“WE THINK THAT WE ARE NO LONGER IN OUR OWN TOWN”: HEALTH, COSMOLOGY, AND PERCEPTION OF CLIMATE CHANGE IN THE PERUVIAN ANDES

by

CARA SIPPRELLE

(Under the Direction of Donald R. Nelson)

ABSTRACT

This research investigates the relationship between culture, risk perception, and adaptation to climate change in three indigenous communities in the Andes of southern Peru, seeking to answer the question of how culture influences perception of the environment, and how this culturally mediated understanding influences adaptation decisions. By analyzing how respondents speak about climate change, the natural environment, and concepts of health and disease, this study proposes that cosmological understanding about the functioning of the natural world and the human body influences how climate change is conceptualized and reacted to in the research communities.

INDEX WORDS: Climate change, Agricultural Anthropology, Medical Anthropology, Cosmology, the Andes

“WE THINK THAT WE ARE NO LONGER IN OUR OWN TOWN”: HEALTH, COSMOLOGY, AND PERCEPTION OF CLIMATE CHANGE IN THE PERUVIAN ANDES

by

CARA SIPPRELLE

BS, University of North Carolina, Chapel Hill, 2006

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

MASTER OF ARTS

ATHENS, GEORGIA

2010

“WE THINK THAT WE ARE NO LONGER IN OUR OWN TOWN”: HEALTH, COSMOLOGY, AND PERCEPTION OF CLIMATE CHANGE IN THE PERUVIAN ANDES

by

CARA SIPPRELLE

BS, University of North Carolina, Chapel Hill, 2006

Major Professor: Donald R. Nelson

Committee: Susan Tanner
Ted Gragson

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
August 2010

DEDICATION

I dedicate this thesis to my mentor, Dr. Robert Rhoades. As I wrote this thesis over my final semester at the University of Georgia, he was struggling with something much more difficult: pancreatic cancer, and he passed away on March 24, 2010. He was my reason for coming to the University of Georgia. I was inspired by his life, characterized not only by ground breaking anthropological research, but a lifetime of sharing his talents with people all across the world, whether through his time in the Peace Corps in Nepal or decades of applied research across the globe.

A decorated career he certainly had, but I will always remember him out on his farm, with his hat and his cowboy-like gait, hollerin' at his herd of pineywoods or teaching a motley crew of undergrads how to hew a log with his collection of antique tools. I remember my first class with him, historical ecology, the class that opened my eyes and sparked my passion for food and farming that I will surely carry with me for the rest of my life. I remember standing in the garden with him. He leaned down, picked a leaf of kale, took a bite, and held it out to me with a twinkle in his eye. Over the last three years he taught me, inspired me, never gave up on me, always encouraged me, even entrusted his collection of heirloom seeds to my care.

I remember his gentleness when I told him that I was leaving the Ph.D. program because I knew it was the wrong path for me. I was terrified of letting him down. Of course all I received was support. And the wise reminder from someone who had stared death in the face and given it the finger, that there are more important things in life than school, like life itself, a gift for which to be thankful every day.

ACKNOWLEDGEMENTS

I would like to acknowledge Dr. Robert Rhoades who served as my advisor for 2 and ¾ of my 3 years in this program. His guidance and unwavering faith in my abilities inspired me and kept me going when I doubted myself, even when he was no longer there to cheer me along in person. His wife, Dr. Virginia Nazarea, was also on my committee and an invaluable help since my arrival at the University. Her classes were among my favorite that I have ever taken and the countless hours discussing, cooking, and laughing had a profound impact not only on this thesis but my experience of graduate school in general. I'm sure she (and any professors with offices within earshot) would concur that those were some of the most memorable and fun classes in the history of graduate school, perhaps only to be challenged by learning to swing an axe in her husband's historical ecology class.

I would also like to thank Dr. Elizabeth Reitz for her patience, honesty, and support. Without her oversight, I do not think this thesis would have been possible. The same goes for Margie Floyd and her labyrinthine knowledge of the inner workings of the University's mysterious and elusive graduate school. This thesis also would not have been possible without Madalena Monteban and her remarkable insight, knowledge of my research site, and translation skills which she so generously shared with me over the past three years.

I must also, of course, thank my cohort, especially those lovely ladies whose love and guidance over the past three years have kept me sane and reminded me of the more important things in life. And last but certainly not least- my Mother. Her love, frequent flyer miles, and infinite patience and support made this thesis happen.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1: INTRODUCTION

Although climate is often thought of in objective terms- as a relatively straightforward physical manifestation of complex but scientifically understandable processes- the climate that is lived and experienced by people around the world is, in reality, much more complicated. Weather and climate have both cultural and physical meaning for the people who live with them. In addition to the more objective effects upon life and livelihood, climate can comfort, frighten, and carry a much deeper significance for all who live within its confines, provoking thought and emotion that affect actions. This thesis seeks to understand this more subjective aspect of climate by exploring how residents of three small villages in the rural Peruvian Andes experience and conceptualize climate change, and how their unique understanding affects their livelihood choices.

The conceptual framework of this research is based on two separate but related theoretical assumptions. Firstly, that people do not necessarily act and respond to the world as it is in objective reality, but to the world as they perceive it, and, secondly, that culture influences these perceptions (Roncoli, Crane, and Orlove 2008, Bjonness 1986, Slovic 1987, Hassan 2000). In this framework, peoples' perceptions of the environment are important, even if "incorrect," because the behavior they produce is real, and understanding these perceptions can provide valuable insights into the process of climate related decision making as well as facilitate cooperation across cultural groups working together to achieve adaptation solutions. Thus, the broad goal of this research is to uncover how culture influences perception of the environment, and how this culturally mediated understanding influences adaptation decisions. To accomplish

this goal, I will explore how Andean cosmological understandings of the functioning of the natural environment and the human body influence perception of climate change, and how this, in turn, affects agricultural decision making.

This research question has both theoretical and practical significance. In the adaptation literature, researchers are increasingly asking the question "*Are there social limits to adaptation to climate change*" (title of Adger et al 2009, see also Grothmann and Patt 2005, Wolf et al 2009, Leiserowitz 2006, Duerden 2004). Adger et al (2009) describe what they call "the typical approach in constructing limits to climate change," as one focused on economic, technological, or ecological limits to adaptation, and counters that people are increasingly recognizing that these are not the only factors affecting how people make adaptation decisions. Ethics, knowledge, risk perception, and cultural values all influence what people perceive as a problem and what people consider to be appropriate, feasible, and desirable solutions. This research, of course, is not meant to imply that the technological, economic, ecological, and structural limitations that influence how people choose to adapt are not important, only that they lie beyond the scope of this particular research question and can be more informative if complemented with a thorough understanding of cultural factors that influence decision making.

On a more practical level, this type of knowledge can facilitate interaction across cultural groups seeking to collaborate on climate related problem solving. Many researchers have recognized that the world's indigenous populations are likely to be the hardest hit from current and predicted climate changes for a number of reasons. First of all, climate change is predicted to be most severe in the tropics, the arctic, and many areas already considered marginal for human habitation, including mountains (Barnett et al 2005). Unfortunately, on a global scale these are the areas where the majority of the world's indigenous populations are located, including the

communities discussed in this particular research, which are located in a tropical mountain range. Not only are these areas likely to see some of the largest changes, the changes are more likely to push conditions into an even more unfavorable state, as opposed to some of the countries in the more temperate latitudes which might actually benefit (at least regarding agricultural productivity) from predicted changes (Mertz et al 2009, Kates 2000). Additionally, unlike the majority of people in the more developed countries of the Global North, many indigenous people still have both an intimate connection to the land as well as livelihoods that are directly dependent on the natural environment (and a relatively predictable climate) (Rayner 2003). Finally, because they are almost universally marginalized by national governments, they are often the last to be considered when developing national climate policy and adaptation strategies (Carter and Parry 1994; Price 1994; Parish and Funnel 1999; Beniston, Diaz, and Bradley 1997).

Social scientists have become increasingly concerned with how these populations will adapt to these changes, and many have focused work on facilitating cross cultural communication between indigenous populations and the climate scientists with whom they work. While some have sought to form productive partnerships with communities interested in mutually beneficial opportunities for exchange of knowledge and strategizing (Krupnik and Jolly 2002, Kruse et al 2004, Berman and Kofinas 2004), others have focused on identifying potential areas for miscommunication between the two groups in order to facilitate the use of scientific knowledge in decision making by indigenous populations (Roncoli 2006, Meze-Hausken 2004). In these projects, success is facilitated if each group is aware of the other's goals and priorities and has a good understanding of how the other thinks. This research speaks directly to these goals.

In order to operationalize my question, I sought to elicit specifically how perceptions of climate change influenced agricultural strategies. Farming seemed an exceptionally appropriate arena in which to measure any behavioral changes. As any experienced farmer knows, detailed and constant observation is key to maintaining the health of his or her agricultural system. Farmers practicing sustainable agriculture (broadly understood as not relying on huge doses of pesticides, insecticides, and fertilizers to control their environment) must be constantly aware of their surroundings: the timing and intensity of precipitation, the appearance of new pests, and the success or failure of different varieties, just to name a few factors with intimate ties to the weather. This detailed observation, combined with experimentation and frequent tweaking of practices in response to subtle environmental shifts helps farmers to successfully adapt to environmental changes and prevent a production failure. Thus, farmers seemed like a population that would be especially vigilant to environmental fluctuations and quick to alter behavior in response.

In devising my interview questions I focused on questions surrounding perception of climatic changes and shifts in agricultural strategies. I had originally planned to look for possible differences in the perception of climatic phenomena within my research site, a project that was inspired by reading the literature addressing how perceptions of climate change differed among American and Western European populations and how this contributed towards vastly different attitudes and behaviors regarding mitigation of greenhouse gas emissions (Grothmann and Patt 2005, Leiserowitz 2006, Oppenheimer and Todorov 2006). However, once the interviews began, it became immediately obvious that my questions were not directly addressing what was actually important to my respondents. They seemed to share many of the same perceptions and feelings about climate change and were quick to gloss over discussions of their agricultural practices,

eager instead to focus on the degradation in the health of their crops, animals, family and friends, and community. Although none of my questions asked about health or disease, all but two of my 24 respondents mentioned it, and frequently multiple times.

As I familiarized myself with my data, I realized that my research questions and analysis plan needed tweaking. Instead of searching for an exciting new agricultural innovation to climate change, I focused more on my initial question about perceptions of climate change, while approaching my analysis from a more qualitative angle than I had initially planned. Following the advice of Maxwell (2005), who explains that the strength of much qualitative research lies in uncovering "how participants make sense of what has happened, in itself a real phenomenon, and how this perspective informs their actions, rather than in determining precisely what happened or what they did," I shifted my research question from asking how awareness of the existence of certain climate features differed among respondents and how respondents were shifting their agricultural practices as a result to questioning how Andean cosmological concepts about the functioning of the natural world and their bodies influence how they experience, understand, and respond to climate change. The remaining chapters of this thesis will facilitate the answering of this question.

In chapter 2 I will review the literature about the processes of adaptation, with a special focus on how culture influences perception of risk and the transforming of perception into action. In chapters 3 through 5, I examine the role of culture and perception in adaptation to climate change in a presentation of ethnographic research located in three indigenous communities in the south Peruvian Andes. In chapter 3, I present necessary background and contextual information about the history, geography, people, and climate of the research site. Chapter 4 serves to inform the reader about the structure of this study: the methods used to collect data and the ways in

which it was analyzed. Chapter 5 presents the results from the research process: what the respondents told me and how I analyzed their responses in the context of the interviews as a whole and my prior knowledge of the region. Finally, I conclude in chapter 6 with thoughts on lessons learned and avenues for further research.

CHAPTER 2: LITERATURE REVIEW

Weather, climate, and climate change in the modern world

How people understand, construct, and explain environmental change can have significant impacts on their actions. This link between cultural beliefs and adaptation is especially relevant to this research, and a topic that has grown in popularity over the last few years. However, before delving into the many facets of climate and its interpretation from an anthropological perspective, some clarification is in order regarding the nature and nuances of weather, climate, and climate change.

Although I would argue that our changing climate is one of the more serious problems facing global society at this moment, as most people who have a glancing familiarity with the history of our planet know, changes in global climate are nothing new. The four and a half billion year history of our planet is peppered with glacial advances and retreats, and the globe has certainly been warmer (and much colder) than it is today. Although temperatures predicted for the first half of the twentieth century are similar to those experienced in the mid Holocene, the rate at which climate is changing far exceeds anything previously experienced (Salick and Byg 2007). This poses a serious challenge to the human race, whose population has effectively exploded exponentially since then, as well as to the plant and animal species upon which we depend to adapt to climates changing at unprecedented rates while simultaneously coping with other challenges that did not exist thousands of years ago such as man-made barriers to migration (Beniston 1994).

While weather is a short term phenomenon that can be felt and measured somewhat objectively at specific places and times, climate is a bit more abstract because it represents longer term trends. Unlike a raindrop or a gusty wind, climate cannot be felt because it is an aggregation of phenomena across time and space (Hulme 2009)[1]. While two people standing next to each other would be hard pressed to argue over whether or not it is raining, they could certainly disagree over whether or not the last month has been more or less rainy than average. As Strauss and Orlove (2007) point out, while the weather is widely considered a politically safe (and frequently dull) topic of conversation in the Western world, talking about climate change can be quite politically and emotionally charged. Point being that climate can be a touchy subject, with various people interpreting and reacting to the same phenomenon differently depending on their unique experiences and viewpoint.

This thesis seeks to address precisely this issue by posing the question of how culture influences perception of climate change, and how this perception informs a person's actions. The remainder of this chapter will address the complex process of cultural adaptation, paying special attention to how people perceive and conceptualize risk, and, subsequently, how people make decisions regarding this risk.

Perceiving risk and taking action: the process of adaptation

The question of how people react to changes in climate is fundamentally a question about adaptation. In the climate change literature, adaptation is generally understood as "adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which

[1] However, even this is up for debate as different authors define weather differently. While Hulme (2009) uses specific climatic events such as a rainstorm as an example of weather, both West and Vasquez-Leon (2007) and Ogilvie and Palsson (2007) describe weather as trends lasting up to one or two years. However, in general people agree that climate represents weather averaged over larger spatial and temporal scales.

moderates harm or exploits beneficial opportunities" (McCarthy et al 2001:982). As it became increasingly obvious that indigenous populations would be among the hardest hit by climate change for reasons discussed in chapter 1, social scientists became increasingly concerned with what can and should be done to facilitate this process (Mertz et al 2009, Kates 2000). As research trajectories have grown and changed over time, an expanding of focus is apparent concerning the factors that limit or affect how indigenous populations choose to adapt. More specifically, there has been an increasing emphasis on incorporating an understanding of how cognitive, psychological, and cultural factors affect adaptation strategies (Adger et al 2009). Of course, I must emphasize again that it is not that other approaches are irrelevant or unhelpful, just that they are only one piece of the puzzle.

Early climate change research addressing factors affecting adaptation tended to be limited to technological, economic, environmental, and structural constraints. Limiting the scope of research to these factors effectively implied that there exists not only an objective and cross culturally definable threshold of "dangerous" climate change universally perceived by all, but a set of identifiable and agreed upon ideal solutions. Today, researchers such as Adger et al (2009), Wolf (2009), and Byg and Salick (2009) are emphasizing the importance of understanding how cognitive factors and culture shape how risk is perceived and subsequently reacted to. Rather than denying that technological, financial, or social constraints are important, they stress that researchers from very different cultural traditions cannot begin a study seeking to understand how people react to a problem with the assumption that all view the original problem in the same light.

According to this viewpoint, critical steps in the process of adaptation take place before any potential solutions are even considered, the most significant being perception of risk,

perception of one's own vulnerability, and perception that one can take actions to mitigate the impacts of the event. Grothmann and Patt (2005) describe the process of adaptation as one of risk appraisal followed by adaptation appraisal. Risk appraisal involves a person's judgment of their chance of being exposed to a particular threat, and how harmful said threat would be to things that he or she values. Adaptation appraisal involves perceived adaptation efficacy- the belief that certain actions *can* be taken to mitigate or avoid the impact, perceived self efficacy- the belief that the individual possesses the knowledge and skills with which to carry out the desired solution, and perceived adaptation costs- the time, money, and other required resources to carry out the solution. In the context of adapting agricultural strategies to climate change, the process of adaptation thus involves multiple steps: 1) the person must believe that the climate is changing, and that it will negatively affect their agricultural livelihood, 2) the person must believe that there are actions to take in response that will be effective, and 3) the person must have the means to carry out this adaptation. While not denying the importance of the third step, this particular research question centers on the first two steps, focusing especially on how understanding of experienced climate change affects what actions people choose to take according to their perception of the problem and their belief that their actions will be effective.

Step one: perception of risk

According to Grothmann and Patt (2005), perceiving that a problem actually exists is the first step in adaptation. Therefore, this section will address the literature and theory relevant to the first part of my research question: How do Andean cosmological concepts about the functioning of the natural world and their bodies influence how they ***experience, understand***, and respond to climate change? Hassan (2000) describes environmental perception as a

combination of past experiences that are framed by inherited world views, values, and cultural strategies of cognition and action. Bjonness (1986) expands the notion of perception to include images, memories, preferences, and attitudes that affect human behavior. With these definitions in mind, it is not difficult to see how widely perceptions of the same environmental phenomenon can vary across different cultural groups. Interestingly, neither of these definitions includes any mention of objective data, showing the subjectivity inherent in perception of environmental phenomena.

However, even an understanding of climate change rooted in scientific understanding of climatic processes and precise, standardized measurements is influenced by worldview and culture and not exempt from subjectivity. Science perceives changes in the earth's climate system and communicates these changes in the language of statistics: as deviations away from expected quantitative patterns. However, in order to express a deviation away from an expected pattern, a pattern must be predefined, despite the fact that the earth's climate is notoriously fickle (Hulme et al 2009). Scientific convention has defined this as the mean from a 30 year period from 1961-1990, but there exist many other potential ways to define the expected climatic pattern including using much longer or shorter baselines or rolling baselines that are updated each year. Each strategy yields different results as to whether or not the current climate can be defined as unusually hot (Hulme et al 2009). Although more examples could be cited of subjectivity in scientific climate research and cross cultural misunderstandings that have resulted (Roncoli 2006, Jones and Thornton 2003), the underlying concept of importance to keep in mind is that science represents a unique worldview in and of itself, not merely the absence of one.

In general, when comparing how scientists and the lay public assess the threat of a new risk, it has been found that while scientists tend to use quantifiable measures such as mortality

statistics, lay people incorporate many more factors and heuristics such as perceived ability to control the threat, catastrophic potential, inequitable distribution of risks, voluntariness of exposure, newness or lack of understanding about the threat, and whether or not the threat is observable (Slovic 1987). Cognitive biases, such as the tendency of people to underestimate large probabilities and overestimate small ones, the tendency of people to believe that their personal risk is less than the average risk attributed to the whole population, and the tendency to estimate risk based on searching memory for past experiences of the event, also influence individual perception of risk (Kahneman and Tversky 1979, Oppenheimer and Todorov 2006).

All of these heuristics point to the fact, quite obvious in actuality but easily forgotten in practice, that unlike scientists lay people do not study the climate in an objectified way, separate from their everyday lives, but rather in the context of their own beliefs and overall vulnerability (Eakin 2006). Climate perceptions are not separate, objective mental estimates of temperature and rainfall over time, but a product of multiple factors that play out in day to day experiences living life. It can involve numerous factors, ranging from the economic to the cognitive to the spiritual, and all interact to produce an individual's unique viewpoint.

Meze-Hausken's (2004) research among farmers and pastoralists in Ethiopia is a good example of how economics can influence perception of climate. In this study, she interviewed respondents about the worst local droughts in their memories. Interestingly, the years the farmers reported did not coincide with the years the scientists had measured the least amount of precipitation (Figure 2-1). The author suggests that one of the reasons for this discrepancy is that scientists' meteorological measurements do not take into account other concerns facing the household simultaneously. For the farmers and pastoralists she interviewed, climate anomalies were less of a threat, and therefore perceived as less severe, if the household had recourse to

other means of obtaining adequate subsistence. The years cited as the worst droughts coincided not necessarily with those of the least precipitation, but when the households were the most strained economically. Although the worst often coincided with generally reduced rainfall, it was the combination of reduced rainfall and other stressors such as poor market prices and lack of food stores that worked together to produce what each respondent considered the "worst" drought. This and other examples in the literature point to the fact that perception of bad droughts (or dangerous climate change) is relative, and influenced by more than simply how much rain falls (Nelson and Finan 2008, Nelson and Finan 2009).

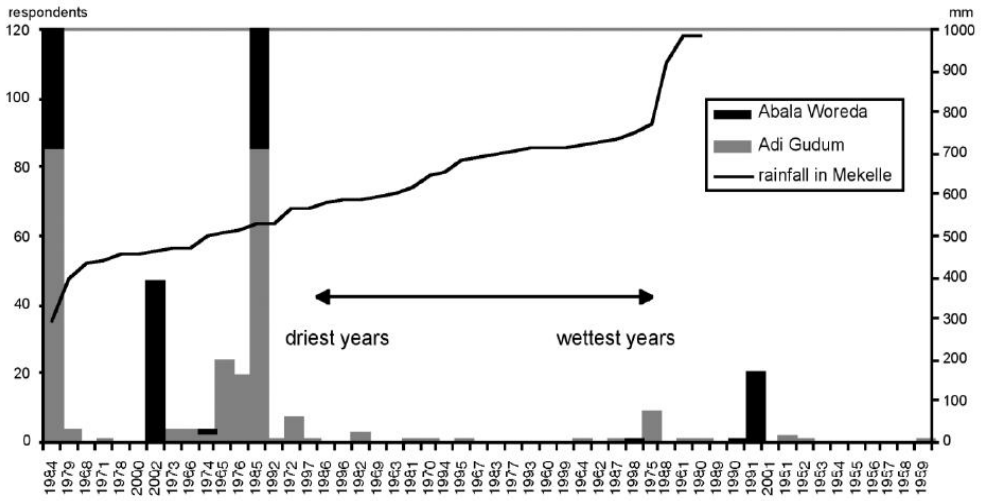

Figure 2-1: A chart depicting perceptions of drought in Ethiopia. The years on the x axis are ordered from driest to wettest from left to right and the bars represent years cited as the worst drought by respondents in two villages (Abala Woreda and Adi Gudum). As you can see from the chart, years cited as the worst drought were not necessarily those with the least precipitation.
Source: Meze Hausken 2004

Cultural beliefs and worldview can also play a significant role in how one conceptualizes environmental change, frequently affecting beliefs regarding causality and, therefore, appropriate solutions. In his review examining anthropological research on hazards and disasters, Oliver Smith (1996) explains that when people confront disasters or extreme environmental change, such as droughts experienced in Ethiopia or unprecedented climate change, it often provokes

more than concern for continued sustainability of livelihoods, but questions about causality linked to social and cosmic justice and the existence and nature of the divine. Turner et al (2008), in their discussion of invisible losses, highlight the cultural impacts of landscape change resulting from external forces such as climate change that are often forgotten by those external to the situation (see also Adger et al 2009). The loss of glaciers, for instance, can mean more than a loss of resources but the loss of identity, lifestyle, and order in the world that often results in a loss of resilience and ability to cope with change**.**

The perception of climate change as the product of retribution from a higher power angry with morally degraded local communities is a widely spread cross-cultural phenomenon (Salick and Byg 2007, Rhoades et al 2006, Orlove, Wiegandt and Luckman 2007, Haeberli 2007). Bjonness (1986) examined how Sherpa in Nepal perceive risks of environmental hazards

Figure 2-2: Sherpa perception of mountain hazards. A painting by Kapa Passang Norbu depicting the Sherpa artist's perception of hazards in the mountains, drawn at request of the author. The painting depicts the mountains as inhabited with the Buddhist pantheon of deities who influence the occurrence of environmental hazards.
Source: Bjonness 1986

associated with living in a mountain environment such as landslides and earthquakes. Because the Sherpa perceive their environment as existing in a dualistic manner, with both spiritual and natural forces at work, they perceive the causes of environmental hazards to lie in either the spiritual or the natural realm, with natural explanations tending to be reserved for more easily understood phenomenon and a belief that environmental hazards were often a form of punishment from displeased deities (Figure 2-2).

Boholm (2003), however, wisely cautions against adopting an idea of risk perception centered entirely on subjective cultural perceptions. In reality, people incorporate both objective and subjective viewpoints, although she also posits that where risks are unfamiliar or completely unknown, a category to which one might imagine climate change to belong, culture rather than rational choice informs strategies to a greater extent. Indeed, Gordon Childe- one of the first archaeologists to espouse the idea that humans act on ideas of the world around them rather than an objective reality- also recognized that perceptions must be somewhat grounded in reality or else those holding them might have difficulty surviving in a world that, although built on perceptions, has very real consequences (Childe 1949:6-8, Childe 1956:58-60, Trigger 2008:349)

Step two: turning perception into action

At the beginning of this chapter it was proposed that the process of adaptation appraisal involved three steps: belief that actions taken would be effective, belief that one has the knowledge and skills to carry out a specific action, and belief that one has the time, money, and other resources to carry out a specific action. Cosmological beliefs and worldview can influence these adaptation decisions in multiple ways. This section will address these processes and the literature relevant to the second part of my research question: How do Andean cosmological

concepts about the functioning of the natural world and their bodies influence how they experience, understand, and ***respond*** to climate change?

Climate change is already creating significant agricultural challenges in the Andes. In a study by Rhoades, Rios, and Ochoa (2006), farmers in the Ecuadorean highlands identified climate change as the most significant factor affecting agricultural change. Because crop growth is closely linked to weather conditions, changing climate patterns alter numerous agricultural factors including growing seasons; growth rates; yield quantity, quality, and variability; sensitivity of crops to agricultural inputs; pest populations, biodiversity; and crop zonation (Vedwan and Rhoades 2001). In addition to these changes, mountain glaciers are also disappearing, leaving highland farmers literally high and dry without the glacial melt that has naturally irrigated their crops for millennia. These shifting climate patterns are making it difficult for farmers to make time sensitive decisions such as when to plant, harvest, and apply inputs (Vedwan and Rhoades 2001, Young and Lipton 2006).

Increases in the frequency of severe weather pose additional challenges for crops: especially at critical stages of development, crops are highly sensitive to extremes in temperature and precipitation (Slingo 2005). Gradual shifts in temperature are problematic as well. In mountainous areas, many crops are limited to certain altitudinal ranges with the necessary climatic conditions for ideal growth. As the climate warms, altitudinal zones will shift and farmers will be forced to move the cultivation of many mountain crops upwards, which may entail moving to areas that are unsuitable or less suitable for cultivation because of increased slope or inhospitable terrain (Brookfield 1991). Some crops might find it difficult to find any suitable growing areas at all, especially those that are already zoned near the top of the mountain.

Although these are formidable challenges indeed, agricultural anthropologists have documented many potential adaptive strategies – simple yet effective techniques- that have allowed indigenous populations to cope with significant environmental variations over preceding millennia, without the benefit of genetically engineered seeds or expensive drip irrigation systems (Netting 1993). Many of these techniques are intimately tied to cultural beliefs, worldview, and culinary traditions that emphasize the importance of diversity, intimate familiarity and knowledge of the local environment, and constant experimentation (Brush 1992, Zimmerer 1996).

Of course deciding between which varieties to plant or whether to adapt a new watering technology represents just one type of adaptation. Others working in the Andes have documented other sorts of responses, such as supplementing agricultural production with wage income earned from permanent or temporary migration. Researchers explain that the process of adaptation often requires compromising certain priorities for others that are more important, a process heavily influenced by cultural values and worldview (O'Brien 2009, Adger et al 2009). Values, in this context, refer to what Adger et al (2009:337) define as "the personal or societal judgement of what is valuable and important in life." In their own research in the Andes, both Wibbelsman (2005) and Bebbington (2000) found a high priority placed on maintaining a home in ones natal community and a toehold in farming, even though this was not the most productive economic decision. This brings to light another factor not included in Grothmann and Patt's (2005) model of decision making: that the solution chosen must lie within ones range of acceptable lifestyles as determined by personal values. As Bebbington (2000) emphasized, this may not be the most profitable one, nor the one assumed to be the most desirable by someone else.

Perceived adaptation efficacy, or believing that one can take actions that will be effective against a particular threat, is closely tied to the causality attributed to a particular event. The attribution of cosmological significance to climatic changes among indigenous populations is a topic that has already been mentioned in this chapter and is important in understanding what responses people believe to be appropriate in reaction to climate change. For instance, in the Pacific Northwest, Native Americans live intimately with glaciers, must frequently traverse them, and constantly deal with glacier related disasters. Not surprisingly, these people understand glaciers to be alive, sentient, and responsive to people's behavior (Cruikshank 2005). Appropriate actions include not speaking loudly, not speaking badly about a glacier, and not cooking with fat when traveling through glaciated country. In the Italian Alps, locals attribute the recession of glaciers to skis and snowmobiles removing surface ice and throwing trash in crevasses (Orlove, Wiegandt, and Luckman 2007). In some cultures, altering behavior in response to forecasts can be perceived as insulting and sacrilegious to divine powers who control the weather (Roncoli 2006, Schmuck 2000). All of these are examples of how cosmological beliefs can influence what behaviors and reactions people consider appropriate or desirable.

Research Question

With this understanding, cosmological beliefs and worldview can exert influence in multiple dimensions of adaptation decision making, most importantly for this research in judging both efficacy and desirability of adaptive actions. Perceptions of climate change are further complicated by the variety of different factors addressed earlier in the chapter including the nature of the threat, cognitive biases, and overall vulnerability. While an understanding of technological and financial constraints on adaptive responses in indigenous communities is

obviously important, this issue is beyond the scope of this particular research. This research question- How do Andean cosmological understandings of the natural world influence their understanding and responses to climate change- focuses instead on the role of values and worldview in shaping human behavior. The next chapters of this thesis will provide a unique case study of how conceptions of weather, climate, and interconnections among the land and its human and non human inhabitants influence adaptation decisions in the research communities.

CHAPTER 3: RESEARCH SITE AND CONTEXT

Study site

Interviews were conducted in three villages in the Region of Cusco, District of Pisac: Cuyo Grande, Chawaytire, and Pampallacta. Pisac is located in the Sacred Valley of Southern Peru- the former heartland of the Inca Empire- in a region characterized by rugged topography and extreme climatic conditions that have always made the region marginal for human habitation (Baker 1969). This chapter will provide context on the ecology, population, history, and, of course, climate of this region.

Figure 3-1: Department of Cusco (in red), Peru
Source: Wikipedia http://en.wikipedia.org/wiki/File:Peru_-_Cuzco_Department_(locator_map).svg

The land and subsistence

The Cusco region is considered a hotspot for biological diversity and is recognized as the center of origin for the potato, the crop that remains to this day the most important staple food for the majority of indigenous inhabitants (Zimmerer 1996, Brush 2004, Allen 2002). In some areas potatoes provide up to 70% of total calories in people's diets (Brush 2004:102). Over thousands of years farmers have bred and selected a vast number of varieties well-suited to the many different microclimates and altitudes that make up their home. Zimmerer (1996) estimates that up to 5,000 landraces of native potatoes still exist in the region. The highly limiting and risky nature of mountain environments and climates has been a significant factor in shaping traditional subsistence strategies based on this high diversity, scattered agricultural plots, and communal management of resources (Rhoades and Thompson 1975, Brush 1985, Hellin and Higman 2005).

Various strategies for exploiting the multiple vertical ecological zones of the Andean slopes have been described in the literature, commonly dubbed "verticality." The four common variations on verticality include the compact or generalized strategy in which contiguous vertical zones are exploited by one ethnic group, the archipelago strategy in which one ethnic group has non contiguous territories among which products are exchanged, the extended strategy in which one ethnic group specializes in one zone and trades with another, and mixed in which some variation of the previous three strategies is pursued. In all strategies, community self sufficiency, risk minimization, and cooperation are emphasized above production maximization (Brush and Guillet 1985, Rhoades and Thompson 1975).

Scientifically speaking, mountains are considered to be ecologically sensitive and highly responsive to even slight changes in temperature (Parish and Funnell 1999). Small shifts in temperature and precipitation can potentially lead to drastic movements in the altitudinal zonation of ecosystems, causing some species to disappear entirely or to move into much smaller areas, profoundly impacting the people who depend upon them (Galvin et al 2001, Parish and Funnell 1999). However, mountain peoples have a long history of dealing with difficult and unpredictable climatic conditions and have long relied on vertical and regional movement of people and goods and risk minimizing behavior in order to adapt to these changes.

The people

The indigenous people who inhabit the Andes make up roughly 45% of Peru's total population and are mostly concentrated in central and southern Peru (U.S. Department of State 2010). In rural areas, over 78% of indigenous people live in poverty according to the World Bank and 40% are considered to be extremely poor (World Bank 2005). As previously mentioned, the indigenous people who inhabit these areas have traditionally practiced some sort of subsistence lifestyle based around farming, pastoralism, or a mix of these two strategies (Brush 1985, Campbell 2006). Communities are typically organized into *ayllus*, a form of organization that emphasizes the importance of community and reciprocity among fellow people, crops, animals, and the environment. (Vasquez 1998, Allen 2002). The potatoes they tend, the animals they raise, and the glaciated peaks that dominate the landscape (many of which are rapidly disappearing) are all considered sentient and equal within the *ayllu* (Bolin 2008, Rhoades, Rios and Ochoa 2007, Appfel-Marglin and PRATEC 1998). This lack of separation between man and nature is one of the fundamental characteristics of Andean culture, and one that

can be seen in cosmological understandings of proper functioning of both the natural world and the human body which rests upon mutual nurturance and maintaining balance among all beings (Vasquez 1998).

All three of the research communities are located within the Potato Park, a loosely structured organization of six communities within the Pisac district. The Park was born of the partnership between the International Institute for Environment and Development (IIED) and Asociación ANDES, a Quechua-Aymara association for sustainable livelihoods governed by a general assembly largely composed of indigenous members. The Potato Park was officially opened in 2000 as a "Community Conserved Area," defined by the Argumedo and Pimbert (2005:7) as a "natural and/or modified ecosystem containing significant biodiversity values, ecological services and cultural values, voluntarily conserved by indigenous, mobile, and local communities through customary laws or other effective means." Although neither the research nor the researcher had any official relationship with Asociación ANDES in this study (the field assistant, however, does work for ANDES occasionally as an assistant) the fact that the communities all receive considerable foot traffic from tourists, developers, activists, and researchers is relevant in understanding the context of the research.

Bebbington (1996a) notes that the rural popular movement in Latin America has shown particular strength compared to others worldwide, and the significance of indigenous identity in their formation and grounding principles is unique. Indigenous organizations can accomplish things that smaller communities and households cannot; their size and influence give them clout in negotiating fair market relationships, pooling resources provides the economic feasibility to engage in product transformation, marketing activities, and technology development; and they are attractive to wealthy international donors (Bebbington 1996a, Hellin and Higman 2002,

Young and Lipton 2006). This has certainly been the case with the Potato Park communities and Asociación ANDES, which has organized and facilitated numerous activities designed to boost income for the local communities including the development of cooperatives dedicated to selling soap and medicinal products, a restaurant for tourists, and a weaving cooperative. Because of their grounding in principles of indigenous identity, these organizations frequently serve as mediators between two worlds, feeding new knowledge into rural communities and adapting it to traditional practices (Bebbington 1996a)

This interaction between indigenous community members and non indigenous outsiders, whether through well meaning social scientists and activists or rabid and ruthless developers, must be understood in the context of the long history of racism and discrimination in the region. Since the arrival of the Europeans[2], indigenous populations have struggled for respect and equality in their own home country, the majority of which is now populated by the descendents of the Spanish conquerors and their mestizo offspring. As Valdivia (2009) points out, no matter how hard an organization tries to leave power and decision making in the hands of indigenous constituents, they are still spreading messages throughout the community whether consciously or not. The very presence of an organization like ANDES implies certain beliefs about the state of local communities themselves and their relation to the outside world, about the adequacy of their lives and modes of subsistence, and the fact that they need an outsider to come and show them what to do. These beliefs are certainly not missed by the indigenous populations with whom they work (Appfel-Marglin and PRATEC 1998). Valdivia (2009) explains that the indigenous rights movement in Peru, when compared with the neighboring Andean countries of Ecuador and Bolivia, is relatively underdeveloped, the effects of which he believes can be seen in

[2] Of course this is not meant to imply that life before Europeans was an egalitarian paradise; living under Inca conquerors was surely no picnic and that was only the last of a long line of expanding states to exert control over your average everyday farmer trying to make a living.

significantly less emphasis on maintaining a distinct indigenous identity within traditional Peruvian communities. He believes that this has made indigenous populations more eager to embrace scientific notions of climate change in the hopes of shedding an identity that is still perceived among indigenous people themselves as being something to hide, rather something in which to take pride, especially when interacting with non indigenous people.

Economically speaking, much of the Andes has experienced a general state of stagnation for much of the past century, restricting potential growth and profits for rural and urban residents alike (Bebbington 1996a). Additionally, there has tended to be a general bias towards urban over rural development in Andean countries, and the few programs designed to benefit rural residents are often underfunded and are highly unequal in geographical and social reach (Zimmerer 1991). There has tended to be a trend towards privatization of Latin America, and the liberalization of markets has made it difficult for local farmers to compete with large scale agribusiness (Zimmerer 2002, Bebbington 1996a, Bebbington 2001). These changes have been accompanied by the privatization and individualization of land rights, facilitating the concentration of land, capital, and knowledge in the hands of agribusiness as opposed of peasant communities, making traditional communal management more and more difficult (Deere and Leon 2001; Postigo, Young, and Crews 2008).

Modernization brought largely by markets, new technologies, and development schemes has resulted in increased availability of jobs, increased communication, and improved health care and education. Although these changes have obviously brought benefits to communities, the long term and less obvious implications on the future and sustainability of livelihoods have been questioned (Young and Lipton 2006, Bebbington 1996a). For example, many researchers are concerned that significant traditional knowledge necessary for coping with short and long term

change is being lost as younger generations spend more time in schools and frequently migrate away from the community to take wage paying jobs in cities (Young 2002). Finally, increased contact with globalized urban centers has sparked new needs for consumer goods such as radios and cars that were absent a few decades ago, placing further stress on household budgets already strained without having to deal with climate related agricultural and livestock failures (Hellin and Higman 2005). In this research, one respondent specifically mentioned that the new expense of paying for electricity was straining her finances.

Although agricultural production for some combination of either subsistence or markets is still common throughout the Andes, it is by no means the only way of making a living. In the research communities, there is an increasing focus on producing textiles for tourists and, occasionally and less desirably, migrating in search of jobs. This has become a popular option across many regions in Latin America as growing populations face increasing land scarcity and parents are unable to pass on sufficient land to their children (Bebbington 1996a; Campbell 2006; Stoorvogel, Antle, Crissman 2004; Postigo, Young, and Crews 2008). Off farm income also provides a valuable buffer against volatile prices for goods produced on the farm and provides cash needed to purchase consumer goods and provision of basic health care (Hellin and Higman 2005).

The climate

Distinctly wet and dry seasons characterize the annual rhythm of the Andean world, with dry, cold winters and rainy, warmer summers. Food production tasks- sowing, weeding, hilling-up of potatoes, harvesting, storage, transformation, and consumption- all revolve around this annual climate pattern (Figure 3-2). Farmers use a diverse array of signs to help predict

precisely when these shifts will occur as well as the nature of the shifts for each particular year (since a certain amount of variation in intensity and timing is normal and expected from year to year) including appearance of celestial bodies, flowering and abundance of wild plants, behavior of wild animals, and dreams (Rivera 1998; Orlove, Chiang, and Cane 2002). However, this annual cycle regulates more than simply agricultural tasks. In this agrocentric society, Zuiderma (1992) explains that the annual calendar, which revolves around observations of the cyclical movement of the sun and other celestial bodies, is used to regulate ritual and social activities throughout space and time and that this, along with kinship, is the primary tool used to organize cosmology. According to the Inca, rains are attracted to the heat of the sun, thus linking annual patterns of precipitation to normal procession of the celestial bodies (Zuiderma 1992).

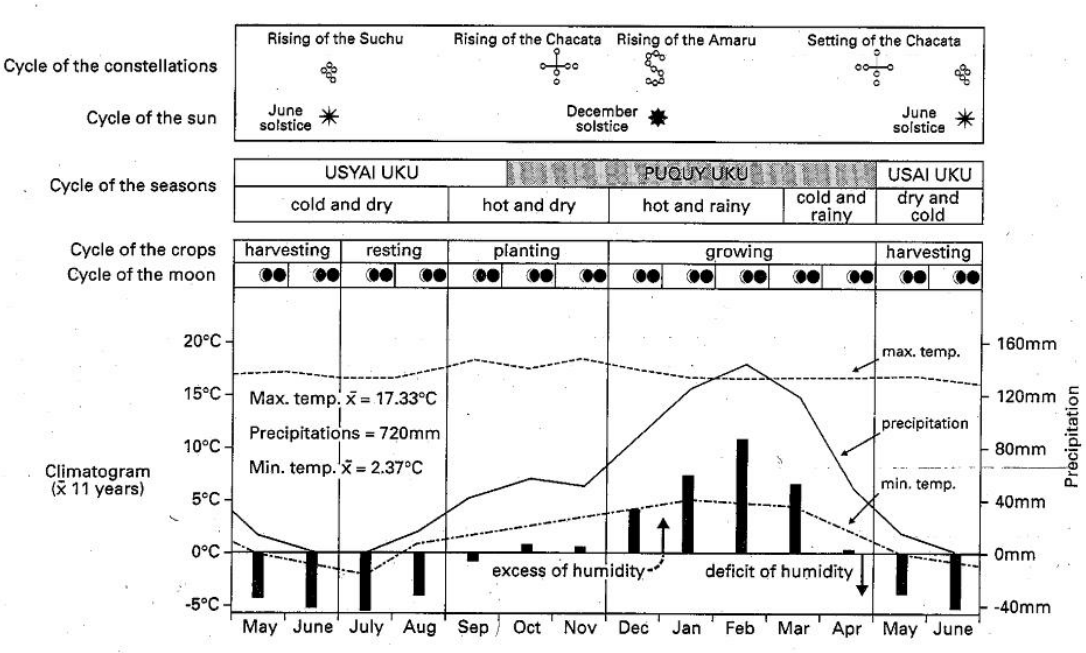

Figure 3-2: Annual cycle of weather and agricultural tasks
Source: Rivera 1998:81

Since the purpose of this thesis is to examine indigenous perceptions of climate change, a review of what is known in the scientific community about climate change in the region is warranted. Although scientific knowledge about climate change is growing exponentially every

year, one area that remains especially fuzzy is climate change in mountains, especially mountains located in developing countries. Data from these regions are notoriously lacking for a number of reasons. Firstly, it is just difficult to get expensive and awkward climate monitoring equipment up in extremely rugged terrain, and almost equally difficult to access and maintain them (Barry 2000, Barry 1992). Secondly, mountain regions are frequently home to less economically valuable land and, consequently, frequently marginalized social groups who are considered less important, or at least a lower priority, than their lowland neighbors (Price 1994; Ives, Messerli, and Spiess 1997). Finally, weather and climate in mountains is inherently more complicated than that in the lowlands: complex topography produces equally complex microclimates, and data in the high mountains does not necessarily mirror regional trends observable for South America as a whole (Salzmann et al 2009; Beniston 1994; Beniston 2003; Barry 1992; Beniston, Diaz, and Bradley 1997).

The Peruvian Meteorological Office (SENAMHI) owns own several long term records (those greater than 40 years) and a larger number of shorter term records for the Cusco and neighboring Apimurac regions, but these are riddled with frequent gaps in both space and time (Salzmann et al 2009). In general, the evidence that does exists points to a general warming trend for the tropical Andes, although there is disagreement over whether this warming is more pronounced (Vuille et al 2003) or less pronounced (Bradley et al 2006) at higher altitudes. There also appears to be different patterns in the North of Peru (more warming) than the South (less warming) as well as between eastern (less warming) and western slopes (more warming) of the mountain. Unfortunately for the research site, the data from Southern Peru is acknowledged to be exceptionally scanty (Salzmann et al 2009). It is difficult to get any statistically significant trends for the region at all, although recent research indicates slightly drier conditions in the region

overall, with decreases in precipitation for the typically rainy summer and increases during the typically dry winter. Beyond this, trends appear weak and insignificant.

Partly because of this relative absence of quantified meteorological data, scientists have largely relied on proxies for estimating long term climate change, most popularly glacier monitoring either directly through personal observation or indirectly through satellite images. In the tropical Andes of Peru alone, 10 glaciers have been monitored since 1932. From the beginnings of monitoring until 1994, all glaciers had retreated between 590 and 1910 m (Ames 1998 in Salzmann et al 2009). In his work in the communities surrounding the formerly glaciated peak of Cotacachi in Ecuador, Robert Rhoades et al (2007) incorporated paintings and travel photos from early explorers dating back as early as the late 19th century to trace the retreat of the glacier in years before the introduction of satellite images. Vergara (ND) reports that between1970 and 1997, glacial area declined by 22% in Peru. The retreat and disappearance of glaciers has reverberated through the social and ecological landscape inhabited by the indigenous Quechua people. Because glaciers are a critical component to the entire mountain ecosystem, their disappearance can affect many facets of the local environment including changing patterns of vegetation, changing locations and sizes of water sources, the disappearance of long known animals and plants, and the appearance of new ones (Steinberg, ND). It is perhaps significant that none of the three communities in this study were located within viewing distance of such a large and culturally significant glacier as Cotacachi. The possible role of glaciers in influencing perception of climate change has yet to be widely addressed by researchers, but has been insinuated (Beniston et al 2004) and is currently being investigated by Orlove (2010) in the Cordillera Blanca region of Peru (north of the research site).

This gap in the scientific record of southern Peru only underscores the importance of research that explores local perceptions of climate change. Even in regions not complicated by complex and heterogeneous topography, researchers have noted that the averages and trends reported for regions can be dangerously misleading. For example, in their study of maize production across Africa and Latin America Jones and Thornton (2003) find that predicted decreases in production for the region (both estimated around 10% from the period of 2000-2055) mask enormous spatial variability, with some regions experiencing production increases of up to 100% and others with production predicted to decline to nothing. In this sense, regional estimates have little relevance for the individual farmer who must make decisions based not upon aggregated averages but actual conditions in his or her field. With science not yet caught up, the local residents who live and breathe the climate everyday are perhaps the best source of information for the next generation of farmers as well as researchers attempting to understand, mitigate, and facilitate adaptation to climates that do not necessarily change uniformly or predictably.

CHAPTER 4: METHODS AND ANALYSIS

Research methods

This research was conducted in three indigenous communities in Pisac district of Cusco, Peru located in the Andean highlands of southern Peru in late July and early August of 2009. This site was chosen for two main reasons: firstly because of the population's significant experience coping with climatic and environmental stress and, secondly, because tropical mountain ranges have been identified as some of the most vulnerable socio-ecological systems in the world to global climate change. Mountain communities have been described as exceptionally vulnerable to climate change due to their extreme environments, social marginalization, and close relationship and dependence upon the natural environment (Crate 2008, Parish and Funnell 1999, Rai and Gurung 2005). Researchers also predict that climate change will be most severe in the tropics, through which the majority of the Andean cordillera (including the proposed research site) passes (Barnett et al 2005).

Semi-structured interviews were conducted with 24 respondents in the communities of Cuyo Grande, Chawaytire, and Pampallacta in July and August of 2009. All communities were located within walking distance of no more than half a day from the others. Interviews were conducted in Quechua with the help of a field assistant from Cuyo Grande and audio-recorded digitally. Two interviews were conducted with Peruvian scholars in Cusco who were also working on issues of climate change adaptation in the region, providing a valuable etic viewpoint from those

directly engaged in long term research with local populations. This project was approved by the University of Georgia Institutional Review Board's Office of Human Subjects.

Because the objective of the research was to gain an understanding of how indigenous farmers perceive and experience climate change, questions were constructed to be open ended in order to avoid biasing responses with my preconceived notions about climate change in the region. In the interest of allowing unexpected themes to emerge, participants were given freedom to identify and discuss issues that they personally believed to be the most important regarding the existence and impacts of climatic changes. Respondents sought were male and female adult farmers. From these restrictions, the field assistant, a resident of Cuyo Grande, was given freedom in selecting respondents who were willing to participate in the study. In total, the final sample includes 24 adults ranging in age from 21 to over 80 years. The majority of respondents were female, perhaps because the gender of both this researcher and the fellow female field assistant facilitated recruitment of female over male respondents. The profile of the respondents by town of residence is detailed below

Table 4-1: Profile of respondents by village, gender, and age
*Includes two older females who did not remember their age. I estimated their ages at 65 for this calculation

	# of Males	# of Females	Average Age	Age Range
Cuyo Grande	2	7	49	24 - 99
Chawaytire	2	6	39	25 - 50
Pampallacta	2	5	47*	21 - 70

Interview questions were divided into three general categories including (1) descriptions of climate changes, (2) responses to climate change, (3) general concerns about climate change.

After obtaining consent to participate (University of Georgia Institutional Review Board's Office of Human Subjects), respondents were asked about their experience of climate change. Specific questions addressed the nature and length of changes, explanations of changes, the possibilities of climate change in the future, and where they got information about climate change (such as on their own, or through a radio program or a neighbor) (Appendix A). Respondents were asked how, if at all, they were changing their agricultural strategies because of climate change and whether they ever thought about moving away from their homes to seek work elsewhere. Finally, respondents were asked to discuss whether they were worried about climate change, and what other worries they were simultaneously coping with. Interviews ranged in duration from five to 15 minutes.

Data analysis

The research data was analyzed for thematic content using the grounded-theory approach. Grounded theory is a primarily inductive approach to analyzing ethnographic data, in this case transcribed and translated interview texts. Instead of identifying a priori themes expected to emerge and then looking for them in the text, the researcher allows themes to emerge from the text from repeated readings, becoming increasingly "grounded" as analysis proceeds. Although this approach of course cannot (and does not claim to) eliminate all researcher bias, it is a method well suited for exploratory research in which a researcher is not attempting to confirm a preexisting theory or hypothesis (Bernard 2006).

This method represents a more qualitative than quantitative approach. It is less concerned with identifying and tabulating exactly what people say and do and focused instead on uncovering implicit beliefs and understandings that lie beneath what may initially appear to be

relatively simple and objective statements. Maxwell (2004) identifies the strength of qualitative analysis as one that seeks to understand how people make sense of phenomena and how this perspective informs their actions, rather than just what happens and what people do, a goal much in line with that of this research.

CHAPTER 5: RESULTS AND DISCUSSION

Although the initial focus of this project centered on understanding whether varying perceptions of climate change influenced agricultural strategies, the process of interviewing and analysis quickly revealed that my questions were failing to address what my respondents most wanted to talk about regarding climate change. As more and more respondents spontaneously mentioned issues of health and illness in various contexts, the existence of an intimate interweaving of climate change and notions of individual, community, and environmental health began to take shape. As a result, I shifted my main research question to focus on how cosmological understandings of the environment and the body influence understanding and responses to climate change. This chapter explores the results of this process and is divided into two major sections. Section one, the results, focuses on extracting the more objective and pertinent data from the interviews including what aspects of the climate respondents perceive as changing, impacts on life and livelihood, and actions taken in response. Section two consists of qualitative analysis and interpretation of information presented in section one, focusing on analyzing responses to gain a better understanding of how respondents are making sense of what is happening, and how this perspective informs the actions discussed in section one. This will support the hypothesis that cultural beliefs influence understanding and responses to climatic changes and provide a detailed case study of this process at work in the southern Peruvian Andes.

Changing climates, changing lives: "We think that we are not in our own town"

Observing climatic changes: increased intensity and unpredictability of weather

Although often casually referred to as "global warming," any scholar of global climate change knows that warming is far from the only impact being experienced by people across the globe. The respondents in this study were quick to identify many of the other trends that have been noted by climate scholars working in the Andes and across the world, most notably increasing intensity and unpredictability of climatic phenomenon.

In discussing perceived climatic changes, descriptions were frequently framed in extremes: respondents reported more heat, more cold, more wind, more rain, and more intense sun. Upon further elaboration, many compared the current climate to that which they remembered from their childhood which, if mentioned, was always described as better, with everything "coming in its time," good production of crops, and weather that was more *templado*. Most respondents reported changes as quite significant, frequently prefacing descriptions with modifiers such as "very," "totally," and "a lot." One woman, aged 38, explained "We think we are not in our own town." Another, in response to a question about how much longer she thought the climate would change replied "I don't know how much more it *could* change." In these statements, both of these women emphasize the extreme and disorienting nature of the climate changes they had experienced, a theme that seemed to recur frequently throughout the interviews.

In addition to more extremes, the other most frequently mentioned observation was weather phenomena- specifically frosts and precipitation- "coming out of time." In this region of the Andes, the year is typically divided into distinctly wet and dry seasons around which the agricultural calendar and tasks neatly revolve (Rivera 1998). The Andean winter, from April

until October, is characteristically cold, dry, and sunny while the summer, from November until March is warmer and wetter. I was able to experience some of this increasingly erratic and unpredictable precipitation myself during my month in Cusco, when it rained several times and was frequently overcast in July. Respondents reported that not only are the rains coming out of time, but the frosts as well. However, unlike the unusual presence of rain in the winter, what respondents were worried about regarding frosts was their unusual absence at the time of the interviews.

When asked how long the climate had been changing, respondents gave varying responses. Of the fifteen who gave a response in years, the average number of years climate had been changing was 3.2 years (mode of 2.25, median of 2.5, minimum of 1, maximum of 10). These responses were somewhat surprising given the time frames cited by scientists and elaborated in Chapter 3 of this document that have traced the gradual but persistent retreat of glaciers since at least the 1930s (Salzmann et al 2009). It is perhaps significant that none of the three communities in this study were located within viewing distance of a large and culturally significant glacier, although one respondent did mention observing the retreat of the Ausangate glacier in response to the question of why she believed the climate was changing. Ausangate is a large and very culturally important glacier located roughly half a day's journey from the Potato Park communities that has been well studied by researchers interested in both the social and natural aspects of climate change in the region. Although once completely white, Fraser (2009) reports that it is now streaked with gray where bare rock shows through the melted ice[3]. One other respondent mentioned retreat of non-specified snowfields. The possible role of glaciers in influencing perception of climate change has yet to be widely addressed by researchers, but has

[33] The glacier is the site of an annual ritual pilgrimage known as Qoyllur Rit'i. Part of the ritual traditionally entailed removing and carrying home a chunk of ice from the glacier, a practice that has since been halted due to concerns for the rapid retreat of the glacier (Fraser 2009).

been insinuated (Beniston et al 2004) and is currently being investigated by Orlove (2010) in the Cordillera Blanca region of Peru. It is not known how many community members participate in the annual pilgrimage, but it is possible that more people did not mention this phenomenon because the question asked in the interviews "Why do you think the climate is changing?" was frequently misunderstood and responded to with a repeated list of how the climate is changing, such as "Because of a lot of cold and heat," (respondent #15) "Because there is a lot of rain, a lot of sun" (respondent #9).

Although the majority of respondents gave numerical estimates of how many years they believed the climate had been changing, several respondents said they either did not know at all, or qualified their responses with a degree of uncertainty. Instead of giving a specific estimate, several respondents emphasized that the climate had been changing much more noticeably in the past few years implying perhaps that the surprisingly short time estimates given in years by other respondents represent not total time the climate has been changing, but the noticing of increasing rates of changes in the past few years, in itself an important observation.

Impacts of climate change: agriculture, health, and livelihoods

These perceived changes have posed numerous challenges to the respondents. Climatic changes reported have impacted the ability of the respondents to successfully produce and store acceptable levels of crops and livestock, and the more extreme weather has brought more disease to their communities, affecting the respondents themselves, their crops, and their animals. In response to this, many have reduced the scope of their farming or are seeking other profitable livelihoods, yet nearly all show a strong desire to remain in their home communities.

Without prompting, participants were quick to discuss the agricultural ramifications of climate change. They mentioned many agricultural challenges that had accompanied climatic changes thus far, including increased incidences of disease and appearance of new diseases (for crops, animals, and humans), difficulty in timing activities, decreases in production levels, and difficulty in storing products due to both diseases and unpredictable weather.

Increasing unpredictability of precipitation and frosts is one of the greatest challenges faced by Quechua farmers and has significantly impaired production. In an area reported to be getting generally drier by both scientists and local residents alike, more rain of at any time might initially be viewed favorably but, as any farmer worth his salt knows, it is not just quantity but intensity and timing that count when trying to coax crops from any environment, especially one as marginal and challenging as the high Andes. Planting of potatoes, the most important crop both culturally and calorie-wise in the region, is carefully timed to coincide with certain predictable periods of appropriate temperature and precipitation. The wet season typically coincides with the Andean summer, ranging from October to April, while the winters are bitterly cold and dry. Timing of potato planting around late August is designed to maximize production: farmers want to get potatoes in the ground as soon as possible to give them the most time to mature before early frosts the following fall, but not before the harsh winter is well on its way to over, and not too early that the freshly sown potatoes will have to wait too long for the first rain to fall (Coscio 2009, Rivera 1998). Recently, respondents have also been planting new potatoes, the moniker given to the non indigenous introduced varieties of potatoes that have different tolerances and requirements for environmental conditions during germination and maturation. Although typically sown around the 15th of June to coincide with the cold, dry weather, this year respondents had not yet been able to get their new potatoes in the ground. The increasing

unpredictability of these events whose timing is crucial to proper growth of food crops is one of the most serious climate related challenges that these farmers face.

Similarly, in an area where nearly all respondents lamented over increasingly cold weather, the absence of frosts might be mistaken for a good thing. However, farmers rely on the frosts to make *ch'uño*, a type of freeze dried potato that requires long stretches of cold and dry weather for proper processing. Production involves leaving potatoes outside on the ground for several days, exposing them to alternating cold frosts at night and strong sunlight the following day. The formation and subsequent breakdown of ice within the potatoes both reduces water content and removes bitter tasting glycoalkaloids. After several days, trampling the tubers underfoot removes any remaining water and, once cleaned, the potatoes can be stored for several years, making it especially important for food security in an area considered marginal for crop production (Tapia and De la Torre 1998). The absence of frost at night and the occurrence of precipitation when potatoes are supposed to be drying both impede this process.

Erratic rainfall is potentially dangerous not only for crops and livestock but for human health as well. At 13,000 to 14,000 feet above sea level, this region has always experienced bitter cold and is considered one of the most biologically challenging settings for humans in the world (Baker 1969). The treeless slopes of the harsh mountain environment provide neither fuel for heating houses nor protection from the cold winds that residents report now whip through their villages during the coldest months, "almost [taking] us away" (respondent #5). The combination of more intense cold, increasing wind, and the appearance of precipitation in the winter months reported by the respondents threatens not only the survival of crops in the ground, but of the local residents who are increasingly struggling to stay warm and healthy. Respondents frequently attributed increases in illness for themselves and their children to winters that have been made

worse by the unusual appearance of wind and rain during this cold, but normally calm and dry season. A similar pattern was reported by Annie Kelly (2010) in the Huancavelica region of the Andes, where people reported increasingly extreme winters. Increasing cold combined with flooding, winds, and poverty have contributed to increasing frequency of pneumonia, bronchitis, and hunger. In the district of Puno (bordering Cusco to the south) the last winter was accompanied by a spike in child mortality, with more than 300 children dying in May of the last year from the cold (Kelly 2010)[4].

Responding to climate change

When asked whether they were altering their agricultural strategies in response to climate change, the biggest change that seemed to come up repeatedly was that people are working less. Some people have given up farming altogether in favor of textile production (although not all can afford the start-up capital to do this), while others report planting smaller amounts of land. Several mentioned that with the rains coming in the dry season this year they have not yet been able to plant new potatoes. (The planting of new potatoes typically takes place around the 15th of June, and this interview took place on the 28th of July, a serious and significant delay). However, besides one respondent who mentioned planting potatoes at higher altitudes as a result of increasing temperatures, no one mentioned any specific changes in strategies in response to climate change except "waiting for it to normalize," planting less, or giving up agriculture

[4] The absence of frosts suggests that it is possible that the area is not actually experiencing a dip in temperatures, but that winters just seem colder because of the unusual appearance of winds and rain during the coldest months. Of course this in no way disqualifies their observations of increased overall. In fact, it is a prime example of why local studies of indigenous perceptions are so important in order to properly address the actual problems being experienced by local residents, and not those hypothesized by scientists (even if they are supported by strong meteorological data).

altogether (although being a newcomer and a *gringa* female conducting relatively short interviews it is quite possible that they did not think that I would be interested in such details).

Largely because of widespread increasing difficulties associated with timing of agricultural tasks, a significant body of literature has grown that addresses the use of seasonal forecasts as an adaptive strategy to facilitate selection of optimal planting times (Batterbury 2008, Grothmann and Patt 2005, Roncoli 2006). Although a few mentioned receiving information over a television or radio, when asked where they got any information about climate change the majority responded with some form of "I just notice on my own." I was surprised by this response because of these community's locations in the Potato Park, a group of communities that are directly engaged with a local non-governmental association (Asociación ANDES) and see lots of foot traffic from Western scholars engaged in climate research.

Although no one mentioned the use of scientific forecasts, several respondents mentioned *cabañillas*, (more commonly known as *cabañuelas* in other areas of Latin America), a pan-Hispanic forecasting technique used to predict weather for the upcoming year. Although more detailed explanations of how the technique worked were not elicited in the interviews, the practice is widespread throughout Latin America and generally involves using weather in the first month of the year (in this region, they begin with the month of August because this is considered the beginning of the agricultural calendar) to predict weather on monthly time scale for the upcoming year. The process is somewhat complicated and variable from location to location, but generally involves using the weather on August 1 as representative of the weather in January, August 2 with the weather in February, and so on down the line (for example if it is sunny on August 1, that means the weather will be good in January). On the 13th of the month, the count begins again in reverse with August 13 representing December and August 14

representing November. The remaining seven days are spread out over the 12 months, and the predictions for each of the months are averaged. Two informants specifically remarked that these forecasts were more accurate than those of the scientists, which was the only mention of scientific forecasts at all.

Despite the relative lack of discussion concerning specific changes in agricultural strategies, all respondents expressed significant worry concerning the increasing difficulty of making a living in their home. With production down, the population growing, weather getting more intense and unpredictable, and increases in the frequency of diseases for crops, animals, and humans alike, respondents certainly do have many things to worry about. Not a single respondent had anything positive to say about the state of their village until they were asked whether they would consider moving away from their home because of climate change. Out of 24 respondents, only five reported any desire to move. The rest were adamant about their desire to stay in their community. Some mentioned possibly leaving for a short period of time (such as one year) and then returning, and one mentioned that those who *had* left had since come back. Those who elaborated on their desire to remain in their community tended to focus on one of four reasons: that the *clima* is in other places too and therefore inescapable; that their home, family, or community is here; that things are worse in other communities (issues mentioned include more poverty and earthquakes), or their faith in God. The quickness and pride with which they defended their homes was initially surprising given all the negative things they had to say in other parts of the interview and is one of the issues that will be addressed in the following section.

Pachamama is tired: climate, disease, and disharmony in the Andean world

While the prior section focuses on reporting changes observed by the respondents and actions taken in response, this section is centered on a qualitative analysis of these responses based in an understanding of Andean cosmological beliefs about the functioning of the natural world and the human body. The thesis of the argument- that Andean cosmological beliefs influence how climate change is experienced, understood, and reacted to- is examined in detail in this section. I hypothesize that Andeans see the natural environment, which includes their crops and livestock, as intimately connected to their own bodies, and understand disturbances in the form of illness and unfavorable climatic events as manifestations of disharmony within this larger system. In this sense, climate change is experienced as not only a troubling change in weather patterns, but as a symptom of a larger problem that has origins and connections outside of the detached meteorological sphere conceptualized by Western science. This understanding of the problem leads to priorities and solutions that are broader and somewhat different from those embraced by non-Andeans. This section will review the data and my interpretations, tracing connections between the interview texts and Andean beliefs that support the thesis discussed above as well as illuminate several aspects of the interviews that emerged as unusual or unexpected.

Celestial bodies and natural rhythms: a world interrupted

As mentioned in the previous section, many informants mentioned more intense heat and sunlight, a comment that I initially classed as not unusual, surprising, or unexpected. Somewhat more mysteriously, however, several informants also mentioned the days becoming shorter. An older woman who did not remember her age [respondent #18] reported that “When I was a girl, it

was not cold. When it rained, it was warm…before the day was long and now it is short." A 33 year old woman [respondent #5] explained that " I notice [the climate changing] on my own because of the sun, it turns around fast…the day is short, it is not like before- long." Although initially quite puzzling, when one considers that rain typically comes when the day is long (in the Andean summer from October to April), it is possible that this somewhat cryptic observation could be accounted for when one takes the unexpected appearance of rainy weather in the short days of winter into account. In other words, the unexpected appearance of rain in the dry season is not merely an anomalous event, but linked to a disruption of the celestial rhythms that govern all aspects of the Andean life and livelihood, as detailed in the agricultural calendar presented in Chapter 3 of this document.

Celestial bodies in general and the sun in particular are of extreme importance in the traditional Andean calendar and cosmology (Orlove, Chiang, and Cane 2002, Rivera 1998, Urton 1981, Zuidema 1992). Allen (2002:36) explains that humans are believed to derive their existence from the sun: "the daily presence of the sun's light and heat is felt to be intimately connected to normal social life and to the very existence of the human race. The previous world age, inhabited by a race of giants was lit only by the moon…if our age is succeeded by another, this new era will have a different sun and a different race of beings." The sun is understood to go through annual cycles, which are intimately tied to the rhythm of dry and wet within the Andean year. Ethnohistorians claim that at least part of this emphasis on the importance of the sun dates back to the time of the Inca, when pillars were constructed in Cusco in order to track the position of the sun on the horizon to determine the best periods for planting. This observation is also complemented by traditional Andean understanding of the transition between day and night. Urton (1981) explains that in traditional Andean cosmology the sun, after setting, travels under

the earth through the underground waters of the Vilcanota (known as the “sacred river” in the region) back to the east, from which it drinks to gain strength. During the dry season that usually coincides with the winter months of May through August, when there is less water to drink, the sun is weak and its shine less bright. Furthermore, the rains are believed to be attracted to the heat of the sun (Zuiderma 1992) This understanding of celestial movements would support observations of more intense sunlight during winter months that have been unusually rainy.

The significance of this interpretation, if correct, lies in its implication that respondents are attributing cosmological significance to shifts in weather patterns. Urton (1981:7) explains that all societies have some type of calendar because the alternative is “economic, political, and psychological chaos.” These observations, combined with the increasing unpredictability of meterological events testifies to climate change as a process that is not only a troublesome shift in weather, but an extremely discombobulating and troubling phenomenon that seems to be mixing up not just the weather, but the entire world. It is not a stretch to see how the mixing and increasing unpredictability of previously seasonal climatic phenomenon that are closely tied to understandings of how the universe operates could produce a sort of psychological chaos leading to larger questions about cosmological significance of events that, in Western understanding, have a purely scientific explanation.

Indeed, three respondents mentioned a Higher Power when asked either why they thought the climate was changing or whether they would move away from their homes because of climate change. A 33 year old man mentioned “I think it is a test of the creator” (respondent #7). A 50 year old woman explained “I would not move since I believe in the Lord. I will only wait until he returns” (respondent #11). A 23 year old woman linked the climatic changes directly with cosmological significance: “According to the Bible everything will dry up so that is already

beginning" (respondent #19)[5]. On a related note, when asked how much longer they thought the climate was going to change, respondents were very reluctant to speculate. While some gave very short time estimates (one year), the majority said either they do not know or they cannot know, perhaps implying an inability to know the future or forecast climate conditions based on the attribution of changes to spiritual rather than natural causes.

In addition to corroborating the hypothesis that people are attributing cosmological significance to climatic changes, the belief in an active role of a higher power in climate change is potentially important for understanding how people perceive their own ability to adapt perceived changes. As mentioned in the second chapter of this document, social scientists studying adaptation to climate change have recently begun to focus on the importance of perceived personal efficacy in adaptation (Grothmann and Patt 2005, Wolf et al 2009). Stripped down of jargon, this simply means that people must have not only have adequate financial and social resources (and perceive themselves to be at risk) in order bring adaptive practices to fruition, but they must believe that their actions will be effective against the perceived threat.

In the Western world, it is commonly (although certainly not universally) believed that climatic changes can be understood scientifically and attributed to, if not human choices and actions, at least to natural processes independent from the general moral state of humanity. This is not necessarily the case in outside of the Western world, a trend observed by social scientists studying climate change in various locations throughout the world (Salick and Byg 2007, Vedwan 2006). In his work in Cotacachi, Ecuador, Robert Rhoades found that especially older informants attributed the disappearance of the glacier and associated warming to punishment

[55] Although reference to the Bible (and likely the Lord by #11 as well) shows clear evidence of Western Judeo-Christian influences, the topic of religious syncretism in the Andes is one that has received much attention and it has generally been agreed upon that adoption of some Christian beliefs and practices frequently coincides and complements rather than replaces traditional Andean cosmology (Kreimer 1990, Abercrombie 1998, Appfel-Marglin and PRATEC 1998)

from Mama Cotacachi (the glacier) (Rhoades, Rios, and Ochoa 2007). In fact, researchers have documented traditions of stories that attribute bad weather to moral failings all across the globe in regions as far flung and disparate as the Andes (Allen 2002), Papua New Guinea (Sillitoe 1996), the Canadian Arctic (Cruikshank 2005), the Himalayas (Salick and Byg 2007), and modern Europe (Orlove, Wiegandt, and Luckman 2007).

Understanding the causes that people attribute to climate change is critical to understanding what they believe to be an appropriate response. If one believes that moral failings are the cause of climatic changes, as has been thoroughly documented in other areas of the Andes, the perceived solution lies (at least partially) not necessarily in changing one's agricultural strategies, but in righting moralistic wrongs committed by oneself or one's community. Bjonness (1986) explains that in her research in Nepal, Sherpas' reactions to environmental hazards depended on whether they attributed the cause to a spiritual or natural force. Responses to a hazard caused by a natural force could include rebuilding a house in a safer location after a landslide, while responses to an event attributed to spiritual causes would be met with ritual activity (although of course doing one of these does not necessarily preclude the other). The point is that responses are guided by what the actors believe will be most effective in a particular situation, which is assessed holistically. This process, of course, occurs in the scientific community as well, although beliefs regarding the ultimate cause and appropriate action frequently differ from indigenous communities.

In this thesis, I hypothesize that respondents *do* attribute cosmological significance to the climatic changes they are observing, and that this understanding affects their responses: most notably the surprisingly little emphasis on altering agricultural strategies and an unexpectedly zealous desire to remain in their home communities. In addition to the references to celestial

bodies and a higher power discussed above, I believe that the frequent spontaneous mentioning of health and disease further supports this hypothesis and illuminates why these responses in particular were mentioned the most frequently, especially the strong desire to stay in one's home community.

Health of the body, health of the land: disease as disharmony

As mentioned previously, health has always been an issue of critical importance and a biological challenge to people living in the tough and unforgiving environment of the high Andes (Baker 1969). Across the globe, many researchers have noted that for many people climate change has brought the introduction of new disease vectors and expansion of habitat favorable to existing vectors (Beniston 2003, Lindsay and Martens 1998, Crate 2008). Combined with malnutrition from declining agricultural production (Keil et al 2008), and shifting or declining distributions of wild medicinal plants (Bolin 2008), climate change has the potential to seriously affect the health of many of the world's inhabitants. The fact that health and disease were mentioned so frequently in interviews was only surprising because none of the interview questions asked respondents about these topics. Although questions did not specifically address health, all but two of the respondents made reference to crop, livestock, or human illnesses increasing with climate change or to the appearance of new illnesses with climate change. Among these 22 respondents, human illness was mentioned 19 times, crop disease was mentioned 13 times, and livestock disease was mentioned 7 times. The main concerns were both an increase in the frequency of disease among all three groups (humans, livestock, and crops) and the appearance of new, unknown diseases. In crops, "maturation sickness" and worms were cited as the two biggest threats while diseases in animals varied but generally included fevers,

diseases of the liver[6], and bloating. For humans, the main concern seemed to be increasing frequency of illness brought about from the colder, windier, and wetter conditions as well as appearance of unknown diseases.

The frequent mention of issues of health and disease can be better understood in the context of Andean cosmology, in which health and disease are closely intertwined with their world view of how the world is structured and functions. Miles and Leatherman (2003:10) explain that "The Andean landscape is supernatural, social, political, economic, rural, urban, global, and local. The environment shifts, emerges, affects and shapes health, as do the constructions of self, identity, family and community of the inhabitants of these multiple landscapes." An important assumption undergirding this research and analysis is that culture is important in understanding a population's experience, expression, and treatment of disease and ideas about health and illness. By exploring the uniquely Andean way of understating the structure and function of their universe, one can begin to see what climate change looks like through their eyes as well.

In traditional Andean cosmology, health of the individual, crops, livestock, community members, and environment are all closely interrelated and dependent upon each other. Unlike the more individualistic philosophy underlying much of the Western world's understanding of health and wellness, in Quechua philosophy the body cannot be separated from the landscape just as individual cannot be separated from the community (Greenway 1998).

[6] In the Andean world, the liver is in a certain sense equivalent to the heart in that it is seen as the home of the essence of the body.

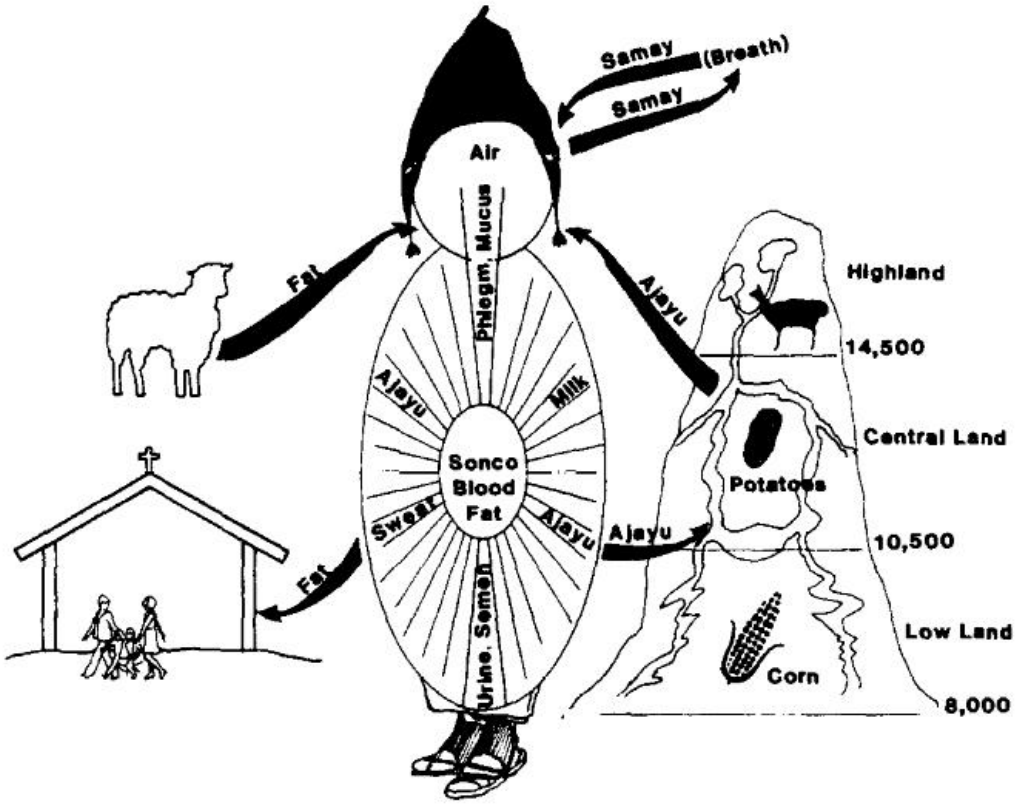

Figure 5-1: Andean conceptualization of the body.
Source: Bastien 1989:46

Bastien (1989) explains that traditional Andean understanding of the body is patterned directly by the mountains in which they live. Both the body and the mountainside have a head, a trunk, and legs just as both are one organic being sustained by the centripetal and centrifugal movement of sustenance- food and other products on the mountainside and fluids within the body (Figure 5-1). Air, blood, and fat are the primary and most important body fluids which circulate through the body and the mountain, pumped by the heart or *sonco*, in centripetal and centrifugal motion. With this understanding, when an Andean person says that he or she is sick, there is an implicit reference to not just his or her individual person, but the well being of the surrounding environment as well.

This understanding is deeply grounded in Andean notions of reciprocity. The environment includes not only the mountain, but the crops and animals that grow on its slopes, and all are engaged in important reciprocal relationships. Crops and animals are seen not only as sustenance, but effectively as members of the family. Belief in reciprocity is manifested in four agricultural relationships: farmer-crop, farmer-deity, farmer-farmer, and crop-crop. The relationship between farmer and crops means that in exchange for proper nurturing on the part of the farmer, the crops will yield handsomely (Zimmerer 1996, Rivera 1998). Zimmerer (1996) elaborates further using the metaphor of a mother and child to explain the relationship between a farmer and her seed (women are typically responsible for seed saving and sorting in Andean culture). When choosing seed, a woman will obviously select those with good production characteristics, but her deeply held sentiments of reciprocity will make her reluctant to "orphan" any variety, a belief that has facilitated the maintenance of unusually high levels of agrobiodiversity (Zimmerer found over 100 varieties in one field alone in his research in Paucartambo, located just east of the research site). Livestock are seen in a similar manner; Oliveira and Nunez (2000) explain that to Andean people, "animals are like them, they are peers, brothers, life companions."

Disease is seen as a manifestation of disharmony among man, animals, nature, and supernatural beings, all of which coexist in a unified reciprocal web of relationships (Greenway 1998, Oliveira and Nunez 2000, Zimmerer 1996). Zimmerer (1996) explains that damage to crops is often interpreted as punishment from Mother Earth, displeased with the failure to fulfill ritual obligations. In this sense, climate change can be understood as not just a meteorological phenomenon but a symptom of a larger problem- loss of balance in the world. When a Quechua person says they are concerned with illness, they are expressing concern over more than a

nagging cough or unexplained fever, but about the direction in which their lives are going. Their community, their way of life, is sick. Therefore, the frequent mention of illness, when analyzed together with other references that imply a loss of cosmological order serves to substantiate the hypothesis that climate change is being experienced as a phenomenon much more serious than a simple shift in weather patterns.

The link between weather and disease etiology is also informative. Exposure to extremes, especially cold, wind, and certain dangerous places are all considered sources for disease (Greenway 1998, Larme 1998). Exposure to cold, especially when it occurs after a rapid temperature shift or when combined with moisture is considered especially dangerous. Winds are often associated with more supernatural illnesses such as soul loss or fright (Allen 2002). Skin is understood to be porous and, in addition to other orifaces, considered to be permeable to ambient air (McKee 2003). Respondents specifically reported increases in cold weather and winds, and stressed the seriousness of the appearance of rains in the cold season. The emotional and physiological imbalances caused by these types of ailments can affect not only the human sufferer, but the well being of his or her crops, families, and animals (Greenway 1998).

Health is also associated with the consumption of salubrious traditional foods (Larme 1998). Although often valued for their associated prestige, mestizo foods are considered less healthy than diets based on traditional foods and rich in native tubers (Graham 2003). These foods nourish the blood and fat, which are considered the primary sources of energy and vitality. Lack of proper nutrition with traditional foods is frequently perceived as leaving one vulnerable to disease. Graham (2003) found that in one southern Peruvian indigenous community that migrants returning to their home villages after a season of mining work are often considered weak and thin precisely because of relying on a primarily mestizo diet when away from the home

village. Unfortunately, when faced with production shortfalls and population growth, as respondents in these communities have reported they are, incorporating mestizo foods into the diet is frequently necessary (Graham 2009). Indeed, upon the recommendation of my field assistant (a resident of one of the three communities visited) respondents were compensated for their time with sacks of rice and sugar, two foods unambiguously classed as non-traditional by nearly anyone's standards.

Although people mentioned significant decreases in agricultural production (both in quantity and quality) as well as storage problems, no one mentioned specifically problems of hunger or inability to meet their own consumption needs. However, this is not entirely surprising given my short period of time in the communities. Graham (2003) explains that in Andean communities, a woman's ability to stretch resources over the entire year is a trait held in high esteem. Any inability to adequately provision one's household with sustenance throughout the year is conversely seen as a sign of poor management and is hidden from both fellow community members (and presumably potentially gossipy visiting anthropologists) with the utmost secrecy. This desire for secrecy, however, runs deeper than protecting the pride of good household management skills. In a society where reciprocal exchange of labor is incredibly important to the sustainability of a household's production and laborers are paid in hearty traditional meals, running out of food supplies entails not only a few months of hunger but an inability to call on one's community for large labor projects. Graham (2003) describes how one woman who had been feeding herself and her family on flour thickened broth one day unearthed a hidden cache of potatoes in order to feed a work party. The woman implored her to keep it a secret, and the only reason that she had let her see the state of the family's food supplies was because she had proven herself trustworthy on a previous visit by not gossiping to the neighbors.

In Andean society, the use of opposites characterizes much of their daily life with the whole universe conceived of as consisting of pairs with inverse characteristics, a pattern that is easily observed in their local environment, in many ways a land of opposites. The year is divided into wet and dry, days are marked by striking diurnal variation with daily temperature swings, and one can travel from the most arid desert on the earth to frigid ice caps to the perpetually soaking Amazon in less than a few hundred miles. Foods are classified as hot and cold, and diseases are characterized as wet and dry (Bastien 1989). Just as the earth moves back and forth between opposites, in this way maintaining order and vitality, health is also maintained by keeping a balance between opposites (Kreimer 1990, Bastien 1989). For example, foods classified as "hot" (which does not have anything to do with their actual temperature; for example, hot soup is considered cold) should be eaten in the morning to warm people after the long and cold night as well as at night in preparation for more cold. People are considered especially vulnerable, for instance, when stepping outside before eating breakfast. Conversely, cool foods should be eaten during the warm day to maintain the proper balance in the body. McKee (2003) explains that the body's internal climate should be "*templado,*" interestingly the same word used by several respondents in describing the ideal weather in childhood. Bastien (1989:49) explains that "health is culturally perceived as a process of dynamic tension, like the arching movement of a pendulum, which guarantees its return…illness is stopping at concentration or dispersal." The mixing of the seasons, in addition to adversely affecting carefully scheduled agricultural tasks, represents a dangerous muddling of the inherently oppositional and dynamic nature of the universe that maintains health and balance of the natural and supernatural environment, including the health of respondents and their crops and livestock.

This understanding of health has clear implications for how problems of disease, imbalance, and climate change are understood and reacted to. In order to treat illness, one must address the cause of the larger imbalance existing in the relationships among man, nature, and the supernatural world. In the Andean universe, leaving one's home community is perhaps the worst thing one could do in response to an illness. Restoring balance might entail restoring one's reciprocal relationship with the earth, the spirits, or ones fellow community members. In any case, this process necessitates being at home. When referring to the earth, the concept is slightly different than that that might initially be assumed in Western culture, in which "returning to the land" might be understood as a reference to a return to nature in any place or form. In the Andean world, this reference to the earth is not a generic reference to the mountains, but to one's home specifically. The landscape is alive and unique to the local residents; peaks or *apus* are home to specific spirits which have supernatural powers. Leaving the homeland is often considered to be quite dangerous to one's health, especially traveling to the lowlands, and many stories exist depicting the consequences of those who left a community for one reason or another that serve as a warning for those who might consider such an alternative. Kreimer (1990) found that migrants to the city attributed illness to the earth and believed that the only cure was to return to one's own land, and breathe the air of that land. This could explain why, despite the many problems, respondents were so adamant in their commitment to remain in their home communities.

Furthermore, healers interviewed by Greenway (2003) in the indigenous Peruvian community of Mollomarca warn against greed, focusing one's economic activities outside the network of community reciprocity, and the simultaneously seductive and destructive power of technology and change. Many of the stories the healers would tell their patients involved

unfortunate souls who had left the community to find outside work and had fallen ill as a result. Several of the respondents who stated that they would not want to leave their home communities explained that those who had left were now returning, and one remarked that if she had to leave she would try to return soon and not be gone for longer than one year. Many of those who were staying reported either turning to textile production themselves or that their fellow community members were giving up agriculture in order to produce textiles. The selling of these traditional textiles to tourists has begun to turn into a productive enterprise, spurred along with the help of Asociación ANDES. Several respondents reported that they would like to make textiles, but could not afford the start-up capital. One of the more lucrative ways to make textiles is to participate in the weaving cooperative, where many women and men gather together to weave in the same open air courtyard which tourists can visit to watch the weavers in action. However, as my field assistant explained wistfully as we walked by, the fee for the weavers to participate is relatively hefty. Although the production of textiles is for tourists, it is considered traditional and it is possible that it is viewed as a more favorable alternative than either leaving the community or bringing in potentially destructive outside technology to facilitate agricultural production in new climate conditions. Both Wibbelsman (2005) and Bebbington (2000) describe the process of decision making regarding one's livelihood as the selection of certain priorities for which people are willing to compromise other aspects of their livelihoods in order to keep. According to Bebbington (1996a) the maintenance of indigenous identity frequently hinges upon corporate rural residence and not on the maintenance of indigenous technologies, although this obviously represents just one of many possible choices (and opinions) for indigenous people whose livelihoods are threatened by climate change.

With this understanding, it is not surprising that the majority of respondents, despite the many problems they are facing, would not consider leaving their homes. Greenway (1998) explains that "there is a blurring of the physical and spiritual and the past and the present that explain *runa*[7] identity and the existence of poverty, illness, and hunger among *runa*." The frequent mention of illness, lack of production, and lack of money can be understood within Quechua philosophy as all part of a connected problem that is clearly not purely physical in nature. Crandon-Malamud (1991) argues that making statements about health and illness is a way of asserting one's identity and making sense of what is going on around oneself. The relationship between health and climate change does not necessarily follow the typical Western understanding of cause and effect, in which climatic changes bring about new diseases; rather both are manifestations of the existence of a larger disharmony, intimately intertwined and inseparable cognitively. As one of Kelly's (2010) respondents explained: "The earth itself is sick."

Conclusions

This chapter has accomplished several goals. It summarized the respondents' perspectives of local climatic changes, its impacts on their lives, and how they are responding to it. In section two, these responses were analyzed qualitatively to support the hypothesis that Andean cosmological beliefs influence how the respondents are experiencing and conceptualizing climate change, and that this is affecting their responses. This hypothesis was able to explain some unexpected and unusual responses that recurred in the data, most notably somewhat cryptic responses to the sun, the frequent spontaneous mentioning of health, the

[7] Runa is the Quechua word for a fellow indigenous person. It is a value laden expression of cultural identity (Allen 2002)

unexpected absence of significant changes in agricultural strategies, and the strong desire to remain in their homes despite the significant problems facing the communities. All together, an understanding of Andean cosmological concepts concerning the functioning of the natural world and the human body provided an illuminating lens with which to understand decisions related to climate change adaptation in this setting.

CHAPTER 6: CONCLUSIONS

Inspired by the call for incorporating human values and perceptions in adaptation research, I designed this study to describe how residents from a particular set of communities in the rural Andes are experiencing climate change and how their understanding of the phenomenon affects their responses. Instead of taking the scientific knowledge of the climatic changes recorded in the region as a given fact and backdrop for a study of adaptation strategies, I adopted the notion of climate as more fluid and subjective, with its perception by community members as central to the main research objectives.

In the literature researchers are increasingly acknowledging that response to climate change cannot be understood without incorporating culture, worldview, and subjective emic perceptions of the environment. This contrasts with earlier studies that emphasize examining financial, technological, and social resources constraining responses. Although they provide many critical insights in themselves, studies such as these must not rest on the assumption that the people with whom they are working will respond predictably and share their perspective on the most important, efficient, and desirable strategies and outcomes. As many researchers have noted, different people have varying visions of their current and future lives that influence how they perceive their own personal efficacy, what they understand to be the ultimate root of the problem, what they believe to be the best solution, and what they are willing to sacrifice in order to solve their problem and achieve their goals.

Summary of findings

Analysis of results focused on how cosmological beliefs about the functioning of the natural world and the human body apparent in the text of interviews could facilitate understanding how Andeans conceptualize and, therefore, react to climate change. Several themes emerged. Firstly, respondents identified the most concerning climatic changes as more extremes in temperature, precipitation, and wind. Shifts in timing and decreasing predictability of climatic events important to scheduling of agricultural tasks- notably frosts and rains- were also of significant concern. This information was particularly interesting because of the marked absence of reliable climate data for the region of southern Peru. Besides a general drying trend, scientists have, as of yet, failed to identify any other definite shifts in climate patterns. This research, therefore, contributes important knowledge to the conditions and problems being experienced by local indigenous residents in this area.

Responses also provided insight into understandings about the structure and functioning of the Andean universe and how these understandings were potentially influencing behavior. In general, reports of changing weather patterns seemed to signify more than a just a shifting of climate patterns but a phenomenon of greater scale that has disrupted the balance of the larger world. This was evident both in more obvious descriptions (“It is like we are not in our own town anymore”) and more subtle references such as cosmological-religious significance of the observed changes.

However, the most unexpected and, in my view, interesting result was the frequent spontaneous mention of health problems and diseases for humans, crops, and livestock associated with changing climates. When these responses were analyzed in light of Andean cosmology, it seemed that the observed climate changes represented just one symptom of a

larger imbalance in the world that was also manifesting in diseases among the human and non human members of the local community. Appfel-Marglin and PRATEC (1998:31) explain that in the Andean world "the environment is not external, a distanced object of observation, rather it flows in and through the body. In the actions of seeing, smelling, eating, breathing, moving and so on, the body and the environment are changing, mutually affecting each other. Neither is a fixed, bounded entity."

Their responses thus far to climatic changes- namely a reduction in agricultural production in favor of textiles and an adamant desire to remain in their home communities despite the many problems they are facing – became more easily understood when these beliefs were taken into account. I hypothesize that in Andean cosmology the growing health problems can be understood as symptomatic of a larger loss of balance and world order, which can best be addressed by repairing reciprocal relationships among the individual, the community (including both human and non human inhabitants), and the land. This requires loyalty to one's community and traditional technologies.

The implications of this research are numerous. Firstly, it shows how values and worldview influence what is considered an acceptable adaptation strategy. It shows that residents' priorities may be different from what people expect. For instance, in these communities rural residence appears to take greater priority than maintaining traditional subsistence lifestyles. If researchers seek to facilitate adaptation in indigenous communities such as these, the first step of any project should be a detailed understanding of residents' goals grounded in an understanding the values and worldview underlying these decisions.

The research also emphasizes the importance of identifying the most pressing local concerns. While this research was initially conceptualized to identify agricultural problems, it

became obvious that worries about health were a very significant concern that could not be ignored. Any attempt to solve agricultural problems would likely be unsuccessful and wrought with confusion if the Andean notion of connection among the health of the land, people, crops, and animals was not understood, respected, and integrated.

Finally, responses seemed to indicate areas of mistrust and potential disconnect between scientists and indigenous populations. The implicit rejection of both short term and long term scientific climate forecasts as well as references to troublesome government meddling imply a distrust of outside intervention. Further research into beliefs surrounding use of scientific forecasts would likely be productive.

Avenues for future research

Although this research takes the perspective of a group of closely related communities, it is recognized that within any group of people differences of opinions will obviously exist. Adger et al (2009:338) explain "the values that underpin adaptation decisions become more diverse and contradictory as one moves from small-scales and single agents to larger-scales and multiple agents. Values in society are not held in isolation and are different for different stakeholders with levels of influence and power over their own destinies." A possible avenue for future research would be a closer examination of individual perspectives and potential conflicts of interest within communities that I did not get to examine in this particular research. Other researchers have found that increasing integration in market economies and contact with the outside world has produced many different ideas about what it means to be indigenous in the Andes. While some value market and migration opportunities and eagerly embrace certain aspects of Western culture (Brush and Guillet 1985, Wibbelsman 2005), others fiercely oppose it (Apffel-Marglin

and PRATEC 1998). These differences are often but not always split along gender or generational lines or between kin groups or communities (or often between indigenous people and the external organizations with whom they work) (Bebbington 1996b, Bebbington 2000). These values and livelihoods have changed within communities, households, and individuals in the past and will likely continue to change in the future (Valdivia and Quiroz 2001, Zimmerer 2002). If other research is any indication, it is quite likely that some of my respondents think that the cosmological beliefs of such importance in this study are a bunch of baloney, and it would be interesting to see how opinions might differ within and between communities.

The decisions that individuals must make about their beliefs, identity, and goals have important implications not only for themselves, but frequently the larger community of which they are a part. One of the factors that has allowed Andean farmers to persist in this marginal and harsh mountain environment for centuries is the cooperation that characterizes so many aspects of their reciprocal society. In patterns that have been noted in other mountain regions throughout the globe, livelihoods are enhanced and stabilized through communal management of resources and frequent exchange of reciprocal labor, especially for large time sensitive tasks that must be completed quickly. In this way, the classic community-centered way of life is dependent upon a threshold of cooperation below which a traditional subsistence way of life is not possible for anyone. In this way, the perception of a few individuals can reverberate strongly through an entire community In a region where many researchers believe that the traditional livelihoods based on farming and herding are seriously imperiled, how the conflicting goals and worldviews *within* communities impact the future of their residents would likely be quite interesting and relevant.

Another potentially fruitful avenue would be a more detailed study of how historical and contemporary relations shape perceptions of the environment and climate change. Although this research was focused on how elements of traditional cosmology impact understandings of climate change, this region, like many in the Andes, has a long history of straining colonial relationships, discrimination, and religious proselytization that has impacted worldview and identity. Miles and Leatherman (2003) explain that social and political relations are significant in informing understandings of the manifestation of health and disease as well as treatment. On a related note, Valdivia (2009) stated that one of the factors influencing how indigenous respondents discussed climate change was a conscious desire to be perceived by the researcher in a certain way; in his opinion as less indigenous and as more a part of Western, scientific culture. A deeper understanding of how indigenous understandings of climate change are affected consciously and unconsciously by past and present sociopolitical relationships would be informative.

Although the issue of climate change might initially seem to be a predominantly scientific problem, the causes, effects, and amelioration of climate change are all ultimately human problems (Crate 2008). Because culture frames the way people understand and experience the world, it affects how climate change is perceived, reacted to, and ultimately experienced by different populations (Roncoli, Crane, and Orlove 2008). This research confirms that anthropology, with its focus on cultural context and understanding local manifestations of global phenomena, is especially well poised to offer a number of important contributions to the field of human dimensions of climate change.

REFERENCES

Abercrombie, Thomas A.

1998 Pathways of Memory and Power: Ethnography and History: Ethnography and History Among an Andean People. Madison: University of Wisconsin Press.

Adger, W. Neil, Suraje Dessai, Marisa Goulden, Mike Hulme, Irene Lorenzoni, Donald R. Nelson, Lars Otto Naess, Johanna Wolf, and Anita Wreford

2009 Are there social limits to adaptation to climate change? Climatic Change 93(3-4):335-354.

Allen, Catherine J.

2002 The Hold Life Has: Coca and Cultural Identity in an Andean Community. Smithsonian Books: Washington

Apffel-Marglin, Frederique with PRATEC

1998 The Spirit of Regeneration: Andean Culture Confronting Western Notions of Development. Zed Books, LTD: London.

Argumedo, Alejandro and Michael Pimbert

2005 Traditional Resource Rights and Indigenous People in the Andes. Book/Report-International Institute for Environment and Deveopment <http://www.iied.org/pubs/pdfs/14504IIED.pdf>

Baker, Paul T.

1969 Human Adaptation to High Altitude. Science 163(3872):1149-1152.

Bastien, Joseph W.

1989 Differences between Kallawaya-Andean and Greek-European Humoral Theory. Social Science and Medicine 28(1):45-51.

Batterbury, Simon

2008 Anthropology and global warming: the need for environmental engagement. The Australian Journal of Anthropology 19(1):62-68

Bebbington, Anthony

1996a Organizations and Intensifications: Campesino Federations, Rural Livelihoods, and Agricultural Technology in the Andes and Amazonia. World Development 24(7):1161-1177.

1996b Movements, modernizations, and markets: indigenous organizations and agrarian strategies in Ecuador. Pp. 86-109. *In* Liberation Ecologies: Environment, Development, Social Movements. R. Peet and M. Watts, eds. Routledge: London

2000 Reencountering Development: Livelihood Transitions and Place Transformations in the Andes. Annals of the Association of American Geographers 90(3):495-520.

2001 Globalized Andes? Livelihoods, Landscapes, and Development. Cultural Geographies 8:414-436.

Beniston, Martin, Harald Bugmann, Paolo Burlando, Wilfried Haeberli, Benjamin Orlove, and Ellen Wiegandt

2004 Synthesis Report of the WENGEN-2004 Workshop. Mountain Glaciers and Society: Perception, Science, Impacts, and Policy. Wengen, Switzerland. October 6-8, 2004.

Beniston, M.

1994 Climate Scenarios for Mountain Regions: An overview of possible approaches. In Mountain Environments in Changing Climates. Martin Beniston (ed.) Pp. 136-152. London: Routledge.

Berman, Matthew and Gary Kofinas

2004 Hunting for models: grounded and rational choice approaches to analyzing effects on subsistence hunting in an Arctic community. Ecological Economics 49:31-46.

Bernard, H. Russell

2006 Research Methods in Anthropology: Qualitative and Quantitative Approaches. Lanham: Rowman & Littlefield Publishers, Inc.

Bjonness, Inger-Marie

1986 Mountain Hazard Perception and Risk-Avoiding Strategies among the Sherpas of Khumbu Himal, Nepal. Mountain Research and Development 6(4):277-292.

Boholm, Asa

2003 The cultural nature of risk: Can there be an anthropology of uncertainty? Ethnos: Journal of Anthropology 68(2):159-178.

Bolin, Inge

2008 The Glaciers of the Andes are Melting: Indigenous and Anthropological Knowledge Merge in Restoring Water Resources. In Anthropology and Climate Change: From Encounters to Action. Susan A. Crate and Mark Nuttall (eds.) Pp. 228-239. Walnut Creek, CA: Left Coast Press.

Bradley, R. S., M. Vuille, M. Diaz, and W. Vergara

2006 Climate Change: Threats to Water supplies in the Tropical Andes. Science 312:1755-1756.

Brookfield, Harold
1991 Research in the Mountains of the Island of New Guinea. Mountain Research and Development 11(3):203-211.

Brush, Stephen B.
2004 Farmers' Bounty: Locating Crop Diversity in the Contemporary World. New Haven: Yale University Press.

Brush, Stephen B. and David W. Guillet
1985 Small-Scale Agro-Pastoral Production in the Central Andes. Mountain Research and Development 5(1):19-30.

Byg, Anja and Jan Salick
2009 Local perspectives on a global phenomenon-Climate change in Eastern Tibetan villages. Global Environmental Change 19(2):156-166.

Campbell, B.C.
2006 Why is the Earth Tired? A Comparative Analysis of Agricultural Change and Intervention in Northern Ecuador. *In* Development with Identity: Community, Culture, and Sustainability in the Andes. Pp. 255- 270 Robert E. Rhoades, ed. CABI Publishing: Cambridge.

Childe, V. G.
1949 Social Worlds of Knowledge. London: Oxford University Press

1956 Society and Knowledge: the Growth of the Human Tradition. New York: Harper

Coscio, Pompeyo
2009 Personal communication. 7/20/2009. Cusco, Peru

Crandon-Malamud, Libbet
1991 From the Fat of Our Souls: Social Change, Political Process, and Medical Pluralism in Bolivia. Berkeley: University of California Press.

Crate, Susan A.
2008 Gone the Bull of Winter? Grappling with the Cultural Implications of and Anthropology's Role(s) in Global Climate Change. Current Anthropology 49(4):569-595.

Crate, Susan A. and Mark Nuttall
2008 Anthropology and Climate Change: from Encounters to Action. Walnut Creek, CA: Left Coast Press, Inc.

Cruikshank, Julie
2005 Do Glaciers Listen? Local Knowledge, Colonial Encounters, and Social Imagination. UBC Press: Vancouver.

Deere, Carmen Diana and Magdalena Leon
2001 Institutional Reform of Agriculture under Neoliberalism: The Impact of the Women's and Indigenous Movements. Latin American Research Review 36(2):31-63.

Dover, Robert V.H., Katharine E. Seibold, and John H. McDowell
1992 Andean Cosmologies through Time: Persistence and Emergence. Bloomington: Indiana University Press.

Duerden, Frank
2004 Translating Climate Change Impacts at the Community Level. Arctic 57(2):204-212.

Eakin, Hallie
2006 Weathering risk in rural Mexico: climatic, institutional, and economic change. Tucson: University of Arizona Press.

Fraser, Barbara
2009 Climate Change Equals Culture Change in the Andes. Scientific American. October 5, 2009.

Fraser, Barbara
2009 Altered climate forces cultural shift high in Andes. The Daily Climate. 5 October 2009 < http://wwwp.dailyclimate.org/tdc-newsroom/2009/10/altered-climate-forces-cultural-change-high-in>

Galvin, Kathleen A., Randall B. Boone, Nicole M. Smith, and Stacy J. Lynn
2001 Impacts of climate variability on East African pastoralists: linking social science and remote sensing. Climate Research 19:161-172

Graham, Margaret A.
2003 Food, health, and identity in a rural Andean community. Chapter 9 in Medical Pluralism in the Andes, pp. 148-165. Joan D. Koss-Chioino, Thomas Leatherman, and Christine Greenway (eds.). London: Routledge.

Greenway, Christine
1998 Hungry Earth and Vengeful Stars: Soul Loss and Identity in the Peruvian Andes. Social Science and Medicine 47(8):993-1004.

Grothmann, Torsten and Anthony Patt
2005 Adaptive capacity and human cognition: The process of individual adaptation to climate change. Global Environmental Change 15:199-213.

Haeberli, Wilfried
2007 Changing views of Changing Glaciers. In Darkening Peaks: Glacier Retreat, Science, and Society. Pp. 23-32. Ben Orlove, Ellen Wiegandt, and Brian H. Luckman (eds.). Berkeley and Los Angeles: University of California Press.

Hassan, Fekri
2000 Environmental Perception and Human Responses in History and Prehistory. Pp. 121-140 in The Way the Wind Blows: Climate, History, and Human Action. R. J. McINtosh, J.A. Tainter, and S. K. McIntosh (eds.) New York: Columbia University Press.

Hellin, Jon and Sophie Higman
2005 Crop diversity and livelihood security in the Andes. Development in Practice 15(2):165-174.

Hulme, Mike, Suraje Dessai, Irene Lorenzoni, and Donald R. Nelson
2009 Unstable climates: Exploring the statistical and social constructions of 'normal'climate. Geoforum 40(2):197-206.

Hulme, Mike
2009 Why We Disagree About Climate Change: Understanding Controversy, Inaction, and Opportunity. Cambridge: Cambridge University Press.

Ives, Jack D., Bruno Messerli, and Ernst Spiess
1997 Mountains of the World- A Global Priority. Chapter 1 in Mountains of the world: a global priority pp. 1-15. Bruno Messerli and Jack Ives (eds.) New York: The Parthenon Publishing Group, Inc.

Jones, Peter G. and Philip K. Thornton
2003 The potential impacts of climate change on maize production in Africa and Latin America in 2055. Global Environmental Change 13:51-59.

Kahneman, Daniel and Amos Tversky
1979 Prospect theory: An analysis of decision under risk. Econometrica 47(2):263-291.

Kates, Robert W.
2000 Cautionary Tales: Adaptation and the Global Poor. Climatic Change 45(1):5-17.

Keil, Alwin, Manfred Zeller, Anastasia Wida, Bunasor Sanim, and Virginia Birner
2008 What determines farmers' resilience towards ENSO-related drought? An empirical assessment in Central Sulawesi, Indonesia. Climatic Change 86:291-307.

Kelly, Annie
2010 Peru's mountain people face fight for survival in a bitter winter. The Guardian 3 January 2010. < http://www.guardian.co.uk/world/2010/jan/03/peru-mountain-farmers-winter-cold>

Koss-Chioino, Joan D., Thomas Leatherman, and Christine Greenway (eds.)
2003 Medical Pluralism in the Andes. London: Routledge.

Kreimer, E.
1990 An Andean view of history and a strategy of cultural survival. In Por las rutas de nuestra America. Universidad Nacional de Bogota. Bogata.

Kruse, J.A., R.G. White, H.E. Epstein, B. Archie, M. Berman, S.R. Braund, I. Chapin, F. Stuart, J. Charlie, Sr., C. J. Daniel, J. Eamer, N. Flanders, B. Griffith, S. Haley, L. Huskey, B. Joseph, D. R. Klein, G. P. Kofinas, S. M. Martin, S. M. Murphy, W. Nebesky, C. Nicolson, D. E. Russell, J. Tetlichi, A. Tussing, M. D. Walker, and O. R. Young.
2004 Modeling sustainability of Arctic communities: An interdisciplinary collaboration of researchers and local knowledge holders. *Ecosystems* 7:815-828.

Krupnik, Igor and Dyanna Jolly (eds.)
2002 The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change. Fairbanks: Arctic Research Consortium of the United States.

Larme, Anne C.
1998 Environment, Vulnerability, and Gender in Andean Ethnomedicine. Social Science and Medicine 47(8):1005-1015.

Leiserowitz, Anthony
2006 Climate Change risk perception and policy preferences: the role of affect, imagery, and values. Climatic Change 77:45-72.

Lindsay, S.W. and W.J.M. Martens
1998 Malaria in the African highlands: past, present, and future. Bulletin of the World Health Organization 76(1):33-45.

Maxwell, Joseph A.
2005 Qualitative Research Design: An Interactive Approach. Thousand Oaks: Sage Publications.

McCarthy, J.J., O. Canziani, N.A. Leary, D.J. Dokken, K.S. White (eds)
2001 Climate Change 2001: impacts, adaptation, and vulnerability. IPCC working group II. Cambridge University Press, Cambridge.

McKee, Lauris A.
2003 Ethnomedicine and enculturation in the Andes of Ecuador. Chapter 8 in in Medical Pluralism in the Andes, pp. 131-147. Joan D. Koss-Chioino, Thomas Leatherman, and Christine Greenway (eds.). London: Routledge.

Mertz, Ole, Kristen Halsnaes, and Jorgen E. Olesen
2009 Adaptation to Climate Change in Developing Countries. Environmental Management 43:743-752.

Meze-Hausken, Elisabeth
2004 Contrasting climate variability and meteorological drought with perceived drought and climate change in northern Ethiopia. Climate Research 27:19-31.

Miles, Ann and Thomas Leatherman
2003 Perspectives on medical anthropology in the Andes. Chapter 1 in Medical Pluralism in the Andes, pp.3-15. Joan D. Koss-Chioino, Thomas Leatherman, and Christine Greenway (eds.). London: Routledge.

Nelson, Donald R. and Timothy J. Finan
2008 Weak Winters: Dynamic decision-Making in the Face of Extended Drought In Northeast Brazil. Chaper 6 in The Political Economy of Hazards and Disasters. EC Jones, AD Murphy (eds.) Walnut Creek, CA:AltaMira. In press

2009 Praying for Drought: Persistent Vulnerability and the Politics of Patronage in CearA, Northeast Brazil. American Anthropologist 111(3):302-316.

Netting, Robert McC.
1993 Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture. Palo Alto, CA: Stanford University Press.

O'Brien, Karen L.
2009 Do values subjectively define the limits to climate change adaptation? Pp. 164-180 In Adapting to Climate Change: Thresholds, Values, Governance. W. Neil Adger, Irene Lorenzoni, and Karen L. O'Brien (eds) Cambridge: Cambridge University Press.

Ogilvie, Astrid E. J. and Gisli Palsson
2003 Mood, Magic, and Metaphor: Allusions to Weather and Climate in the Sagas of the Icelanders. *In* Weather, Climate, Culture. Pp. 251-274. Sarah Strauss and Ben Orlove, eds. Berg: Oxford.

Oliver-Smith, Anthony
1996 Anthropological Research on Hazards and Disasters. Annual Review of Anthropology 25:303-328.

Oliveira, Edgar and Emma Nuñez
2000 Animal health practices in the Andes. COMPAS Newsletter- July 2000 < http://www.docstoc.com/docs/28485332/Animal-health-practices-in-The-Andes>

Oppenheimer, M. and A. Todorov
2006 Global Warming: The Psychology of Long Term Risk, Guest Editorial. Climatic Change 77:1-6.

Orlove, Benjamin
2010 Decision Making under the Impact of Glacial Retreat among residents of Vulnerable Zones: Perception of and Response to Climate Change. National Science Foundation (NSF SES 0345840) http://www.cred.columbia.edu/research/projects/glacialretreat/

Orlove, Benjamin, John C.H. Chiang, and Mark A. Cane
2002 Ethnoclimatology in the Andes. American Scientist 90:428-435.

Orlove, Ben, Ellen Wiegandt, and Brian H. Luckman
2007 The Place of Glaciers in Natural and Cultural Landscapes. *In* Darkening Peaks: Glacier Retreat, Science, and Society. Pp. 3-19 Ben Orlove, Ellen Wiegandt, and Brian H. Luckman, eds. University of California Press: Berkeley.

Parish, R. and D.C. Funnell
1999 Climate change in mountain regions: some possible consequences in the Moroccan High Atlas. Global Environmental Change 9:45-58.

Postigo, Julio C., Kenneth R. Young, and Kelley A. Crews
2008 Change and Continuity in a Pastoralist Community in the High Peruvian Andes. Human Ecology 36:535-551.

Price, M.F.
1994 Should mountain communities be concerned about climate change? In Mountain Environments in Changing Climates. Martin Beniston (ed.) Pp. 431-451. London: Routledge.

Rai, Sandeep Chamling and Aarati Gurung
2005 Raising Awareness of the Impacts of Climate Change: Initial steps in Shaping Policy in Nepal. Mountain Research and Development 25(4):316-320.

Rayner, Steve
2003 Domesticating Nature: Commentary on the Anthropological Study of Weather and Climate Discourse. *In* Weather, Climate, Culture. Pp. 277-290. Sarah Strauss and Ben Orlove, eds. Berg: Oxford.

Rhoades, Robert E.
2005 Development with Identity: Community, Culture, and Sustainability in the Andes. CABI Publishing: Wallingford.

Rhoades, Robert E., Xavier Zapata Rios, and Jenny Aragundy
2006 Climate Change in Cotacachi. *In* Development with Identity: Community, Culture, and Sustainability in the Andes. Pp.64-74. Robert E. Rhoades, ed. CABI Publishing: Cambridge.

Rhoades, Robert E., Xavier Zapata Rios, and Jenny Aragundy Ochoa
2007 Mama Cotacachi. *In* Darkening Peaks: Glacier Retreat, Science, and Society. Pp. 216-225. Ben Orlove, Ellen Wiegandt, and Brian H. Luckman, eds. University of California Press: Berkeley.

Rhoades, Robert E. and Stephen I. Thompson
1975 Adaptive Strategies in Alpine Environments: Beyond Ecological Particularism. American Ethnologist 2(3):535-551.

Rivera, Julio Valladolid
1998 Andean Peasant Agriculture: Nurturing a Diversity of Life in the *Chacra. In* The Spirit of Regeneration. Pp.51-88. Frederique Apffel-Marglin with PRATEC (eds). Zed Books: London.

Roncoli, Carla
2006 Ethnographic and participatory approaches to research on farmers' responses to climate predictions. Climate Research 33:81-99.

Roncoli, Carla, Todd Crane, and Ben Orlove
2008 Fielding Climate Change in Cultural Anthropology. Chapter 3 in Anthropology and Climate Change: From Encounters to Actions. Susan A. Crate and Mark Nutall (eds.). Walnut Creek, CA: Left Coast Press, Inc.

Salick, Jan and Anja Byg (eds.)
2007 Indigenous Peoples and Climate Change. A Tyndall centre Publication. Tyndall Centre for Climate Change Research: Oxford.

Salzmann, N., C. Huggel, P. Calanca, A. Diaz, T. Jonas, C. Jurt, T. Konzelmann, P. Lagos, M. Rohrer, W. Silverio, and M. Zappa
2009 Integrated assessment and adaptation to climate change impacts in the Peruvian Andes. Advances in Geosciences 22:35-39.

Schmuck, H.
2000 An act of Allah: religious explanations for floods in Bangladesh as survival strategy. International Journal of Mass Emergencies and Disasters 18(1):85-95.

Sillitoe, Paul
1996 A Place Against Time: Land and Environment in the Papua New Guinea Highlands. Harwood Academic Publishers: Amsterdam.

Slingo, Julia M., Andrew J. Challinor, Brian J. Hoskins, Timothy R. Wheeler
2005 Introduction: Food Crops in a Changing Climate. Philosophical Transactions: Biological Sciences, 360(1463):1983-1989.

Slovic, Paul
1987 Perception of Risk. Science 236(4799):280-285.

Steinberg, Jonah
ND Intangible Ecologies: Sacred Mountain Landscapes in a Changing Climate. Sacred Mountains Program, The Mountain Institute. http://www2.mtnforum.org/oldocs/1081.pdf

Stoorvogel, J.J., J.M. Antle, and C.C. Crissman
2004 Trade-off analysis in the Northern Andes to study the dynamics in agricultural land use. Journal of Environmental Management 72:23-33.

Strauss, Sarah and Ben Orlove
2003 Up in the Air: The Anthropology of Weather and Climate. *In* Weather, Climate, Culture. Pp. 3-14. Sarah Strauss and Ben Orlove, eds. Berg: Oxford.

Strauss, Sarah and Benjamin S. Orlove (eds.)
2003 Weather, Climate, Culture. Oxford: Berg.

Tapia, Mario E. and Ana De la Torre
1998 Women Farmers and Andean Seeds. Rome: International Plant Genetic Resources Institute. <http://www.fao.org/SD/nrm/WomenFarmers.pdf>

Trigger, Bruce
2008 A History of Archaeological Thought. Cambridge: Cambridge University Press.

Turner, Nancy J., Cheryl Brooks, Lee Failing, and Terre Satterfield
2008 From invisibility to Transparency: Identifying the Implications. Ecology and Society 13(2):7[online]

Urton, Gary
1981 At the Crossroads of the Earth and the Sky: An Andean Cosmology. Austin: University of Texas Press.

U.S. Department of State
2010 Background Notes: Peru. Bureau of Western Hemisphere Affairs <http://www.state.gov/r/pa/ei/bgn/35762.htm>

Valdivia, Corinne and Roberto Quiroz
2001 Rural Livelihood Strategies, Assets, and Economic Portfolios in Coping with Climatic Perturbations: A Case Study of the Bolivian Andes. Paper presented at the Social Organization and Land Management Session, Integrated Natural Resource Management for Sustainable Agriculture Forestry and Fisheries 28-31 August, CIAT, Cali Columbia.

Valvia, Gustavo
2009 Personal communication, 24 July 2009. Cusco, Peru.

Vasquez, Grimaldo Rangifo
1998 The Ayllu. *In* The Spirit of Regeneration. Pp.89-123. Frederique Apffel-Marglin with PRATEC (eds). Zed Books: London.

Vedwan, Neerah
2006 Culture, Climate and the Environment: Local Knowledge and Perception of Climate Change among Apple Growers in Northwestern India. Journal of Ecological Anthropology 10:4-18.

Vedwan, Neerah and Robert E. Rhoades
2001 climate change in the Western Himalayas of India: a study of local perception and response. Climate Research 19:109-117.

Vergara, Walter, Alejandro Deeb, Adriana Valencia, Seraphine Haeussling, Alonso Zarzar, Raymond S. Bradley, and Bernard Francou
ND The Potential Consequences of Rapid Glacier Retreat in the Northern Andes. LCR Sustainable Development Working Paper #32. World Bank.

Vuille, Mathiaas, Raymond S. Bradley, Martin Werner, and Frank Keimig
2003 20th Century Climate Change in the Tropical Andes: Observations and Model results. Climatic Change 59:75-99.

West, Colin Thor and Marcela Vasquez-Leon
2003 Testing Farmers Perceptions of Climate Variability: A Case Study from the Sulphur Springs Valley, Arizona. Chapter 13 in Weather, Climate, Culture, Pp. 233-250. Sarah Strauss and Benjamin S. Orlove (eds.) Oxford: Berg.

Wibbelsman, Michelle
2005 Otavalenos at the Crossroads: Physical and Metaphysical Coordinates of an Indigenous World. Journal of Latin American Anthropology 10(1): 151-185.

Wolf, Johanna, Irene Lorenzoni, Roger Few, Vanessa Abrahamson, and Rosalind Raine
2009 Conceptual and practical barriers to adaptation: vulnerability and responses to heat waves in the UK. Pp. 181-196 in Adapting to Cliamte Change: Thresholds, Values, Governance. W. Neil Adger, Irene Lorenzoni, and Karen L. O'Brien (eds). Cambridge: Cambridge University Press.

World Bank
2005 Opportunities for All: Peru Poverty Assessment. Report No. 29825-PE. <http://irispublic.worldbank.org/85257559006C22E9/All+Documents/85257559006C22E98525715B004B489C/$File/PeruPovertyAssessment2006.pdf >

Young, Kenneth R.
2002 Minding the Children: Knowledge Transfer and the future of Sustainable Agriculture. Conservation Biology 16(4):855-856.

Young, Kenneth R. and Jennifer K. Lipton
2006 Adaptive governance and climate change in the tropical highlands of western South America. Climatic Change 78:63-102.

Zimmerer, Karl S.
1991 Wetland Production and Smallholder Persistence: Agricultural Change in a Highland Peruvian Region. Annals of the Association of American Geographers. 81(3):443-463.

1996 Changing Fortunes: Biodiversity and Peasant Livelihoods in the Peruvian Andes. University of California Press: Berkeley.

2002 Common Field Agriculture as a Cultural Landscape of Latin America: Development and History in the Geographical Customs of Resources Use. Journal of Culutral Geography 19(2):37-63.

Zuiderma, R. Tom
1992 Inca Cosmos in Andean Context: From the Perspective of the capac Raymi Camay Quilla Feast Celebrating the December Solstice in Cuzco. Chapter 2 in Andean Cosmologies through Time Pp.17-45. Robert V.H. Dover, Katharine E. Seibold, John H. Mcdowell (eds). Bloomington: Indiana University Press.

APPENDIX A: SEMI-STRUCTURED INTERVIEW QUESTIONS

Personal Information

1. Gender
2. Age

Perceptions of Climate Change

1. How is the climate changing?
2. For how long has the climate been changing?
3. For how much longer do you think the climate will change?
4. Where do you get information about climate change?
5. Why do you think the climate is changing?
6. Would you want to move to another place because of climate change?
7. Have you changed your agricultural strategies because of climate change?
8. Do you worry about climate change?
9. Do you think there are problems more serious than climate change?