Agenda

- Introductions
- Coastal Flood Risk Study and Mapping Program
- Current Status
- Technical Overview of Study and Mapping
- Floodplain Management
- Next Steps
- Q&A
- Work map Review
St. Louis County, MN

COASTAL FLOOD RISK STUDY AND MAPPING PROGRAM
Great Lakes Flood Study

- Comprehensive study of the Coastal Great Lakes flood hazards
- Latest technology, data, and models – including response based modelling concepts

Partners involved:

- FEMA
- US Army Corps of Engineers ® Detroit District
- ERDC
- RAMPP
- STARR
Response-Based Wave Runup

- Wave runup is the uprush of water from wave action on a beach, steep bluff or coastal structure.
- Calculated at each transect using appropriate hydrodynamic equations that simulate events for every time step captured for selected storms using lake-wide gridded record (ADCIRC-SWAN).
- Statistical analysis is performed on the maximum runup results at each transect to obtain the 1-percent-annual-chance runup elevation.
Response-Based Wave Runup

St. Louis Transect 6

Optimized Return Period Plot

- Excel Data
- GPD Fit

Return Period (years)

10^{-1} 10^{0} 10^{1} 10^{2} 10^{3}

IWL (ft, IGSL-85)
FEMA’s Risk MAP Program

Risk **Mapping**, **Assessment**, and **Planning** ...

- Will deliver quality data to **increase** public awareness and lead to action that reduces risk to life and property
- New non-regulatory products and datasets
Mitigation Actions: A Shared Responsibility

**Structure and Infrastructure Projects**
- Acquisition
- Elevation
- Revetments and Seawalls
- Breakwater

**Local Plan and Regulations**
- Zoning
- Building Codes
- Open Space Plan
- Lake Front Development
- Master Plan

**Citizen and Business Engagement**
- Firewise
- StormReady
- NFIP and CRS

**Natural System Protection**
- Vegetation management
- Wetland restoration
- Erosion control
Analyses/Mapping: Grouping

Minnesota
- St. Louis
- Cook
- Lake

- FRR Meetings fall at the end of a multi-year study including sophisticated modeling

- Next, coastal work maps and data would need to tie into riverine studies before proceeding to develop official regulatory Flood Insurance Rate Maps
Work Map Data Viewer: Online GIS Data

Link to the St. Louis County, MN Work Map Data Viewer: [http://arcg.is/0SKnie](http://arcg.is/0SKnie)
Work Map Data Viewer: Maps
Work Map Data Viewer: Transect Summary Sheets
St. Louis County, MN
TECHNICAL OVERVIEW OF STUDY AND MAPPING
Coastal Flood Hazard Modeling Overview

Lake-Wide Variation

Step 1: Offshore Water Level and Wave Modeling

Step 2: Nearshore Wave Setup, Runup & Overtopping

Step 3: Floodplain Mapping

Local Variation
Run-up Methods
Approach for Upper Lakes numerical modeling

Runup Method Decision Flow Chart

Shoreline Type

Bluff
Bluff Face Slope
- Between 1V:10H and 1V:1H
  - van Gent
- 1V:1H or Steeper
  - SPM – Vertical Wall Runup

Shore Protection Structure

Gradually Sloping Beach (1V:10H or more gradual)

Stockdon

Revetment (Structure Slope between 1V:10H and 1V:1H)
- van Gent

Vertical Wall (Structure Slope of 1V:1H or Steeper)
- SPM – Vertical Wall Runup
Step 1: ADCIRC+SWAN Mesh

- Resolution as Fine as 10 m Along Complex Shoreline Features including Jetties, Breakwaters, Inlets, and Natural Shoals
Step 1: Run the Models

Baseline

Water Level

Meteorological Forcing

Wind

Pressure

Ice

Physical Setting

Bathymetry

Waves

Still Water Elevations

Total of 150 events between 1960-2009
Step 1: Lake Levels
Step 1: Lake Levels

Lake Level (ft, LWD) vs. Year

- Pre-2010

X-axis: Year (1960 to 2019)
Y-axis: Lake Level (ft, LWD)
Step 1: Lake Levels
Step 1: Example Surge Behavior
Step 1: Water Level Accuracy Assessment

<table>
<thead>
<tr>
<th>Location</th>
<th>1-percent-annual chance SWEL (m, IGLD85)</th>
<th>Modeled</th>
<th>Observed</th>
</tr>
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<tbody>
<tr>
<td>9099004</td>
<td>Point Iroquois, MI</td>
<td>183.99</td>
<td>184.24</td>
</tr>
<tr>
<td>9099018</td>
<td>Marquette, MI</td>
<td>183.92</td>
<td>184.13</td>
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<tr>
<td>9099044</td>
<td>Ontonagon, MI</td>
<td>183.87</td>
<td>183.95</td>
</tr>
<tr>
<td>9099064</td>
<td>Duluth, MN</td>
<td>183.96</td>
<td>184.13</td>
</tr>
<tr>
<td>9099090</td>
<td>Grand Marais, MN</td>
<td>183.87</td>
<td>183.98</td>
</tr>
</tbody>
</table>
Step 2: Nearshore Wave-Induced Flood Hazards

- Nearshore Wave-Induced Flood Hazards Analysis includes:
  - Shoreline classification
  - 2-D Wave and Surge Model data extraction
  - Wave setup
  - Erosion
  - Evaluation of coastal structures
  - Wave runup
  - Wave overtopping
  - Overland wave propagation
  - Statistical analysis

Along 1-D Transects
Step 2: Transect Layout

- St. Louis County
- 14 transects
- 18 panels
Step 2: Transect Analysis Overview

Water Level & Offshore Waves → Transect Analysis → Total Water Level

1. Water Level (Surge)
2. Waves
3. Setup, Runup and/or Overtopping
Step 2: Transect Analysis: Wave Setup and Runup

- Wave Runup is the uprush of water on a barrier
  - Barriers include dune, seawall, revetment, bluff, or other steep shoreline feature
Step 2: Transect Analysis: Wave Overtopping

- If the wave runup exceeds the elevation of the barrier, overtopping will occur
Step 2: Runup
Step 2: Overtopping

https://twitter.com/akpix/status/985285850245271552
Step 2: Compute Setup, Runup, and Overtopping

- 150 storms with hourly waves and water levels yields hourly wave setup, runup and overtopping rates
- Hourly Stillwater Levels (SWELs)
- Hourly Setup + Runup = Hourly Total Water Levels (TWLs)
- Extract the peak SWEL and TWL from each storm
- Return period analysis performed on TWL and SWEL
Step 2: Overland Wave Propagation

- Identify 5 pairs of water level and wave height that represent a 1% annual-chance occurrence (Joint Probability Method or JPM)
- Determine if transect is subject to erosion
  - Develop a theoretical storm event using the 5 pairs
- Determine wave setup elevations
  - Using the Direct Integration Method (DIM)
  - Wave setup + SWL = Total Stillwater Level (TSWL)
- Use Wave Height Analysis for Flood Insurance Studies (WHAFIS) to determine interaction of waves with the backshore
Step 3: Mapping

- Identification of
  - VE
  - AE
  - AO
  - X
Step 3: Runup VE Zones

- Intact transects
  - VE zone mapped to elevation associated with TWL

- Failed transects (coastal structures)
  - VE zone mapped to station along the profile associated with TWL
  - Elevation will not match topography since failure include profile modification

- Eroded profiles
  - VE zone mapped to station along the profile associated with TWL
  - Elevation will not match topography since profile is eroded
Step 3: Other Overtopping Zones

- AO Zones
  - Applied in areas of shallow flooding, usually sheet flow on sloping terrain
  - BFEs not provided, instead average flood depths of between one and three feet is specified
  - Flooding depth associated with overtopping rate

<table>
<thead>
<tr>
<th>$\bar{Q}$ Order of Magnitude</th>
<th>Flood insurance risk zone Behind Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.0001 cfs/ft</td>
<td>Zone X</td>
</tr>
<tr>
<td>0.0001-0.01 cfs/ft</td>
<td>Zone AO (1 foot depth) or Zone AE with BFE</td>
</tr>
<tr>
<td>0.01-0.1 cfs/ft</td>
<td>Zone AO (2 foot depth) or Zone AE with BFE</td>
</tr>
<tr>
<td>0.1-1.0 cfs/ft</td>
<td>Zone AO (3 foot depth) or Zone AE with BFE</td>
</tr>
<tr>
<td>&gt;1.0 cfs/ft*</td>
<td>30-foot width* of Zone VE (elevation 3 feet above barrier crest), landward Zone AO (3 foot depth) or Zone AE with BFE</td>
</tr>
</tbody>
</table>
Step 3: Overland Wave Propagation VE Zones

- VE zone associated with the location of the 3 foot breaking wave
- AE zones can exist with BFEs higher than TSWL as wave action is considered
- Most conservative of the 5 WHAFIS runs selected for mapping
- Most conservative is associated with largest extend of flooding and highest VE zone
Step 3: SWL or TSWL Inundation
Step 3: Zone Breaks

Zone Breaks Along the Coast

Represent the Extents of Each Unique Coastal Feature
Draft Work Map vs FIS/FIRM

St. Louis County, MN Work Map

St. Louis County, MN effective FIRM

Will not affect flood insurance requirements or costs
Interactive session to review the coastal work maps

COASTAL WORK MAP DEMO
St. Louis County, MN

FEMA FLOODPLAIN MANAGEMENT
Current Study Status

Lake-Wide Storm Surge and Waves Study
County Based Overland Analyses
Workmap Production
Comment Period
FIRM Production
Preliminary FIRM
Community Coordination Meeting
Comment and Appeal Periods
Letter of Final Determination
Effective FIRM

You are here

FPM Workshops

6 months – update ordinance
Floodplain Management Workshops

▸ Conducted by FEMA/DNR just before preliminary maps are released

▸ Workshop details:
  • Approximately 3 – 4 hours
  • Designed for floodplain administrator, zoning official, building inspectors, permit officials, etc.
  • Basics of Coastal Flooding
  • Using the Flood Insurance Study and FIRM for coastal studies
  • Floodplain Management Standards in Coastal High Hazard Areas (in depth)
  • NFIP Insurance in Coastal Zones
The community must require that all new construction and substantial improvements have the lowest horizontal structural member of the lowest floor elevated to or above the base flood level,

... with the space below the lowest floor either free of obstruction or constructed with non-supporting breakaway walls ...
Lowest horizontal structural member
Other key standards in Zone VE:

- Fill for structural support is prohibited
- Elevated portion of the building and piling/column foundation must be designed to withstand water and wind loads acting simultaneously under base flood conditions
- Structural design, specifications and plans for construction must be developed or reviewed and certified by a registered professional engineer or architect
Model Ordinance Development

- FEMA Region V and Wisconsin DNR are working together to prepare a model ordinance to incorporate V zone standards
- Wisconsin DNR is working through their legal chains to determine the requirements per NR 116
- Ordinances must be updated/adopted by effective date of maps
Online Resources

High resolution oblique aerial images
https://greatlakes.erdc.dren.mil/

Great Lakes Coastal Resilience Planning:
https://coast.noaa.gov/digitalcoast/tools/gl-resilience.html
Welcome to the Great Lakes Coastal Flood Study website at greatlakescoast.org. This is the official public website for FEMA's comprehensive storm and wind study of the Great Lakes basin for the purpose of updating the coastal flood hazard information and Flood Insurance Rate Maps (FIRM) for Great Lakes coastal communities. This is the main page of the website and contains the most recent content posted to the site. Use the menu at the left to visit pages with additional content pertaining to the Great Lakes Coastal Flood Study.

FEMA Announces Additional Lake Michigan WorkMap Meetings

July 27, 2017 — Great Lakes Coast

Local officials and technical stakeholders are being invited to community meetings to review and comment on FEMA’s draft coastal flood hazard workmaps for the Lake Michigan Shoreline. FEMA’s outreach for the 2017 workmaps started in early July. Meetings have already occurred for Illinois, Indiana and Wisconsin communities. The meeting schedule for Michigan and the remaining Wisconsin counties is below.

Each meeting will include a summary of the draft work maps, Q&A, and a breakout for review of community-specific data via printed and online maps. Staff members and officials representing villages, cities, and county government, regional organizations, non-governmental bodies, neighborhood associations, and harbor and shoreline protection engineers are encouraged to attend and to provide feedback within the 60-day comment period.

Link to Map Viewer User Guide to learn more about the Draft Work Maps.

For more Information:
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Additional Information:
USACE High Resolution Oblique Aerial Images: https://greatlakes.ordc.dren.mil/

Wisconsin

Ozaukee and Sheboygan County
Tuesday, August 8, 9:30-11:30am
Rocca Meeting Room
Moon Park (Milwaukee)

http://www.greatlakescoast.org/
St. Louis County, MN

NEXT STEPS
Coastal Risk Awareness

KNOW YOUR RISK
*Do your residents know about their flood risk?*

KNOW YOUR ROLE
*Do your residents know what mitigation actions they should/can take?*

Multi-Hazard Mitigation Plan for St. Louis County – Last update March 2013

TAKE ACTION
*Encourage your residents to take the actions that can build their resiliency to flooding.*
FEMA’s next steps:

1. Inventory all comments received
2. Evaluate and incorporate comments and data as appropriate
3. Move studies into the NFIP regulatory process (developing FIRMs)

Review and comment period ends 6/18/2018
Comments

Send comments via email to williamsjo@cdmsmith.com or mail to:

Great Lakes Coastal Flood Study
Comment Repository
c/o CDM Smith
Attn: Jordan Williams
555 17th Ave, Suite 500
Denver, CO 80202

Include county, community, map panel number, description of area (screenshots or drawings are very helpful), detailed comment, and contact information

▸ You will receive acknowledgement of receipt of your comment within 3 business days

▸ Within 3 weeks, FEMA’s response will indicate if enough technical justification was provided to necessitate a map change

▸ If you are not satisfied with a comment response on technical grounds, consider using the appeal process during Preliminary FIRM rollout
FEMA Contacts

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COMMENT REPOSITORY:
Send comments via email to williamsjo@cdmsmith.com or mail to:
Great Lakes Coastal Flood Study
Comment Repository
c/o CDM Smith
Attn: Jordan Williams
555 17th Ave, Suite 500
Denver, CO 80202
Thank you for your participation!