Floodplains and Riparian Buffers Function and Purpose

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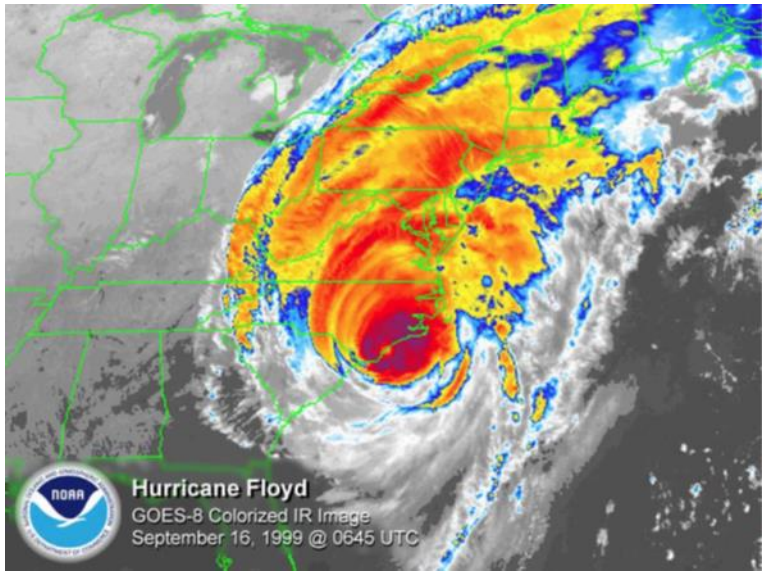
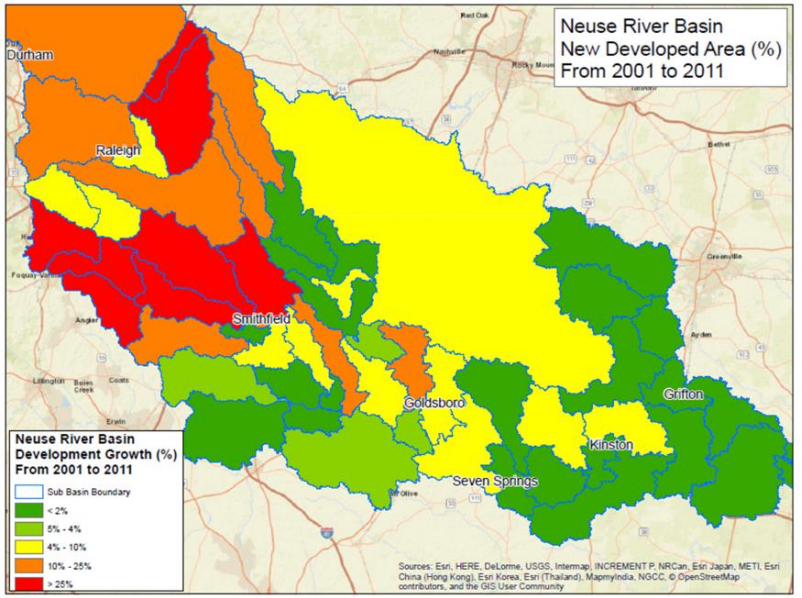


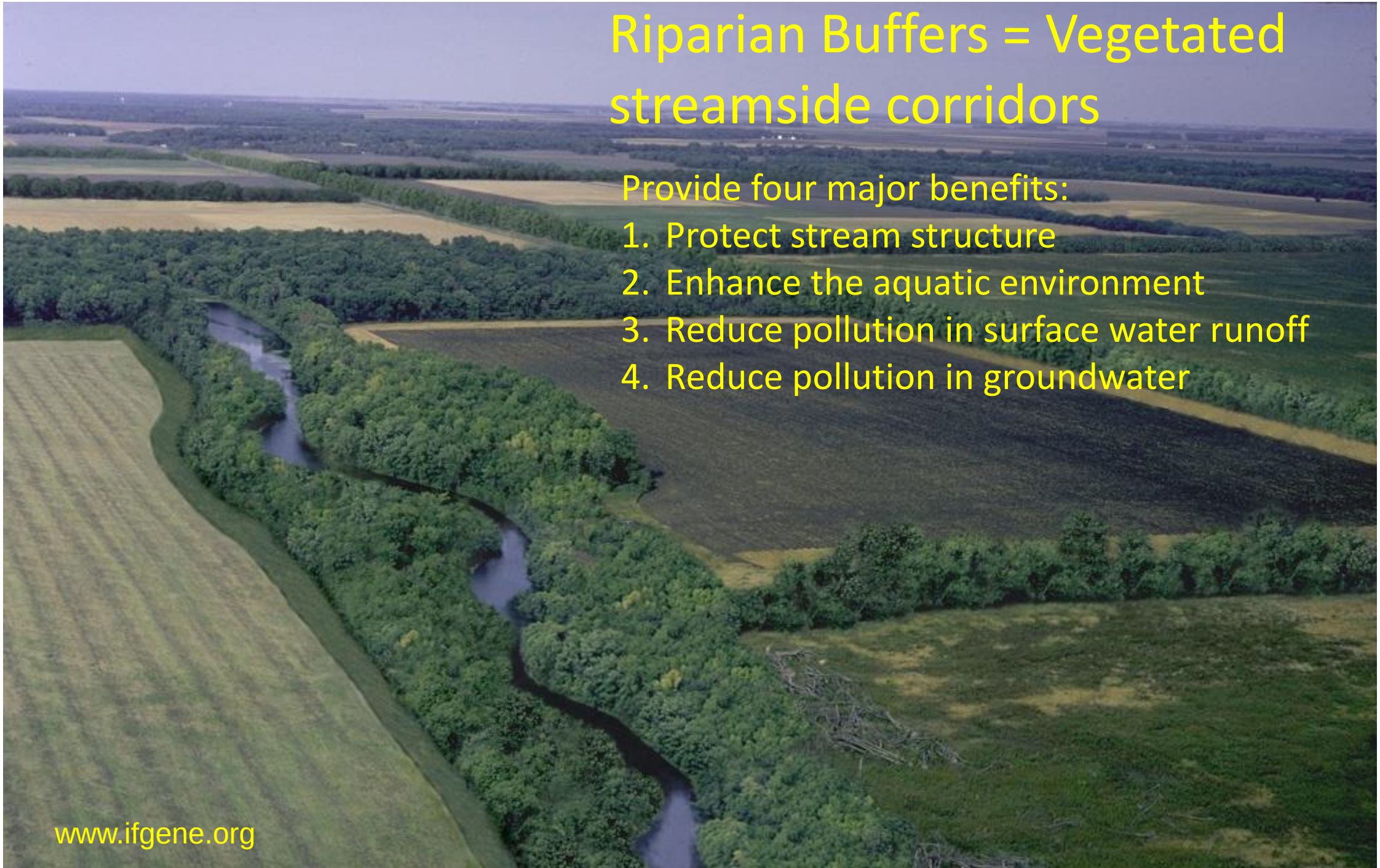


What makes a stream healthy?

1. Stable & diverse streambed
2. Stable streambanks
3. Balanced sediment transport
4. Diverse flow & habitat
5. Healthy riparian buffer
6. Active floodplain
7. Healthy watershed

Stream Impairments

- Straightening & dredging
- Floodplain filling
- Watershed manipulation
- Sedimentation & stormwater
- Pollution discharges
- Utilities & culverts
- Riparian buffer removal
- Disdain & neglect



Riparian Buffers = Vegetated streamside corridors

Provide four major benefits:

1. Protect stream structure
2. Enhance the aquatic environment
3. Reduce pollution in surface water runoff
4. Reduce pollution in groundwater

www.ifgene.org

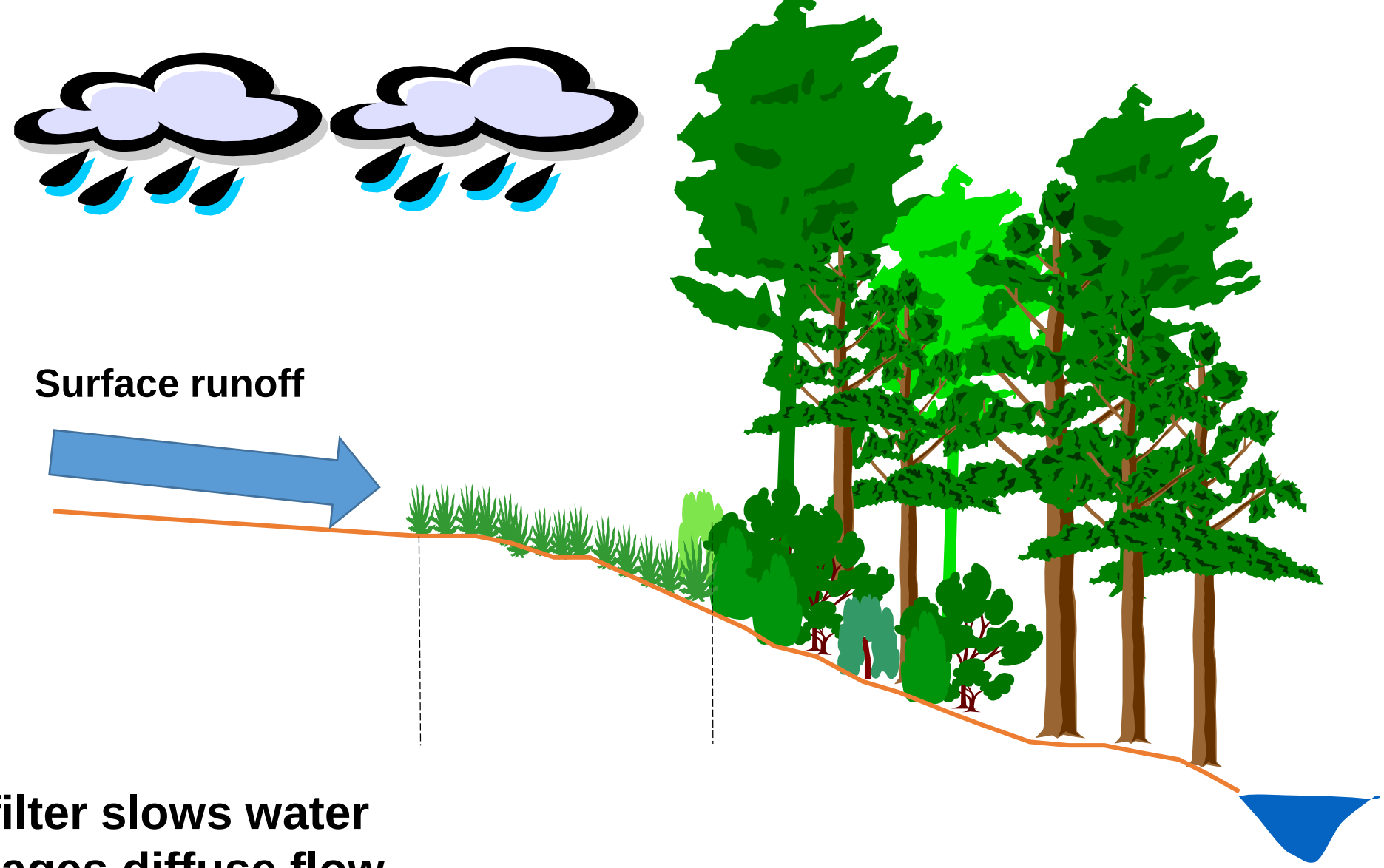
1. Protect stream structure

- Vegetation within the buffer slows surface water down
- Roots near stream stabilize banks (particularly in bends)
- Slower runoff+ reinforced streambanks = less erosion
- Less streambank erosion = less sediment loss downstream

2. Enhance the aquatic environment

- Tree canopy provides shade
  - Temp control
  - Higher oxygen
  - Controls algae
- Leaf litter
  - Carbon and organic nutrients (energy for food web)
  - Habitat
- Coarse woody debris
  - Habitat

3. Reduce pollution in surface water runoff - sediment and phosphorus



- **Grass filter slows water**
- **Encourages diffuse flow**
- **Sediment and sediment –bound Phosphorus is deposited**
- **Sediment can be trapped, P uptake by vegetation possible**

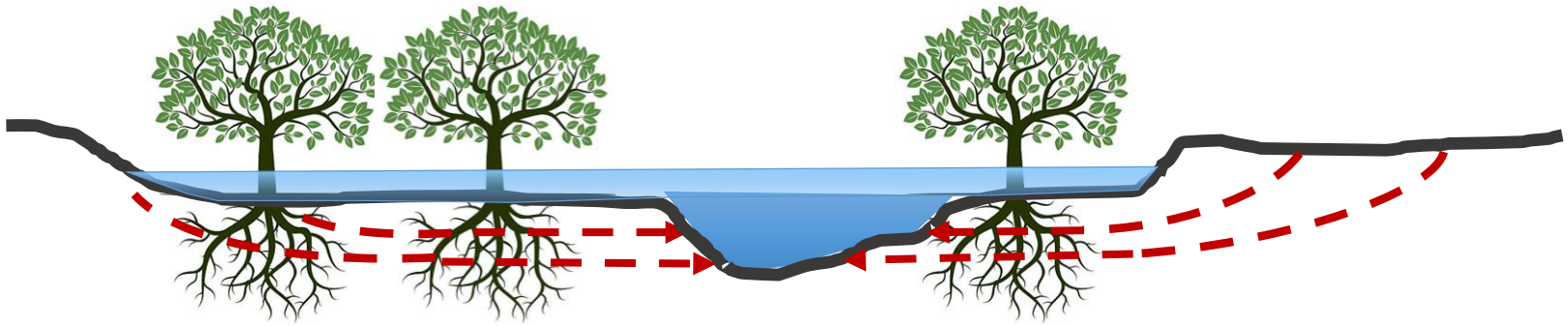
4. Reduce pollution in <u>groundwater</u> (nitrate-nitrogen)

Buffers **<u>can</u>** be effective sinks of **NO_3** through

1. **microbial denitrification**
2. **plant uptake**

Active Floodplain = Stable & Healthy Stream

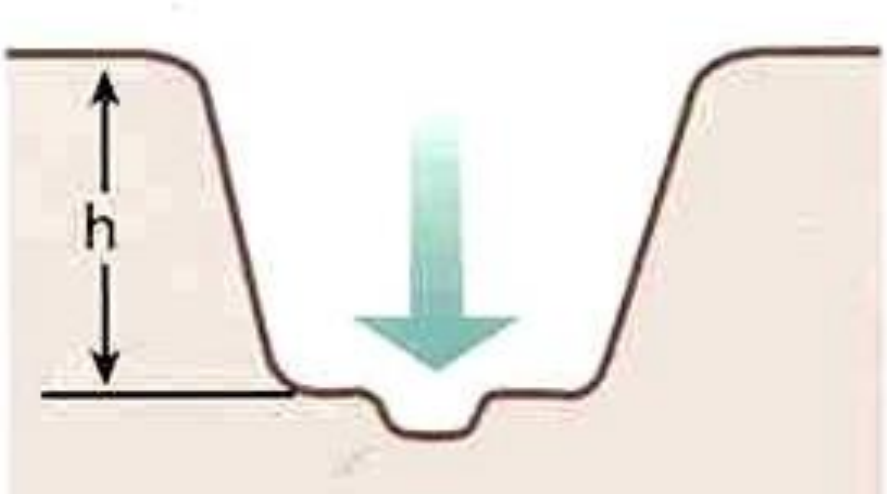
- Well-defined channel and floodplain
- Water will frequently flow onto the floodplain, which will help to dissipate energy during high flows (Return Period of 1 to 2 years)
- Infiltrated runoff will flow through the rootzone of the buffer



Active Floodplain Reduces Downstream Flooding

- Excess water storage
- Flow rate and erosion reduction
- Slow runoff

Urban hydrology results in stream incision and reduced base flow

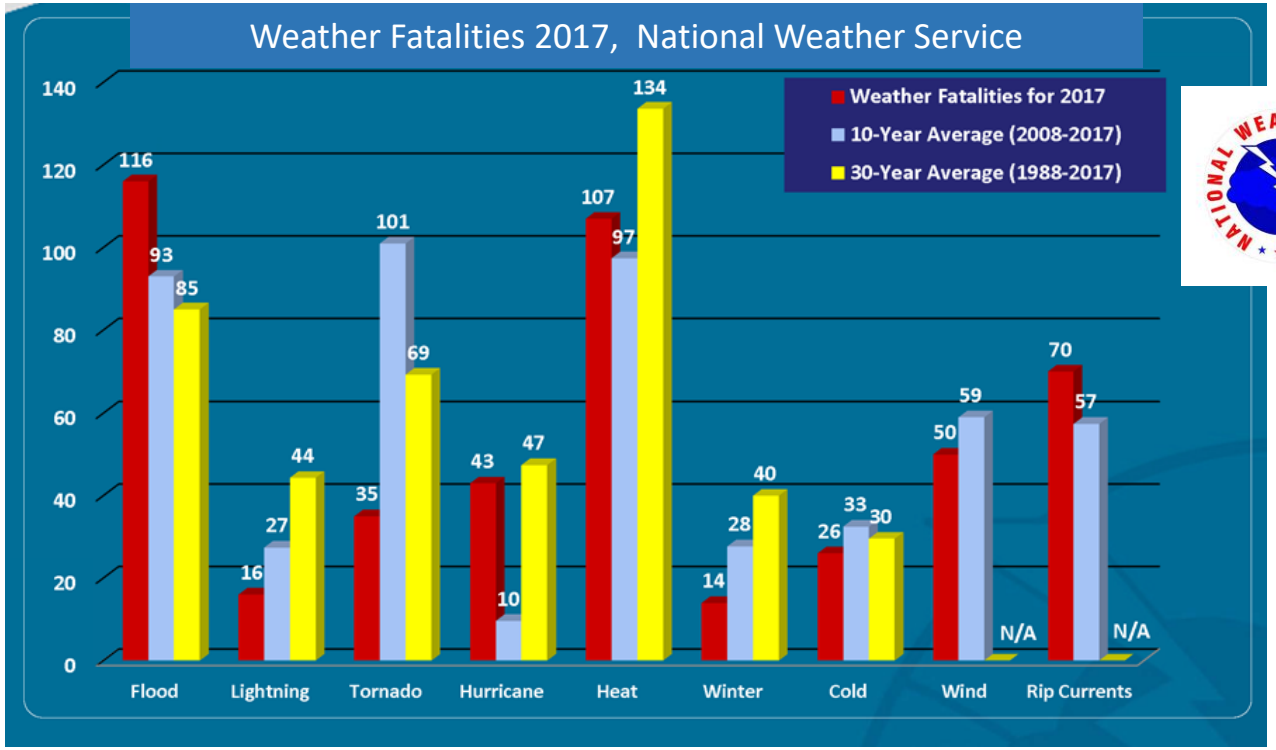


Stream & Floodplain Restoration

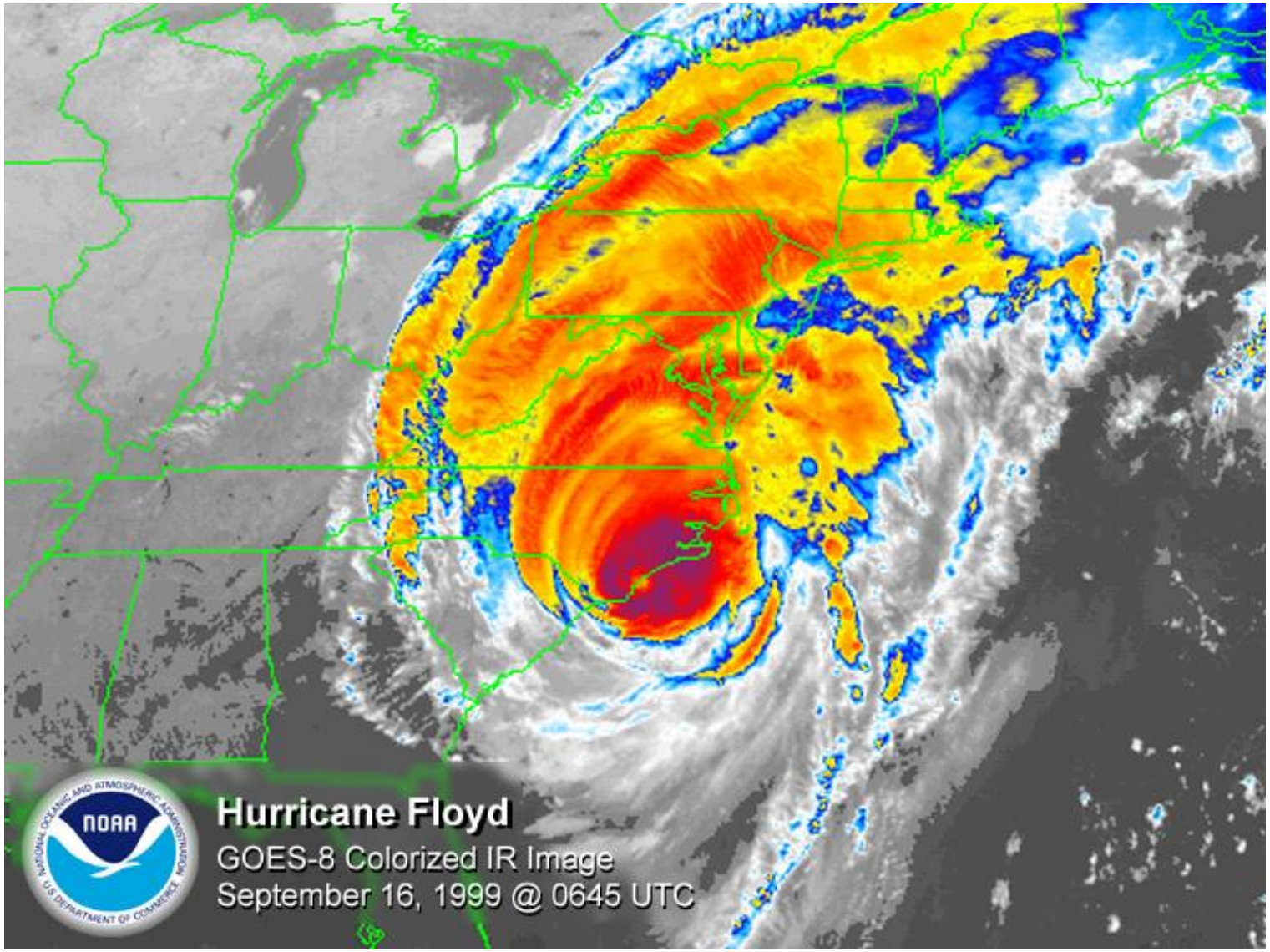
Cost of Flooding (U.S.)

- 85 deaths per year (30-year average)
- $59 billion in property damage (2017)
- 90% of all US natural disasters result from flooding. (National Oceanic and Atmospheric Administration, 2005)
- 41 million U.S. residents – about 13 percent of the entire population– are at risk from flooding along rivers. 3 X more than FEMA regulatory flood map (100-year) estimates- *Environmental Research Letters, 2018*

Hurricane Matthew, Hope Mills, N.C., October 2016
Drone Image by Quavas Hart, Source: NPR

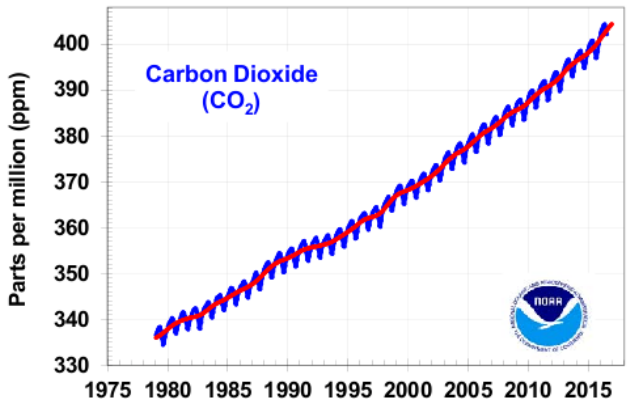


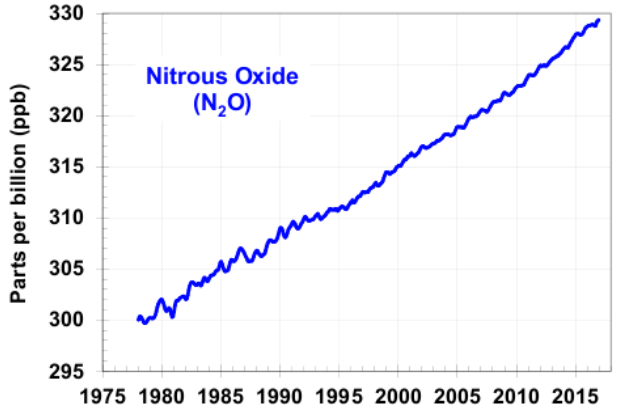
More Severe Weather Patterns

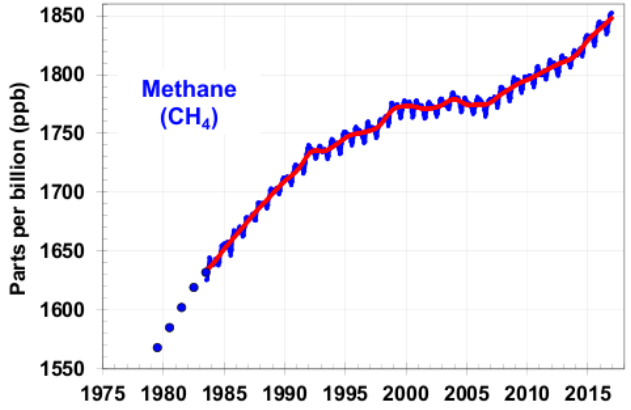


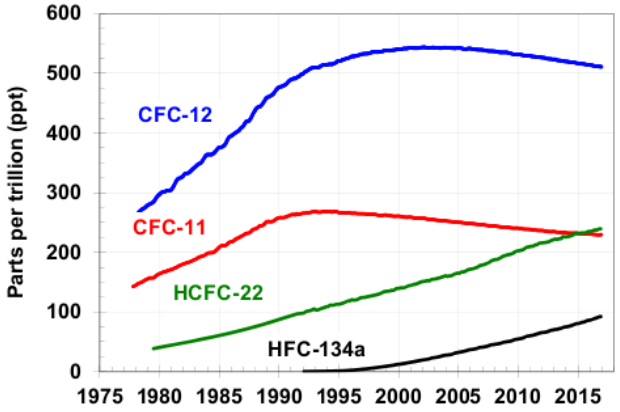
A shot of greenhouse gases

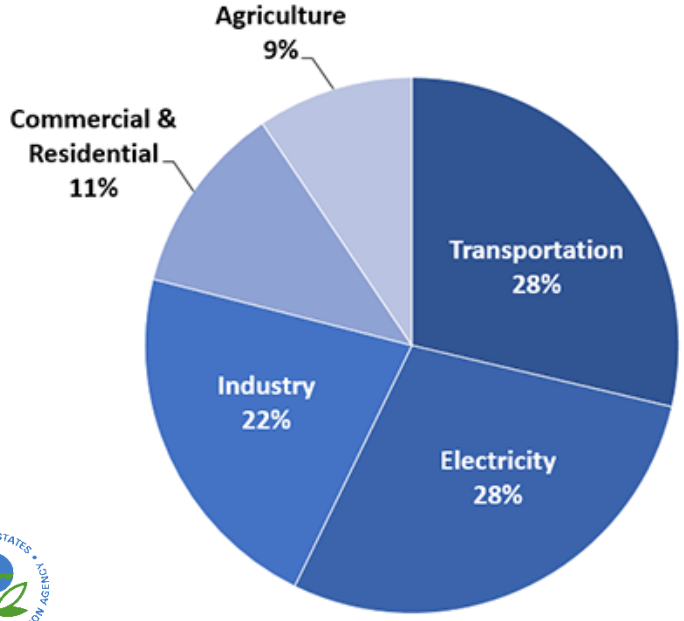
trapping heat in the atmosphere

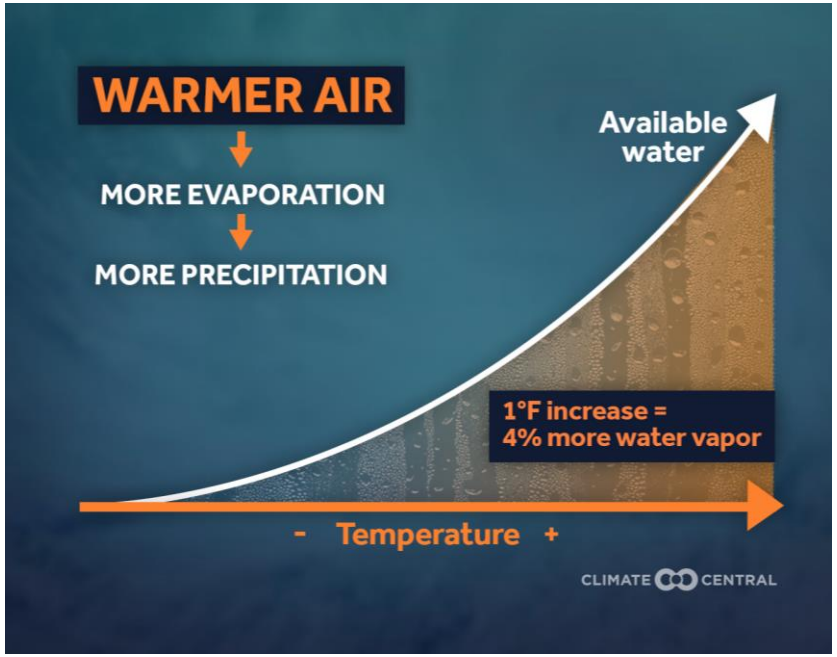




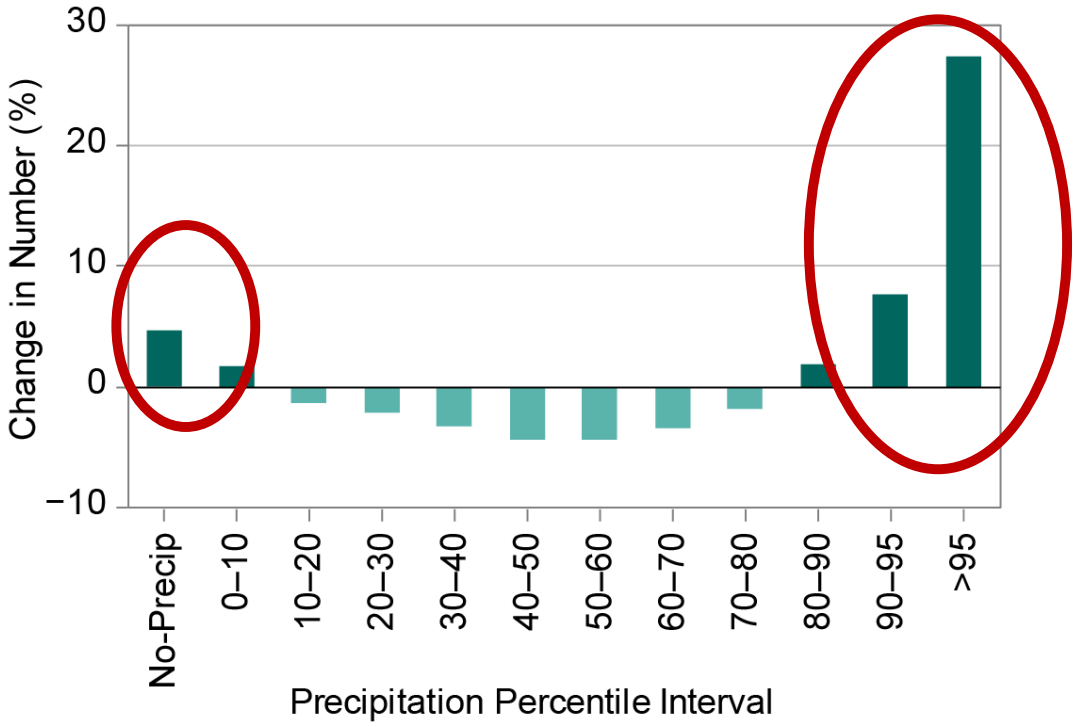







WARMER AIR
MORE EVAPORATION
MORE PRECIPITATION
Available water
1°F increase = 4% more water vapor
- Temperature +
CLIMATE CENTRAL

Future extreme weather?



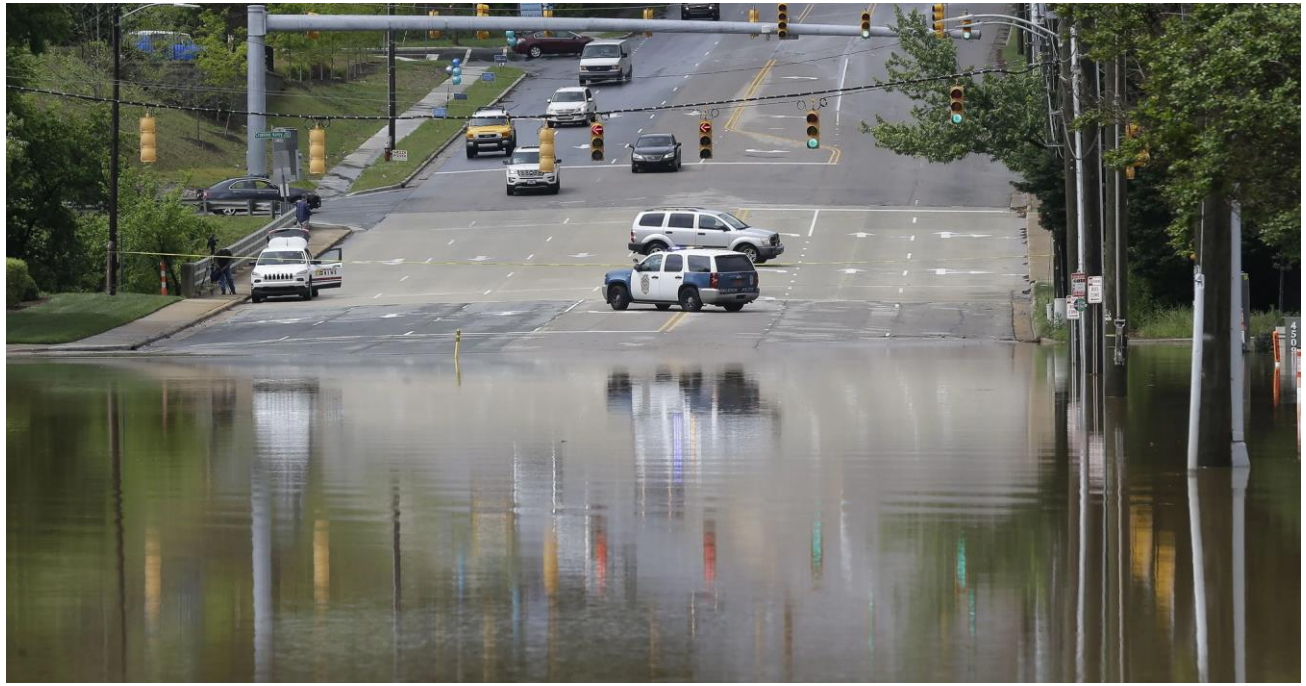
Projected increase in the frequency of light-no rainfall as well as heavy rainfall

What we know as normal is expected to shift with more extreme weather (both droughts and floods)

USCRP, 2017: Climate Science Special Report

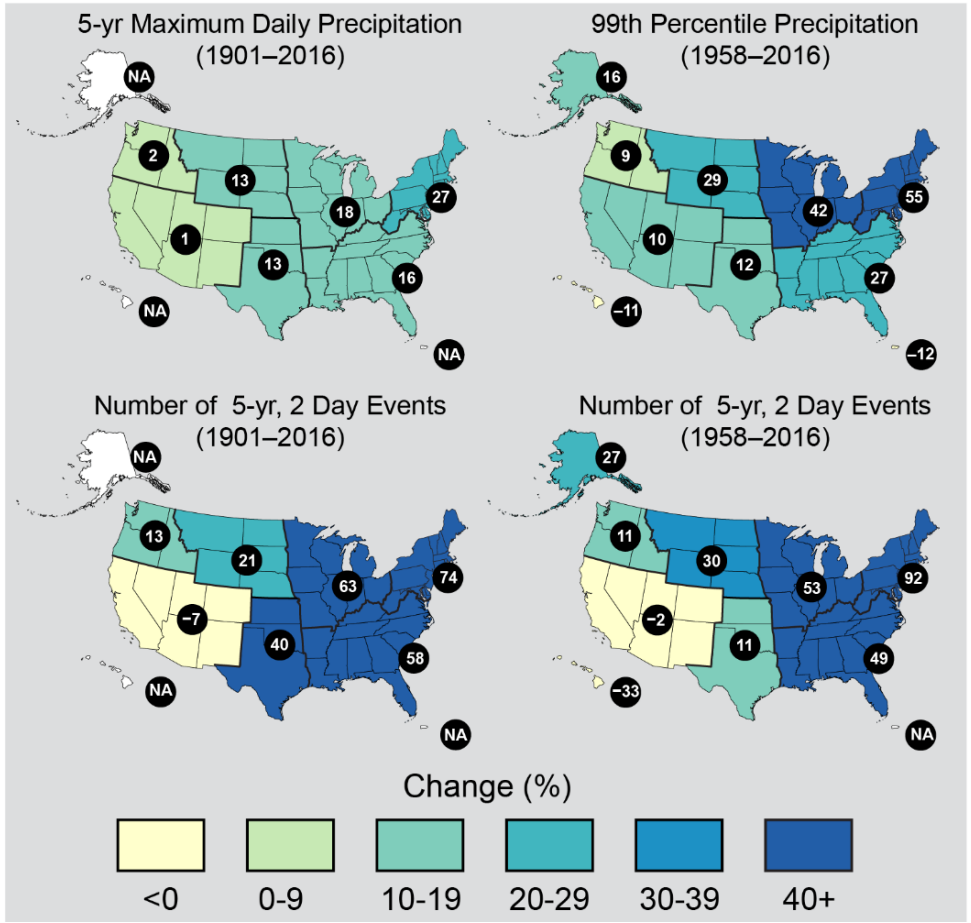
What factors affect how severe the flooding will be?

- Rainfall depth: How much it rains
- Rainfall intensity: How hard it rains
- Rainfall duration: How long it rains
- Antecedent Conditions: How wet are conditions prior to the storm.
- Hydraulic conditions in the river



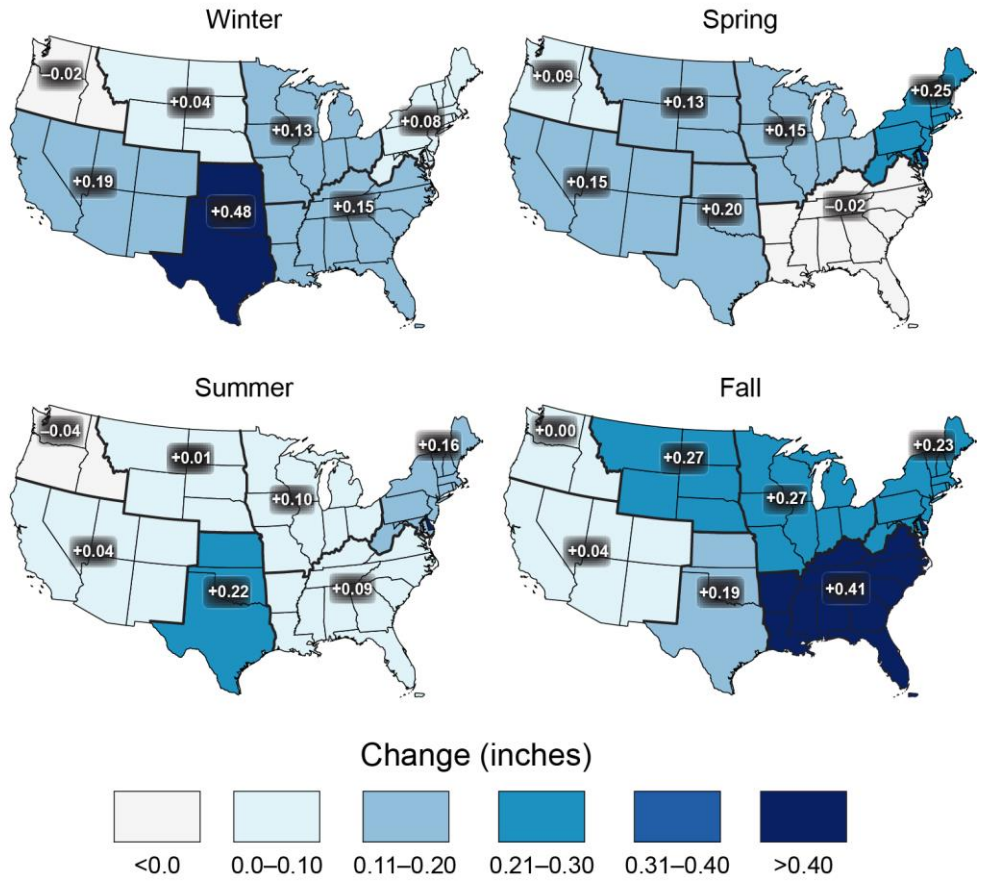
USA Today, April 25, 2017

Observed Change in Heavy Precipitation



Trend towards more very heavy precipitation for the Southeast US

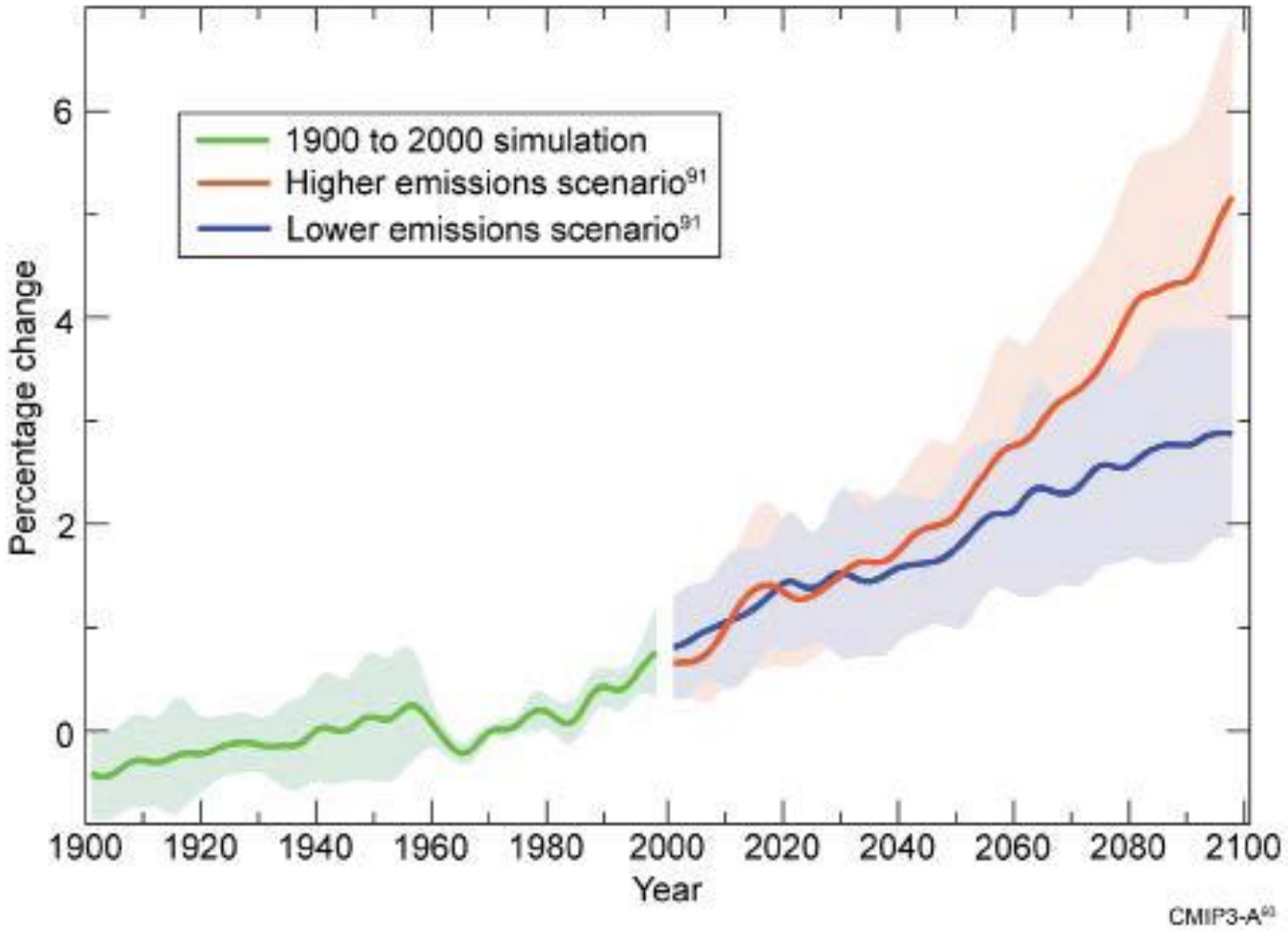
Observed Change in Daily, 20-year Return Level Precipitation



FALL and WINTER notable increases for the Southeast US

USCRP, 2017: Climate Science Special Report

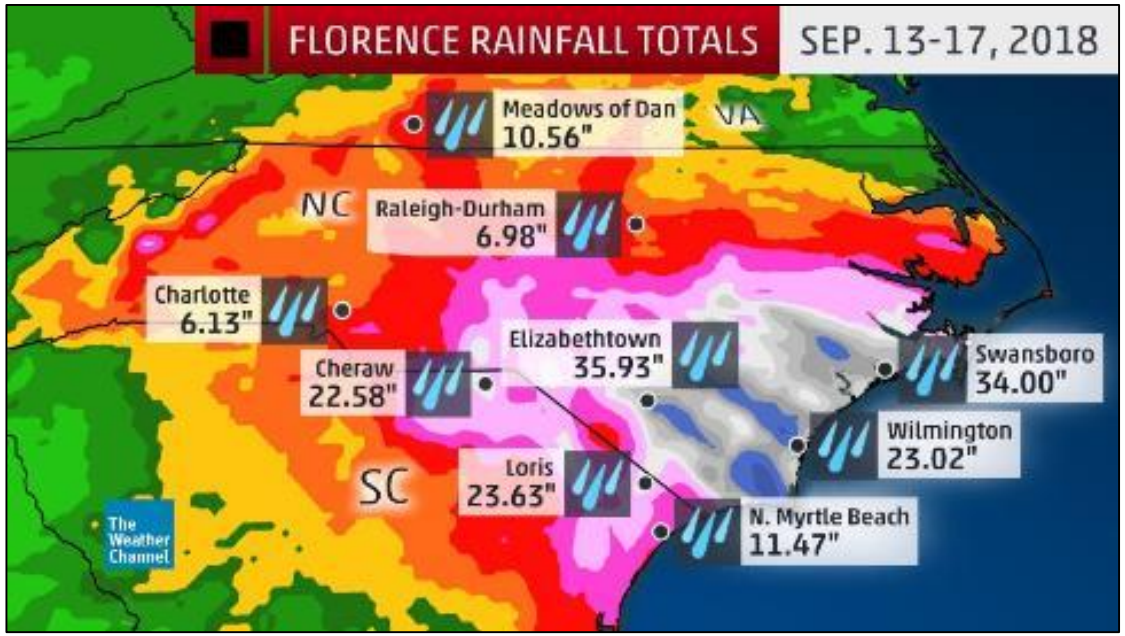
Climate Change will make flooding worse



US Global Change Research Program: Observed and projected increase in the amount of precipitation falling in the largest 5% of daily storm events

N&O, Mark Turner Drone Footage Crabtree Creek, April, 2017

Future extreme weather?



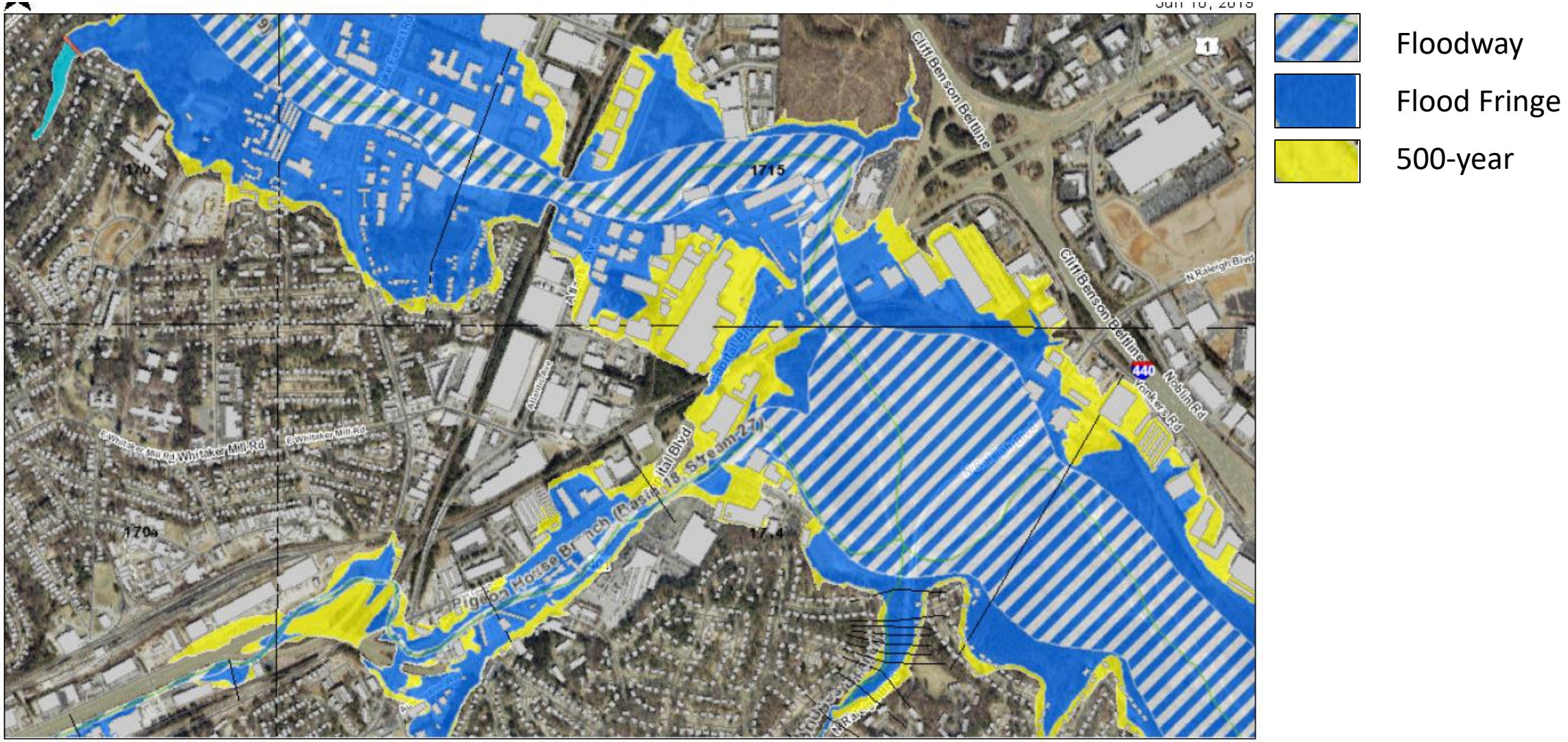
Source: The Weather Channel, NOAA NWS Preliminary Rainfall Totals

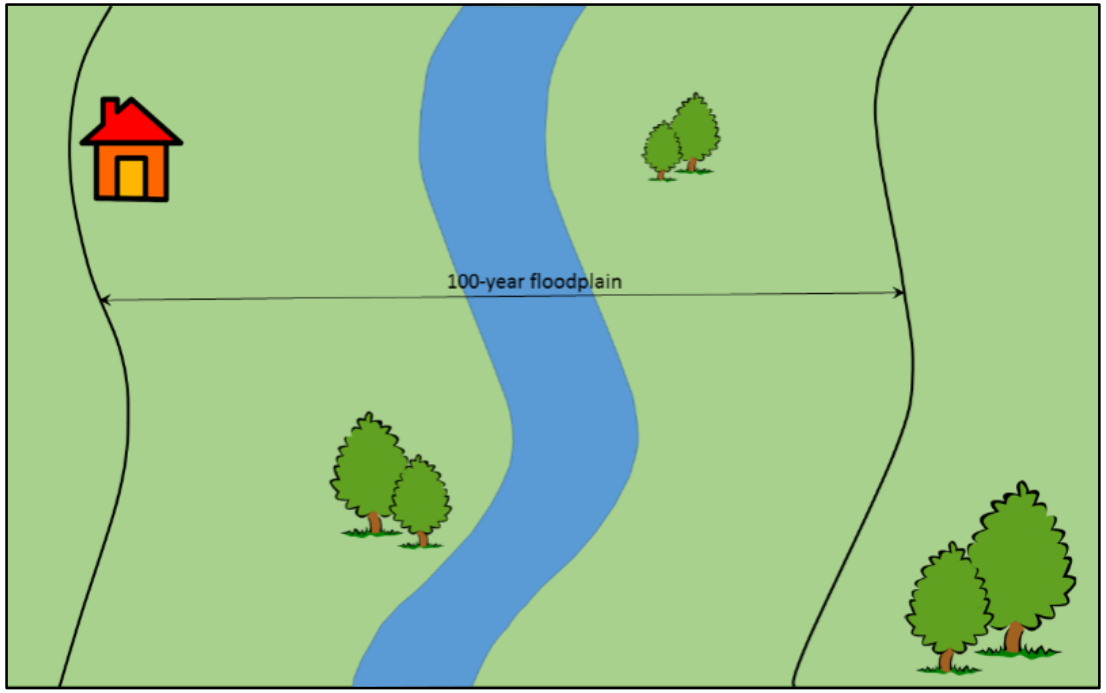
- Matthew - $1.5 billion in damages
- Florence – Estimated $ 1 billion in damages
- Major interstates closed more than a week
- Hundreds of secondary roads washed away (Matthew 830, Florence 481)
- Significant Agricultural Impacts (Florence: 3.4 million chickens and turkeys and about 5,500 hogs)

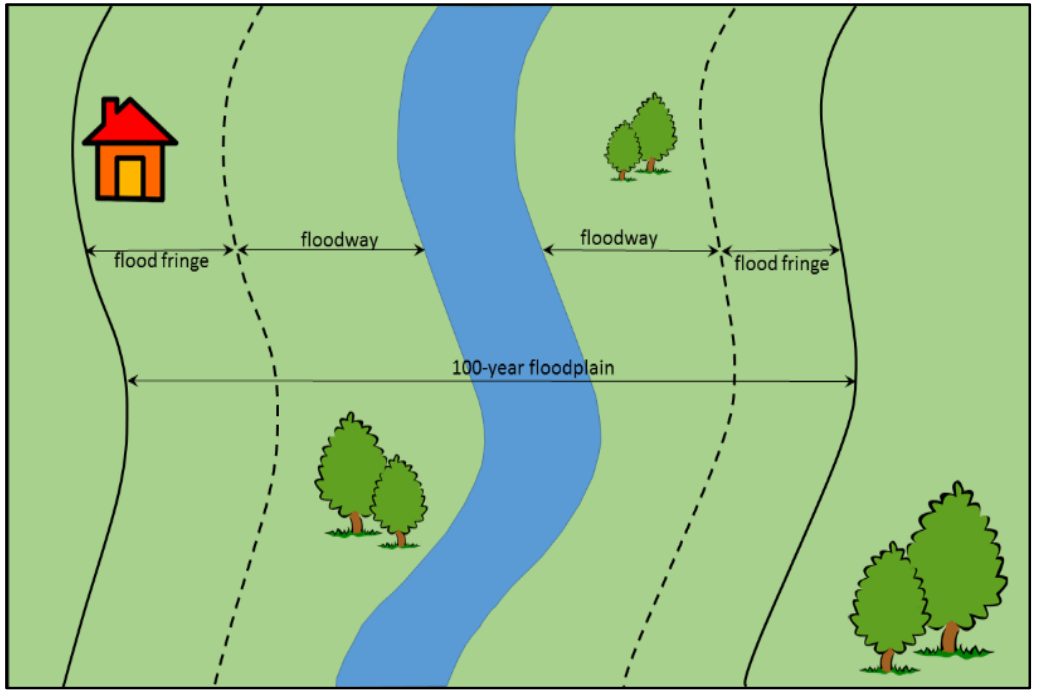
Flood map interpretation

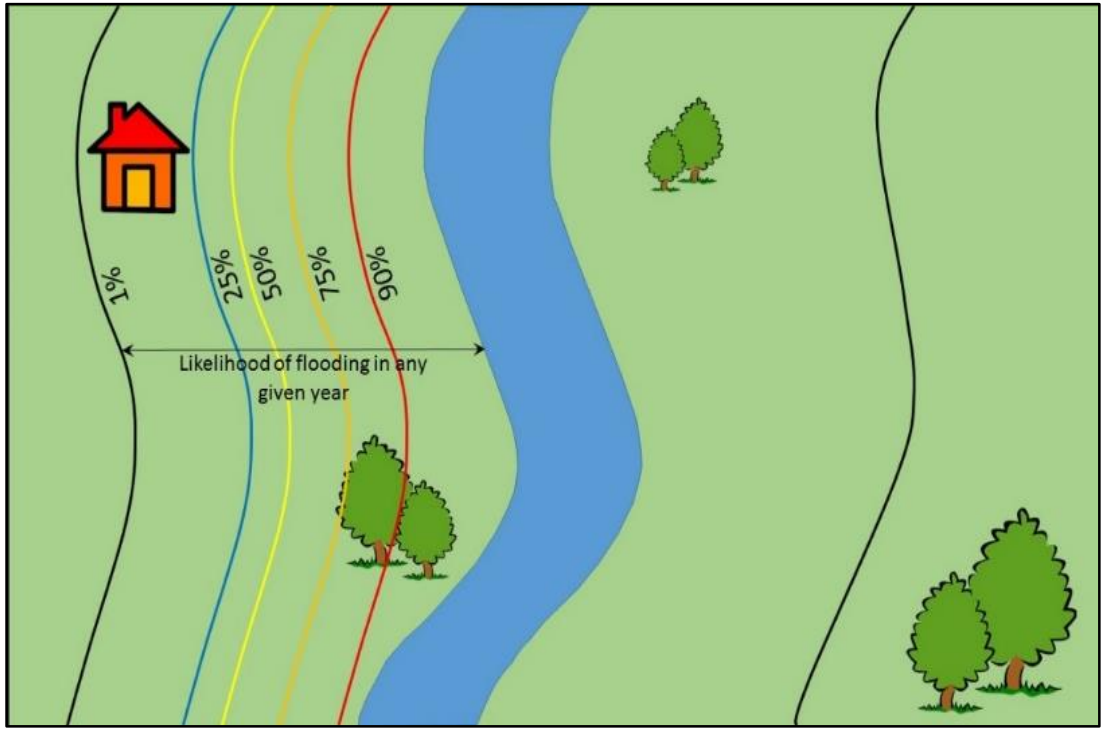
- **Floodway:**
  - The channel and adjacent land that is reserved to convey the base flood without increasing the water surface elevation above a designated height.
  - Communities must regulate development in floodways to prevent increases in upstream flood elevations.
  - Usually the deepest, swiftest moving, and most dangerous part of a flood flow.
- **Flood Fringe:**
  - Areas outside the regulated floodway
  - Inundated by designated 1% annual chance flood (also known as the floodway fringe).
- **500-Year Floodplain:**
  - Also known as the .2% chance annual flood.
  - Area not regulated by FEMA but it is usually mapped since it represents a significant threat to life and property.

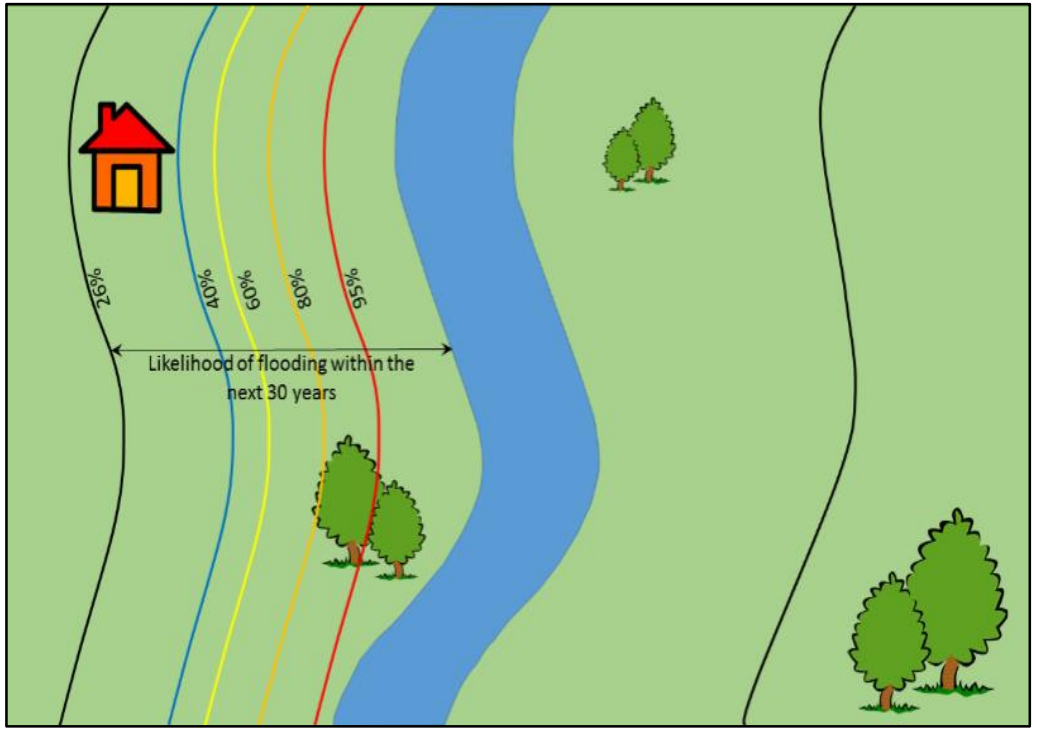
FIRM Map – Flood Insurance Rate Map



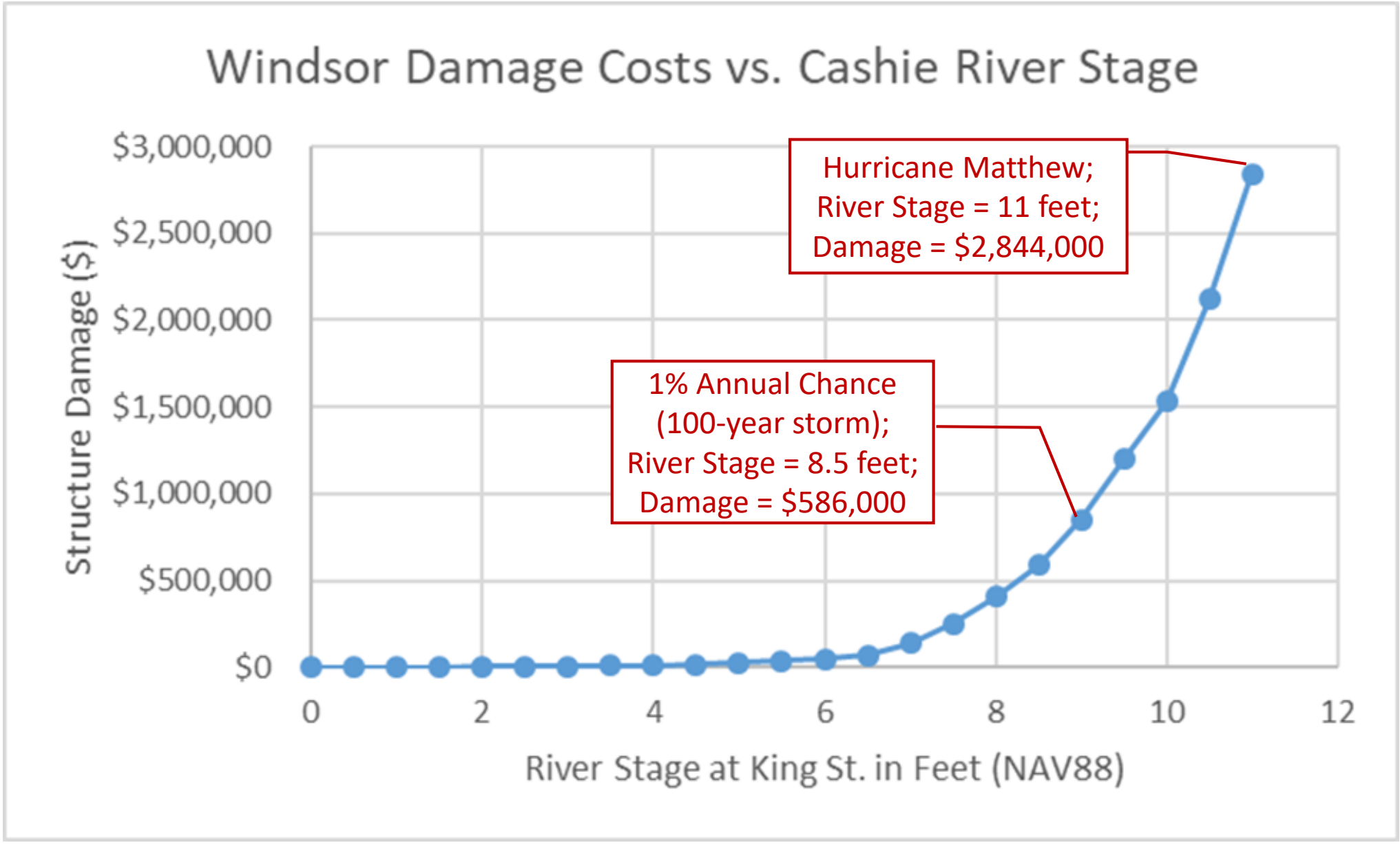

100-year floodplain


flood fringe
floodway
floodway
flood fringe
100-year floodplain

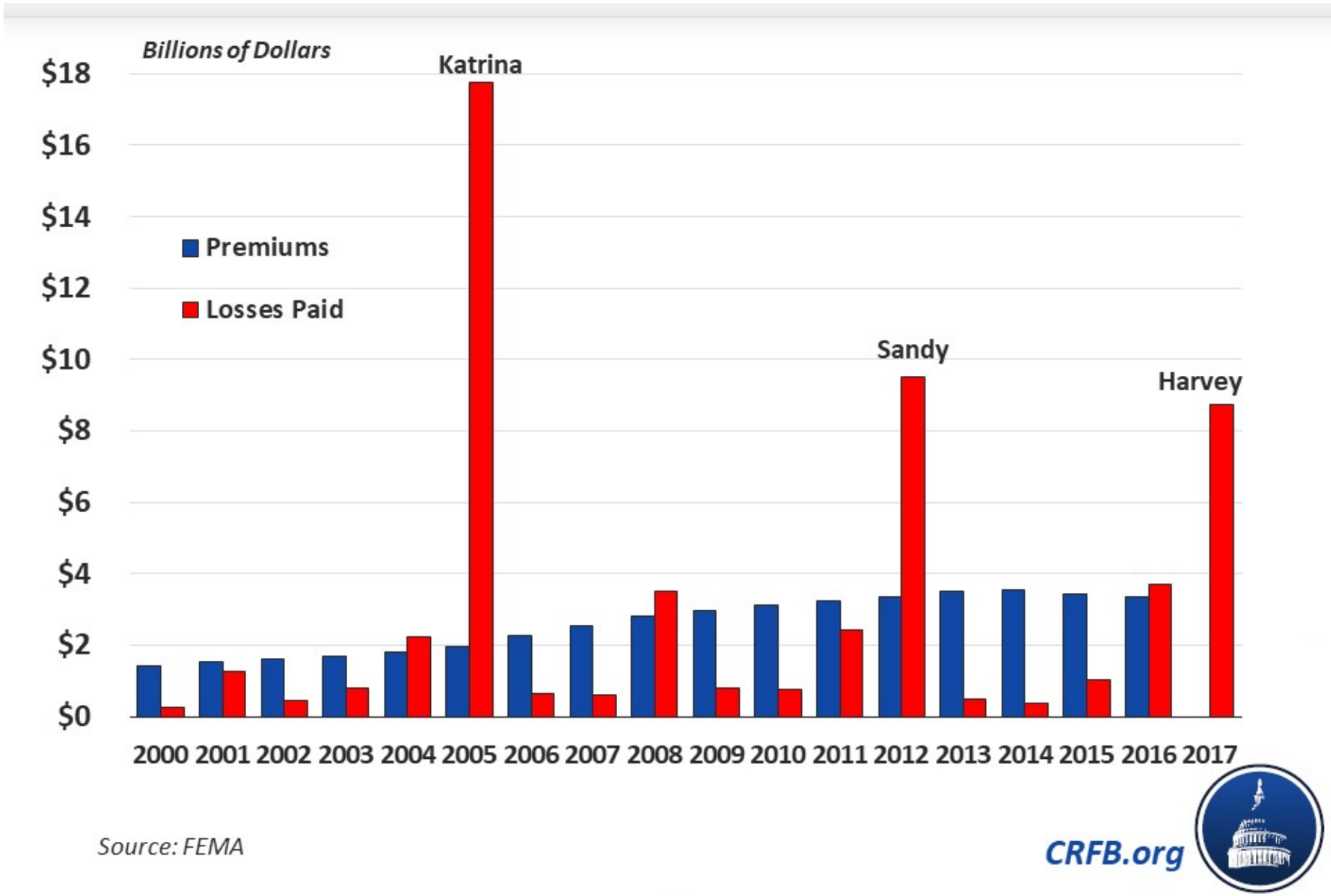

1%
25%
50%
75%
90%
Likelihood of flooding in any given year


26%
40%
60%
80%
95%
Likelihood of flooding within the next 30 years

Cashie River: Flood Damage vs. River Stage



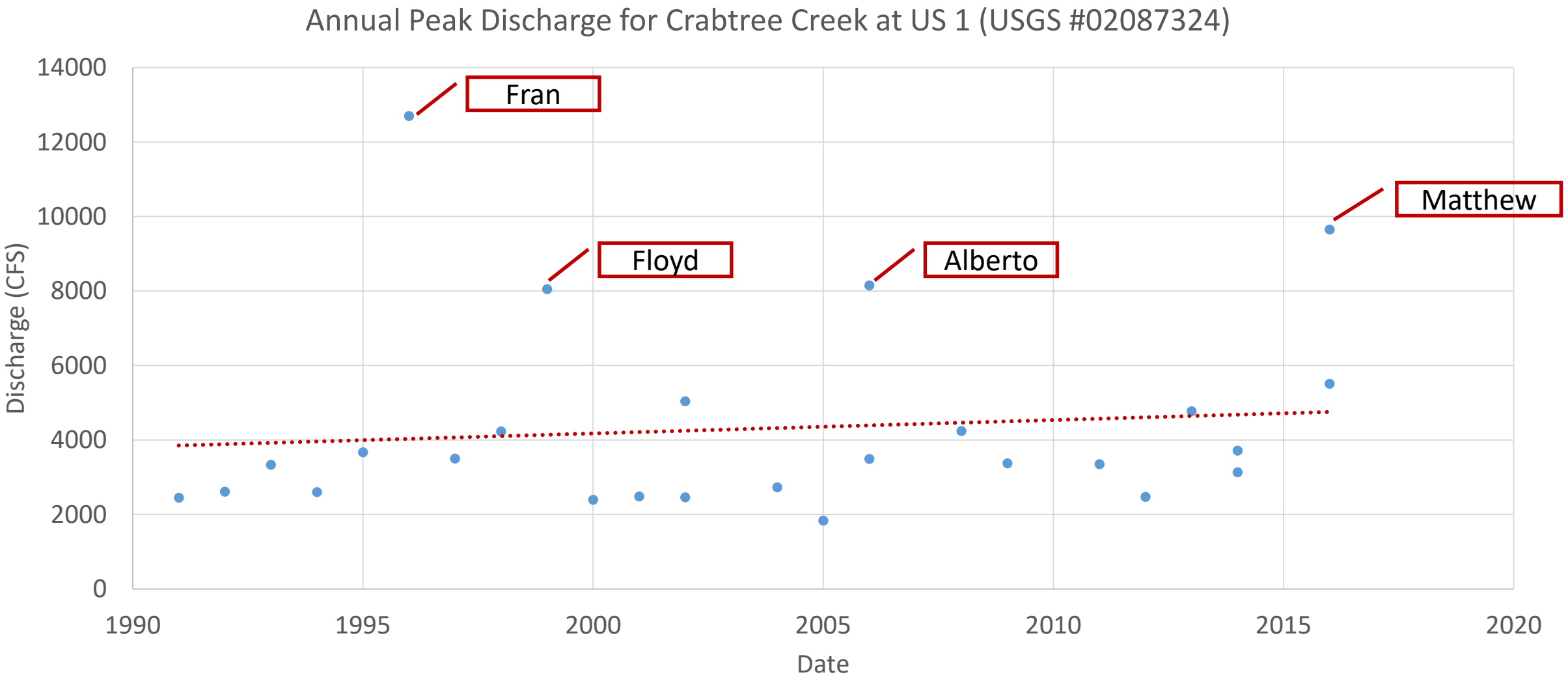
NFIP not solvent due to extreme events



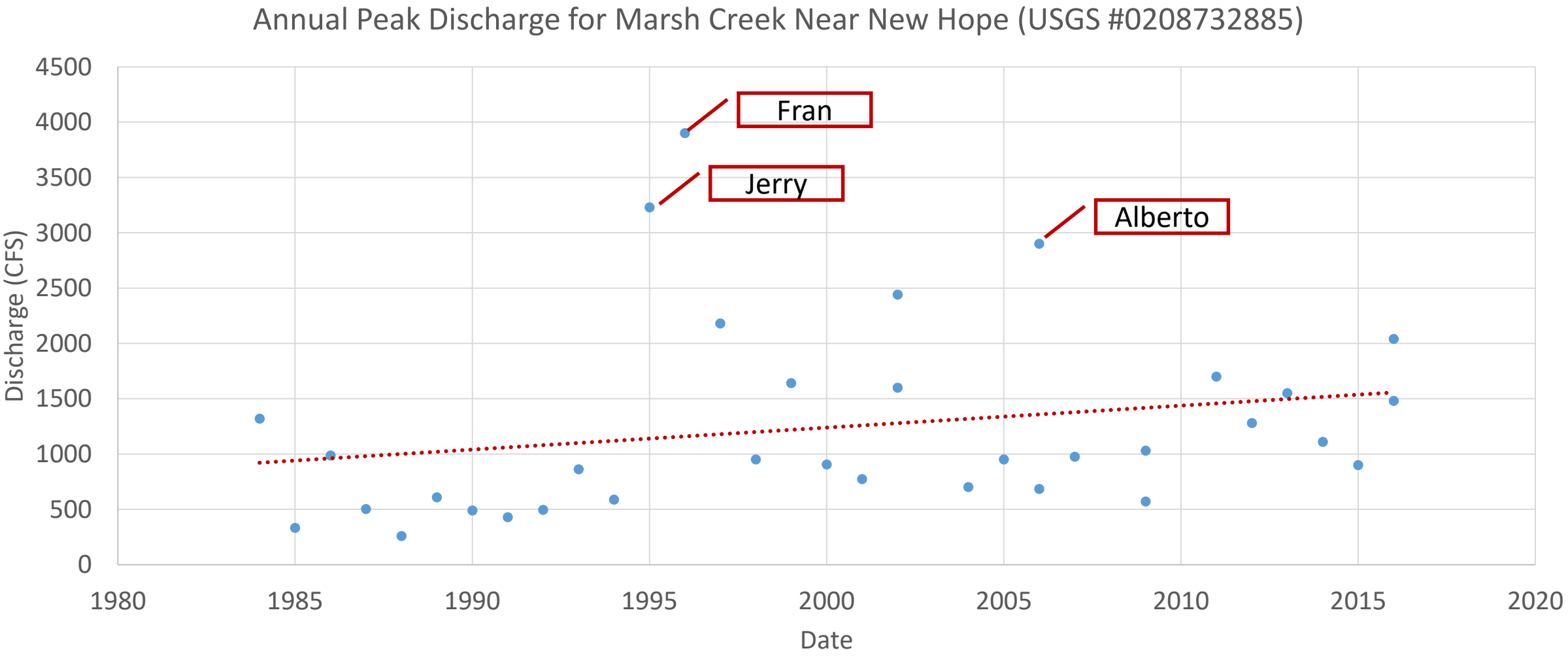
Source: FEMA

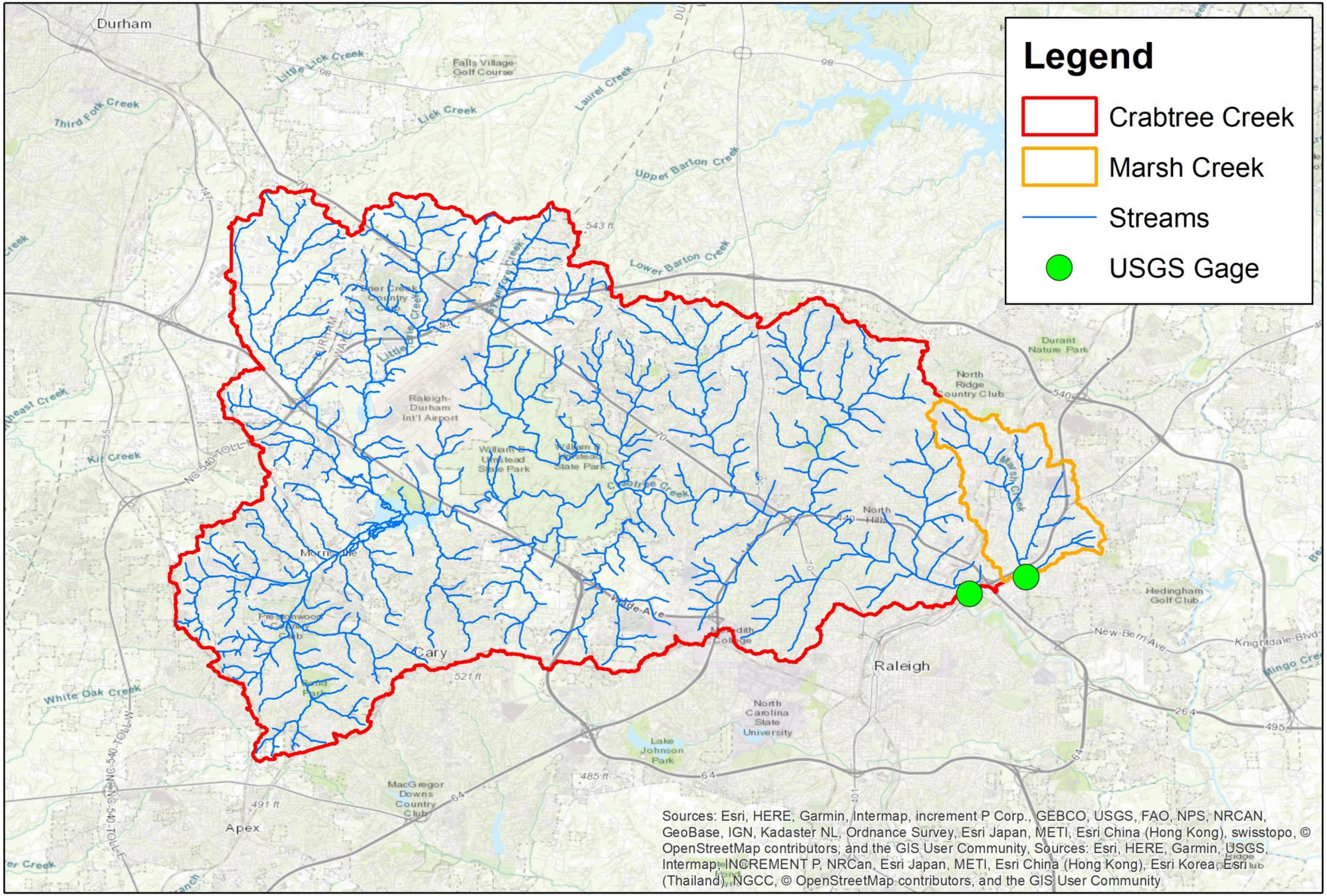
CRFB.org

Peak Flow for Crabtree Creek



Peak Flow for Marsh Creek





Legend
Crabtree Creek
Marsh Creek
Streams
USGS Gage
Durham
Raleigh
Cary
Apex
Morrisville
Raleigh-Durham Int'l Airport
William B. Umstead State Park
Crabtree Creek
Marsh Creek
North Hills
Meredith College
North Carolina State University
Lake Johnson Park
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community, Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

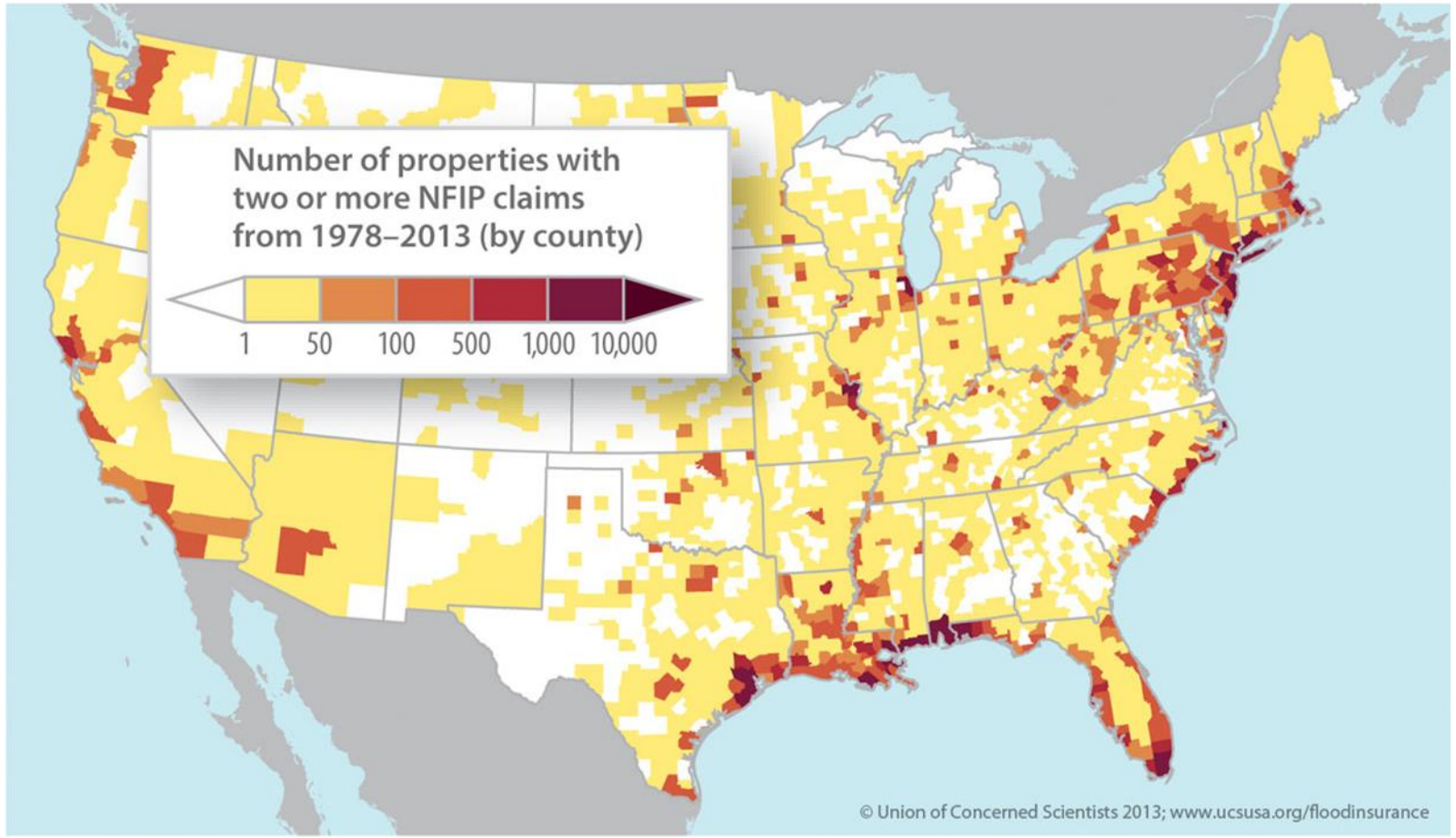
How can we become more resilient?

(Adapt & transform to reduce chance of future disturbance or better withstand the disturbance)

- Remove and relocate repetitive loss structures from floodprone areas
- Raise roads, enlarge bridges and improve infrastructure to be more resilient during flood events (better prevent loss of life and reduce economic impacts)
- Better modeling and preparedness for potential future events
- Improve floodplain ordinances
- Better communicate risks to the public
- Recover floodplains for the river
- What about natural and green Infrastructure?

Aerial photograph of inland flooding caused by Hurricane Floyd.
Photographer J. Jordan of the US Army Corps of Engineers

Repetitive-Loss Properties by U.S. County



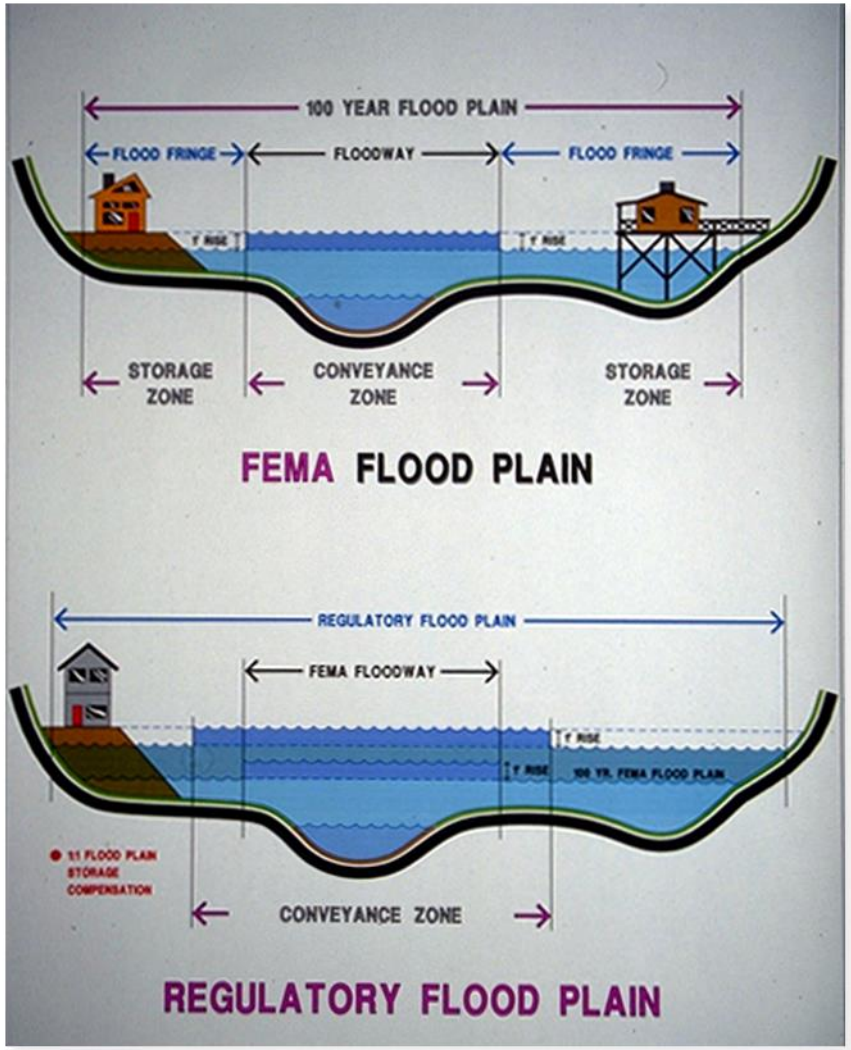
Insurance claims on properties that are repeatedly damaged by flooding, or "repetitive losses," are of particular concern to the National Flood Insurance Program (NFIP). NFIP has paid out almost $9 billion in claims to repetitive-loss properties, which amounts to about a quarter of all NFIP payments since 1978. Repetitive-loss properties, shown here, account for just 1.3 percent of all policies but are responsible for fully 25 percent of all NFIP claim payments since 1978. The darker colors show counties particularly prone to repetitive losses. Map based on data from FEMA as of May 2013.

Darker colors indicate counties prone to repetitive loss claims.

Repetitive Loss Claims:

- Represent 1.3 % of all policies
- Responsible for 25% of all claims (1978-2013) totaling $9 billion

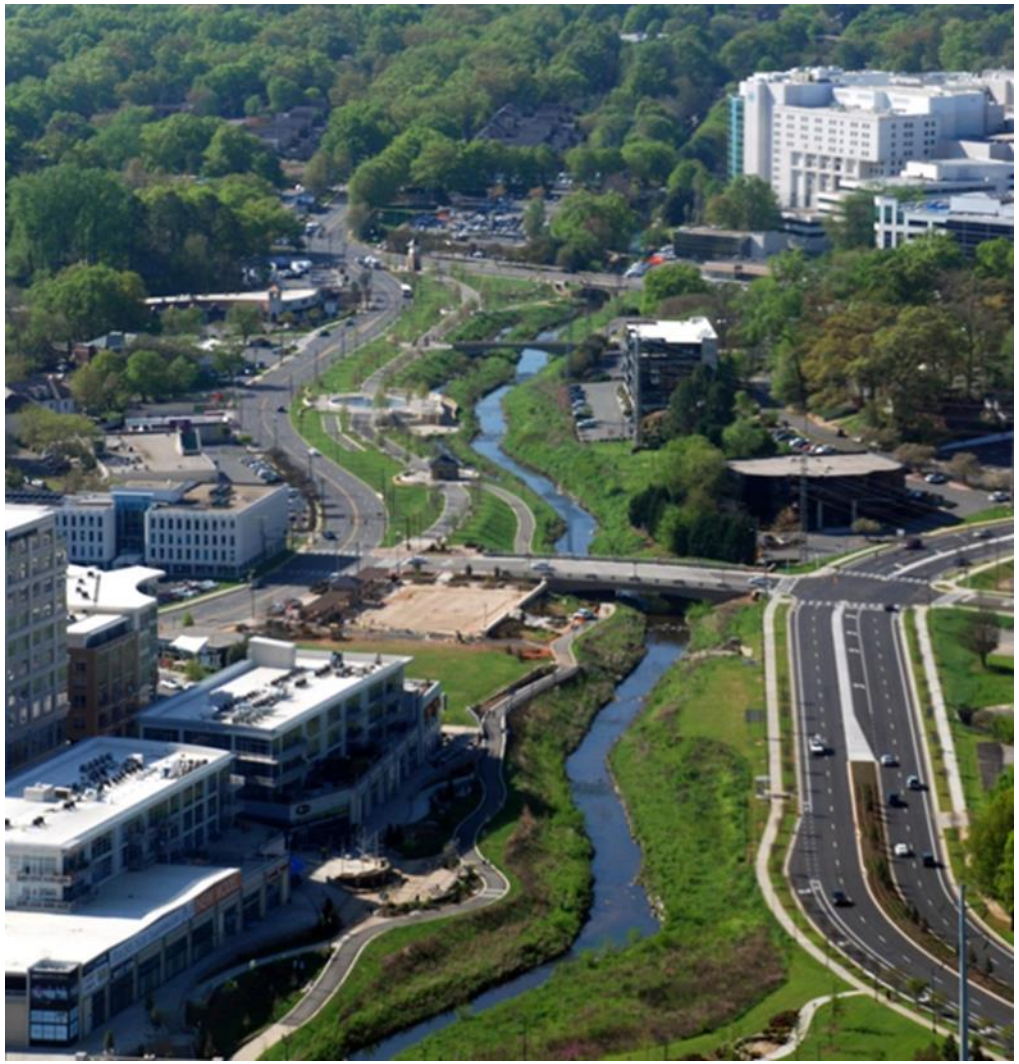
Louisville/Jefferson County Metropolitan Sewer District (MSD) Floodplain Ordinance



The highest and best use of floodplain land is for the storage of flood waters

Floodplain Management in Charlotte/Mecklenburg County

- Established floodplain buyout program (1999)
  - $1.25/mo Major System Storm Water fee
  - $3 million/yr
  - Buy and demolish 10-20+ homes per year
  - Rainy day funding for “quick-buy” program
  - To date: $68 million, 400+ buildings removed
- Expand community natural resource assets
  - $3 million/yr to restore streams and floodplains
  - Improve stormwater management
  - Expand parks and greenways
- Improved floodplain maps and regulations
  - Created “future conditions” floodplain maps (2004)



Midtown Redevelopment

Example Buyout Neighborhood

Doral-Cavalier Apartments

2008 Flood

Floodplain Buyout Benefits

- Less tax money spent on emergency rescues
- Less tax money spent on disaster relief
- Less tax money spent to replenish the National Flood Insurance Program
- Restoring the natural floodplain to enhance water quality and the ecosystem
- Safer housing stock
- Increased opportunities for recreation and interacting with nature, such as creek-side greenways


Patrick Priest, WNCN, July 7, 2018

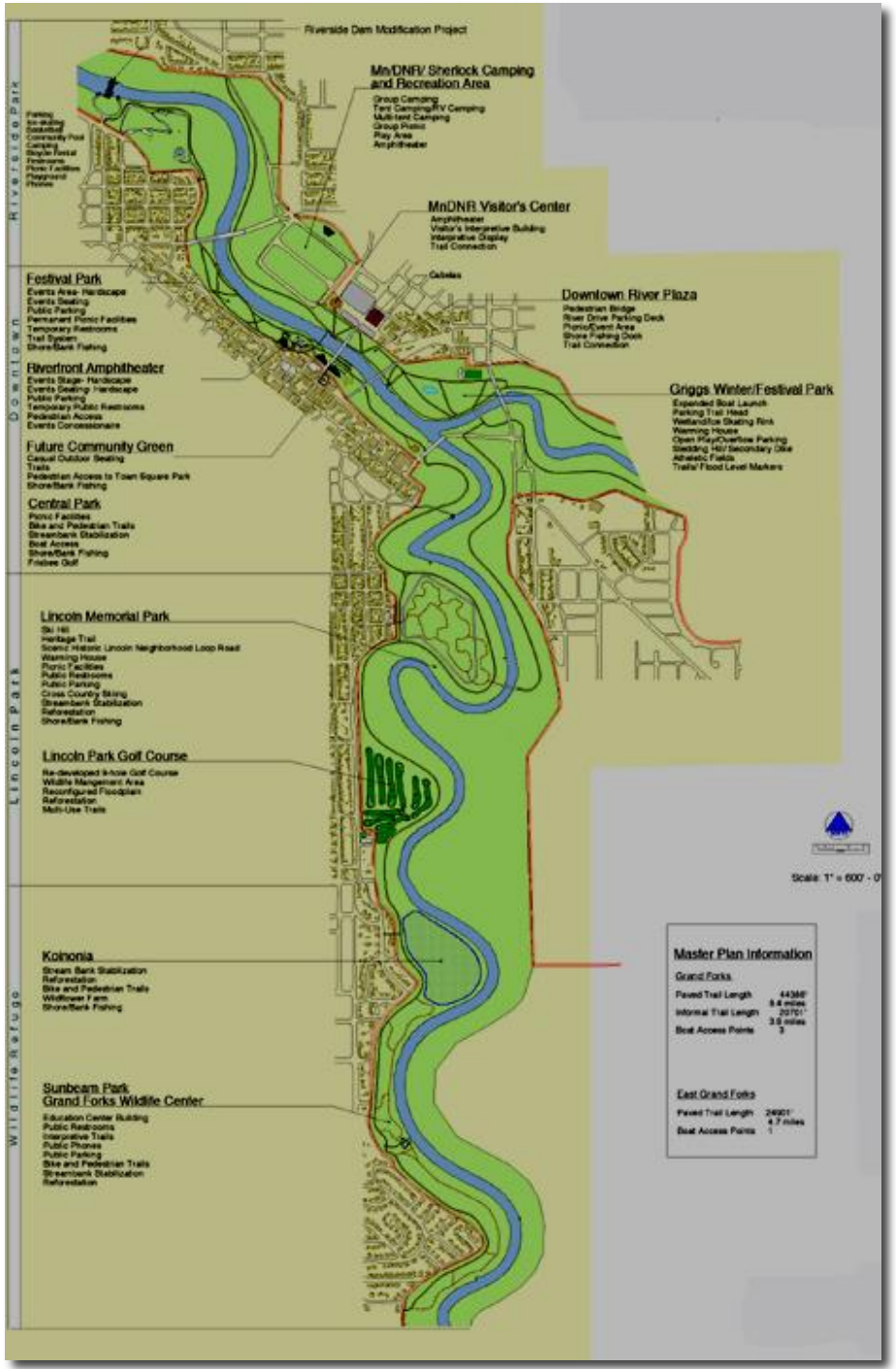
WTVD abc11.com, May 6, 2016

Case Study: Grand Forks, North Dakota

- Spring 1997 Flood -most severe flood of the river since 1826
- 54 feet flood stage
- 50,000 people evacuated
- 11 buildings on fire & 60 apartment units

Source: Grand Forks Herald

Greater Grand Forks Greenway Master Plan



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EST. 1987
planning & design for open space, parks, trails, & alternative transportation

The Recovery – Toward a more resilient Red River community

- FEMA buyout of repetitive flood loss properties (downtown buildings and 50 residential homes)
- Built a protective, flexible floodwall/levee system
- Reimagine/rebuild the downtown
- Implement a 2,200-acre greenway plan (20 miles of trails) - $15 million
- Program the greenway for activity

Annual Revenue Projections

	Base Dollars	Total Dollars (multiplier effect)
Direct Revenue	$28,860	$50,148
Indirect Revenue	$600,660	$1,081,188
Community Revenue	$8,580,863	$15,445,553
Total	$9,209,383	$16,576,889

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Take Home Points

- Riparian buffers and active floodplains are essential to stream health and water quality
- Need to better understand and better communicate the risks and uncertainty of future flood events, especially considering current and future climate conditions
- Relocation of repeat loss structures should be a priority
- The most important use of floodplains is to store floodwater!
- Recovery of floodplains and green infrastructure can create beneficial opportunities for communities, economies and the environment