Linking Knowledge Systems for Rural Livelihoods Adaptation Under Uncertainty: Drying and Warming in Andean Ecosystems

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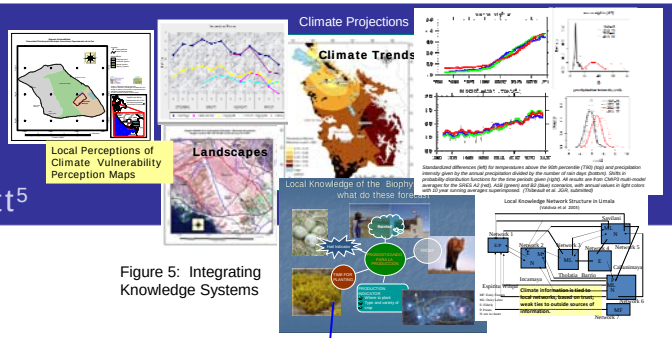

Figure 5: Integrating Knowledge Systems

ABSTRACT

Climate change will reduce food security in agricultural regions of the developing world such as the Andes (Loeb et al *Science* **2008**,319,607-610; Brown and Funk, *Science* **2008**,319,580-581). The rural populations of the Altiplano of Peru and Bolivia are particularly vulnerable as they produce in a risky environment, relying mostly on local safety nets and institutions. This is exacerbated by lack of government resources and infrastructure to respond to their conditions. Climate changes are being perceived in the Altiplano. Local knowledge observations are explained by observed trends. Projections show increases in variability and shifts in the distributions of temperature and precipitation, creating an environment of uncertainty for decision makers.

THE PROJECT

Adapting to change in Vulnerable Andean Ecosystems, funded by the Sustainable Agriculture and Resource Management Collaborative Research Support Program SANREM-CRSP, is a collaborative research and capacity building effort of eight universities, an NGO, an international research center, and ten rural communities in Bolivia, Peru and the USA, since 2006. The objectives are to understand drivers of change and identify practices and strategies that lead to adaptation in Altiplano ecosystems. Disciplinary, cross disciplinary, and participatory research in livelihoods, markets, soils, biodiversity, pests and diseases, climate trends and climate change, landscapes, is developed integrating local knowledge (figure 1). The rural landscapes are presented in figure 2. A transformational dimension of the project focuses on capacities and capabilities of all stakeholders involved (figures 1 and 4).

THE RESEACH FOCUS & APPROACH

The SANREM-CRSP program in the Altiplano is studying the biological, physical, social and economic drivers that are changing agricultural production systems, as well as the local knowledge and perceptions of farmers, the way they assess the risks of climate hazards and change (Slovic and Weber 2002). Although trust in traditional decision making tools is declining, trust in scientific knowledge is almost non-existent (Gilles and Valdivia 2009). Two-way participatory communication can enhance this trust and build knowledge that can facilitate adaptation. Using traditional scientific research methods combined with participatory research, the project is building new knowledge base, which returns to decision makers' as information about their livelihoods, their resources and market integration capacity. It seeks to build new knowledge by bridging scientific and local knowledge systems, and by strengthening human, social and political capitals of decision makers to enable human agency for adaptation. This includes agronomic trials to identify new varieties, crops, or production techniques that can buffer the new risks of changing weather patterns. In addition to involving farmers in the evaluation of research findings, members of vulnerable groups are purposely included to engage them in the discussions and plans necessary to develop adaptation strategies that will require extra-community resources to be successful. Livelihood strategies and risk perceptions analysis are presented in figure 3, as an example of the diversity of livelihoods and perceptions, conditions under which local and new knowledge on climate change are being developed and socialized by the project (Figure 3).

CLIMATE

Analysis of observational data collected to study climate trends of the past thirty years showed warming in the Central Altiplano and drying in the Northern Altiplano. Projections of climate change for the Altiplano suggest increasing temperatures and later onset of rains during the planting season. Analysis of extreme events show increases in variability. The overall scenario for decision making is one of increased uncertainty. Weather related risks are the greatest threat to the livelihoods of Andean farmers (figure 3), so they have developed a large number of strategies to reduce and mitigate them. These strategies revolve around the use of climate indicators to help farmers decide, when, where and what to plant, so as to minimize losses to droughts, floods, frosts and hail. Stars, clouds, winds, plants and animals are observed to help make production decisions. In some cases, (Orlove et al 2000 *Nature* **403**, 68–71, Orlove et al 2002 *American Scientist* **90**, 428–435) the scientific validity of these practices has been confirmed.

CLIMATE KNOWLEDGE SYSTEMS FINDINGS

Climate Highlights: Projected Changes in Annual Cycle Northern Altiplano

- Temperature: 1.5 - 2 C increase in mean by 2030; 4-5 C increases by end of century.
- Precipitation: possible small decrease in SON; sig. increase in DJFMA
- Both changes are larger and significant by end of century.

Climate - Projected Changes in Extremes

- Temperature extremes are consistent with warmer temperatures (increases in Warm Nights, Heat Waves*, Extreme Temperature Range, and decrease in Frost Days**)
- Precipitation extremes suggest redistribution with more precipitation in fewer rainy days (increases in Dry Days, Max 5 day, Simple Intensity, and Heavy precipitation) - in accordance with station data from Patacamaya.

Farmers Workshop Results

Climate becoming warmer and drier.
Less predictable—droughts and floods make farming more difficult.
More extreme and intense events, later arrival of rains.

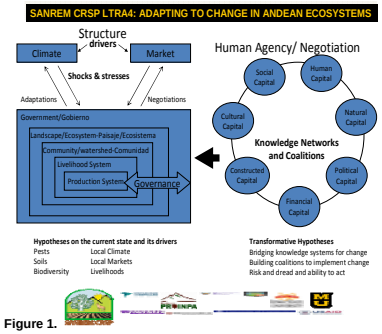

Figure 1.
Conceptual cross disciplinary and participatory research model, with a livelihoods and agency approach, implemented in Adapting to change. Climate, soils, pests and diseases, biodiversity, and landscape analysis, is intertwined with social sciences research, and local knowledge systems to develop practices and strategies for adaptation.

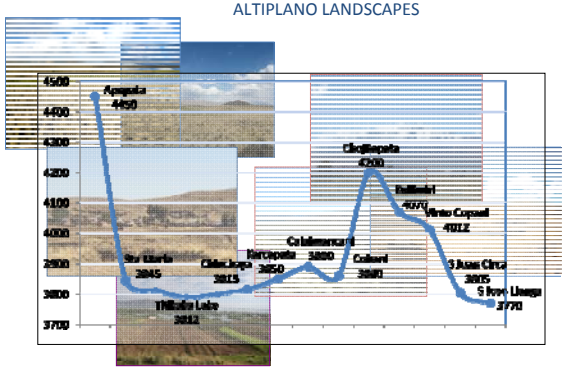

Figure 2.
Landscapes of the three regions, in the Northern and Central Altiplano of Bolivia, and Southern Altiplano of Peru, are represented in Altiplano Ecosystems. Eleven rural communities, and 450 households comprise the household survey. Ten collaborative research groups participate in identification research and evaluation of practices and strategies. Results from ten communities are presented here.

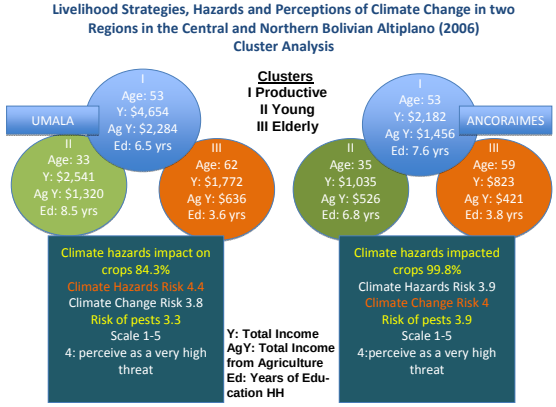

Figure 3.
Cluster Analysis of 330 households identified three groups in each region with livelihood strategies that differ between and within regions by wealth, life cycle and education, dread of climate change and hazards. Risks of pests are perceived to be high. A majority of households in both regions experienced climate shocks in 2006. Differences between regions lie on the nature of the climate event, multiple hazard events a concern in Umala (Central Altiplano of Bolivia), and climate change a concerns in Ancoraimes (Northern Bolivian Altiplano).

Research on various types participatory research groups (institutions) with farmers is necessary in order to determine how, when, & why knowledge in rural communities flows through networks and if it leads to action.

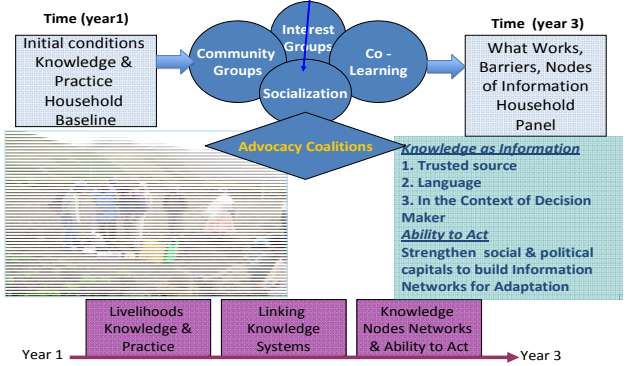

Figure 4.
Participatory research approaches are studied and their impact is evaluated among households through on going evaluation and ex-post household surveys. The process integrates local knowledge on indicators, perception maps of vulnerabilities, with analysis of data on climate observations, climate trends of past 30 years, and discussions about climate projections, a process of socializing knowledge.

DISCUSSION

Extreme event projections from the models relate a sense of uncertainty and variability, with presentations unlike the present, with potential for more stress in access to water, and more extreme events in temperature and precipitation that affect agriculture, today the main source of livelihood of families in the Andes.

In the Altiplano of Bolivia, changes in climate, particularly associated with later on-set of the rainy season and the presentation of more extreme rainfall, drought, and frost events have undermined the production strategies tied to the use of these indicators. The later onset of the rains is also reducing the options that farmers have for planting dates and is threatening the production of two of the most important sources of plant protein in their diets (quinoa and fava beans). In addition, the behavior of certain indicator species has been changing due to climate and environmental changes. So while climate is changing, the ability to respond to climate related risks is declining.

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