



# *Can we weather the storm? The Path to Resilient Infrastructure*

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MAFSM Annual Conference  
October 15, 2015

*“Snapshots for Floodplain and Stormwater Management”*

**University of Maryland Center for Disaster Resilience**  
***Building Resilience: Reducing Risk***

[www.cdr.umd.edu](http://www.cdr.umd.edu)

*Department of Civil and Environmental Engineering*



# Sustainable, Resilient Communities Collaborative Framework



Coastal Governance & Policies



Income Inequality



Government Debt & Economic Stability



Health & Epidemics



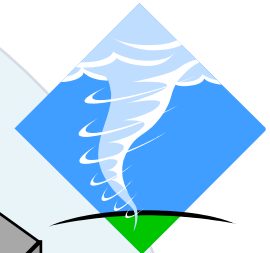
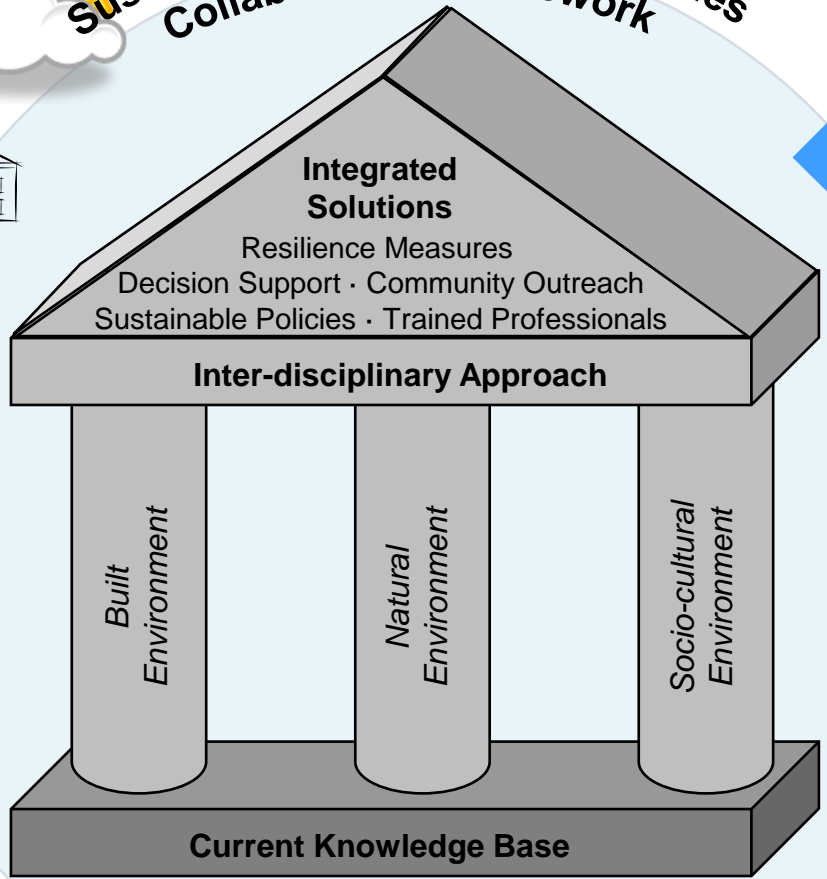
Hazardous Spills



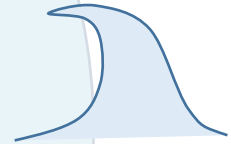
Invasive Species



Aging Infrastructure



Wind



Waves & Surge

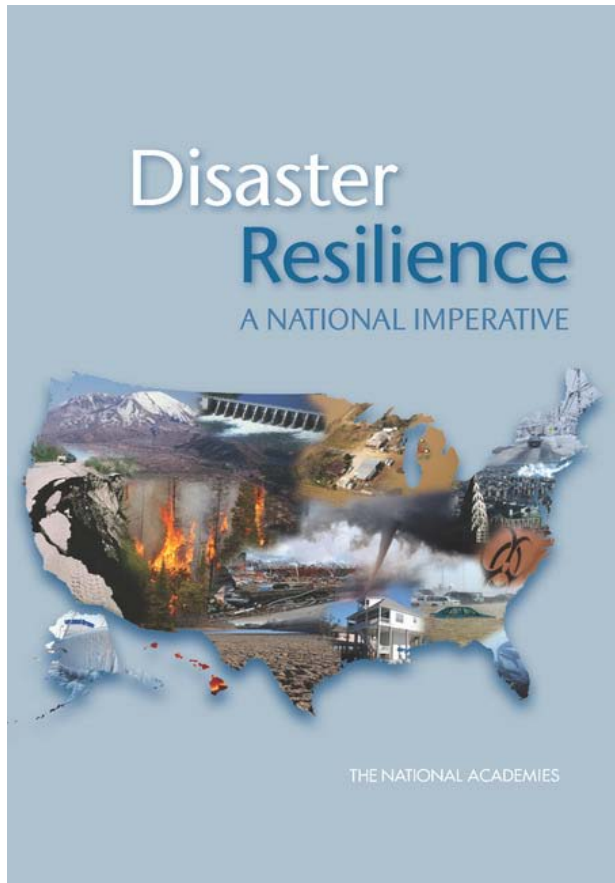


Flooding



Earthquakes

# What is Resilience?



Definition in the Report:

*“Resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.”*

## Common Elements across definitions:

- Prepare/Plan
- Absorb/Withstand
- Recover/Bounce Back
- Adapt/Change

## In the face of:

- Adverse event/disaster/boom
- Both acute and chronic

# What's in your toolbox?

## Resilient Actions

- **Plan/prepare** (emergency evacuation, response, recovery and mitigation planning, regional development plans, business contingency planning)
- **Withstand/absorb** (flood risk protection works, **green infrastructure**, adherence to floodplain management standards)
- **Recover/bounce back** (Coordinated programs/governance, aligned federal policies, pre-disaster recovery planning, flood **insurance**, flood risk standards)
- **Adapt/change** (elevations, relocate, floodproofing, **landuse/building codes**, accept risk)

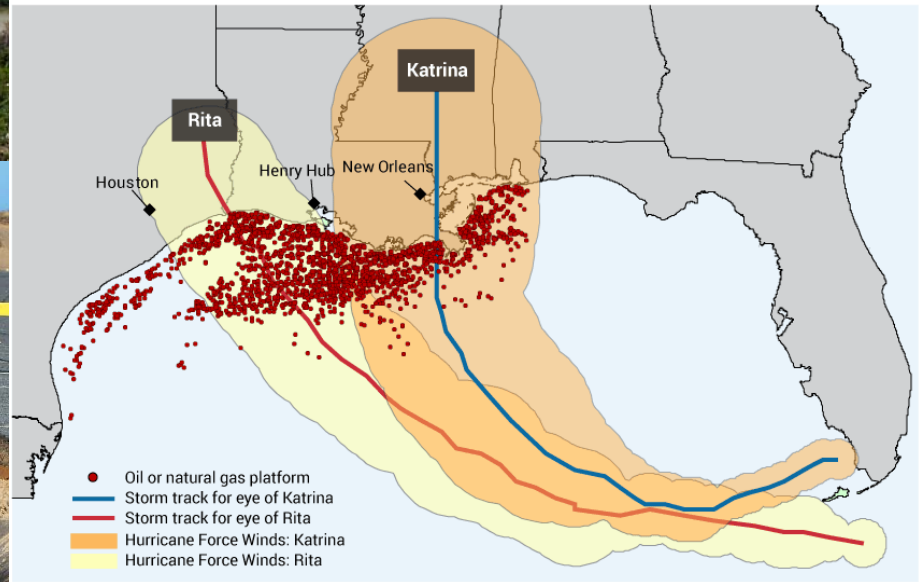


# COASTAL DISASTER: A PERFECT STORM

## RISING RISK: BUILT ENVIRONMENT



Paths of Hurricanes Katrina and Rita Relative to Oil and Gas Production Facilities



# COASTAL DISASTER: A PERFECT STORM RISING RISK: NATURAL ENVIRONMENT



# COASTAL DISASTER: A PERFECT STORM AT RISK: SOCIO-CULTURAL ENVIRONMENT



# *Can we weather the storm?*

## A Recipe for Disaster

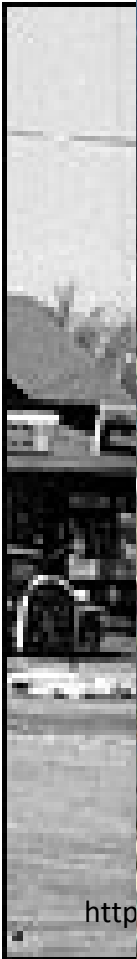
### Ingredients:

- Urbanization and Development
- Rising Population growth
- Aging and inadequate infrastructure
- Changing climate
- Operational complexity
- Regional and national perspectives and priorities





# Urbanization and Development



[http](http://)

# NOAA's National Coastal Population Report

## The Bottom Line

### POPULATION DENSITY IS GROWING AT THE COAST

Regardless of how the coast is defined, it is **substantially more crowded** than the U.S. as a whole, and population density in coastal areas will continue to increase in the future.

In 2010: Out of the 3 million mi<sup>2</sup> of land in the US



or 275,351 mi<sup>2</sup> comprise Coastal Shoreline Counties



or 511,971 mi<sup>2</sup> comprise Coastal Watershed Counties

Within the limited space of the nation's coast, population density far exceeds the nation as a whole, and this trend will continue into the future. This situation presents coastal managers with the challenge of protecting both coastal ecosystems from a growing population and protecting a growing population from coastal hazards.

In 2010: Out of the 313 million people living in the US

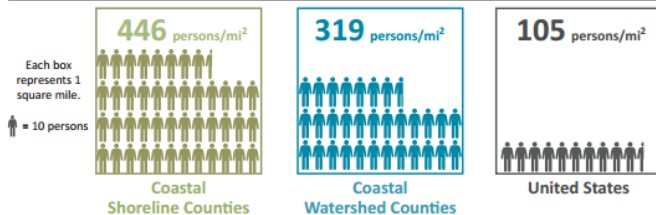


or 123.3 million people lived in Coastal Shoreline Counties



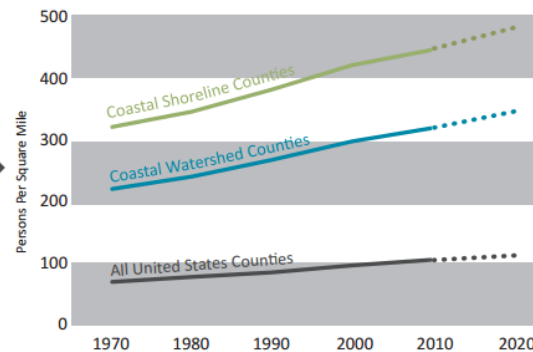
or 163.8 million people lived in Coastal Watershed Counties

In 2010: A small amount of land and a large number of people means high density



In Just 40 Years: 1970-2010

Coastal Shoreline Counties added **125 persons/mi<sup>2</sup>**  
 Coastal Watershed Counties added **99 persons/mi<sup>2</sup>**  
 United States as a whole added **36 persons/mi<sup>2</sup>**



Note: Land area and density values exclude Alaska. Population values include Alaska and US Territories.

Source: U.S. Census Bureau, 2011b; NOAA, 2012; Crowell et al., 2010

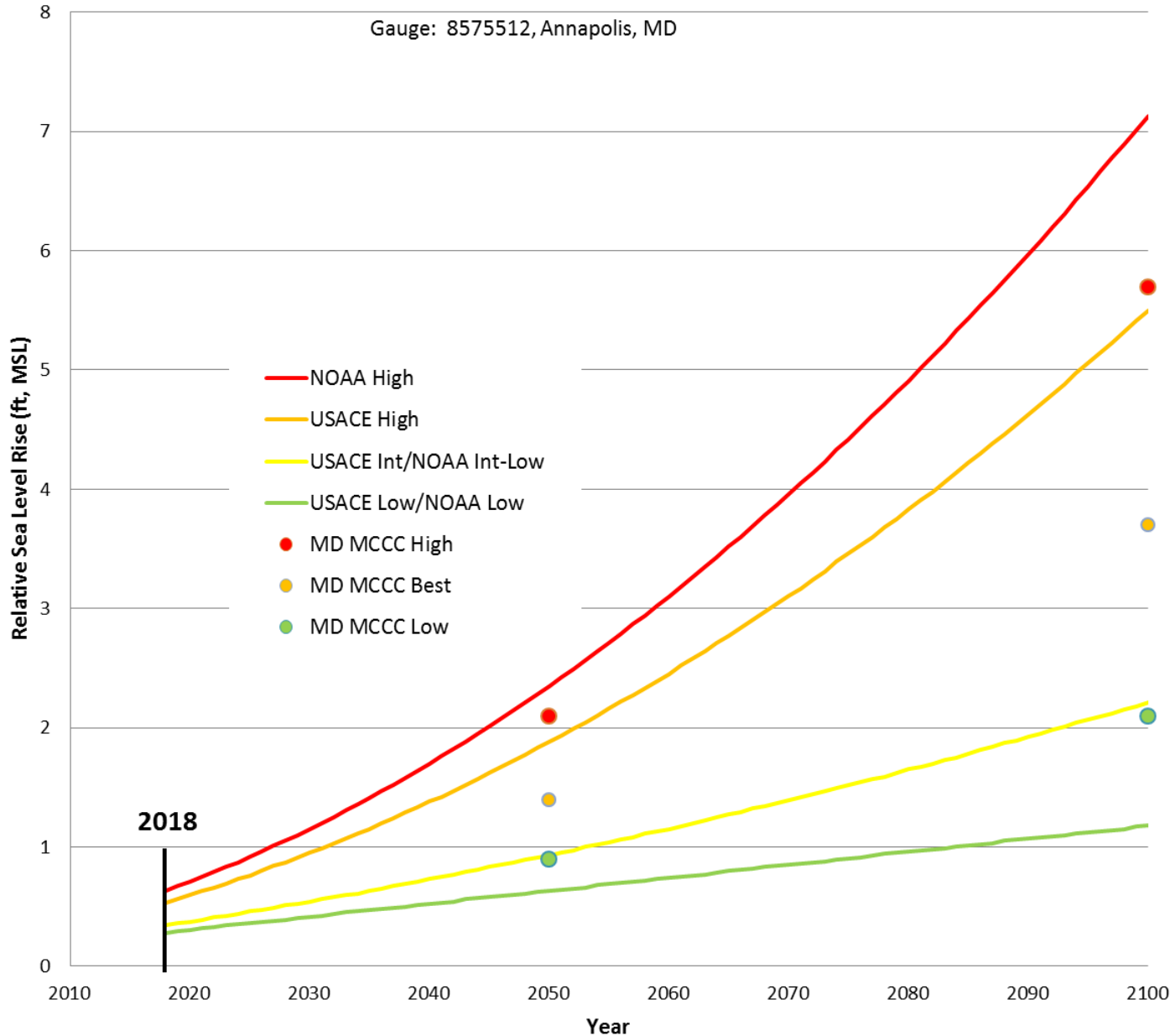
# Coastal Watershed Counties

|            | Persons/sq.<br>mi. 2010 | % Change in<br>Population<br>1970-2010 | % Change<br>projected<br>2010-2020 |
|------------|-------------------------|--|------------------------------------|
| Nationally | 319                     | 45                                     | 9                                  |
| Maryland   | 703                     | 40                                     | 8                                  |

<http://stateofthecoast.noaa.gov/features/coastal-population-report.pdf>

# Maryland Relative Sea Level Change Scenarios

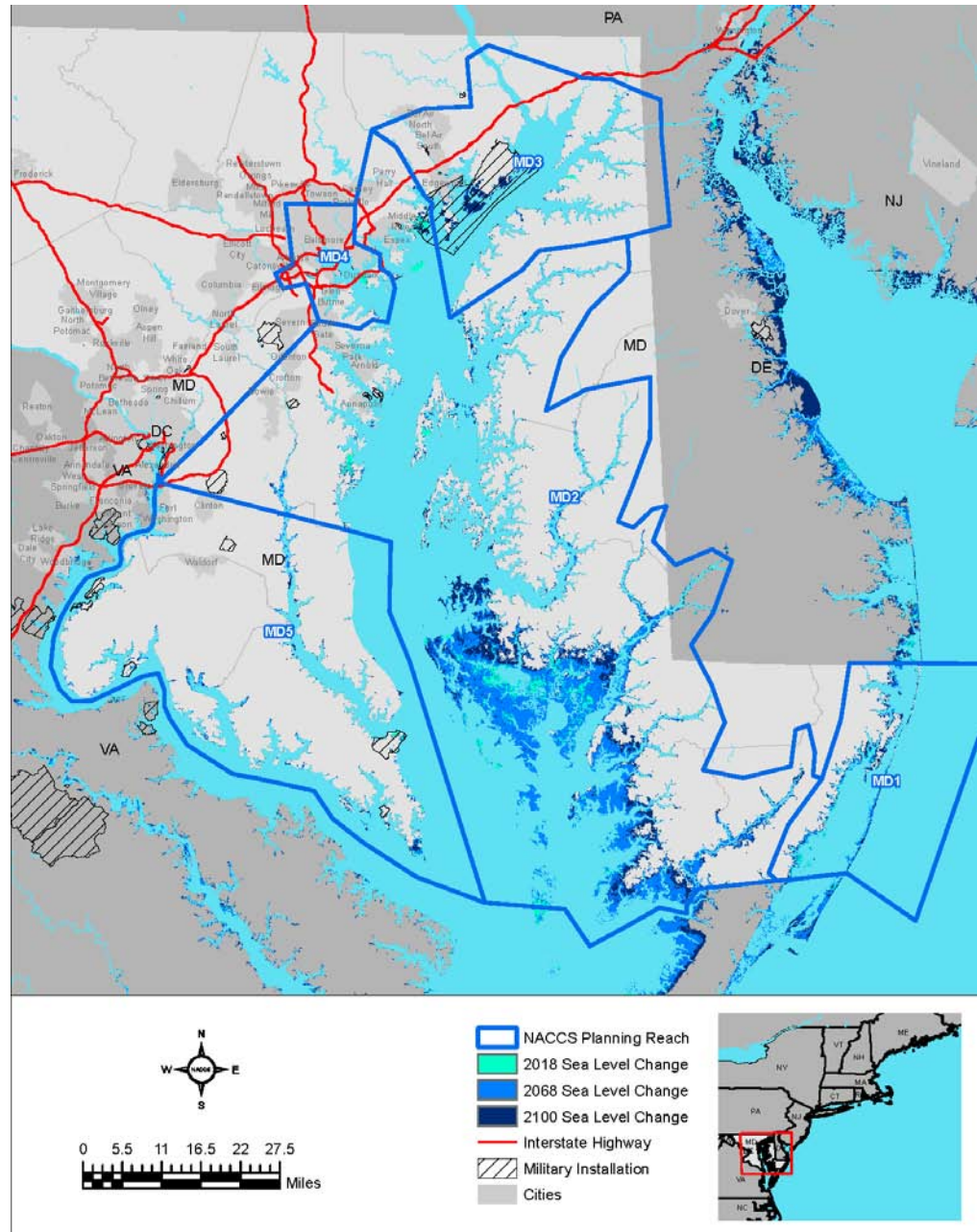
Gauge: 8575512, Annapolis, MD



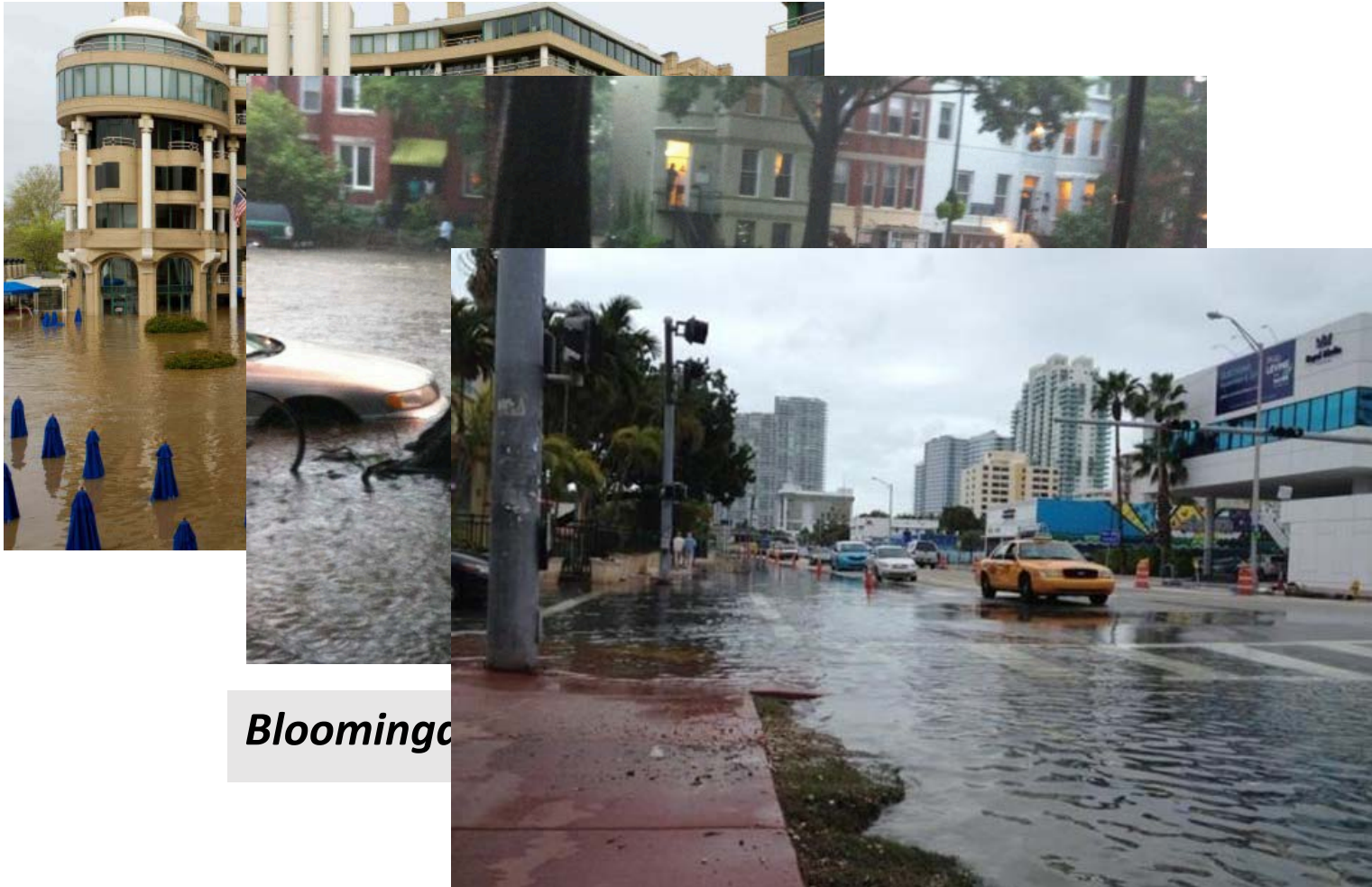
# What's Vulnerable?

- Critical infrastructure
- Military installations
- Residential homes
- Businesses
- Hospitals
- Roads
- Utilities
- Schools
- Ecosystems
- Cultures

What's it worth?  
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Are all disasters based on catastrophic events?



# Happening in neighborhoods near you...

Annapolis December 21, 2014



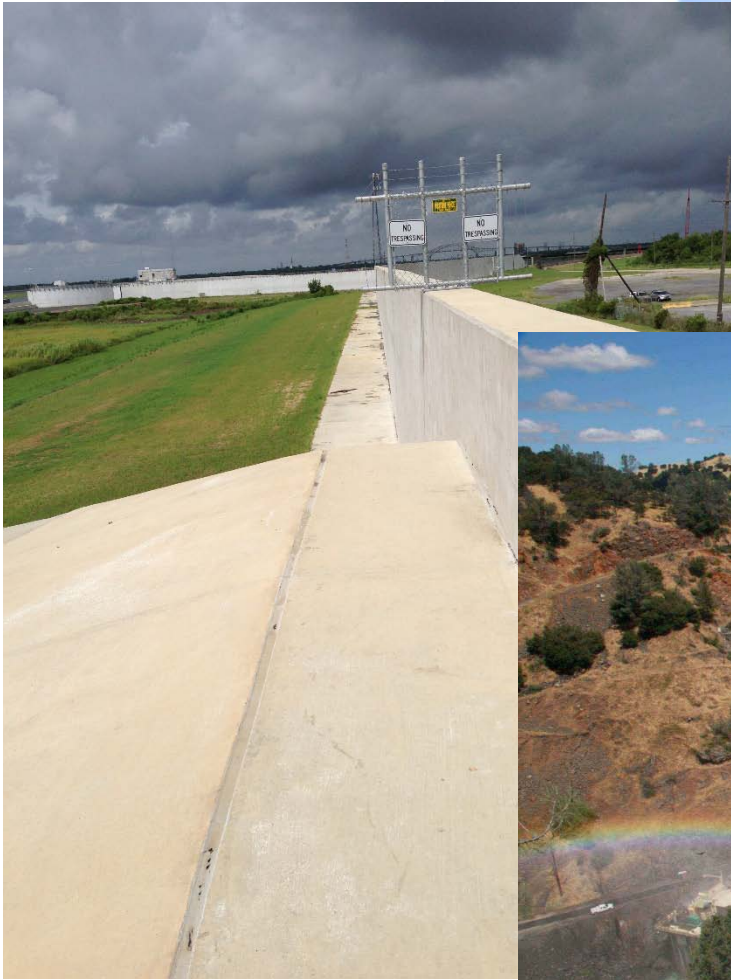
From Annapolis Patch

# Is America's Infrastructure Resilient?





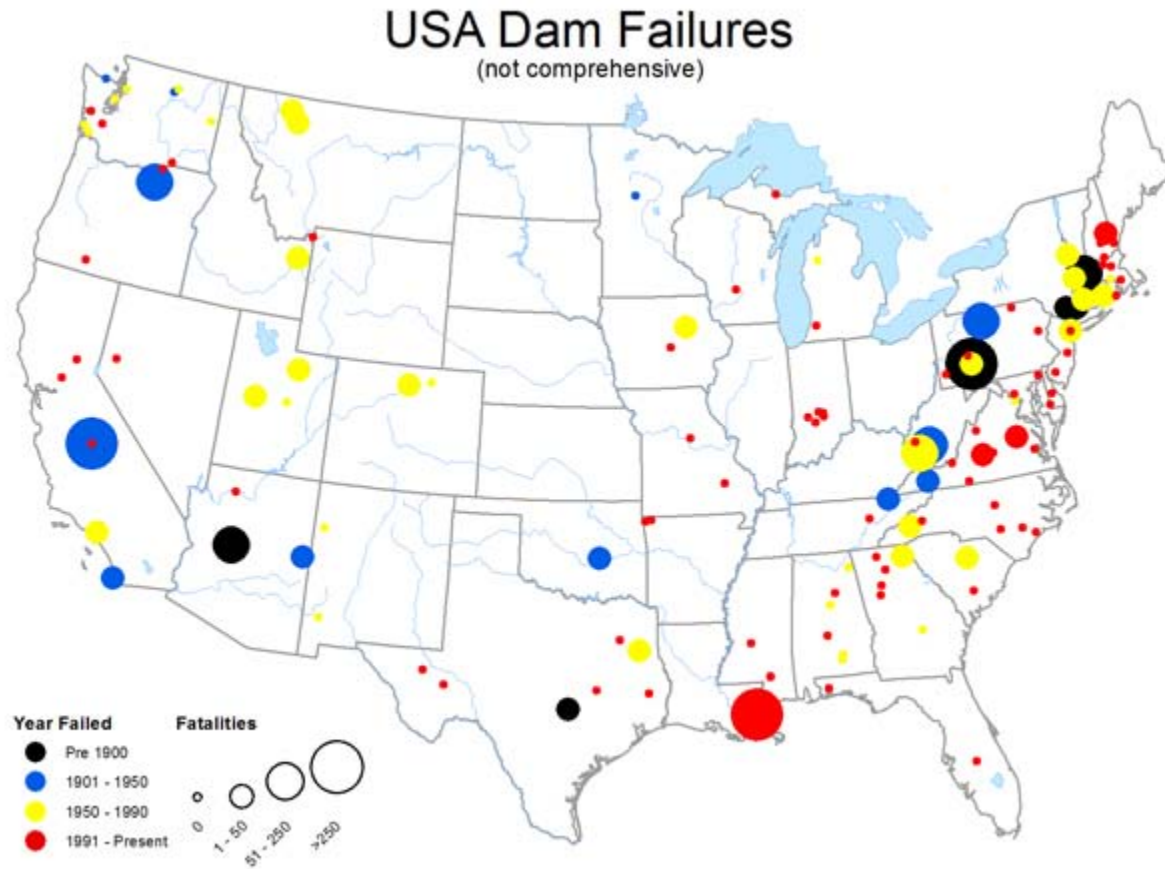
# Is Gray Infrastructure Resilient?



When it's not.. Bad things happen



# Are Dams Resilient?



# When it's not.. Bad things happen

## South Carolina

- 18 Dam Breaches
- 19 Deaths
- 350,000 customers boiling water
- 300 Roads and Bridges remain closed as of 10/12/15



# Numbers by the states (taken from ASDSO)

|                | #State regulated dams | # High-Hazard Dam Potential | % HH Inspected in 2014 | Annual Budget | Dams Per FTE |
|----------------|-----------------------|-----------------------------|------------------------|---------------|--------------|
| South Carolina | 2499                  | 7                           | 32                     | 260,000       | 379.8        |
| Maryland       | 439                   | 18                          | 96                     | 481,780       | 92.4         |
|                |                       |                             |                        |               |              |

# Is Green Infrastructure Resilient?

“Defined as the integration of natural systems and processes, or engineered systems that mimic natural system and processes, into investments in resilient infrastructure.

Green infrastructure takes advantage of the services and natural defenses provided by land and water systems such as wetlands, natural areas, vegetated sand dunes and forests, while contributing to the health and quality of life of America’s communities.”



# Who Pays?

## Who We Are - EFC @ UMD



- 1 of 10 university-based Environmental Finance Centers.
- We serve the Mid-Atlantic including VA, MD, DE, PA, WV, and Washington, DC.
- History: supported by the EPA to help communities and municipalities with "How to pay?"

Sponsorship, among others:

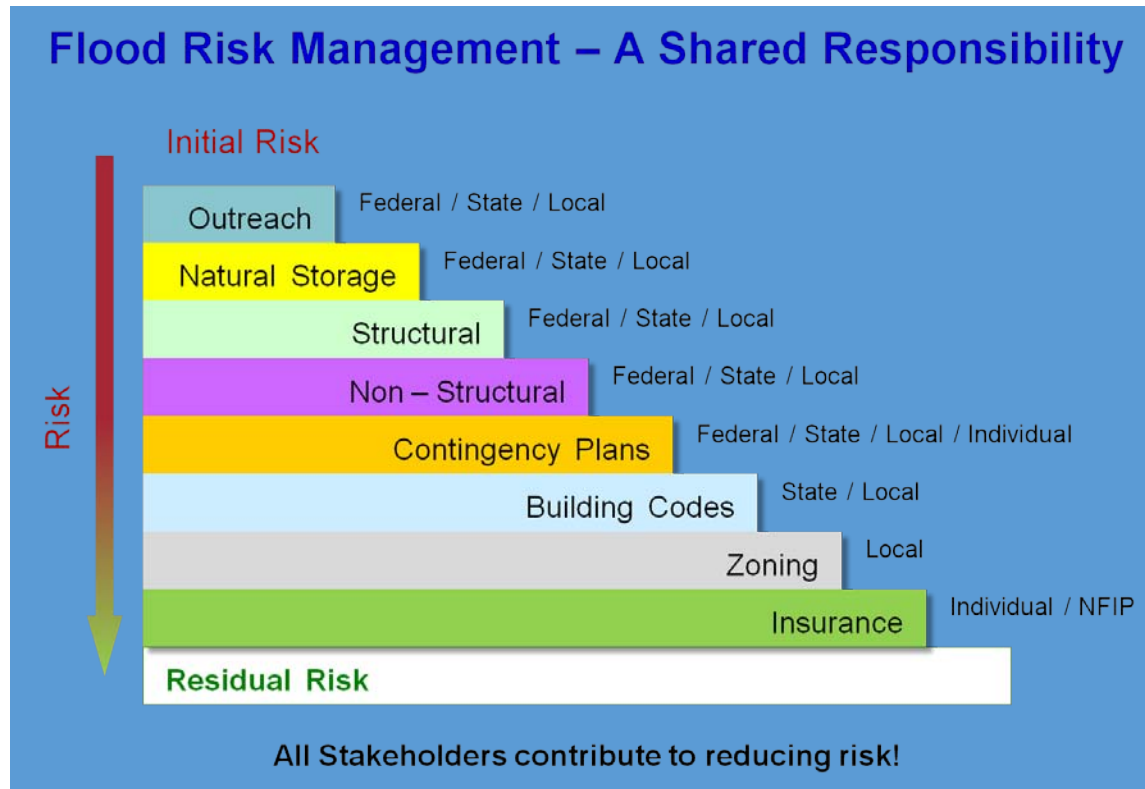


## A Here and Now Problem: High Water

- Oxford experiences regular nuisance flooding in its Historic District and across the main road into/out of Town.
- Much of the stormwater infrastructure is undersized or aged. The Town *was* budgeting for a stable problem when in reality it is a rapidly worsening problem.



# Who owns resilience?



USACE graphic of shared responsibility



# Last Thought:

“The world will not evolve past its current state of crisis by using the same thinking that created the situation.”

Albert Einstein





**Fear the Turtle**

# Is this resilience?

