

# Evaluation of Methodology to Quantify Coastal System Resilience:

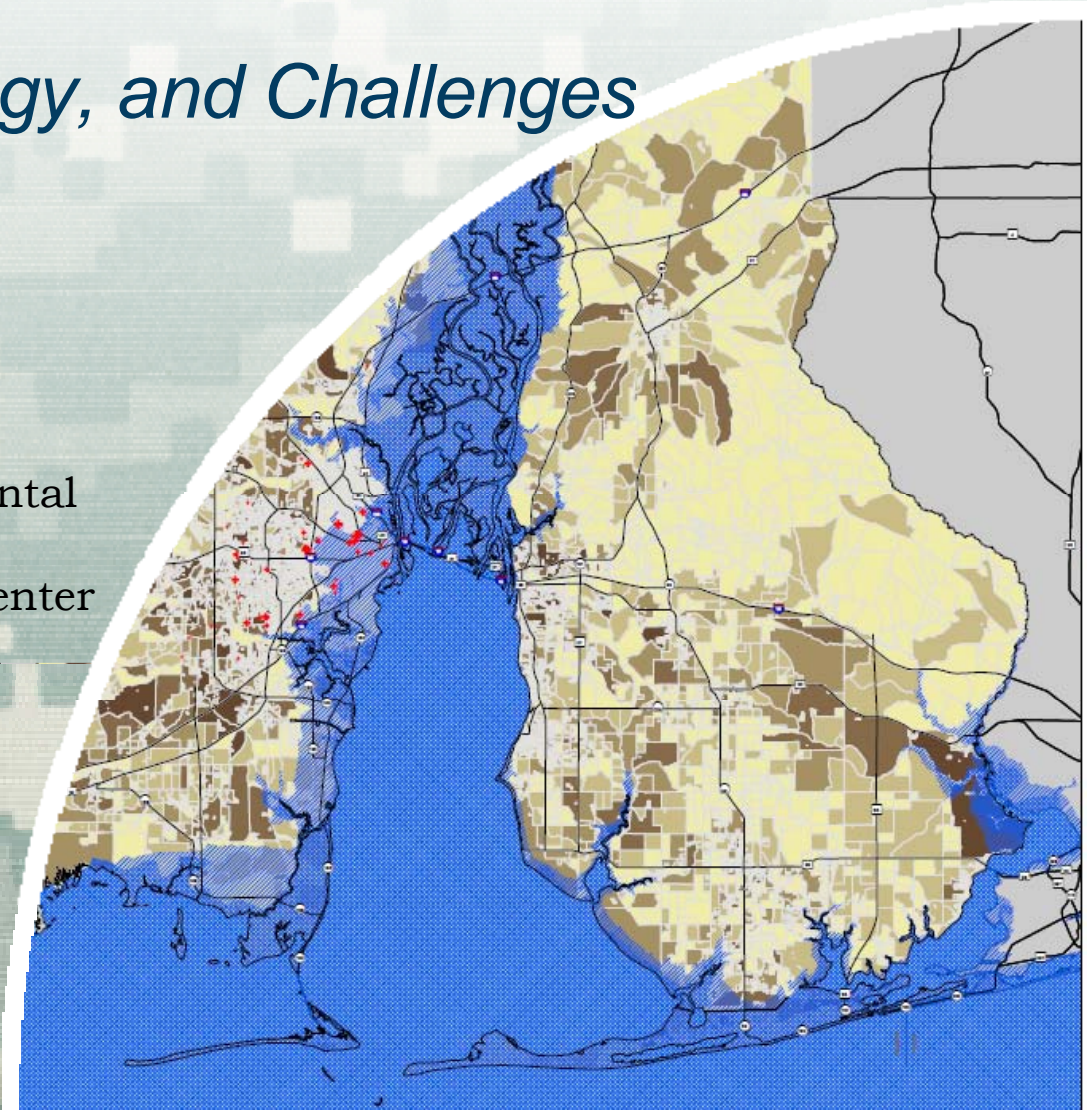
*Mobile Bay Workshop*

*Findings, Future Strategy, and Challenges*



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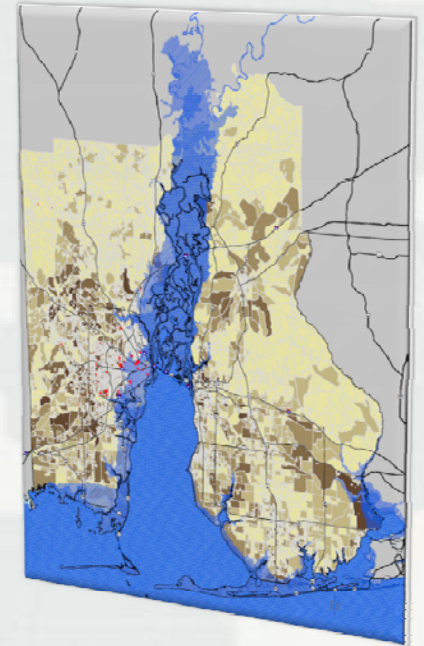


**ERDC**

*Innovative solutions for a safer, better world*

# Outline

- Review Resilience Concepts & Motivation
- Summarize Workshop
  - ▶ Purpose of workshop was to test methods
- Workshop Findings & Recommendations
- Future Strategy
- Challenges – Need your input!



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Workshop

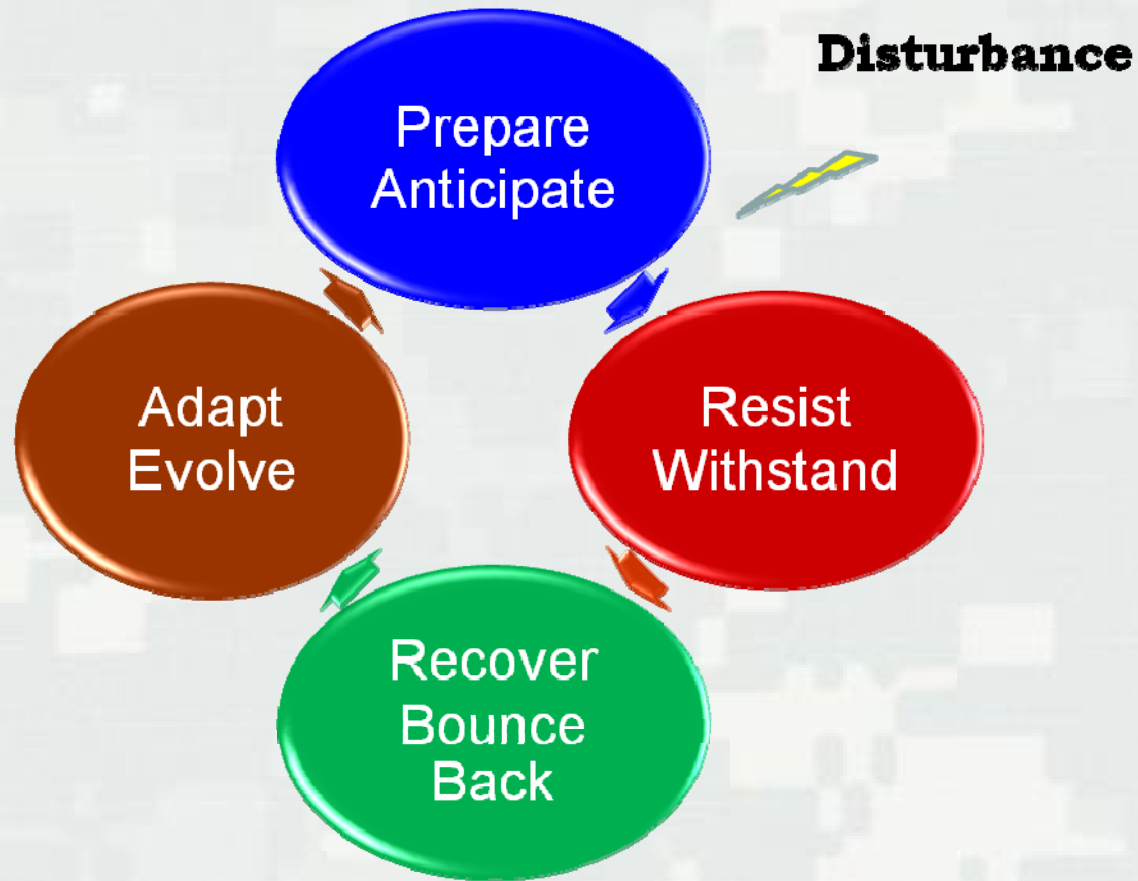
Recommendations

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# Cycle of Resilience

*Prepare, resist, recover, and adapt*



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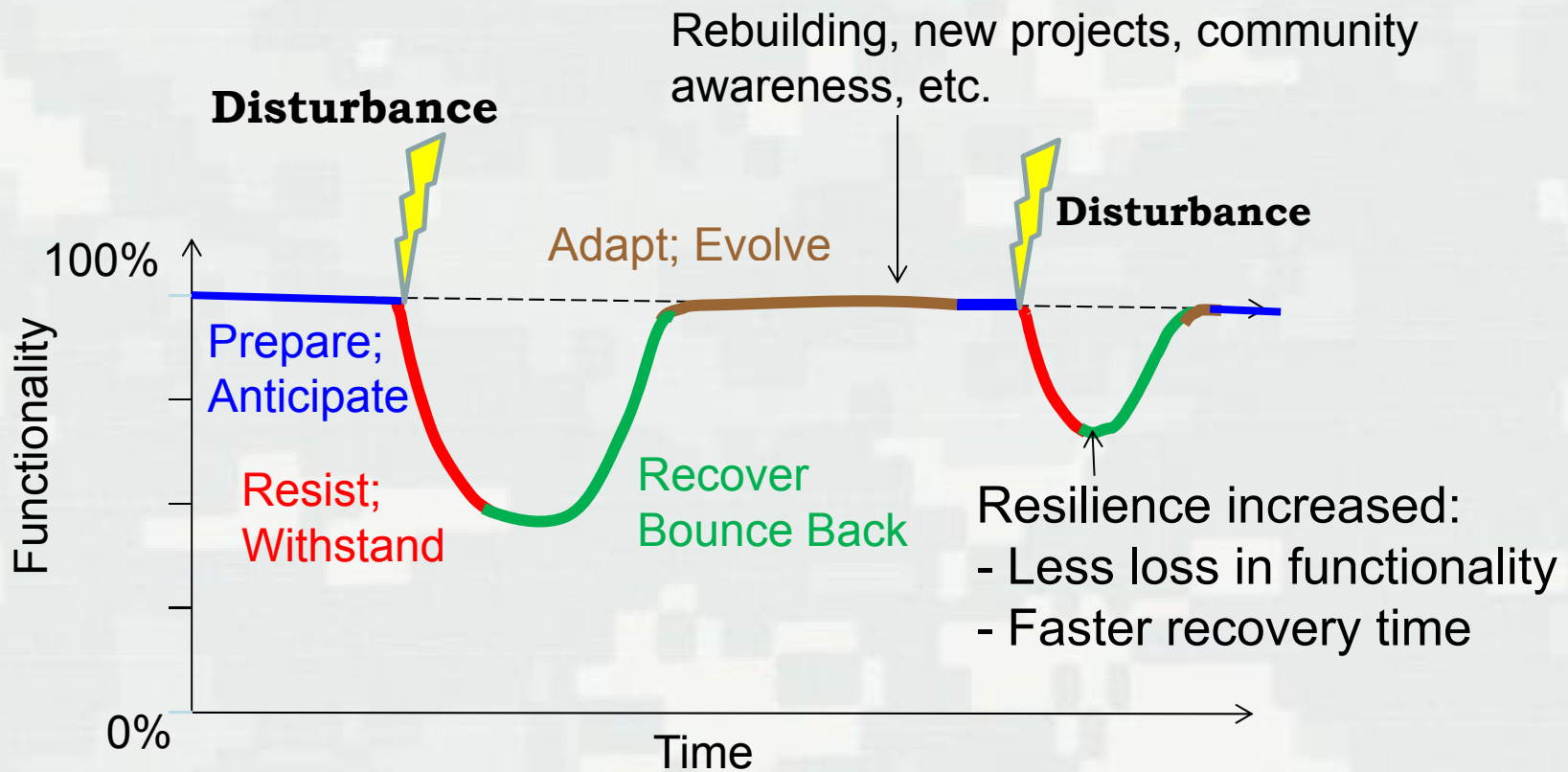
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# Resilience Timeline

*Prepare, resist, recover, and adapt*



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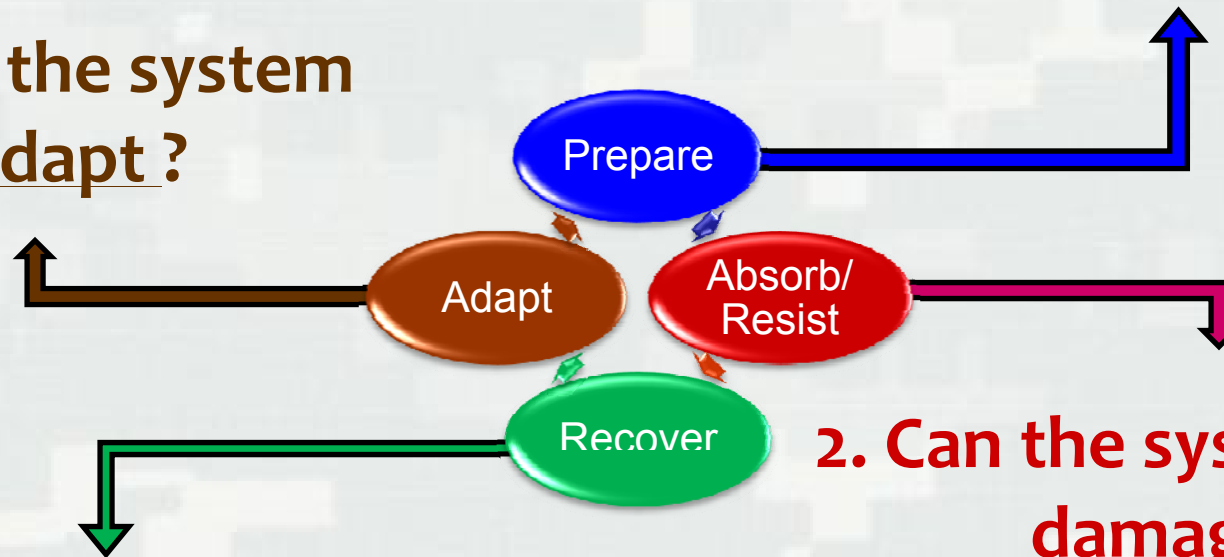
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# How do we Quantify Coastal System Resilience?

1. How prepared is the system?

4. Can the system adapt?



2. Can the system resist damages?

3. Has the time of recovery been adequate?

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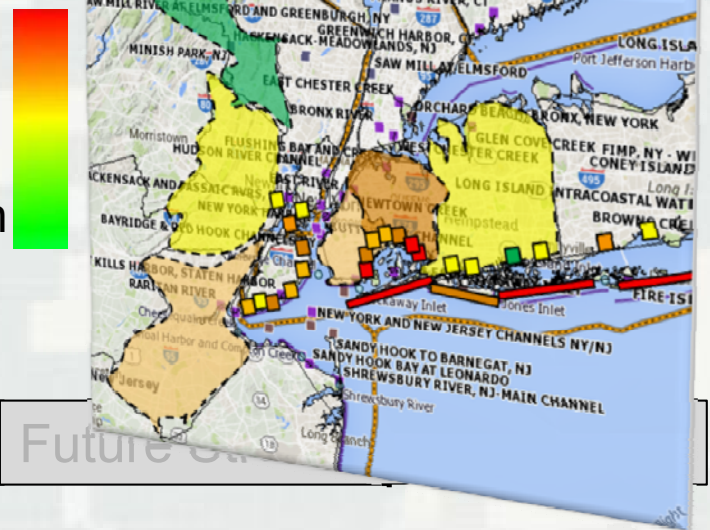
# USACE Motivation

## *Why Quantify Coastal Resilience?*

- Need to quantify how individual components and system-as-a-whole will perform in order to...
  - ▶ **Intercompare** alternatives
  - ▶ Understand **weakest parts** of system
  - ▶ Determine forcings/critical links in **cascading failures**
  - ▶ **Communicate and defend** decisions
- Need to develop understandable measures that are
  - ▶ **Reproducible**
  - ▶ **Unbiased**
  - ▶ **Transparent**
  - ▶ **Scalable**
  - ▶ **Transferable**

Low

High



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# Vision for Tiered Resilience Assessments

## Tier 1 – Community System-Scale

*Prepare, Absorb/Resist, Recover, Adapt*

- Assess overall coastal system resilience, community priorities and needs

## ➤ Planning (3x3x3)

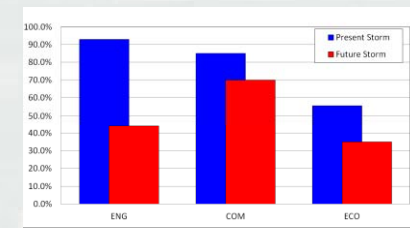
	Prep	Abs	Rec	Adapt
Phys	..	..	..	..
Info	..	..	..	..
Cog	..	..	..	..
Soc	..	..	..	..

## Tier 2 – Coastal System Infrastructure

*Resist, Recover, Adapt*

- Quantify capacity to function and recover

## ➤ Operations & Maintenance

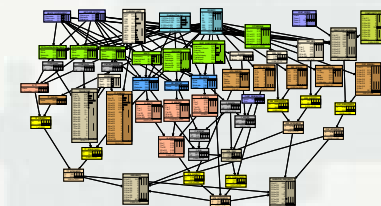


## Tier 3 – Bayesian Network Analysis:

*Resist, Recover, Adapt*

- Optimize engineering design & operation

## ➤ Engineering & Construction



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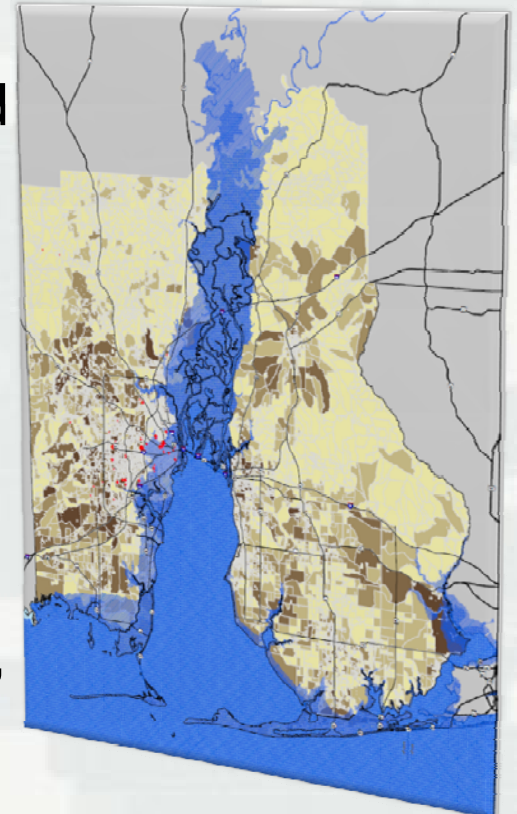
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# Focus of Mobile Bay, AL Workshop

- **Goals of Workshop:** *Test approaches; get feedback & recommendations*
- **Tier 1:** Community System-Scale Assessment and  
**Tier 2:** Coastal System Infrastructure Assessment
  - ▶ Test and gather input to revise methodology
  - ▶ Emphasis: Obtain feedback on methodology *not* specific workshop outcomes
  - ▶ 32 professional attendees from regional and local area representing engineering, ecological, and community infrastructure



Storm calculations courtesy  
South Coast Engineers,  
LLC\*

\*Supported by the Federal Highways Administration's 2014 "Gulf Coast Study"

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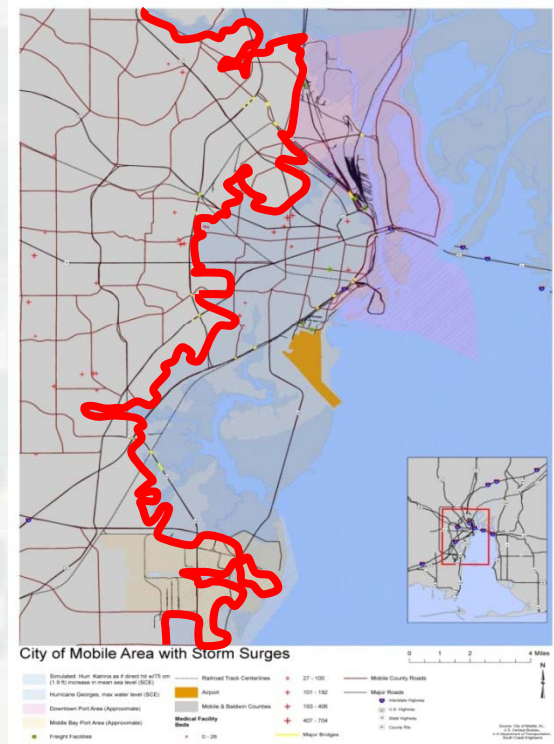
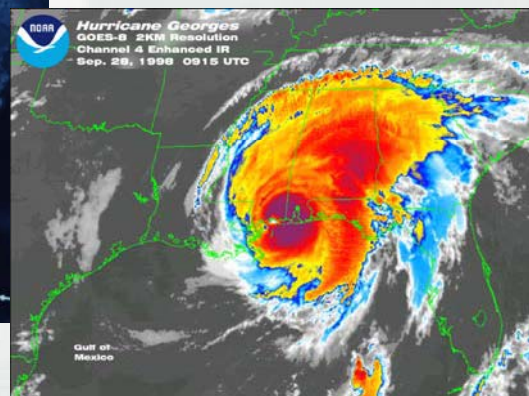
# Considered Two Storms

## Historic Storm: Hurricane Georges

- Cat 2 Hurricane
- Landfall Biloxi, MS
- Sep 29<sup>th</sup>, 1998
- Extensive flooding in downtown Mobile

## Hypothetical Storm: Future Direct-Hit Katrina

- With 2.5-ft sea level rise



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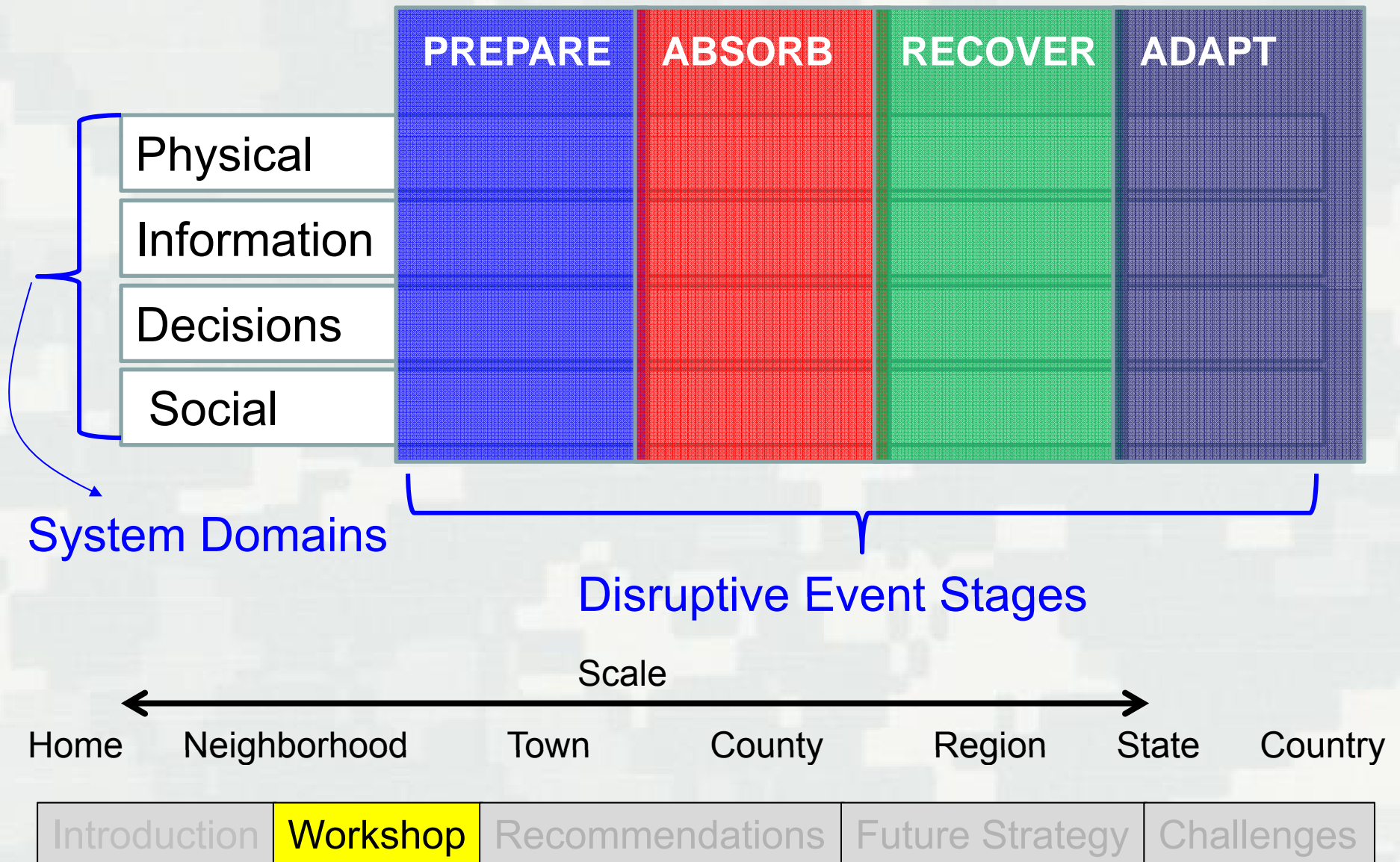
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# First Assessment Evaluated...

## Tier 1: Community System-Scale Assessment

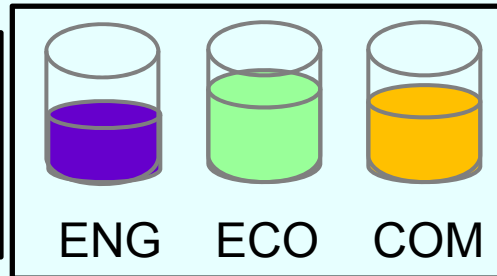


## Second Assessment Evaluated...

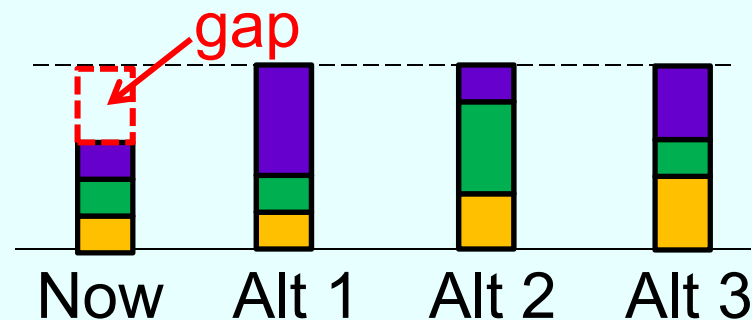
# Tier 2: Coastal System Infrastructure Assessment

### Three Types of Infrastructure:

- Engineering
- Ecological
- Community



Must have **ENG**, **ECO**, and **COM** working as a **system** to achieve resilience



## *Second Assessment Evaluated...*

# Tier 2: Coastal System Infrastructure Assessment

### **Set Goals for Infrastructure:**

- **Functioning**

How should infrastructure perform? *For example...*

*Beach-reduce damage from Cat 3*

*Wetland-provide 10 units habitat*

*Road-evacuate 1000 cars/hr*

- **Recovery**

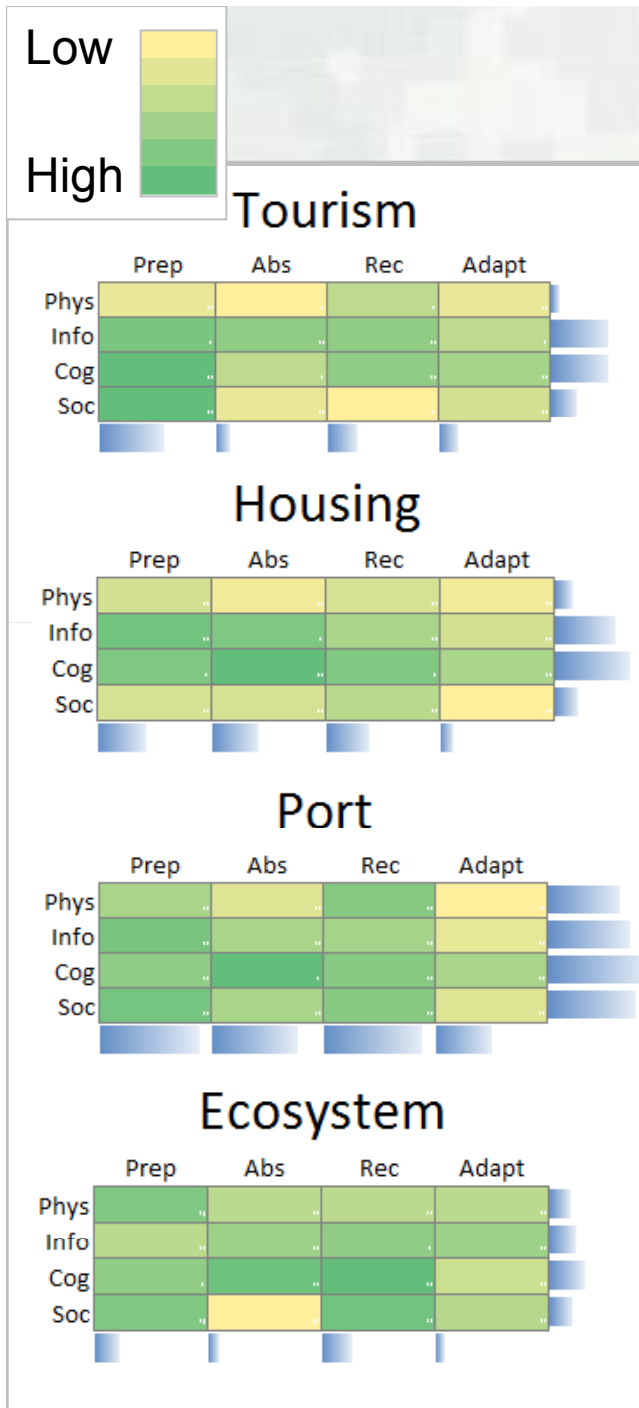
How fast should infrastructure recover? *For example...*

*Beach - rebuilt within 6 mos*

*Wetland - rebuild within 1 yr*

*Road - reopen within 24 hours*





## Findings: Tier 1

- Overall:** Higher capacity to perform in information & decision-support
- Tourism:** Appears to be prepared, but doesn't translate in to capacity to absorb storm impacts
- Port:** highly resilient, well prepared and managed; somewhat lower capacity to adapt to future conditions
- Ecosystem:** historic focus has been on recovery rather than preventing or minimizing damage

Recommendations

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## Recommendations: Tier 2 (1 of 2)

- Develop **ENG**, **COM**, and **ECO** Reference Lists

- Types of ENG, COM, and ECO infrastructure

- Typical order of recovery

- Example: critical roads cleared prior to restoration of utilities*



- Facilitate **Partial Achievement** of Performance & Recovery Goals

- Example: 50% of roads open; 25% utilities back on-line in time*



- Allow for **Range in Recovery Timescales**

- **ECO** features typically need greater recovery times

- **ENG**, **COM** may have variation by infrastructure and function

- o *Immediate Action – resume ‘business as usual’ ASAP*

- o *Mid-Term Action – restore damaged facilities and functions*

- o *Long-Term Adaptation – economic rebound, large project recovery, natural evolution*



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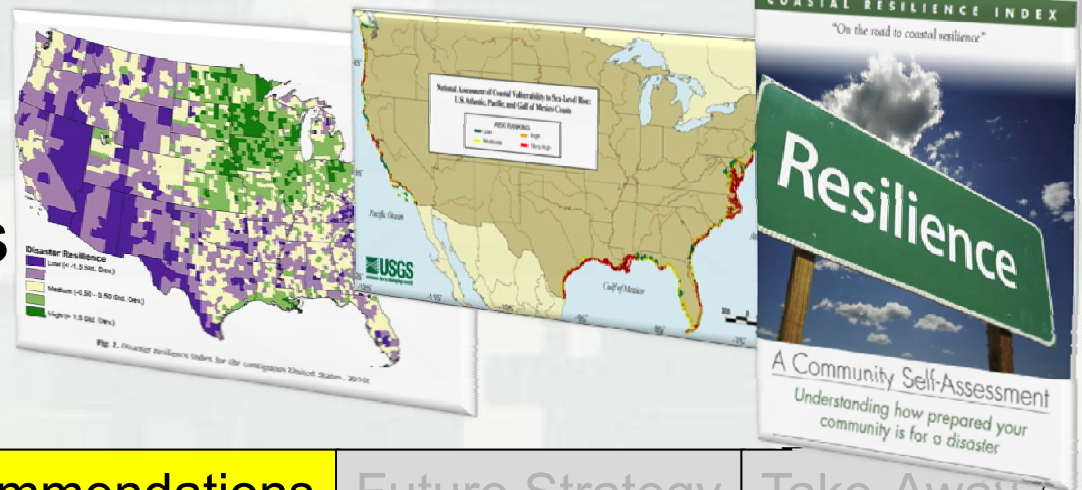
## Recommendations: Tier 2 (2 of 2)

- Provide a **tangible benefit** for community participation
  - ▶ E.g., project eligibility, monetary, certification, insurance offset



- Avoid perception of “poor” resilience score
  - ▶ Minimize concern that low rating would hinder eligibility for future funding

- Leverage with other assessment methods



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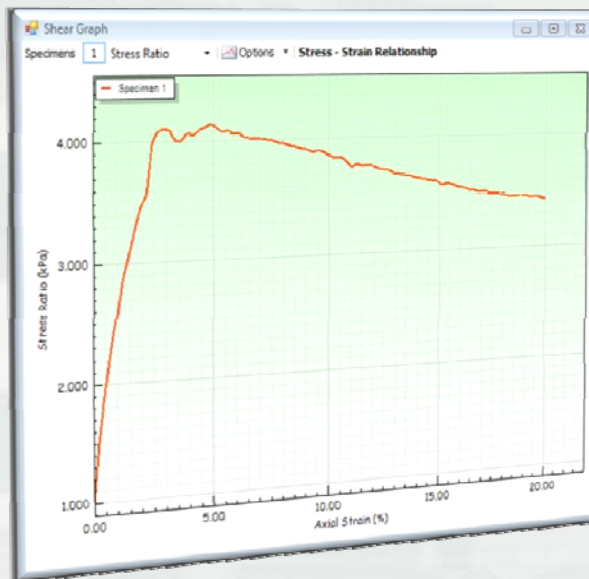
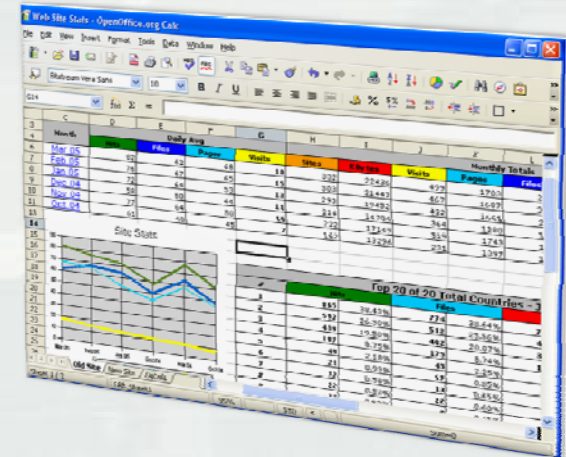
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Take-Away

# Future Strategy (1 of 2)

- Develop performance, recovery and long-term adaptation **data resources**



- Develop **resilience relationships**
  - Fragility curves* – how does infrastructure perform
  - Damage curves* – under what conditions does infrastructure fail
  - Recovery curves* – temporal and spatial scales of recovery

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# Future Strategy (2 of 2)

- Capture **coastal system resilience**
  - Reproducible, unbiased, transparent, scalable, transferable
- Modify **coastal design** for resiliency?

← Possible?

Can we design for autonomous recovery & adaptation?



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## Challenges – Need your Input!

- How do we obtain **recovery data** for engineering features, ecosystems, and communities?
- Do we need to modify **coastal design guidance** for resilience?
- How do we alleviate local concerns in **sharing community resilience assessments**?
- Is it possible to **quantify coastal resilience** that is...
  - Unbiased – not based on opinion
  - Reproducible – obtain similar results regardless of originator
  - Transparent – clear how results were obtained
  - Scalable – from project, to community, to watershed
  - Transferable – comparable between different sites

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