Building Resilience to Flooding

A Complex—but Achievable—Challenge

Jim Fox, Matt Hutchins, Greg Dobson

Photo courtesy of the J.B. Mills Collection and Betty Mills Thomas
Pinetops, North Carolina | 2016 (Charlotte Observer)
What is Resilience?

Resilience is investing now for a better future.

What’s the Solution?

- Risk Analysis Framework
- Quantified Assessment
- Implementable Options
Our Approach: the U.S. Climate Resilience Toolkit’s Steps to Resilience

1. Explore Threats
2. Assess Vulnerability & Risks
3. Investigate Options
4. Prioritize & Plan
5. Take Action
A model for assessing vulnerability and risk

- Climate is integrated with other threats and stressors
- Vulnerability is (mostly) linked to hazards
- Risk is (mostly) linked to stressors
Many Causes of Flooding

- Riverine
- Heavy precipitation driven
- Storm Surge tied to Tropical Storms
- Tidal

Assets (People and Infrastructure)
Risk is increasing due to the

- Changing severity and frequency of heavy precipitation events
- Sea Level Rise
- Increasing amounts of impervious surfaces
- Other factors
The Problem in Context

Heavy Precipitation Driven Flooding

**Annual Frequency of Extreme Heavy Precipitation Events**

- **Wetter**
- **Drier**

*2-day precipitation total that is exceeded on average only once in a five-year period, also known as a once-in-five-year event*

**Seven years of 500-year storms**

Locations of major 500-year rains since 2010 analyzed by the Hydrometeorological Design Studies Center of the National Weather Service

Source: National Weather Service
The frequency and severity of extreme weather events is increasing, leading to increased risk of riverine flooding.
The Problem in Context
Increasing probability and severity of tidal-driven flooding

Billy Sweet, NOAA, 2017
The Problem in Context
Riverine Flooding - Consider not just the local watershed...but also what’s upstream
The Problem in Context - Flood Exposure - Asheville

Buncombe County Multi-Hazard Risk Exposure Tool
The Problem in Context - NOAA Sea Level Rise Map - Charleston

Slide Courtesy Mark Wilbert, City of Charleston Resilience Director
Process to Build Resilience - Quantify vulnerability and risk
Quantify vulnerability and risk

Same exposure...
Quantify vulnerability and risk

... different sensitivity and adaptive capacity.
Biltmore Village, Asheville -
Understanding what drives Vulnerability and Risk yields better decisions

AccelAdapt, City of Asheville
Loss of Critical Access

Loss of access can be more problematic than direct impacts

City of Asheville Resilience Assessment
Actions to Build Resilience need to be our Focus

- Stressors are changing
- Actions to build resilience are linked to assets and non-climate stressors
- Decisions are driven by values attached to assets
Identify Options: Target All Aspects of Vulnerability

Reduce Exposure

Build Adaptive Capacity

Reduce Sensitivity of Key Systems

Assist with Response and Recovery
Options linked to specific type of flooding and asset type impacted

- Stormwater
- Sea Walls
- Harden Dams
- Buyouts to Reduce Exposure
- Many others...
Flooding due to Rainfall & Infrastructure

Note that the option is linked to specific asset (and asset/threat pair!)

Heavy Precipitation → Flooding → Stormwater Actions
Lost mobility and Property Damage → Roads, Buildings and Property

Using Demonstration Storms to Prepare for Extreme Rainfall

An extreme precipitation event in 2008 cost one town more than a million dollars in infrastructure repairs. Now, other municipalities can simulate how their homes, businesses, and facilities might fare if they experienced a similar event.

Heavy rain

Prolonged heavy rains over south central Wisconsin in June 2008 did not particularly concern Reedsburg Public Works Director Steve Zibell. After all, just two years earlier the city had completed an $11 million upgrade to their wastewater treatment plant, including construction of a new berm along the Baraboo River to protect the plant from a 100-year flood. However, after two weeks a whopping 14 inches of rain had fallen across the area, and river levels rose two feet higher than the new berm. The new treatment plant was inundated and inoperable for weeks, discharging raw sewage into the Baraboo River.

After spending $850,000 in repairs, plus $400,000 to raise the berm an additional three feet, Zibell feels that...
Limited Points of Access

Note that the option is linked to specific asset (and asset/threat pair!)

- **Sea Level Rise**
- **Storm Surge**
- **Flooding**
  - **Lost mobility and connectivity**
  - **Replace Highway and Bridge**
  - **Roads and Bridges**
Building Adaptive Capacity for Buildings

Note that the option is linked to specific asset (and asset/threat pair!)

Heavy Precipitation

Flooding

Lost business and access

Buildings

Build new building with base floor 2 foot above flood elevation

Photo courtesy of Scott Shuford
Questions?

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