

**Building a Great Lakes Spatial Decision Support Toolbox  
to Address Comprehensive Plan Implementation  
and Coastal Hazards Resilience**

**Wisconsin Department of Administration  
Wisconsin Coastal Management Program**

**Proposal for the  
Coastal Management Fellowship  
NOAA Coastal Services Center  
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Division of Intergovernmental Relations  
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## **Background and Introduction:**

### Comprehensive Plan Implementation

During the 1990s, land use emerged as a major public policy issue in Wisconsin. Many citizens and government officials expressed concern over degradation of natural resources, loss of productive farmland, decline of central cities, and the inefficiencies of suburban sprawl. This interest in land use culminated in the passage of a landmark local comprehensive planning law in October 1999. The law updated the state's antiquated planning enabling legislation for local governments. It provided local governments with the state's first definition of a local comprehensive plan and created a state grant program that has since provided \$20 million to fund comprehensive planning efforts. The law also requires that, beginning on January 1, 2010, local zoning, subdivision, and official mapping ordinances need to be consistent with a local government's comprehensive plan.

Wisconsin has 105 local governments that include Great Lakes coastline (15 counties, 22 cities, 16 villages, and 52 townships). Nearly half (42%) of Wisconsin's coastal communities have adopted plans consistent with the comprehensive planning law. These communities are now exploring the next step of the planning process – implementation of the recommendations included in their plans. An additional 44% of the coastal communities are actively preparing plans and are anticipating implementation. As coastal communities complete their plans, there is a significant need for assistance in developing the recommended implementation tools.

Local governments face several challenges in plan implementation. In fact, many planning practitioners have long felt that the issues associated with plan implementation have been ignored (Berke et al 2006, Talen 1996, Burby 2003, Knapp et al 2001). Geospatial technologies, including planning support systems, have the potential to increase the effectiveness of plan implementation. Planning support systems have typically been applied to facilitate the plan development process. With nearly 90% of Wisconsin's coastal communities facing plan implementation, there is a unique opportunity to develop and apply geospatial technologies to plan implementation in a coastal context.

### Coastal Hazards

Natural hazards have been a focus of the Wisconsin Coastal Management Program (WCMP) since the program was created. Nearly 80% of Wisconsin's erodible Great Lakes shoreline suffers from bluff erosion and recession problems. Wisconsin's Lake Michigan shoreline is generally vulnerable to shore erosion from the Illinois State line to the Sturgeon Bay Canal, a distance of 185 miles. Erosion rates are particularly high along sand plains and high bluffs composed of till, with short-term erosion rates of 3-15 feet per year having been recorded along sand plains and 2-6 feet per year along high bluff lines. Wisconsin's Lake Superior shoreline is vulnerable to shore erosion except for rocky portions of the Bayfield Peninsula, and the low wetlands in Chequamegon Bay and at the mouth of the Bad River. Coastal flooding is a serious issue along two low-lying sections of the Lake Michigan shore: southern Kenosha County and the western shore of Green Bay from the City of Green Bay to the Michigan state line (WCMP 2006, p. 9).

There is evidence that the risk of damage from coastal hazards in Wisconsin is increasing. The last time coastal storms caused significant damages in Wisconsin was the 1986-1987 period when water levels on the Great Lakes reached record levels. Damages of more than \$16 million were reported for public facilities alone. In the spring of 1997, there was alarm again when water levels approached the record highs of the mid-1980s. While the trend towards high lake levels has reversed, the current low levels pose a risk because they give a false sense of security for construction and development near the shore. Growth along the coast has outpaced growth within the state as a whole. Furthermore, erosion processes continue even when the levels are low, especially through lakebed erosion.

Managing hazards is a priority of many coastal stakeholders. The WCMP, University of Wisconsin, Wisconsin Department of Natural Resources (WDNR) and Wisconsin Emergency Management (WEM) participate in a Natural Hazards Work Group to provide technical assistance and coordinate state resources. When the Work Group first started meeting, the participants determined that improved information was the most important factor in managing coastal hazards. Lack of data continues to be an impediment to directing development away from hazardous areas. Without better data on recession rates, communities have been reluctant to adopt stringent setback requirements. Inability to access information on how to integrate hazards planning with other planning efforts is a related obstacle for coastal communities (WCMP 2006, p. 16).

### **Goals and Objectives:**

- Develop a framework to evaluate existing spatial decision support tools used for sustainable management of the Great Lakes. This will promote more effective development and use of spatial decision support tools.
- Evaluate existing spatial decision support tools used to address coastal planning and hazards issues in Wisconsin. Promote these tools through projects such as the Midwest Spatial Decision Support Partnership, the Ecosystem-Based Management Tools Network, the proposed Wisconsin Coastal Web Atlas, as well as at state, regional, and national conferences.
- Develop tutorials and training sessions to guide coastal resource managers and other coastal constituencies on the effective use of spatial decision support tools.
- Develop new spatial decision support tools to facilitate implementation of comprehensive plans in coastal communities and the adoption of policies to build communities resilient to coastal hazards.

## Milestones and Outcomes:

Activities	Duration
<ul style="list-style-type: none"> <li>• Orientation to Wisconsin Coastal Management Program and Wisconsin's Great Lakes coasts</li> <li>• Orientation to the University of Wisconsin Sea Grant Institute and Great Lakes GIS initiatives</li> <li>• Orientation to Wisconsin's Comprehensive Planning and Land Information Programs</li> <li>• Become familiar with existing natural hazards mitigation and comprehensive planning policies</li> <li>• Meet with Coastal Hazards Work Group</li> <li>• Meet with coastal hazards and planning stakeholders</li> <li>• Meet with Wisconsin Coastal Management Council</li> </ul>	Aug. 1, 2009 to Aug. 31, 2009
<ul style="list-style-type: none"> <li>• Develop a framework for evaluating Great Lakes spatial decision support tools</li> </ul>	Sept. 1, 2009 to Oct. 31, 2009
<ul style="list-style-type: none"> <li>• Review #1 (Visualizing Coastal Erosion on the Great Lakes)</li> <li>• Tutorial #1 (Coastal Population Trends)</li> </ul>	Nov. 1, 2009 to Dec. 31, 2009
<ul style="list-style-type: none"> <li>• Tool #1 (Shoreline Recession and Oblique Photo Tool)</li> </ul>	Nov. 1, 2009 to Feb. 28, 2010
<ul style="list-style-type: none"> <li>• Review #2 (Lake Superior Coastal Mapping Portal)</li> <li>• Tutorial #2 (Coastal Property Value)</li> </ul>	Mar. 1, 2010 to Apr. 30, 2010
<ul style="list-style-type: none"> <li>• Tool #2 (Coastal Resilience Tools)</li> </ul>	Mar. 1, 2010 to Aug. 31, 2010
<ul style="list-style-type: none"> <li>• Review #3 (Hydrologic Dashboard)</li> <li>• Tutorial #3 (Coastal Land Use)</li> </ul>	Sept. 1, 2010 to Oct. 31, 2010
<ul style="list-style-type: none"> <li>• Tool #3 (Comprehensive Plan Implementation Tools)</li> </ul>	Nov. 1, 2010 to Jul. 31, 2010
<ul style="list-style-type: none"> <li>• Review #4 (Climate Change Lake Level Visualization)</li> <li>• Tutorial #4 (Coastal Terrain Models)</li> </ul>	Nov. 1, 2010 to Dec. 31, 2010
<ul style="list-style-type: none"> <li>• Training sessions</li> <li>• Coastal GeoTools, Great Lakes Regional Data Exchange, and Wisconsin Land Information Association conference presentations</li> </ul>	Jan. 1, 2011 to Jun. 30, 2011
<ul style="list-style-type: none"> <li>• Tutorial #5 (Coastal Flooding)</li> </ul>	Mar. 1, 2011 to Apr. 30, 2011
<ul style="list-style-type: none"> <li>• Project wrap-up and evaluation</li> <li>• Coastal Zone conference presentation</li> </ul>	Jul. 1, 2011 to Jul. 31, 2011

Specific outcomes anticipated from this project include:

- broader access to spatial decision support tools for Great Lakes management;
- development of more effective spatial decision support tools;
- diffusion of spatial decision support tools within and outside the Great Lakes region through publication of GIS tutorials and training sessions on the use of selected decision support tools;
- more effective implementation of comprehensive plans in Great Lakes coastal communities; and,
- increased knowledge and proficiency in assessing coastal hazards and applying hazards information during planning and implementation processes.

## **Project Description:**

### Orientation

The Coastal Fellow will be introduced to the staff of the Wisconsin Coastal Management Program (WCMP), the University of Wisconsin Sea Grant Institute, and relevant project partners. In addition, the Fellow will be introduced to the Natural Hazards Work Group and the Wisconsin Coastal Management Council. The Fellow will become familiar with the Great Lakes coast of Wisconsin through field visits, participation in meetings in coastal communities, and review of program documents. The Fellow will work closely with the Smart Growth and Hazards teams at the NOAA Coastal Services Center to keep them apprised of project progress.

### Spatial Decision Support Tool Evaluation Framework

The first task associated with project is to build a template for evaluating decision support tools used for sustainable management of the Great Lakes. The template should allow for efficient review of existing spatial decision support tools. Applying the template should provide insight into the institutional factors that impact the application of decision support tools, as well as promote the effective design of new tools. The template will draw on existing decision support tool inventories and evaluation techniques, including the Midwest Spatial Decision Support System Partnership (<http://www.epa.gov/waterspace/>), the Ecosystem-Based Management Tools Network (<http://www.ebmtools.org/>), research funded by the New York Sea Grant College Program on the effectiveness of Great Lakes models (<http://www.esf.edu/es/documents/GreatLakesRpt.pdf>), and the LOGIC model for project design and evaluation developed by University of Wisconsin Extension (<http://www.uwex.edu/ces/pdande/evaluation/evallogicmodel.html>). The Fellow and mentors will consult with NOAA Coastal Services Center staff on the template.

### Evaluation of Existing Spatial Decision Support Tools

Four existing decision support tools will be evaluated using the template described in the previous section. These tools address coastal planning and hazards issues in Wisconsin and include:

- *Visualizing Coastal Erosion on the Great Lakes*. This website integrates animation, aerial photography, pictures, charts, and text to help the public better understand: (1) the natural process of coastal erosion; (2) how local land development decisions impact

coastal erosion; and (3) the case for scientifically-based coastal development setbacks. (<http://www.geography.wisc.edu/coastal/>)

- *Lake Superior Coastal Mapping Portal*. This website catalogs interoperable Web Map Services (WMS) along the Lake Superior coast of Wisconsin. Web map context files allow integration of distributed web map services to address regional coastal management issues, including coastal hazards and comprehensive planning. (<http://maps.aqua.wisc.edu/lscmp/>)
- *Hydrologic Dashboard*. This website integrates and visualizes distributed web services to support water resource management. The dashboard consumes web services from USGS stream gages and includes modules to visualize the temporal characteristics of stream flow and precipitation data in conjunction with NEXRAD radar imagery. This allows water resource managers and researchers to explore, define, and analyze recent and historic storm events and view the spatial and temporal patterns that result. (<http://maps.aqua.wisc.edu/hydrologicDashboard/>)
- *Climate Change Lake Level Visualization*. The tool will provide visualization of shoreline and water level change based on new climate and lake level scenarios for the harbors of Toledo, Ohio; Duluth, Minnesota; and Port Washington, Wisconsin. It will be completed as part of a Great Lakes regional project funded by the NOAA Climate Program Office titled “Preparing Coastal Communities for Climate Change: Translating Model Results to Prepare Ports, Harbors and Stormwater Management Facilities in an Era of Climate Variability and Scientific Uncertainty.”

These tools will be promoted through publishing the reviews in venues such as the Midwest Spatial Decision Support Partnership, the Ecosystem-Based Management Tools Network, and the proposed Wisconsin Coastal Web Atlas.

### GIS Tutorials

The Coastal Fellow will work with David Hart, GIS Specialist at UW Sea Grant, to develop GIS tutorials to guide coastal resource managers and other coastal constituencies on the effective use of geospatial technologies to address planning and hazards issues. They will be modeled on existing GIS tutorials for shoreland management, coastal erosion, and stormwater management developed as part of the Wisconsin Coastal GIS Applications project

(<http://coastal.lic.wisc.edu/apps.htm>). Step-by-step instructions and data sets are bundled and available on-line for others to use. The existing tutorials have been extensively used in Wisconsin and internationally. New tutorials will focus on the following topics:

- *Coastal Population Trends*. This tutorial will examine demographic trends along the Great Lakes at different resolutions. Data sets include census geography, night-time light satellite images (DMSP), state population estimates, tax revenue, and parcel maps.
- *Coastal Property Value*. This tutorial will demonstrate the methods used to calculate the assessed value of land and improvements along the Great Lakes coast of Wisconsin. Data sets include parcel maps and tax assessment data.
- *Coastal Land Use*. This tutorial will demonstrate the use of the Land-Based Classification Standards developed by the American Planning Association (<http://myapa.planning.org/LBCS/>) to identify, map and analyze coastal dependent uses. Data sets include parcel maps and LBCS surveys.

- *Coastal Terrain Models.* This tutorial will demonstrate the how to build an integrated coastal terrain model for the Great Lakes coast using topographic and bathymetric mapping. Data sets include LIDAR surveys, contour maps, TINs, hydrographic surveys, and digital nautical charts.
- *Coastal Flooding.* This tutorial will demonstrate the how to use an integrated topographic/bathymetric data set to predict flooding from coastal storms. Data sets include a coastal terrain model, flood insurance rate maps, and coastal observations.

The existing and new tutorials will be compiled and published as a coastal GIS applications workbook.

### Spatial Decision Support Tools

New spatial decision support tools will be developed to facilitate the implementation of comprehensive plans in coastal communities and the adoption of policies to build communities resilient to coastal hazards.

- *Shoreline Recession and Oblique Photo Tool.* Several recession rate studies of the Great Lakes coasts have been conducted since the 1970s. In addition, oblique photos of the coast were taken during the 1970s and 2007/2008. This tool will allow coastal managers and riparian owners to view site-specific recession rate information along with historical and current orthophotos and oblique photos.
- *Coastal Resilience Tools.* The NOAA Coastal Services Center develops tools to assist coastal communities to become more resilient to coastal hazards. These include the Community Vulnerability Assessment Tool, Hazard Assessment Tools, and the Risk-Wise Resilience Calculator. The Fellow will work with UW Sea Grant to adapt and apply CSC resilience tools to a Great Lakes coastal community.
- *Comprehensive Plan Implementation Tools.* Spatial decision support tools will be developed to allow citizens to explore and analyze plan elements (especially as they relate to coastal issues), measure new coastal developments against plan language, and measure the success of plan implementation at specific intervals.

### Training

Training sessions will be held for coastal resource managers on the effective use of selected spatial decision support tools. Screencasts will be developed to demonstrate tool use.

### **Fellow Mentoring:**

The Coastal Fellow will be mentored by Kate Angel, Coastal Hazards Specialist at the Wisconsin Coastal Management Program, with assistance from David Hart, GIS Specialist at UW Sea Grant. The Fellow will be considered part of the Resource Policy Team within the Division of Intergovernmental Relations at the Wisconsin Department of Administration.

The Fellow will participate in staff meetings. The Fellow will be provided opportunities to participate in site visits, intra- and inter-agency meetings, regional events such as the Great Lakes Regional Meeting of Coastal Management Programs, and meetings of the Coastal

Management Council. The Coastal Fellow will be expected to work closely with the coastal hazards work group, the comprehensive planning program staff, and WCMP staff.

The Fellow will also have access to the staff and facilities of the University of Wisconsin Sea Grant Institute on the University of Wisconsin-Madison campus. This includes office space with a computer that includes a wide variety of GIS software. This arrangement allows the Fellow all the resources of state government, in addition to the resources available on campus (technical expertise, lectures, libraries, computer software training, etc.).

**Project Partners:**

The project will require coordination with various state, regional, and local communities. In addition to working closely with the WCMP, the Comprehensive Planning and Land Information Programs, and the University of Wisconsin Sea Grant Institute, the Fellow will coordinate with the following agencies and organizations:

- Wisconsin Department of Natural Resources
- Wisconsin Emergency Management
- Department of Urban and Regional Planning, University of Wisconsin-Madison
- Department of Geography, University of Wisconsin-Madison
- Department of Geology, University of Wisconsin-Madison
- Department of Civil Engineering, University of Wisconsin-Madison
- University of Wisconsin, Cooperative Extension
- Wisconsin State Cartographer's Office
- Northwest Wisconsin Regional Planning Commission
- Bay-Lake Regional Planning Commission
- Southeastern Wisconsin Regional Planning Commission
- 1000 Friends of Wisconsin
- Wisconsin Chapter of the American Planning Association
- Wisconsin Association of Stormwater, Floodplain, and Coastal Managers
- County government agencies
- Local government agencies

**Cost Share Description:**

The funding for cost sharing (\$7,500 per year for two years) will be provided by the Wisconsin Department of Administration, which has state funding allocated through the fellowship period.

**Thematic Areas:**

This proposal addresses several of the priorities identified by the NOAA Coastal Services Center for the coastal management fellowship program, including:

- *iv. Projects that increase information about or develop visualization tools related to shoreline changes and coastal buffers, coastal storms and flooding, and climate variability and changing lake levels*

The project will develop a framework for evaluating existing support tools. After developing the framework, the Fellow will evaluate existing visualization tools relevant to coastal erosion, including the Visualizing Coastal Erosion on the Great Lakes website and Climate Change Lake Level Visualization tool.

- *v. Projects that provide economic, social science, and spatial data and tools or support collaborative efforts to support alternative land use planning and climate change adaptation*

The Fellow will create new GIS tutorials for Coastal Population Trends, Coastal Property Value, Coastal Land Use, Coastal Terrain Models, and Coastal Flooding. The tutorials will demonstrate how resource managers and planners can effectively use geospatial technologies to address land use issues.

- *vi. Projects that show how decision-support tools for the coastal environments have been used by planners to make decisions and plan for balancing uses in those environments.*

In addition to evaluating existing tools, the Fellow will develop new spatial decision support tools to facilitate the implementation of comprehensive plans in coastal communities. The development of more effective spatial decision-support tools and dissemination of spatial decision-support tools are specific outcomes of the project.

## **References:**

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Burby, R. 2003. "Making plans that matter: citizen involvement and government action" Journal of the American Planning Association. Vol. 69, pp. 33-49.

Knapp, G, C Deng, and L Hopkins. 2001. "Do plans matter? The effects of light rail plans on land values in station areas" Journal of Planning Education and Research. Vol. 21, pp. 32-39.

Talen, E. 1996. "Do plans get implemented? A review of evaluation in planning" Journal of Planning Literature. Vol. 10, pp. 248-259.

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