Defining Soil Quality

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Simplest Definition

- The capacity of soil to function (Karlen, 1997).
- What is the function of soil??

Obvious Functions of Soil

- Crop production
  - Grain, biomass, habitat, trees
- Building material
  - Home construction, Waste water Treatment, etc.

Additional Functions

- Maintain or enhance air and water Quality
  - Erosion by wind and water are indicators of poor function
    - Erosion itself reduces Productivity.
  - Release of excess solutes to surface and ground waters is an indicator of poor function.

Additional Functions

- Water Flow Regulation
  - Excessive Runoff
    - Flooding
    - Erosion
    - H_2O available for crop production
- Cycle and Store of Nutrients
  - Maintenance of inherent Fertility
  - Gaseous losses
  - Solute losses

Soil Properties that Impact Quality

- Two categories of soil properties:
  - Inherent
  - Dynamic

Inherent Properties.

- Result from soil forming factors
- Do not change on human time scale
  - Texture
  - Depth
  - Clay type
  - Landscape position

Inherent Soil Properties

- Set limitations to soils functionality:
- Therefore these properties are used to classify soils into Capability Classes.
  - The first soil quality assessment based on: Capability to produce crops without deteriorating soil productivity:
    - I-IV, suitable for cultivation
      - Increasing levels of management
      - Decreasing production potential
    - V-VII, not suitable for cultivation

Dynamic Properties

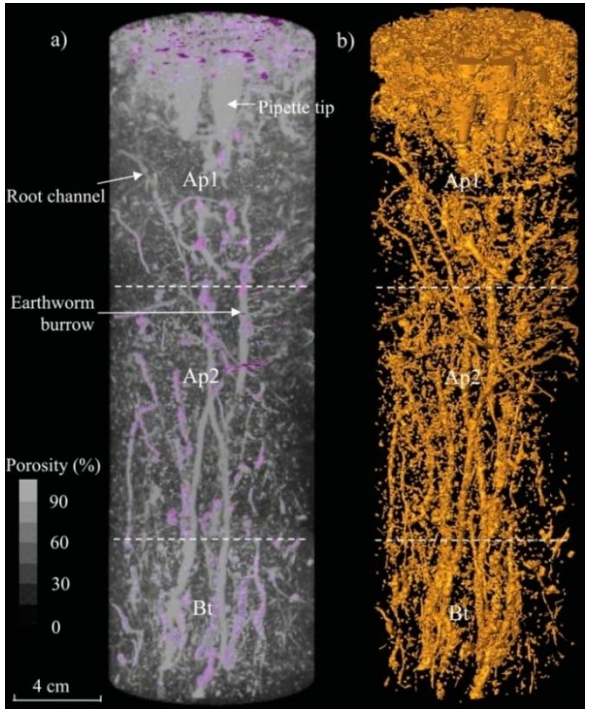
- Management Dependent
  - Cultivated vs. Non-cultivated
- Can change during human time scale
  - Short-term and Long-term
- Characteristics most often discussed in the context of soil quality

Dynamic Soil Properties

- Structure
- Compaction/ bulk density
- Surface Crusts
- Aggregate Stability
- Permeability
- Water Holding Capacity
- Organic Matter
- Biological Activity
- Fertility

Structure

- Provides for macroporosity in soils
- Influenced by texture, clay type, biological activity, and organic matter content.
- The shrink and swell capacity of clays can create macropores.
- Biological activity create biopores
- Macropores provide rapid air and water movement, and promote root growth



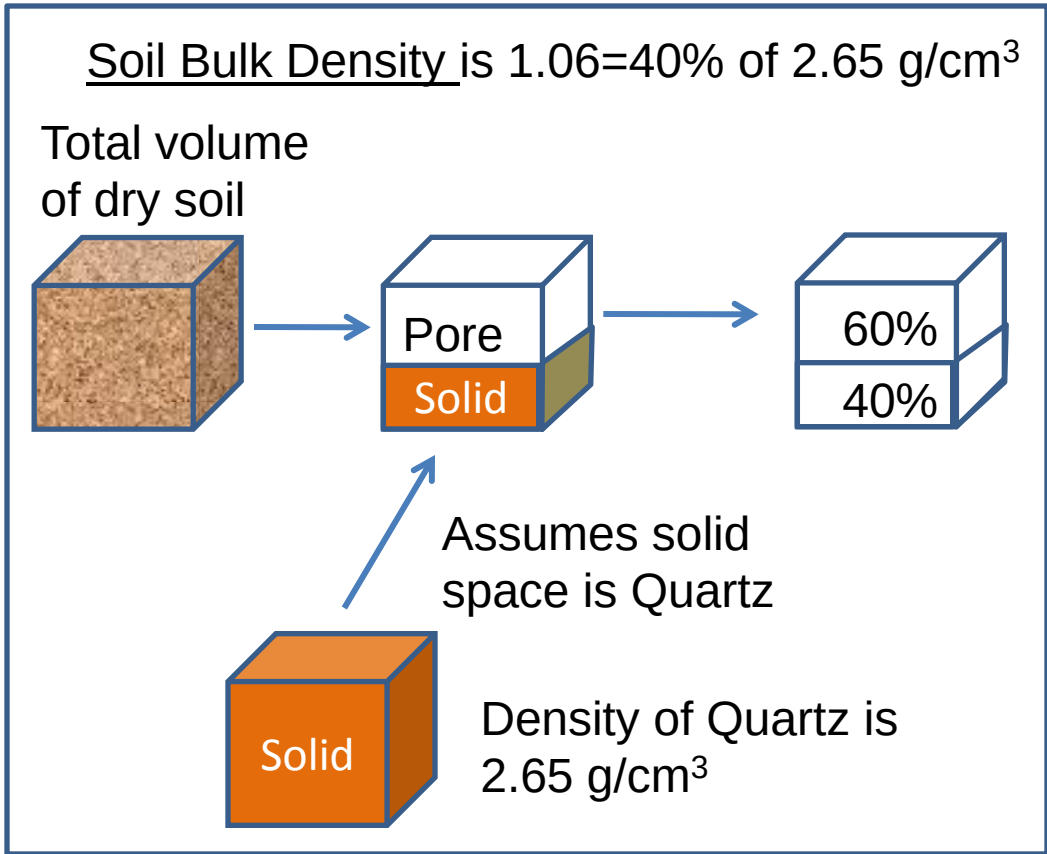
Luo et al. (2007)

Structure

- Is generally stable in subsoil, but can be influenced by management in surface soil
  - Cultivation destroys surface structure and provides short-term artificial porosity.
  - Cultivation and traffic causes compaction which increases bulk density and reduces permeability of soils

Bulk Density

- Dependent on soil texture, organic matter content, soil structure,



Bulk Density

- Excessively high bulk densities restrict root growth; and air, and water movement.
- Compaction increases bulk density
- Tillage artificially and temporarily decreases bulk density of soil surface.
- Organic matter reduces bulk density because of low particle density and its impact of aggregate stability.

Soil Crusting

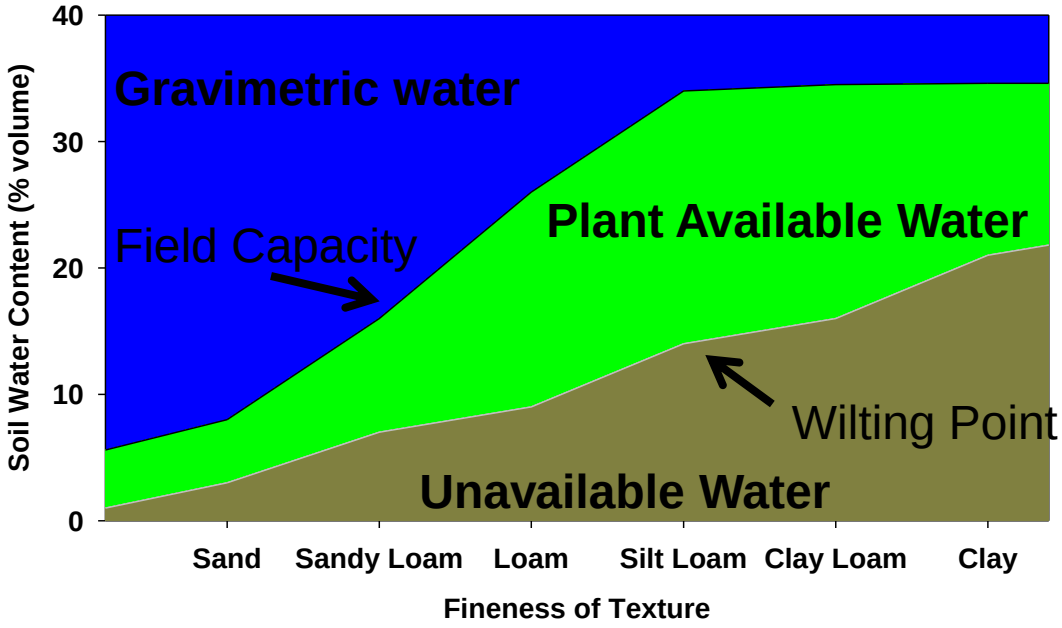
- Reduces water infiltration
- Reduces crop emergence
- A soils susceptibility to crusting is influences by texture, sodium content, organic matter, and crop residue

Aggregate Stability

- Ability of soil aggregates to resist disintegration
- Important indicator of a soils ability to resist erosion, surface crusting and compaction.
- Influenced by clay type, adsorbed cations, organic matter, and microbial activity.
- Reduced tillage and the promotion of organic matter accumulation increase aggregate stability.

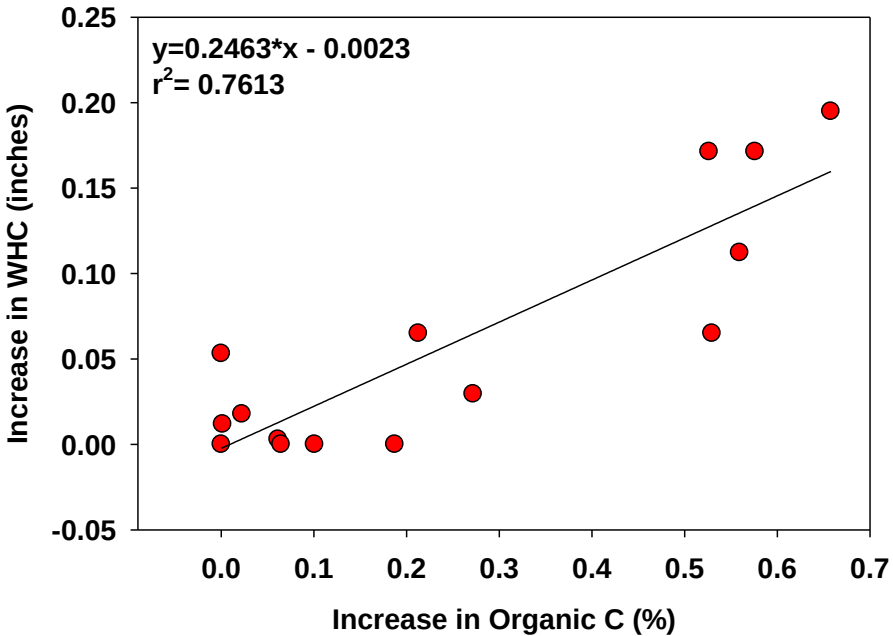
Water Holding Capacity

- Amount of water held in the soil between permanent wilting point and field capacity.
- Dependent on texture, depth, organic matter and
  bulk density



Organic Matters impact on Water Holding Capacity

- Increasing organic C content by 1% in top 6 inches of soil increased water holding capacity by 0.25 inches



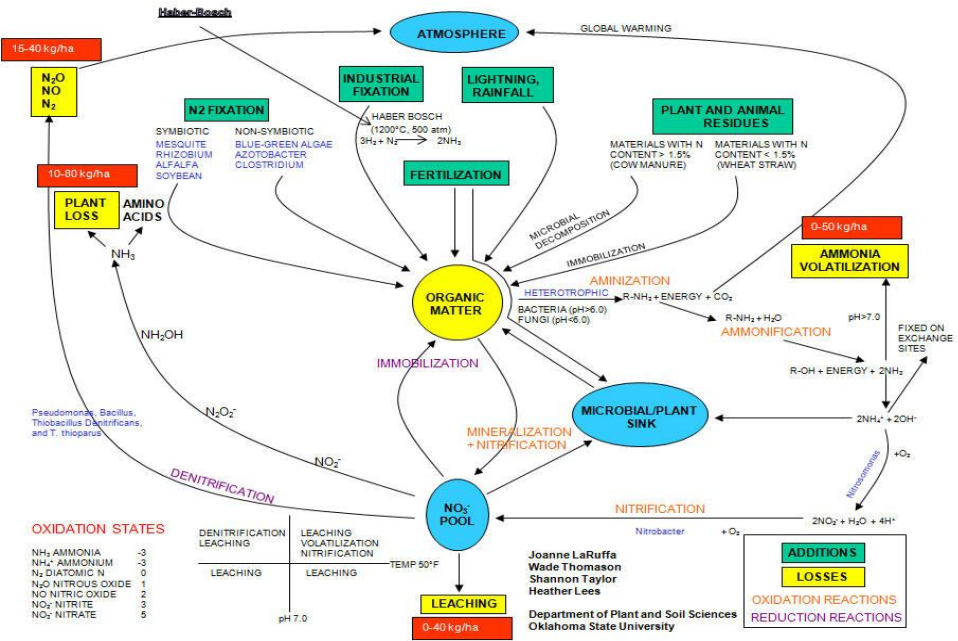
McVay, 2006

Permeability

- Ease with which gases, liquids and roots penetrate the soil.
- Dependent on soil texture and soil structure
- Tillage can temporarily increase macroporosity, therefore permeability.
  - However, it also removes residue and organic matter, therefore surface crusting can limit infiltration.

Biological Activity

- Dependent on soil organic matter content, texture, and moisture regime
- Influences aggregate stability, soils structure, and nutrient cycling

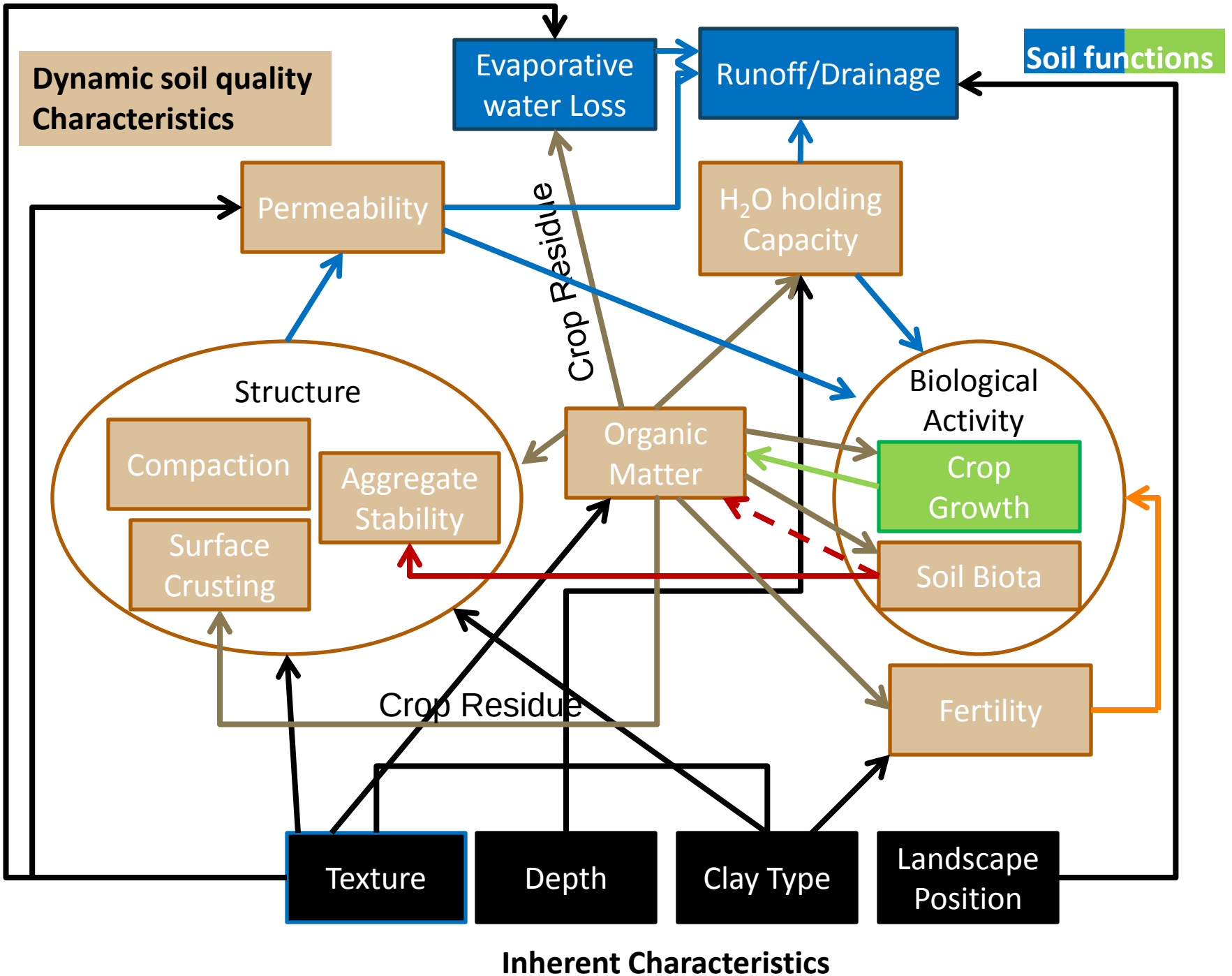


Soil Organic Matter

- Comprised of living biomass, dead yet recognizable residue, and amorphous organic compounds.
- Influences:
  - Nutrient cycling,
  - Biological activity
  - Aggregate stability
  - Bulk density.
  - Global carbon cycle.
  - Water holding Capacity

Interaction Among Soil Quality Indicators

- Physical, chemical, and biological indicators are interdependent and interact to determine the quality of a soil
- They do not respond independently to management
- This makes it very challenging to assess soil quality.


Dynamic soil quality Characteristics
Evaporative water Loss
Runoff/Drainage
Soil functions
Permeability
H_2O holding Capacity
Crop Residue
Structure
Compaction
Aggregate Stability
Surface Crusting
Organic Matter
Biological Activity
Crop Growth
Soil Biota
Crop Residue
Fertility
Texture
Depth
Clay Type
Landscape Position
Inherent Characteristics