Resilience in the Age of Climate Change

Resilience in the Age of Climate Change

What do we do when the weather “rules” change?

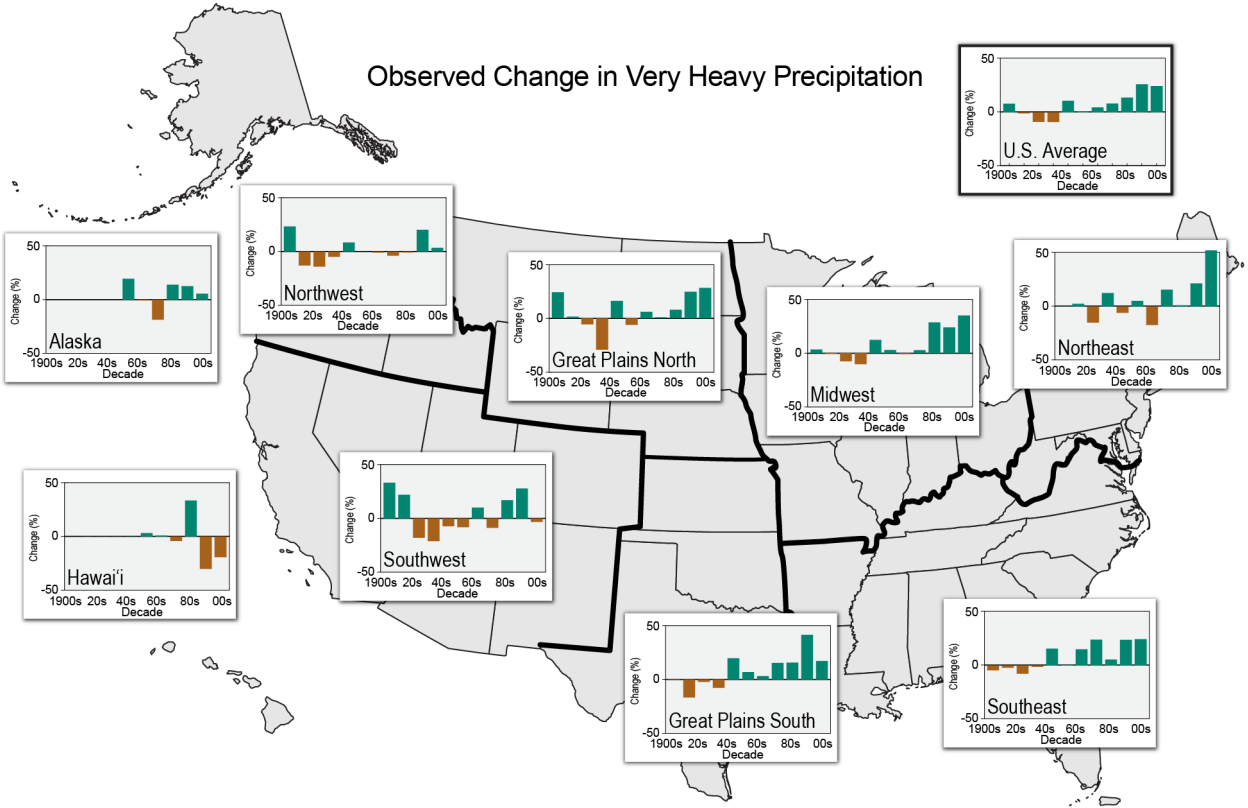
- Design to accommodate
- Manage what we can
- Understand those things we cannot control

Climate Change in Marina Environs

Lakes and Rivers

What is Changing in our environment

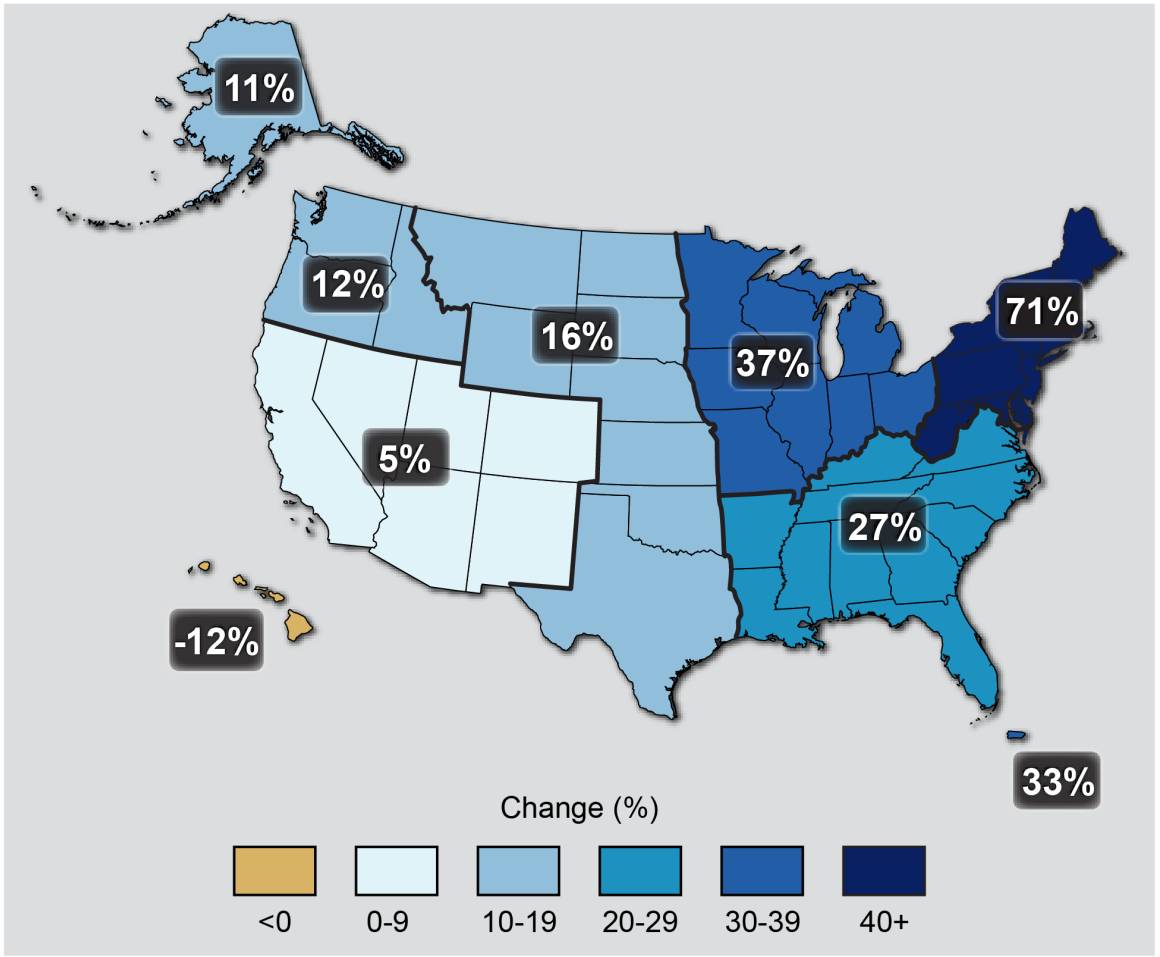
- Climate Change means wilder swings in rainfall.
  - Flooding potential increases
  - Drought conditions will happen, too



Source: US Resilience Toolkit

Changing Rainfall Patterns

The eastern half of the US has already seen significant increases in rainfall

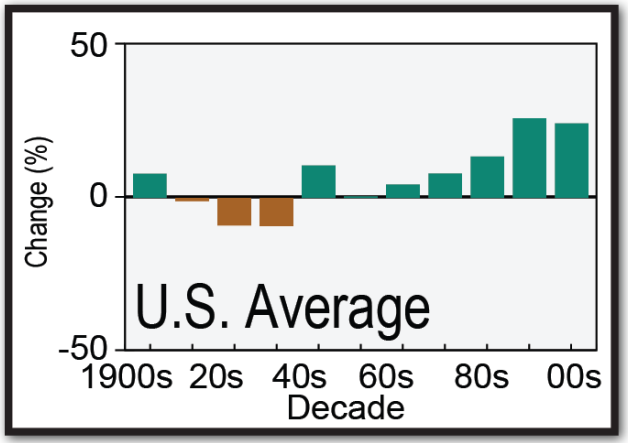


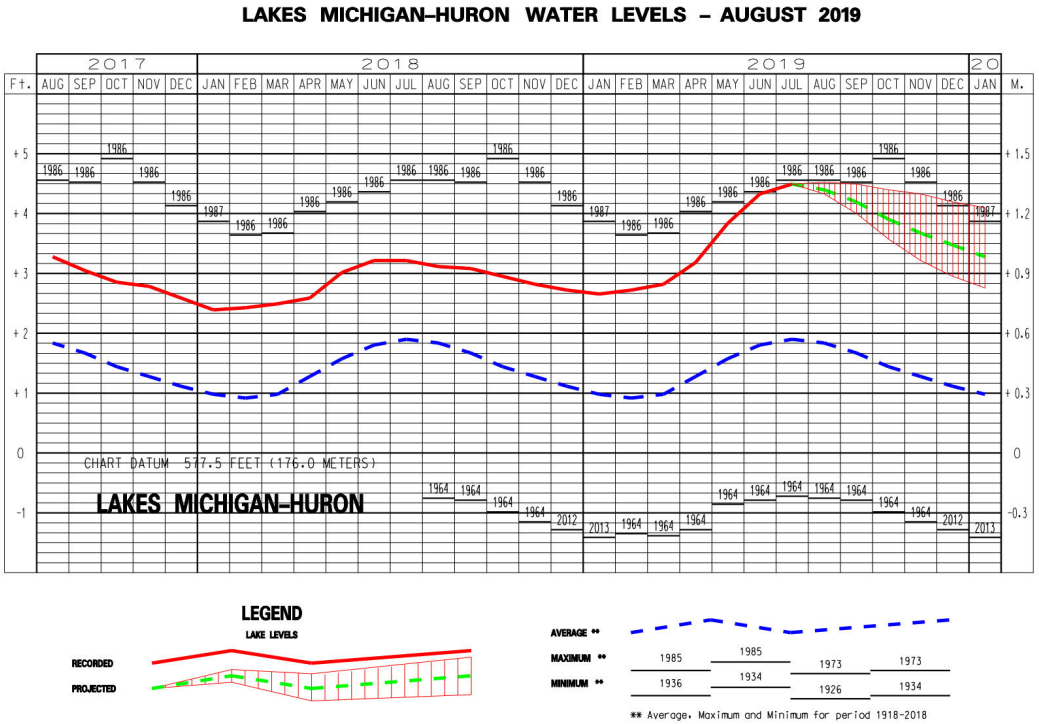
Changing Environs, Changing Rules

- Predicted Flood Elevations
  - Flood maps are often outdated and should not be the only resource used.
- FEMA is making improvements, but their maps should not be design controls.
- USGS is working on improving the tools

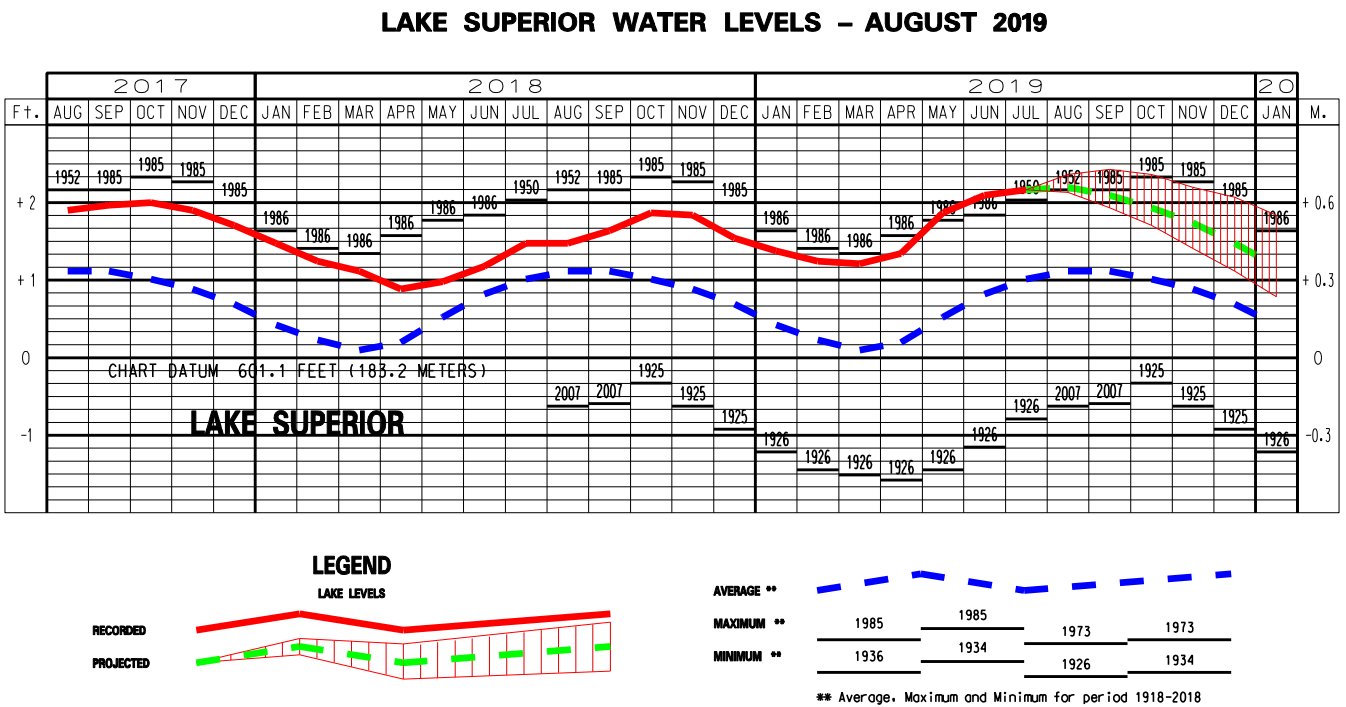
US Rainfall

With more rain, our Lakes and Rivers have to react





RECORD BREAKING!



Designing for Events

- Understanding USACE parameters
  - Using conservative data where applicable
  - Don’t believe “it can’t happen here”
- Taking long term approach to design
  - Higher Highs
  - Lower Lows

MSA

Project Examples

Inland Rivers

Alton Design Controls

- Developed parameters based on 500 year flood predictions and 1993 experiences.
  - Pile design to accommodate full range of flood heights
  - Underwater truss design modified for unusual water level drawdowns
  - Everything either floats or is flood resilient
  - Utility connections were made waterproof or located to minimize risk

Alton Design

Piles were designed to allow full height of levee flooding plus 2’ for floating dock

Alton- Low water during construction

Floating Platforms

Reinforced Concrete Platforms with polystyrene flotation and integrated utilities

Floating Platforms

Building the structural shell upland minimized costs and allowed for quicker construction

Floating Swimming Pool

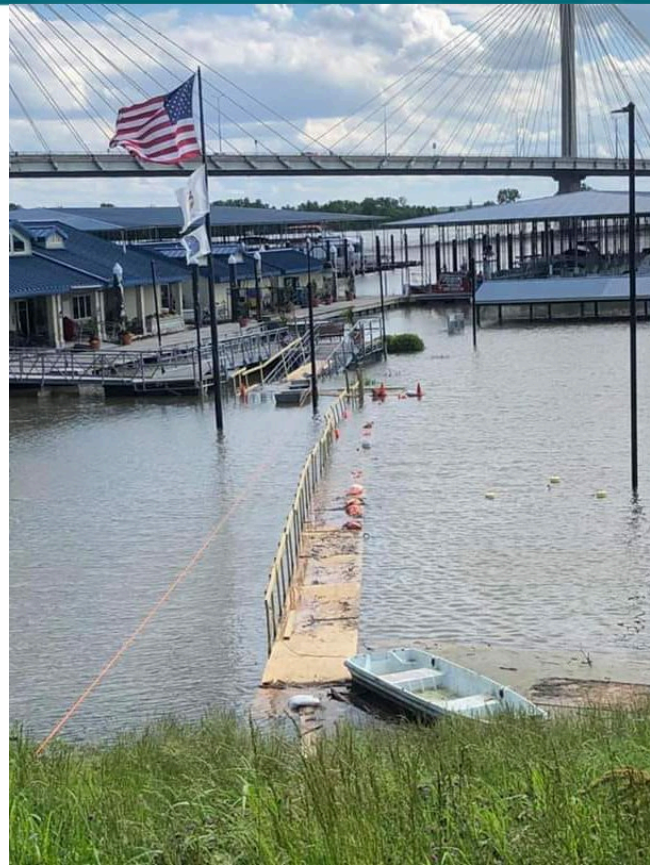
Using traditional design in new ways

Alton Design

Structures vulnerable to flooding were designed to float

Fuel systems using fuel barges

Alton 2019 Flood




Henry St
67
Landmarks Blvd
67
Ridge St
Marian Heights Dr
Clark Brg
Riverfront Dr
Henry St
Asphalt Damage
Armorstone washout
Light Standard with Silting
Bent Pile Guide
Damaged Pile guide
Stressed Trees
Dead Trees
Cypress Tree
Boat Launch Rd
Discovery Pkwy
Pavilion
Retaining wall and Utility Vault
Trail Dike Failure
Silted Parking
67
Flex Hose
Launch Ramp Silt
Clark Brg
Clark Brg

Post Flood Documentation

Post Flood Documentation

- Cleanup costs significant, unavoidable, and repairable

Alton Flood

Site furnishings require hand washing and in some cases repainting.

Post Flood Lessons Learned

- Extreme conditions will happen; good design can minimize damage
- The right vegetation will survive and revive more quickly.
- Don’t forget the impact of flow through a site.

Other Projects

Other Lessons

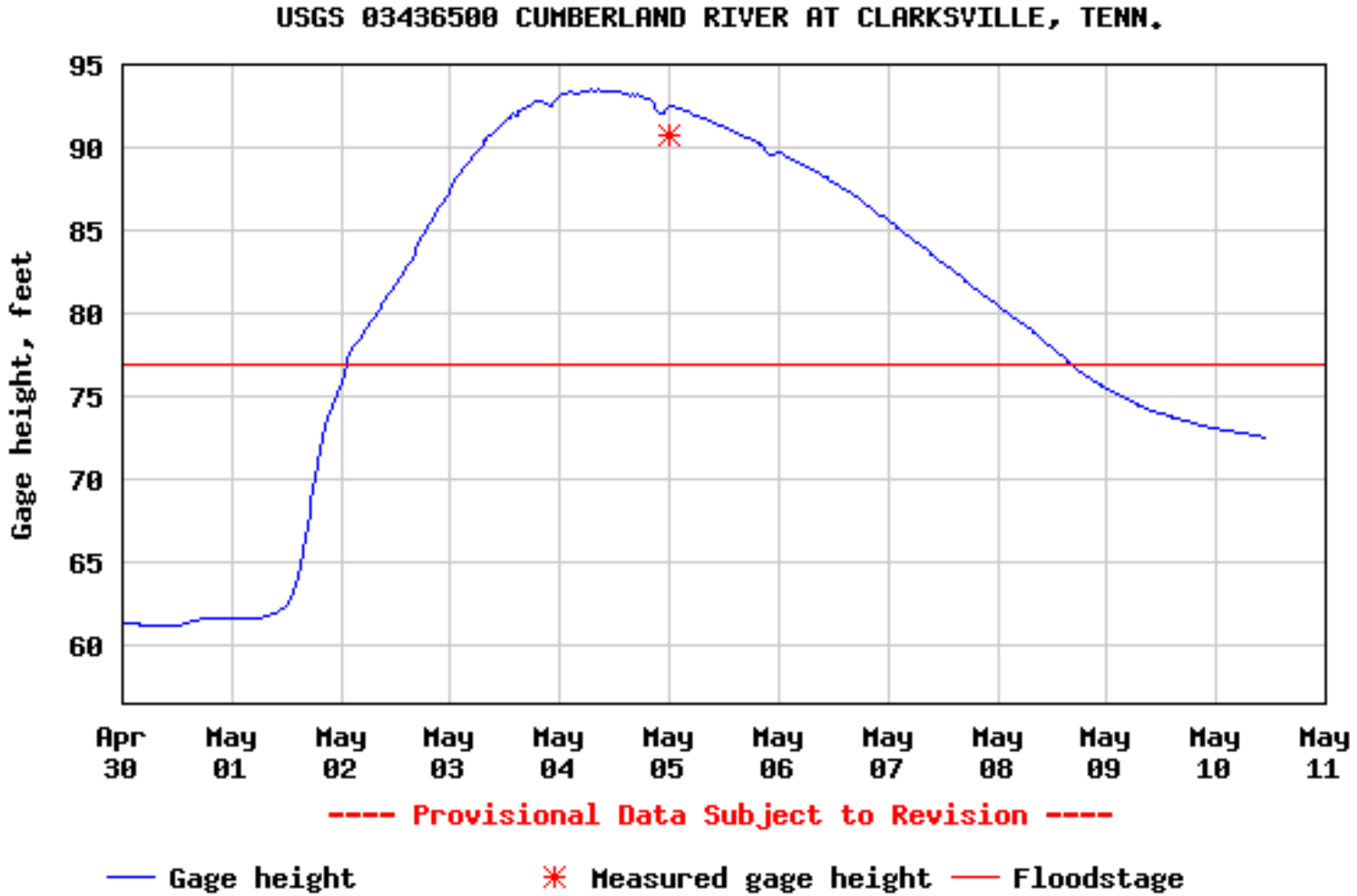
Clarksville Construction

- Designed for 500 year flood in 2008-2009
- Static from locals “It can’t happen here”
- 2010 Cumberland River Flood

Liberty Park

- 37 acres all in flood plain
- All buildings designed to be flood resistant

Liberty Park


USGS 03436500 CUMBERLAND RIVER AT CLARKSVILLE, TENN.
Gage height, feet
95
90
85
80
75
70
65
60
Apr 30
May 01
May 02
May 03
May 04
May 05
May 06
May 07
May 08
May 09
May 10
May 11
---- Provisional Data Subject to Revision ----
Gage height
Measured gage height
Floodstage

Clarksville- Planning for the worst

Clarksville- Electrical Structure

Floating office and ships store

Owensboro Transient Marina

On the Boards

Owensboro Planning

- 40’ Flood heights
- 4-5 knot flow rates
- Debris deflection at all elevations

Owensboro Design

Owensboro

Maintaining Accessibility

Thank You