The Hidden Mystery Behind Soil Contamination and Simple Ways to Defeat It

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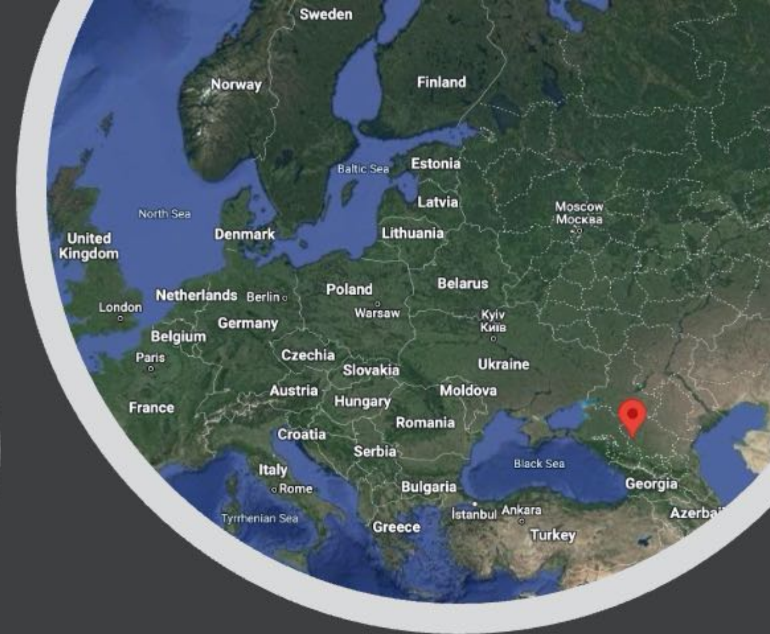
My background



Outline

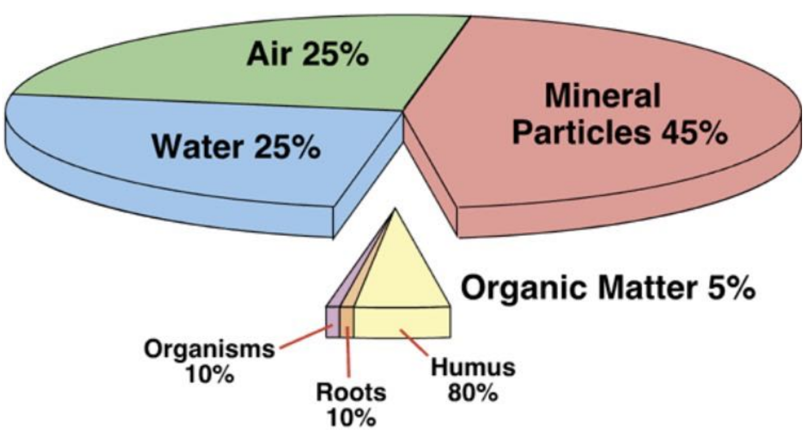
1. Soil Basics
2. Urban Soils
3. Soil Contamination
4. Contamination remediation
5. Delta Urban Soils Laboratory

Soils are More than Dirt!

- ✓ Soil is a living system
- ✓ There are more microorganisms in a handful of soil than there are people on earth

- ✓ It takes ~100 years to produce just 1 cm of soil
- ✓ Soil provides all the nutrients required for successful plant growth

- ✓ % of sand, clay and silt → soil textures
- ✓ 6 layers: horizons O, A, E, B, C and R

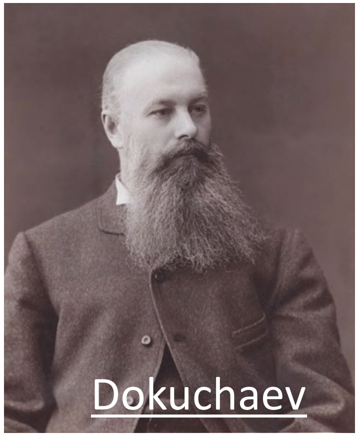


Why is Soil Important?

How is Soil Formed?

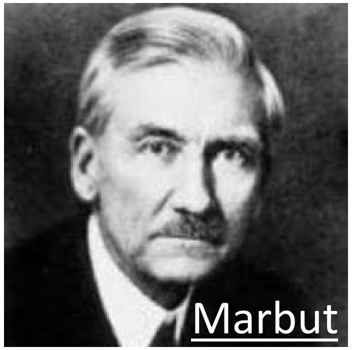
Soil is a very slow renewable resource

Edaphology studies the influences of soils on organisms (plants)



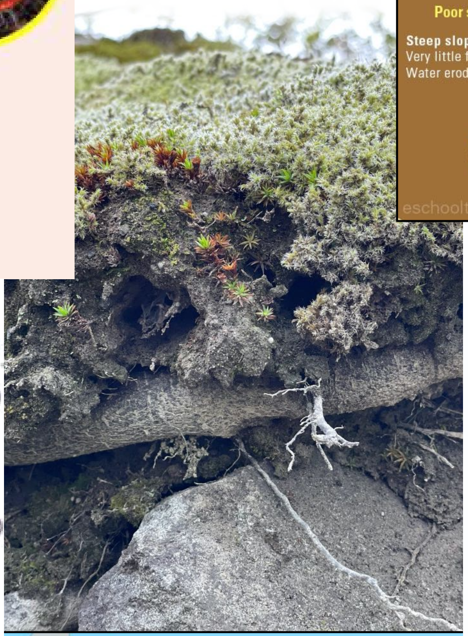
Pedology is the study of:

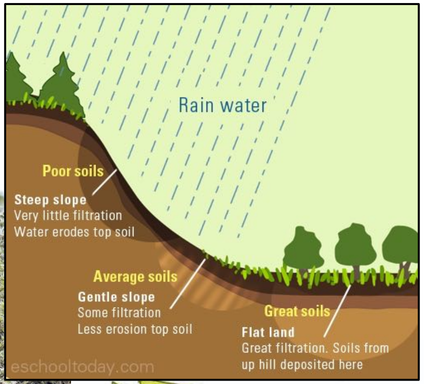
- Soil formation (or soil genesis)
- Soil classification
- Soil mapping

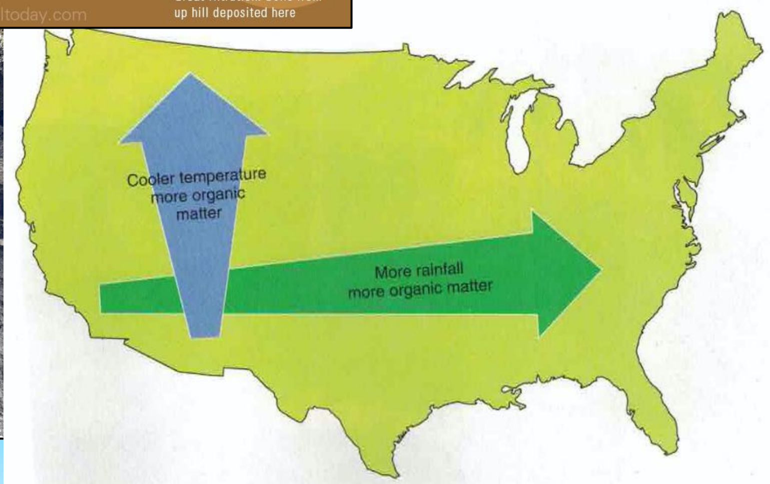


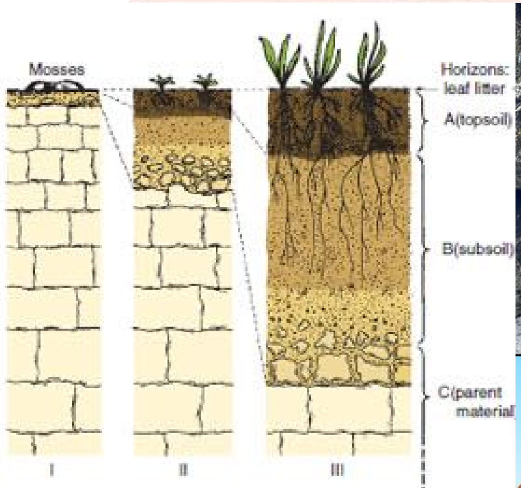
- Beginning in 1870, the Russian school of soil science under the leadership of V. V. Dokuchaev (1846–1903) was developing a new concept of soil.
- Under the leadership of C. F. Marbut (1863–1935), the Russian concept was broadened and adapted to conditions in the United States.

5 Soil Formation Factors

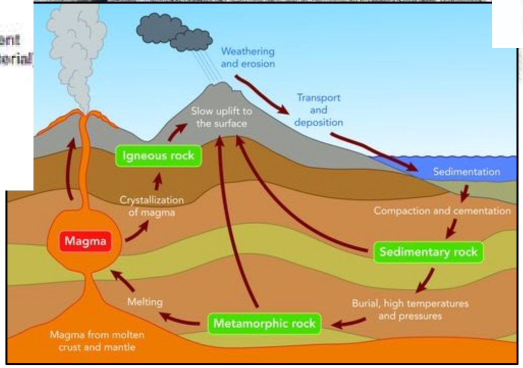


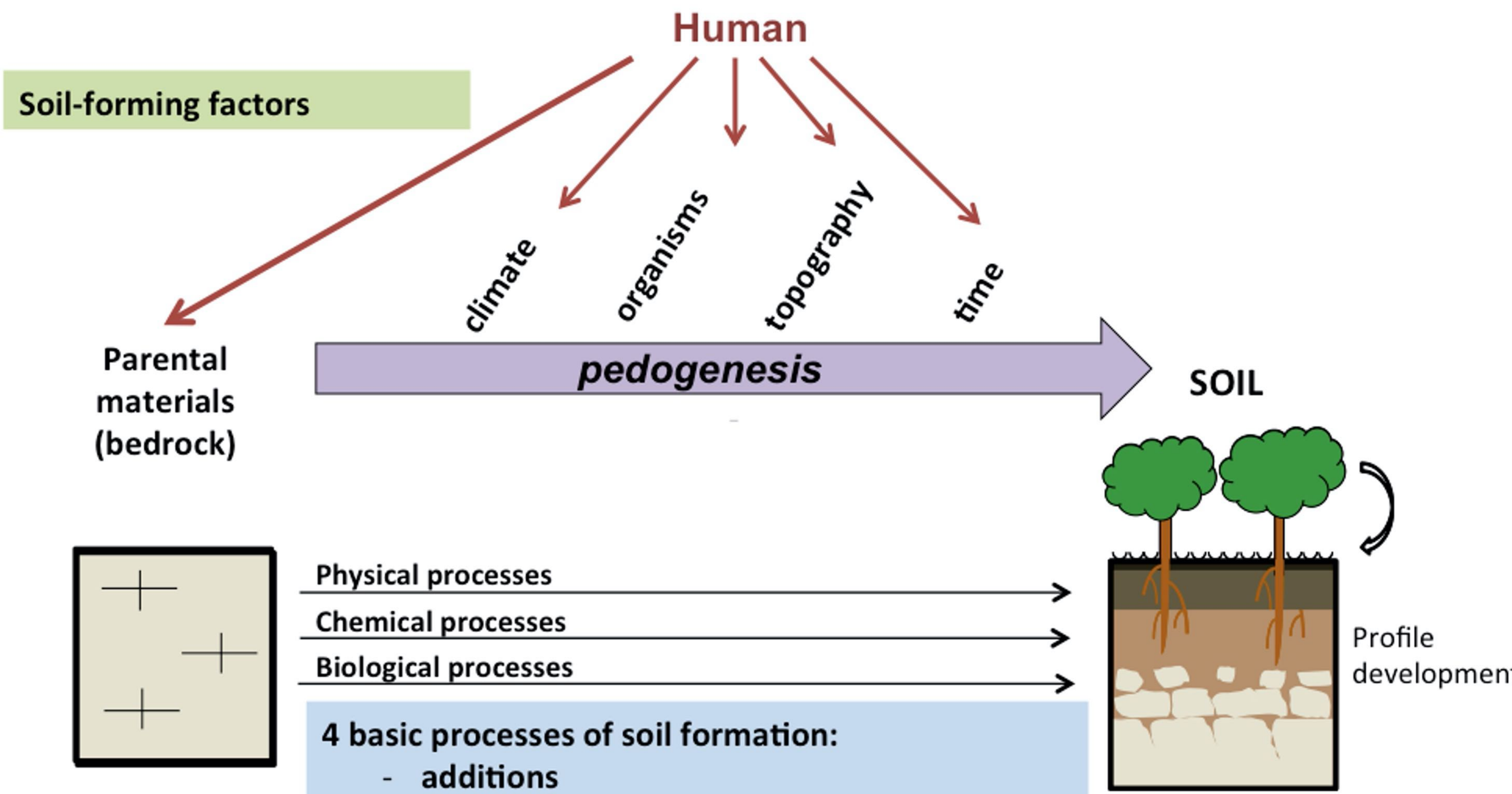






Stages in the formation of sedentary soils





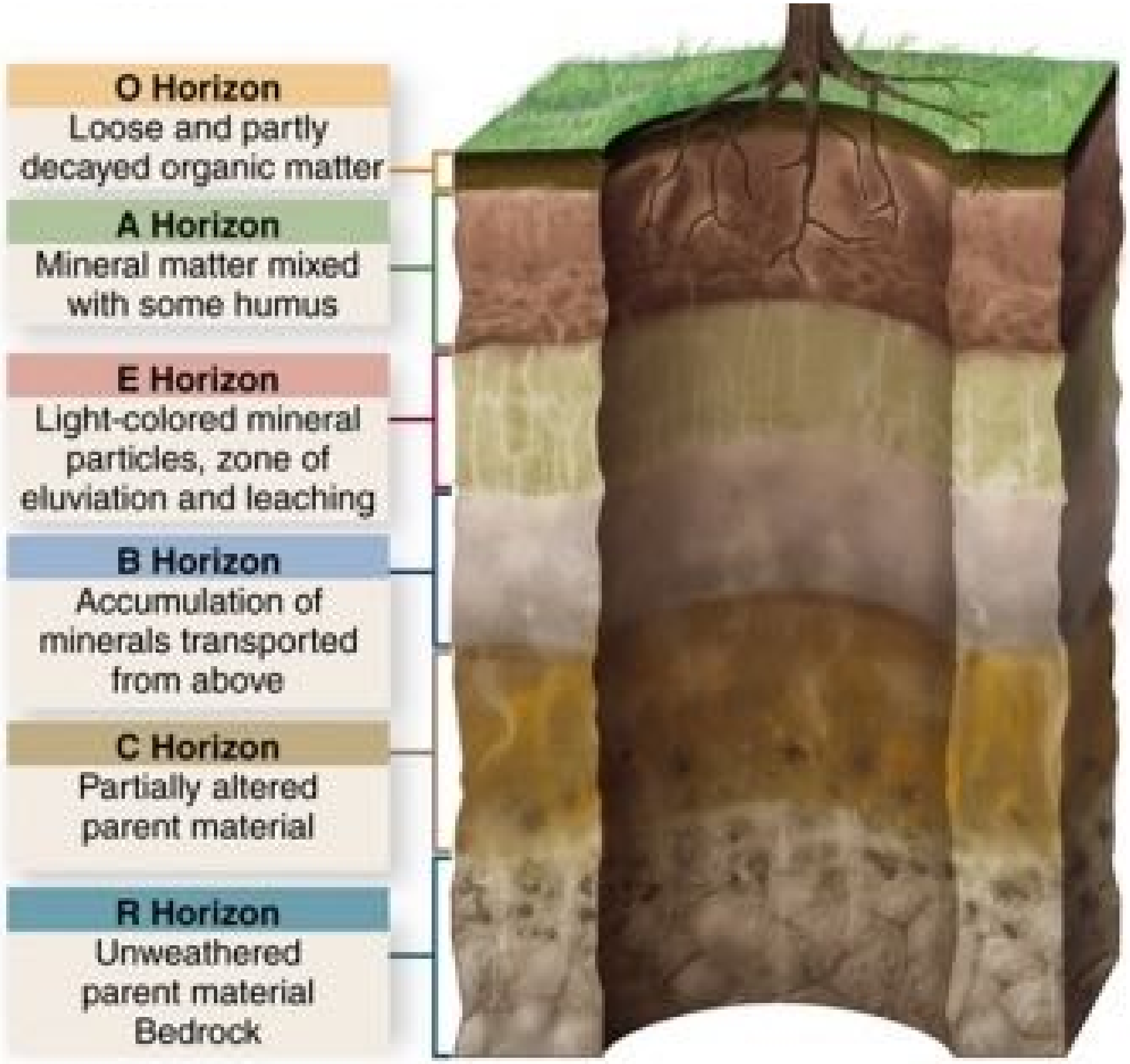
4 basic processes of soil formation:

- **additions**
- **losses**
- **transformations**
- **translocations**

Huot et. al, 2013

Soil Profile and Horizons

- Layers develop over time called soil horizons
- The soil profile is a vertical section that shows all the horizons
- Processes occur differently at different depths



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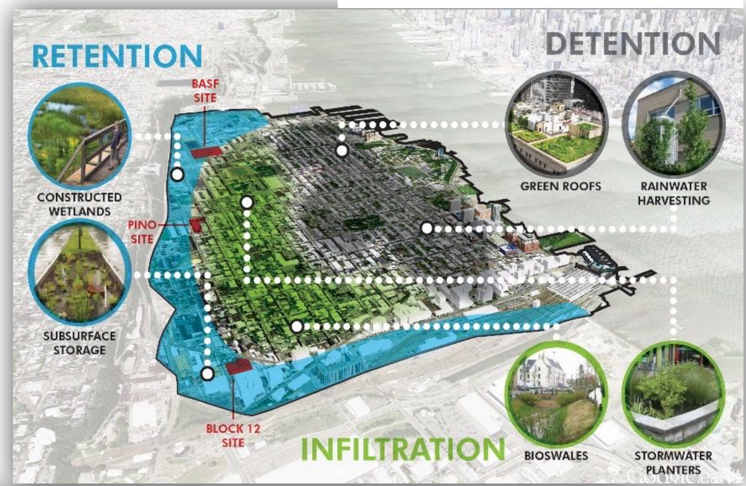
Urban Soils

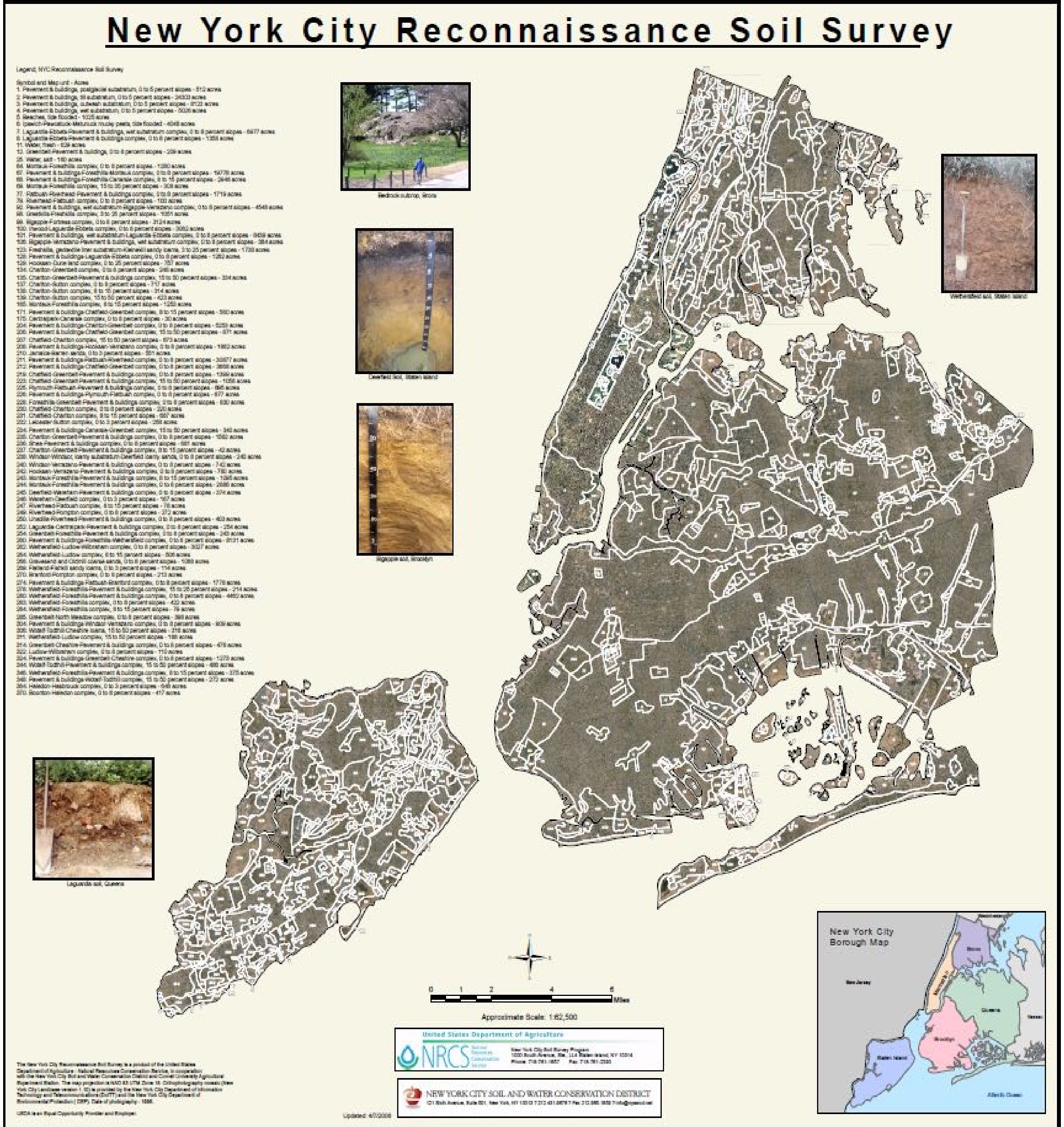
Urban soil is a key component of urban ecosystems, because it performs **essential functions**:

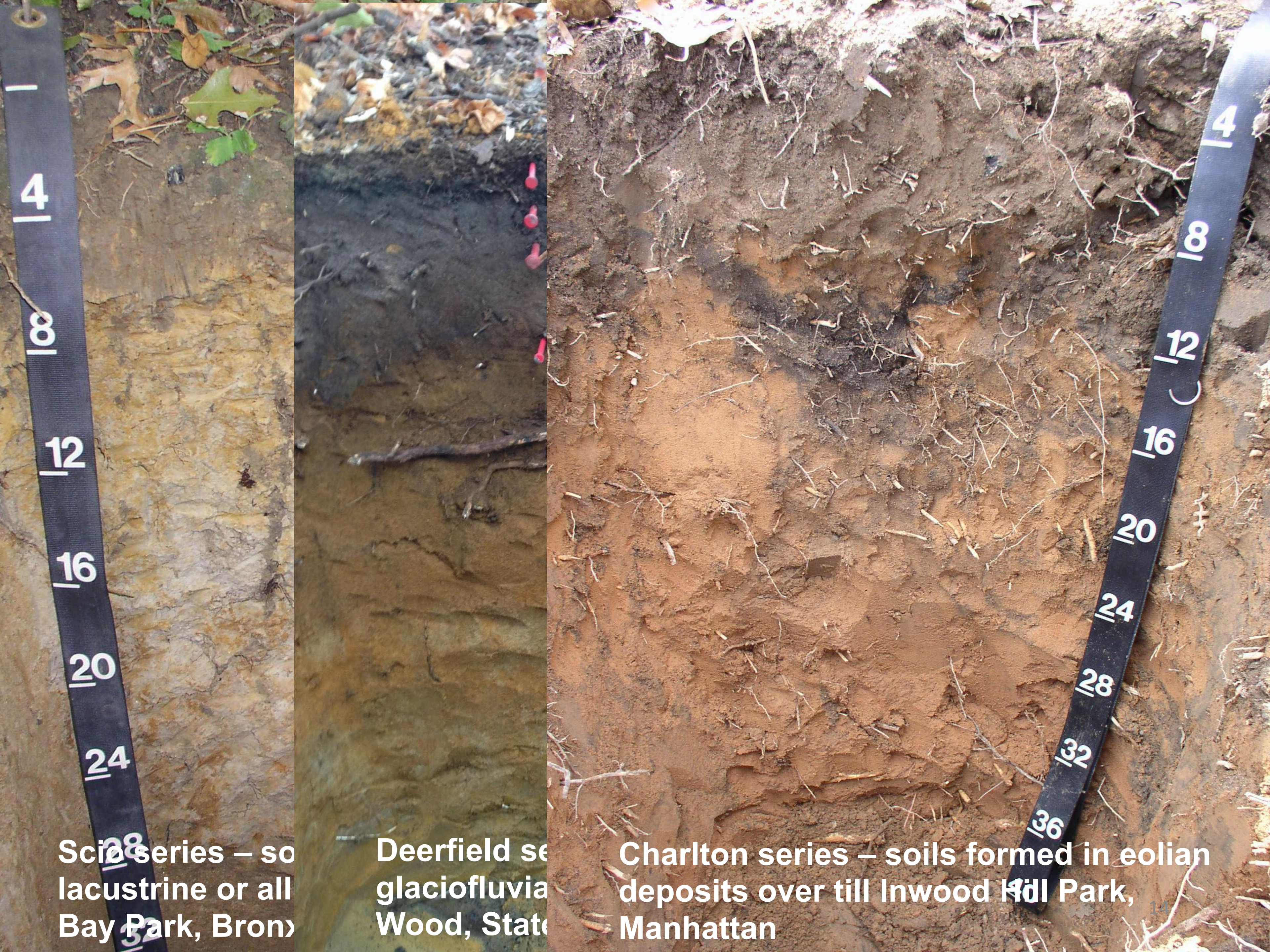
- regulation of water flow and quality
- carbon storage
- reservoir of biodiversity
- platform for buildings
- support for food and biomass production



Urban soils:

- high heterogeneity
- modified temperatures
- artifacts in soil profiles
- limited soil resource


New York City Reconnaissance Soil Survey
New York City
Borough Map
Approximate Scale: 1:62,500
United States Department of Agriculture
NRCS
NEW YORK CITY SOIL AND WATER CONSERVATION DISTRICT



Scio series – so
lacustrine or all
Bay Park, Bronx
Deerfield se
glaciofluvia
Wood, Stat
Charlton series – soils formed in eolian
deposits over till Inwood Hill Park,
Manhattan


Rikers series
Greenbelt , S


Bigapple series
sandy materials
Brooklyn

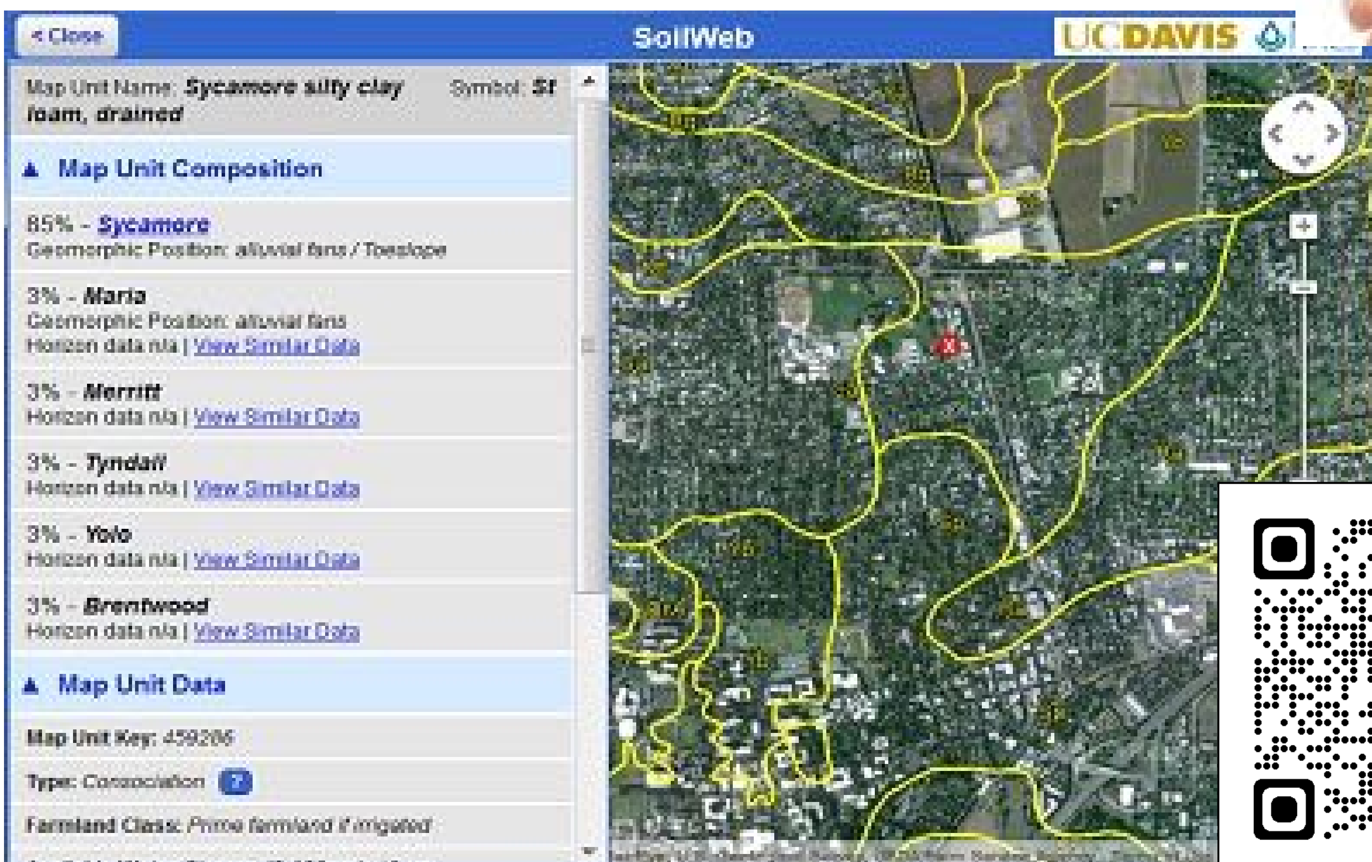

Laguardia series - soils formed in
construction debris Bronx

Learn more about soils under your feet

California Soil Resource Lab – UC Davis

Soilweb for GPS-enabled cellphones

http://casoilresource.lawr.ucdavis.edu/soilweb-apps/



Outline

Urban Gardening and Its Benefits

- ✓ Nutritious food to locals
- ✓ Grocery bill reduction
- ✓ Health benefits
- ✓ Minimizing criminal activities
- ✓ A deeper connection to agriculture and nature

Lead and Arsenic are Important Environmental Contaminants

Pb is a neurotoxin affecting cognitive development, quite immobile

Main sources:

-lead-based paint,

-point source emitters,

-leaded gasoline emissions.

As is a human carcinogen, very slowly leached through soils.

Main sources :

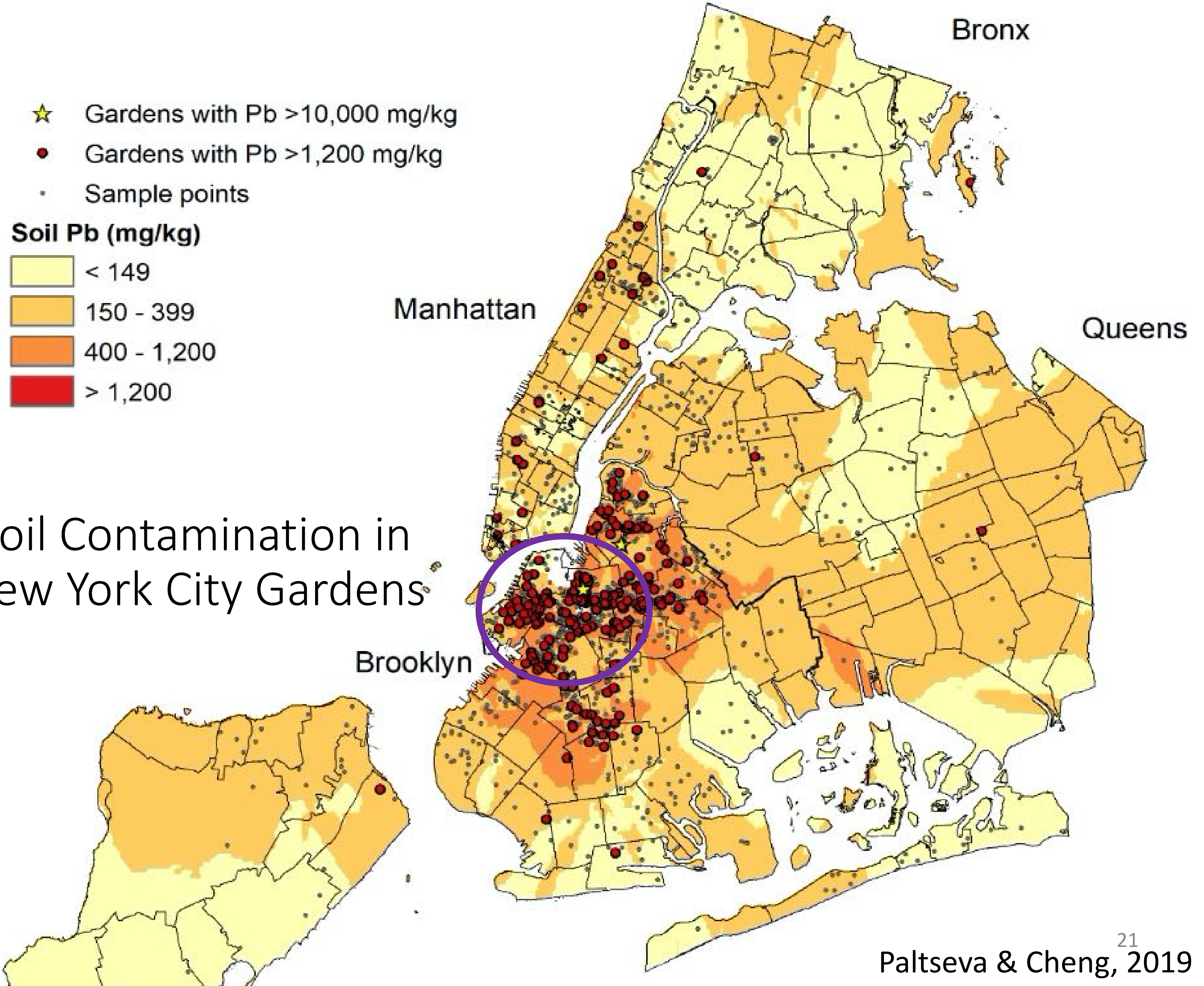
-pesticides,

-pressure treated lumber.

Comparison of Mean Heavy Metal Concentrations in Urban Soils in Different Cities

	# samples	Cr	Ni	Cu	Zn	As	Cd	Pb	Type of samples	Referen
					Cities over 1 million people					
New York City	1652	49	28	77	248	10	1.2	355	Garden soil	(Cheng et 2015)
Bangkok	30	25	23	27	38	-	0.15	29	Topsoil	(Wilcke al., 199
Hong Kong	236	17	4	10	78	-	0.33	71	Urban	(Lee et a 2006)
Beijing	~770	34	27	21	62	7.8	0.12	27	Topsoil, mean	(Chen et a 2005)
London - Richmond	214	-	-	30	108	-	<0.2	158	Topsoil	(Kelly et 1996)
London - Wolverhampton	295	-	-	62	231	-	0.80	106	Topsoil	(Kelly et 1996)
Vienna	96	80	-	18	97	8	0.2	65	Urban, 0-20 cm	(Simon et 2013)
Warsaw	nd	32	12	31	166	-	0.73	57	nd	(Czarnow 1980)
Madrid	55	75	14	72	210	-	-	161	0-20 cm	(De Mig et al., 19
Moscow	224	-	17	30	105	4	0.5	30	Public areas, 0-20 cm	(Romzayk et al., 20
Berlin	2182	25	8	31	129	3.9	0.35	77	0-20 cm	(Birke a Rauch, 20
Damascus	51	51	35	30	84	-	-	10	Topsoil, agriculture	(Möller et 2005)
Manila	286	114	21	99	440	-	0.57	214	Metropolitan area, 0-5 cm	(Pfeiffer al., 198
Dublin	1058	44	41	51	248	15.5	1.8	123	0-10 cm	(Glennon al., 201
Torino	123	129	153	71	147	-	-	94	1-10 cm	(Biasioli al., 200
Coruna	15	39	28	60	206	-	0.3	309	Garden soil, 0-5 cm	(Cal-Priet al., 200
Quezon City	64	370	150	445	1540	-	-	594	Metropolitan area, 0-15 cm	(Navarret al., 201
Mumbai (Bombay)	30	79	144.5	147	-	-	1.3	42.5	Urban soil	(Ratha a Sahu, 19

Soil Contamination in New York City Gardens

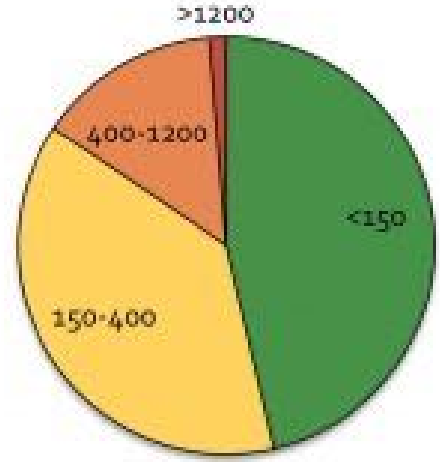


Paltseva & Cheng, 2019

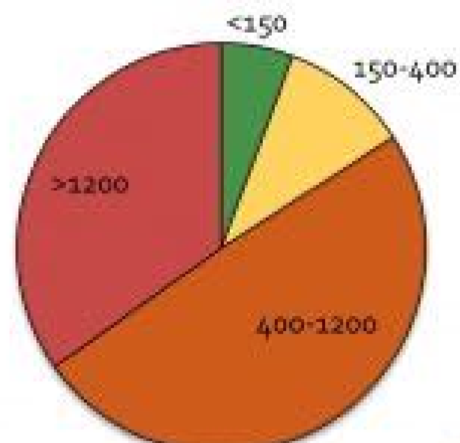
Lead (Pb) levels in soils as measured by XRF

Updated: 10/4/17

Public samples n= 463



Private samples n= 264



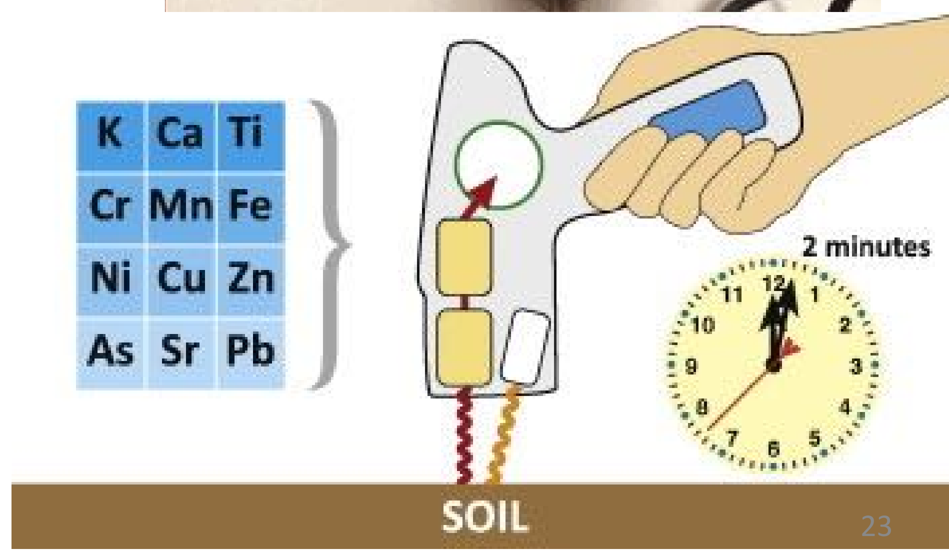
Landes et al (2017)

Data collected as part of the Columbia/ Barnard Soil Lead Study 2017. Please contact lead.study@ldeo.columbia.edu or fcl2115@columbia.edu with questions.

Lamont-Doherty Earth Observatory

BARNARD

How do we test for metals? XRF measurements



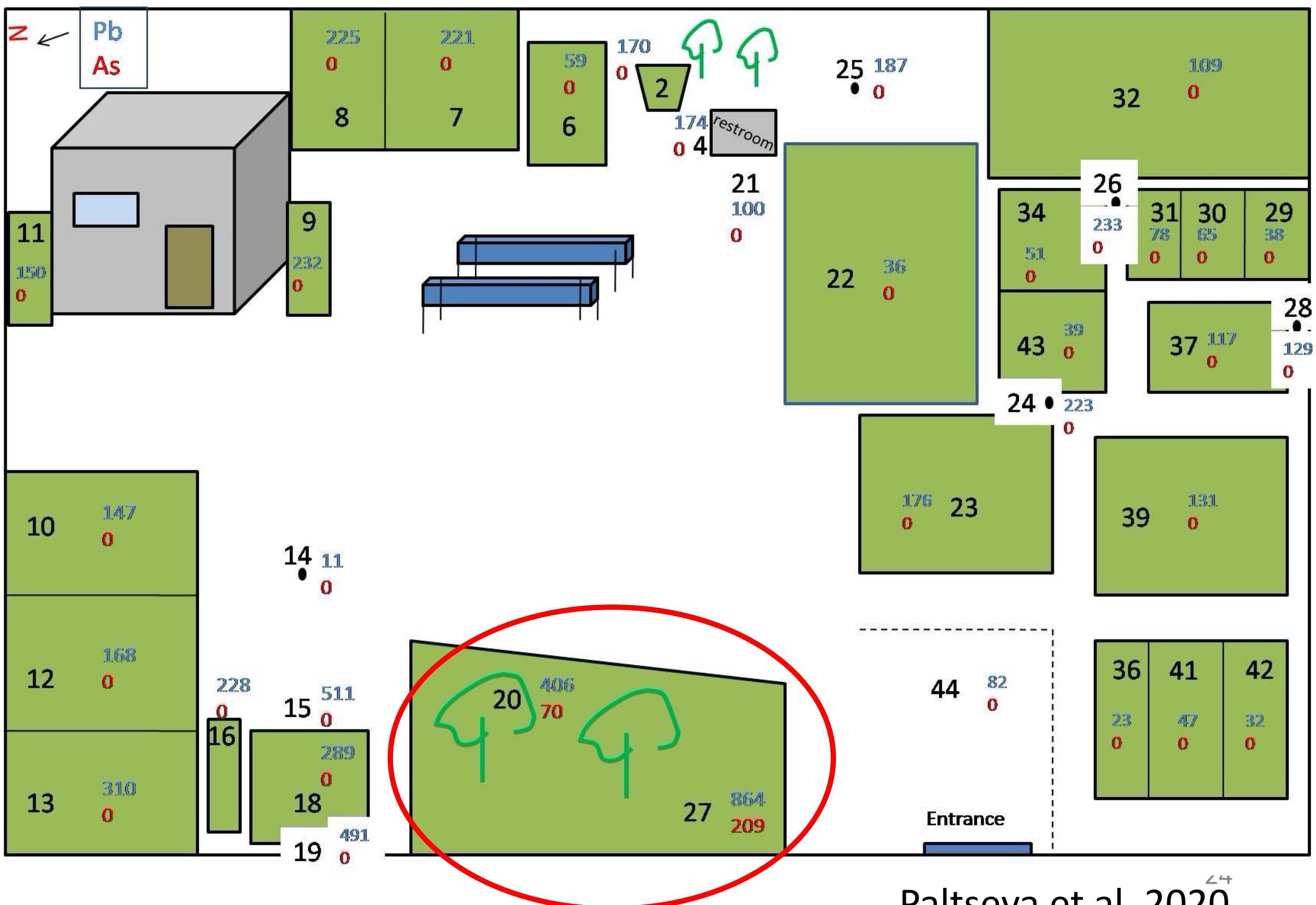

METRO EXCLUSIVE

Why NYC's toxic community gardens may give you cancer

By Gary Buiso

Catherine Bryant says she had no idea the community ga

J.C. Rice



Paltseva et al, 2020

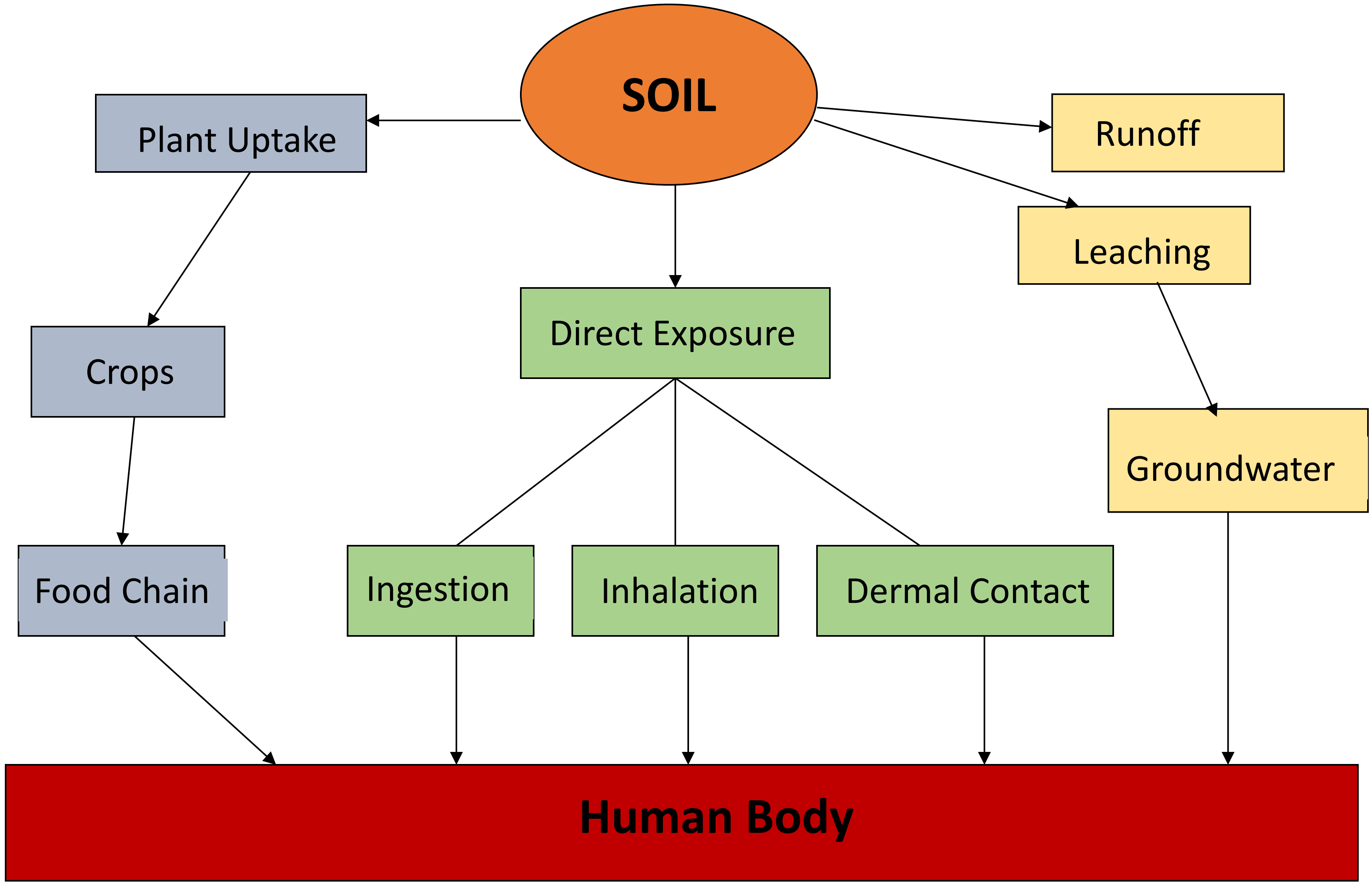
Suburban Duke Farm, NJ

Contamination is not just urban but also suburban problem

Soil Guidelines

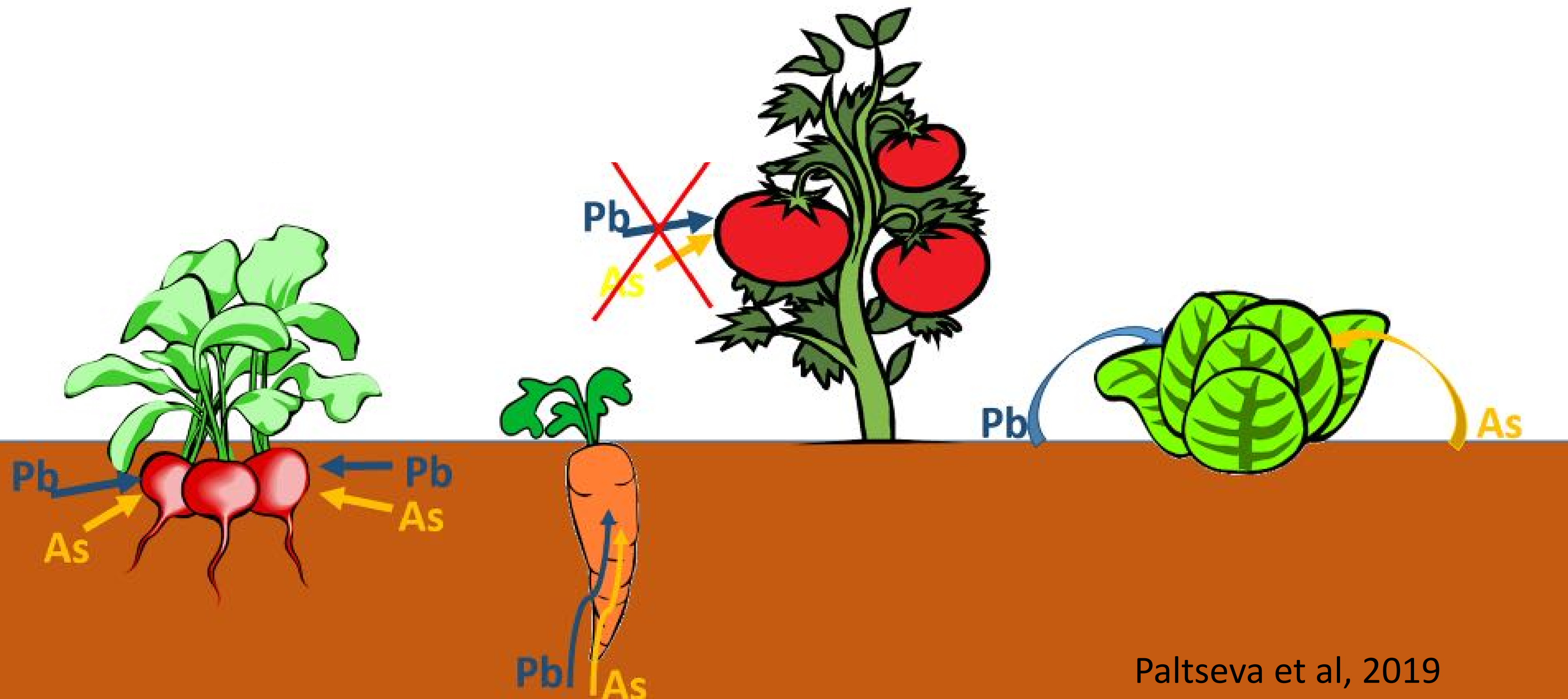
	New Jersey	New York	Connecticut
Residential, mg/kg			
Arsenic	22	16	10
Copper	3100	270	2500
Cadmium	71	2.5	34
Chromium	--	36	100
Mercury	23	0.81	20
Nickel	1600	140	1400
Lead	--	400	400
Zinc	23000	2200	20000

Exposure Pathways



Plant type is more important than amendment type

Surface contamination, not plant uptake



Paltseva et al, 2019

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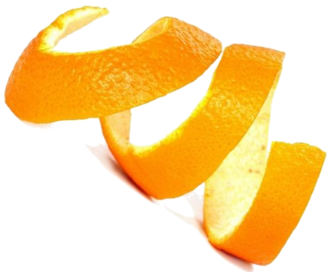
Emerging agricultural waste by-products as soil amendments



NYC Clean Soil Bank provide sediments to community-based organizations

Strategies and Techniques to Mitigate Soil Contamination

ORGANIC MATTER

How:

Add compost • biosolids • biochars to soils

Benefits:

Promote soil aggregates that adsorb contaminants • Improve soil structure • Reduce erosion • Reduce fine particle suspension in air

LIMING

How:

Add Ca and Mg rich material in soils

Benefits:

Increase in soil pH • Reduce trace metal availablity to organisms • Increase soil aggregates and texture

What is a soil aggregate? These are soil particle groups that are bound together stronger that the particles around them. Pore space is formed around these which helps the soils move or retain water and helps the movement of air within the soils.

CONSERVATIVE TILLAGE PRACTICES

How:

Use no-till • ridge-till • strip-till methods • Have stable vegetation coverage

Benefits:

Immobilize metals in soils •Reduce topsoil erosion • Lower organic mineral decomposition rates • Longer remediation rates from organic matter • Increase soil aggregates • Reduce fine particle suspension in the air

PLACEMENT

How:

Install garden areas at least 50 meters from heavy traffic areas

Benefits:

Directly avoid accumulation of contaminants in soils

DUST CONTROL

How:

Add mulch on contaminated soils • use drip irrigation

Benefits:

Reduce fine particle suspension in air • Reduce flooding and spashing • Decrease risk of recontamination of surface soil or plant tissues

Paltseva AA, Cheng Z, McBride M, Deeb M, Egendorf SP, Groffman PM (2022) Legacy Lead in Urban Garden Soils: Communicating Risk and Limiting Exposure. Front. Ecol. Evol. 10:873542.

Community Service in Low-Income Areas

- *EPA Soil Kitchen Events, Soil-SHOP, NAG, USI workshops*

Conducting XRF analysis of soils brought by the public, advising on remediation strategies

- *Brooklyn Bloom, NYC Housing Authority, NAG, NYC Compost, Understory, USI annual events*

Lecturing with hands on activities on soil basics and soil interpretations. Presenting issues associated with urban gardening and how to mitigate the hazards.

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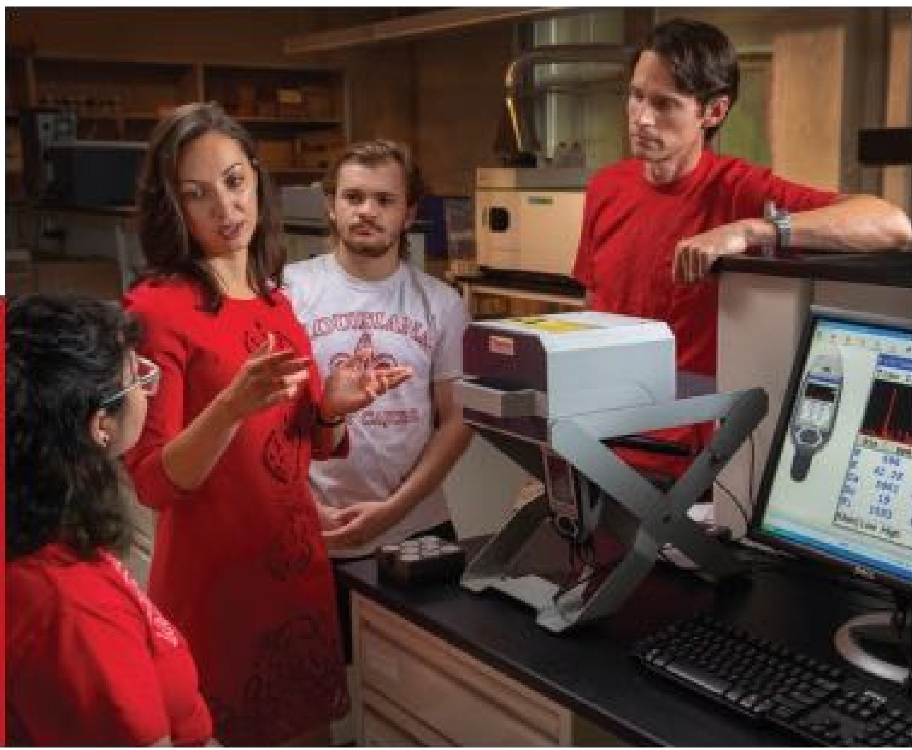
UNIVERSITY of LOUISIANA LAFAYETTE

Ray P. Authement College of Sciences | School of Geosciences

DELTA URBAN SOILS LABORATORY



We can help you to find the best way to remediate contaminated soils; promote organic waste recycling and conservation practices; use smart technologies to evaluate soil resources

We offer informal education via social media channels; publish in academic and non-academic media; facilitate research partnerships

We collaborate with citizen scientists, artists, gardeners; lead workshops for communities

We provide expert recommendations for management practices to increase carbon storage and reduce greenhouse gases;
promote urban agriculture in food deserts

Coming soon…

THE URBAN SOIL GUIDE: FIELD AND LAB MANUAL

TABLE OF CONTENTS

Key Points

- Soil is heterogeneous with various properties
- 5 soil formation factors
- Urban soil testing should be prioritized
- Different remediation options exist for contaminated soils
- Certain crops are much less susceptible to contamination than others
- Raised beds filled with upcycled local mineral and organics are preferred.

Stay Connected

- Email me with any questions at **anna.paltseva@Louisiana.edu**
- Subscribe to my **YouTube** Channel at **Anna Paltseva**
- For more information on my projects go to **annapaltseva.com**

SOIL_EXPERT