

THE ROLE OF SOIL ORGANIC MATTER IN MITIGATION AND ADAPTATION IN THE BOLIVIAN HIGHLANDS



Peter Motavalli
Dept. of Soil, Environ.
and Atmos. Sci.
University of Missouri

CONSEQUENCES OF CLIMATE CHANGE FOR SOIL RESOURCES



- Lower or excessive soil water content during critical periods of the growing season (*high temp., high rainfall events*)
- Increased soil organic matter loss (*high temp.*)
- Increased soil erosion (*high rainfall events with lack of cover*)
- Change in cropping systems with possible subsequent deleterious effects on soil properties (*delay in early season rains, frost incidence, higher temperature*)
- Increased landslides and mudflows - (*high rainfall events*)



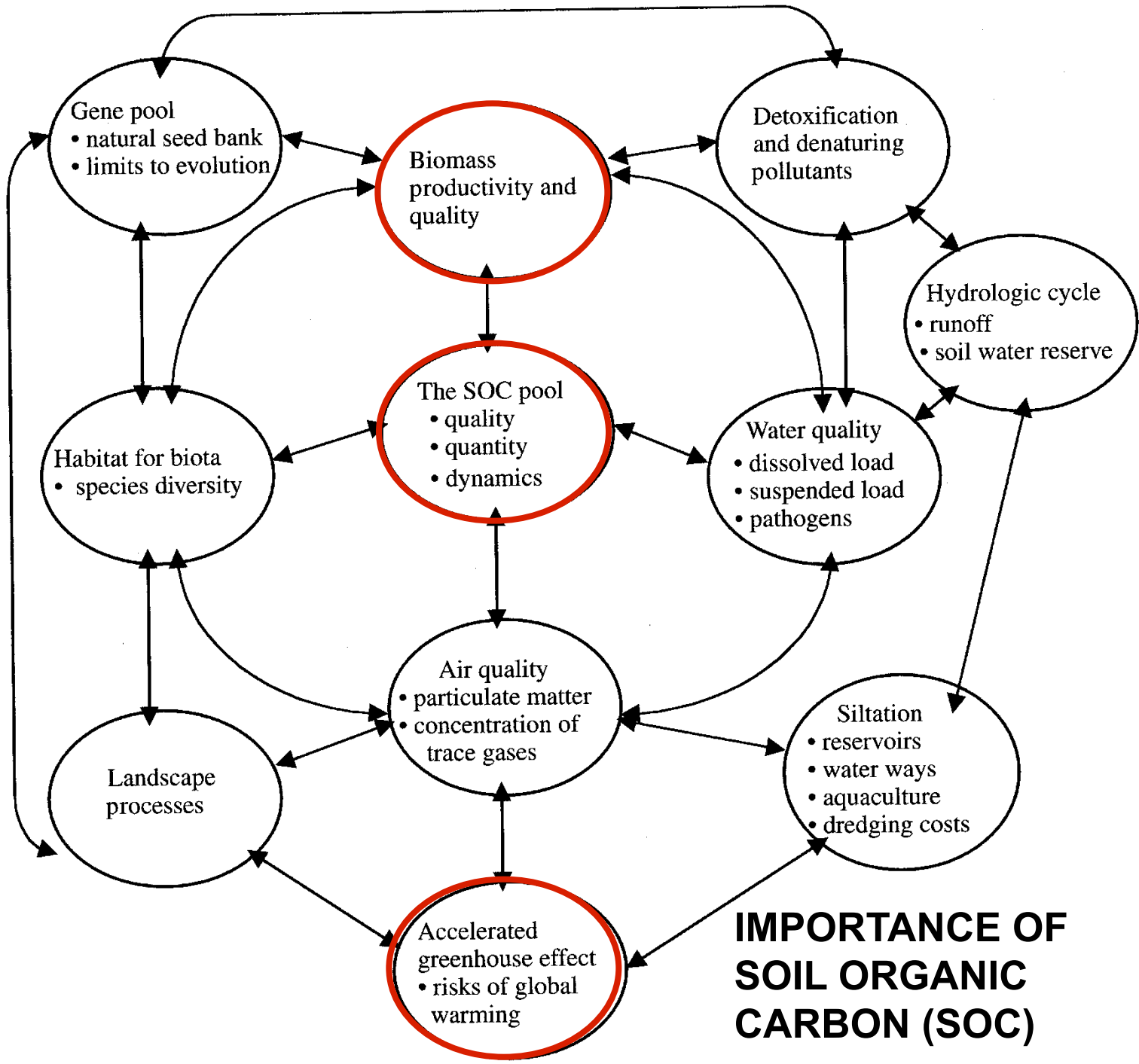
(Adapted from IPCC, 2007)

ADAPTATIONS FOR CLIMATE CHANGE



- **Andean farmers have developed several strategies to adapt to climate extremes including use of genetic diversity and knowledge of differential impacts of climate events among their soil resources.**
- **Adaptation strategies for climate change may also address the effects of other factors affecting soil degradation (e.g., socioeconomic changes)**
- **Successful adaptation strategies will require community participation and address the limited availability of resources.**





IMPORTANCE OF SOIL ORGANIC CARBON (SOC)

ADAPTATIONS FOR CLIMATE CHANGE



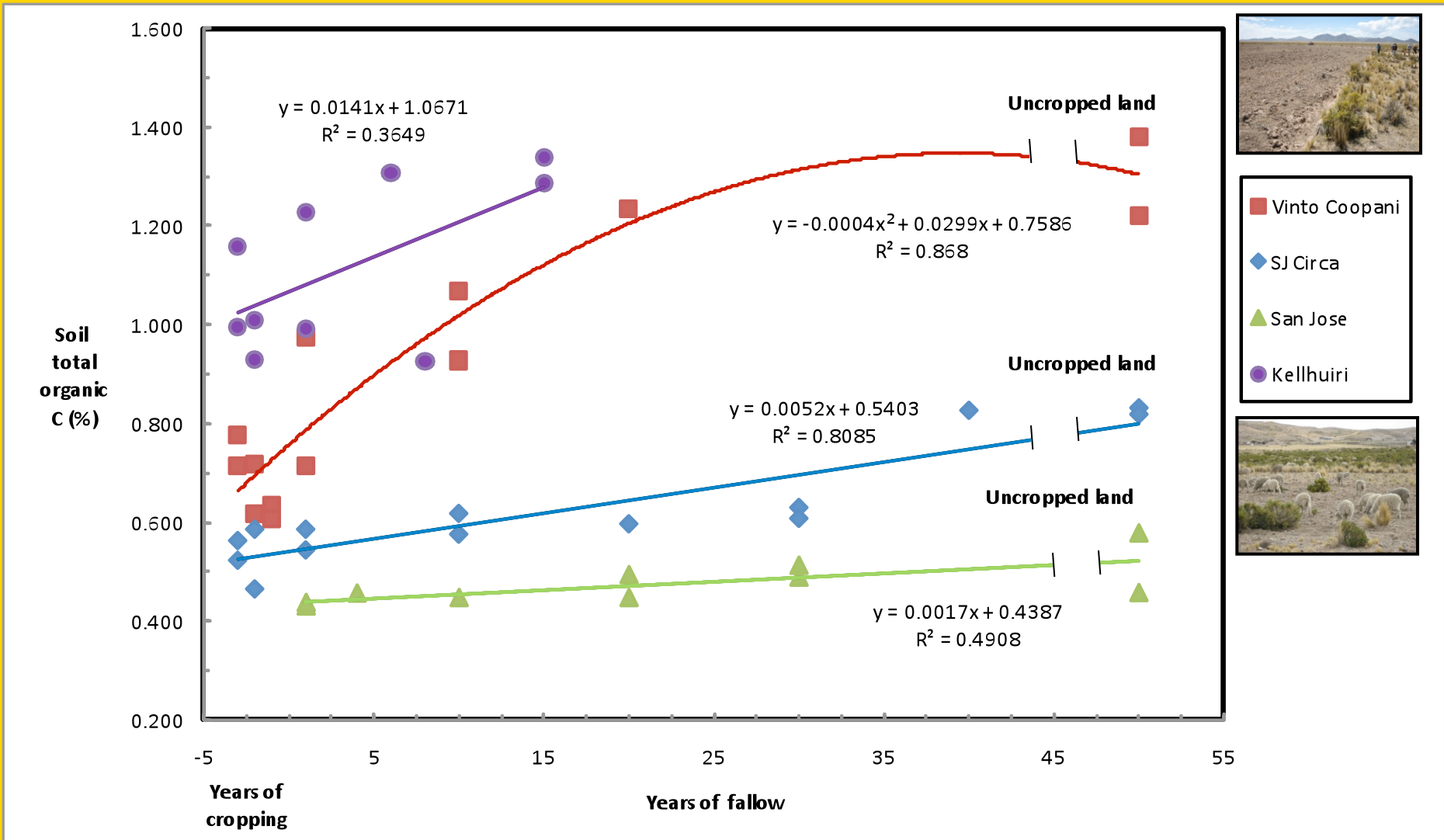
- **Focus of research effort is to develop practices to increase soil organic matter as a means to improve agricultural sustainability and productivity and buffer against the impacts of climate change.**

Possible strategies for the Altiplano include:

- ✓ **Improved use of organic soil amendments and chemical fertilizers**
- ✓ **Better management of crop residues**
- ✓ **Use of green manures**
- ✓ **Development of managed fallow systems with multipurpose plants (i.e., for forage, soil fertility and erosion control)**
- ✓ **Reduced tillage practices**



EFFECTS OF FALLOW AND CROPPING ON SOIL ORGANIC C IN UMALA



Changes in Selected Soil Properties Due to Application of Organic and Inorganic Soil Amendments in 2007 in Umala.

Soil amendment	Bulk density - g cm ⁻³ -	Gravimetric* water content ----- % -----	Soil organic** matter
Control	1.30	7.75	1.15
DAP + urea	1.22	8.29	1.19
Cow manure (CM)	1.22	9.32	1.36
Sheep manure (SM)	1.26	11.62	1.22
CM + SM	1.22	10.39	1.28
Compost	1.20	10.19	1.28
CM + (DAP + urea)	1.18	10.09	1.34
SM + (DAP + urea)	1.26	11.27	1.25
CM + SM + (DAP + urea)	1.22	9.29	1.23
CM + Biofert	1.19	10.00	1.42
SM + Biofert	1.22	11.29	1.35
CM + SM + Biofert	1.18	10.02	1.38
DMRT_(0.01)	0.09	3.50	0.14

* Results from a soil sampling at harvest.

**Soil organic matter level before treatment application was 1.11%.

FIELD METHODS



Labile C Determination Using $KMnO_4$ (Weil, 2003)

- Hand-held field spectrometer – 550 nm
- Field chart
- Relatively low-cost, rapid and portable



Solución $KMnO_4$ después de agitarlo con el suelo			
Pobre	Regular	Bueno	Excelente
>0 – 0.25	>0.25 – 0.50	>0.50 – 0.75	>0.75 – 1.0

Escala del Índice de Calidad de Suelos

Tabla de campo sobre Calidad de Suelos



FIELD METHODS



Portable Field Near Infrared (NIR) Spectrometer

- **Determination of soil organic C fractions using a portable field NIR spectrometer, Fieldspec Pro FR (Stevens et al., 2006)**
- **It may relate to use of remotely sensed infrared imagery to improve diagnostic capabilities to assess plant and soil health.**
- **Rapid, portable, and non-destructive method.**



KNOWLEDGE GAPS



- **Insufficient inventory of soil resources in the region for improved land use management and for evaluation of climate change impacts**
- **Limited understanding of the direct and indirect effects of climate change on soil processes (e.g., carbon and nutrient cycling), soil quality, and soil management in the region.**
- **Limited development and evaluation of adaptive soil management practices for climate change which include community participation and assessment to improve adoption.**
- **Need to assess the long-term impacts of climate change in the region using soil simulation models which incorporate parameters and climate change scenarios developed for the region.**

ADAPTATIONS FOR CLIMATE CHANGE



- **Possible adaptations include:**
 - ✓ **Soil water conservation measures to capture and reduce soil moisture loss**
 - ✓ **Soil conservation measures to reduce soil erosion and landslides**
 - ✓ **Improved irrigation methods (e.g., deficit irrigation)**
 - ✓ **Use of alternative multipurpose plants for forage, soil fertility and groundcover**

ADAPTATIONS FOR CLIMATE CHANGE



- **Possible adaptations (continued):**
 - ✓ **Alternative soil preparation practices (e.g., conservation tillage)**
 - ✓ **Alternative crop species and varieties that are short season and drought- and frost resistant**
 - ✓ **Increased soil fertility inputs including use of alternative organic amendments**
 - ✓ **Improved crop residue management**
 - ✓ **Maintenance of genetic diversity**