USE DEPENDENT SOIL PROPERTIES: RESULTS FROM SOME STUDIES IN NJ & NYC

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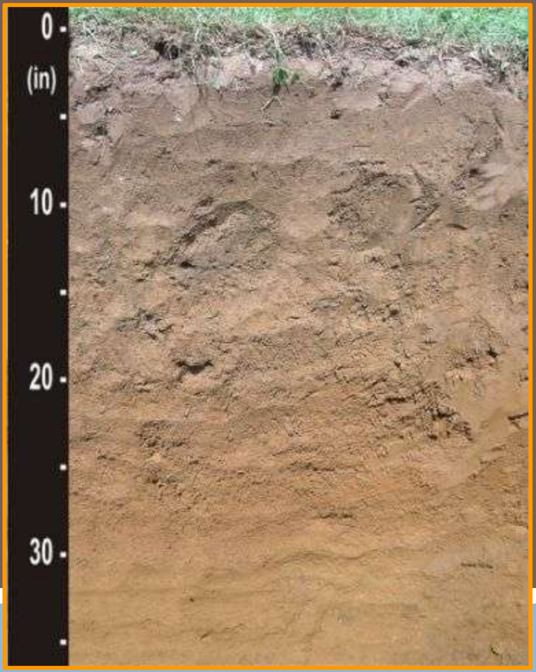
USDA-NRCS



"We can save 700 Lira by not taking soil tests"

Outline

- Definitions
- NJ matched pair study
- NYC infiltration & land use study
- Other related NRCS Projects
- What's Next?

Use-dependent
or management-dependent properties

**Soil properties that show change
and respond to use and management of the soil, such as soil organic matter levels and aggregate stability.**

http://soils.usda.gov/sqi/concepts/glossary.html

Dynamic soil properties

Soil properties that change over the human time scale in response to anthropogenic (management, land use) **and non-anthropogenic** (natural disturbances and cycles) **factors.**
Many are important for characterizing soil functions and ecological processes and for predicting soil behavior on human time scales.

http://soils.usda.gov/sqi/concepts/glossary.html

Use-independent properties

Soil properties that show little change over time and are not affected by use and management of the soil, such as mineralogy * and particle size distribution.

http://soils.usda.gov/sqi/concepts/glossary.html

Use dependent properties

***Effects of Cultivation on Hydroxy-Interlayering of 2:1 Clay Minerals in Some New Jersey Soils**

In some soils, vermiculite or smectite →
hydroxy-Al interlayered vermiculite or smectite

R.K. Shaw, 1994

Dissertation, Dept of Soils and Crops, Rutgers University

L.A. Douglas, Advisor
H.L. Motto
P.H. Hsu
J.C.F. Tedrow
J.R. Heckman

Soil Quality

- **soil quality or soil health -** the capacity of the soil to function.

Two aspects of soil quality include:

- **dynamic soil quality -** That aspect of soil quality relating to soil properties that change as a result of soil use and management or over the human time scale.

- **inherent soil quality -** That aspect of soil quality relating to a soil's natural composition and properties as influenced by the factors and processes of soil formation, in the absence of human impacts.

NJ Matched Pair Study

1991 NRCS-NJ: Ron Taylor, Daryl Lund, Maxine Levin, Dave Kingsbury, Thornton Hole, Lenore Matula

Examine changes in soil properties upon cultivation.

Full characterization at NSS Lab.

Matched pairs

Same series (prime farmland soils) under 2 land uses:

a) Woodland - not cropped ≥50 yrs

b) Cultivation - continually cropped ≥ 30 yrs

NJ Matched Pair Study

Bob Grossman, Research Soil Scientist

NSSC, Lincoln, NE

- ✓Fragipan properties
- ✓Desert soil project
- ✓Soil Survey Manual
- ✓Assessment methods soil physical properties

NJ Matched Pairs: 1991-present

32 pairs: same soil series in woodland & cultivation

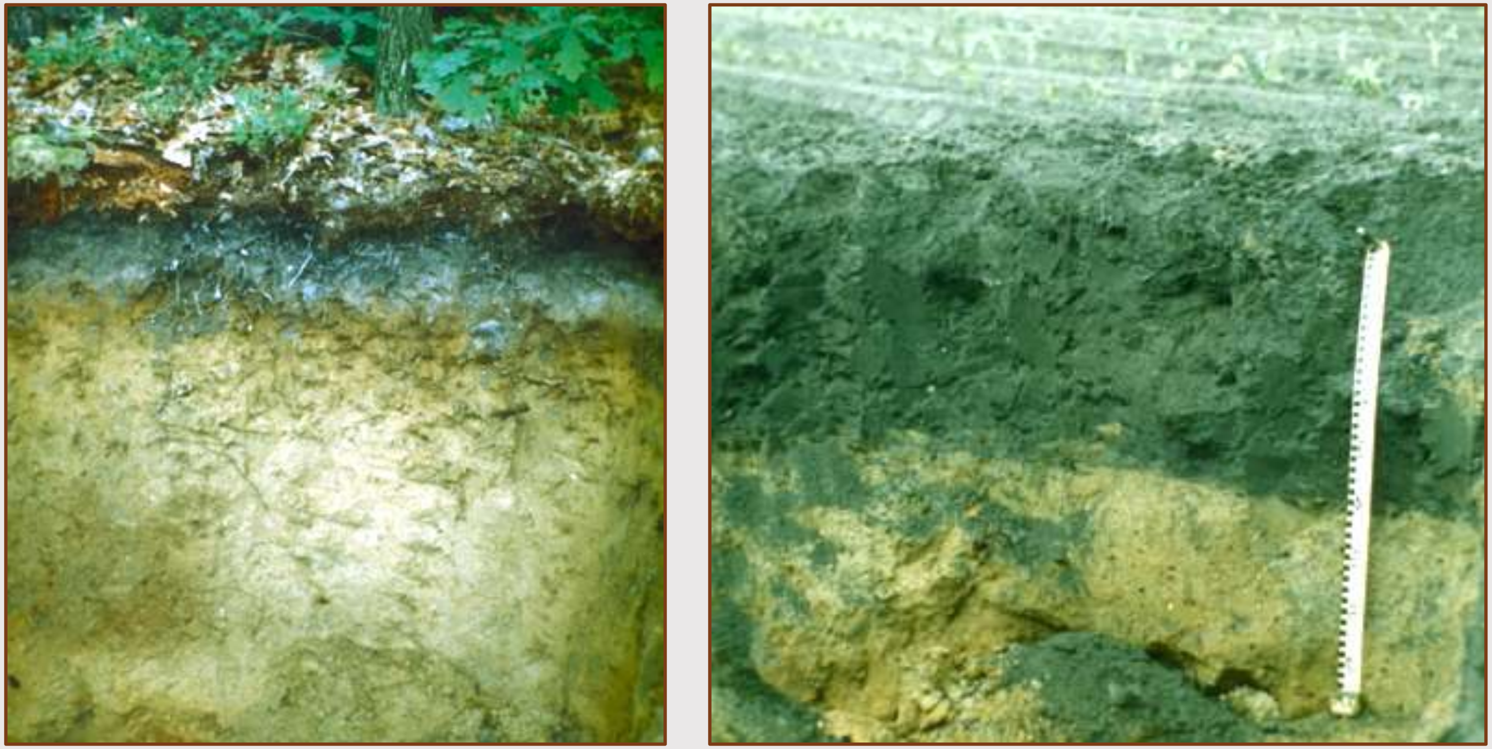
144A & 140
Hazen*
Delaware
Lordstown*
Bath (Wurtsboro)*
Galway*
Wassaic
Chatfield
Wurtsboro
Albia (Venango)

148
Washington (2 pairs)*
Gladstone*
Berks*
Penn*
Ryder (Berks)*
Quakertown*

149A & 153D
Freehold*
Collington*
Holmdel*
Sassafras*
Keyport*
Chillum*
Mattapex
Westphalia*
Aura*
Lakewood
Lakehurst
Evesboro
Klej

*included in statistical analyses

Comparing the Matched Pairs



Downer matched pair, Buena, Atlantic County

Comparing the Matched Pairs

1. Compare Soil Organic Carbon Density or Areal organic carbon to 1 meter depth

Sum (all horizons to 1 m):

% SOC x thickness x Db = kg C / m^2

Comparing the Matched Pairs

2. Compare properties of selected horizons (3)

Wooded				Cultivated	
O	0 to 5 cm				
✓ **A**	**5 to 13 cm**	←	→	**Ap**	**0 to 27 cm**
AB, BA, E or BE	13 to 23 cm				
✓ **Bt or Bw**	**23 to 45 cm**	←	→	**Bt or Bw**	**27 to 45 cm**
✓ **100 cm depth**		←	→	**100 cm depth**	

Comparing the Matched Pairs

Soil Organic Carbon Density to 1 meter depth

average values kg C / m^2

n	Wooded	Cultivated	t-value
18	14.53	6.98	9.82***

Average loss upon cultivation = 52%

**** significant at .001 level*

Areal Org. Carbon: Linear Regression

<u>regression equation</u>	18 pairs	<u>r value</u>
Simple linear regression		
cult AOC = 0.348 wood AOC + 1.924		.6176
Stepwise multiple regression		
cult AOC = 0.319 wood AOC + 0.023 %silt + 1.410		.6391
Simple linear regression		
AOC loss = 0.652 wood AOC - 1.924		.8272
Stepwise multiple regression		
AOC loss = .6807 wood AOC - 0.023%silt - 1.410		.8355

Wooded vs Cultivated; A horizons

Variable	n	Means		t-value
		wood	cult	
% sand	19	45.91	47.33	-0.88
% silt	19	41.63	39.62	1.33
% clay	19	11.69	12.10	-0.86
% OC	19	4.72	1.18	4.31 ***
Db	17	0.90	1.52	-6.33 ***

*** *significant at the .001 level*

Wooded vs Cultivated; A horizons

Variable	n	Means		t-value
		wood	cult	
1/3 Bar H_2O	9	29.36	19.67	3.44 **
15 Bar H_2O	19	11.17	6.02	3.37 **
% AWC	9	19.99	12.31	3.02 *
% TPS	9	56.40	45.49	4.74 **
% AFP	9	25.40	17.84	2.91 *

*** significant at the .01 level* **significant at the .05 level*

Wooded vs Cultivated; A horizons

Variable	n	Means		t-value
		wood	cult	
CEC	19	17.44	7.61	4.54 ***
pH (H_2O)	19	4.49	5.92	-6.19 ***
% Base Sat.	19	36.37	80.22	-4.68 ***
Kf	17	0.26	0.35	-6.20 ***

**** significant at the .001 level*

Correlation Coefficients; A Horizons

	%C	Db	1/3 Bar H_2O	15 Bar H_2O	PAWC	TPS	AFP
Db	-.747**	-----	-.691**	-.651**	-.647**	-.994**	-.737**
%C	-----	-.747**	.528**	.880**	.440*	.706**	.518**

** significant at the .05 level*

*** significant at the .01 level*

Cult vs wooded; B horizons

Variable	n	Means		t-value
		wood	cult	
% sand	19	45.25	46.05	-0.51
% silt	19	38.83	36.39	1.29
% clay	19	16.25	17.61	-0.73
% OC	19	0.47	0.29	3.89 **
Db	17	1.44	1.76	-3.69**

*** significant at the .01 level*

Cult vs wooded; B horizons

Variable	n	Means		t-value
		wood	cult	
1/3 Bar H_2O	17	19.00	17.98	0.85
15 Bar H_2O	19	7.36	7.53	-0.22
% PAWC	17	11.44	10.28	0.97
% TPS	17	45.69	41.23	3.68 **
% AFP	17	18.91	13.99	3.56 **

***significant at the .01 level*

Cult vs wooded; B horizons

Variable	n	Means		t-value
		wood	cult	
CEC	19	7.21	6.46	0.99
pH (H_2O)	19	4.85	5.97	-5.02 ***
% Base Sat.	19	26.58	72.21	-5.32 ***

*** *significant at the .001 level*

Cult vs wooded; 100 cm depth

Variable	n	Means		t-value
		wood	cult	
% sand	15	53.36	60.44	-1.46
% silt	15	28.77	21.65	1.67
% clay	15	20.03	17.91	1.01
% OC	14	0.13	0.08	3.29 **
Db	11	1.59	1. 61	-0.45

*** significant at the .01 level*

Cult vs wooded; 100 cm depth

Variable	n	Means: wood	Means: cult	t-value
1/3 Bar H_2O	11	17.90	16.80	0.64
15 Bar H_2O	15	9.05	8.07	1.08
% PAWC	11	7.17	7.64	-0.47
% TPS	11	40.25	39.24	0.44
% AFP	11	13.43	12.74	0.35

Cult vs wooded; 100 cm depth

Variable	n	Means: wood	Means: cult	t-value
CEC	15	7.59	5.99	1.53
pH (H_2O)	15	4.84	5.41	-3.26 **
% Base Sat.	14	23.29	51.43	-4.68***

*** significant at the .01 level*

**** significant at the .001 level*

Effects on Soil Classification

n = 19 pairs

2 from *ultisol* to *alfisol*	**order**
2 from *dystrudept* to *eutrudept*	**great group**
2 from *ultic hapludalf* to *typic*	**subgroup**

All from changes in base saturation

Implications

- Most soil survey map units cover different land use types, but list only one set of soil properties per component

Gladstone series- residuum & colluvium from granitic gneiss

21% **agriculture** 47% **woodland** 31% **urban**

Freehold series- low greensand inner coastal plain

23% **agriculture** 13% **woodland** 58% **urban**

NYC Infiltration & Land Use Study

- Hydrologic Soil Group = most requested soil interpretation in NYC

- Based on soil properties:
  - Ksat
  - Depth to restrictive layer (20 to 40") or water table (24 to 40")

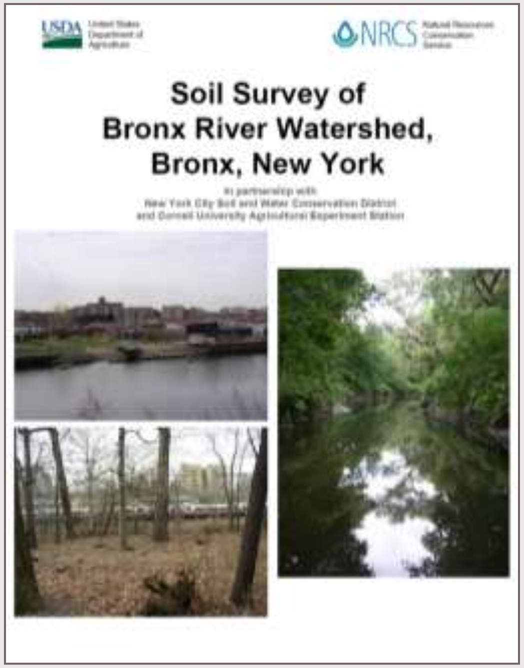
- Traditionally assigned to a soil series

Bronx River Watershed Soil Survey

1:6000 scale, high intensity survey, ~7000 acres
Minimum size delineation = 0.5 acre

<u>**Land use diversity**</u>

- Undisturbed woodlands
- Low Use parkland (mugwort, very stony)
- High use parkland (lawn, non-stony)
- Woodlawn Cemetery
- Residential areas



BRW Infiltration & Land Use Study

Cornell Sprinkle Infiltrometer
Soundview Park - Low use area

Soils:

- Parent material:
  - ✓Fill (HTM)
  - ✓Natural Materials
- Particle Size Class:
  - ✓Coarse-silty
  - ✓Coarse-loamy
  - ✓Loamy-skeletal
  - ✓Sandy

Land uses:

- Woodland
- Parkland
  - ✓Low-use
  - ✓High-use
- Residential

USDA-NRCS Infiltration and Land Use Study
Bronx River Watershed, New York City

Soil Series	Particle-Size Class	Landuse	in/hr
Chatfield	coarse-loamy	woodland	6.14
Charlton	coarse-loamy	woodland	6.61
Olinville*	coarse-loamy	woodland	7.32
Chatfield	coarse-loamy	woodland	7.56
Suncook	sandy	woodland	7.80
Deerfield	sandy	woodland	10.39

* formed in HTM (fill)

USDA-NRCS Infiltration and Land Use Study
Bronx River Watershed, New York City

Soil Series	Particle-Size Class	Landuse	in/hr
Tonawanda	coarse-silty	city park (high use)	0.12
Laguardia*	loamy-skeletal	city park (high use)	0.24
Centralpark*	loamy-skeletal	city park (high use)	0.24
Centralpark*	loamy-skeletal	city park (high use)	0.47
Greenbelt*	coarse-loamy	city park (high use)	0.71

*formed in HTM (fill)

USDA-NRCS Infiltration and Land Use Study
Bronx River Watershed, New York City

Soil Series	Particle-Size Class	Landuse	in/hr
Greenbelt*	coarse-loamy	low use parkland	3.78
Hollis	coarse-loamy	low use parkland	4.49
Laguardia*	loamy-skeletal	low use parkland	4.70
Suncook*	sandy	low use parkland	7.80
Laguardia*	loamy-skeletal	low use parkland	9.45

*formed in HTM (fill)

USDA-NRCS Infiltration and Land Use Study
Bronx River Watershed, New York City

Soil Series	Particle-Size Class	Landuse	in/hr
Centralpark	loamy-skeletal	residential (back yard)	0.00
Greenbelt	coarse-loamy	residential (tree pit)	0.00
Bigapple	sandy	residential (vacant lot)	1.38
Greenbelt	coarse-loamy	residential (landscaped)	2.36
Greenbelt	coarse-loamy	residential (landscaped)	2.60
Greenbelt	coarse-loamy	residential (rain garden)	6.38

All soils formed in HTM (fill)

USDA-NRCS Infiltration and Land Use Study
Bronx River Watershed, New York City

Soil Series	Particle-Size Class	Landuse	in/hr
Greenbelt	coarse-loamy	residential (tree pit)	0.00
Greenbelt	coarse-loamy	city park - high use	0.71
Greenbelt	coarse-loamy	residential (landscaping)	2.36
Greenbelt	coarse-loamy	residential (landscaping)	2.60
Greenbelt	coarse-loamy	city park – low use	3.78
Greenbelt	coarse-loamy	residential (rain garden)	6.38

Greenbelt soils are formed in HTM (fill)

USDA-NRCS Infiltration and Land Use Study
Bronx River Watershed, New York City

Soil Series	Particle-Size Class	Landuse	in/hr
Laguardia	loamy-skeletal	industrial	0.00
Laguardia	loamy-skeletal	city park (high use)	0.24
Laguardia	loamy-skeletal	city park (high use)	0.71
Laguardia	loamy-skeletal	city park (low use)	4.70
Laguardia	loamy-skeletal	city park (low use)	9.45

Laguardia soils are formed in HTM (fill)

Laguardia series
fill with construction debris
loamy-skeletal
industrial land use
<u>0.00 in/hr infiltration</u>

Sims Hugo Neu
Metal Recycling
Hunts Point, Bronx

Bronx River Watershed Soil Survey
1:6000 scale, high intensity survey

Our model:

Undisturbed woodlands		More foot traffic
Low Use Parkland		Increase in Db
	↓	
Cemeteries		Decrease in Ksat
High use parkland & Industrial		Decrease in infiltration rate

BRW use dependent map units, soil properties

	Surface Db	Ksat	HSG
	g/cm^3	in/hr	
Woodlands Charlton	0.9 - 1.47	0.6 to 7.14	B
Low use parkland Laguardia	0.9 - 1.65	0.6 to 6	B
Cemetery Greenbelt	0.9 – 1.65	0.6 to 3.6	B
High use parkland Laguardia	1.2 - 1.8	0.14 to <1.42	C

Other related NRCS projects

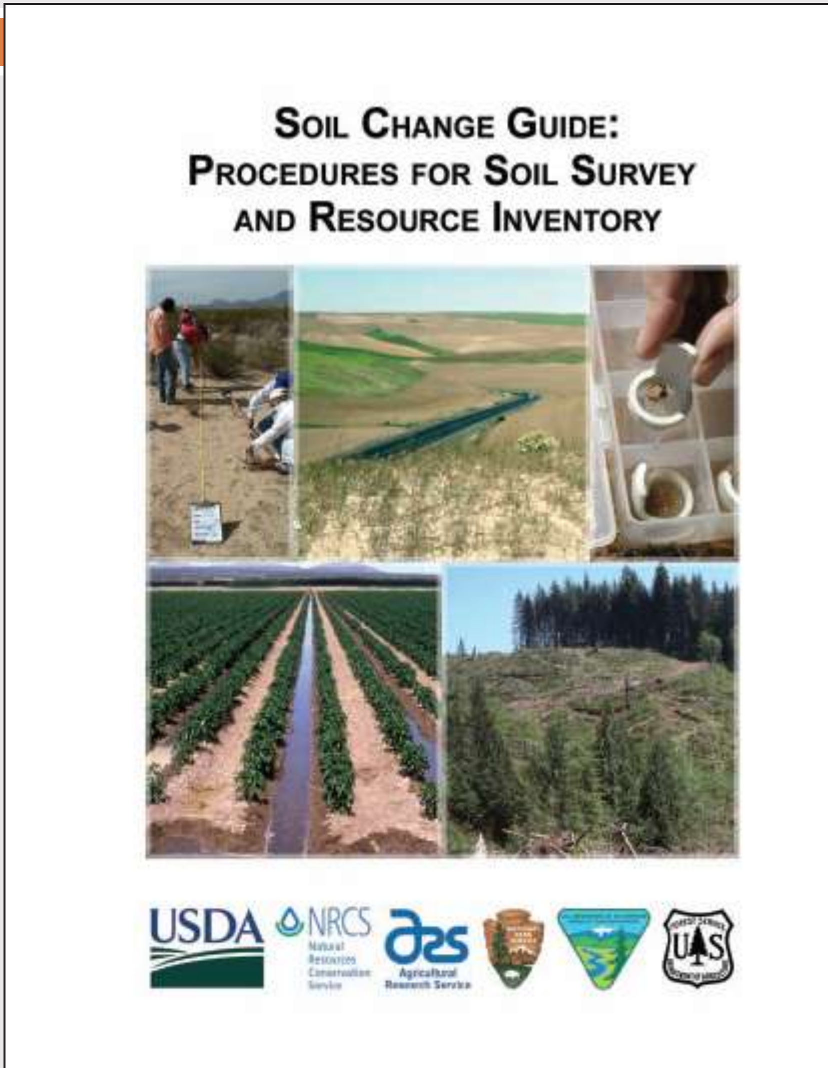
Soil Change Working Group (now *Soil & Ecosystem Dynamics*)

NRCS & other members

<u>Mission areas</u>

- ✓ **Soil Quality**
- ✓ **Dynamic Soil Properties**
- ✓ **Ecological Site Index**

Soil Change Guide



This Guide is designed for soil survey, vegetation, and ecological site or unit inventory work in order to help soil scientists and other inventory specialists collect interpretable data about soil change within the human time scale. This Guide describes a sampling system to measure dynamic soil properties for all major land uses (except urban lands where the land and soil have been significantly reshaped).

Rapid Carbon Assessment

- A comprehensive inventory of soil carbon stocks for soils of the U.S. as affected by soil properties, agricultural management, ecosystems, and land uses.
- Enhanced carbon data are needed for evaluating the effects of conservation practices on soil carbon and for global carbon accounting.

Soil Survey Division Program Plan 2011-2015

#4 of 17 items.

Collect dynamic soil properties and other pertinent features focusing on benchmark soils, landscapes and ecological sites.

What's missing?

Use dependent data base would:

- **Allow users to select more applicable data**
- **Increase accuracy of interpretations**
- **Enable an evaluation of soil quality**
- **Provide more accurate information about the state of the land**

from ***Aspects of a Use- Dependent Data Base***

By Robert B. Grossman and Jim R. Fortner,

NSSC, Lincoln, NE. NCSS Newsletter, October1999

Summary

- Differences in soil properties from land use can be significant
- In some cases may affect interpretations
- Use dependent map units may be an option, depending on mapping scale, and extent of land use changes
- A database that can accommodate use dependent properties would be more flexible

"Me future is settled, Willie. I'm gonna be a perfessor on types o' European soil."

Bill Mauldin