2 – relate conservation actions to water quality and the health of the biological community;
- Phase 3 – develop data and decision tools to target and track;
- Phase 4 – partner to set goals and test innovative strategies to achieve them.

It is clear that economic information in BMP decision tools have played an important role in TNC's conservation planning. Incorporating more complete information about economic costs and benefits of non-market valuation, such as fish recreation and biodiversity value, could be beneficial.

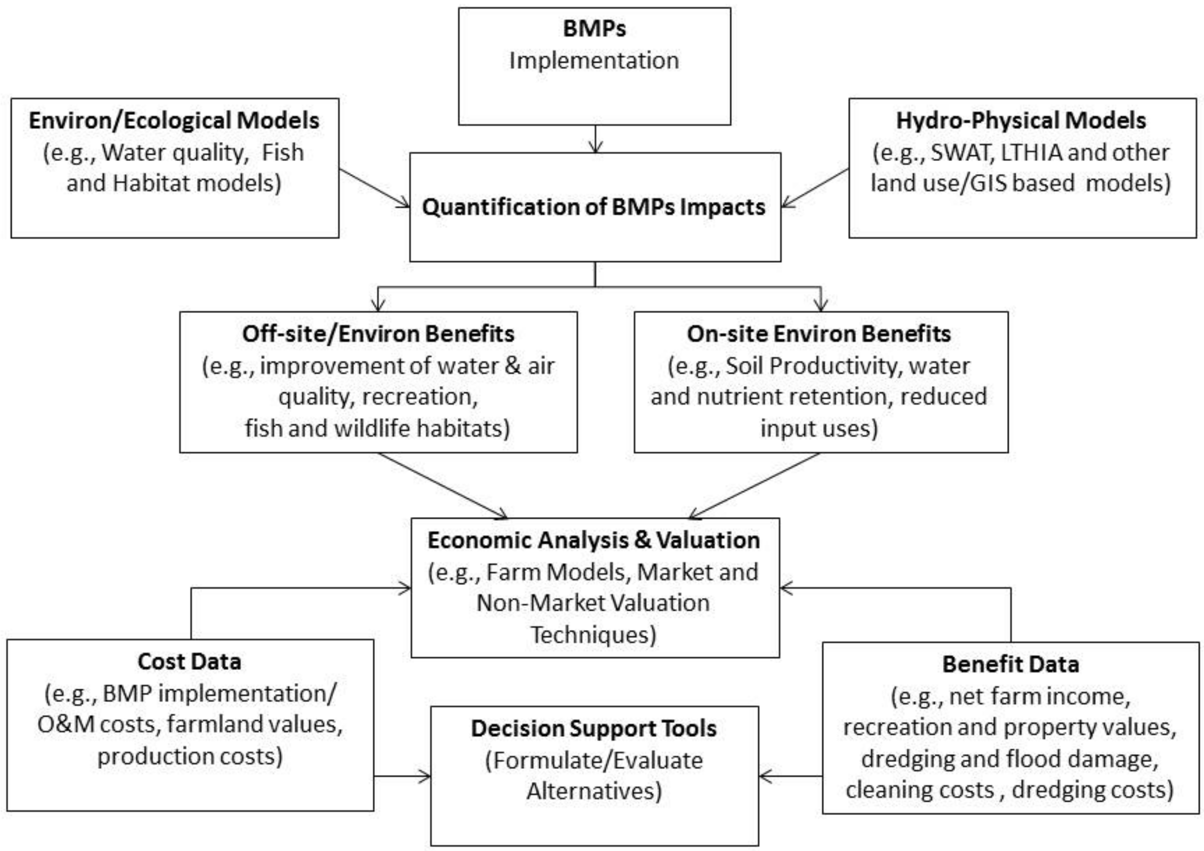
James Selegean of USACE presented the current efforts of USACE in sediment dredging. Several concerns related to sediment dredging and efforts to control sedimentation at the landscape level exist and need to be addressed. These concerns include the amount of sediment, and their source, that actually end up at the dredging point downstream. Since there are many factors related to sedimentation transport and long-term accumulation, it is also important to understand how long it takes for BMPs to have a positive effect on the reduction of sediment at the downstream dredging point. Economic information on the cost of dredging and BMP costs of sediment reduction may be linked to draw a general conclusion of the benefits of sediment reduction on land.

Adding another policy dimension, Brent Sohngen of Ohio State University (OSU) presented a model of nutrient concentrations in the Maumee and Sandusky rivers. By using data of long-term nutrient concentrations from two watersheds for the analysis, it was found that in general, the concentrations of nutrients (P-Phosphorus) largely depend on nutrient inputs (P) and crop prices (corn price). However, conservation measures (conservation tillage) provided mixed results on their effect on the P concentrations in the two rivers. This may suggest that efforts to reduce P inputs to improve water quality could also be done by using tax policy (e.g. fertilizer tax). The study also spurred discussion that considered whether more regulations on phosphorus use (i.e., ban of using phosphorus in some activities) to reduce the additional pollutants entering water bodies might be a potential policy option.

3.2 The Linkages of BMPs, Costs, and Benefits

An overview of economic considerations and linkages of conservation BMPs can be illustrated in Figure 1. BMP implementation on farmland needs quantifications of their impacts on sediment reduction, which in turn requires some physical models (i.e., SWAT model) to estimate load reduction (i.e., amount of sediment loadings). Since most policy interests are on downstream environmental improvement (offsite benefits) on sediment reduction, there is a need to quantify the changes resulting from sediment load reduction. For example, if policy interest is the improvement of recreation fishing, it must be understood how sediment reduction will improve water quality and habitat. This requires bio-economic models to capture the chain of impacts on water quality of BMPs before and after sediment reduction. The models may include a water quality model, ecological model (fish recreation model), and/or economic model. If all changes (effects) can be measured, the estimate of BMP costs can be compared to the economic benefits of downstream recreation. Some effects of BMPs can be relatively easy to measure and economic costs and benefits can be calculated. For example, onsite costs and benefits of BMP implementation are useful for landowners and/or conservation planners for their conservation decision making.

The workshop participants also went through an exercise to identify the possible on-site and off-site costs and downstream benefits of implementing a buffer strip to encourage sediment reduction. It was clear from this exercise that identifying the full economic costs and benefits of BMP implementation, and their impacts, is not an easy task.



<u>Figure 1</u> Onsite/Offsite Costs and Benefits of BMP Implementation with Data and Models Needed for Quantification within the Decision Support Tools

4. CHALLENGES OF INCORPORATING ECONOMIC INFORMATION INTO DECISION SUPPORT TOOLS

While utilizing economic information would likely result in better decision making, there are several challenges to obtaining complete economic information, and incorporating it in decision support tools. Some principal challenges are summarized below:

- **Identifying and Quantifying Opportunity Costs** - Not all economic costs and benefits of conservation are easy to identify and/or quantify in monetary terms. Some costs may be relatively easy to obtain, such as per unit cost of BMP installation. However, the opportunity cost of taking land out of production depends on farmers and their net profits.

- **Quantifying Benefits that are Not Captured in Market Transactions** - The benefits of conservation are the most challenging to incorporate into decision support tools, as many of these benefits are not captured in market transactions. For example, the benefits of water quality improvement by sediment reduction may include increased biodiversity, expanded habitat for endangered species, and increased opportunities for sport fishing and recreation. Although there are available estimated economic benefit values from various studies (e.g., Hansen & Ribaudo, 2008), more site-specific values are still needed. These site-specific benefits needed to be quantified into monetary terms.

- **Reducing Uncertainty of Linkages Between Upstream Costs and Downstream Benefits** - Even if there were complete information about costs and benefits, it would be difficult to provide answers with certainty. This uncertainty relates to the difficulty of clearly demonstrating the link between upstream costs and downstream benefits of BMPs. These linkages need to be captured and quantified by models at various scales (i.e., field models, watershed hydrologic models, stream flow models, water quality models, ecological models).

- **Developing User-Friendly Tools -** Economic information in a decision support tool can be used by various users to assist decision-making at different levels. Therefore, when integrating information into the tool, one must design it in such a way that it is appropriate for their end user's preferences. A non-industry end user (or the general public) may also benefit from using information with a simple design and easy-to-use decision tools.

- **Large-Scale Data Collection** - Economic costs and benefits of BMPs at a farm scale can be captured and included in a decision tool. However, obtaining the information may be problematic, due to the privacy of such information. Therefore the expanded use of the enterprise budget to incorporate BMP cost and benefit options for farmer use could be beneficial.

5. SUMMARY AND NEXT STEPS

Decision support tools can help users systematically prioritize and target areas for BMP implementation. An effort to include economic information into these tools will enhance the ability for users to compare economic costs and benefits of their conservation decisions. Landowners, farmers, and resource managers can use the information to direct resource allocation to where they could maximize net economic benefits. Currently, limited cost information (primarily installation costs) has been used and integrated into the tools. Challenges to include more complete economic information into the tools are mostly due to data availability, especially the offsite benefits of BMPs. As a result, there is a need for increased research efforts and funding for several areas, including model quantification of the linkages between the impacts of BMPs on water quality improvement and the benefits to downstream users, empirical studies on non-market valuation, and techniques to develop an economic database. A greater understanding of the linkages of BMP impacts, both on costs and benefits, will result in more informed decisions on investment and funding for BMPs. In addition, other economic information for decision support tools (e.g., tax, cap, trading, subsidies, performance based incentives, conservation credits/trading, payment for ecosystem services) can be developed to assist policy makers.

A number of strategies should be pursued to improve decision tools used in the implementation of conservation practices. These strategies include:

- Economic costs of BMPs should be fully integrated into decision support tools; due to data availability and simple calculation methods, this plan should be implemented first. Some standard economic costs, such as those associated with implementation, operation and maintenance can be obtained from conservation agencies such as the NRCS; opportunity costs can be determined through the observation (survey) of farmers' willingness to adopt the BMPs. In addition, existing benefit estimates, such as those provided in the study by Hansen and Ribaudo (2008) are already available for use and could potentially be incorporated into decision support tools.

- Many factors must be considered in any decision regarding conservation practice adoption, and economic information alone may not provide sufficient incentive to meet sediment reduction targets. Other measures, including taxation and regulation of pollution sources, could be integrated in decision support tools (e.g., tax mechanisms can help reduce phosphorus use, as suggested by research in the Maumee and Sandusky River).

- As the downstream benefits of implementing BMPs often take a long time to be realized (e.g., from physical to biological effects), the outcome of environmental improvement is often beyond the conservation program's contract term (usually 3-10 years). Therefore, conservation programs and practices which rely on contracting private landowners or farmers to implement BMPs may not be a sustainable approach. Regional restoration approaches which could be modeled and developed for decision tools, such as large-scale wetland restoration or creation, may be a better method to ensure conservation sustainability. This approach would take land out of production permanently, and could be accomplished by land acquisition and permanent easements at sites where wetlands can be restored, enhanced, or preserved in order to capture agricultural runoff.

- A new proactive voluntary conservation program, such as the 4R Nutrient Stewardship Certification Program on Lake Erie's water quality, may provide an overall reduction of conservation cost and ensure sustainability of conservation benefits. This approach encourages agricultural retailers, service providers and other certified professionals to adopt proven best practices. It provides a science-based framework for plant nutrition management and sustained crop production, while considering specific individual farms' needs (see http://4rcertified.org/about/).

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REFERENCES

Cattaneo, A., Claassen, R., Johansson, R. C., & Weinberg, M. (2005). Flexible conservation measures on working land: What challenges lie ahead? (No. 7248). United States Department of Agriculture, Economic Research Service.

Bracmort, K.S., Lee, J.G., Frankenberger, J.R., & Engel, B.A. (2004). Estimating the long-term benefits and costs of BMPs in an agricultural watershed. American Society of Agricultural and Biological Engineers (ASAE), Annual International Meeting 2004.

Feather, P., Hellerstein, D., & Hansen, L. (1999). Economic valuation of environmental benefits and the targeting of conservation programs. Washington, DC: US Department of Agriculture.

Hansen, L., & Ribaudo, M. (2008). Economic measures of soil conservation benefits: Regional values for policy assessment. USDA Technical Bulletin, (1922).

Hansen, L. T., Breneman, V. E., Davison, C. W., & Dicken, C. W. (2002). The cost of soil erosion to downstream navigation. Journal of Soil and Water Conservation, 57(4), 205-212.

Huszar, P. C., & Piper, S. L. (1986). Estimating the off-site costs of wind erosion in New Mexico. Journal of Soil and Water Conservation, 41(6), 414-416.

Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., & Blair, R. (1995). Environmental and economic costs of soil erosion and conservation benefits. Science-AAAS-Weekly Paper Edition, 267(5201), 1117-1122.

Ribaudo, M. O. (1992). Options for agricultural nonpoint-source pollution control. Journal of soil and water conservation, 47(1), 42-46.

Naidoo, R., Balmford, A., Ferraro, P. J., Polasky, S., Ricketts, T. H., & Rouget, M. (2006). Integrating economic costs into conservation planning. Trends in Ecology & Evolution, 21(12), 681-687.

NRCS. (2009). National Resource Economics Handbook, Part 613 – Payment Schedules (section 613.11) http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_009583.pdf (accessed 12/15/14).

NRCS. (2012). NRCS-Natural Resource Economics Handbook ftp://ftp-fc.sc.egov.usda.gov/Economics/econhandbook/EconHandbook610all.pdf (accessed 12/02/14).

Telles, T. S., Guimarães, M. D. F., & Dechen, S. C. F. (2011). The costs of soil erosion. Revista Brasileira de Ciência do Solo, 35(2), 287-298.

USDA. (2006). Conservation reserve program: summary and enrollment statistics–2005. United States Department of Agriculture Farm Service Agency, Washington.

Uri, N. D. (2000). An evaluation of the economic benefits and costs of conservation tillage. Environmental Geology, 39(3-4), 238-248.

Yuan, Y., Dabney, S. M., & Bingner, R. L. (2002). Cost effectiveness of agricultural BMPs for sediment reduction in the Mississippi Delta. Journal of Soil and Water Conservation, 57(5), 259-267.

Zhou, X., Helmers, M. J., Al-Kaisi, M., & Hanna, H. M. (2009). Cost-effectiveness and cost-benefit analysis of conservation management practices for sediment reduction in an Iowa agricultural watershed. Journal of Soil and Water Conservation, 64(5), 314-323.

APPENDIX

Workshop Agenda

The Potential for Incorporating Economics into the Decision Support Tools

17 October, 2014

Room 105, Manly Miles Building, Michigan State University, East Lansing

Address: 1405 S. Harrison Road, East Lansing, MI 48823-5243

8:30	Breakfast provided
9:00	Welcome/Introductions
9:10	Welcome (Jan Miller)
9:20	Economics Overview – BMPs, costs, benefits, linkages (Frank Lupi)
10:00	Overview of the Decision Support System (DSS) (Jon Bartholic)
10:15	Break with refreshments
10:30	Presentation 1 - Great Lakes Tributary Model (GLTM)(Tom Crane)
10:55	Presentation 2 - BMPs and Benefits (Scott Sowa)
11:20	Presentation 3 - BMPs and Costs (Steve Miller)
11:40	Presentation 4 - Downstream Dredging (Jim Selegean)
12:00	Presentation 5 - BMPs/Phosphorus - Maumee Watershed (Brent Sohngen)
12:30	Working Lunch provided
1:15	Tasks/plans to be accomplished (Frank Lupi)
1:30	Information/Sources/Experiences (Frank Lupi)
3:00	Break with refreshments
3:15	Information Evaluation: Quality & What is missing? (Frank Lupi)
4:15	Integration - economic information and DSS (Jon Bartholic)
4:30	Workshop summary and next steps (Jon Bartholic & Team)

List of Participants:		
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