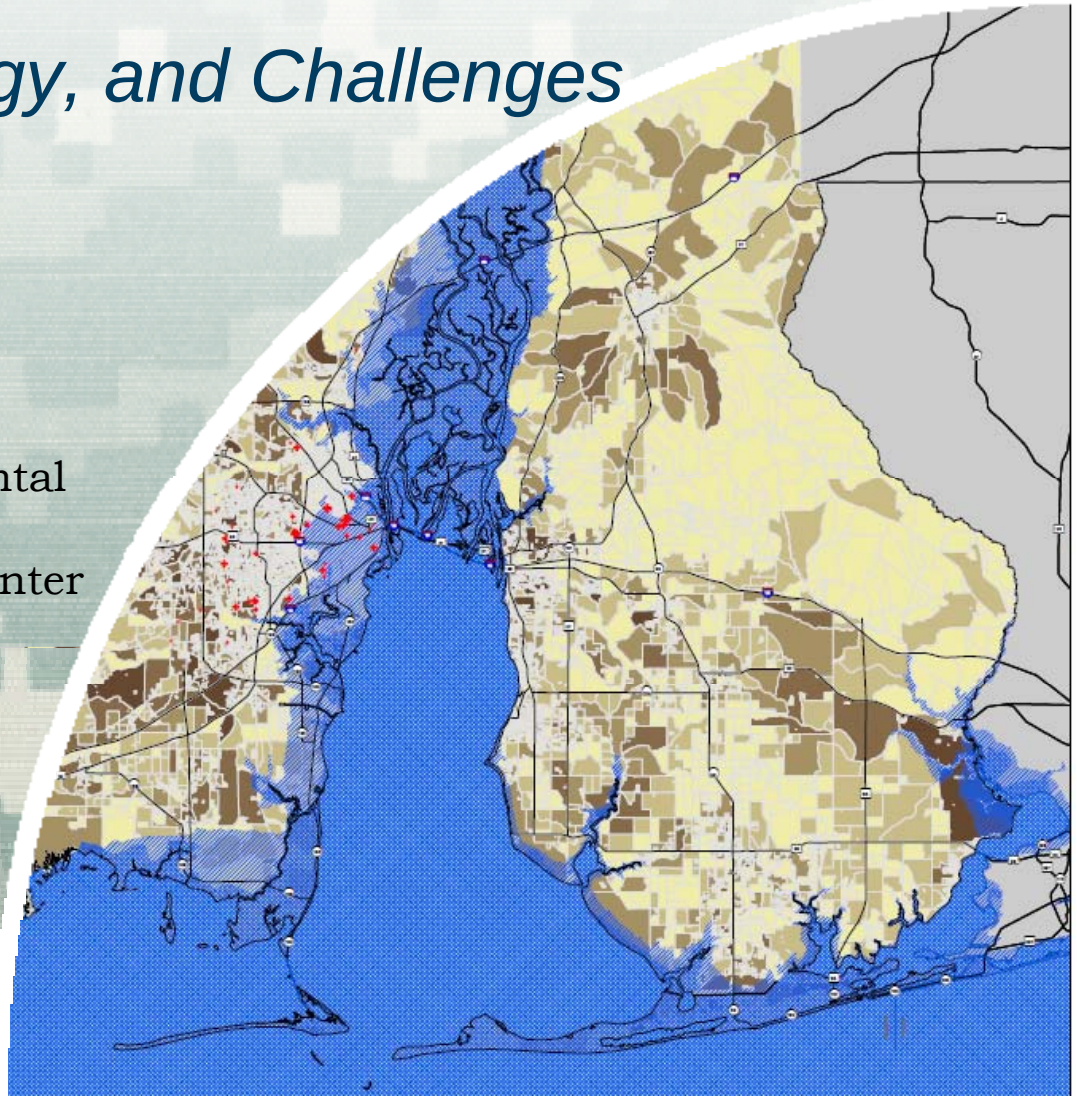
Evaluation of Methodology to Quantify Coastal System Resilience:

Mobile Bay Workshop

Findings, Future Strategy, and Challenges

Julie Dean Rosati
Cate Fox-Lent
Katherine Touzinsky

Coastal & Hydraulics and Environmental Laboratories
Engineer Research & Development Center
US Army Corps of Engineers



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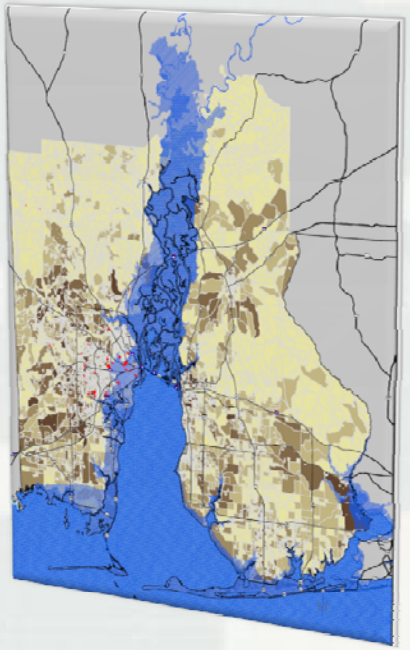
Outline

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

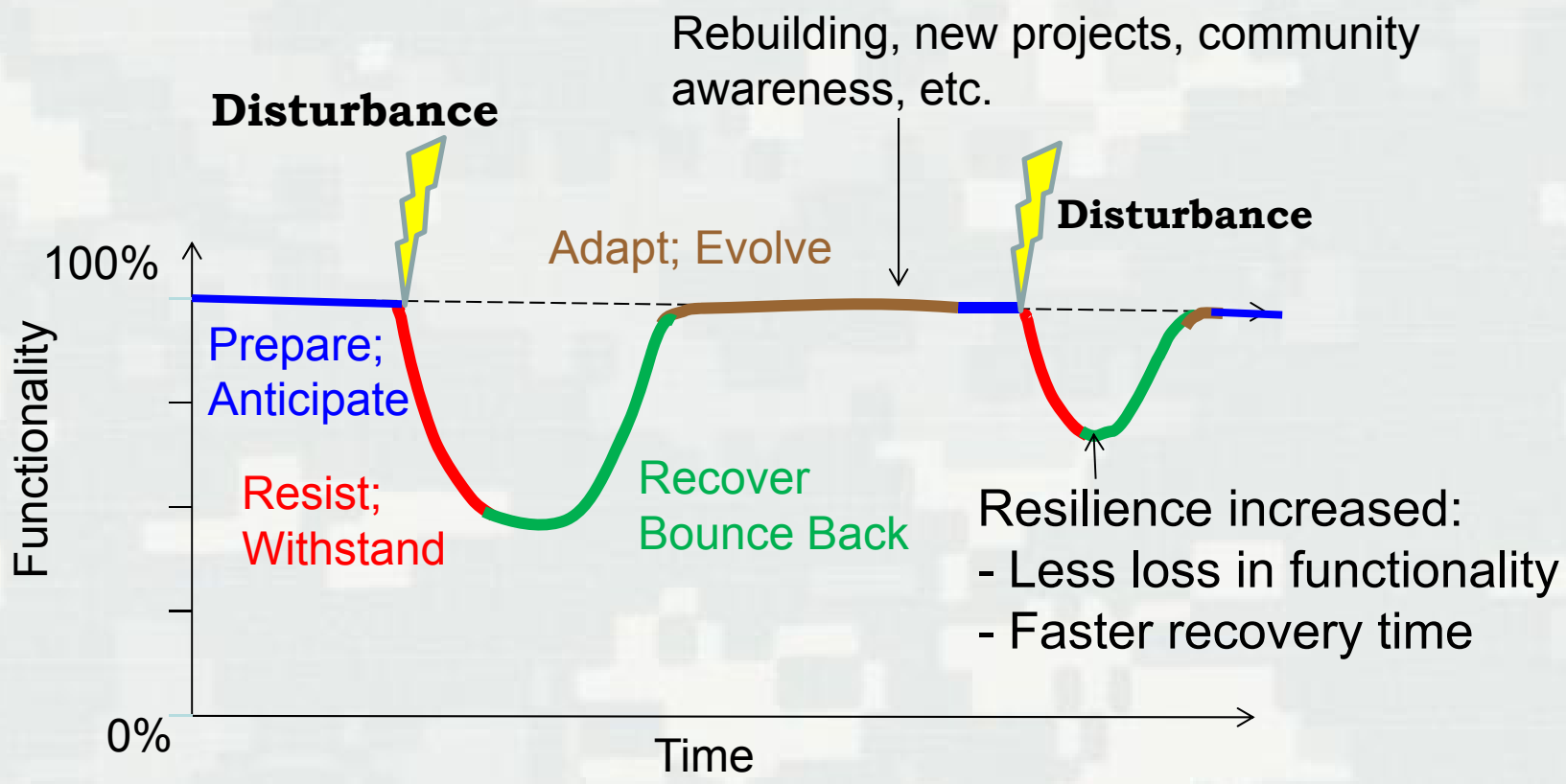


Cycle of Resilience

Prepare, resist, recover, and adapt

Resilience Timeline

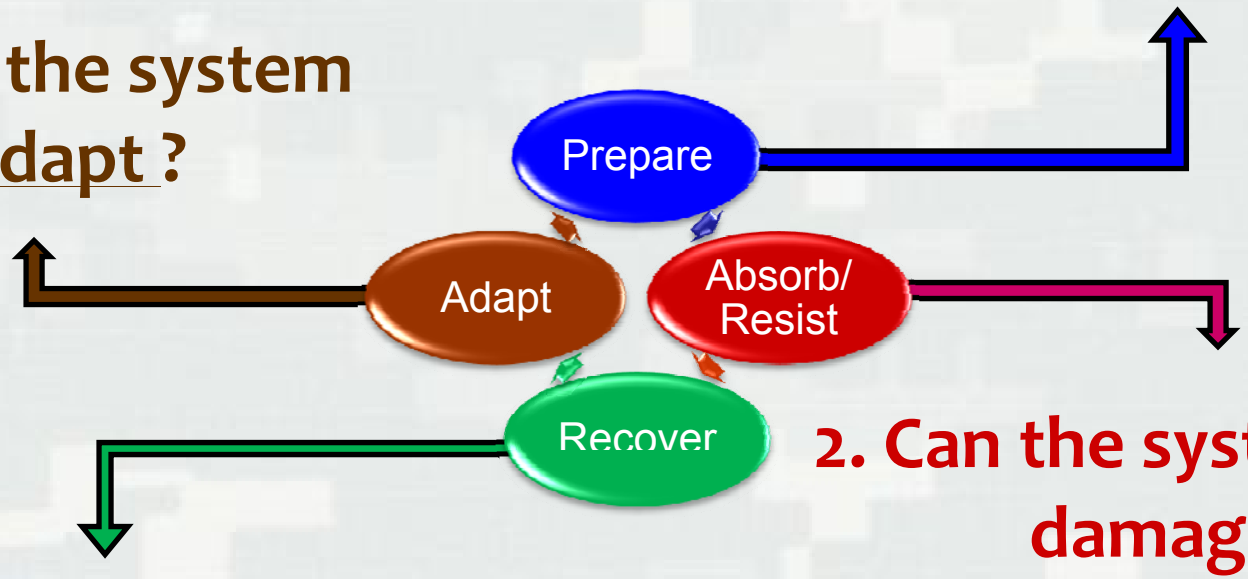
Prepare, resist, recover, and adapt



How do we Quantify Coastal System Resilience?

1. How prepared is the system?

4. Can the system adapt ?



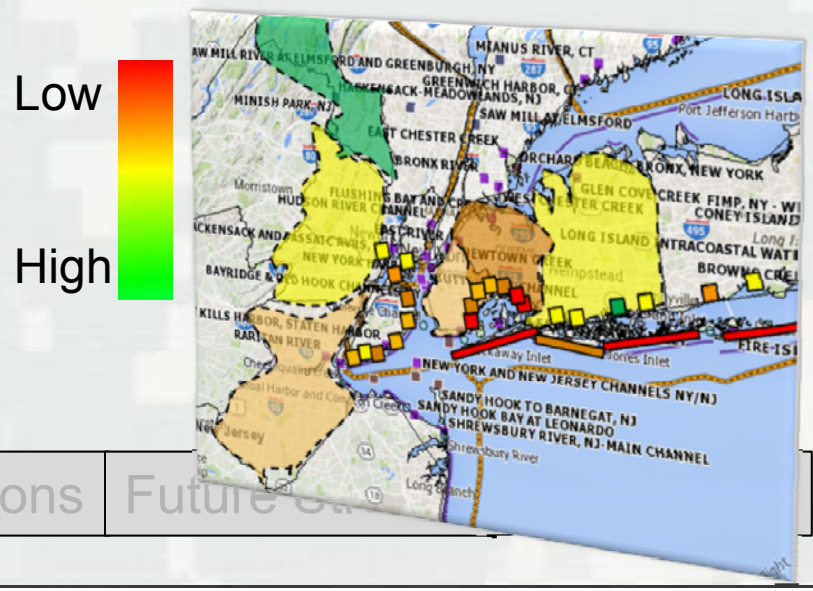
2. Can the system resist damages?

3. Has the time of recovery been adequate?

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**



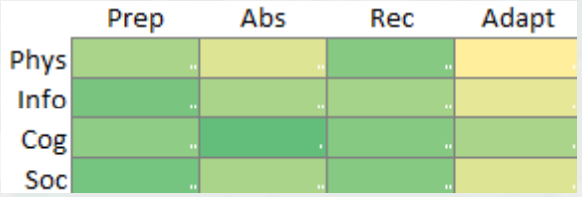
Vision for Tiered Resilience Assessments

Tier 1 – Community System-Scale

Prepare, *Absorb/Resist*, *Recover, Adapt*

- Assess overall coastal system resilience, community priorities and needs

➢Planning (3x3x3)

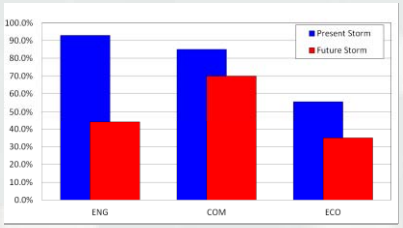


Tier 2 – Coastal System Infrastructure

Resist, *Recover, Adapt*

- Quantify capacity to function and recover

➢Operations & Maintenance

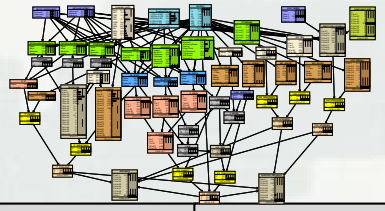


Tier 3 –Bayesian Network Analysis:

Resist, *Recover, Adapt*

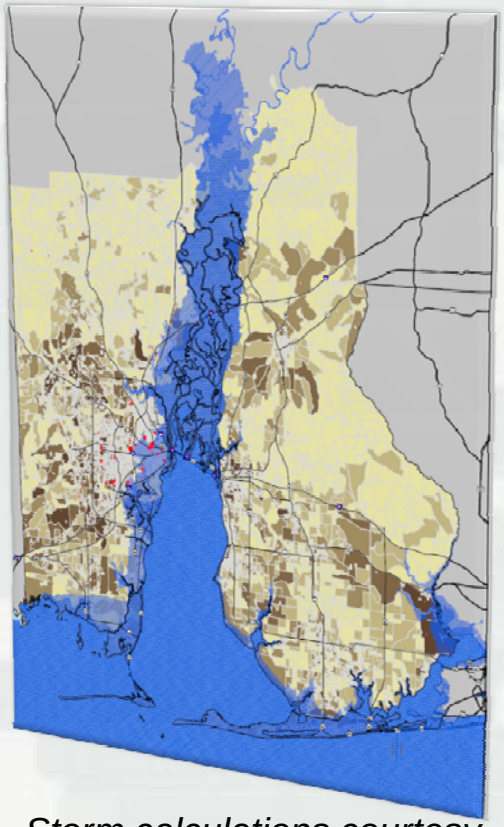
- Optimize engineering design & operation

➢Engineering & Construction



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



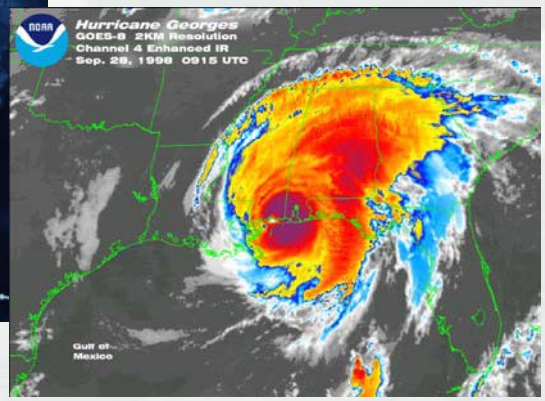
*Storm calculations courtesy South Coast Engineers, LLC**

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

Considered Two Storms

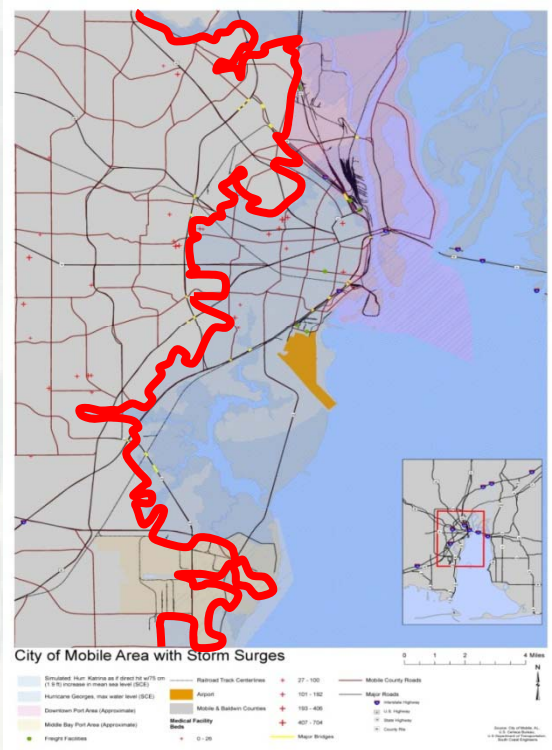
Historic Storm: Hurricane Georges

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



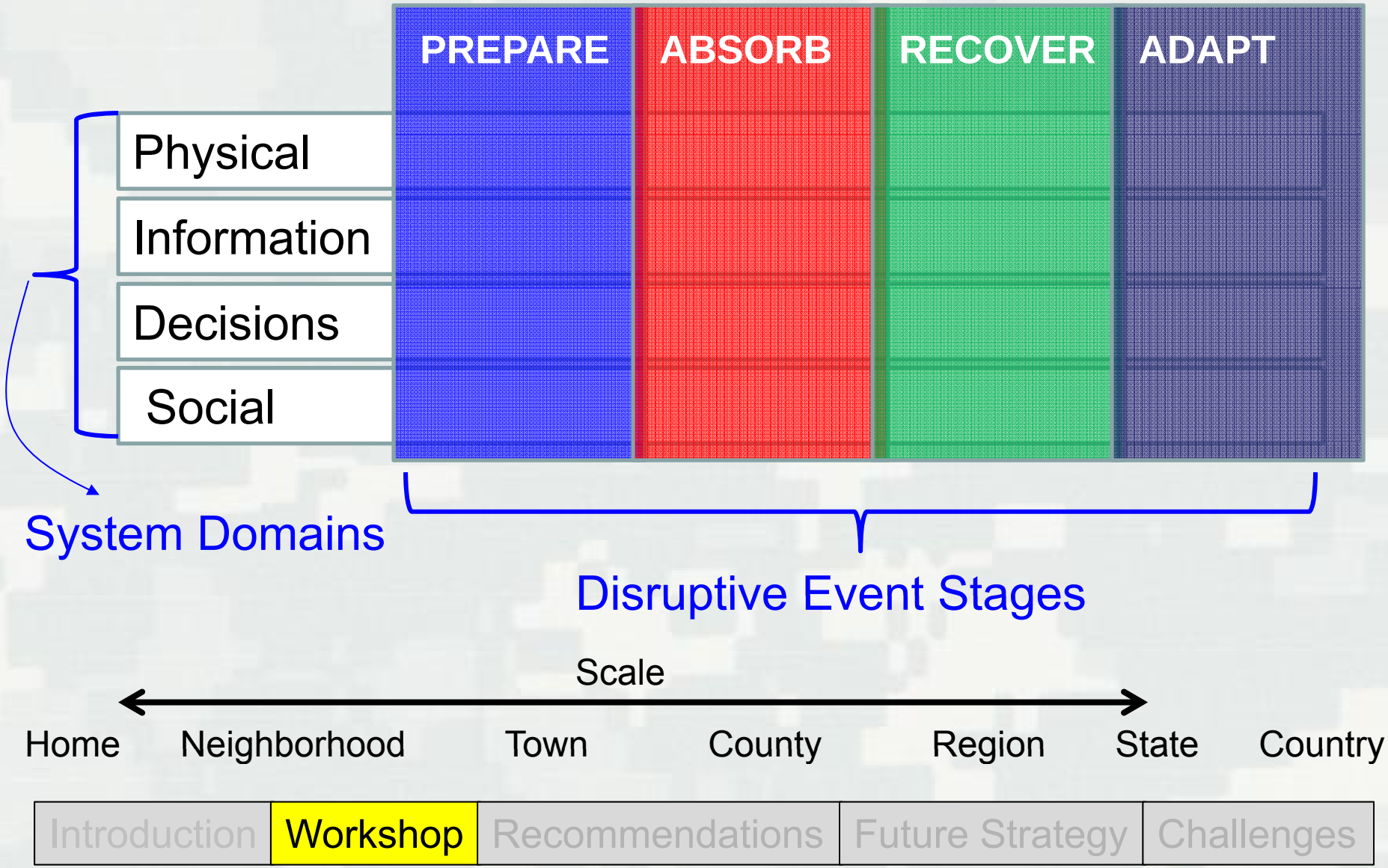
Hypothetical Storm: Future Direct-Hit Katrina

- With 2.5-ft sea level rise



First Assessment Evaluated…

Tier 1: Community System-Scale Assessment

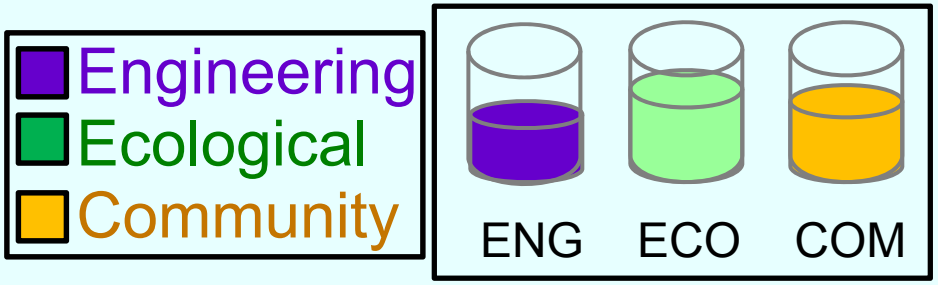


Introduction	Workshop	Recommendations	Future Strategy	Challenges

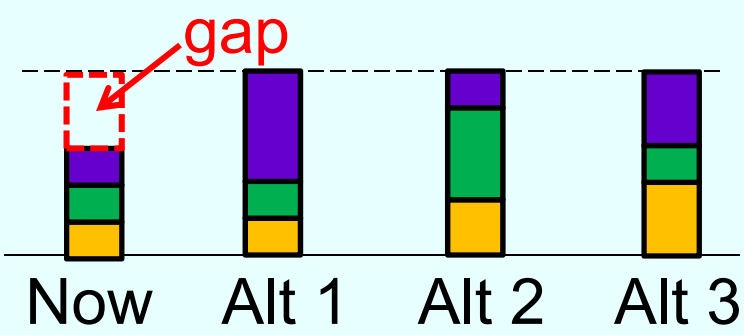
Second Assessment Evaluated…

Tier 2: Coastal System Infrastructure Assessment

Three Types of Infrastructure:



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**

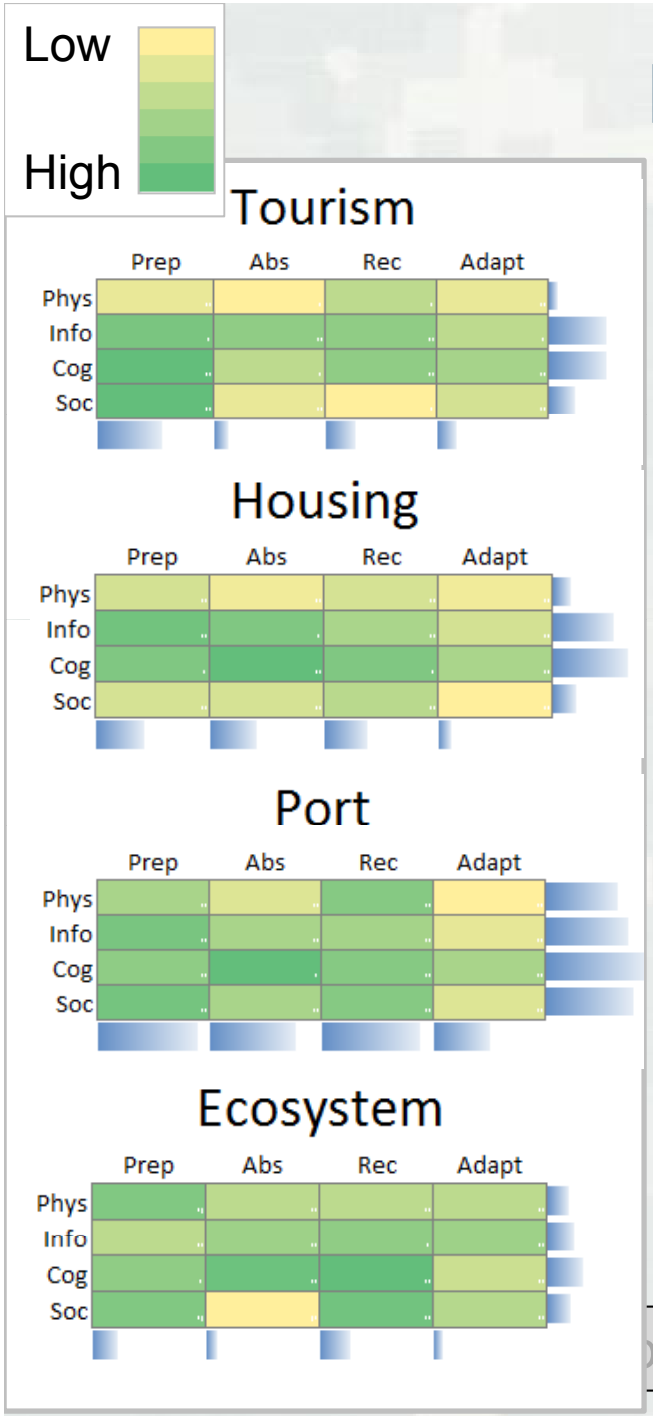
How fast should infrastructure recover? *For example…*

Beach - rebuilt within 6 mos

Wetland - rebuild within 1 yr

Road - reopen within 24 hours

Findings: Tier 1



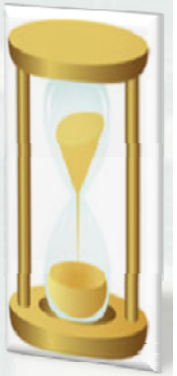
- **Overall:** Higher capacity to perform in information & decision-support
- **Tourism:** Appears to be prepared, but doesn't translate in to capacity to absorb storm impacts
- **Port:** highly resilient, well prepared and managed; somewhat lower capacity to adapt to future conditions
  - **Ecosystem:**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

Recommendations: 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
    - *Immediate Action – resume 'business as usual' ASAP*
    - *Mid-Term Action – restore damaged facilities and functions*
    - *Long-Term Adaptation – economic rebound, large project recovery, natural evolution*



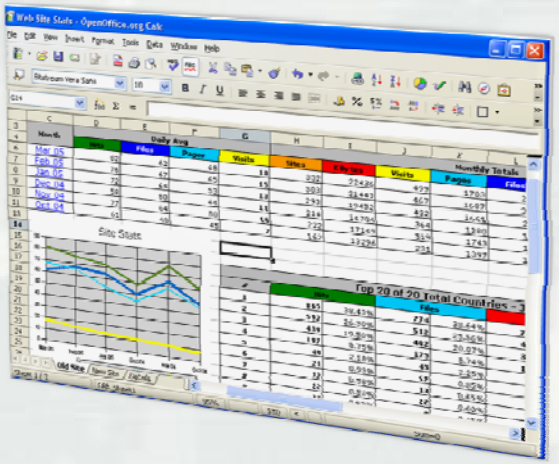
Recommendations: Tier 2 (2 of 2)

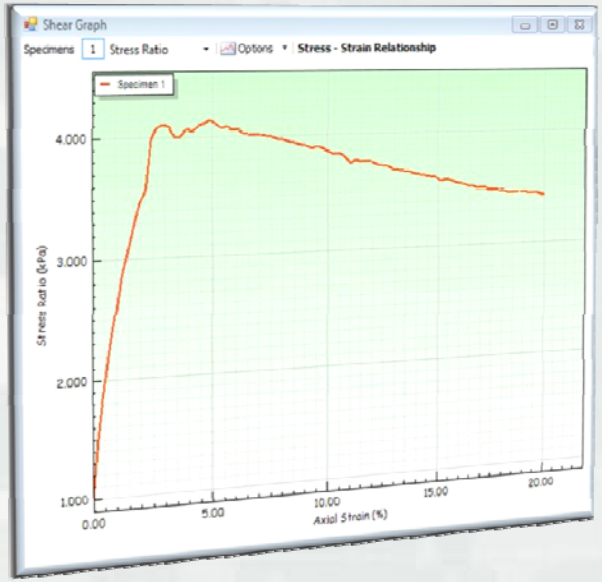
- Provide a **tangible benefit** for community participation
  - E.g., project eligibility, monetary, certification, insurance offset

- Avoid perception of "poor" resilience score
  - Minimize concern that low rating would hinder eligibility for future funding
- Leverage with other assessment methods

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

Future Strategy (2 of 2)

← Possible?

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

Can we design for autonomous recovery & adaptation?

Julie Rosati, Julie.D.Rosati@usace.army.mil

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