



Soil Quality

Concept, assessment and issues

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Definition, Minimum Data Set, Soil Quality Indices

PART 1



Soil quality

→ Value

- Interest in the quality and health of soil has been stimulated by the awareness that soil is vital to both production of food and fiber and ecosystems function influencing the quality of air we breath and water we drink.

→ Definition

- The capacity of a soil to function, within natural or managed ecosystem boundaries, to sustain productivity, maintain or enhance water and air quality, and promote plant and animal health (Doran et al., 1996, SSSA).



Soil quality criteria

- Criteria for indicators of soil quality have been addressed in a comprehensive manner in that they should:
- *Relate to ecosystem processes*
 - *Integrate physical, chemical and biological properties*
 - *Be sensitive to management and climatic variations*
 - *Be accessible to agricultural specialists, producers, conservationists and policy makers*



Minimum Data Set (MDS)

Tested indicators in different agricultural systems



Physical

- WHC
- Bulk density
- Infiltration rate
- Aggregate stability
- Rooting depth



Chemical

- Total organic C
- Nutrient availability
- Electr. conductivity
- pH
- PMN



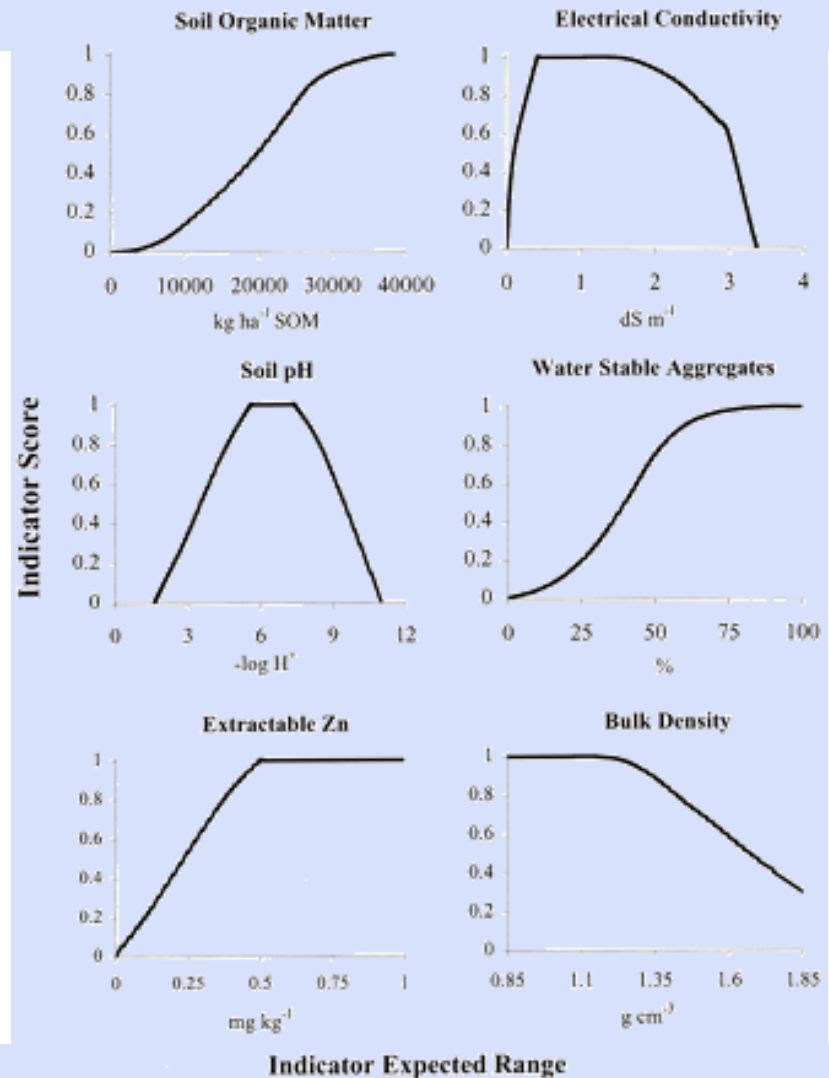
Biological

- Microbial biomass C
- $q\text{CO}_2$



Indicators tested for direction and magnitude of change

Scoring involves threshold values and indexing from 0 to 1 (*Andrews et al. 2002*)





Soil Quality Index

Integrated soil quality indices are based on a MDS for assessing critical soil functions or the ability of soil to:

- **Sustain biological productivity**
- **Regulate and partition soil water**
- **Store and cycle nutrients**
- **Function as a filter and buffer**



Available soil quality indices

for assessing effects of management practices

- ➔ Indicators assigned to soil functions, soil function scores combined into an index
 - AgroEcosystem Performance Assessment Tool (AEPAT)
 - Soil Conditioning Index (SCI)
 - adopted by USDA NRCS for predicting SOM trends
 - Cornell Soil Health Test
 - for education and monitoring NRCS programs
 - Soil Management Assessment Framework (SMAF)
 - evaluates farm sustainability



Some considerations and issues

PART 2



Considerations with reference to soil organic matter (SOM)

- Several LIFE projects are adopting indicators of soil quality to assess the efficiency of their management practices or as input variables in decision support systems
- SOM is a major indicator because of its direct relevance to soil quality, erosion and degradation, physical properties, availability of plant nutrients, efficacy of pesticides, and crop yield.
- The soil quality concept was developed in the 90s, but new tools are available today to improve assessment in terms of precision of measurement, spatial resolution and more realistic sampling designs. These new tools are also useful in understanding assessment limitations.

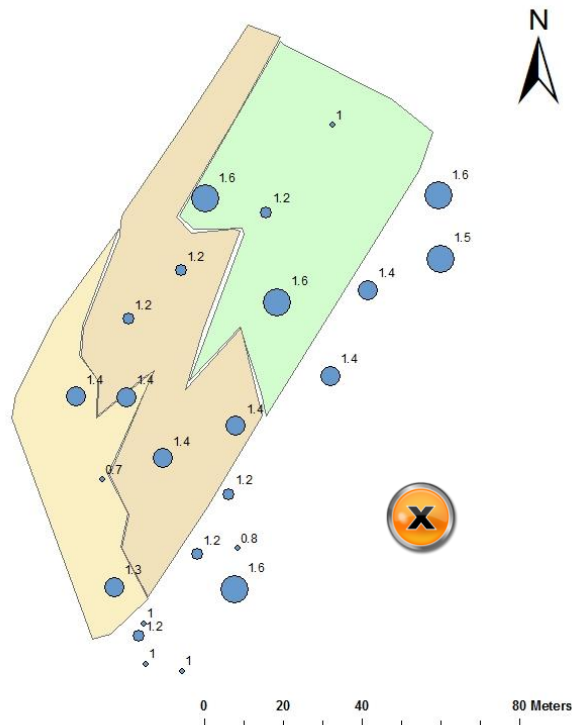


Mapping SOM – which method?

HydroSense project (unpublished data)

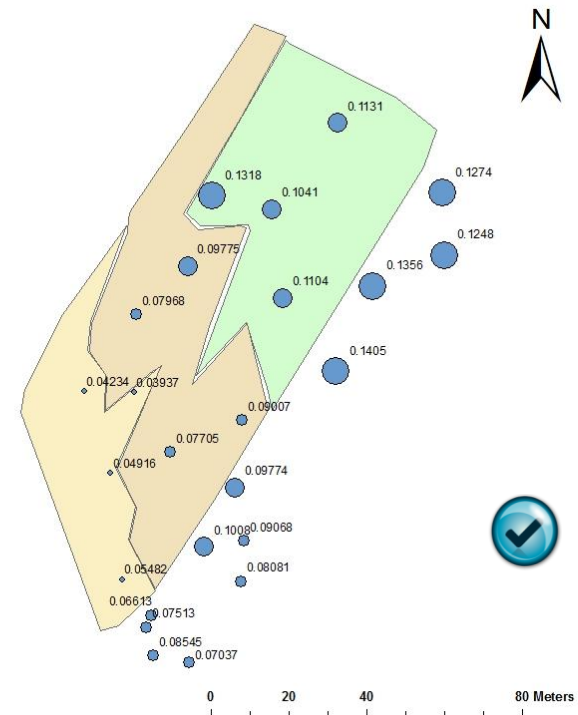
Wet oxidation by Walkley-Black

(0.7-1.6% SOM)



Combustion with elemental analyzer

(0.04-0.14% N)





Inverse spatial relationship of soil N to soil erosion

HydroSense project (unpublished data)

Soil carbonates (%)

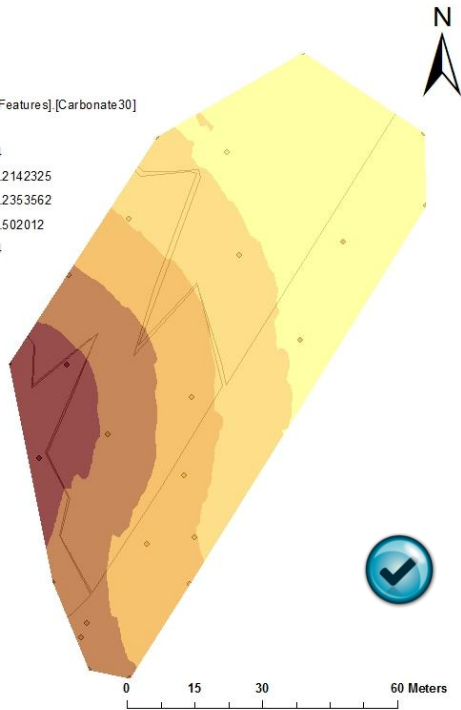
Legend

Kriging_3
Prediction Map

[Gentiki_2011\$_Features]. [Carbonate30]

Filled Contours

- 4.8 - 7.14408004
- 7.14408004 - 10.2142325
- 10.2142325 - 14.2353562
- 14.2353562 - 19.502012
- 19.502012 - 26.4



Soil N (%)

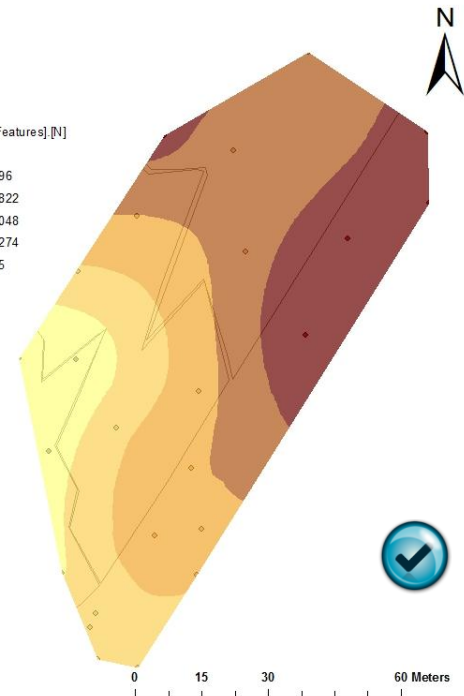
Legend Soil N

Kriging_9
Prediction Map

[Gentiki_2011\$_Features]. [N]

Filled Contours

- 0.03937 - 0.059596
- 0.059596 - 0.079822
- 0.079822 - 0.100048
- 0.100048 - 0.120274
- 0.120274 - 0.1405

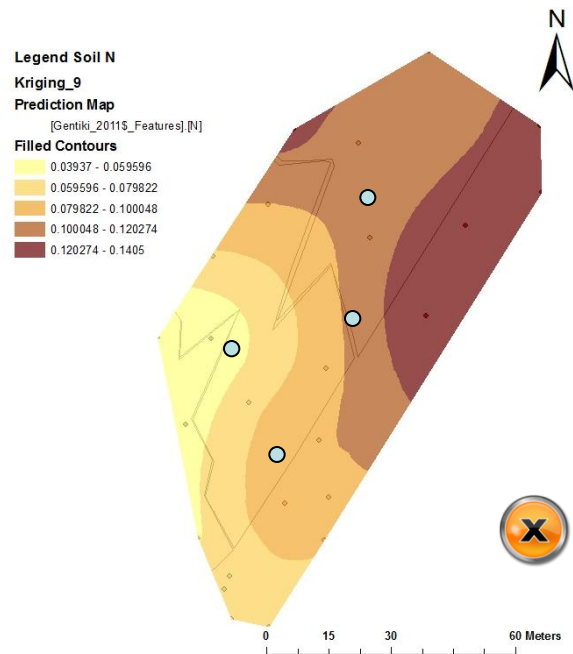




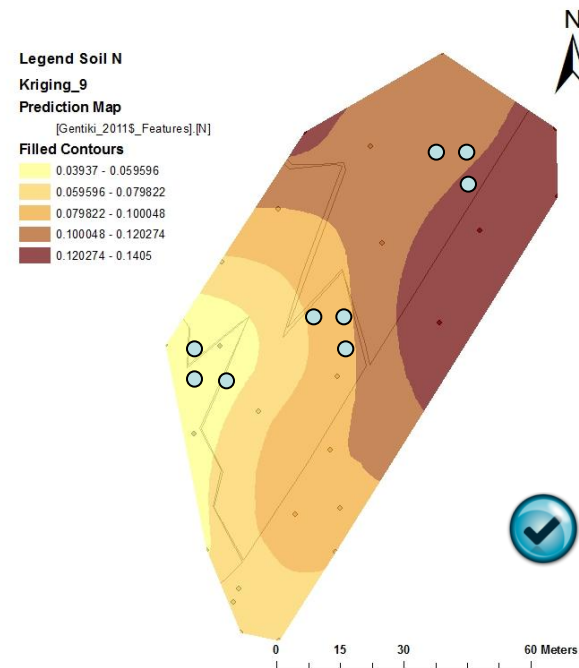
What sampling design?

HydroSense project (unpublished data)

Random composite sampling



Guided composite sampling

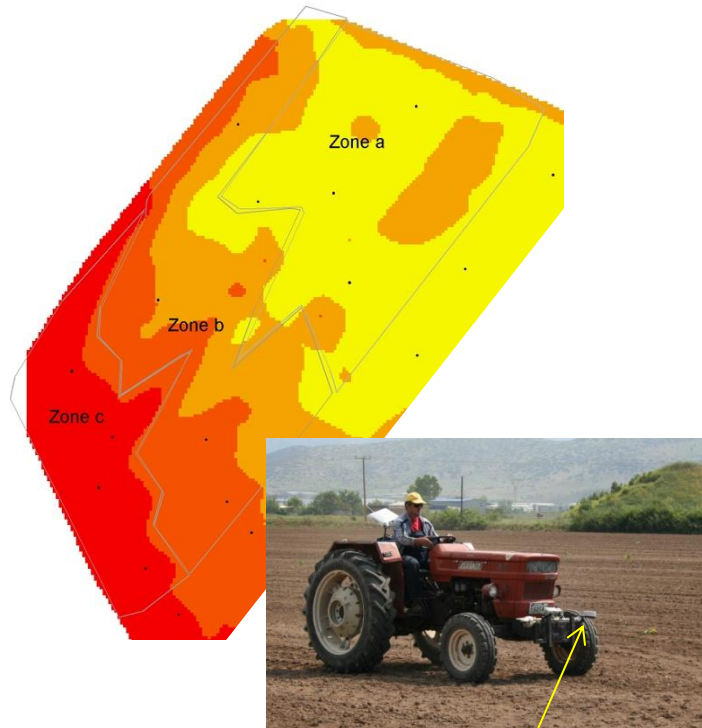




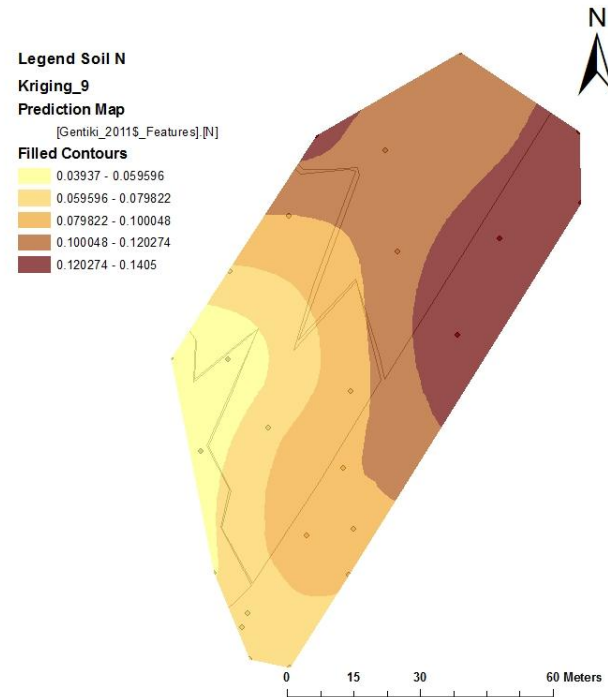
Capturing spatial variability of SOM

HydroSense project (unpublished data)

Sensor NIR reflectance



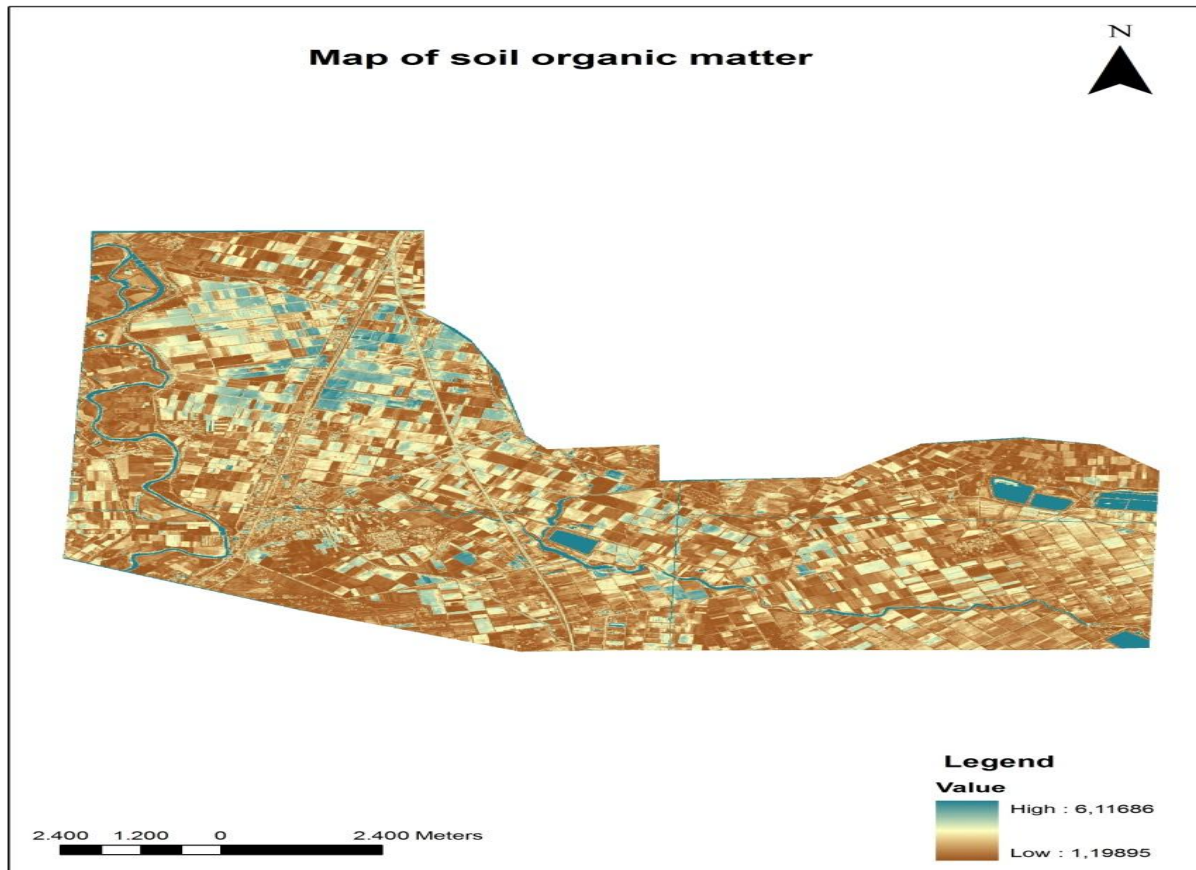
Soil N (%)



Crop Circle
sensor



Capturing organic matter distribution at a regional scale



$$\text{Soil N} = 0.19 - 3.66 \times 10^{-4}(\text{NIR}) + 2.65 \times 10^{-7}(\text{NIR})^2$$

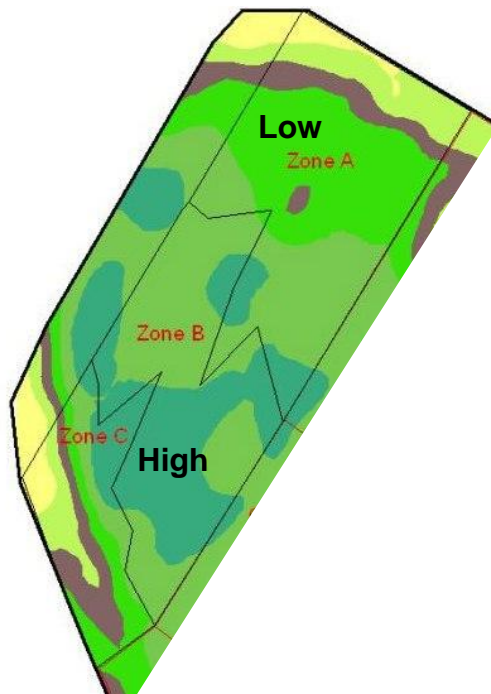
Regression equation translates satellite NIR band to soil N values at 1-m spatial resolution



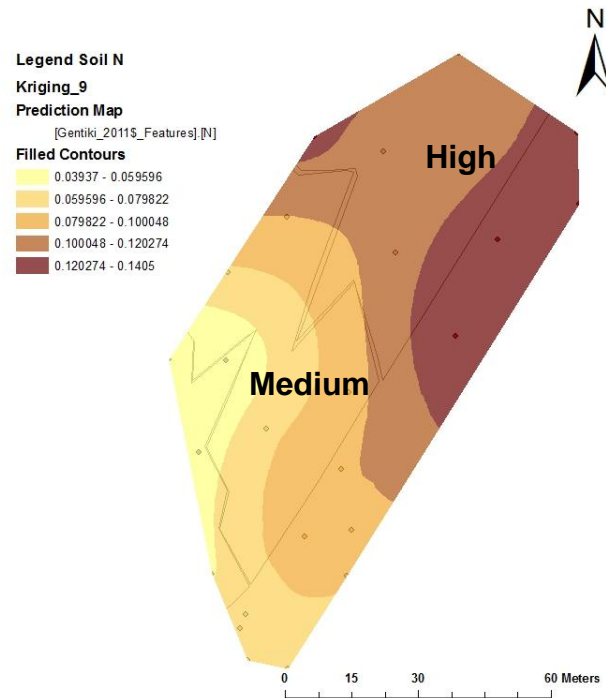
Can SOM predict relative yield?

HydroSense project (unpublished data)

Cotton yield (kg ha⁻¹)



Soil N (%)





Summary

- Soil quality is a concept developed by increasing awareness of the diverse soil functions
- Criteria for indicators of soil quality have been addressed in a comprehensive manner
- Integrated soil quality indices are available today for use by a wide range of audiences
- The selection of suitable indicators needs careful examination
- Interpretation of single soil quality indicators can lead to erroneous conclusions
- Spatial variability and its scale of resolution is an important issue to be addressed for proper assessment of management practices