Addressing Flooding and Extreme Weather with Restoration Efforts

Brian Bledsoe, Ph.D., P.E.

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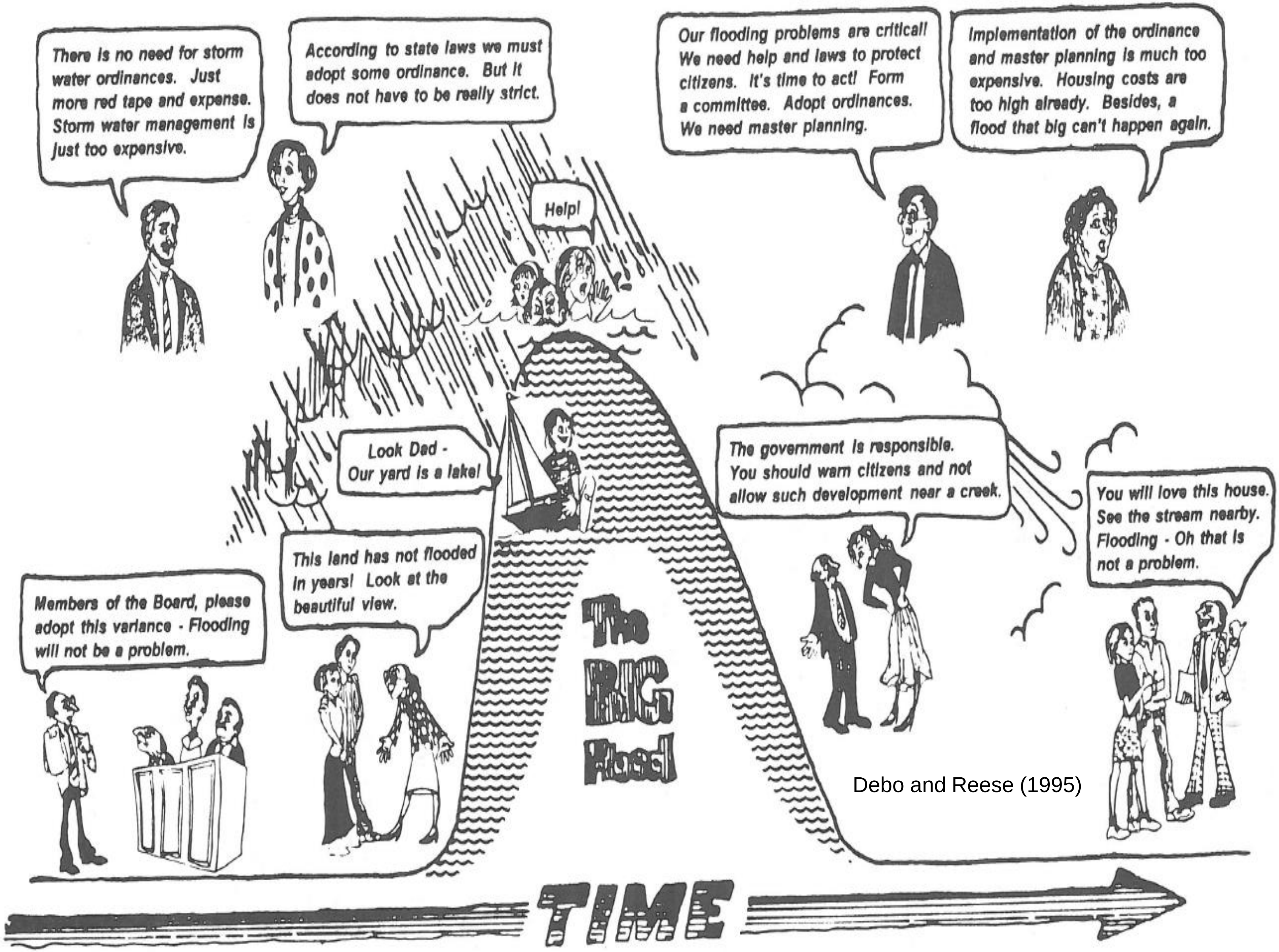
UNIVERSITY OF GEORGIA



Debo and Reese (1995)

Outline – 3 C's

- **Compounding effects**
- **Context**
- **Communication**

COMPOUNDING EFFECTS

Increasing Magnitude of Floods

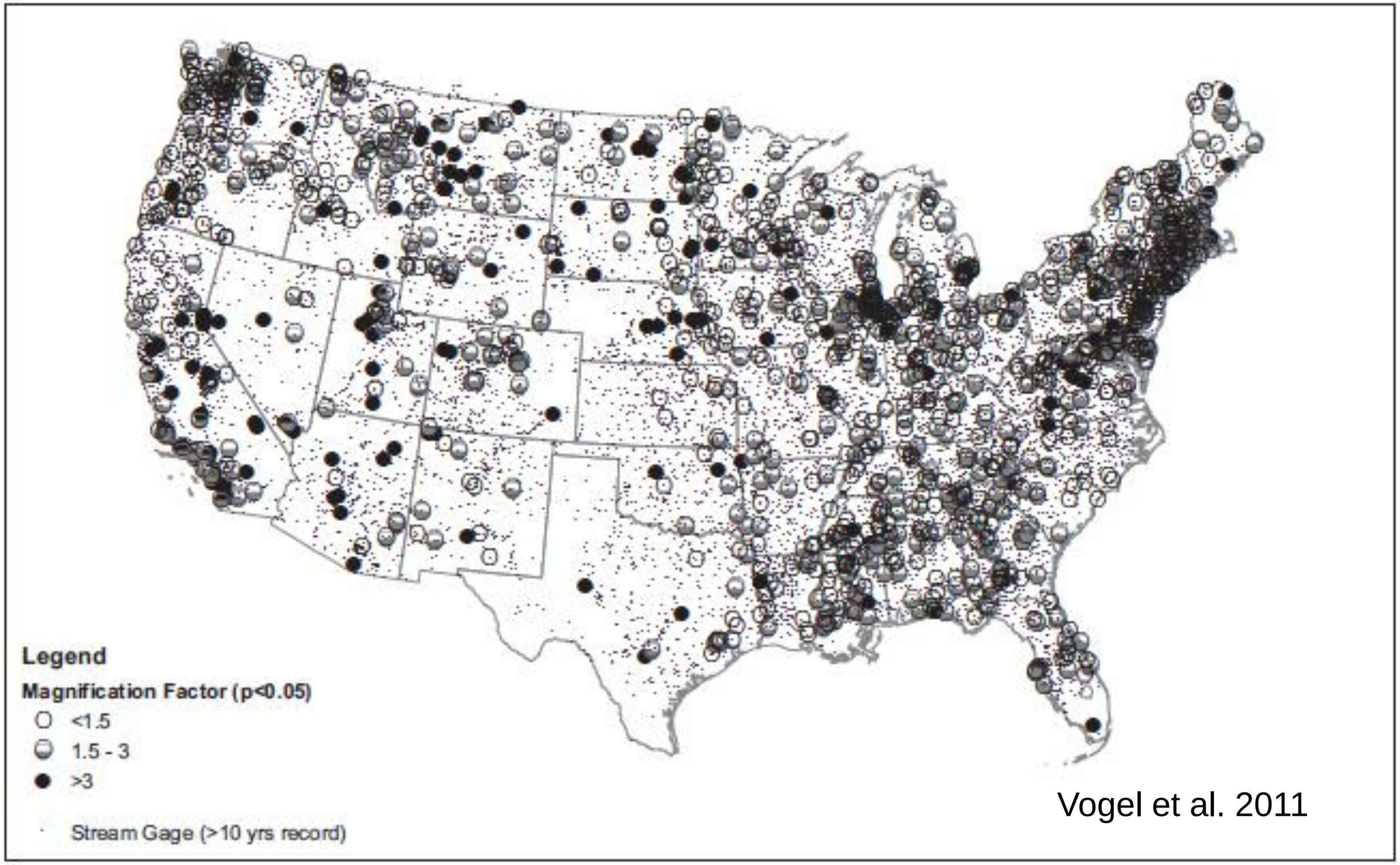
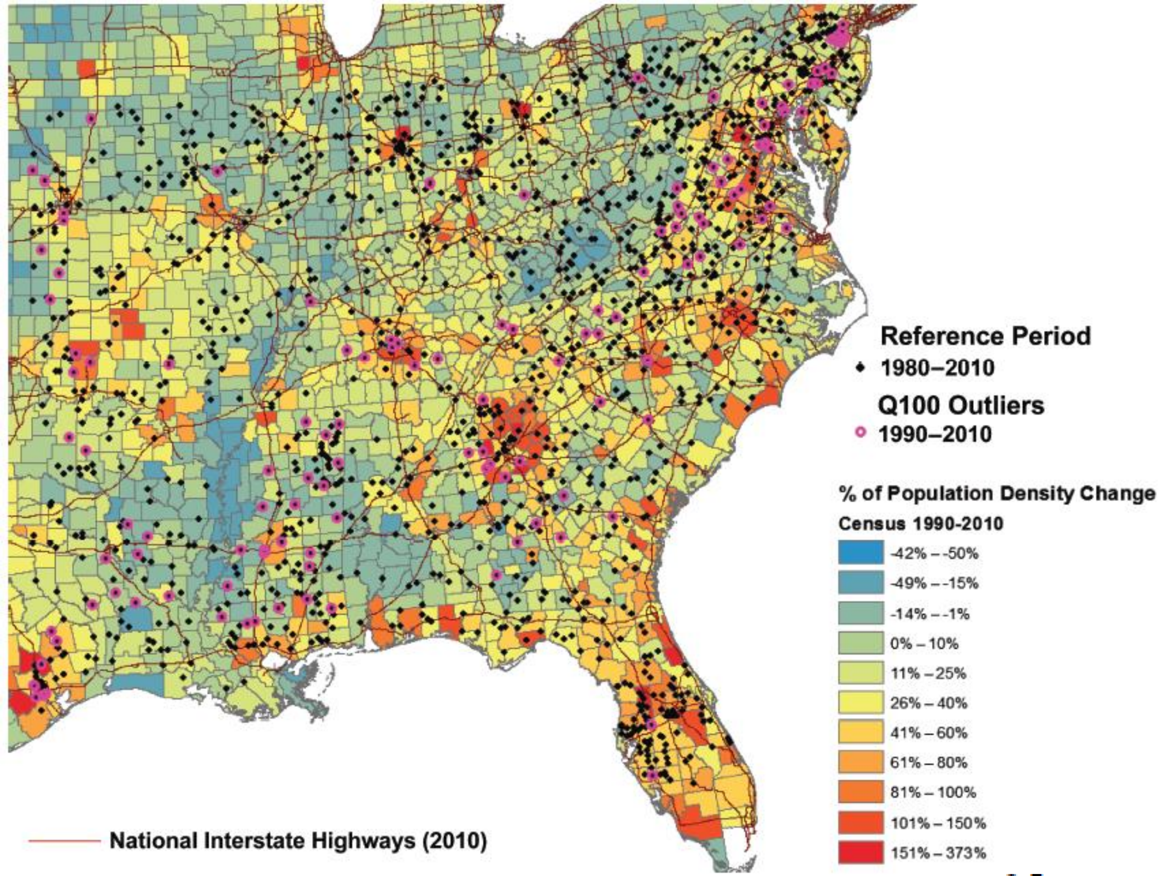
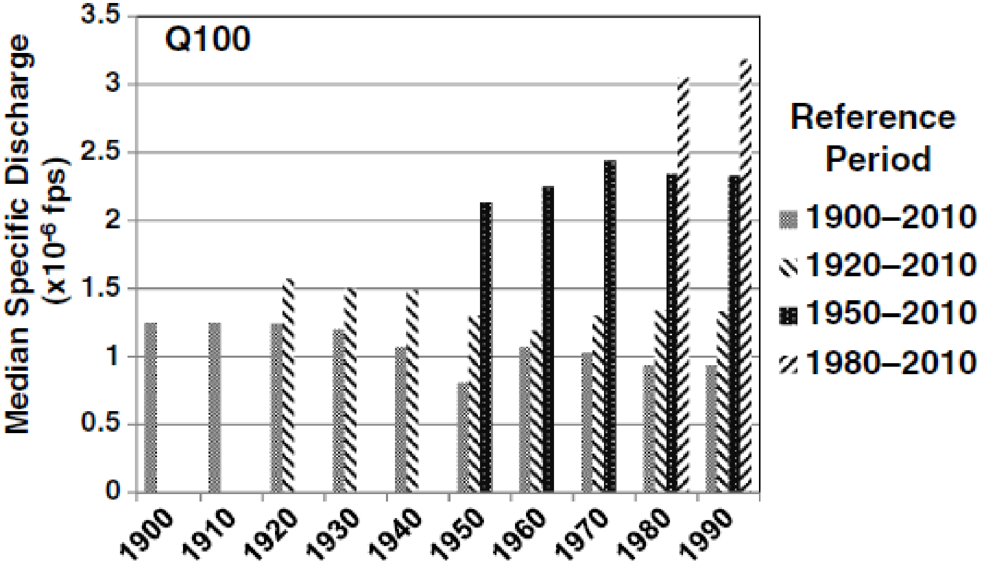


FIGURE 3. Location of 14,893 Stations in the "No Regulation" Group and the Decadal Magnification Factors Associated With the 1,642 (11%) Stations Which Exhibited Positive Trends.

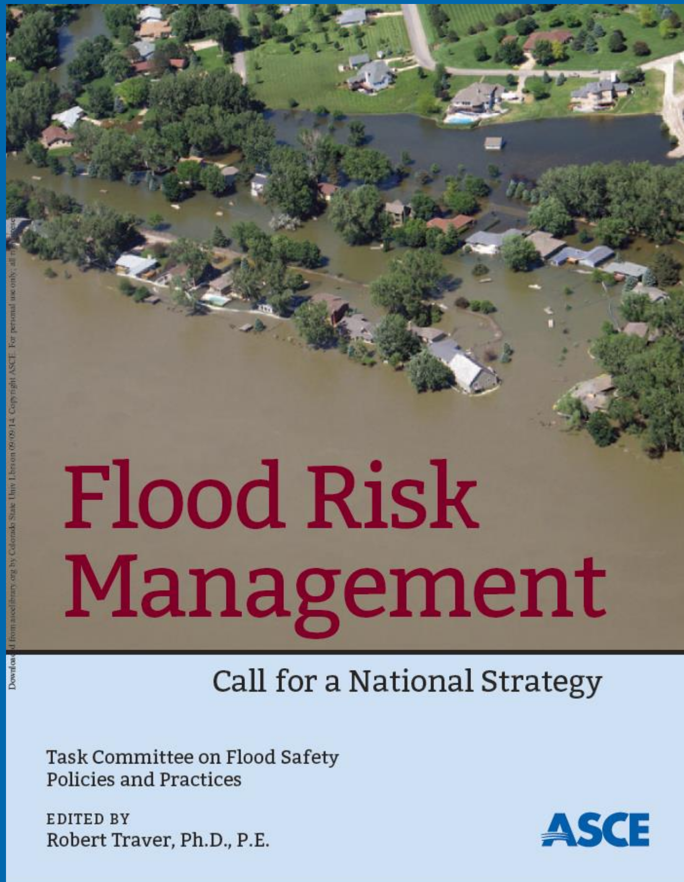


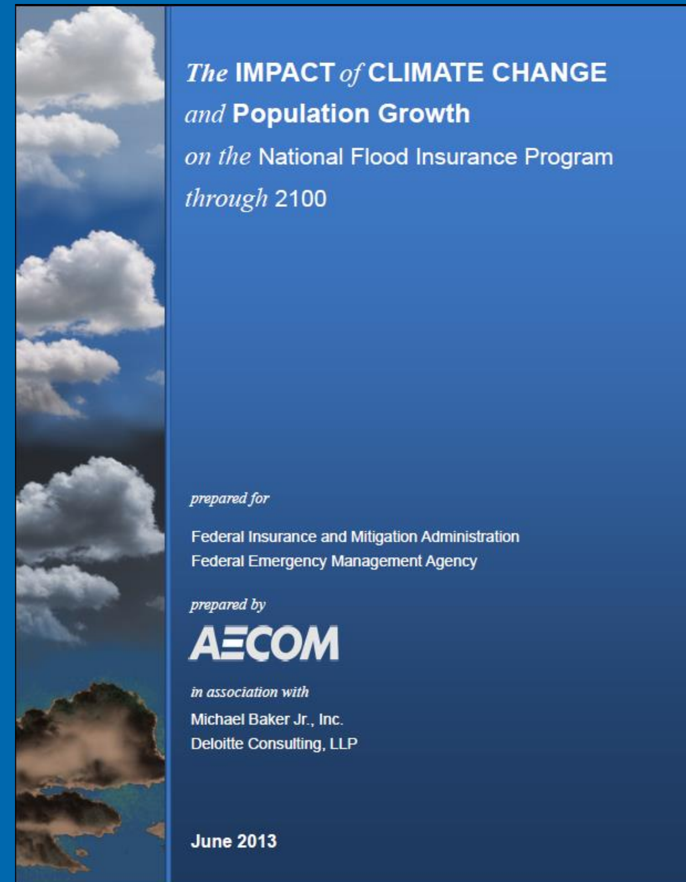
Change in flood risk is not new.

But how will land use change interact with climate?



Barros et al. (2014)



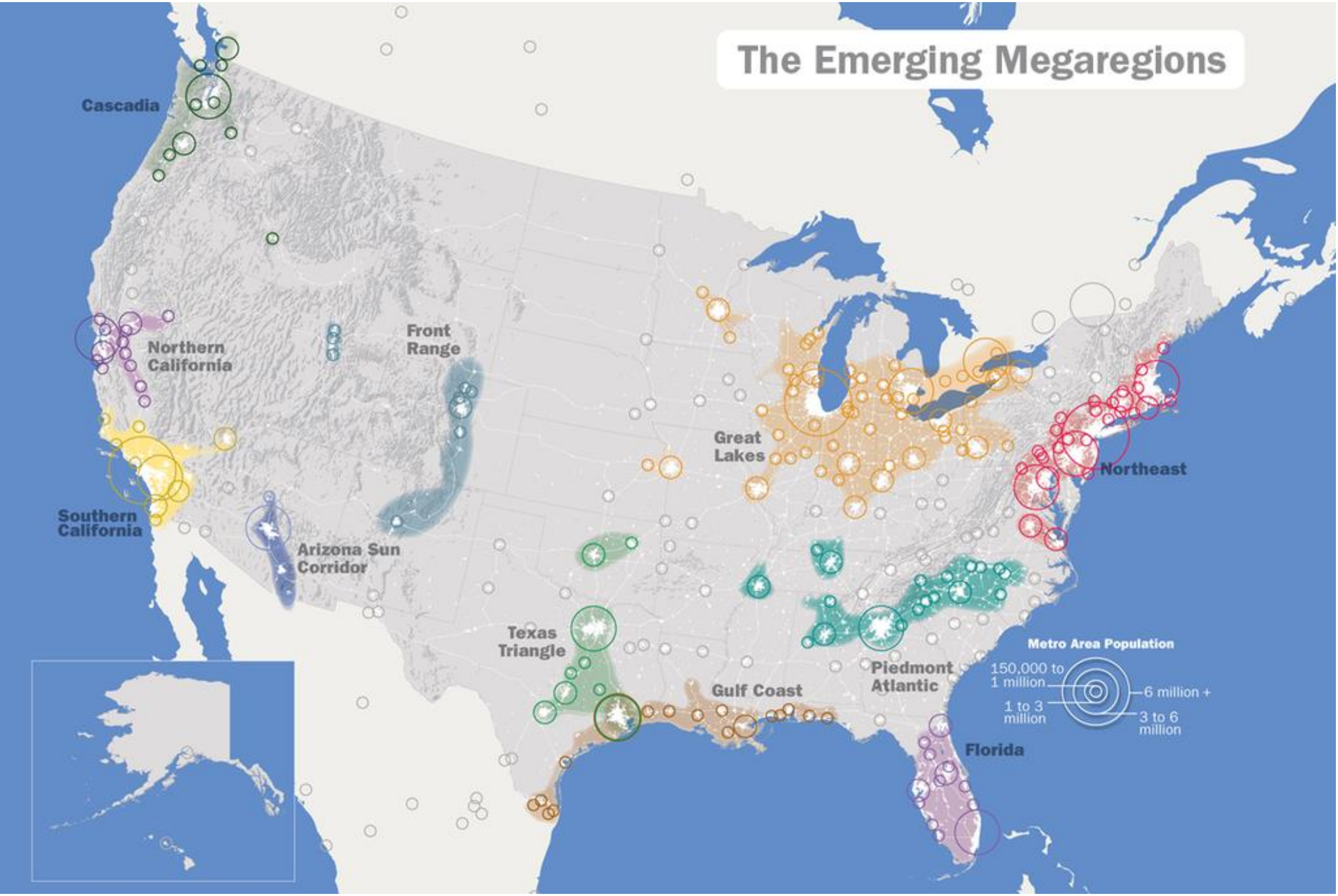


"Climate change and population growth will further stress this already difficult situation."

…the 100-year floodplain in the contiguous states could expand by 45 percent in the 21st century

…"continuing development affecting flood-prone areas exacerbates this problem."

"If something is not done to reduce risk, we are passing on to succeeding generations a potentially insurmountable challenge."

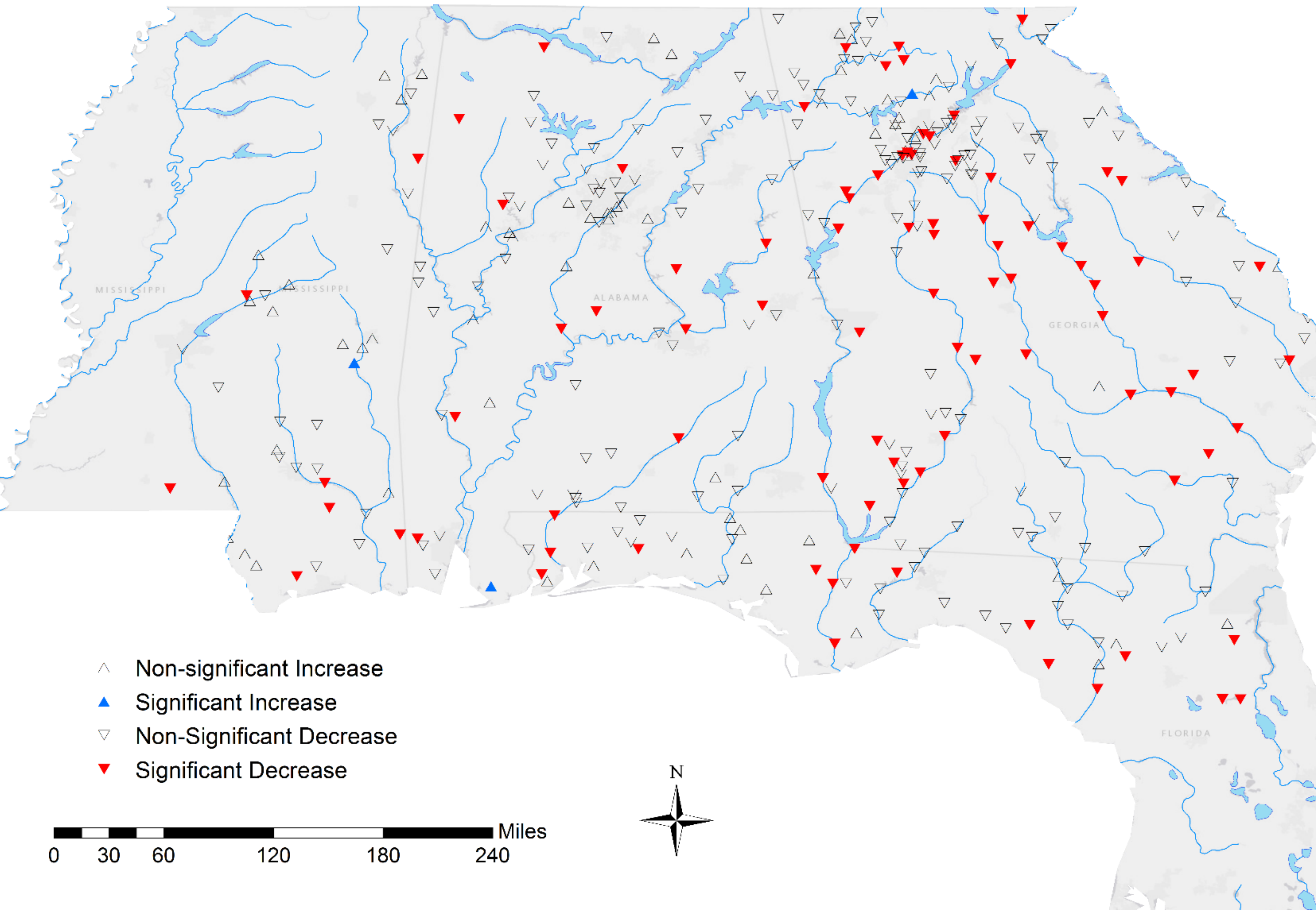

The Emerging Megaregions
Cascadia
Northern California
Southern California
Arizona Sun Corridor
Front Range
Texas Triangle
Great Lakes
Gulf Coast
Piedmont Atlantic
Florida
Northeast
Metro Area Population
150,000 to 1 million
1 to 3 million
3 to 6 million
6 million +

Increasing summer rainfall intensity in the southeast US

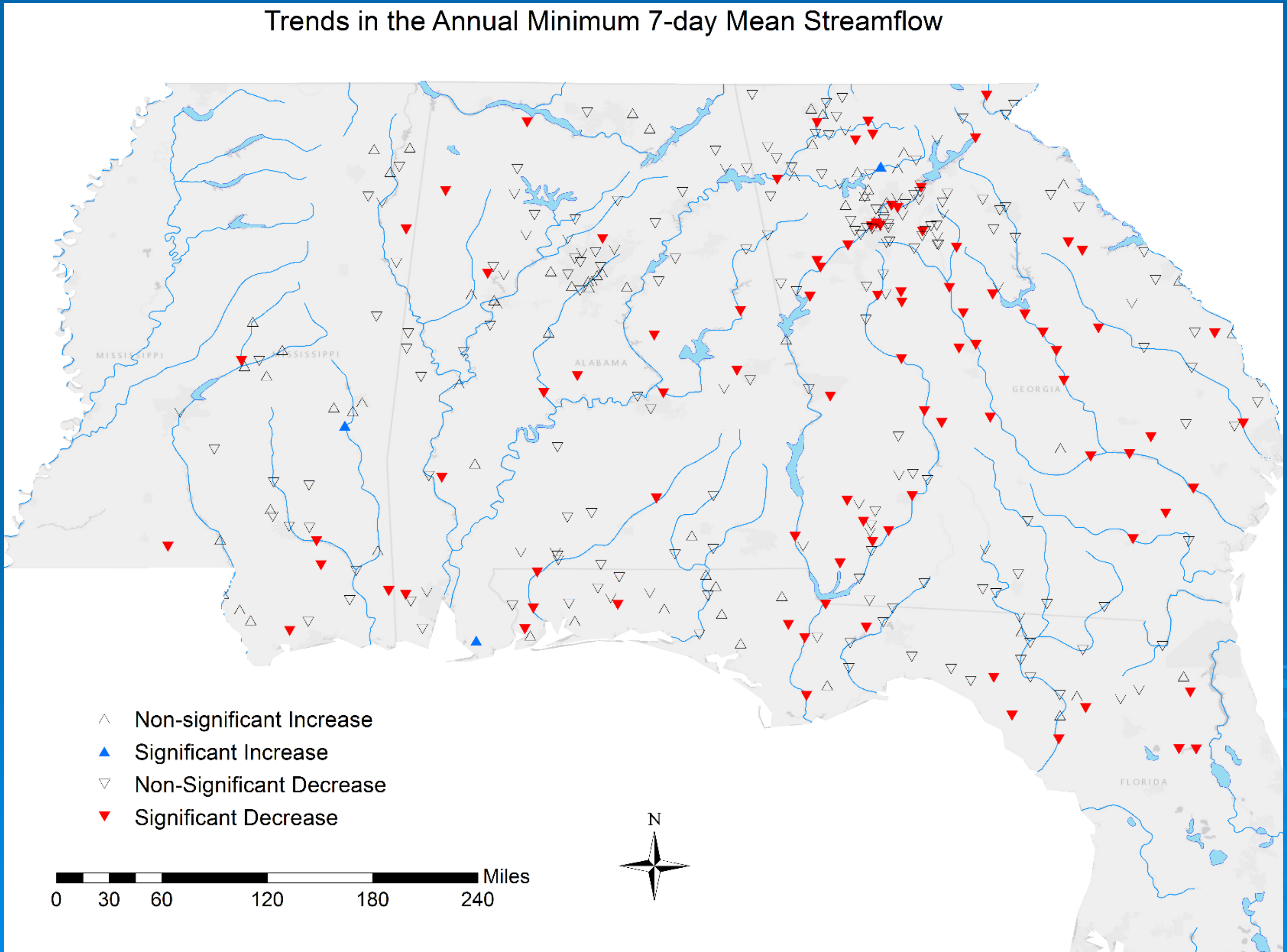
Domain	mm/day	Year		JFM		AMJ		JAS		OND	
		tau	p-value	tau	p-value	tau	p-value	tau	p-value	tau	p-value
Contiguous US	>25	0.116	0.334	-0.0655	0.589	0.126	0.293	0.24	0.044	-0.0891	0.460
	>25 to 50	0.106	0.379	-0.0891	0.460	0.129	0.280	0.173	0.147	-0.113	0.349
	>50 to 75	0.133	0.268	-0.0891	0.460	0.17	0.156	0.365	0.002	-0.0622	0.609
	>75 to 100	0.119	0.320	-0.136	0.256	0.15	0.211	0.348	0.003	-0.0353	0.776
	>100	0.0555	0.650	-0.15	0.211	0.0084	0.955	0.227	0.057	-0.109	0.363
Southeast	>25	0.0387	0.755	-0.123	0.307	0.0555	0.650	0.314	0.008	-0.0924	0.443
	>25 to 50	0.0454	0.712	-0.0824	0.495	0.0286	0.820	0.294	0.013	-0.079	0.514
	>50 to 75	0.119	0.320	-0.123	0.307	0.17	0.156	0.345	0.004	-0.0588	0.629
	>75 to 100	0.0924	0.443	-0.193	0.105	0.156	0.191	0.304	0.011	-0.0521	0.670
	>100	0.0151	0.910	-0.106	0.379	0.0857	0.478	0.176	0.140	-0.153	0.201

Shepherd (in prep)

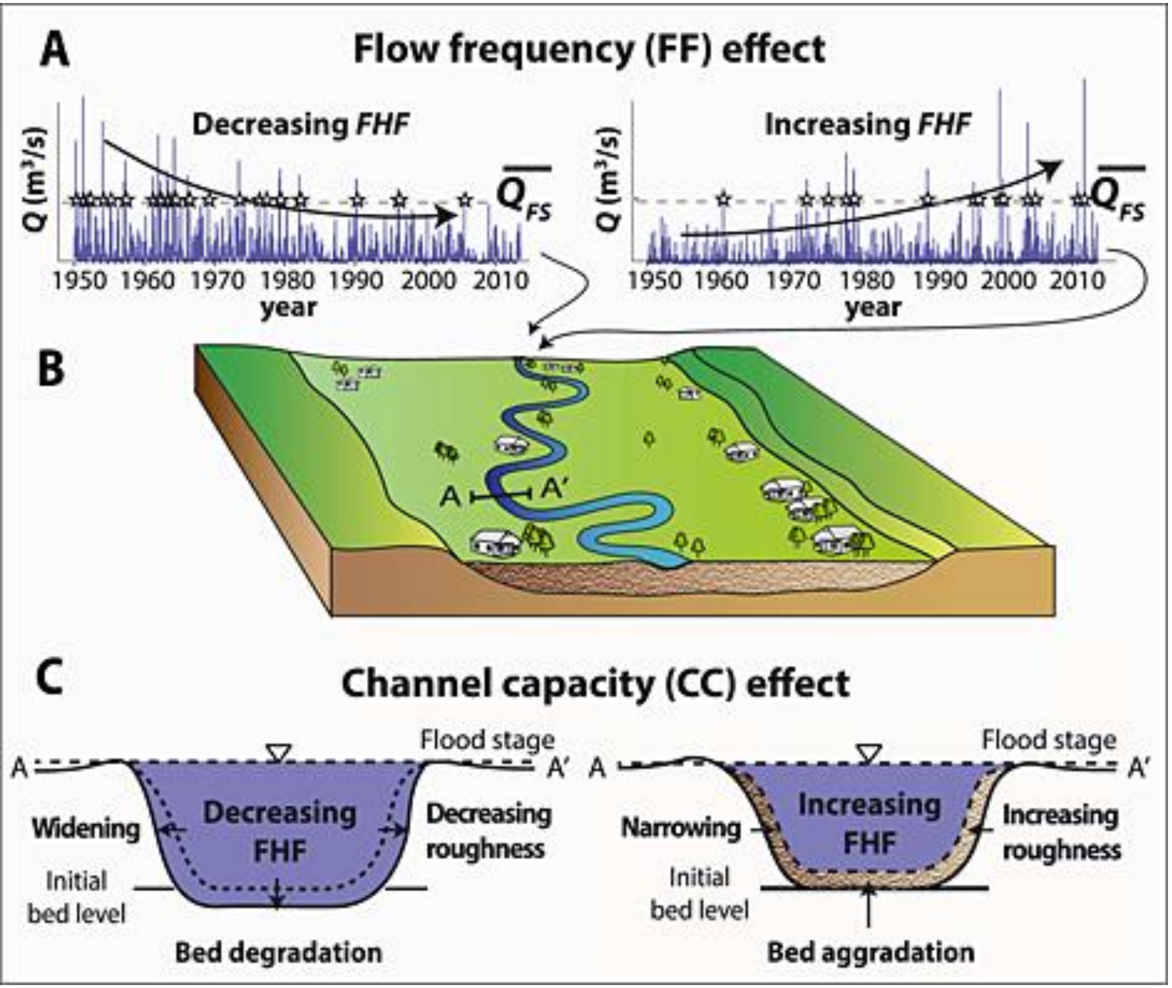
Trends in the Annual Minimum 7-day Mean Streamflow



Could peak attenuation result in higher baseflows in the dry season due to gradual draining of storage areas?



Changing flood hazards: hydrology vs. channel capacity



Flood hazard frequency is changing from:

- A change in the frequency of high flow events
- A change in channel capacity to convey flood waters due to aggradation/degradation

Geophysical Research Letters

Volume 42, Issue 2, pages 370-376, 23 JAN 2015 DOI: 10.1002/2014GL062482

http://onlinelibrary.wiley.com/doi/10.1002/2014GL062482/full#grl52509-fig-0001

All changing together

- Precipitation / storm intensity
- Urbanization – imperviousness / soils
- Sea level
- Drainage systems
- Stormwater control measures
- Channels and floodplains

POLICYFORUM

CLIMATE CHANGE

Stationarity Is Dead: Whither Water Management?

Climate change undermines a basic assumption that historically has facilitated management of water supplies, demands, and risks.

P. C. D. Milly,[1*] Julio Betancourt,[2] Malin Falkenmark,[3] Robert M. Hirsch,[4] Zbigniew W. Kundzewicz,[5] Dennis P. Lettenmaier,[6] Ronald J. Stouffer[7]

- Is stationarity dying? (McCarl et al. 2008)
- Stationarity is dead (Milly et al. 2008)
- Collateral damage from the death of stationarity (Pielke Jr. 2009)
- Stationarity: Wanted Dead or Alive? (Lins et al. 2011)
- Stationarity is immortal! (Montanari et al. 2014)
- Make stationarity great again (Doll and Jennings 2018)

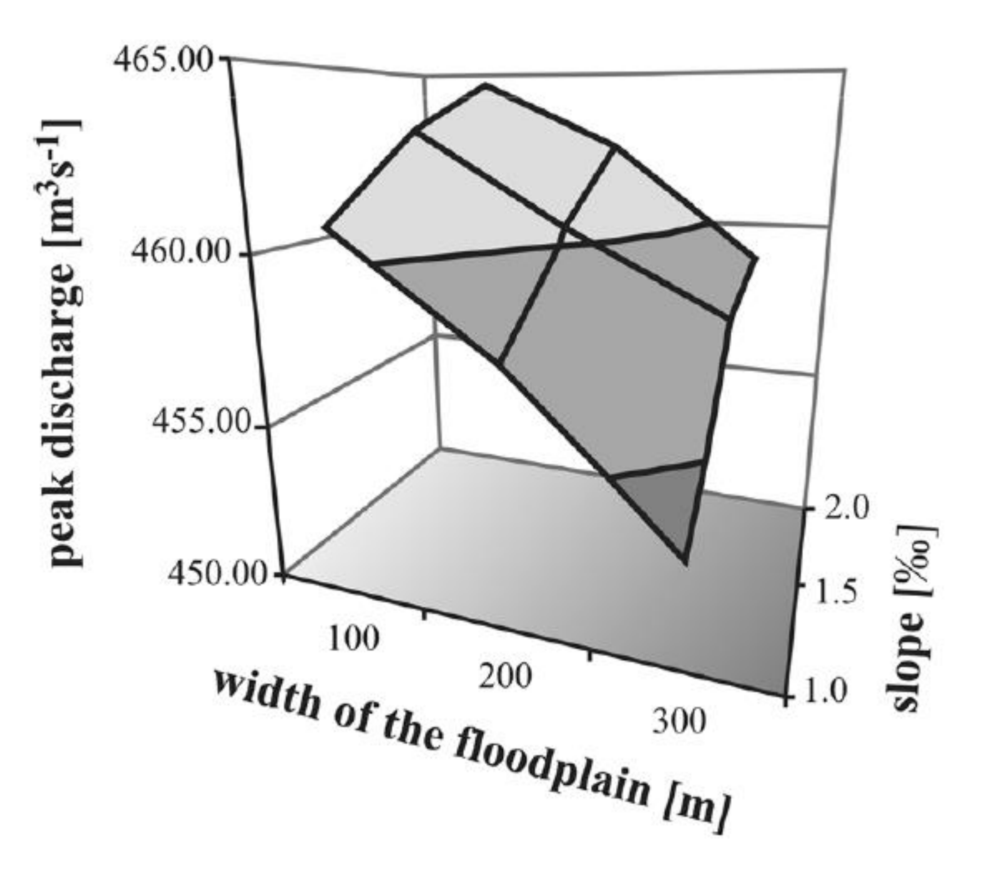
When in do[redacted]d it stout!

When in doubt spread it out!

CATCHMENT CONTEXT

What controls flood attenuation?

- Slope
- Floodplain width
- Roughness
- Geometry
- Length



Habersack et al. 2015

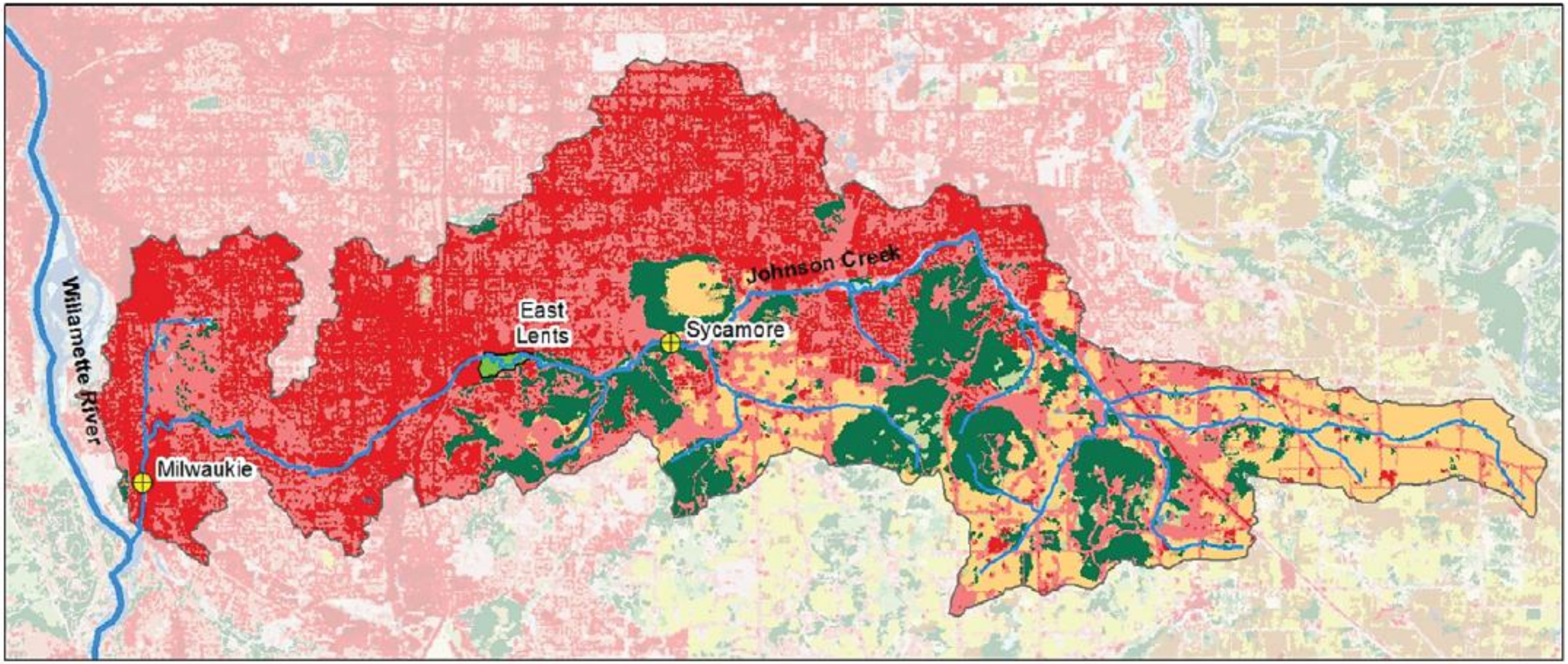
Literature review – generally 0-30% peak flow attenuation

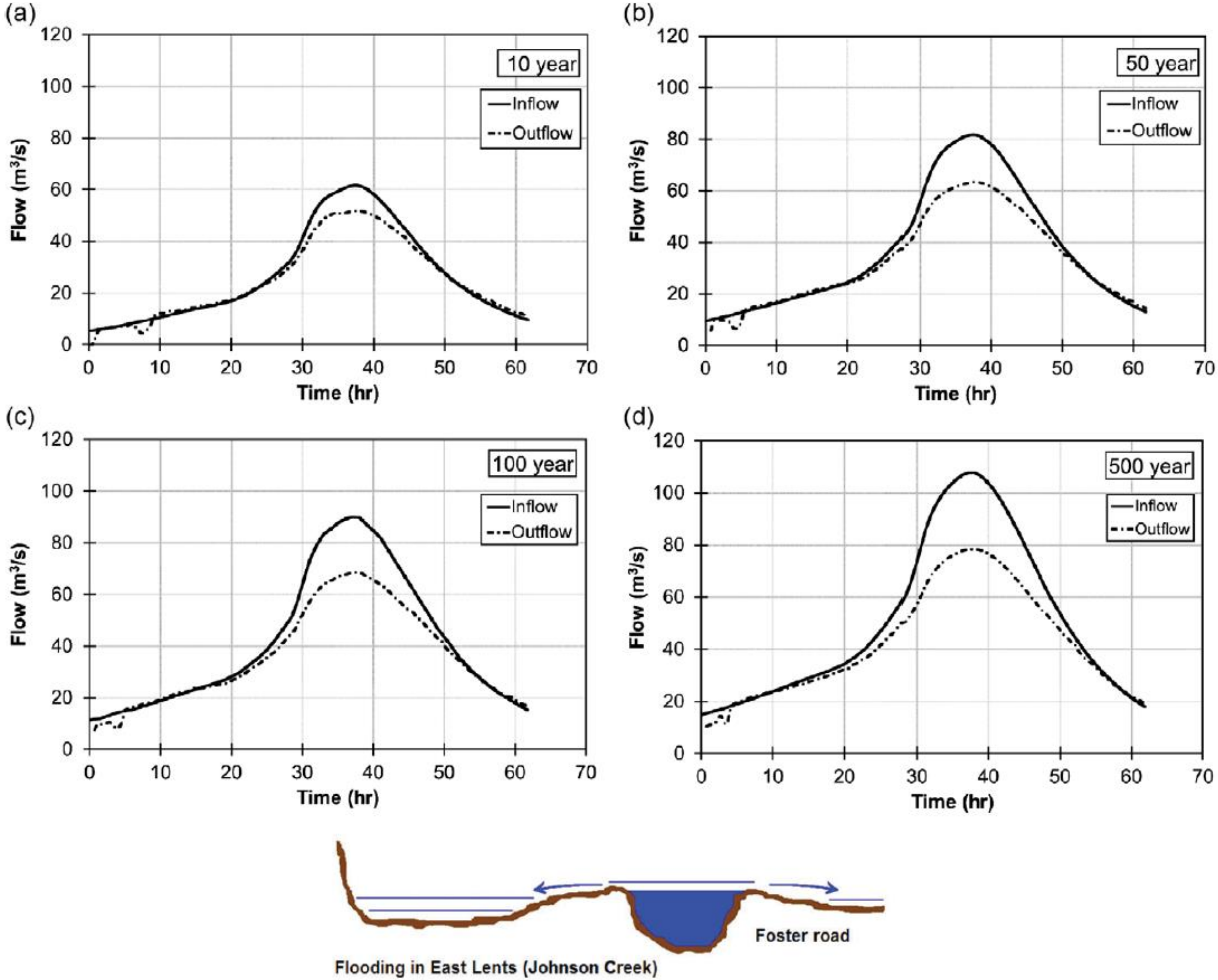
Journal of
Flood Risk Management

The influence of floodplain restoration on flow and sediment dynamics in an urban river

S. Ahilan[1], M. Guan[1], A. Sleigh[1], N. Wright[2] and H. Chang[3]

1 water@leeds, School of Civil Engineering, University of Leeds, Leeds, UK
2 Faculty of Technology, De Montfort University, Leicester, UK
3 Department of Geography, Portland State University, Portland, OR, USA





(a)
10 year
Inflow
Outflow
Flow (m³/s)
Time (hr)
(b)
50 year
Inflow
Outflow
Flow (m³/s)
Time (hr)
(c)
100 year
Inflow
Outflow
Flow (m³/s)
Time (hr)
(d)
500 year
Inflow
Outflow
Flow (m³/s)
Time (hr)
Foster road
Flooding in East Lents (Johnson Creek)

Primer

Natural flood management

Stuart N. Lane*

The effects of river restoration on catchment scale flood risk and flood hydrology

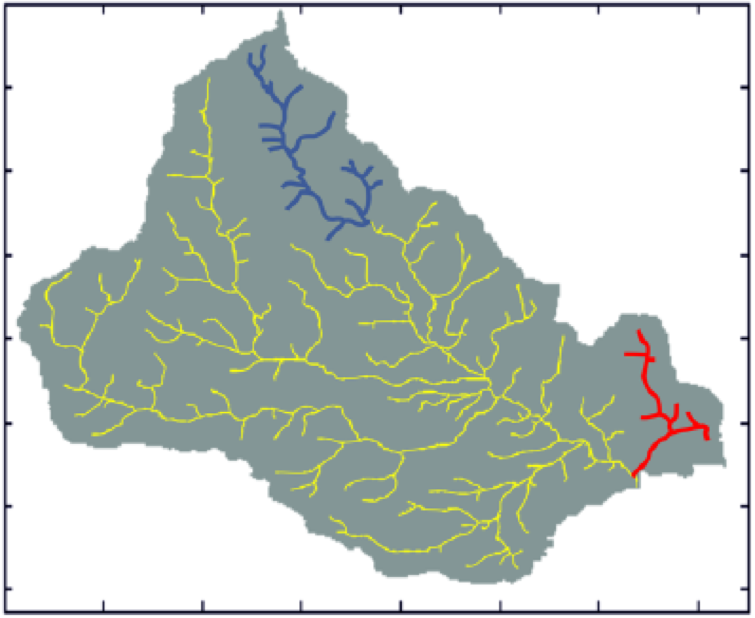
Simon J. Dixon,[1]* David A. Sear,[2] Nicholas A. Odoni,[3] Tim Sykes[4] and Stuart N. Lane[5]
[1] Birmingham Institute of Forest Research, School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, UK
[2] Geography and Environment, University of Southampton, Southampton, UK
[3] Department of Geography, Durham University, Durham, UK
[4] Environment Agency, Solent Fisheries & Biodiversity Team, Romsey, Hampshire, UK
[5] Institute of Earth Surface Dynamics, University of Lausanne, Lausanne, Switzerland

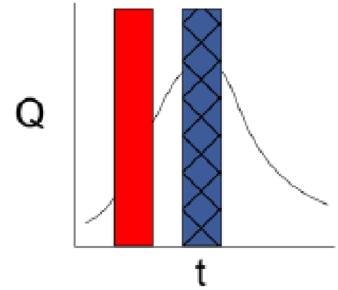
RESEARCH ARTICLE

A modelling framework for evaluation of the hydrological impacts of nature-based approaches to flood risk management, with application to in-channel interventions across a 29-km^2 scale catchment in the United Kingdom

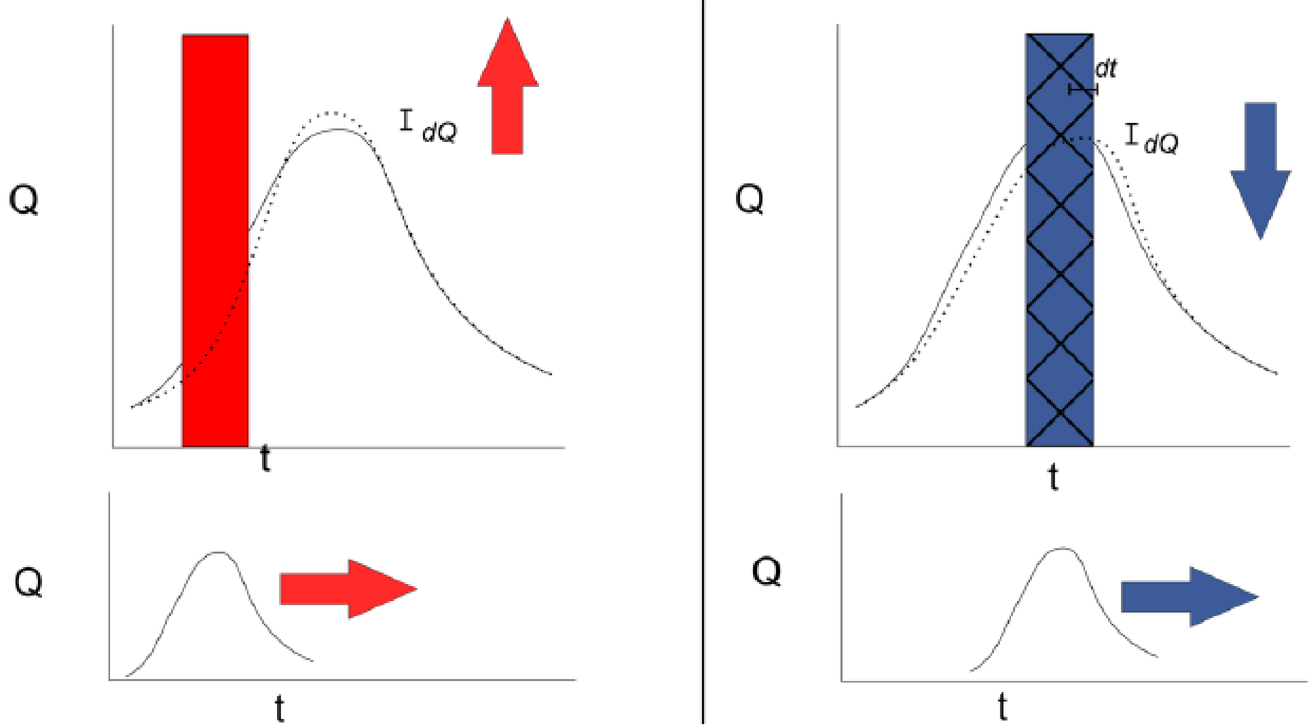
Peter Metcalfe[1] | Keith Beven[1,2] | Barry Hankin[3] | Rob Lamb[1,4]

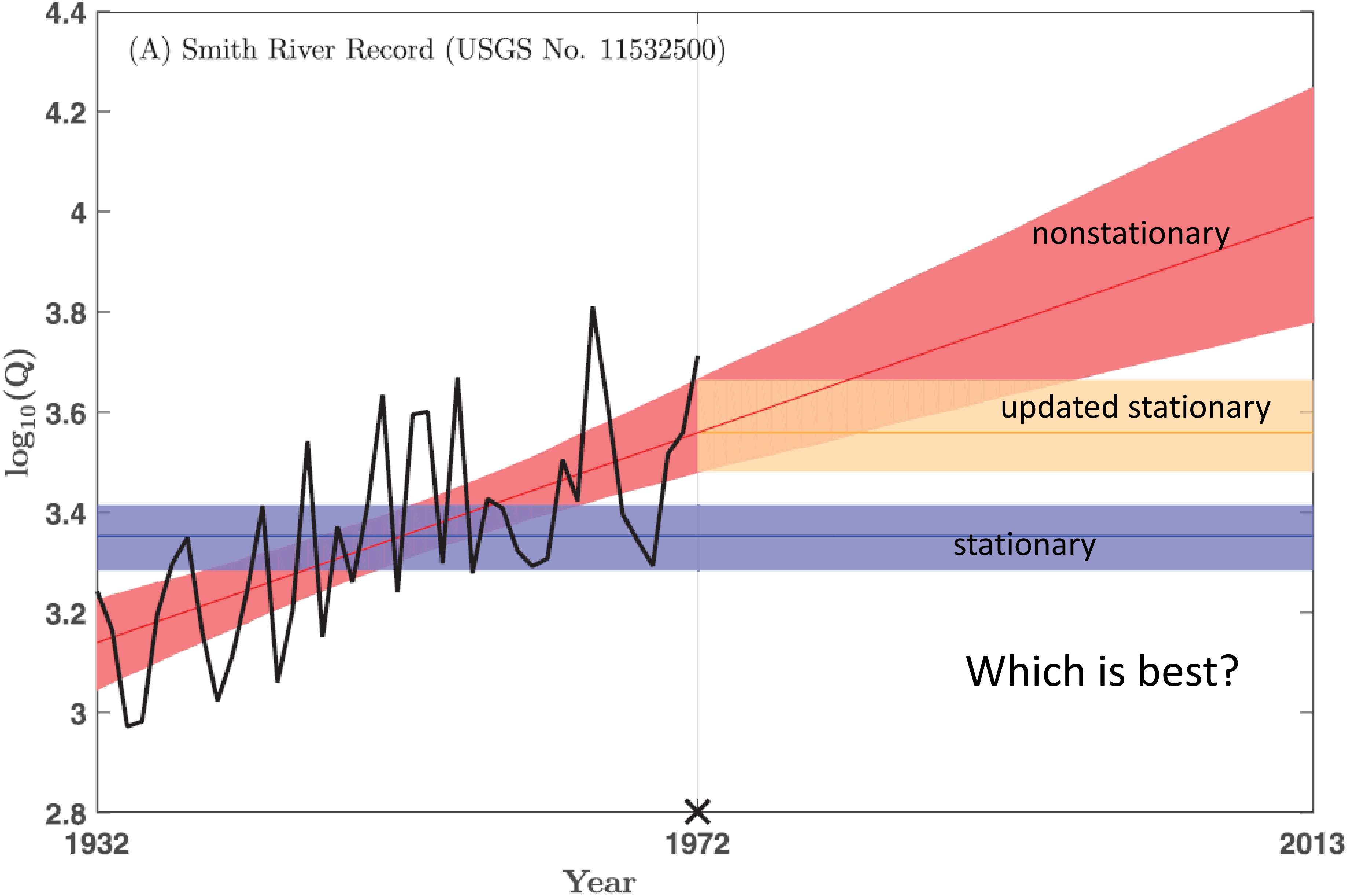
Synchronization vs. desynchronization



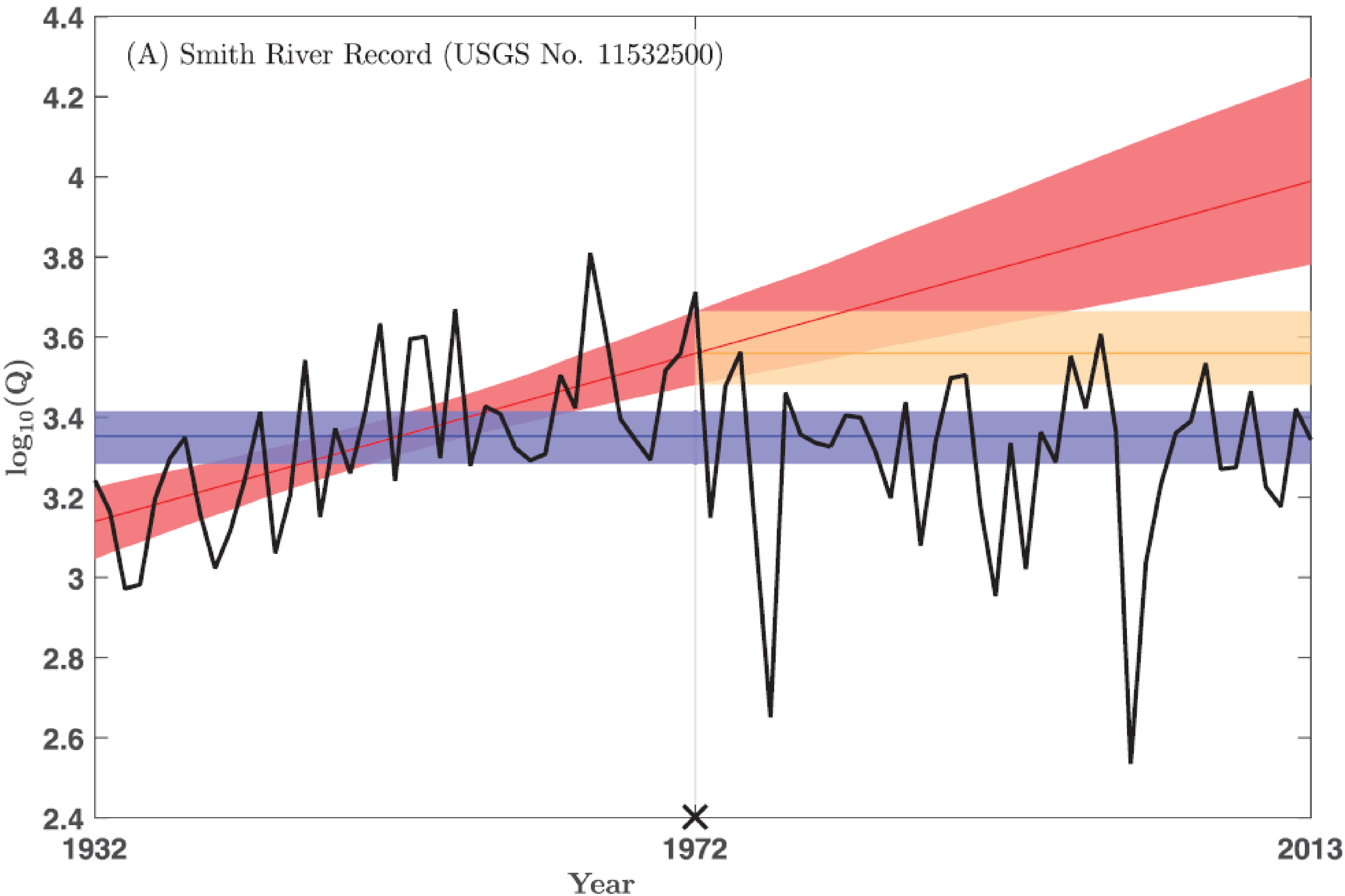


The contributions of flood water from different parts of a catchment will arrive at the catchment outflow at different points in the flood event/hydrograph. Here the red sub-catchment is hydrologically proximal to the outflow and delivers storm water on the rising limb of the hydrograph, whereas the hashed blue sub-catchment contribution arrives coincident with the hydrograph peak.

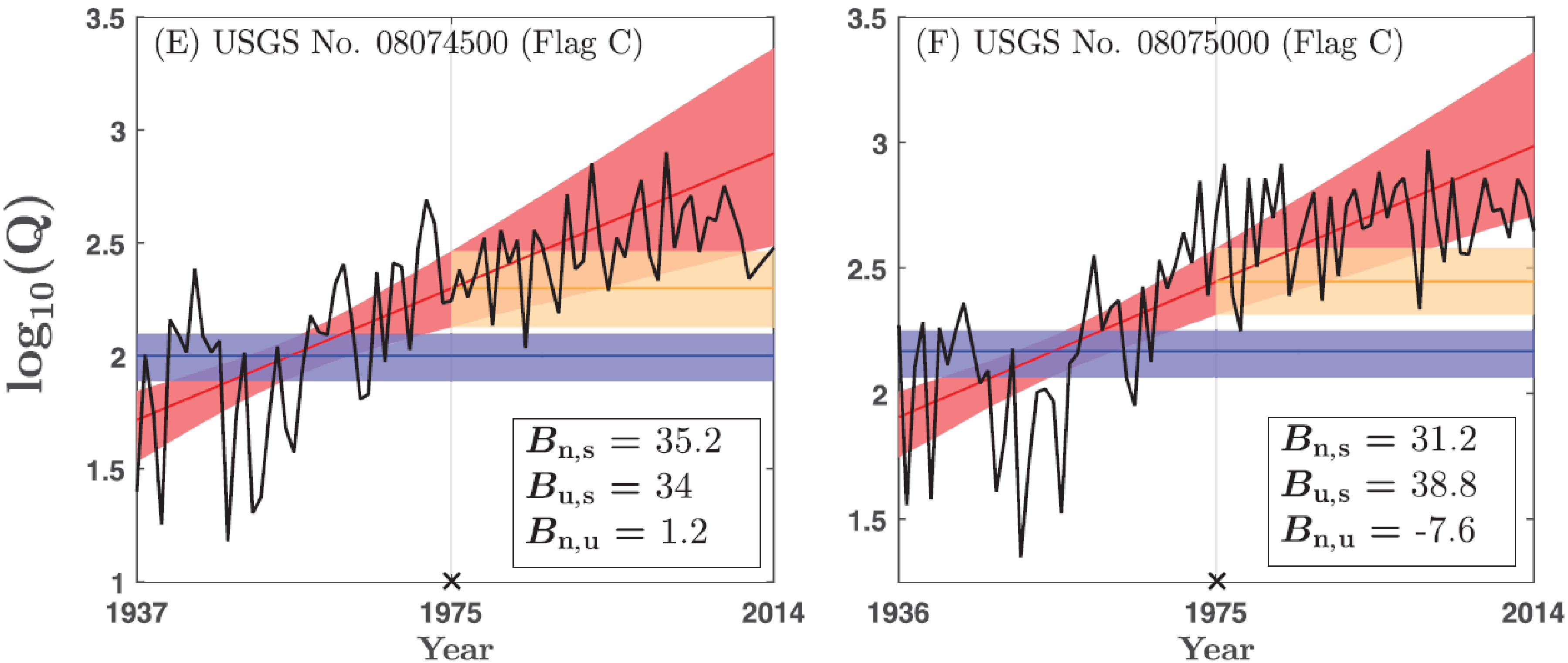




Luke et al. (2017)



Luke et al. (2017)



Luke et al. (2017)

COMMUNICATION

Capital Weather Gang • Perspective

We still don't know how to talk about floods

By Brian Bledsoe September 13, 2017

Floodwaters surround houses and apartment complexes in West Houston on Aug. 30. (Jabin Botsford/The Washington Post)

The author, Brian Bledsoe, is a professor of civil and environmental engineering at the University of Georgia. His research focuses on the interface of hydrology, ecology and urban water sustainability.

Making risk relatable

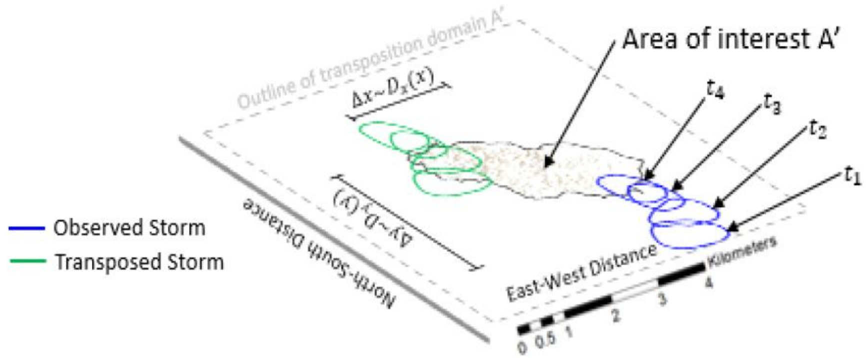
- The 100-year flood at a given location has more than a 1 in 4 chance of occurring within the term of a 30-year mortgage
- For 90% reliability over a 30-year mortgage, structures must be above the height of the **285**-year flood
- For 90% reliability over 50 years, structures are above the height of the **474**-year flood
- IF THE FUTURE BEHAVES LIKE THE PAST

UNIVERSITY OF GEORGIA
Institute for Resilient Infrastructure Systems

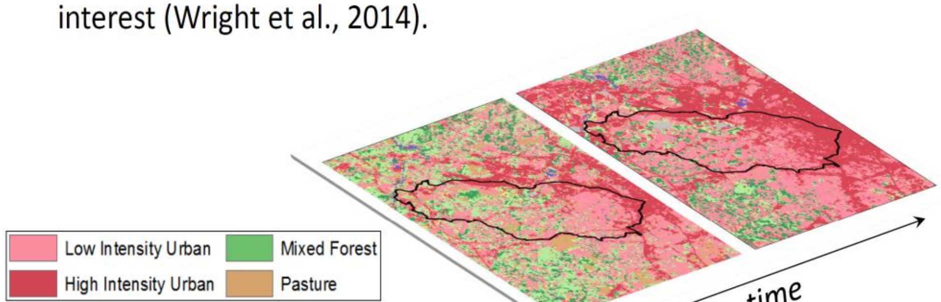
National Science Foundation
WHERE DISCOVERIES BEGIN

UWIN

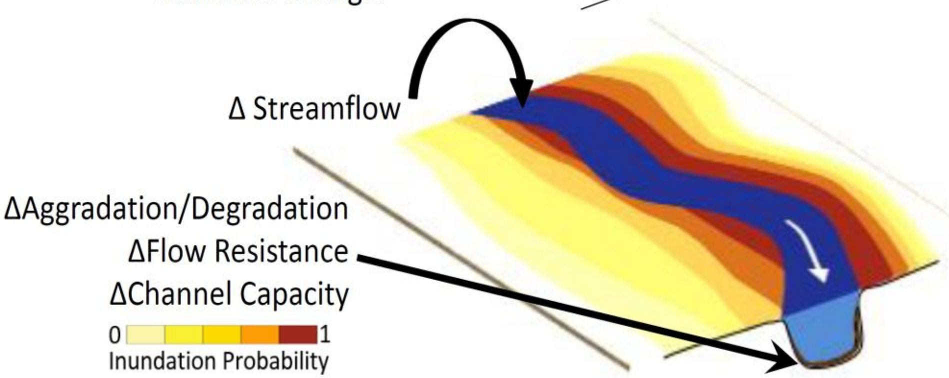
Compounding effects of rainfall intensity, urbanization, and channel change



Stochastic storm transposition schematic over area of interest (Wright et al., 2014).



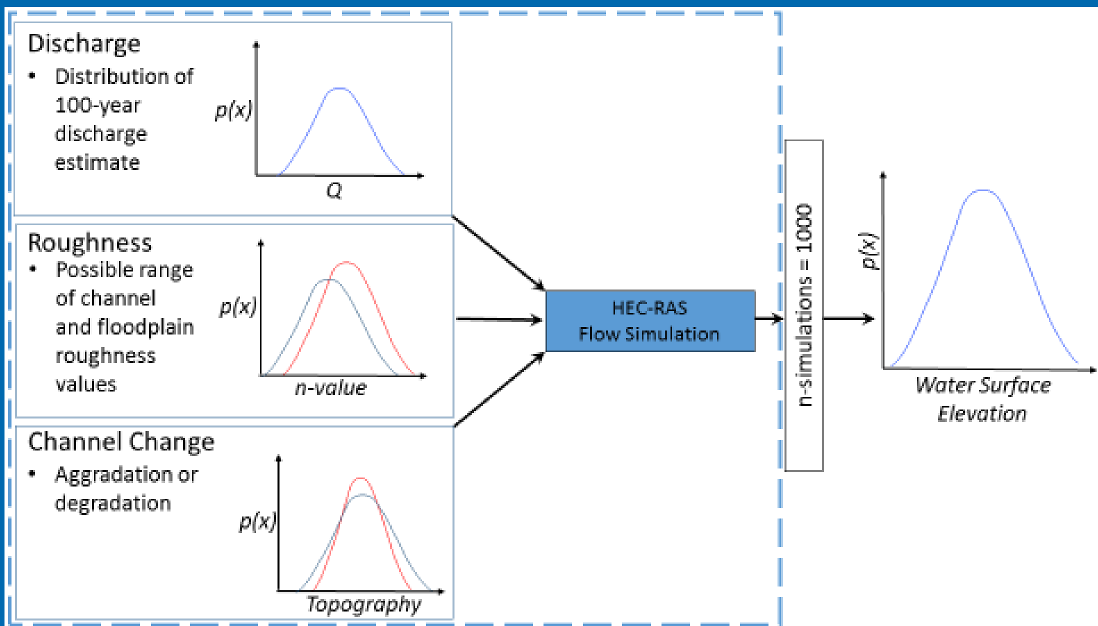
Land use change.



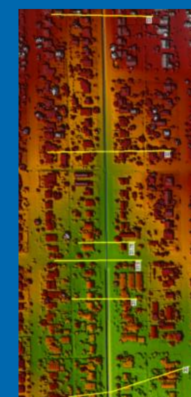
Changing:

- Rainfall intensity
- Land use
- River channels
- Gray and green stormwater practices

Probabilistic Floodplain Mapping



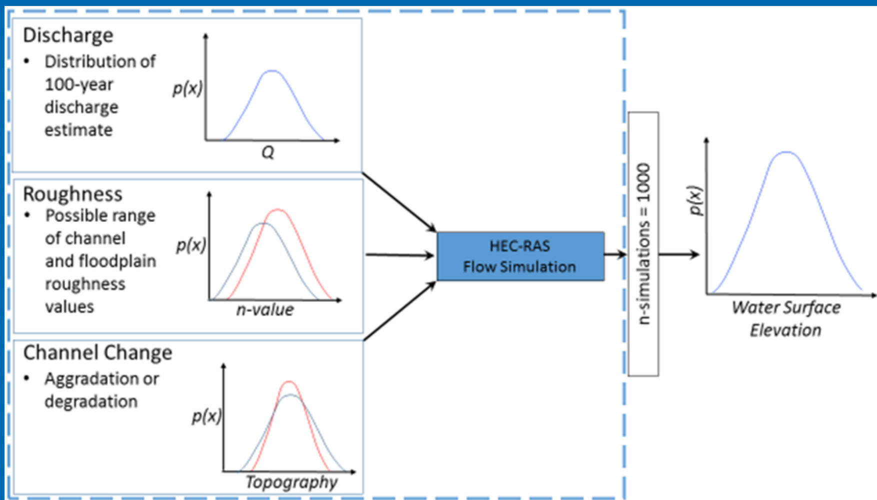
Terrain



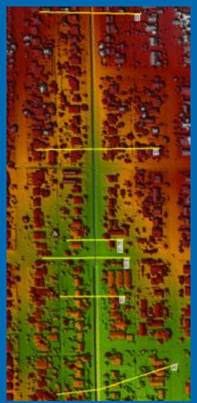
Inundatio

0	0	1	0
0	1	0	0
0	0	1	0
0	1	0	0
0	1	0	0

Probabilistic Floodplain Mapping

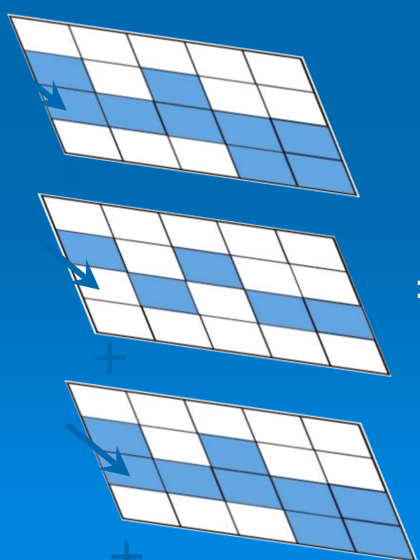


Terrain



Inundatio

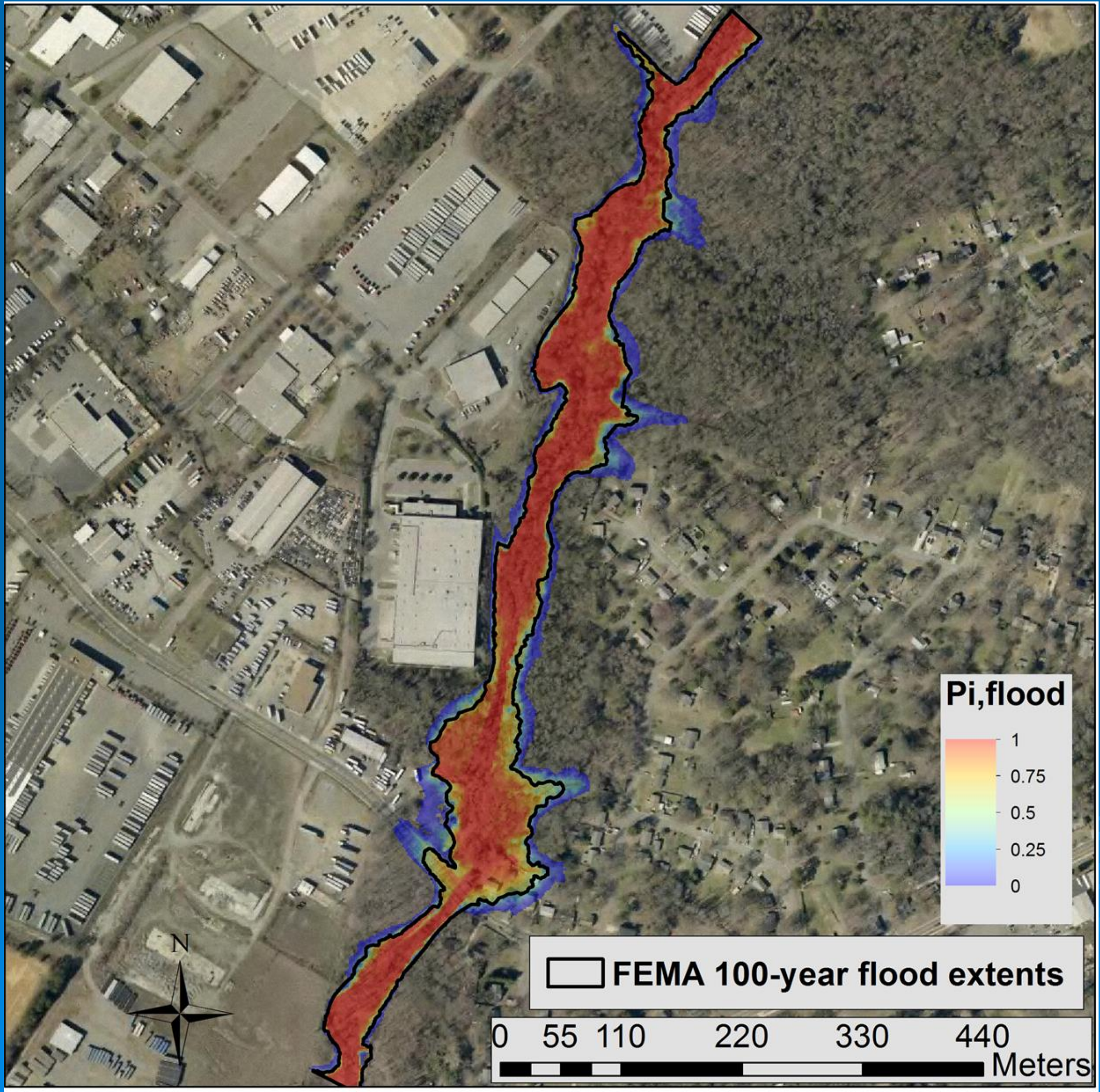
0	0	1	0
0	1	0	0
0	0	1	0
0	1	0	0
0	1	0	0



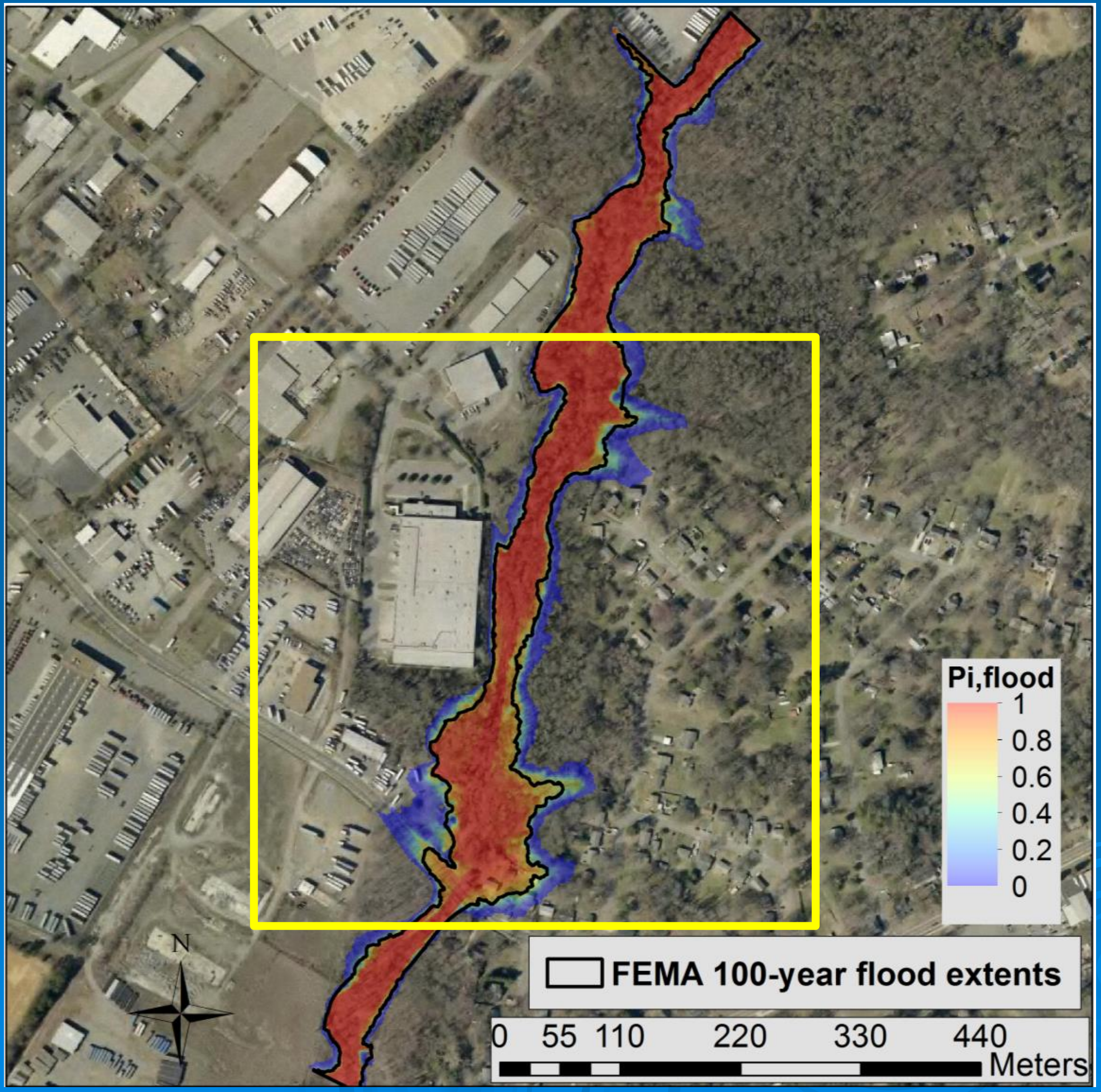
$$= \frac{\sum_{j=1}^{n} f_{i,j}}{n} = P_{i,flood}$$

- $f_{i,j}$ = inundation state of pixel, i, at simulation, j
- *flood* denotes a specified return frequency

Derita Branch

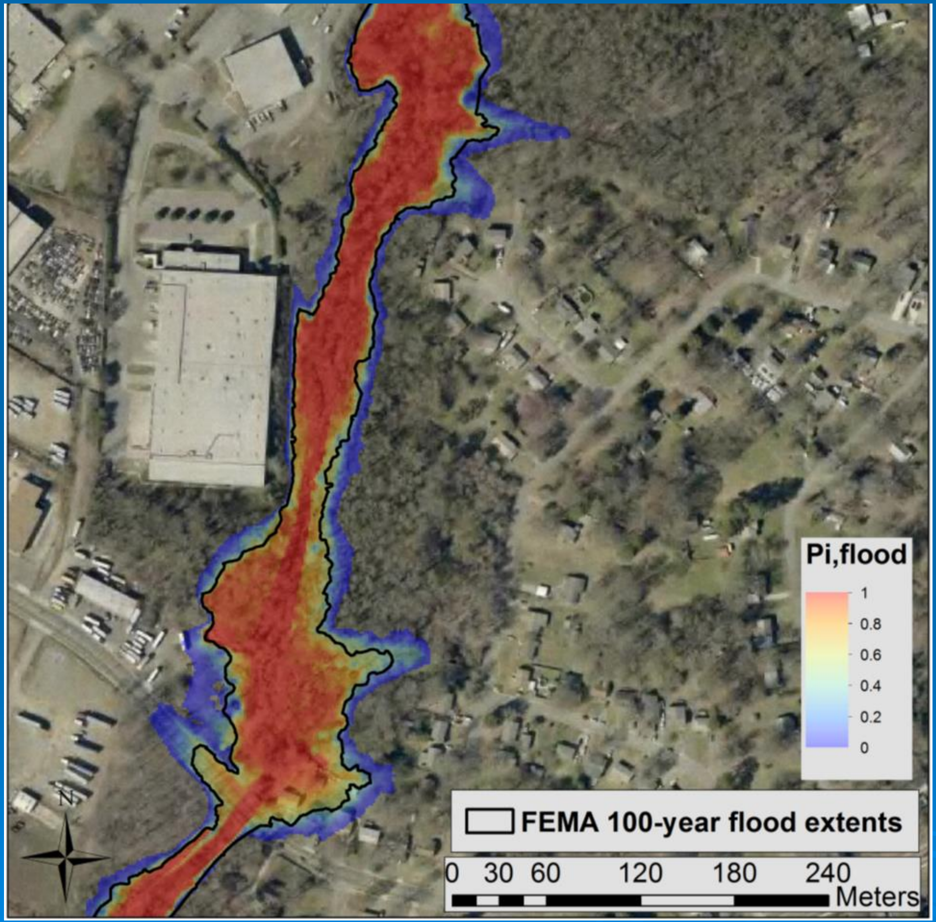


Projected Land-Use Scenario

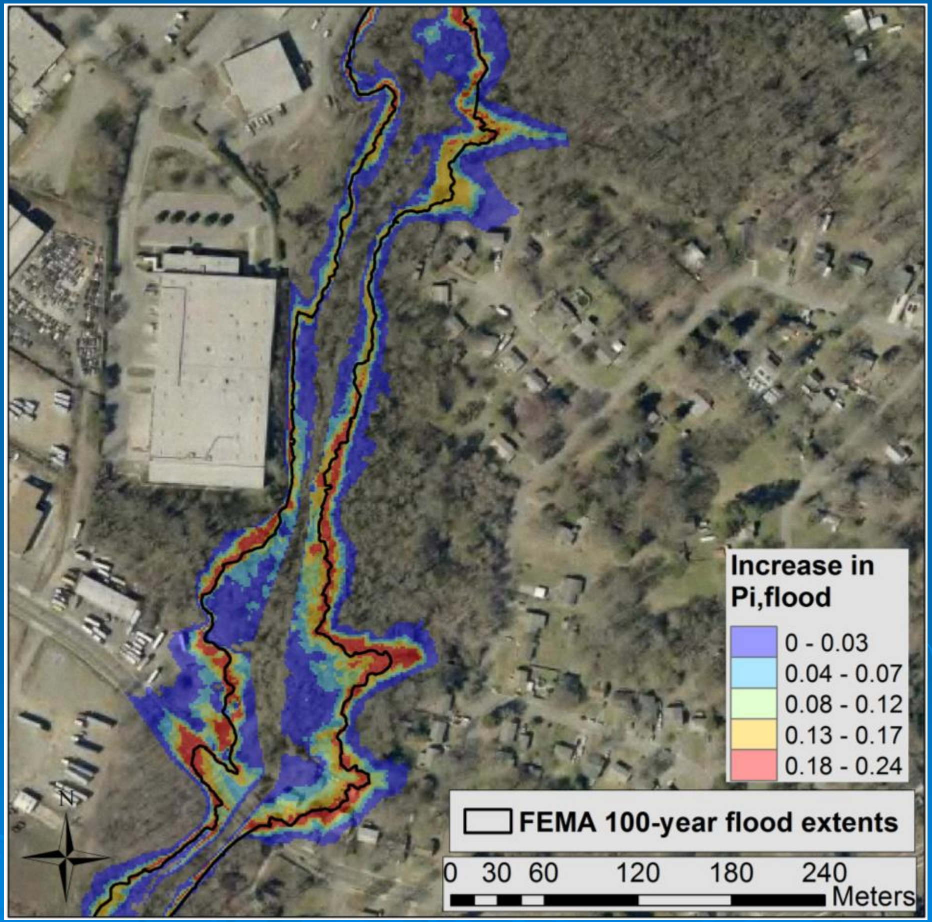


Projected Land-Use Scenario

Existing Conditions



Projected Scenario



- Clean air 
- Quiet 
- Short commutes 
- Nature contact 
- “Third places” 
- Beauty 

Urban River Parkways

An Essential Tool for Public Health

Richard J. Jackson, MD, MPH - UCLA Fielding School of Public Health

Tyler D. Watson, MPH - UCLA Fielding School of Public Health

Andrew Tsiu, MPH - UCLA Fielding School of Public Health

Bianca Shulaker, MURP - USC Department of Urban Planning

Stephanie Hopp, MPH - Johns Hopkins School of Public Health

Mladen Popovic - UC Santa Barbara

July 2014

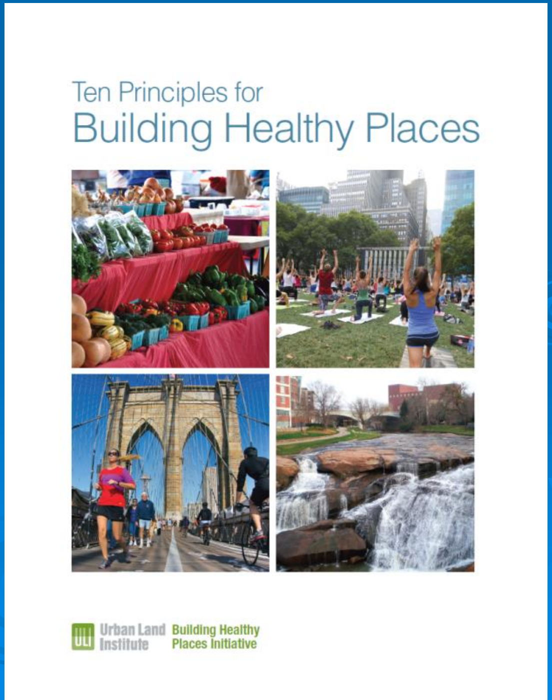
COEH

Center for Occupational & Enviromental Health UCLA

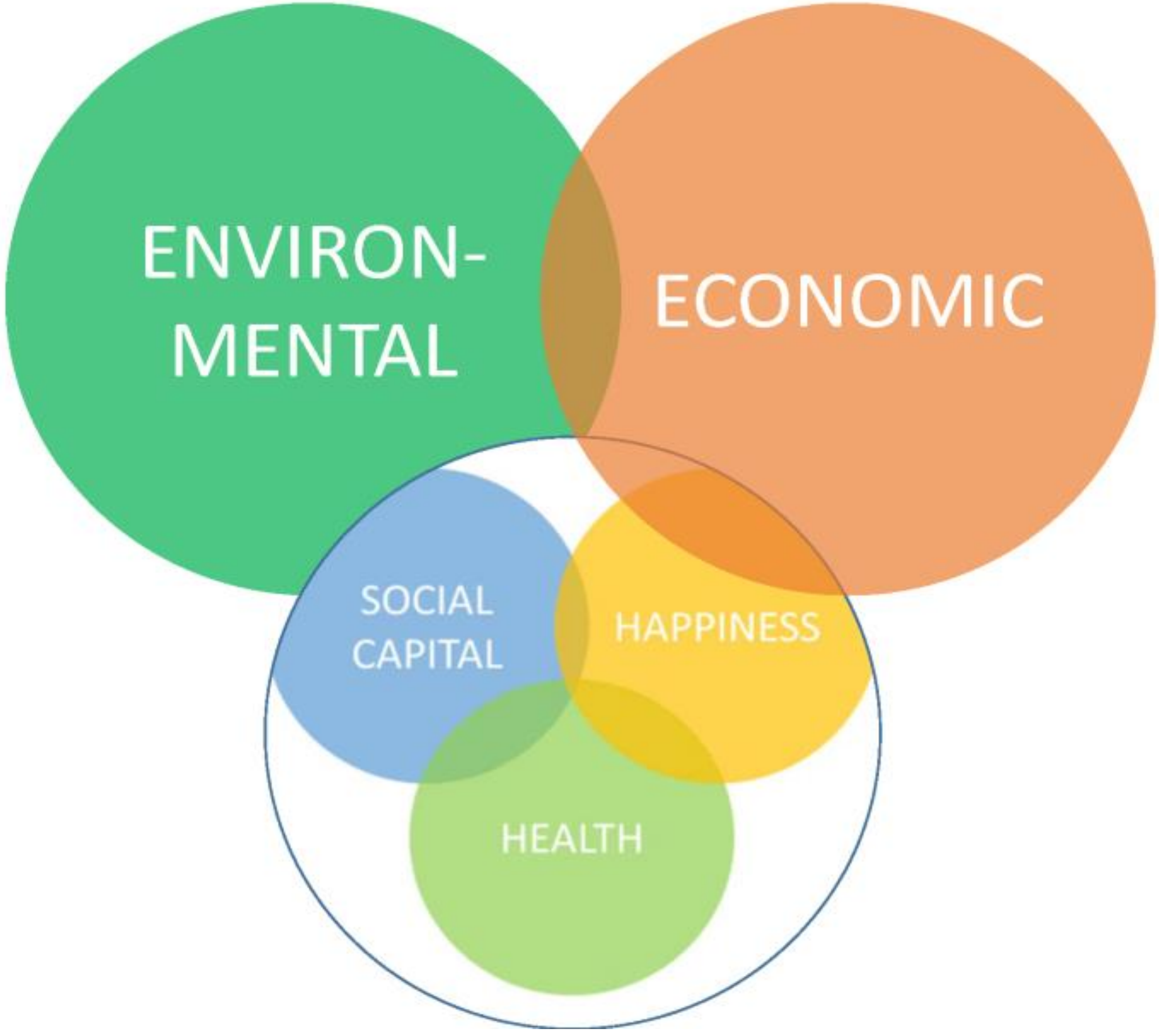
Every 1 dollar spent on trails results in $3 to >$10 of direct medical benefit

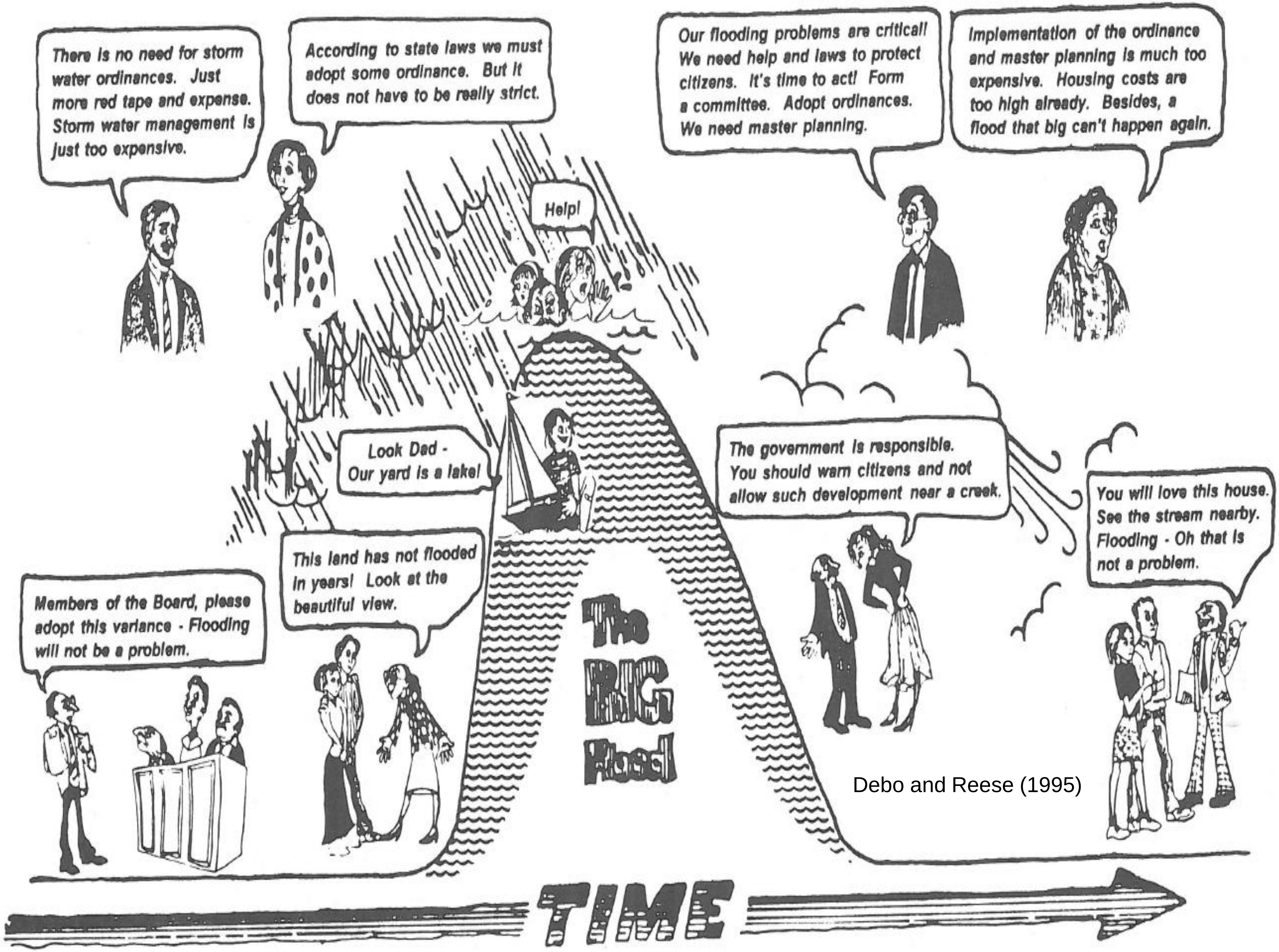
- Is there a role for the built environment and green infrastructure in helping make people happier, more connected with each other, and even healthier?

- There is a growing literature that suggests there is, that there is what some have called a "geography of happiness." An approach to place making that aims to:
  - make people happy
  - to connect them to each other
  - to promote good health
  - help them thrive




©Frank Ippolito 2010


ENVIRON-
MENTAL
ECONOMIC
SOCIAL
CAPITAL
HAPPINESS
HEALTH



Debo and Reese (1995)

Recommendations

- Examine trends and opportunities for attenuation in a watershed context
- Use full spectrum of discharges (inc. partial dur.)
- Err of the side of smaller channels
  - Veg is your friend (but quantify erosion thresholds)
  - Rough up the floodplain – resist chute / cutoff formation
  - The more degrees of freedom for adjustment the better
- Use probabilistic floodplain maps as a template for corridor design
- Improve communication of compounding risks and all co-benefits – social, environmental, economic

Thanks to Tim Stephens, Holly Y Hall, Barbara Doll, …

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