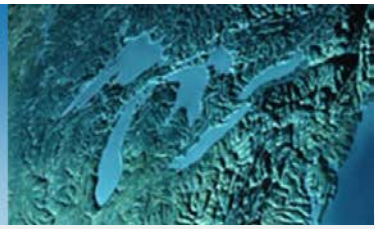
Great Lakes Coastal Flood Study

greatlakescoast.org



Storm Surge and Wave Modeling

FEMA, U.S. Army Corps of Engineers (USACE) Detroit District and the Engineer Research and Development Center (ERDC), Association of State Floodplain Managers (ASFPM), State partners and FEMA contractors have collaborated to establish technically sound processes for updating Great Lakes coastal Base Flood Elevations (BFE) and flood hazard maps. This storm study is one of the most extensive coastal storm surge analyses to date, encompassing coastal floodplains in the eight States with coastlines on the Great Lakes. This fact sheet provides an overview of the methodology. A detailed flow chart of the methodology process is available on the *greatlakescoast.org* website.

Storm Surge and Wave Modeling Methodology

USACE and ERDC have developed a process that incorporates meteorological records for 50 years of water levels, ice conditions, wind and pressure data to create a comprehensive gridded water level, storm surge and wave data set for each of the Great Lakes. Nearshore bathymetric and topographic data are collected using Light Detection and Ranging (LiDAR) and are used in the site-specific wave propagation and runup models that determine flooding hazards in communities along the coast of the Great Lakes. Historic storm data are used to statistically validate the model to ensure these data sets properly delineate the flood hazard.

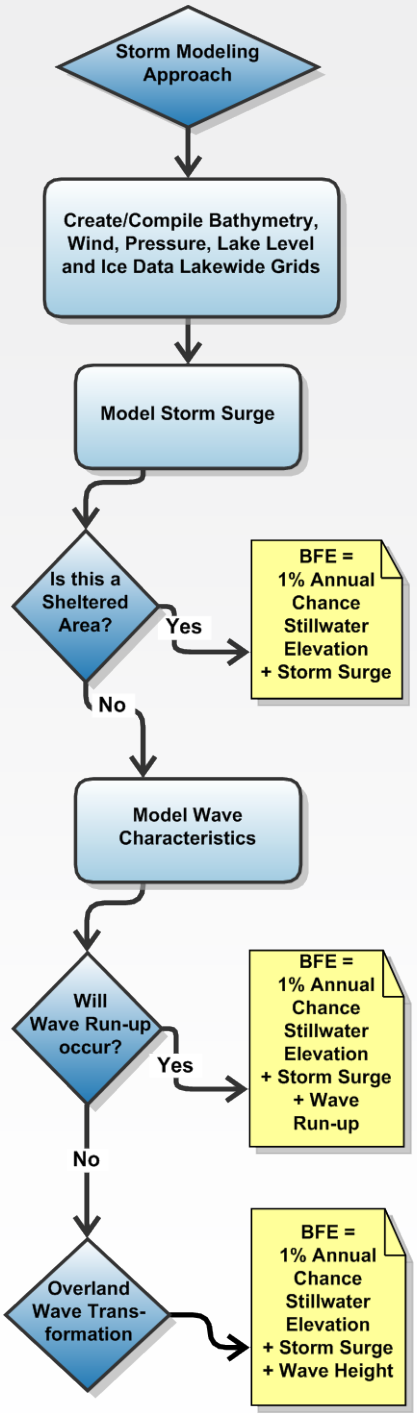
Great Lakes water level data are collected and archived by the National Oceanic and Atmospheric Administration's (NOAA) National Ocean Service (NOS). Reference gage records begin about 1860 and sporadic records date back to the early 1800's, constituting one of the longest high quality hydrometeorological data sets in North America. See the *Great Lakes Water Levels* fact sheet at *greatlakescoast.org* for more information on the historical fluctuations in water levels on the Great Lakes. The detailed water height grid produced for this analysis is based on the 1960-2009 time period. This time period was selected because hourly data were available to enable assessments of rapidly moving storm systems.

Wind data after 1979 is already gridded data representing over-water surface winds and are interpolated onto the wave and surge modeling grids. Wind data for years prior to 1979 are derived from nearby land and water based measurement sites around each lake. These anemometers readings are converted to over-water winds at a consistant elevation and interpolated to the surge and wave model grids being developed for each of the lakes.

Historical ice data is to used determine the locations and timeframes that ice is at substantial density to dampen the impact of waves and storm surge.

The storm surge and wave models are validated against severe historical storms on each lake by comparing simulated water levels with measured water levels from the NOAA NOS long-term measurement stations.

Simplified Methodology Process



RiskMAP

Increasing Resilience Together

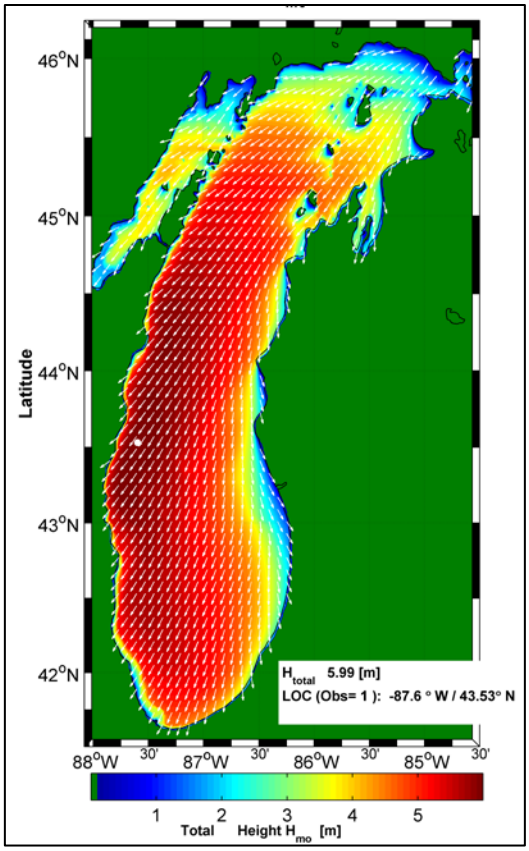
Move from event-based to stochastic modeling (statistical) approach

The previous methodology to determine Base Flood Elevation (BFE) involved using the one percent annual chance open coast water elevation in conjunction with a selected storm, which for most of the lakes was a 3 year storm. This method did not take into account the wide variation that is possible among storms on the Great Lakes. The new methodology applies a more scientifically valid statistical analysis to water levels and storm data to determine the most important storm and water levels combinations that could potentially impact the coastline.

This storm surge and wave information is used in site specific analyses to establish Base Flood Elevations (BFE) along the Great Lakes coastlines. BFE calculations for specific areas are dependent on the characteristics of the shoreline and whether wave height or wave runup are a factor, as seen in the flow chart on opposite page.

If waves are not present in sheltered areas, water levels from selected major storms are statistically analyzed to calculate the BFE. If waves are present, the wave run-up will be computed for each of these storms and the results analyzed statistically to determine BFE. For cases of overland wave transformation, the waves and water levels for the storms will be analyzed statistically to establish the BFE at the land elevation that the storm water penetrates inland, which is equal to the 1% still water elevation plus wave height.

Wave run-up applies when waves strike a structure with a relatively steep slope whereas overland wave propagation applies when waves can flow inland unimpeded.



Storm Surge and Wave Modeling on Lakewide Domain

Technical transfer effort with USACE and contractors to develop grids for each lake

The initial process was developed by ERDC on Lake Michigan-Huron and validated by a number of pilot studies. After being fully developed, tested and validated, FEMA's Production and Technical Support (PTS) contractors developed the storm surge, water level and wave data sets for the remainder of the Great Lakes.

Upcoming efforts

The Great Lakes Coastal Flood Study is a multi-year program that is still in an early phase. There are a number of efforts the project is currently undertaking, including the finalization of the methodology, collection of oblique photography along the entire coast of the Great Lakes, analysis of topographic and bathometric data availability. Additional tasks that the project will perform include outreach with Congressional delegations, technical experts and state and regional entities. After completion of the methodology described in this fact sheet, the process of involving local governments and revising county coastal flood hazard mapping will begin. Outreach such as the *greatlakescoast.org* website and fact sheets like this will be developed throughout the life of the project.