SOILS AND CLIMATE: CONSEQUENCES AND POTENTIAL ADAPTATION

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CLIMATE CHANGE

- The region will experience temperature increases of up to 6°C by the end of the century (Bradley et al., 2006, IPCC, 2007).
- A consequence of global climate change has and will be a higher incidence of extreme weather events (Haylock et al., 2006; Thibeault et al., 2008).
- The Altiplano region's climate is characterized by high diurnal temperature variations, frost risks, low and irregular precipitation and high risks of drought during the growing season (Garcia et al., 2007).

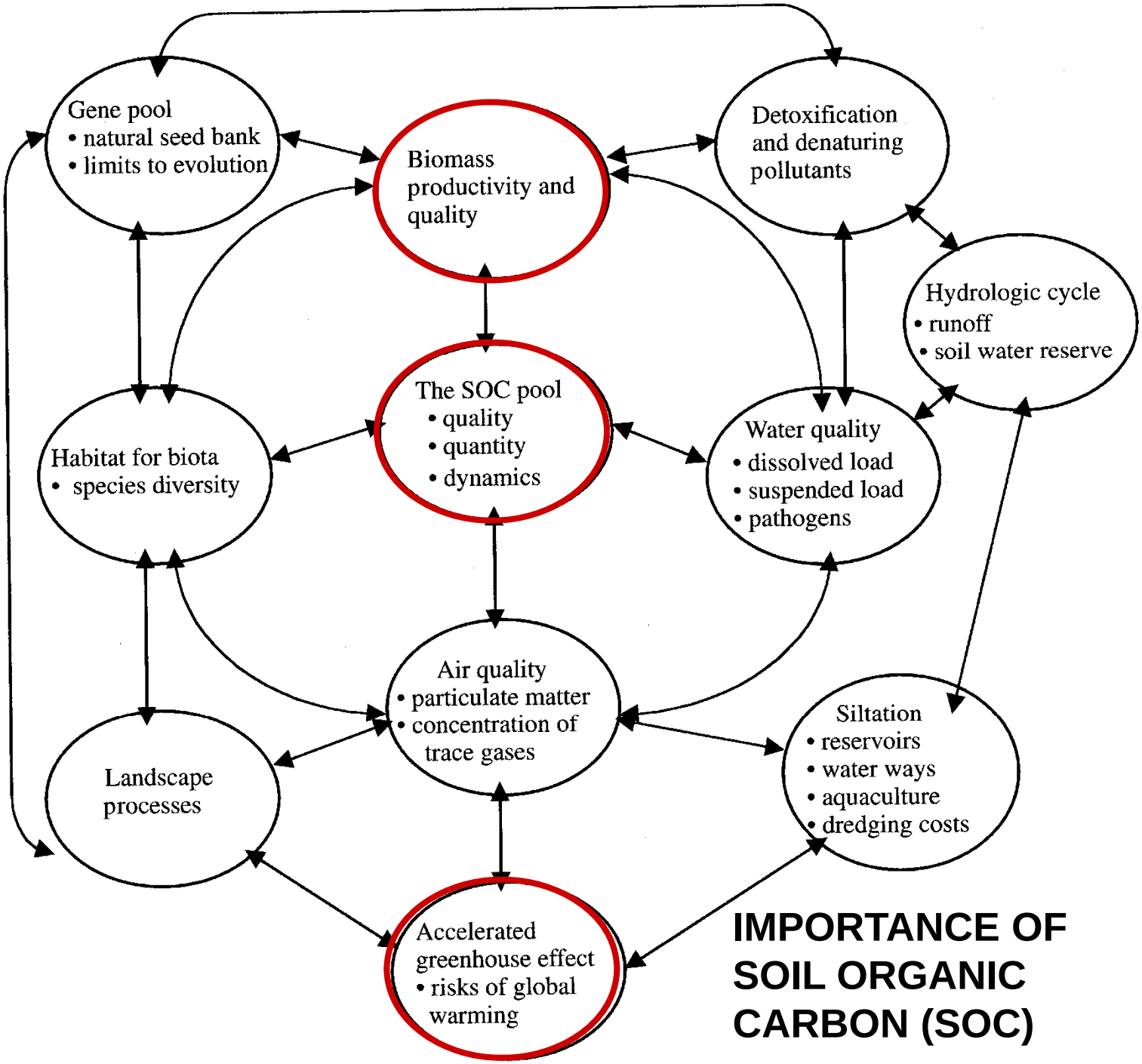
CONSEQUENCES OF CLIMATE CHANGE FOR SOIL RESOURCES

- **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)

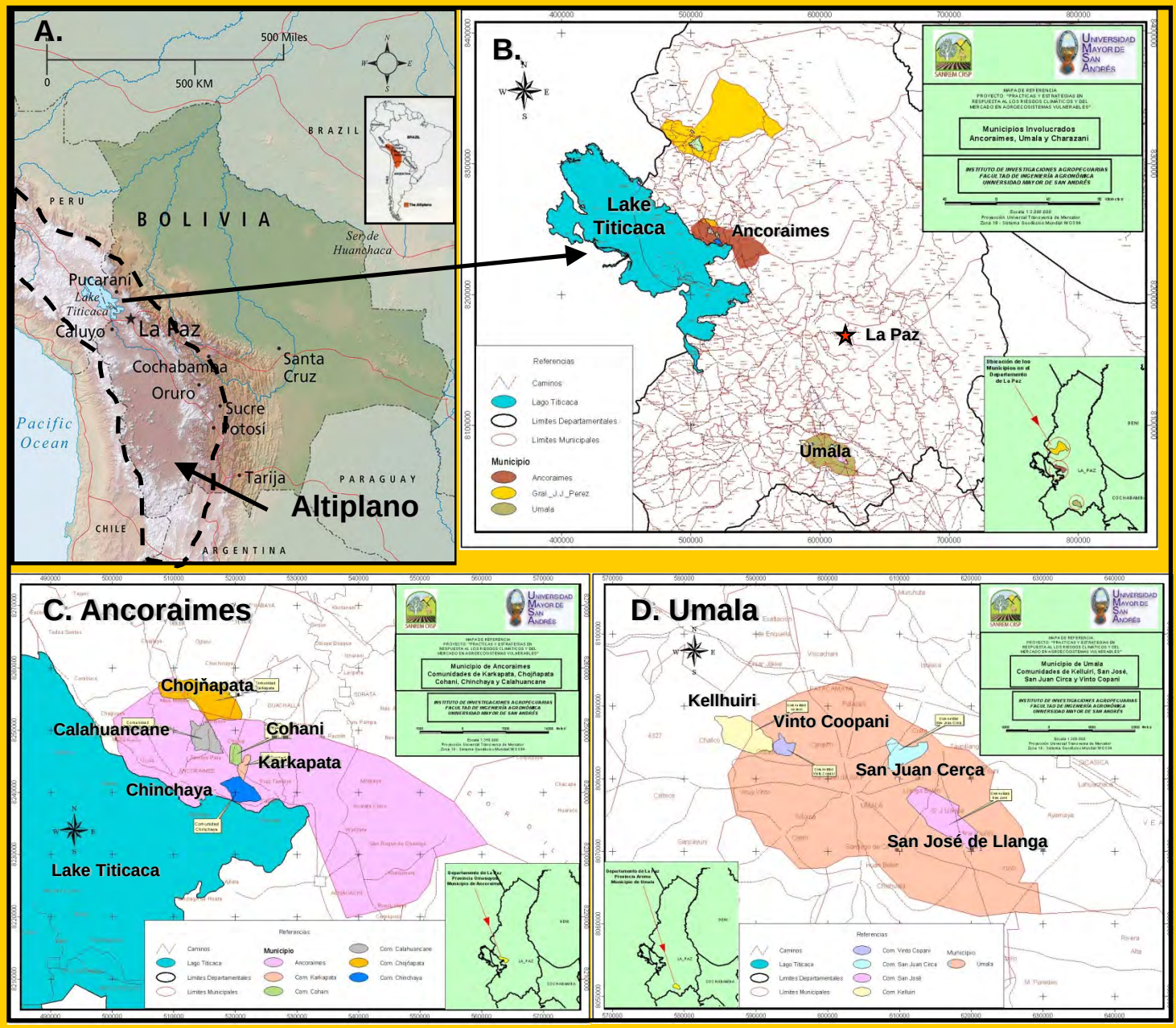
SOIL ORGANIC MATTER FUNCTIONS

- Provides soil nutrients and enhances soil nutrient availability over several growing seasons.
- Improves soil physical, chemical and biological properties for plant growth.
- Buffers changes in soil properties due to disturbance or variation in other environmental factors (e.g. climate).
- Reduces environmental contamination and soil loss.
- Possibly reduces need for external inputs and enhances internal recycling when crop residues and/or organic soil amendments are applied.

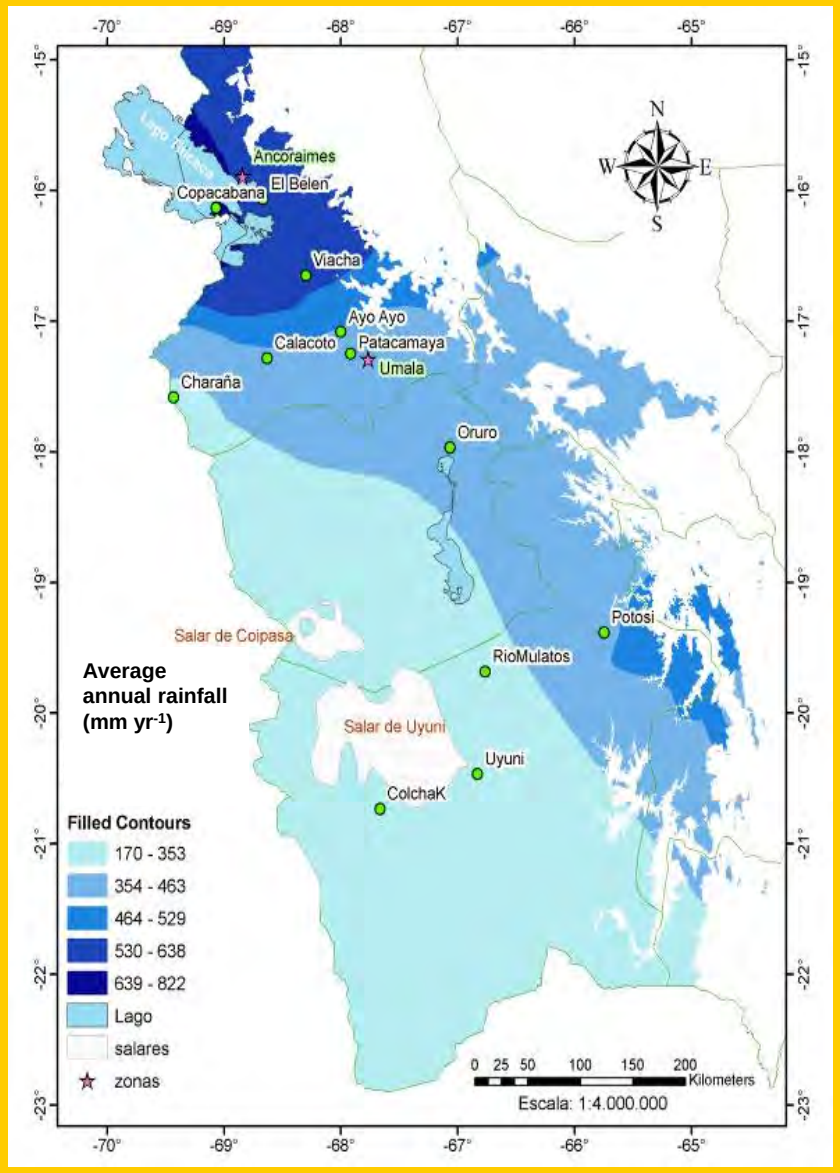


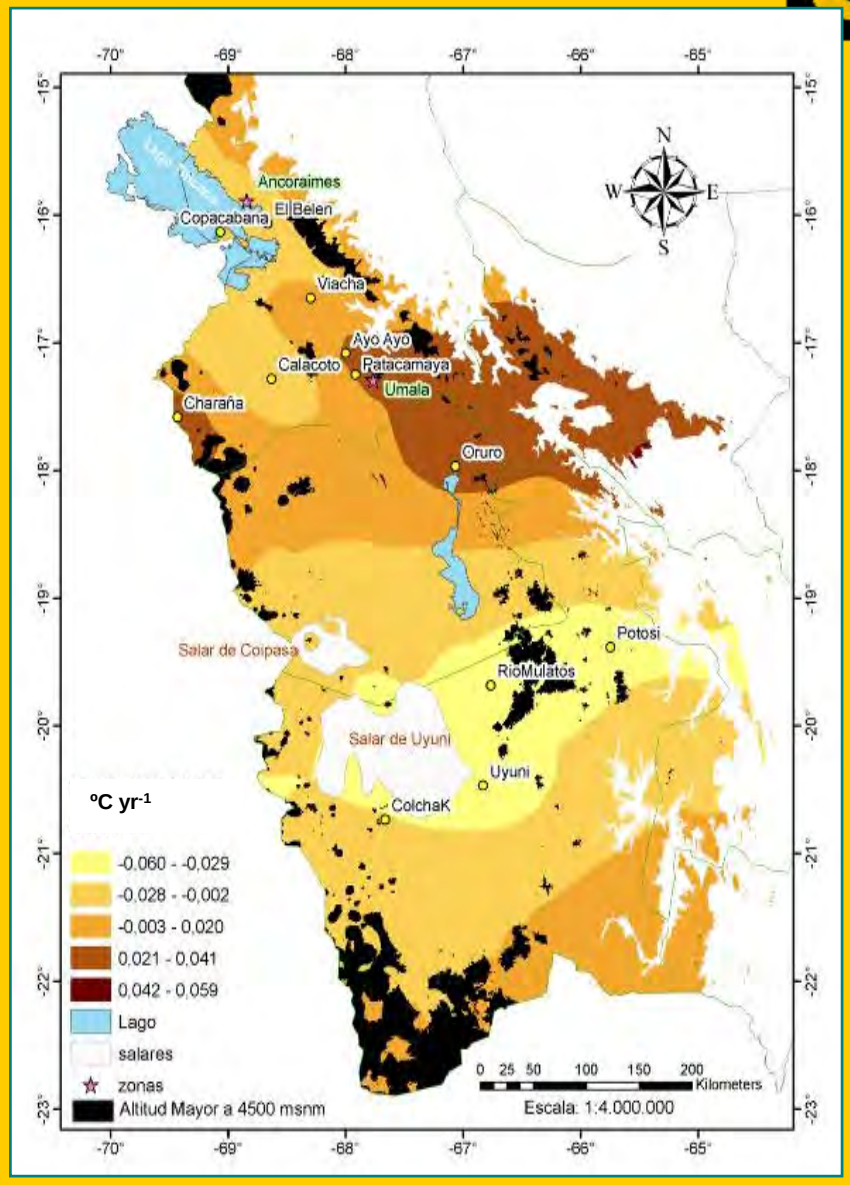
IMPORTANCE OF SOIL ORGANIC CARBON (SOC)

SANREM STUDY AREA IN BOLIVIA



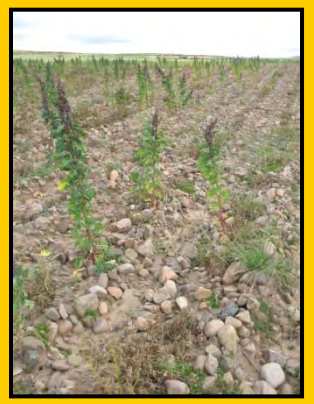
STUDY AREA IN BOLIVIA





Garcia and Seth (in prep.)

COMMUNITY PERCEPTIONS OF SOIL RESOURCES AND SOIL-RELATED PROBLEMS



- **Soil-related problems are only one of several factors limiting crop production.**
- **Soil management problems identified were:**
  - ✓ **Low soil quality and soil fertility** (***low soil nutrient content, high clay content and stoniness***)
  - ✓ **Excessive water and wind-induced soil erosion**
  - ✓ **Insufficient soil moisture due to lower rainfall**
  - ✓ **Inadequate soil management practices** (***Inappropriate tractor tillage practices, lack of a suitable crop rotation strategy, insufficient soil fertility inputs, and overgrazing by sheep)***

CHANGES IN SOIL MANAGEMENT PRACTICES

20 years ago in Chinchaya

Present

(Yucra and Gilles, unpublished)

CHANGES IN SOIL MANAGEMENT PRACTICES

- Increase in production of some cash crops (e.g. onion) and other income-generating activities (e.g. dairy production, day labor)
- Decrease in the length of the fallow period in the crop rotation.
- Reduction in planting of early season crops (e.g., fava beans and quinoa) due to early season rainfall uncertainty.
- Greater tractor use for tillage in lower elevation communities.
- Loss of native species (e.g., th'ola) that have multiple uses to restore soil fertility during fallow period and are a fuel source.

CONSEQUENCES AND SOME EXAMPLES OF ADAPTATION TO CLIMATE CHANGE

Consequences	Adaptation
Lower soil water content	Soil water conservation measures
Increased soil organic matter loss	Improved crop residue management
Increased soil erosion	Alternative multipurpose plants
Changes in cropping systems	Resistant crop species and varieties
Increased landslides	Soil conservation measures

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.

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**

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**

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.


THANK YOU!
GRACIAS!