An Overview of Potential NFIP Risk Reduction Benefits of Mapping Shoreline Change (Erosion/Accretion) on Flood Maps

Darryl J. Hatheway, CFM, Senior Coastal Scientist, BakerAECOM, San Diego, CA
and
Ed Curtis, PE, CFM, Senior Civil Engineer, Risk Analysis Branch, FEMA Region IX
Presentation Outline:

- An overview will be presented on program history and data supporting potential NFIP risk reduction benefits of mapping Erosion Hazard Areas on the FIRM based on local, regional and/or state-wide shoreline change assessments.
Presentation Outline:

- It will include a look at the use of regulatory or non-regulatory products under Risk MAP to communicate the erosion risks, and a review of past efforts to examine the coastal population at risk to coastal hazards (specifically those at risk to long-term shoreline change hazards).
Presentation Outline:

- Infrastructure impacts due to erosion will not be included in this presentation.

- For background, the presentation will re-visit past FEMA studies and analyses of erosion hazards, at risk population and housing units GIS analyses, and a recent California assessment that factors in sea level rise impacts.
Risk Mapping, Assessment and Planning (Risk MAP) Vision

To deliver quality data that increases public awareness and leads to action that reduces risk to life and property

Objective (Coastal)

To provide updated flood hazard data for 100% of the populated U.S. coast

- Coastal risk assessment of long-term erosion not possible with current FIRM and needs programmatic support to map effectively.
Typical Study Process

Typical Study Process

Coastal Engineering Analyses

Offshore modeling

- Extra-Tropical, Hurricane, and Northeaster Coastal Flood Events
- Storm Surge & Deepwater Wave modeling

Coastal Analyses

- Transect locations and profiles
- Transect-based wave hazard analyses
- Overland Waves & Wave Runup

Typical Study Process Diagram:

- Setup
- Runup
- Erosion
- Overtopping
- Overland wave propagation
Typical Study Process

1. Discovery/Kick-Off Meeting
2. Data Acquisition
3. Engineering Analyses
4. Floodplain Mapping
5. Map Production
6. Post-Preliminary Processing

Additional Step:
- Bluff Erosion and Shoreline Change Mapping
NFIP Regulations and Erosion Hazard Area mapping

- In the 1994 National Flood Insurance Reform Act, section 577, Congress directed FEMA to prepare and submit an evaluation of economic impacts and feasibility of mapping Erosion Hazard Areas (EHA) as part of the NFIP.

- The study of the mapping effort was documented in a special issue (No. 28) of the Journal of Coastal Research in 1999.
The 1995 Phase 1 effort included 27 coastal county pilot studies of shoreline change mapping which were conducted to determine methodologies for erosion rate analysis and mapping of risks, including structure inventories within a 60-yr EHA.
FEMA coordinated with local and state agencies, universities, and study contractors on the erosion (and accretion) rate determinations and mapping criteria.

This included identification of mapping resources utilized to establish the long-term shoreline changes for a statistically significant portion of the US coastal floodplain population areas.
FEMA Erosion Hazard Studies and Heinz Center Assessment

- This study was followed in 1997 by Phase 2, which was completed in April 2000 by the H. John Heinz III Center for Science, Economics, and Environment (Heinz Center) by assessing the national picture on Erosion Hazard Areas (EHAs):
  - structures within the EHA,
  - economic impacts of including EHA in the NFIP, and
  - a cost-benefit analysis of the potential program.
In the final assessment the Heinz Center determined that it was economically cost effective and feasible to map the high risk EHA on the FIRM as a new flood insurance risk class.

The Heinz Center also recommended that in these developed coastal regions of the Atlantic Ocean, Pacific Ocean, Great Lakes, and Gulf of Mexico erosion mapping is needed,
FEMA Erosion Hazard Studies and Heinz Center Assessment

- Mapping of erosion was recommended to be a depiction of the shoreline change rates of erosion or accretion.

- This mapping should be projected as a future shoreline change condition (based on historical measurements) by delineating a 60-yr EHA boundary on the FEMA flood maps.
FIGURE S.4 Average Annual Erosion Rates (feet/year) within Counties studied in The Heinz Center’s Evaluation of Erosion Hazards
Notes: As shown on this aerial photo of South Bethany, Delaware, the beach is expected to erode inland 65 feet (from the white line on the right to the one on the left) over the next 60 years. Two to three rows of houses, marked with circles, are likely to be lost to erosion over this period.
The final Heinz Center nationwide assessment reported that:

- Development in several high-risk coastal areas studied has increased by more than 60% over the last 20 years.
- Property owners within a few hundred feet of the nation's coasts face an equivalent risk of damage from erosion as they do from flooding.
- Only roughly 50% of homeowners in high erosion areas on the Atlantic and Gulf coasts currently hold flood insurance policies.
- The regulatory components of the NFIP have been effective in reducing damage from flooding, but were not designed to directly address erosion.
The final Heinz Center nationwide assessment reported that:

- To fully reflect erosion risk, insurance rates in the highest hazard coastal areas would have to be double today's rates, on the average.
- Assuming that enrollment in the federal flood insurance program holds steady, the NFIP's payout for erosion-related losses over the next few decades will average about $80 million per year.
- It would cost approximately $44 million for FEMA to identify, map, and disseminate information on erosion hazards nationwide (cost in 1999 dollars).
The final Heinz Center nationwide assessment reported that:

- In shore areas there are approximately 10,000 structures within the estimated 10-year erosion zone (the amount of land expected to erode within 10 years).
- There are approximately 87,000 structures within the estimated 60-year erosion zone.
- There are approximately 338,000 structures within 500 feet of the shoreline; 50% of these structures are located on the Atlantic coast, 13% are on the Gulf, 20% on the Pacific coast, and 17% are on the Great Lakes.
The final Heinz Center nationwide assessment recommendations:

(1) “Congress should instruct the Federal Emergency Management Agency to develop erosion hazard maps that display the location and extent of coastal areas subject to erosion. The erosion maps should be made widely available in both print and electronic formats.”

Without mapping of long-term erosion risks, existing coastal property owners and those interested in purchasing and/or considering new construction on coastal property cannot be adequately informed of the additional hazards (over the next 60 years).
FEMA Erosion Hazard Studies and Heinz Center Assessment

- The final Heinz Center nationwide assessment recommendations:
  - (2) “Congress should require the Federal Emergency Management Agency to include the cost of expected erosion losses when setting flood insurance rates along the coast.”
  - By incorporating the risk from coastal erosion into the cost of insurance, FEMA can reduce the subsidy of other policyholders and taxpayers for those property owners expected to be subject to erosion losses.
### TABLE S.1 Nationwide Estimate of Structures Susceptible to Erosion

<table>
<thead>
<tr>
<th>Variable</th>
<th>Atlantic Coast</th>
<th>Gulf of Mexico</th>
<th>Pacific Coast</th>
<th>Great Lakes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of coastline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miles</td>
<td>2,300</td>
<td>2,000</td>
<td>1,600</td>
<td>3,600</td>
<td>9,500</td>
</tr>
<tr>
<td>Percentage of total</td>
<td>24%</td>
<td>21%</td>
<td>17%</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td>Structures within 500 feet of shoreline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>170,000</td>
<td>44,000</td>
<td>66,000</td>
<td>58,000</td>
<td>338,000</td>
</tr>
<tr>
<td>Percentage of total</td>
<td>50%</td>
<td>13%</td>
<td>20%</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Structures within 60-year erosion hazard area (EHA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>53,000</td>
<td>13,000</td>
<td>4,600</td>
<td>16,000</td>
<td>87,000</td>
</tr>
<tr>
<td>EHA structures as % of those within 500 feet of shoreline</td>
<td>31%</td>
<td>29%</td>
<td>7%</td>
<td>28%</td>
<td></td>
</tr>
<tr>
<td>Structures within 60-year EHA assuming all open lots are filled</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>76,000</td>
<td>22,000</td>
<td>5,200</td>
<td>&gt;16,000c</td>
<td>&gt;120,000</td>
</tr>
</tbody>
</table>

---

*a* All estimates exclude structures in major urban areas. The analysis assumes these structures will be protected from the erosion hazard.

*b* The 60-year EHA is determined by multiplying local erosion rates by 60 years.

*c* Data on open lots not available in Great Lakes

Data may not add to totals because of rounding.
Coastal Demographic Study and At Risk Populations

- Additional documentation of the coastal population at risk can be found in the September 2008 FEMA report “Coastal AE Zone and VE Zone Demographics Study and Primary Frontal Dune Study to Support the NFIP”.

Coastal AE Zone and VE Zone Demographics Study and Primary Frontal Dune Study to Support the NFIP

Final Technical Report – 09/21/08

September 2008
Coastal Demographic Study and At Risk Populations

- September 2008 FEMA report “Coastal AE Zone and VE Zone Demographics Study and Primary Frontal Dune Study to Support the NFIP”.
  - This 2008 Coastal Demographics Study documented through data research and GIS analyses of NFIP policy and claims data, and 2000 Census data that the US coastal floodplain population (excluding Pacific Territories) was estimated to be 8,524,652 people, and further refined to include the following:
Coastal Demographic Study and At Risk Populations

- September 2008 FEMA report “Coastal AE Zone and VE Zone Demographics Study and Primary Frontal Dune Study to Support the NFIP”.
  - For mapped coastal AE Zone floodplains, there is population of 7,889,585 with 3,797,566 housing units, and 2,129,756 floodplain policies in force (as of 2005); and
  - For mapped coastal VE Zones floodplains, there is a population of 635,067 with 402,832 housing units, and 61,032 policies in force.
Coastal Demographic Study and At Risk Populations

- September 2008 FEMA report “Coastal AE Zone and VE Zone Demographics Study and Primary Frontal Dune Study to Support the NFIP”.
  - The coastal VE Zones would typically be the area most likely to included erosion areas subject to long-term shoreline change impacts.
  - However, in many areas with coastal bluffs the structures at risk to erosion (based on a projected 60-yr EHA) are currently mapped in the X Zone (outside the special flood hazard area).
Another recent study of erosion losses can be found in May 2009 “Impacts of Sea Level Rise on California Coast” by the Pacific Institute (for the California Ocean Protection Council and others).

This study looked at a 1.4 meter sea level rise (by 2100) and its impacts on open Pacific Ocean coastlines and embayments in California.

This study determined that of the 480,000 people at risk to sea level rise, an estimated 14,000 of those live in areas subject to erosion hazards and future losses.
This is a graph of sea level rise in San Francisco Bay. The most important thing to note about this graph is that it is not a prediction. This is history.
Pacific Institute Report on Sea Level Rise Impacts on Coastal Areas

Pacific Institute Sea Level Rise Study

Sea-level rise will accelerate:
Scripps scenarios for California

CA Projected 1.4 meter (4.5 ft) SLR by 2100
Mapping Areas at Risk of Flooding

New 100-yr Flood Elevation with Sea Level Rise

100-yr Flood Elevation

Wave height

100-yr Still-Water Elevation

Cliff Hazard Zones:
- 2025 High
- 2050 High
- 2100 High
- Cliff Baseline

Steps result from different input values used to calculate the hazard zones.
Current Status of Erosion Hazard Mapping in NFIP

- FEMA still needs Congressional approval to map long-term erosion hazards in the NFIP and include them as part of the flood insurance risk area on the FIRM.

- As of today, there has been no NFIP mapping and specific inclusion of the EHA and projected shoreline change rates on the FIRM.
The purpose of this presentation is to look further into the risk reduction benefits of mapping the EHA on the FIRM and/or produce special non-regulatory products showing this unique hazard area under Risk MAP.

To do so, an update to the April 2000 Heinz Center study would help show how the population is changing and trends in coastal growth may be increasing the risk.
Risk Reduction Benefits to NFIP from Erosion Hazard Area Mapping

- Ideally, the shoreline change rates could be applied for mapping new EHAs along with new Risk MAP coastal studies and revised coastal floodplain mapping along the open coasts.

- This would have been the most cost effective method to create a new regulatory area of the coastal oceanfront at highest risk to erosion.

- When finally mapped, the high risk erosion hazard areas can be identified and then factored into coastal zone management strategies, hazard mitigation planning, and coastal development practices.
Summary

- At present in the Pacific Region, we are unable to determine and map bluff-erosion hazards in a meaningful fashion on the FIRM.

- This points to a current need to either map this hazard on the FIRM or create a non-regulatory product that identifies the risk of erosion damages and losses to coastal structures.

Source: FEMA G&S Feb 2005
Questions
Prototype Maps