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Facing the Flood:

Challenges and Opportunities for Urban Flooding and Public Health

Add image

Dr. Virginia Smith
Civil and Environmental Engineering

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Outline

Establish the relationship between public health and flooding → Define the current impact of flooding on public health → Look to the future for solutions

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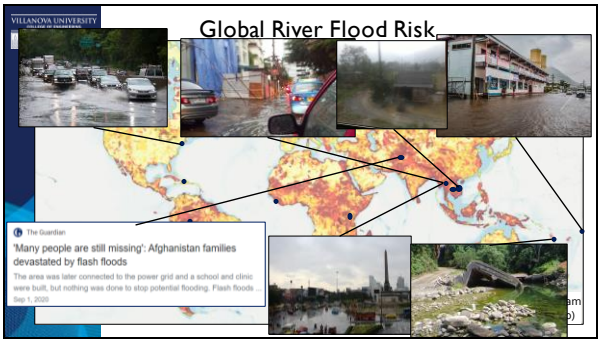
Global River Flood Risk



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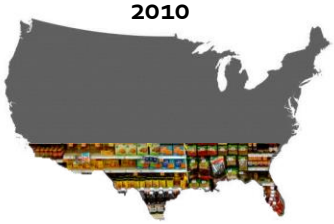
2010



Flood recovery = roughly 20% of the cost of feeding the US for one year

World Resource Institute, 2020and US Census, 2018

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2030
(77%)

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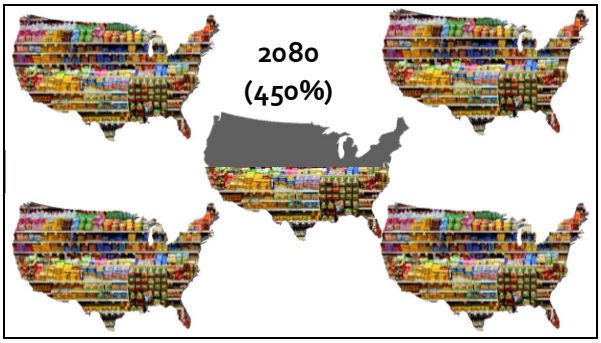
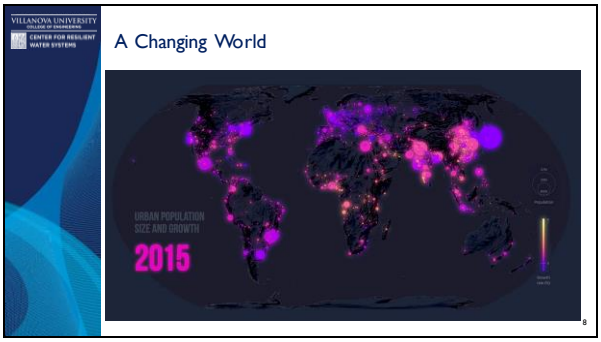
2050
(185%)

6


2080
(450%)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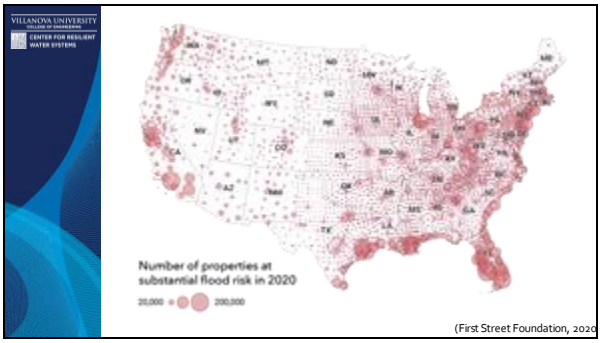
A Changing World
URBAN POPULATION SIZE AND GROWTH
2015
8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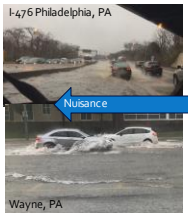
Number of properties at substantial flood risk in 2020
20,000
200,000
(First Street Foundation, 2020

Reported waterborne illnesses linked to pathogens or involving gastrointestinal illnesses of unknown etiology, 1991–2000

10

Is a flood a flood?



Nuisance

Extreme

11

Extreme Events – Public Health

- Drowning/Injury
  - 7% of all worldwide injury-related deaths
- Access to Clean Water
- Landslides
- Other Infrastructure Risk
  - Electrical shock
  - Mold
  - Gas line damage
- Waterborne Illness

Add images

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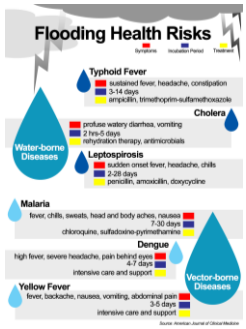

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Nuisance

- Drowning
- Exposure
- Waterborne Illness
- Other Infrastructure Risk
  - Transportation access
  - Mold

Add images

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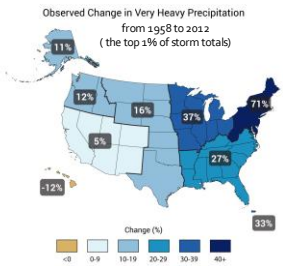
What about the future?



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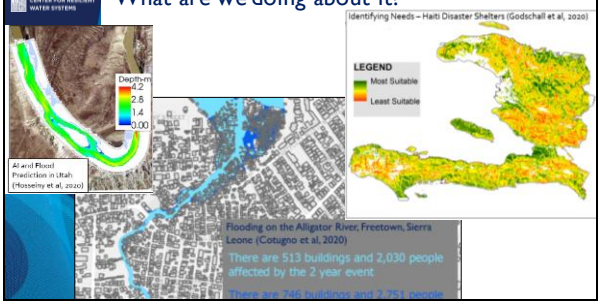
What are we doing about it?



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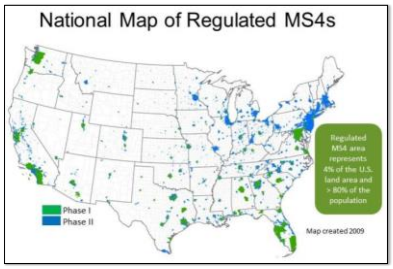
Complex Urban Environments



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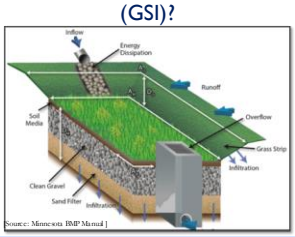
What is Green Stormwater Infrastructure (GSI)?



Source: Minnesota BMP Manual]

"…ecological systems, both natural and engineered, that act as living infrastructure …planned and managed primarily for stormwater control, but also exhibit social, economic and environmental benefits."
—www.wcel.org

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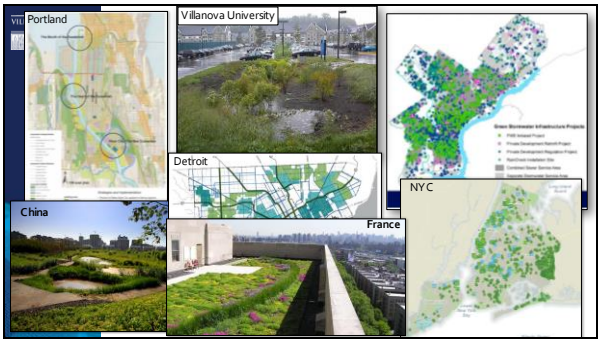
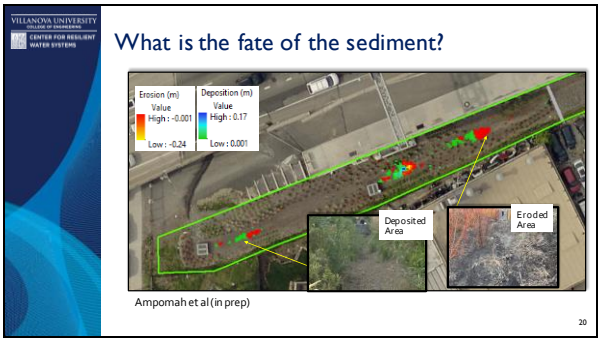

Portland
Villanova University
Detroit
NYC
China
France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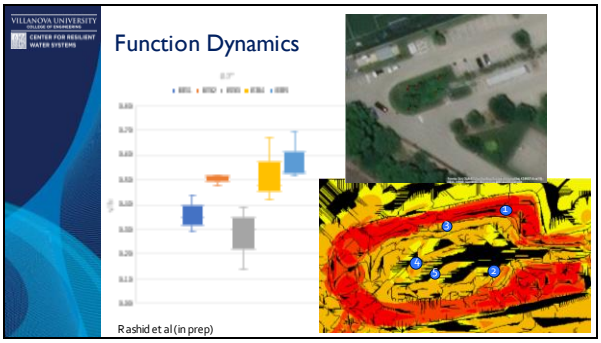
What is the fate of the sediment?
Erosion (m)
Value
High : -0.001
Low : -0.24
Deposition (m)
Value
High : 0.17
Low : 0.001
Deposited Area
Eroded Area
Ampomah et al (in prep)
20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Function Dynamics
Rashid et al (in prep)

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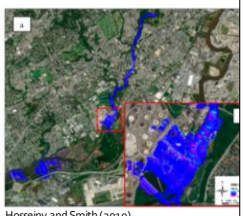
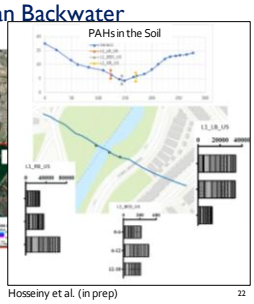
Deposition in the Urban Backwater



Hosseiny and Smith (2019)



Hosseiny et al. (in prep)

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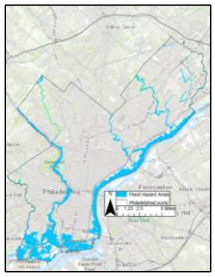
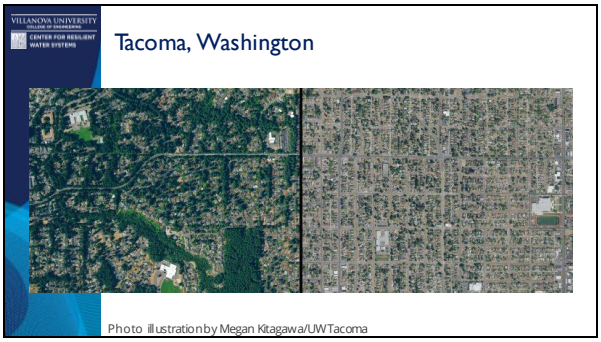
But….big challenges remain




GERMANTOWN
SOUTHPLAIL EAST FALLS MANAYUNK
NORTHERN LIBERTIES
PORT RICHMOND
EAST WICK
SOUTH PHILLY
Type of Flooding
Flood Prone Areas
CLEAN AIR + WATER:
SOURCES OF POLLUTION
WHYY, 2017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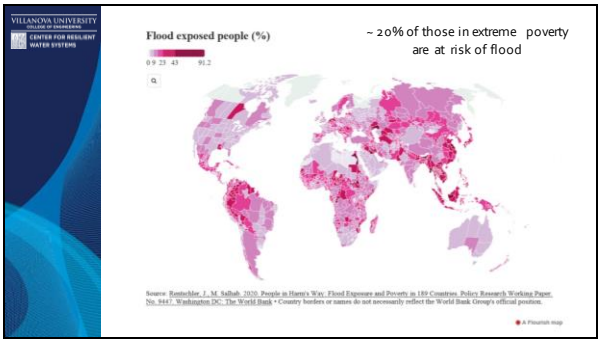
Tacoma, Washington
Photo illustration by Megan Kitagawa/UW Tacoma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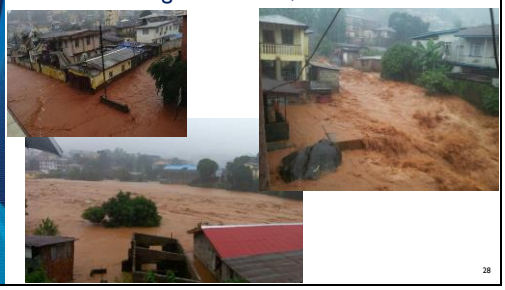
Flood exposed people (%)
0 9 23 43 91.2
~ 20% of those in extreme poverty are at risk of flood
Source: Rentschler, J., M. Salhab. 2020. People in Harm's Way: Flood Exposure and Poverty in 189 Countries. Policy Research Working Paper No. 9447. Washington DC: The World Bank. • Country borders or names do not necessarily reflect the World Bank Group's official position.
A Flourish map

Urban Flooding - Freetown, Sierra Leone



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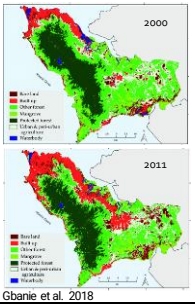
Freetown, Sierra Leone

- Rapid urbanization
- Monsoonal flooding
- High sediment generation
- Unstable slopes



Gbanie et al. 2018

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Water Security Freetown, Sierra Leone

Congo Dam

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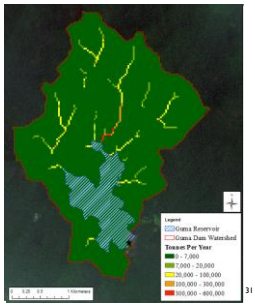
Guma Reservoir Sedimentation Estimates

Reservoir Capacity: 23 Million m^3

Percent of Watershed Deforested	Total Volume of Soil (m^3/yr)*	Years to Reservoir Capacity
10	112,337	205
20	206,283	111
30	310,350	74
40	503,902	46
50	886,833	26
60	1,166,050	20
70	1,227,378	19
80	1,293,134	18
90	1,300,049	18
100	1,321,361	17

Includes a 0.2 compression factor

*Dredging can be estimated as $2.5/m3 to $25.0/m3 (Kawashima, 2007)



RUSLE Output

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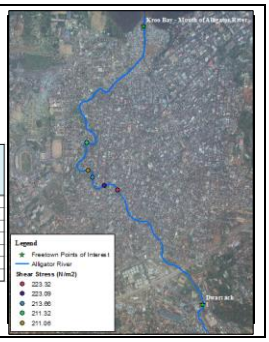
Urban Flooding – HEC-RAS Flooding Analysis

Flood extents of the Alligator River for varying flow events

Flow (m^3/s)	Inundation Area (m^2)	Number of Buildings Affected*	Number of People Affected**	Required Storage Volume (m^3/day)
106.6	205,088	1,019	4396	
96.6	201,638	1,002	4298	36,000
86.6	198,245	991	4109	72,000
76.6	193,996	980	4045	108,000
66.6	189,692	965	3975	144,000

*Based on building shapefile provided by CRS

**Based on population raster provided by CRS



Cotugno et al (in prep)

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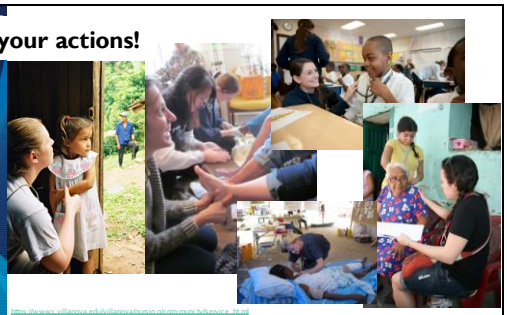
1. Use your voice!

Cruz

2. Use your actions!



https://www.v.villanova.edu/villanovatrue/in-pic/community/service_day.html
https://www.v.villanova.edu/villanovatrue/in-pic/organizations/inv_h_h.html
https://www.v.villanova.edu/villanovatrue/in-pic/community/ch.html

3. Innovate!

(ASCE's Future World Vision)

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  - Catholic Relief Services
  - Philadelphia Water Department's Green Cities Clean Water Program
  - PA Dept. of Environmental Protection Growing Greener Program
  - The National Science Foundation

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Thank You!

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