Coastal Flood Risk Study Project for South Florida

Storm Surge Analysis Update Meeting
Miami-Dade County, Florida

April 25, 2018
Agenda

- Welcome and Introductions
- Update on Coastal Flood Risk Study
- Stillwater Elevation Information
- Risk MAP Products Overview
- Open Discussion of Flood Risk Study
- Coastal Flood Risk Study Contacts
Introduction

- **Project Team**
  - FEMA Region IV
  - BakerAECOM, FEMA Mapping Partner

- **Project Stakeholders**
  - Community CEOs
  - Community FPAs
  - Political Representatives
  - Other State and Federal Agencies
  - Public
FEMA Region IV Coastal Flood Risk Studies in Florida

*FYxx indicates the fiscal year of future planned or past actual funding for the coastal surge study.
Why the Coastal Flood Risk Study Is Being Updated

- Flood risk changes over time – Effective study based on outdated hurricane modeling and topographic data
- Ability to more accurately define risk and account for significant development in project area
- To gain a complete and current picture of coastal flood risks, which helps the community:
  - Plan for the risk.
  - Communicate the risk to citizens.
  - Take action to reduce flood risk to lives and property.
  - Build smarter and safer.
Why the Study Is Being Updated (Cont’d)

- **Current surge analysis is 30 to 40+ years old**
  - SURGE – FEMA Coastal Flood Storm Surge Model, last updated 1988
  - Climate data from 1975, 1978, and 1979 NOAA reports

- **Your risk is better defined through**
  - Updated elevation data (topographic data and aerial imagery)
  - New climatological data based on recent storms
  - Computing resources – a lot has changed in 30 years!
  - Updated coastal hazard methodologies/modeling
  - Improvement in Geographic Information System technologies to improve coastal mapping accuracy
Basic Elements of a Coastal Flood Risk Study

Base Flood Elevation (BFE) on FIRM includes four components:

1. Storm surge stillwater elevation (SWEL)
2. Amount of wave setup
3. Wave height above storm surge (SWEL) elevation
4. Wave runup above storm surge elevation (where present)

Determined from storm surge model
Coastal Flood Risk Study – Completed and Future Work

- Coordinated with community officials and stakeholders regarding available data
- Conducted thorough data investigation
- Conducted field investigations
- Set up hurricane model
- Calculated stillwater levels
Completed and Future Work (Cont’d)

- **Phase I – Collect Data and Set Up/Run Hurricane Model**
  - Set up hurricane/storm surge model - Complete
  - Validate model using five historic storms - Complete
  - Execute hypothetical storms - Complete

- **Phase II – Calculate Stillwater Levels**
  - Run statistics on millions of nodes - Complete
  - Calculate 1-percent-annual-chance flood elevations - Complete
Completed and Future Work (Cont’d)

- Phase III – Run WHAFIS Wave Model - **Started**
  - Use local scale land-use data for vegetation, obstructions, open fetch, sheltered fetch, dunes, etc.
  - Calculate Special Flood Hazard Areas (SFHAs) – Zones AE and VE

- Phase IV – Map Results
  - Map AE and VE zones
  - Map Limit of Moderate Wave Action (LiMWA)
  - Prepare draft work maps
  - Prepare Flood Risk Products

- Phase V – Issue Preliminary FIRMs

- Phase VI – Execute Due Process
South Florida (SFL) Study Area Schedule

- Phase I – Collect Data and Set Up/Run Hurricane Model - Complete
- Phase II – Calculate Stillwater Levels - Complete
- Phase III – Run WHAFIS Wave Model - Complete
- Phase IV – Prepare Work Maps/Hold Flood Risk Review Meeting - Estimated April 2019
- Phase V – Issue Preliminary FIRMs - Estimated July 2019
- Phase VI – Execute Due Process – 2019-2021
Current Study: Hurricane/Storm Surge Model

- **Current Study**
  - Completed early 1980s
  - Used TT Surge model
  - Used 0.5-nautical mile (nm) grid near shore and 5-nm grid offshore
  - Used U.S. Geological Survey quadrangles

Example of 0.5-nm grid at St. Lucie Inlet
LIDAR and Bathymetric Data

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
<th>Data Type</th>
<th>Source/Owner</th>
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<tbody>
<tr>
<td>2007</td>
<td>St. Lucie and Martin Counties, FL LIDAR</td>
<td>Airborne LIDAR</td>
<td>FDEM</td>
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<tr>
<td>2007</td>
<td>Palm Beach County, FL LIDAR</td>
<td>Airborne LIDAR</td>
<td>FDEM</td>
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<td>2007</td>
<td>Herbert Hoover Dike Project, FL LIDAR</td>
<td>Airborne LIDAR</td>
<td>FDEM</td>
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<td>2001</td>
<td>Palm Beach County, FL LIDAR (DEM)</td>
<td>Airborne LIDAR</td>
<td>SFWMMD</td>
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<td>2007</td>
<td>Broward County, FL LIDAR</td>
<td>Airborne LIDAR</td>
<td>FDEM</td>
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<td>2007</td>
<td>Miami-Dade County, FL LIDAR</td>
<td>Airborne LIDAR</td>
<td>FDEM</td>
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<tr>
<td>2008</td>
<td>Florida Keys Project, FL LIDAR</td>
<td>Airborne LIDAR</td>
<td>FDEM</td>
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<td>2007</td>
<td>Monroe County, FL LIDAR</td>
<td>Airborne LIDAR</td>
<td>FDEM</td>
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<tr>
<td>2007</td>
<td>Collier County, FL LIDAR</td>
<td>Airborne LIDAR</td>
<td>FDEM</td>
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<tr>
<td>Various</td>
<td>USGS National Elevation Data (10 meter DEMs)</td>
<td>Digital Elevation Model</td>
<td>USGS</td>
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<tr>
<td>2014</td>
<td>South FL Composite Topography</td>
<td>Digital Elevation Model</td>
<td>SFWMMD</td>
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The bathymetric Digital Elevation Model (DEM) is constructed from different types of data that required different construction methods:

1. Traditional sounding data (e.g., NOS survey)
2. NOS bathymetric attributed grid surveys
3. High-resolution raster data (e.g., JALBTCX topobathy LIDAR)
4. Trackline navigation channel survey data (e.g., U.S. Army Corps of Engineers channel surveys)
5. Intracoastal Waterway (ICW) soundings (FINDS)
6. SFWMD soundings and control structure data
7. Two-dimensional river cross-section data (FEMA FIS)
Hurricane Model Mesh Development
Mesh Development (Cont’d)

Old Mesh

New Mesh
Mesh Development (Cont’d)

- 30m mesh captures Elliot Cut
- 150m mesh does not capture Elliot Cut nor the majority of Wapoo Creek
Mesh Development (Cont’d)
SWAN+ADCIRC Mesh – Miami-Dade County
Storm Climatology

- Reviewed historical storms
- Selected five storms to validate the hurricane/surge model
- Generated hundreds of hypothetical storms
- Analyzed important storm parameters
  - Central pressure
  - Radius to maximum winds
  - Forward speed
  - Storm heading
  - Holland’s B (shape parameter)
Validation Storm Selection: Significant Surge Events, 1970-1979

Landfalling, bypassing, and exiting storms that passed near study area
Validation Storm Selection: Significant Surge Events, 2000-2010

Landfalling, bypassing, and exiting storms that passed near study area
Validation Storm Selection: Available NOAA Water Level Data

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Station ID (NOAA)</th>
<th>Water Level Data</th>
<th>Start Date</th>
<th>End Date</th>
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<tr>
<td>Lake Worth ICW</td>
<td>8722669</td>
<td>Verified 6+ min</td>
<td>1/25/2008</td>
<td>10/18/2010</td>
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<tr>
<td>PGA BLVD</td>
<td>8722548</td>
<td>Verified 6+ min</td>
<td>4/8/2008</td>
<td>10/13/2010</td>
</tr>
<tr>
<td>Port of WPB</td>
<td>8722588</td>
<td>Verified 6+ min</td>
<td>1/25/2008</td>
<td>10/20/2010</td>
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<tr>
<td>Miami Beach¹</td>
<td>8723170</td>
<td>Monthly Mean</td>
<td>5/27/1931</td>
<td>6/30/1981</td>
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<tr>
<td>Virginia Key (Miami)</td>
<td>8723214</td>
<td>Verified 6+ min</td>
<td>1/1/1996</td>
<td>9/30/2013</td>
</tr>
<tr>
<td>Vaca Key (Marathon)</td>
<td>8723970</td>
<td>Verified 6+ min</td>
<td>12/1/1995</td>
<td>8/31/2013</td>
</tr>
<tr>
<td>Key West</td>
<td>8724580</td>
<td>Verified Hourly</td>
<td>9/1/1953</td>
<td>8/31/2013</td>
</tr>
<tr>
<td>Lake Worth Pier</td>
<td>8722670</td>
<td>Verified 6+ min</td>
<td>6/17/2010</td>
<td>9/30/2013</td>
</tr>
<tr>
<td>Loggerhead Key, FL</td>
<td>8724698</td>
<td>Verified 6+ min</td>
<td>5/28/2004</td>
<td>2/14/2005</td>
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¹Miami Beach station contains Maximum Water Level data point for Hurricane Betsy (1965)
NOAA National Buoy Data Center (NDBC) – No measured wave data available for the SFL study area
Five storms selected

1. Hurricane Betsy (1965)
2. Hurricane David (1979)
3. Hurricane Andrew (1992)
5. Hurricane Wilma (2005)
Validation: Historical Storms: Hurricane Andrew

Maximum water level (ft–NAVD)

Biscayne Bay Zoom
Validation: Historical Storms: Hurricane Andrew (Cont’d)

Andrew, S21_T Station

- MEASURED
- SWAN+ADCIRC

Water Surface Elevation (ft NAVD)

8/14/92 0:00 to 8/28/92 0:00
Validation: Historical Storms: Hurricane Wilma
Validation: Summary

- Validation completed for tides and five historical storms

- Demonstrated model capability to reproduce water levels and waves in project area

- Comparisons to available data showed reasonable agreement for water levels and waves
SWEL Results Obtained at Each Mesh Node

- Set up “mesh” for hurricane/surge model
- Validated hurricane/surge model
- Ran hundreds of hypothetical storms
- Computed return periods for study area
- Result: storm surge stillwater elevations for 1-percent-annual-chance event
How Comparison Maps Are Created

- For each county, changes are shown for the 2-, 1-, and 0.2-percent-annual-chance SWELs.

- The map indicates the difference between the effective SWEL and the 2018 Storm Surge Study SWEL.

- The 2018 data:
  - includes wave setup
  - Does not include overland wave height
Step 1: SWELs Obtained from Effective FIS

Wave setup was not computed within the effective Miami-Dade County FIS.
Step 2: Effective and 2018 Data Entered into Geodatabase

- The 2018 surge values already include integrated setup levels.
- Setup was not included in the effective values.

<table>
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<tr>
<th></th>
<th>Effective</th>
<th>Diff.</th>
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<tbody>
<tr>
<td></td>
<td>1% SWE (surge only)L</td>
<td>Wave Setup</td>
</tr>
<tr>
<td>Atlantic Ocean</td>
<td>5.8</td>
<td>-</td>
</tr>
<tr>
<td>ICW</td>
<td>10.0</td>
<td>-</td>
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</tbody>
</table>

*Values in ft NAVD88

Legend:
- NA
- < -3
- -3 to -2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4

Miami-Dade

2018
Next Phase - Overland Wave Analysis

- Perform overland wave modeling
- Prepare mapping of SFHA (VE and AE zones), BFEs, and LiMWA
- Develop draft work maps and present at Flood Risk Review Meeting
- Deliver Preliminary FIRM and FIS report for use at Consultation Coordination Officer (CCO) Meeting and Flood Risk Open Houses
- Execute due process
- Develop Flood Risk Products and present at Resilience Meeting
Overland Wave Analysis (Cont’d)

Wave height ≥ 3 ft

3 ft > Wave height ≥ 1.5 ft

Wave height < 1.5 ft

BFE < 1 ft

Properly elevated (post-FIRM) building in CHHA

Best practice - Elevated building in Coastal A Zone

Improperly elevated (pre-FIRM) building

BFE including wave effects

1-percent-annual-chance SWEL

Normal water level

Shoreline

Beach face

Limit of SFHA

Vegetated region

BFE = Base Flood Elevation
CHHA = Coastal High Hazard Area

LiMWA = Limit of Moderate Wave Action
SWEL = Stillwater Flood Elevation
Basic Elements of a Coastal Flood Risk Study

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1. Storm surge stillwater elevation (SWEL)
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4. Wave runup above storm surge elevation (where present)

- Determined from storm surge model
- From wave height analyses
Basic Elements of a Coastal Flood Risk Study (Cont’d)

- Normal water level
- Storm surge level
- Wave setup
- Wave action
Basic Elements of a Coastal Flood Risk Study (Cont’d)

Dune erosion - retreat
Basic Elements of a Coastal Flood Risk Study (Cont’d)

Dune erosion - removal
Primary Frontal Dune (PFD)

“a continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms” – NFIP regulations
WHAFIS Models Waves Overland

- One-dimensional transect approach based on limited water depth
- Accounts for wave dissipation/regeneration overland
- BU, VE, VH, AS cards as source of wave dissipation
- IF, OF cards as source of wave regeneration
- Wave crest elevations => BFEs
Coastal Structure Stability and 2% Wave Runup Calculation

- Evaluation of failed vs intact structure slope
- Current FEMA Guidelines require computation of 2% runup.
- Prior to 2007, mean runup was computed.
- Runup methods:
  - Runup 2.0 for moderate slopes
  - TAW method for structures
  - SPM method for vertical walls
LiMWA

- FEMA Operating Guidance 13 (2013) – Most recent guidance in use
- Areas exposed to a breaking wave higher than 1.5 feet are subjected to high-velocity flows and/or debris that can erode and scour foundations and possibly cause failure.
- LiMWA is used to define the Coastal A Zone. The Coastal A Zone is the area included between the VE zone inland limit and the LiMWA line.
- Communities can receive Community Rating System (CRS) credit for requiring VE zone construction standards in areas defined by LiMWA or areas subject to waves greater than 1.5 feet.
Evidence suggests that design and construction requirements in some portions of the coastal AE Zone should be more like VE Zone requirements.

Areas exposed to a breaking wave higher than 1.5 ft are subjected to high-velocity flows and/or debris that can erode and scour foundations and possibly cause failure.

Communities and property owners can better understand flood risk to their property defining the Coastal A Zone (CAZ).

By reference to ASCE 24, the Florida Building Code (FBC) requires Zone V construction methods in CAZs. If the CAZ is delineated, the FBC requires dwellings to be elevated at least 1 foot above the BFE.
Flood Risk Products

- Flood Risk Report
- Flood Risk Map
- Flood Risk Database
Changes Since Last FIRM (CSLF)
CSLF (Cont’d)

- Identifies where changes have occurred and number of properties impacted by the change
- Facilitates answering Congressional Inquiries
- Allows FEMA and communities to understand if broad outreach is needed during presentation of regulatory products (FIRMs)
- Facilitates smoother communications with and among local communities
Outreach Activities

- Data Collection & Stakeholder Coordination
- Kickoff Meeting
- Discovery Meeting
- Discovery Map, Discovery Report, & Project Charter Creation/Distribution

Technical Update Meetings (As Needed)
- Storm Surge Analysis Update Meeting

- Preliminary Map Release Planning
- Flood Risk Review Meeting
- Resilience Meeting

- CCO Meeting/Open House
- Community FIRM/FIS Report Review

- Appeal Period
- Appeal/Comment Review & Resolution
- Letter of Final Determination Issuance
SFL Study Area Schedule

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Coastal Flood Risk Study Contacts

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