

Data Mining and Meta-analysis as Tools to Evaluate the Impact of Management Practices on Dynamic Soil Properties

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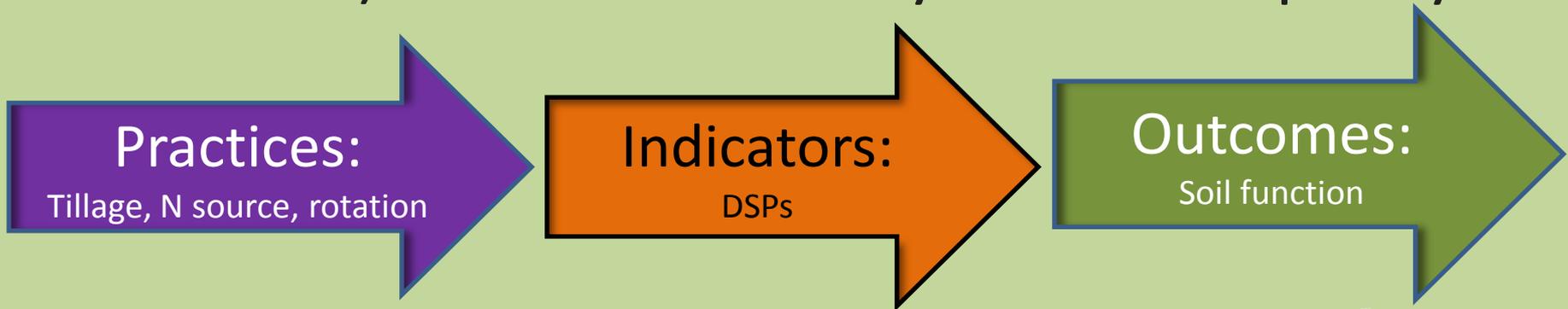
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Dynamic Soil Properties

They are soil attributes that are important to soil function and are rapidly altered by soil management practices (anthropogenic influences). DSPs influence dynamic soil quality.



Selected DSPs from the NRCS Soil Change Guide

Proposed Dynamic Soil Properties for inventory
CEC
CaCO ₃
Total organic matter (C:N ratio)
Particulate organic matter (POM)
Active C
Microbial biomass C
β-glucosidase
Potentially mineralizable N
Plant available P
Pore size distribution
Dry aggregate stability
Penetration resistance



Characteristics of Meta-Analysis

- Meta-analysis is applicable to collections of research
- Meta-analysis examines data addressing the same research question
- Meta-analysis examines quantitative data by transforming data to a comparable variable called effect size.



Data-Mining Sequence to Populate Databases for Meta-Analysis

- Data gathering criteria:
 - Publications addressing the same question
 - Avoid publication bias
 - Independence of studies
 - Field layout and replications
 - Clearly defined controls
 - Sampling methods and depth
 - Statistics reported



Selected DSPs from the NRCS Soil Change Guide

Proposed Dynamic Soil Properties for inventory	Output from web of science (# of articles)
CEC	470
CaCO ₃	282
Total Organic Matter (SOM and C:N ratio)	2,670
Particulate Organic Matter (POM)	1,403
Active C	397
Microbial Biomass C	1102
B-glucosidase	182
Potentially mineralizable N	252
Plant available P	1,701
Pore size distribution	622
Dry aggregate stability	462
Penetration resistance	766

Management practices and CMT weighting system

Soil quality/ soil organic matter

Rotation characteristics

Proportion of years under bare fallow -5

Proportion of harvested crops (vegetables) -3

Proportion of grain harvested crops 3

Proportion of harvested crops under hay or perennial conditions 5

Frequency of cover crops in the rotation 5

Number of different species 5

Frequency of hay fallow 5

Residue and tillage management

Frequency of spring full-width tillage -4

Frequency of fall full-width tillage -5

Frequency of fall full-width tillage with 30% residue cover -4

Full-width tillage + soil cover from residues, compost or mulch 0

Frequency of no till with 30-75% soil cover 3

Frequency of no till with more than 75% soil cover 5

No application of fertilizers or manure 0

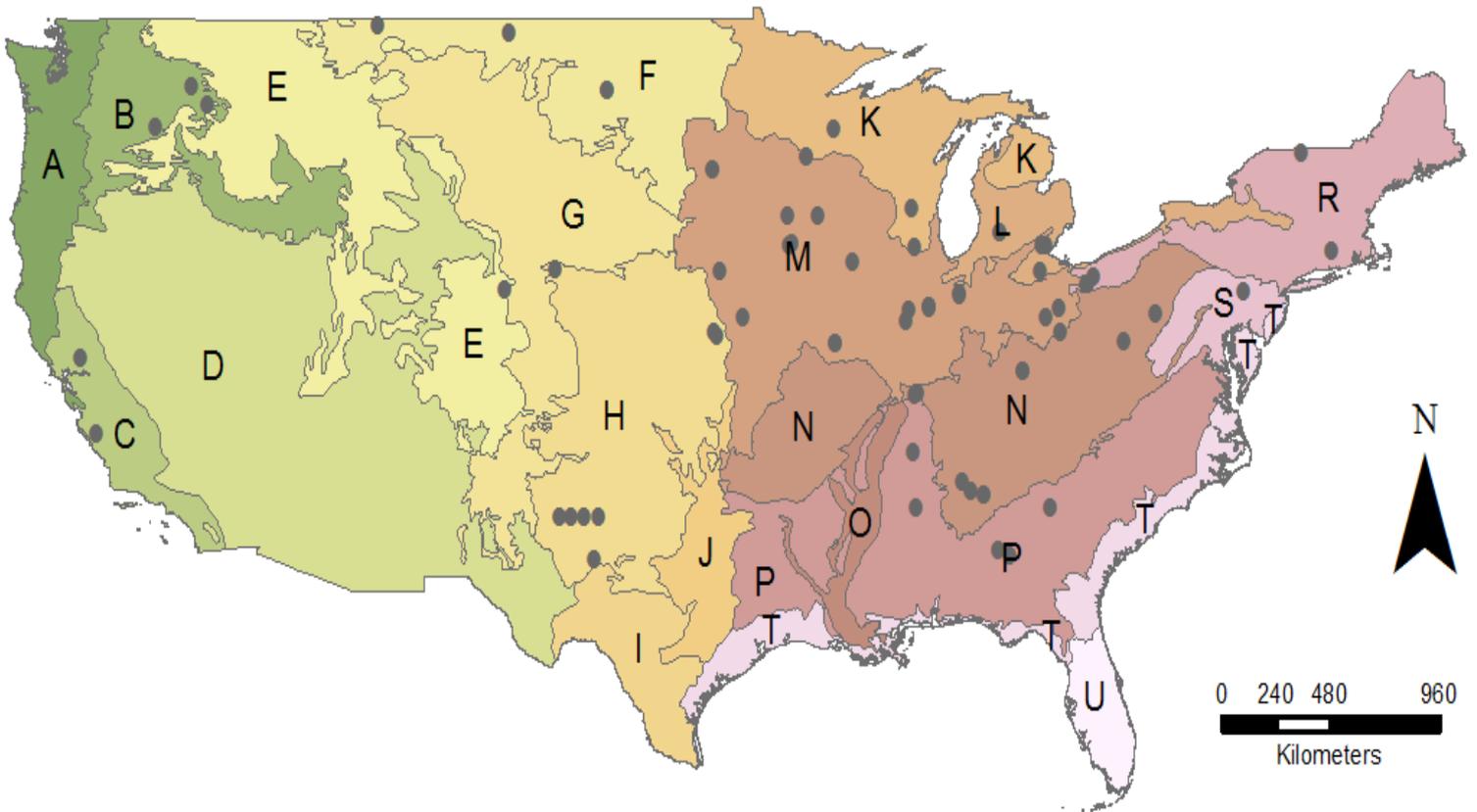
Application of fertilizers or manure 2

Use of organic fertility sources (manure, compost) 5

Frequent of soil testing 2

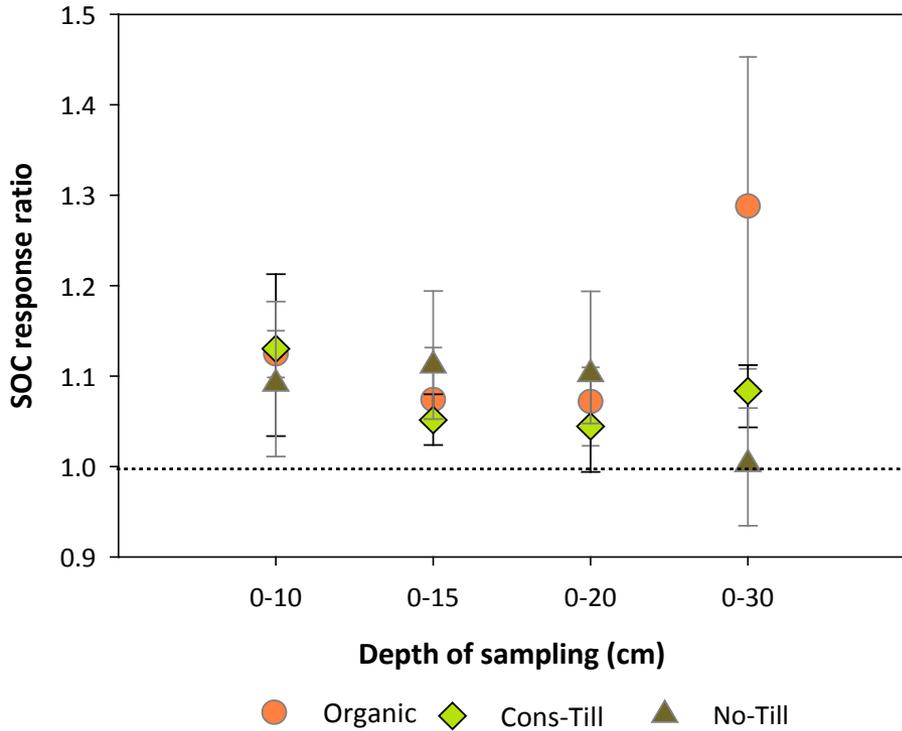
Applications are advised by soil tests 3

Location of Study Sites Used in SOC Meta-Analysis



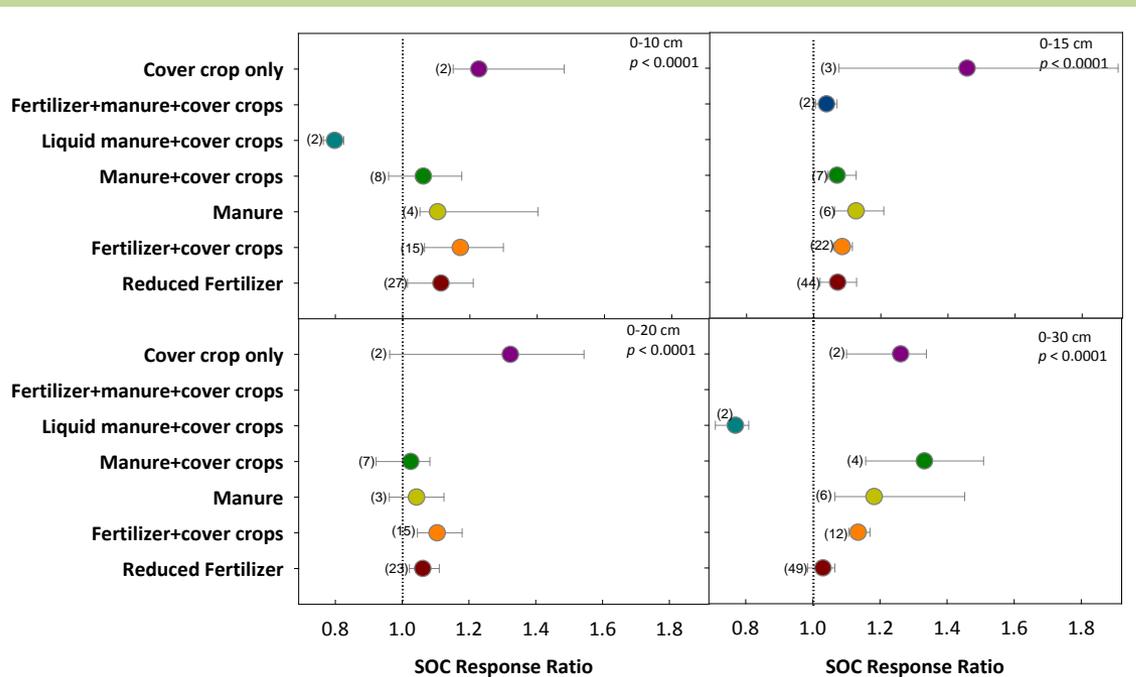
Data sources
County Boundaries of the United States, 2001, National Atlas of the United States, 1:2,000,000-scale
Major Land Resource Area boundaries for the conterminous United States 2002, the U.S. Geological Survey, 1:2,000,000 scale

Effect of Cropping Systems on SOC Accumulation



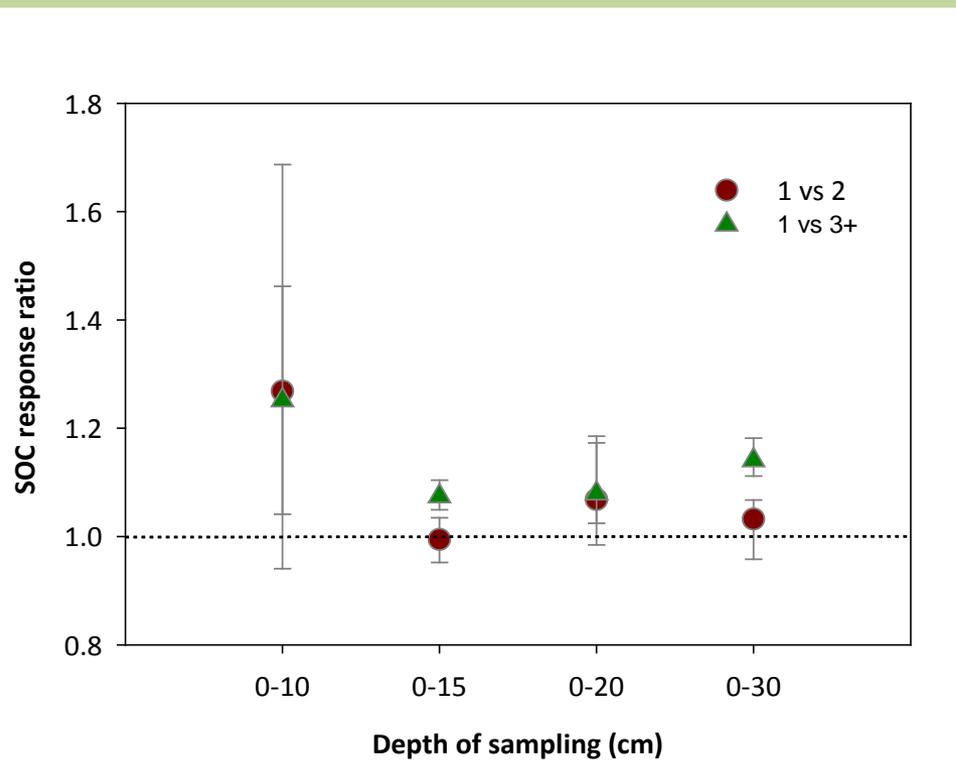
	Organic	Conservation Till	No-Till
	Scores for SOM micro-concern		
Harvested crops with low residue	0	0	0
Harvested crops with high residue	3	3	3
Frequency of cover crops	5		
High diversity within the rotation	5		
Frequency of hay fallow	5		
Spring tillage	-4	-4	
Fall tillage			
Conservation tillage	0	0	
No tillage with low residue			3
No tillage with high residue			5
Residue management practices	4	4	4
Strip cropping		3	
Practices to reduce erosion			
Appl. of fertilizers or manure	2	2	2
Manure or compost appl.	5		
SUM	25	8	20

Effect of N Fertility Source on SOC Accumulation (Reduced Synthetic Fertilizer, Synthetic Fertilizer in Combination with Cover Crops and Manure)



CMT sub scores based on the fertility practices	Score for SOM
Fertilizer or manure application	2
Use of organic fertility	5
Soil testing	3
Applications based on soil tests	3
Frequency of cover crops	5

Effect of Rotation Length on SOC Accumulation (1-, 2-, 3- to 5-yr Rotation)



CMT sub scores based on the length of the rotation

	2-yr rotation	3-yr rotation
	SOM Scores	
Harvested crops with low residue	0 x 1	0 x 1
Harvested crops with high residue	3 x 1	3 x 2
High diversity within the rotation		5 x 1
SUM	3	11

Summary and Implication for Evaluation of DSPs

- Researchers publishing in the peer reviewed literature need to provide more detail about management practices (timing, equipment used) and variance.
- Strategize to identify studies based on regional management practices.
- Need to identify geographical coverage of existing data sets.
- Process models can be used to fill in gaps, describe complex systems, and estimate regional differences driven by differences in climate.

