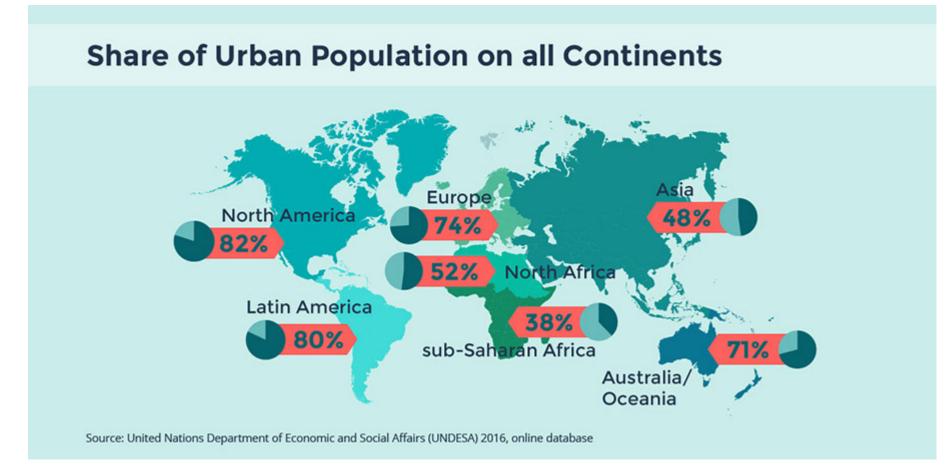
A Move Towards Sustainable Cities via Integrated Water Resources Management and Public Health

Laura Schifman, Ph.D.

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

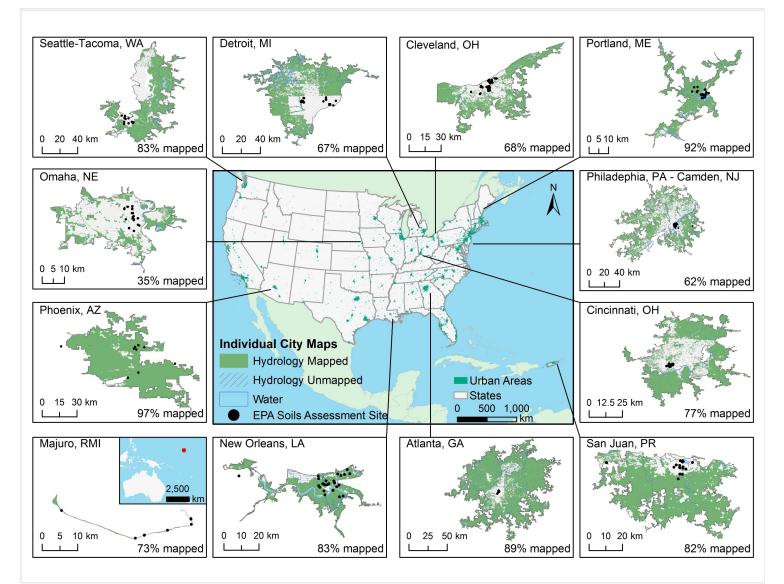
Today, >50% of people live in cities globally ... by 2050 we can expect this number to be 66%



Integrated environmental management for sustainable cities



Where do we start?



Site Scale

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 vectorborne diseases and affiliated vector abundance

What is my approach?

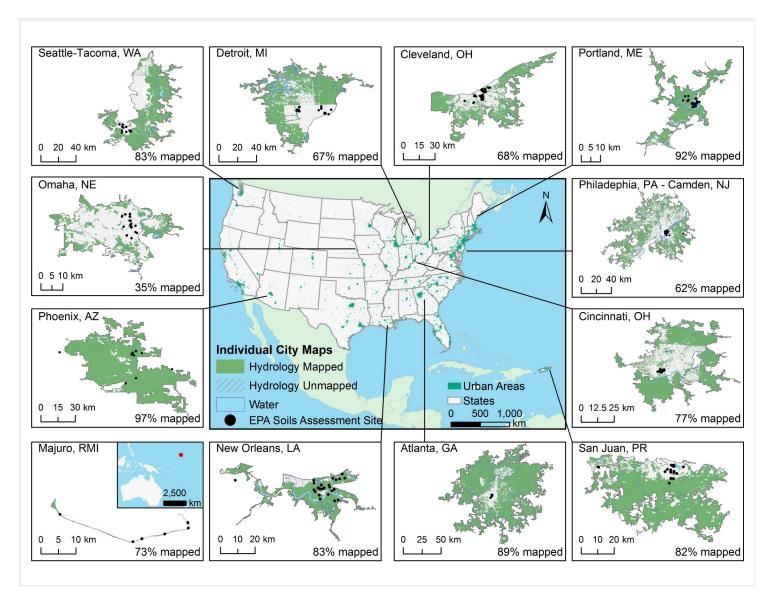
Both!

- 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

Plot Scale

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)

Plot Scale

City Scale

Site Scale

Three common tools used in soil hydrology

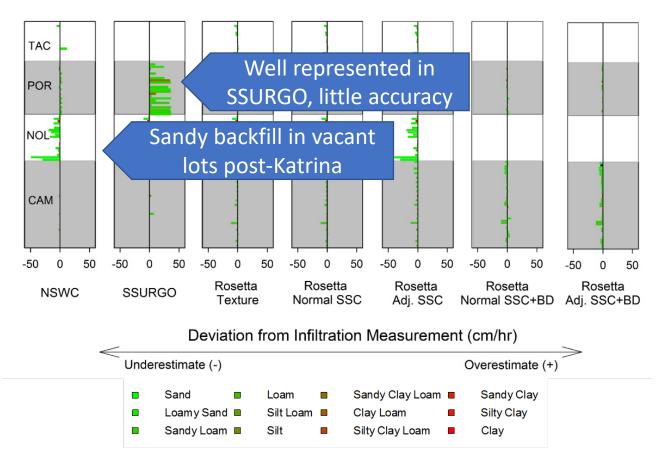
- **USDA** Rosetta
 - Uses pedotransfer functions ۲
 - Integrated into HYDRUS ۲ modeling software
- SSURGO WebSoilSurvey •
 - National soil survey datasets
 - Integrated into many surface water models
- National Stormwater EPA • Calculator
 - Uses interpolation of SSURGO data for simulation

		Antional Stormwater Calculator				
		Overview Location Soil Type Soil Drainage T	opography Precipitation 8	Evaporation Land Cove	r LID Controls Rund	
or Use	Soil Properties and Qualities Ecological S	Welcome to the EPA National Stormwater Calculator This calculator estimates the amount of stormwater upoff generated from a land Site Assessment	DIA (Road*	MERI	ĊĄ
Map – Satu	urated Hydraulic Conductivity (Ksat)				A ATES	
and the second sec		C:\Program Files\Rosetta\Same Elle Becord Model Predict View Image: Second Model Predict View Image: Second Model Predict View Image: Second Model Predict View Image: Second Model Predict View Image: Second Model Image: Second Model </th <th>1</th> <th>etta II 😵 K? SSCBD</th> <th></th> <th>-</th>	1	etta II 😵 K? SSCBD		-
		UNSODA(lab)		Model Output	Uncertainty	
A		TXT Class Loamy Sand	Theta_r	0.0394	0.0066	cm3/cm3
1		Sand % 83	Theta_s	0.3428	0.0059	cm3/cm3
	8,000 ft	Sik % 14	log10(Alpha)	-1.3526	0.0716	log10(1/cm
Tables — Satu	urated Hydraulic Conductivity (Ksat) — Summary	Clay % 3	log10(N)	0.2952	0.0187	logroenen
Summary by Map unit symbol	r <mark>Map Unit — Cumberland County and Part of Oxf</mark> o Map unit name	Bulkd. gr/cm3 1.64	log10(Ks)	2.0549	0.1094	log10(cm/d
Au	Au Gres loamy sand	33 kPa WC 0.087681869	test O(Ya)	1.5712	0.2733	- In - 10 cm /c
BgB	Belgrade very fine sandy loam, 0 to 8 percent slopes	0.001001000	log10(Ko)		_	log10(cm/c
BgC2	Belgrade very fine sandy loam, 8 to 15 percent slopes, eroded	1500 kPa WC 0.077854791	L	0.9164	0.7162	
Во	Biddeford mucky peat, 0 to 3 percent slopes		C			
BuB	Lamoine silt loam, 3 to 8 percent slopes	C Textural classes	C 55	CBD+ water con	itent at 33 kPa [(TH33)
BuC2	Buxton silt loam, 8 to 15 percent slopes	C % Sand, Silt and Clay (SSC)		me + water conte	ent at 1500 kPa	(TH1500)
		Sand, Silt, Clay and Bulk Density	(BD) C Be	st possible mode	l)	
		For Help, press F1				N
	/	ruineip, piess ri				

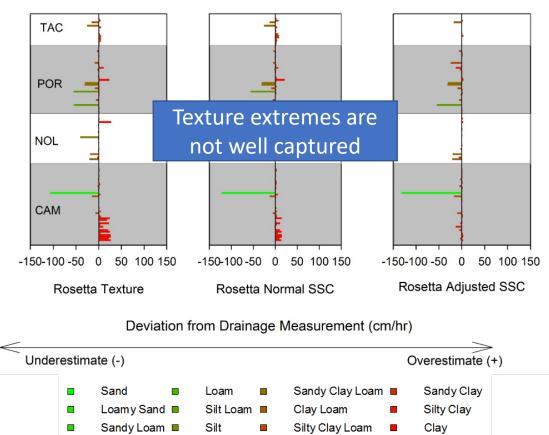
... hard to tell

Which is the best?

Surface



Subsurface



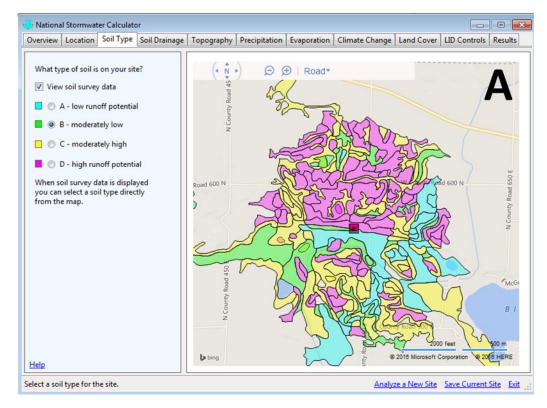
Schifman and Shuster (under review, Landscape and Urban Planning)

Site Scale

City Scale

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*)

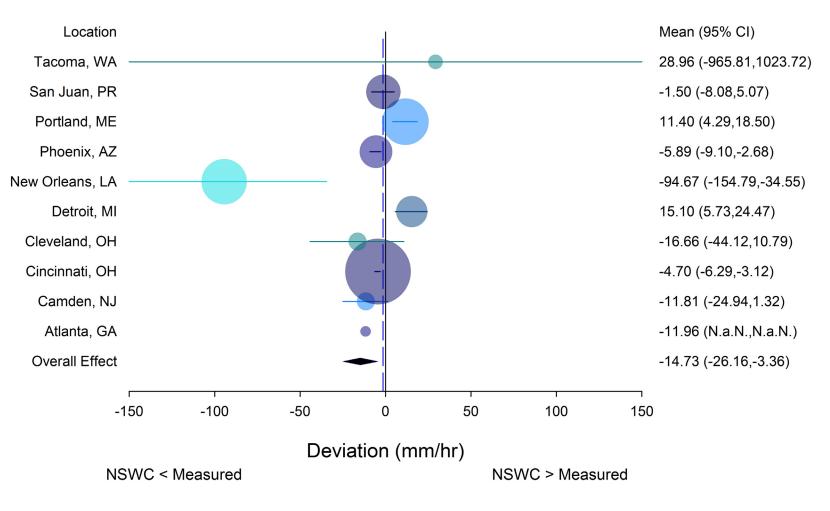
Site Scale

Plot Scale

City Scale

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

Overall an underestimate, but dependent on location



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

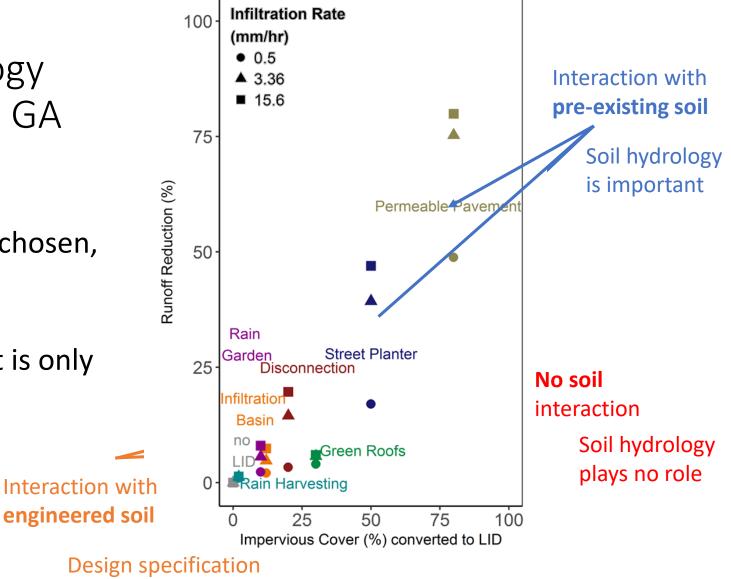
Site Scale	Plot Scale			City S	cale
EPA National Storm Calculator and soil h		100-	Infiltration (mm/hr) ● 0.5 ▲ 3.36	ı Rate	Interaction with

normalizes hydrology

 Depending on the LID feature chosen, soil hydrology drives runoff characteristics

Case study in Watkinsville, GA

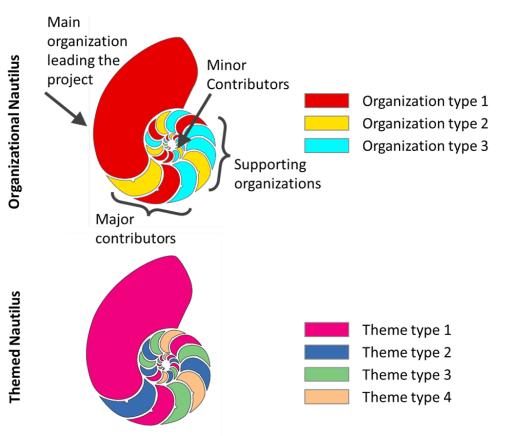
 Runoff depth modeling output is only as good as the input data

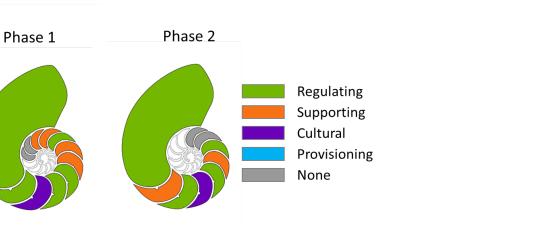


Schifman et al. (in revision, *Journal of the American Water Resources Association*)

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.





Phase 2

Phase 1

Organizational Nautilus

Ecosystem Services Nautilus

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

Site Scale

Federal Research Agency

Community Development Corporation

Public Utility

Regional Agency

Federal Agency

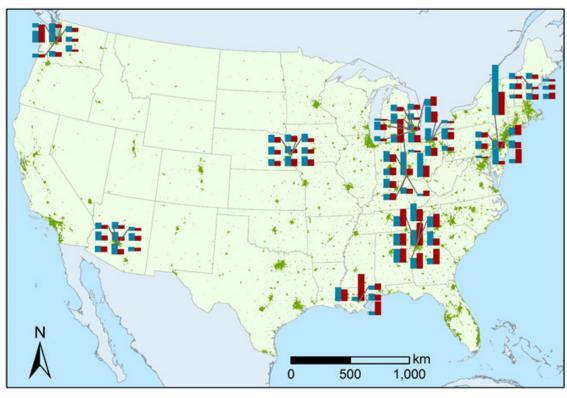
None

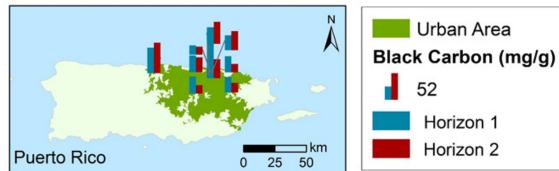
University Research Non-profit Organization Plot Scale

Black Carbon and Green Infrastructure

Site Scale

- 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

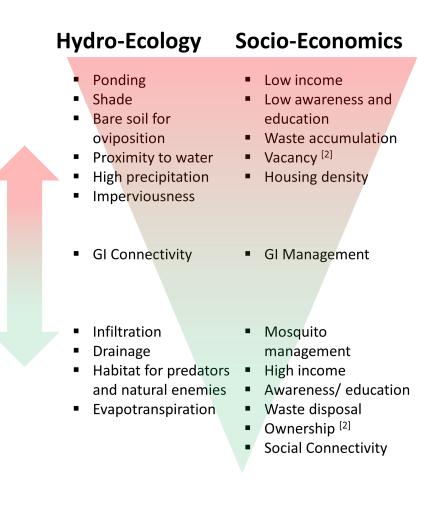




Integrating public health into water resources management: New Orleans, LA and Caguas, PR

- 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

Mosquito presence **Oviposition suitability** Human exposure Disease incidence Mosquito dispersal Soil-hydrology Housing density Vegetation cover Per capita income Landscape elevation Neighborhood age Imperviousness Social inequality Microclimate Urban morphology Vacancy Socio-Economi Vdro-Fcolog



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 Scale

 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).
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- 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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