WHAT IS THE IMPACT OF LIVELIHOOD STRATEGIES ON FARMERS' CLIMATE RISK PERCEPTIONS IN THE BOLIVIAN HIGHLANDS?

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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled:

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To Mom and Dad, Robert and Norma Rees, Thank you for all of your love, support and encouragement throughout my academic journey.

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ABSTRACT

The Andean Highland region in Bolivia possesses a harsh climate environment that is highly variable. This study combines risk perception literature and livelihood strategy literature to examine climate risk perceptions. Studying the risk perceptions of the Aymara people can give policy-makers an understanding of the people's perception of risk, allowing them to make better climate adaptation polices aimed at the individuals.

The analysis uses survey data collected through interviews of 330 households in the municipalities of Ancoraimes and Umala in Bolivia. Ordinary least square models are used to examine the relationship between climate risk perceptions and the factors of dread and unknown, along with livelihood risk management strategies. In this study, it is found that lower dread feelings are significantly related to lower climate risk perceptions, supporting the findings in the risk perception literature. In addition, the study shows that diversification through raising crops, sheep and dairy and having off-farm income significantly reduce climate risk perceptions. Climate change adaptation polices should support farmers' livelihood diversification and off-farm farm income risk management strategies. This study shows that differences in perceptions of climate events differ within the communities of Umala and Ancoraimes. This suggests that climate adaptation policies should be flexible to include spatial diversity defined by geography and markets.

Chapter I

INTRODUCTION

Problem

Agriculture production decisions are made in the face of uncertainty and risk. Agriculturalists face uncertainty through natural hazards, the market, social environment and government actions (Ellis, 1988). "Uncertainty refers to situations where it is not possible to attach probabilities to the occurrences. The likelihood of their occurrence is neither known by the decision maker nor by anyone else (Ellis, 1998, p. 85)." "Risk is restricted to situations where probabilities can be attached to the occurrence of events which influence the outcome of a decision-making process (Ellis, 1998, p. 84)." Risk refers to individuals using subjective probabilities to make their decision (Ellis, 1998). This study looks at how livelihood strategies impact climate risk perceptions. Climate risk perceptions consist, of both, risk and uncertainty; there is an element of risk from frost, hail, flood and drought events, while climate change in general is an uncertain event.

The industry of agriculture is unique compared to other industries, because production depends on climate and weather conditions, which introduces an element of risk. Risk is defined as the ability to tie an objective probability to an event assuming that the individual has the proper information (Ellis, 1988). Risk is typically calculated by technical analysts. A farmer's decision is based upon their subjective view of the risk of an event, not the actual objective assessed risk (Ellis, 1988). For example, patterns of

frost are important to farmers planting decisions; however, a farmer will use his/her personal knowledge of the likelihood of frost, instead of purely historical averages of frost models. Since, individuals make subjective risk analyses known as their risk perceptions, there is a difference between a layperson's estimate of risk and the actual objective risk calculation (Slovic, 1987). The closer one's risk perceptions are to the actual risk level the more near they are to full information, allowing them to make more efficient decisions.

The Andean Highland region (Altiplano) in Bolivia possesses a harsh climate environment. The climate variability is created by the large variations in temperature, frost dates, precipitation, and lengths of drought occurrences during the growing season (Francois, Bosseno, Vacher & Seguin, 1999). The study is based in the municipalities of Ancoraimes and Umala. Participatory research in the municipalities of Ancoraimes and Umala, indicates three general conclusions concerning local climate change (Valdivia, Jimenez & Romero, 2007). Individuals in the area believe the climate is changing to be hotter and drier (Valdivia et al., 2007). In addition, they believe that the weather is less predictable (Valdivia et al., 2007). The individuals also believe that events, such as rain are more extreme and intense (Valdivia et al., 2007). The region's inhabitants mostly sustain themselves through production agriculture; the returns are greatly affected by the variable climate events.

Crops that are typically grown in the Altiplano region consist of potatoes, quinoa and barley. In addition, some individuals raise livestock that include cattle, alpacas and sheep. Potato production is the most important crop (Hijmans, 1999). However, potato crops have a high production risk of being affected by drought, hail and frost (Hijmans,

1999). Some families who are unable to adapt to the harsh climate have migrated to lowland regions (Valdivia & Gilles, 2005).

Individuals' in the Altiplano region live in a highly vulnerable environment. Vulnerability refers to the risk of one's livelihood collapsing due to a shock event, such as a flood or drought (Ellis, 1998). "The notion of vulnerability is further captured by reference to the resilience and sensitivity of the livelihood system, where resilience means the ability of the system to absorb change or even utilize change to advantage; while sensitivity refers to the susceptibility of the natural resource base to change following human interference" (Ellis, 1998, p. 14). Resilience refers to a household's ability to cope and recover when faced with a shock, while sensitivity refers to being susceptible to a shock. A livelihood consists of one's capabilities, assets and entitlements. The individuals in the Altiplano have livelihoods that are highly vulnerable because they are highly sensitive to weather events.

Livelihood management strategies can reduce vulnerability by increasing one's resilience to weather shock events. Households can increase their resilience by engaging in ex-ante risk management strategies. These include diversifying one's portfolio, by engaging in non-covariant activities (Valdivia, Dunn & Jette, 1996). This can include having off-farm income and livestock. The peasant economy consists of imperfect or incomplete markets[1], interconnected production and consumption decisions and

[1] "-capital markets are fragmentary or non-existent, credit obtained from local landlords, merchants, or moneylenders rates of interest which reflect the individual circumstances of each transaction, not a market clearing condition;
-credit and rates of interest may be tied to other factor prices like land and labour within a dependent economic relationship, thus factor markets may be locked together contractually rather than being independent;

households performing multiple activities due to the nature of their economy. The final characteristic of a household economy is that households with low income levels are very susceptible to shocks that could put them below the subsistence level. This is why these economies do not respond in the same way as those that are integrated to markets because they don't have the mechanisms provided by the market to help them deal with shocks.

In the Altiplano region, there is no insurance mechanism to allow them to cope when a climate event occurs. According to Morduch (1995), if households know that they can't obtain insurance, then it is more likely that they will use income smoothing strategies to manage the risk before it occurs. This can be accomplished by diversifying one's portfolio with off-farm income. Another coping mechanism that is expected in a household economy is consumption smoothing (Morduch, 1995). The strategies include: borrowing, saving, depleting assets and using formal and informal insurance mechanisms (Morduch, 1995). Non-agricultural income and cattle have been used as an income smoothing strategy in the Andes region (Valdivia & Quiroz, 2001). Individuals build their land and animal assets, allowing them to smooth consumption in the Altiplano (Valdivia, 2004). Specifically, it has been shown that sheep in the Altiplano region have been used for consumption smoothing (Valdivia & Quiroz, 2001).

This study aims to identify individuals' risk perceptions to floods, drought, hail, frost and climate change. The relationship between an individual's risk perception and

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-variable production inputs may be erratically available or unavailable, their quality may vary, access to them may involve formal or informal system of rationing;
-market information is poor, erratic, fragmentary and incomplete, and there is a high cost for the farm household in acquiring information beyond the immediate confines of village or community;
-a freehold market for land does not always exist, and where it does non-market rights of access or non-price forms of tenancy are likely to predominate over open market transactions in land;
-markets and communications in general are not well integrated and depending of isolation between local communities, regions, and the more developed segments of the national economy" (Ellis, 1988; p. 12).

their risk management strategies can be examined. In order to propose alternatives that decrease the Altiplano's inhabitants' vulnerability, we must better understand how one's livelihood strategy is constructed. This consists of understanding the connection of one's risk management strategies to his or her risk perceptions. If an individual is practicing a risk reducing management strategy, it is expected that the individual would have a lower perception of risk to climate events than someone not using or who doesn't have that risk management strategy option. This information can be used to evaluate if individual's livelihood strategies are making them more resilient to risk as in the capacity to recover from a shock, which is the goal for many development institutions. If this isn't the case, then it would be important to investigate the reasons because maybe the individual isn't able to manage the risk, or the strategy may not actually be a risk reducing strategy.

According to Morduch (1995), if better coping mechanisms are available to households, then we would expect more efficiency in production because there are high costs associated with imperfect insurance and credit markets. When households don't have to set aside resources in order to cope with events and instead invest all the resources in production, allowing them to achieve higher efficiencies in production. It is necessary to understand which livelihood strategies lead to a reduction in perceptions of risk, as these strategies may point to more efficient coping mechanisms.

This study will try to identify the risk management strategies that individuals use to reduce their vulnerability to climate risks. It will be investigated whether personal risk communication networks are related to one's risk perceptions. By having an understanding how these individuals manage their climate risk perceptions, this can lead

us to better identify policies that can be directed towards aiding in their risk management strategies.

The importance of the study of risk perception research lies on the assumption that policy-makers need a basic understanding of risk perceptions of the individuals that the policy is aimed (Slovic, 1987). This allows policy-makers to have a basis to anticipate responses and improve their communication of the risk with the individuals (Slovic, 1987). This is critical in terms of developing policy to aid in adaptation to climate change.

Objectives

Main objective- Understand how farmers' climate risk perceptions are impacted by livelihood strategies; where perceptions are linked to their assets (financial capital and social capital) within their livelihood

Specific objective 1- Identify and describe farmers' climate risk perceptions of climate hazards and identify differences by gender and region

Specific Objective 2 – Determine the factors that explain risk perceptions among farmers in the Andes

Chapter II

LITERATURE REVIEW

The literature review will encompass peasant economy, livelihood strategies and risk perception literature. These three areas are key to this study. The peasant economy literature describes the type of economy that households in the Bolivian Highlands live within. The household is the unit of analysis in this study. This study uses the livelihood risk management strategy literature to explain climate risk perceptions, along with the factors identified in the risk perception literature.

Peasant Economy

The Peasant Economy will be one part of the framework used to encompass the contextual environment surrounding the analysis. A household is a social unit defined by "the share of the same abode or hearth" (Ellis, 1993, p. 14). Households are assumed to pool resources and decisions are made mutually by the adults of the household (Ellis, 1993). The household economy is defined by imperfect or incomplete markets, interconnected production and consumptions decisions, household performs multiple activities and households are vulnerable to economic shocks. The household economic model deals with the issue of jointness in production and consumption, partial market integration and safety net mechanisms that don't rely on the market institution; which characterizes the Bolivian Altiplano region.

The first characteristic of the peasant economy is that households make their decisions in an economic environment of imperfect or incomplete markets (Dunn, Kalaitzandonakes & Valdivia, 1996). "This means that many resource and output

markets may be missing, or may not function well (Dunn et al., 1996, p. 5)." Often in rural areas in developing countries, credit and insurance markets do not run properly or do not exist (Dunn et al., 1996). "[If] these markets are incomplete, production and consumption decisions are interlinked and the household must rely on a variety of non-market relations and risk management strategies to fill this void" (Dunn et al., 1996, p. 5).

Another defining condition of household economics is that production and consumption decisions are interlinked.

> Production and consumption considerations are considered simultaneously when the household is deciding how to allocate its resources, such as labor and capital, to the set of possible production activities aimed for the market or for home consumption. This interaction between consumption and production may result in decision about each individual enterprise that differ from the predictions of standard neoclassical theory (Dunn et. al., 1996, p. 5).

Since production and consumptions decisions are interconnected, this causes shocks to affect not only production but also consumption (Dunn et al., 1996). This connective cycle is exhibited when households try to maintain a certain consumption level, which affects the production choices (Dunn et al., 1996). The linkage between consumption and production in the peasant economy for low-income families creates a strong relationship between a good production year and the family's well-being (Dunn et al., 1996).

The third characteristic of household economics is that these households with lower revenues tend to perform multiple production activities (Dunn et al., 1996). "Some of these activities are oriented toward home consumption, others are for both consumption and sale, while other activities are intended exclusively for the market"

(Dunn et al., 1996, p. 6). These households engage in agricultural production and may have a job to earn wages (Dunn et al., 1996).

According to Dunn et al. (1996), there are four main reasons why households perform a number of production activities. The household may need to engage in more than one activity in order to earn sufficient income (Dunn et al., 1996). This means that there may not be a single activity that the household can put their resources towards that will be productive and provide enough profit to provide for the entire family (Dunn et al., 1996). The second reason may be because many agricultural activities are seasonal, so the family may need to engage in other activities in order to have a more constant stream of income (Dunn et al., 1996). The third motivation is that a household that is in a rural region of a developing country will usually need to produce goods and services for use in the home, while still needing to earn money to buy products that they are not able to produce (Dunn et al., 1996). The fourth reason is that it may simply be too risky economically for a household to only engage in one activity (Dunn et al., 1996). Many of these households have no access to credit or insurance markets, so they must bear their own risk (Dunn et al., 1996). This is why many households perform several activities, so that they have a more diversified portfolio, so that they can spread out their risk (Dunn et al., 1996).

The final characteristic of the peasant economy is that the households are more susceptible to risk. Households with low income, few assets and ineffective or no risk management strategies are open to face severe consequences from a sudden shock.

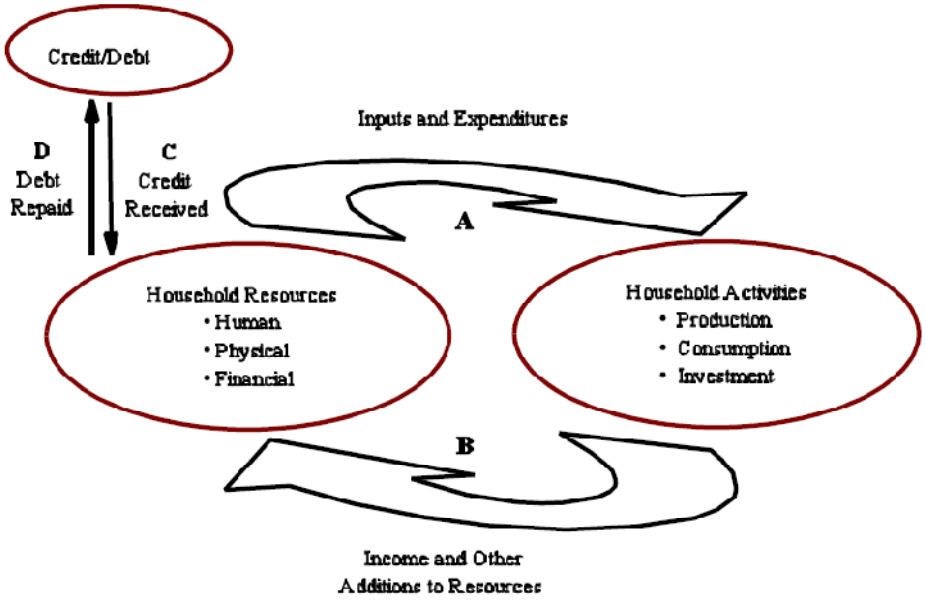
The household economic portfolio is defined by "the circular flow of interaction between household resources and household activities" (Dunn et al., 1996, p. 7). The household economic portfolio is shown in figure 1.

Household resources include human, physical and financial resources available at a certain time for use, whether being through the means of ownership, borrowing or other methods (Dunn et al., 1996). Human resources are the labor and skill of the members of the household (Dunn et al., 1996). Physical resources include the assets of the household, which may consist of land, machinery, inputs, livestock and buildings (Dunn et al., 1996). Financial resources may include cash, bonds and other liquid assets (Dunn et al., 1996).

A household performs certain household activities that include production and consumption activities, as well as other investment projects that a household engages in at a certain time (Dunn et al., 1996). Consumption activities are thought to meet the needs of a household, such as food and clothing (Dunn et al., 1996). Production activities include household activities and outside work (Dunn et al., 1996). Household maintenance activities include any activity that creates a product or service that is solely for household consumption; this would include child care.

Figure 1 represents how the household must have resources in order to produce household activities; this is shown by the arrow denoted by A. Arrow B demonstrates how the household activities contribute to the household resources. The C arrow and D arrows show how credit/debit can either positively or negatively affect the household's resources at a given time. When credit is available, this allows the household to smooth consumption when needed (Dunn et al., 1996).

Figure 1- Conceptual Model of the Household Economic Portfolio



Source: (Dunn, E., Kalaitzandonakes, N., and Valdivia, C. (1996). *Risk and the Impacts of Microenterprise Services.* Manuscript submitted to USAID by the AIMS Project for publication, p. 8)

Livelihoods Strategies

Livelihoods are created by livelihood resources which include: natural capital, financial capital, human capital and social capital. An individual creates livelihood strategies by recognizing their livelihood resources. Livelihood strategies can take the form of agricultural intensification, diversification and migration. These strategies can create a sustainable livelihood. Sustainable livelihood outcomes can include: poverty reduction, improved well-being, improved capabilities, livelihood adaptation, enhanced resilience and natural resources that are sustainable (Scoones, 1998). Chambers and Conway (1992) state that sustainable livelihoods can be developed by building capability, equity and sustainability in order to cope with shocks; thus, reducing the risk that a shock could cause.

The household's management of risk can be divided into two main categories that include ex-ante and ex-post management. These management strategies are part of a household's livelihood strategy. One part of livelihood strategies includes how the household manages risk. Ex-ante management refers to using strategies to cope with risk before the event occurs, while ex-post management refers to activities to deal with a risk event after it has already occurred.

One method of ex-ante risk management is known as income smoothing. Morduch (1995) states that this can be accomplished by diversifying one's portfolio (Valdivia et al., 1996), along with engaging in conservative production and jobs. Morduch (1995) points out that the neoclassical assumption of complete markets assumes away the necessity of income smoothing. One diversification strategy for a household is to engage in activities that create equilibrium between risk and anticipated profits (Morduch, 1995). Off-farm income can provide another avenue to diversify the household portfolio (Morduch, 1995). Another risk reduction strategy is for a household to sustain communal relations, which can allow them access to others' resources (Dunn et al., 1996).

A method of ex-post risk management is known as consumption smoothing. Morduch (1995, p. 104) states that "households can smooth consumption by borrowing and saving, depleting and accumulating nonfinancial assts, adjusting labor supply, and employing formal and informal insurance arrangements."

The least dangerous strategies for the households are using "insurance and reversible mechanisms, such as increased labor sales, temporary migration for employment, and reduced consumption, to deal with income loss" (Dunn et al., 1996, p.

ix). In addition, the liquidation of assets that are used as a storing value is another less devastating strategy (Dunn et al., 1996). These types of management all have the same characteristics of being reversible and have a small impact on the potential earnings for the household (Dunn et al., 1996).

Households can smooth consumption by decreasing their productive assets (Dunn et al., 1996). This includes the strategy of liquidating livestock (Valdivia et al., 1996). However, the liquidation of productive assets can put the household in even greater economic risk in the future; since they are getting rid of some of their income generating assets (Dunn et al., 1996).

If none of the previous loss management strategies are possible or they have been exhausted, then the household may actually try to rely on charity and/or break up (Dunn et al., 1996).

Risk Perception

Individuals form intuitive judgments about potential risk hazards (Slovic, 1987). These judgments are commonly known as one's risk perceptions. Everyone develops their own individual perceptions about many topics. In this study the individuals' risk perceptions to climate events are examined.

Cognitive psychologists have found that lay person's estimates of risk are not in accordance with actual calculated risk (Slovic, 1987). The majority of people rely on intuitive risk judgments, called "risk perceptions" (Slovic, 1987). People base their perceptions upon their personal experiences, knowledge and character (Raden-Fessenden & Heath, 1987). This study will use experience with dealing with climate event hazards.

In addition, one's information network will be used to represent one's knowledge. People tend to overestimate small risks, while underestimating large risks (Sjoberg, 2000). Most people view all current levels of risk as unacceptable (Slovic, 1987).

The first studies of risk perception research focus on public perceptions of technological hazards, such as, nuclear power and pesticides (Slovic, 2000). Researchers find it difficult to collect data on risk and benefits (Slovic, 2000). It is hard to collect data because actual risks and benefits are hard variables to measure. This spurs Slovic (1987) to develop an easier method to collect data on risk perceptions, by using questionnaires to directly ask individuals about their perceptions of risk (Slovic, 2000). This method is developed because it allows data to be gathered in large number with current perceptions. He applies the personality theory to hazards; this is known as psychometric research. The personality theory refers to individual's associating characteristics, such as dread or unknown, towards an event. Slovic further develops Starr's (1969) method that hypothesizes that an individual's personal viewpoint of a hazard would influence one's perceptions (Slovic, 2000). He finds that the individual's risk perceptions is "systematic and predictable" (Slovic, 2000, p. xxiii).

Studies show that perceived risk is affected (Slovic, 1987; Slovic, Fischoff, & Lichtenstein, 1985) by the characteristics of the actual risk, and can be predicted through quantitative methods (Marks et. al, 2003). Slovic's 1987 model "provide[s] the framework for a quantitative model of risk perception" (Marks, Kalaitzandonakes, Allison & Zakharova, 2003, p.3). Slovic (1987) uses two factors to group risks. The first factor is the degree that the risk is a *dread,* defined "at its high end by- perceived lack of control, dread, catastrophic potential, fatal consequences, and the inequitable distribution

of risks and benefits" (Slovic, 1987, p. 283). The second factor is the degree that the risk is *unknown,* defined "at its high end by hazards judged to be unobservable, unknown, new and delayed in their manifestation of harm" (Slovic, 1987, p. 283).

The factors of unknown and dread are closely related to one's perception of risk (Slovic, 1987). According to Sjoberg (2002), the psychometric model is risk perception being a function of the properties of the hazard, which include Slovic's (1987) factors of dread and unknown. Slovic applies the psychometric paradigm successfully to a useable risk model. Risk perceptions are highly correlated to dread, consequence severity, and unfamiliarity with a hazard (Sjoberg, 1996; Slovic, 1987). This model has been found to explain 20% of the unexplained relationship between the factors (dread and unknown) and risk perceptions (Sjoberg, 2000). This points to the need for more research to find other determinants of risk perceptions.

One must understand that Slovic's model analyzes why people judge risks differently (Sjoberg, 1996). Other researchers point to a limitation of this model is that it doesn't explain why people judge the same risk differently (Sjoberg, 1996).

There are other theories that have been used to explain risk perceptions. The theories included are: social cognitive, social amplification, cultural, cultivation, knowledge, prospective reference, Bayesian learning, and social learning.

The social cognitive theory is based on Bandura's (1986) belief that one's actions are controlled by that person's evaluation of their behavioral possibilities. Weigman and Guetteling's (1995) research apply this theory to show that more feelings of insecurity and fear are found in women, in individuals with a liberal perspective and individuals

who are highly exposed to media reports of hazards. This points that access to information can influence individuals' perceptions of risk.

The social amplification theory states that the way people see risks is influenced by their values, attitudes, social influences and cultural identity. When an event occurs, the message is interpreted and individuals respond to the risk information. The individuals act as an amplification station through their behavioral and communication reactions in response to an event (Renn, Burns, J. Kasperson, R. Kasperson & Slovic, 1992). So individual characteristics such as gender or education may influence how individuals' perceive and react.

Five variables that have been used to measure the amplification process include physical consequences, press coverage, individual perceptions, public response and socio-economics (Renn et al., 1992). Renn et al. (1992) found moderate correlations between media coverage and risk perception variables. The risk perception variables includes future risk, dread, managerial incompetence and blame (Renn et al., 1992). The media coverage variables include number of stories, duration and half life (Renn et al., 1992). Half life is defined by the amount of time taken for half of the total stories about an event to appear (Renn et al., 1992). The individual's perceptions of risks of that study are rated by University of Oregon students, which is a limiting factor in the study.

Cultural theorists believe that individuals choose what to fear in order to support their lifestyle (Wildavsky, 1990). The cultural theory developed by Douglas and Wildavsky classifies people as egalitarians, individualists, hierarchists, and fatalists to determine people's risk perceptions. They believe that egalitarians are more concerned with risk from technology and the environment, while individualist care more about the

risks from war and market failure. Hierarchists are more inclined to care about risk associated with law and order, while fatalists don't fit into any of the previous classifications. Cultural theory accounts for 5-10% of the unexplained relationship between people and their risk perceptions (Sjoberg, 2000). However, when the cultural aspect is added to the psychometric model, there is no additional explanatory value added (Sjoberg, 1996). So culture may or may not matter in influencing risk perceptions.

The principal of the cultivation theory is that television portrays the world as dangerous. This confirms that individuals with high television exposure develop stronger risks perceptions (Grandy, 2001). One must realize that this theory only describes one type of medium. Hirsch has added a modification to this theory. He states that cultural values disseminate through television strengthen perceptions (Sjobert & Wahlberg, 2000).

The knowledge theory states that if an individual perceives an act as risky this is because they have the knowledge that there is an actual risk associated with the act (Wildavsky, 1990). This next theory builds upon the knowledge theory. The prospective reference theory states that the perceived risk is a weighted average based on one's information about a risk (Smith, Kerry, Johnson, 1988). The Bayesian learning models assumes that one's risk perceptions depend on the information one has at a certain time (Smith et al., 1988). The social learning theory is based on the idea that learning is not only done by doing, but also by watching (Sjobert & Wahlberg, 2000). Learning by doing, such as one's experience in dealing with shocks influences their perceptions. An example of learning by watching others is when individuals use local indicators/knowledge to understand how to manage under climate variability.

The research of risk perceptions has included specialized studies of gender. Men and women perceive different risks and have different meanings to the same risks (Gustafon, 1998). Gender is associated with differences in risk perceptions (Weber, Blais, Betz, 2002). Overall, women have higher risk perceptions of the same incident than men. However, this is more specifically found in studies of white populations (Finucane, Slovic, Mertz, Flynn & Satterfield, 2000; Flynn, Slovic & Mertz, 1994). It is found that race and gender differences in the United States can be accounted to the fact that 30% of the white male population judge risks to be low (Flynn et al., 1994). The study finds that white men differ the most in their perceptions of risk than compared to everyone else (Flynn et al., 1994). In addition, individuals of color have higher perceptions of risk than white people (Finucane et al., 2000). No gender differences are identified among non-white men and women (Flynn et al., 1994).

Weber et al. (2000) cites Gustafon's (1998) review of the gender risk perception literature saying that differences in risk perceptions among gender is because of gender ideology, social roles and activities that gender groups participate in. In order to understand gender and racial difference, studies need to be conducted that look into sociopolitical influences instead of biological factors on risk perceptions (Finucane et al., 2000). It is possible that factors such as power, status, alienation and trust can better explain risk perceptions (Flynn et al., 1994).

There is a lack of literature that has investigated risk perception of non-white ethnicities. The majority of the research has investigated perceptions of individuals that

are of European descent. This study will contribute to the literature by looking at climate risk perceptions of Bolivians.

An area related to the risk perception literature is the field of risk communication, which examines the assessment of the intentional distribution of messages of risks between risk assessors and lay people (Smith, 1988; Plough & Kirmsky, 1987). The information provides guidance to policy-makers and institutions that seek to distribute risk information with the motive of trying to correct individuals risk perception biases. The format of how the information is distributed does make a difference. Information that is presented in a quantitative form with probabilistic probabilities will reduce one's risk perception compared with a qualitative approach (Smith, 1990). In addition, education reduces U.S. citizens' risk perceptions (Smith, 1990). This should be taken into account when planning a risk communication agenda.

The idea of the risk communication field is that risk estimates of individuals are subject to biases. People believe that risk communication messages can help correct the biases. The idea of effective risk communication is that it can help people reduce their health, environmental or technological risks. The theory of risk communication depends not only on the individuals understanding the information conveyed to them, but accepting it as important to their own circumstance (Fischoff, 1998). Information that is found to be more credible is more likely to result in behavior change (Coleman, 1993). The communication of information is another factor that influences risk perceptions.

This risk perception analysis will be applied to individuals of the Altiplano region in Bolivia to explore the impacts of climate variability and change. There have been

studies that do suggest that climate change is occurring globally. There has been research looking into Bolivia's vulnerability to climate variability due to El Niño Southern Oscillation (ENSO) and to climate change. A study that examines station data in the Central Andes shows an increase in the trend in maximum temperature and lack of trend in annual precipitation (Garreaud, Vuille and Clement, 2003)

There is extensive research on how rural livelihoods can become sustainable. Sustainable livelihoods can be created by developing individual's capacities that may lead to equity (Chambers & Conway, 1991). An individual's knowledge base of climate information will influence their climate risk perceptions. It is important that individuals have reliable climate information in order to create their climate perceptions. Risk perception analysis shows that there is a positive correlation between dread and the unknown factor of an event to risk perceptions. The unknown factor can be contributed to lack of information. Capacities can be built by providing individuals with current and reliable climate information. The probabilistic nature of climate information adds to the challenge of understanding and trusting it, in order to incorporate the information into the decision making process.

There are not many studies that have looked at risk perception in agriculture of developing countries. A recent study looks into farmers' risk perceptions, including climate, in Ethiopia. Factor analysis is used to identify factors influencing farmers' risk perceptions (Legesse & Drake, 2005). This study uses the theories of psychometric risk theory, cultural risk theory and the farm structural model theory (Legesse & Drake., 2005). The variables they use to represent the psychometric paradigm include education and access to information. One of their cultural variables includes gender. The farm

structure variables include asset variables, income and farm experience. They find that farmers' asset amount and diversification of their portfolio, as well as their location determine farmers' risk perceptions (Legesse & Drake, 2005).

They find this through conducting logit regression models. The dependent variables are created from a five level Likert scale measuring perceived risk occurrences and another of perceived risk consequences. The five levels represent- 1=negligible, 2=low, 3=medium, 4=high and 5=very high. The dependent variables of perceived risk occurrences and consequences are converted into a binary form with 1-3 being 0, while 4-5 equating to 1. Dependent variables of perceived risk occurrences and consequences are created for the events of drought, flooding, hail and frost. The independent variables include asset base, infrastructure, climatic zone, gender, human capital, spatial diversification, enterprise diversification, income diversification, human capital and retention capacity, information related and religion/ethic.

A further description is given on the items included within the independent variables. The asset base variable includes income, animals owned and farm size. The infrastructure variable includes information on markets, roads and information. The climatic zone variable is composed on ecological zones. The gender variable includes the sex of the household head and marital status. The human capital variable includes experience in farming and education. The spatial diversification variable includes the number of plots. The variable of enterprise diversification includes intercropping. The income diversification variable includes involvement in non/off-farm activities. The human capital and retention variable includes the items of health, family size and retained output. The information variable includes access to information. And the religion/ethnic

origin is self-explained. The input variables are created from scores from principal components through factor analysis.

In the two drought models, only one variable comes up significant in the perceived frequency risk model. Asset base is significant at the less than 10% level. The asset base variable is negative, which indicates that a higher asset base results in lower ratings of perceived risk frequencies. The r-squared value for the perceived drought risk frequency is .3, while the drought consequence model has a value of .235.

In the perceived flooding risk frequency model, the asset base variable is significant at less than 1%; however, the coefficient has a positive sign. This indicates that as the asset base goes up, so does the perceived flooding risk. The infrastructure variable is significant at less than 5%. The infrastructure variable's coefficient is negative; indicating that less infrastructure is related to higher perceived flooding risk frequencies. The climatic zone variable is significant at the less than 1% level in both flooding models. Gender is significant in both flooding models, having significance at the less than 5% level for the perceived flooding risk frequency and a significance of less than 10% for the consequence model. The income diversification variable is significant at the less than 1% level for the perceived flooding risk consequence model. The income diversification has a negative coefficient that indicates that individuals, who are able to diversify their income, have lower levels of perceived flooding risk consequences. The r-squared for the flooding frequency model was .409, while the flooding consequence model has an r-square value of .463.

In the both hail models, asset base has a significant at less than 5% for the hail frequency model and less than 1% for the hail consequence model. The hail coefficients

are positive in both models, indicating that having a higher asset base is related to having a higher perceived hail risk level. The climatic zone variable is significant at less than 1% in the perceived hail risk frequency model. The r-squared for the hail frequency model was .203, while the consequence model has a value of .249.

In the perceived frost risk consequence model, the asset base variable is significant at less than 5%. The asset base coefficient is positive in this model, indicating that a high asset base is related to a higher perceived frost risk consequence level. The infrastructure variable is significant at less than 5% in the perceived frost risk consequence model. The infrastructure variable has a positive coefficient, indicating that less infrastructure is related to having a lower level of perceived frost risk consequence. The climatic zone variable is significant in both frost models at the less than 1% level. Income diversification is significant at less than 1% in the perceived frost risk consequence model. The income diversification has a negative coefficient, indicating that as one is more diversified in their income, they will have a lower level of perceived frost risk consequence. In addition, the human capital and retention capacity variable is significant at less than 5% in the perceived frost risk consequence model. The perceived frost risk frequency model has an r-squared of .381, while the consequence model has a .392 value.

This study did not find any relationships between perceptions and human capital, and religion (Legesse & Drake, 2005). In addition, Legesse and Drake (2005) did not find a relationship between the information variable and perceptions (frost, hail, flooding and drought). The figure 2 is the conceptual framework of a farmer's risk perceptions in Ethiopia according to this study. Examination of the conceptual framework, focusing on

the direct relationship between perceived risk and factors, shows that there is a bi-directional relationship between the natural environment, asset endowment, livelihood diversification, household characteristic/orientation and institutional/policy factors. In addition, there is a relationship of infrastructure affecting perceived risks and a fuzzy relationship of perceived risk affecting infrastructure. The term fuzzy relationship is not defined by the authors; however, it appears to mean an unclear relationship. The conceptual framework also has relationships between the factors identified. This is the only known study that specified this type of model. The results from this research are comparable to the study done in Ethiopia. This will allow one to see if the determinants of risk perceptions are similar across different regions of the world, as well as different cultures.

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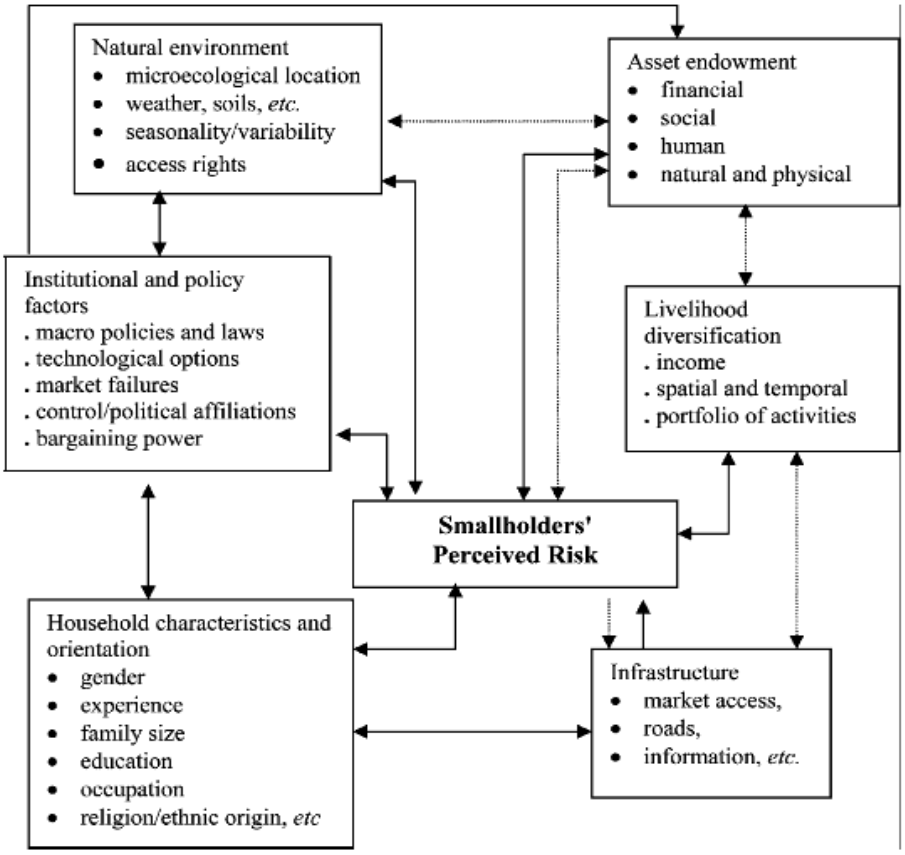
Figure 2- Conceptual Framework for a Smallholder Farmer's Risk Perception in Ethiopia



Source: (Legesse, B., and L. Drake. "Determinants of smallholder farmers' perceptions of risk in the Eastern Highlands of Ethiopia." *Journal of Risk Research* 8.5 (2005): 383-416, p. 412.)

The review of literature on the peasant economy indicates that the unit of the risk perception analysis should be at the household level. This points to the use of a model based upon household data.

The literature review of livelihood strategies points to the importance of risk management strategies within one's livelihoods. This indicates how the household's assets, diversification and access to credit are instrumental in coping or anticipating the effects of shocks, which shape the risk they face. This suggests variables that represent

access to credit, assets and diversification should be included. Diversification can be measured with other income, sheep and a diversification dummy variable.

The literature of risk perceptions contributes to the study because it points to the importance of information, dread and location, influencing individuals' risk perceptions. This literature suggests a dread component to the model. In addition, the unknown factor identified by Slovic (1987) should be included. The unknown factor can be represented by knowledge networks that make events more known, such as a Spanish speaking[2] network and outside climate information from family members- representing a traditional information source. In addition, the unknown factor identified by Slovic (1987) can include one's experience with dealing with a climate event because this knowledge will make it more known to the individual. The risk perception literature also points to differences in risk perceptions according to gender and location, which can be used in the model.

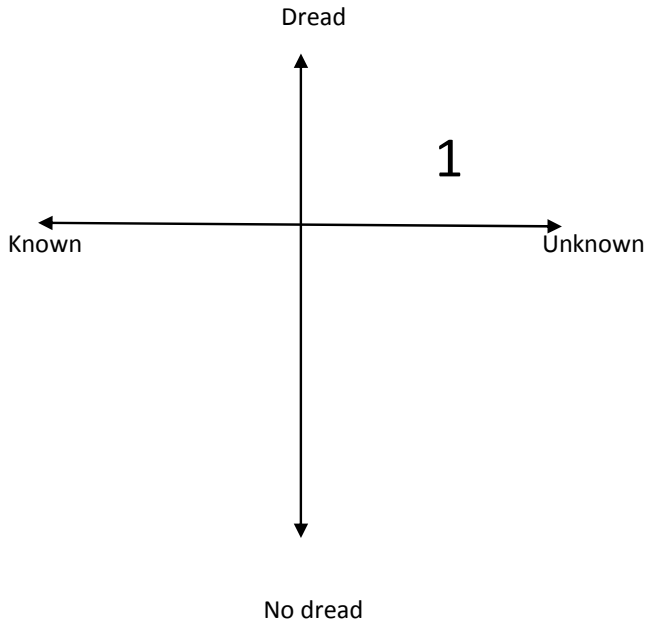
[2] Spanish is not the main language of the survey respondents. Aymara is main language of the survey respondents. 85% of individuals of the survey are able to speak Spanish.

Chapter III

CONCEPTUAL FRAMEWORK

The framework is created by combining the theory of livelihood strategies and risk perceptions. This study will incorporate livelihood strategies with Slovic's (1987) factors of unknown and dread to explain farmers' risk perceptions of people who live in a household economy. Figure 3 shows Slovic's (1987) factors' relationship to risk perception. Quadrant 1 shows where an individual has the highest perception of risk. Farmer's experience with their livelihood strategies will be taken into account to explain risk perceptions because individual's experiences play a role in their development of their perceptions (Slovic & Weber, 2002). The farmer's experience in dealing with climate events shocks is included as a mechanism for them to know more about the event- referring to Slovic's (1987) factor of unknown.

Figure 3- Slovic's (1987) Dread and Unknown Relationship to Risk Perception

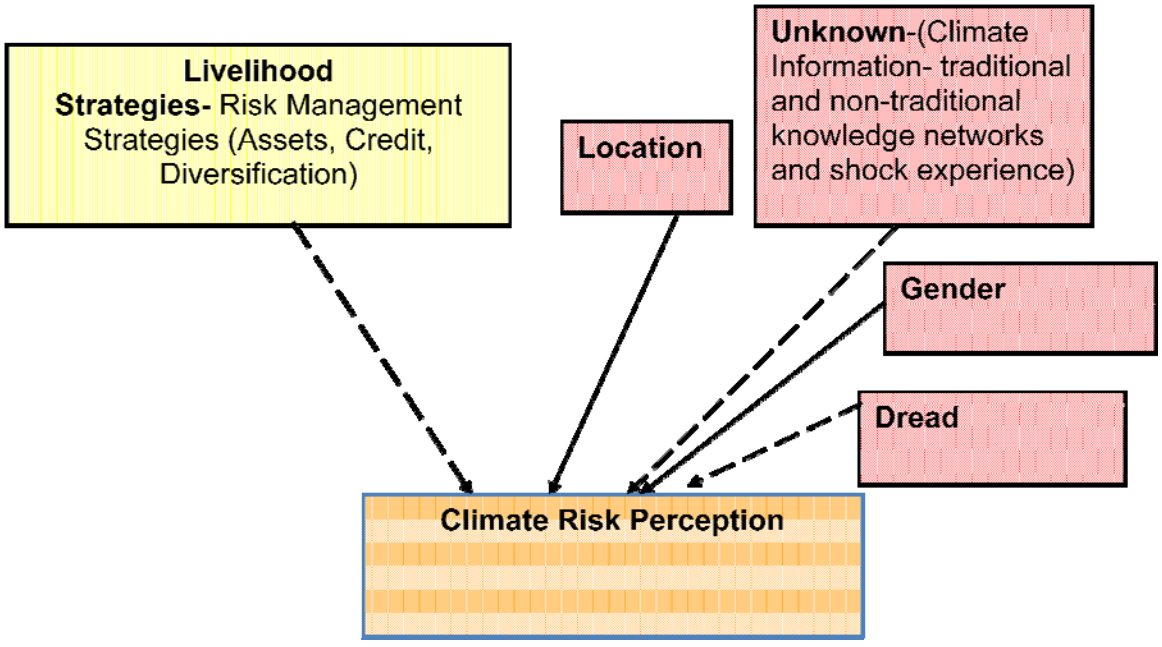


The model incorporates both of Slovic's (1987) factors and variables that represent livelihood risk management strategies. These variables will include assets, credit access and diversification. As stated by Chambers and Conway (1992) sustainable livelihood strategies are those that reduce the risk one faces when encountering a shock. An individual's perception of risk can be used to measure their level of risk to a given factor.

Figure 4 is a diagram showing the conceptual framework that will be used in this study. This study begins by using the household as the unit of analysis. First, the decision of the household depends on many factors, which include the risk environment (Dunn et. al., 1996). A household's climate risk perceptions are influenced by their experience (Slovic & Weber, 2002; Raden-Fessenden & Heath 1987) with handling the climate variability. This is represented with the dashed arrow pointing from the

Unknown box towards the Risk Perception box. Shock experience is a variable of unknown, also whether individuals get climate information from family members outside of the community and whether they speak Spanish- are all forms of climate information represented in the Unknown box. The unknown variable that enters into determining Climate Risk Perception box can be thought as one's amount of knowledge (Raden-Fessenden & Heath, 1987) they have about the climate. In addition, dread influences climate risk perceptions. This can be seen in the diagram by the arrow pointing from the Dread box to the Climate Risk Perception box. Also, location can influence one's climate risk perception. This can be seen with the arrow from the Location box pointing towards the Climate Risk Perception box. The Climate Risk Perception, Unknown and Dread boxes with the dashed arrows pointing from them to Climate Risk Perception box are the relationships that will be focused on in this study.

Figure 4- Contributing Factors to Climate Risk Perceptions



The following hypotheses are formulated from the relationship between risk perceptions and livelihood strategies bodies of knowledge. By combing the risk perception and livelihood strategies framework, it leads to these hypotheses:

Hypothesis 1: *If individuals have a diversified portfolio, then they will have lower climate risk perceptions.* The literature points to diversification as an income smoothing strategy that allows one to buffer one's livelihood against a climate shock (Morduch, 1995; Reardon, Delgado & Matlon, 1992; Valdivia, 2001). This type of strategy can help prevent the effects of a climate shock.

Hypothesis 2: *If individuals have access to credit, then they will have lower climate risk perceptions.* Being able to access credit is a consumption smoothing strategy, which allows one to deal with a shock ex-post (Morduch, 1995; Valdivia, 2004). This type of strategy can help one cope with the effects of a shock. Slovic and Weber (2002) explain how one deals with a risk, such as a climate shock, will affect their risk perception of that shock.

Hypothesis 3: *If individuals have access to climate information, then they will have lower climate risk perceptions.* One factor that Slovic (1987), identifies as an important factor in determining one's risk perception is- the unknown factor. The unknown factor can be thought of as one's knowledge. Slovic (1987) says that the more unknown a risk is, the higher one's perception of risk will be. The more access to information, the more potential knowledge one has. In addition, one can gain knowledge by their personal experience to climate shocks (Slovic & Weber, 2002). Slovic and Weber (2002) explain that one's experience in handling a risk, such as a climate shock,

will affect their risk perception of that shock. The more knowledge one has about climate risk, then the lower their climate risk perceptions will be. Knowledge can be transferred through networks (Cowan & Jonard, 2004). A network can be thought of as a communication structure (Cowan & Jonard, 2004). This is where agents are on a network and communicate with other agents who are also on a network (Cowan & Jonard, 2004). Knowledge is diffused through people's networks (Cowan & Jonard, 2004).

Hypothesis 4: *If individuals have lower dread feeling levels, then they will have lower climate risk perceptions.* Slovic's (1987) framework shows risk perceptions as a function of dread. He shows that lower dread levels are associated with lower risk perceptions. In addition, Fischhoff, Slovic, Lichtenstein, Read and Combs (1978) study shows that higher levels of dread are associated with higher perceptions of risk. Slovic and Weber (2002) state that dread is the most important factor, with the higher dread score associated with a higher perception of risk.

Location is included in the conceptual framework, as Legesse and Drake (2005) show that climatic location affects individuals' climate event risk perceptions. Since most risk perceptions studies are related to events not location specific; few studies have used location as a factor that influence risk perceptions.

This framework also includes gender because of the studies that have found differences in perceptions of risk between male and females. Research has shown that in white populations that women have higher perceptions of risk compared to men (Finucane et al., 2000; Flynn et al., 1994). Individuals of color have higher perceptions

of risk compared to white people (Finucane et al., 2000). There was no gender difference between non-whites (Flynn et al., 1994). As suggested by Flynn et al. (1994) it is possible that factors such as power, status, alienation and trust can better explain risk perceptions (Flynn et al., 1994). This study will contribute to the literature of risk perceptions by providing a study of perceptions of Aymara people in the Altiplano region in Bolivian, adding a study of a different ethnicity type to the literature. This study can show if differences do exist between genders in the Aymara people.

This research can add to the literature by incorporating Slovic's (1987) factors of risk perceptions with livelihood risk management strategies to determine individuals' risk perceptions. This study can show the relationship between all of these factors with risk perceptions. There are many studies that use risk perception factors to determine risk perceptions, while they are few studies that look at livelihood risk management strategies affects on risk perceptions. This study will combine both literatures to see the effects on risk perceptions.

Chapter IV

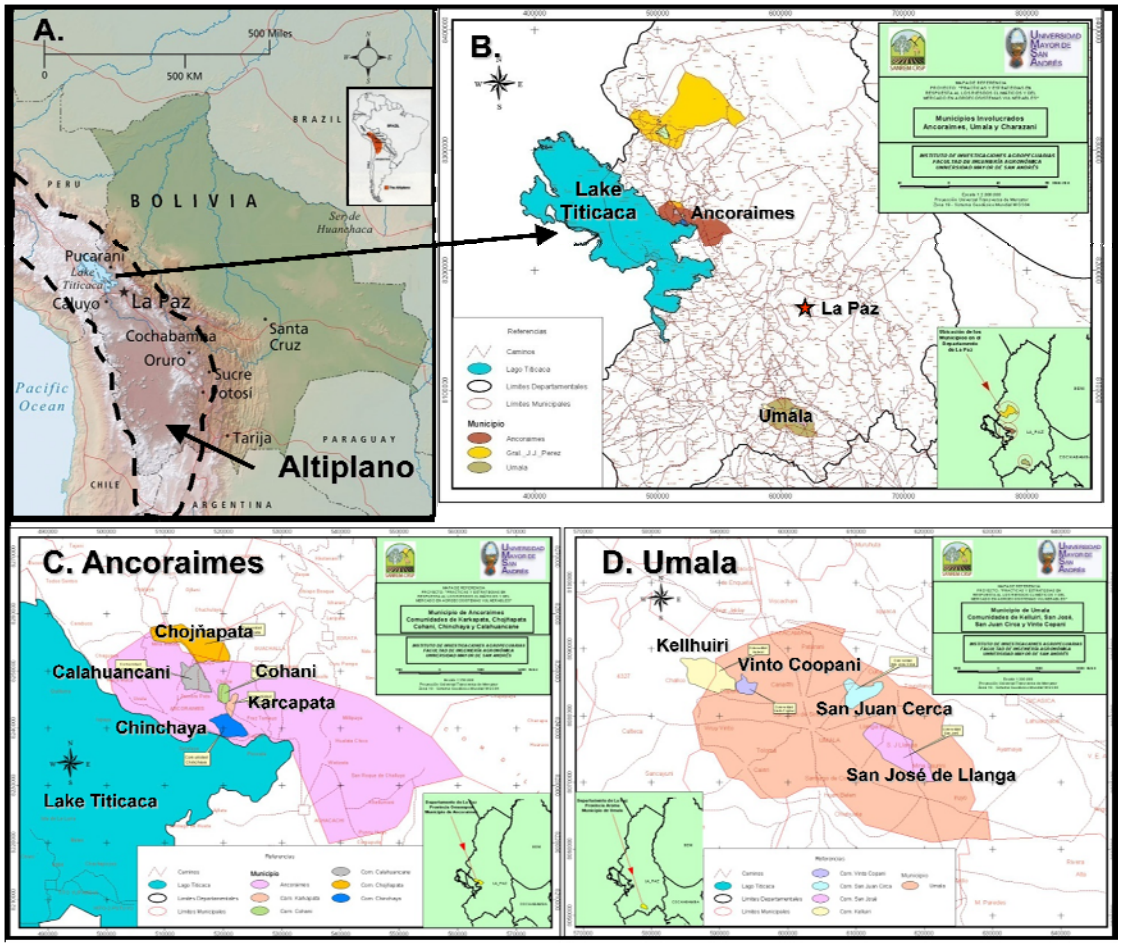
BOLIVIAN ALTIPLANO

Overview of Ancoraimes and Umala

Physical

Focus groups are conducted in the municipalities of Ancoraimes and Umala in Bolivia. Figure 5 is a map of the focus group locations. In part C of Figure 5, it is shown the locations of the Ancoraimes communities of Chinchaya (3800m), Karcapata (3850m), Chojnapata (4200m), Calahuancani (3890m) and Cohani (3860m). While in part D of Figure 5, it is shown the Umala locations of Kellhuiri (4070m), Vinto Coopani (4012m), San Juan Circa (3805m) and San Jose de Llanga (3770m). The elevation in Ancoraimes ranges from 3800m to 4200m (12,467ft – 13,780ft), while in Umala it ranges from 3770m to 4070m (12,369ft – 13,353ft).

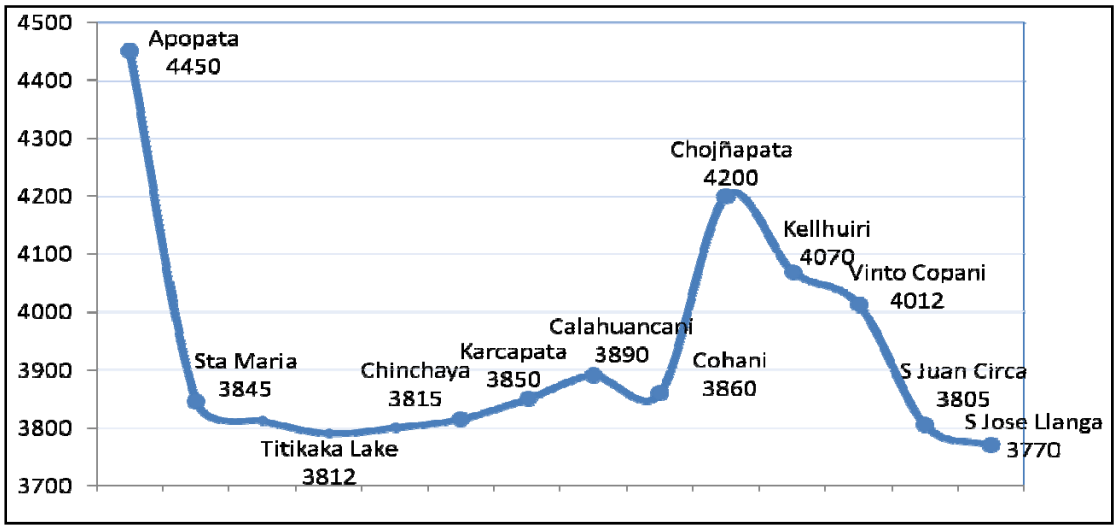
Figure 5- (A-D) Location of the Study Communities in the Altiplano of Bolivia



Source: (Motavalli, P. (2006, April 24-26). *Adapting to change: Changes in community perceptions and management of soil quality and soil organic matter*. Paper presented at the First Scientific Workshop of SANREM CRSP: Adapting to Change in Andean Ecosystems, La Paz, Bolivia. Retrieved from http://sanrem.cals.vt.edu/1125/2motavallipres4_24_06rev.ppt)

The figure 6 below shows the altitude distribution of the Umala communities (Kellhuiri, Vinto Coopani, San Juan Circa and San Jose de Llanga) and the Ancoraimes communities (Chinchaya, Karcapata, Chojnapata, Calahuancani and Cohani). The communities of Ancoraimes are located close to Lake Titicaca.

Figure 6- Altitude Distribution of the Communities of Umala and Ancoraimes



Source: (Turin, Thomas and Gilles. (2008, April 24-27). *Livelihood strategies in the Altiplano sites of SANREM's project: A comparative analysis*. Paper presented at the SANREM CRSP LTR-4 Annual Meeting, Puno, Peru. Retrieved from http://www.ext.vt.edu/cgibin/WebObjects/SANREM.woa/wa/viewMetadata?resourceID=3535)

The Garcia, Raes, Jacobsen and Michel (2007) study calculates objective risk probabilities for drought, flooding and frost. The Garcia et al. (2007) study uses data from four weather stations, which includes two representatives of the north region of the Altiplano and two representatives of the south region. They choose the representative stations to represent the agricultural regions of the Altiplano. The risk probabilities in the Garcia et al. (2007) study uses daily temperature data spanning 36 to 51 years from the four stations. If flooding is associated with their calculated very wet risk, then Belen, Viacha and Oruro, have a 2% chance of flooding (Gracia et al., 2007). However, the flooding chance in Patacamaya would be 4%. If drought is associated with very dry risk,

then the objective probabilistic risk of Belen and Oruro is 12% (Gracia et al., 2007). In Viacha, the drought risk would be 18%, while in Patacamaya there is a 16% chance of a drought each year.

Table 1- Mean, standard deviation (S.D), coefficient of variation (CV), maximum (Max) and minimum (min) annual precipitation, and frequency distribution (%) of precipitation patterns of four locations the Bolivian Altiplano

Location	Mean (mm)	S.D. (mm)	CV (%)	Max (mm)	Min (mm)	Types of Year				
						Very Wet	Wet	Normal	Dry	Very Dry
Belen	450	95	21	650	322	2	28	30	28	12
Viacha	515	125	24	715	242	2	18	16	38	16
Patacamaya	395	115	29	550	203	4	14	24	42	16
Oruro	363	130	36	580	215	2	14	20	52	12

Source: (Garcia, M., Raes, D., Jacobsen, S. E., Michel, T. (2007). Agroclimatic constraints for rainfed agriculture in the Bolivian Altiplano. *Journal of Arid Environments*, 71, p. 114)

Comparisons can be made with the Bolivians risk perceptions in this study with the frequency distribution of precipitation in the Garcia et al. (2007) study. This survey consists of the community of Ancoraimes in the north, while Umala is located in the central part of the Altiplano. The objective risk probabilities of flooding and drought using the Belen data can be compared to Ancoraimes, while the Patacamaya data can be compared to Umala. The table below shows the subjective risk perceptions from this study and the objective risk probabilities from the Garcia et al. (2007) study.

Table 2- Subjective Climate Risk vs. Objective Risk

	Flood		Drought	
	Subjective	*Objective*	*Subjective*	*Objective*
North	3.88	2%	3.81	12%
Central	4.29	4%	4.72	16%
Combined	4.085	3%	4.265	14%

Source: [data in the Objective columns are from] (Garcia, M., Raes, D., Jacobsen, S. E., Michel, T. (2007). Agroclimatic constraints for rainfed agriculture in the Bolivian Altiplano. *Journal of Arid Environments*, 71, 109-121.)

In the North region (Belen objective risk compared to Ancoramies subjective risk), there is a higher objective risk of drought than flooding. However, the individuals in the north region (Ancoraimes) have a slightly higher perception of risk of flooding than drought. In the central (Patacamaya objective risk compared to Umala subjective risk) region, the objective risk is higher for drought than flooding and the subjective risk perception follows the objective ranking. Overall, in these two regions drought is more likely than flooding and the subjective risk perceptions mirror this in the Central region, while the North region's subjective risk is almost the same for flooding and drought. The subjective risk perceptions in this study are represented by- 3=moderate risk, 4=very strong risk and 5=extreme risk. Additional studies of objective weather risk in this region are needed in order to better compare them with subjective risk perceptions.

Economic

The people who live in the municipalities of Umala and Ancoraimes live in poorer conditions compared to overall Bolivia. The following table gives some comparisons between overall Bolivia and the municipalities.

Table 3- 2001 Standard of Living Indicators for Bolivia and Municipalities

Indicators	Bolivia	Ancoraimes	Umala
Per capita Income ($US/year)	1,417	658	789
Poverty (% of population)	58.6	98.4	97.1
Human Development Index	0.641	0.529	0.561
Life Expectancy	63.3	60.6	61
Annual Net Migration (%)	-	-20.38	-2.33
Literacy (%)	86.72	70	85.3
Years of Education (19yrs. & older)	7.43	3.9	5.7

Source: [data from] (United Nations Development Programme- Bolivia. *Indicadores de Desarrollo Humano Municipal & Indicadores de Desarrollo Humano Municipal de Desigualdad y Pobreza* [Data file]. Retrieved from http://cdteca.enlared.org.bo/IndiceDesarrollo/idh.htm)

It can be seen that both the municipalities of Ancoraimes and Umala have worse standard of living indicators compared to overall Bolivia. Also, it shows that the indicators for Umala are all better compared to Ancoraimes.

The following table shows some asset descriptive statistics for the survey data in the two municipalities.

Table 4- Household Survey Descriptive Statistics- Size, Age and Assets

	Min.	Max.	Mean	S.D.
Household Members	1	12	5.19	2.49
Age- Head of Household	19	90	49.19	15.03
Assets				
Household Income U.S. Dollars (3 soles/$1)	150.67	57,869.00	8,109.92	6,782.73
Crop Hectares	0.05	17.00	2.12	2.54
Cattle	1	15.00	4.62	2.87
Sheep	0	180.00	25.01	23.52

The majority of the income in these two sites comes from agriculture activities. In Umala, 88% of their income comes from agriculture activities, while 8% comes from activities done outside of the community (Romero, 2008b). In

Ancoraimes, 73% of the household income comes from agriculture, while 21% comes from outside the community (Romero, 2008a).

The main language for the survey area is Aymara, followed by Spanish.

Table 5- Household Survey Language Percentages

	Yes	No
Speak Spanish	85%	15%
Speak Aymara	99%	1%
Speak Quechua	1%	99%

The individuals of the area mostly have a primary education. Only 2% have a high school education.

Table 6- Household Survey Education Level Percentages

	None	Primary	Secondary	High School	Technical	University
Level of Education	10%	62%	24%	2%	1%	1%

Production

In Umala, their income from agriculture is divided as follows- 39% sub-products, 26% sell of animals, 35% agriculture products (Romero, 2008b). In Ancoraimes, the household income from agriculture is divided as follows- 17% sub-products, 21% sell of animals and 61% agriculture products (Romero, 2008a). Umala's income in agriculture is more diversified among the categories, while Ancoraimes' income is more concentrated in agriculture products category.

In Umala, the distribution of crops is as follows- 53% potato, 23% barley and 15% oats (Romero, 2008b). In Ancoraimes, the distribution is as follows- 47% onion, 14% potato 7% oca, 6% turnip and 5% oats (Romero, 2008a). In

Umala, there is more concentrated agriculture production in potatoes and barley, while in Ancoraimes their production is based on onions and potatoes.

There are differences in the distributional use of the potato between the two sites. Umala consumes 17%, sells 42%, transforms (chuño and tunta) 27% and use for seed 12% of the potato (Romero, 2008b). Ancoraimes consumes 37%, sells 19%, transforms 23% and saves for seed 20% of the potato (Romero, 2008a).

Chapter V

PERCEPTION OF CLIMATE IN THE RURAL COMMUNITIES

In order to understand how Bolivian rural community members perceive climate risk events and how they deal with the risks ex-ante and ex-post, focus groups are conducted. The focus groups enable us to understand specific strategies that individuals use in order to cope with climate risk events. In addition, since dread is identified as a major factor in risk perceptions, their feelings of dread are explored in the focus groups.

Method

A case study is conducted to look into how they develop strategies to respond to their climate risk and how individuals obtain climate information. Focus groups are used because of the exploratory nature of this research. Focus groups allow for flexibility in the responses due to the loose nature of the questions that are created. Conducting focus groups is chosen because of the exploratory nature of this research, which does not make it possible to create direct targeted questions to the individuals. This is because of the lack of research and knowledge on how risk perceptions are developed.

A multiple case study with two embedded sub-units is used. This method is called a type 4 research design according to Yin (2003). The unit of analysis is the household heads, while the sub-unit is, gender and assets. This type of case study is used because I want to see if there are differences across gender and income groups. The risk perception literature has shown differences between men and women in their perceptions through models. This type of case study is chosen to investigate the roots of these

differences between genders. Also, by creating one sub-unit of analysis by high and low incomes, one would expect that individuals with high incomes would have lower risk perceptions. This would be because they have more resources for coping with risk and are less vulnerable then people with low incomes. This study will potentially show other factors not identified before among the high income individuals that cause them to have lower risk perceptions.

The focus group participants are determined from the survey data. The survey is used to develop a ranking of all of the survey participants on the basis of income and gender in the two municipalities of Umala and Ancoraimes. The survey individuals within each community are ranked by income. High is defined as income above the average according to the associated location, while low income is anyone below the average. Invitations were sent to the appropriate individuals according to the rankings to participate in the focus groups. Table 7 is the basis for how the focus groups are structured in each site.

Table 7- Division of Focus Groups

		Assets	
		High Income	Low Income
Gender	Male	Focus Group 1	Focus Group 3
	Female	Focus Group 2	Focus Group 4

There are four focus groups according to the diagram in Umala. However, there are three focus groups conducted in Ancoraimes. The male high income focus group is not conducted.[3]

Four focus groups are organized in the municipality of Umala (July 12, 2007):

- women with high incomes (7 participants)
- women with low incomes (7 participants)
- men with high incomes (7 participants)
- men with low income (6 participants)

Three focus groups are organized in the municipality of Ancoraimes (July 26, 2007):

- women with high incomes (6 participants)
- women with low incomes (6 participants)
- men with high incomes (4 participants)[4]

A questionnaire is developed to lead the discussion for all of the focus groups. The questions are associated with the participants' risk and dread perceptions of the climate events of hail, frosts, floods and drought. There are also questions on identifying the individuals' risk reduction strategies. The questions that are created to be asked by the facilitator of each group are as follows-

Risk

1. What climate risk events (frost, drought, flood and hail) affect your crops, livestock and children's health?

2. How do you know when a frost, drought, flood or hail will occur? (Bio-indicators, observation, community members, neighbors, other)

3. What information about climate events (frost, drought, flood and hail) do you trust the most?

[3] This happens because only one participant showed up for the male high income group. This person is put into the male low income group. However, in the translation process, this person is identified when he contributed to the discussion.

[4] One male participant with a low income was included in this group. See footnote 2.

4. Where would you place the effects of frost, drought, floods and hail on a scale from no effect, a little, medium, or large effect on your livelihood?

5. What do you do to prevent the effects of frost, floods and hail?

6. What do you do to prevent the effects of a drought before you have planted?

7. What do you do to lessen the effects of a drought after you have planted?

8. What do you do after you have faced a climate event (frost, drought, flood, and hail)?

FEAR

1. How do you feel when a climate event (frost, drought, flood, hail) affects your crops and livestock?

2. How do you feel fear when you think a climate event will come (frost, drought, flood, hail) that will affect your crops and livestock? How do you describe this feeling?

EXTERNAL SOURCES OF INFORMATION

1. What types of information (radio, TV, NGOs, government, markets information, other) do you use to make decisions related to the climate (frost, drought, flood and hail)? What are the names of your sources of information?

2. During what months do you listen for information about frost, drought, floods and hail?

3. What information (radio, TV, NGOS, government, market, other) do you trust the most about climate events (frost, drought, flood and hail)?

4. What information do you use to prevent the effects of climate risk events? Why?

5. How do you use the information you obtain (frost, drought, flood and hail)?

6. What is the best information to use when you are faced with a frost, drought, flood or hail?

Each focus group has an Aymara speaking facilitator leading it. Before the discussion, each participant introduces themselves and states which community they are from. The moderator then asks everyone whether they would mind if the conversation is taped. Every focus group discussion is taped on a recording device. Every focus group

discussion is translated from the native language of Aymara to Spanish, when necessary and then into English.

The transcriptions of the focus groups shows that the initial questions that are supposed to be asked to the focus groups are altered and carried out in a different form by the facilitators. The transcriptions showed that five questions are answered across all the focus groups. These questions are as follows-

1. How do climate events (frost, drought, floods, and hail) affect you?
2. What do you do before a climate event occurs to prevent the effects?
3. What do you do after a climate events occurs to lessen the effects?
4. How severe are the effects of climate events (frost, drought, floods, and hail)?
5. How do you feel when you are affected by a climate event (frost, drought, flood, hail)?

The four focus group transcriptions from Umala and the three focus group transcriptions from Ancoraimes are analyzed. The answers to the developed questions are compared and contrasted for each question across each group. It is investigated whether the expected characteristics of the group are shown. The group descriptions are backed up with statements from the focus groups.

The analysis is used to identify similar themes and issues across different groups in a systematic way. Stockdale's (2002) approach is used to analyze the focus group data. This type of analysis results in relevant themes identified and allows for comparison across groups (Stockdale, 2002). The entire transcription of the focus group is put into a spreadsheet. Then each individual comment is given its own cell, along with

an associated group type id cell and question id cell. Then each comment is read and given an associated description identification with a few words.

After this is completed, all of the descriptions are put into a word document and themes are developed from this list. Each description is placed with its associated theme. Then all of the comments associated with a given theme are put together, being sub-divided between the two sites and within gender in those sites. This allows for themes to be identified and enhanced by using the participants' comments. Weather/climate change, weather event feelings, weather event severity, weather event effects, elder, prevention, coping, radio, other information sources, other and indicators are identified as themes that emerge from the focus groups.

Findings

Weather/Climate Change

All focus groups are questioned about the topic of weather and climate change, expressing that they believe they are experiencing weather and climate change.

Umala residents indentify that the climate has changed since they observe receiving less rain, more wind and lower temperatures. In addition, they explain that they have fewer frosts now. One Umala male participant expresses this as follows,

> Before, frosts and climate events came on their usual time. They had their time to come, but that has changed now. There are places where people made chuño before, but now they do not do it anymore due to the lack of frosts in that area. Frosts are not good anymore.

They say that they used to know when to expect weather events; however, currently they say that the events now occur at different times. The Umala men

explain how their weather indicators, the radio and people are not able to predict weather events because the weather has changed.

The people of Ancoraimes speak less about climate and weather change than the Umala residents. Residents of Ancoraimes express that they believe that their weather has changed and that they are experiencing a change in climate. They say that they currently are experiencing drier conditions.

Weather Event Severity

The focus group participants agree that floods have the least severe effect on them. The focus group participants from both sites believe that they are severely affected by hail, frost and drought. They identify that flooding has the least severe effects on the area. One Ancoraimes participant explains that he would rate the severity of weather events by his ability to control it.

Event Effects

The individuals in both sites explain that they are affected by hail, frost, drought and floods. In both sites, the participants say that the effects of hail on their plants depend upon the stage of the plant. In both sites, individuals say that water can get into their homes when floods occur.

One Umala resident explains that hail only affects grain crops. Umala residents explain that hail affects only certain areas, while leaving other areas untouched.

The Umala residents say that a plant affected by frost can sometimes recover, while other times the plant will be destroyed. They explain that frost can be beneficial when it allows them to make chuño. However, the coldness that is associated with frost

has negative effects on their livestock. One participant producer explains this with his experience,

> Our livestock has always been affected by frosts and coldness. How? It produces pneumonia (khoto) in young cows and sheep. It is like the altitude disease, but when it affects them we already know we will lose them. We don't know how to cure them, and we have just a few barns to protect them. In the flat plains located far away from the house, yards are made only from stones, which makes possible only for native livestock to survive.

In Umala, they say that drought affects everything. They say those droughts can cause them to have no food or water for themselves or their livestock. They say that it lowers their crop yields and stunts plants' growth. In addition, a drought can cause diseases in their children.

The residents of Umala say that flooding can cause their plants and produce to rot. One resident says that flooding doesn't affect their potato crop; it just affects grain crops. One resident points out that flooding can cause water to get into their homes.

The weather events in Ancoraimes can result in lower crop yields, problems with livestock, no money to send children to school, no money to pay hired labor and migration. In Ancoraimes, hail lowers their yields and can even destroy the plants. However, sometimes the plants can recover from the effects of hail. They say that hail and frost can result in potatoes having worms in them and being small. Also, they say that when their crops are affected by frost that it will lower their yields. They say that it depends on the growth stage of the plant to determine effects of the frost. The participants in Ancoraimes say that drought happens at higher altitudes. They also say that the community of Chojnapata doesn't experience droughts. They say that floods

affect their plants, resulting in them not producing. Flooding can also can kill their children and livestock.

Prevention

All the groups identify a way of preventing frost and hail is by performing rituals. One participant explains one ritual that the community engages in to prevent the effects of hail,

> We also have field agents (authority in charge of taking care of the crops around the community). He walks around the plots, makes smoke; this happens in my community (Kellhuiri). He always has to stir fire, make smoke; if he doesn't do it there is a sanction and a fine he has to pay. When it is about to hail, the field agent has to make smoke the entire week. It is clear that when the day is sunny you feel a cold breeze, so before it comes we make smoke. This is how we protect ourselves.

Individuals at both sites plant in three different areas to prevent the effects of weather events.

Umala residents say that they can prevent a frost by performing rituals and praying. The men say that they try to prevent frost by using chemicals, performing experiments and performing rituals. One man explains how he prevents frost by using different crop varieties.

Umala individuals say they plant multiple times to prevent the effects of a drought. Umala residents explain that they plant in higher altitudes to prevent the effects of flooding. They say they plant vertical furrows and plant on higher lands to prevent the effects of flooding.

Ancoraimes individuals can prevent the effects of weather events by praying and performing rituals. They also say that they used to have other relatives in different areas they could rely on; however, this isn't working anymore.

Also, they say that they can prevent the effects of frost by performing their rituals. Ancoraimes individuals say they plant in areas less prone to drought. They use chemicals and make canals to prevent drought effects. To prevent the effects of a drought, the women plant in higher areas and plow deep. In addition, to prevent the effects of drought, they don't sell many items; they store more products.

Coping

All groups use some form of performing rituals to cope with weather events. One individual describes the ritual they do in order to cope with drought, "Regarding drought, when it does not rain we do K'uanchar (Andean ritual), which consists in bringing water from different places located far away and put it together with a sheep's blood. With these two elements we go around the churches several times, while we pray at the same time." In both sites, some individuals believe that they can't cope when they are affected by a weather event.

One Umala individual points that in hard times people help each other get through the times. In general, when faced with weather events they ask the institutions, prefectura, and municipal for help. One Umala resident explains his experience, "If we were affected by drought, hail, frosts or floods, the only thing we could do is to ask institutions for help. We are also thinking that the prefectura should help us." Umala residents say sometimes they don't have enough money to send their children to school,

so their children quit school to find jobs. One Umala individual explains her only option, "In that case, there is no other option than to migrate to other places." They also pray during these times.

One Umala individual says when his crops are affected by hail, he works for his neighbors. They say that they cope with drought by performing rituals, going to church and praying. Umala participants identify that they cope by performing rituals when a frost occurs.

Umala residents describe several mechanisms for dealing with drought conditions. They explain that they will use their reserves of chuño. One Umala individual explains it as follows, "During bad times, our reserves of chuño helped us to face the drought. That was the only thing we had to support ourselves. Sometimes we have to buy some products." One Umala residents says that some people don't have the coping strategy of using reserves of chuño during a drought, because those people no longer make chuño. One Umala person explains that during drought times, they repent their sins. They say that irrigation could help them cope with drought. One Umala resident explains how he has migrated during a drought, "We need to migrate to work. I, for example, in the event of a drought, used to go to work to the Colquiri mine."

Some Ancoraimes individuals say that they don't ask the government for help. One Ancoraimes resident explains,

> There is nothing we can do in the event of a drought, because the plants depend on the water. If it does not rain we have to stand it and that's it. We neither ask the government for help. We just stand it. It seems like recently the government is offering help, but it did not happen before.

Some try to go to the prefectura, but they just make them wait so long that they just leave.

They say that they go to church during these times. Others say that during a weather event that they have to migrate.

Chapter VI

METHODS AND PROCEDURES

Survey

The survey is conducted by investigators of The Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM) Project LTR-4 in the Altiplano region of the Ancoraimes and Umala municipalities. The sample is selected in two stages. First, representative sites of regions that are vulnerable according to the measures established by the United Nations Development Program are used. Regions are chosen to reflect low and high production systems in the Central Altiplano, and transect from Lake Titicaca to higher elevation in a watershed in the Northern Altiplano.

The second step is to contact rural communities, present the project and invite them to participate. If the community agrees, then a list of members is requested to be used in a selection of the random sampling with replacement to ensure that everyone in the sample has the same chance of being selected. The selection continues until 165 households are chosen in each region.

The objective of the survey is to identify the livelihoods strategies, capitals and practices of the people of that region. A sample of twenty-five percent of the population is surveyed in the municipalities of Ancoraimes and Umala. A total of 330 household surveys are acquired. A head of the household or other representative member filled out the survey, while some additional questions are answered by an adult of the opposite

gender of the head of the household. The content of the survey includes: demographics, education, health, crop and livestock production, biodiversity, product marketing, sources of income, shocks and risk perceptions.

A section of risk perceptions questions is included in the questionnaire. The risk perception questions that relate to the climate events are analyzed. These events include: hail, frosts, floods, drought and change in climate. The participants identify their risk perception level of the event affecting their family. They use a scale from 1-5 to identify their perception of risk to the event (1=no risk, 2=minimal risk, 3=moderate risk, 4=very strong risk, and 5=extreme risk).

Other survey information is collected to be used in this analysis. Number of sheep is used to represent diversified risk management strategies. Also, a diversification dummy variable is created that indicates whether an individual has dairy cattle, crops and sheep. Also, other income that includes income from selling thola and crafts is included in the analysis to represent a diversification mechanism. The individuals indicate whether they have access to credit by an answer of yes/no. This information will be used in the analysis to represent whether they have this management strategy available.

In addition, there are variables in the model that represent one's knowledge of climate events. The information on whether they are able to speak and understand Spanish is used in the analysis. The native language for the participants of this survey is Aymara. If an individual is able to speak Spanish, this can represent a way from them to obtain risk information through different networks. In addition, the experience level of the individual in dealing with shock is used. Also, the individuals indicate whether they have experienced a loss of production from each climate hazard. This is included in the

analysis because one's experiences are used to develop perceptions. A composite variable of shock experience is created that includes the four climate events.

A community location variable is used in the model because of the variability of climate across communities. This variable represents the communities of Chinchaya, Karcapata, Chojnapata, San Jose Llanga, San Juan Circa, Vinto Coopani, Kellhuiri, Calahuancani compared to Cohani. Cohani is used as a reference for the other locations since its elevation of 3860m puts it in the center of the locations, according to elevation. In addition, a dread variable is used in the model. The individuals indicate the level of dread for each of the risks of hail, frost, flood, drought and climate change on a scale from 1-2 (1=a common risk, 2= fearful). A variable composing dread of the five events is created. This is used because dread is one of the main indicators of one's risk perceptions according to Slovic (1987). Variables that are answered with Yes=1 and No=2 are converted into dummy variables with Yes=1 and No=0.

An overall model is created to see how factors are related to the household's climate risk perceptions on the events of drought, frost, hail, flooding and climate change collectively since the household must deal with all events over time. However, individual models are also created to see the relationship of climate risk perceptions and factors to a specific climate event. Individual climate event models are created to see how the independent variables are related to specific climate event risk perceptions.

Figure 7- Climate Risk Perception Model

Climate Risk Perceptions ← Other Income + Total Sheep + Spanish Speaking + Outside Family Information + Dread + Credit Access + Shock Experience + Location + Gender + CropsSheepDairy

Table 8- Variable Descriptions of the Model

	Variable	Description
Dependent	Climate Risk Percpetions	1=no risk
		2=minimal risk
		3=moderate risk
		4=very strong risk
		5=extreme risk
Independent	Other Income	measured in Bolivanos
	Sheep	total number
	Location	Chinchaya=1
		Karcapata=2
		Chojnapata=3
		San Jose Llanga=4
		San Juan Circa=5
		Vinto Coopani=6
		Kellhuiri=7
		Calahuancani=8
		Cohani=9
	Dread	low dread=5
		dread=5
		dread=6
		dread=7
		dread=8
		dread=9
		high dread=10
	Access to credit	yes=1 no=0
	Shock Experience	high shock experience=4
		shock experience=5
		shock experience=6
		shock experience=7
		no shock experience=8
	Contact family outside	yes=1 no=0
	Spanish speaking	yes=1 no=0
	Gender	male=1 female=0
	CropsSheepDairy	yes=1 no=0

Table 9 shows the expected signs of the variables in the model according to livelihood and risk perception theory. The variables of sheep, other income and the

diversification dummy variable of CropsSheepDairy will represent diversification, which will allow hypothesis 1 to be tested.

Hypothesis 1: *If individuals have a diversified portfolio, then they will have lower climate risk perceptions.* "Households with portfolios of economic activities which are diversified and have fewer covariant activities will be better able to cope with climatic risk" (Valdivia, 2004, p. 71). These variables represent activities that have less covariant climate risk. The variables of other income, sheep and cattle should be negatively correlated with climate risk perceptions because these diversifying activities should be reducing one's risk to a climate event.

The variable of credit access will be used to test hypothesis 2. ***Hypothesis 2:*** *If individuals have access to credit, then they will have lower climate risk perceptions.* It is expected that when one has the consumption smoothing strategy of being able to access credit that they will have a lower climate perception of risk; thus, being negatively correlated with perceptions. The access to credit variable includes any type of access whether formal or informal methods. If one has the strategy to smooth their income after they experience a climate event, then it is expected that they will have a lower climate risk perception; thus, being negatively correlated with perceptions.

Hypothesis 3 is tested by using one's personal experience with the shock variable, which should be negatively correlated with perceptions. ***Hypothesis 3:*** *If individuals have access to climate information, then they will have lower climate risk perceptions.*

The more experience one has with dealing with shocks, the lower their perception of risk. The more shock experience one has, the more known it is to the individual. According to Slovic (1987), the more known an event is, the lower the perceptions of risk. So it is expected, that the more shock experience an individual has, the lower their perceptions of risk. Two other variables will represent networks of information access, being able to speak Spanish and talking to family members outside the community. So individuals who are able to speak Spanish and talk with family members outside the community will potentially have more knowledge, leading them to know more about a climate event. According to Slovic (1987), the more known a risk is, the lower the perception of risk should be towards that event. These variables should be negatively correlated with climate risk perceptions.

Hypothesis 4 is tested by using the dread variable, which should be positively correlated with risk climate risk perceptions. ***Hypothesis 4:*** *If individuals have lower dread feeling levels, then they will have lower climate risk perceptions.* Slovic (1987) shows that lower dread levels are associated with lower risk perceptions levels.

Table 9- Expected Model Variable Signs

Climate Risk Percpetion	-	Other income
	-	Sheep
		Location
	+	Dread
	-	Credit Access
	+	Shock Experience
	-	Contact Family Outside
	-	Speak Spanish
	-	Gender
	-	CropsSheepDairy

Regression Models

An ordinal logistic regression model is attempted to analyze the individuals' risk perceptions. This type of model is chosen in order to preserve the ordinal scales used in the survey to measure risk perceptions.

The dependent variable uses the independent variables to calculate predicted probabilities of each of the five levels of the dependent variable (SPSS, 2007). The link function of an ordinal logistic regression transforms the cumulative probabilities in order to run the regression (SPSS, 2007). The dependent variable of climate risk perceptions is best described as an even distribution among the five levels. The model is shown as follows.

Figure 8- Ordinal Logistic Regression Model- Logit link

$$\text{logit}(p_1) \equiv \log \frac{p_1}{1 - p_1} = \alpha_1 + \beta' x$$

$$\text{logit}(p_1 + p_2) \equiv \log \frac{p_1 + p_2}{1 - p_1 - p_2} = \alpha_2 + \beta' x$$

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$$\text{logit}(p_1 + p_2 + \ldots + p_k) \equiv \log \frac{p_1 + p_2 + \ldots + p_k}{1 - p_1 - p_2 - \ldots - p_k} = \alpha_k + \beta' x$$

$$\text{and } p_1 + p_2 + \ldots + p_{k+1} = 1$$

Source: (Snedker, K., Glynn, P. & Wang, C. Ordered/ordinal logistic regression with SAS and Stata. (2002) <http://www.staff.washington.edu/ glynn/olr.pdf>. University of Washington, DC, USA. 25 August 2008)

The ordinal logistic model doesn't assume normality of the distribution of the error distribution or constant variance (Chen & Hughes, 2004). The model does assume

that the dependent and explanatory variables are independent (Chen & Hughes, 2004). "This model is known as the proportional-odds model because the odds ratio of the event is independent of the category…[pj]. The odds ratio is assumed to be constant for all categories" (Snedker, Glynn & Wang, 2002).

The test of parallel lines in the ordinal logistic regression model indicates that there is a significant difference for corresponding coefficients across the response categories at the 5% level. This suggests the ordinal regression assumption of the parallel lines is violated. The model results are located in the appendix.

Since the parallel lines assumption is violated in the ordinal logistic regression model, an ordinary least squares regression model is used. This model assumes that there is a linear relationship between the dependent variable and each independent variable (SPSS, 2007). The error term in this model is assumed to be normally distributed with mean 0 (SPSS, 2007). In addition, it is assumed that the variance of the error term is constant for each entry and independent of the variables in the model (SPSS, 2007). "The value of the error term for a given case is independent of the values of the variables in the model and the values of the error term for other cases" (SPSS, 2007).

An OLS model is used because the ordinal dependent variable represents a continuous, interval attribute of climate risk perceptions. However, an ordinal 5 level likert scale is used to try to measure this continuous, interval variable. The use of OLS regression with a dependent five level ordinal variable is common in social science (Garson, 1998). However, Garson (1998) cautions the use of less than a 5 level ordinal scale as a dependent variable in regression models, such as OLS because of the increased chance of violating normality assumptions (Garson, 1998). Garson (1998) states, "for

many statistical tests, rather severe departures (from intervalness) do not seem to affect Type I and Type II errors dramatically" (as cited in Jaccard and Wan, 1996, p. 4). In addition Garson (1998) argues that robustness of coefficients has been shown in respect of ordinal distortions (as cited in Labovitz, 1967; Labovitz, 1970; Kim, 1975; Binder, 1984; Zumbo & Zimmerman, 1993).

The assumption that the errors are independently and identically distributed is investigated by creating histograms of standardized residuals for all of the models. Standardized residuals are created by dividing the residual by its standard error. This standardizes the data so that the mean is zero with a standard deviation of one. The histograms appear to represent an approximate normal distribution of the errors for the models.

The possibility of multicollinearity is explored. The collinearity diagnostic of the variance inflation factor is used in all OLS regressions. The variable with the highest VIF in all regressions is the location variable of San Jose Llanga. The highest VIF is in the overall model with the San Jose Llanga variable at a value of 5.861. All of the individual models' VIFs for San Jose Llanga are all lower compared with the overall model. It appears there is a low possibility of multicollinearity in all of the models according to this diagnostic. Myers, Gamst and Guarino (2006) state that a VIF of greater than 10 suggests a serious multicollinearity problem (as cited in Stevens, 2002).

The dependent variable is the individuals' perception to risk, while the explanatory variables are sheep, other income and the diversification dummy variable. These variables represent the individual's asset base and diversification level. The explanatory variable of access to credit, representing a coping strategy is used. In

addition, the explanatory knowledge variables of shock experience, contact with family outside community and being able to speak Spanish are used in the model. The location and dread variables are in the model to explain climate risk perceptions.

The following table shows the frequency distribution on a scale of one to five for the climate risk perceptions of drought, frost, flood, climate change and hail. In addition, the table shows the mean and the standard deviations of the climate risk perceptions. Table 10 shows the frequency percentages in parentheses below the frequency of a level of an event. The climate risk with the highest mean perception was drought (4.31), indicating a very strong risk. Following, the climate risk of drought is frost (4.18), flood (4.11), climate change (3.88) and hail (3.86); all of the risks are indicated as being very strong risks.

Table 10- Climate Risk Perception Frequency and Percentage Statistics

	Risk Perceptions Levels 1-5				
	1	2	3	4	5
Drought (N=327) Mean=4.31 S.D=0.767	0 (0%)	12 (3.7%)	25 (7.6%)	140 (42.8%)	150 (45.9%)
Frost (N=329) Mean=4.18 S.D=0.671	1 (0.3%)	7 (2.1%)	23 (7%)	200 (60.8%)	98 (29.8%)
Flood (N=329) Mean=4.11 S.D.=0.903	8 (2.4%)	14 (4.3%)	28 (8.5%)	164 (49.8%)	115 (35%)
Climate Change (N=327) Mean=3.88 S.D.=1.004	16 (4.9%)	17 (5.2%)	39 (11.9%)	173 (52.9%)	82 (25.1%)
Hail (N=330) Mean=3.86 S.D.=0.787	2 (0.6%)	20 (6.1%)	56 (17%)	196 (59.4%)	56 (17%)

An average risk variable for each individual is created by adding their risk perceptions of the events of hail, frost, flood, drought and change in climate. Then this result is divided by five. This results of the frequency statistics are for 0 observations (1=no risk), 7 observations (2=minimal risk), 94 observations (3=moderate risk), 217 observations (4=very strong risk), 5 observations (5=extreme risk). This creates a variable with most of the observations clumping into the 3 and 4 risk categories. So this variable is transformed again in an effort for the distribution to be more equally spread out among the five categories since the link function of the logistic regression is logit assuming an equal distribution of cases within each category.

The average risk variable is recorded into a new variable with five new categories representing different levels of risk perceptions. Five new levels are created by using perceptions between (2.50-3.50) for level 1, (3.51-3.83) for level 2, (3.84-4.16) for level 3, (4.17-4.50) for level 4 and (4.51-5.00) for level 5. This results in a more equally distributed scale with level 1- 25 observations, level 2- 73 observations, level 3- 74 observations, level 4- 85 observations and level 5- 63 observations. This new scale has different meaning than the initial scale. This scale's interpretation is 1=moderate risk, 2=low high, 3=mid-high, 4=high and 5=extreme. The new average risk variable is used as the dependent variable in the overall model.

The explanatory variables of total sheep and other income (the sell of thola and crafts; expressed in Bolivianos) are included in the model. In addition, the ability to speak and understand Spanish (yes/no), contact with family members outside community (yes/no) and experience with climate shocks (yes/no) variables are all used in the model. The shock variable is created by summing each individual's answer to the question on whether one experienced a loss from a risk (yes=1 and no=2) for hail, frost, flood and drought. The shock variable's scale is from 4-8, with 4 being a person who has experience loss from all four events; while a person with a shock value of 8, is someone who hasn't experienced any loss from the four hazards. Access to credit (yes/no) is included in the model.

The dread variable is created by adding up each individual's dread of hail, frost, flood, drought and climate change. The new dread scale is from 5-10, with 5 being the lowest dread feeling and 10 being the very highest dread feeling.

The following table gives descriptive statistics of survey variables that are used in the model.

Table 11- Survey Independent Variable Descriptive Statistics

Independent Variables					
	N	Min	Max	Mean	S.D.
Other Income (Bolivianos)	330	0	3276	46.060	234.047
Total Sheep	286	0	180	25.011	23.517
Shock Experience (4, high - 8, no exp.)	306	5	8	7.219	0.743
Dread (5, no dread - 10, high dread)	167	5	10	9.283	0.897
Valid N	130				

Also, a table of frequency distributions of survey variables used in the model is included.

Table 12- Survey Independent Variable Frequencies and Percentages

Independent Variables		
	Frequency	Valid Percent
Spanish Speaking	280	85.1
Not Spanish Speaking	49	14.9
Outside Family Information	8	2.4
No Outside Family Information	321	97.6
Shock Experience		
High Shock Experience- 4	0	0
Shock Experience- 5	3	1
Shock Experience- 6	49	16
Shock Experience- 7	132	43.1
No Shock Experience- 8	122	39.9
Credit		
Credit Access	83	25.2
No Credit Access	247	74.8
Dread		
No Dread- 5	1	0.5
Dread-6	2	1
Dread- 7	2	1
Dread-8	22	10.5
Dread-9	52	24.8
High Dread- 10	131	62.4
Location		
Chinchaya	57	17.3
Karcapata	15	4.5
Chojnapata	27	8.2
San Jose Llanga	96	29.1
San Juan Circa	31	9.4
Vinto Coopani	29	8.8
Kellhuiri	25	7.6
Calahuancani	23	7
Cohani	27	8.2
Gender		
Male	248	75.2
Female	82	24.8
CropsSheepDairy	154	46.7
No CropsSheepDairy	176	53.3

Individual Climate Event Models

In order to see whether risk perceptions matter by the type of event, five ordinary least squares regression models are attempted. Five dependent variables of the OLS regressions include hail, frost, drought, flooding, and climate change. The independent variables for these models are created from the original data. The individual models are based on a 1-5 scale that represent the perception of risk to the events (1=no risk, 2=minimal risk, 3=moderate risk, 4=very strong risk, and 5=extreme risk). The explanatory variables include other income, total sheep, ability to speak Spanish, outside information, access to credit, specific locations and a diversification variable. The variables of the overall model that are changed include overall climate shock experience, which is changed to the specific climate event experience corresponding to the dependent variable. However, the climate change model did not include a specific climate change shock experience variable because this was not addressed in the survey. The dread variable in the overall model is changed in the individual models to dread for the specific climate event corresponding to the dependent variable.

Five individual OLS models are created. All five of these individual models are run. It appears that a possible transformation of the dependent variable could result in a more normal residual distribution. The dependent variable is squared in an attempt to have a more normal distribution of the regression residuals. This transformation helps normalize the regression residuals with the r-squared value and f statistic value improving on all five of the models, except the climate change model. The results of the three

individual models, of frost, drought and flooding, with the transformation of the dependent variable are reported. The individual hail model using the transformed dependent variable is not reported because the model is not significant. However, the model for climate change will not use a transformation of the dependent variable. The models for frost, drought and flooding with an untransformed dependent variable and the climate change model with the transformed dependent variable can be seen in the appendix.

Chapter VII

FINDINGS

Overall Model

The following chart shows the results of the ordinary least squares regression.

Table 13- Climate Risk Perceptions Ordinary Least Squares Regression Results

Dependent Variable	Climate Risk Perceptions (1-5)				
Parameter Estimates		B	S.E.	Sig	
	Other Income (Bolivianos)	-0.001	0.001	0.055	*
	Total Sheep	0.004	0.005	0.393	
	Spanish speaking	0.058	0.272	0.833	
	Not able to Speak Spanish	-	-	-	
	Outside Climate Information	-0.857	0.784	0.276	
	No Outside Climate Information	-	-	-	
	Access to Credit	-0.216	0.215	0.317	
	No Access to Credit	-	-	-	
	Climate Shock Experience (high to low)	-0.202	0.152	0.187	
	Dread (low to high)	0.398	0.102	0.000	***
	CropsSheepDairy	-0.403	0.191	0.037	**
	No CropsSheepDairy	-	-	-	
	Male	-0.127	0.234	0.588	
	Female	-	-	-	
	Chinchaya	-0.75	0.456	0.102	
	Karcapata	-0.336	0.54	0.535	
	Chojnapata	-0.382	0.521	0.465	
	San Jose Llanga	0.98	0.427	0.023	**
	San Juan Circa	1.258	0.525	0.018	**
	Vinto Coopani	0.968	0.468	0.04	**
	Kellhuiri	1.076	0.513	0.038	**
	Calahuancani	0.149	0.48	0.757	
	Cohani	-	-	-	
***-Significant at <1% level, **-Significant at <5% level, *-Significant at <10% level					

Table- 14 Climate Risk Perceptions Ordinary Least Squares Regression Summary

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	80.488	17	4.735	4.239	0.000
Residual	156.379	140	1.117		
Total	236.867	157			
Model Summary					
R-Square	0.34				

This model has a significant fit at less than one percent. The r-square statistic shows that the model is explaining 34 % of the variation in the dependent variable.

The location variables that are significant when compared to Cohani include San Jose Llanga, San Juan Circa, Vinto Coopani and Kellhuiri. In San Jose Llanga individuals have higher climate risk perceptions compared to Cohani. Vinto Coopani individuals have higher climate risk perceptions compared to Cohani. This may be because this area is more vulnerable because of it lower soil quality resulting in less potato farming compared to lower elevation levels. Also, in Vinto Coopani it is difficult to access water and the individuals rely mainly on crop production. In both San Juan Circa and Kellhuiri individuals have higher climate risk perceptions than Cohani community members. Kellhuiri is located at a higher elevation than Cohani. Both of these communities have less access to water and rely more on crops than livestock.

The model's results are analyzed with respect to the hypotheses.

Hypothesis 1: *If individuals have a diversified portfolio, then they will have lower climate risk perceptions.* The variables that test this hypothesis include- other income, sheep and the diversification variable. These variables are expected to be significant with the following signs- other income(-), sheep(-), and

diversification(-). Other income and diversification came up as significant with the expected signs. Other income was significant at the 10% level. An increase in other income will decrease the climate risk perceptions, holding all other independent variables constant. In addition, the diversification variable comes up significant at the 5% level. If an individual has crops, sheep and dairy their climate risk perceptions are reduced. Sheep may not have come up as significant because it may be more correlated with weather events than expected. The focus group data points to this. The focus group data reveal that individuals lose animals when weather events occur. They explain that during a frost when the temperature gets so low that their animals get sick and sometimes die. The focus groups also reveal that many individuals fear and don't believe in using chemicals. So these individuals may not be using antibiotics when their animals get sick due to fear and cost.

Hypothesis 2: *If individuals have access to credit, then they will have lower climate risk perceptions.* The variable that tests this hypothesis is the credit variable. The credit variable did not come up as significant. This may be because they are not able to obtain enough credit to make a difference to them.

Hypothesis 3: *If individuals have access to climate information, then they will have lower climate risk perceptions.* The variables that test this hypothesis include shock experience, contact with family outside community and ability to speak Spanish. None of these variables are significant in the model. This may be because the people may not think that the information is reliable, so they do not incorporate it in their planning.

Hypothesis 4: *If individuals have lower dread feeling levels, then they will have lower climate risk perceptions.* Dread is significant in the model at the .000 level. The dread variable has the expected positive sign. If dread increases, the risk perception level will increase.

Table 15- Expected vs. Actual Relationship Signs between Dependent and Independent Variables

Dependent Variabe	Expected=Actual Sign	Significant	Independent Variable
Climate Risk Percpetion	Yes	Yes	Other income
		No	Sheep
		No	Speak Spanish
		No	Contact Family Outside
		No	Credit Access
		No	Shock Experience
		Yes	Location
	Yes	Yes	Dread
		No	Gender
	Yes	Yes	CropSheep Dairy

Individual Climate Event Models

All of the models, except the hail model have a significant fit at less than one percent. The results of the other four models are shared. The frost model explains 30.6% of the variation in the dependent variable of frost climate risk perceptions. The explanatory variables that are significant include other income, total sheep, access to credit and dread. In addition the location variables of San Jose Llanga, San Juan Circa, Vinto Coopani, Kellhuiri and Calahuancani are significant in comparison to Cohani. This is exhibited in Table 16. The access to credit variable is significant at the less than 1% level. If an individual has access to credit, then they will have lower climate risk perceptions. This sign is expected according to the hypothesis. In addition, the locations

of San Jose Llanga, San Juan Circa, and Vinto Coopani are significant at the less than 1% level. The signs of these variables indicate higher frost perceptions in comparison to Cohani, which is left out of the model. The variables of Kellhuiri and Calahuancani are significant at the 5% level, indicating higher frost perceptions than Cohani. Other income is significant at the 5% level, indicating the more income one has the lower their frost climate risk perceptions. This follows in accordance to the hypothesis. High dread was significant at the 5% level, indicating that the higher one's frost dread, the higher their frost risk perceptions. This follows according to the hypothesis. The total sheep variable is significant at the 10% level, indicating the more sheep one has, the lower their frost climate risk perceptions. This follows according to the hypothesis.

Table 16- Frost Risk Perceptions Ordinary Least Squares Regression Results

Dependent Variable	Frost Risk Perceptions				
		B	S.E.	Sig	
Parameter Estimates					
	Other Income (Bolivianos)	-0.003	0.002	0.040	**
	Total Sheep	-0.026	0.014	0.066	*
	Spanish speaking	1.374	0.924	0.138	
	Not able to Speak Spanish	-	-	-	
	Outside Climate Information	-1.537	1.874	0.413	
	No Outside Climate Information	-	-	-	
	Access to Credit	-1.877	0.686	0.007	***
	No Access to Credit	-	-	-	
	Frost Shock Experience	-0.384	0.868	0.659	
	No Frost Shock Experience	-	-	-	
	High Frost Dread	2.088	1.016	0.041	**
	Low Frost Dread	-	-	-	
	CropsSheepDairy	-0.466	0.664	0.483	
	No CropsSheepDairy	-	-	-	
	Male	-1.216	0.747	0.105	
	Female	-	-	-	
	Chinchaya	0.511	1.406	0.717	
	Karcapata	1.498	1.687	0.375	
	Chojnapata	1.124	1.597	0.482	
	San Jose Llanga	4.489	1.434	0.002	***
	San Juan Circa	6.173	1.752	0.001	***
	Vinto Coopani	7.341	1.587	0.000	***
	Kellhuiri	3.623	1.747	0.039	**
	Calahuancani	3.971	1.536	0.010	**
	Cohani	-	-	-	

****-Significant at <1% level, **-Significant at <5% level, *-Significant at <10% level*

Table- 17 Frost Risk Perceptions Ordinary Least Squares Regression Summary

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	1887.663	17	111.040	5.744	0.000
Residual	4272.32	221	19.332		
Total	6159.99	238			
Model Summary					
R-Square	0.306				

The drought model explains 52.4% of the variation in the dependent variable of drought risk perceptions. The explanatory variables that are significant include dread and gender. Also, the location variables of Chinchaya, Chojnapata, San Jose Llanga, San Juan Circa, Vinto Coopani and Kellhuiri are significant in comparison to Cohani. The results of the drought model are shown in Table 18. Dread is significant at the less than 1% level. Higher drought dread is associated with higher drought risk perceptions, which is what the hypothesis suggests. Chinchaya is significant at the less than 1% level in comparison to Cohani. Drought risk perceptions are lower in Chinchaya than Cohani. In addition, San Jose Llanga, Vinto Coopani and Kellhuiri are significant at the less than 1% level. It shows that drought risk perceptions are higher in San Jose Llanga, Vinto Coopani and Kellhuiri in comparison to Cohani. The location variable of Chojnapata and San Juan Circa are significant at the 5% level. Chojnapata has lower drought risk perceptions, while San Juan Circa has higher drought risk perceptions compared to Cohani. The gender variable is significant at the 10% level, indicating that men have lower drought risk perceptions than females.

Table 18- Drought Risk Perceptions Ordinary Least Squares Regression Results

Dependent Variable	Drought Risk Perceptions				
		B	S.E.	Sig	
Parameter Estimates					
	Other Income (Bolivianos)	-0.001	0.001	0.404	
	Total Sheep	0.005	0.016	0.770	
	Spanish speaking	0.094	0.921	0.919	
	Not able to Speak Spanish	-	-	-	
	Outside Climate Information	-1.497	2.677	0.577	
	No Outside Climate Information	-	-	-	
	Access to Credit	-0.460	0.743	0.536	
	No Access to Credit	-	-	-	
	Drought Shock Experience	-1.299	0.955	0.175	
	No Drought Shock Experience	-	-	-	
	High Drought Dread	4.469	1.289	0.001	***
	Low Drought Dread	-	-	-	
	CropsSheepDairy	0.236	0.675	0.726	
	No CropsSheepDairy	-	-	-	
	Male	-1.344	0.775	0.084	*
	Female	-	-	-	
	Chinchaya	-5.411	1.428	0.000	***
	Karcapata	-2.130	1.657	0.200	
	Chojnapata	-3.589	1.713	0.037	**
	San Jose Llanga	4.381	1.321	0.001	***
	San Juan Circa	3.962	1.656	0.018	**
	Vinto Coopani	5.143	1.466	0.001	***
	Kellhuiri	5.745	1.651	0.001	***
	Calahuancani	-1.662	1.490	0.266	
	Cohani	-	-	-	

****-Significant at <1% level, **-Significant at <5% level, *-Significant at <10% level*

Table 19- Drought Risk Perceptions Ordinary Least Squares Regression Summary

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	4614.907	17	271.465	13.792	0.000
Residual	4192.452	213	19.683		
Total	8807.359	230			
Model Summary					
R-Square	0.524				

The flooding model explains 22.1% of the variation in the dependent variable of flooding risk perceptions. The explanatory variables that are significant include dread, and the location variables of San Jose Llanga, Kellhuiri and San Juan Circa. The flooding model results can be seen in Table 20. Dread is significant at the less than 1% level. Higher flooding dread is associated with higher flooding risk perceptions, which follows the hypothesis. The location variables of San Jose Llanga and Kellhuiri are significant at the 1% level in comparison to Cohani. The San Juan Circa variable is significant at the 10% level. The location variables of San Jose Llanga, San Juan Circa, and Kellhuri, show that these areas are associated with higher flooding risk perceptions in comparison to Cohani.

Table 20- Flooding Risk Perceptions Ordinary Least Squares Regression Results

Dependent Variable	Flooding Risk Perceptions				
		B	S.E.	Sig	
Parameter Estimates					
	Other Income (Bolivianos)	-0.001	0.001	0.485	
	Total Sheep	-0.006	0.019	0.732	
	Spanish speaking	-0.930	1.182	0.432	
	Not able to Speak Spanish	-	-	-	
	Outside Climate Information	0.701	2.665	0.793	
	No Outside Climate Information	-	-	-	
	Access to Credit	-1.260	0.919	0.172	
	No Access to Credit	-	-	-	
	Flooding Shock Experience	1.168	1.128	0.302	
	No Flooding Shock Experience	-	-	-	
	High Flooding Dread	6.638	1.527	0.000	***
	Low Flooding Dread	-	-	-	
	CropsSheepDairy	-0.137	0.885	0.877	
	No CropsSheepDairy	-	-	-	
	Male	-0.576	1.003	0.566	
	Female	-	-	-	
	Chinchaya	0.556	1.716	0.746	
	Karcapata	-1.131	2.265	0.618	
	Chojnapata	-0.882	2.166	0.684	
	San Jose Llanga	4.885	1.629	0.003	***
	San Juan Circa	3.978	2.071	0.056	*
	Vinto Coopani	1.718	1.841	0.352	
	Kellhuiri	6.515	2.123	0.002	***
	Calahuancani	1.047	1.851	0.572	
	Cohani	-	-	-	
****-Significant at <1% level, **-Significant at <5% level, *-Significant at <10% level*					

Table 21- Flooding Risk Perceptions Ordinary Least Squares Regression Summary

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	1977.724	17	116.337	3.562	0.000
Residual	6955.843	213	32.657		
Total	8933.567	230			
Model Summary					
R-Square	0.221				

The climate change model explains 28.9% of the variation in the dependent untransformed variable of climate change risk perceptions. The explanatory variables that are significant include total sheep and climate change dread, and the location variable of Vinto Coopani. The results of the climate change model can be seen in Table 22. Dread is significant at the less than 1% level. Higher climate change dread is associated with higher climate change risk perceptions, which supports the hypothesis. The total sheep variable is significant at the 5% level, indicating the more sheep one has, the higher their climate change risk perceptions; which is contrary to the hypothesis. The location variable of Vinto Coopani is significant at the 1% level, indicating lower climate change risk perceptions than Cohani.

Table 22- Climate Change Risk Perceptions Ordinary Least Squares Regressions Results (not squared)

Dependent Variable	Climate Change Risk Perceptions (1-5)				
		B	S.E.	Sig	
Parameter Estimates					
	Other Income (Bolivianos)	0.000	0.000	0.484	
	Total Sheep	0.006	0.003	0.025	**
	Spanish speaking	0.065	0.179	0.718	
	Not able to Speak Spanish	-	-	-	
	Outside Climate Information	-0.241	0.370	0.515	
	No Outside Climate Information	-	-	-	
	Access to Credit	0.170	0.143	0.235	
	No Access to Credit	-	-	-	
	High Climate Change Dread	1.214	0.175	0.000	***
	Low Climate Change Dread	-	-	-	
	CropsSheepDairy	-0.139	0.132	0.294	
	No CropsSheepDairy	-	-	-	
	Male	0.021	0.151	0.889	
	Female	-	-	-	
	Chinchaya	-0.264	0.299	0.378	
	Karcapata	-0.491	0.354	0.166	
	Chojnapata	-0.090	0.335	0.789	
	San Jose Llanga	-0.343	0.283	0.227	
	San Juan Circa	-0.136	0.336	0.687	
	Vinto Coopani	-0.852	0.307	0.006	***
	Kellhuiri	-0.460	0.330	0.164	
	Calahuancani	-0.184	0.317	0.562	
	Cohani	-	-	-	
****-Significant at <1% level, **-Significant at <5% level, *-Significant at <10% level*					

Table 23- Climate Change Risk Perceptions Ordinary Least Squares Regressions Results (not squared)

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	66.036	16	4.127	5.437	0.000
Residual	162.441	214	0.759		
Total	228.476	230			
Model Summary					
R-Square	0.289				

Hypothesis 4: *If individuals have lower dread feeling levels, then they will have lower climate risk perceptions.* It is the only hypothesis that holds up under the overall model and all of the individual climate event models. This may be because dread makes such an impact on individual's risks regardless of the type of climate event.

Focus Groups

Risk Management Strategies

Themes emerge when comparing the strategies of the individuals of Umala and Ancoraimes. The groups share several of the same prevention risk management strategies. In both sites, individual perform rituals, pray, plant multiple times, use chemicals and plant in areas they believe are less prone to climate risks. However, in Umala they also plant different crop varieties to manage risk ex-ante. In Ancoraimes, they mention that they used to rely on relatives in other areas that planted crops; however, they said that this doesn't work anymore. They said the reason that this doesn't work is because their relatives are lazy. In Ancoraimes, they do plant in higher areas to deal with climate risk ex-ante. In Ancoraimes, they do plow deeper and use canals to deal with the risk of drought.

Themes emerge when comparing how Umala and Ancoraimes deal with risk ex-post. In both sites, they mentioned that they perform rituals and ask the prefectura for help. In Umala and Ancoraimes, they mentioned that their last resort is to migrate. In addition in Umala, they mentioned other strategies which include- using chuño reserves, praying, working for others and having their children quit school to get a job. In Umala,

they cope with risk by asking people, the government, institutions, and municipalities for help. In Ancoraimes, they talk with other people to cope with climate risks.

Overall, it appears that Umala discusses more coping strategies than Ancoraimes. This may be due to the fact the Umala does have higher climate risk perceptions than Ancoraimes; so they may need more coping strategies because they are at greater risk for climate shocks.

Climate Risk Information

In both areas, there seems to be mixed messages on whether they believed that the radio provides weather information. Also in both sites, they have mixed feeling on whether they trust the weather information on the radio. In Umala and Ancoraimes, they both talk and observe others to in order to obtain climate information. In both areas, they do use indicators for climate information; however, there is some mixed feeling on whether they trust these indicators. However, overall they trust more in their indicators than the radio. In Ancoraimes, they talk to people at the markets to get climate information. They have mixed feeling on whether they trust the information from others in their community. However, in Ancoraimes they do not use the almanac for climate information. Overall, it appears that individuals in both sites get there climate information in similar ways.

Climate Risk Feelings

The individual's climate risk feelings are explored in the focus groups in an effort to try to see if they have dread (Slovic, 1987) feelings toward climate risks and how they define their feelings through their Aymara culture.

Both women and men, say that they are afraid of climate risk events. In addition, women say that they worry about climate events and they get scared when they think of being affected by climate events. The women say that they cope with climate events by talking with other women.

The men said that they just have to continue to believe that the next year will be better. They also say that they can't cry. The men say they have feelings of fear, sadness and that they feel bad when they think of climate risk.

Chapter VIII

CONCLUSION

The conclusion is divided into three parts. The first section restates the important findings. In addition, the findings are used to see whether the hypotheses can be supported. The second section will discuss what policy implications the findings point towards. The final section of the conclusion states potential areas of further research.

Findings

Bolivian climate risk perceptions are higher in the Umala region compared to the Ancoraimes region. The climate risk perception variable that is created for the overall regression analysis shows Ancoraimes at a mean climate risk perception of 2.73 (mid-high), while Umala's average climate risk perception is 3.71 (high). A t-test is done and shows that the climate risk perception between the two municipalities is significant at the 5% level. This is consistent with the Garcia et al. (2007) study that identifies the south area of the Altiplano region as more susceptible to drought and flooding compared to the north area. This points to the idea that the difference between Umala and Ancoraimes' climate risk perception, is greatly due to their location.

Hypothesis 1 states that more diversification will lower one's climate risk perceptions. It is expected that if one's portfolio is diversified by having sheep, other sources of income and having the combination of crops, sheep and dairy; it lowers one's climate risk perceptions. The diversification variable did come up as significant in the overall model. Other income sources did come up as significant in the overall model,

indicating the more other income one has, the lower their risk perceptions. Other income sources also came up as significant in the frost model. However, the sheep variable is not significant in the overall model. In the individual models, total sheep is significant in the climate change model, as well as the frost model. Overall Hypothesis 1 cannot be supported since all of the variables of diversification did not come up as significant in all of the models. However, it appears that other income and having crops, sheep and dairy can help lower overall climate risk perception as shown in the overall model. Also, it is shown that some diversification mechanisms help lowers individuals' climate risk perceptions toward frost and climate change.

Hypothesis 2 states that having access to credit would lower one's climate risk perceptions. Credit access isn't significant in explaining one's overall climate risk perceptions. However, the only model where access to credit comes up significant is in the frost model. Hypothesis 2 cannot be supported through all of the models. However, Hypothesis 2 can be supported with the frost model.

It is expected that Bolivians that have access to credit would lower climate risk perceptions. 24% of survey residents in Umala say they have access to some type of credit, while 26% of residents in Ancoraimes have credit access. It is important to note how the sources of credit vary from the two sites with individuals who have access to credit. In Umala, the 66% of the individuals acquire credit from the bank, while 34% acquire credit from the friends and relatives. However, in Ancoraimes, the majority of individuals (77%) acquire their credit from friends and relatives, while 23% of individuals have access through credit by banks. Individuals in Ancoraimes who have credit access rely more on informal methods, while Umala residents rely more on credit

through formal mechanisms. The variable of access to credit may not have come up as significant because it is possible that the credit they are receiving is an amount too small to alter their climate risk perceptions.

Hypothesis 3 states that one who has climate information, would have lower climate risk perceptions. It is shown that individual's type of information access did not significantly impact their climate risk perceptions. This may be due to the fact that these individual are constantly dealing with these weather events unlike most risk perceptions studies. Most of those studies look at a person's perception of risk to something they have never experienced like a nuclear explosion. Hypothesis 3 cannot be supported at all.

Hypothesis 4 states that lower dread feelings should lower one's climate risk perceptions. The variable of dread is significant in the overall model, as well as all of the individual models. The variable indicates that as dread increases, one's climate risk perceptions increase. This confirms what the literature has indicated in that dread plays a large role in individual's risk perceptions. Hypothesis 4 is supported with this study.

The focus groups showed how the gender groups feel about being affected by weather events. This is investigated because dread has been shown to have a strong impact on one's risk perceptions. The focus group participants associated negative feeling towards weather events. Both genders associated feelings of being afraid. The female participants have feeling of worry and feeling of being scared about being affected by the events. The men have feelings of feeling fear and sadness when they are affected by the events. In addition, the men point out that they can't cry to show their feelings.

The overall model explains 34% of the variation between the independent variables and the dependent variable of climate risk perceptions. However the model that uses only the factors (dread and unknown) to explain risk perceptions has been found to explain about 20% of the variation in the relationship (Sjoberg, 2000). The overall model has an increased explanation of the variation between the factors (livelihood management strategies along with the factors of dread and unknown with other variables) and climate risk perceptions.

The individual climate hazard models show that dread is significant in the five models, with higher dread associated with higher risk perceptions. Also, some community location variables come up significant in all five models. The communities of San Jose Llanga, San Juan Circa and Kellhuiri come up significant in the frost, drought and flooding model; indicating that individuals in these communities have higher perceptions of risk of these hazards in comparison to Cohani. The three communities are located in Umala compared to Cohani in Ancoraimes.

In the frost model more variables come up significant compared to the other models. The variables of dread, other income, sheep and credit are all significant with the correct signs. As individual have more other income and sheep, their perceptions of risk go down. People who have access to credit have lower risk perceptions. Individuals with higher dread, have higher frost risk perceptions. Also, in the frost model the communities of San Jose Llanga, San Juan Circa, Kellhuiri, Vinto Coopani and Calahuancani are significant, having a higher perception of frost compared to Cohani.

The outcomes of the frost model can be compared with the Legesse and Drake (2005) study that looks at the factors that influence farmers' perceived drought, flooding

and frost risks. In the Legesse and Drake (2005) study, the perceived frost risk consequence model shows that the asset base variable is significant. The asset base variable has a coefficient that indicates that higher asset bases are associated with higher perceived frost risk levels. However, in this paper's frost risk model, the variable of total sheep is significant with a coefficient that indicates higher sheep numbers with lower perceived risk levels. This asset base variable in the Legesse and Drake (2005) study has the opposite sign of the sheep number variable in this study, a variable that composes household's asset base. The sheep number variable has the expected sign as hypothesized. In the Legesse and Drake (2005) study the income diversification variable is significant with the coefficient indicating that diversification is related to lower perceived risk levels. The other income variable in this paper's frost model is significance with the variable indicating that the more other income an individual has, the lower their perceived risk levels. This supports the Legesse and Drake (2005) income diversification coefficient sign for the frost model. The Legesse and Drake (2005) frost model also has significant variables of infrastructure, climate zone and human capital. However, the coefficient on the infrastructure variable indicates that more infrastructures are related to higher perceived risks. This paper also had several community location variables as significant. This paper's frost risk model along with the Legesse and Drake (2005) model, both explained more than 30% of the variation for their own contexts.

In the drought model, dread gender and location are significant. Drought and gender have the correct signs. Males have lower drought risk perception than females. The communities of San Jose Llanga, San Juan Circa, Vinto Coopani and Kellhuiri all have higher drought risk perceptions than Cohani. Chinchaya and Chojnapata have lower

drought risk perceptions than Cohani. This model has few variables besides the location variables as significant, this may indicate that this hazard may be one of the worst for individuals to manage. The finding that gender is significant in the drought model is important because this is the only model in this paper where gender comes up as significant.

In the Legesse and Drake (2005) study, the drought risk frequency model has the asset base variable significant. However, the drought model has gender significant, while the Legesse and Drake (2005) model did not. In addition, the drought model also has location significant, while the Legesse and Drake (2005) study did not have climatic zone as significant in their drought models. The Legesse and Drake (2005) drought risk frequency model has a r-squared of .3, while this study's drought model has a r-squared value of .524.

In the flooding model, dread and location variables are significant. Dread has the appropriate sign. San Jose Llanga, San Juan Circa and Kellhuiri all have higher flooding risk perceptions compared to Cohani.

The Legesse and Drake (2005) flooding frequency risk model has asset base, infrastructure, climatic zone, gender and income diversification as significant. However, the coefficient on the asset base variable indicates that higher asset levels are related to higher perceived risk levels. This flooding model supports the Legesse and Drake (2005) flooding model in that location is significant in this model as well. This model's r-squared was .221, while the Legesse and Drake (2005) flooding frequency model is .409.

In, the climate change model, dread, sheep and one location variable are significant. Dread has the correct sign. However, the sign of the sheep coefficient

indicates that the more sheep an individual has, the higher their climate risk perceptions. The community of Vinto Coopani has lower climate risk perceptions than Cohani.

Between the two sites their ex-ante risk management strategies are very similar. In Umala, the focus group data reveals that they do plant different varieties of potatoes. In Umala they mainly grow potatoes, barley and oats, while in Ancoraimes they grow onions, potatoes, oca, turnips and oats. Umala's crop production is more concentrated on mainly three crops compared with Ancoraimes, where residents grow five different types of crops. 53% of Umala's crop production is based on potatoes, while only 14% in Ancoraimes. Since Umala has a majority of their crop production as potatoes, we would expect them to raise more varieties of potatoes to help diversify their risks. This coincides with the focus group results of Umala residents planting many potato varieties.

Between the two sites they have similar ex-post risk management strategies. However in Umala, they mentioned that they use their reserves of chuño. This can be related to their production portfolio, where Umala's crop production is more concentrated in potatoes. The Umala focus groups show that they are more willing to ask the government, institutions and others for help than Ancoraimes.

This study shows that dread is significantly related to individual's climate risk perceptions through the overall model and the four individual models. Hypothesis 4 relating to dread is fully supported in this study. Lower dread feelings are significantly related to lower climate risk perceptions in the overall model, as well as all individual climate models.

In the overall model it shows the diversification and having off-farm income sources, reduces individual's climate risk perceptions. The study shows that

diversification in crops sheep and dairy, along with having other income sources significantly reduce individuals' overall climate risk perceptions. Income smoothing through diversification by the previous mechanisms show that using this type of ex-ante risk management strategy can lower overall climate risk perceptions. In addition, the overall model and individual climate model's show that location can be significant in determining climate risks perceptions. The individual models show that individuals' risk perceptions toward frosts, droughts, floods and climate change have different factors that influence their perceptions to each of the events.

Policy Implications

The Patt and Shroter (2008) study finds that perception of risk differences exist between policy-makers and farmers. Since policy-makers and farmers have different perceptions of risk, then if policies are created in purely the aspect of policy-makers their policy design will reflect their perceptions. If policy-makers and farmers have difference risk perceptions, then a policy created solely by policy-makers may not work for farmers, whose perceptions of risk may not be aligned with policy-makers. This points to the importance of climate change policies incorporating farmer's risk perceptions in order to have a successful adaptation policy.

This study helps to identify the relationship between diversification, access to credit and knowledge to climate risk perceptions. The factors that influence climate risk perceptions are important to understand in order to identify changes in perceptions when a factor is changed. Changes in factors of climate risk perceptions could lower their perceptions of risk- helping them mitigate risks. The factor of dread is shown to significantly influence the Bolivian households' climate risk perceptions in the Umala

and Ancoraimes municipalities. The Bolivians' overall climate risk perceptions are influenced by diversification and off-farm income. Climate change adaptation polices should support farmers' livelihood diversification and off-farm farm income risk management strategies. This study shows that differences in perceptions of climate events differ within the communities of Umala and Ancoraimes. Climate adaptation policies should be flexible to include spatial diversity defined by geography and markets.

Further Research

It must be noted that as Garson (1998) argues the robustness of the coefficients when a ordinal dependent variable is used in a OLS model; however, he acknowledges that there are ordinal distortion in the coefficients when this is done (as cited in Labovitz, 1967; Labovitz, 1970; Kim, 1975; Binder, 1984; Zumbo & Zimmerman, 1993). Another model type could be used if an individual is interested in detailed relationship effects and not just a type of relationship being negatively or positively correlated.

Tests of significance could be conducted to see if there are differences between an individual's personal perceptions of risk compared to their societal perception of risk. Risk perception literature shows that individuals have higher perceptions of risk towards their personal well-being compared to their perceptions of risk of their community.

Further research could investigate the impact of local rituals on individuals' climate risk perceptions; since the focus group data shows that practicing rituals is a significant part of their climate risk strategy. Individuals in Mozambique believe that climate change is caused by gods being unhappy with them and not carbon emissions by developed countries (Pratt & Schroter, 2008). The risk management strategies that are discussed in the focus groups most in-depth are rituals- to make the gods happy. This

may relate to the possibility that they believe that climate change is caused by their gods being unhappy and not reasons such as, carbon emissions. Further research into finding out what sources they believe are behind climate events could provide knowledge that could aid in developing climate adaptation policies.

APPENDIX

A. TRANSCRIPTIONS OF FOCUS GROUPS

WORKSHOP – MUNICIPALITY OF UMALA

Topic: Sources of information and perceptions about climate risks.
Patacamaya: July 12th, 2007
Group: women with low income
Participants:

Name	Community
Participant UW1	Kellhuiri
Participant UW2	San José Llanga
Participant UW3	Vinto Coopani
Participant UW4	Vinto Coopani
Participant UW5	San Juan Circa
Participant UW6	Vinto Coopani
Participant UW7	San Juan Circa

Language: Aymara
Facilitator- 1
Transcription-1

RISKS

1. **Which are the climatic events that affect your crops, livestock and health of your children?**
   - Participant UW1: When flowers are blooming, the frost causes crop damage. Also, the hail affects crops; this is the most harmful, it destroys everything.
   - Drought does not allow crops to produce well; we only harvest small potatoes. Flood also affects the plants, which get rotten and do not produce potatoes anymore.
2. **What sources of information do you consider to know about the climate variability along the year?**
   - We look at the sky. If it is clear with no clouds, then this year is going to be better than last year (one word is missing in this sentence, I assume they said "better"). Because since may-june there was a lot of wind, the first yield might be good.
   - We guide ourselves by what our grandparents passed along to us. They have taught us to look at the sank'ayu flower and the t'ula flower (Thola).
3. **How would you know if this year is going to be a good one, if there is going to be frost or hail?**

- Participant UW1: We know it from the lik'i lik'i (a bird that announces when frost is coming). We do it is by observing the egg; when the egg is put in deep places it is because we have a dry year ahead.
- About the egg itself, when black spots on its shell are seen it shows that we will have hail this year. For a normal year, the egg shell is light gray.
- Participant UW2: When the South Cross (a group of stars that form a cross shape) shows up before time indicates we have to plant before time. When it shows up late it indicates we have to plant later. We have learned this from our grandparents who know much about that. They used to use this knowledge to plant different crops in the past.

4. Sisters, how do you know if there is going to be a frost?

- To know about frosts you have to look at the sky. A clear sky with no clouds indicates frost is coming soon. Another way is to look at the Illimani and Sajama (Illimani is located in La Paz and Sajama is in Oruro). When there is silence and no wind at all coming from these two mountains, we know the frost is coming for sure. On the contrary, when there are clouds and wind blows, then there is not going to be any frost.
- We also look at the t'ula (Thola). When its flowers are covered by something that looks like cotton, then I say this is going to be a good year. One year I observed this and it rained a lot.
- Participant UW3: But that happens in the low lands, not in the high lands. Strong winds take the dirt from high lands to low lands, and that is why that year might be good for you, but not for us who live in the high lands.
- In august, we observe the egg from lik'i lik'i (bird). For a dry year, the egg shell is gray. When the shell has many spots it shows there is going to be a lot of rain that year. For hail, the lik'I lik'i nest has stones and sheep manure. For the hail to come down, little wheat straws need to be seen.
- Participant UW4: Some people say that when the fox howls you have to seed earlier. When the fox howl stops it is because the harvest is going to be good.
- When the lik'i lik'i puts his egg over the river is because there is going to be flood. That is what our grandparents have told us. I have also heard that when the fox puts his manure in deep holes and close by the t'ula (Thola) it means that we have to plant earlier or that the first yield will be good.

5. What else would you add to what the other sisters have mentioned?

- Participant UW5: Another grandmother said: I have accumulated cow manure, and when that gets decomposed, it becomes gray color covered by a layer that looks like cotton. She says that means we have to plant earlier. After I heard this I did the same. I accumulated cow manure, which is getting decomposed

these days. After a few days I will see whether I get the same "cotton" on top that shows a good first yield.

- Some other people say that the Hornero (*Furnarius leucopus*) knows. According to this, for a good year the nest is built in direction of the frost, which means to the Sajama.
- And because last week we had snow, my father says this year we will have a better first yield than last year. He says we have to plant earlier. My father thinks that because the grandparents used to talk that when snow comes in July we have to plant earlier. It seems like it is going to be like that because rain has come before time.

6. **When you forecast by watching the birds, clouds and so on, does it come true? Have you effectively forecasted?**
   - It is true that sometimes what you forecast becomes true, but it is also true that sometimes it does not. I would say we should have to guide ourselves by what our grandparents used to say because they know a lot more than us.
   - Participant UW5: In my community, my grandfather uses to look at the South Cross and he never makes mistakes with his forecasts. He makes us produce good big potatoes, and almost never lose yield. He always knows the right time for the first, middle and last growing season.
   - Participant UW1: I think we have to watch , ask out grandparents and pass that information to our children, so we don't keep them out of that knowledge that it part of our culture.
   - We watch our grandparents, when they start to plant we follow them because they know.
   - Participant UW2: Some other people look at certain group of stars. When those stars are small is because we are going to have a normal year, but when those are big that means we will have a good potato yield.
   - On June 22nd, we observed the South Cross, a group of stars. On the night of the 22nd it appeared on the sky. There are other groups of stars in plow shape and bell shape. These stars are watched during the last week of June and first week of July.
   - On august 1st, when the sky is completely clear, it means that year we are going to have a drought. But when the sky is covered by clouds we certainly know yield will be good.
   - To know if hail is coming, we look at the lik'i lik'i's nest For the hail to come down, stoned must be found inside the nest. This can be observed in august.
   - Participant UW5: During growing season, in October, when the fox howls is because we have to plant when we do not expect to plant yet.

7. **In a scale from 1 to 4, what place do you give to each event, in regard to the effects it produces?**
    - First: Hail destroys the whole plant and it does not produce anything else. The few potatoes that do not get destroyed get sour with no flavor.
    - Second: Frost causes a lot of damage. After a frost, only those plants that had big seed are left. On the contrary, those that have small seed die and never bud again.
    - Third: In the event of a drought, potato plant produces yield but the tubers are small.
    - Finally, flood makes potatoes get rotten.
8. **What do you do to prevent the effects of each event? What do you do before a frost, flood or hail come?**
    - Nowadays we just look. Before, we used to sing to drive away the frost, but now we just look.
    - When potato flowers are blooming, and to prevent hail to come down we stir fire wood and t'ula (thola), with a poker. When we pour alcohol, the clouds that were intense (black) get notoriously cleared.
9. **Once you forecast that there is going to be hail this year, what do you do to reduce the effects?**
    - For the hail we light fireworks, provoke smoke, and stir up the t'ulas (Thola). When we don't provoke smoke hail always comes. We can protect ourselves from hail, but there is nothing we can do against the frost.
    - When there is hail everything gets destroyed, but when there is frost plants can recover because the plant is not completely destroyed as it happens with hail.
    - But we can only smoke the land close to our houses. We can not smoke those crops that are located far away (aynuqas). We can not run fast to do it.
    - We also have field agents (authority in charge of taking care of the crops around the community). He walks around the plots, makes smoke; this happens in my community (Kellhuiri). He always has to stir fire, make smoke; if he doesn't do it there is a sanction and a fine he has to pay. When it is about to hail, the field agent has to make smoke the entire week. It is clear that when the day is sunny you feel a cold breeze, so before it comes we make smoke. This is how we protect ourselves.
    - For a rainy year, wind is strong. On the other hand, when there is not much wind, then there is not much rain.
    - If rains are forecasted, we have to plant in vertical furrows. If we plant in horizontal furrows potatoes could get rotten.

- When there is a rainy year, the plots produce well in fallow lands (Purumas), while those plots that are cultivated intensively (without any rest) are washed by the rain. For those of us who live in hillsides, it is preferable to seed in vertical furrows.
- When we know it is going to be a rainy year, we seed in the higher lands, and not in low lands where water can get stagnated.

10. What do you do before growing season to prevent the effects of a possible drought?

- In order not to lose our entire yield, we seed in three times: first planting, middle planting and late planting. The first planting, on the hillsides is in September, while that on the flat lands is in October. The middle planting is due to the "holiday of all saints". The third planting is one or two weeks after this holiday.
- We plant anyway, either to lose or to win.
- We still plant, even knowing there is going to be a drought, because at least it is going to produce something. If we don't plant, we don't get anything at all.

11. Once the crops are planted, what do you do to prevent the effects of a drought?

- There is nothing we can do. We resign because we accept that year we will not get any yield.
- In previous years, when drought was strong, there was no other option than migrating to the Yungas or La Paz city to work, along with our children. This is the reason why nowadays some of our children quit their studies and are currently working as house maids, construction workers, etc.
- During bad times, our reserves of chuño helped us to face the drought. That was the only thing we had to support ourselves. Sometimes we have to buy some products.
- But there are families that do not have reserves anymore. The potatoes they produce are directly taken to the market; they do not make chuño. For example, in communities located on hillsides a lot of potato is being produced. From that side, even the cars come full of produce. Some people take 2 or 3 hundred-pounds-bags to sell in the market. They also sell chuño, and that is the reason why they do not have reserves anymore.

12. What else could you add to all this, sisters?

- But most of the families have their reserves, even if in small quantities, they always have reserves of chuño. If the drought last a year, our reserves are enough. However, if the drought lasts do or more years, our reserves will not be enough.
- In that case, there is not other option than to migrate to other places.

FEARS

13. How do you feel when adverse climate events (frost, drought, flood and hail) affect your crops and livestock?

- When there is a frost or hail we get really worried. Those people who have children like I do get more worried. During a drought there is no food or pasture for the animals. The barley does not grow, and this crop is indispensable for our livestock.
- Because of the drought or frost there is no development in the fields. We don't step forward. During the drought, the animals get weak or die for lack of food.
- During a frost, the young sheep die of coldness. Livestock market prices get lower because the animals become weak for the lack of food. Before they die, we have to sell them, even if a very low price.

EXTERNAL SOURCES OF INFORMATION

14. Sisters, do you listen to radio to know how this year is going to be?

- We do not listen to the radio. They do not talk about weather in the radio.
- In the radio they talk about weather, but it is not clear, concrete or trustable. We mainly trust in what our grandparents say. Apparently, people from the radio do not know anything because they are never right.

15. What radio and what programs do you listen to?

- The radio we listen to is the San Gabriel radio and the programs are in Aymara language. There is a program that runs at 5am, because the radio starts its activities at 4:30am. The program starts talking about medicine, then reading, writing and finally about the crops.
- But it talks more about health. They say that soda consume as well as beer is bad for our health. They also tell us how to get cured.

16. Sisters, what else would you like to add to this?

- We don't listen to the radio very often, just a few times, because it is too early. Also, we don't have electricity. We buy batteries to run the radio, but since they are expensive, and we can not buy them so often, we use the radio as little as possible.
- Sometimes we listen to the "Integration" Radio, but it does not talk about the crops.
- We are sure there are other radios, but we don't listen to them. We don't know much about what is going on.

17. When you go to the fairs where you sell or buy products, have you ever heard about the weather?

- Everywhere people say this year the first planting will be better; that is what we have heard in the fairs. It seems like it is going to be like that, because it is doing well so far. The winds also say so.
- Most of the radios announce news about national and international issues, but not about crops or animals.

18. Have you ever asked to the engineers from those institutions that work for your communities?

- We don't ask these people because, for example, Proinpa, they do not know. Our grandparents know. Besides, nowadays it is difficult to forecast.
- We just observe other people from the community, who always know.

19. Sisters, what else could you add to this?

- Also, people from the community talk about the best time to plant. For example, in the community of San José, a woman forecasts splitting the potato by half. When the middle part of the potato dries like white starch, it means it is time to plant.

20. Sisters, do you watch TV programs where they talk about weather? Which ones?

- We do not have TV in our communities; some of us just have radio. But there are no programs about crops. Besides, we don't believe they know, it isn't them who produce.

WORKSHOP – MUNICIPALITY OF UMALA

Topic: Sources of information and perceptions about climate risks
Patacamaya: July 12th, 2007
Group: women with high income
Participants:

Name	Community
Participant UW8	Kellhuiri
Participant UW9	Kellhuiri
Participant UW10	San José Llanga
Participant UW11	Vinto Coopani
Participant UW12	San José Llanga
Participant UW13	San José Llanga
Participant UW14	San José Llanga

Language: Aymara
Facilitator- 2
Transcription- 3

Regarding the question: How has the weather changed in these last years for your families, livestock and crops? These were the answers:

- There are no frosts anymore for chuño production, just a few hours that give as a result green chuño without consistency. There is little rain. There is more wind that lowers down the temperature and makes it difficult to warm up.

How do the frost, drought and hail affect you?

- It does not rain much and plants get dry. The hail destroys crops and leaves them naked like sticks. It also affects our livestock because there is no water anymore for them to drink, and pastures get dry. Our children get affected by flu and other diseases.

How do you know or what do you see to forecast a frost, drought of hail?

- The tiki tiki (bird of the area), accumulates small stones to make the land produce more. For a dry year, the Tuju builds his nest in deep places; for a rainy year, it does so in high places. For hail, we look at the leke leke eggs, which are put in the middle of holes. In this last case, we say it will be a year with hail.
- These indicators become true and we always follow them. For hail, the leke leke makes a noise (chis) and we know it is about to hail. For frost, the day before we feel a cold wind, which make us know it is going to frost at late night. When the wind comes from the Illimani, we say it is going to rain.

Which one of these affects more your crops or livestock?

- Firstly, frosts are the ones that effect us the most. After that, we would mention hail and also the drought, because it is does not rain nothing would grow, not even for the sheep, as it happened long time ago when there was a drought and animals ended up dying while walking.
- For me, the drought would be in the first place, because without rain everything will be dry. Frost and hail would come after drought.

What do we do against the frost, when crops are already planted?

- To face the frost we warm up the burned environment. We do it after midnight, burning those places of Aynoka (communal lands) around the community until the sun rises up.
- In other places, we help each other when there is no rain, as sign of repentance.
- For the hail, it clearly comes with lightening, so we light fireworks. Doing this, hail comes less strong or it goes somewhere else. We also burn dry herbs or Thola, and so it does not come down as hail anymore but as rain.

- When there is a drought, there is nothing we can do. Some of us repent from our sins, but most do not.
- If there were floods, there is nothing we can do either and it would affect us a lot. There is nothing we can do to stop water coming in.
- When hail is coming slowly we can do these things, but when it comes suddenly, it is impossible to stop it and it finds us unprepared. But it is important to observe all the time.
- Participant UW12: There is nothing we can do against hail, so we work vainly. We usually spread ashes to the air to minimize the effect of the hail, but not even this works. Sometimes we try everything without any result.
- Other people burn Thola, light fireworks, whatever is needed to face the hail. Some time ago we used to scream to the sky throwing hats.

And before you seed, what do we do to face frosts, droughts, hails or floods?

- Participant UW9: In the old times we had Jilakatas or justice decision makers. We used to walk around the plots with two or three "aguayos" and they delegated to us the protection of the crops. And if we got hail, it was supposed to be our fault, so they hit us with whips. Nowadays it is not like that anymore.
- Before seeding we used to Khoanchar (traditional ceremony) with khoa and others to present offerings to the Pachamama.
- Before planting we observe the wind. When winds come earlier, the planting needs be done earlier. Plantings that are done later are gotten by the drought; hence the potato yield is smaller. In the latter case, there is nothing we can do against the drought.
- Even in the event of a drought we plant anyway, because there is nothing we can do to face the drought.

Once, there was a drought that left nothing to eat neither for humans nor for the animals. The animal ended up dying, and there was no yield of potatoes or onions at all. The drought lasted along the entire year. That drought did not happen again.

- At the end, as our last resource, we asked the government to help us with these problems. We told them we were really sorry because there were no rain at all and we had nothing to feed our children with.
- In that moment, we were wishing more help might come to help us. There was no harvest left to buy and we had to buy potatoes with worms, and even these were scarce. Those people who go first to the market buy the best of what is available, but for those who go later, there is nothing left. Our children do not stop asking for food, potatoes, and this is the reason why we cry.

How do you feel when you are affected by or lose your production due to a climate event?

- We are really afraid when we think about the weather. We pray for the frosts not to come. So we pray for droughts.

Aside from plants or birds, how do you know about the weather?

- To know about the weather, we listen to the radio. Especially, we listen to the San Gabriel radio program that runs in the mornings.
- San Gabriel radio advices about the weather, but I do not remember the name of the program. I just know it is in the mornings, at 5am.
- There are no other sources of information; we just talk to each other. For example, we ask ourselves what the next year is going to be like and we share that with other women in the community. We also comment about the tuju (bird) and how it accumulates little stones, which means it will be a good year.
- When we are about to plant, the tik'i tik'i walks around the plots. Then we say this year we will have potatoes; this is luck for me.
- When I am planting potatoes or quinoa in the furrows, and the alkamari (bird from the place) fly in circles above my plot, I get really happy because it means to me that I will have a good yield.
- When I am planting potatoes or quinoa in the furrows, and the alkamari (bird from the place) fly in circles above my plot, I get really happy because it means to me that I will have a good yield.
- In august, we listen to the radio to know more or less how this year is going to be like.
- In the case of frosts, we listen to the radio during those months when it is more probable to have the event.

Who do you trust the most?

- Between our grandparents and the radio, those who know more about the weather are our parents. They also know more about natural indicators. For example, in the case of the kella, those flowers that bloom well or earlier indicate that the planting needs to be done earlier too. To indicate we should plant later, it also blooms later.
- For us, it is very important all what our grandparents have taught us. They taught us to watch the indicators and they are very useful. When the indicators predict there is going to be hail, we burn wood, for example. So we do in the event of a frost.
- Besides of the radio, our grandparents come to the community to talk about the weather.

WORKSHOP – MUNICIPALITY OF UMALA

Topic: Sources of information and perceptions about climate risks
Patacamaya: July 12th, 2007
Group: Men with low incomes
Participants:

Name	Community
Participant UM1	San Juan Circa
Participant UM2	San Juan Circa
Participant UM3	San Juan Circa
Participant UM4	Kellhuiri
Participant UM5	San José Llanga
Participant UM6	San Juan Circa

Language: Aymara
Facilitator: 4
Transcription: 3
How do you see the climate change currently?

- Participant UM4: I compare the weather we had before with that we have today, and I notice everything has changed. Today, it seems like everything is based on chemicals. Before, our soils were Purumas (soils with many fallow years), and we did not need medicines. Today, soils seem tired. When talking about livestock, before we did not use those chemicals showers to fight mange. Before, when I was a kid, there were ticks, but the animals were still strong. Today, animals can not stand them and we need to shower them with all those chemicals. About climate, it has also changed for me; when the sky is clear, the sun rays burn us and warm up our skin completely. Other people say the sun has descended and that is the reason why it burns us now. Before, frosts and climate events came on their usual time. They had their time to come, but that has changed now. There are places where people made chuño before, but now they do not do it anymore due to the lack of frosts in that area. Frosts are not good anymore. I, for example, have accumulated my potatoes, but can not make chuño from them. Climate change events like hail or lightening (kejo kejo) attack anywhere. They also affect our families and our children because they are young and they did not know how it was before. I notice the changes because I have seen them from before. Some of my children notice the difference now because of what I tell them.
- I see that before, in the time of our grandparents, there were no fertilizers, pesticides or vaccines for livestock, but today everything requires chemicals. Before, my grandfather has many cows and he did not need vaccines, he did

not used to cure the animals; now, cows get vaccinated and at the birth the calf already has keucha cururu (disease). These calves die three months later. Nowadays, people keep vaccinating their cows and push us to do so. They say that if we do not vaccinate our livestock, the milk will have no price in the market. We are doing wrong by adding chemical fertilizers to potatoes. By trying to protect potatoes from pests, we fumigate and that medicine gets inside our bodies by the food we eat. Now, for example, my son looks older than me.

Who has taught you to forecast the weather?

- Our grandparents knew well about the weather from looking at the plants, observing the mountains, and more. Today, our grandparents can not forecast the weather because the clouds, for example, do not come out on time as they used to. Neither do the animals. These days, hail comes with lightening. Some people used to tell us that we do not manage well our crops and that was the reason why the lightening was coming to our livestock. They also said we should bury those cows, because if we ate that meat we could get a terrible disease.
- Our grandparents knew when the year was going to be good, with rain, droughts or anything else. We know from them how the year could be.
- Participant UM4: We know from the animals, by watching the leke leke (bird) eggs. When the egg is green color and is located above a furrow (chuto) it means it is going to be a rainy year. To know about hail, we observe if the leke leke accumulates stones. If these stones are small, then we say there will not be hail this year. We can talk about many things, for example, whether or not we will have a frost. For the latter, we observe a little bird called Curcutaya and a plant which two sides are hot and cold respectively. When the egg is being put on the cold side of the plant, it means there will not be frost (because the bird still puts the eggs in the cold side). On the contrary, if the egg is put on the hot side, then there is going to be frosts. According to this, we look for plots where we can plant.

What about droughts?

- Participant UM1: frosts destroy our potatoes and quinoa. Especially in January, there is no more production. Hail comes right when potato hasn't finished its ripeness. And the question is how we can protect ourselves from frosts and hail. Now we also put urea and other chemical fertilizers that help the plants to grow, but I do not agree with chemical options. Hail affects the plants anyway. When frost does not affect plants we are fine. For me, the best pesticides would be the natural ones, since I do not trust on chemicals (which

are many) that get inside the potatoes, quinoa and vegetables. These chemicals also get inside our bodies, and I have read in the PRESENCIA newspaper (which does not exist anymore) that every pesticide like Tamarón, Cupravit and others contaminate our products, and that is how we get Cancer. Before, these products were not used at all and people lived more than a hundred years. It was because the diet was based on quinoa, barley or Cañahua. Today, even being forty years old, we already have gray hair because we do not eat organic products. For example, when talking about an apple from Zahapaqui and another one from Chile, the one from Zahapaqui is sour while the one from Chile is sweet and big, but has many chemical products, in comparison with the first, which has no chemicals in it. Thus, I see this could also happen to potatoes; native varieties could be better and more resistant. Improved livestock is less resistant than native livestock. Holstein livestock does not resist cold; for them not to have diseases we use vaccinations. We also use chemicals to fight ticks or louses. Neither the meat nor the milk or potatoes get rid of contamination. Weather has changed, according to what industrialized countries say. The latter have destroyed the ozone layer; their industries capture the hydrogen available in the sky that protects us from sun rays. This is why coldness is higher at nights. Weather has changed and diseased have increased.

- Participant UM2: …….. (Not understandable what he says on the cassette).

Which event is worse for you?

- Participant UM1: For me, frost is the worst because it takes the potato when it has not ripened yet, so yield decreases considerably and we don't have enough money to feed our families. I would say droughts are next, because it does not allow potatoes to ripe. Finally, hail.

How do drought and hail affect you?

- Drought affects us completely because nothing grows without water. Hail affects us, but does not much to potatoes, but to grains, which get dispersed over the soil. These grains lose their seeds and are useful only as forage. With floods is the same.

For you, Participant UM4, what is more harmful?

- Participant UM4: For me, drought is the most harmful. Less harmful are the frost, hail and flood. These events go to specific places, from one sector to another, but drought affects everything. How could we get rid of it?

- Participant UM5: For me, frost is the most important. However, when it comes on the right time it is beneficial, because it allows us to transform potato into chuño. Frost is harmful when it falls over green plants. Drought destroys everything. After drought, I would mention flood and hail. When there are floods, we can go to higher places to save ourselves, but we can not save ourselves from hail or drought.
- Participant UM6: Frosts affect us completely. Hail does not affect us much and we can save ourselves from it. Floods affect us completely, as much as drought.
- Participant UM1: We have tried experiments in three places to fight frosts: one on muddy soil, one in sandy soils and one in stony lands. According to our grandparents forecasts, in January, between the 20th and 25th, frosts are terribly dangerous. When frosts do not come in those days, it means we will have good yield, at least in one of the three lands we chose to plant. There are lucky years when the three places produce good yield. There are some soils that require a lot of water and some others that almost do not require any, like sandy soils.

Which event does fear you the most?

- Participant UM2: For me, drought would be the first place, then frost. Hail goes from one sector to another, and if it comes over my plot, then I would work for my neighbor and would not die. However, there is nothing I can do in the event of a drought. Floods affect deep places. In my community, we all know where to plant and what soils to choose for it.

Outside participant makes a comment about the agricultural insurance.

- About the agricultural insurance that the government can offer, I suppose it will not reimburse all what we lose from climate events, but it would be good if we can get something back. I think it would be a good decision and we should have to get used to pay for it.
- For me, it is good if government helps us with these, and if we give money for it, it should also give it back to us when we need it. It might be difficult at the beginning to pay for it, but I think it will be fine.
- We, as farmers, are forgotten by the government. We don’t get a penny. In this case, if we pay for the insurance, we might be paying for government’s employees. If we lose production one year, with what we give, we should get seed from the government for the next year. There would be a problem. We can pay for insurance, but we work with yoke, which does not work fast since we are in different topographic areas. In other areas, their lands are extensive plains, so we need machinery to plant in big plots. We use yoke only in small

plots. Some brothers plant three hectares per day using machinery, while it takes me six days to finish a hectare of quinoa by yoke. Thus, we would have different amounts of yield. Sometimes, we have different ideas within the same community. To work, we need to follow the same idea, and this is the reason why organizations fail. We need help from government, but if the help is through bank loans, we will be working just for the bank.

- Participant UM2: Sometimes it rains at night, but it gets clear after midnight, when the frost comes.

How can we fight against frost, drought, hail or flood?

- Participant UM1: According to our grandparents, to fight the frost it is important to set a small fire on the field. I think that reduces some of its effects. Regarding hail, I have heard that fireworks are effective to get it away from the area, but it has not been proved yet. About drought, there is nothing we can do. Perhaps a pump from the municipality could help us irrigate the crops.
- Participant UM4: We know from our ancestors that to fight a frost we have to set a small fire on the field, but there are some parts that are not being protected. I think it is difficult to fight against flood. If we want to save the crops in the event of a flood, then we have to plant in places where water can not affect them.
- We could predict where the water from rivers might go through, but we could not do so to know in what part of the river the water might overthrow. Hence, the only way how we can control it is by building acequias.

If there is a frost, drought, hail or flood, and you have already planted potatoes and other crops, what would you do?

- If we were affected by drought, hail, frosts or floods, the only thing we could do is to ask institutions for help. We are also thinking that the prefectura should help us. In the meanwhile, as a way of prevention, we choose three places to plant our crops. From those, at least one could get saved.

And personally, how does it affect your mood? How do you feel?

- Regarding how these events affect our mood, when we get affected we can not cry. We only think next year we will recover from it.
- In August and September we use natural indicators to know how the year will be in terms of frosts and droughts.

Do you listen to radio or TV to forecast the weather?

- Today, radio, TV, Thola and others do not know about the weather, because it has changed. Forecasts from radio or TV become true sometimes, but generally they come earlier or later.
- For example, last year the Scientifics forecasted the Niño event and the areas that will be affected. From that we knew what to do. We did not look for newspapers; we found out about this from other people. However, we don't know what specific areas will get affected.

What is the source of information you trust the most?

- We trust more in nature and its indicators to forecast the weather. There are some people like me, who prefer to compare what nature's indicators say with that of the radio or TV, but others do not do the same. I see and compare.

WORKSHOP – MUNICIPALITY OF UMALA

Topic: Sources of information and perceptions about climate risks
Patacamaya: July 12th, 2007
Group: Men with high incomes
Participants:

Name	Community
Participant UM7	San Juan Circa
Participant UM8	Kellhuiri
Participant UM9	San José Llanga
Participant UM10	Vinto Coopani
Participant UM11	San José Llanga
Participant UM12	San José Llanga
Participant UM13	Vinto Coopani

Language: Spanish
Facilitator- 3 & 5
Transcription- 3

How does the frost, drought or hail affect us?

- Here in the Highlands, the frost is what mostly affects us because we can not control it. I think hail can still be controlled, but not frosts.
- Frost comes when potato plant flowers are blooming. This year we have had loses in some areas, but not in others.

How does the frost go?

- It goes like a wind, by sectors.

How about the drought?

- Regarding droughts, there are some years with no rain at all. In these cases, since we are used to agriculture, some plants, birds or animals let us know with anticipation whether this is going to be a rainy or a dry year. According to these indications, we proceed to get our crops ready to face the events.

Does the drought affect your children and family's health?

- It does affect us because when there is a drought the temperature warms up, and more diseases show up, especially in kids, who get sick with flu. Animals are also affected by droughts, because there is no rain and hence there is no water for them to drink.

Are there hails in Umala?

- Talking about hails, these are worse than frosts. When there is a frost there is rain, and it still allows plants to grow, so at least something gets saved. On the other hand, hail is the worst, because right when flowers are blooming the hail destroys the leaves and they can not recover anymore as they do in the event of a frost. The hail takes the leaves somewhere else, and that is the reason why people say hail is a thief that takes the yield to other places.

Are there floods in Umala?

- We have suffered especially in 2000 and 2001. This year for example, there was a flood from the Desaguadero River that severely affected potato and forage production. There have been years when floods have taken even houses.

How would you scale the frost in respect to how it affects you?

- It has increased during this season. Temperature has decreased up to 10 degrees below zero (Celsius), causing diseases both to humans and animals. Due to the frosts, this year the coldness has been intolerable, which has not happened before. Even the animals were trembling, however they did not die. The frosts have made dogs sick. Heat is stronger and drier than before. Frosts affect us a lot and it can not be controlled.

How can we face these events?

- There is nothing we can do to face or fight climate events like hail frost or drought. Perhaps, we can protect a small plot of land, but since we plant in bigger extensions of land it is impossible to control the effects of any event.
- Our livestock has always been affected by frosts and coldness. How? It produces pneumonia (khoto) in young cows and sheep. It is like the altitude disease, but when it affects them we already know we will lose them. We

don’t know how to cure them, and we have just a few barns to protect them. In the flat plains located far away from the house, yards are made only from stones, which makes possible only for native livestock to survive.

- When it is hot we suffer a lot because after the animals eat alfalfa, this does not grow again due to the lack of humidity in the soil. Hence, we have no food for animals.

What can be done to fight hail?

- There is nothing we can do to fight hail. It comes at night or anytime, lately it is being coming at early morning hours.

What about floods?

- Regarding floods, there are some things we can do. For example, we could control some water by opening canals using machinery, or we could escape with the animals to the mountains. On the contrary, regarding frost, drought of hail there is nothing we can do.

How do we know when there is a drought or frost in the community?

- Before we plant, the birds announce frosts. When there is going to be a frost, many birds announce it, so we plant different varieties. The potato varieties Blanca and Desiré are more delicate to frosts, which burns and destroys them. The most resistant varieties are Ajahuiri and Luki, which do not get affected by frosts and keep growing. Thus, our strategy as farmers is to diversify the varieties we plant, as a way to ensure at least our self consumption yield from frost effects.
- We get advised by lecke leckes (birds from the area), winds, kellus, chururuncus, Thola flower, stars, tujus and many others.
- These indicators work very well. For example, for this new year we already know that there are going to be rains in the low lands, because the tuju is in chuto and not in k’awa (this means the bird did not make its nest in high places as a way of prevention against the potential accumulation of water in deep places). Looking at this we know we have to plant in places with higher altitudes.

What do you have to say about this in Kellhuiri?

- In those communities located in higher altitudes, like Kellhuiri, the forecast differs from ours. We have the same indicators, but apparently the effects might not be the same in higher altitudes. Old people from the community points that there is not going to be much rain in the higher lands because the leckechus are still in deep places.

- Another indicator we have for frosts is the Chururunku (bird), which in the event of a frost, builds its nest in north direction. In the absence of a frost, the bird builds its nest in south direction. This has been working well since our grandparents' times.
- For a rainy year, other birds build their nests over wheat straw or Thola. On the contrary, when a drought is expected, their nests are built over the bottom of the plants.

What are your indicators for floods?

- Regarding floods, we observe the lecke lecke. When a lot of rain is expected, this bird builds its nest in chutitos (high places), and when the opposite is anticipated it does it in flat plains or deep places. Also, when it is about to rain its eggs are green color, and when it is not, the eggs have some other color. There are some other indicators like the foxes singing during September, which was mostly heard by our grandparents. Nowadays, it does not work 100% anymore.
- Also, for floods we observe the amañoque (native species). If it is julluta (rotten) it means floods might be expected. If the plant is fine, it means no floods are coming.

What indicators do you have for hail?

- There is another indicator for hail, which is a bird called tiwtira. This bird puts in its nest sheep manure, cow manure and also coal. This indicates hails can be expected during the year. This is observed before plating and as a prevention procedure we plant in three groups (three planting times): during the first days of October, Todos los Santos holiday (November 2nd) and at the end of November.

What can we do to prevent hail and drought?

- For hail, we can burn and provoke smoke the entire day on the fields, but not even doing this we can control it. At other places like Ingavi Province, people use a type of fireworks before hails comes. If they do it later it might not be effective.
- There is nothing we can do against drought. However, communities that have sources of water might be able to introduce irrigation systems to reduce the effects.
- Regarding drought, when it does not rain we do K'uanchar (Andean ritual), which consists in bringing water from different places located far away and put it together with a sheep's blood. With these two elements we go around the churches several times, while we pray at the same time.

- Once we have planted there is nothing we can do. The only thing we can do is to pray to God to take care of our crops.

What event frightens you the most?

- What we are most afraid of is the lightening that falls in the area when it rains or is about to hail. It kills our livestock or even human beings, our children or people herding on the fields.
- Another fear we have is when the frost freezes everything. We think there will be nothing to eat, that we might lose everything during the night.
- Finally, another fear we have is when, while herding our livestock on alfalfa fields, our best animals die from Myringitis, which makes our family members cry.

What do you do when you lose your yield due to a drought?

- When we lose our animals or crops, we go to our municipal authorities. They sometimes give us a kilogram of sugar, rice or used clothes, which are not enough for a year. What we would like to receive from institutions is seed or equipment to carry water to irrigate our crops.
- We need to emigrate to work. I, for example, in the event of a drought, used to go to work to the Colquiri mine.

EXTERNAL SOURCES OF INFORMATION

- Through the radio we know about climate events that are about to happen. For example, people on the radio said we will have complete coldness; we are about to confirm whether this information was true or not. These advices used to be effective before, but since climate is changing a frost, hail or drought can be expected anytime. We have heard climate or weather change every five years.
- We can trust in Tuju (ant), but we can not trust in radio. This is because, for example, they say it is going to rain, but they do not specify in which zones or regions of the Municipio it will rain or hail. On the other hand, lands at higher altitude require much rain, which differs from lands in lower altitude, where the contrary is necessary. This is not known by the radio; hence they can not inform us about it. The institutions might be able to forecast this if they go to the communities, but the media can not, because every time they advice something it is about the entire Altiplano or the big cities.
- And if they give us information about the weather, there is nothing at all we can do, but just trust in God, luck or perhaps plant in three groups (three different times) to ensure some yield.

WORKSHOP – MUNICIPALITY OF ANCORAIMES

Topic: Sources of information and perceptions of climate risks
Chojñapata: July 26th, 2007
Group: Women with low income
Participants:

Name	Community
Participant AW1	Chojñapata
Participant AW2	Chinchaya
Participant AW3	Chinchaya
Participant AW4	Calahuancani Baja
Participant AW5	Chojñapata
Participant AW6	Calahuancani Baja

Language: Aymara
Facilitator- 1
Transcription- 1
RISKS

1. **What are the climate events that affect your crops, livestock and your children's health?**
   - Frost does not stop potato from producing. In the event of a frost, sometimes we produce a little bit and potatoes are small.
   - Hail is what affects us the most. It destroys the whole production. When hail comes everything gets destroyed, furrows are left covered by leaves, so their color is green. Only the stem of the potato plant is left. Flowers and leaves are left completely destroyed or smashed, and so they do not produce anymore. Hail takes everything.
   - The flood also affects us. In a rainy year the potato plant does not produce anymore because the roots get rotten. Sometimes we have big plants, but with no produce. When there is a lot of rain, the potato plant gets damaged, it turns into brown color and do not produce well.

2. **What sources of information do you take into account to know how the weather will be throughout the year?**
   - To know whether or not hail will come, we just look at the sky. When the sky is cloudy, dark, black is because hail is coming. But, we protect ourselves from hail by lightening fireworks.
   - Before hail comes we try to scare it by using fireworks, because if we don't do that the hail will destroy our crops and nothing will be left for us.
   - We prepare ourselves for frost in the same way. Before it comes we stir firewood with Llama fat.

- We cry a lot, so we can scare the hail and the frost, and they leave.
- But the frost comes at night around 3 or 4am. However, we still stir firewood to provoke a lot of smoke. This is the only way how we can protect our crops.

3. **What information do you get from your sources about frost, drought, flood and hail?**
   - When the sky gets clear, with no clouds, we know frost is coming.
   - We know frost might appear during these holidays: Carnaval, Ash's Wednesday, temptation. Frost always comes on the days of these holidays.

4. **What do you observe for hail?**
   - When hail is coming, it is very clear. The wind is strong, the clouds start playing. It is well-known, when clouds get together and it gets really dark, we know it will hail.
   - When we see the sky getting dark, we immediately bring fireworks to disperse the clouds, so the hail does not come. But when hail wants to come, it just does so and destroys our crops.

5. **What do you do when you know it is about to hail?**
   - When we realize it is about to hail, we all have to burn firewood along with the authorities of the community.

6. **Sisters, how do you know how the weather will be this year? What do you observe to know it is going to be a dry year?**
   - About droughts, in my community, we get guided by the potato plant.
   - When plants are affected by the frost, their leaves get dry. This means the plants will not produce well this year. But, when the plants bud late and are not affected by the frost, then we know they will produce good potatoes.
   - Participant AW1: We also know by observing the crops in the valleys. In communities located in valleys, the potato planting is before (milli) ours, and when these crops get affected by frosts, we are sure our first potato planting (before planting) will get affected by the frost. On the contrary, when crops in the valley are not affected by frosts, our middle planting (second planting) and last planting will be affected by the frost and we will not have a good yield.

7. **What other information would you share with us, sisters?**
   - Some of us get guided by the month of august. During the last week of august, we lift the stone to know how the year will be. When the dirt under the stone

- Participant AW6: But some of us lift the stone during the first days of august. What we do is to observe the sky during the first three days. When the sky has clouds at the first day is because our first planting will be good; and when at the second day the sky is cloudy, it is because it is not good to plant earlier or later, but on the right time, so the middle planting will produce well. If only at the third day the sky is cloudy, it means that only the third planting (late planting) will produce well. These dates help us decide when is good to plant.
- But if the sky is completely empty during those three days, with no clouds at all, the frost that year will be really strong. It could also mean the year will be dry.
- We know how the year will be by observing the lik'i lik'i bird. For example, last year the bird used to be on humid places; you could find it on the lake's border. The same happens this year, which means it will be a regular year, we will have some drought.
- Participant AW4: Others say that when this bird lays its egg on the water or on the lake's border it is because it will rain strongly this year.
- There is a bird called Huallata. Some people say that when this bird comes to the plots on the flat plains, it means yield will be good. But, when it comes to the plots located in higher altitudes or away from the lake, it is because drought might occur.
- One year, I saw Huallatas coming to Canta (community located close to Calahuancani). That year drought occurred.
- Also, some of us observe the fox. When the fox finishes well its howl it is because it will be g good year. When we are planting and the fox goes to the mountains is because the communities located in higher altitudes will have good yield, but when the fox runs downhill, yield will be better on the flat plains (pampa).

8. Sisters, would you like to say something else?

- : We also observe the fox manure. When it is white, for those who live in Chojñapata, it represents the color of tunta, which means yield this year will be better. But when the manure is black, it is because yield this year will not be good, and a lot of frost or hail might occur.
- : After we plow the land, there are always dirt blocks (khulas), so when we plow we must break those blocks. We do this in August and September. Thus, while we do this we observe the dirt blocks to know how the year will be.

When the dirt under the blocks is smooth and humid, it means we need to start our planting.

9. When do you start to plant, and how many times do you plant?

- In Chojñapata, the first planting is in September, middle planting is in October, and finally, we plant for the last time in November. Planting in this community starts earlier because the cold weather delays the plant growth.
- My grandfather, during June in San Juan, uses to observe a group of stars (qutu) to know whether the first or the last planting will be better.

10. What else do you remember, sisters?

- I have an uncle who permanently watches that group of stars. I usually ask him what it means when that group appears in trinity, to what he answers it means that middle planting will be good, but we have to plant on the right time, neither before nor late.
- Also, there is another group of stars in cross shape. When this group of stars shows up on the west side, it is because potatoes will not ripe well because they might get affected by drought or frost. But when it shows up on the east side, above the Illimani, yield will be good this year.
- Old people say that when it snows in San Juan, it means yield will be good that year. It will rain, they usually say.
- That is true, because last year in San Juan it snowed a lot, and it was a good year for us (Chojñapata). There was no much frost, so potatoes produced well.
- Participant 1AW: Besides that, people from CIPCA have told us to cultivate in terraces using horizontal furrows, but we cannot do that, because when it rains intensely the potato plants might get rotten from the roots. We can not follow that advice; the rain obligates us to plant in vertical furrows, so rain water can flow easily. It always rains in his community.
- In the last years, young people like us don’t know much about the forecast abilities our grandparents have, because we don’t ask them anymore.

11. Why aren’t you asking anymore?

- That might be because of lack of interest. I think it would be really good to know deeply about forecasts through the birds and other animals, because if we know this we can cultivate better.
- : women have worked several years with CIPCA. At the beginning, there was no interest from us, so they started with just three women. Those three women had very good yield that year; they produced big potatoes on terraces. Thus, looking at their yield I got interested, and I sent my husband to observe. We

did exactly the same in our plots, but it did not work well. They have decided to make bokashi and use that for the crops, so we decided to join them and work on it.

- We have cooked herbs, tacachilla, and ajinco. They have taught that to the entire community.
- We have worked with CIPCA, we have made Bocash. The mixture is two kilograms of cow manure, half a kilogram of chancaca, one liter of milk, and egg shell. We put all that together and provoke fermentation like in Chicha, for a month. Some people leave it for two months, it varies. And, when potato is budding we put the bocash, so it grows better. After a while, we fumigate again so the flowers bloom. Later on, we fumigate again but this time with lime (cal) to prevent the plants to get attacked by the weevil (gorgojo). This latter mixture has sulfur and oil to keep everything together in the plant. We have observed the animal dies on the plant. But, we have not done these things with the university this year.
- Participant AW6: But in my community the authorities have not cared about it. Edwin has told us we will do it, and they have settled up a time with the general, but the authority has not informed us. So, when the institution comes there are no people, and we come vainly to the meeting. This situation demoralizes the work; we think further activities might be the same.
- After that, he did not come anymore. We don't know when he was supposed to come either. This is why we haven't work well.
- Firstly with CIPCA, we started a group of three people, within which we elected a president. This organization has worked well. The president used to let us know. CIPCA coordinated with the president, gave him the invitation and he then communicated us house by house. We reply to that, we do what is planned.
- The institution has taken us to Cochabamba, Quillacollo, Perú, Yunguyo; everywhere. We already knew who was about to participate in those activities; people in the group elected us and we, as elected, have participated.

12. What have you learned in those trips to Cochabamba, sisters?

- In Cochabamba, we have learned to make amendments with yeast. We have mixed barley, pea pod and every kind of pods with yeast. After mixing the pods, we have ground it until it became powder. They told us they used that mixture as an amendment for potato. We were really surprised looking at such big pretty potatoes.
- After the visit, we did the same here. It really produced well; we got big potatoes in our yield.

- CIPCA taught us how to look for worms, and so we used to fumigate them with these mixtures, as the sisters said.

13. In a scale from 1 to 4, how would you rate each event according to the harm it causes you?

- Hail and frost are the most harmful because they destroy everything. After hail or frost has come in the plants can not recover anymore and die. But the strongest is the hail; it completely destroys crops.
- It harms more when the plants are small; it is hard for them to bud again.
- In Chojñapata, when it rains much plants do not produce well because the water damages them. They become yellow color and little by little it gets rotten as a consequence of humidity.
- After hail and frost I would say comes the drought and rain.

14. What do you do before planting to prevent the effects of a potential drought?

- When we know it will be a dry year, since we have land in the pampas, hillsides and up the hill, we choose to plant in the higher lands because the pampas will not produce. Besides, lands in higher altitudes are fallow lands (purumas). At the pampas we only plant forage for the animals. For example, Oka does not produce well in the pampa; it produces well in higher altitudes.
- But communities are not the same, it depend on the places. Some of us live in the pampa and some other in the hillsides, and this is why we observe different animals to know how the year will be.
- Participant AW6: Knowing it will be a dry year, we plant with more amendments because the amendment keeps humidity. Some others add urea too (chemical fertilizer).
- But in Chojñapata we don't add urea because the place is already humid. Besides, since we live in Apacheta (pick of the hill), it always rains.
- Even knowing there will be a drought, we still plant because there is nothing we can do.

15. In your communities, do you present offerings to the Pachamama or the hills?

- Participant AW1: we protect ourselves according to our needs and the customs of our communities. We make a dish in San Andrés, and that is how we defend ourselves. We pay to the places; we pass the offerings to the hills of achachilas. We make one offering for each hill. We present the qaqawara offerings to the frost. With its name we pass the offering to each hill. The authorities of the communities are responsible of presenting the offerings to the hills. The entire community participates of it. When it does not produce

well, people say, the authority has been stingy or that he has not offered the masses (the mass is a mixture of colorful candies in different shapes, accompanied by Llama fat, colored fiber and others). The authority has not offered well to the achachilas.

- Participant AW1: To start planting, the first thing we are going to do is to break or cut the pain. To do this, we pass an offering and a week after that we start planting.
- In Chojñapata, we have a major hill, very respected, which name is Cóndor Utjaña (Condor's habitat). This hill is like the boss of the community.
- With the offerings we take away the hail and frost to the west, to the hill close to the Matilde mine. We present the offerings not once, but as times as it is necessary to take the hail away.

16. **Once you have planted the crops, what do you do to prevent the effects of a drought?**
    - There is nothing we can do, we look at them. There is nothing we can do, nothing. We pray for it not to get much affected, to produce at least a bit.
    - Participant AW3: In Chinchaya, we invoke the rain. To call the rain, the authorities of the community use to go to present the offerings to the Cajiata River. They say water has to be taken from it. Rain is called by presenting offerings. This river is located in the community Chejepampa. Some year it really works out, it really uses to rain.
    - We, people from Chojñapata, don't know what a drought is. When communities on the pampa are affected by a drought, we produce even more potatoes, and make a lot of chuño. When we have much chuño, we take it to the valleys (close) to exchange with corn.

17. **How many times do you plant?**
    - This community has three areas; now we are in one of its areas.
    - We have land in other areas within this community located at lower altitudes like a valley. That land produces everything: potato, peas, oka, even corn. Our relatives plant in those lands. Some of those lands only have weeds. They do not plant anymore because they are lazy.

FEARS

18. **How do you feel when the adverse climate events (frost, drought, flood and hail) affect your crops and livestock?**
    - We get really worried; we know we will not have good yield.

- Those who suffer the most are those of us who have several children. We can not get money to send our kids to school, because the money we get comes from selling our produce and livestock. In a bad year not only the crops get affected, but also the livestock. There is no food for the animals.
- We don't know what to do. Every year the weather is changing; it is not like before. Potatoes are affected by worms; it does not rain as before. It rains just a little bit.
- : Our young children just ask for money; they just want to go to the city. When frost or hail affects the crops, these do not produce well anymore, and we only harvest small potatoes with worms, which are not good for the market.
- We don't have big lands either to grow a lot and produce better. The climate change is affecting us a lot. Every year it seems like weather is changing.

EXTERNAL SOURCES OF INFORMATION

19. Do you listen in the radio programs about weather? Do you watch TV? Do you listen at the fair conversations about weather, crops or livestock?

- We always get guided by what other people in the community say.
- They say this year will be regular; we need to plant late, they say.
- We listen when we go to the fair; people are always talking. We only get guided by that. They already know.
- I also listen to the radio Wara. I have heard from them this will be a regular year. The program runs in the mornings. I don't listen to it very often, just sometimes.
- To plant, we are guided by our older uncles because they do not make mistakes and know how the year will be. We plant according to what they plant. We follow them. If they start planting we do the same.

20. What radio programs do you listen to?

- But what they say in the radio is not true. I do not believe in the radio. One year, for example, they said that the last planting will be better and that year all the crops got affected by the frost. Because we planted late, the frost took everything. That happened to us two years ago.
- I have heard that information from the San Gabriel radio during a night show. That is why I do not believe in them.

21. And you, sisters, what programs do you listen to?

- In our communities, we mainly listen to the San Gabriel radio because their programs are in Aymara, but few times they talk about livestock and crops.

Sometimes what they say becomes true, but it mostly does not, because it depends on the places, which are not the same.

- Participant AW6: I remember one year when at the San Gabriel radio they said we should plant earlier to have good yield, and people listened to that. We planted as they said and we completely failed. Since then, because they were wrong we don't believe in them anymore. Besides, they just read the almanac, and how can they know from that?

22. What is the almanac that is read by the person who talks in the program?

- The almanac is Bristol, but we don't look at the almanac. We plant from what we want. Others are guided by what they watch in the sky or the birds.
- We know when we have to plant, so that is what we do. We plant potatoes before the "All Saints" holiday; we plant Oka in September.
- Participant AW3: In Chinchaya, young people like me do not know about forecasts anymore, as our grandparents and parents do, and we do not ask them anymore. We just observe our uncles and listen to the people at the fair.

23. Have you ever asked the engineers that work in your communities about the weather, or how this year will be?

- We don't ask the engineers from the institutions, because they do not know about the weather. They can teach us some things about the crops but do not know anything about climate change; they are not farmers.
- Those (us) who have been cultivating for years know how the weather will be.

WORKSHOP – MUNICIPALITY OF ANCORAIMES

Topic: Sources of information and perceptions about climate risks
Chojñapata: July 26th, 2007
Group: women with high incomes
Participants:

Name	Community
Participant AW7	Calahuancani Baja
Participant AW8	Chojñapata
Participant AW9	Chojñapata
Participant AW10	Calahuancani Baja
Participant AW11	Chojñapata
Participant AW12	Chojñapata

Language: Aymara
Facilitator- 4
Transcription- 3

24. How do you get affected by the frost, drought, hail or flood?

- We, in Chojñapata, are located in a chain or mountains that are also the border between the province of Larecaja and the province of Camacho. We live in a Chuja (cold place at high altitude), and that is why we are affected by everything. There are some years when the frost affects everything and leave us with no yield at all. We gather the potatoes like we do for peas. Some other years, we are affected by rains. Young sheep get into the water and die. In the same way, small goats fall into the water. Rivers run with such strength that even children are taken on it. Water comes from anywhere and drags dirt along the ground. You find water even inside the houses. Children get sick with flu, but there is no reason to leave animals alone because they could get attacked by condors and foxes. Thus, we have to be close to them all the time, even when we don't want to.
- : I can say that what affects us is the frost, hail or excess of rain. Sometimes it does not rain and becomes Apachita (clear sky), and so it freezes.

25. How do you forecast the frost, drought, hail or floods?

- We can forecast the frost and the hail. We have some holidays like the "Spirit holiday" that guide us. If there are clouds in the sky that day, then we say it will be a good agricultural year. And, if the sky is clear we get worried because it might be a bad year.
- I would like to ask you something. Our grandparents ask us about Science. You come to teach us, and I want to ask you to teach us how to protect ourselves from these events. We think you know about this and can teach us

what to do and how we can do it. We ask ourselves why you ask us about this issues, when you are the ones who should know about this all.

Facilitator 4 answers.

26. How have you learned to forecast the weather?

- We know about the weather from what we have learned from our grandparents, who used to teach us which indicators we should follow to know whether it will be a good or a chuso year (bad, with scarce yield, observed especially in August).
- It has been two weeks since the last time it snowed here; just strong cold winds we have had. During the San Juan holiday (June 24th) there were no clouds. When there are clouds before the holiday we say it will be an early year, which means we need to plant before time. If clouds appear after the holiday, then it will be a late year, which means we need to plant later. But this year there were no clouds, so perhaps this year we will have some yield. Some years, it does not even freeze during these months. We are sure people from Yungas have burned wood on the rivers of that area. We think this year there will not be a good yield.

27. What other indicators do you know?

- Others get guide from the lecke lecke or the foxes, and say that because of what they show the soil will produce.
- For me, it is more important to trust the worms on the river (they are like wrapped wool). When they exist in every river it means we will have a good year; they are very green. Now I don't see many of them, and I believe this will be a difficult year.

28. Which event does affect you the most?

- The frost and drought affects us the same. Moreover, the frost seriously affects us because it comes when the potato plant's flowers are blooming, and the plant is destroyed completely. Then, when hail attacks the plant recovers a little bit, but not much, because the hail takes all the leaves from the plant and it does not produce anymore.

29. What do you do to face the drought, hail, frost and floods?

- The hail leaves the plants like ribs or fish bones. It completely hits them and leaves the soil green color. To face it, we get ready to burn, and we scream to the sky as well as we do for frost, especially at night. The farmer who screams saves his/her crops. That who does not might lose everything. We can see this

on the next day, how one side is totally destroyed and the other side is green and vigorous.

- Clearly in the afternoon an intense coldness can be felt, so then we get ready to do not sleep. We go to the aynoka like in a race to burn.
- There is nothing we can do in the event of a drought, because the plants depend on the water. If it does not rain we have to stand it and that's it. We neither ask the government for help. We just stand it. It seems like recently the government is offering help, but it did not happen before.
- When we know we might have a drought during the year, what we do is to plant in those lands with lower altitude. When we know it will be a rainy year, we plant in those lands located at higher altitudes. But sometimes it does not work, because the water drains from inside the soil and can not go back to the crops.

30. What do you feel when you think you might be affected by these events?

- We get scared when we think about the frosts. When it happens we talk to each other woman and do not sleep anymore. Even during the Carnaval holiday we are worried that somebody might come to rob us, so we pay a lot of attention. After Candelaria day, Carnaval and Ash Wednesday we feel better, because before these holidays we pray for our crops to be alive by that time.
- We are from a community located at a high altitude, and that is why we have more droughts. This does not happen in other places where soil is sandy.
- We have generals in the communities to which we invite over for dinner or snacks. At least twice a year we have to organize this ceremonies and grills to the spirits. Nothing can be produced just like that. With these ceremonies we send the frosts, hails or droughts to other places. Sometimes we take them away in cars.
- Some time ago the Methodist church showed up around here, so we left everything on God's hands, and nothing was produced, neither potato nor other crops. We had nothing to eat. Later on, we thought about taking away or throwing out a saint we had in the community, but since it was a custom of our grandparents we thought it might be a sin to do so.
- The Christian brothers used to ask us about that saint and asked us to pray to God for help. But we can not produce just with that, and that is why we present offerings to the Pachamama.
- TV signal does not work here, even though we have electricity, channels can not be caught by the TV. Cell phones do not work either. People who live in the lowest parts of the field are the only ones who have that.

- I would like to ask you: When we are affected by these events, where can we go to ask for help?

Facilitator 4 answers (comment about the agricultural insurance).

- In previous years when we had droughts, they said they will help us, but they have never done so. They also promised tractors, but the same as before, nothing has happened yet. We don't get anything.
- Perhaps our land is not good to work with tractor because we have many lower parts on the field (like big holes). We might be interested in that thing about the agricultural insurance.
- When we know there is going to be a drought, we plow deep lands and make canals to drain the water. Sometimes we do it vainly.
- These upcoming years are coming with a lot of rain. The water might go high and even destroy some walls. When it is said a drought might happen, we keep all our products and do not sell much. Instead, we buy corn that is brought from other areas, and with that we walk.
- We trust more in what our grandparents teach us; we do not trust much on what other communities say.

WORKSHOP – MUNICIPALITY OF ANCORAIMES

Topic: Sources of information and perceptions about climate risks
Chojñapata: July 26th, 2007
Group: men with high incomes
Participants:

Name	Community
Participant AW1	Cohani
Participant AW2	Chinchaya
Participant AW3	Chinchaya
Participant AW4	Chinchaya

Language: Spanish
Facilitators- 3 & 5
Transcription- 3

31. How do you forecast the weather?

- We forecast the weather using indicators. Now we don't know much, but our grand-grandparents knew more. From the stars, the moon or the clouds, they knew when it was about to frost. About stars, they observed the South Cross and others, but I do not know much anymore. They also looked at the leke leke nests. For example, if it has little stones it meant that during the year hails

will be present. If the nest was above a furrow, then it will be a rainy year. If the nest is within the furrow, then there will be droughts. Right now, before planting, to know how the year will be we observe the K'ariwa flowers. When that tree has many flowers, it means there will be a good yield of potatoes. When there are a few flowers only, then yield will have few potatoes too. I think this upcoming year will be regular because it has snowed twice already. It means a good potato production, because last year it did not snow and there was no yield. All this happens in my community, Chinchaya.

- On the contrary, in my community (Chinchaya) yield will be low, because the snow has happened in the hills only and not in the pampas. When I was little, I remember the snow was happening in the pampas, but there was a lot of rain back then and the fields produced well. Now, because it did not snow in the pampas, it will rain just a little bit. Then, we plant in two places, a humid place and another one that is aynoka. When it snows in a dry area or in the hills, then we forecast planting needs to happen in humid places. So, we don't plant much in dry places because we know we are going to have small yield like we had last year. Here, it is very different.
- Here in Chojñapata, it will rain but at the end. Rains will happen in August, but it will be dry in September and October. Frosts are about to happen in January, because frosts has affected our first potato planting, the one we do in may-june (Milli), so it will also affect the potato planted in October. To know whether there will be hail; during September we will observe when gulls and leke lekes lay their eggs. Frost will affect the first planting, but it will happen without affecting the second planting. After January it will not rain anymore. I don't think there will be floods. How are we going to plant this year? We plant on October 15th and during the last days of October.
- In Chinchaya, we forecast the weather 24 hours in advance, more or less. My father and mother used to tell me they forecasted before using indicators, but I have not learned that. I observe 24 hours in advance. For example, if today I feel wind coming from the lake (west), I know for sure it will freeze at night. When the wind comes from the north, then it will not freeze. We also forecast the hail 24 hours in advance. When the day's temperature is high, the clouds are black, and there are winds coming from different directions, then we know there will be a hail that night or during the next days. Hence, we need to be ready, and for that we have designated some farmers who light the fireworks to stop the hail. Some other times the hail wins, because you need to know how to light the fireworks. You have to shoot when just one or two drops of hail are felt. Sometimes we shoot the target where the hail is circulating like in a twister; doing so we disperse the hail and it does not come down anymore.

Sometimes we don't aim the target well and we shoot somewhere else, so the hail wins. It depends on how you aim, so if the hail comes people blame the jilakata for not shooting right. Those things still work. Sometimes the hail threatens from one side to another, so we have to shoot to both sides. There is nothing we can do to defend ourselves from the frost, because it comes anytime, especially when we are sleeping, around two or three in the morning. Sometimes we burn or stir up some wood vainly. When there is wind the work is vane, but when there is no wind the smoke stays there and do not allow the frost to freeze. If there is wind around two or six in the morning our work might be vane, so we don't do anything. Now, about floods, in Chinchaya we suffer from floods annually because the river surpasses its border. Because of this, every year we fight the river to control it from coming out. A frost can also be controlled as we do with the hail.

32. What do you do if there is a frost, drought or hail when you have already planted your crops?

- Once we have planted our crops there is nothing we can do against a drought. We can only do wajtas (ceremonies or rituals). Sometimes, the yatiris take water out from a waterfall so it rains.
- When it hails sometimes we lose almost all or half of it. I remember in 1985, when we worked with the National Brewery, they brought barley seeds, and when the flowers were blooming and the barley was about to ripe, we got a hail. The certified seed brought by the brewery, which was supposed to produce well, was brought for nothing. They gave one hundred pounds of seeds to each one of us, and so we had to give five hundred pounds of yield back. They came to inspect and just saw the grains dispersed throughout the ground. We just gave the seeds back. In that case we use seed reserves we have kept from previous years.

33. How would you rate the frost, drought or hail if they affect your crops?

- If we want to rate the frost it will depend on how we control it. The same for drought or hail. We plant three times to ensure the yield.

34. How do you feel when you are affected?

- Participant AM1- "It depends when the hail comes, if the plant is small or large. The situation is the worst when the plant is producing because we lose everything."

- Once we have planted our crops and they are affected by frosts or hails, we get sad because our work has been done for nothing. Also, when we have hired 15 or 20 people to work with us, there is no way how we can recover that money. Sometimes, the potato recovers after a few weeks, but that is not good anymore.
- It is a complete lost when the potato's flowers are blooming and the frost affects them. When the potato's flowers have not come up yet or when the plant has 20 centimeters of height, then the plant can recover on the sides, but that production is not very good because those potatoes that grow were really small at the beginning. In that case we lose 50%. We gather seed and potato for chuño. There is no good potato to peel. Thus, if the potato's flowers are blooming and the frost affects them we lose everything, because the root itself gets dry. When hail comes, we can not recover either.
- We feel bad. Some of us go to church. If we compare ourselves with the people who live in the city, those in the city are generally dependant from a salary that comes every month, so they know they can buy what they need. On the contrary, those of us who live in the rural areas expect an annual salary. If the year is good, then we have money to buy what our children need, but when there is a frost or hail we lose our yield and this is the reason why our children are undernourished. It is in these cases when the man has to leave the community and look for a job to support the family. Here, there is nobody to claim for it. In the city, on the other hand, it is easier and they just go to the Metropolitan radio. When we go to the prefectura, they make us wait two or three days until we get tired and leave. Sometimes we just don't want to go to the prefectura anymore.

35. What other sources do you listen to forecast the weather?

- Sometimes we listen to the radio or the TV, but there is no information about the weather.
- At San Gabriel radio, they sometimes inform about the weather and say, for example, that it will rain in Caranavi or the Altiplano. They mainly inform in the afternoons and mornings. Sometimes what they say becomes true, but many times it does not. We can not trust much in the radio.

- Participant AM1- "Last week they said in the FIDES radio that it will snow or hail on Wednesday, and that it was recommendable to take care of ourselves, but nothing happened. Thus, it is not trustable what they say in the

radios. Today it snowed, but not everywhere. Also, they have talked about the wind we were going to have in August, but it wasn't as much as they said."

- They do not inform constantly, but just as a few comments. There is not a specific program.
- We trust more in the indicators we have because the radio says something, but that does not become true.
- I used to buy the Bristol Almanac before. It had information about when it will rain or hail, but nothing really happened as it said.
- Sometimes this knowledge gets lost because it is not working well anymore. Our children do not know about these natural indicators anymore; they are not interested. Another factor is that the radios do not inform about other aspects; here there are some radios from Achacachi on FM that run music the entire day.
- Participant AM1- "The weather station is in my home, but it does not work. I always ask myself, why have I put it in my home because I know it doesn't help me.

Note: *The focus group on men with low incomes could not be done because of the absence of those who were invited to participate. The only person with low incomes is Participant AM1, from the community of Cohani. He participated in the group on men with high incomes, which was also small in number.*

B. ORDINAL LOGISTIC MODEL

Climate Risk Perceptions Ordinal Logistic Regression Results (link-logit)

Dependent Variable		B	S.E.			
	Moderate Climate Risk Perception- 1	-2.025	0.918			
	Low High-2	0.214	0.867			
	Mid-High-3	1.639	0.866			
	High-4	3.289	0.897			
	Extreme-5	-	-			
Parameter Estimates		B	Odds Ratio	S.E.	Sig	
	Other Income (Bolivianos)	-0.003	0.997	0.001	0.013	**
	Total Sheep	0.003	1.003	0.008	0.714	
	Spanish speaking	0.421	1.523	0.490	0.391	
	Not able to Speak Spanish	-	-	-	-	
	Outside Climate Information	-1.803	0.165	1.358	0.184	
	No Outside Climate Information	-	-	-	-	
	Access to Credit	-0.350	0.705	0.385	0.363	
	No Access to Credit	-	-	-	-	
	High Shock Experience- 5	0.151	1.163	1.454	0.917	
	Shock Experience- 6	0.604	1.830	0.592	0.308	
	Shock Experience- 7	0.718	2.050	0.398	0.071	*
	No Shock Experience-8	-	-	-	-	
	No Dread- 5	-0.229	0.795	1.940	0.906	
	Dread- 6	-1.776	0.169	1.386	0.200	
	Dread- 7	-1.733	0.177	1.930	0.369	
	Dread- 8	-2.921	0.054	0.587	0.000	***
	Dread- 9	-0.796	0.451	0.383	0.038	
	High Dread- 10	-	-	-	-	
	CropsSheepDairy	0.870	2.388	0.351	0.013	**
	No CropsSheepDairy	-	-	-	-	
	Male	0.002	1.002	0.414	0.996	
	Female	-	-	-	-	
	Chinchaya	-1.328	0.265	0.805	0.099	*
	Karcapata	-0.436	0.647	0.954	0.648	
	Chojnapata	-0.501	0.606	0.934	0.592	
	San Jose Llanga	1.935	6.922	0.774	0.012	**
	San Juan Circa	2.647	14.115	0.960	0.006	***
	Vinto Coopani	2.180	8.846	0.845	0.010	**
	Kellhuiri	2.453	11.627	0.961	0.011	**
	Calahuancani	0.427	1.533	0.859	0.619	
	Cohani	-	-	-	-	
****-Significant at <1% level, **-Significant at <5% level, *-Significant at <10% level*						

Climate Risk Perceptions Ordinal Logistic Regression Summary (link-logit)

Model Fitting Information				
Model	(-2Log Likelihood)	Chisq	df	Sig
Intercept	479.709	77.470	23	0.000
Final	402.238			
Goodness of Fit				
Deviance	Chi Sq	df	Sig	
	399.466	597	1	
Pseudo R-Square				
Nagelkerke	0.407			
Test of Parallel Lines				
	(-2Log Likelihood)	Chisq	df	Sig
Null Hypothesis	402.238			
General	307.903	94.335	69	0.023

C. OTHER INDIVIDUAL CLIMATE EVENT MODELS

Frost Risk Perceptions Ordinary Least Squares Regression Results (not squared)

Dependent Variable	Frost Risk Perceptions (not squared) 1-5				
Parameter Estimates		B	S.E.	Sig	
	Other Income (Bolivianos)	-0.001	0.000	0.004	***
	Total Sheep	-0.003	0.002	0.086	*
	Spanish speaking	0.179	0.119	0.135	
	Not able to Speak Spanish	-	-	-	
	Outside Climate Information	-0.178	0.242	0.462	
	No Outside Climate Information	-	-	-	
	Access to Credit	-0.241	0.089	0.007	***
	No Access to Credit	-	-	-	
	Frost Shock Experience	-0.032	0.112	0.777	
	No Frost Shock Experience	-	-	-	
	High Frost Dread	0.294	0.131	0.026	**
	Low Frost Dread	-	-	-	
	CropsSheepDairy	-0.053	0.086	0.533	
	No CropsSheepDairy	-	-	-	
	Male	-0.156	0.096	0.107	
	Female	-	-	-	
	Chinchaya	0.054	0.181	0.765	
	Karcapata	0.195	0.218	0.372	
	Chojnapata	0.114	0.206	0.580	
	San Jose Llanga	0.518	0.185	0.006	***
	San Juan Circa	0.706	0.226	0.002	***
	Vinto Coopani	0.845	0.205	0.000	***
	Kellhuiri	0.409	0.225	0.071	*
	Calahuancani	0.448	0.198	0.025	**
	Cohani	-	-	-	

****-Significant at <1% level, **-Significant at <5% level, *-Significant at <10% level*

Frost Risk Perceptions Ordinary Least Squares Regression Summary (not squared)

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	28.097	17	1.653	5.14	0.000
Residual	71.049	221	0.321		
Total	99.146	238			
Model Summary					
R-Square	0.283				

Drought Risk Perceptions Ordinary Least Squares Regression Results (not squared)

Dependent Variable	Drought Risk Perceptions (not squared) 1-5				
Parameter Estimates		B	S.E.	Sig	
	Other Income (Bolivianos)	0.000	0.000	0.527	
	Total Sheep	0.000	0.002	0.927	
	Spanish speaking	0.008	0.123	0.951	
	Not able to Speak Spanish	-	-	-	
	Outside Climate Information	-0.099	0.356	0.782	
	No Outside Climate Information	-	-	-	
	Access to Credit	-0.049	0.099	0.621	
	No Access to Credit	-	-	-	
	Drought Shock Experience	-0.157	0.127	0.217	
	No Drought Shock Experience	-	-	-	
	High Drought Dread	0.597	0.172	0.001	***
	Low Drought Dread	-	-	-	
	CropsSheepDairy	0.026	0.090	0.772	
	No CropsSheepDairy	-	-	-	
	Male	-0.166	0.103	0.109	
	Female	-	-	-	
	Chinchaya	-0.762	0.190	0.000	***
	Karcapata	-0.248	0.221	0.262	
	Chojnapata	-0.524	0.228	0.023	
	San Jose Llanga	0.497	0.176	0.005	***
	San Juan Circa	0.413	0.221	0.063	*
	Vinto Coopani	0.584	0.195	0.003	***
	Kellhuiri	0.665	0.220	0.003	***
	Calahuancani	-0.183	0.198	0.358	
	Cohani	-	-	-	
****-Significant at <1% level, **-Significant at <5% level, *-Significant at <10% level*					

Drought Risk Perceptions Ordinary Least Squares Regression Summary (not squared)

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	73.568	17	4.328	12.396	0.000
Residual	74.363	213	0.359		
Total	147.931	230			
Model Summary					
R-Square	0.497				

Flooding Risk Perceptions Ordinary Least Squares Regression Results (not squared)

Dependent Variable	Flooding Risk Perceptions (not squared) 1-5				
		B	S.E.	Sig	
Parameter Estimates					
	Other Income (Bolivianos)	0.000	0.000	0.616	
	Total Sheep	0.000	0.003	0.858	
	Spanish speaking	-0.105	0.165	0.524	
	Not able to Speak Spanish	-	-	-	
	Outside Climate Information	0.119	0.372	0.750	
	No Outside Climate Informatio	-	-	-	
	Access to Credit	-0.154	0.128	0.232	
	No Access to Credit	-	-	-	
	Flooding Shock Experience	0.171	0.157	0.280	
	No Flooding Shock Experience	-	-	-	
	High Flooding Dread	0.970	0.213	0.000	***
	Low Flooding Dread	-	-	-	
	CropsSheepDairy	-0.049	0.123	0.691	
	No CropsSheepDairy	-	-	-	
	Male	-0.094	0.140	0.504	
	Female	-	-	-	
	Chinchaya	0.070	0.240	0.772	
	Karcapata	-0.152	0.316	0.632	
	Chojnapata	-0.099	0.302	0.742	
	San Jose Llanga	0.600	0.227	0.009	***
	San Juan Circa	0.515	0.289	0.076	*
	Vinto Coopani	0.162	0.257	0.528	
	Kellhuiri	0.788	0.296	0.008	***
	Calahuancani	0.180	0.258	0.487	
	Cohani	-	-	-	
****-Significant at <1% level, **-Significant at <5% level, *-Significant at <10%*					

Flooding Risk Perceptions Ordinary Least Squares Regression Summary (not squared)

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Regression	34.1	17	2.006	3.15	0.000
Residual	135.467	213	0.636		
Total	169.567	230			
Model Summary					
R-Square	0.201				

Climate Change Risk Perceptions Ordinary Least Squares Regression Results (squared)

Dependent Variable	Climate Change Risk Perceptions				
Parameter Estimates		B	S.E.	Sig	
	Other Income (Bolivianos)	-0.001	0.001	0.479	
	Total Sheep	0.044	0.018	0.018	**
	Spanish speaking	0.207	1.230	0.866	
	Not able to Speak Spanish	-	-	-	
	Outside Climate Information	-1.576	2.543	0.536	
	No Outside Climate Information	-	-	-	
	Access to Credit	1.210	0.982	0.219	
	No Access to Credit	-	-	-	
	High Climate Change Dread	7.376	1.200	0.000	***
	Low Climate Change Dread	-	-	-	
	CropsSheepDairy	-0.951	0.906	0.295	
	No CropsSheepDairy	-	-	-	
	Male	-0.150	1.036	0.885	
	Female	-	-	-	
	Chinchaya	-1.791	2.053	0.384	
	Karcapata	-4.476	2.434	0.067	*
	Chojnapata	-0.968	2.305	0.675	
	San Jose Llanga	-2.985	1.942	0.126	
	San Juan Circa	-1.992	2.309	0.389	
	Vinto Coopani	-5.739	2.113	0.007	***
	Kellhuiri	-3.330	2.266	0.143	
	Calahuancani	-2.059	2.178	0.346	
	Cohani	-	-	-	
****-Significant at <1% level, **-Significant at <5% level, *-Significant at <10% level*					

Climate Change Risk Perceptions Ordinary Least Squares Regression Summary (squared)

ANOVA	Sum of Squares	df	Mean Squar	F	Sig.
Regression	2674.233	16	167.140	4.66	0.000
Residual	7676.702	214	35.872		
Total	10350.935	230			
Model Summary					
R-Square	0.258				

BIBLIOGRAPHY

Bandura, A. (1986). *Self-Efficacy, Social Foundation of Thought & Action: A Social Cognitive Theory.* Englewood Cliffs, N.J.: Prentice-Hall.

Bebbington, A. (1999). Capitals and Capabilities: A Framework for Analysing Peasant Viability, Rural Livelihoods and Poverty in the Andes. *World Development,* 12(12), 2021-2044.

Binder, A. (1984). Restrictions on statistics imposed by method of measurement: Some reality, some myth. *Journal of Criminal Justice*, 12, 467-481.

Chambers, R. & Conway, G. (1992). *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century*. Brighton, England: Institute of Development Studies.

Chen, C. K., & Hughes, J., Jr. (2004). Using ordinal regression model to analyze students' satisfaction questionnaires. *Association for Institutional Research,* 1, 1-21. Retrieved August 25, 2008, from http://www.airweb.org/page.asp?page=554.

Coleman, C. (1993). The influence of mass media and interpersonal communication on societal and personal risk judgments. *Communication Research,* August, 611-628.

Cowan, R. & Jonard, N. (2004). Network structure and the diffusion of knowledge. *Journal of Economic Dynamics and Control*, 28(8), 1557-1575.

Dunn, E., Kalaitzandonakes, N., & Valdivia, C. (1996). *Risk and the Impacts of Microenterprise Services.* Manuscript submitted to USAID by the AIMS Project for publication.

Ellis, F. (1988). *Peasant economics: farm households and agrarian development.* Cambridge [Cambridgeshire], New York: Cambridge University Press.

Ellis, F. (1998). Household Strategies and Rural Livelihood Diversification. *The Journal of Development Studies,* 35(1), 1-38.

Finucane, M. L., Slovic, P., Mertz, C. K., Flynn, J., & Satterfield, T. A. (2000). Gender, race, perceived risk: The "white male" effect. *Health, Risk & Society*, 2, 159-172.

Fischhoff, B. (1998). Risk perception and communication and unplugged: 20 years of process. *Risk Analysis,* 15(2), 137-45.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., & Barbara, C. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy Sciences*, 9(2), 127-152.

Flynn, J., Slovic, P., & Mertz, C. K. (1994). Gender, race and perception of environmental health risks. *Risk Analysis*, 14(6), 1101-1108.

Francois, C, Bosseno, R, Vacher, J. J. & Seguin, B. (1999). Frost risk mapping derived from satellite and surface data over the Bolivian Altiplano. *Agricultural and Forest Meteorology*, 95, 113–137.

Garcia, M., Raes, D., Jacobsen, S. E., Michel, T. (2007). Agroclimatic constraints for rainfed agriculture in the Bolivian Altiplano. *Journal of Arid Environments*, 71, 109-121.

Garreaud, R., Vuille, M., & Clement, A. C. (2003). The climate of the Altiplano: observed current conditions and mechanisms of past changes. *Palaeoclimatology*, 194.1(15), 5-22.

Garson, D. (1998). *Data Levels and Measurement.* Retrieved February 10, 2009, from http://faculty.chass.ncsu.edu/garson/PA765/datalevl.htm

Grandy, O., Jr. (2001). Racial identity, media use, and the societal construction of risk among African Americans. *Journal of Black Studies*, 31(5), 600-618.

Gustafson, P. (1998). Gender differences in risk perception: Theoretical and methodological perspectives. *Risk Analysis*, 18(6), 805-811.

Hijmans, R. Estimating frost risk in potato production on the Altiplano using interpolated climate data impact on a changing world. International Potato Center Program Report 1997–98. Lima, Peru: CIP, (1999) p. 373–380.

Jaccard, J. & Wan, C. K. (1996). *LISREL approaches to interaction effects in multiple regression.* Thousand Oaks, CA: Sage Publications.

Kim, J. O. (1975). Multivariate analysis of ordinal variables. *American Journal of Sociology*, 81, 261-298.

Labovitz, S. (1967). Some observation on measurement and statistics. *Social Forces*, 46, 151-160.

Labovitz, S. (1970). The assignment of numbers to rank order categories. *American Sociological Review*, 35, 515-524.

Legesse, B., & Drake, L. (2005). Determinants of smallholder farmers' perceptions of risk in the Eastern Highlands of Ethiopia. *Journal of Risk Research,* 8(5), 383-416.

Marks, L., Kalaitzandonakes, N., Allison, K. & Zakharova, L. (Spring 2003). Media Coverage of Agrobiotechnology: Did the Butterfly Have an Effect?. *Journal of Agribusiness,* 21(1), 1-20.

Meyers, L., Gamst, G., & Guarino, A. J. (2006). *Applied multivariate research: design and interpretation.* Thousand Oaks, CA: Sage Publication.

Morduch, J. (1995). Income Smoothing and Consumption Smoothing. *The Journal of Economic Perspectives,* 9(3), 103-114.

Motavalli, P. (2006, April 24-26). *Adapting to change: Changes in community perceptions and management of soil quality and soil organic matter*. Paper presented at the First Scientific Workshop of SANREM CRSP: Adapting to Change in Andean Ecosystems, La Paz, Bolivia. Retrieved from http://sanrem.cals.vt.edu/1125/2motavallipres4_24_06rev.ppt

Patt, A. & Schroter, D. (2008). Perceptions of climate risk in Mozambique: Implications for the success of adaptation strategies. *Global Environmental Change,* 18, 458-467.

Plough, A. & Krimsky, S. (1987). The emergence of risk communication studies: Social and political context. *Science, Technology and Human Values,* 12(3-4), 4-10.

Raden-Fessenden, F. & Heath, J. (1987). Providing Risk Information in Communities: Factors Influencing What is Heard and Accepted. *Science, Technology and Human Values,* 12(3-4), 94-101.

Reardon, T., Delgado, C., & Matlon, P. (1992). Determinants and effects of income diversification amongst farm households in Burkina Faso. *Journal of Development Studies,* 28(2), 264-296.

Renn, O., Burns, W., Kasperson, J., Kasperson, R & Slovic, P. (1992). The social amplification of risk: Theoretical foundations and empirical applications. *Journal of Social Issues,* 48(4), 137-160.

Romero, A. M. (2008a, March 15). *Report of results from baseline survey: Ancoraimes*. Paper presented at the SANREM CRSP LTR-4 internal meeting, La Paz, Bolivia. Retrieved from http://www.ext.vt.edu/cgi-bin/WebObjects/SANREM.woa/wa/viewMetadata?resourceID=3415

Romero, A. M. (2008b, March 15). *Report of results from baseline survey: Umala.* Paper presented at the SANREM CRSP LTR-4 internal meeting, La Paz, Bolivia. Retrieved from http://www.ext.vt.edu/cgi-bin/WebObjects/SANREM.woa/wa/viewMetadata?resourceID=3414

Scoones, I. (1998). *Sustainable rural livelihoods: a framework for analysis. IDS Discussion Paper 72*. University of Sussex, Brighton.

Sjoberg, L. (1996). A discussion of the limitations of the psychometric and cultural theory approaches to risk perception. *Radiation Protection Dosimetry,* 68(3/4), 219-225.

Sjoberg, L. (2000). Factors in Risk Perception. *Risk Analysis,* 20(1), 1-12.

Sjobert, L. & Wahlberg, A. (2000). Risk perception and the media. *Journal of Risk Research,* 3(1), 31-50.

Slovic, P. (1987). Perception of Risk. *Science,* 236, 280-285.

Slovic, P. (2000). *The perception of risk*. London; Sterling, VA: Earthscan Publications.

Slovic, P., Fischhoff, B. & Lichtenstein, S. (1984). Behavioral decision theory perspectives on risk and safety. *Acta Psychologica,* 56, 183-203

Slovic, P. & Weber, E. (2002) *Perception of risk posed by extreme events.* Unpublished paper, Columbia University Center for Hazards and Risk Research. Retrieved from www.ldeo.columbia.edu/chrr/documents/meetings/roundtable/white_papers/slovic_wp.pdf

Smith, K., Desvousges, W., Johnson, R. & Fisher, A. (1990). Can public information programs affect risk perception? *Journal of Policy Analysis and Management* 9(1), 41-59.

Smith, K. & Johnson, R. (1988). How do risk perceptions respond to information? The case of radon. *The Review of Economics and Statistics,* 70(1), 1-8.

Snedker, K., Glynn, P. & Wang, C. (2002). *Ordered/ordinal logistic regression with SAS and Stata*, University of Washington Web site: http://www.staff.washington.edu/glynn/olr.pdf

Sowby, F. (1965). Radiation and other risks. *Health Physics,* 11, 879-87.

SPSS Inc. SPSS Base 16.0.1. Online help. SPSS Inc., Chicago IL, 2007.

Starr, C. (1969). Social Benefit versus Technological Risk. *Science*, 165(3899), 1232-1238.

Stevens, J. P. (2002). *Applied multivariate statistics for the social sciences* (4th ed.). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Stockdale, M. S. (2002). Analyzing focus group data with spreadsheets. *American Journal of Health Studies*, 18(1), 55-60.

Turin, Thomas and Gilles. (2008, April 24-27). *Livelihood strategies in the Altiplano sites of SANREM's project: A comparative analysis*. Paper presented at the SANREM CRSP LTR-4 Annual Meeting, Puno, Peru. Retrieved from http://www.ext.vt.edu/cgibin/WebObjects/SANREM.woa/wa/viewMetadata?resourceID=3535

United Nations Development Programme- Bolivia. *Indicadores de Desarrollo Humano Municipal* [Data file]. Retrieved from http://cdteca.enlared.org.bo/IndiceDesarrollo/idh.htm

United Nations Development Programme- Bolivia. *Indicadores de Desarrollo Humano Municipal de Desigualdad y Pobreza* [Data file]. Retrieved from http://cdteca.enlared.org.bo/IndiceDesarrollo/idh.htm

Valdivia, C. (2001). Chapter 6- Household socioeconomic diversity and coping response to a drought year at San José Llanga. In D. L. & C. Valdivia (Eds.), *Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San Jose Llanga* (266). Logan, Utah: Rangeland Resources Department, Utah State University.

Valdivia, C. (2004). Andean Livelihood Strategies and the Livestock Portfolio. *Culture & Agriculture*, 26(1-2), 69-79.

Valdivia, C., Dunn, E & Jette, C. (1996). Diversification as a Risk Management Strategy in an Andean Agropastoral Community. *American Journal of Agricultural Economics*, 78(5), 1329-1334.

Valdivia, C. & Gilles, J. (2005). *Adapting to change in the Andean Highlands: Practices and Strategies to address climate and market risk in vulnerable agro-ecosystems- Long Term Research Award Proposal*. Submitted to the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program SANREM CRSP. University of Misssouri, Columbia, MO.

Valdivia, C., Jimenez, E. & Romero, A. (2007). El impacto de los Cambio Climaticos y de Mercado en Comunidades Campesinas del Altiplano de La Paz. *Umbrales*, 17, 233-262.

Valdivia, C. & Quiroz, R. (2001). Rural Livelihood Strategies, Assets, and Economic Portfolios in Coping with Climatic Perturbations: A Case Study of the Bolivian Andes. INRM. University of Missouri and Centro Internacional de la Papa.

Weber, E., Blais, A.-R., & Betz, N. (2002). A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making* 15, 1-28.

Wiegman, O. & Gutteling, J. (1995). Risk appraisal and risk communication: Some empirical data from The Netherlands reviewed. *Basic and Applied Social Psychology*, 16(1-2), 227-249.

Wildavsky, A. & Dake, K. (Fall 1990). Theories of risk perception: Who fears what and why?. *Daedalus*, 119(4), 41-60.

Yin, R. (2003). *Case Study Research Design and Methods.* Thousand Oaks: Sage Publications.

Zumbo, B. & Zimmerman, D. (1993). Is the selection of statistical methods governed by level of measurement?. *Canadian Psychology*, 34, 390-399.