COPING AND ADAPTING TO CLIMATE VARIABILITY: THE ROLE OF ASSETS, NETWORKS, KNOWLEDGE AND INSTITUTIONS

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INTRODUCTION

Research on Climate Variability and Household Welfare in the Andes was funded by the Human Dimensions Program of NOAA to study the livelihood strategies of rural families in agropastoral systems of the highlands (above 3,700 m above sea level). The purpose of this research was to understand how families cope and adapt to climate variability, and how information about climate forecasts affects their production and consumption decisions. What are the roles of cultural capital -- local knowledge forecasts --- and social capital --the social networks to access information—in the capabilities to cope and adapt to climate variability. Adapting in this research is defined as the capacity to cope with and recover from streesses and shocks, while assets (productive, social, financial, natural) and capabilities (cultural and human capital) are maintained or enhanced. The capabilities of people are esential in coping and adapting to climate variability. Human agency, local and new knowledge are elements of people's capabilities to negotiate climate shocks and stresses, as well as shocks created by markets, social and political structures.

Countries in the Andes of Latin America have experienced many losses to agriculture as a results of ENSO events. Assessments of climate change predict that countries in the Tropics will be worse off under different scenarios, especially countries lacking in resources or not investing in adaptation strategies (Kayser). Our research focuses on understanding how rural households, in the most depressed economic regions of two countries cope with climate variability, and what are the means to build capacity to respond to change, locally and regionaly. Our research also takes into account other sources of stress and shocks, markets and political conditions. We find that some households successfully cope with these events, and exhibit livelihood systems that adapt, while others in the same communities are not able to.

People in the Andes of Bolivia and Peru have remained in agriculture for centuries, coping with climate variability, and with political, social and economic changes (Mayer; Orlove et al). Diversification has been a key characteristic of Andean rural livelihoods (Cotlear; Ellis), and for many, a reason for lack of development as specialization was believed to be the engine of growth as experienced in developed countries of Temperate regions (Markowitz and Valdivia). We studied how diversification contributes to coping with climate variability: Is diversification consistent with climatic risk management (Sakurai and Reardon)? Is it consistent with maximizing use of resources (Mayer; Ellis;

Valdivia et al) and achieving multiple household goals (Valdivia and Gilles)? What is the interaction between diversification and markets and other institutions in the context of climate variability? We studied knowledge and information in rural household decisions: What is the role of local knowledge? What is the link between rural households and institutions providing climate forecasts, promoting food security, and radio? What information is trusted and how it is accessed in the highlands?

FRAMEWORK: LIVELIHOOD STRATEGIES AND SOCIAL NETWORKS

Resilience of peoples' livelihoods depends on their capabilities to adapt to internal and external shocks and stresses (Figure 1, Chambers and Conway). Tangible assets (natural, productive, physical, and livestock and other forms of stock), intangible assets (social capital and non-market institutions allowing access or control of assets or resources, like reciprocity relations in the Andes), and capabilities (human and cultural capital, life cycle characteristics) shape livelihood strategies (Conway and Chambers; Bebbington; Adatto and Meinzen-Dick; Valdivia et al.; Valdivia and Gilles). These are observed as a set of activities pursued by the household. Production and consumption decisions are joint (Ellis; Valdivia et al 2000), capitals are fungible (Chen and Dunn; Winters et al), many factor and product markets are incomplete, and households partially integrate/participate in markets. Household pursue many objectives – maximizing income, managing risk, and wellbeing. Assets are managed, strategies developed, and institutions accessed to cope with shocks (droughts, market failure, strikes). To explain which factors shape strategies that contribute to both income and diversification we study economic portfolios of households in Andean rural communities (Valdivia et al, 2000; Valdivia and Gilles, 2001; Bebbington; Valdivia and Gilles; Winters et al.). To determine the relation between the capacity to cope and adapt to climate change or other external forces we study how assets, capitals, and capabilities such as local knowledge and institutions (Bebbington; Ellis; Valdivia and Gilles) relate to household strategies, income generation, portfolio diversity index, and markets.

To understand capabilities we studied the current access to climate forecast information and the technologies rural households in the Andes manage, along with local knowledge. **I**nformation on ENSO event of 1997-1998 was available months in advance, and broadcasted through radio, television, and newspapers. Although widely published, studies have shown that in Southern Africa and Northeast Brazil farmers could not use or did not trust the forecast information. The lack of utilization in these regions suggests that: a) a gap exists between the information needed and delivered; b) lack of trust or miscommunication between users and providers; or c) even if the information is available the ability to respond by changing practices is limited or non existent; and/or d) that capacity is not available at a local scale to address agriculture's needs. The relationship between agriculture and climate is intricate; farmers base their crop and other production decisions on their local knowledge of indicators, developed from years of observations, experiences, and experiments. Our project studied current sources of information, mechanisms to access them, and avenues to connect rural households with institutions that develop technologies and information.

This paper presents the findings of changing rural household strategies in an Andean community of Bolivia, contrasts and compares with findins in Peru, and what we learnt of climate forecast information use in all three communities. Data on assets and life cycle characteristics were obtained with three household surveys applied in 1993 (after an el Niño), 1995 (drought) and 1999 (a year of floods after El Niño). In the Peruvian Altiplano household strategies were studied in two communities with the same methods in 1999-2000. Cluster and canonical correlation analysis, case study methods, and network analysis were used (Valdivia et al 2000; Valdivia and Quiroz, 2003; Materer, 2001; Espejo et al. 2003). Network analysis of households in three communities was conducted to identify which and how information flows, and what are the characteristics of those generating the information. Case studies of organizations that are potential sources of information were also studied, a Radio and an Early Warning and Food Security effort in Bolivia. The findings on changing strategies, coping dynamics and use of information provide lessons for long term adaptation to climate variability.

FINDINGS ON COPING AND ADAPTING

Cluster analysis of assets, life cycle variables and production capacity of three data sets in Bolivia yielded consistent results through time. Figure 2 shows results of cluster analysis for 1998-1999. Previous years' cluster results for Bolivia are reported in Valdivia et al. (2000) and for Peru in Valdivia and Gilles (2003. We find several livelihood strategies, first distinguished by life cycle, and then by the quantity and type of assets accessed and controlled, and the type of markets they can link to. Figure 2 shows for 1998-199 that there are four different groups, the elderly, those that have a great source of income from crop production, and two types of dairy producers, those with a large amount of forages and another group with more labor. Our study of diversification of these strategies through time (Figure 3) shows that households that have livestock assets and participate more in dairy markets have increased their diversification through time, while those that had less access to land for forages, and have recently emphasized crops, have lost diversity. The elderly are the most vulnerable because they have low diversity and also very low income (Figure 4).

What do the results mean in terms of coping and adapting to variability? In Bolivia, 1993, a year of average rainfall, three major groups are identified. A first difference is between younger and older families, and a second among younger families between those that have improved cattle and forages, and those that practice extensive livestock production. In this year potato production was basically for produced for household consumption. Canonical correlations explores the relation between assets and income and diversity in Bolivia (Valdivia and Quiroz, 2003), and activities and income and diversity in Peru (Barreda et al., 2003). Households with high value of food crops, improved cattle and off farm employment score high in income (cash and in-kind) and negligible on diversity. Households with a combination of food crops, old age, and low labor and forages access have a positive income but a negative effect on diversity in 1993. A decrease in diversity results in increased vulnerability to climate as families rely

mostly on crops (figure 3 and 4). Vulnerability does not increase if the income source is off farm employment. The elderly relying on family networks receive remittances.

During a year of drought, 1995, households that pursue a rural strategy (Bebbington) of off-farm employment are better-off (Valdivia et al 2000), as the correlation to income is high, and negligible with diversity (Valdivia and Quiroz 2003). Cluster analysis shows that a second group of households cope within agricultural activities. This is consistent with canonical correlation findings: households with a large amount of forages and improved cattle and low off-farm employment and food crops are very diverse. Livestock and forage assets maintain diversity during drought periods, for households that don't have access to off-farm labor markets.

In contrast, 1999, an average year of rainfall following el Niño of 1997-98, identified four household strategies (Figures 2 and 4), two of dairy producer groups with different amounts of labor and forage assets, one dedicated to potato production, and an elderly group. A strategy based on food crop production is consistent with high income and negative diversity index (Valdivia and Quiroz, 2003). On the other hand, households with a high number of improved cattle and with young household members correlate with high on diversity index in the response. The results point to a tradeoff based on access to resources or assets. Household with mostly access to land for food crops may benefit in good years and lose during bad years. This has an impact on smoothing income and on assets. Only if accumulation takes place in the good years, buffers can be built for the bad. In the Andes chuño is an example of this possibility, both for home consumption and for market. This freeze dried potato can be stored for many years, and as a value added product commands higher market prices. Commercial potato production has increased through the years. It has become a strategy for a group of families that link to markets, and provides an opportunity for accumulation. For this group prices and climate variability are concerns. Households that are more diverse and have livestock and dairy activities appear to have a consistent income in years of stress, smoothing income from year to year as the diversity indexes show (Figure 5).

Two major differences exist between findings in Bolivia and Peru (Valdivia 2003; Barreda et al 2003). In the case of cluster analysis in Peru we find that although there are income differences between groups in both communities, there are no significant differences in the diversity index. Canonical correlation results are consistent with this, and also highlight that households that only diversify within crops are more vulnerable, and households that only exhibit capacity to produce for consumption, although diverse, are not able to accumulate income. On the other hand, as off farm and less covariant activities exist in the portfolio, a greater level of income identified (Barreda et al. 2003), but off-farm employment has consequences on local knowledge as will be shown in the next session.

LESSONS FROM LOCAL KNOWLEDGE, NETWORKS, AND INSTITUTIONS

Our analysis of local knowledge and mechanisms to access information about climate found that farmers don't incorporate scientific forecasts in their decisions because of a

preference for locally based forecasts. Previous work in more developed countries has suggested that a barrier to forecast use has been lack of understanding of probabilistic forecasts. Considerable effort has been placed on educating users on how to interpret these. Figure 4 shows an example the local knowledge networks (San Jose Llanga in Bolivia), where information on local climate forecasts flows from experts, the nodes, to other members of the community. The main nodes are potato producers, and there are intermediary nodes most dairy producers that observed the main nodes, and are observed by others in their own neighborhoods.

Understanding probabilities does not seem to be the main barrier in the Altiplano. The local forecasters that producers trust use techniques that include an intuitive approach to probabilities (Espejo et al 2003). Local forecasters are potentially the conduit by which forecasts could reach producers. If local experts believed in the accuracy of scientific forecasts, this information would be incorporated into their predictions. In the case of Altiplano producers, the widespread belief that forecasts are only valid for the location in which they are generated is the major barrier to forecast use. Improvements in the communication of forecasts will not lead to increased use of forecasts, unless there is a way to overcome this belief. These results emphasize the importance of working with local experts and with validating down-scaled forecasts.

The current research suggests that we should modify some of our beliefs about indigenous/local knowledge. It has long been noted by anthropologists and folklorists that traditional knowledge disappears with modernization and the incorporation of indigenous peoples into global and national economic systems. Traditional knowledge becomes confined to the elderly and is lost when they die. The situation found in the three communities examined suggests that these ideas need to be modified. Although local climate experts are elderly, the knowledge of traditional forecast indicators is not limited to this cohort of individuals. Knowledge of traditional indicators remains widely distributed across age and economic groups. The ability to manage multiple, sometimes contradictory, indicators is being lost however. Almost all of the local experts were nearly full time farmers who spent nearly all of their time in their villages working on their farms. People with off-farm or non-farm activities did not spend sufficient time in the field to develop accurate forecasts and people who were primarily livestock producers were not as interested in forecast information. In short one of the techniques that farmers use to deal with risk, income diversification off the farm, is undermining their abilities to forecast climate risk.

ADAPTATION

There is a diversity of livelihood strategies even in one community. Farmers have been coping and adapting to climate variability and other stressors. Our research shows that interactions between structures (markets and government policies) and climate may result in increased vulnerability through time for households constrained by assets, increasing vulnerability to shocks. While some farmers benefited from policies such as incentives to dairy production in the Altiplano, others could not and focused on commercial potato production as markets grew. These farmers do take into account climate forecasts, but

only locally generated ones. They have less choices and insurance mechanisms, but have some flexibility in adjusting planting and varieties. These households experiment and have incorporated new varieties in their portfolio of crops. New technologies on the one hand require new management knowledge, as well as understanding of the interactions with climate. This creates an opportunity for collaborating in the production of knowledge to inform decisions.

The development of dairy production demonstrated that new technologies with supporting policies, institutions and secure markets make farmers less sensitive to climate variability, have provided opportunities for some rural households to incorporate activities less sensitive to climate variability. These households are more diversified in non covariant activities, and still pursue local knowledge forecasts for potato planting, as they also plant this crop. These households can assume the risk of loss when climate stress or shock takes place. Secure dairy markets has allowed these farmers access to credit that protects them against crop losses. Political unrest and privatization though are current concerns in this group. Our study in Peru and Bolivia showed that households with various strategies accessed local knowledge forecasts, but those that managed the indicators were expert potato producers. It also suggests that institutions (rules of the game, organizations, and networks) are a vehicle to facilitate coping and adapting, but a disconnect exists between them and local rural people. Changes in government, such as des-centralizing decisions and resources allocation are creating an opportunity in Peru and Bolivia to strengthen institutions and build capabilities to adapt. But this requires a dialogue. Because traditional knowledge is still widespread and because it uses some indicators that have a scientific basis, the best way to improve and to communicate forecast information is probably through a partnership with local experts.

Our study finds that locality is what matters in useful climate information. Local scale information tools act as a means to facilitate communication and discussion of forecasts, creating for learning about perceptions of risks, and measurable outcomes of new technologies and climate variability. Our experience is that these spaces contribute to a mutual process of learning and agency of rural people and institutions working to produce new knowledge and information.

ACKNOWLEDGEMENTS

The Office of Global Programs, National Oceanic and Atmospheric Administration provided partial funding for this research through grant NA96GP0239. We are grateful for their support. We also would like to acknowledge the SR-CRSP, USAID Grant no. 138-G-00-0046-00, Sustainable Agropastoralist Systems in the Andes, for 1995 data collected. We are especially grateful to the people who accepted us, and to Ramiro Carrillo for his outstanding work, and who we miss.

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Figure 1: Livelihoods Framework

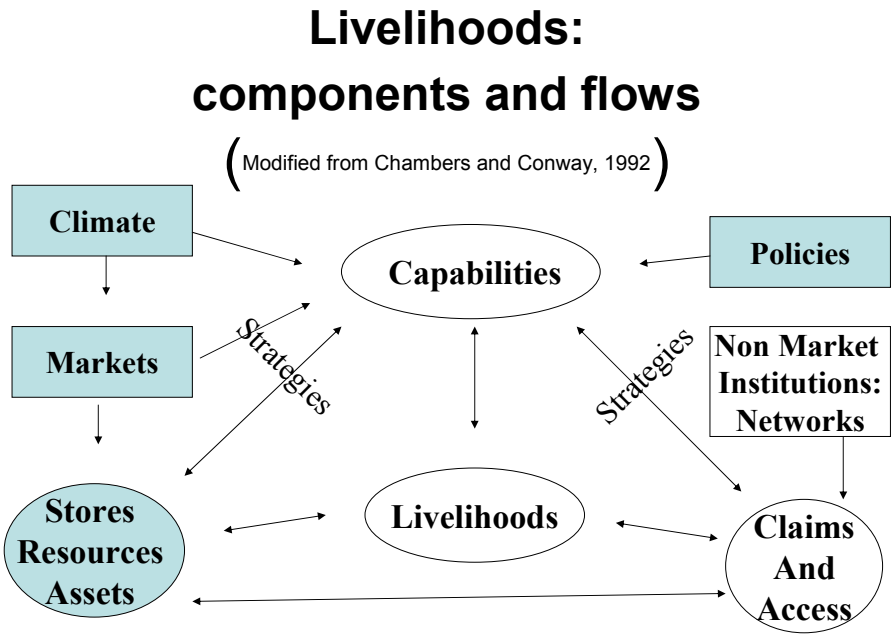
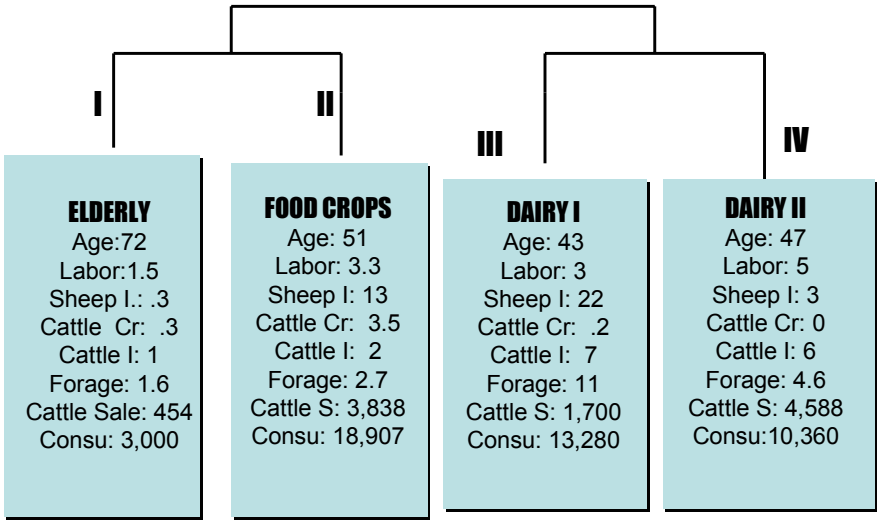


Figure 2: Livelihood Strategies in San Jose Llanga: Cluster Analysis



Dendogram San Jose: Cluster Analysis,1998-1999 (N=45)

Figure 3:

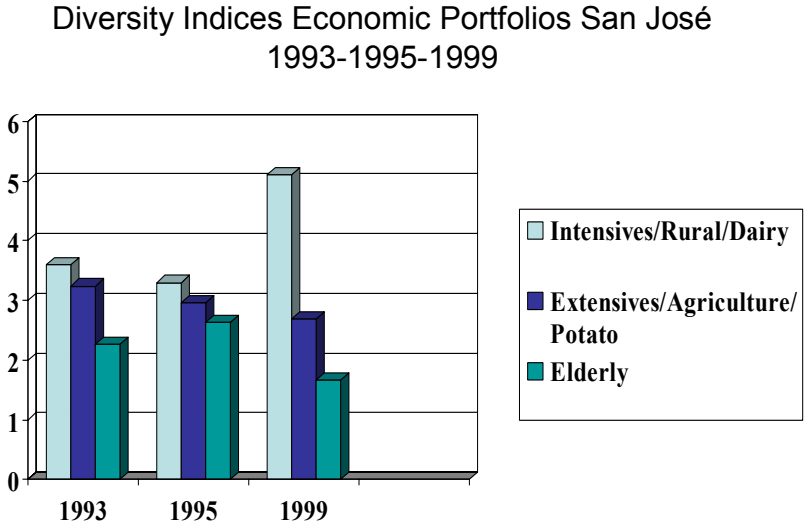


Figure 4:

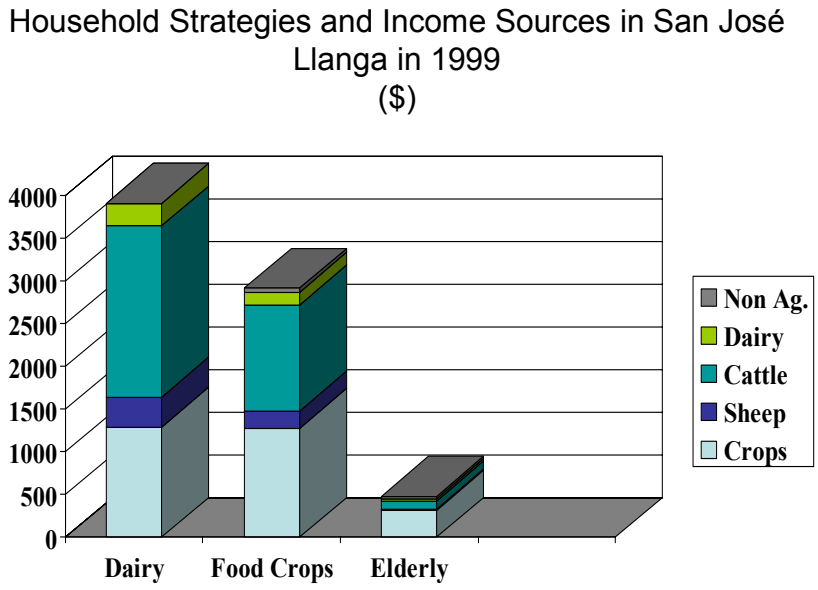


Figure 5: