# Port asset values and economic impacts

*New tools for estimating risks of water level changes, failing infrastructure*

**DALE BERGERON**
*Maritime Transportation Specialist*
University of Minnesota Sea Grant

**GENE CLARK**
*Coastal Engineering Specialist*
University of Wisconsin Sea Grant

Improving the resilience of coastal communities to environmental hazards, including the potential impacts of climate change, is one of the four priorities of the National Oceanic and Atmospheric Administration (NOAA) Sea Grant Program. A goal associated with this priority is to provide coastal communities and interests such as the maritime industry with the information they need to identify, evaluate and plan for hazards.

Part of the process of preparing for coastal hazards has been formalized through the Great Lakes Ports & Harbor Infrastructure Matrix and Dredging Cost Database. The matrix helps coastal communities and maritime interests understand what critical port and harbor infrastructures are vulnerable to potential climate variation and relates that risk to potential economic impacts.

The Great Lakes Sea Grant Network, with funding from the NOAA Sectoral Applications Research Program (SARP), designed the infrastructure matrix and dredging cost database to help communities identify the current value of their navigational and port infrastructure, as well as the potential costs for maintaining those resources in the face of changing water levels and storm conditions. Because of the degree of uncertainty involved in regional climatic modeling, the scalable matrix takes into account several possible impacts associated with specific types of navigational aides and port infrastructure. The economic assessment matrix can be applied to any port or marina within the Great Lakes region (we also included private marina and facility costs).

**The matrix can be used to inform port communities and states about the federal government's sizable investments supporting their current and future opportunities.**

**ECONOMIC IMPACT RISKS OF CLIMATE CHANGE & WATER LEVELS CHANGES**
*Matrix and Dredging Database results for Toledo Harbor and Maumee River*

**Federal Channel Dredging Estimate**

18,530,167 cy/ft x $5/cy = **$92,650,835/ft of depth**
ADAPTED FROM U.S. ARMY CORPS OF ENGINEERS, BUFFALO DISTRICT

**Single Slip Dredging Estimate**
**Midwest Terminals of Toledo International Facility 1**

Vessel: 105' x 1000'
1.2 factor for maneuverability & connection to main channel
Dredging Vol/ft: 105 ft x 4,196 ft x 1.2 = 176,232 cy/ft

| | | | |
|---|---|---|---|
| $5/cy | x 176,232 cy/ft | = | **$881,160** |
| $10/cy | x 176,232 cy/ft | = | **$1,762,320** |
| $15/cy | x 176,232 cy/ft | = | **$2,643,480** |

**Single Slip Repair & Replacement Estimate**
**Midwest Terminals of Toledo International Facility 1**

| *STRUCTURE TYPE* | *NEW/REPAIR* | *8'-13'* | *14'-25'* | *26'-35'* |
|---|---|---|---|---|
| SSP Bulkhead w/Concrete Cap (I-I) | New | 1,250-2,400 | 1,700-4,300 | 3,300-5,300 |
| | Repair | 835-1,350 | 1,400-2,500 | 2,400-3,360 |

| | | | | | |
|---|---|---|---|---|---|
| **New** | $5,300/ft | x | 4,196 ft | = | **$22,238,800** |
| **Repair** | $3,000/ft | x | 4,196 ft | = | **$11,748,800** |

SOURCE: GENE CLARK, UW SEA GRANT

The matrix and dredging cost database was beta-tested using data from the ports of Duluth/Superior and Toledo. In addition, data from the U.S. Army Corps of Enginners "current infrastructure condition ratings" project, now being conducted in Great Lakes ports, is poised to add rigor and depth to information produced through the matrix tools.

Climate model predictions fluctuate greatly throughout the Great Lakes region, and include both higher and lower water levels. However, all predictions indicate increases in the number and intensity of major storm events. This combination can result in unanticipated water level changes, larger waves, more dramatic seiches and greater storm surges than considered in the original designs of aids to navigation and harbor infrastructure. The added stresses could damage the condition of current facilities and accelerate the decline of certain components of harbor infrastructure.

**Structure costs vs. depth ranges.** The infrastructure matrix is designed for preliminary cost evaluation/comparison only. Many factors could impact final actual cost.

The matrix structure cost tables are divided into two categories of common Great Lakes navigation and port infrastructure types: Entrance Structures and Interior Harbor Structures. Tables include information for either repair/rehabilitation or total replacement of structures and can be scaled to three different depth levels. Cost estimates do not include variables such as site investigations, design work or permitting.

For convenience, structure depth is categorized into three ranges (shallow = 8'-13', medium = 14'-25', deep = 26'-35'). Typically, lower costs are associated with shallower depths.

The Entrance Structure Types table provides cost estimates for 11 different harbor entrance structures built to withstand direct impacts by large waves and significant storm surges and seiche events. Entrance Structures Types include steel sheet pile bulkheads with a variety of structure caps, rubble mound breakwaters, timber cribs with a variety of structure caps and closed steel sheet pile cells.

The cost table regarding Interior Structure Types provides estimates for nine different harbor interior structure types, including slip wall designs, standard steel sheet pile walls, timber cribs, soldier-pile walls with timber or concrete and open dock structures with piling supports.

The figures for the cost ranges in each table were compiled from multiple sources. The Corps' Great Lakes district offices provided structure costs estimates based upon actual project bid prices (after using the Corps Civil Works Construction Cost Index System to escalate historic costs to June 2010 levels). Three different nationally-known engineering design firms with offices and projects in the Great Lakes provided 2010 cost estimates derived from actual construction, contract/bid costs and from design or study estimates. Three Great Lakes construction firms also provided cost estimates for several of the structures most commonly used in the Great Lakes.

*Low water levels contributed to this structural damage at Port Wing, Wisconsin.*

SOURCE: GENE CLARK, UW SEA GRANT

**Harbor dredging costs.** Dredging costs are, and will continue to be, the key issue to be addressed in support of the Great Lakes maritime transportation system. Great Lakes dredging costs differ widely depending upon location and size of the dredging project. Therefore, dredging costs are categorized based on the relative region of the harbor and on the size of the actual dredging project (i.e., large scale harbor project or smaller individual slip project).

The dredging cost data are from the archived Corps dredging database (http://www.ndc.iwr.usace.army.mil/dredge/dredge.htm), which includes projects from 1993-2009 divided into the port regions of Buffalo, Chicago and Detroit districts. The information is further sorted into large commercial harbors and small recreational harbors categories. As noted previously, Great Lakes dredging contractors were contacted for typical dredging costs of both large-scale public and small-scale private projects.

*Example: Facility 1 - Midwest Terminals of Toledo International General Cargo Dock*

The Toledo-Lucas County Port Authority general cargo dock is constructed of a steel sheet pile bulkhead with a concrete cap. It has approximately 4,196 feet of berthing capacity and has a top deck to lake bottom depth of 38 feet. Plugging this information into the matrix, it was determined that repairing/rehabilitating the entire 4,196-foot structure would cost approximately $11.8 million, using the matrix's middle range of depth costs. Entire replacement costs are projected to reach $22.2 million when selecting this type of structure from the "Interior Structures" cost table.

*Example: Port of Toledo Authorized Federal Harbor Channel*

Applying the dredging database costs "per-foot-of-depth" for the entire Port of Toledo harbor channel provides an estimated cost of $92.7 million (based upon $5/cy dredged and Corps authorized channel dimensions). This value only takes the main channel into account, not each of the port's slips.

Dredging costs per-foot-of-depth for the Port's #1 slip can be estimated at $630,000 (using $5/cy, large commercial costs) to more than $1.8 million, using single project, small contractor costs. Individual slip dredging costs were estimated using a 20 percent overage factor when compared to typical vessel width multiplied by the docking berths available length to account for vessel maneuverability and connections to the main channel.

The matrix structure cost tables are divided into two categories of common Great Lakes navigation and port infrastructure types: Entrance Structures and Interior Harbor Structures.

**Matrix benefits.** The matrix allows harbor managers and communities to define the current value of infrastructure committed to commercial navigation. In addition, it can be used to inform port communities and states about the federal government's sizable investments supporting their current and future opportunities. It also puts communities on notice of future liabilities when considering waterfront gentrification. Federal dollars only support commercial maritime transportation activities. Gentrification or recreational redirection of harbor use removes facilities from federal oversight and they become the responsibility of the local community or state.

The matrix, in conjunction with Corps data, can also serve as a tool for exploring port and harbor costs that might be expected to be levied by a changing climate. The matrix puts communities on notice by helping them understand the investments, opportunities and potential liabilities today and as they plan for the future. The majority of port communities have little or no understanding of the value, costs and opportunities related to maritime transportation in their ports. The matrix can provide a starting point for discussions.

Maritime transportation investments impact not only regional and national opportunity, but global opportunity as well. While the land separates us, the water connects us by way of the most cost efficient, environmentally-sound form of transportation available. The Great Lakes Sea Grant Network encourages port communities to use the matrix and dredging cost database to develop base-line economic data for their ports to improve public awareness and appreciation for the investment and opportunity that resides in their harbors.

Although much of the attention regarding climate change has focused on sea level rise, impacts due to climate variation in the Great Lakes are likely to be felt first, and have dramatic, immediate physical and economic consequences for both water dependent businesses and Great Lakes communities. The matrix is poised to help communities anticipate and adapt to predicted climate variation impacts.

Through the NOAA Sectoral Applications Research Program (SARP), the Great Lakes Sea Grant Network identified and addressed regional climate change issues. Some of the issues addressed include: communicating degrees of uncertainty in modeling regional and local climate change; designing and implementing predictive modeling tools for the Great Lakes; building climate change visualization tools; and creating scalable models for evaluating potential economic impacts to navigation and harbor infrastructure due to climate induced variation.

While some continue to debate the specific causes of climate change, the group chose to move forward to identify potential threats and look for opportunities for adaptive measures.

In the future, potential secondary economic impacts, anticipated as the result of the failure of primary support infrastructure, could be factored into the matrix.

For information about the Infrastructure Matrix & Dredging Cost Database or to obtain a copy, contact Bergeron at dbergeron@d.umn.edu or Clark at gclark1@uwsuper.edu. To assure a complete harbor assessment, it is important to include both public and private infrastructure. For information on specific dock details for a large number of Great Lakes ports and harbors see http://www.maritime.utoledo.edu/. ■