All Sites Are Ecological

Research Approaches for Dynamic Properties and Soil Change

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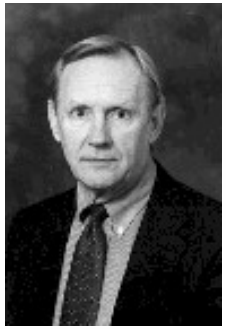
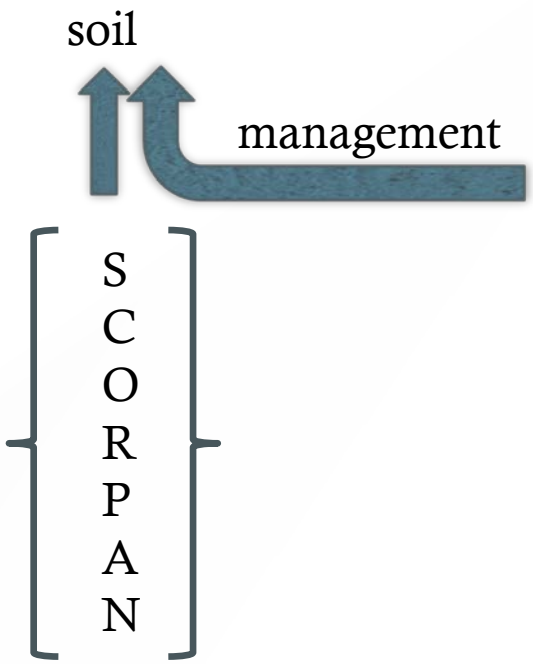
In memory of

- Fred Miller
- Frank Calhoun



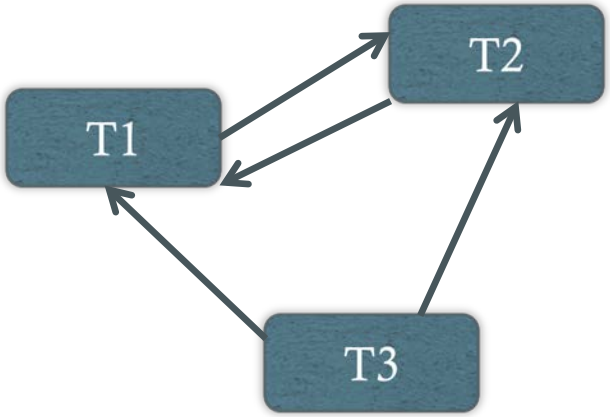
Paradigm

$$S = f\,(cl, o, r, p, t)$$



Themes

- Soils change
- All soils are disturbed,, influenced by human management, even if just benign neglect
- Spatial and attribute databases need to reflect this reality
  - Management history and effects
  - Benchmark sites
  - Range of interventions



Soil Change

19C	21C
Intrinsic properties	Dynamic properties
Physico-chemical	Biological
Natural	Managed

Genoforms and Phenoforms

- Droogers and Bouma (1997)
- Genoform
  - Genetic soil type
- Phenoforms
  - Variants resulting from various kinds of management

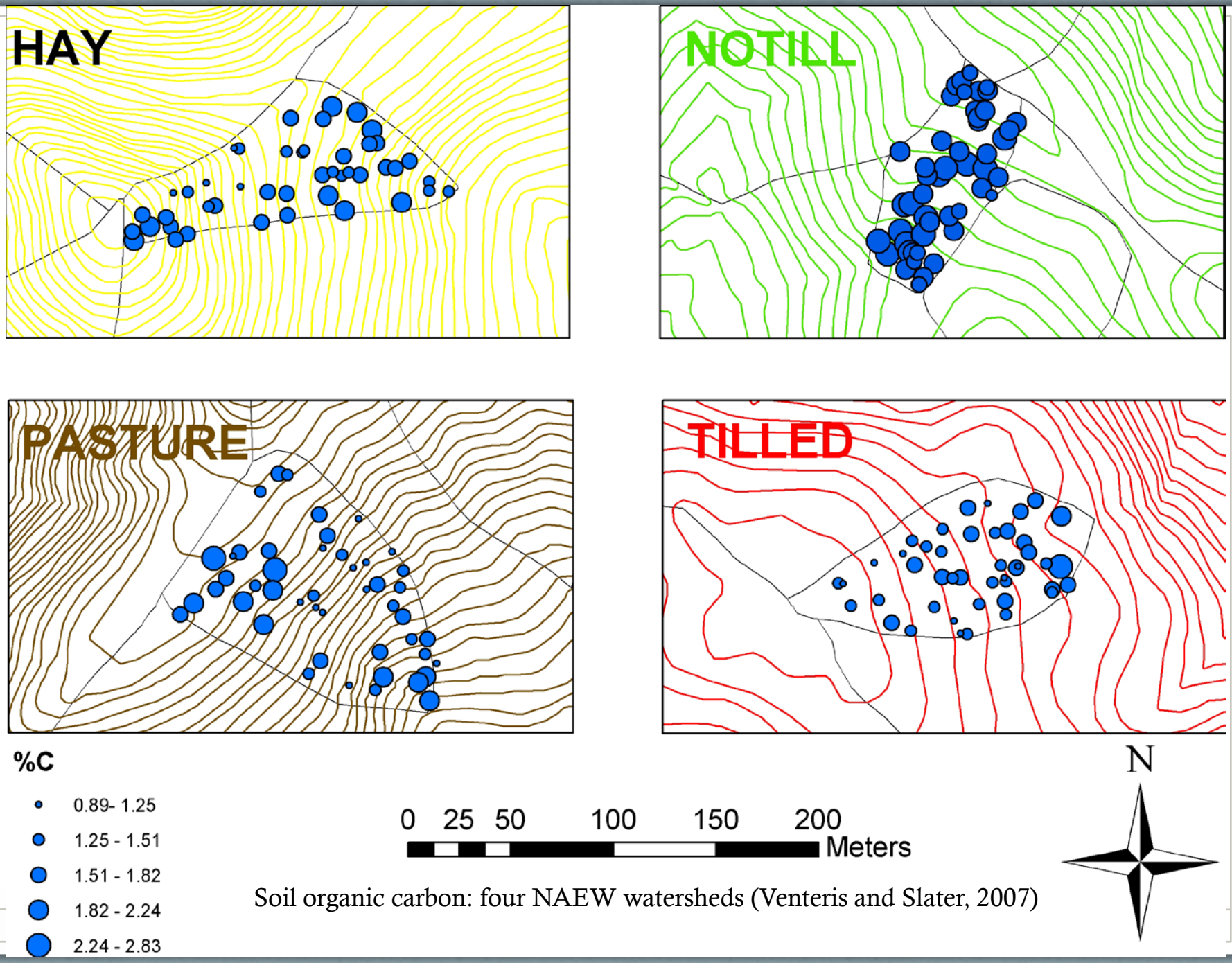
- A problem with applying soil classification and soil maps to land-use problems, has always been that pedology had to consider genetic soil types, formed by long-range processes. If a classification of soil would change after each land-use change, it would be of little value. We find, however, that soil management drastically changes soil properties even within a given soil type, often without *necessarily* changing the soil classification. This was the reason to establish the phenoform concept which leaves the existing soil classification structure intact and expands on it in a way that makes existing soil expertise more relevant for practical applications.

Research Approaches

- Long term sites
- Revisited sites
- Space for time substitution

Long Term Sites

- Controlled
- May not have many land management regimes or soils to compare
- In Ohio:
  - Van Doren No till plots
  - North Appalachian Experimental Watershed (deceased)

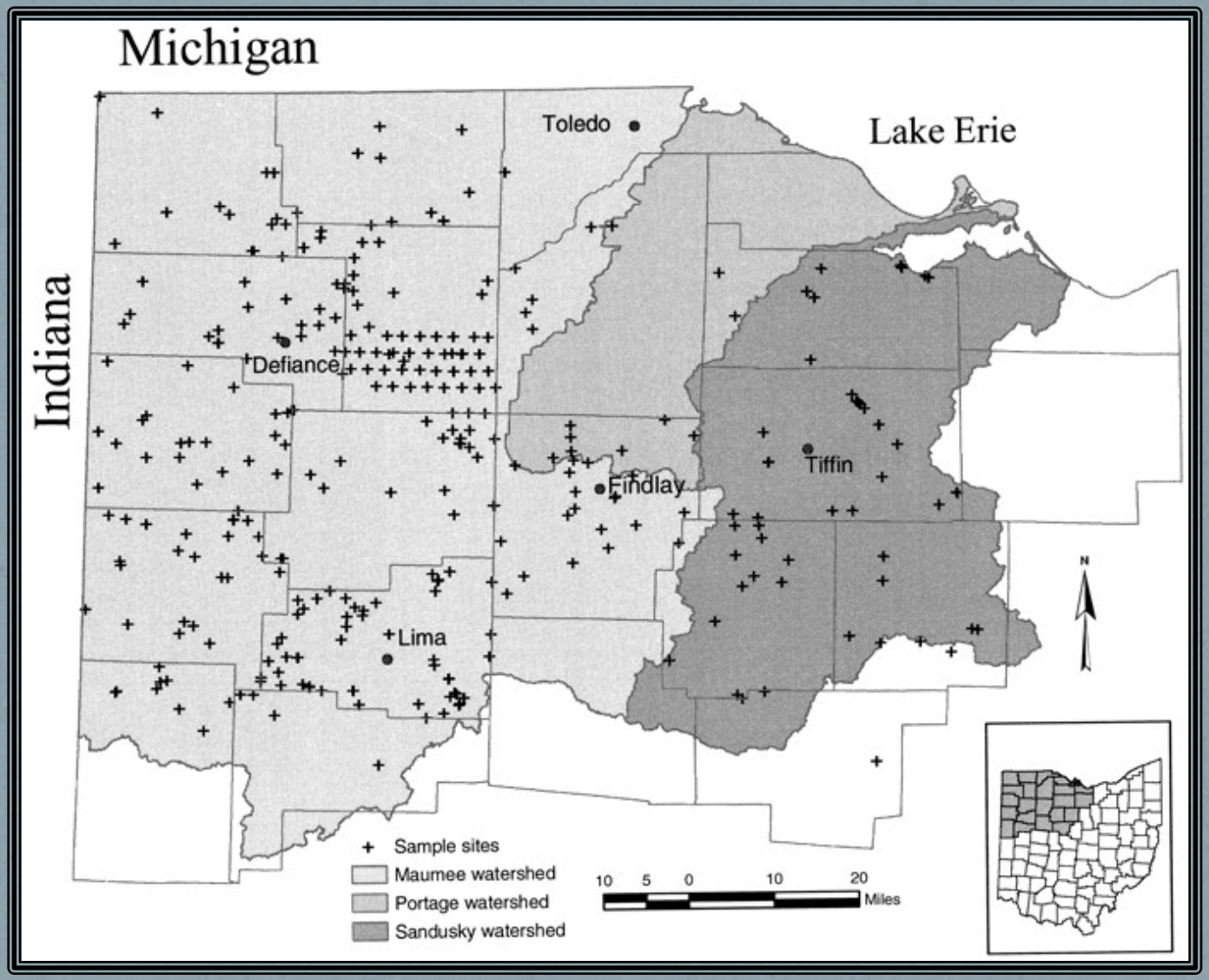


Soil organic carbon: four NAEW watersheds (Venteris and Slater, 2007)

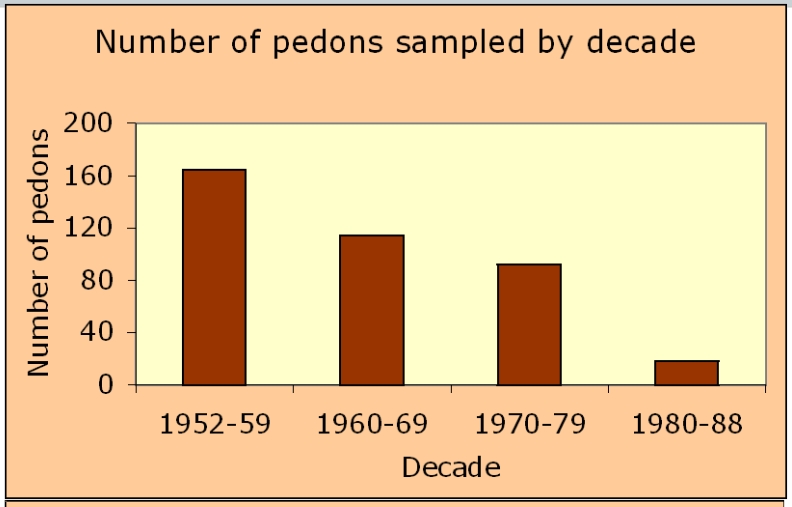
Revisited Sites

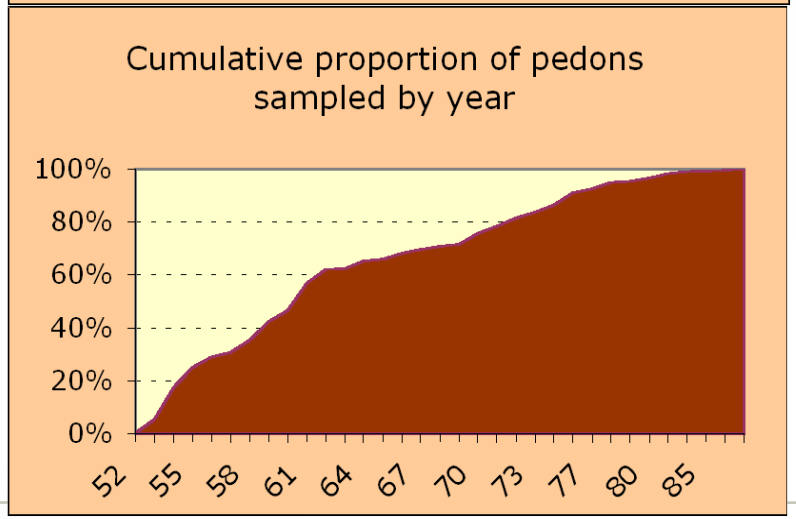
- >60 year history of pedon samples
- Sites can be resampled to assess change
- Major challenges:
  - Poor georeferencing
  - Management?

Resample locations in NW Ohio



Distribution of sampling over time:

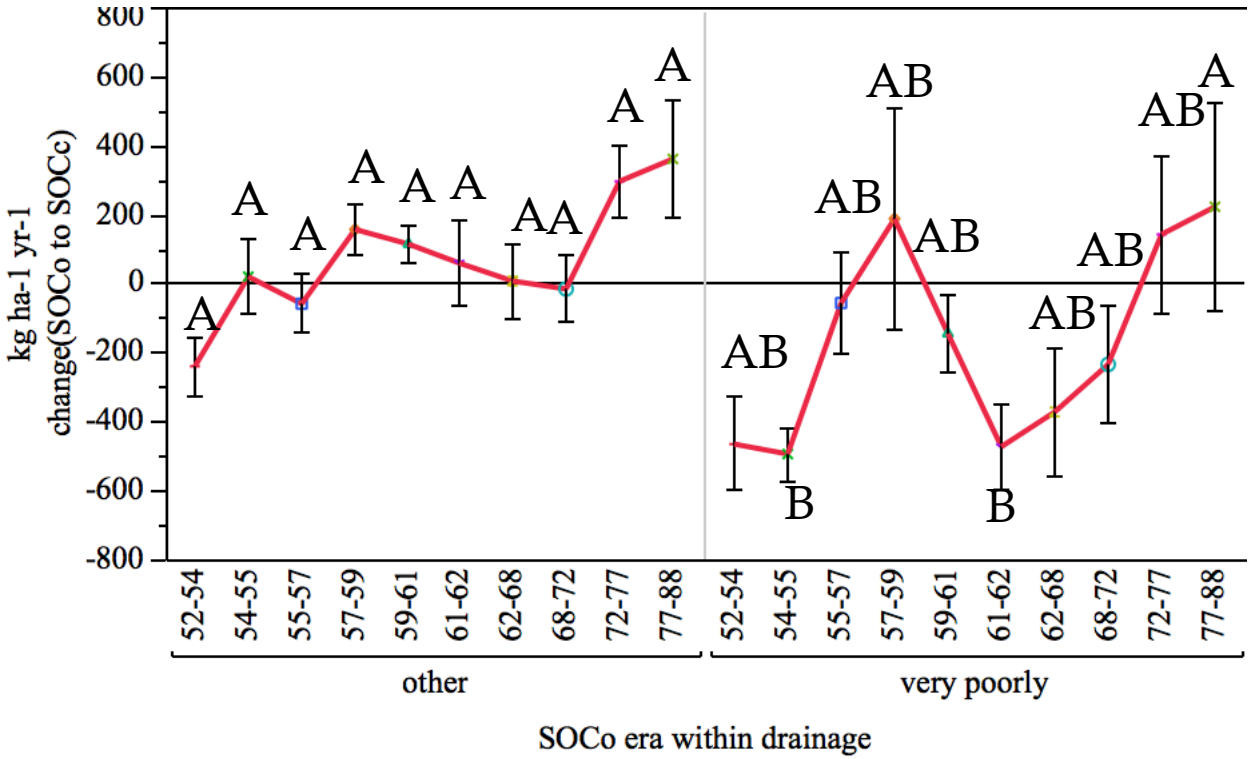




- N = 388 for soils continuously cultivated
- Forested sites (N = 89) included for comparison
- Over 75% sampled by 1970
- "Modern": 1996-98

Results

$\{(SOC_c - SOC_o) / (date_c - date_o)\}*10{,}000$



other = somewhat poorly + moderately well + well

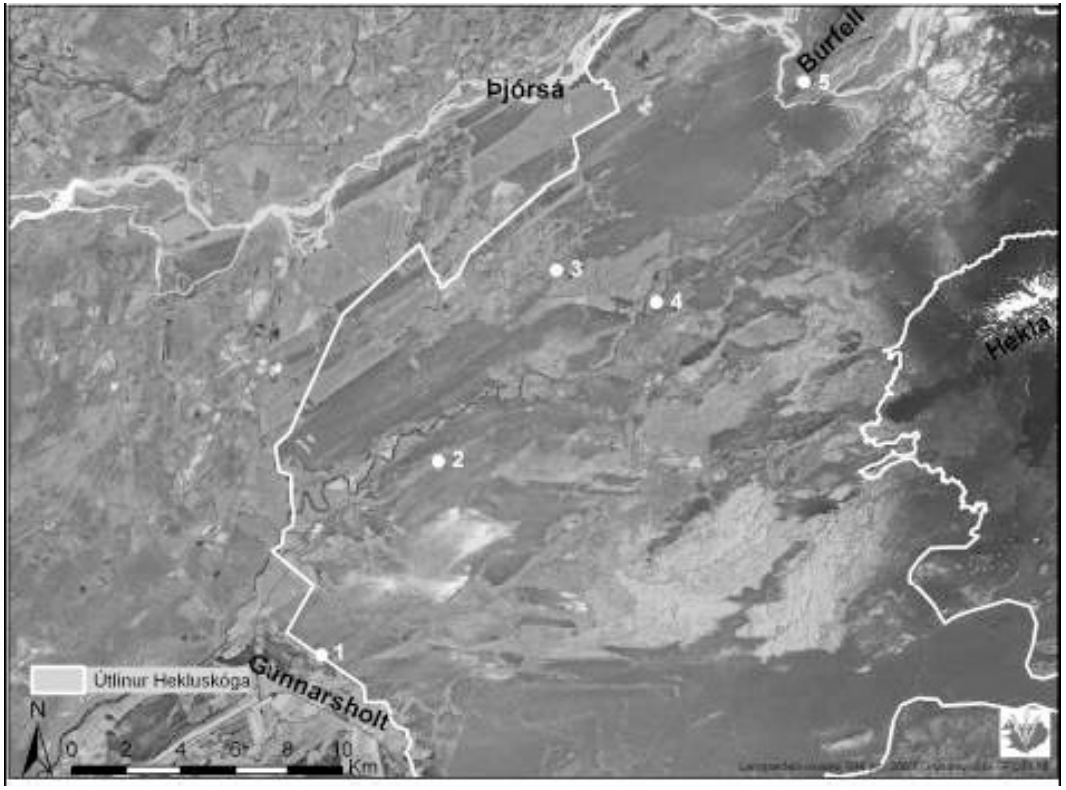
Space-time substitution

- Multiple phenoforms for each genoform
- Major challenge is validity of comparison due to unknown variation

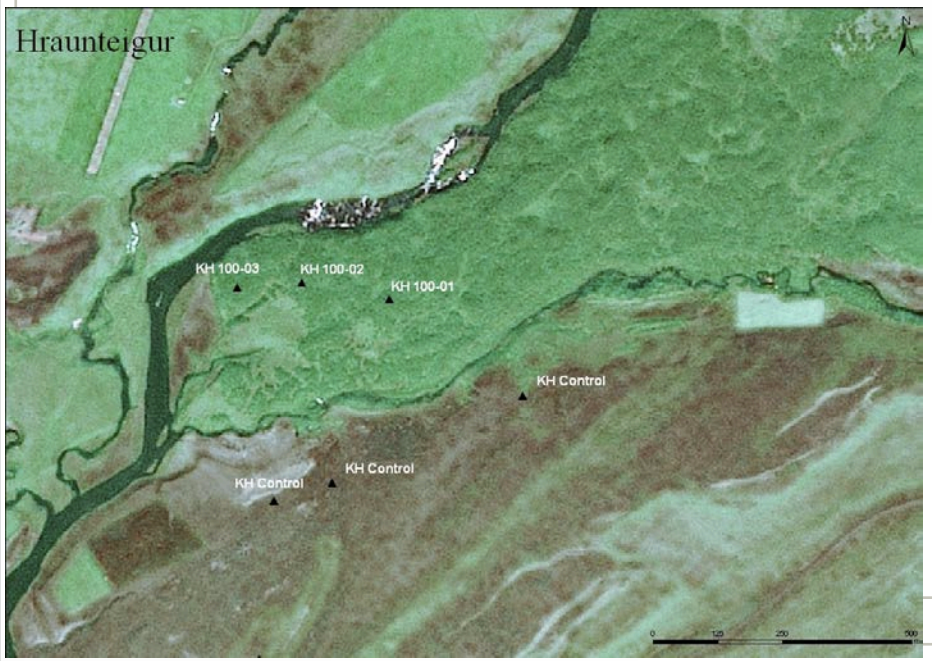
Hekla Forests Project, Iceland

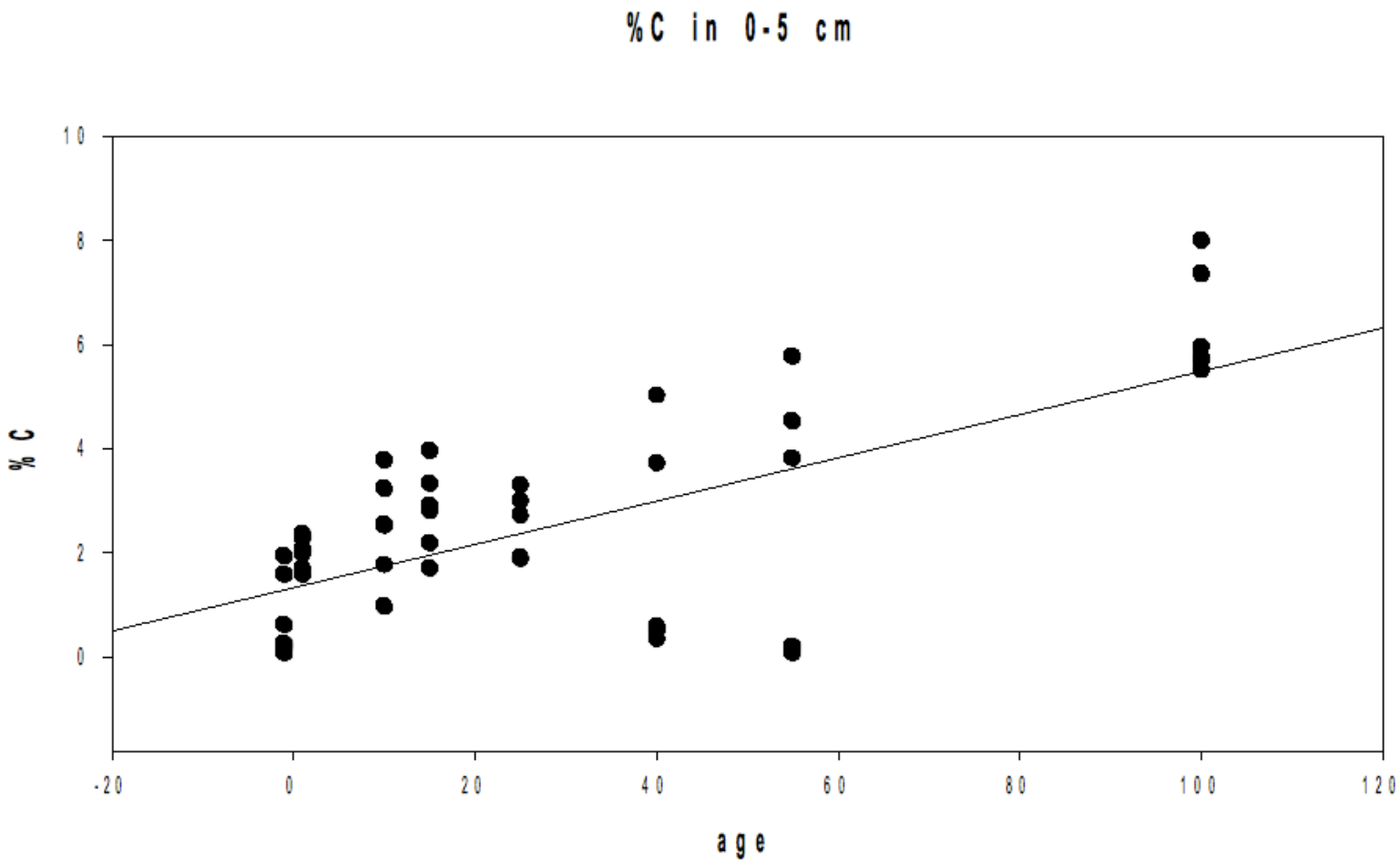
Sampling Sites

1 Gunnlaugsskógur
2 Bolholt
3 StóriKlofi
4 Hraunteigur
5 Búrfell



Land type	Research sites
Unvegetated, eroded	SK, B
Unforested, restored	SK, B
Pioneering stage, 0-15 year birch	SK
Young forest, 10-20 year birch	B
Young forest, 20-30 year birch	B
Forest, 35-45 year birch	SK
Forest, 45-65 year birch	SK
Old growth forest	H



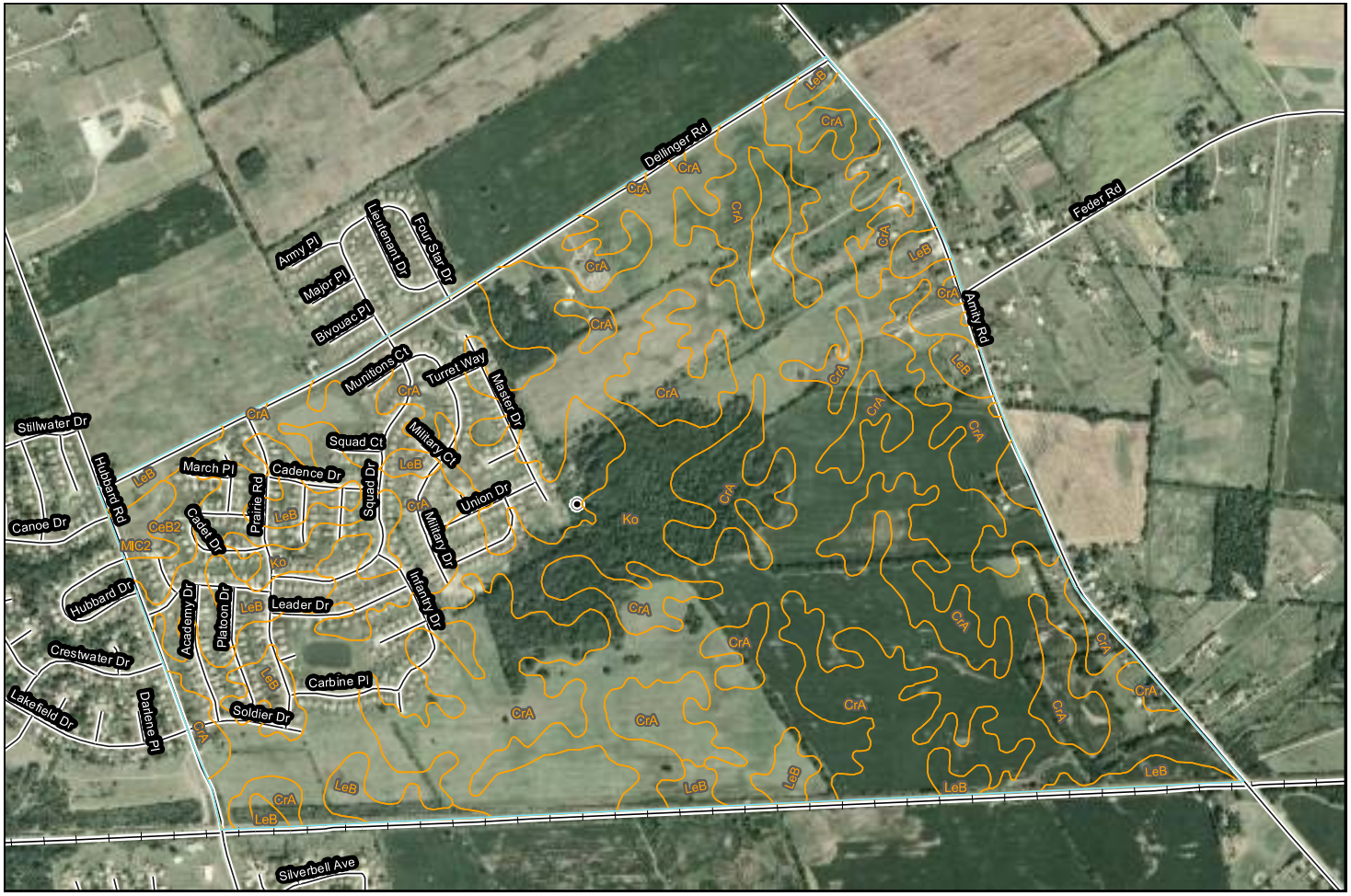


%C in 0-5 cm regression fit: %C = 1.3357944 +v 0.0415339*age, R^2 = 0.4495, P= <0.001

Benchmark Sites

- Lawrence Woods, Hardin County Ohio
- Battelle-Darby, Franklin County Ohio

Taylor Creek
Wolf Creek
Ne
Mf
FpC2
KbA
GwB
Gwd5C2
GyB2
BoA
BoB
Pm
Mnl3A


Dellinger Rd
Feder Rd
Army Pl
Major Pl
Lieutenant Dr
Four Star Dr
Bivouac Pl
Munitions Ct
Turret Way
Master Dr
Amity Rd
Stillwater Dr
Hubbard Rd
March Pl
Cadence Dr
Squad Ct
Squad Dr
Military Ct
Union Dr
Military Dr
Canoe Dr
Cadet Dr
Prairie Rd
Hubbard Dr
Academy Dr
Platoon Dr
Leader Dr
Infantry Dr
Crestwater Dr
Carbine Pl
Lakefield Dr
Darlene Pl
Soldier Dr
Silverbell Ave
CrA
LeB
Ko
CeB2
MIC2

Resistance and Resilience

- Over time, variation in attributes can be assessed
- Quantification of variation from genoform to phenoforms and rates of change can indicate resistance to disturbance and perhaps resilience