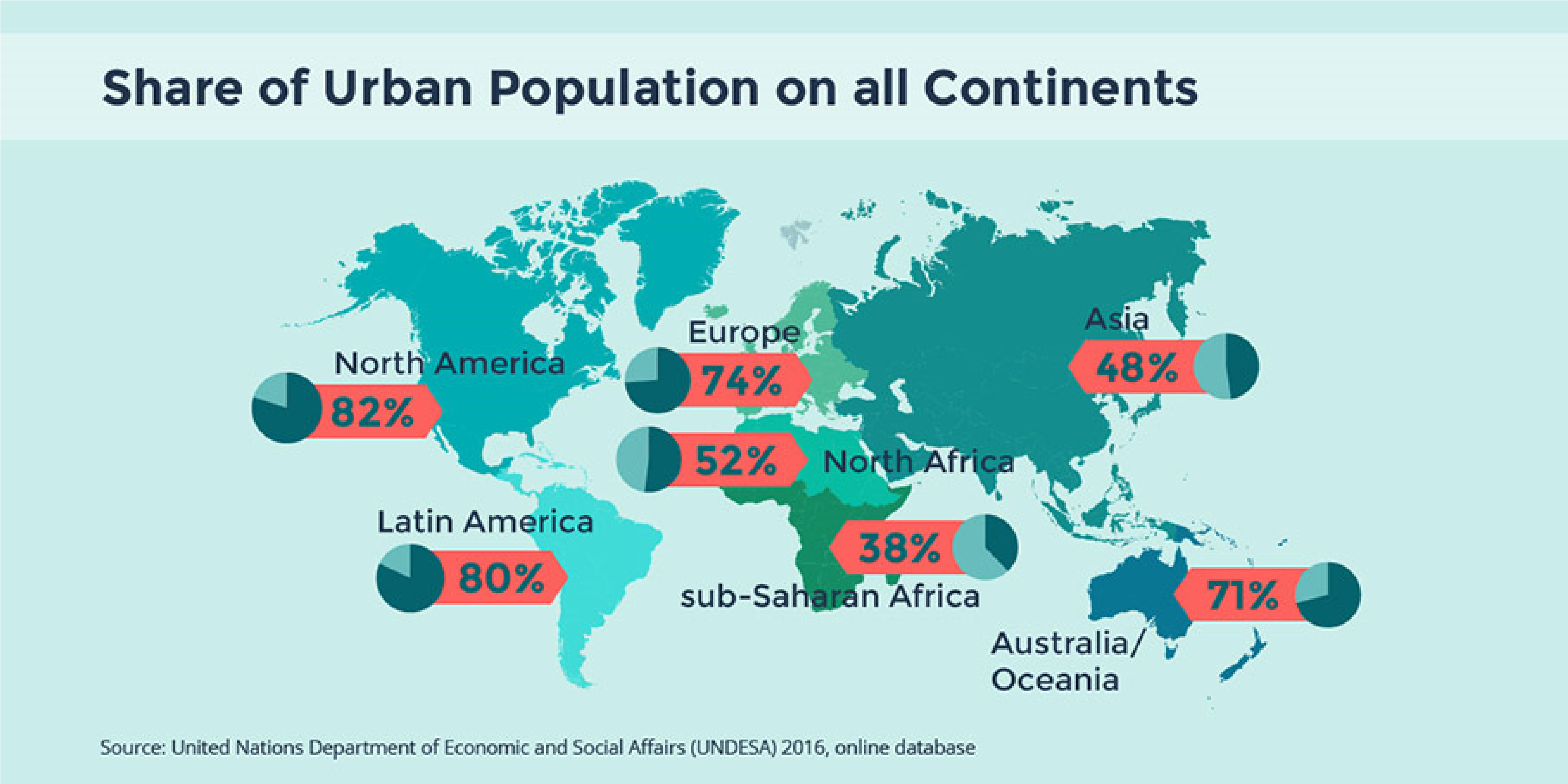
A Move Towards Sustainable Cities via Integrated Water Resources Management and Public Health

Laura Schifman, Ph.D.

NRC Postdoctoral Research Fellow
U.S. EPA National Risk Management Research Laboratory

Today, >50% of people live in cities globally

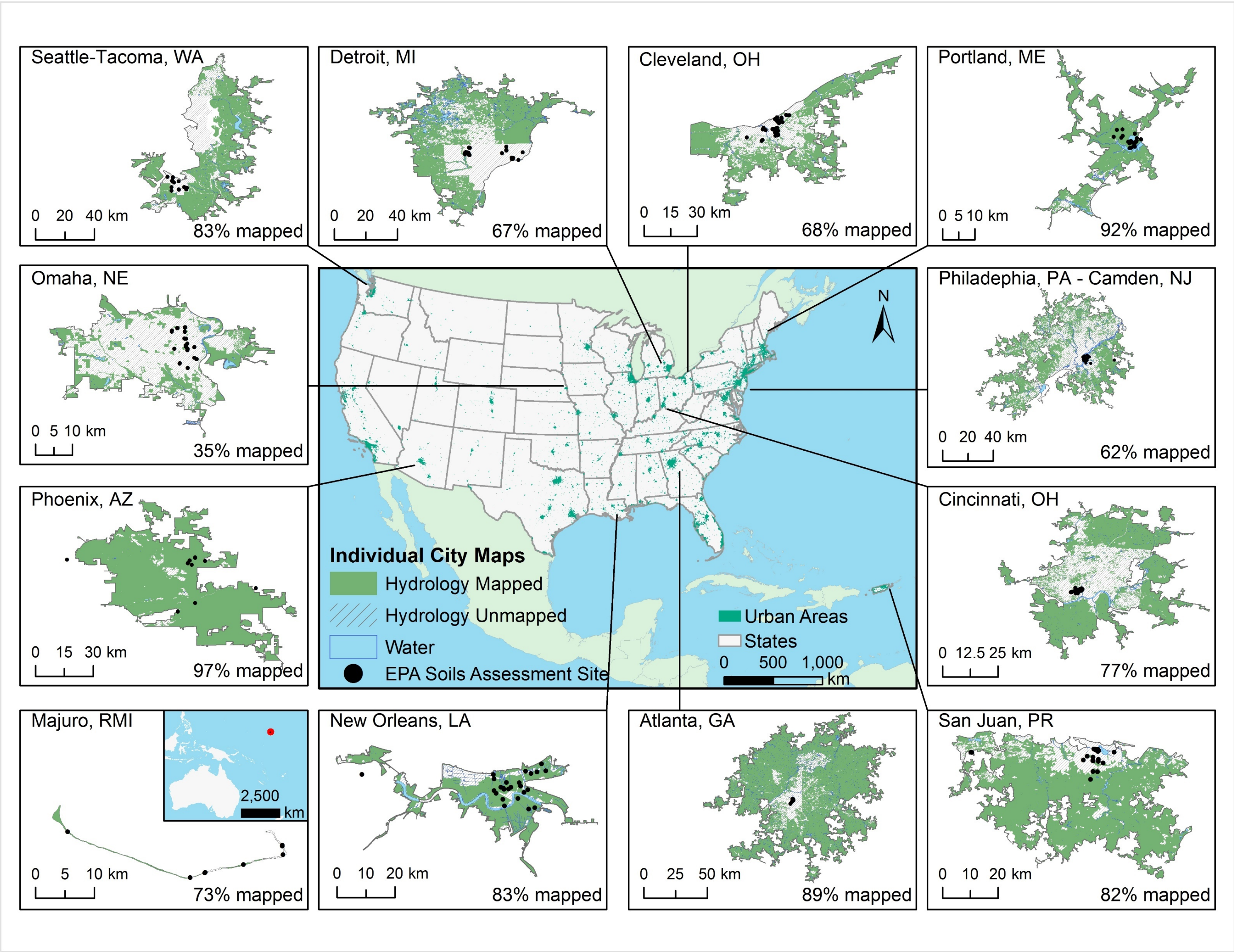
… by 2050 we can expect this number to be 66%



Integrated environmental management for sustainable cities

Site Scale | Plot Scale | City Scale

Where do we start?



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Data-driven approaches to environmental management

Site to plot scale

- How do we understand environmental processes?
  - Soil assessments
  - Hydrologic monitoring/ measurements
  - Physico-chemical sampling
  - Impacts of disturbance (e.g., humans in cities)

City to regional scale

- How do we understand large scale processes?
  - Geospatial land cover analysis
  - Field data driven numerical models
  - Geospatial and statistical modeling
  - Incidence monitoring of vector-borne diseases and affiliated vector abundance

Site Scale | Plot Scale | City Scale

What is my approach? Both!

1. Understand variation between urban soil hydrological measurements and hydrological parameter estimation techniques
2. The EPA National Stormwater Calculator and soil hydrology
3. Develop a framework that aims for interdisciplinary planning of urban multi-functional green infrastructure projects
4. Integrating public health into water resources management by modeling eco-hydrological impacts on mosquito borne disease incidence
5. Assessment of black carbon in urban soils and its role in expanding the types of ecosystem services generated from green infrastructure
6. Understand urban soil in a larger sense – vertical structure, carbon stocks, hydrology, ecosystem services

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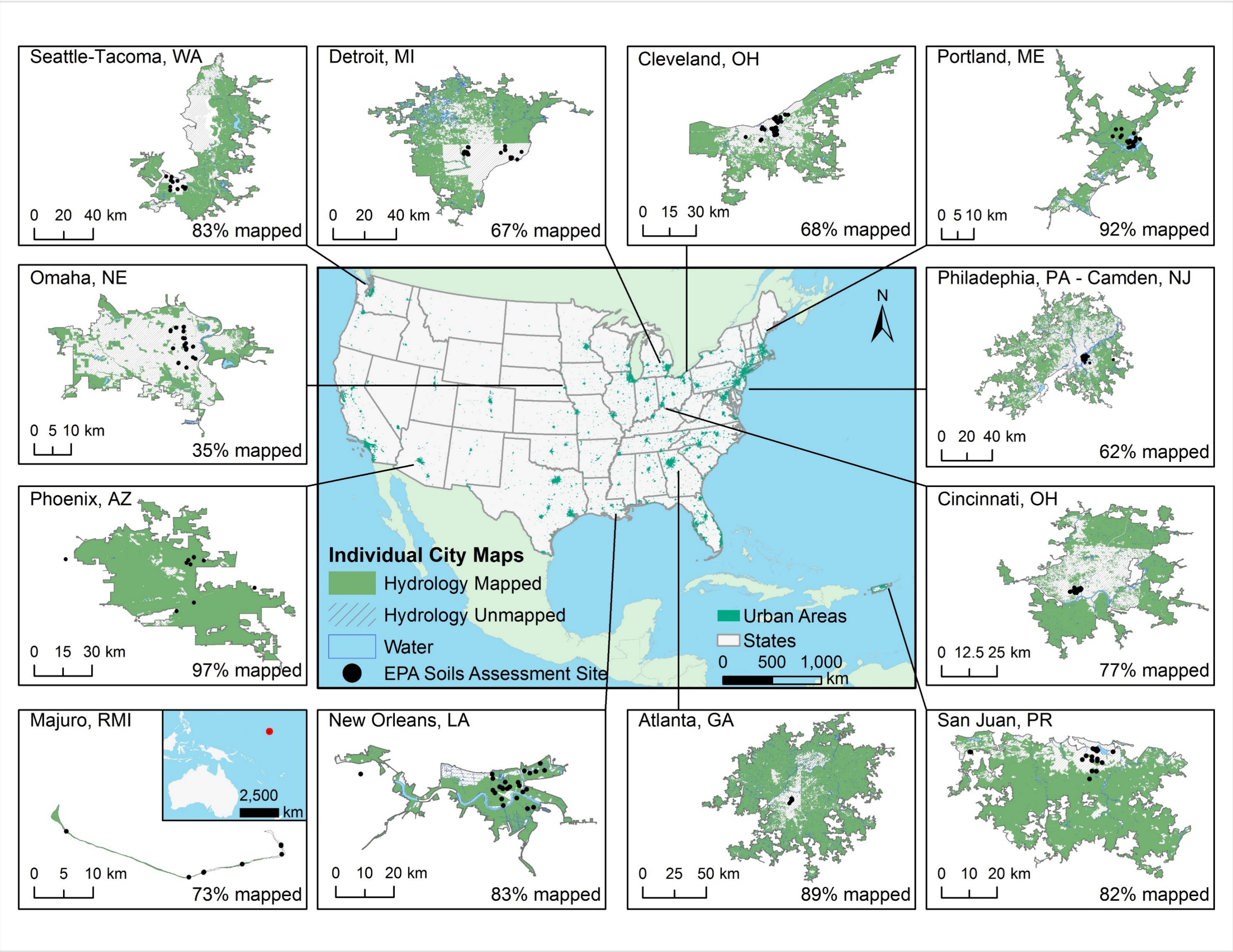
Understanding urban soil hydrology

- >400 sites
- 12 cities
- 4+ infiltration measurements per site
- 2+ drainage measurements per site
- Comparison of measured data to model-predicted values



Schifman and Shuster (under review, *Landscape and Urban Planning)*

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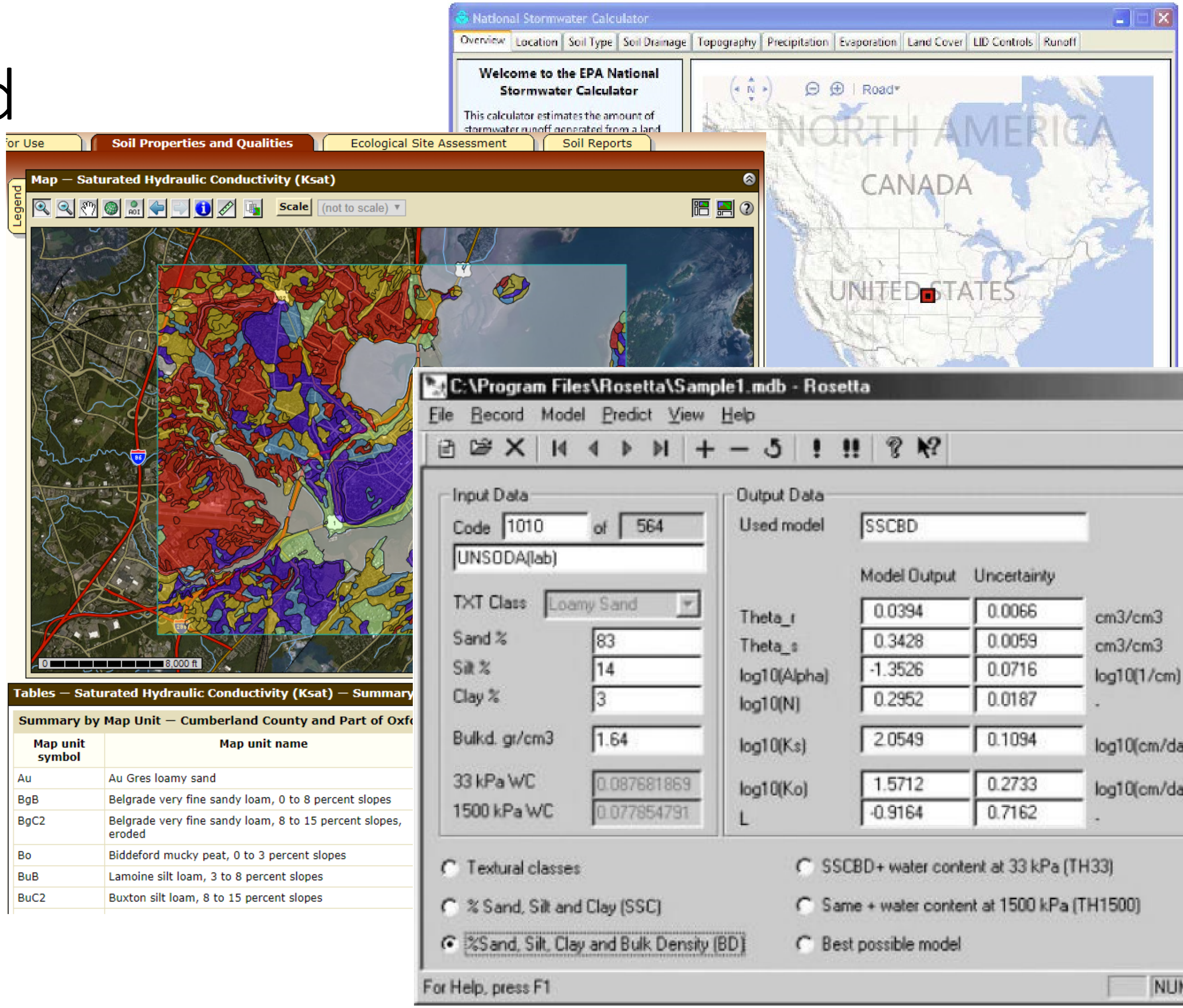
Three common tools used in soil hydrology

- USDA Rosetta
  - Uses pedotransfer functions
  - Integrated into HYDRUS modeling software
- SSURGO WebSoilSurvey
  - National soil survey datasets
  - Integrated into many surface water models
- National Stormwater EPA Calculator
  - Uses interpolation of SSURGO data for simulation



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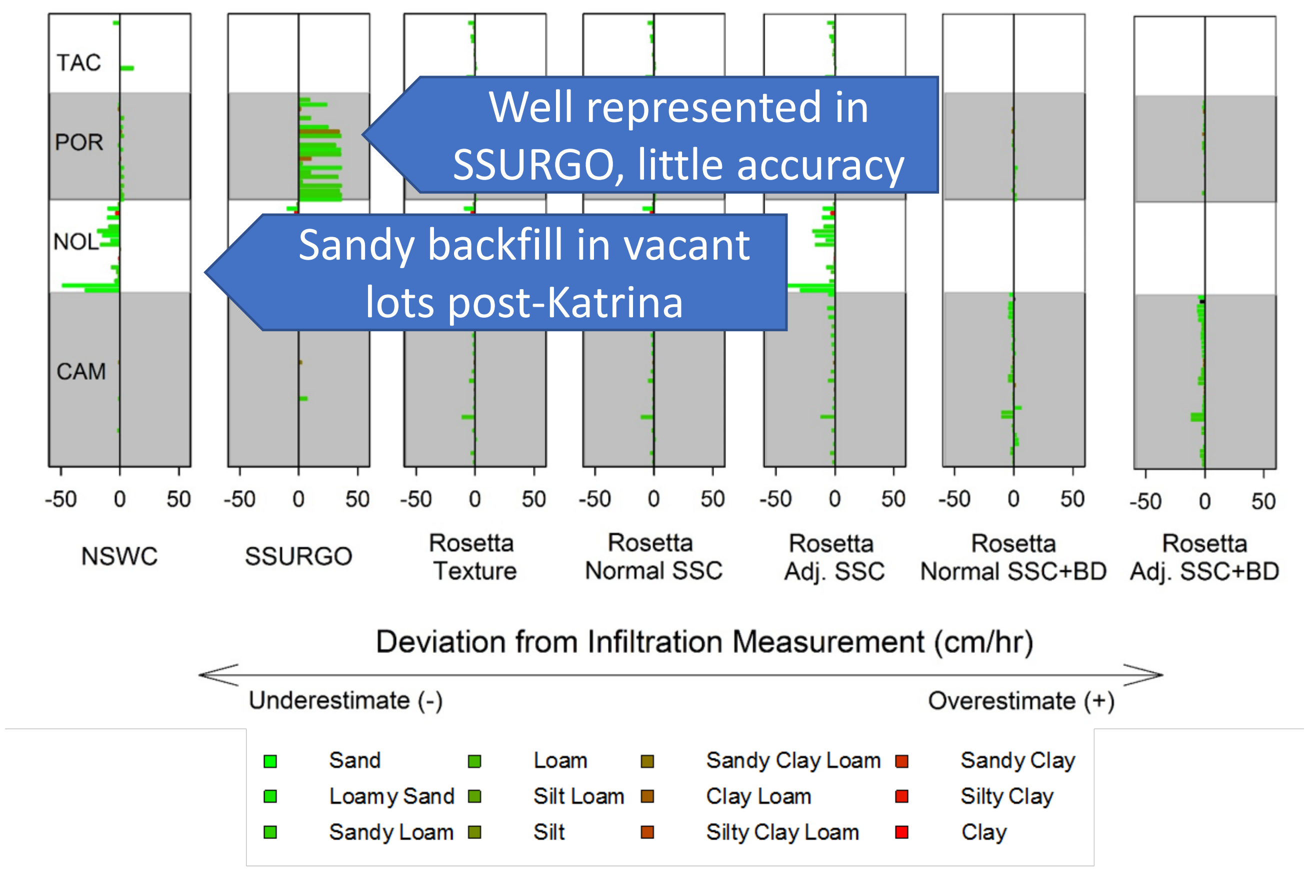
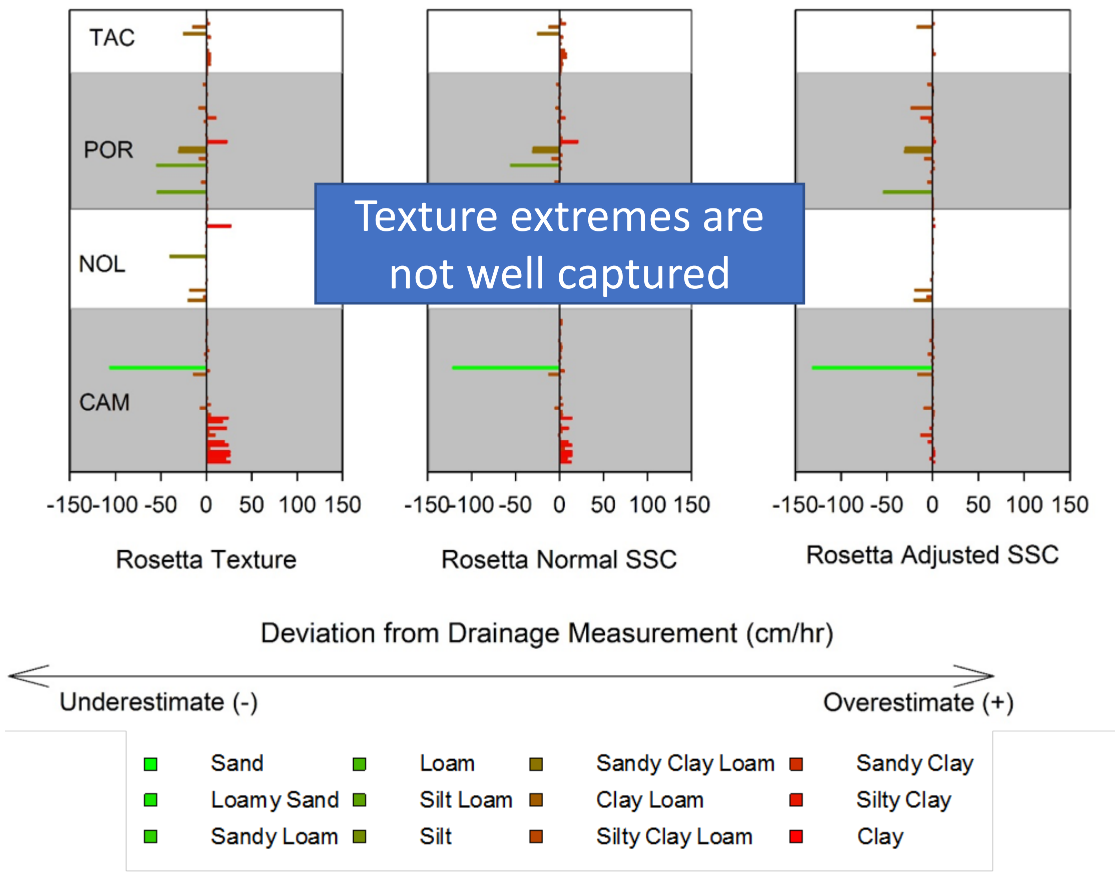
Which is the best? … hard to tell

Surface



Subsurface



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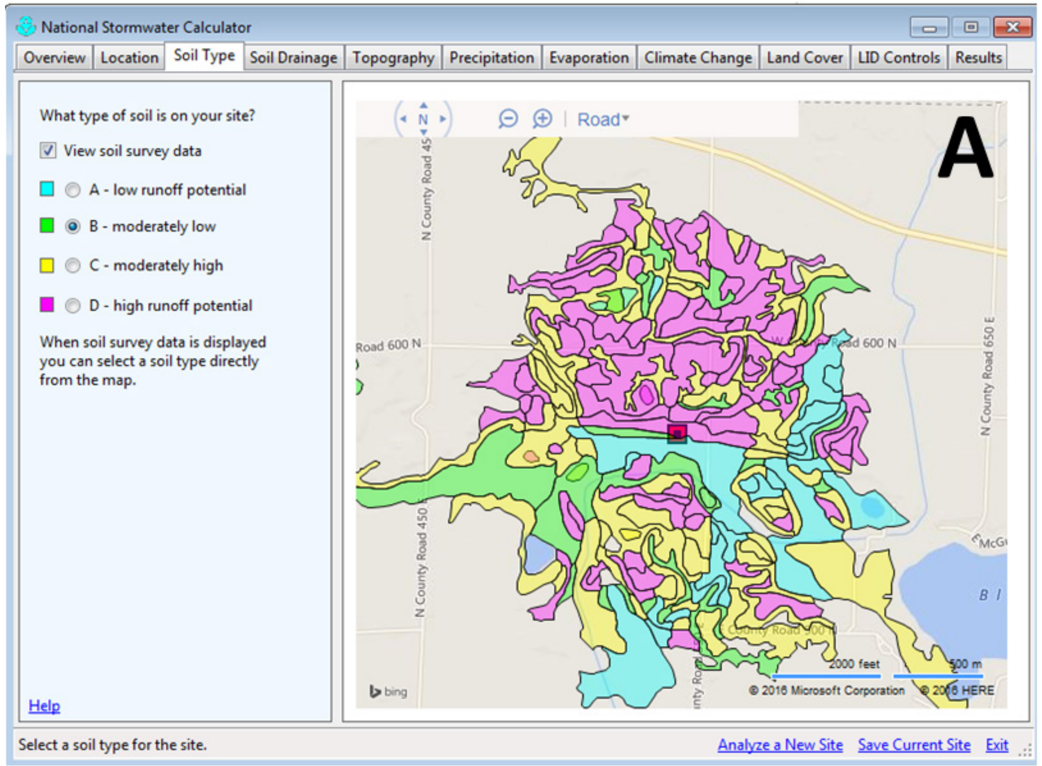
A closer look at Soil Hydrology in the EPA National Stormwater Calculator

- Evaluation of hydraulic conductivity



Location	Number of EPA Sites	% in NSWC	% in SSURGO
Atlanta GA	12	8	8
Camden NJ	21	10	10
Cincinnati OH	40	100	15
Cleveland OH	109	2	0
Detroit MI	55	16	0
New Orleans LA	20	100	95
Majuro RMI	8	0	0
Omaha NE	26	0	65
Phoenix AZ	10	100	100
Portland ME	20	100	100
San Juan PR	20	57	35
Tacoma WA	17	12	0

Schifman et al. (in revision, *Journal of the American Water Resources Association*)

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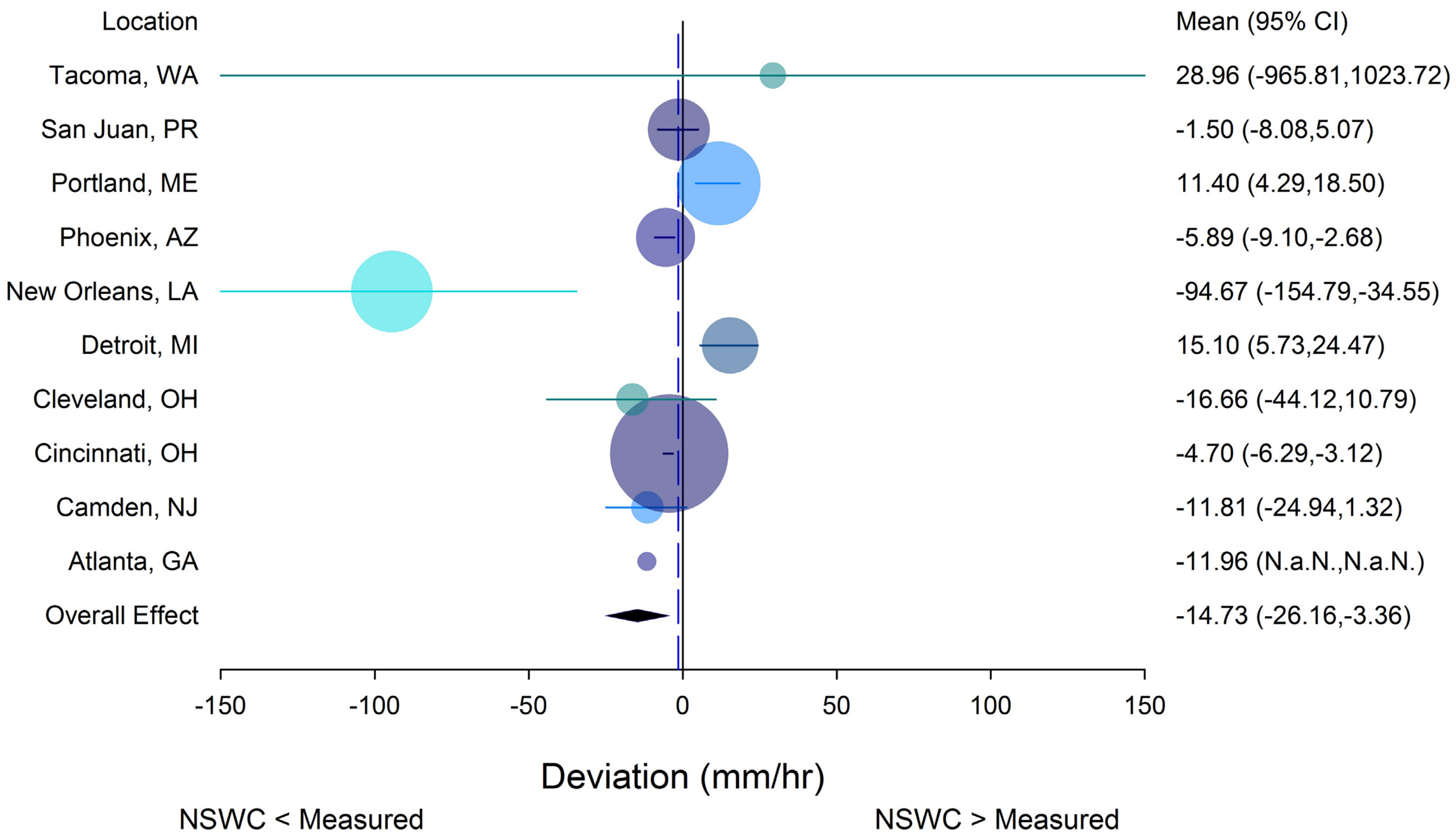
A closer look at Soil Hydrology in the EPA National Stormwater Calculator

Overall an underestimate, but dependent on location



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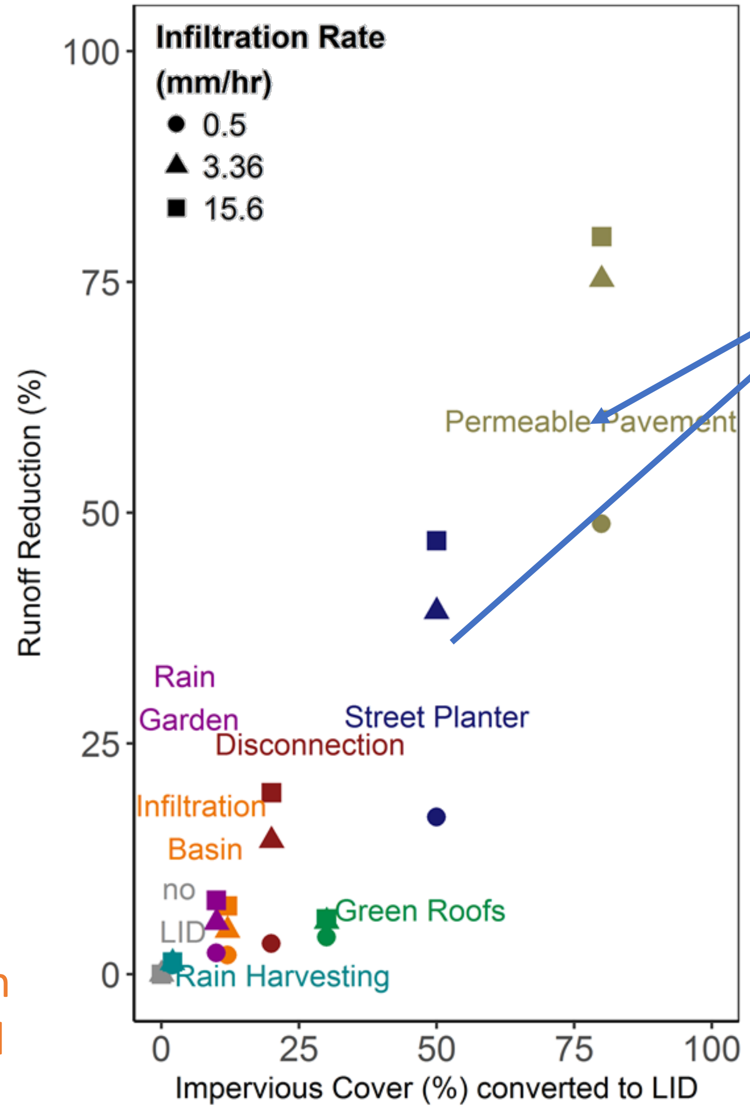
EPA National Stormwater Calculator and soil hydrology Case study in Watkinsville, GA

- Depending on the LID feature chosen, soil hydrology drives runoff characteristics
- Runoff depth modeling output is only as good as the input data



Interaction with **pre-existing soil**

Soil hydrology is important

No soil interaction

Soil hydrology plays no role

Interaction with **engineered soil**

Design specification normalizes hydrology

Schifman et al. (in revision, *Journal of the American Water Resources Association*)

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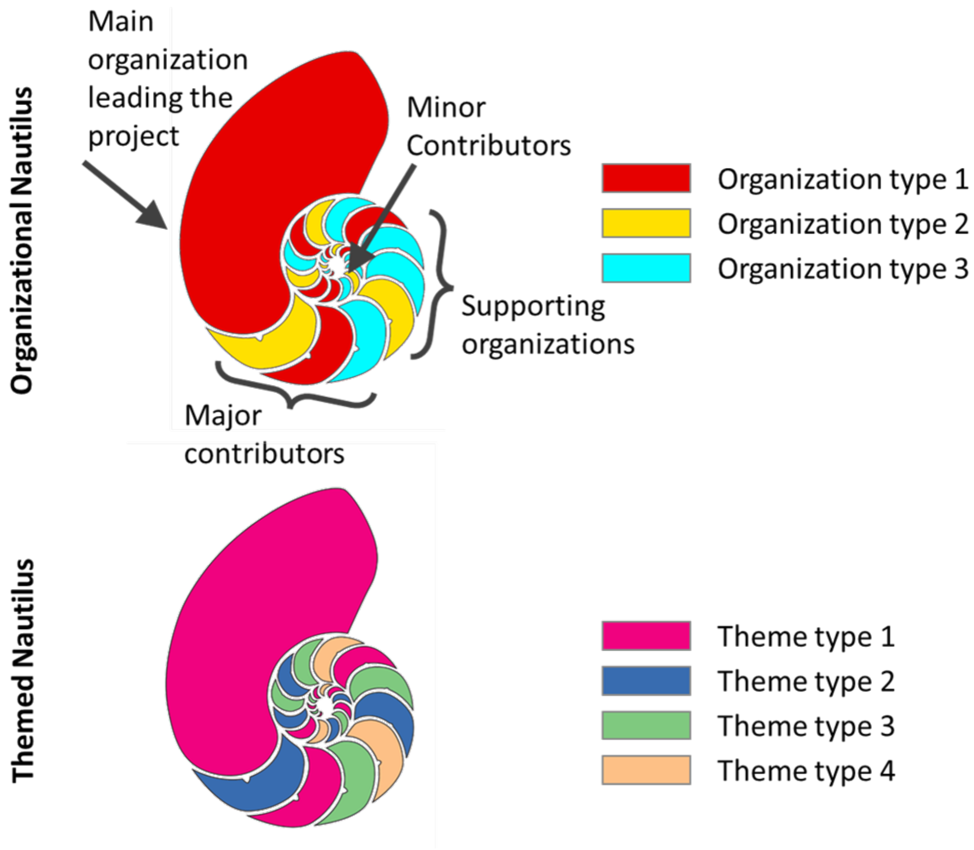
Stormwater management ☑
What about other ecosystem services?

- Sustainable cities are about more than just stormwater regulation
- How do we integrate multifunctionality in green infrastructure?
  - Cultural, provisioning, supporting services
- Situating GI vs. Siting GI
  - The nexus of several contexts defines the placement and design of a GI installation.
  - Assumes multiple functions of the system interact synergistically in sharing a physical place.
  - Siting uses hydrologic objectives only.



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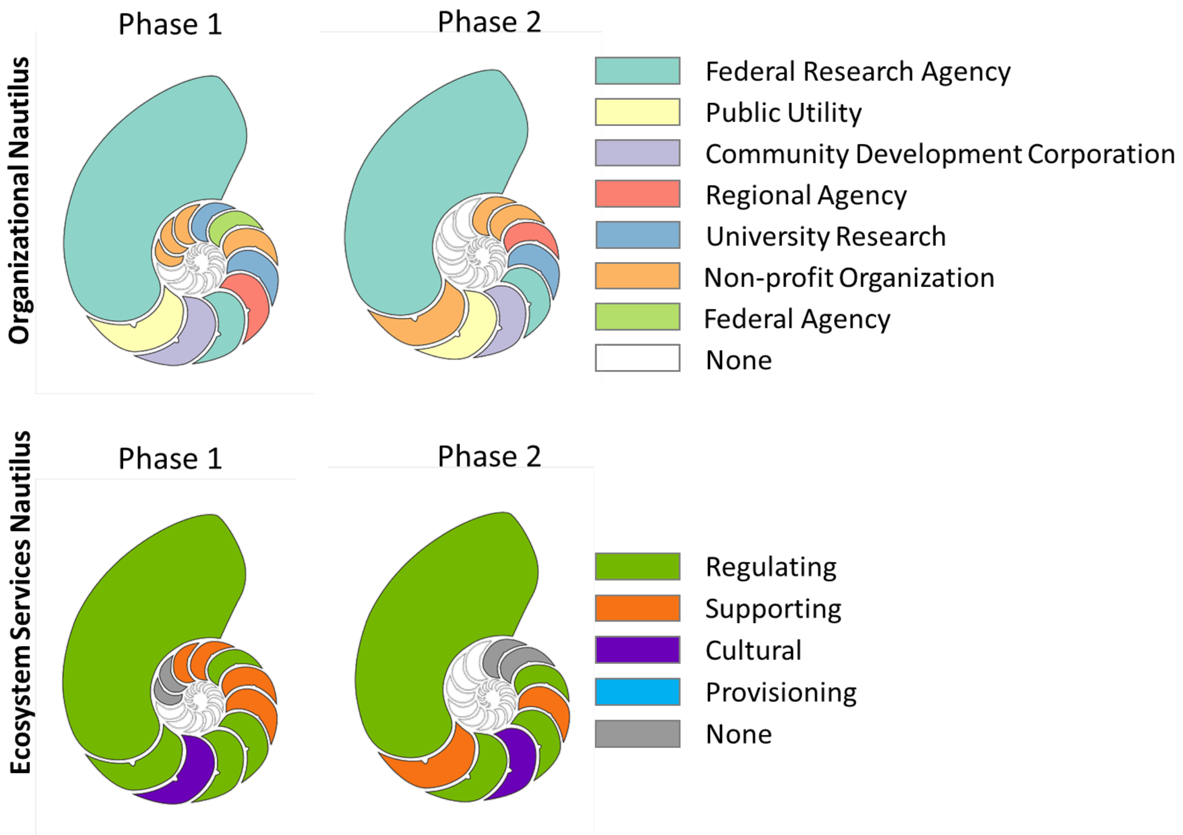
The Chambered Nautilus and Situating GI

- Identifies key organizations and supporting partners
- Interdisciplinary organizational structure
- Multiple objectives in green space usage
- Temporal variation in organizational structure and project objectives



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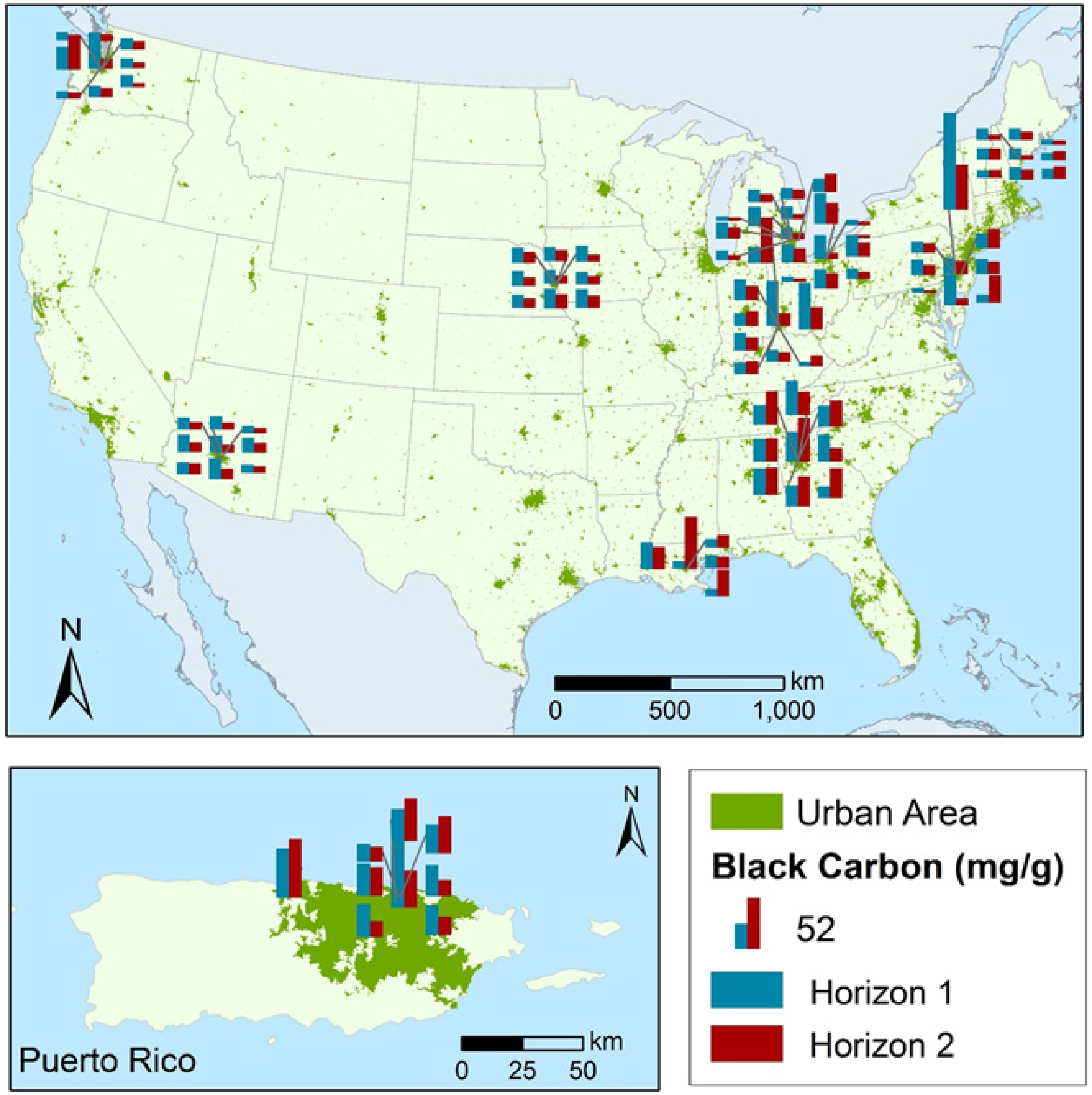
Black Carbon and Green Infrastructure

- Black carbon concentrations in soil are influenced by anthropogenic landscape level characteristics
  - Air permits
  - Average annual daily traffic
  - City “greenness”
- Characteristics of BC can be beneficial to adsorbing contaminants-filtration in passive green infrastructure on a city-level scale



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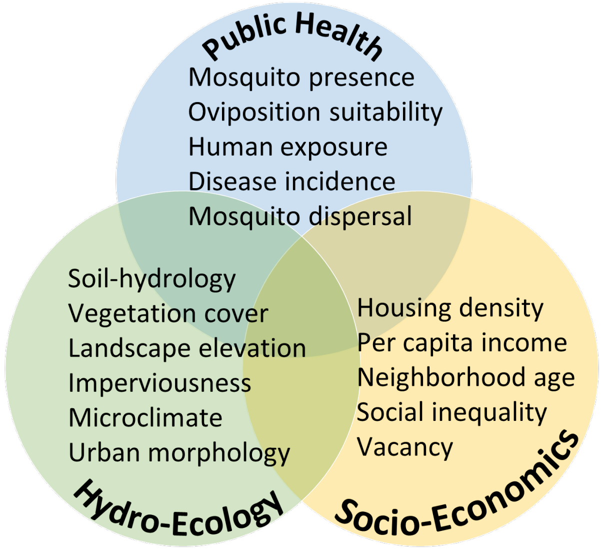
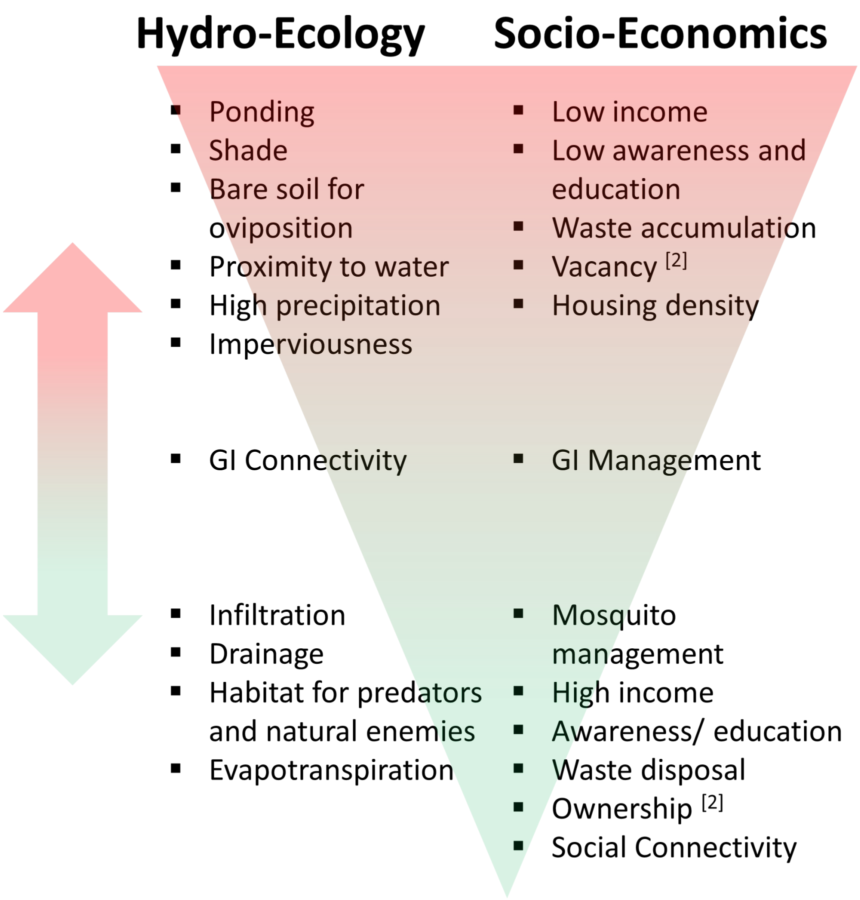
Integrating public health into water resources management: New Orleans, LA and Caguas, PR

- Public health is usually not included as a cultural ecosystem service
- Linkages between mosquito-borne disease outbreaks and standing water suggest we should consider a public health-water management nexus





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Integrated Management for Sustainable Cities

- Understanding urban environmental science for sustainable city management takes an interdisciplinary approach
- Problems can be addressed at various scales
- Site level processes need to be understood to make inferences on larger scale impacts

Manuscripts related to this work

- **Schifman L.A.**, M. Tryby, J. Berner, W.D. Shuster. (in revision *JAWRA*). A matter of estimation - the role of the EPA National Stormwater Calculator in framing effective stormwater management.
- **Schifman L.A.**, D.L. Herrmann, W.D. Shuster, A. Ossola, A.S. Garmestani, M. Hopton. (in revision *Water Resources Research*). Situating Green Infrastructure in Context: A Framework for Adaptive Socio-Hydrology in Cities.
- **Schifman L.A.** and W.D. Shuster. (under review *Landscape and Urban Planning*). Urban soil hydrology: finding common ground between pedotransfer functions and field data.
- Ossola, A., D.L. Herrmann, **L.A. Schifman**, A. S. Garmestani, K. Schwarz, M.E. Hopton. (to be submitted to *Ecosystem Services*). The provision of urban ecosystem services throughout the private-social-public domain: A conceptual framework.
- Shuster W.D., R. Darner, **L.A. Schifman**, D.L. Herrmann (to be submitted to *MDPI Infrastructures*). Adaptive responses to monitored green infrastructure and controls on the hydrologic effectiveness of biodetention (Cincinnati OH USA).
- Fries. A, **L.A. Schifman**, W.D. Shuster, A. Townsend-Small. (to be submitted to *Environmental Pollution*). Quantification of Methane and Nitrous Oxide Emissions from Wastewater Collection System (Cincinnati, OH, USA).
- **Schifman L.A.**, A. Ossola, C.J. Nytch, D.L. Wiegand, A. Ossola, M.E. Hopton, W.D. Shuster (in preparation). Integrating green infrastructure generated ecosystem services into public health benefits in New Orleans, LA and Caguas, PR.
- **Schifman L.A.**, A. Prues, K. Gilkey, W.D. Shuster. (in preparation). Black Carbon and Soil Organic Matter in urban soils.
- Herrmann D.L., **L.A. Schifman**, and W.D. Shuster. The vertical geography of urban soils (in preparation).
- **L.A. Schifman,** Herrmann D.L., and W.D. Shuster. Relating soil carbon stocks and soil color to ecosystem services (in preparation).
- **L.A. Schifman,** Herrmann D.L., and W.D. Shuster. Soil horizon sequencing as affected by urbanization: hydrologic impacts (in preparation)

Thank you!

Questions?

Collaborators:
Bill Shuster
Dustin Herrmann
Alessandro Ossola
Matt Hopton
Ahjond Garmestani
Amy Prues
Michael Tryby
Jason Berner

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