Echando la Culpa: Social Barriers to Climate Change Adaptation in Peru's Río Santa Basin

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For my aunt, Tina Thacker

When you change the way you look at things, the things you look at change.

-Wayne Dyer

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It is certainly hard to believe that nearly two years have passed since I first stepped off a bus in Huaraz, Ancash, Peru in search of adventure and purpose. This thesis is a bi-product of my experiences, but was only made possible through the support of a loving and encouraging network of friends to whom I owe a great deal of thanks. To my colleagues at Instituto de Montaña - Doris, Anaïs, Vidal, Lucho, Antonio, Fidél, Juancito, Irina, Edson, and Laura - for taking me under your wings and always making me feel at home; Dr. Jorge Recharte, for taking a chance on an ambitious undergraduate - it has meant more to me than you will ever know; Dr. Patricia Hammer and Pocha, for your guidance and introducing me to PAR methodology; Yachatsiqkuna, César Vargas Arce and Martín León Huarac, for showing me the difference between *alli kaway* (to live well) and *shumaq kaway* (to live better). Also, a special thanks to the engineers at ANA, ALA, and UGRH, officials from Parque Nacional Huascarán, professors in the Department of Environmental Science at UNASAM, and the many other individuals who took the time to share their perspectives on water, governance, and society in the Río Santa Basin.

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ABSTRACT

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Climate change affects a variety of natural resources, but its impact on water availability warrants the most concern. This issue highlights that systems developed to allocate water resources have a low capacity to adapt to shifts in hydrological regimes. Variations in water availability are most pressing in low-lying geographical areas surrounding the Peruvian glaciated mountain range, the *Cordillera Blanca*, where subsistence agriculture, hydro-electric projects, and coastal commercial farms compete for seemingly dwindling hydrological resources. In spite of documented glacial retreat and increasingly unpredictable seasonal rains, do popular claims of physical scarcity reflect the reality of water availability in this Andean basin? Do all actors view scarcity in the same way? How do contradicting views of the origin and legitimacy of scarcity impede adaptation measures in preparing for an envisioned future with significantly less water? These questions are addressed in the present study through qualitative research methods, particularly semi-structured interviews that were conducted (n = 28) highlighting perceptions of root causes of scarcity among actors in the Río Santa Basin. Interview data were analyzed collectively, allowing participants to be categorized into discourse coalitions based on expressed notions of causality of scarcity and recommendations for future adaptation policy. Inconsistencies and contradictions were highlighted among these expressed perceptions of participants, resulting in the identification of two distinct discourse coalitions. One group insisted scarcity is a purely natural phenomenon, while the other claimed it to be rooted in human activities.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

ALA	*Autoridad Local del Agua* (Local Water Authority)
AMS	American Meteorological Society
ANA	*Autoridad Nacional del Agua* (National Water Authority)
DRA	*Dirección Regional de Agricultura* (Regional Department of Agriculture)
DRS	*Dirección Regional de Salud* (Regional Department of Health)
INAIGEM	*Instituto Nacional de Investigación en Glaciares y Ecostistemas de Montaña* (National Research Institute of Glaciers and Mountain Ecosystems)
IPCC	Inter-Governmental Panel on Climate Change
JUCH	*Junta de Usuarios – Callejón de Huaylas* (Irrigation Board of the *Callejón de Huaylas*)
LRH	*Ley de Recursos Hídricos* (Peru's Law of Hydrological Resources)
MINAM	*Ministerio del Ambiente* (Peruvian Ministry of the Environment)
NGO	Non-governmental organization
PNH	*Parque Nacional Huascarán* (Huascarán National Park)
SERNAN-P	*Servicio Nacional de Áreas Naturales Protegidas por el Estado* (National Service of Protected Natural Areas by the State)
TARN	Transdisciplinary Andean Research Network
UGRH	*Unidad de Glaciología y Recursos Hídricos* (Unit of Glaciology and Hydrological Resources)
UNCCC	United Nations Convention on Climate Change

LIST OF FIGURES

INTRODUCTION

The auditorium in Huaraz's municipal theater was limited to standing room only. A buzz of excitement filled the air as if something truly monumental were about to take place. Local politicians, European climber-scientists, the Regional President, as well as representatives from the Peruvian Ministry of the Environment were all present among the large crowd for the official inauguration of INAIGEM, Peru's National Research Institute of Glaciers and Mountain Ecosystems. With the mission of expanding scientific knowledge in these fields of natural science for the promotion of sustainable development, INAIGEM was soon to join the ranks of a complex social network of state entities, advocacy groups, economic enterprises, and rural farmers that represent the diverse interests in the water resources of a shared Andean basin.

Unlike a typical watershed, streamflow in the Río Santa is dependent on high-altitude glaciers in providing stable, year-round supplies. Concerns over observed glacial retreat result in added elements of tension surrounding any events related to water resources. This was certainly the case at the inaugural ceremony as opening speeches by policy-makers and the institute's leaders emphasized the importance of INAIGEM in the national "fight" against climate change and overcoming water scarcity. The fervor surrounding the hot topic of water seemed strangely oxymoronic. How can scarcity exist in a context of melting glaciers? This study is an attempt to understand the ostensible paradoxes that characterize human-environment relationships in Peru's Río Santa Basin.

The idea of water scarcity permeates discourse on a variety of social levels within the Río Santa watershed. From casual conversations with rural subsistence farmers to the rhetoric of political candidates, nearly all oral communication is saturated with the theme of water scarcity. Given that glacial mass has reduced by

some 30% over the last century, effectively altering melt-off contribution to local water supplies (Georges, 2004; Mark and Seltzer, 2003) how important are physical changes in water availability in constituting physical water scarcity? Additionally, research suggests that this particular section of high-altitude tropical glaciers will provide continually diminishing discharge for the Río Santa Basin, highlighting the importance of the local population to adapt to this new hydrological reality. Can adaptation action be impeded by differing notions of the root drivers of water scarcity? Furthermore, can these contradicting understandings and their socio-political implications be identified?

The aim of this study is to shed light on a relatively unexplored yet integral component of scarcity and water management: the thoughts and voices of people. Although the natural sciences offer important insight on the interdependence among natural processes of the water cycle, a purely qualitative scope fails to incorporate the varied ways in which human activities and social networks impact water availability and, in turn, can serve as agents of scarcity (Bury, et al., 2013; Carey, et al., 2014). Offering insight on a missing piece of quantitative hydrological models, this paper illuminates how perceptions of water scarcity in a climate change context pose challenges for effective adaptation planning.

The Canary in the Coal Mine: The Santa Basin in the Context of Global Climate Change

The aim of this project is not to enter the debate over human's capacity to irreversibly alter the global climate. Irrespective of one's position in this argument, shifts in ecological systems are well documented (AMS, 2014; IPCC, 2014; Stern, 2007). Disagreements over the source of these environmental changes and the human role therein should not obscure the importance of promoting societies capable of adapting to variations in resource availability. As is the case of the Río Santa Basin,

contradicting perceptions of the underlying drivers of scarcity may work to impede resiliency of water management systems tied to an increasingly stressed hydrological regime (Bryan, 2010; Bury, et al., 2010). To comprehend the importance of identifying social barriers to adaptation, it is first necessary to contextualize this seemingly local issue of water availability within the global phenomenon of climate change.

Science is clear that the planet's climate and ecological systems are shifting, leading a number of nations to adopt preemptive policies that address the growing concerns of projected scenarios (AMS, 2014; IPCC, 2014; Stern, 2007). The Intergovernmental Panel on Climate Change (IPCC), a group composed of the world's leading natural scientists, has worked to foster international collaboration in mitigating climate change impacts on livelihoods. Formed in 1988, the IPCC's mission is to generate accurate research that informs adaptation planning on the global, national, and local levels (IPCC, 2016). The panel's research and recommendations are disseminated through assessment reports, with the most recent, Assessment Report 5, *Climate Change 2014: Impacts, Adaptation, and Vulnerability* published in 2014 (IPCC, 2014).

In addition to providing these sources addressing climate change's coupled natural and social implications, the group also works to promote concerted efforts of mitigation and adaptation through orchestrating transnational climate treaties. An exemplary result of the panel's efforts at organizing various national bodies for action was the United Nations' proposal of the Kyoto Protocol. Adopted in 1997, the goal of this treaty was to achieve the joint reduction of emissions linked to promoting the process of global warming (UNCCC, 2014). These efforts on the international stage reinforce the idea that climate change is not an anomaly, but a slow-onset natural

disaster that transcends geo-political boundaries. As suggested by the IPCC's work, it will require a multinational effort to forge viable solutions to this global problem. These efforts to foster collaboration underscore the growing sense of urgency to take action while also working to legitimize the rise in concern for a critical global issue.

The American Meteorological Society, or AMS, is another credible source of information on the behavior of the global climate system (AMS, 2015). This scientific conglomerate produces, "State of the Climate," an annual briefing on observations of the multitude of climate parameters that the society's affiliates monitor such as ocean levels, average global temperatures, atmospheric chemical composition, and glacier retreat among others. The most current publication is laden with new records in several fields. These include the nominally highest annual global surface temperature in the last 135 years and the highest globally averaged sea surface temperature to date. In addition, the report also highlights trends of regional and localized drought and decreased global terrestrial precipitation (AMS, 2015). These statistics generate serious concern within the scientific community, but often lack the degree of tangibility necessary to effect change in policy and public opinion. Nevertheless, recent water crises in developed regions such as southwestern United States and southeast Brazil have forced the general public to begin considering how climate change may impact their respective regions in the future (Davis & Chornesky, 2014; Haglund, 2014).

In addition to environmentally-oriented impacts, an exponential rate of population growth compounds existent pressure on natural resources such as water. Projections estimate global population will reach 10 billion individuals by 2056, a 35% increase from the current 7.4 billion (Bloom, 2016). This expansion raises concern over physical space for settlement in addition to uncertainties of how policy

should address the increased demand for food, sanitary services, and efficient potable water distribution. This scenario is especially alarming considering that 99% of growth will occur in developing countries that already find themselves at an adaptive disadvantage when compared to nations with ample economic resources, stable governments, and relatively sound infrastructure (Bloom, 2016). Obviously important for the primary use of human consumption, water is also an integral component in food production, energy generation, and manufacturing of everyday goods. Playing a vital role in countless human activities, water is the natural resource that will receive the most pressure from coupled population growth and climate change (Chebly, 2014). Therefore, it is essential to remain vigilant of the integrity of the greater water cycle. As hydrologist Michal Kravcik (2007) suggests, the collective neglect of water resources through contamination and excessive extraction will ultimately lead to the compromise of the hydrological cycle, resulting in a crisis for a booming population (as cited in Barlow, 2008).

Similar to climate science, it is equally important to note that population projections should not be mistaken for predictions as they embody varying degrees of uncertainty. Taagepera (2014) asserts that identifying a single limiting factor in population growth and accounting for dramatic spurts and declines are outside the scope of current models. Falling short of absolute accuracy should not discourage efforts to understand the implications of projected situations for both climate change and population growth. It is important to contemplate the capacity of current policy to handle the challenges of plausible future scenarios and identify shortcomings in services and resources within the context of both environmental and social change. To reiterate, the aim of this thesis is not to focus on climate science. Interpreting the conclusions of reports by the IPCC and AMS are essential in providing the necessary

context for why water management in the Río Santa Basin matters for the world. Additionally, juxtaposing rising human pressure on water resources with emerging trends of drought provides the appropriate lens through which to view water scarcity for the multi-dimensional complexity that it embodies as a coupled human-environmental issue (Carey, et al., 2014; Gleick, 2014).

A Look into the Local: A Short Ethnography of Water:

As in any given area of the world, demands for hydrological resources within a single watershed can be quite diverse. There are a variety of stakeholders that influence water's path by their distinct use and need of the resource. In the Río Santa Basin, demands range from the local, national, and global levels, providing additional layers of complexity to this "hydro-social" system (Carey, et al., 2013). The goal of this chapter is not to provide an exhaustive list of basin-wide water uses. Rather, the aim is to provide a socio-geographical context through which the diverse path and uses of water may be better understood. Mattias Rasmussen's, "Andean Waterways: Resource Politics in Highland Peru" (2015), Paul Trawick's "The Struggle for Water in Peru: Comedy and Tragedy in the Andean Commons" (2002) and María Teresa Oré's "Water, the Common Good and Private Use: Irrigation, State and Conflicts in the *La Achirana del Inca*" (2006) provide more complete insight on the intersection of Andean society and water.

Water is life. It is not a resource reserved for an exclusive set of uses, but a vital component of nearly every human activity imaginable. What distinguishes the Río Santa Basin from other watersheds is its premier geographical feature: the *Cordillera Blanca* or, the White Mountain Range, a name derived from its succession of glaciated peaks. Approximately 99% of the planet's high-altitude tropical glaciers are found within the Andean regions of Venezuela, Colombia, Ecuador, Peru,

Argentina, and Chile. Seventy-one percent of Peru's total glacial mass resides in the *Cordillera Blanca*, making it the most densely glaciated mountain range in the tropical latitudes.

This glaciated expanse of the Peruvian Andes plays the integral role of maintaining regional water availability in surrounding low-lying areas during the dry season months of May through September, when roughly .2% of total annual precipitation is received between the winter months of June and August. (MINAM, 2014). Glacial melt-off and precipitation are stored in glacial lakes and high-altitude wetlands known locally as *bofedales.* These sources of water contribute to mountain streams, providing a consistent flow that may vary in level between the dry and wet seasons. Rather than transition from ice to a readily available resource, water passes through the sponge-like wetlands that play the important function of regulating both quantity and quality as they perform the dual service of bio-remediation and regulation of discharge (Garcia and Otto, 2015).

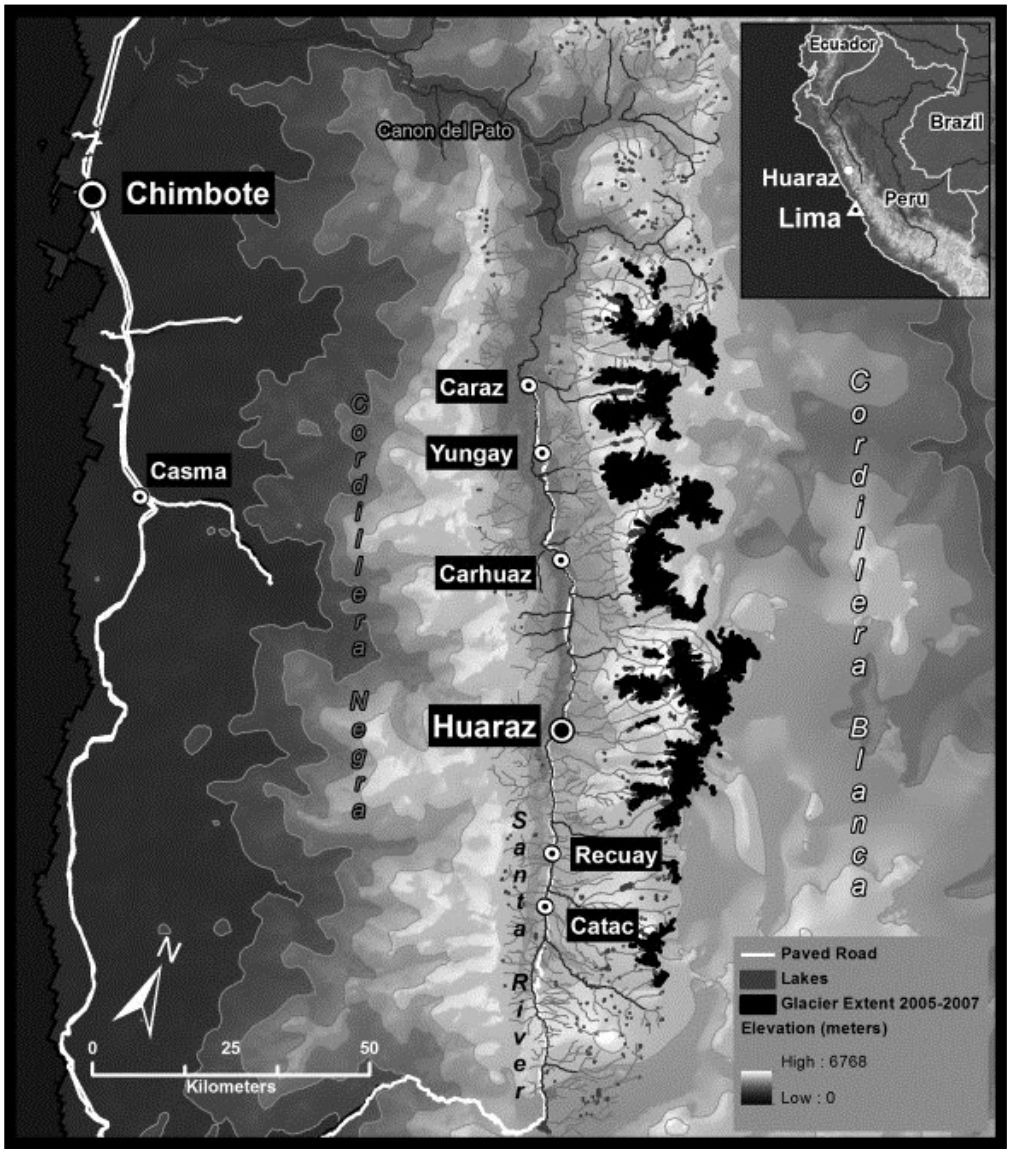

Figure 1: Geographic map of the Río Santa Basin. Source: Carey, French, & O'Brien, 2012

Figure 2. A Viewing of the southern *Cordillera Blanca*. Source: Photograph by Samuel Hulsey.

The official headwaters of the Río Santa originate from the glacial lake *Conococha*, residing at some 4,050 meters above sea-level. Running parallel to the *Cordillera Blanca* and crossing the river lies the *Cordillera Negra* or, the Black Mountain Range. Contrary to its counterpart the *Cordillera Negra* is void of glaciers, procuring its water stores through natural springs and precipitation during the wet season when the region receives roughly 60% of the total annual rainfall between the months of December and March (MINAM, 2014). Eastern-flowing streams of the *Cordillera Negra* and western-bound tributaries of the *Cordillera Blanca* converge at the bottom of the valley forming the Río Santa, Peru's second largest Pacific flowing river. Glacial discharge from the eastern-lying *Cordillera Blanca* contributes to the Santa as far north as the town of Caraz, where the waterway cuts north-west through the *Cordillera Negra*. The river then drops down through arid coastal foothills as it meanders towards the Pacific. The upper-section of the Río Santa Basin between the

headwaters and the point at which the river veers to the north-west is known as the *Callejón de Huaylas*. "Upper-basin" and "*Callejón de Huaylas*" are used interchangeably to refer to this specific section while the term "lower-basin" refers to the point in which the river heads towards the arid coast at the site known as *Cañón del Pato*. "Río Santa Basin," however is intended to refer to the entire watershed and the river collectively.

Water resources within the Río Santa Basin serve a variety of purposes during their journey from glacial origins to crossing the hydrological "finish line" on the coast. As discharge from glacial lakes, high-altitude wetlands, and seasonal rains make their way into mountain tributaries and subterranean aquifers, water is first utilized in highland subsistence agriculture irrigation. The fertile soil of the basin has proved productive for centuries of agriculture, spanning far earlier than the arrival of the Spanish in 1532. Although contemporary rural farming practices are mere -

Figure 3. Traditional irrigation practices – Cajamarquilla, Carhuaz, Ancash, Peru. Source: Photo by Samuel Hulsey.

remnants of the pre-Columbian traditions, farmers themselves continue to keep Quechua, a local indigenous language, as the lingua-franca in some of the more remote communities. Customary flood irrigation in which earthen and cement canal-flows are redirected to inundate fields remains the watering practice of choice. Countless varieties of tubers, quinoa, barely, and tarwi, a legume endemic to the Andes, grow in the various micro-climates throughout the mountainous gradient. With observed hyper-seasonality and increasingly unpredictable seasonal rains (Vuille, 2008), the apparent randomization of plots acts as a form of food security minimizing the chance of multiple crop failures. Harvested agricultural products may be sold within rural hamlets or taken to larger open-air markets in close proximity to the Río Santa. However, in the spirit of subsistence, crop yields typically serve as major food staple for the growers.

Descending through ancient highland canal systems, water is also utilized for cooking, small trout farms (*piscigranjas*), laundry, livestock, and other domestic purposes. Subsistence farmers, or *campesinos*, may contest irrigation turns between neighbors or upstream communities that direct the flow of water through control gates in the canal system known as, *bocatomas*. Conflicts over water contamination are also not uncommon. An issue facing all that hold stake in the basin's water resources is the acidification of local waterways. This phenomenon is both naturally occurring and mining induced, resulting in acidic pH levels that can render water unsuitable for human consumption and crop irrigation. As glacial retreat intensifies rock material is exposed that has been sequestered from the elements for millennia. When rock and air meet a chemical reaction ensues resulting in the release of heavy metals such as lead (Pb), Arsenic (As), and Cadmium (Cd), which in turn, proceed to infiltrate glacial

lakes and mountain tributaries, altering the chemistry of small streams and ultimately, the Río Santa (Walsh, 2013).

After passing through upper rural sectors, all water eventually finds its way into the central Santa Basin. Agricultural production becomes increasingly market oriented the closer one gets to the Río Santa proper. The larger tributaries such as Quillcay, Manta, and Pariac funnel precipitation and glacial discharge that support urban hubs of the upper-basin. Larger population centers that form around these tributaries include Carhuaz (pop. 47,097), Yungay (pop. 58,683), Recuay (pop. 19,348) and the Department capital city, Huaraz (pop. 166,625) (INEI, 2015). In these lower urbanized areas, highland subsistence agriculture is replaced by industry and wage labor as water's principal use transitions from agricultural irrigation to human consumption.

Figure 4. Rural, subsistence-based community – Pumpa, Ancash, Peru. Source: Photo by Samuel Hulsey

Figure 5. View of an urban hub on the Río Santa– Huaraz, Ancash, Peru.
Source: Photo by Samuel Hulsey.

Leaving the tributaries and converging with the Río Santa, water continues through the remainder of the *Callejón de Huaylas* to be utilized in electricity generation. After by-passing Caraz, the Río Santa's currents power the turbines of the *Cañón del Pato* hydro-electric station run by the U.S. power corporation, Duke Energy. Established in 1958, the *Cañón del Pato* station initially provided energy exclusively for the urban coastal hub of Chimbote. As a result of mounting social tensions in response to overt preferential treatment for coastal populations, larger centers of the upper-basin began receiving electricity in the 1960's. This facilitated further development that radiated into the surrounding rural communities of the *Callejón de Huaylas* (Carey, 2005).

Reaching the coast, the Río Santa provides irrigation for large tracts of vegetation, offering a verdant reprieve to the dominantly arid landscape. Similar to its role in highland communities and urban centers of the upper-basin, the Río Santa's waters continue to satisfy the domestic needs of coastal populations, such as the industrial city of Chimbote (pop. 221,582) (INEI, 2015). In the coastal lowlands the river's confluence gives life to the large scale agro-export operations: Chavi-Mochic of Ancash, and Chinecas in the bordering Department of La Libertad. These commercial agro-industries cater almost exclusively to the global market with a strong emphasis on exportation (Bury, et al., 2013; Lynch 2013). Unlike the subsistence-based crop selections of the upper-basin, coastal industrial farms focus on monocultures of water intensive products such as sugarcane, asparagus, and rice.

The uses of hydrological resources of the Río Santa Basin are as diverse in function as the geographical localities through which the waters travel. Irrigation of smallholder subsistence plots, regional hydro-power generation, and a coastal agro-industry are all distinct human activities that influence this Andean water regime on

the local, national, and global levels (Carey, French, and O'Brien 2012; Lynch, 2013). It is necessary to take a deeper look at how this diverse group of actors interact with one another, influencing how the resource is allocated in this Andean basin.

The Cordillera Blanca: An Overview of Advances in Alpine Glaciology and Andean Hydrology

A synopsis of the various human and geographical landscapes that water must navigate within the Río Santa Basin is key in understanding the unique situation of this particular watershed. Still, there is one part of the water "story" that calls for a greater consideration, the origin of the resource itself: glaciers. Advances in glaciology and Andean hydrology have provided insight as to how high-altitude ice masses behave in a climate change context. These efforts have begun to explain how shifting climate parameters impact water availability in the Río Santa Basin in turn, influencing regional water policy.

The idea of glaciers in the tropics is a paradox in itself. These masses of ice reside in the upper reaches of mountain chains throughout the world at elevations reaching well over 5,000 meters above sea-level and represent important stores of water for lowland populations. Regardless of glacial contributions, tropical and sub-tropical regions depend on mountain hydrology for more than 80% of available water sources (Barnett et al., 2005). This statistic is particularly eye-opening when considering that this implies consistent provisions of water supporting the livelihoods of roughly half the global population (Viviroloi et al., 2007). With this understanding of the importance of mountains in providing water for lowland regions, the crucial role of glacial melt-off from the *Cordillera Blanca* becomes magnified for those dependent on water resources of the Río Santa Basin.

Boasting roughly 600 km² of high-altitude ice mass, the *Cordillera Blanca* holds the title of world's most glaciated tropical mountain range (Kaser and

Osmaston, 2002 in Carey et al., 2014). Reacting more immediately to shifts in global climate trends than arctic ice, high-altitude tropical glaciers serve as key indicators of climate change as they are more sensitive to shifts in temperature, precipitation, and radiation (Chavallier et al., 2010; Molg et al., in "Darkening Peaks"; Ribstein et al., 2010). As a result Andean hydrology and glaciology are key informants for the ongoing climate change discussion.

On a local scale, glacial retreat in the *Cordillera Blanca* underpins society's concerns about noticeable alterations in the surrounding natural environment. A conversation with any inhabitant of the Río Santa Basin reveals a sense of anxiety over observations of disappearing ice. Unlike the mountains themselves, glaciers are not static geographical features but undergo processes of perceivable change, most notably their retreat (Rhoades, Ríos and Ochoa, 2008). Christian Georges (2004) carried out a glacial mass study utilizing satellite imagery to compare photographic records from the early 20th-century with the current extent of glacial coverage. The report suggested a reduction of 800 - 850 km² in 1930 to a coverage of just under 600 km² by the turn of the century, roughly a 25% - 29.4% loss in glaciated area (Georges, 2004). Although this research contributes to a greater understanding of how high-altitude tropical glaciers behave in the context of climate change, scholarly work is not needed to convince locals that their concerns for the security of traditional water stores are well-founded.

Over the last two decades glaciologists have furthered the understanding of the hydrology of the Río Santa Basin. One of the more prolific academic entities to emerge recently is the Transdisciplinary Andean Research Network, also known by the acronym TARN. Composed of Peruvian and international researchers in the fields of geography, glaciology, alpine hydrology, and ecology among others disciplines,

TARN has been instrumental in providing new knowledge surrounding the behavior of Andean glaciers in a climate change context. Scientific research in the *Cordillera Blanca* and its contributions to water availability in the Río Santa Basin have posited two important conclusions: First, glaciers are retreating at increasing rates and the collective annual discharge contributions the watershed are declining over time (Bury et al., 2013; Chevallier et al., 2010; Juen, Georges, and Kaser 2005). Second, despite the many advances in understanding tropical alpine glaciology, there remain many unknowns concerning the impacts of various climate parameters and the resulting influence on recession rates and discharge (Baraer et al., 2012; Chevallier et al., 2010; Condom et al., 2012; Gordon et al., 2015) In short, glaciers are retreating and their contributions to water availability are projected to continue declining in long-term. For the moment, understanding glacial contributions in the short-term is an area that lacks clarity.

An important work that gives insight into how glacial discharge may vary through the 21st-century is the recent study, "Glacier recession and water resources in Peru's Cordillera Blanca" (Baraer et al., 2012). This paper puts forth the theory of peak water, suggesting that retreating glaciers reach a "critical transition point in which they begin to exhibit decreasing dry-season discharge." Each glacier in the Cordillera Blanca may be found in a distinct phase of this discharge curve rather than retreating in unison. This concept may be better visualized in the provided graph that represents Bury et al.'s representation of peak water (2013). This figure shows the current discharge phase of nine glaciers that the project incorporated. Seven of these have broken the peak water threshold and are projected to display continually declining discharge as they continue to retreat.

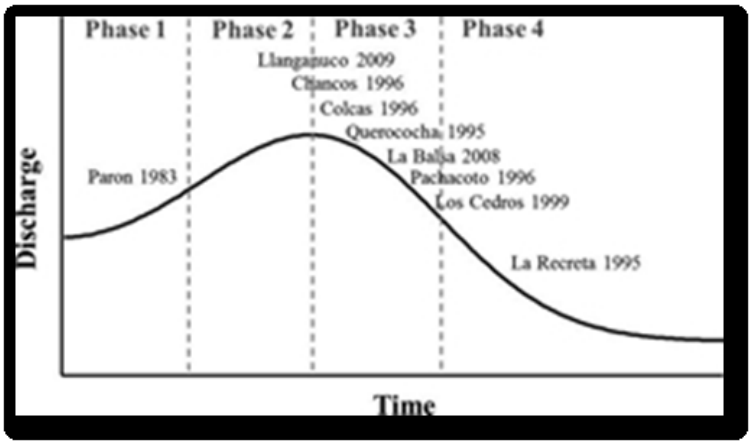

Figure 6. A visual interpretation of the Baraer Peak Water Theory. This curve originally developed by Baraer et al. illustrates the trend of glacial melt-off contribution to the Río Santa watershed. Listed are specific glaciers of the *Cordillera Blanca* in their corresponding phases of discharge over time with the majority exhibited as having surpassed maximum levels. Source: Bury et al., 2013.

The study is also quick to point out that, despite diminishing contributions of melt-off from the *Cordillera Blanca*, the basin will have ample hydrological resources when the ice masses are gone (Baraer et al., 2012). The main concern is how the basin will adapt to losing glacial discharge that has served as a buffer to sparse dry-season precipitation. In a 2014 study, Wrathall, et al., provided qualitative data supporting the peak water theory as they utilized interviews with inhabitants dependent on glacial discharge from the nine glaciers represented in the peak water study. In addition to backing up the results of a quantitative analysis, interview data highlighted the vulnerability of surrounding communities in adapting to changes in this Andean hydrological regime.

Research Methodology

Data collection for this project consisted of the implementation of semi-structured interviews (n = 28) with various representatives from entities involved in the public, private, and non-governmental/advocacy spheres. Fifteen interviews were

conducted in the summer of 2015 and with the aim of expanding the data-set, thirteen interviews from 2014 were also included in the analysis. Interviews were conducted in Spanish within professional settings and ranged from 17 – 110 minutes in duration. Conversations were audio recorded with the participant's permission and later transcribed. Only portions of the interviews pertinent to the scope of this project were translated from Spanish to English. An interview schedule was created consisting of ten open-ended questions eliciting participants to reflect on personal notions of water scarcity and associated drivers, changes in availability, efficacy of infrastructure and policy, and the envisioned future scenario of water in the region. During interviews probing questions were implemented as a means of further exploring topics of interest as they arose. All data was collected in the department capital, Huaraz, where there is a concentration of the various entities that this study aims to explore. This allowed for the compilation of a relatively large data-set within the allotted time-frame. In an effort to maintain anonymity of informants, all references to interviews are cited with institutional affiliation and the month the interview was conducted. Any information that could lead to the identification of participants was altered to maintain the integrity of their anonymity.

Participants were selected based on a direct or indirect interest in water resources of the Río Santa Basin and their inherent levels of influence on regional water governance. Throughout the study this group is collectively referred to as the Water Governance. Rather than restrict governance as referring to traditional roles of lawmakers and state entities, the definition is broadened in order to recognize that actors outside of the governmental sphere retain considerable degrees of influence in shaping water policy. For example, professors in the department of environmental science at the local university may have little pull within the municipal, regional, and

national political spheres, but their research on local climate change impacts, water availability, and glacial discharge form the body of information on which decisions are made. This, in turn, represents a degree of influence.

This broader interpretation of the term 'governance' is further explored through mapping the inconspicuous inter-play of socio-political arrangements that bind seemingly disparate actors in the network. A flow chart is provided that lends itself to a more holistic conceptualization of these social underpinnings in chapter one. The data-set represents a diverse cross-section of ideas, perspectives, and concerns surrounding the theme of water availability, climate change, and perceptions of future scenarios held by individuals who live in the Río Santa Basin. Methods derived from "discourse analysis" were utilized in examining this qualitative data. The identification of reoccurring themes allowed for the grouping of actors based on views of the legitimacy of regional claims of physical water scarcity, expressed opinions of causality, and ideas about the future regional water scenario. Furthermore, the use of common words in explaining causality such as 'climate change' and 'global warming' as opposed to 'infrastructure' and 'policy' allowed for the categorization of participants into loose "discourse coalitions." These emerging discourse coalitions may be defined as two groups comprised of actors from the Water Governance Network that represent contradicting views on the origin and legitimacy of basin-wide water scarcity. They also provide contrasting solutions for adapting to an envisioned future with considerably less available hydrological resources. Participants are identified as members of one of these binary coalitions based on expressed opinions in the oral interviews.

Through previous work with a local environmental NGO (non-governmental organization) in 2014, a strong network of contacts within the regional "water sphere"

had been cultivated. Relying on an established rapport among a diverse range of informants, snowballing and purposive sampling techniques were used in determining participants for the study. This allowed greater freedom and flexibility in collecting a diverse range of qualitative data through access to representatives from entities that have unique relationships with local water resources. Despite an advantageous affiliation with a well-known local environmental NGO, the limited timeframe for data collection made it difficult to obtain all the desired interviews.

Risking criticism for a lack of objectivity, a purely subjective analytical approach was employed. This method does not allow for support from statistical analysis, but it serves to answer the driving questions that, in themselves, are unapologetically subjective. The incorporation of quantitative methods should be considered for future studies of this nature. The compilation and analysis of qualitative, social-based data is what researchers in the natural sciences of glaciology and hydrology are calling for in furthering the collective understanding of "hydro-social models" in Andean watersheds (Bury, et al., 2013; Carey, et. al., 2013). This study may be viewed as an attempt at using tools from the social sciences to offer insight into a largely unexplored, yet vital component of the water puzzle.

CHAPTER 1.

Players of the Game: Untangling the Water Governance Network

This chapter seeks to expand the discussion regarding the web of socio-political arrangements that connect all stakeholders of hydrological resources within the Río Santa Basin: The Water Governance Network. First, an outline of Peruvian water law is provided, which further details the institutional mechanisms charged with regulating national policies. These "rules of the game" form the legal framework to which all water interests must adhere, shaping the relationship between the Peruvian State and multi-level users of the resource. A full review of natural resource policy would be deserving of its own study. For this reason, only the most relevant sections of the current Peruvian national water law are underlined here. These, too, will be referenced in the data analysis and discussion.

The Santa Basin's Water Governance Network can be best understood by examining four distinct subsections or "spheres of emphasis." The first section details Peruvian water law and the authorities charged with its implementation. Next is a brief exploration of peripheral state entities that are indirectly involved with water governance through their varying institutional missions. The third section serves to highlight the roles and functions of civil institutions and non-governmental organizations (NGOs) that work in advocacy for water related projects and contribute to the understanding of water availability through research initiatives. Finally, organizations in the private sector that favor water as an economic good are examined.

In chapters two and three, the interviews with representatives of entities from these four spheres are analyzed. Therefore, an understanding of the laws that hold them together as well as their various independent functions is necessary to fully

grasp the trends that will be identified. More importantly, this contextual foundation will provide support in answering the central questions concerning how climate change adaptation may be impeded by differing notions of scarcity. For now, let us turn our attention to the government entities that form and enforce water policy, the administrative vigilantes of all hydrological resources of the Río Santa Basin.

Arms of the State: Ley de Recursos Hídricos, The National Water Authority and Selected Subsidiaries

In 2008, Peruvian water law underwent its most dramatic change in over four decades. Ley n° 29338, better known as the Law of Hydrological Resources (LRH), set forth three new governance criteria that characterize the current framework of Peruvian water policy. The first noticeable shift was a call for a more integrated approach to water governance that strived to promote participation among all stakeholders as to reduce inequity in distribution and access to the resource. Editions to the LRH aimed to accomplish increased multi-level involvement by establishing basin-specific water councils. These mechanisms of decentralization would ideally consist of representatives from all entities that have interests in the basin's water resources. For example, this roundtable may include actors with unique and varying degrees of interest such as subsistence-based rural irrigators, engineers from hydroelectric projects, national park directors, and private water distributors, to name a few. This notion of multilateral equity is reinforced by the first, third, and tenth principles of the LRH that insist water must be viewed as equally valuable for sociocultural, economic, and environmental ends and that no singular use should be given priority over another.

Historically, natural resource policy has given preference to specific interest groups, reflecting the activities prioritized by the ruling party's agenda. This tactic was most notable in the Alberto Fujimori regime that held power from 1990 to 2000.

This party's exceedingly neo-liberal focus sought to open the nation's wealth of natural resources for exploration by the international community. As a result, Andean water resources were affected both through contamination by irresponsible foreign mining operations and the exclusive view of the Río Santa waters for providing electricity to the industrialized coast (Carey, French, and O'Brian, 2012; Lynch, 2013). Indeed, on paper, the LRH makes an attempt to mitigate politically-rooted preferential treatment of water use that has resulted in the marginalization of rural Peruvians and various manifestations of social tension (Lynch, 2013).

To a push for equity in governance, the LRH is clear that primary use of water resources (i.e. domestic activities and human consumption) takes precedence over any commercial end. Economic and national development interests should be secondary to utilizing water in sustaining livelihoods. This idea of people before industry becomes murky in the Eleventh Article, the Principle of Legal Guardianship. This portion stipulates that, the state protects, oversees and controls water in the various natural and non-natural states in which it may be found: liquid, solid, gaseous, in addition to any other phase of the hydrological cycle (MINAM, 2014). It is here that the classification of water as a "common good" works to obscure the pre-established notion of equity that is reinforced by the proposed shift towards a participatory governance framework. As demonstrated by previous Peruvian governments, the idea of the common good is malleable. Under the Fujimori regime, the common good was centered on the nation's economic development as it worked to raise national GDP through attracting foreign investment. In the wake of the international mining boom and ongoing legal battles over water rights, rural Andean communities continued to suffer forced relocation as they were disregarded in the consideration of the common good.

To promote the desired equitable, participatory governance while paradoxically maintaining a firm top-down authoritarian framework headed by the State, the LRH calls for the formation of the Peruvian National Water Authority. Commonly referred to by the acronym ANA, the National Water Authority plays an interesting role of promoting equitable water governance while, in praxis, working to secure the state's firm hold on the nation's hydrological resources. Embodying the inherently contradictory responsibilities outlined by the LRH, ANA may be likened to a water warden disguised as a referee. The engineers it employs view its role differently. As one long-time institutional advisor commented, "[ANA] is the director. [It is] the one that directs everything, [like] the director of the orchestra … It oversees the quantity and quality of water within the nation" (ANA, July 2015). As an institution, this is an apt description of ANA's position and role within the Water Governance Network.

As the foremost governing body for water resources, ANA's primary focus is the allocation of water rights to public and private entities utilizing the resource for purposes other than primary use. This is achieved through the granting of water licenses that entitle holders to, as one engineer put it, "official permission and authorization at the national level" (ANA, July 2015). Legitimate access to a designated source and pre-determined volume of water is specified in the license that is allocated through ANA's local branches: the Local Water Authorities, or ALA for short. The smaller Local Water Authorities employ state engineers as field agents that work to collect data on the regional sum of hydrological resources. These collected figures are compiled into a national database. There are 72 ALAs in all of Peru, 5 of which are located in Ancash. For the Río Santa Basin, the central offices of both entities are located in the same building in the departmental capital of Huaraz.

With glacial melt-off representing an important contribution to the annual balance of the Río Santa, ANA came to encompass the pre-existing Unit of Glaciology and Hydrological Resources, or the UGRH. A government institution that specializes in quantification of glacial discharge, the UGRH is currently focused on understanding glacial retreat in the context of climate change. The unit was originally formed to minimize public risks of natural disasters as the glaciers of the *Cordillera Blanca* have been the source of several lethal events over the last century. The most notable occurrences included the 1941 glacial lake outburst flood that decimated nearly one-third of the city of Huaraz and claimed nearly 5,000 lives (Carey, 2005). The 1941 flood was violent and unexpected, but it paled in comparison to the 1971 earthquake that triggered an avalanche that buried the town of Yungay. This event, which killed 75,000 people throughout the Santa Basin, was marked as the deadliest natural disaster in the history of the western hemisphere (Bode, 1989). Floods and avalanches continue to pose risks for populations throughout the *Callejón de Huaylas*, but the Glaciology Unit has shifted gears to address emerging environmental threats at the opposite end of the water spectrum: scarcity induced by glacial retreat. Mitigating potential risks of sustaining natural disasters remains a priority of the UGRH. Nevertheless, their research endeavors are becoming increasingly focused on understanding the role of glaciers in the hydrology of the Río Santa Basin.

ANA relies on Local Water Authorities and the Glaciology Unit to determine the regional water availability within the greater basin. As outlined by the LRH, the National Water Authority utilizes this data to inform its decisions on where, when, and how water resources may be used, and which actors may access them. Fulfilling the dual role of securing national control of hydrological resources while fostering equitable governance, ANA and its subsidiaries play the collective role of both

guardians and gatekeepers of the Río Santa Basin's water resources. As pointed out by an engineer and reinforced by legislature, ANA and its affiliates act as the legitimate maestro of the Water Governance Network.

Peripheral Normative Institutions: PSI, SERNAM-P, DSA, and the Regional Department of Agriculture

Similar to ANA and its affiliates, the entities represented in this group are also state mechanisms, each born out of specific legislature. Rather than enforce regulation, these state institutions are characterized by indirect interests in water through virtue of their distinct institutional scopes. The Sub-Sectorial Irrigation Program, or PSI, is a state-funded initiative geared towards promoting efficiency in water use among small to medium-scale commercial farming operations. Ample state subsidies have been allocated through the program *Fundo mi Riego*, literally "My Irrigation Fund," but, as one PSI engineer lamented, this is still not enough funding to make the desired impact in improving water efficiency for the majority of farmers that the program seeks to assist:

> If you want to help out subsistence farmers, who are thousands and millions in number, it is extremely complicated. It is like having three kids and only having enough money to take one of them for ice cream. If you take one, the others will know their turn will come the next week. But you can't do it like that. It's the same with rural farmers. (PSI Interview, August 2015)

At the structural level, there is thus, an inherent complication resulting from a lack of real monetary resources needed for all subsistence farmers.

Another entity is, SERNAM-P (National Service of State-Protected Natural Areas of Peru), which has a strong interest in water through virtue of its focus on conservation. In the context of the Water Governance Network of the Río Santa Basin, Huascarán National Park Service (PNH), represents the most directly influential branch of SERNAM-P. Like other international park services, PNH is concerned with the conservation of biodiversity and maintaining the integrity of the

mountain ecosystems that comprise this unique biome. With a focus on conservation, PNH must invest its efforts in managing human activity within the park boundaries, as a lack of oversight could lead to environmental degradation. These responsibilities include regulating domestic and foreign tourists who wish to visit the national nature reserve in addition to negotiating highland grazing right with local rural pastoralists. Unlike other actors within the Water Governance Network, PNH is interested in hydrological resources for the sole end of conservation. Indeed, glacial discharge in the Huascarán National Park is the cornerstone of this specific mountain ecology. Without water, these ecosystems would become unhinged, resulting in a critical loss for global biodiversity as endemic flora and fauna are pushed towards extinction.

Similar to the scope of PSI, the Regional Department of Agriculture (DRA) is concerned with water resources as a tool for improving the production of small to medium-scale farmers of Ancash. Their work focuses on promoting agriculture through implementing efficient irrigation technology in rural communities. In a basin where water scarcity is a growing concern, the DRA works to replace traditional flood irrigation techniques with drip irrigation and sprinkler systems. Additionally, the Regional Department of Agriculture addresses issues of contamination that impact irrigation quality, resulting in lower agricultural productivity in rural communities. Analogous to the DRA, the Department of Environmental Health (DSA) is a regional satellite of the national Ministry of Health. With no clear ties to irrigation, the DSA's primary involvement with water resources in the Santa Basin involves monitoring water quality. This role is particularly important at the regional level because urban hubs are lagging to develop systems of waste water management. As several participants explain in the interviews, residual water is directed into tributaries, culminating in the Río Santa and flowing down to coastal communities.

Although these peripheral institutions are not involved in the allocation of water licenses and enforcing national policy, they still represent important forces within the broader Water Governance Network. Their varying focuses in the fields of public health, environmental conservation, and improving agricultural production throughout the region lend themselves to an explicit interest in how, when, and where basin-wide water resources are used and the resulting impacts of that use on their respective initiatives.

Research, Advocacy, and NGOs: CARE, JUCH, UNASAM

In addition to organizations that serve roles as mechanisms for the successful implementation of policy, the Río Santa Basin also counts a strong presence of non-governmental organizations, civil institutions, and academic entities. A defining feature of this specific sub-set is that, unlike state institutions, their scopes of work are not inherently molded by government policy. In contrast, these actors attempt to fill the gaps where government institutions fall short. However, their sources of funding are quite different.

Although there are many NGOs and non-profits that work in the region, CARE Peru is the only one included in this study. CARE is a prime example of the characteristics that most non-governmental organizations tend to embody. Like many NGOs, CARE Peru is a branch of an international development-oriented initiative that has a global presence in other countries around the world. Rather than offer cookie-cutter services to the diverse groups that it serves, CARE tailors its activities to address the needs of local communities. In the context of the Santa Basin and working to highlight the organizations interest in water, this entails promoting international collaboration in engineering solutions to manage the quickly-filling glacial lakes. In addition to engineering activities, CARE also works to promote water and sanitation

in addition to climate change adaptation projects. A common characteristic of most NGOs, CARE is funded by international donors such as USAID and the World Wildlife Fund, and Peruvian entities such as the Ministry of the Environment.

Considering the contentious water rights policy that calls for prudent water use and promotion of equity, there are groups who are marginalized. Throughout the Peruvian history the position of second-class citizen has largely been sloughed off to rural farmers who value water for irrigation of subsistence-based plots. In response, this particular demographic has formed a well-organized advocacy group for rural irrigation rights: The Board of Users of *Callejón de Huaylas* (JUCH). One of many basin-specific irrigation boards, the JUCH is a civil institution that is organized through varying levels of canal systems throughout the basin. The Board of Users is composed of several basin-wide committees that, in turn, are composed of irrigation blocks. The blocks are the lowest level of the group and are composed of individual irrigators who share physical waterways and must coordinate between themselves to avoid conflict. The most important role of the JUCH is acting as the concerted voice of the roughly 60,000 individual irrigators that it represents through the upper portion of the Río Santa Basin.

Academic institutions are not normally considered as having any significant level of influence on traditional water governance. However, in the case of the Río Santa Basin, the local university UNASAM plays an important role through its Department of Environmental Science. Faculty are involved in both teaching duties as well as varying levels of involvement within other groups such as the National Water Authority, the UGRH, meteorology, and the municipal government. The faculty in this department are also active researchers who spend time conducting studies of water availability, measuring glacial retreat, monitoring water quality, and conflict

resolution concerning disputes over water. With this level of involvement in water related research, but lacking political pull, the faculty of the Department of Environmental Science may be compared to the backseat drivers of the Río Santa Basin's Water Governance Network. These academics voice their opinions on the direction policy-makers should take, but they have little means of doing anything more than providing information and making suggestions.

Focused on advocacy, serving the population, and providing the results of accurate research, this group of actors influences the Water Governance Network through attempts at persuasion and actively striving to fill gaps for Peruvians who remain on the fringes of the dominant society. This indirect impact on policy serves as an important critical voice.

Production: EPS Chavín, Duke Energy, and Coastal Agro-Export

The final sub-set of actors that play influential roles in the larger Water Governance Network are linked by their common interest in water through an economic lens. The water distribution service, EPS Chavín, is the only private company represented in this study. It is important to consider actors that are governed by the international market such as hydro-electric projects and coastal agro-export operations.

EPS Chavín focuses primarily on water sanitation and distribution within the larger urban hubs of the basin such as Huaraz, Carhuaz, and Yungay. Their primary source of funding comes from tariffs levied on customers who are connected to a grid of water distribution infrastructure. With this funding, EPS Chavín provides maintenance on ground pipes, works to create potable water, and conducts public outreach events to promote good practices of waste disposal throughout the Basin.

As outlined in the introduction, Peru's premier hydroelectric station, *Cañón del Pato,* is located on the lower end of the *Callejón de Huaylas*. Operated as a national project for many years, the power station was privatized and then relinquished to North Carolina-based power company, Duke Energy. With the goal of maximizing energy output to be used throughout the Basin as well as the coast, Duke Energy works to maintain the water level of the Río Santa proper high enough to operate the station's power turbines. To maximize output, the company has secured rights to several glacial lakes that it utilizes as a form of regulating the balance of the Río Santa. This political maneuver has fueled a decade-long controversy and promoted open conflict between the power station and rural subsistence-based communities who rely on a steady water flow to irrigate their fields (Carey, et al., 2012).

The final economic enterprises tied to water of the Río Santa are the coastal agro-export projects, CHAVIMOCHIC and CHINECAS. Backed by national subsidies, these coastal commercial endeavors share much in common with California's Central Valley in that they are incredibly fecund lands, but are products of human intervention. Similar to Southern California, the coast is defined by an overly arid climate with little yearly precipitation. Nearly 184,000 hectares of land are currently under irrigation between the two operations. Oriented on trade with water-poor countries, these commercial endeavors focus on producing crops that are highly water intensive such as asparagus, rice, and sugarcane. As the world's leading exporter of asparagus, a crop that requires 20.32 gallons of water per ounce, an estimated 99% is destined for the global market (Bury, et al., 2013).

Although they are neither politicians nor researchers, private companies hold a considerable influence over how water is governed in the Río Santa Basin. The

common thread that ties these three organizations together is that they are not concerned with equitable distribution among all users but rather, are focused on extracting water resources as the key element in creating their final products – agro-exports, electricity, and potable water. When taking into account their contributions to Peruvian national GDP, one begins to understand how the State's interpretation of water as a "common good" in the LHRG becomes malleable as it prioritizes these lucrative national industries over the demands of less powerful stakeholders such as rural, subsistence farmers.

Another way to understand the intersections of the various actors and their respective spheres of emphasis is to offer a visual representation, which is provided below. At first glance, the flowchart that I have designed below may seem overwhelming, with so many variables at play. This display is helpful, however, in understanding the relationships between actors that are not always apparent.

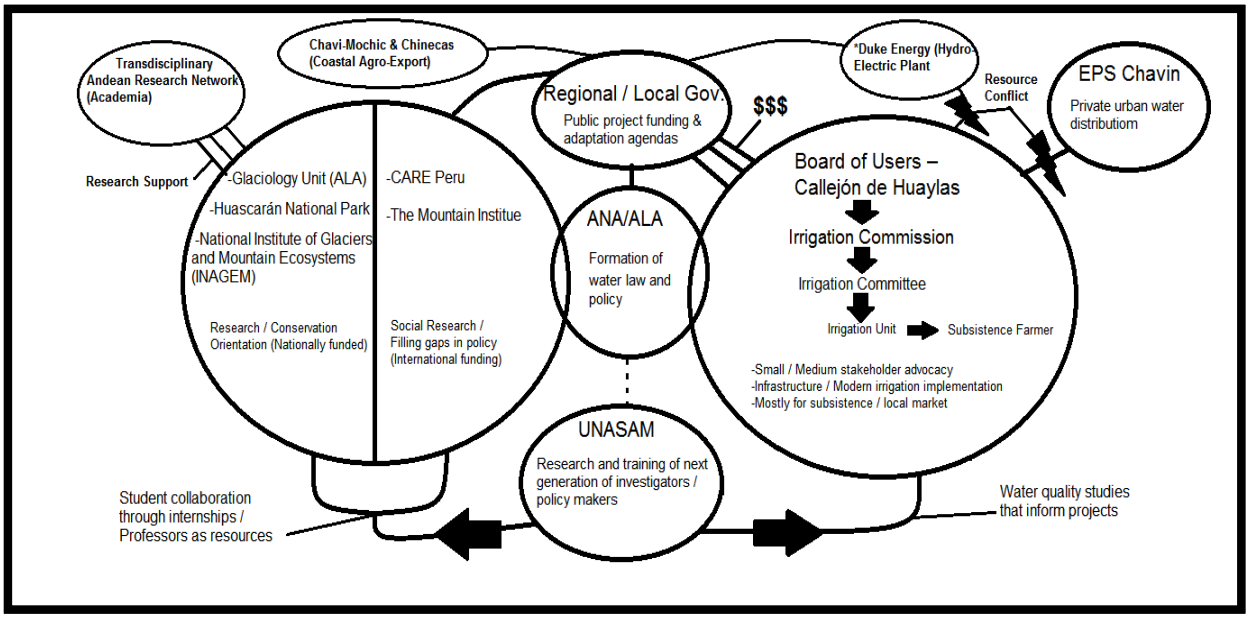

Figure 7. Flowchart of the Río Santa Basin Water Governance Network.
Source: Samuel Hulsey.

There are different spheres of influence in the above representation. The central sphere represents the National Water Authority. As the highest governing authority of hydrological resources, all other organizations - private, civil, and governmental - are beholden to ANA's norms and regulations. Merging into ANA's central sphere and creating a Venn diagram of sorts are two spheres of actors that both influence and are influenced by ANA's national water policies. Flanking ANA on the may be considered as the "research" sphere. This sphere is split into two hemispheres; the left half represents state-funded initiatives focus on research geared towards understanding water as a physical natural resources. This includes PNH who is dedicated to biodiversity conservation and the UGRH that strives to understand glacial behavior. These organizations also have strong ties with the international research community such as the TARN, or Trans-Andean Research Initiative. On the right side of the sphere are NGOs ad non-profits whose scope encompasses social

implications of water scarcity. This includes CARE who works in managing natural disaster risks from glacial lake outburst floods and organizations like the Mountain Institute that has supported climate change adaptation projects focused on securing water resources for rural communities. Together, this complete sphere works to provide ANA and policy-makers with accurate information on the social implications of climate change and, to some extent, their campaign of Basin-wide quantification of hydraulic resources.

Merging with the central sphere to the right side of ANA are small-medium holder irrigators. In this sphere also lies the structure of the Board of Water Users of *Callejón de Huaylas*. The JUCH represents over 60,000 rural irrigators that utilize the waters of the upper-basin. It is largely involved with ANA in negotiating for the construction of new canals that are funded either by communities themselves or municipal and provincial municipalities, as noted by the ($) symbol. It is also important to note the peripheral normative institutions such as PSI, DSA and Regional Department of Agriculture are also considered components of the Regional / Local Government sphere since they work to promote infrastructure, irrigation, and public health projects in the communities of rural irrigators. ANA through its various subsidiaries of ALA also works in allocating formal water-use permits to all irrigators. Rural irrigation committees and commissions often find themselves at odds with private industries who also have production interests in water. Duke Energy and EPS Chavín are constantly at the negotiating table with rural farmers. Costal agro-export operations have considerable leverage over water policy and continually demand larger portions of the Río Santa's output, but their geographical location as coastal end-users keeps them removed from conflict. Although they demand more

water than most other users, impacts are not as tangible since they primarily manifest as extraction-oriented policy (see Lynch, 2013).

Finally, the bottom sphere of this flow chart represents the local university, UNASAM. Their ties with ANA are weak at best. Several professors from the Department of Environmental Science were past employees or currently work as consultants for the National Water Authority. This link also represents the several UNASAM students that serve as interns in various units of ANA. The university is more closely tied with JUCH and the research/advocacy sphere. Students and professors of environmental engineering assist to rural communities through conducting water quality studies and assisting in technical aspects of building new canals. In the research sphere students gain professional experience with NGOs like CARE and The Mountain Institute or national entities like Huascarán National Park Service and the newly formed National Research Institute of Glaciers and Mountain Ecosystems (INAIGEM) based in Huaraz. Through these internships, students not only gain valuable professional experience, but contribute to the studies and development/adaptation initiatives of these various organizations.

This diagram may be improved by providing further insight on the connection between spheres and provincial, regional, and national governing bodies. It would be helpful to consider mining as an extractive, yet lucrative international industry that has an indirect interest in water of the Río Santa Basin and a considerable degree of influence over Peruvian natural resource policy. Ancash consistently ranks as one of the Departments with the most recorded socio-environmental conflicts in all of Peru with this civil unrest largely generated by the negative impacts of mining operations (Defensoría del Pueblo, 2015). Utilizing this diagram to depict groups involved in this study provides a deeper understanding of actors' levels of influence in the decision-

making process of basin-wide water use. It also offers greater insight into how seemingly disparate entities are connected through their shared interests in local water resources and thus, constituting the greater Water Governance Network. This hydrological-social context is necessary for interpreting the significance of the conflicting views regarding scarcity and climate change that exist within the this network and are explored in the following chapter.

CHAPTER 2.

Emerging Discourse Coalitions and the Roots of Scarcity

The sections leading up to this chapter provided two key contextual components. First, insights from contemporary Andean glaciology and hydrology were explored, revealing that although water availability is projected to diminish increasingly in a long-term timeframe, claims of physical scarcity on a basin-wide level are premature. This literature review served to elucidate the first central question: How important are physical changes in water availability in constituting scarcity in the Río Santa Basin? Although this watershed is experiencing changes in the hydrological regime (i.e. diminishing dry-season glacier discharge), these physical shifts do not support current assertions of a deficit in water resources. Second, a foundational understanding of the Water Governance Network and the role of Peruvian water policy as the nexus of the various entities represented therein was offered. In this explanation, linkages were identified between seemingly disparate interest groups while highlighting the varying levels of agency that all actors maintain in influencing the formal and de facto governance of regional water resources. Departing from contextual support offered in earlier sections, this chapter transitions to the data analysis of semi-structured interviews. The purpose of this analysis is to identify how perceptions of scarcity exist among actors in the Water Governance Network and exploring the rationale behind these claims. Deconstructing notions of regional water availability works to reveal how scarcity is conceptualized through identifying believed root causes or, culprits, of this hydrological phenomenon.

The analysis provided in this chapter is presented in two sections. The first aims to establish a baseline for perceptions of environmental change in the context of

the Río Santa Basin. After illustrating a consensus among actors that the region is undergoing a transformative, physical process (i.e. climate change), views on water availability are explored. The second section seeks to sift through the various ways in which participants derive distinct understandings of scarcity, or rather, an evaluation of water scarcity epistemologies. If the first section puts forth participant views concerning changes in the water resources in the Santa Basin, then the second section explores how this is understood by those dealing with it.

It was decided more efficient to consider the interview data collectively. Quotations from the original sources are utilized in the analysis to support identified trends and common ideas as they emerge among the sample group. Following the outline of the interview schedule, this analysis funnels down from broader themes such as notions of climate change to ideas on how impacts play a role in local water availability. Overall, the goal of this analysis is to identify competing and conflicting views of the basin-wide hydrological situation as they present themselves through the discourse of actors in the Río Santa Basin's Water Governance Network.

Notions of Change and Depictions of Scarcity

Before prompting participants to expand on notions of scarcity and ideas of socio-environmental processes that drive them, it was first important to demonstrate a consensus that the Río Santa Basin is experiencing changes in the natural environment. The latter part of this study's argument is hinged on a shared reality of local environmental processes among the representatives of the Water Governance Network. That is to say, if there were no consensus on the legitimacy of regional climate change impacts, then it would not be surprising that competing ideas regarding the roots of water scarcity would also be present within the Water Governance Network. In fact, if there were competing views on the credibility of, for

instance, glacier retreat, then it would be expected that each side of the argument would put forth unique policy measures according to their respective envisioned futures.

After establishing a degree of homogeneity among local views of the Río Santa Basin in a climate change context, ideas concerning water scarcity are explored. Participants' hesitancy or willingness to define the region as being in a state of "*escasez*" or, water scarcity, allowed them to be sorted into groups based on these expressed beliefs. After establishing this conceptual foundation of scarcity, further interview questions sought to draw out ideas of causality behind these claims.

All interview questions were open-ended, eliciting an explanatory response while attempting to give the interviewee autonomy as to how the question might be answered. Conversations were initiated with inquiries regarding broader notions of environmental shifts in the region such as, "What impacts have you observed in regard to climate change?" and "How would you describe the current regional water situation?" The broader preliminary questions were met with consistent responses detailing environmental change in the region, specifically focusing on glacier retreat in the *Cordillera Blanca*. This theme of vanishing *nevados*, or ice-capped peaks, was treated with a high level of concern reflecting that of the greater basin-wide population. One PSI engineer commented, "We can't try to hide it. The *nevados* are always changing color. They are darker now, appearing more like earth than snow" (PSI, August 2015). These visual observations were commonly expressed in the interviews among environmental engineers, policy-makers, and advocacy groups alike. Participants would also draw on personal memories of glacial extent, highlighting how the high-altitude ice masses have transformed during their lived

experience. For example, a PNH representative spoke of witnessing an entire glacier slowly melt over time:

> I have seen a glacier disappear. This was the case with Brogi that I first [came to know] in 1995, but [it] ceased to exist in 2005. The glacier Yanamarey, where I have worked for many years is in the same situation. It is destined to disappear … This is the most visual, most objective way of seeing the impact of climate change in tropical mountain ecosystems. (PNH, August 2015)

The key component of this comment is the idea of local climate change as a process that may be *seen* by inhabitants of the Río Santa Basin. Rather than an intangible "scientific theory," actors of the Water Governance Network need only a set of eyes to confirm suspicions that change is occurring in the surrounding environment.

These expressed notions of physical change utilized a lived experience, recalling a slow but noticeable retreat over an individuals' lifetime. Another expression of perceptions of environmental change were accompanied by empirical evidence. Environmental engineers more up to date on advances in the fields of local glaciology often cited some of the more prominent studies concerning mass balance in the *Cordillera Blanca*. In addition to acknowledging the visually perceivable extent of retreat, several representatives cited research entities like the international conglomerate TARN. A recent UGRH engineer and long-time ANA consultant pointed out, "I think that we've carried out enough studies. We have the diagnostics. For example, I've read Michel Baraer's study (2012) that clearly shows that 7 of the 9 sub-basins are putting out less and less water. [Glacial retreat] is inevitable and undoubtable" (Independent, August 2015). Another UGRH hydrologist noted the results of this same study in commenting on local environmental shifts.

However, he argued that although studies provide helpful data for understanding the glacial behavior in a climate change context, it is not needed to convince anyone that ice is on the move:

> Besides results from researchers like Michel Baraer, Christian Georges, and from our own researchers, we can see that there exists a strong impact. Not only is this something that is happening [abroad], but it is hitting close to home. We are not waiting 100 years or even 50 years to begin talking about climate change. We are talking about … [seeing] a significant change in as little as 5 to 10 years. (UGRH, July 2015)

These examples of expressions of change underscore the growing sense of urgency present among all participants. Glacial retreat and, consequently, climate change, is not treated as a distant future scenario, but an ever-nearing reality.

A noticeable rise in temperature accompanied several shared observations of melting glaciers. Similar to employing lived experience in recalling past glacial extent, some participants reminisced about their childhood in a basin with noticeably less heat. This, too, was commonly identified as a driver of glacier retreat rather than an independent occurrence. "The [masses] of ice are reducing" one municipal environmental engineer reported. "So, now we have this problem … In the past we did not have this heat …You could walk all around Huaraz and you'd feel fine. But [now] you begin to walk and man [sic] … you really begin to burn. So, now [we] feel climate change" (Provincial municipality, August 2015). Here, climate change is noted as a process with environmental and social implications. The noticeable increase in regional temperature is collectively viewed as a driver of melting and an active threat to livelihoods.

Sentiments of perceivable environmental change in the Río Santa Basin were revealed by all participants. The popular expressions of glacier retreat and temperature increase provide evidence of a common shared reality among actors in the Water Governance Network. In addition to these popular observations, increases

in seasonal rain variability and changes in local species populations were also cited. Although glaciological studies are vital for informing policy decisions that address approach water issues, the reports are not needed to promote a sense of urgency within the greater population. Participants clearly reflect the ANA consultant's sentiments that local climate change impacts are, "undoubtable" and permeate the public consciousness. Overall, the expressed concerns for glacier retreat and temperature change are indicative of the notions for Río Santa Basin as a whole. More importantly, common notions regarding the current state of the surrounding natural environment validate the presence of a consensus among actors in the Water Governance Network.

Depictions of the Current Local Water Situation

Once on the topic of glacier retreat, which came up in almost every interview, participants tended to transition organically to the theme of water availability without much prompting. Throughout the conversations a causal connection was made between shared observations of disappearing ice and noticed changes in water availability. The second item of the schedule aimed at addressing this theme indirectly through the questions: "Is there sufficient water to meet the needs of all activities [within the Río Santa Basin]?" and/or "How would you describe the water situation of the basin?"

The purpose of these inquiries was two-fold. First, asking participants to define the hydrological situation of the basin would lead to either a claim of water scarcity or an assertion of surplus. Moreover, each of these responses would then call for an explanation of the reasoning behind this expressed idea. For claims of scarcity, this would mean identifying the mechanisms that cause it. Likewise, if scarcity were refuted, then participants would expound on theories of why popular assertions of

scarcity have gained so much traction throughout the region. Second, having participants classify the basin's water situation made it possible to see if scarcity were utilized as a blanket term for the entire region, or if individuals were more precise in their use of the term.

As anticipated, several participants did not hesitate in defining the Río Santa Basin as an area experiencing physical water scarcity. There was little evidence given to support this claim and the term tended to be utilized as a buzzword among the participants that implemented it. There was seemingly little reflection on the specifics of scarcity. When brought up, it was employed as a blanket term that did not reflect the uniqueness of the low-lying geographical areas surrounding the *Cordillera Blanca*. When questioned on the regional importance of water, one DRA engineer stated, "As everyone knows, we are observing that climate change is really reducing the [amount of available] water. In the past, for many years back, there had not been a deficit in the *Cordillera Blanca*. But now we are seeing that there is [a deficit]" (Regional Department of Agriculture, July 2015). When scarcity was used as an all-encompassing term, responses linked it with the previously discussed glacial retreat. This connection arose again with a municipal engineer who lamented, "Look, it's the context of Huaraz. It is the problem of water here, right. There is constantly less [water]. The *nevados* [keep getting] further way. There is much concern" (Provincial Municipality, August 2015). As will be explored more in depth in the following section, there was almost always a deliberate causal tie made between claims of regional water scarcity and observations of climate change. As highlighted in these two comments, this was most immediately connected with glacier retreat.

Similar to expressed notions of environmental change, a lived experience was utilized in comparing contemporary issues in water availability with that of years past.

Scarcity, in this context, is constituted through the participant's observed variations in availability over his/her lifetime. Another state environmental engineer recalled growing up in a rural community where irrigation was a daily practice. Through this, he was constantly observing water levels in local streams and canals, allowing him a greater awareness of changes in stream flow:

> Look, when I was a boy you had your field … and you used the water you needed and for however long it took you. Anyone could go and take water, but now it is not like that. Because of how the volume of water has reduced they have formed water boards [JUCH] that allocate irrigation by turns. So, this makes you understand that the volume of water has really gone down. (Provincial Municipality, August 2015)

Here, the engineer highlights the creation of authoritative entities that work to manage water resources. He claims that an abundance of water in the recent past made authoritative intervention unnecessary. However, in the context of a transforming hydrological regime, a top-down regulatory mechanism was needed to successfully partition water among irrigators.

Out of all twenty-five interviews, the representatives of the Water Governance Network that were willing to use scarcity as a term to describe the basin was surprisingly small. It was anticipated that this group would have been larger considering the popular expressions of scarcity in daily conversation and political rhetoric. This group also could have been expanded if more legislators and policy-makers had been available for interview. Although this "scarcity group" represents the minority perspective in this data set, it should not be considered as representative of the larger population. Further studies that incorporate more interviews on a larger, basin-wide scale will likely illuminate this reality.

A second trend to emerge from the interview analysis was a group that coalesced around the notion that scarcity requires substantial consideration before being applied as a general description for any larger region, such as the Río Santa

Basin. Participants in this group were quick to refute claims of wide-spread water scarcity and remained wary of using blanket terms. To be clear, these actors did not suggest that local water issues were non-existent. What they did put forth is that, similar to glaciology reports, it is still too early to define the Río Santa Basin as a region of physical water scarcity. Most representatives that formed part of this group reported the Santa Basin is still rich in hydrological resources in spite of glacial retreat. One UNASAM professor whose research focuses specifically on measuring water availability in the Quillcay sub-basin above Huaraz put forth, "We have an annual surplus [of water]. What does this mean? It means that there is much water lost during the rainy season … through glacial discharge and the rains" (UNASAM, July 2015). Although there are issues of water availability in the dry season, several actors in this group suggested that there still remains an annual net-surplus of water. The same notion was expressed by an ANA engineer charged with the task of quantifying regional resources. When asked about availability fulfilling regional demands he responded, "I would say yes – yes with sincerity. Logically, in a few cases during the dry season we have deficits in a few basins or sub-basins. But, if we analyze the amount of water that is lost in the rainy season, it is nearly 10-million m^3 that goes straight to the sea" (ANA, July 2015). The idea of abundance in the face of melting glaciers represents a stark contrast to popular scarcity discourse.

A second major point made by contenders of scarcity was emphasizing the importance of considering each community, sub-basin, and locale as pertaining to a unique hydrological reality. This was made clear by the central leader of the JUCH. When asked if he would classify the basin as a region of scarcity he replied, "Well, currently there is certainly a deficit in a few places. But, like I said, the population still isn't feeling the blow. We have had a sufficient [supply of] water. I'm not sure if

there will be worse consequences. But yes, the people have become aware that climate change is impacting the region." (Board of Water Users – *Callejón de Huaylas*, August 2015) This focus on the specificity of scarcity is especially important when considering that is coming from the single individual that represents over 60,000 irrigators of the *Callejón de Huaylas.*

Scarcity specificity was also commonly addressed through highlighting an important feature of the Río Santa Basin: two mountain ranges defined by their hydrological potential. The very name *Cordillera Negra* is derived from the fact that these western slopes the high-altitude glacier of the eastern counter parts. Despite glacial presence, both mountain ranges are considered parts of the Río Santa Basin. This poses a problem for individuals who use scarcity as a blanket term for the region, as many participants suggest. "The *Cordillera Blanca* has the characteristics such as *nevados*, glacial lakes, and springs" described an engineer from the Department of Environmental Health, "And [in] the *Cordillera Negra*, which is arid, there are none … All of the populations situated [in the *Cordillera Negra*] are the ones that are dealing with disappearing water" (DSA, July 2015). Indeed, these coexisting hydrological realities highlight the diversity of water situations of various locales within the basin.

Among the actors who claimed water scarcity, a large portion was more precise in this labeling. These participants were hesitant in suggesting that scarcity was an apt term as a basin-wide description. Rather than employ this as a blanket term for the region, several participants provided a, "yes and no" answer. One of the more common sources of evidence used to back this claim was pointing out that the Río Santa Basin encompasses two distinct hydrological realities within itself: the *Cordillera Negra* and the *Cordillera Blanca*. In contrast to individuals that were quick

to jump to scarcity as a term for describing the whole basin, several participants were careful in pointing out the contrasts between the two unique mountain ranges. This initial part of the analysis highlights the complexity of water issues in this Andean region. Although there is agreement that the hydrological regime is transforming, there is disagreement over the exact implications.

The Epistemology of Scarcity

Having established competing notions of scarcity as they exist among the Water Governance Network, the second goal of the interview aimed at identifying how participants conceptualize these notions, namely through identifying the socio-environmental mechanisms attributed with driving regional water availability complications. The previous section demonstrated that claims of physical water scarcity were refuted by the bulk of participants, challenged by assertions of abundance despite the reality of a stressed hydrological regime. To be clear, participants contesting claims of true scarcity did not deny that there still exist difficulties in regional water availability.

In an attempt to explore the foundations of beliefs surrounding presumed scarcity origins, this portion of the interview sought for participants to elaborate on what causes water scarcity. Individual views were explored using the questions, "Is scarcity a function of climate change" and/or "What would you define as the root driver of regional issues of water availability?" The ensuing conversations shed light on two dominant beliefs, allowing for participants to be grouped according to views that frame scarcity as an environmentally deterministic rather than social problem. These emerging discourses are explored as actors identify climate change and associated environmental impacts as the core perpetuators of water availability complications. In contrast, opinions of scarcity as socially deterministic through

means of increased demand, disorganized governance, and inadequate infrastructure constituted the second dominant line of reasoning. The responses offered to these questions regarding the origins of scarcity served to further outline discourse groups within the Río Santa Basin's Water Governance Network.

Participants who comprised the "environmentally deterministic" group were linked through their common emphasis on portraying diminishing hydrological resources as a function of observed changes in the natural environment. Referencing glacier retreat and seemingly dwindling water resources served as the leading rationale for employing this notion of causality. In spite of empirical studies that point to long-term, slow onset impacts on water resources (Carey, 2012; Mark, 2008), actors in this group suggested that the water crisis has arrived: "The quantity of available water is depleting, as well as [sources such as] the ice-capped peaks, as the glacial lakes, and obviously, [aquifers]" (DSA, July 2015). This Department of Environmental Health representative was responding to a question regarding scarcity as a function of climate change. The way in which this was expressed lent itself to a sense of immediacy. A President of a rural canal committee reiterated this idea of climate change impacts as the sole driver of contemporary difficulty in availability: "[Yes], there is water scarcity. Each year the level is getting lower due to climate change and global warming. We are also lacking rains" (Canal Committee, September 2014). Despite the research suggesting that physical water could be the basin's reality by the end of the century, participants in this group were consistent in considering water availability as a product of environmental shifts. Through these representations, the driving roots of scarcity are associated with natural processes that may not be controlled.

Scientific data was also used to frame water availability issues as purely environmental in nature. Empirical data was used to support an emphasis on glacial retreat as the driver of regional scarcity. This was a trend observed primarily among engineers, who referenced glaciological studies, citing reductions in mass balance and increasingly diminishing streamflow. As one such UGHR hydrologist put forth, "We haven't adapted by taking into account that scientific studies show that scarcity will become [increasingly] prevalent. There are initiatives by the state and by ANA to continue collecting data … in order to [inform] adaptation strategies to climate change that we are beginning to better understand locally in Huaraz" (UNGH, July 2015). What makes this comment stand out is the focus on the importance of data collection for influencing policy. In analyzing these interviews, it became apparent that instead of just considering expressed themes, it was also essential to be sensitive to which topics were not mentioned. In this instance, the UGRH representative did not reference social drivers of water scarcity. Instead, he claimed that effective adaptation measures are contingent on data collection, emphasizing the value of scientific reports that largely deal with quantitative data concerning glaciers and water. An important conceptual gap to be aware of, this engineer did not once mention the importance of taking into account the various social drivers of scarcity.

In identifying how participants understand scarcity, it is essential to consider what is being left out of the conversation. Participants that view scarcity through an environmentally deterministic lens tended to do so with blinders, as they refrained from acknowledging how social institution and human demand for water resources play a role in producing complications in water availability. To be developed in the following chapter, this lack of consideration of multiple sources of influence can work to impede adaptation action.

A competing and more prevalent discourse was identified in the sample group: scarcity as a socially-rooted phenomenon. Participants aligned with this coalition expressed notions of water scarcity as a product of heightened basin-wide demands, contamination from human activities, and inefficient uses of water. These actors shared a common view of local climate change impacts, but were confident that a poor governance of the basin's hydrological resources contributed more greatly to scarcity than do retreating glaciers.

This group offered key insight of scarcity as a product of overall rise in demand for water resources. Population increase, the presence of multi-level interests, and inefficiency within uses were posited as sources of higher demand. The relatively recent boom in the basin's urban hubs was cited as one origin of this heightened requirement of hydrological resources for human use: "The population has doubled from what it was back in the 1970's. And this isn't to complain [that] we're in a bad situation. The problem is that we have a poor governance of water. We are not doing it right" (PNH, September 2014). This representative of the Huascarán National Park Service was vocal about observed changes in glacier retreat in discussing observed environmental changes, but this was not offered as a valid driver of regional water scarcity. In opposition to the environmentally deterministic position, this participant pointed out social institutions' lack of capacity to manage a resource that is exceedingly stressed by shifts in coupled climate-social parameters.

A second focus of this discourse group centered on the multitude of activities that utilize the Río Santa's waters, identifying specific local, national, and global interests present in the basin. Subsistence agriculture received particular attention for largely sticking to customary flood irrigation techniques instead of transitioning to sprinkler systems. Participants tended to portray the traditional rural irrigation

practices as inefficient, displaying deep-rooted social biases, historically common to technocrats (Lynch, 2013). This, too, is an interesting assertion considering that rural agricultural production is dramatically declining while coastal agro-export project continue to expand, demanding ever higher volumes of water (Bury et al., 2013; Carey et al., 2014): "Throughout the *Callejón de Hauylas*, in the *Cordillera Blanca*, people still don't care about conserving water. They irrigate their crops in very irrational ways. They do not take into consideration the value of water, or that it could be of use to someone else" (UGRH, July 2015). Although the idea of wasteful water practices amongst subsistence farmers does not reflect the reality of decreasing subsistence production in the face of expanding agro-export operations, it serves to demonstrate that local activities are reported to have an impact on scarcity. Although it lends itself to further marginalization of rural groups, it highlights an awareness that demand for water can have a substantive impact on availability.

On a regional scale, Duke Energy was identified as source of open conflict and an institutional driver of water scarcity. Consistent naming of the *Cañón del Pato* hydro-electric station as perpetuator of regional resource conflict came as no surprise as its activities are geared towards extracting water resources to run its turbines for energy production. One environmental engineer and local sustainable development consultant relayed that, "There are [water] needs of the population. So, that is why conflicts are started. It is a difficult conflict because in the end, political decisions establish that [business] can come in and use Peru's [natural] resources. Political decisions will always favor big business" (Independent Engineer, September 2014). In this excerpt, the participant makes a connection between national water policy and the paradox of the "common good" as its outlined in the LRH. His reference is an example of the malleable use of this term, as the interpretation of the common good

often results in winners and losers. References to social drivers of scarcity through production demand shows that participants in this discourse coalition recognize a basin-wide interdependence among various uses. This idea was best verbalized by a provincial political representative when he commented, "We do not have a great quantity of water, and of late have been without water. So, we are not administering it well. And why are we losing water to light (sic), [when] we are not managing it for human consumption?" (Provincial Municipality, July 2015). This excerpt demonstrates a clear awareness that seemingly disparate activities that utilize water can impact one another when located in the same basin. This idea is an essential component of the group that asserts water scarcity as a socially-deterministic phenomenon.

A final intriguing point that was brought up by the social determinism group was scarcity as a function of political discord. It was widely perceived that decision-makers and other members of the greater Water Governance Network lack a level of coordination to formulate impactful adaptation policy in the context of a transforming water regime. One local government official claimed that the policy-makers and other entities with great potential for agency often slough off the responsibility of proactive adaptation initiatives to other actors:

> The other day I was in the street after a meeting with SERNAM-P and I asked the national director that was there: 'You are [in charge of] Huascarán National Park? And within the park there are glacial lakes. And are you concerned [about the lakes]?' [And he replied,] 'No, the glaciology unit oversees [the lakes].' He passed off the responsibility to UGRH … This is an issue. They are like, 'this doesn't concern me. It's your problem.' And it isn't like that. [Water scarcity] is everyone's problem. (Provincial Municipality, August 2015)

This lack of solidarity represents cause of concern for stakeholders in regional water. As this one local leader commented, issues in availability impact the basin as a whole. A lack of cohesion among those who determine the norms and regulations addressing

adaptation and water distribution have an immense impact on shaping how water is utilized among varying interest groups (e.g. Duke Energy). Challenges within governance institutions pose a major hurtle for achieving equitable water distribution. Narrowly viewing responsibilities in promoting availability as the role of one singular institution rather than an issue to be met with a concerted effort has the potential to indirectly implicate scarcity.

It is this split in the fundamental understanding of how scarcity is produced that hinders joint efforts for effective adaptation planning. Although actors that make up the Water Governance Network agree that the glacial-fed basin is undergoing a hydrological transformation resulting in stress on water resources, there are disconnects as to how this transformation is impacting the true physical availability. This underlying conceptualization of scarcity forms the basis of two emerging discourse coalitions. The discord between these two ideological groups is further compounded by how understandings of scarcity are derived and represented in conversation. As the interview data serves to highlight, there are important components of the Water Governance Network with comparatively high levels of agency for influencing policy such as environmental engineers and representatives of municipal governments that view water scarcity through an exceedingly environmentally deterministic lens. In contrast, other agents approach the theme with a more critical perspective, highlighting the low capacity of social institutions such as policy and distribution infrastructure in adapting to stresses in the hydrological regime. Additionally, this group underlines contamination and ever-increasing demand for water resources as key drivers of socially-rooted scarcity. As will be explored in the following chapter, the distinct and competing ideologies of these two

discourse coalitions influence how these two groups propose to adapt to a new water reality in the Río Santa Basin.

CHAPTER 3.

Perceptions Informing Solutions

Actors in the Water Governance Network agree that the Río Santa Basin is undergoing a radical transformation, with glacial retreat serving as the evidential crux of this shared socio-environmental reality. Despite a consensus on the issues at hand, disagreements remain on the phenomenon's implications for regional water resources. The network is polarized by contrasting opinions on the legitimacy of scarcity as an appropriate description of the regional hydrological situation. Contradicting perceptions of local water availability issues as environmentally rather than socially deterministic further compound this conceptual dichotomy. Conflicting notions of water scarcity as a function of climate change as opposed to being grounded in shortcomings of human systems work to entrench interest groups in competing discourse coalitions. This section is dedicated to exploring the connections between understandings, or the epistemologies of scarcity, and proposed courses of adaptation action for a future with considerably less available water.

Similar to the previous chapter, to strengthen the argument that conflicting views of scarcity can work to impede adaptation action, it was first important to establish that all participants shared a common envisioned future of a basin with significantly less available water. This foundation will help draw attention to the self-defeating nature of two competing scarcity philosophies existing within the Water Governance Network. This chapter explores how these contradicting core ideas obstruct the formation of effective solutions as they frame scarcity as either an environmental or social issue. The coexistence of these opposing views inherently impedes action because, as demonstrated in the interview data, participants' proposed measures reflect contradictory understandings of scarcity.

Shared Notions of an Imagined Future

The second half of the interview schedule attempted to paint a picture of the envisioned hydrological future among the members of the Water Governance Network. Similar to the consensus on contemporary environmental change, there was a surprising level of homogeneity among depictions of future scenarios of water in the Río Santa Basin. Just as actors had shared similar concerns for melting glaciers, all seemed to embody a common imagined future that consisted of considerably less available water. Regardless on one's position on the current state of scarcity in the basin, a true physical water deficit was expected to be the new reality by the end of the century. Environmental engineers, legislators, national park service agents, and professors all shared a common sentiment of uncertainty and anxiety about moving into a dry future.

The final question of the interview was broad yet, simple: "How do you envision the future of water in the Río Santa Basin?" This elicited participants to expand on opinions of future scarcity while also opening the door for a discussion on how the Water Governance Network should address this prediction. Like the mentions of melting glaciers, all participants envisioned a future with less water resources. This admission was met with anxiety about leaving future generations in a precarious hydrological situation. As one government representative confessed, "Little by little our water levels are reducing … Thankfully, I will not be here, but my children will be. And that is what worries me" (Provincial Municipality, July 2015). Indeed, an imagined future with no glaciers represented a major concern across the board. However, there was also an expressed concern for the capacity of policy-makers to deal with such a complex issue as several engineers insisted: "It is a worry for the future … Some leaders do not realize how things will be in the future, or even in three

to five years with growing water needs … The adaptation measures on the part of the local authorities are not advancing [and] it is slower than the impacts. So, we will have consequences" (UGRH, July 2015). This excerpt highlights both a concern for diminishing water stores while also addressing increasing social pressures on the basin's hydrological regime. Notions of uncertainty were expressed among all members of the Water Governance Network who took part in this study. Furthermore, there existed a serious concern surrounding the population's adaptation capacity.

Proposed Solutions Based on Perceived Roots of Scarcity

After establishing scarcity as the shared envisioned future for Río Santa Basin, the next question aimed at exploring participants' ideas about how society should move forward in dealing with this nearing reality: "What do participants plan to do to secure water resources?" The final question employed was, "What should be done to adapt to this future scenario of water scarcity?" The responses followed two lines of thought. The first entailed solutions aimed at securing water through technical projects such as the construction of dams and reservoirs. These proposals valued water storage as the key for stabilizing livelihoods in the basin. In contrast, the second trend of proposals emphasized the importance of improving how hydrological resources are managed. This included exclusively social elements such as regulating demands for water, facilitating an integrated governance framework, and forcing politicians to take water scarcity more seriously. Reminiscent of the binary understandings scarcity origins, these two suggested paths for successful adaptation focused exclusively on water availability as either an environmentally driven or socially-based issue.

Water-saving Technology and an Emphasis on Efficiency

Unlike the initial representations of scarcity in this sample set, proposals for addressing a future with diminished resources were split evenly among the twenty-five participants. When asked about appropriate adaptation measures, the construction of dams and reservoirs was considered a top priority among one side of the sample group. Glacial discharge running freely into the Río Santa was perceived as a waste of resources since it was not being utilized for production or human consumption. A popular proposal to "take advantage" of melt-off was through macro storage infrastructure. A representative from the DSA insisted that large-scale engineering projects held the key to ensuring salvation from scarcity: "So what should be done? We have to make reservoirs. We have to dam this water … so that the population can use it for irrigation and consumption. For [both ends]. So, something must be done. Some project. A reservoir. A dam" (Department of Environmental Health, July 2015). Other participants referenced macro-infrastructure projects in other countries, arguing that Peru should have be able to replicate these examples. One local policy-maker was particularly adamant about the necessity of dams for ensuring the basin's future: "We should make what they [construct] in other countries: dikes. Dams, right? To have water for the future. We are not [currently] building these dams, [but] they are incredibly important" (Provincial Municipality, August 2015). In these proposals, an engineer's solution was provided for an engineer's problem. In other words, the future of water scarcity was viewed as a future complication solely dependent on natural processes such as climate change and the ensuing melting of glaciers. Storage projects such as dams and reservoirs represented viable solutions an environmentally framed issue.

Suggestions of dams and reservoirs were complemented by calls for the wide-spread implementation of efficient irrigation technology. This was offered by participants who also pointed to rural subsistence farmers as proponents of scarcity through the use of flood irrigation techniques. As an alternative to field inundation, mechanisms such as sprinkler systems and drip irrigation apparatuses were expressed as necessary transitions for watering practices. A JUCH representative made this point abundantly clear as he outlined his personal vision of future adaptation strategies: "Well, the steps … One is damming the glacial lakes. Others: construction of reservoirs, installation of modern irrigation systems. That is what we are most interested in. [With these strategies] we can prevent water scarcity" (JUCH, August 2015). Although sprinkler systems are a form of mitigating excessive demands for water, similar to storage infrastructure, they are forms of technology that refrain from addressing scarcity as a social issue. Like dams, these efficiency focused mechanisms would do little to promote dialogue among stakeholder of water resources.

These technology-centered solutions stemmed from visions of scarcity as an issue that can be solved quantitatively. In other words, engineering ways of retaining water in reservoirs or promoting efficient uses in irrigation would serve as viable means of overcoming scarcity for this group. This does not, however, take into consideration the human variables that other participants sought to address through their proposed solution for the future.

Integrated management, handling demand, and promoting political action

On the opposite end of the spectrum, a second group of participants proposed addressing underlying social drivers of scarcity such as demand, inequitable governance, and a lack of political involvement. Methods of mitigating a water scarce future were noted as being dependent on proactive government leaders. Participants

expressed concerns over the apparent lack of concern among bureaucrats in addressing the slow onset issue of water scarcity. This identified as a major challenge for promoting basin-wide adaptation to diminishing water resources and was expressed throughout the interviews:

> I think the problem is that there is no regional political push for an efficient management of water … On one side you have [private water distribution companies (EPS Chavín)] that only think of their interests. On another side you have agriculture. On another side you have hydro-electricity. Everyone has to unite. Currently there is no political push for an integrated management of water resources. (Independent Engineer, August 2015)

Although climate change impacts are tangible, especially with clear signs of glacial retreat, local, regional, and national politics have done little more than talk about the pending reality of scarcity. As highlighted earlier, current Peruvian water law requires that each basin to form a "water council" with representatives from all interests groups. The goal of this table would be to promote equitable distribution of hydrological resources in a basin-specific area. Although governance framework was established by law in 2008, along with National Water Authority, a water council has yet to be formed in the Río Santa Basin. Participants in the socially-focused solution group emphasize dialogue among all members of the Water Governance Network in order to prosper in the coming decades. However, this will remain a law on paper as long as there is not deliberate political action to carry out the creation of a basin-wide water council.

Building upon the discontent with political action was an expressed aggravation of how bureaucrats take advantage of the population's collective sense of anxiety as people continue to see glaciers melt. Politicians implement climate change as a buzzword within the political arena as a means of harvesting votes through promises of large infrastructure projects such as reservoirs. Despite, proposals aimed

at "fighting" climate change, political leaders seldom address the ways in which human activity perpetuates scarcity:

> Climate change, from my point of view, is also used politically, right. Politically in order to gain resources for projects that, many times, are not properly designed … No one says, for example, we have to improve [inefficient] irrigation practice[s] [or that] we have to clean up our rivers [and] create sewage treatment plants. No one talks about these things. (PNH, July 2015)

Several participants in the socially deterministic group stressed that misdirected and misinformed political action often proves far worse than inaction. As described in the mapping of the Water Governance Network, actors involved in active research are similar to back seat drivers. They can suggest what action should be taken within the political realm, but they have no real capacity to initiate policy. This is perceived as a hurdle for successful adaptation.

Finally, managing water demands among the various activities present in the Río Santa Basin was considered the most important measure for dealing with increasingly stressed water resources. Socially deterministic views of scarcity take into account the interdependence of all activities that utilize the basin's hydrological resources. This was identified through accounts of Duke Energy occasioning conflict as a result of their massive demand and control of the Santa's water. Actors in this proposal group stressed the importance of considering demand as a component of water management that will become increasingly crucial in the coming years. As one local independent engineer expressed, "According to a report by ANA, 84% of water is used in agriculture … Of this volume, some 65% is lost. Its lost … It is clear that what is lacking is management. And, above everything, a management of the demand – that is, a better use of water. That's the idea" (Independent, August 2015). Rather than focus on quantifying water availability, which, all actors conveyed as important, this group suggested that quantifying demand should be given priority. Identifying

how much water different activities need and how those uses impact other stakeholders will need to be further developed in the coming years.

In offering proposals for action for a shared envisioned future of reduced basin-wide water availability, two groups coalesced around the pre-established epistemologies of water scarcity. In alignment with understandings of scarcity as a strictly environmentally driven phenomenon, actors proposed engineering-based solutions that focused on retaining the physical resource. Storage technology such as dams and reservoirs accompanied by efficiency mechanisms in irrigation would serve to address scarcity as a strictly natural phenomenon. In contrast, a second proposal group emerged, aligning itself with the expressed idea that water scarcity is intimately tied to human activities and the social institutions that strive to govern and allocate it. Rather than demonstrate concern for diminishing streamflow, this socially-based proposal group supported the idea that managing demand is more important than amassing water, especially as an adaptation method. Political action and a strong organization among the Water Governance Network were pushed as key necessary components in avoiding resource conflict and promoting equitable distribution in the near future. These two competing proposal groups are reflections of the two existing conceptualizations of water scarcity within the Water Governance network of the Río Santa Basin.

CONCLUSION

Moving into the new millennium, the glaciers of the *Cordillera Blanca* will continue to retreat. Research through entities like TARN and the UNGH will keep up efforts to understand more fully how the inevitable future of scarcity will play out in the short term. As the populations grow in the urban hubs of the upper-basin, coastal agro-export projects will expand to meet market demands, and Duke Energy will position itself to control the level of the Santa River to power electricity generating turbines. It is unclear if ANA will make any adjustments as a promotor of equity and regulation, but it is likely that it could come to embrace more fully its authoritarian role. Regardless of the institutional path of ANA, it remains uncertain if the voices of Water Governance Network's backseat drivers will ever be heard by the policy-makers and engineers in control of the political wheel. Despite these uncertainties, it is clear that the shared envisioned future among the participants in this study will slowly transition from a distant worry to an immediate reality. The Río Santa Basin is on the brink of scarcity.

As demand for water increases and glacial contributions become exceedingly less significant, conflicts of interest, restrictions on autonomy, and public health will become issues of concern. Although there is plenty cause for worry, there is also much hope for the Río Santa Basin. Reflecting a popular notion among the participants in this study, a representative of the Provincial Municipality of Huaraz expressed it best when he emphasized, "Climate change is done. So, the people have to be aware that the problem is the poor use and administration of water. Climate change is climate change, that is, it is going to run its course …" (Provincial Municipality, August 2015). Profound in its frankness, this statement highlights the hidden potential of human agency in the face of seemingly uncontrollable problems

such as global climate change. This study supports the idea that resource management in a climate change context is not a purely environmental problem, but a socially-rooted issue that is highlighted by climate induced stress on natural resources. If issues such as governance, perspective, and miscommunication represent the true barriers to adaptation, then, as this policy-maker suggests, the solution should be achievable. After all, local and regional social systems are far easier to influence than a global climate system. This idea, however, should not underestimate the challenges that social barriers represent.

It would be exceeding my level of expertise to attempt to offer any significant recommendation. I will, however, borrow the words of an environmental engineer who shared what he planned to vent to leaders at an upcoming Municipal Environmental Commission meeting: "Sirs, less blah blah blah! What is your plan? What is your aim? What are your goals? What is most important to you and what do you plan to do about it?" (Independent Engineer, August 2015). This expressed frustration with political non-action and lack of direction would be an appropriate area for of focus for overcoming social barriers to adaptation. This study has merely begun to explore the social undercurrents that have a tremendous influence on water resources in this Andean hydrological regime. A more inclusive headwaters-to-coast study should be carried out. Broadening the data set to include voices, perspectives, and opinions of additional actors will strengthen the mapping and understanding of the Water Governance Network. This, too, will also lend itself to a further solidification of the emerging discourse coalitions that have only been loosely outlined in the present study. In spite of the seemingly binary nature of perspectives in the Water Governance Network, there exists an ample middle ground of opinions. The discourse coalitions outlined here should not be considered as two purist ideologies of

scarcity and adaptation. Stakeholders' opinions are multi-faceted, and this complexity should be taken into account. A firm understanding of how these varying interest groups interact and influence one another is essential in understanding how water scarcity will develop in the Río Santa Basin.

This study merely engaged on one level by loosely employing constructionist frameworks through discourse analysis. For future research objectives, a critical discourse analytical approach could provide better insight on how representations of regional water scarcity produce winners and losers among the various stakeholders in hydrological regimes. Recalling the malleability of the "common good," it would be helpful to identify ways in which various actors representing multi-level interests are prioritized over others, which is the central concern that emerged in this study. A more critical approach could offer important recommendations for moving towards true equity in hydrological resource management, an issue that will become increasingly pressing as glaciers continue their retreat and scarcity becomes an emerging global issue.

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APPENDIX A: IRB Approval

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

EXEMPT APPROVAL NOTICE

7/13/2015

Investigator(s): Sam Hulsey
Department: Global Studies & Cultural Geography
Investigator(s) Email: skh4p@mtmail.mtsu.edu
Protocol Title: "Blame it on the Weather: Challenges to Climate Change Adaptation in the Callejon de Huaylas Region of Ancash, Peru "
Protocol ID: 15-325

Dear Investigator(s),

The MTSU Institutional Review Board, or a representative of the IRB, has reviewed the research proposal identified above and this study has been designated to be EXEMPT.. The exemption is pursuant to 45 CFR 46.101(b) **(2) Educational Tests, Surveys, Interviews, or Observations**

The following changes to this protocol must be reported prior to implementation:

- Addition of new subject population or exclusion of currently approved demographics
- Addition/removal of investigators
- Addition of new procedures
- Other changes that may make this study to be no longer be considered exempt

The following changes do not have to be reported:

- Editorial/administrative revisions to the consent of other study documents
- Changes to the number of subjects from the original proposal

All research materials must be retained by the PI or the faculty advisor (if the PI is a student) for at least three (3) years after study completion. Subsequently, the researcher may destroy the data in a manner that maintains confidentiality and anonymity. IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

NOTE: All necessary forms can be obtained from www.mtsu.edu/irb.

IRBN005 Version 1.0 Revision Date 06.03.2015

APPENDIX B: Semi-structured Interview Guide

1. Can you tell me a bit about your organization and your role there?

2. Why is water important to your organization? How do your activities relate to water management in the Río Santa Basin?

3. What are the impacts that you and/or your organization have observed in regards to climate change? (Agriculture, migration, water availability, etc.)

4. How would you describe the current situation concerning water in the Callejón de Huaylas / greater Santa Basin?

5. Is there sufficient water to meet the needs of all users, or would you say there is a deficit?

6. *(*If participant responds deficit)* In your own words, could you define a water deficit? What is causing a deficit in this specific case? That is, what is the source of deficit here in the Santa Basin?

7. Have you noticed differences in natural processes like seasonal rains? How so?

8. Have you observed differences in glacial retreat / melt-off? How so? What are the current / future implications of melting?

9. From your personal perspective, how effective is the water distribution infrastructure in the Callejón de Huaylas and the greater Santa Basin? Is it functioning efficiently? If not, why? Is there room for improvement? How so?

10. What is the role of the Local and National Water Authorities? (ANA/ALA)

11. In your opinion, are ANA/ALA fulfilling their responsibility in overseeing hydrological resources? If not, why?

APPENDIX C: Informed Consent Form

Consentimiento Informado

Middle Tennessee State University

Título del Proyecto: Echando la Culpa: Desafíos a la Adaptación al Cambio Climático en el Callejón de Huaylas

Propósito del Proyecto: En este proyecto se trata de analizar las perspectivas de los varios actores de la red de agua en el Callejón de Huaylas acerca de los impactos que el cambio climático ha tenido, y sigue teniendo en la disponibilidad del agua.

Métodos: Se implementa entrevistas informales como el método de investigación en este proyecto. El investigador principal tratará de realizar entrevistas con varios actores de la red de agua en la región del Callejón de Huaylas. Para mantener una alta nivel de precisión en la recopilación de información, cada entrevista será grabada con un grabador de voz. La grabación solo será usada por el investigador principal para repasar y sacar información de la entrevista. No va a ser usado en una manera en que el entrevistado puede ser identificado por su voz.

Riesgos / Beneficios (del participante): En este proyecto el investigador solo quiere hablar de la perspectiva del participante sobre los problemas existentes del agua. Quiere que el participante hable del rol del cambio climático en la situación actual, describa la situación del agua, e identifique otras raíces de los problemas como los ve el participante. En este sentido, no existen riesgos al participante ni beneficios directos. Al contrario, la información que el participante provea puede ser incorporado en un análisis de la situación del agua, indicando otras fuentes de problemas que contribuyen a la escasez del agua.

Confidencialidad: El investigador principal no usará nombres de los entrevistados ni pondrá información en el informe final por la cual el entrevistado podría ser identificado. Toda la información sacado por el investigador principal será guardado en un disco duro externo que está protegido por una contraseña. Además, toda la data de la investigación será guardada con Dr. Doug Heffington por 3 años después de la terminación del proyecto.

Investigador Principal / Información de Contacto: Samuel Hulsey / samuelkhulsey@gmail.com; Tele. Perú: (51) 946-665-837 EE.UU (01) 615-587-8559

Dirección: 692 Hunt Lane, Lebanon, Tennessee 37090, USA

Participación en este proyecto es voluntario y negando participar o retirándose de participar en cualquier momento del proyecto no involucrará una penalidad ni una pérdida de los beneficios de los cuales usted podría ser intitulado. El investigador va a intentar proteger la información personal del participante para que se quede privada, sin embargo no se puede prometer una privacidad completa, por ejemplo, la información que se provenga puede ser compartido con el Comité de Revistas Institucionales de la Universidad de Middle Tennessee (MTSU). Por ser caso que se tenga preguntas durante o después de participar en el proyecto, se puede contactar el Investigador Principal (Samuel Hulsey) directamente, como está indicado arriba. Por información adicional acerca de confinamiento o sus derechos como un participante de este proyecto, se puede contactar la Oficina de Conformidad de MTSU: (01) 615-494-8918

Consentimiento:

Yo he leído la información arriba y mis preguntas han sido abordados a mi satisfacción por el Investigador Principal (Samuel Hulsey). Yo creo que tenga un entendimiento del concepto, los beneficios y los riesgos del proyecto, y yo doy mi consentimiento informado para ser un participante en este proyecto.

Firma: _____

Fecha: _____