Creating Resiliency in Streams

Restoration and Floodplain Reconnection

Brian Murphy, P.E. CFM

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CDM Smith

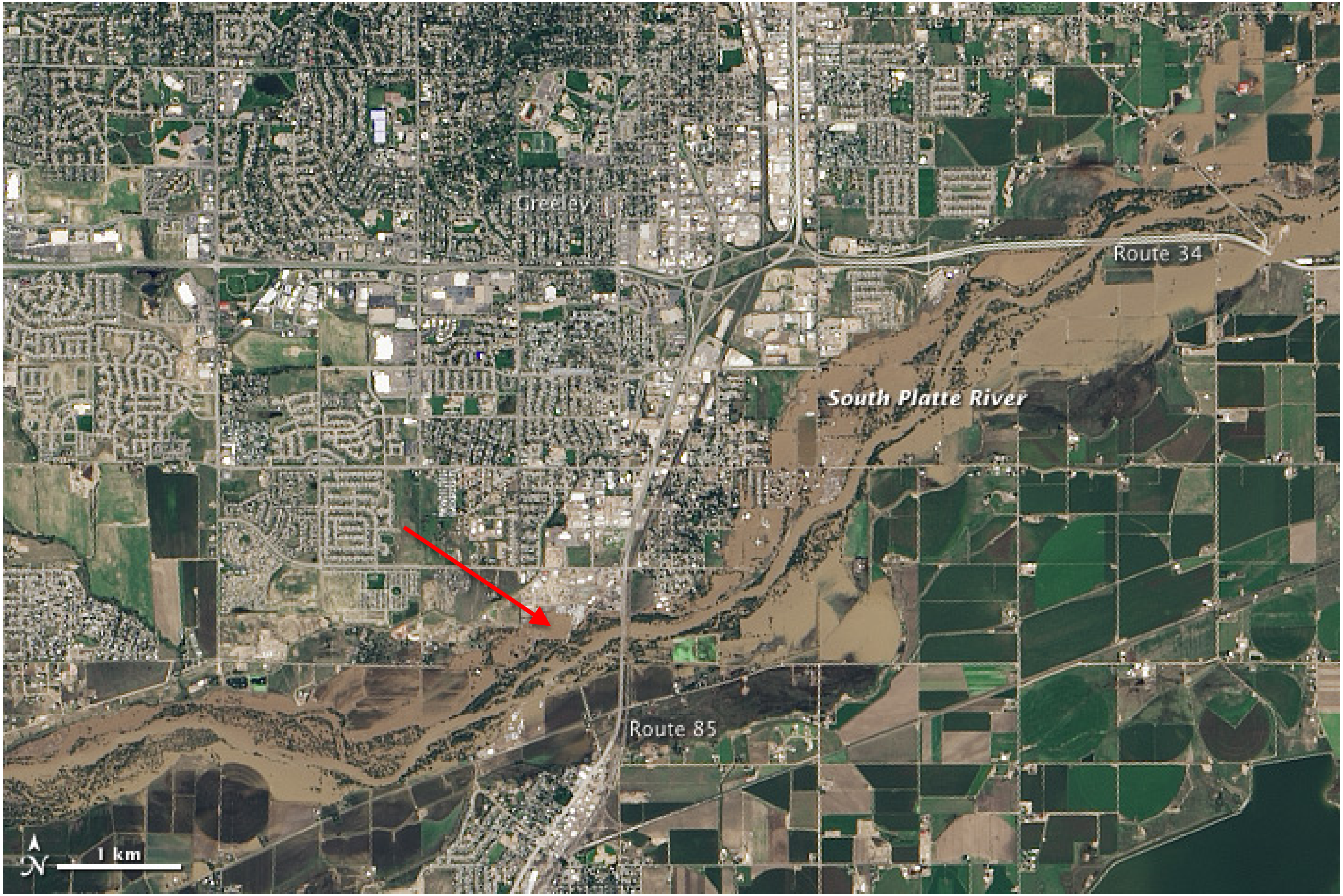
“…the United States will experience more frequent and more severe flood events in coming years.”

From: Addressing Affordability and Long-term Resiliency through the National Flood Insurance Program

“The next century will, I believe, be the era of restoration”

-E.O. Wilson


Our Disaster Recovery Plan
Goes Something Like This...
HELP!
HELP!
DILBERT
By Scott Adams


Greeley
Route 34
South Platte River
Route 85
N
1 km

Overview

- Risk vs. Uncertainty
- What is resilience and how do we measure it?
- Challenges
- Opportunities
- Take Home Messages

Risk

vs.

Uncertainty

Human created encroachments = risks

Natural variability = uncertainty

Risk

vs.

Uncertainty

No one knows for sure whether any altered landscape or its biodiversity will come back better, worse, or simply different.

Anticipate how ecosystems may adapt or respond to altered trajectories of change.

What is the Likelihood of Flooding?

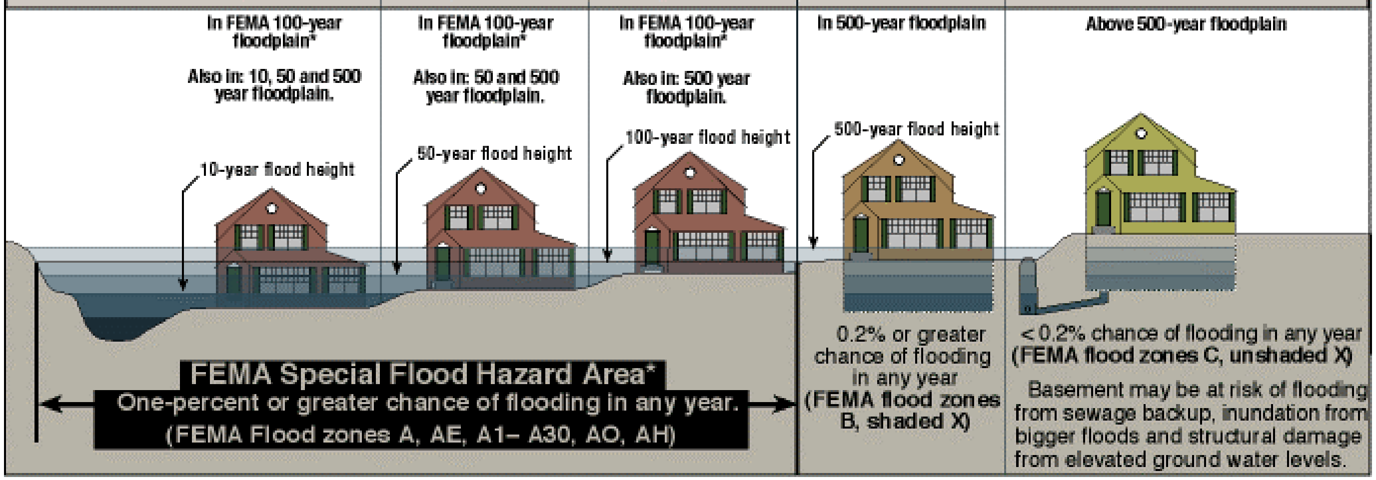
Years in floodplain	Chance of at least one **10-year flood**	Chance of at least one **50-year flood**	Chance of at least one **100-year flood**	Chance of at least one **500-year flood**
1	10%	2%	1%	<1%
2	19%	4%	2%	<1%
3	27%	6%	3%	1%
4	34%	8%	4%	1%
5	41%	10%	5%	1%
10	65%	18%	10%	2%
15	79%	26%	14%	3%
20	88%	33%	18%	4%
25	93%	40%	22%	5%
30	96%	45%	26%**	6%
Risk Level:	**High Risk**	**High Risk**	**High Risk**	**Medium Risk**

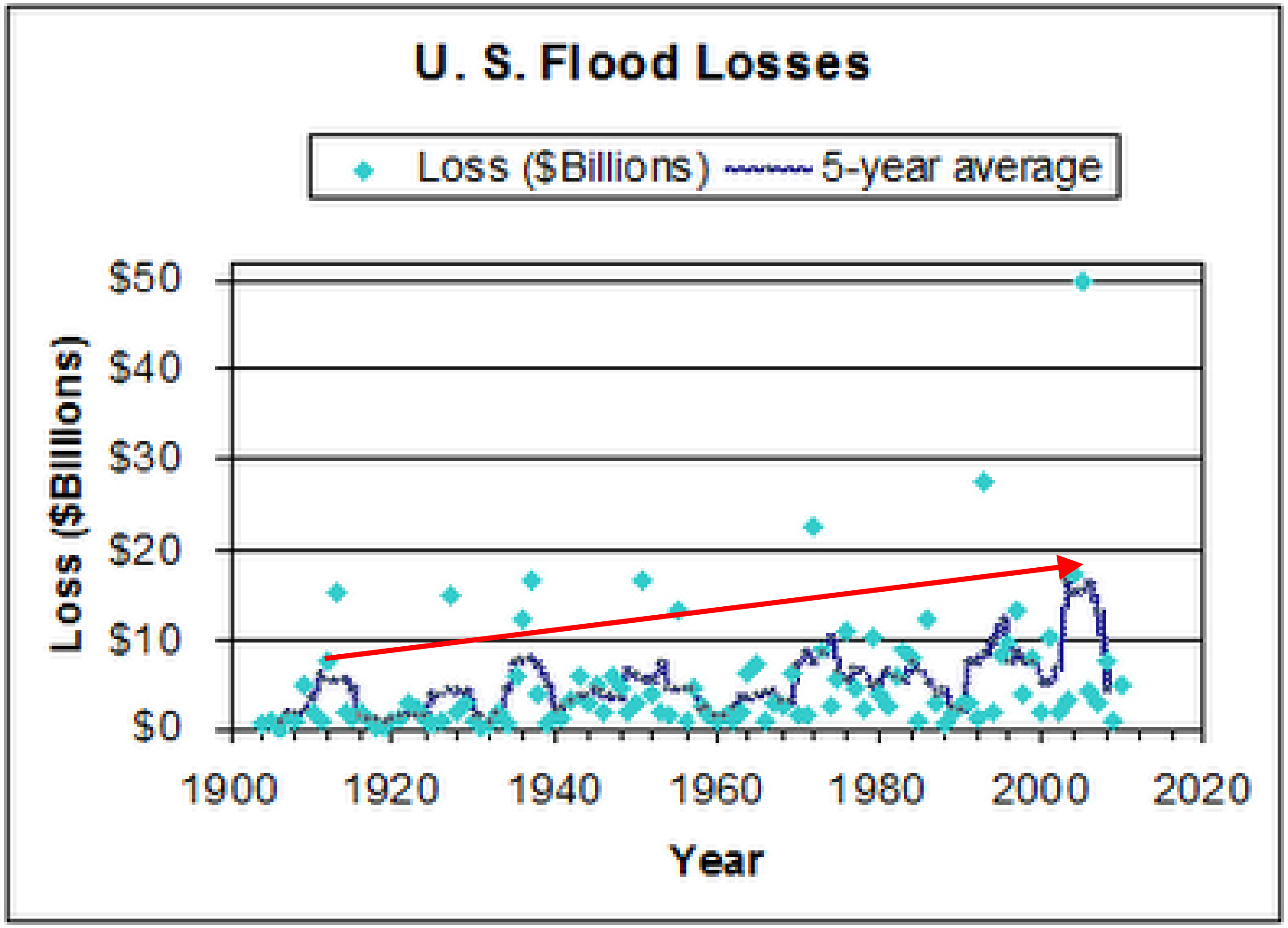
The longer you occupy the floodplain, the greater your chance of being flooded.

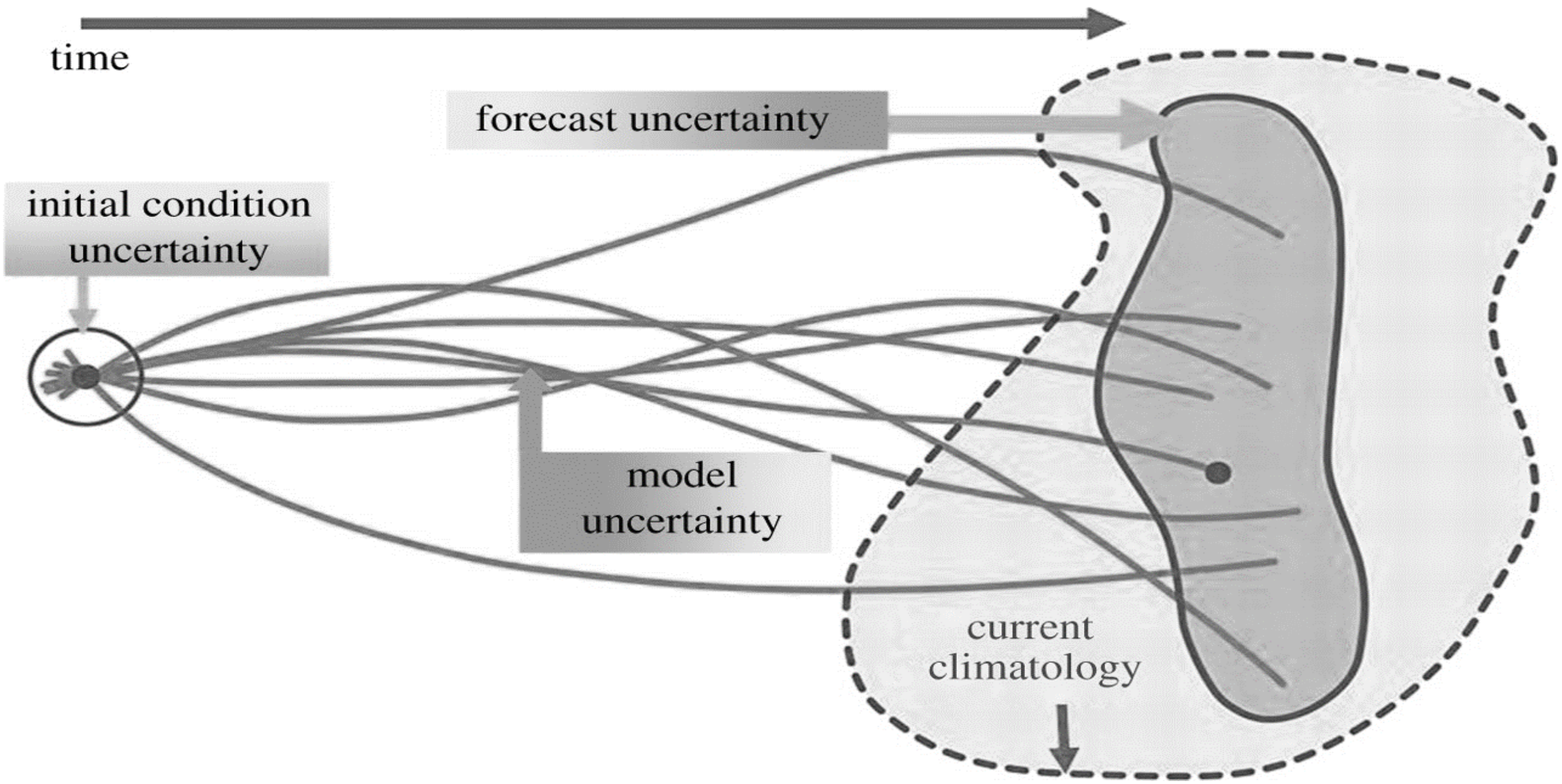
FEMA has not identified all areas that may be at risk of flooding. Between 20%–25% of flood insurance claims are from areas OUTSIDE of the FEMA Special Flood Hazard Area in supposedly "low risk" areas.

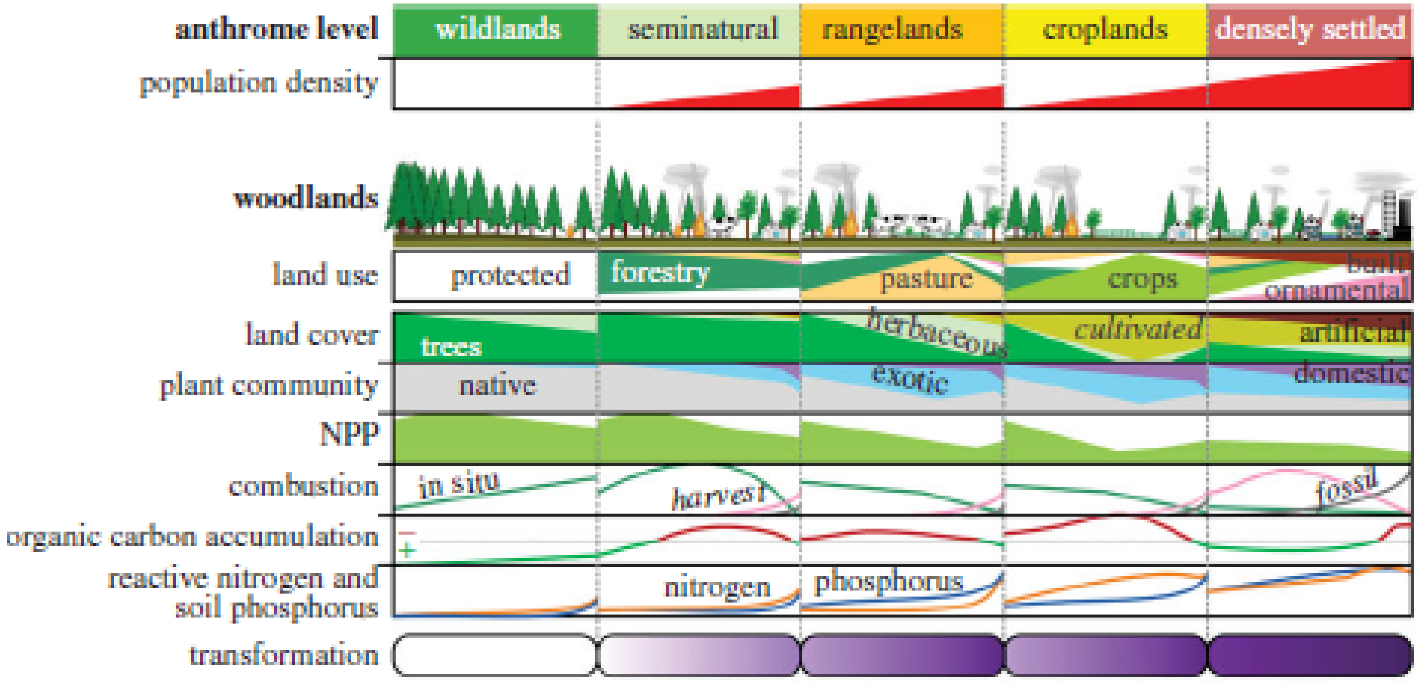
**Over a 30 year mortgage, there is a 26% chance of a 100-year flood.

Low Risk




U. S. Flood Losses
Loss ($Billions)
5-year average
$50
$40
$30
$20
$10
$0
Loss ($Billions)
1900
1920
1940
1960
1980
2000
2020
Year


time
forecast uncertainty
initial condition
uncertainty
model
uncertainty
current
climatology



From: Anthropogenic Transformations in the Terrestrial Biosphere (Ellis 2011)

Resilience

The power or ability to return to the original form after being stretched.

Toughness.

Anticipating/preparing for disturbance.

Resilience

Resiliency

Pivoting from trying to prevent natural disturbances to naturally managing disturbances

Considering both flood risk and erosion risk

Floodplain reconnection

Resiliency

"Natural" or "green" infrastructure tends to be more resilient to water stress than human-engineered infrastructure because it bends, rather than breaks.

Resiliency Metrics

Percent reduction of land area in the 100-year floodplain

Number of insurable structures left in the floodplain & number of structures removed from the floodplain

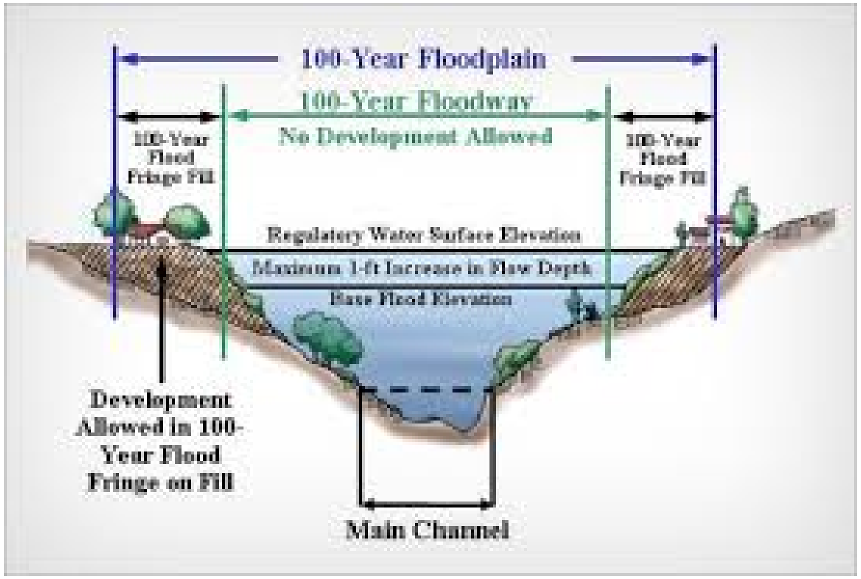
Resiliency Metrics

Reconnection of the channel to an active floodplain bench

Increased room for the river channel – will the alternative better allow the river to "be a river"

Challenges

Considering Human Factors such as Private property and Redevelopment



Challenges

Communicating benefits associated w/ floodplain reconnection

Where I See Opportunities

Riparian Corridor Management

“Freedom Space”

- Flood protection
- Urbanization Buffers
- Infrastructure Protection
- Aquatic Habitat
- Water Quality

Where I See Opportunities

"Activate" floodplain for larger flows

- Natural process
- Biological lifeline

↓ Capital and maintenance costs

↑ Ecosystem services

Where I See Opportunities

FEMA

Fact Sheet

Federal Insurance and Mitigation Administration

Climate Resilient Mitigation Activities
Floodplain and Stream Restoration

Purpose

The President's 2015 Opportunity, Growth, and Security Initiative (OGSI); Executive Order 13653 Preparing the United States for the Impacts of Climate Change; the President's 2013 Climate Action Plan; FEMA's Climate Change Adaptation Policy; and the 2014-2018 FEMA Strategic Plan, all identify the risks and impacts associated with climate change on community resilience to natural hazards, and direct Federal agencies to support climate resilient infrastructure.

FEMA is encouraging communities to incorporate methods to mitigate the impacts of climate change into eligible Hazard Mitigation Assistance (HMA) funded risk reduction activities by providing guidance on Climate Resilient Mitigation Activities. FEMA has developed initial guidance on Climate Resilient Mitigation Activities including green infrastructure methods, expanded ecosystem service benefits, and three flood reduction and drought mitigation activities: Aquifer Storage and Recovery (ASR), Floodplain and Stream Restoration (FSR), and Flood Diversion and Storage (FDS).

FEMA encourages communities to use this information in developing eligible HMA project applications that leverage risk reduction actions and increase resilience to the impacts of climate change.

Project Description

Floodplain and Stream Restoration is the reestablishment of the structure and function of ecosystems and floodplains to return the ecosystem as closely as possible to its natural conditions and functions prior to being developed. Ecosystems are naturally dynamic and it would not be possible to replicate the system to the exact pre-development conditions. Rather, the restoration process reestablishes the general structure, function, and dynamic, self-sustaining behavior of the ecosystem. FSR projects are already eligible for HMA funding and typically mitigate erosion and flood risk. This guidance focuses on FSR projects implemented using green infrastructure methods as much as possible to address drought mitigation and climate change resilience, in addition to reducing flood risk. FSR projects lend themselves readily to design and implementation using green infrastructure methods.

Coastal and riverine floodplain and stream restoration (and stabilization) can be successful methods in providing benefits of flood risk reduction and improving water quality and habitat for fish and wildlife, recreational opportunities, and erosion control. Restoration of adversely impacted, flood prone river systems is accomplished by restoring floodplains and associated wetlands through connectivity and storage, and by modifying the physical stability, hydrology, and biological functions of the impaired river banks to that of a natural stable river with periodic overbank flow. The floodplain of a riverine or stream system provides capacity for storing storm water runoff, reducing the number and severity of floods, and minimizing non-point source pollution. Restoring floodplains and wetlands and their native vegetation are integral components of stream restoration efforts.

"FEMA's mission is to support our citizens and first responders to ensure that as a nation we work together to build, sustain, and Improve our capability to prepare for, protect against, respond to, recover from, and mitigate all hazards."

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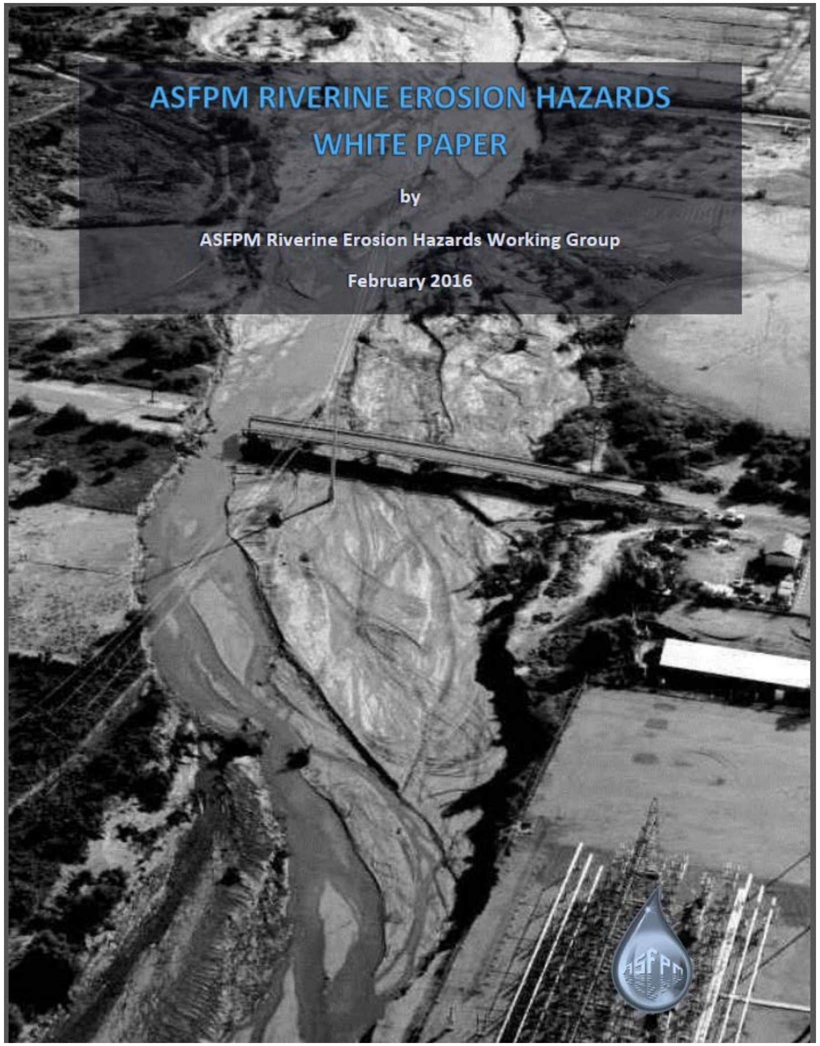
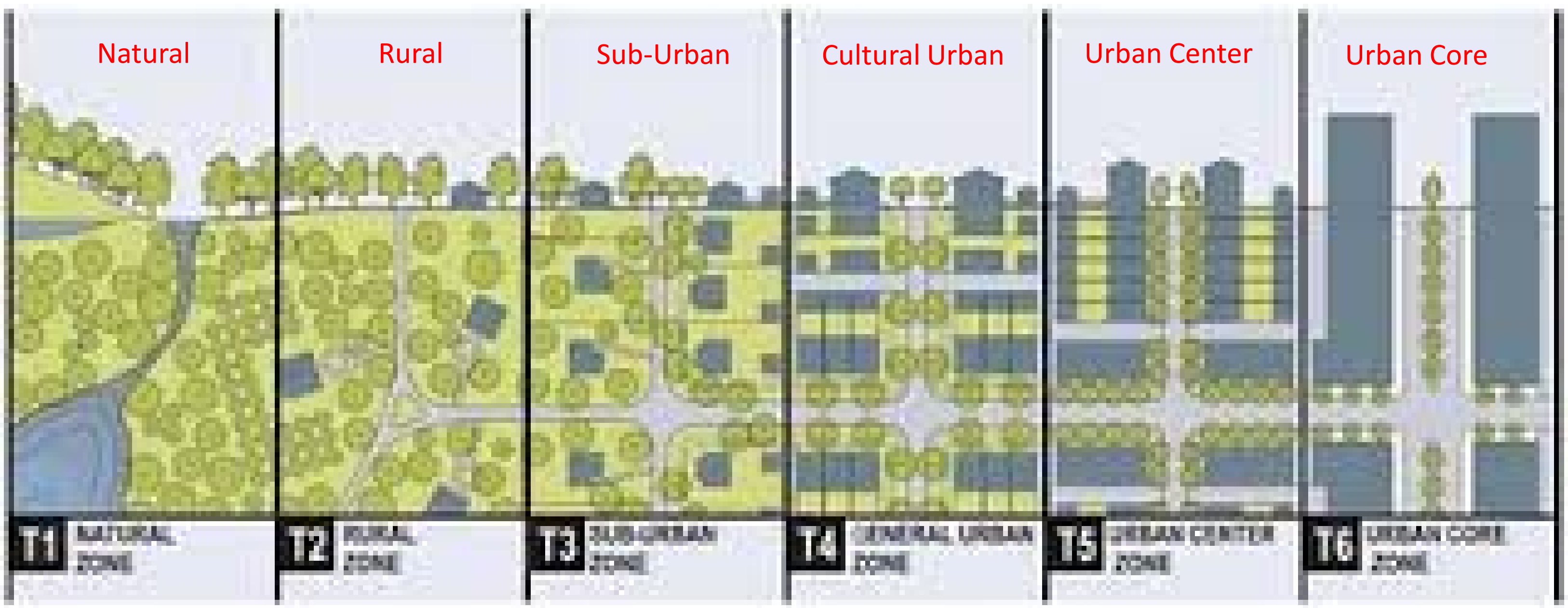
Where I See Opportunities



Where I See Opportunities



Where I See Opportunities

Communicating the benefits of floodplains to the public.

For example, City of Fort Collins, CO

https://youtu.be/Z2uKS0S82q4

Take Home Message

Floodplains (and wetlands) are **driven by strong, periodic disturbances** and their **ecosystem functions** and biogeochemical processes are highly rate-limited, spatiotemporally variable and driven by relatively species-poor assemblages of plants and animals adapted to withstand drought and flooding. **Extreme drying represents the primary mechanism via which resilience is lost.**

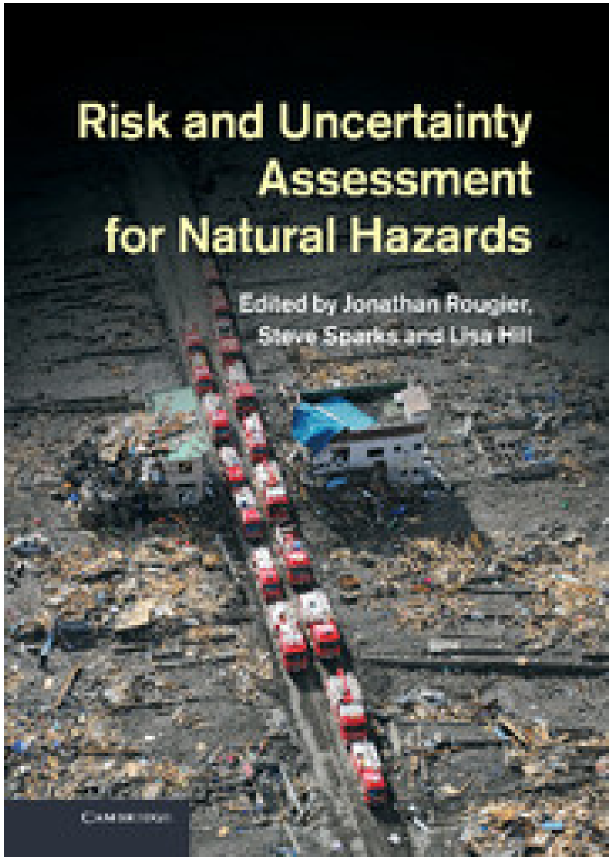
Take Home Message

Include natural variability within studies and designs to address risk AND uncertainty

Resiliency Metrics

1. Percent reduction of land area in the 500-year floodplain
2. Increased hydraulic capacity of the bridge crossing
3. Flow rate that causes overtopping of structure
4. Depth of overtopping of a structure during a 100-year event (the lower the depth, the greater the level of safety)
5. Number and value of properties that should be purchased by community to remove structures from the floodplain (assuming willing sellers)
6. Flow velocity through the bridge (lower velocity means reduced scour and damage potential during flood events)
7. Increased land area available for ecological restoration and improvements
8. Percent increase in available open space/natural land area
9. Opportunity for outdoor/natural areas recreation (i.e., soft path trails, environmental education, access to river, bird watching, fishing, etc.)
10. Benefits to pedestrian and bicycle safety
11. Reduced flooding frequency and damages to the pedestrian trail underpass
12. Number of properties with improved redevelopment potential
13. Ability of the proposed improvements to be resistant and adaptable to future disruptions
14. Reduced maintenance effort and costs
15. Anticipated cost of damages from a flood event

References


Risk and Uncertainty
Assessment
for Natural Hazards
Edited by Jonathan Rougier,
Steve Sparks and Lisa Hill