ENGINEERING FOR CLIMATE RESILIENCE: THE BBSEER APPROACH

BBSEER AND BEYOND:
Planning for Resilience in Changing Seas

Greater Everglades Ecosystem Restoration Conference
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U.S. ARMY

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PRESENTATION OUTLINE

- Study Area
- BBSEER Objectives
- Challenges
- USACE Role in Resilience
- BBSEER SLC Approach
- Numerical Modeling
- Application to a PM: Adaptive Foundational Resilience

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PROJECT OBJECTIVES

1) RESTORE SALINITY REGIMES, MINIMIZE UNNATURAL CANAL RELEASES:

Improve quantity, timing, and distribution of freshwater to estuarine and nearshore subtidal areas, including mangrove and seagrass areas (500-meter zone).

2) FRESHWATER WETLAND WATER DEPTH, PONDING DURATION AND FLOW TIMING:

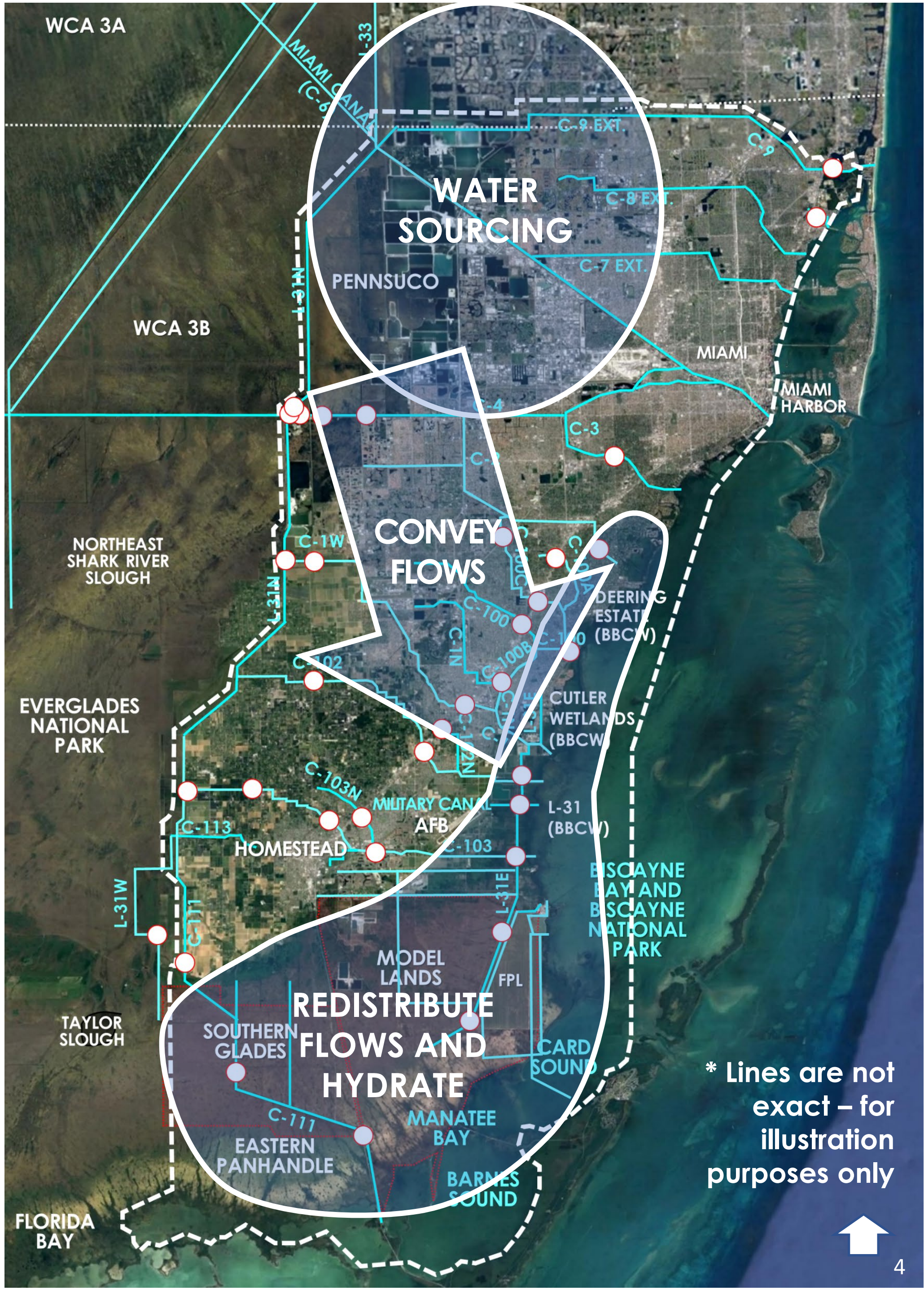
Restore freshwater depths, hydroperiods, and flows, for dry and wet seasons in terrestrial wetlands.

3) RESTORE NATURAL ECOLOGICAL AND HYDROLOGICAL CONNECTIVITY:

Restore connectivity and habitat gradients in areas compartmentalized by federal and state canal systems in Southern Everglades, Model Lands, Biscayne Bay Coastal Wetlands.

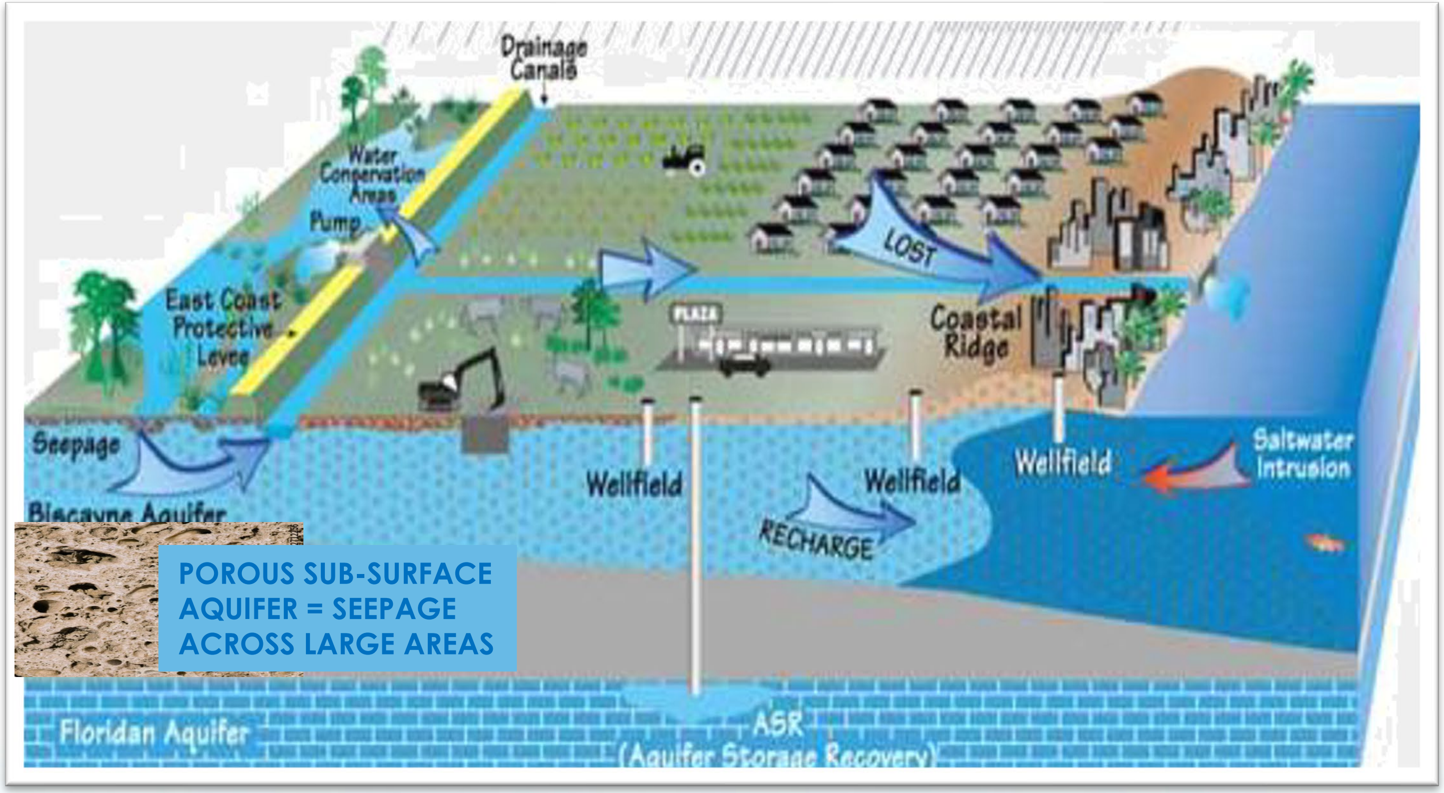
4) SEA LEVEL CHANGE RESILIENCY:

Increase and restore ecological resilience in coastal habitats in southeastern Miami-Dade County.



WATER RESILIENCE CHALLENGES IN SOUTH FLORIDA

TYPICAL LANDSCAPE AND CROSS-SECTION



• Flood Protection Canals through Densely Populated Areas • Mixed Land Uses
• Flat Topography • Porous Limestone • Susceptible to Sea Level Change

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USACE'S ROLE IN EXTREME WEATHER RESILIENCE

W.E. Walker, R.J. Lempert, J.H. Kwakkel (2013)

Close the gap between current engineering practice and future conditions

Developing Scenario based approaches

Implement adaptation pathways

Very Certain — Total Ignorance

	Level 1	Level 2	Level 3	Level 4	Level 5
Context	A clear enough future (with sensitivity)	Alternate futures (with probabilities)	Alternate futures (with ranking)	A multiplicity of plausible futures (unranked)	Unknown future
System model	A single system model	A single system model with a probabilistic parameterization	Several system models, one of which is most likely	Several system models, with different structures	Unknown system model; know we don't know

Traditional Engineering Practice

USACE

Current State of Knowledge

NOAA, NCAR, Academia

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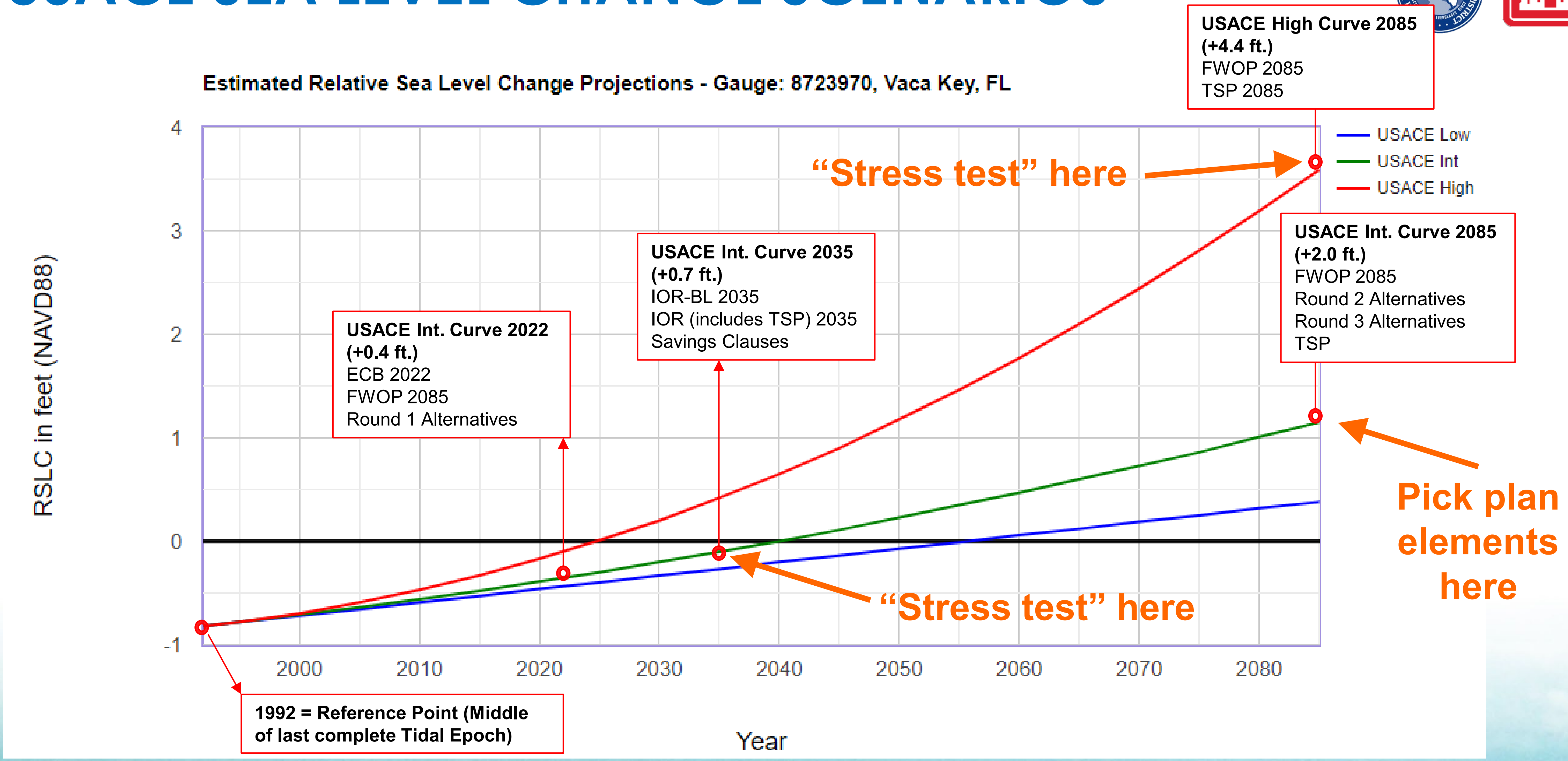
USACE SEA LEVEL CHANGE SCENARIOS



https://resilience.sec.usace.army.mil/slat/

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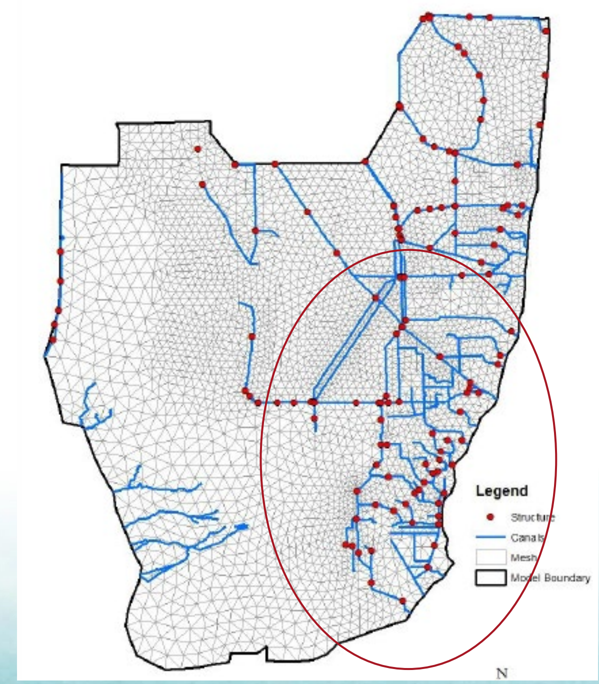
BBSEER MODELS, ROLES & RESPONSIBILITIES

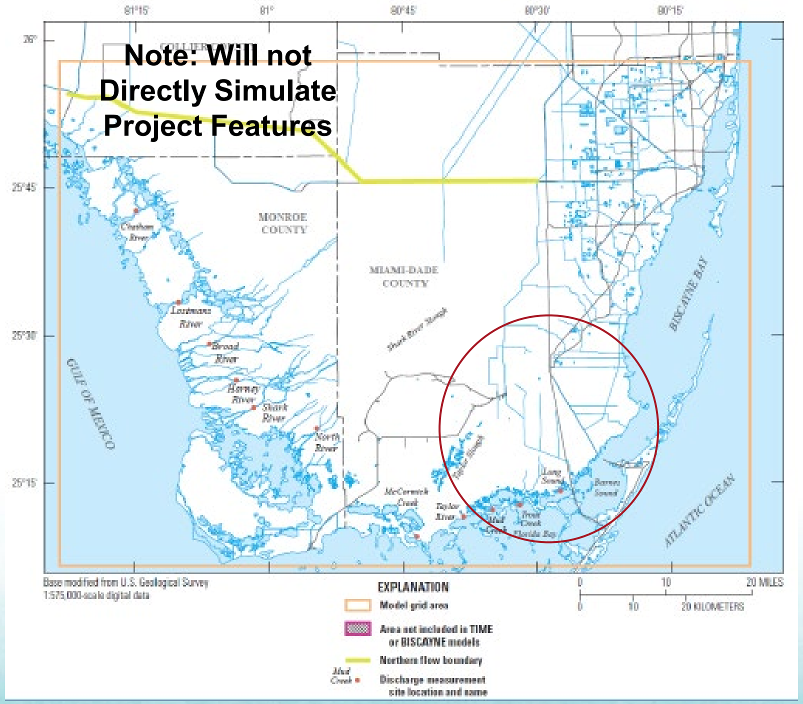
RSMGL
Hydrology
Run by IMC
(Primary Formulation Tool)

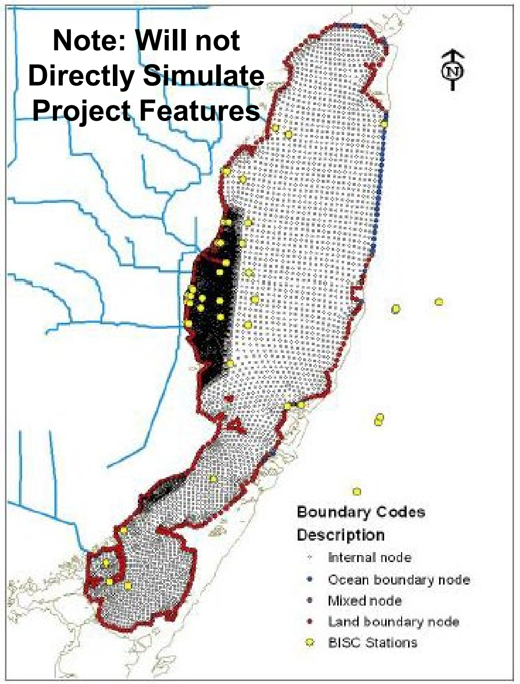
BISECT
Wetland Salinity
Run by FIU

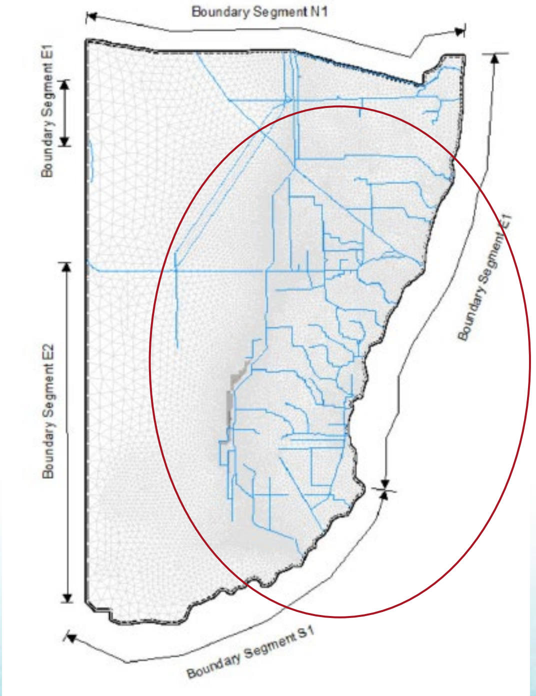
BBSM
Nearshore Salinity
Run by IMC

MDRSM
Flood Hydrology
Run by IMC









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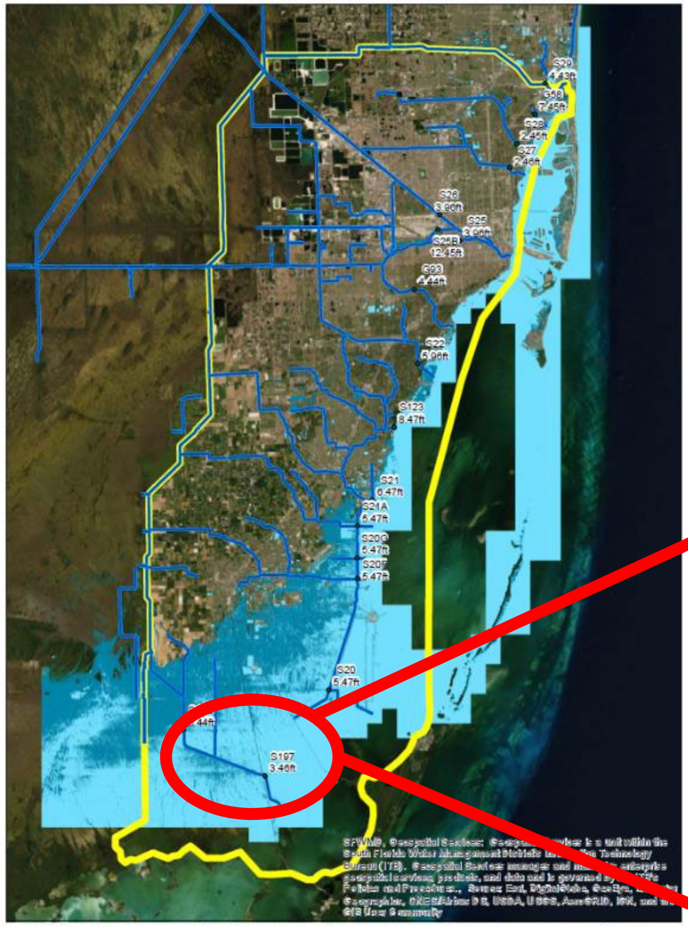
PERFORMANCE MEASURE: ADAPTIVE FOUNDATIONAL RESILIENCE (AFR)

Adaptive Foundational Resilience is the ability of the foundational vegetation (marsh and mangrove) to adapt to sea level rise by building elevation (peat accretion) as a function of water depth, salinity and flow.



Inundation Map Representing USACE SLC Intermediate and High Curves Assuming 50-

Applying a Mangrove Transition Projection to BBSEER

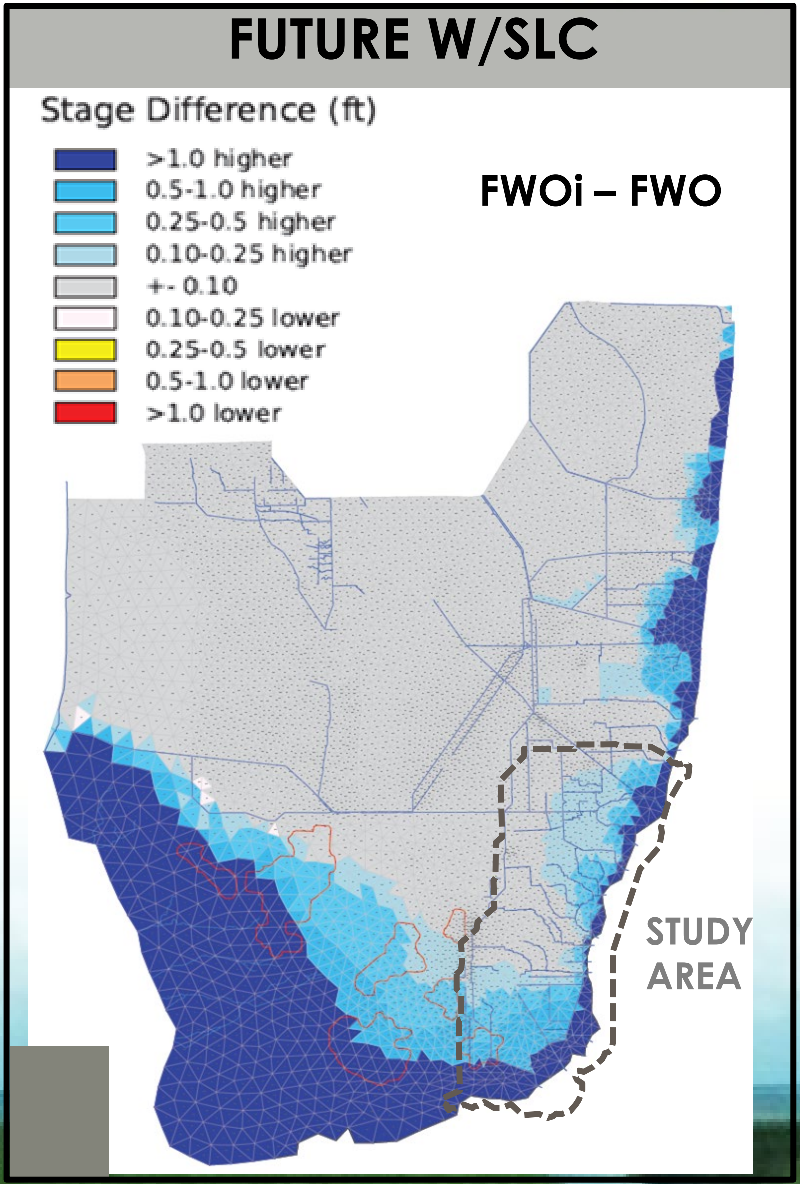
Mangrove Transition

Mangrove Transition

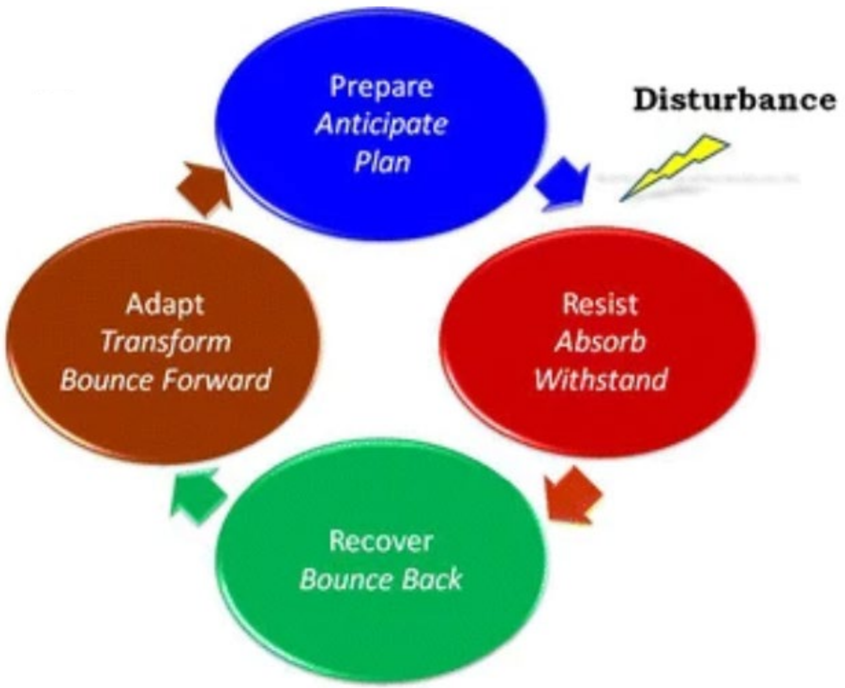
FUTURE SEA LEVELS IMPACTS ON AFR

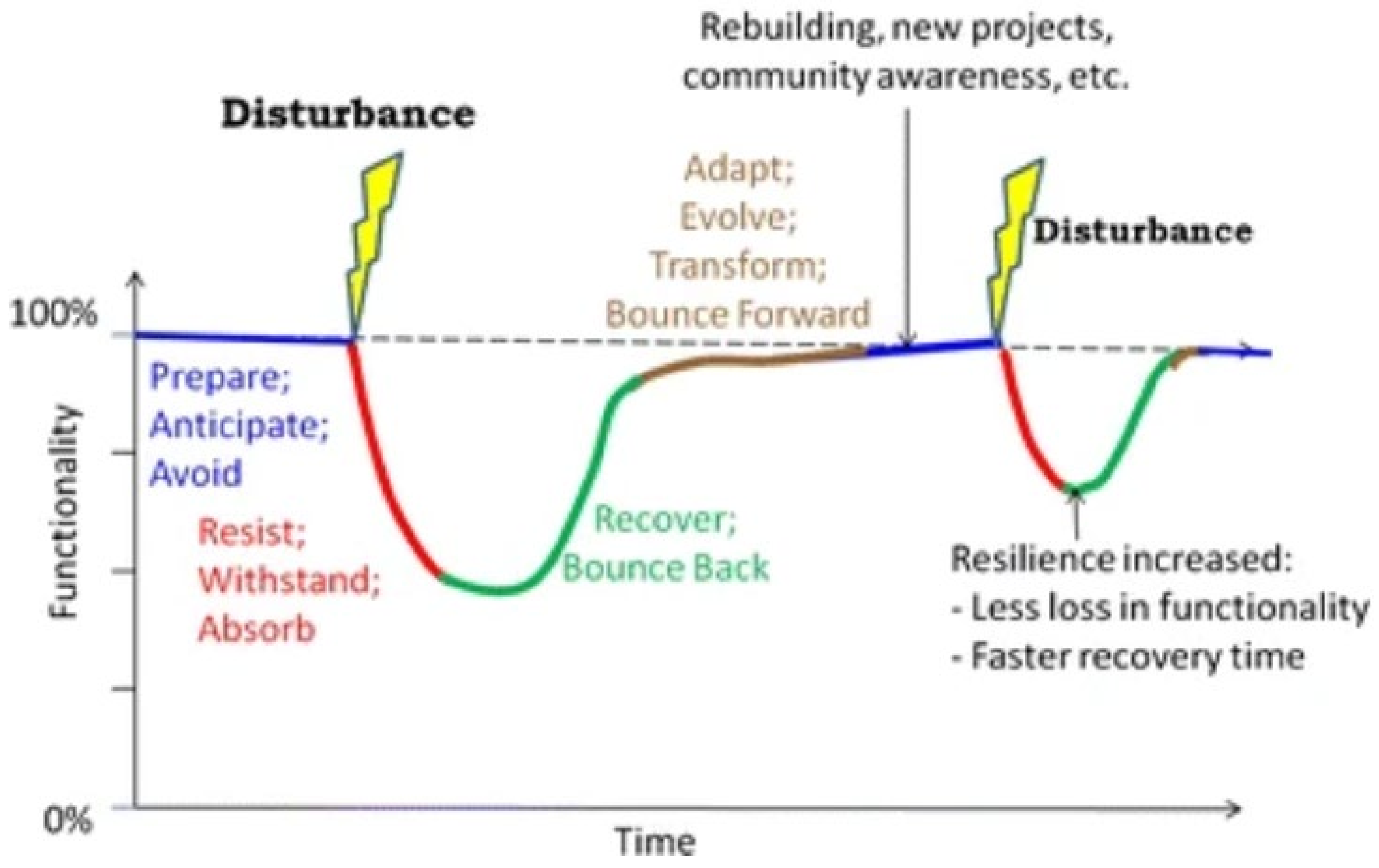
- Topography and the ability to build topography resulting from actions in project alternatives, is a measure of resilience.

- Ecological outcomes depend on future sea levels



PREPARE, ABSORB, RECOVER, AND ADAPT (PARA) FRAMEWORK





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THANK YOU

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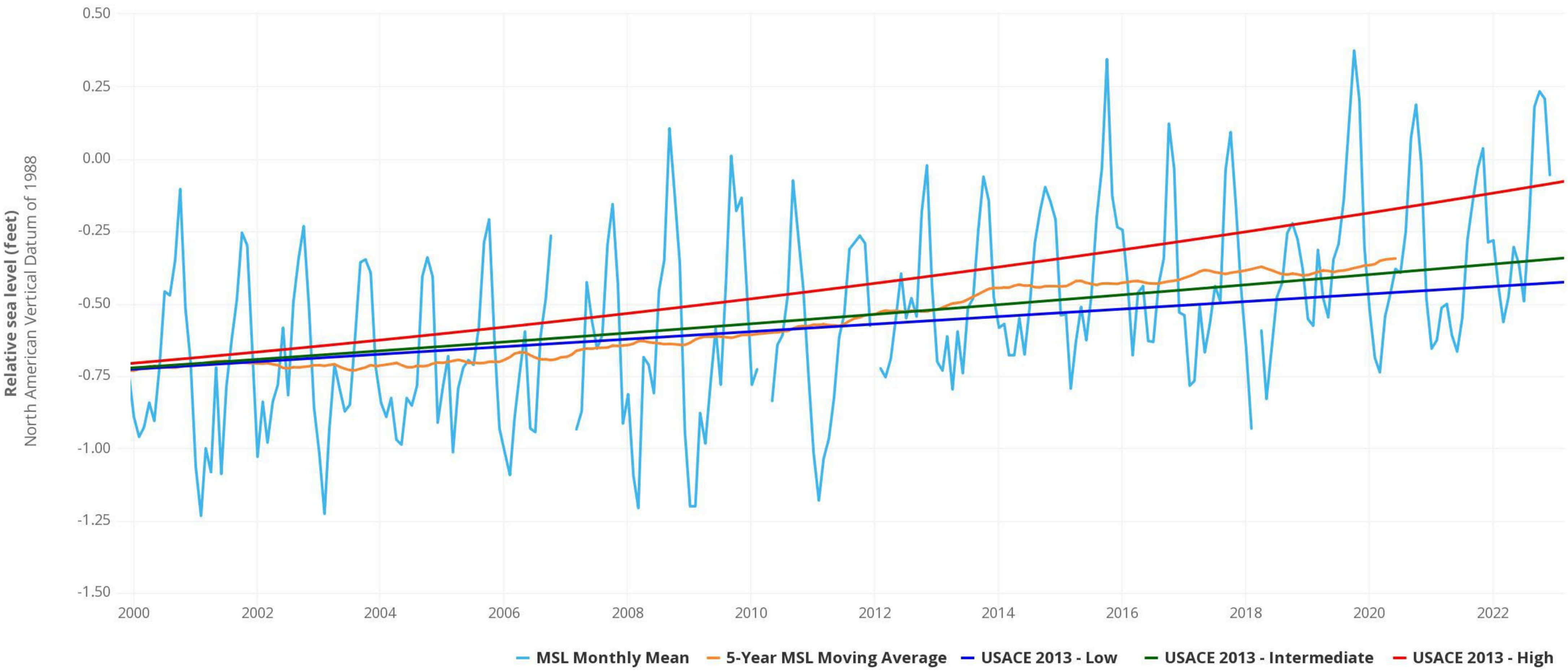
EXTRA SLIDES

SEA LEVEL TRACKER

Sea Level Data and Projections for Vaca Key, FL (8723970)

Active and compliant tide gauge



USACE Sea Level Change Predictions for Vaca Key, FL (8723970) using the NAVD88 datum.
Timeframe: Jan, 2000 - Jan, 2023 (23 years, 1 months).
Timeframe contains 275 missing points; the longest gap is 0 years, 4 months.
Rate of Sea Level Change: 0.013 ft/yr (2021) .

USACE INTERMEDIATE SLC CURVE AT VACA KEY, FL

- USACE Sea Level Change Intermediate Curve assuming 50-year period of economic analysis to year 2085, which results in sea level increase to 1.2 ft. NAVD88, using NOAA 2021 SLC linear trend of 0.013 ft/yr (3.95 mm/yr).
- Existing Condition Baseline (ECB) modeled with 2022 sea level condition of -0.4 ft NAVD88
- Future Without with Intermediate Curve (FWOI) modeled with 2085 sea level condition of 1.2 ft NAVD88 (+1.6 feet relative to the 2022 ECB)

SLC curve	1992 Elevation ft-NAVD88	2022 Elevation ft-NAVD88	2085 Elevation ft-NAVD88
USACE Intermediate	-0.8	-0.4	1.2

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Note: Displayed values were developed on the Sea Level Calculator.

3.6 ft NAVD88

KEY SLC MODELING ASSUMPTIONS

1. 2085 Future with SLC will apply +1.6 ft offset to ECB22 (2022 current) tidal boundaries
   - Recall that tidal boundary condition for RSMGL have already been updated to reflect a more “realistic” signal & retain higher observed variability
   - i.e. Harmonics/signal analyses developed by IMC (and coordinated through NOAA) create tidal boundaries that accommodate both harmonic and residual behavior
2. Coastal Structures will be modeled to continue to function as they do today and maintain ECB22 discharge capacity despite increased tailwater due to SLC.
   - This is a modeling technique used in planning to account for specific infrastructure adaptations that have yet to be identified (this avoids BBSEER from having to formulate those features)
   - Other programs and projects will be responsible for implementing changes to coastal spillway structures and operations to achieve this assumed performance.
   - It is important to note that while hydraulic capacities will be maintained, simulated performance will still change in response to canal / headwater changes.
3. Land use changes w/r to developed areas to remain static, same as existing condition

KEY SLC MODELING ASSUMPTIONS (CONT)

4. Assume that land cover, vegetation & topography in natural systems will change in response to sea level change
   - Land cover migration will be informed by historic trends.
   - Accretion rates will be derived from the Adaptive Foundation Resilience (AFR) Performance Measure which performed a comprehensive literature review of what is possible.
   - This set of assumptions will help to illustrate in the modeling a realistic future and the potential restoration resilience provided by the BBSEER project (i.e. conversely, assuming no changes would just illustrate a "worst case" scenario of sea level incursion)
   - Application of the AFR performance measure during evaluation will "close the loop" by testing the assumed accretion hypothesis to ensure that BBSEER can create the necessary hydrology and porewater salinity conditions that promote the expected accretion.