ENABLING CONDITIONS TO ACHIEVE ROI

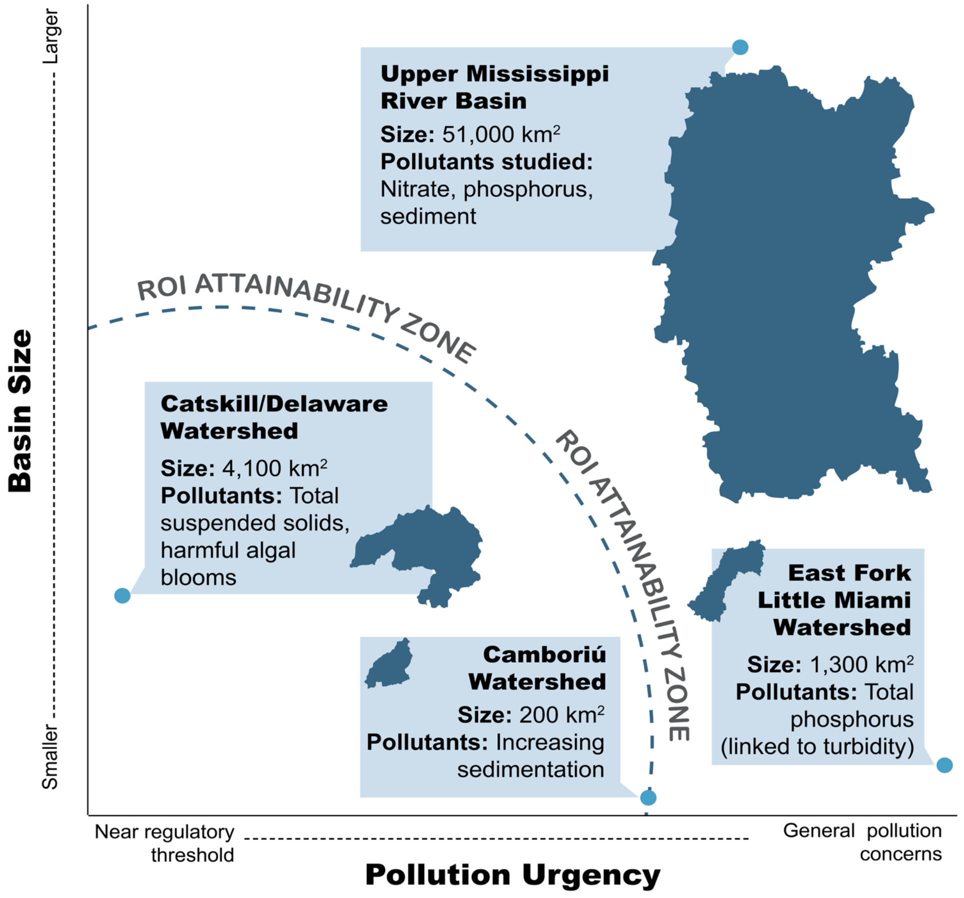

Figure 4
A graph of watersheds where ROI for source water protection efforts has been assessed. Basins are plotted according to size and the pollution concern.

An analysis of similar case studies suggests two important factors for building an ROI case are basin size and pollution urgency. As basin size increases, the required scale of land purchases and easements will generally also increase, increasing the cost of conservation. Pollution urgency refers to how critical and how much action the pollutant of interest requires.

CONCLUSIONS

Our modeling results suggest conservation interventions would avert relatively small increases in nutrient and sediment concentrations, resulting in minimal cost savings for drinking water providers. Based on other case studies, the strongest ROI case for watershed-level drinking water protection occurs in smaller basins with pollutant levels near a regulatory threshold.

ACKNOWLEDGMENTS

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REFERENCES

[1] Lark, T. J., Salmon, J. M., & Gibbs, H. K. (2015). Cropland expansion outpaces agricultural and biofuel policies in the United States. Environmental Research Letters, 10(4), 044003.
[2] Minnesota Department of Natural Resources (2010). Water Ways: A Minnesota Water Primer & Project WET Companion.
[3] U.S. Environmental Protection Agency (2016). Hydrologic and Water Quality System (HAWQS) Model. Beta version. June 2016.

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Exploring the Return on Investment Case for Drinking Water Protection in the Upper Mississippi River Basin

BACKGROUND

From 2008-2012, Minnesota ranked first in the nation for wetland-to-cropland conversion, and second for forest-to-cropland conversion[1]. This land use change may be contributing to increases in nutrient and sediment pollution in the Upper Mississippi River Basin.

Over one million Minnesotans receive drinking water from the Mississippi River[2]. As such, water providers have a financial interest in maintaining or improving the basin's water quality to manage treatment costs now and into the future.

Research Questions

- What is the value of source water protection to drinking water utilities under changing land use conditions?
- Could utilities see a return on investment (ROI) by engaging in watershed conservation efforts?

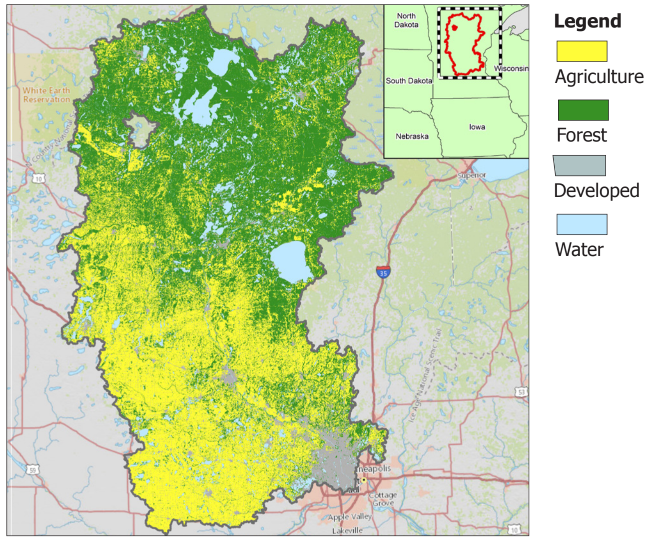

Figure 1
Upper Mississippi River Basin and dominant land use classes in Minnesota.

STRATEGIES

We employed a multi-tiered approach to explore potential economic benefits of source water protection under dynamic land use conditions. Specifically, we outline four key strategies.

1. Talk to utilities to identify needs and obtain data.

We spoke with the cities of Minneapolis, St. Cloud, and Hastings, Minnesota to understand their treatment processes, investment decision-making, and obtain data on water quality and treatment costs.

2. Model water quality under future land use scenarios.

We used a cloud-based model, the Hydrologic and Water Quality System (HAWQS)[3], to predict water quality under baseline, moderate and aggressive agricultural expansion land use change scenarios in the basin.

3. Link modeled water quality to treatment costs to determine ROI.

We used the outputs of our water quality model to quantify changes in treatment costs relative to costs of conservation.

4. Develop a set of enabling conditions.

We took what we learned in the Upper Mississippi River Basin, and information from case studies, to better understand where ROI may be attainable.

BASIN MODELING RESULTS

Water quality parameters like Total Nitrogen (TN), Total Phosphorus (TP), and sediment concentrations were estimated for baseline land use, future land use with moderate agricultural expansion, and for future land use with aggressive agricultural expansion in the study area.

Cropland is expected to expand by approximately 350 km^2 in the moderate scenario and approximately 525 km^2 for the aggressive scenario. The area of forested land loss was approximately 1410 km^2 in the moderate scenario and 1500 km^2 in the aggressive scenario.

Conservation interventions explored by The Nature Conservancy (TNC) would make future land use in the Upper Mississippi River Basin similar to the moderate agricultural expansion scenario.

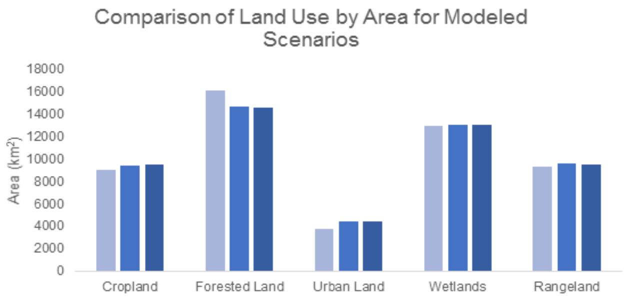

Figure 2
Land use areas across the three agricultural expansion scenarios modeled.

Such interventions would result in TN reductions of around 0.4-0.8%, TP reductions of around 0.6-1.2%, and sediment reductions of around 0.1-0.2% at Minneapolis and St. Cloud water intakes.

Based on land use scenarios and model outputs, we estimate conservation interventions could avert:

Total Nitrogen increases of 0.4 - 0.8%

Total Phosphorus increases of 0.6 - 1.2%

Sediment increases of 0.1 - 0.2%

ECONOMIC ANALYSIS

Reduction in TN and sediment concentrations could not be linked to treatment cost savings. But, we estimated that a 1% reduction in TP concentrations near the Minneapolis water intake location reduces the treatment cost by around $340 per year.

Assuming, conservatively, that these benefits, accrue in perpetuity once TNC's interventions are fully implemented, the net present value (NPV) of the benefits is around $10,200 - $18,900 (in 2015 USD). These benefits are minimal compared to the proposed scale of investments (of the order of millions of dollars) in source water protection in the study area by TNC.

Cost of conservation interventions
~$10 million

Treatment cost savings
$10,200 - $18,900 (NPV)

**Net present value (NPV) of benefits assumes $340 accrued annually in perpetuity at 2% discount rate.*

SUBBASIN ANALYSIS

Analysis of modeling results on a subbasin level was used to determine both the spatial distribution and magnitude of changes to water quality parameters. Conversion of non-agricultural lands in the central and northern parts of the basin into agriculture was expected to be associated with the most significant changes in water quality parameters, and HAWQS outputs were consistent with these expectations. If mitigation of impacts to local water quality parameters is considered a worthwhile investment for TNC, then targeting subbasins where the largest increases in nitrogen and phosphorous yields are expected to occur could buffer the effect of land use change and lead to the greatest water quality protection.

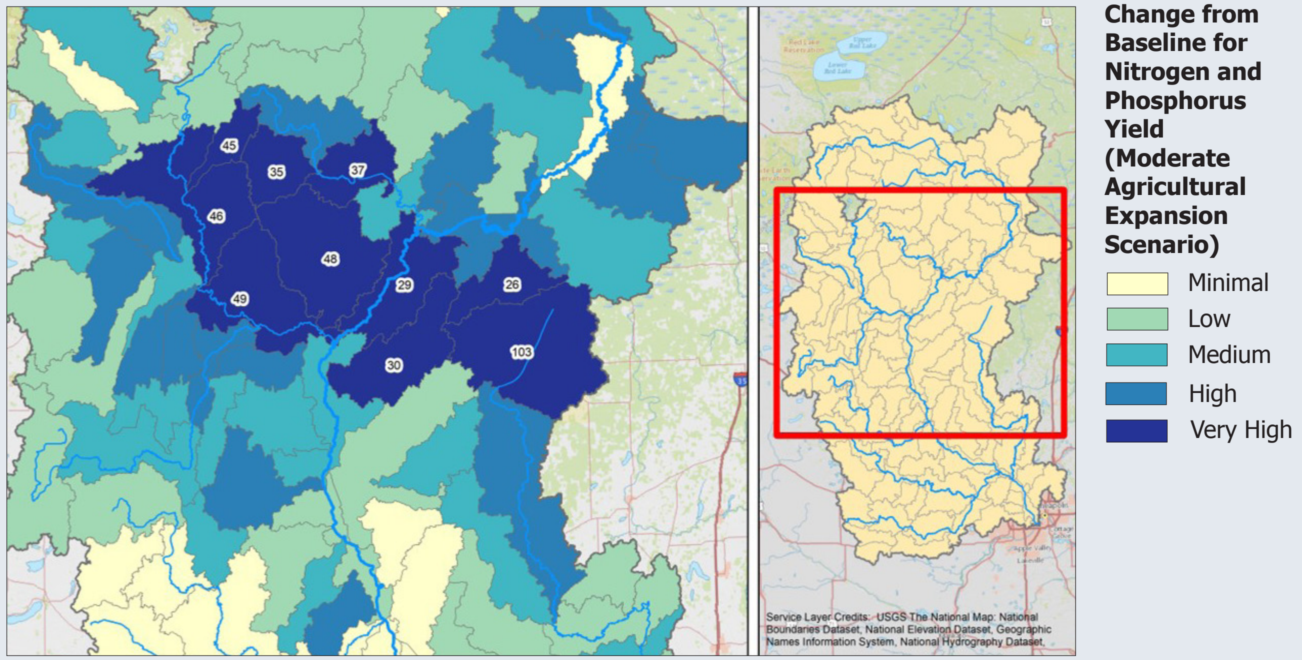

Figure 3
Results from subbasin analysis of changes to N and P from the baseline scenario. Darker shades of blue indicate a larger relative increase in N and P loading within each subbasin.