Agenda

- Introductions
- Coastal Flood Risk Study and Mapping Program
- Current Status
- Technical Overview of Study and Mapping
- Floodplain Management
- Next Steps
- Q&A
- Workmap Review
Mackinac County, MI

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
- RiskMAP
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.
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

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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
Link to the Mackinac County, MI Work Map Data Viewer: http://arcg.is/9K4yK
Work Map Data Viewer

Mackinac Coastal Web App

Layers

- Project Boundary
- Communities
- Coastal Transects
- Work Map Grids
- FIRM Panel Outlines
- Flood Boundaries
- Coastal Flooding
- NFHL: FEMA's National Flood Hazard Layer

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Work Map Data Viewer

FEMA Work Map Data Viewer User Guide

Project Background

The Federal Emergency Management Agency (FEMA) releases draft work maps for communities as engineering data is completed. These products display the results of FEMA’s analysis. The intent of this release is to help community officials understand current flood risk and potential flood insurance requirements as well as provide them with an opportunity to review the findings prior to their inclusion within Preliminary Flood Insurance Rate Maps (FIRMs).

Leveraging FEMA’s GeoPlatform, this information has been organized and shared with community partners through an interactive ArcGIS online web map viewer. This document provides an overview of how to navigate, visualize, and access the data and information within this tool.

Viewing work maps via FEMA GeoPlatform

When opening the FEMA Work Map Data Viewer for a county your screen should appear similar to Figure 1 below. If you want a general overview of the map click on the “Details” button (outlined below in Figure 1).

User guide location:

Mackinac County, MI

TECHNICAL OVERVIEW OF STUDY AND MAPPING
Coastal Flood Hazard Modeling Overview

Lake-Wide Variation
Step 1: Offshore Water Level and Wave Modeling

Local Variation
Step 2: Nearshore Wave Setup, Runup & Overtopping

Step 3: Floodplain Mapping
Step 1: ADCIRC+SWAN Mesh

- Resolution as fine as 10 m along complex shoreline features including:
  - Jetties
  - Breakwaters
  - Inlets
  - Natural Shoals
Step 1: Run the Models

Baseline Meteorological Forcing Physical Setting

Water Level Wind Ice Bathymetry

Pressure Waves Still Water Elevations

Total of 151 events between 1960-2009
Step 1: Lake Levels
Step 1: Lake Levels
Step 1: Example Surge Behavior

Storm 099
December 1990

Datum, 176.0 Plus 0.4 m IGLD 1985

Water Level, m

Vector Legend
△ 30.00 m/sec
→ 30.00 m/sec
□ 0.00 m/sec
## Step 1: Model Accuracy Assessment

### Water Level Gauge Station

<table>
<thead>
<tr>
<th>Station</th>
<th>Water Level Gauge Station</th>
<th>RMS error (m)</th>
<th>Bias (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9075014</td>
<td>Harbor Beach</td>
<td>0.054</td>
<td>0.018</td>
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<td>9075080</td>
<td>Mackinaw City</td>
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<td>9075099</td>
<td>De Tour Village</td>
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<td>9014098</td>
<td>Fort Gratiot</td>
<td>0.106</td>
<td>0.069</td>
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<tr>
<td>9075002</td>
<td>Lakeport</td>
<td>0.072</td>
<td>0.011</td>
</tr>
<tr>
<td>9075035</td>
<td>Essexville</td>
<td>0.103</td>
<td>-0.003</td>
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<tr>
<td>9075059</td>
<td>Harrisville</td>
<td>0.054</td>
<td>0.027</td>
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<tr>
<td><strong>Average</strong></td>
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<td><strong>0.071</strong></td>
<td><strong>0.023</strong></td>
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</table>

### Wave Buoy Station

<table>
<thead>
<tr>
<th>Station</th>
<th>Wave Buoy Station</th>
<th>RMS error (m)</th>
<th>Bias (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>45003</td>
<td>North Lake Huron</td>
<td>0.317</td>
<td>-0.024</td>
</tr>
<tr>
<td>45008</td>
<td>South Lake Huron</td>
<td>0.310</td>
<td>0.051</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td><strong>0.313</strong></td>
<td><strong>0.014</strong></td>
</tr>
</tbody>
</table>
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 Analysis Overview

Water Level & Offshore Waves

Transect Analysis

Total Water Level

- Water Level (Surge)
- Waves
- Setup, Runup and Overtopping

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Mackinac County (Lake Huron):
  - 37 Analysis Transects
  - 260 Shoreline Miles

Transects placed at representative shoreline reaches based on:
  - Topography
  - Exposure
  - Shoreline Material
  - Upland Development

Mackinac County has 30 analysis transects on Lake Michigan
Step 2: Transect Analysis: Wave Setup and Runup

• Wave runup is the uprush of water from wave action on a beach or shore barrier such as a steep dune, bluff or coastal structure.

• Runup was calculated for every time step of each of the 151 storm events at each transect for the response-based approach.

• A statistical analysis was performed on the maximum runup results at each transect to obtain the 1-percent-annual-chance runup elevation.
Response-Based Wave Runup

Runup Method Decision Flow Chart

Shoreline Type

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

Stockdon

Bluff

Bluff Face Slope

Between 1V:10H and 1V:1H

van Gent

1V:1H or Steeper

SPM – Vertical Wall Runup

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

van Gent

Shore Protection Structure

Vertical Wall (Structure Slope of 1V:1H or Steeper)

SPM – Vertical Wall Runup
Step 2: Runup
Step 2: Transect Analysis: Wave Overtopping

- If wave runup exceeds the barrier crest elevation, overtopping occurs.
- Overtopping rates are calculated using methods described in the EurOTop Manual.
- Overtopping rates determine VE splash zones and AO Zone (sheet flow) depths.
Step 2: Wave Overtopping
Step 2: Wave Overtopping – Plateau Method

- When overtopping occurs, the zone behind the barrier is designated as:
  - AE if landward slope is positive
  - AO if landward slope is negative
- Inland extent of overtopping mapping generally follows the 1-percent-annual-chance BFE contour
- Plateau method allows for an inland limit of runup to be calculated as the AE zone extent for gradually sloping upland areas behind a steep barrier
- Mapping extends to the seaward-most of the BFE contour or the inland extent of flooding
Step 2: Compute Setup, Runup, and Overtopping

- 151 storms with hourly waves and water levels yields hourly wave setup, runup and overtopping rates
- Hourly Still Water Levels (SWELs)
- Hourly Water Levels + Setup + Runup = Hourly Total Water Levels (TWLs)
- Extract the Peak SWEL and TWL from each storm
- Perform Return Period Analysis on SWEL and TWL
- 1-percent-annual-chance TWEL is used to define the Base Flood Elevation (BFE)
Step 2: Return Period Analysis

Transect MAK31: Initial TWL Analysis # Events: 151

Transect MAK31: Optimized TWL Analysis # Events: 108

Optimized Return Period Plot: Quantiles 25-75
Step 3: Mapping

Coastal Flood Hazard Zones

- **Zone VE:**
  - Represents coastal high hazard areas
  - Wave heights ≥ 3ft
  - Wave runup ≥ 3ft above ground elevation
  - Overtopping splash zones
  - BFEs are assigned

- **Zone AE:**
  - Inundation areas
  - Wave heights < 3ft
  - Wave runup < 3ft above ground elevation
  - BFEs are assigned

- **Zone AO:**
  - Applied in areas of sheet-flow shallow flooding
  - Designated with depths of 1-, 2-, or 3-ft

- **Zone Shaded-X:**
  - Areas impacted by the 0.2-percent-annual-chance event
Step 3: Zone Breaks

- Zone breaks are placed along the coast where the characteristics of the shoreline transition from one shore type to another.
- Define the extents of each representative shoreline reach.
Step 3: Runup VE Zones

- Runup VE zones are limited to steep face of beaches, bluffs, revetments, and other similar coastal barriers.
- Runup mapped to elevation associated with BFE or structure crest elevation.
- VE/AE transition occurs where runup is less than 3 feet above ground elevation.
- Where Plateau Method is applied, mapping extends to the seaward-most of the BFE contour or the inland extent of flooding.
Step 3: Overtopping Zones

AO Zones

- Applied in areas of shallow flooding, usually sheet flow on sloping terrain
- BFE not provided, instead average flood depth between one and three feet is specified
- Flood depth determined based on 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: SWEL Inundation
Draft Work Map vs FIS/FIRM

Mackinac County, MI Workmap

Mackinac County, MI Effective FIRM

Not a Regulatory Product

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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
Online Resources

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

Great Lakes Coastal Flood Study
http://www.greatlakescoast.org

Great Lakes Coastal Resilience Planning:
http://www.greatlakesresilience.org/
Mackinac County, MI

NEXT STEPS
Comments

Send comments via email to brett.holthaus@atkinsglobal.com or mail to:

Great Lakes Coastal Flood Study
Comment Repository
c/o Atkins
Attn: Brett Holthaus
3901 Calverton Boulevard, Suite 400
Calverton, MD 20705

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
Next Steps

60 day review and comment period ends August 19, 2018.

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)
KEN HINTERLONG  
Senior Engineer, Risk Analysis  
FEMA Region 5  
312-408-5529  
ken.hinterlong@fema.dhs.gov

COMMENT REPOSITORY:  
Send comments via email to brett.holthaus@atkinsglobal.com  
or mail to:  
Great Lakes Coastal Flood Study  
Comment Repository  
c/o Atkins  
Attn: Brett Holthaus  
3901 Calverton Boulevard, Suite 400  
Calverton, MD 20705
Questions?

Thank you for your participation!