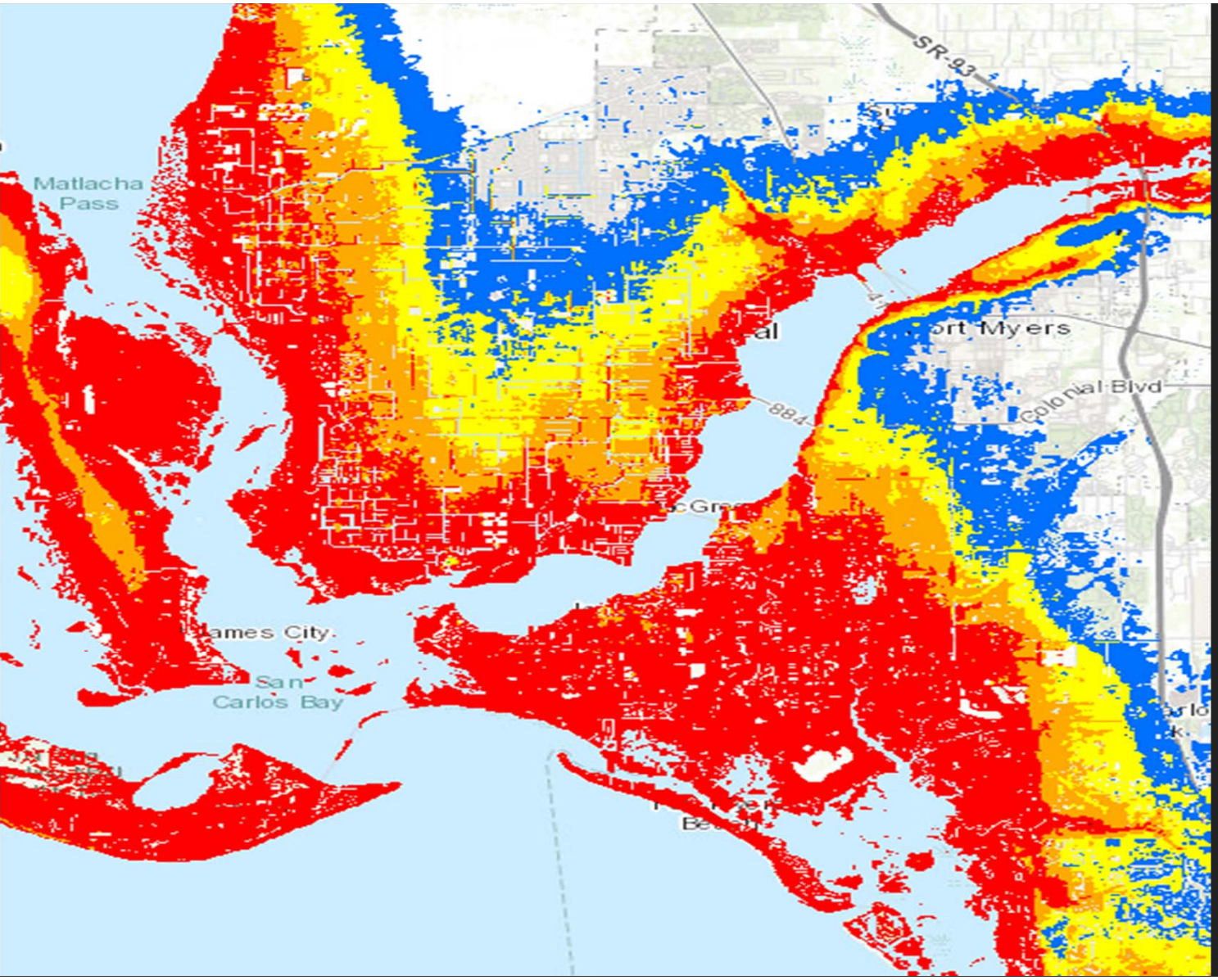


Florida Stormwater Association 2019 Annual Conference

Planning for Resiliency in Coastal Communities

June 21, 2019

Stantec

Cape Coral FLORIDA

Resiliency

Resiliency

Survivability

Sustainability

Preparedness

Disaster Recovery

Best Practices

Adaptive Management

Agenda

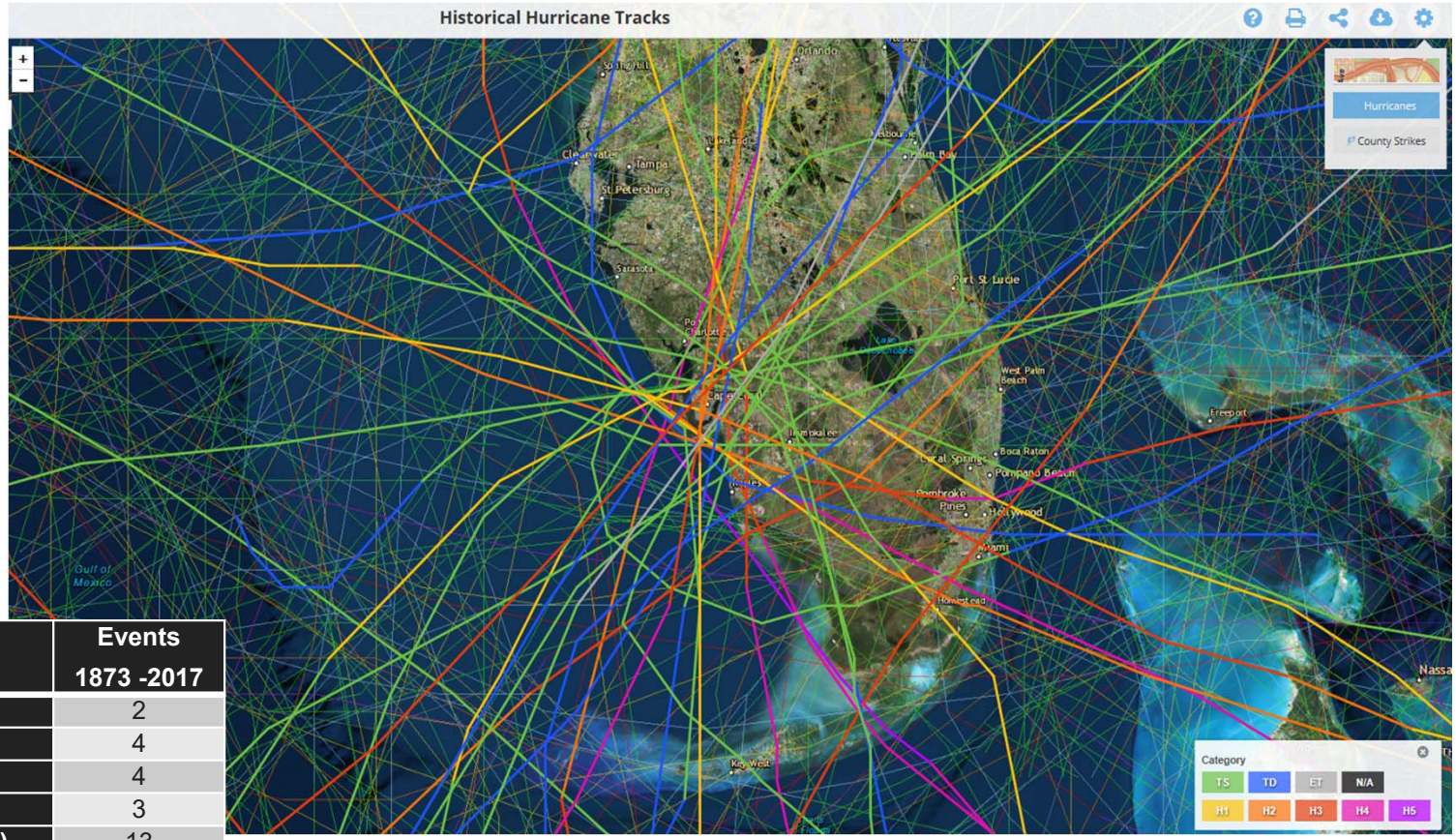
1. Hurricane History
2. Evaluation
3. Long Term Planning
4. Funding Opportunities
5. Questions

Planning for Resiliency in Coastal Communities

Hurricane History

Hurricane History

Cape Coral Area Hurricanes



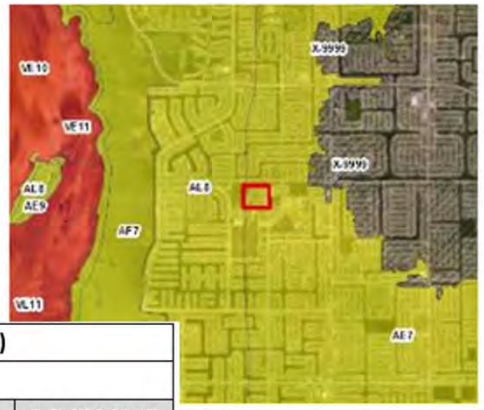
Category	Events 1873 -2017
Hurricane 4 (H4)	2
Hurricane 3 (H3)	4
Hurricane 2 (H2)	4
Hurricane 1 (H1)	3
Tropical Storm (TS)	13
Tropical Depression (TD)	6

Planning for Resiliency in Coastal Communities

Evaluation

Evaluation

FEMA Flood Insurance Rate Maps (FIRM) and Flood Insurance Study (FIS)



FEMA FIS Table 5 - Summary of Coastal Stillwater Elevations (partial data)				
ELEVATION (feet NAVD*)				
FLOODING SOURCE AND LOCATION	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
CALOOSAHATCHEE RIVER (Everest)				
From mouth to Beautiful Island	3.3	N/A	7	8.1
MATLACHA PASS (Southwest)				
Between State Road 78 and south end Pine Island	3.5	N/A	7.3	9.3

*NORTH AMERICAN VERTICAL DATUM of 1988

- Stillwater conditions (surge and tide) but does not include waves or sea level rise
- Determined elevation of the 1-Percent and the 0.2-Percent annual chance of flood

Evaluation

NOAA Sea, Lake and Overland Surges from Hurricanes (SLOSH)

Reclamation Facility	Water Levels (ft, NAVD88)				
	Category 1	Category 2	Category 3	Category 4	Category 5
Everest	6.4	10.2	14.8	22.1	27
Southwest	6.1	10.9	15.4	21.7	26.2

- High tide + Surge conditions
- Determined theoretical elevations during hurricane events
- Intended to provide regional operational direction
- Not intended to be relied upon for site-specific predicted water levels
- Quickly performs hundreds of simulations to predict potential changes in hurricane size, intensity, and track
- Shortcomings due to a combination of poor mesh resolution, missing internal physics such as tides, nonlinear advection, and internal frictional parameterization

Evaluation

NOAA / USACE Sea Level Rise Calculator

Year	Recurrence Interval (ft, NAVD88)									
	Intermediate Low		Intermediate		**Intermediate High**		High		Extreme	
	100 Year	500 Year	100 Year	500 Year	**100 Year**	**500 Year**	100 Year	500 Year	100 Year	500 Year
Present	7	8.1	7	8.1	**7**	**8.1**	7	8.1	7	8.1
2020	7.33	8.43	7.46	8.56	**7.59**	**8.69**	7.69	8.79	7.72	8.82
2040	7.69	8.79	8.02	9.12	**8.38**	**9.48**	8.74	9.84	9	10.1
2060	8.08	9.18	8.8	9.9	**9.56**	**10.66**	10.41	11.51	11.04	12.14
2080	8.44	9.54	9.72	10.82	**11.13**	**12.23**	12.61	13.71	13.82	14.92
2100	8.77	9.87	10.77	11.87	**13**	**14.1**	15.37	16.47	17.37	18.47

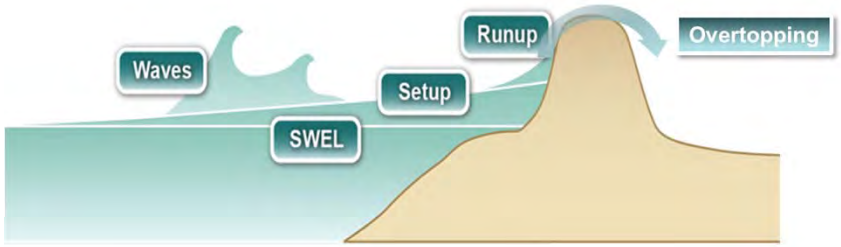
- Stillwater conditions from FIRM / FIS + SLRC
- SLR can be linearly added to stillwater conditions
- Theoretical projections for intermediate low, intermediate, intermediate high, high, and extreme conditions
- Flooding vulnerability focused on projected SLR in 2020, 2040, 2060, 2080, and 2100 for the Intermediate High scenario

Evaluation

Automated Coastal Engineering System (ACES)

Evaluation

Non-Linearity



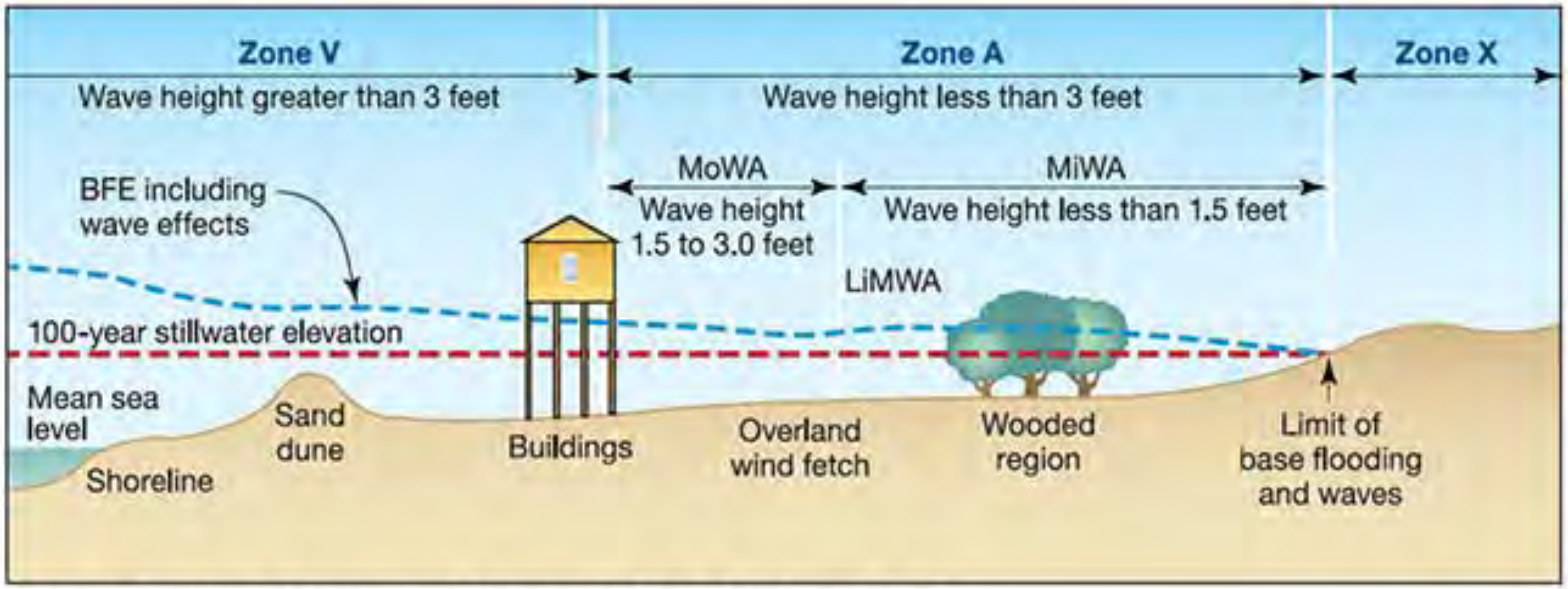


Figure 2-4. Wave height transect showing LiMWA, MoWA, and MiWA

Evaluation

Automated Coastal Engineering System (ACES)

Year	Recurrence Interval (ft, NAVD88)									
	Intermediate Low		Intermediate		**Intermediate High**		High		Extreme	
	100 Year	500 Year	100 Year	500 Year	**100 Year**	**500 Year**	100 Year	500 Year	100 Year	500 Year
Present	-	0.31*	-	0.31*	**-**	**0.31***	-	0.31*	-	0.31*
2020	-	0.57*	-	0.67*	**-**	**0.77***	-	0.85*	0.02*	0.87*
2040	-	0.85*	0.25*	1.11*	**0.53***	**1.39***	0.81*	1.67*	1.01*	1.87*
2060	0.30*	1.15*	0.86*	1.72*	**1.45***	**2.31***	2.11*	2.97*	2.61*	3.46*
2080	0.58*	1.44*	1.58*	2.43*	**2.68***	**3.53***	3.83*	4.69*	4.05	5.14
2100	0.83*	1.69*	2.39*	3.25*	**3.99**	**4.99***	4.15	5.28	4.26	5.43

- Predicted waves heights
- Increased water elevations due to waves were approximated as 0.7 times the wave height
- Runup and overtopping can be ignored in lieu of wave heights

Predicted Cumulative Water Levels

Year	Water Levels (ft, NAVD88) – Tides + Surge + SLR + Waves									
	Intermediate Low		Intermediate		**Intermediate High**		High		Extreme	
	100 Year	500 Year	100 Year	500 Year	**100 Year**	**500 Year**	100 Year	500 Year	100 Year	500 Year
Present	7.00	8.32	7.00	8.32	**7.00**	**8.32**	7.00	8.32	7.00	8.32
2020	7.33	8.83	7.46	9.10	**7.59**	**9.23**	7.69	9.39	7.73	9.43
2040	7.69	9.39	8.19	10.09	**8.75**	**10.45**	9.31	11.01	9.71	11.41
2060	8.29	9.99	9.40	11.52	**10.58**	**12.28**	11.89	13.59	12.86	14.56
2080	8.84	10.54	10.82	13.29	**13.00**	**14.70**	15.29	16.99	16.66	18.52
2100	9.35	11.05	12.45	15.36	**15.79**	**17.59**	18.28	20.17	20.35	22.27

- Theoretical predicted water elevations accounting for tide, surge, sea level rise, and waves
- Sea level rise can be linearly added to stillwater conditions
- Increased water elevations due to waves were approximated as 0.7 times the wave height

Evaluation

Stillwater Conditions (Surge + Tide) → Stillwater Conditions + Sea Level Rise (SLR) → Stillwater Conditions + SLR + Wave Action

Stillwater Conditions	Stillwater Conditions + SLR	Stillwater Conditions + SLR + Wave Action
FEMA Flood Insurance Rate Maps (FIRM) FEMA Flood Insurance Rate Study (FIS) ✓ Stillwater conditions (surge and tide) does not include waves or sea level rise ✓ Determined elevations for Annual Chance of Flood: • 1-Percent • 0.2 Percent Looked at NOAA Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Model	NOAA/USACE Sea Level Rise Calculator (SLRC) ✓ Theoretical Projections for following conditions: • intermediate low • intermediate • intermediate high • high • extreme ✓ Flooding vulnerability focused on projected Intermediate High SLR in: • 2020 • 2040 • 2060 • 2080 • 2100 ✓ SLR can be linearly added to stillwater conditions	Automated Coastal Engineering Systems (ACES) ✓ Conducted fetch analysis ✓ Assessment of potential wave heights ✓ Winds approximated at 120 mph and 157 mph ✓ Increase water elevations due to waves approximated as 0.7 times the predicted wave height ✓ Runup and overtopping can be ignored in lieu of wave heights

Planning for Resiliency in Coastal Communities

Long Term Planning

Development of a Long Term Strategy

Four step process:

✓ 1. Understand the Threat of Flooding

✓ 2. Identify Vulnerable Assets and Determine Risk

3. Identify and Evaluate Mitigation Measures

4. Develop Plan to Implement Mitigation Measures

Identify and Evaluate Mitigation Measures

- Emergency planning activities - emergency SOP in advance of a storm
- Physical improvements
  - changes in equipment location
  - new capital improvement projects
- May be multiple methods to mitigate a flood hazard
- Develop overall cost-benefit analysis
  - Optimize mitigation options
  - Key to qualifying for most grant funding sources
- Develop priority ranking for mitigation measures
- Include in long-term flood mitigation strategy or Local Mitigation Strategy (LMS)

Develop Plan to Implement Mitigation Measures

- Develop plan to address actions
- Establish a schedule for implementation
- Identify funding mechanisms
- assign responsibility for overseeing the measures
- Review plan periodically
- Coordinate with on-going / real-time maintenance
  - Equipment upgrades and replacements.

Long Term Planning

Understand Threat of Flooding	Identify Vulnerable Assets/ Determine Risk	Identify Mitigation Measures	Develop Plan to Implement
Determine parameters for critical storm event ✓ Stillwater ✓ Sea Level Rise • Scenario • Year ✓ Site impacted by wave action?	What are critical assets? Connection to function of system When are they impacted by critical storm event? What is the level of risk?	Emergency planning activities Physical Improvements ✓ Maintenance vs. Capital Improvement ✓ Life Cycle Analysis Cost Benefit Analysis ✓ Optimize mitigation options ✓ Key to grant funding sources Develop Prioritization Ranking Include in facility long-term mitigation strategy and/or Local Mitigation Strategy (LMS)	Develop plan to address actions Establish a schedule for implementation Identify funding mechanisms Assign responsibility for overseeing the measures Review plan periodically Coordinate with on-going/ real-time maintenance Equipment upgrades and replacements

Planning for Resiliency in Coastal Communities

Funding Opportunities

Funding Opportunities

Federal Programs

Hazard Mitigation Grant Program (HMGP)

- Reduce / eliminate losses and threats associated with future disasters
- Infrastructure upgrades
- Prioritized projects in LMS for submission to FEMA
- Funding appropriated by Congress
- Federal / Local Cost Share of 75% / 25%

Pre-Disaster Mitigation Program (PDM)

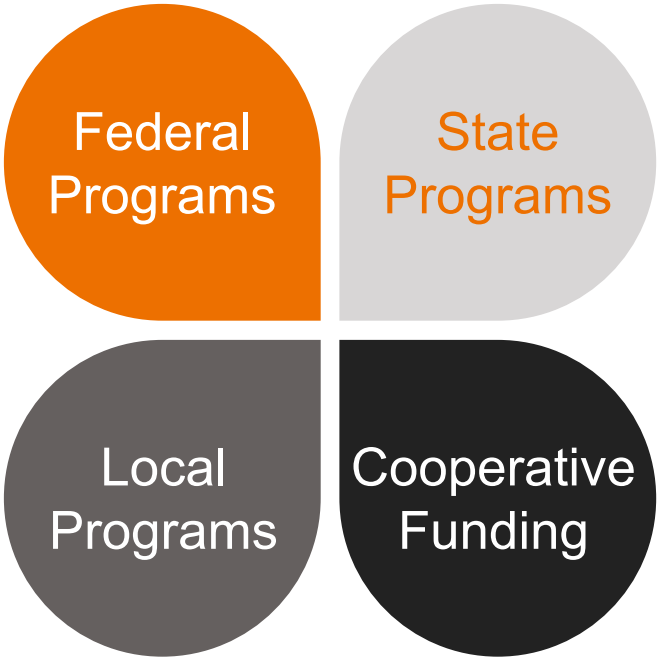
- Strengthen national disaster preparedness
- Cost effective measures to reduce risk to individuals and property and reliance on Federal funding from future disasters
- Federal / Local Cost Share of 75% / 25%
- Maximum award is $4 million for projects and $150,000 for planning

State and Local Grant Program

Water Management Districts in Florida

- Flood mitigation and stormwater projects consistent with the core mission
- There is a 50% local match requirement for projects
- Evaluate opportunities that benefit multiple cities and / or counties

Funding Opportunities



Federal Programs

- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation Program (PDM)
- Community Development Block Grants (CDBG)

State Programs

- Local Mitigation Strategy (LMS)
- Water Management Districts

Local Government Programs

Cooperative Funding

- Evaluate / coordinate opportunities that benefit multiple cities and / or counties

Questions?

Planning for Resiliency in Coastal Communities

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