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TIPPING POINT PLANNER
Supporting Sustainable Communities in Great Lakes States

Sea Grant ILLINOIS-INDIANA

Informing the Development of the Great Lakes Region Decision Support System

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Introduction and Motivation

Land use planners in the Great Lakes region make recommendations that have the potential, short-term and long-term, to impact both the quality and quantity of ground and surface water resources. Temporally and spatially, land use/cover change is one of the most prominent drivers of environmental change, especially water quality (Zhang et al., 2008). Changes in land use/cover(s) over time have been linked to numerous environmental impacts, such as altered atmospheric dynamics (Houghton, 2009) and degraded aquatic ecosystems condition (Forman, 2008). Other impacts associated with land development for human uses, such as agriculture and urbanization, have resulted in wildlife habitat degradation (Sanderson et al., 2002), soil loss due to unsustainable agricultural and forestry practices (Napier and Tucker, 2001), and increased air and water pollution (Marshall and Shortle, 2005; Greenstein, Tiefenthaler, and Bay, 2004).

Understanding the potential effects of planning decisions can be challenging due to: 1) lack of access to up-to-date water quality data (if it exists at all); 2) insufficient political and financial support for land use planning; and 3) lack of understanding about how land development decisions impact water resources at multiple temporal and geographic scales. To assist land use planners, university researchers within the Great Lakes region – Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin – work collaboratively in the development and maintenance of an online decision support system.

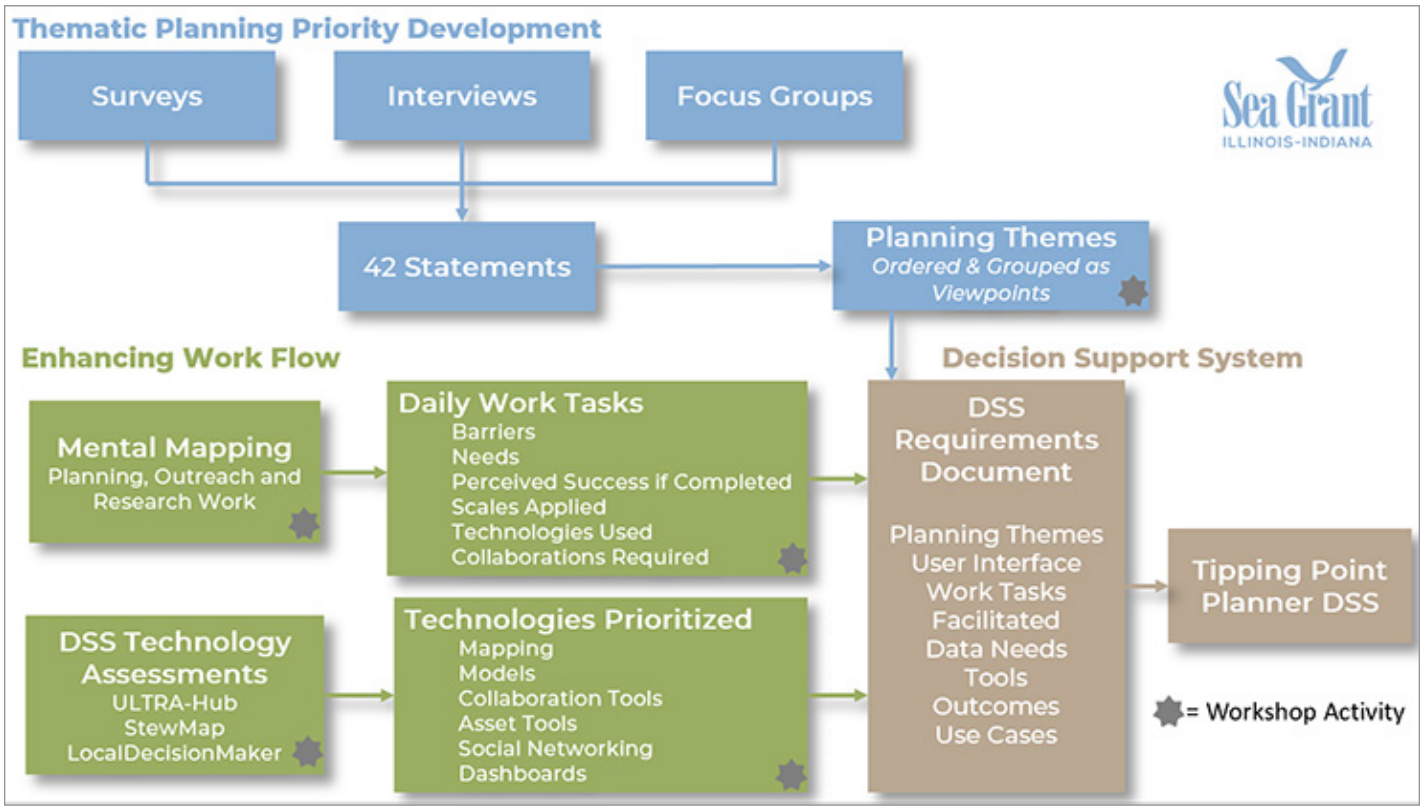

Figure 1. Workflow for developing a Decision Support System that represents many stakeholders.

Stakeholders in a decision support system include land use planners, Sea Grant extension specialists, and university researchers. The system was developed in two phases: 1) Thematic Planning Priority Development, and 2) Enhancing the Workflow (Figure 1). The team strove to ensure that the information is useful to its intended audience, verify that information and data are presented in an easy-to-understand format, and guarantee that the system caters to a variety of user viewpoints/perspectives and spatial land use planning jurisdictional scales. The team used qualitative and quantitative research methods with information gathered from surveys, interviews, and focus group activities.

Thematic Planning Priority Development: Surveys

The team used an online survey to identify current water quality perceptions held by regional, county/township, and municipal land use planners throughout the Great Lakes states (626 online surveys mailed in 2011 and 2013 with 48.2% response rate). The surveys were designed to rank perceptions about water quality issues and tools that could benefit the improvement of water quality.

Surveys asked land use planners to identify what types of information they thought would be useful (yet was currently unavailable to them) for assessing the potential impact of land use/cover changes on water quality. The majority of respondents believed that the overall quality of surface water was good or excellent (65%); municipal land use planners had the highest perception of overall surface water quality (78.3%) compared to regional planners (57.4%). The respondents ranked the top issues they dealt with on a daily basis (Table 1), and water quality issues overall (Table 2), and what to consider when making land use decisions (Table 3).

Table 1: Top ranked water quality issues *dealt with on a daily basis, as ranked by planners*	
#1	Confined animal feeding operations
#2	Discharge of industrial pollutants
#3	Algal blooms

Table 2: Top ranked water quality issues *overall,* as ranked by planners
Improper trash/garbage disposal
Motor vehicle oil and fluids entering the water
Soil erosion from development or construction sites
Water pollution from industrial fluids
Water pollution from heavy metals (zinc, mercury, lead, and cadmium)

Table 3: Top ranked water uses to consider when making land use decision, *ranked by planners*	
#1	Drinking water
#2	Recreational use
#3	Aesthetic/scenic appeal
#4	Commercial/industrial use

More than 25% of the planners believed it was difficult or extremely difficult to link water quality to potential impacts of land use planning decisions or recommendations; 43% believed they could have a moderate impact, and nearly 14% believed they could have a large impact on water quality.

The remaining survey questions asked land use planners how they currently evaluate potential impacts. Such methods include GIS mapping websites/tools, land use forecasting tools, traffic flow calculators, water runoff models, decision support systems, and environmental cost/benefit calculators. Other available types of decision support systems include those used to assess expected population growth, assess impacts transportation, predict economic stability and growth, assess potential impacts on recreational opportunities and wildlife habitat, and identify soil loss/erosion potentials.

When asked about a new decision support system to support the Great Lakes region, land use planners said such a tool will be most beneficial if it can: 1) allow the user to evaluate potential water quality impacts of future land use planning/development scenarios (45%); 2) allow users to assess existing environmental conditions and their causes (47%); 3) allow users to view information/data in a variety of formats (e.g., GIS layers, charts, and pdf. files); and 4) allow users to view data aggregated across multiple geographic scales. Information and data identified as important to include in any decision support system was identified as: 1) current information about water resources condition and land use/cover; 2) land use change (both past and predicted); and 3) information concerning groundwater resources within the Great Lakes states.

Thematic Planning Priority Development: Interview and Focus Groups

The team conducted interviews with key informants and developed a workbook for focus group sessions (Figure 2), resulting in a list of 42 statements pertaining to decision support system data, tools, and functionality needs. In spring 2012, a handful of land use planners, Sea Grant extension staff, and university researchers were asked to sort the statements based on how strongly they agreed or disagreed with the statements. The 42 statements

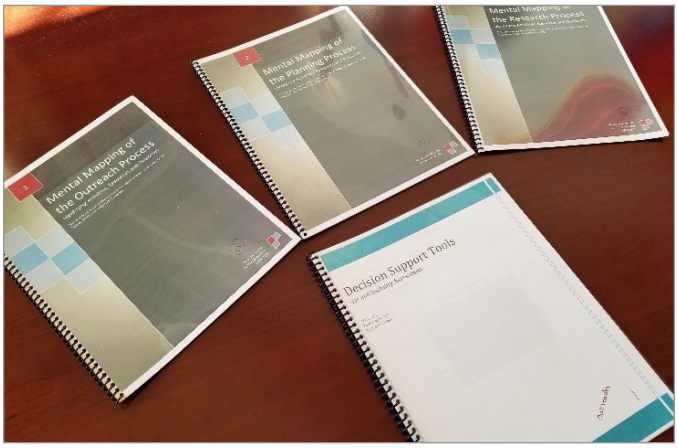

Figure 2. Workbooks used during the Tipping Point Planner, Extension Specialist, Researcher Workshop

span topics such as economics, social needs and communication, water quality/quantity information, land use/cover change modeling scenarios, and information/data presentation. The end goal was to identify viewpoints or perspectives in relation to what the individuals felt the Great Lakes decision support system should include to "provide the best opportunity for assessing and protecting water resources within the Great Lakes region." The 25 participants (Figure 3) were:

- Six (6) land use planners (identified as the pilot community to test the system);
- Nine (9) Sea Grant extension specialists (representing each of the Great Lakes states);
- Ten (10) university researchers (also representing each Great Lakes state and Ontario, Canada) currently working on the development of the decision support system and data/information being input into the system.

Figure 3. Community visioning exercises

From the 25 responses, 10 viewpoints were identified (summarized in Box 1).

Box 1. Viewpoints of study participants as it pertains to a decision support system for the Great Lakes region.

Land Use Planners	Sea Grant Extension Specialists	Univeristy Researchers
Viewpoint 1: Forward thinkers Forward thinking planners showed strong support for the inclusion of ecological 'tipping points' (or thresholds) within the system. (Note that the term 'ecological tipping point' is used to represent the point reached by an ecosystem in which its structure, function, and processes may be greatly altered. If a tipping point is crossed (often due to increase human induced stress to the ecosystem), the ecosystem's ability to function will be altered frequently for the worse.) These individuals also believe that the decision support system should allow users to identify areas for planning outside of their current jurisdictional boundaries.	*Viewpoint 1: Risk minimizers* Risk minimizers were described using 4 distinguishing statements. These statements are as follows. The Great Lakes region decision support system should: ▪ Include tools to evaluate the potential effect of biological contaminants on human health ▪ Allow user(s) to identify sensitive (or high risk) areas in greatest risk for water quality degradation ▪ Not need to allow for individuals to collaborate with other planning jurisdictions in order to address water resource issues/concerns ▪ Not need to provide information and tools to system users who wish to improve water quality education within local communities	*Viewpoint 1: Tipping point advocates* University researchers within the first viewpoint believed that the system should identify ecological tipping points that if crossed may negatively impact water resources. These individuals also believed that the system should include tools to identify sensitive or high risk areas at greatest risk for water quality degradation and include future land use/cover change predictions assuming current rates and patterns of urban growth continue.
Viewpoint 2: Protectors of natural lands Land use planners holding this second viewpoint expressed strong support for using the decision support system to prioritize the protection and restoration of natural areas (e.g., wetlands and forests), including riparian areas along rivers and streams. They also believed that the system should include possible land use/cover change scenarios that placed an emphasis on protecting critical (or high quality) wildlife habitat.	*Viewpoint 2: Land use change modelers* Land use change modelers were interested in using the system to assess potential impacts of land use/cover change on water resources while allowing system users to upload data/information layers into the system for analysis using GIS tools. They also believe the system should allow users to identify areas for planning outside of current jurisdictional boundaries.	*Viewpoint 2: Economic optimists* Economic optimists strongly agreed that they system should incorporate tools to assign monetary value to water resources and assess the potential impact of future land use/cover change scenarios of commercially harvested fish communities.
Viewpoint 3: Water enthusiasts This group strongly agrees that the decision support system should include tools to assess where immediate action is needed to protect/restore water quality. They also believe the system should: ▪ Help them to identify 'sensitive' areas at greatest risk for water quality degradation ▪ Include tools to help assign monetary value to water resources ▪ Contain hydrologic impact models to estimate potential nutrient/pollutant runoff given possible land use/cover change scenarios	Viewpoint 3: Wildlife guardians Sea Grant extension specialist represented the wildlife guardian's viewpoint believed that the Great Lakes decision support system should include land use/cover change scenarios prioritizing the protection of critical (or high quality) wildlife habitat. --- Viewpoint 4: Recreationalists Sea Grant extension specialists holding this fourth viewpoint believed that the decision support system should be used to prioritize the protection/restoration of water resources for recreational use.	*Viewpoint 3: Groundwater and what-if model enthusiasts* These individuals believed that the Great Lakes region decision support system should include tools to assess the potential impact of user defined land use/cover changes scenarios on water resources. They also believed that the system would be most useful if it were designed in a way to prioritize the protection of 'natural lands' and the protection/restoration of groundwater quality and quantity over that of surface water bodies.

Thematic Planning Priority Development: Enhancing Workflow

Lastly, the same group of individuals was given time to explore each system tool and functionality as well as some decision support system prototypes and fill out an anonymous questionnaire related to the "usefulness" and "ease of use" of the system architecture characteristics. Analysis of participant responses revealed that favored decision support system tools should: 1) allow users to map natural resource assets and tools that enable system users to assess potential impact of what-if land use/cover change modeling scenarios on water resources; 2) provide data/information needs about ecological "tipping point" impacts from potential land use/cover change scenarios; and 3) guide land use planners through the process of identifying natural resource assets and concerns and setting planning priorities.

Thematic Planning Priority Development: Decision Support System

Overall, survey results indicated that the majority of land use planners were lacking necessary information and wanted more data concerning current land use/cover and water quality, information on groundwater resources, and tools to assess potential impacts of future land use/cover change models. Nearly 66 percent of planners never or seldom had any type of decision support system available to them when making planning decisions/recommendations. Of those individuals who did have access to such systems, only 14 percent used them. The conclusion of surveys, interviews, and focus groups supported the need for a "useful" and "usable" decision support system for land use planners in the Great Lakes states and to help identify potential natural resource impacts of land use/cover change in the future.

To develop such a system, it is necessary to balance all of the stakeholders, such as land use planners, university researchers, and Sea Grant extension specialists. In this effort, these stakeholders were able to identify impacts, develop techniques to monitor the impacts, and devise management strategies aimed at meeting both current and future natural resource management (e.g., water quality and quantity) goals and needs.

Not all land use planning jurisdictions face the same water quality and quantity concerns. Thus, decision support systems with regional approaches, like a Great Lakes region decision support system, should be developed to meet a variety of the unique jurisdictional needs that include, but are not limited to, differing viewpoints, presenting data/information in many different formats, allowing for users to define their planning area and set planning priorities, and providing tools to help planners assess the potential impacts of user-defined what-if modeling scenarios on water resources.

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