Welcome

Moderator: Nicole Cortez
Housekeeping

Q&A Session

If you’re participating in person – please fill out Section 5 at the Technical Question / Public Comment Card and give to a meeting attendant.

If you’re participating via Zoom – use the Q&A function to submit a written question or use the Raise Hand feature.

If you’re participating via Phone:
*9 Raises Hand
*6 Mutes/Unmutes

Moderator: Nicole Cortez
Housekeeping

Public Comments

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If you’re participating via Phone:
* 9 Raises Hand
* 6 Mutes/Unmutes
1. Welcome and Opening Remarks

John P. Mitnik, P.E.
Assistant Executive Director and Chief Engineer
South Florida Water Management District
2. WORKSHOP GOALS AND FLOOD RESILIENCY PLANNING INTRODUCTION

Carolina Maran, Ph.D., P.E.
District Resiliency Officer
South Florida Water Management District
3. FLOOD PROTECTION
LEVEL OF SERVICE (FPLOS)
ADAPTATION PLANNING AND
FLOOD DAMAGE COST ESTIMATES

Hongying Zhao, Ph.D., P.E.
Hydrology and Hydraulics Bureau
South Florida Water Management District
Flood Protection Level of Service Program

How we ensure that our flood control assets are up to the task considering development, land use change, SLR and climate change

- Assess level of flood protection throughout the 16-counties of the SFWMD – relative to design
- Identify at-risk structures and needed improvements to operations, canal conveyance or structures
- Provide a formal process to initiate retrofit and adaptation efforts for future infrastructure improvements and/or modification of regulatory criteria
- Incorporate resilient design standards and constructions
- Coordinated with SFWMD Operations, local government entities, drainage districts and other agencies with flood control or related responsibility
Three Phases of the FPLOS Program

**Phase 1: Assessment**
- Focus on Flood Control Assets in Primary system
- Identify flood vulnerable assets and regions

**Phase 2: Mitigation and Adaptation Planning**
- Focus on Primary, Secondary and Tertiary systems
- Collaboratively identify projects, operations or regulations to meet flood control needs

**Phase 3: Implementation**
- Design, permit and build identified projects to achieve resilient flood protection goals, integrated into the Sea Level and Flood Resiliency Plan

Presenter: Hongying Zhao
Current Status of FPOLS Program

Completed FPLOS studies
- BCB FPLOS Phase I
- C4 FPLOS Phase I
- C7 FPLOS Phase I
- Low-Lying Tidal Structure Assessment
- C8/C9 FPLOS Phase I
- South Miami-Dade
- Broward County
- Atlas Update

Ongoing FPLOS studies
- FPLOS Phase I
  - C111-Model Land-L31NS
  - C2-C3W-C5-C6
  - Upper Kissimmee Basin
  - Palm Beach County

FY2023 Planned study
- C8/C9 Phase II
- Atlas Update

FY2023 Planned study
- Two Phase I projects
- C7 Phase II
- Atlas Update

Presenter: Hongying Zhao
C8/C9 FPLOS Adaptation and Mitigation Study

1. Stakeholders/partners engagement
2. H&H assessment
3. Economic assessment
   • Flood damage reduction estimate
   • Mitigation strategy cost estimate
   • Cost/Benefit estimate
4. Adaptation planning
5. Workshop to present the results

work in progress, subject to change

Presenter: Hongying Zhao
Estimate the expected annual damage

What liability or risk is the system exposed to – due to action or inaction?

What is the cost/benefit ratio for different mitigation strategies

Provide strong support in selecting the best cause of action
SFWMD-FIAT Application in C8/C9 FPLOS
Adaptation and Mitigation Study

Preliminary M2A (regional level strategy)

- S28 and S29 forward pumps
- Gate improvement
- Tieback levees
- 500 ac-ft distributed storage
- Canal improvement

work in progress, subject to change

Presenter: Hongying Zhao
Flood Depth Reduction Map

Flood Risk/Damage Reduction Comparison

<table>
<thead>
<tr>
<th>Basin</th>
<th>Scenario</th>
<th>WSEL</th>
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</thead>
<tbody>
<tr>
<td>C8</td>
<td>SLR3 no mitigation</td>
<td>$13,163,070</td>
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<tr>
<td></td>
<td>SLR3 with M2A mitigation</td>
<td>$4,878,539</td>
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<tr>
<td></td>
<td>Flood damage reduction $</td>
<td>$8,284,531</td>
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<tr>
<td></td>
<td>Flood damage reduction %</td>
<td>63%</td>
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<tr>
<td>C9</td>
<td>SLR3 no mitigation</td>
<td>$10,956,530</td>
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<tr>
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<td>SLR3 with M2A mitigation</td>
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<tr>
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<td>Flood damage reduction $</td>
<td>$1,851,526</td>
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<tr>
<td></td>
<td>Flood damage reduction %</td>
<td>17%</td>
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</table>

work in progress, subject to change
FIAT-SFWMD Application in C8/C9 FPLOS
Adaptation and Mitigation Study

EAD assessment for different mitigation strategies using **SFWMD-FIAT Tool**
Cost estimate
Cost/benefit analysis

- Adaptation planning
- Final comprehensive plan

Example of an adaptation pathway map (Deltares)

*work in progress, subject to change*

Presenter: Hongying Zhao
Other Applications

- C-7 basin
- Future FPLOS adaptation planning and mitigation study in other regions
4. Collaborations, Partnerships and Engagement

Claire Jeuken, Ph.D.
Senior Consultant and Researcher Nature-Based Solutions
Deltares USA
Preparing for the future

Presenter: Claire Jeuken
Drivers of flood risk
What is the system response?
Modeling needs to be better, easier and faster
Deltares and U.S. Agencies on Coasts and Flood Risk

U.S. Geological Survey
Understanding coastal hazards and processes using models and data

Office of Naval Research
Model capability to enable naval operations in the coastal zone

The Department of Homeland Security
Collaborate on the development of a community flood resilience support system (CFRSS)

NOAA-NWS
Development of the CHPS, operational forecasting system USA, at all 13 river Forecast Centers

U.S. Corps of Engineers
Development of XBeach & prediction of hurricane hazards for the Mississippi, NNBF guideline

SFWMD, Broward and Miami Dade County
Alameda Flood Control District, San Francisco Estuary Institute (SFEI)
Development and application of tools and adaptation strategies

Massachusetts Water Resources Authority
Hydrodynamics and water quality modeling Massachusetts Bay

Presenter: Claire Jeuken
SFL Government and Deltares: 2015 -present

2014
MOA
SFWMD-RWS

2015-2016
NOAA
grant 1

2015
Delft3D
@SFWMD

2016-2017
FEMA
grant 1

2016-2017
NOAA
grant 2

2018-2019
FEMA
grant 2

2019-2021
NOAA
grant 3

2020-2021
BRIC
support

2021-2022
FIAT
desktop

We need adaptation pathways:

Presenter: Claire Jeuken
Adaptation pathways for C7-basin – 2016-2017

Presenter: Claire Jeuken
Critical infrastructure vulnerability and dependencies

OpenStreetMap
- Hospitals
- Power
- Roads
- Telecommunication
- ...

Stakeholders

Flood Simulation (USGS)
- Intense rainfall 22"
- Increased sea water level (2060)

Workshop 1: Inventory of dependencies with Circle

Workshop 2: Review of Cascading Effects

Workshop 2: Identification of measures to increase resilience
Cascading Impact of Critical infrastructure disruptions

Identify, quantify and communicate cascading impacts to other critical infrastructures and the community.

Presenter: Claire Jeuken
Cascading Impacts of flooded Critical Infrastructure 2016-2021

Water Resilience of Critical Infrastructure: Approach and Method Applied to Fort Lauderdale, Florida

Karin M. de Bruijn 1, Carolina Mazan 1, Mike Zyguenwib 1, Jennifer Juzado 1, Andreas Burrer 1
Claire Jeukens 1, and Jayantha Obeyesekera 1 2

Presenter: Claire Jeukens
Thank you for your attention

www.deltares-usa.us

Claire.Jeuken@deltaxres-usa.us per September 1, 2022 Claire.Jeuken@deltaxres.nl

240-338-6526
5. Q&A Session 1

If you’re participating in person – please fill out Section 5 at the Technical Question Card and give to a meeting attendant.

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Moderator: Nicole Cortez
6. Flood Impact Assessment Tool and Functions Overview

Frederique de Groen, M.S.
Junior Advisor/Researcher
Deltares
Contents

- Calculation engine: Delft-FIAT
- SFWMD-FIAT
- Output results

Presenter: Frederique de Groen
FIAT – Flood Impact Assessment Tool

RISK / DAMAGE = HAZARD × EXPOSURE × VULNERABILITY

Damage/risk maps

Flood hazard maps

Exposure maps

Damage functions

Presenter: Frederique de Groen
Flood hazard maps → Exposure maps → Damage functions → Maximum damages

Damage/risk maps

Presenter: Frederique de Groen
Maximum potential damage: $100k

Damage = max potential damage * damage percent

42k = 100k * 42%
Contents

- Calculation engine: Delft-FIAT
- SFWMD-FIAT
- Output results

Presenter: Frederique de Groen
Desktop Damage Tool for SFWMD

Set up a streamlined system
- Easy to use
- Standardized

All data set up for C-8 and C-9

Presenter: Frederique de Groen
37

Damage/risk maps

User-input flood map: event or probabilistic

Per region

Mapping of lookup
occupancy type >
damage function and max potential damage

Mapping of lookup
source data >
occupancy type

Exposure data builder

Exposure maps

Flood hazard maps

Damage functions

Damage function databases

Damage/risk maps

Database

Presenter: Frederique de Groen
Contents

Calculation engine: Delft-FIAT

SFWMD-FIAT

Output results
Output results

- Tabulated per object
- Aggregated
- Spatial

Presenter: Frederique de Groen
### Output CSV

<table>
<thead>
<tr>
<th>Structure Damage Event</th>
<th>Content Damage Event</th>
<th>Other Damage Event</th>
<th>Total Damage Event</th>
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## Global overview

### Global overview ($)

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<th>Total damages</th>
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<tr>
<td>RP = 2 year</td>
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<tr>
<td>RP = 5 year</td>
<td></td>
</tr>
<tr>
<td>RP = 10 year</td>
<td></td>
</tr>
<tr>
<td>RP = 25 year</td>
<td></td>
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<td>RP = 50 year</td>
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<td>RP = 100 year</td>
<td></td>
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<tr>
<td>RP = 500 year</td>
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</tr>
<tr>
<td>EAD</td>
<td></td>
</tr>
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</table>

### Damaged roads

<table>
<thead>
<tr>
<th></th>
<th>Road damages</th>
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<tbody>
<tr>
<td>RP = 1 year</td>
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<td>RP = 2 year</td>
<td></td>
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<tr>
<td>RP = 5 year</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>EAD</td>
<td></td>
</tr>
</tbody>
</table>

**Presenter:** Frederique de Groen
### Aggregated information

#### Aggregated: Land use

<table>
<thead>
<tr>
<th>Land use</th>
<th>Damages</th>
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<td></td>
<td>RP = 1 year</td>
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<tr>
<td>Airports</td>
<td></td>
</tr>
<tr>
<td>Cemeteries</td>
<td></td>
</tr>
<tr>
<td>Commercial and Services</td>
<td></td>
</tr>
<tr>
<td>Educational Facilities</td>
<td></td>
</tr>
<tr>
<td>Golf Course</td>
<td></td>
</tr>
</tbody>
</table>

#### Aggregated: Sub basin

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<thead>
<tr>
<th>Zip code</th>
<th>Damages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RP = 1 year</td>
</tr>
<tr>
<td>135ST-2</td>
<td></td>
</tr>
<tr>
<td>135ST-3</td>
<td></td>
</tr>
<tr>
<td>135ST-4</td>
<td></td>
</tr>
<tr>
<td>135ST-5</td>
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</tr>
<tr>
<td>135ST-6</td>
<td></td>
</tr>
<tr>
<td>135ST-7</td>
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</table>

#### Aggregated: Tax use

#### Aggregated: Census Tract

#### Aggregated: Census Block

#### Aggregated: Poverty

---

Presenter: Frederique de Groen
### Grouped information

<table>
<thead>
<tr>
<th>Social Vulnerability Index</th>
<th>Damages</th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>RP = 1 year</td>
<td>RP = 2 year</td>
<td>RP = 5 year</td>
<td>…</td>
<td>Risk (EAD)</td>
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</tr>
<tr>
<td>0.00 - 0.25</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0.25 - 0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0.50 - 0.75</td>
<td></td>
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<tr>
<td>0.75 - 1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Grouped: SVI**

**Total Damage Event (sum) per Social Vulnerability Index bin**
- Low (0.0, 0.25): 9.4%
- Medium-low (0.25, 0.5): 27.9%
- Medium-high (0.5, 0.75): 30.3%
- High (0.75, 1.0): 32.3%

**Presenter:** Frederique de Groen
Spatial results

Deltires

Presenter: Frederique de Groen
Thanks for your attention

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facebook.com/deltaresNL
7. Building Exposure Data Sets for Damage Assessment

Chris Carlson, M.S.
Lead Geospatial Scientist, IT Geospatial Services
South Florida Water Management District
Exposure Data Sources

- County Supplied Building Footprints
- SFWMD Normalized Parcel and Land Use
- High Resolution Topo-Bathymetric Data
- HAZUS Occupancy Types, Damage Functions and Depreciated Replacement Values
• Inundation Depth
• Water Surface elevation

SFWMD-FIAT Damage Calculator

1. Flood maps
2. Damage functions
3. Exposure data
4. SFWMD-FIAT
5. Flood damages

$ Total, Detailed breakdown, and aggregated values $
Building Data

Building Exposure Data Sources:

- County Supplied Building Footprints

<table>
<thead>
<tr>
<th>Object Name</th>
<th>Primary Object Type</th>
<th>Secondary Object Type</th>
<th>Damage Function: Structure</th>
<th>Finished Floor Elevation</th>
<th>Ground Elevation</th>
<th>Max Potential Damage: Structure</th>
<th>Shape Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>fp_15</td>
<td>COM4</td>
<td>Average Prof/ Tech Services</td>
<td>g_struct_35</td>
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<td>2145321</td>
<td>11274421</td>
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<tr>
<td>fp_16</td>
<td>RES3C</td>
<td>Condominium, living area on multiple floors</td>
<td>g_struct_23</td>
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<td>1029773</td>
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<td>fp_17</td>
<td>IND3</td>
<td>Average Food/ Drug/ Chem</td>
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<td>3533954</td>
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<td>fp_18</td>
<td>RES3E</td>
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<td>5953807</td>
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<td>6359</td>
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<td>4782653075</td>
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</table>
Building Data

- Building Exposure Data Sources:
  - County Supplied Building Footprints
  - SFWMD Normalized Parcel and Land Use

Object Name | Primary Object Type | Secondary Object Type | Damage Function: Structure | Finished Floor Elevation | Ground Elevation | Max Potential Damage: Structure | Shape_Area
---|---|---|---|---|---|---|---
fp_15 | COM4 | Average Prof/Tech Services | g_struct_35 | 1 | 4.319839 | 2145381 | 11274.214758
fp_16 | RES3C | Condominium, living area on multiple floors | g_struct_23 | 1 | 10.29773 | 947148.1 | 4857.908334
fp_17 | IND3 | Average Food/Drug/Chem | h_struct_575 | 1 | 7.725961 | 353555.4 | 1014.705511
fp_18 | RES3E | Condominium, living area on multiple floors | g_struct_23 | 1 | 5.953007 | 1091480 | 5021.298025
fp_19 | RES3E | Condominium, living area on multiple floors | g_struct_23 | 1 | 6.359 | 1039605 | 4782.653075
Building Exposure Data Sources:

- County Supplied Building Footprints
- SFWMD Normalized Parcel and Land Use
- HAZUS Occupancy Types, Damage Functions and Depreciated Replacement Values
Building Data

Building Exposure Data Sources:
- County Supplied Building Footprints
- SFWMD Normalized Parcel and Land Use
- HAZUS Occupancy Types, Damage Functions and Depreciated Replacement Values

![Building Data Table]

<table>
<thead>
<tr>
<th>Object Name</th>
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<th>Secondary Object Type</th>
<th>Damage Function: Structure</th>
<th>Ground Elevation</th>
<th>Max Potential Damage: Structure</th>
<th>Shape Area</th>
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<tbody>
<tr>
<td>fp_15</td>
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<td>Average Prot/Tech Services</td>
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Presenter: Chris Carlson
Building Exposure Data Sources:

- County Supplied Building Footprints
- SFWMD Normalized Parcel and Land Use
- **High Resolution Topo-Bathymetric Data**
- HAZUS Occupancy Types, Damage Functions and Depreciated Replacement Values

Presenter: Chris Carlson
Road Data

- Road Exposure Data Sources:
  - Navteq / HERE Roads
  - HAZUS Occupancy Types, Damage Functions, and Depreciated Replacement Values

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<tr>
<th>ST_NAME</th>
<th>FUNC_CLASS</th>
<th>SPEED_CLASS</th>
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<th>TUNNEL</th>
<th>RAMP</th>
<th>PHYS_LANES</th>
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<tr>
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</table>
**Road Data**

- **Road Exposure Data Sources:**
  - Navteq / HERE Roads
  - HAZUS Occupancy Types, Damage Functions, and Depreciated Replacement Values
Road Data

- Road Exposure Data Sources:
  - Navteq / HERE Roads
  - HAZUS Occupancy Types, Damage Functions, and Depreciated Replacement Values
  - High Resolution Topo-Bathymetric Data

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Road Damage Function

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<th>Damage Function Structure</th>
<th>Structure Replacement Value</th>
<th>Critical Infrastructure</th>
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<td>road_damage_8</td>
<td>road_damage</td>
<td>984.12</td>
<td>Y</td>
</tr>
</tbody>
</table>

Presenter: Chris Carlson
Utility Data

Utility Exposure Data Sources:
- SFWMD Normalized Parcel and Land Use
- High Resolution Topo-Bathymetric Data
- HAZUS Occupancy Types, Damage Functions, and Depreciated Replacement Values

Presenter: Chris Carlson
Utility Data

- Building Exposure Data Sources:
  - SFWMD Normalized Parcel and Land Use
  - High Resolution Topo-Bathymetric Data
  - HAZUS Occupancy Types, Damage Functions, and Depreciated Replacement Values
SFWMD Districtwide Elevation Mosaic

- Developed using Esri’s Image Management Workflows
- Incorporates best available USGS 3D Elevation Program terrestrial and NOAA topobathymetric digital elevation models (DEMs)
Exposure data includes road segments, building and utility footprints, finished floor elevations, primary and secondary object types, damage functions, and maximum potential replacement costs.

These data provide a means for us to quantify the cost of flooding within the built environment and put a financial value on a flood mitigation strategy.

Quality of the damage estimation is dependent on the combined quality of all input data sets.
Geospatial data are critical to our ability to evaluate and understand how to respond to and mitigate for changed conditions brought on by changes in rainfall, ET, groundwater, sea levels, etc.

- Land Cover
- Building Footprints
- Normalized Parcels
- Structures
- Canals
- Lakes, Impoundments, Reservoirs, Stormwater Treatment Areas (STA), Flow Equalization Basins (FEB)
- Water Control Units
- Water Control Systems
- Water Control Networks
- Land Surface Elevations
- Predicted / modeled water surface elevations
- Etc.
- https://geo-sfwmd.hub.arcgis.com/
8. REFLECTIONS: Lessons Learned and Next Steps to Scale it Up

Kathryn Roscoe, Ph.D.,
Senior Researcher
Deltares USA
Great collaboration and open-ness

Timely meetings to resolve and address challenges

Big picture discussions about future as well as current issues

Scientifically sound and user friendly

The tool is very easy to use

Technical sharing

Great teamwork and communication

Detailed and insightful reviews

Thorough and very useful reviews

Great collaboration and open-ness

Knowledge exchange

Great collaboration and energy

Awesome co-creation

Presenter: Kathryn Roscoe
NEXT STEPS…

Improve the generation and quality of input data

- Damage function validations and updates
- Develop exposure model-building tool in Python
- Develop method for first-floor home elevations

Develop new functionality

Training

Presenter: Kathryn Roscoe
If you’re participating in person – please fill out Section 5 at the Technical Question Card and give to a meeting attendant.

If you’re participating via Zoom – use the Q&A function to submit a written question or use the Raise Hand feature.

If you’re participating via Phone:
*9 Raises Hand
*6 Mutes/Unmutes

Moderator: Nicole Cortez
10. PARALLEL EFFORTS: SACS HAZUS Web Mapping Application & Measures and Cost Library Tool

Idris Dobbs, M.S.
Senior Economist
U.S. Army Corps of Engineers
South Atlantic Coastal Study (SACS)

TIER 2 ECONOMIC RISK ASSESSMENT (ERA) & THE MEASURES & COST LIBRARY (MCL)

- Idris Dobbs
- Jacksonville District, Planning Division Economics Branch
- U.S. Army Corps of Engineers
- May 31th, 2022

*The views, opinions and findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other official documentation.*
SACS Tier 2 ERA & MCL BLUF

- Framing problems, assumptions, and opportunities are crucial for CSRM plan formulation as well as using the Tier 2 ERA and the MCL

- SACS Tier 2 Economic Risk Assessment (ERA) - tool to help understand the spatial distribution of storm surge risk to economic development.

- SACS Measures & Cost Library (MCL) – tool to help users align CSRM problems and opportunities with the appropriate measures for plan formulation purposes

*Working Today to Build a Better Tomorrow*
Problems, Assumptions, & Opportunities

**CSRM Problems** -
- **Who/What** – Subject of concern that is susceptible to harm (subject/resource context)
- **Where** – Location of subject that is susceptible to harm (spatial context)
- **Why** – Coastal storm related hazard(s) that causes harm (hazard context)
- **How** – How do we know this is a problem? What is the proof?

**CSRM Assumptions** –
- Exogenous factors that influence context (resource, spatial, and or hazard)
- Leads to change over time
- Source of uncertainty
- State rationale for and effect of assumption

**CSRM Opportunities** -
- Desired future outcome for resources potentially impacted by coastal storms
- Derived from interplay between CSRM problems and assumptions

*Working Today to Build a Better Tomorrow*
SACS – Tier 2 Economic Risk Assessment (ERA)

- Provide information to support designation of potential high-risk areas based on damage to property for the SACS.
- Provide a method for users to quickly estimate the economic risk of coastal storm surge
- Provide a method for users to scale damages from coastal storm events to cost of CSRM measures.
- Help users define boundary conditions for areas that warrant a deeper technical analysis

Working Today to Build a Better Tomorrow

Presenter: Idris Dobbs
• **Products** - Technical Report & Web Application

• **Models Used / Area Covered:**
  - Hazus (Level-1) – North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi
  - FAST (Flood Assessment Structure Tool) – Puerto Rico, & US Virgin Islands

• **Consequence & Risk Estimates**
  - Consequences - $ damage depreciated losses from 10 yr., 20 yr. *, 50 yr., 100 yr., & 500 yr. Return Periods
  - Risk – Expected Annual Damages (EAD) in any given year if consequence likelihoods and magnitudes are evenly distributed over time
  - Consequence & Risk estimates by census block

• **Scenarios:** Presented as a range between low (existing) & high (future)
  - Existing Conditions (low) – no sea level change included
  - Future Conditions – (high) sea level change included
    - CONUS: 3’ of Sea Level Rise
    - OCONUS: 2.33’ of Sea Level Rise
Florida:
- Existing Risk: $9 Billion
- Future Risk: $24 Billion
- Comparison of highest risk census places, counties, and planning reaches throughout Florida
**Existing Condition Risk (EAD)**

Select the census blocks that define the spatial extent of the problem. The existing condition and future condition EAD totals update with the risk for the selected census blocks. This defines the lower and upper bound of the risk for the problem area.

**Future Condition Risk (EAD with 2′-3′ of SLR)**

**Existing Condition Damages per AEP event ($)**

Census block selection tools

**Existing condition economic risk by census block.**

**Future condition economic risk by census block.**

**Annual Exceedance Probability (AEP):** The percent chance a hazard of a certain magnitude or lesser will occur in any given year. Higher magnitude events are associated with lower AEPs.

**Damages (Consequences):** The damages are the consequences expressed in dollars given the occurrence of an AEP event. These damages represent the cost of replacing structure and content asset losses minus the depreciation of those assets.

**Expected Annual Damages (EAD):** The damages expressed as a monetary value that occur in any given year if all AEP event probabilities and magnitudes were spread out equally over time. Expense that would occur in any given year if monetary damages from all hazard probabilities and magnitudes were spread out equally over time. This is not to imply that the same level of damages will happen every year; some years could see large impacts, other years could receive moderate impacts, while other years could see minimal to no impacts. **EAD is a reflection of economic risk and is linked to the NED (National Economic Development) account.**

**Future Condition Damages per AEP event ($)**

Presenter: Idris Dobbs
**SACS - Measures & Cost Library (MCL)**

<table>
<thead>
<tr>
<th><strong>MCL</strong></th>
<th>Library of standardized measures &amp; costs for use in USACE PDT &amp; stakeholder entry level CSRM planning efforts</th>
</tr>
</thead>
</table>
| **Purpose / Usage:** | - Link CSRM problems/CSRM opportunities to appropriate CSRM measures and cost  
- Develop conceptual understanding of ROM range of cost of associated with CSRM effort  
- Inform alternative development decisions  
- Use in development of FAAS for the SACS |
| **Products** | - (Current)Technical Report/Spreadsheet Tool  
- (Potential) Technical Report / Web Application |
| **Measures** | - 13 (ea.) Structural Measures  
- 12 (ea.) Natural & Nature Based Features  
- 15 (ea.) Nonstructural Measures (5 costed) |
| **Costs** | - Constant dollar & Equivalent Annual Costs (EAC for life cycle)  
- Unit Costs & ROM based on user input ranges |
| **Status** | - SME, Focus ATR  
- Legal & Policy Review |

---

**Use of the MCL**

- Specify regional location of measure within SAD (22 planning reaches)

- Specify unit parameters for measure(s) of interest such as:
  - project or shoreline length  
  - # nourishments  
  - # acres  
  - # buildings to retrofit

- Tool computes range of costs for measures in constant dollar or annualized terms (EAC).
  - Return period consequences from Tier 2 ERA can be compared to constant dollar cost from MCL  
  - EAD from Tier 2 ERA can be compared to EAC from MCL  
  - Use with Tier 2 ERA not required...
SACS - MCL Considerations

- Non-cost Considerations
  - CSRM Approach / Method
  - Resiliency principles (PARA)
  - CSRM function
  - Applicability
  - Physical / Temporal effect on risk
  - NED, RED, OSE, & EQ effects
  - Sea level change adaptability

- Cost Considerations
  - Regional location
  - Cost Features (unit price/quantity)
  - Contingency
  - S&A, E&D, M&AM
  - Uncertainty

Working Today to Build a Better Tomorrow

Presenter: Idris Dobbs
<table>
<thead>
<tr>
<th>Measure Category</th>
<th>Measure to Address Performance</th>
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<td>Absorb</td>
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<tr>
<td>Seawall</td>
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<td>Levees / Dikes</td>
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**Decision Based CSRM Approaches**

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<td>Decision-Based</td>
<td>Future Exposure</td>
<td>Adapt</td>
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**Non-Structural Measures**

- Building Elevation
- Dry Flood Proofing
- Wet Flood Proofing

**Structural Measures**

- Permanent
- Temporary
- Adapt
- Prepare
Process for Use of Tier-II Economic Risk & MCL Tools

- Step-1 Clearly define problem / opportunity in terms of:
  - Who, What, Where, Why & How
- Step-2 Using Tier 2 ERA web app tools, select census blocks that define the extent of the problem
- Step-3 Record range of risk
  - Risk between $4M - $9.6M
  - Record range of consequences per return period (user discretion)

Step-1: Define the Problem
Storm surge inundation damages to the Belvedere Estates, SC area

Step-3:
- Existing Condition EAD $4.078M (Low Range)
- Future Condition EAD $9.623M (High Range)
**Process for Use of Tier 2 ERA & MCL Tools**

1. **Select the Planning Reach**
2. **Select the Type of Cost**
3. **Enter parameters to populate ROM cost range**
4. **Compare measure annual cost ranges with risk range ($4.078M - $9.623M)**

**Step 4:** Use MCL to select measures that correspond with problem described in step 1.
- Select planning reach to apply regional factors
- Select constant or annualized cost

**Step 5:** Enter the estimated project length & other parameters

**Step 6:** Observe the annualized range of cost and compare to range of risk

**Decision Criteria**
- If low boundary of cost exceed high boundary of damages indicates that measure that may be too costly from an economics perspective.

**Describe risks and uncertainties with making decisions without getting more specific info**

**Table:**

<table>
<thead>
<tr>
<th>Measure Code</th>
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11. Tool Application: Vulnerability Scenarios in the Arch Creek Basin for Single and Multiple Flood Drivers

Francisco Peña, Ph.D.
Resiliency Project Manager, SFWMD
Courtesy Post-Doc, Florida International University
H&H Models to Damage Assessment

Source: Taylor Engineering
Case Study: Arch Creek Basin

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Arch Creek Basin</th>
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<tbody>
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<td>Tropical monsoon</td>
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<tr>
<td>Topography</td>
<td>Flat</td>
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<td>Precipitation</td>
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<td>Fluvial</td>
<td>Medium risk</td>
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<tr>
<td>Coastal surge</td>
<td>High risk</td>
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<tr>
<td>Groundwater</td>
<td>High risk</td>
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<td>Sea level rise</td>
<td>5-13 mm/year</td>
</tr>
<tr>
<td>Flood risk</td>
<td>Very high</td>
</tr>
</tbody>
</table>

![Map of Arch Creek Basin](image_url)
Quantile isoline for a 100-year return period between rainfall and Ocean-side Water Levels at site S29_R and S28_T
Results
Tool Application

Inland & Coastal Flooding vs Compound Flooding

- Projection: NOAA Int High
- Event: “Most Likely”
- Year: 2070
- GW: 3 feet

<table>
<thead>
<tr>
<th>ID</th>
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<tbody>
<tr>
<td>A</td>
<td>Rainfall + GW</td>
<td>$30,682,624</td>
</tr>
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</table>

(a) Rainfall + GW
(b) Surge + GW

Overland Flooding Depth (ft)
- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2 - 2.25
- > 2.25
Inland & Coastal Flooding vs Compound Flooding

- Projection: NOAA Int High
- Event: “Most Likely”
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Tool Application

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<tr>
<td>AB</td>
<td>A + B</td>
<td>$32,228,376</td>
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Tool Application

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- Projection: NOAA Int High
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<td>C</td>
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Tool Application

Inland & Coastal Flooding vs Compound Flooding
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</tr>
<tr>
<td>C</td>
<td>Compound Events</td>
<td>$35,611,731</td>
</tr>
<tr>
<td>D</td>
<td>Estimate Difference (%)</td>
<td>11.05%</td>
</tr>
</tbody>
</table>
Example #1

Megan

- Elected Official for a city in North Miami
- Concerned coastal property values
- Cares about her constituents
- Planning around election cycles
Example #1

Megan

- Highest tax base lives within 1 mile shoreline (Coastal centered)
- Projection: IPCC Median Curve
- Water Table: 3 feet

<table>
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<td></td>
<td>2040</td>
</tr>
<tr>
<td>A</td>
<td>Only Surge</td>
<td>$35.43</td>
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<tr>
<td>B</td>
<td>Most Likely</td>
<td>$58.60</td>
</tr>
<tr>
<td>C</td>
<td>Heavy Rainfall</td>
<td>$90.14</td>
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Example #1

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<td>A</td>
<td>Only Surge</td>
<td>$35.43 $51.03 $170.47</td>
</tr>
<tr>
<td>B</td>
<td>Most Likely</td>
<td>$58.60 $62.82 $122.96</td>
</tr>
<tr>
<td>C</td>
<td>Heavy Rainfall</td>
<td>$90.14 $90.32 $91.77</td>
</tr>
</tbody>
</table>

Year
- 2040
- 2070
- 2120

Map showing different scenarios of flooding conditions.
Example #1

Few weeks later...
Example #1

Megan

- **Projected damage to short term horizons: 2040 scenario**

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Example #2

Michael

• Planning Director for a city in North Miami

• Responsible to adapt buildings and roads to future flood conditions and rising sea levels

• Seeking grant funding
Example #2

Michael

- Ensure safe neighborhoods and access to essential services
- Risk averse mindset (NOAA Intermediate High) + long term planning: 2070

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<tr>
<td>A</td>
<td>Only Surge</td>
<td>$171.07</td>
</tr>
<tr>
<td>B</td>
<td>Most Likely</td>
<td>$124.00</td>
</tr>
<tr>
<td>C</td>
<td>Heavy Rainfall</td>
<td>$92.94</td>
</tr>
</tbody>
</table>

Probability of occurrence:
- Only Surge: 13%
- Most Likely: 55%
- Heavy Rainfall: 32%
Michael

- Ensure safe neighborhoods and access to essential services
- Risk averse mindset (NOAA Intermediate High) + long term planning: 2070

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Probability of occurrence:
- "Only Surge": 13%
- "Most Likely": 55%
- "Heavy Rainfall": 32%
Take Away Messages

- SFWMD-FIAT Tool:
  - Translates hydrodynamic modeling results into economic risk assessments
  - Supports the selection of advanced H&H models that can produce more accurate flood risk estimates, while neglecting the dependence of flood drivers reduces the accuracy of estimations.
  - Performs future flood damage cost estimates using multiple flood elevation/inundation scenarios developed as part of future conditions modeling efforts
  - Helps support recommendations for flood mitigation and adaptation measures by providing a non-action cost baseline
12. Tool Application: District Resiliency Planning and Priority Projects: C-8 Basin Resiliency FEMA BRIC Application

David Colangelo
Resiliency Grant Manager
South Florida Water Management District
C-8 Basin Information

- Population of approx. 270,000
  - 19% financially disadvantaged
- 28 square miles in the northeastern portion of Miami Dade County (8 cities/towns)
- Fully developed residential/commercial
- Critical assets supporting Community Lifelines include:
  - Fire stations, other emergency operations
  - Schools and emergency shelters
  - Utilities
  - Medical facilities and others

Presenter: Dave Colangelo
Main flood control features are the C-8 Canal and S-28 Coastal Structure

S-28 conveys floodwaters by gravity to Biscayne Bay

C-8 Canal managed by SFWMD

Secondary canals managed by Miami-Dade County
Limitations in Operation

Structure Inspection Program

S28 SPILLWAY
MIAMI Field Station
South C&SF
C-8
# of Gates: 2
Lifting/Pumping Mechanism: Cable Drum, Description: Roller

Lead P.E.:
Jill Staggis, Lead Inspector
SFWMD
Underwater P.E.:
Jeffrey O’Connor, Underwater Checklist
Underwater Engineering Services Inc.
Sep 30 2020 15:10:02

Presenter: Dave Colangelo
Flood Risks in the C-8 Basin - FPLOS PM5

Figure 4: Flood Inundation Map for 100-Year Sea Level Rise 3 Design Storm Event

Presenter: Dave Colangelo
Replacement of S-28 Structure with a more robust structure and elevated components to withstand the impacts of sea level rise and climate change

Installation of a 500 cubic foot per second forward pump station adjacent to the S-28 structure to maintain basin discharge levels while sea levels rise.

Construction of a flood barrier tying S-28 Structure to higher ground elevations to mitigate the impacts of sea level rise and storm surge.

GOALS: reduce flood risk under sea-level rise, by restoring the structure discharge capacity and the basin’s flood level of service to enhancing quality of life in the region
Enhancement of secondary canal banks to improve flood control throughout the basin.

Construction of a temporary floodwater detention area in a portion of the Miami Shores Golf Course near the S-28 Structure to provide temporary storage of floodwaters during extreme rainfall events.

Installation of nature-based features such as living shoreline along the C-8 Canal and vegetated flood control berms to enhance flood protection.

GOALS: reduce flood risk under sea-level rise, by restoring the structure discharge capacity and the basin’s flood level of service to enhancing quality of life in the region.
Figure 6: Maximum Flood Overland Depth Difference at C-8 Basin – Existing versus Mitigation Implementation
Cost Benefit Analysis:
Flood Damage Cost Estimate using SFWMD FIAT Tool

Total Cost including O&M = $78M
Total Benefits = $233M

Benefit Cost Ratio = 2.98

Damages calculated using SFWMD-FIAT Tool: Flood Depth Maps – FPLOS Model Simulation Results; Exposure Data – SFWMD latest spatial databases; Damage functions – USACE IWR for single family residents, other RES types, COM, EDU light industrial; FEMA Hazus 4.0 for remaining building occupancy types, roads with 100% damage at 0.6ft flood depth
If you’re participating in person – please fill out Section 5 at the Technical Question Card and give to a meeting attendant.

If you’re participating via Zoom – use the Q&A function to submit a written question or use the Raise Hand feature.

If you’re participating via Phone:
*9 Raises Hand
*6 Mutes/Unmutes

Moderator: Nicole Cortez
14. Public Comments

If you’re participating in person – please fill out Section 6 at the Public Comment Card and give to a meeting attendant.

If you’re participating via Zoom – use the Raise Hand feature.

If you’re participating via Phone:
  *9 Raises Hand
  *6 Mutes/Unmutes

Moderator: Nicole Cortez
15. Closing Remarks

Carolina Maran, Ph.D., P.E.
District Resiliency Officer
South Florida Water Management District
Invitation for Collaboration

- SFWMD partnered with Deltares to enhance and customize the FIAT tool and facilitate its use and post-processing of results.
- SFWMD leveraged Deltares expertise in building exposure datasets, identifying additional sources of data and processing workflows.
- SFWMD is committed to continued enhancement of the SFWMD-FIAT to include automated exposure data compilation and processing tools.
- SFWMD-FIAT tool and the associated manual are available for download (via Deltares Website) and use as is.
- SFWMD will provide existing exposure datasets via e-mail request to resilience@sfwmd.gov.
- SFWMD will create and provide new exposure datasets during and in preparation for FPLOS Phase II Studies.
- Partnerships to further develop automation of exposure data compilation and processing tools are welcome.

Presenter: Carolina Maran
Subscribe for District Resiliency Updates

- Sign-up for our updates by visiting https://www.sfwmd.gov/news-events and following these steps:
  1. Click on the “Subscribe for Email” icon
  2. Enter your email address
  3. Select “District Resiliency” under Subscription Topics
Thanks for participating!