Can we weather the storm?
The Path to Resilient Infrastructure

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“Snapshots for Floodplain and Stormwater Management”

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

www.cdr.umd.edu

Department of Civil and Environmental Engineering
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
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
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 mi² of land in the US

- <10% < 20%

or 275,351 mi² comprise Coastal Shoreline Counties

or 511,971 mi² comprise Coastal Watershed Counties

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

- 39% 52%

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

- Coastal Shoreline Counties: 446 persons/mi²
- Coastal Watershed Counties: 319 persons/mi²
- United States: 105 persons/mi²

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 Just 40 Years: 1970-2010

- Coastal Shoreline Counties added 125 persons/mi²
- Coastal Watershed Counties added 99 persons/mi²

United States as a whole added 36 persons/mi²

Note: Land area and density values exclude Alaska. Population values include Alaska and US Territories. Source: U.S. Census Bureau, 2010; NOAA, 2012; Crowell et al., 2020
## Coastal Watershed Counties

<table>
<thead>
<tr>
<th></th>
<th>Persons/sq.mi. 2010</th>
<th>% Change in Population 1970-2010</th>
<th>% Change projected 2010-2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nationally</td>
<td>319</td>
<td>45</td>
<td>9</td>
</tr>
<tr>
<td>Maryland</td>
<td>703</td>
<td>40</td>
<td>8</td>
</tr>
</tbody>
</table>

What’s Vulnerable?

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

What’s it worth?  
$$$$$$
Are all disasters based on catastrophic events?
Happening in neighborhoods near you...
Annapolis December 21, 2014

From Annapolis Patch
Is America’s Infrastructure Resilient?

<table>
<thead>
<tr>
<th>Category</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td>D</td>
</tr>
<tr>
<td>Bridges</td>
<td>C+</td>
</tr>
<tr>
<td>Dams</td>
<td>D</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>D</td>
</tr>
<tr>
<td>Energy</td>
<td>D+</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>D</td>
</tr>
<tr>
<td>Inland Waterways</td>
<td>D+</td>
</tr>
<tr>
<td>Levees</td>
<td>D+</td>
</tr>
<tr>
<td>Ports</td>
<td>C</td>
</tr>
<tr>
<td>Public Parks and Recreation</td>
<td>C-</td>
</tr>
<tr>
<td>Rail</td>
<td>C+</td>
</tr>
<tr>
<td>Roads</td>
<td>D</td>
</tr>
<tr>
<td>Schools</td>
<td>D</td>
</tr>
<tr>
<td>Solid Waste</td>
<td>B-</td>
</tr>
<tr>
<td>Transit</td>
<td>D</td>
</tr>
<tr>
<td>Wastewater</td>
<td>D</td>
</tr>
</tbody>
</table>

Each category was evaluated on the basis of capacity, condition, funding, future need, operation and maintenance, public safety and resilience.

Methodology:

A = Exceptional
B = Good
C = Mediocre
D = Poor
F = Failing

Estimated investment needed by 2020: $3.6 trillion

http://www.asce.org/reportcard/
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)

<table>
<thead>
<tr>
<th>State</th>
<th># State regulated dams</th>
<th># High-Hazard Dam Potential</th>
<th>% HH Inspected in 2014</th>
<th>Annual Budget</th>
<th>Dams Per FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Carolina</td>
<td>2499</td>
<td>7</td>
<td>32</td>
<td>260,000</td>
<td>379.8</td>
</tr>
<tr>
<td>Maryland</td>
<td>439</td>
<td>18</td>
<td>96</td>
<td>481,780</td>
<td>92.4</td>
</tr>
</tbody>
</table>
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?

Flood Risk Management – A Shared Responsibility

All Stakeholders contribute to reducing risk!

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?

Center for Disaster Resilience