Soils: The Virtual SDG

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Global Symposium

Soils and Water

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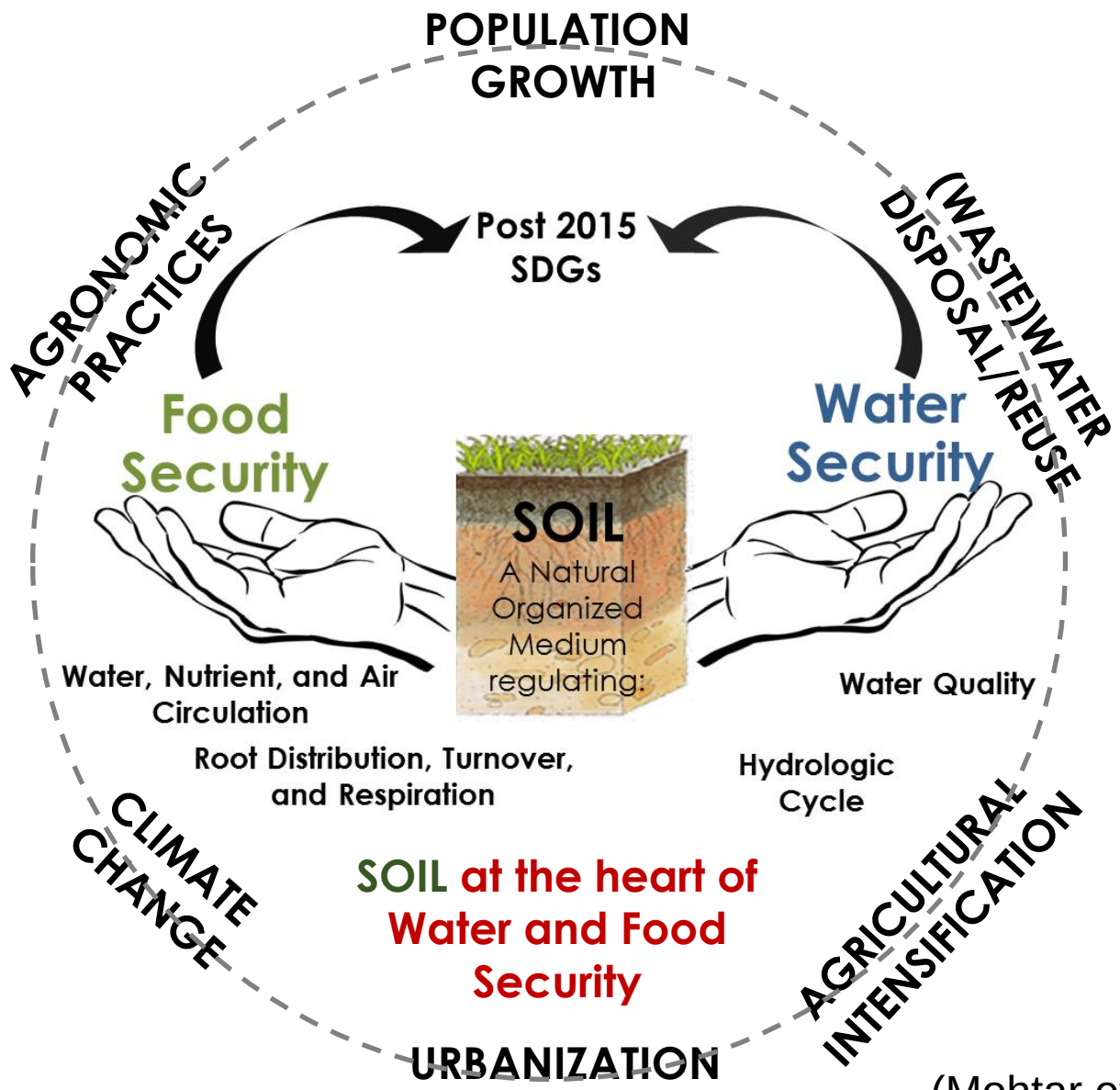
Soil as a Nexus Tool: The Role of Soil in Water & Food Security [Soil Health & Productivity] and Carbon Management



(Mohtar et al., 2017)

Soil Quality

Sustainable management of food and water resources and Carbon management are highly dependent on soil quality.

Characterization of Soil Medium

Studying the long-term impacts of the agro-environmental characteristics questions the use of (textured-based) soil information to face such a challenging world!!

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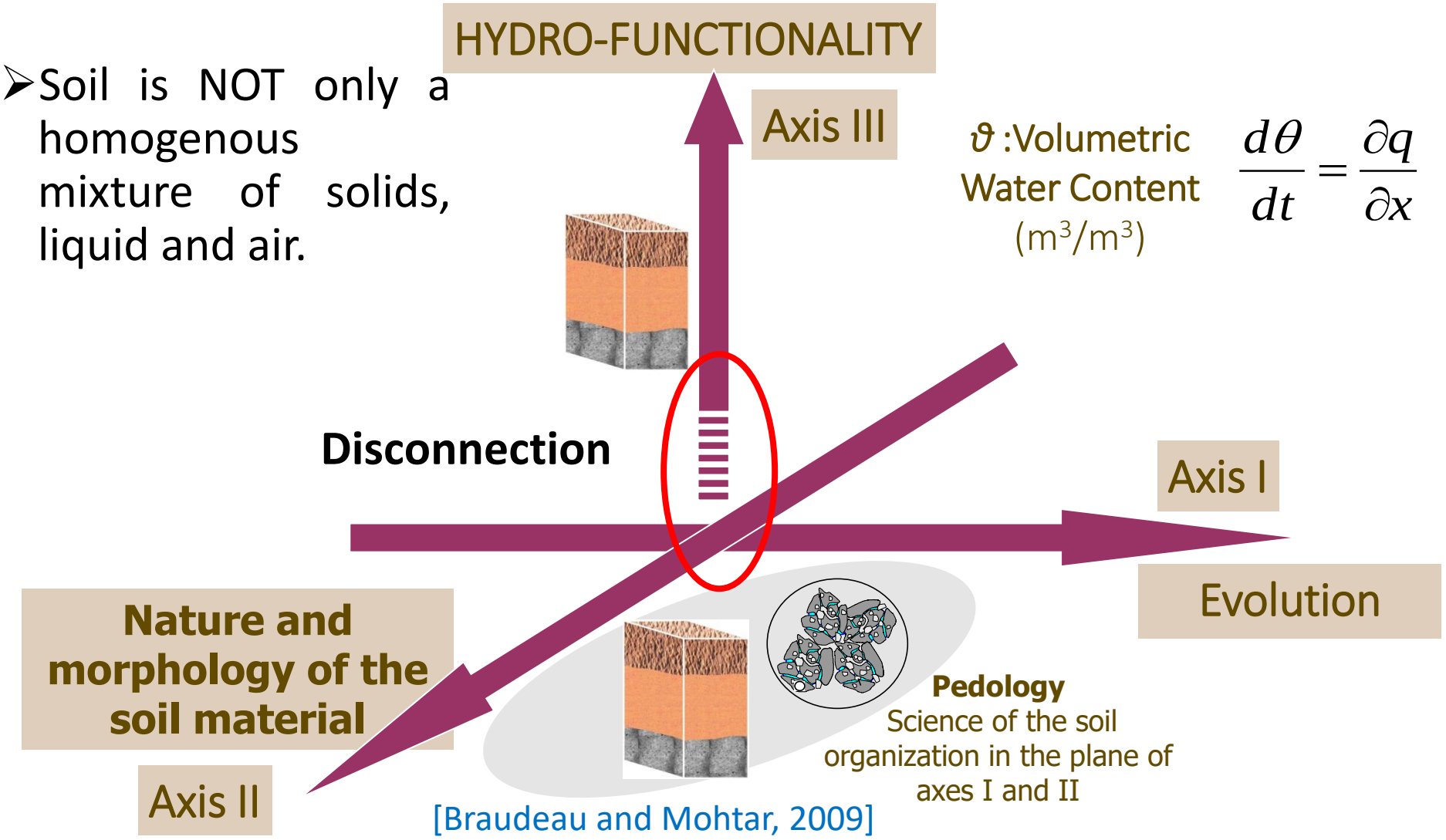
Soil Organization: A Need Ingredient to Understanding Soil

- Soil is NOT only a homogenous mixture of solids, liquid and air.



ϑ :Volumetric Water Content (m^3/m^3)

$$\frac{d\theta}{dt} = \frac{\partial q}{\partial x}$$

Hydro-Structural Pedology Paradigm [System Approach Theory]

- Reference:

  Structural mass

Hydro-structural Properties

Axis III

REV

$\theta = V_{water}/REV$ (m^3/m^3)

SREV

$W = M_{water}/M_{solids}$

$V_S = SREV / M_s$

Water content (kg/kg)

Specific volume (dm^3/kg)

Continuity equation [SREV]

$$\frac{dW}{dt} = \rho_w \overline{V} \frac{\partial q}{\partial x}$$

Axis I

Evolution

Structure [Organization]

Axis II

Pedostructure, Horizon, Pedon, Soil mapping unit…

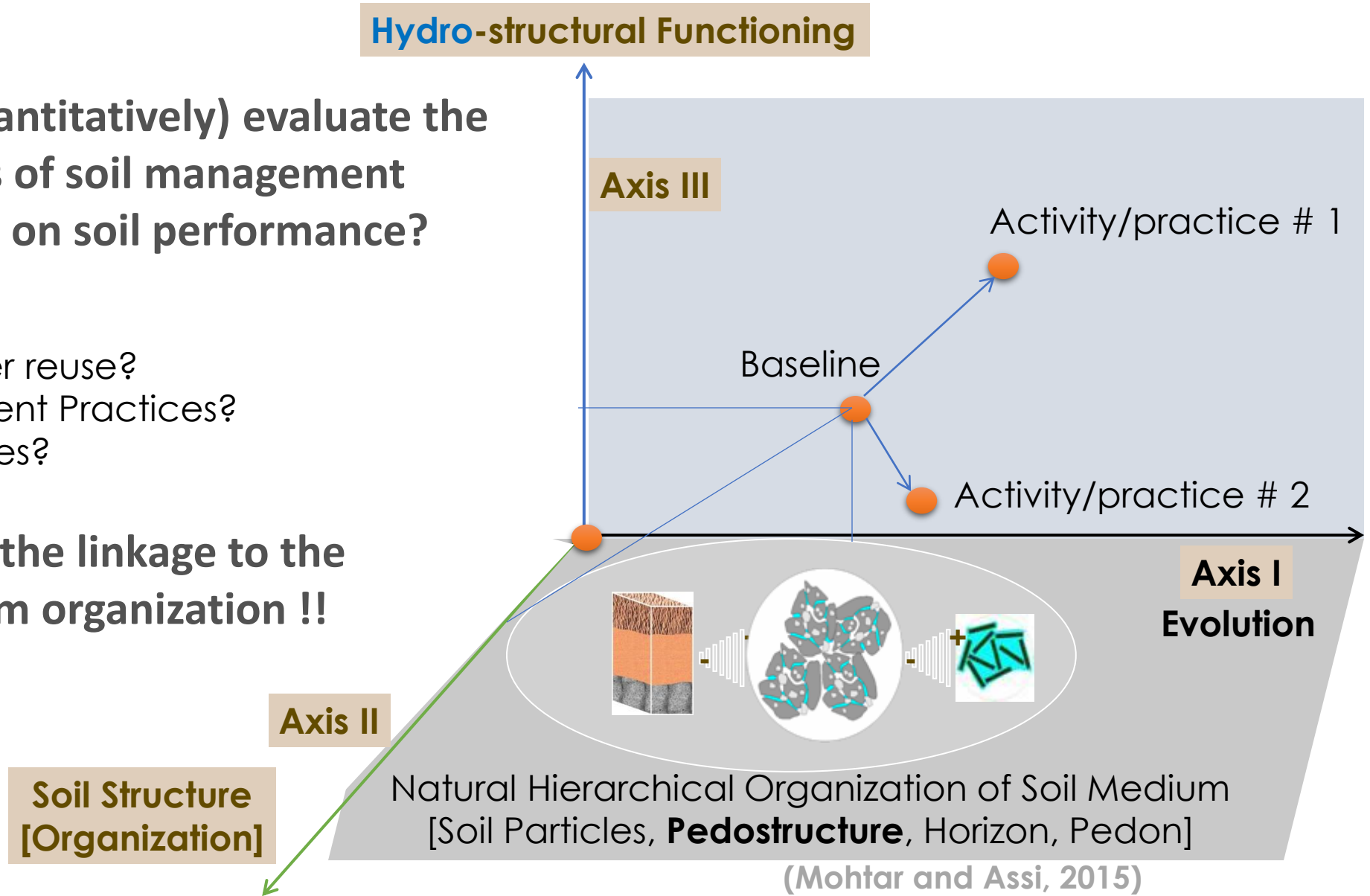
(Braudeau and Mohtar, 2009)

ONLY then, we can quantify the impact of soil management practices

How to (Quantitatively) evaluate the impacts of soil management practices on soil performance?

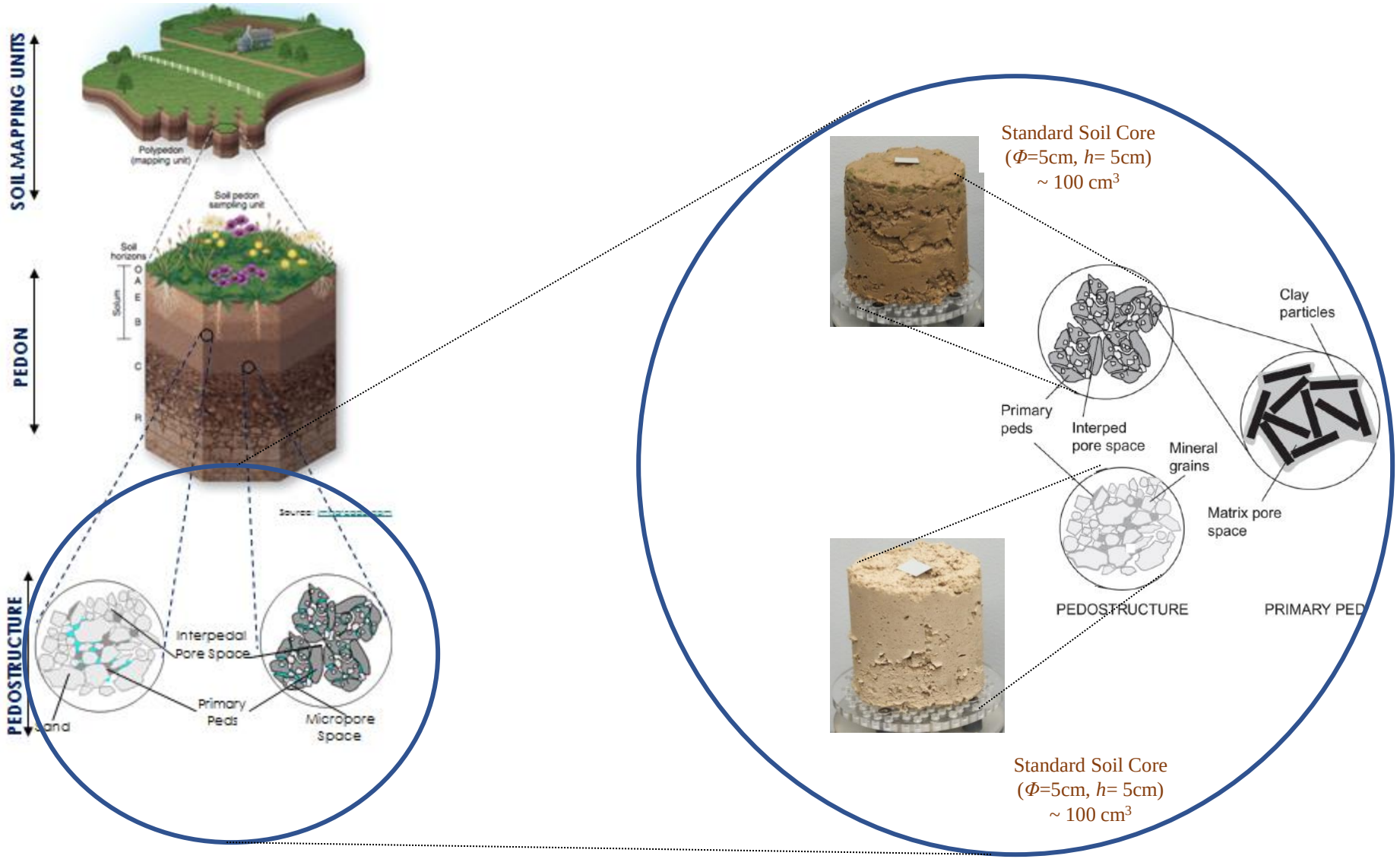
- Wastewater reuse?
- Management Practices?
- Soil additives?

The key is the linkage to the soil system organization !!



(Mohtar and Assi, 2015)

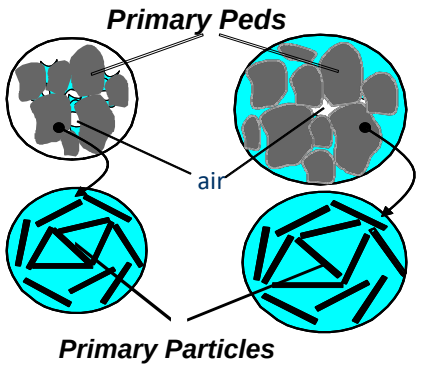
Pedostructure characterization
Hydro-structural "Physical" Parameters



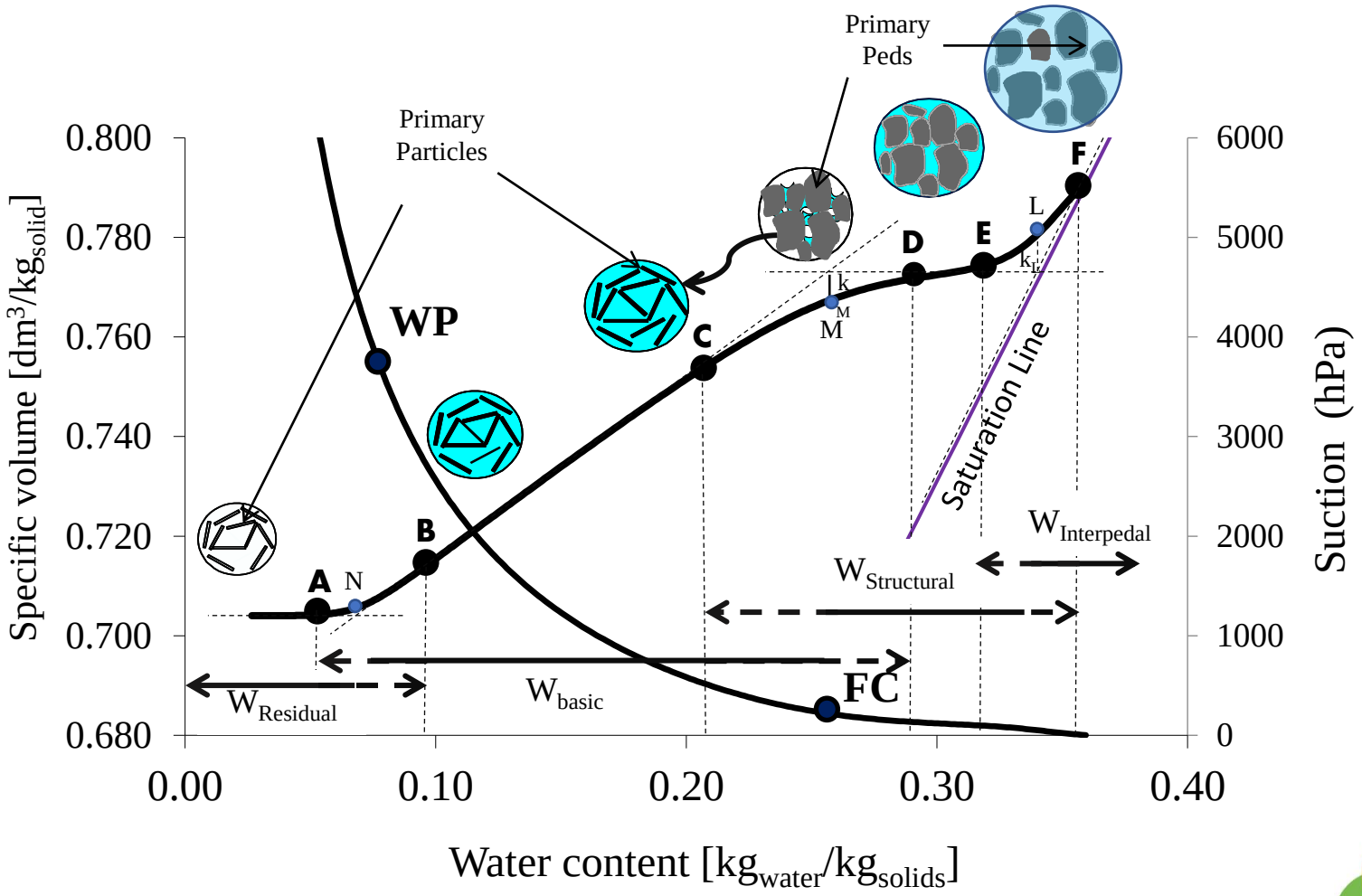
Pedostructure Concept

Soil Aggregates Structure & Thermodynamic Interaction with Water]

Standard Soil Core
(Φ=5cm, h= 5cm)
~ 100 cm^3



Pedostructure
[Soil medium organization as an assembly of primary peds]



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Pedostructure characterization
Hydro-structural "Physical" Parameters

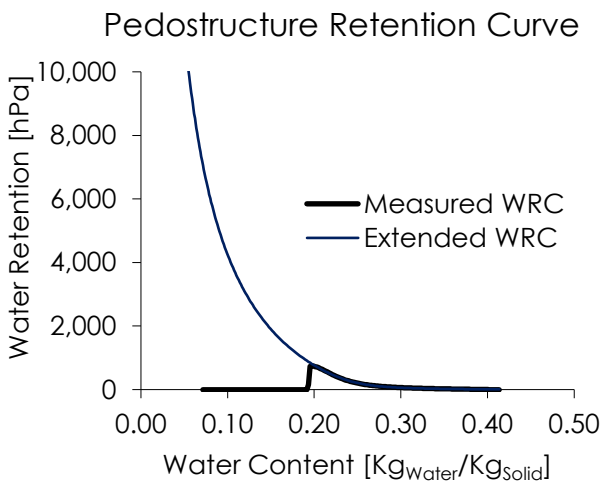
Pedostructure: is like the motor of the soil that fuels is the pedostructural water (soil moisture).

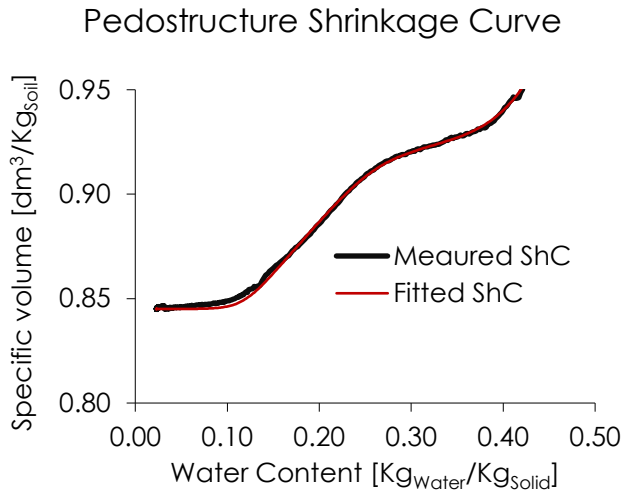
Soil hydrostructural properties are dependent on the **thermodynamic interaction** between water and the surface charges of soil particles, organic and mineral constituting the non-rigid structure of the soil. These thermodynamic interactions are characterized by **four characteristic curves**:

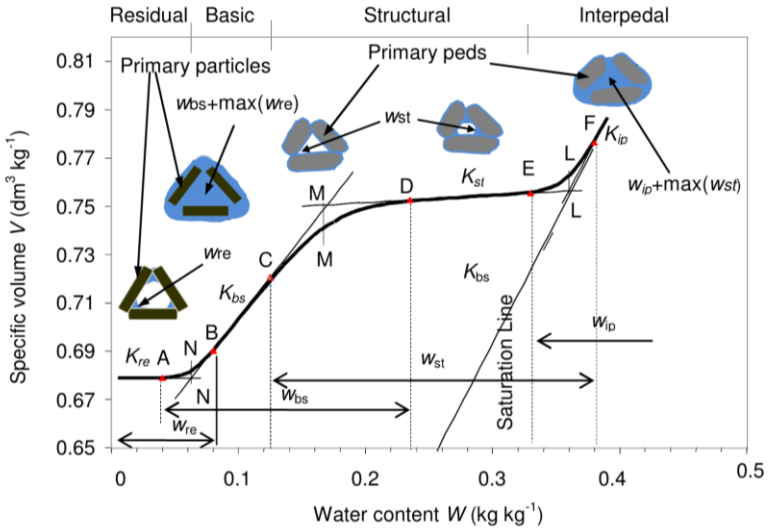
1. Water retention curve, $h=f(Wps)$,
2. Hydraulic conductivity curve, $kps=f(Wps)$,
3. Shrinkage curve, $\bar{V}=f(Wps)$,
4. Swelling curve,$\bar{V}=f(t)$.

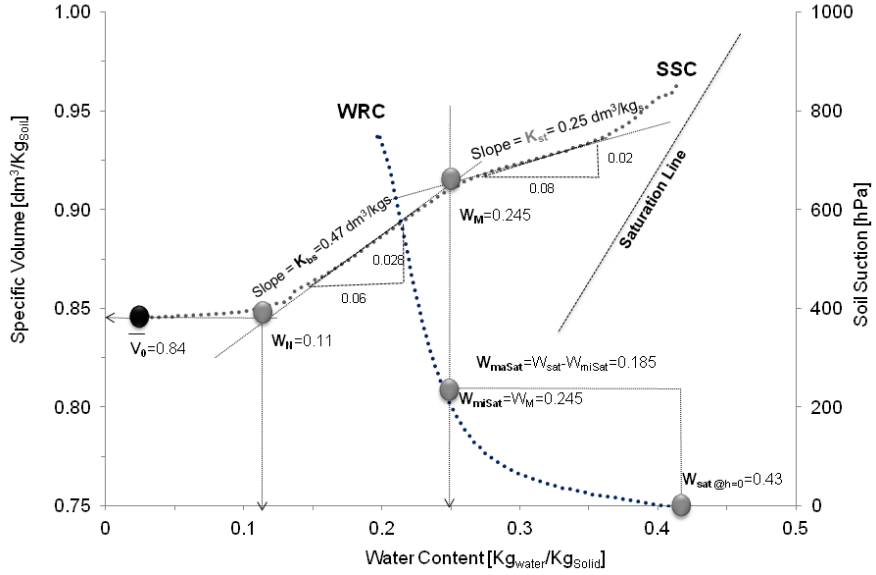
Pedostructure Characterization Lab

TYPOSOIL®









At Aggregates Scale [Pedostructure Scale]

(Assi et al., 2014)

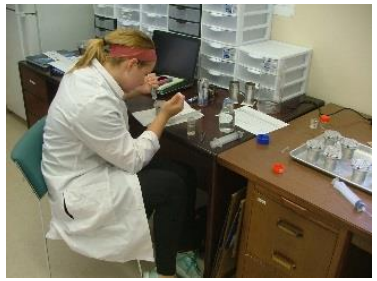
Pedostructure Characterization Lab

Typosoil™:State-of-art facility based in a new paradigm in soil physics.

Main research activities:

1. Long term impact of non-conventional water reuse on soil health and productivity.
2. Quantifying & green water and soil-water holding properties.

Water Management



1. **Efficient Water Management [Green Water Management].**
2. **Impact of Soil Health and Productivity.**

Biochar Additives

Greywater for Irrigation

Treated Wastewater for Irrigation

Erik Braudeau, Amjad T. Assi, Rabi H. Mohtar. (2016). **Hydrostructural Pedology**. Wiley-ISTE. 186 pages. ISBN: 978-1-84821-994-6 Link to English Version. Link to the lab: https://wefnexus.tamu.edu/pedostructure-characterization-lab-2/

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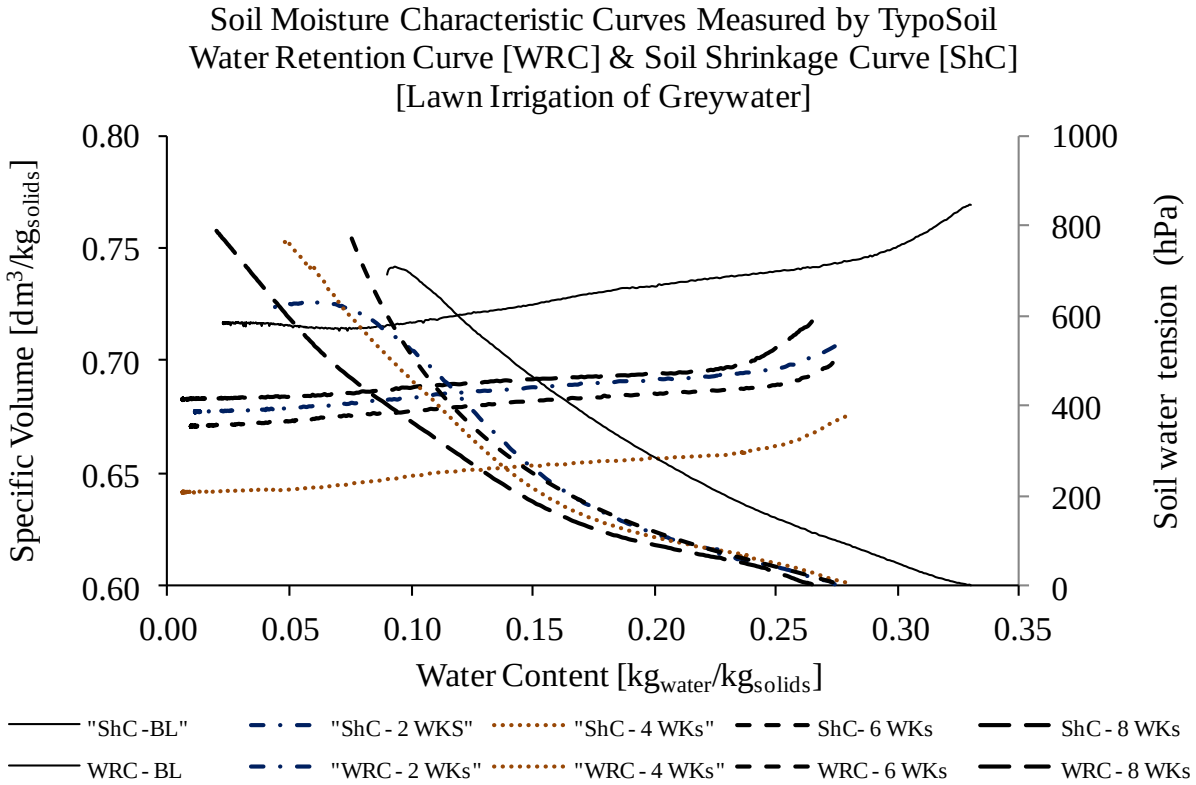
Greywater Irrigation Results



Time period	Parameter	% change
Baseline to 2 weeks	W_{sat}	↓ 15%
	K_{bs}	↓ 50%
2 to 4 weeks	W_{sat}	0%
	K_{bs}	↓ 28%
4 to 6 weeks	W_{sat}	↓ 6%
	K_{bs}	↑ 2%
6 to 8 weeks	W_{sat}	↑ 3%
	K_{bs}	↓ 1.6%
Baseline to 8 weeks	W_{sat}	↓ 18%
	K_{bs}	↓ 64%

Major Conclusions

- Loss in ability to store water
- Loss in ability to shrink
- Effect most noticeable after first 2 weeks
- Affected W_{sat} and K_{bs} most significantly

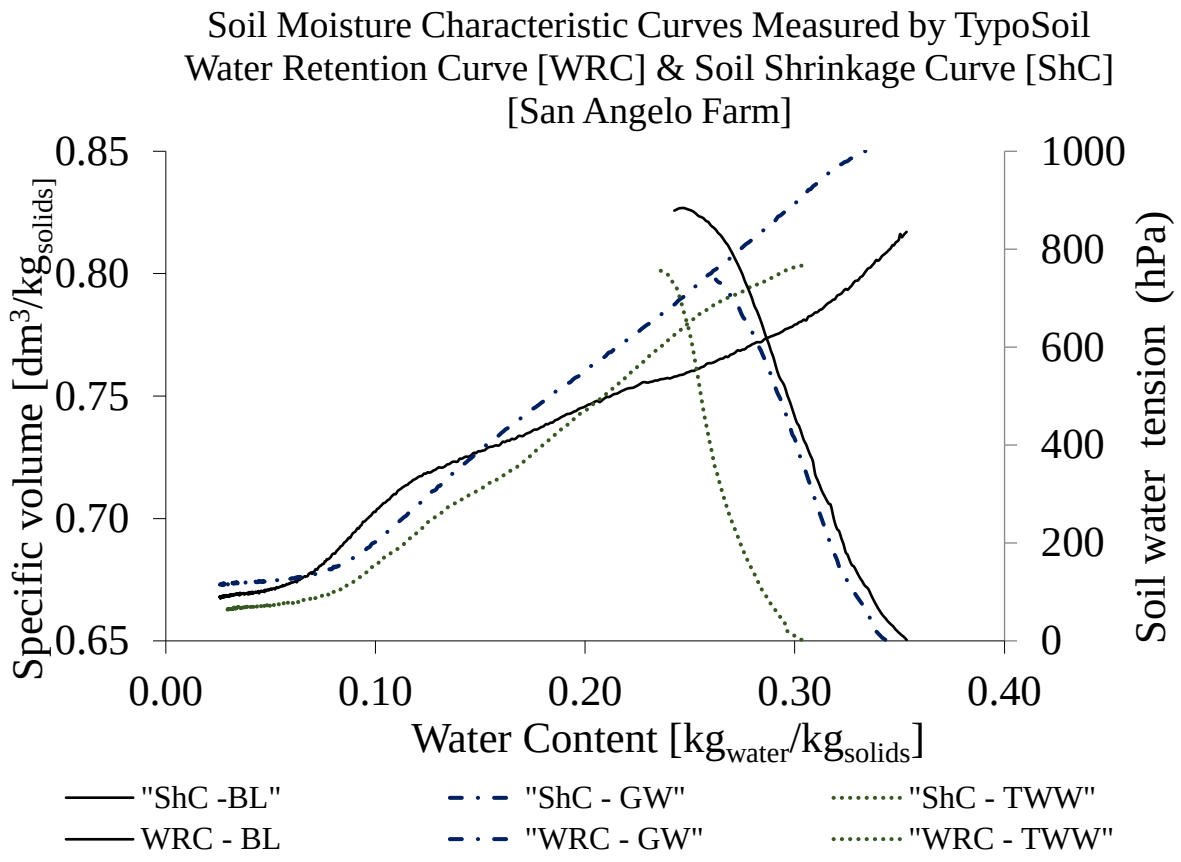
Treated Wastewater Irrigation Results

Conclusions

- Most noticeable change in water retention curve for TWW

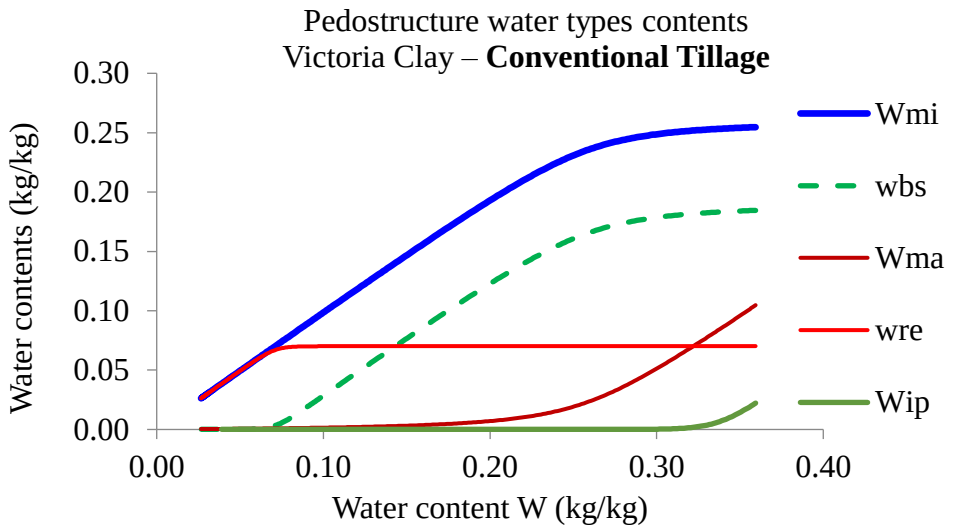
- Loss in structural shrinkage

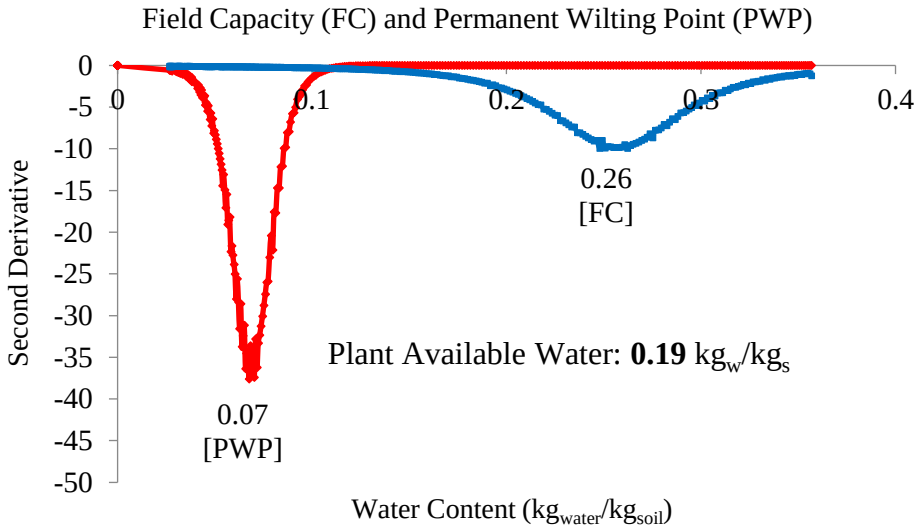
- There are more changes than just hydraulic conductivity

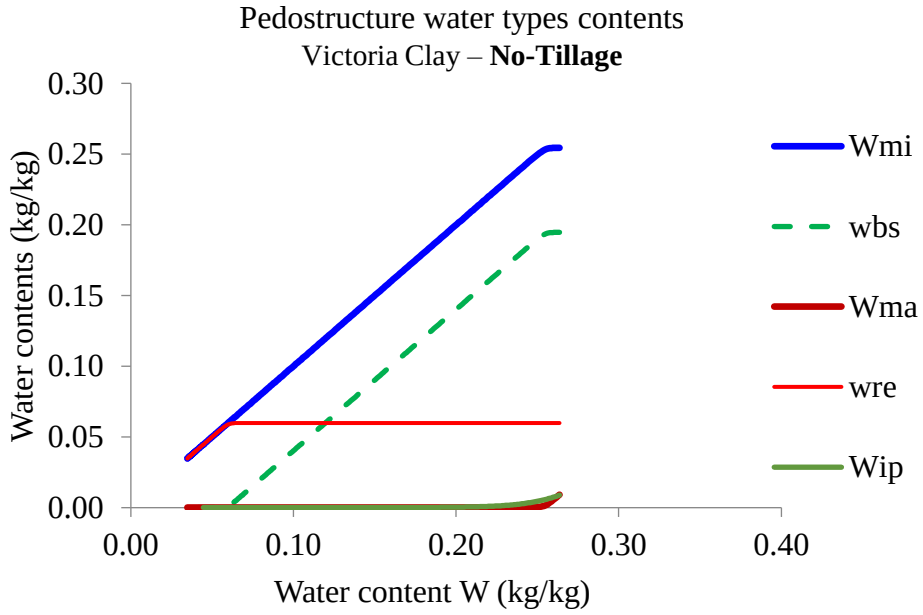


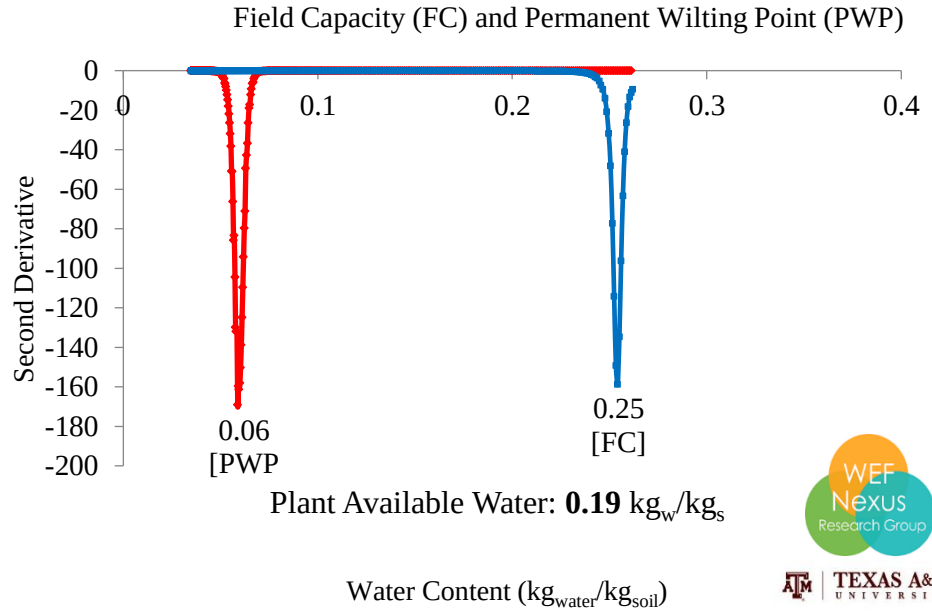
Soil-Water Holding Properties

Plant available water (green-water) is **the same for conventional and no tillage**, but a clear impact on blue water. Implications on water and nutrient management are being studied.









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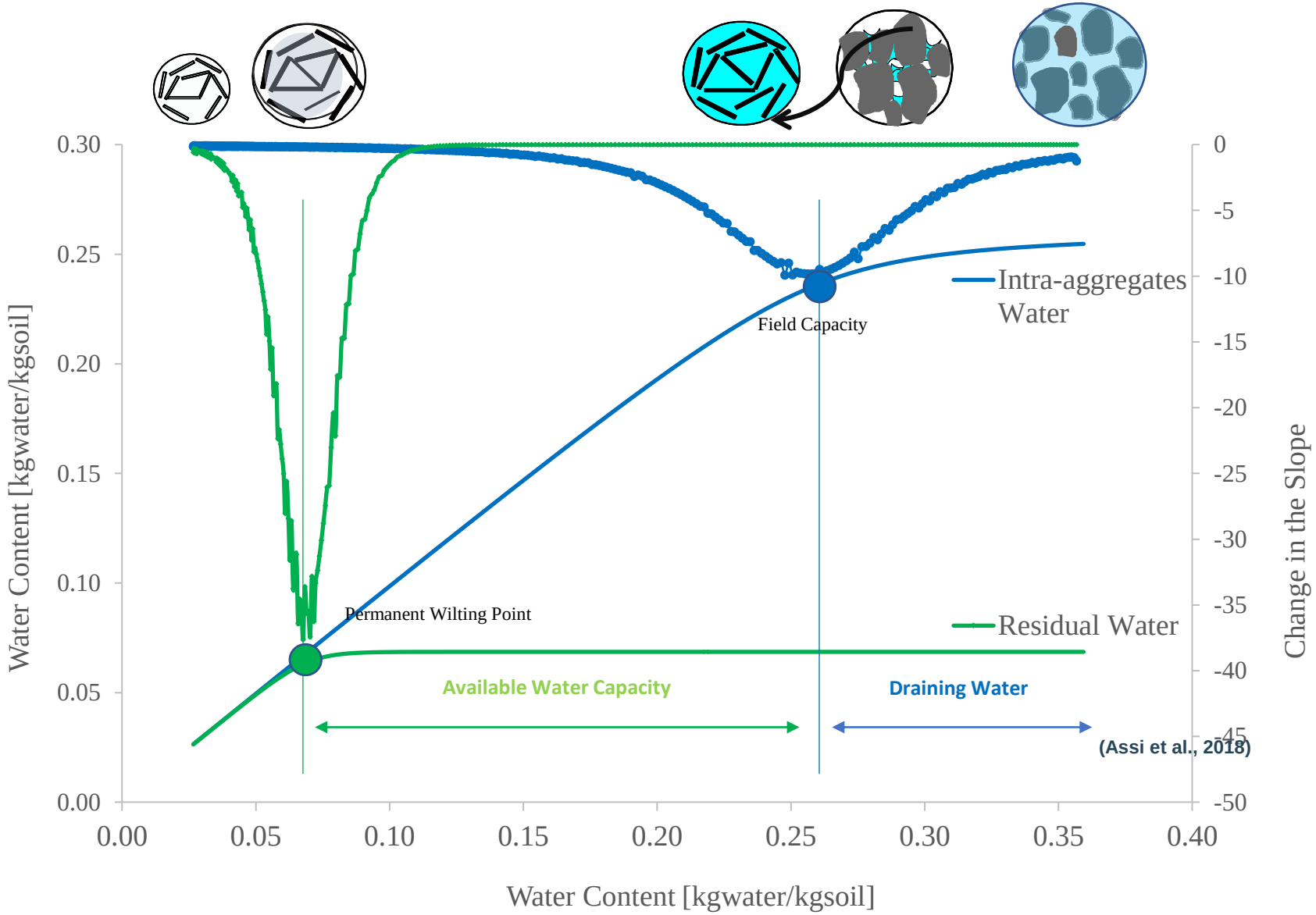
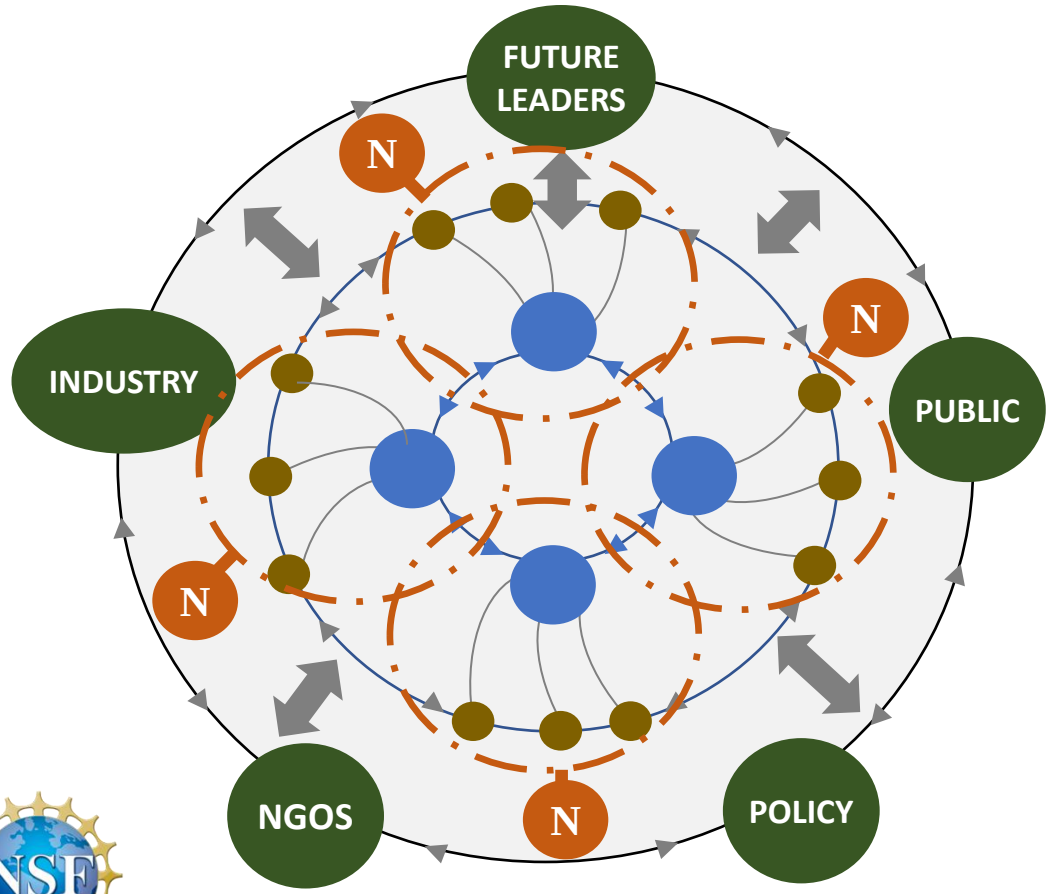
Quantifying Soil-Water Holding Properties



Engagement



Collaboration between researchers, farmers & practioners, public secotor, NextGen, NGO, Multi-national, Private sector, society members, is needed **to solve grand challenges of land & soil** management at a global scale.

Concluding Remarks

1. Dynamic Soil Characterization is needed to:
    1. Quantify and manage Green Water.
    2. Quantify the impact of Non-traditional water for irrigation on soil quality and productivity
2. Action is to modify the existing soil maps to cope with these changes
3. These updated maps allow to quantify inter-linkages & tradeoffs of social & environmental risks & water allocation strategies.
4. Global Soil Network of Network will enable these actions.

THANK YOU

Soil for Society Network

Vision: *To empower a globally connected network of soil systems advocates for sustainable development.*

Mission: *To co-create a diverse and inclusive soil systems community of scientists, practitioners, and society toward climate-smart, sustainable, food and water systems.*

National Science Foundation
AccelNet - Design

Motivation

1) *How can the **global community transform the management of soil systems** to support a growing population, store carbon, & enhance resiliency?*

2) *How can society **shift the paradigm** to view soil & land use as a solution?*

3) *How can we **create a diverse, inclusive, & supportive learning environment** that transcends environmental, political, and social stressors impeding global coordination to advance soil as a critical resource?*

Soil for Society Network