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WATER IS LIFE: CLIMATE CHANGE, GLOBALIZATION, AND ADAPTIVE RESOURCE GOVERNANCE IN PERU'S SANTA RIVER WATERSHED

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ABSTRACT

Water is Life: Climate Change, Globalization, and Adaptive Resource Governance in Peru's Santa River Watershed

Adam K. French

The converging impacts of climate change and economic globalization are driving adaptive resource governance through both conflict and institutional innovation on Peru's Pacific slope. Linking social and ecological systems, freshwater is particularly critical and becoming more scarce in this region due to both supply and demand-side pressures related to global change. As accelerating glacial recession reduces vital reserves stored in the natural water towers of the Andean cryosphere, the burgeoning Peruvian economy exerts growing demand on existing hydrologic supplies while causing severe impacts on water quality. In this setting, diverse actors are increasingly connected across geographic and political scales and economic sectors through reliance on shared flows that know no such boundaries. In a context of mounting hydrologic crisis, the Peruvian state passed a new water law in 2009 that restructured and rescaled national water governance through a model of integrated management at the level of the country's principal watersheds. The implementation of this model has proven difficult and remains incipient, however, and water conflicts continue to rise. This dissertation research examines global change and contemporary

resource governance in one of Peru's most important Pacific-draining basins, the Santa River watershed. Drawing upon the research tradition of political ecology, the study employs interdisciplinary and participatory approaches to explore shifting resource access and institutional innovation and the implications of these processes for resource governance and social vulnerability. Through examination of theoretical perspectives from diverse disciplines coupled with the findings of more than two years of empirical fieldwork, the dissertation research highlights the socio-natural character of resource governance and social vulnerability and analyzes the complex governance networks and processes emerging through adaptation to linked processes of global change in the Santa River basin.

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INTRODUCTION

From conversations with Andean farmers to protest banners in desert cities, the phrase "*agua es vida*,"—"water is life"—is increasingly prevalent across the western slope of Peru. This truism, however simple or cliché it may seem, expresses urgent concern in this region where water is increasingly scarce due to the conjuncture of supply and demand-side pressures linked to converging processes of global change. On the one hand, marked climate change and the recession of glaciers that serve as natural water towers are leading to rapid declines in precious hydrologic reserves. These glacial resources and the meltwater they provide are vital not only in the Andean highlands but also on the Pacific coast, a desert region that supports 70% of Peru's population and 80% of its GDP-producing economic activity but contains only 2% of the country's freshwater (Peru 2004). On the other hand, the impacts of globalization are compounding climate change impacts as demand for water rises across diverse sectors of the country's burgeoning economy. Meanwhile contamination linked to mining, sewage, agricultural runoff and other anthropogenic causes is also increasing (Bebbington and Bury 2009, Vergara 2009). In light of these converging pressures on hydrologic resources, western Peru has been described as one of the world's most vulnerable regions to future water stress (Painter 2007).

This dissertation explores contemporary resource governance in one of western Peru's most important Pacific-draining watersheds, the Santa River basin. The Santa is the second largest river in western Peru and has the most consistent

discharge of all western rivers due to glacial runoff from the Cordillera Blanca, the world's largest remaining concentration of tropical glaciers (Vuille et al. 2008, Mark et al. 2010). Given the basin's significant hydrologic reserves, visions for regional development premised on Santa River water emerged early in the 20th century, with a proposal to build a hydropower plant along the river's middle reaches that would fuel the growth of regional industry and spur the modernization of the countryside. Bringing this project to fruition required nearly half a century and the negotiation of many setbacks but was eventually accomplished, and the power plant continues to contribute to the growth of the department of Ancash and its neighbors while supplying critical electricity to the national energy grid (Carey 2010) .

Many other developments, from large mines to coastal plantations have more recently been established in the Santa basin, especially since the liberalization of the national economy that began in the 1990's (Bury et al. 2013). This ongoing growth increasingly links a broad range of actors and water uses from the glaciated sub-catchments of the Santa's highland tributaries to the large urban centers of the arid coastal shelf to the dispersed markets providing global consumers with commodities like gold and pickled asparagus. The current intensification of water use in the Santa coupled with increasing concerns about long-term supplies in the context of glacial recession has led to widespread concerns of water scarcity and crisis in the future as well as to growing conflicts between users from different economic sectors with incompatible visions of how water should be governed (Carey, French and O'Brien 2012). The Santa watershed is thus an emblematic case of the resource governance

challenges facing other glacial-fed basins in western Peru and elsewhere in the world and provides clear rationale for the development of integrative water management strategies. In light of its economic importance and rising conflicts, the Santa was selected as a pilot site for the attempted implementation of new water governance approaches mandated by the 2009 Peruvian water law—the first major reform of Peruvian water legislation in 40 years. The system of water governance that the new law establishes is closely aligned with the paradigm of Integrated Water Resource Management (IWRM) that has become increasingly influential at the global scale in recent decades despite significant critiques of its efficacy and outcomes (Biswas 2004, Goldman 2005, Conca 2006).

In broad terms, this dissertation examines the diverse and converging impacts of climate change, economic globalization, and legal reform on the ways in which resources, and especially water, are valued, governed, and used in the Santa River watershed. Employing a political ecology approach, the study draws on critical theoretical perspectives, research methods, and empirical findings from across multiple disciplines in an effort to present a grounded and thorough treatment of the diverse forces shaping resource availability, use, and governance in the study region. In so doing, it explores a variety of questions, ranging from empirical queries about shifting climatic and hydrologic regimes and resource management strategies to ontological and epistemological questions about Nature and the production of knowledge and expertise to normative debates over where scarce water should flow. While this work focuses on resource governance in the Santa River watershed

specifically, its conclusions speak to global challenges of governing resources across geographic and political scales in a context of rapid and unprecedented environmental and economic change.

Before describing the dissertation in further detail it is worth explaining briefly how I decided to focus on the region and the particular topics that emerge in the chapters to follow. This project has grown out of more than a decade of academic and personal engagement with Peru's Cordillera Blanca and the Santa River valley. These experiences began with an initial visit to the region in 1999 as part of a Thomas J. Watson Fellowship focused on conservation areas in Latin America. Specifically, I had been drawn to the region by Huascaran National Park, the 340,000-hectare UNESCO Biosphere Reserve that encircles the great majority of the Cordillera Blanca. Upon arrival to Huaraz, the urban center of the region and the location of the Park headquarters, the first person I met—by sharing a table in a local pizzeria—recounted his experience of watching a team of climbers be crushed under falling ice several days earlier on Peru's highest mountain, Huascaran Sur (6768 meters). As a budding mountaineer the story made an impression on me; and as I learned more about the region, I became fascinated by its grisly history of natural disasters and the high levels of risk that accompany daily life in this part of the Andes. Captivated by the impressive landscapes and the fusion of rural Andean life with diverse elements of the outside world (e.g. myself), I returned in 2003 as part of a Master's degree that focused on tourism impacts in the region. During this exploratory work and two

additional summers of applied research[1], I became increasingly aware of the rapid glacial melt impacting the mountains and highland watersheds of the region, and I began to realize the scale of local concern over these changes.

In 2007, with serendipity, I had the opportunity to join a transdisciplinary research group beginning a study of hydrologic change and its impacts on rural livelihoods in the Cordillera Blanca for my PhD study. Since that time, I have been continuously involved in this project with my advisor Jeffrey Bury, fellow geographer Bryan Mark, and geochemists Jeffrey McKenzie and Michel Baraer. More recently, environmental historian Mark Carey and biogeographer Kenneth Young have joined us in expanding this work to focus on the resilience and adaptive capacity of the hydro-social system at the scale of the Santa watershed. This innovative collaboration integrates a wide array of field methods to examine questions related to glacial change, stream discharge, water quality, land cover change, human perceptions of climate change, sources of livelihood vulnerability, and histories and futures of adaptation to global change. My principal role in the early stages of the project was in assessing local households' perceptions of environmental change and livelihood vulnerability in 3 case study communities. I helped design the questionnaire, conducted dozens of household surveys and interviews, and supervised a team of Quechua-speaking field assistants. This work was undertaken over three summer

[1] These experiences were diverse and included delivering informational materials to remote rural communities and constructing a prototype composting toilet system in one of the valleys of Huascaran National Park. The latter process was invaluable in its lessons for working with both Peruvian bureaucracy and rural communities.

periods, in which we surveyed more than 100 households and conducted dozens of interviews with key informants. During this time, I was also involved in collecting a wide array of hydrologic and climatic data, experiences through which I learned important details about the geo-physical characteristics of the region as well as new methodological approaches.

After several years spent working closely with this larger team, I designed my dissertation to build upon our collaborative work by looking in further detail at local-level adaptations to changing water availability as well as at institutional responses to the mandates of the new 2009 water law in two case-study communities with recent histories of water conflicts. To accomplish these goals, I planned a cross-scalar and multi-method analysis in which I would map local water systems and take hydrologic measurements of monthly stream flows in important water courses, conduct interviews and participatory risk-mapping activities with local residents, undertake historical analyses of water system development and management, attend ongoing water committee meetings, and conduct interviews with external actors involved in water governance in the case study sites. This multi-pronged approach would provide an understanding of hydrologic change and adaptive water management at the local level while also examining how local-level institutions were linked to larger actor networks through water governance processes.

Not surprisingly, the dissertation research evolved somewhat differently than I initially envisioned. I discovered early on, for example, that the majority of people in my case-study communities reported little in the way of consistent change in their

access to water. Respondents thus had little to say about adaptive measures beyond the typical adjustments made during dry years, which are relatively common in the highly variable climate regime of the Central Andes. Many respondents in fact mentioned the abundance of water available, though in some areas many also indicated that there was less water than in the past. This finding was not entirely surprising given that enhanced glacial melt would add water to the local hydrologic regime until the remaining glacial cover reached a critical threshold (peak water), after which meltwater contributions would begin to decline. In catchments with high levels of remaining glacial cover, which characterized one of my principal study sites, absolute water scarcity would not likely emerge as an issue until much more of the glacier cover had melted away. In research sites with far less glacial cover, declines relative to historical supplies were noted but, in general, there was still sufficient water for most local needs.

Other factors also complicated my initial plans. I found, for example, that local water user committees were not excited to undertake the monthly stream discharge monitoring that I had hoped would become a key participatory element of my research. In one community, not only did they seem uninterested in this data collection, but they also declined to grant me permission to conduct these measurements in their territory. While I was surprised by this response initially, especially after having cleared the plan with local leaders, I would eventually come to realize that the locals' unwillingness to engage in these activities was linked to their distrust of me as an outsider. The community in question was involved in ongoing

conflicts with both a large transnational energy firm and a foreign mining company, and, I would later learn—after more than eight months of interacting and building trust with residents—that many locals initially suspected that I was a spy from one of the corporations.

Fortunately, as these challenges to my original research plan emerged, they were offset by opportunities to study adaptive water governance through other aspects of the project. Most importantly, the conflicts related to hydropower and mining in my case-studies both continued to evolve and draw in new actors, providing windows into the governance processes and the multi-level institutional networks engaged in conflict resolution in each case. To study these conflicts, I attended dozens of formal meetings over 20 months of fieldwork, spent hundreds of hours in interviews and conversations with a diversity of respondents[2], took part in site inspections and monitoring activities, and compiled a substantial archive of meeting notes and official minutes (*Actas*), actor communications, historical accounts, technical studies, legal documents, and press reports. My dissertation fieldwork also coincided with the beginning of the process, mandated under the new water law, to form a watershed council at the level of the entire Santa basin. Through my relationship with Huascaran National Park, I was invited to participate in the first regional gathering to form this council, and this initial access allowed me to establish contacts that permitted my

[2] I interviewed an extremely diverse array of respondents, including campesinos, local water managers, community leaders, regional level politicians, specialists at all levels of the National Water Authority's bureaucracy, representatives of numerous other state ministries and authorities, corporate public relations specialists and facility operators and technicians, engineers, legal experts, scholars, NGO staff, and, of course, taxi drivers.

ongoing participation in this process as it evolved over the following year (October 2010-November 2011).

My consistent presence and transparent participation in these diverse events—almost always as the only *gringo* in the room—helped me build relationships (as well as some enduring friendships) and cultivate trust that greatly facilitated many other aspects of my research and ongoing work in this region. I thus gradually overcame many local suspicions about my affiliation with transnational companies and established a rapport with a wide range of actors, both at the local level of my case studies and in the broader governance networks upon which my work increasingly focused. I also began to feel more welcome in local communities and their public fora, which enabled me to undertake the participatory risk mapping activities that I had planned as well as a wide range of key informant interviews at the local level. Results from these activities emphasized concerns about the impacts of both climate change and economic globalization on local livelihoods, though these processes were generally identified as specific actors and impacts (e.g. the mine or extreme frosts). Residents also expressed concerns about how the new water law would impact their usufructuary water rights and many feared water privatization in the future. It also became clear that most residents had little firsthand knowledge about the new law. These findings drove me into more detailed analysis of the 2009 water legislation as well as the prior legal regime for water governance in Peru.

It is my hope that the preceding details will provide the reader a sense of the personal context from which the following work has emerged. The three chapters

included in the dissertation are each intended to stand alone but also enter into dialogue with one another. The first chapter presents a critical historical analysis of the evolution of Peruvian water law from the early 20th century to present, highlighting the processes leading to the passage of the 2009 Hydrologic Resources Law and the ambiguities and contradictions of this new legislation. This chapter also discusses the fundamental role of water in economic development and territorial dynamics in the 20th century, in Peru and beyond, and explores the historical formation of the Peruvian hydraulic bureaucracy as well as its current institutional form and role in promulgating a vision of Integrated Water Resource Management (IWRM) in Peru. The chapter concludes with an examination of important challenges to the implementation of the 2009 law and the IWRM model it promotes in the Santa River watershed of north-central Peru.

The second chapter examines a specific case of the "neoliberalization" of Nature—the privatization of control of water from glacial Lake Parón in the Peruvian Andes—and analyzes the socio-natural conditions and networks that have contested, resisted, and transformed this process over time. Drawing on a Polanyian approach to nature-society dialectics, the chapter explores how neoliberal policies coupled with technocratic expertise worked to disembed the lake's water from its existing hydro-social context, leading to a countermovement to reestablish local control of the resource. Through a detailed analysis of hydrologic and geophysical conditions at the lake and their linkages to histories of social regulation and resistance I show how this attempted neoliberalization process is inherently shaped by socio-natural webs of

relation that bind human and Natural actors through the metabolism of social (re)production.

In the third chapter, I look broadly at the converging impacts of climatic change and economic globalization on the Pacific slope of Peru, focusing especially on how these processes are affecting rural livelihoods. The chapter begins with an overview of theoretical approaches to human vulnerability to global change and highlights the critical importance of access to resources in determining both vulnerability and adaptive capacity. The chapter then turns to a multi-level historical and empirical analysis that begins with a discussion of global change at the level of western Peru and scales down to the level of the Cordillera Blanca and further still to the household level in two case-study communities in this region. These nested analyses illustrate the extreme heterogeneity of vulnerability in the study region, both between and within communities and even households, and highlight the importance of feedbacks and synergies between diverse impacts of global change processes.

Together, these three chapters illustrate many of the theoretical engagements and analytical and empirical approaches that I have drawn upon and developed in my graduate study. By integrating materials and techniques from geography, political economy, environmental history, legal analysis, sustainability science, hydrology, glaciology, etc., this work practices the transdisciplinarity critical to what I consider to be political ecology. Readers from the Department of Environmental Studies at UCSC (my degree-granting department) will likely note that there is no specific "natural science" chapter included here to satisfy our interdisciplinary requirements.

Instead, the work presented intends to weave the social and natural sciences together throughout in ways that transcend more traditional disciplinary approaches. This approach highlights the complex socio-natural character of the productive metabolisms that are central to our work in environmental studies and allied interdisciplinary fields.

While I have chosen not to include previously published materials in this document, several recent publications have included work from the dissertation, including both peer-reviewed journal articles and materials addressed to both policy-makers and the general public[3]. Had I more time, I would have liked to include two additional chapters in this work, one detailing the (still incomplete) process of watershed council formation in the Santa basin and the other focusing on the collision of incompatible visions of social and economic (re)production occurring through the global mining sector's ongoing expansion in the rural Andes. Eventually, all of these stories will be told, though the exact form in which they will emerge in print is still up for some debate. In any case, while the chapters that follow formally constitute the dissertation, they are but one aspect of what I hope to be a long career of research and writing about global change and water governance in this region of the Peruvian Andes that has, over the last decade, become an important and influential part of my

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[3] See, for example Carey, M., A. French & E. O'Brien (2012) Unintended effects of technology on climate change adaptation: an historical analysis of water conflicts below Andean glaciers. *The Journal of Historical Geography*, French, A. (2012) La Laguna Parón: hacia la hestión integrada? *La Revista Agraria*, French, A. & J. Bury (2009) Livelihoods at Risk: Agricultural Viability and Converging Climatic and Economic Change in the Central Andes. *Mountain Forum Bulletin,* Vol.IX**,** 7-9.

professional and personal life. Moreover, I hope that the findings presented in these pages will contribute positively to the adaptive governance of resources in the Santa River watershed and, above all, to the wellbeing of the people with whom the work is centrally concerned.

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CHAPTER ONE

Law and Disorder:
Legal pluralism, cultural hybridity, and the conflicted quest to bring water to market in Peru

I. Introduction

Water scarcity is an increasingly critical problem on the western slope of Peru. While this Andean nation boasts high per capita water availability due to precipitation on its eastern (Amazonian) slope, less than 2% of the available freshwater flows to the Pacific side of the continental divide where roughly 70% of the population and 80% of the GDP production of the country is located (Peru 2004) The glaciers of the central Andes have long played an important role in buffering this lack of freshwater on the arid Pacific slope, especially during the tropical dry season, but these natural water towers are declining markedly as global climate change impacts the region. Meanwhile, in recent years Peru's economy has grown rapidly and the demand for water in export sectors such as large-scale agriculture and mining has increased as water contamination has also burgeoned.

While these dynamics are leading to growing worries over an impending water crisis, such concerns are not new in western Peru. Given the stark geographic division in water availability, the control and provision of this vital resource has been a central necessity of human civilizations in the region for millennia (Dobyns and

Doughty 1976, Klaren 2000, Dillehay and Kolata 2004). Since well before the formation of the Peruvian state, water has been a key component of territorial development schemes, and as the post-independence political landscape has oscillated from liberalism to military-led agrarian reform and back to doctrinaire neoliberalism and beyond, so too have strategies of water access and control been transformed through both national legislation and shifting local practices (e.g. Mitchell and Guillet 1994, Oré 2005, Boelens, Getches and Guevara-Gil 2010). Currently, as competing values and demands over water fuel some of the country's most explosive and intractable socio-environmental conflicts, the use and management of the resource has become the target of a sweeping program of legal, economic, and socio-cultural reform enshrined in the 2009 Hydrologic Resources Law (Law N^{o} 29338 hereafter).

Law N^{o} 29338, which marked the first comprehensive reform of the country's water legislation in forty years, was finally passed in early 2009 after a prolonged and contested process. The law is surprisingly general and unsettlingly ambiguous in its treatment, leaving a great deal of definition and clarification up to its implementing legislation as well as to the National Water Authority (ANA)—the state bureaucracy tasked with water management (Del Castillo 2011, Peru 2009). Despite this ambiguity, the guiding influence of the global paradigm of Integrated Water Resource Management (IWRM) and its emphases on efficiency and participatory, multi-sectoral water governance at the scale of the watershed is apparent from the outset. Promoting discourses of "water for all" (*agua para todos*) and a "new water culture" (*cultura del agua*), the law attempts to establish new norms and subjectivities among

water users at a variety of governance levels. Not surprisingly, this process has engendered resistance and conflict, as existing cultures of water use management clash with the state's new vision for water governance.

In this paper, I examine the diverse influences that have contributed to this transformation of the legal framework for Peruvian water management, placing the shift along a trajectory of historic legal and political economic developments related to water. In so doing, I explore how, since the early 20th century, both material and ideological power over water has been a crucial focus for specific development and modernization projects advanced by networks of politicians, elites, engineers, and, more recently, international banks and development agencies. The analysis is particularly concerned with the legal and institutional context established by Law Nº 29338 as well as the conditions and contradictions that emerge as the law's implementation is undertaken in settings of legal and cultural pluralism, where diverse values and customs over water mingle and hybridize, at times subtlety and gradually and at other moments in explosive conflicts.

The paper is divided into three sections. The first section discusses theoretical and empirical research on historical trends in water governance, including the emergence of hydraulic bureaucracies, the formation of global water policy advocacy networks, and the spread of IWRM. The paper considers these processes in relation to the 20th century's drive to control water for human gain through the application of science and technology, as well as more recent strategies that emphasize market-based solutions to emerging problems of water scarcity. The second section presents

an overview of the evolution of water legislation and governance in Peru since the early 20th century. This section illustrates the ways in which water law in Peru has been linked to particular models of development enacted by powerful political and economic interests and supported through scientific innovation and techno-expertise. It also shows that despite the growing number of actors involved in Peruvian water governance and the legal tenets mandating decentralization and participation, the state remains the pivotal actor through which others must negotiate. This section will strike some as long-winded and overly focused on a legal fiction rather than the negotiated and hybrid realities of legal pluralism that emerge in the process of governance. I include these details to show how diverse actors and institutions have gained formal authority over water—or at least an official role in hydrologic governance—through specific changes in national water legislation in particular historical moments. The section also highlights important critical work by Peruvian scholars, much of which has not appeared in the Anglophone literature. The paper's final section provides an overview of contemporary water governance dynamics in one of the most important watersheds on Peru's Pacific slope, the Santa River basin. This section describes the social and physical setting of the watershed and briefly explores water's role in the development of the region before examining some of the implications and challenges arising from efforts to implement Law N° 29338 in a setting rife with competing values and cross-level political conflict.

II. Water, power, and history

The power of water over history is a very old discovery.

--Donald Worster, *Rivers of Empire*

That water plays a critical role in shaping society, culture, and space is hardly a novel insight. As a vital component of all life and most productive processes, water is an ever-present phenomenon but its influence on processes and outcomes varies greatly across time and space. Karl Wittfogel (1957) has provided perhaps the best-known argument for the crucial importance of water in history in his thesis of "hydraulic societies" in the Orient that developed large and despotic central state bureaucracies through the control of water, principally through the construction and management of massive irrigation works. While his thesis has been thoroughly critiqued, his insights about how water and its control contribute to structuring societies, states, and bureaucracies have been expanded and refined by research in diverse settings and disciplines (e.g. Worster 1985, Reisner 1993, Harvey 1996, Swyngedouw 1999, Swyngedouw 2007, Lopez-Gunn 2009, Oré and Rap 2009, for reviews see Molle, Mollinga and Wester 2009, Orlove and Caton 2010).

In this paper, I explore how power over water has evolved as an object of state management and control in Peru since the early 20th century, shaping the development of enduring legal and bureaucratic structures as well as socio-environmental and political-economic relations. I attempt to illustrate how water management increasingly became a technical and scientific *problem* for the state and its experts to solve and how this process has fomented and entrenched a technocratic

culture that continues to shape water governance in a contemporary context of neoliberal eco-governmentality (Goldman 2004, Oré and Rap 2009). I also attempt to show how this technical order has become enshrined in Peru's water legislation over time, even as the specific problems to be solved have changed. I highlight how this process has had important impacts on the scaling of power and authority over water and concomitantly over social reproduction more broadly (Swyngedouw 2000, Budds 2004, Perreault 2005). However, I contend that this power and authority has not simply become hegemonic across all levels of water administration and governance but instead has operated through discursive and material practices that have often been contested, negotiated, and transformed, leading to a plurality of water laws and cultures that hybridize across spatial and temporal scales (Boelens et al. 2010, Guevara Gil 2008, Oré 2005, Roth, Boelens and Zwarteveen 2005).

High modernism and the hydraulic mission

> Anchored in 19th century scientism and an ideology of the domination of nature, inspired by colonial hydraulic feats, and fuelled by technological improvements …, large-scale water resources development has been a defining feature of the 20th century. Whether out of a need to increase food production, raise rural incomes or strengthen state building and the legitimacy of the state, governments—North, South, East, and West—embraced the 'hydraulic mission' and entrusted it to powerful state water bureaucracies (hydrocracies) (Molle et al. 2009, 328).

As Molle et al. suggest, the 20th century's large-scale water resource development and the linked formation of hydraulic bureaucracies were processes deeply entangled with broader "modernization" projects rooted in Enlightenment-era beliefs about progress through the powers of science and rationality (cf. Rostow 1991[1960]) In

his work on the modernization of Egypt under colonial rule, Timothy Mitchell provides a description of the ideology underlying such projects:

> The movement of history could be ascribed to the growing technical control that reason acquired over the natural and social world, to the power of reason to expand the scope of human freedom, or to the economic forms that were said to flow from the spread of rational calculation and freedom—the exchange relations of modern capitalism. Whichever aspect of modern, secular rationality one emphasized, everything could be understood as the development of this universal principle of reason. Or a reaction against it, or its failure, delay, or absence" (2002 , 1).

When concretized such "high modernist"[4] sentiments have significantly restructured socio-natural and political economic relations around the globe in ways that imply "a truly radical break with history and tradition" (Scott 1998, 93, Harvey 1989). These developments have entailed a wide range of bio- and techno-political tactics of governmentality including mapping, remote sensing, and surveillance technologies that redefine the relations between physical spaces and the populations inhabiting them, statistical techniques for quantifying, and comparing elements of these spaces and populations, and the creation and promulgation of specific expertise and scientific methods, data, and discourses that deeply influence both legal norms and cultural beliefs and values across society (Agrawal 2005, Bridge 2001, Budds 2009, Foucault 1980, Foucault 2007, Mitchell 2002, Scott 1998, Swyngedouw 2009).

Such re-conceptualizations and transformations of socio-natural relations, of course, are not universally accepted as the path towards some commonly envisioned

[4] Scott borrows the term "high modernist" from David Harvey who describes a "'positivistic, technocentric, and rationalistic'" modernism founded on a belief "'in linear progress, absolute truths, and rational planning of ideal social orders' under standardized conditions of knowledge and production…" (1989, 35).

utopia. These are power-laden processes, often fraught with conflict, whose fracturing of history and tradition demands deep ideological commitment, and, in some cases, authoritarian resolve exercised in the name of rationality and progress. As Scott suggests of the high-modernist mentality, "only those who have the scientific knowledge to discern and create this superior social order are fit to rule in the new age. Further, those who through retrograde ignorance refuse to yield to the scientific plan need to be educated to its benefits or else swept aside" (Scott 1998, 94).[5] It is critical to note, however, how this exercise of power is depoliticized through appeals to rationality and the purported ability to establish a productive *ordering* through the objective knowledge of science and its formative influences on laws and policies. As Scott continues, "high modernist ideology thus tends to devalue or banish politics," since "political interests can only frustrate the social *solutions* devised by specialists with scientific tools adequate to their analysis" (1998, p. 94, emphasis added). Here I highlight *solutions* for its implication of a fundamental element of the high-modernist equation: a clear *problem* to be solved.

In her study of development interventions in Southeast Asia, Tania Li suggests that "problematization, that is, identifying deficiencies that need to be rectified" is a "key practice" required to form explicit programs of intervention and that "the identification of a problem is intimately linked to the availability of a

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[5] Scott's language may seem hyperbolic, but consider ex-Peruvian President Alan Garcia's now infamous 2007 *Perro del Hortelano* discourse in which he chastises indigenous groups in Peru's oil and mineral rich regions for obstructing national development by resisting resource exploitation in their traditional territories.

solution" (Li 2007, 7). Li, drawing on the work of Rose, goes on to describe a second key practice of "rendering technical" whereby a domain of intervention is defined and delineated and specific techniques for intervening are developed. Importantly, for Li, "questions that are rendered technical are simultaneously rendered nonpolitical" (Li 2007, 7). There are clear parallels here, which Li acknowledges, with James Ferguson's classic work *The Anti-Politics Machine* (Ferguson 1990), which stressed the role of depoliticized discursive constructions that deviated from reality in creating contexts ripe for targeted development interventions.[6]

Molle et al.'s quote at the beginning of this section points to the ways in which hydraulic bureaucracies employ the practices of *problematization* and *rendering technical*. Whether the need is greater food production or higher rural incomes, the control of water through technocratic and bureaucratic means offers purportedly scientific and rational solutions to these problems. Yet varied case studies of the implementation of such solutions illustrate that these processes are fundamentally political and are driven by the mobilization of power and authority, often via the collusive actions of particular groups (e.g. see Worster 1985 and Reisner 1993 on the American West and Swyngedouw 1999, 2007 and Lopez-Gunn 2009 on Spain). In a review of many such cases, Molle *et al.* suggest that "as history tells us, the interests of nation states and hydraulic bureaucracies in water resources

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[6] Ferguson's work illustrates how international development discourse promulgated by the World Bank and other development agencies created its own "object of intervention" in Lesotho through framing the nation's history and contemporary context in ways that identified problems amenable to the solutions these very groups were positioned to offer.

development is (*sic*) also shared by four other categories of powerful actors, namely politicians, construction companies, landed elites, and development banks" (2009, 336). This constellation of key actors is hardly surprising, particularly in the context of the large infrastructural works characteristic of the "hydraulic mission" so vehemently pursued in many parts of the world during the 20th century.

Integrated Water Resource Management (IWRM): Soft-path solutions to the scarcity problem

While the infrastructural and institutional legacies of hydraulic bureaucracies and their allies are evident the world over, in recent decades a marked shift in water resource management strategies is occurring. The drivers of this transition are diverse and include the direct social and environmental impacts that come with large-scale infrastructure projects as well as the social resistance that these impacts engender; rivalries and conflicts between different state bureaucracies and across political and administrative levels (e.g. national, regional, local); decreases in funding allocations to large-scale projects; and decreases in the physical supply of freshwater available for such mega-projects (Conca 2006, Gleick 2000, Gleick 2003, Molle et al. 2009, WCD 2000). Additionally, a growing emphasis on water scarcity as one of the future's principal social and technical challenges is shifting the problematization of water management from maximizing supplies to managing demands (cf. Mehta 2010). Together these impacts are reorienting the administrative focus on water towards what have been termed "soft-path solutions" that work "to improve the

productivity of water use rather than seek endless sources of new supply" (Gleick 2003, 1526).[7] Prevailing soft-path strategies emphasize the control of water demand through approaches such as water markets and pricing mechanisms, more efficient technologies and water-use practices, and integrated management activities that feature multi-sectoral and participatory decision-making processes (Gleick 2000, 2003).

If a single paradigm has emerged to encompass the reframing of the water "problem" and the soft-path solutions required in response, it is that of Integrated Water Resource Management (IWRM). IWRM according to the commonly cited definition of the Global Water Partnership (GWP)—one of the concept's chief advocates—is "a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment" (GWP n.d.). Furthermore, IWRM "is a cross-sectoral policy approach…based on the understanding that water resources are an integral component of the ecosystem, a natural resource, and a social and economic good". Discursively, IWRM is appealing for its rational and balanced approach. While the large-scale water works of the 20th century's hydraulic mission achieved many important outcomes, these often came at the expense of ecological

[7] While Gleick applies this term to the paradigm for water management emerging in the 21st century, he borrows the phrase from Amory Lovins' work on transitions in the energy sector. Lovins, A. B. 1977. *Soft energy paths: Toward a durable peace*. San Francisco and New York: Ballinger Publishing Company.

sustainability and social equity and led to a fragmented system of management by privileging certain sectors and ways of valuing water over others. IWRM, according to its proponents, is poised to address these shortcomings through a combination of management instruments, institutional innovations, and enabling conditions that promote broad participation, cross-sectoral integration, and rational and efficient resource use (see Figure 1.1).

For all its discursive promise, IWRM is not without its critics. Indeed, the very characteristics that make the concept so appealing in theory – valuing water for its diverse uses across human needs and economic sectors while promoting participation, equity, and sustainability – present extreme challenges to its implementation. The model has been called a *nirvana concept* for its vision of "what the world should tend to…although, just as with nirvana, the likelihood that we may reach [this state] is admittedly low…" (Molle 2008, 132). After outlining a compelling list of ambiguities in the GWP's definition of IWRM quoted above, Biswas suggests that while the definition "appears impressive, it is really unusable, or un-implementable, in operational terms," and "even though the rhetoric of integrated water resources management has been very strong in the various international forums of the past decade, its actual use (irrespective of what it means) has been minimal" (Biswas 2004, 250). Conca provides a more balanced critique of the challenges of recognizing water's value as both a human right and an economic good, and he points to the diverse and conflicted framings of such values even among IWRM proponents themselves. He also highlights the difficulties in creating spaces of dialogue that lead

to a meaningful devolution of power and authority, suggesting that as "an approach grounded in expert knowledge, scientific rationality, and increasingly bureaucratic organization [IWRM] has often reinforced a limited, hub-and-spoke notion of participation" in which "helpful information about uses, preferences, behavior, and effects flow in from society to expert centers [while] scientific truths as guides to social action flow out" (2006, 158). Considering such challenges and shortcomings, Conca suggests that the "apogee of IWRM influence" passed at the turn of the 21st century.

Despite such claims about fading influence or minimal real-world impacts, IWRM concepts continue to have formative effects on the water management policies of governments around the world. Peru provides a striking example of this influence. Law N° 29338 passed in 2009 is largely defined by IWRM principles, an outcome linked to more than a decade of funding and technical advice from the international IWRM complex of development banks and advocacy networks. One result of this influence is that the ambiguities inherent to IWRM rhetoric discussed above (i.e. how should different values be balanced, what counts as meaningful participation?) have become key challenges for water governance in Peru and other places where the model has taken hold. In the IWRM *nirvana*, science and techno-expertise overcome such ambiguities through neutral rationality. But in the reality of a politicized and culturally pluralistic world, where science is but one of many belief systems and competing values are not easily reconciled, these ambiguities may obscure

inequalities and entrenched patterns of power that continue beneath a façade of more balanced valuation and empowered participation.

Yet, while IWRM in practice may not live up to the paradigm's rhetorical promise, it is important to recognize that "IWRM networks can be understood as a political space in which participatory conflicts are joined, rather than as a dominant form marked by the hegemonic imposition of solutions and the negation of controversies" (Conca 2006, 159). Such a perspective challenges assertions of IWRM's "increasingly hegemonic" character (cf. Orlove and Caton 2010), but must be validated through empirical examinations of the governance processes and outcomes occurring in these networked political spaces. The final section of this paper turns to this empirical task, but first I examine further the ideological agenda that has brought IWRM to the fore of global water governance in the 21st century.

IWRM's Veiled Agenda: Bringing Water to Market

As noted above, constellations of powerful actors have typically promoted high modernist visions of progress for the benefits these groups accrue in the process. Similarly Molle suggests that "influential concepts in policy making are not merely neutral or scientific; they do not emerge by chance but, rather, are the emanation of complex webs of interests, ideologies, and power" (2008, 132). Pinpointing the chief proponents of the IWRM vision is complicated, however, given the widely dispersed and variable character of the concept. An examination of the history and evolution of IWRM strategies is helpful in illuminating who is championing this often "un-

implementable" model of water governance, through what means, and to what ends, though these questions remain difficult to answer definitively given the great diversity of actors swept up in the IWRM vision in the current global conjuncture.

Biswas states that the IWRM model was being promoted as early as the 1950's by groups like the United Nations (UN) and that it was also taken up at the UN Water Conference in Mar del Plata in 1977 (2004). Given this history, Biswas chides the GWP for attributing the inspiration of the model to the 1992 Dublin Principles.[8] Yet despite this earlier history, there is little doubt that IWRM has grown in visibility and power since the mid-1990's, after the concept had embraced the Dublin Principles and was being promoted vigorously by a number of global policy networks and advocacy organizations.

The GWP, a self-styled "global action network", provides an exemplary case of these advocacy organizations working at the global level. The group was founded in 1996 by the World Bank, the Swedish International Development Agency (SIDA) and the UN Development Program (UNDP) to "'support countries in the sustainable management of their water resources' by means of an advocacy network based on the principles of IWRM" (WB 2010, vii). During the 2004-08 Strategy period, the group's "overall development objective" was to "achieve global water security…"

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[8] The Dublin Principles emerged from the 1992 International Conference on Water and the Environment and consist of the following assertions: 1) Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment; 2) Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; 3) Women play a central part in the provision, management and safeguarding of water; 4) Water has an economic value in all its competing uses and should be recognized as an economic good.

while their immediate objective was more feasibly "to ensure that IWRM is applied in a growing number of countries and regions, as a means to foster equitable and efficient management and sustainable use of water" (WB 2010, ix). To accomplish this objective, the GWP and allies like the World Water Council and the World Commission on Water for the 21st Century served, in one expert's opinion, as "key production nodes for transnational water conferences, training seminars, policy papers, and ultimately, a highly mobile set of global experts on water that comprise the leadership and establish the guiding principles of the water reform movement" (Goldman 2007, 793). The IWRM discourse has been broadly disseminated through the networks of these groups, which in the case of the GWP currently consists of more than 2800 partner organizations in 164 countries.[9] However, lest specific proponents of the IWRM strain of high modernism get lost in the complicated networks of these dispersed groups, it is important to emphasize the "enormous role the World Bank[10] has played in constituting and supporting these networks and their agendas" that have "…effectively filled the spaces and saturated the marketplace of ideas on water policy in global civil society" (Goldman, 2007, 793).

In light of the significant resources that actors like the World Bank have mobilized in support of IWRM, it is important to ask how the IWRM paradigm fits

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[9] See: http://www.gwp.org/en/About-GWP/The-network/

[10] In a footnote, Goldman lists other major funders that have contributed to these networks including "the bilateral aid agencies of the countries in which the world's largest water-service firms reside", e.g. DFID (UK); SIDA (Sweden); USAID (US); the French Ministry of Foreign Affairs; and the Netherlands Ministry of Foreign Affairs (2007, 793, Footnote 21).

into the larger vision of resource governance that such groups promote. In the mid-1990's when the GWP was founded and began its IWRM advocacy work, the World Bank and its allies were aggressively supporting the formation of water markets and the privatization of water rights and provisioning systems along the lines of the model that had been implemented in Chile (Bauer 2004b, Oré and Rap 2009, Trawick 2003, Urteaga 2010) This privatization agenda was supported by the tenets of neoliberalism (cf. Williamson 1990, Boelens 2009, Solanes 2013) and enacted in some cases through the structural adjustment mechanisms mandated by groups like the International Monetary Fund (IMF). It was also supported ideologically by the most contested of the Dublin Principles: the conception of water as an economic good. In his analysis of the transnational policy networks that helped shape and disseminate the IWRM vision and other forms of the World Bank's "green neoliberalism", Michael Goldman describes the Dublin statement on water's economic character as a "pillar of truth around which all competing ideas [about water management] revolve" (2005, 244). This principle provides clear rationale for addressing the linked "problems" of water scarcity and inefficient use through systems of water markets, formalized rights, and pricing mechanisms that economize through cost-recovery and by letting water flow to its highest value uses (Rosegrant and Binswanger 1994, Serageldin 1995, WB 1993). In this vision, private investment, often in partnership with public agencies, has an important role to play in providing both capital and expertise for the expansion of water provision and the improvement of water-use efficiency. Such logic has driven a wave of water rights privatization efforts since the

1990's and has been instrumental in shaping the evolution of IWRM as a global policy paradigm. Nevertheless, this aspect of IWRM and the privatization processes it promotes have been met with significant social resistance and other challenges that have caused a retrenchment and spatial consolidation of private investment in the water sector (e.g. Bakker 2013, Bauer 2004a, Perreault 2006, Roberts 2008).

A great deal of research across disciplines has documented privatization processes in the water sector in accord with neoliberal policy prescriptions. Yet as Boelens and Zwarteveen point out, much of this work has focused on the efforts of large international corporations to privatize potable water provision in urban contexts (2005). In contrast, these authors and many colleagues have drawn attention to the impacts of neo-liberal policies on the water tenure arrangements and collective management institutions of rural irrigators, especially in the central Andean countries. Much of this work highlights the legal pluralism and resulting socio-legal complexities that endure in these rural contexts where local systems of collective water management coexist with formal legal frameworks imposed by distant central government bureaucracies. This scholarship includes an array of ethnographic work detailing the practices of local irrigators and their evolving relations with the state and other actors as well as more recent work focusing on the threats of legal reform and consolidation, and neoliberal privatization initiatives in particular, to these plural practices and systems (e.g. Boelens 2009, Boelens, Getches and Guevara-Gil 2006, Bustamante 2010, Gelles 2000, Guillet 1992, Mitchell and Guillet 1994, Oré 2005, Oré et al. 2009, Trawick 2002, Trawick 2003, Zimmerer 1991).

In the following sections, it is my intent to build upon this scholarship on water governance in the Andes by examining the historical trajectory of legal and institutional development that has led to the adoption of IWRM principles by the Peruvian state. I also illustrate some of the important tactics and impacts of the initial stages of IWRM implementation in the Peruvian highlands. This analysis proceeds in two steps. First, I provide an overview of 20th century Peruvian water law and the formation of the state water bureaucracy, linking these developments to high modernist principles of economic growth and state territorialization through science, engineering, and the control of hydrologic processes. This section considers how this technocratic approach to state water management and the bureaucratic culture it has promoted evolved under different historical political regimes and looks in detail at how neoliberal reforms have impacted the water sector since the 1990's. This section concludes with an examination of the ongoing implementation of the IWRM model under the new Hydrologic Resources Law N° 29338. In the final section of the paper, I analyze some of the emerging implications of and challenges to IWRM implementation in one of the country's principal watersheds, the Santa River basin.

III. Water law and power in Peru: 1902 -2013

> The structure of every legal order directly influences the distribution of power, economic or otherwise, within its respective community.
>
> -Max Weber, *Economy and Society, Vol. 2*

Given the scarcity[11] of water on Peru's arid Pacific slope, the control of hydrologic resources has long been both an objective of political power and a legitimizing force for political projects. Archaeological evidence from coastal and highland sites illustrates the importance of irrigation works as well as the symbolic force of water for pre-colonial civilizations and suggests that shifting hydrologic conditions and extreme events contributed to the rise and demise of particular power structures (Binford et al. 1997, Dillehay and Kolata 2004, Ortloff and Kolata 1993). The circumscribed overview presented here, however, focuses only on how legal authority over water in Peru has been distributed through national legislation since the beginning of the 20th century. Of course, the formal authority over water granted through national legislation is but one aspect of power over the resource and much has been written about the legal pluralisms that exist around water governance in contexts where government legislation co-exists with enduring local systems of water use and management (see previous section). Nevertheless, as de Vos et al. suggest "in political terms it is important to recognize that state law is a source of great social

[11] Absolute scarcity can be thought of as the limits of a resource imposed by natural conditions, allotments, etc…whereas relative scarcity is a distributional problem that is socially determined. Both forms of scarcity are important on Peru's western slope.

power" that at once can constrain water users while also serving as a "resource for claiming and defending their interests and rights" (Vos, Boelens and Bustamante 2006, 40). In the following history, I attempt to highlight the shifting scalar dynamics of formal authority while illustrating the growing numbers of actors and ideologies involved in modern water governance in Peru.

The 1902 Water Code: Colonial dispossession and the growth of hydro-expertise

In 1902, the first Peruvian Water Code (*Código de Aguas*) was approved, modeled closely after Spain's water code of 1879 (Del Castillo 2008). This legislation granted water rights in connection with land ownership, securing much of the available water for estates and haciendas, including the large-scale coastal sugar and cotton plantations of the post-colonial period (Thorp and Bertram 1978). This system of water rights tied to landed property favored the Spanish and Creole elites, dispossessing many rural populations of the water they had traditionally used and legitimizing the water system enclosures that occurred during the colonial period (Del Castillo 2008).

In 1901, a year before the Water Code was passed, the Peruvian state formed the Corps of Mining and Water Engineers to produce technical studies of development opportunities in the agriculture and mining sectors, including the potential for large-scale, public irrigation works (Thorp and Bertram, 1978, 57). During Augusto Leguía's presidencies (1908-1912; 1919-1930), efforts to collect hydrological data for the major coastal valleys began in earnest and U.S. engineer

Charles Sutton was contracted to provide expert advice on state-led irrigation development in these watersheds. The investigations of Sutton as well as of Peruvian engineers like Santiago Antúnez de Mayolo marked the emergence of a culture of engineering and techno-expertise in early 20th century Peru that would flourish in the decades to come, with important impacts on policy formation and national development (Antunez de Mayolo 1957, Oré and Rap 2009). Sutton advocated for a large-scale techno-political project in which the Peruvian state would use the control of water through the development of major irrigation infrastructure to expand its territorial presence. This vision of engineering state power through centralized irrigation control generated significant resistance from the hacienda owners, however, and was ultimately unsuccessful.

Instead, throughout the early-mid 20th century the Peruvian state invested heavily in the design and construction of infrastructure to move water from the Andean highlands to the arid coast, subsidizing landed interests and both domestic and export production in the process (Eguren 2003). To supply rising energy demands, the state also developed its hydropower resources, and in settings like the Santa watershed, projects integrating energy production and coastal water provision were pursued. Thus controlling and exploiting the scarce water supplies on the western slope through the engineering of tunnels, turbines and vast canal networks became critical elements in the gradual modernization of Peruvian society. Not surprisingly, elites managed to capture many of the benefits of the modernization process, creating inequalities and tensions that would eventually bring a program of

sweeping reform to the water sector and Peruvian society more broadly (Dobyns and Doughty 1976, Cotler 1978).

The 1969 General Water Law: Agrarian reform and centralization of authority

Formal state control over water resources was eventually established with the passage of the General Water Law (*Ley General de Aguas* N^{o} 17552) in 1969 by the military government of General Velasco Alvarado. This formal rescaling of water governance was closely linked to the regime's vision for sweeping social and economic change through agrarian land reform (Del Castillo, 2008). In making water the inalienable patrimony of the nation with use rights distributed through licenses granted by the central government, the General Water Law helped the state's reform program by redistributing water to small-scale farmers and the agricultural cooperatives it had created from many of the larger haciendas.

These authoritarian reforms helped to break down the entrenched powers of the landed classes over both land and freshwater on much of the country's Pacific slope and created new powers and responsibilities for the central government in the construction, maintenance, and regulation of hydraulic infrastructure. These efforts were to be carried out by the new national Water Directorate (*Dirección General de Aguas*) and the Ministry of Agriculture (MINAG) and overseen at the local level by Technical Administrators of Irrigation Districts (ATDR) (Oré and Rap 2009).

The vision of the new water law was highly technocratic, imported from the U.S. land grant universities and based in an agronomic approach that allotted water

on the modeled needs of particular crops to be identified through a formal Crop and Irrigation Plan (*Plan de Cultivo y Riego)* (Trawick 2003). This process, which shifted the design of water management from local experience to the technical realm and required the expertise of the ATDR's and their agrarian engineers, made little sense in relation to the grounded customary practices of the countryside at the time (de Vos et al. 2006). The state also lacked the financial resources as well as the local presence to fulfill the responsibilities it had created for itself (Guillet 1981). Perhaps partly to address the shortcomings of state action at the local level, in 1979, the implementing legislation (*reglamento*) for the Organization of Water Users brought citizen actors more directly into the governance process through the creation of irrigator user groups (*juntas de usuarios*) and irrigation commissions (*comisiones*) at the level of specific irrigation districts (Oré and Rap, 2009). These groups were meant to support the efforts of the ATDR, and were subject to the ATDR's authority, but they had no formal roles specified within the General Water Law (Del Castillo 2004, Budds and Hinojosa 2012).

The military government's efforts to redirect Peru's development ran counter to dominant global macro-economic patterns, and the regime would never fully accomplish its program of political and economic reform. After the restoration of democratic rule in 1979 an extended period of economic stagnation ensued, culminating in one of Latin America's worst experiences with hyperinflation (Crabtree 1992). By the early 1990's, national fiscal insolvency would lead to IMF and development-bank dictated structural adjustment programs. In 1989, just before

major economic adjustments began under the Fujimori administration, a Supreme Decree (*Decreto Supremo* 037-89-AG) transferred formal responsibilities over water infrastructure and control from state institutions to the irrigator user groups that had been created in 1979. While water remained the patrimony of the nation, the decree ended the extremely centralized control over water that had been created by the military government as well as the state's obligations to maintain a system of water management and distribution. This rescaling of responsibility over water-provision infrastructure suddenly required the irrigator user groups to finance themselves through the collection of water use fees. Like many structural adjustments, Peruvian society was largely unprepared for this change and fee collection occurred to varying degrees, especially in rural areas.

Oré and Rap (2009) explore the rationale for this decree, suggesting that its causes included a bankrupt state government divesting its responsibilities over a dilapidated irrigation infrastructure as well as a policy shift towards neoliberal models for downscaling the state and creating private property rights in water and other sectors. One of the ex-supervisors of the Water Directorate interviewed by Oré and Rap suggested that this transfer of responsibilities to the user groups was "for them the first step towards water privatization" (2009, 48). The decree would have contradictory effects on later efforts to privatize water, however, through its creation and funding of a national-level governing body of the dispersed irrigation user groups, the *Junta Nacional de Usuarios de los Distritos de Riego del Peru*

(JNUDRP). This irrigators' group would become an important participant in later negotiations over the control of water.

Neoliberal Water Reform: Decentralization and the turn towards privatization

Surprisingly, the General Water Law was not successfully overhauled through the structural adjustment programs of the early 1990's. Instead, under the populism-turned-neoliberal authoritarianism of Alberto Fujimori, water legislation would be gradually modified through a number of smaller reforms across sectors. The failure to fully privatize water in Peru after the model of the Chilean experience was not for a lack of effort, however. From the early 1990's onward, the World Bank and the Inter-American Development Bank proposed establishing private property over water in Peru and many other countries in Latin America and beyond (Trawick 2003; de Vos et al. 2006, Urteaga 2008, Solanes 2013). Resistance from rural irrigators in particular (organized through the increasingly powerful JNUDRP) consistently blocked these sustained privatization efforts (Trawick 2003).

Although direct privatization of water did not occur under Fujimori, multiple reforms in this period had important impacts in rescaling formal authority and control over water governance. For example, decentralization of authority over water progressed with Legislative Decree 653, passed in 1991, which transferred full responsibility for granting water licenses from the central water intendancy to the ATDR and required that all irrigators join their respective irrigators' commissions and pay the water fees for membership. L.D. 653 also worked to foment private

investment in agriculture, undoing restrictions on the size of landholdings and eroding other provisions made during the agrarian reform to regulate and control private interests (Eguren 2006). In the water sector, in particular, it also gave rise to a growing focus on efficiency in the state-vision for hydrologic resource management (Del Castillo 2004, 48; Oré and Rap 2009, 51). These changes allowed export-led agricultural projects on the coast to grow significantly, incentivizing territorial expansion and the entry of larger firms, which would drive the demand for water ever higher (Oré et al. 2009).

L.D. 653 also created an entirely new governance entity at the watershed scale. Autonomous Watershed Authorities were formed in several of the most-important coastal watersheds (including the Santa River) where large-scale, state-led irrigation projects (*proyectos especiales*) had been developed (Oré 2005) . These Autonomous Authorities were directed by multi-sectoral committees led by the ATDR (MINAG) and including representatives from the Ministry of Energy and Mines, the Ministry of Housing and Construction, the National Institute for Development (INADE), local governments, and local agrarian user groups (Del Castillo 2004, Ortiz-Sánchez 2008). The official tasks of the Autonomous Authorities were to formulate plans for water use, to monitor and enforce regulations, and to coordinate management between actors at the scale of the watershed while also serving as the final authority in resolving conflicts over water.

Notably, the Autonomous Authorities were composed of a majority of representatives from the central government, and the ATDR remained the first-level

authority that handled most of the quotidian activities of water governance, including initial attempts to resolve water conflicts. Despite the continued emphasis on agriculture via strong links to special irrigation projects, the formation of these Autonomous Authorities represented an incipient shift towards IWRM strategies that would emerge fully in the 2009 water law. Critics of the Autonomous Authorities have pointed to their underlying structural problems, issues with corruption, and a lack of sufficient resources that insured these institutions accomplished very little (Del Castillo 2004, 109). One state water official claimed the institutions had overseen "a lost decade in watershed management" (Ortiz-Sánchez 2008, 70).

After Fujimori's decline, concerted efforts to undo his administration's extreme concentration of power contributed to the administrative decentralization of the Peruvian state under the Toledo administration (2001-06) and a partial devolution of powers and responsibilities from the central government to the regional level (Crabtree 2006). With the reinstatement of elections for regional government positions in 2002, the regions immediately became important new actors in the water governance equation, especially in cases where special irrigation projects were transferred to their oversight. This creation of authority at the regional level coupled with the effects of ongoing legislative reform created a system of overlapping and oft-contested claims to authority over hydrologic resources (Del Castillo 2004, 55-56; Oré et al. 2009).

In the early 21st century, the Peruvian economy was experiencing robust growth driven by water-intensive activities like mining and export agriculture, with

powerful transnational corporations increasingly a part of the hydro-governance equation (Bebbington and Bury 2009, Bury 2004, Liverman and Vilas 2006, Oré et al. 2009). With decentralization, these corporations suddenly had to negotiate their business with both state and regional authorities, and in many cases, central state and regional preferences for development were not aligned (Eaton 2010). These divisions—often over environmental impacts involving water—continuously produced conflicts and negotiations between administrative levels and private actors, underscoring the need to address unclear and overlapping legal authority in the water realm (Del Castillo 2004, 2008, Oré et al. 2009).

In this context, congressional efforts to forge a new national water law were reinitiated while the development banks and their allies continued to push forward agendas of water privatization and water management modernization that were now more than a decade in the works. In 2004, a Multi-sectoral Technical Commission (*Comisión Técnica Multisectorial)*—consisting largely of ministerial representatives and presided over by the Chief of the Intendancy of Hydrologic Resources[12]—was formed to draft a National Water Strategy (Peru 2004). The policy vision that resulted showed the obvious influence of IWRM. On its first page, the strategy document suggests that the country's long-standing privileging of water for agriculture should be replaced by a multi-sectoral approach based in an understanding of water as

[12] In 1992, under Fujimori, the General Water Directorate in the Ministry of Agriculture was reduced in scale and transferred to the National Institute of Natural Resources (INRENA) as the Intendancy of Hydrologic Resources. Oré argues that this change in institutional stature marked the end of a cycle of increasing state intervention in and administration of irrigation that had begun in the early 20th century (Oré 2005, 170).

economic good to be managed according to criteria of efficiency, equity, and sustainability (Peru 2004). The strategy also calls for mandatory enrollment in water user committees and associated payment of water tariffs as well as a "persuasive strategy" at the national level to convince both policy-makers and the general populace of the private sector's importance in water management (Peru 2004,16; Urteaga 2010).

After this initial conceptualization of the National Water Strategy, additional development loans flowed into the country to support the formalization and dissemination of the vision (IDB 2007). The process was referred to as modernization of the system, much of which entailed "the transfer of public tasks to the private sector" (Vos et al. 2006, 41) and a continued emphasis on improving the "efficiency" of water use. Fundamental to such efforts was the establishment of private and quantifiable rights over water use. With financial support from the World Bank, the Program for the Formalization of Water Rights (PROFODUA) was created in 2004 and re-funded in 2007 in order to formalize irrigators' licenses for specific volumes of water (IDB 2007, Del Castillo 2008, 46, Urteaga 2010). PROFODUA's efforts reflected a continued emphasis on technocratic approaches to water management linked to the development of Crop and Irrigation Plans and illustrated the enduring influence of the water engineering culture that first emerged in Peru in the early 20th century.

PROFODUA's ongoing efforts have largely occurred behind the scenes of daily water governance, and many irrigators remain uncertain about whether formal

use licenses are in their best interests and skeptical about the long-term effects of the program (Llupa 2008, Parón-Llullán 2009). Oré and Rap provide insight into the process of licensing through the testimony of an ex-superintendent of the Intendancy of Hydrologic Resources who suggests that "at some point these rights will be able to be converted into private rights, but if no rights exist we won't be able to convert anything" (2009, p. 58). While it is not outright privatization, the establishment of fixed water licenses based on state-administered, technocratic techniques of volume allotment has important implications for irrigators' rights to modify their water use practices in the future, whether in response to the production of new crops, the need to bring additional areas under cultivation, or efforts to adapt to climatic change.

The 2009 Water Law: Re-centralizing authority under the guise of integration

After a series of failures to move comprehensive new water legislation through congress, Alan Garcia's second administration would employ a different tactic to advance neoliberal reforms in the water sector. Taking advantage of extraordinary powers delegated by congress to the executive branch—supposedly in order to expedite the approval of the Free-Trade Agreement between Peru and the United States—the Garcia administration unilaterally passed more than one hundred legislative decrees in early 2008 (Bebbington 2009). Several of these decrees affected water governance in important ways. At the bureaucratic level, Legislative Decree 997 supplanted the Intendancy of Hydrologic Resources with the National Water Authority (ANA) while Legislative Decree 1081 created the National System of

Hydrologic Resources. These decrees shifted formal authority in the water sector, substantially reconsolidating power at the level of the central state (Del Castillo 2011, Oré and Rap 2009, Urteaga 2010). This rescaling of authority included failing to incorporate the JNURDP into the Supervisory Committee (Comité Directivo) of the National System of Hydrologic Resources and the dissolution of the Autonomous Watershed Authorities, which caused dissent and resistance at the regional level (Oré and Rap 2009, Del Castillo 2011).

Legislative Decree 1083 also had important implications for water management by establishing incentives for greater efficiency in water use. This particular decree caused major concern for irrigators and the JNUDRP due to its provisions to award more water to those users whose management practices were most efficient. Small-scale rural irrigators in particular showed great concern that they might lose access to water as it was reallocated to larger-scale users with greater access to technology and capital that would ensure their "efficiency" as defined by the central government's engineers and technocrats (Oré and Rap 2009, Urteaga 2010).

The reconfigurations in formal water authority accomplished by the legislative decrees undermined the efforts by civil society and congress to reform national water legislation that had been underway since 2001. Moreover, the decrees created a position of power from which the central government could negotiate ongoing reform of the water law. It has been suggested that the JNURDP's desires to annul these decrees contributed to their willingness to accept the version of the new water law

that would be passed under less-than-transparent circumstances in early 2009 (Del Castillo 2011).

Peru's new Hydrologic Resources Law N° 29338[13] was finally approved on March 30, 2009. The law's passage through Congress was characterized by a series of last-minute changes that forestalled debates over content and struck many participants as inappropriate for a piece of legislation of such critical importance (del Castillo 2011). In its final form, Law N° 29338 is perhaps most notable for its ambiguity (Oré and Rap, 2009). For example the law is clear that water is the patrimony of the state and that there can be no private ownership of water (Article 2) while also declaring that the state will promote "private participation" in the construction and improvement of hydraulic infrastructure as well as in its operation and maintenance (Article 105). In Article 44, the Law asserts that, apart from direct human consumption, a state-issued use right is required for any consumptive purposes; however, in Article 64 the Law says that it will recognize and respect the water uses of *campesino* and indigenous communities in accordance with their ancestral uses and customs (*usos y costumbres*). Preserving the content of the contested Legislative Decree 1083, the law also states that it can incentivize efficient water use but leaves the parameters of efficiency undefined (Articles 84-86). Critics of Law N° 29338's lack of precision in such issues expected the law's implementing legislation to clarify many of these details. Yet the implementing legislation, which was released a year

[13] The implications of the discursive shift from the General *Water* Law of 1969 to the *Hydrologic Resources* Law of 2009 are worth considering (cf. Bakker and Bridge 2007).

after the law in March 2010, is similarly vague and leaves most of the specification up to ANA and its multi-level bureaucracy (Peru, 2009, 2010).

Peru's Modern Hydrocracy

The bureaucratic character of ANA established in Legislative Decrees 997 and 1081 is largely preserved in Law #29338. As instituted by LD 997, ANA remains within the Ministry of Agriculture under Law #29338, though in the Law's final complementary dispositions the possibility of transferring ANA to the Ministry of the Environment (MINAM) once that ministry had been fully established is clearly stated. Nevertheless, four years after Law N^{o} 29338's passage and in a context in which MINAM is fully functional, ANA remains a part of MINAG. This positioning is not surprising given the fact that ANA was initially created upon the base of the existing Intendancy of Hydrologic Resources, which itself had evolved from the Water Directorate that had developed in the technocratic culture of the Agricultural Ministry for decades. Many of the same engineers who had long worked in the process of modernizing the Peruvian hydrocracy continued to work at high-levels in the ANA bureaucracy guiding its development. This institutional inertia and ANA's continued control by MINAG raises questions about how well the institution is positioned to guide a transition to a system based on multi-sectoral management (IDB 2011).

As the highest technical-regulatory authority in the National System of Hydrologic Resource Management, ANA has a wide range of powers and

responsibilities from elaborating guiding strategies and plans for water use in the country to determining the value at which water should be priced in different contexts to assigning water-use rights (Article 15). ANA executes its duties through its large central bureaucracy as well as its regional and local-level institutions, the Administrative Water Authorities (AAA's) and the Local Water Authorities (ALA's) respectively. The AAA's, of which there are 14 designated in the country—though many remain un-constituted—are a new bureaucratic level purportedly corresponding to major hydrographic divisions. The ALA's, of which there are 72, were created out of the existing ATDR's. It is important to note that both the AAA's and the ALA's are considered part of ANA as "*organos desconcentrados*" and that their fiscal and regulatory authority is tightly bound to the central offices of ANA. Thus there is a striking contradiction in Article 3 of Law N^{o} 29338's Preliminary Title, where it calls for the *decentralization* of public water management through the conduct of a single and *de-concentrated* authority, the ANA (Peru 2009, Del Castillo 2011). While regional and local-level government representatives are incorporated into advisory groups like the watershed councils (*consejos de cuenca*) mandated by the law, these groups do not have formal decision-making power, which is reserved by the executive authority (Peru 2009, 2010).

In addition to the levels of the ANA described above, the institution formally consists of several other elements including a Board of Directors (*Consejo Directivo*), and a National Tribunal for the Resolution of Hydrologic Conflicts (*Tribunal Nacional de Resolución de Controversias Hídricas*) (see Figure 1.2). The Board of

Directors was finally constituted in July 2012, though little further information had been made available by mid-2013, at which date the Tribunal still remained unformed. The fact that neither of these fundamental elements of ANA's organizational structure—nor many of the AAA's—were constituted during the first three years after Law N° 29338's passage underscores the gradual and piecemeal process of bureaucratic formation that has occurred thus far under the new law.

While it does not appear formally in most depictions of the organizational structure of ANA, the Project for the Modernization of Hydrologic Resource Management (PMGRH) must be included in any complete description of the institution (compare Figures 1.2 and 1.3). The PMGRH, directed by its Project Execution Unit, operates out of a non-descript office across Lima from ANA's headquarters and maintains fiscal and administrative autonomy from the central institution.[14] The PMGRH's formal objective is to strengthen capacities and tools for integrated water management in ANA and other institutions at the national, regional, and local levels. The project's specific goals include technical training for bureaucrats at each of these administrative levels, the formation of multi-sectoral watershed councils and management plans in six pilot watersheds, and the nation-wide dissemination of a "new water culture" (*nueva cultura del agua)* rooted in the tenets of IWRM (ANA 2008). According to the program's planning documents, key indicators for evaluation of the project's success include water use efficiency

[14] In an interview, a respondent from the PMGRH stressed that the project oversaw technical, as opposed to political, aspects of integrated water management and, at times, indicated that the PMGRH was part of ANA while in other instances suggested it was a separate entity.

improvements of 5% in the irrigation practices of pilot watersheds, a 50% increase in the fees collected per volumetric unit of water used in the pilot watersheds, a 50% reduction in water use disputes, and IWRM plans approved by watershed councils in the pilot watersheds (IDB 2010). To support these objectives, the PMGRH administers approximately $20 million in loans from the World Bank and the IDB, and its activities build upon the outcomes of earlier loan agreements between these actors, including support for multiple stages of water license formalization by PROFODUA (ANA 2008, IDB 2010, IDB 2011) and support for the development of the National Water Strategy. The great majority of this funding ($17.5 million) is directed at the formation of watershed councils in six economically important watersheds where significant tensions exist between sectoral actors (IDB, 2010). These efforts entail both bureaucratic expansion and sub-contracted technical work across administrative levels.[15]

These modernization objectives—funded largely by international development banks and disseminated by technical advocacy networks in conjunction with institutional bureaucrats—guide a significant portion of ANA's quotidian work as well as the organization's discursive strategies[16]. Yet, although their influence is growing, ANA's projects and discourses remain far from hegemonic and instead

[15] For example, while the designation of watershed councils is to be led by the regional governments, the formation of IWRM management plans for pilot watersheds is to be conducted by private-sector consultants contracted by the PMGRH.

[16] The press releases on the ANA web site illustrate the formal discursive strategies of the institution. See: http://www.ana.gob.pe/sala-de-prensa/noticias/noticias-2013.aspx

confront settings where diverse uses and customs still shape relations to water and where local socio-political dynamics often contradict national-level mandates. Where these value systems clash, resistance, conflict, and negotiation have often resulted, leading to a rise in water use disputes rather than the reduction hoped for by the PMGRH. In one sense, the very process of modernization can be seen as an effort to replace this diversity of values over water and the pluralisms of belief and praxis that they shape with a homogenous water culture inspired by the principles of IWRM and governed by Law N^{o} 29338 and the bureaucracy it establishes. Yet, it is critical to highlight that this is a partial and hybrid transformation, co-produced uniquely throughout Peru in local contexts with distinct histories of conflict and cooperation between actors, variable institutional capacities, differential levels of access to resources, and many other site-specific conditions. In an effort to present an empirical example of this hybridization, the following section looks at some of the key challenges that have confronted the implementation of Law N^{o} 29338 and ANA's bureaucratic vision in the Santa River watershed.

IV. Modernization in Empirical Context: Struggles for authority and recognition in the Santa watershed

The long and contested process of passing Law N^{o} 29338 in Peru is testament to the complexity of existing cultures of water use in the country as well as to the conflicting visions of how water should be managed in the future. The transition to an IWRM system on one hand reflects the necessity of balancing rapidly growing multi-

sectoral demands with increasingly scarce supplies of water in ways that promote broad participation and cooperation rather than conflict. On the other hand, the shift to an IWRM model can be seen as the extension of an increasingly hegemonic form of eco-governmentality that is rooted in the neoliberal project of bringing even the most vital of substances into the sphere of the economic market through appeals to efficiency and science-based management. Of course, neither of these framings provides a grounded understanding of how the implementation of IWRM strategies is actually impacting water supplies and the people who depend on them across Peru's diverse geographies. In the following section, I provide an introduction to the Santa River watershed as well as an overview of how recent events in the river basin challenge efforts to institute an IWRM vision in this region.

The Changing Context of the Santa Watershed

The Santa River is one of the most important watercourses on Peru's arid western slope. Flowing more than 300 kilometers from its origins in the Andean highlands of the Department of Ancash to its mouth just north of the port of Chimbote, the Santa drains an area of roughly 12,200 km^2 and traverses a diverse array of socio-natural zones and divisions (see Figure 1.4). The Santa has the most consistent annual flow of any major river on Peru's Pacific slope, due largely to the contributions of glacial meltwater from the Cordillera Blanca - the highest and most-extensively glaciated mountain range in the Tropics - that make up an important

percentage of its volume, especially during the tropical dry season (Mark et al. 2010, Mark, McKenzie and Gomez 2005).

Given the large volumes and consistency of its flows, the Santa has played a critical role in the development of both the Department of Ancash and the neighboring Department of La Libertad and has been a central object of study and manipulation for state engineers and technocrats since the early 20th century. Rooted in the vision of engineer Santiago Antunéz de Mayolo and carried out by the state-administered Santa Corporation, a project was developed to use the Santa's waters to generate hydro-electricity for both industrial development on the coast and domestic use throughout the Santa watershed (Carey 2010). But hydropower was just one aspect of this integrative project, it also included a railway, a steel mill and export pier in Chimbote, a chain of hotels, as well as plans for the construction of irrigation infrastructure capable of greening the coastal desert (Antunez de Mayolo 1957, Sotelo 1982, Santa 1999). These developments occurred in the spirit of the hydraulic mission, at a time when water was relatively abundant and the belief that nature should be harnessed for economic development and state growth was flourishing.

Socio-natural forces, however, would consistently challenge humankind's attempts to control and exploit the Santa's flows. This challenge is intricately linked to the very sources of the project's viability: the same glaciers that provide vital dry-season river flows can also pose a significant threat to downstream life and infrastructure, especially under the destabilizing impacts of climate change. The region has a lethal and destructive history of natural disasters linked to seismic

activity and glacier collapse and glacier lake outburst floods (Carey 2005, Carey 2010). The most notable of these disasters was an earthquake in 1970 that flattened much of the region's urban center of Huaraz while also unleashing an icefall that triggered a debris flow of catastrophic proportions in the middle reaches of the Cordillera Blanca. This debris flow buried a city of 15,000 inhabitants before entering the Santa River. Once entrained in the river channel, the flow continued downstream, damaging the hydropower plant[17] and eventually flowing out into the Pacific Ocean (Bode 1989, Oliver-Smith 1986).

While the destructive potential of Cordillera Blanca glaciers is tremendous and has generated an impressive legacy of engineering responses (Portocarrero 1995, Carey 2010), these icy masses also present a more insidious threat to the region's well being through their steady decline under global warming. This rapid melt has serious implications for the sustainability of current production activities in the Santa basin, particularly in the coastal desert where large agro-export operations have developed. Multiple analyses of satellite imagery reveal that more than 30% of the region's areal glacial cover has disappeared since 1970 and that the rate of glacial decline is accelerating (Baraer et al. 2012, Georges 2004, Racoviteanu et al. 2008). This reduction in water reserves is occurring as social demand for water rises precipitously through urban growth and a booming regional economy in mining and export agriculture. Moreover, while some studies have suggested that the contributions of

[17] This was the second time the hydropower plant had been damaged by glacier-related disasters in two decades: a glacier lake outburst flood in 1950 had destroyed much of the nearly constructed plant, postponing its completion until 1958.

melting glaciers to Santa River flows would likely peak in the middle to second half of the 21st century (Juen, Kaser and Georges 2007), recent analyses suggest that "peak water" likely passed in the 1970's (Baraer et al. 2012, Bury et al. 2013).

This rapid deglaciation in the Santa River watershed is a growing concern for water users and policy makers, and the region has become a crucible for studying the ongoing and predicted impacts of climate change on hydrologic and socio-ecological systems (Kaser et al. 2003, Mark and Seltzer 2003, Mark et al. 2005, Fortner et al. 2011, Bury et al. 2013). Such inquiries have not been limited to academic research, and the region has served as an illustrative case for work by the UNDP (Painter 2007) and more substantially as a key site for the World Bank's development of a methodology for assessing the impacts of climate change on mountain hydrology (Vergara 2009, Vergara et al. 2007). While the details of much of this work vary, common conclusions regarding the challenges likely to result from continued deglaciation coupled with water-intensive economic growth highlight the necessity of more integrative and adaptive approaches to water governance in a rapidly changing and highly uncertain future. Given this pressing need, the Santa basin was prioritized by the PMGRH as one of the six pilot watersheds where a multi-sectoral council and an IWRM management plan would be developed. Yet it remains to be seen whether the model of IWRM being promoted under Law N° 29338 will be able to achieve effective integration in water management in the Santa watershed and other dynamic contexts in the country.

Towards IWRM in the Santa: Antecedents and obstacles

Plans for integrated water management in the Santa watershed, as in other important Pacific-draining basins in Peru, arrived well before the passage of Law N^{o} 29338. Hydrologic data from numerous points along the Santa and many of its important tributaries had been collected regularly since the early 1950's, the *Cañon del Pato* hydro-power plant had gone on-line in 1958, and, in the 1970s and 80's the National Office for the Evaluation of Natural Resources (ONERN) undertook a series of studies of the "rational" use of the watershed's hydrologic resources (e.g. ONERN 1987). These studies were particularly concerned with meeting the dry-season water deficits of the large coastal irrigation projects (*proyectos especiales*) CHAVIMOCHIC and CHINECAS that were moving towards viability. Unfortunately, under the structural adjustment policies of the early 1990's that led to the privatization of many state functions, the hydrologic monitoring efforts in the Santa were abandoned and the instrument network fell into disrepair (Carey 2010). While recent research efforts by international and Peruvian institutions have worked to refurbish this data-gathering network, the lack of consistent and comprehensive hydrologic data for the basin remains an important challenge to integrated planning and management.

In 1994, the Autonomous Authority of the Santa River Hydrographic Watershed (AACHS) was established (Peru 1994). The formation of this decentralized, multi-sectoral authority should have been a critical step towards more integrated water management but instead it helped foment and reinforce socio-

political divisions that remain significant obstacles to implementing IWRM in the region. This effect occurred through an imbalance in the geographic areas and political groups represented by the governing body of the AACHS. Specifically, the composition of the institution's governing council favored the coastal regions of the Ancash Department, to the slight of both highland Ancash and the irrigated coastal valleys of the neighboring Department of La Libertad, where the successful CHAVIMOCHIC project is located. This imbalance is important to emphasize as it has helped create an enduring obstacle to collaboration across departmental political boundaries. Additionally, despite having decisive power over water use and management under law, the AACHS, like the several other Autonomous Watershed Authorities in Peru, accomplished little before its dissolution in 2008 due at least in part to a lack of devolution of decision-making authority and financial support and from the central government (CHAVIMOCHIC 2001, Ortiz-Sánchez 2008, ANA 2009).

In the mid-late 1990's, in a context where deglaciation in the Cordillera Blanca was becoming worrisome to local and international experts and where IWRM policy advocacy was on the march, a group of Peruvian NGO's with guidance from the Dutch donor NOVIB focused on the theme of integrated basin management and the Santa watershed was selected as an area for a pilot study. This effort produced a number of activities in the region as well as the publication of a *Methodological and Strategic Proposal for Integrated Management of the Santa Watershed* (Santa 1999). This book and the work of the NGO coalition behind its production provide an

example of the co-production of the IWRM concept through the fusion of prominent aspects of the international discourse with local conditions, interests, and values (cf. Ward 2013). The book highlights key challenges to water management in the basin while offering a series of recommendations for implementing IWRM. Ironically, participation in the NGO coalition's efforts was limited to actors within the Ancash Department, again slighting representatives from the neighboring Department of La Libertad. The exclusion of the CHAVIMOCHIC project from the effort is particularly surprising given its significant use of water from the Santa as well as the project's management of an impressive record of water quality and quantity data for the basin.

Explaining the exclusion of the La Libertad Department and CHAVIMOCHIC from early attempts at fostering IWRM requires a consideration of both geographic and political conditions in the region. On one hand, the physical geography of the watershed is certainly important to the Ancash Department's sense of ownership of the Santa: more than 80% of the watershed's area falls within Ancash. Perhaps more important, however, is Ancash's longstanding resentment of La Libertad for its exploitation of Santa waters and for the central government's purported favoring of CHAVIMOCHIC over CHINECAS, at least under the administrations of Alan Garcia[18] (Alvarez 2011, CHINECAS 2010, FOAPS 2010). The bitterness is made worse by the success of the former project, which is heralded

[18] Alan Garcia's APRA party (Alianza Popular Revolucionaria Americana) has a strong base in the La Libertad capital of Trujillo. Central government spending was prioritized for CHAVIMOCHIC under both of Garcia's administrations (1985-90; 2006-11) leading Ancash residents to decry favoritism.

as a model of efficiency and integration, in contrast to the stagnation of the latter, which has suffered from land invasion and other problems. To further complicate the situation, this inter-departmental rivalry has become a plank in the president of Ancash's political platform, creating a key hurdle to the implementation of Law N^{o} 29338 in the Santa Basin (Alvarez 2011).

Given its dependence on the Santa's flows, CHAVIMOCHIC, however, has continuously pursued participation in the management of the watershed. In 2001, in conjunction with the National Institute for Development (INADE), CHAVIMOCHIC published a thorough diagnostic of water management in the Santa basin and the valleys to the north. This study emphasizes the need for multi-sectoral governance and the lack of existing institutions to accomplish such management (the AACHS notwithstanding), and, not surprisingly, recommends a new authority in which CHAVIMOCHIC would be included. Although this proposal was ignored in the early 2000's, a watershed council model that brings the two irrigation projects (and the departments that house them) together is a key component of Law N^{o} 29338. Specifically, the law states that in the case of watersheds where a river's flows link the territories of two departments, an inter-regional council is mandated with its leadership rotating periodically between the departments (Article 24).

Law N^{o} 29338's designation of an interregional council for the Santa has become a central point of contention in Ancash, made worse by outrage in the department over the dissolution of the AACHS (Alvarez 2011). The unwillingness to share control of the Santa has contributed to the Ancash regional government's

refusal to cooperate with both ANA and La Libertad to establish the council, as well as its unequivocal rejection of the PMGRH pilot project and the associated IDB loan funding slated for the Santa watershed (Ancash 2009, Ancash 2011a). Instead, from 2010-11, the Ancash departmental government conducted its own efforts to advance a watershed council consisting only of actors from Ancash, led principally by irrigators from CHINECAS who were closely linked to the regional government itself. Through a series of successive multi-day workshops held in different parts of the department, this effort worked to consolidate support for an Ancash-led watershed council while also building a number of specific critiques of Law N^{o} 29338. These critiques have yielded detailed recommendations for amending the water law that include the creation of a regional council for the Santa River, greater representation for civil society actors in the watershed council structure, modifications to the criteria for efficiency rewards under the law, and the prioritization of domestic food security in water management policies (Ancash 2011b). While these recommendations have not led to changes in the water law at the national level, the Ancash regional government's position has delayed the development of the Santa basin council and highlights the challenges to Law N^{o} 29338 stemming from divergent politics across political levels.

Towards Formalized Water Rights: Quantifying Customary Uses

While the formation of a watershed council in the Santa has become extremely politicized, PROFODUA's awarding of formal water licenses to many of

the local water commissions has progressed with little resistance despite the uncertain and potentially problematic outcomes of this process over the long-term. Several possible explanations for this implicit acceptance of formalization warrant discussion. On one hand, the licensing process has been carefully distinguished discursively from privatization and instead is portrayed as a kind of award for local communities that will enhance local water security (ANA 2010b, ANA 2011a). The formalization process has also avoided individualizing rights, awarding licenses in blocks to user commissions, though individuals are required by law to join their respective user groups and are recorded by name in the water licenses[19]. Furthermore, the ongoing licensing process in the Santa is a case of rendering a problem so technical that users have difficulty knowing to what, if anything, they should be objecting. In most cases, local water users lack ways to verify or even envision their licenses, as most of the rustic irrigation infrastructure in use offers no precise means for measuring the *liters/sec* or m^3/sec that have been allotted. Moreover, the fact that rural irrigators have rarely, if ever measured or conceived of their water supplies in these terms makes the very idea that a volumetric allotment would be critical difficult to comprehend (Parón-Llullán 2009).

Despite the lack of major social resistance to rights formalization in the Santa watershed, the establishment of fixed water allotments may be challenged in the future by shifting environmental and economic conditions linked to variability and

[19] In some cases in the Santa basin, users have purposefully refused registration in the water user committees despite the law's mandates. Under the existing system, this refusal has not yet affected their access to water.

uncertainty in both hydrologic supplies and socio-ecological water demand. In the highland districts of Ancash, PROFODUA has used a complex hydrologic model (DISAPRO) to generate volumetric allotments corresponding to land area and common crop assemblages and taking into account available historical meteorological and hydrologic data, topographic features, typical seasonal crop rotations, etc. (ANA 2010a). The outcomes of the model, no matter how accurate they may (or may not) prove to be, provide a kind of snapshot of use under specific conditions in a socio-environmental context that is undergoing constant and rapid change. Thus a water license awarded in 2010 may fail to provide ample water in 2015 under a distinct climate or crop regime, and planting more water-intensive crops or expanding the agricultural frontier in the future would depend on obtaining new water rights or conserving water from other points in the system if an existing license's allotment is insufficient. While such limitations may indeed lead to important improvements in the efficiency of water use, they may also lead to conflict, particularly if the potential implications of the licenses are not made clear to the users receiving them. Such concerns may seem irrelevant in a context where canals are still earthen and discharge gauges are rare, but given the growing efforts to improve rural irrigation infrastructure, a future in which fixed volumetric allotments have real bearing may not be so distant.

Furthermore, despite the need for verifying the accuracy of the DISAPRO allotments, downstream users like CHAVIMOCHIC have voiced requests for PROFODUA to finish its work in the upper watershed so that those downstream will

have a clearer sense of the water available for further development (ANA 2011b). Such requests by powerful downstream actors show the increasing demand for Santa water but also raise important concerns about the ability of future water supplies to meet licensed quotas throughout the watershed. Moreover, given the uncertain changes in water supply and demand in the Santa basin, one must question the wisdom of establishing an inflexible rights regime, especially one that is lacking contingency agreements for periods of insufficient supply like drought years. In watersheds like the Santa, where already high inter-annual and seasonal variability is likely to become only more extreme and unpredictable under the ongoing impacts of climate change (Juen and Kaser 2007, Baraer et al. 2012, Bury et al. 2013), a less rigid and more adaptive system for allotting water to users across sectors and geographic regions may prove necessary.

Flows that Bind …and Divide: Conflicts and water cultures

Given the diverse and competing claims to the flows of the Santa and its tributaries, water conflicts have recently arisen in a variety of contexts in the basin. In the majority of cases, these conflicts have pitted local communities and civil society actors against both domestic and transnational corporations[20]. While the state has played a direct role in some conflicts, it has more often acted as an arbitrator between

[20] The Peruvian ombudsman's office (*Defensoria del Pueblo*) monitors formally declared conflicts throughout the country and provides a monthly synthesis of new, ongoing, and resolved conflicts to the general public. See: http://www.defensoria.gob.pe/conflictos-sociales/home.php.

local and corporate actors. The dynamics of these disputes emphasize the distinct cultural meanings, practices, and values associated with water in the basin while also underscoring the need for management strategies capable of bringing actors towards dialogue and compromise. Nevertheless, in many cases sustained dialogue has failed to bring compromise, illustrating the deep convictions and incompatible visions brought together by attempts at integrated management in the watershed.

The most pervasive points of recent contention have been linked to the impacts of the region's booming mining industry on local environments, health, and livelihoods. An example of such friction was a conflict that broke out in late 2010 over the development of a mining concession adjoining Lake Conococha, the emblematic headwaters of the Santa River. After local opposition to the project failed to sway regional and national governments through formal complaints and petitions, a mobilization led to the blocking of roads in Ancash and to the death of a local activist, which escalated the conflict significantly. As the dispute intensified it brought diverse groups together across geographic (e.g. highland-coast) and cultural (*campesinos* and urban university students) divides to defend the lake and the shared flows to which it gave rise. Under the gravity of the situation, the national government suspended the concession in question and a ministerial delegation was assembled to lead a resolution process.

Although this conflict was ostensibly about much more than Lake Conococha, the lake, as the origin of the Santa, became iconic in the struggle and some called for its designation as a strict protected area where mining would be forbidden in

perpetuity. Proponents of protecting the lake looked to Article 75 of Law N^{o} 29338, which establishes the legal basis for ANA, in concert with MINAM, to designate sensitive areas, such as the heads of watersheds, as intangible zones (*zonas intangibles*), where no formal use licenses can be granted (Peru 2009). Requests for this strict protection for Conococha led to a heated debate about whether such a classification made sense in a zone that was already significantly impacted by human activities like agro-pastoralism, as the great majority of highland watersheds are throughout Peru. It was decided that a detailed analysis of the site would be undertaken to determine its appropriate status, and a group of civil society and state actors developed the terms of reference for a study so thorough that its completion would require far more expertise and funding than available (MINAG 2011). Not surprisingly, more than two years later, the process of analysis and designation remains incomplete, with the temporary suspension of the concession still in place (ANA 2011c). The situation leaves important questions unanswered about the circumstances under which ANA might invoke Article 75 of Law N^{o} 29338 and, more generally, about its willingness to set a precedent of protecting mineral-rich headwaters of watersheds from mining impacts.[21]

Another emblematic conflict in the Santa watershed has developed between local users and the transnational corporation Duke Energy over the latter's management of Lake Parón—the largest lake in the Cordillera Blanca—for energy

[21] As Bebbington and Bury (2010) illustrate, the heads of watersheds are more often than not also the sources of ore deposits that attract extractive industries.

production at the Cañon del Pato hydropower facility (Carey, French and O'Brien 2012). In this conflict, after years of formal complaints with only ineffectual responses from the corporation and state regulatory agencies, local residents expelled Duke's personnel from the lake and took control of its discharge infrastructure. This conflict, which has dragged on for almost five years, illustrates the challenges in establishing multi-sectoral water management strategies as well as institutional forms capable of leading such strategies to mutually acceptable outcomes. The dynamics of the case highlight the marked differences in the existing water culture of rural farmers and that of Lima technocrats who have consistently worked to manage the case as their expertise dictates in a setting where these recommendations are neither accepted nor well-disseminated or fully understood.

Analysis of the factors contributing to the conflict at Lake Parón illustrates that Duke Energy's water license permits discharges in excess of what downstream environments and infrastructure can sustain and that detailed evaluation of these impacts has not been undertaken by the state or the corporation (Carey et al. 2012). Additionally, the license permits the company to drain the lake to a point at which additional outflow is minimal, thereby reducing the lake's capacity to buffer the dry-season impacts on local agricultural production. While the conflict has long persisted and dozens of participatory meetings have been conducted, the details of the license still have not been amended. This is ironic because it at once contradicts both the rational scientism of the Peruvian hydrocracy and the IWRM tenets of the new water culture that bureaucrats are working to promote. As discussed above, the challenges

to fixed volumetric allotments posed by a shifting and unpredictable climate are also clearly relevant in this case.

Together the struggles over the Santa watershed council and the conflicts at Lakes Conococha and Parón highlight the challenges of moving the IWRM strategy from a bureaucratic discourse to grounded practice in regions where local water cultures and histories of legal pluralism and political division have developed over time and in specific contexts. While in many of these cases, actors have shown a willingness to come to the table to negotiate multi-sectoral management, there is an abiding frustration that ANA has recentralized and reconsolidated decision-making authority and that these spaces of dialogue create a façade of meaningful participation with little actual empowerment of non-state actors. The complexities of these conflicts and their mingling of laws and policies with hydrologic and ecological conditions as well as socio-cultural and political economic factors also underscore the urgent need for an arbitrating body capable of effectively considering this diversity of elements in legal decisions that will establish important precedents for the future of Peruvian water governance under Law N^{o} 29338. The law itself recognizes this need with its mandate of a National Tribunal for the Resolution of Hydrologic Conflicts, and the fact that this important arbitrating body remains un-constituted after four years speaks to the partial and problematic implementation process of Law N^{o} 29338.

Despite the many challenges that the implementation of ANA's version of IWRM faces in the Santa basin, it is important to note that the governance processes emerging from the struggles and conflicts described above in many ways reflect core

principles of IWRM discourse. While these processes are not as formally ordered as the law might like, the spaces of dialogue and contention that have opened up in the wake of these conflicts have brought competing values over water into conversation in broadly participatory fora. They have also forged important connections among actors typically divided, creating the beginnings of governance networks necessary for managing shared resources across the watershed. The fact that these conflicts remain so intransigent shows both the gravity of the challenges that face the implementation of IWRM as well as the strength of people's commitments to values formed by far more than the laws of government or science.

Conclusions

In this paper, I have attempted to show how the current promulgation of IWRM strategies in Peru can, on one hand, be seen as the evolution of a century-old trend towards technocratic water management rooted in the modernizing "hydraulic mission" of the early-mid 20th century. On the other hand, the national government's current push to promote a new water culture and legal regime in Peru is indicative of a widespread shift towards "soft-path" solutions to water management resulting in part from a systematic diffusion of IWRM principles by international development banks and linked policy advocacy networks. In Peru, such international advocacy has played a critical role in shaping the 2009 Hydrologic Resources Law (N^{o} 29338) and continues to have a formative influence on the law's implementation through the

activities of the development bank-funded PMGRH[22]. I have suggested that the IWRM strategies developing in Peru reflect an overarching problematization of water *scarcity* as a result of both growing supply and demand-side pressures. These IWRM strategies propose various solutions to the scarcity problem such as the formalization of water rights, more complete cost recovery through expanded water pricing and fee collection, and the improvement of water use efficiency through new technologies and the allocation of water to its highest value uses. IWRM tenets also call for multi-sectoral, participatory and decentralized processes of water governance. In this paper, I have attempted to illustrate important challenges to and contradictions of these IWRM-inspired governance models that arise from specific legal, political, and cultural histories in Peru and in the Santa River watershed specifically. I have also tried to point to some opportunities for IWRM development and implementation that are linked, somewhat counter-intuitively, to water governance conflicts.

I have also considered the historical and contemporary legal and institutional contexts for water management in Peru in an attempt to understand the larger trajectory in which IWRM and Law N^{o} 29338 are embedded. While I have tried to illustrate the importance of both law and bureaucracy in shaping water governance practices, I have also emphasized the legal and cultural pluralisms around water that

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[22] On April 24, 2013, ANA announced an agreement between Peru and the 2030 Water Resources Group (2030 WRG) in support of further development of IWRM strategies in Peru. 2030 WRG is a "neutral platform" supported by groups like the World Economic Forum, the WB's International Finance Corporation, the IDB, SIDA, USAID, Pepsi, Coca Cola, Nestle, and the World Wildlife Fund. The group has worked in India, Jordan, South Africa, Mongolia, and Mexico. For further information, see: http://www.2030wrg.org/.

exist due to competing values and beliefs. I suggest that the hybridization of such plural norms and practices are fundamental in shaping water use and management, an assertion I have tried to support with empirical details from recent governance processes in the Santa River watershed. I also have argued that it is necessary to recognize and account for, to the degree possible, the importance of natural conditions (e.g. hydrologic variability, climate change, etc.) when designing and adapting governance strategies. Failing to include such conditions in water governance decisions, or failing to admit the limitations in understanding and accounting for them, has already and will continue to generate conflicts and problems across geographic and political scales and social and economic sectors. While science and engineering, as well as market mechanisms, may provide important means for coming to terms with such conditions, alternative approaches rooted in radically different systems of belief must also be taken seriously. The creation of governance spaces capable of accommodating all of these perspectives and promoting productive hybridization is both the great promise and fundamental challenge of IWRM.

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Figure 1.1: The IWRM Framework as envisioned by the Global Water Partnership. Source: http://www.gwp.org/en/The-Challenge/What-is-IWRM/IWRM-pillars/.

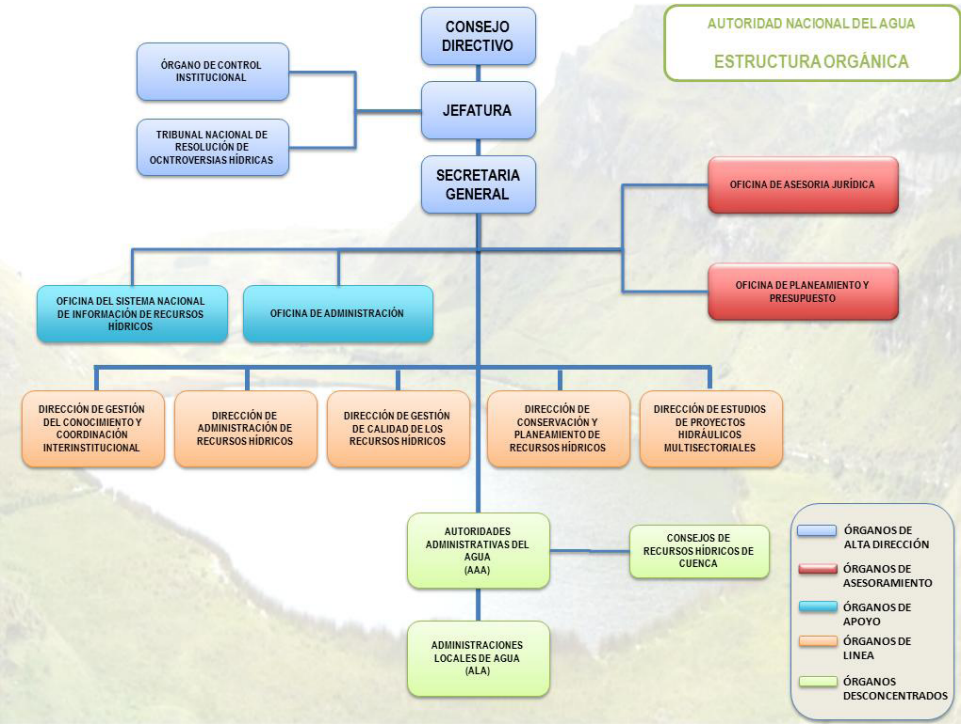
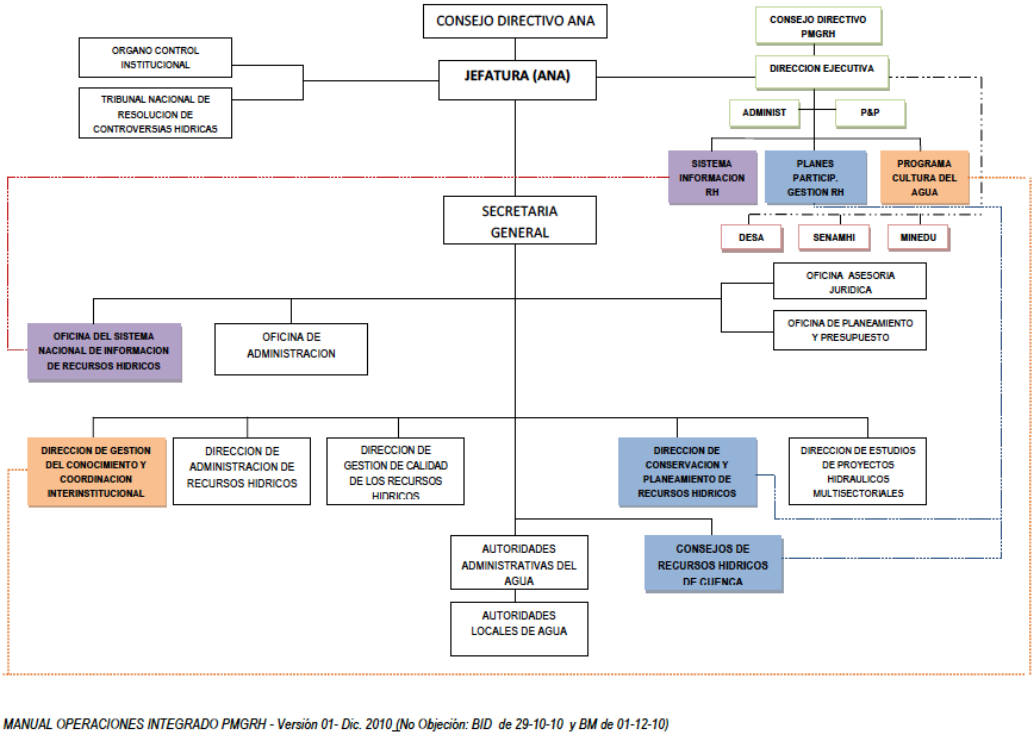


Figure 1.2: The bureaucratic structure of the National Water Authority. Only the three lowest boxes (órganos desconcentrados) are physically located outside the national level of government in Lima. The category of watershed council (lowest box on right: *consejos de recursos hídricos de cuenca*) is the only unit with representation from civil society. Source: National Water Authority.



MANUAL OPERACIONES INTEGRADO PMGRH - Versión 01- Dic. 2010 (No Objeción: BID de 29-10-10 y BM de 01-12-10)

Figure 1.3: The bureaucratic structure of the National Water Authority with the addition of the Moderzniation Project (PMGRH: see units in upper right corner). The dashed and colored lines show how the PMGRH is positioned to feed expertise and information directly into other units of the structure through a nationwide Data and Information System, through participatory watershed management plans, and the "water culture" program. Source: PMGRH Integrated Operations Manual, 2010.

Figure 1.4: Overview map of the Santa River watershed. Source: USAID/TMI.

CHAPTER TWO

Webs and Flows:

A Political Hydrology of Risk and Resistance at Peru's Lake Parón

> "Nature is far from 'stingy' and enables as well as constrains human production, but its rhythms and cycles are governed by a different logic than the rhythms and cycles of capital."
>
> --James O'Connor, *Natural Causes*, 1998

1. Introduction

Early on July 29, 2008, before the sun had crested the glaciated summits of Peru's Cordillera Blanca, a coalition of local residents from the Cruz de Mayo *Campesino* Community and the city of Caraz traveled the steep and winding track leading to Lake Parón. Other mornings, they might have made this same trip to clean canal intakes or to shuttle foreign mountaineers hoping to scale one of the icy peaks that ring the lake basin. That morning, however, they were on a mission to banish the transnational corporation Duke Energy from their lake. Specifically, they were going to evict a lone technician, who was housed on the frigid lakeshore at 4200 meters to operate a set of hydraulic valves that controlled the water running from the lake. Once the coalition had peacefully accomplished this task, some of the residents remained at the lake to occupy the discharge control station, while others descended to block the road leading up the canyon. Meanwhile, a large crowd—from schoolchildren to community elders—assembled far below in the city plaza of Caraz to proclaim their

right to the lake that had long been a critical water source and a potent symbol of the region and was now threatened by foreign corporate control.

These acts of coordinated resistance had come after almost a decade of local complaints against Duke Energy's management of the lake. During this period, attempts to modify Duke's practices through formal regulatory processes had effected little change, and local residents felt direct resistance was the best option that remained to them. Since the occupation of the lake nearly five years have elapsed; and, while the conflict has led to the emergence of a complex governance network, the case still shows few signs of resolution. Instead, in endless meetings and strategic press releases, the central actors continue to defend distinct visions and discourses of both risk and the right to water at Lake Parón, with local residents fighting for water security and territorial authority and the hydropower company claiming its legal rights and the need to control glacial hazards.

In this paper, I examine the historical basis and evolution of the conflict at Lake Parón in an attempt to understand the key drivers of its emergence and persistence. Using a political ecology approach, I analyze the ongoing dispute as a conjuncture of environmental, political economic, socio-cultural, and historical factors interacting across geographic and temporal scales that crystallize around conflicting logics of economic and social (re)production as well as discordant perceptions of risk. As such, the case provides a compelling example of the environmental governance challenges resulting from the neoliberalization of nature: a vital resource is dis-embedded from its socio-cultural context through neoliberal

reform, generating enduring social resistance through a kind of Polanyian double movement. By exploring the socio-natural dynamics of this ongoing governance process, this work contributes additional empirical support to an already rich body of scholarship on neoliberal natures and attempts to respond to the call for "more robust ethnographic accounts of the complex and place-based sets of practices through which particular actors have produced, reproduced, and challenged these novel modes of [neoliberal] governance…" (Himley 2008).

My primary intent in this work is somewhat different, however, and focuses on bringing Nature (as embodied in hydrologic, geophysical, and ecological processes and conditions) squarely into the analysis in ways that illustrate its fundamental role in co-producing the socio-natural system in which the Parón conflict has evolved and the contradictions that have emerged under neoliberal management of the lake. To accomplish this task, I conceptualize the socio-natural system at Parón through the linked concepts of the *hydro-social cycle* and the *waterscape*, drawing upon critical work in geography that envisions water as a substance transcending the physical properties of H_2O to embody a diversity of social relations and power asymmetries through its flows (Swyngedouw 1999, Bakker 2002, Budds 2009, Swyngedouw 2009). This is not a novel approach: close attention to Nature and its complex articulations with society has long been a hallmark of cultural and political ecology approaches. In this paper, however, I examine the discursive constructions and socio-natural materiality of the Parón conflict in order to conceptualize Nature's agency (cf. Bakker and Bridge 2006, Bakker 2010) through a depiction of Lake Parón's

waterscape as a kind of "relational web" (Rocheleau and Roth 2007) where assemblages of social, natural, and socio-natural actors and processes interact and "where agency becomes an emergent property of network associations rather than a property inherent in discrete entities" (Bakker and Bridge 2006, 19). To be clear, this is not a call for environmental determinism but rather for a kind of historical materialism that carefully analyzes the particularities and implications of the socio-natural metabolism and the dialectical and networked relations to which it gives rise.

2. Social-Natural Contradictions and Dialectics

In his seminal critique of market liberalism, *The Great Transformation*, Karl Polanyi outlines the attempted subjugation of nature to a free market economy through the commodification of land (2001 [1944]). Positing land as "only another name for nature" (75), he describes the commodity description as "entirely fictitious" (76), based on the fact that nature is not produced for sale on the market. Moreover, he emphasizes that to include nature, along with human labor, "in the market mechanism means to subordinate the substance of society itself to the laws of the market" (75). This process left unchecked, he contends, "would result in the demolition of society" (76). With the "double movement" (136), Polanyi describes how society avoids its own destruction and that of its natural environment by challenging the creation of fictitious commodities and an unregulated free market through a countermovement that struggles to maintain the embeddedness of the economy in broader socio-cultural contexts (Polanyi 2001 [1944]).

Beginning from Polanyi's assertions about the unfettered market's long-run propensity to savage both Nature and society, James O'Connor elaborates his theory of the "second contradiction of capital" (O'Connor 1988, O'Connor 1997). In this theory, capitalism undermines the very *conditions of production*—including Nature—upon which its growth is predicated, generating economic crisis and social resistance in the process. While O'Connor does not explicitly reference Polanyi's double movement in relation to the social resistance produced by this fundamental contradiction, the relevance to Polanyi's dialectic is clear (Foster 2002).

In recent years, critical geographers have returned to both O'Connor and Polanyi's critiques of the domination of nature by the free market for their marked relevance to the dynamics of environmental governance under neoliberalism, including to processes of institutional change and social resistance in response to the socio-environmental contradictions of neoliberal policies (e.g. Dubash 2004, Mansfield 2004, McCarthy and Prudham 2004, Prudham 2004, Prudham 2005, Guthman 2007, Watts 2009, Bakker 2010). Such work illustrates the diverse ways in which "environmental re-regulation is woven into the very fabric of neoliberalism" (Prudham 2004, 346), while also elucidating how natural conditions and socio-natural artifacts and processes themselves are incorporated into neoliberal projects in both enabling and constraining ways.

Recent scholarship examining the geographies of natural resource extraction also analyzes the ecological contradictions that arise through the "metabolism of production" in mining and other industries, as well as the regulatory practices that

develop to permit production to continue in the face of social resistance (Bridge 2000, Bridge and Jonas 2002, Bury 2005, Perreault and Martin 2005, Perreault 2006, Himley 2008, Bebbington and Bury 2009). Bridge and Jonas, for example, suggest that "…potential conflicts are often negotiated through historically and geographically specific sociopolitical struggles that become codified as the institutions and social practices within which resource extraction activities are embedded" (Bridge and Jonas 2002, 759-60). In cases like that of Lake Parón, however, underlying ecological contradictions are not managed effectively, and social conflict itself gives rise to networked processes of negotiation and regulation that are expressed as much through struggle as by codified institutions and social norms. It is within these networks of both struggle and regulation—these "relational webs shot through with power" (Rocheleau and Roth 2007)—where, I argue, we must locate Nature's constitutive influences and take them seriously as agential factors. Such conceptualization is critical to addressing the contradictions that arise through socio-natural metabolisms of production (of neoliberal practices and more broadly) and to furthering adaptive governance processes in the increasingly uncertain and changing contexts that characterize our world.

2.1. Towards Socio-natures

While scholarship in geography has done much over the last twenty years to address the "peculiar silence on … the geographical and historical dialectic between societies and their material environments," (Fitzsimmons 1989, 106, see also e.g.

Watts 1983, Smith 1984, Harvey 1996, Peet and Watts 1996, Swyngedouw 1999), important challenges remain in recognizing the possibilities of a critical "material turn" for analytical treatments of Nature (Bakker and Bridge 2006). In particular, there is still work to be done in conceptualizing Nature's role in co-producing neoliberal natures, as well as in the co-production of socio-natural processes more broadly. There has been important progress on this front. For example, research has illustrated how natural processes can obstruct capital accumulation through incongruities in agricultural and business processes and cycles (Mann and Dickinson 1978, Goodman, Sorj and Wilkinson 1987) or through the "uncooperative" material characteristics of a resource like water (Bakker 2004). Innovative work showing how Nature acts as "obstacle, opportunity, and surprise" for capitalism and how the strategies for incorporating natural processes into production vary markedly across specific industrial sectors also suggests diverse possibilities for conceptualizing Nature's role in socio-natural processes (Boyd, Prudham and Schurman 2001). Such advances notwithstanding, there remains a need for careful empirical investigations of how materiality matters, both in production processes and in the socio-natural contradictions that challenge them, as well as in the conflicts and regulatory processes that result. Additionally, difficult challenges of how to discuss Nature's agency discursively and demonstrate it empirically while avoiding traps of environmental determinism remain prominent.

2.2. Waterscapes and the Hydro-social Cycle

In recent decades, hybrid socio-natural framings have been developed in an effort to overcome the fundamental ontological challenge of the nature-society dualism in ways that do not merely reproduce categorical divisions or err towards either environmental or social determinism (e.g. Haraway 1991, Latour 1993, Harvey 1996). In relation to the complex entanglements between society and hydrologic systems, Daniel Worster's dialectical perspective was an early and influential example of Nature and society's co-production (1985). More recently, work developing hybrid concepts such as the waterscape and the hydro-social cycle has advanced socio-natural perspectives in the water realm further (e.g. Swyngedouw 1999, Bakker 2004, Swyngedouw 2004, Loftus 2006, Perreault 2006, Budds 2009, Linton 2010).

As Swyngedouw states, "in a sustained attempt to transcend the modernist nature-society binaries, hydro-social research envisions the circulation of water as a combined physical and social process, as a hybridized socio-natural flow that fuses together nature and society in inseparable manners" (Swyngedouw 2009, 56). Similarly Budds suggests, "the reworking of the hydrologic cycle into the hydro*social* cycle reflects th[e] incorporation of water's social relations alongside its physical materiality through the socio-ecological concept of the waterscape" (Budds 2009, 3). Elsewhere, Budds and Hinojosa describe the waterscape as "compris[ing] the assemblage of a wide range of water flows, technologies, issues, institutions, discourses, and meanings, … which produce, and are produced by, power relations"

(Budds and Hinojosa 2012, 125). The inclusion of power relations in these socio-natural configurations is a central point as "the mobilization of water for different uses in different places is a conflict-ridden process and …shows how social power is distributed in a given society" (Swyngedouw 2009, 57). Thus in channeling water through irrigation canals and over hydroelectric turbines, specific socio-natures are created that underpin productive processes while forging connections not only among human actors but between human actors and natural processes. Moreover, through its ability to flow across all manner of geographical, cultural, and political divides, water weaves together diverse socio-natures, creating webs of relations where both humans and natural conditions as well as the relations between them effect change and influence outcomes. In this paper, I draw on these hybrid conceptualizations in an attempt to show how diverse actors and processes have impacted the hydro-social cycle at Lake Parón over time, dis-embedding it from certain sets of social-natural relations and re-embedding it in others as the Parón waterscape is continuously transformed.

3. The Lake Parón Waterscape

Invisible from the populated landscapes below, Lake Parón (4200 m) is nestled in a narrow glacial basin ringed by some of the highest mountains in the world's tropical zone (see Figure 2.1). From the northern slopes of the largest of these peaks, Mt. Huandoy (6350 m), a massive lateral moraine of the Hatunraju glacier spills down into the Parón basin. As this moraine reaches the valley floor it bends

sharply to the west crushing a debris cone against the opposing wall's sheer granite flanks. Over time, this natural dam blocked the runoff of glacial melt and precipitation from upstream of the dam, forming Lake Parón in the basin (see Figure 2.2).

Lake Parón is the largest of some 400 glacial lakes in the Cordillera Blanca, the highest and most-extensively glaciated mountain range in the Tropics (ANA 2011b). When full to its brim, the lake is nearly four kilometers (km) long by a half km wide and its surface is roughly 90 meters (m) above its bed at the deepest point. Under these conditions, the morainal dam of Hatunraju holds back almost 80 million cubic meters (80 x $10^6 m^3$) of water (S&Z 1986). The watershed that feeds Lake Parón is 42 km^2 in area (S&Z 1986) and has the highest percentage of glacial cover of any major basin in the Cordillera Blanca with an estimated 39% glacial cover in 2009 (Baraer et al. 2012). Illustrating the dramatic rate of deglaciation in this region, the percentage of glacial cover in the Parón basin has decreased from 72% glacial cover in 1930 and 55% glacial cover in 1970 to its current levels, and deglaciation is predicted to continue in the future (Baraer et al. 2012, Bury et al. 2013).

Despite Lake Parón's isolation in a mountain canyon at 4200 m, it is intricately connected to a diversity of landscapes and communities through the waters that flow from the lake into the Parón River (see Figure 2.3). This river flows through a steep, narrow valley amidst the *Polylepis* forests of Huascaran National Park and then passes into a mosaic of agricultural parcels before joining the Huancutey River to form the Llullán River, which continues its descent to a confluence with the Santa

River near the regional center of Caraz (pop. ~20,000). Along its roughly 20 km length, the Parón-Llullán River feeds a dozen irrigation canals that provide water to more than 2700 irrigators growing an array of crops ranging from staple varieties of tuber and *maiz* to carnations and other ornamental flowers for regional and international markets (ANA 2010a). This irrigation water is particularly critical during the tropical dry season (May-October), when little precipitation falls. Additionally, the river is the principal source of potable water for the growing urban districts of Caraz.

But unlike many of the smaller glacial lakes in the Cordillera Blanca, the hydrosocial cycle of Lake Parón is not limited to the kinds of local water uses described above. Instead Lake Parón's flows create a waterscape that articulates the residents and ecologies of the Parón-Llullán watershed with diverse actors and environments in the downstream reaches of the Santa River and beyond.

3.1. Water as Progress: Development in the Cañón del Pato

To grasp the complexity of the contemporary waterscape at Lake Parón, one must explore how the lake and its waters fit into the 20th century's history of both regional development and disaster in the Santa River watershed. A good place to begin this account is with the early explorations of Peruvian physicist and engineer Santiago Antúnez de Mayolo. In 1913 in search of a site suitable for a hydroelectric plant, Antúnez de Mayolo ventured through an impressive gorge located just downstream of Caraz on the Santa River called the Cañón del Pato. In this rocky

defile, which dropped more than 500 m over a length of 13 km, he envisioned a power plant capable of providing the energy necessary to make synthetic fertilizer (Antunez de Mayolo 1957, Sotelo 1982). He presented his idea to the Peruvian government on more than one occasion but was not taken seriously and his personal efforts to complete the project failed for lack of capital. Yet by the early 1940's the government's interest in the hydroelectric plant had been piqued and both Antúnez de Mayolo and Tennessee Valley Authority engineer Barton Jones were contracted to design the facility (Carey 2010). In 1943, Peru's government founded the Santa Corporation to build the power plant as well as a steel mill on the coast at Chimbote that replaced the fertilizer plant originally envisioned as part of the integrated project.

The design of the plant was a feat of both imagination and engineering. At the top of the Cañón del Pato, water would be diverted into a nine-kilometer long tunnel excavated in the sheer granite cliffs forming the river's right bank. Along this route, the water would lose its coarsest sediments and then plummet 400 meters onto a set of turbines, releasing its energy and returning to the river just below the bottom end of the canyon. The plant would have more than enough water in the wet season, and, in the future, additional engineering of the glacial lakes in the Cordillera Blanca could create regulating reservoirs to boost production in the dry season while also contributing to agricultural development on the coast near Chimbote. The facility's design was at once elegant, efficient, and durable.

3.2. Water as Threat: Growing Glacial Hazards

By 1945, the Cañón del Pato construction project had drilling equipment and nearly 600 laborers in its employ. By the end of that year, some 1600 meters of tunnels had been dug and the initial set of turbines had been ordered (Duke 2008). Steady progress on the plant continued until October 20, 1950 when a terrible setback occurred. On that day, a glacial lake in the Los Cedros Valley—several watersheds to the north of the Parón Valley—overtopped its morainal dam after a large ice avalanche fell into the lake generating a series of waves that the moraine could not withstand. Three and a half million cubic meters of water poured out of the lake in a few minutes on its way to the Cañón del Pato. The flood ravaged the hydropower plant's nearly completed infrastructure and killed close to 200 people in Huallanca, the town that had grown up at the bottom of the canyon as the hydropower project developed (Carey 2010).

The Los Cedros glacial lake outburst flood (GLOF) was hardly the first such disaster in the Santa watershed; the region had long been plagued by such catastrophes. Yet in this case the presence of the hydropower plant made the disaster a national concern. As historian Mark Carey argues "had the flood occurred a decade earlier, before the Santa Corporation existed, the flood might not have even warranted media attention in Lima, to say nothing of concentrated consideration and funding from the president of the republic" (2010, 81). As it was, however, a development project of major national importance had been nearly destroyed. Engineers such as Antúnez de Mayolo sought to blame the disaster on a group of laborers who had been

working to drain the lake to avoid just such a GLOF, but technical assessments attributed the accident to the scale of the ice fall and the instability of the morainal dam rather than to any human error. In hindsight, the extreme vulnerability of the plant to glacier-related disasters was obvious, but the developers of the project seemed convinced that these risks could be controlled in order to realize the benefits of economic development (Carey 2010). Such optimism about the capacity to harness nature's forces for human gain in the face of risk would carry the Cañón del Pato project on to completion in 1958 and, in time, would fundamentally alter the Lake Parón waterscape as well.

3.2.1. Fears of Catastrophe at Lake Parón

In late 1941—nearly a decade before the Los Cedros disaster—glacial Lake Palcacocha burst through its morainal dam and destroyed much of Huaraz, the largest city in the upper Santa River watershed where some 5000 people perished. In the wake of this tragedy, residents living in the city of Caraz beneath Lake Parón began to express concerns over the possibility of an even more catastrophic GLOF coming from Parón. Early studies of Lake Parón's morainal dam suggested that it was stable, but a smaller lake located higher up in the glacial basin above Parón was a growing concern (see Figure 2.2). Unlike Lake Parón, the smaller Lake Artesoncocha had significant room to increase in volume and was directly exposed to ice and rock fall from the steep walls that bounded it on three sides (Carey 2010). In mid 1951, Lake Artesoncocha partially burst through its morainal dam, sending a slurry of water and

debris into Lake Parón. Several months later, Lake Artesoncocha sent another even larger outburst into Lake Parón. The lower lake's morainal dam held, but as the seasonal precipitation began, Parón's level crept to within inches of the top of the dam. By early 1952, state engineers were working to fortify Parón's morainal dam with a wall of sandbags while simultaneously assuring local residents that the lake presented little danger to them (Carey 2010). Fortunately, the moraine at Parón did not fail during the wet season of 1952 and over the dry season of that year its volume decreased significantly. While concerns over a GLOF at Parón diminished with the dropping water level, the underlying risks at the lake remained significant and more visible than ever before to the local population.

3.2.2. Modernity's Gamble: Profit over Caution

Despite the near overtopping of the moraine at Lake Parón in the 1951-52 wet season, no decisive action to mitigate GLOF risks at the lake were taken until 1967 when a group of French scientists completed a study of the lake that suggested the morainal dam could fail due to the impacts of an earthquake, large avalanche, or an additional GLOF from Lake Artesoncocha. The scientists concluded that the lake should be drained, and that a thorough study of the lake's moraine should then be undertaken to evaluate whether the lake might serve as a regulating reservoir for the hydropower plant at the Cañón del Pato (S&Z 1986, ANA 2012). It is important to note how risk mitigation at Lake Parón through lowering the lake level was a precondition for integrating the lake into the system of electricity production at Cañón

del Pato, whose productive capacity had been doubled in 1967 from the initial 50 MW installed in 1958 to 100 MW (Duke 2008). Would risk mitigation activities have been undertaken at Lake Parón had it not been for the possibility of using the lake to boost production at the Cañón del Pato? The fact that the draining of the lake began 15 years after Lake Parón had nearly overtopped its dam and that this step was critical for assessing the lake's capacity to serve as a regulating reservoir suggests that economic concerns were at least as important as risk mitigation in the decision to drain the lake.

Draining Lake Parón, which contained nearly 20 times the volume of water that had caused the Los Cedros disaster, was no simple undertaking. Rather than risking the destabilization of the morainal dam by excavating and reinforcing a spillway as had been accomplished at a number of smaller Cordillera Blanca lakes, a 1.2 km tunnel was to be drilled through the granite walls on the right side of Lake Parón (Carey 2010) . This colossal project required significant time and capital and faced an array of setbacks, both technical and financial. Nevertheless, the tunnel was finally completed in 1984, and the lake was lowered approximately 45 meters as more than 50 million cubic meters of water were released down the Parón-Llullán River (Carey, French and O'Brien 2012).

A contracted engineering firm undertook the evaluation of the stability of the lake's morainal dam, both during and after the draining of the lake. In addition to the compilation and analysis of meteorological and hydrologic data for the basin, the evaluation included analyses of how the water table and points of seepage in the

morainal dam responded to the lowering of the lake, the collection of core samples from various points and depths of the moraine to determine whether or not fossil ice was present, and monitoring of the stability of the lake's shorelines as the water level was lowered (S&Z, 1986).

These analyses determined that the lake's moraine was stable, well-consolidated material with no fossil ice present. Moreover, the lake's shorelines had remained stable during the lake-lowering process, which had begun in March 1984, only to be interrupted in May by a collapse in the drainage tunnel, and was then reinitiated in February 1985. As the lake level was lowered in both 1984 and 1985, it also became clear that the majority of the seepage occurring on the upper part of the morainal dam diminished as the lake level dropped below 4190 m. The analyses of hydrological data coupled with information about downstream demand for agriculture, potable water use in Caraz, and hydropower generation also suggested that the lake could provide sufficient water to cover all local needs at that time (~18 x $10^6 m^3$) while still contributing a significant volume to the Cañón del Pato plant annually (~27 x $10^6 m^3$) (S&Z 1986, 127). On the basis of these findings, it was determined unequivocally that the lake could be used as a regulating reservoir for the Cañón del Pato power plant under specific management conditions.

Through technical expertise and the collection and analysis of an array of scientific data, the engineers in charge of evaluating Lake Parón's morainal dam had approved the lake for use as a regulating reservoir. In so doing, these engineers accepted a certain level of risk as a trade-off for the electricity production and

economic gains that this management strategy would enable. Obviously, the safest course of action in terms of the prevention of a catastrophic GLOF was to leave the lake nearly empty, but this choice would have ignored the importance of the lake's stored waters to both local residents and the hydropower plant.

In an effort to ensure the security of the lake while realizing its potential contributions to regional development, the engineers provided a set of detailed recommendations for the use of the lake as a regulating reservoir. Specifically, the experts suggested that the lake's normal maximum operating elevation be maintained at 4185 meters, leaving 15 meters of freeboard between this level and the lake's brim to absorb any possible impacts related to icefall or a GLOF in the higher reaches of the Parón basin[23]. They also suggested constructing the final intake tunnel at an elevation of 4155 m, which would provide a usable volume of 36 x $10^6 m^3$ between the intake and the maximum level of 4185 m (see Figure 2.4). Additionally, they established that the lake level should be lowered no more than 20 cm per day[24] to assure the continued stability of the sides and bottom of the lake. This guideline for maximum daily discharge did not translate into a specific uniform discharge rate, as this rate necessarily fluctuates with the elevation of the lake's surface, the topography

[23] Within the 1986 technical report, the engineers suggest that the maximum operating elevation could be set at 4190 m to take further of advantage of the lake's capacity, but that such a decision would require a thorough and updated study of the hazards in the basin.

[24] In their technical report, the Peruvian consultants noted that the foreign experts participating in the evaluation had recommended lowering the lake level at only 15 cm per day, which the Peruvians considered to be overly conservative ("*sumamente conservadora*") (S&Z 1986, 88).

of the lake bottom, and the volume thus contained.[25] As we shall see below, this lack of a fixed discharge rate, which is insignificant at this point in the story, becomes a point of contention as the lake's use in hydropower regulation at the Cañón del Pato evolves.

3.4. Lake Parón Comes Online

In order for Lake Parón's promise as a regulating reservoir to be realized, the drainage tunnel project had to be completed through the expansion of the tunnel's intake and the installation of a new set of heavy-duty regulating valves capable of permitting the secure control of the lake's discharge at levels sufficient for the hydropower plant's needs. These final steps were finished in 1992, and Lake Parón's incorporation into the Cañón del Pato plant's production system was complete. Although water from Parón was discharged in 1992-93, it was not until November 1994 that the first formal use license for Lake Parón's water was awarded to the state-owned company Electroperu that ran the Cañón del Pato. This license stipulated that Electroperu had rights to use 35 mm^3/year at a discharge rate of up to 8 m^3/sec (MINAG 1994) while the company was required to discharge at least 1m^3/sec for use by the local irrigators' commission. Under the license, adjustments to the discharge rate were to be coordinated with the irrigators' commission and approved by the Huaraz Irrigation District Administrator (ATDR) (Untiveros 2011).

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[25] When the lake contains a greater volume of water, a higher discharge rate is required to achieve the lowering of its level by 20 cm.

Only two years later, as the privatization of public utilities in Peru was enacted by the Fujimori administration, the Cañón del Pato and its supporting infrastructure, including Lake Parón, were sold (MEM 1996, Carey et al. 2012). In this sale, existing use licenses were transferred and EGENOR inherited Electroperu's rights to the water from Lake Parón with the added requirement of having to conduct an environmental impact study of their activities at the lake in accordance with Huascaran National Park's guidelines (MINAG 1996). By 1999, Duke Energy, a US-based energy company who had been a major partner in EGENOR, consolidated control over the company and became a central actor in the Parón waterscape (Duke 2002).

As part of the initial contract for the privatization of Electroperu's facilities, EGENOR (Duke hereafter) agreed to increase electricity generation in the country, partly through the expansion of production at the Cañón del Pato plant. This expansion required both greater infrastructural capacity to handle increased volumes of water and the legal right to use a larger quantity of Santa River water. The company reinforced and expanded its intake at the top of the Cañón del Pato, and in 1999 the government increased Duke's license from 48 m^3/sec to 79 m^3/sec (MINAG 1999). During the annual dry season, however, when Santa River flows often drop to as low as 30-40 m^3/sec at the plant's intake, this new legal right alone did little good. Under these seasonal conditions, expanded power production also required the intensified use of water from highland reservoirs like Lake Parón.

4. The Lake Parón Use License: Rationale and Contradictions

The license that Duke had inherited from Electroperu over Parón's water supported this intensification. The license gave rights to discharge nearly the entire volume of the lake contained between the elevation of the tunnel intake at 4155 m (below which the lake volume is referred to as "dead" or *muerto*) and the maximum operating elevation at 4185 m (35 of a total 36.5 x $10^6 m^3$ stored in the reservoir). Additionally, this water could be discharged at rates of up to 8 m^3/sec, more than three times the average maximum annual flow of the Parón River over the previous three decades (2.55 m^3/sec from 1954-1984) (S&Z 1986).

The existing hydrologic, geomorphologic, and ecological conditions along with the water infrastructure and irrigation practices in the Parón basin were less supportive of such intensified use of Lake Parón as a regulating reservoir. On the one hand, in many years the annual recharge of the lake, given the maintenance of minimal discharge, is less than the 35 x $10^6 m^3$ of lake water that Duke is entitled to release. On the other hand, the riverbanks and irrigation infrastructure in the Parón-Llullán watershed could not sustain the awarded discharge rate of 8 m^3/sec without serious erosion problems. As explored in further detail below, these contradictions between the water license and the use regime it established and the conditions of the socio-natural waterscape have been at the center of the intractable conflict over control of Lake Parón for more than a decade.

Used strategically, Lake Parón's flows are of high value to the Cañón del Pato. In 1990, it was estimated that use of water from the lake would produce at least

$3 million in added profit at the plant (Carey et al. 2012). Water from Lake Parón is clean, bearing little sediment in comparison to the Santa River, which saves wear to the blades of the plant's generating turbines[26]. More importantly, the water can be saved at its source until the dry season drops flows in the Santa to levels at which water from Parón becomes critical to keeping more of the turbines spinning—it is typical to generate at half capacity during much of the dry-season. Taking into account the 8 hours the water travels between the Lake Parón tunnel outlet and the turbines, timed discharges could be released from Parón to heighten production in hours of peak demand.

With the construction of the 600,000 m^3 San Diego Reservoir just above the Cañón del Pato intake in 2001 Duke enhanced its ability to contribute to peak-hour energy production. Some experts have suggested that this impoundment diminished Duke's reliance on Lake Parón, but, with this new element in the waterscape, Lake Parón actually took on a critical role in the daily recharge of the holding reservoir. When full, San Diego could continuously contribute 30 m^3/sec to the river's flow for more than five hours, almost doubling the average minimum monthly flow of the Santa at the plant intake (31 m^3/sec in August) and allowing nearly all of the turbine groups to enter into production. The ability to flush large volumes from Lake Parón to

[26] The erosion of the turbine blades is a major operating expense for the Cañón del Pato. A new turbine wheel cost $600,000 in the 1990's, while shipping and repairing the eroded blades in Europe cost $80,000. After 2000, these repairs were conducted in the steel mill in Chimbote, lowering the cost of repairs to $15,000 (Ocaña, J. 2011).

augment the Santa's flows and refill San Diego both helped sustain minimum production and contributed to satisfying peak-energy demand.

Though always useful, this integrated regulating system capable of addressing peak demand in virtually real-time would have become particularly valuable from around 2004-07, which as we see below was a period of intensifying local complaints over Duke's management of Lake Parón. During this period, the structure of electricity regulation permitted energy producers like Duke to avoid contracting much of their energy production in advance, leaving it available for sale on the short-term spot market. Due to the very high spot-market prices for energy during the months of the dry season from 2004-08 (see Figure 2.5), the ability to produce energy at these periods of peak demand for sale on the spot market yielded returns much higher than energy's standard price. In this context, the Parón-San Diego-Cañón del Pato system was a veritable treasure.

Given Lake Parón's contribution to power generation and economic production during periods when energy is most scarce in Peru, it is not surprising that the Fujimori administration was generous in awarding the terms of the initial water license or that the state-owned Electroperu was not required to produce an EIA for its use of the lake's water. Indeed, the decision to set the maximum discharge rate at 8 m^3/sec showed no consideration for erosive impacts on the Parón-Llullán River's course or for protecting the local irrigators' infrastructure or assuring the quality of Caraz's drinking water supply. Diverse inquiries failed to yield precisely how this discharge rate was established. One feasible explanation is that in the initial lake

drainage project, the engineers had lowered the lake 15 centimeters a day at a discharge rate of 6 m^3/sec, but the Peruvian engineers directing the process found this rate conservative and recommended that the lake could be lowered faster (20 cm/day) while still avoiding dangerous changes to the stability of the sides of the lake (S&Z 1986). Based on this recommendation, a 20-cm drop in the lake level over 24 hours would be produced by around 8 m^3/sec in discharge, though this rate of descent would increase as the total remaining volume of the lake declined. The technical report also recommends that the discharge valves should permit at least a 7 m^3/sec discharge to satisfy the needs of the local users and the hydropower plant (S&Z 1986, 133).

Considering these details, the 1986 technical report seems to at least indirectly support the 8 m^3/sec maximum discharge rate given in the license. According to specifications, this discharge was well within the capacity of the tunnel: the valves that were eventually installed at the tunnel intake could manage up to 12 m^3/sec and the reinforced tunnel itself could supposedly sustain 17 m^3/sec. This study, however, had focused exclusively on the conditions of the lake and the morainal dam, largely neglecting the impacts of the lake's use as a regulating reservoir on the other elements and actors of the waterscape located downstream of the tunnel's outflow. Had an EIA been required during the granting of the initial license to state-owned Electroperu, it might have identified the downstream impacts and identified ways to avoid or mitigate the problems. As it was, the alteration of the hydrosocial regime in the watershed through the ability to discharge far more water than the system was

accustomed to produced enduring problems downstream. Thus, just as the use of the lake's water intensified under Duke's management, so too did local complaints about the impacts of the process.

While the discharge rate has been at the root of many of the complaints over Duke's management of Lake Parón, the total volume allotment provided by the license has also been an important source of conflict. Specifically, by granting use rights to 35 x $10^6 m^3$ of water, the license permitted Lake Parón to be emptied of the great majority of its total usable volume every year. This volume was allotted despite the fact that in many years there is not sufficient water flowing into the lake to completely recharge the reservoir to its maximum operating level, nor can a constant flow of 1 m^3/sec be guaranteed if the entire allotted volume is discharged before the rainy season begins to refill the lake see (Figure 2.6). Compounding these contradictions, there are no provisions in the license by which to adapt the hydroelectric use rights to variable and shifting hydrologic conditions, namely drought years. Looking to the future, this situation becomes even more worrisome in a context where the contribution of glacial melt to the lake's volume is likely to be significantly reduced, thus decreasing the melt's buffering effect on seasonal water scarcity (cf. Baraer et al., 2012).

Had the articulations of social, hydrologic, and ecological conditions in the downstream reaches of the Lake Parón waterscape been considered in the granting of the initial water license, the Lake Parón conflict might have unfolded differently or even have been avoided. As awarded, the license is at odds with climatic and

hydrologic variability in the region, with historic stream flows and established local practices, with Peru's current water legislation, and with adaptive management principles. In the following sections, the paper explores how these contradictions between the license's details and the hydro-social reality in the Parón-Llullán watershed gave rise to local resistance and the emergence of an intransigent conflict that over five years has spun together an intricate and cross-scalar web of actors, each with distinct claims to knowledge, power and authority.

5. Growing Discontent over Controlled Flows

Public complaint with the controlled discharges from Lake Parón began as early as 1985 when during the initial lake lowering effort the turbidity in the Caraz water system increased to levels far higher than those acceptable for potable water. These changes in water quality led to the formation of a citizen-led Defense Committee and to a meeting in early 1986 between the various parties involved. At that time, several mitigating measures were discussed, but it was also explained that the water in the Parón-Llullán River would never again run so clean as it had prior to the construction of the drainage tunnel (S&Z 1986, 110).

After these initial complaints over the change in downstream water quality, there is little record of further problems until the era of Duke's management. Soon after Duke had consolidated control over the Cañón del Pato plant as well as the Lake Parón tunnel in 1999, local complaints over the management of the lake and its discharge began to increase. One of the first grievances, which appeared in September

2001 in the Caraz newspaper *Rima Rima,* had little to do with Duke but instead brought to the public attention the fact that 540 hectares of Huascarán National Park, including Lake Parón and its surroundings, had been formally titled, albeit in error, to Electroperu in 1994 (Rima 2001). With privatization of Electroperu's Cañón del Pato assets, this erroneous title had passed, along with the water licenses, to EGENOR and then on to Duke. Later that same month, the mayor of Caraz sent a formal letter to the Regional Agrarian Director of the Ancash Department complaining that Duke was practicing "…an indiscriminate use of Lake Parón's waters in quantities greater than that of the normal flow of the Llullán River…"[27] (Caraz 2001). These actions, the mayor asserted, were causing damage to roads, bridges, and irrigation infrastructure downstream of the lake. Moreover, Duke had failed to comply with the conditions it had established in its cursory 1998 environmental impact study for the Lake Parón infrastructure (Caraz 2001).

Then, in mid-October 2002, at the end of the dry season when the lake level hovered just above the "dead" level, the president of the Parón-Llullán irrigators' commission submitted a formal complaint to the Technical Administrator of the Huaraz Irrigation District (ATDR) stating that the farmers in his district lacked water and were beginning to lose crops. He said this stemmed from the illegal transfer of the lake that allowed EGENOR to use the water in ways contradicting the national water law. In a penultimate sentence presaging the 2008 conflict, the head of the

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[27] "…realizando un uso indiscriminado de las aguas de la Laguna de Parón, utilizándolas en cantidades que superan el cauce normal del Río Llullán…"

irrigators' commission solicited the ATDR to take action against the company before the water users were forced to resort to other means (Parón-Llullán 2002).

Duke defended itself against these diverse complaints in several ways in 2002, including through press releases and public relations materials. For example, in a pamphlet titled *Egenor: Facts, Data, and Figures* under the section "Frequent Doubts," the company first explained that the transfer of the land title of Lake Parón and its surroundings to Electroperu was a mistake that Duke had inherited and that the company's legal team was working to fix the error. Next the company described why it had drained Lake Parón entirely in 2001, stating "it was a dry year that forced those in charge of the hydropower plant to make the decision to drain the lake to the *authorized levels*" (Duke 2002, 30, emphasis added)[28]. The company went on to acknowledge the impacts of this decision on the scenic value of the lake as well as on water availability for irrigators, explaining that the problem was only temporary and that by the time of writing in 2002 most of the water in the lake had already been replenished—though, as the irrigators' formal complaint later that year asserted, the problem, albeit temporary, was prone to repeat itself at the end of each dry season, when there was the greatest need for water across sectors.

Notably, Duke justifies its practices largely through reference to the details of its water license, which gave the company the right to discharge virtually all of the lake's volume that could be accessed by the drainage tunnel. Had it chosen to do so,

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[28] "El 2001 fue un año seco, lo que obligó a los responsables de la central hidroeléctrica a tomar la decisión de descargar las aguas de la laguna de Parón hasta los límites autorizados."

the company might have responded similarly regarding the Caraz mayor's charge that the company was flushing far more water down the Llullán River than had flowed there historically. Indeed, its license to discharge 8 m^3/sec gave the company the right to release more than 4 times the river's average maximum flow (2.55 m^3/sec) for the period between 1954 and 1984 (S&Z 1986). Thus, while Duke's discharges may have caused damage to riverbanks and irrigation canal intakes that contradicted the regulations of Huascarán National Park, as well as laws regulating the hydropower sector, these discharges remained within the company's legal rights. Similarly, when there was no longer any additional water to flush from the lake at the end of the dry season, the company failed to comply with its responsibility to discharge at least 1 m^3/sec from Lake Parón, but it was only because that water did not remain in the lake after the company had used its rightful allotment. My goal in emphasizing these points is not to excuse Duke for their management strategies. Rather, I want to highlight how the specific character of Duke's water license at Lake Parón, initially granted to Electroperu in 1994 and still largely valid in 2013, has contributed fundamentally to the origin and persistence of the Lake Parón conflict.

5.1. Spinning the Web: New actors, little resolution

As local complaints against Duke mounted after 2002, attention from Huascarán National Park and other state institutions increasingly focused on the downstream damage caused by the large discharges permitted under the original license. In a 2005 inspection, the state Organization for the Supervision of Investment

in Energy and Mining (OSINERGMIN) reported obvious damage to irrigation infrastructure due to flows of 6 m^3/sec. More thorough evaluations followed in 2006-07 leading OSINERGMIN to require a more detailed EIA for Duke's operations at Lake Parón. More significantly, in 2006 the Technical Administrator of the Huaraz Irrigation District (ATDR) intervened by reducing the company's license from 8 to 5.5 m^3/sec (MINAG 2006). While this was a significant step, many local residents argued that it was not sufficient. At a rate still double the 30-year average maximum discharge, erosion problems continued and turbidity rose at times as the lake was drawn down towards its "dead" level. Local users presented other grievances as well, for instance the company's failure to coordinate discharges with them in advance through the ATDR. Especially annoying for local irrigators were the releases of large amounts of water at night, which complicated their efforts to control the flows for their crops (Parón-Llullán 2009) Despite these obvious impacts, between late 2007 and early 2008 Duke repeatedly appealed the requirement that they produce an EIA while the state's Ministry of Energy and Mines insisted. Meanwhile, the company continued its intensive use of Parón despite the increasingly tenuous relations with the local community around the lake.

At the end of July 2007, just as Duke began its seasonal use of water from Lake Parón, local discontent again flared. On August 3, EPS Chavín, the company responsible for potable water provision in Caraz, filed a press release lambasting Duke's releases of "enormous quantities of water" that had "caused new damage to the intake, sediment removal system, and filters of the recently inaugurated water

treatment plant leading to temporary cuts in water provision as well as increased turbidity" (EPSChavin 2007). The company closed their statement with a request to the local population to come together with local authorities to reject Duke's abuses.

5.2. Attempts at Regulation

Sensing an impending—and potentially violent—conflict, the Director of the Autonomous Authority of the Santa River Hydrographic Watershed (AACHS), which according to its founding legislation (Peru 1994) was the highest authority in the river basin, suspended Duke's license to use water from Lake Parón on August 7, 2007 (AACHS 2007, AACHS 2011). This suspension was explicitly temporary and valid until Peru's judicial system could respond to a petition by the mayor of Caraz requesting a revocation of Duke's license. Following the order of the AACHS, the ATDR set the lake's discharge rate at 2.63 m^3/sec until the matter could be settled definitively in court (MINAG 2007a, MINAG 2007b). Duke quickly appealed the AACHS decision before a civil court in Lima, where a decision was made in October to reinstate the company's license to discharge 5.5 m^3/sec (Peru 2007). Local authorities rejected this ruling, however, and the decision passed to the Supreme Court in Lima (Caraz 2007).

Table 2.1: Lake Parón's Discharge Regimes

	Avg. Annual Maximum (1954-84)	Legal License (1994-2006)	Legal License (2006-2013) (Reinstated by Constitutional Tribunal, 2011)	AACHS/ATDR Suspension (2007-11) (Reflects local water demand)	"Ecological Flow" (Set by local coalition after 2008 seizure)	Suggested Maximum (S&Z) (UGRH)
Discharge Rate (m^3/sec.)	**2.55**	**8**	**5.5**	**2.63**	**1**	**4**

With Duke generally respecting the lower discharge rate, tensions eased somewhat in late 2007, but by late July 2008, the company once again began to discharge volumes in excess of the 2.63 m^3/sec limit established by the ATDR. It was then that local residents occupied the discharge infrastructure and restricted road access to the site. They maintained the discharge rate at the ecological flow of 1 m^3/sec and kept permanent vigilance of the facility while also maintaining a gate on the access road.

In the wake of the seizure of the discharge infrastructure at Lake Parón, a number of actors and institutions were drawn into the governance network from across geographic and political scales. Playing a key mediating role was the recently formed National Water Authority[29], which assumed within its bureaucratic structure

[29] In 2008, Peruvian president Alan Garcia was granted special privileges by Congress to issue a series of legislative decrees to speed the country's compliance with the terms of the U.S.-Peru Free Trade Agreement. Among these decrees, #997 created the National Water Authority, reinvigorating a longstanding hydraulic bureaucracy under a new title and, along with decrees #1081 and #1083, laying the institutional groundwork for the passage of the country's 2009 Hydrologic Resources Law.

the ATDR under the new name of the Local Water Authority (ALA). Yet, in the conflict resolution process, Lima-based experts from ANA rather than the Huaraz-based ALA took the lead in coordinating meetings and negotiations between Duke and the community-led coalition. While the details of the conflict resolution process are worthy of more thorough treatment than can be offered here[30], in the following sections I focus principally on how hydrologic and geophysical conditions and their active roles in the Parón waterscape have helped shape the governance of the conflict over time. I also show how each side in the dispute has mobilized particular, and in some ways competing, discourses of its right to water that stem from distinct socio-cultural values and economic production practices. Additionally, I show how efforts to manage the technical aspects of the discharge infrastructure at the lake have created spaces of engagement and collaboration that have been critical in the temporary advances towards conflict resolution.

6. Water as Life, Water as Risk: Discursive Tactics for Control of Lake Parón

After seizing the discharge infrastructure at Lake Parón, the local coalition, justified its actions through what can be characterized as a "water is life" (*agua es vida*) discourse. In so doing, local actors suggested that the seizure, which was soon rebranded as the "recuperation of the lake," was necessary and just in light of the

[30] I have written elsewhere about this with colleagues: see Carey, M., A. French & E. O'Brien (2012) Unintended effects of technology on climate change adaptation: an historical analysis of water conflicts below Andean glaciers. *The Journal of Historical Geography*, French, A. (2012) La Laguna Parón: hacia la hestión integrada? *La Revista Agraria*.

human right to water, the priorities established in the Peruvian water law, and their own customary uses of Lake Parón for livelihood production and potable water (e.g. Inca 2008, Teran and Fernandez 2008, Terry 2008, Parón-Llullán 2009). In many instances, this discourse was buttressed by concerns of climate change, glacial recession, and impending water scarcity in the future, despite the fact that their complaints against Duke had nothing to do with climate change impacts directly.

As for Duke, the company initially responded to the taking of the discharge valves primarily as an affront to their property and rights; but, as the conflict dragged on, they increasingly appealed to a discourse of "water as risk," suggesting that the incorrect use of the discharge infrastructure and the failure to control Lake Parón effectively could cause serious threats to the security of those downstream of the lake. Of course, both of these discourses are grounded in socio-cultural knowledge and expertise that coexist within the Parón waterscape. Nevertheless, the eruption of the conflict at Lake Parón has placed these discourses in opposition in ways that obscure the importance of both perspectives and the need to strike a balance between them to improve the long-term security against water scarcity and GLOF hazard for the Parón basin and the larger waterscape it supports.

6.1. Rising Waters, Firm Resistance

As initial attempts at resolving the conflict failed, the 2008 rainy season began and, with the discharge fixed at 1 m^3/sec, the lake level rose steadily. In February 2009, the lake surpassed its maximum operating elevation of 4185 m and by mid-

April, the lake had reached 4190 m, its absolute maximum elevation under the technical recommendations. Beyond this point, the freeboard in the lake was less than 10 meters, which increased the possibility of ice or rock fall or a GLOF higher up in the basin leading to the overtopping of Parón's morainal dam. Additionally, when the lake's elevation rose above 4190 m the seepage points in the higher reaches of the morainal dam that had been evaluated in the 1986 study also began to reappear.

Soon after the lake level passed 4185 m, ANA declared formally that the lake had to be lowered (ANA 2009b). Duke also directed a letter to the Ministry of Energy and Mines, with copy to several other ministries and the major institutions involved in the conflict, expressing its concern about the status of the lake and emphasizing the need to "avoid high risk situations that could cause irreparable damage to populations and infrastructure" in the region (Duke 2009b). While the local coalition resisted lowering the lake's level, they permitted and willingly cooperated in technical inspections of the discharge infrastructure in late 2008 and early 2009 to ensure its continued operational capacity. These regulatory inspections created opportunities for a small group of local actors—principally the leaders of the coalition—to learn about the details of the discharge system and to gain a better understanding of the significance of Lake Parón's flows to the hydropower plant at the Cañón del Pato. Unfortunately, these spaces of engagement were limited and this growing awareness of the larger waterscape was not shared more broadly among the population despite local residents' requests for informational meetings (*capacitaciones*).

In April-May 2009, with the lake level hovering around 4190 m, ANA led an effort to form a watershed committee for the Parón-Llullán basin to work cooperatively to begin discharging some of the lake's volume. The local coalition leaders, however, resisted the formation of the committee, stating that this step should occur only once it was clear that the land title to the lake and its surroundings was being returned to the state. The situation continued at this impasse throughout 2009, with the prolonged legal process over the correction of a "mistaken" title entry the most obvious of the obstructions to progress. Meanwhile, although the lake level had stabilized around 4190 m in May and then dropped through the dry season, with the onset of the 2009-10 wet season the lake once again began to rise.

By December 2009, with the discharge still set at the ecological flow, the lake crept to nearly 4195 meters. With less than five meters of freeboard remaining (as opposed to the recommended 15 m) and with points of seepage re-emerging in the upper slopes of the morainal dam, authorities increasingly pressed to lower the lake. Still, the local coalition remained firm. As a participant in the process reported, "the lack of understanding of the risk along with the lack of confidence in the state, who had been absent through the years of Duke's destructive discharges, led the local population to reject lowering the lake while it still remained private property" (Untiveros 2011, 9). Despite this demand and a legal process that had been underway for at least 8 years (see section 5. above), amendment of the title error dragged on and the lake was not lowered.

Then, on January 3, 2010—in what some considered an act of divine intervention—a 5.7 magnitude earthquake with its epicenter in the vicinity of Lake Parón shook the entire region (Tavera, Bernal and Torres 2010). Fortunately, the morainal dams at Lake Parón and Lake Artesoncocha survived the earthquake, and no major rock or icefalls were triggered in the basin. The quake did however seem to spur the authorities to action. Locally, the President of Cruz de Mayo asked the national Institute of Civil Defense to inform residents about GLOF risks at Lake Parón. Some local residents swore that they "would rather die in an avalanche than of thirst" while others dismissed the seismic threat, referencing the fact that Parón's dam had survived the much stronger 1970 earthquake in the region (Untiveros 2011). Here the continued opposition between the "water is life" and "water as risk" discourses created obvious challenges to advancing a plan for lowering the lake, and long-standing divisions and distrust between rural populations and state-led experts complicated their exchanges (cf. Guillet 1981, Carey 2005).

Authorities in Lima however showed resolve in addressing risks of a catastrophic GLOF at Parón, and on January 20, a presidential decree declared a 60-day state of emergency at Lake Parón, during which its level would be reduced (PCM 2010). Still the local residents refused access to the discharge valves, demanding that the state regain formal title to the lake before any action be taken (HuarazNoticias 2010, Untiveros 2011). On February 6, a second supreme decree finally pronounced Lake Parón the inalienable patrimony of the nation (MINAM 2010). After nearly a decade of complaints, the local community had finally achieved one of its central

goals in the Parón conflict: the striking from the public registry of Duke's erroneous title to the lake. Ironically, this change had little effect on the major causes of the conflict, which were linked to the still-valid water license. Nevertheless, this victory punctuated by a visit to the lake by the Minister of Agriculture and the Chief of ANA finally swayed local residents to facilitate the lowering of the lake. Within a few days, the valves had been opened and a discharge rate of around 4 m^3/sec was established. By mid-April, the lake height had fallen below the maximum permissible level of 4190 m (UGRH 2011).

6.2. Towards integrated regulation and management?

The lowering process was the first consistent use of the discharge infrastructure since its dispossession from Duke in mid-2008. To guide the process, a committee (*Comité de Operación)* was formed consisting of many of the central actors in the case. These included the Administrator of the ALA, the chief of Huascarán National Park, the mayor of Caraz, the President of Cruz de Mayo, and the President of the Parón-Llullán Irrigators. Initially, Duke was intended to be the final member of the committee, labeled in the founding resolution as "the non-agricultural water user below the Santa River confluence" (ANA 2010b). ANA's inclusion of Duke in this obfuscating way was not accepted by Cruz de Mayo (Untiveros 2011), however, and the resolution was eventually modified to include only the non-agricultural users within the Parón-Llullán watershed (ANA 2010c).

While the locals' mistrust of the corporation was understandable, Duke's exclusion undermined the integrative character of the committee and maintained the corporation's distance from the rest of the actors. This distance had been increasing since mid-2009, when the first attempts to form a technical committee were undertaken and Duke was banned from the committee by the local actors, despite the company's protestations (Duke 2009a). While Duke's absence may have made the meetings easier—the relations between the local actors and the company remained tense—it also meant that the central actors in the conflict never interacted directly, instead communicating only through ANA and occasional letters and press releases. Duke, as opposed to the groups participating in the technical committee meetings, had little human presence in the governance network and thus little ability to build social relations that might aid in furthering the firm's participation in the integrative governance of the lake.

After the lake had been successfully lowered and the state of emergency had expired, the operating committee evolved into a more inclusive body that continued to meet regularly to discuss the management of the lake and the resolution of the conflict. These meetings provided an important space for actors from across governance levels to exchange perspectives, pose questions, and discuss management alternatives (Parón-Llullán 2009). At times, the group's proceedings moved beyond the bounds of the conflict at-hand to address other water issues in the Parón-Llullán basin, such as mining concessions and agricultural-use licenses. Most importantly, the

committee successfully maintained the lake below maximum operating levels through the 2010-11 wet season.

This is not to suggest that the committee meetings were typically congenial or even productive of desired outcomes: local actors often complained that the authorities from Lima came demanding compliance with proposals that had been formulated without local consultation, and, for their part, the Lima officials expressed frustration at the local actors' refusals to let the state experts manage the situation as their technical expertise dictated (ANA 2009a, Parón-Llullán 2009). Moreover, local actors often requested additional information and more-detailed studies (e.g. a current water balance for the basin) than ANA was prepared to provide or fund. Another point of contention was the formalization of the committee itself, which local actors continued to advocate and ANA seemed to endorse but never execute. This hesitation may have been linked to Duke's continued absence from the process. The company had denied ANA's invitation to take part in the broader management committee and challenged the legitimacy of the committee's continued activities (Peru 2011). Despite these challenges as well as the significant costs of participating in the endless meetings, the management committee provided spaces where actors could engage directly, practicing a form of more integrated and participatory water governance[31].

Unfortunately, as had been the case with the technical inspections at the lake, this space of social learning and engagement reached a relatively small segment of

[31] The 2009 Peruvian Hydrologic Resources Law mandates participatory governance in the model of the paradigm of Integrated Water Resource Management (IWRM).

the local population (Parón-Llullán 2009, Mayo 2010). While it was up to the local authorities to share the outcomes of the meetings with their constituents, it was not possible to keep the entire population well informed, nor could the more technical aspects of the proposals be realistically conveyed without more-detailed information from authorities. The need for broad-reaching educational strategies to build local awareness of hydrologic conditions and the uses of Lake Parón's waters was raised on various occasions by both local residents and ANA personnel, but, as noted above, such activities face significant hurdles (e.g. Spanish-Quechua language and cultural divides) and are yet to materialize in any meaningful way (ANA 2009a, Mayo 2010, Parón-Llullán 2009).[32]

6.3. Trials and tribulations

During the rainy season of early 2011, the committee encountered a mechanical problem with the electric panel that controlled the discharge valves. This issue, which could be over-ridden manually, heightened already growing concerns over the need to perform thorough maintenance on the discharge infrastructure—something that had not occurred since the tunnel project's completion almost two decades prior. This maintenance, however, would require the drainage of the lake to the level of the tunnel intake, followed by a thorough evaluation and repair of the equipment. The process would take significant funds, resources that the state could

[32] Educational activities undertaken by Huascaran National Park and the Episcopal Social Action Committee (CEAS) represented important attempts at building local awareness, though these activities still reached a relatively small portion of the total population.

not legally invest because the infrastructure remained Duke's private property, even though the mountain it was located within had reverted to state ownership.

This scenario led to new demands from local actors about the reversion of the discharge infrastructure to the state, which was significantly less tenable from a legal standpoint than the correction of the title error had been. Moreover, Duke was the entity most qualified to perform the maintenance procedures, but local actors were not comfortable with the company leading the effort. Under these complicated circumstances, ANA recommended pursuing an additional declaration of a state of emergency that would sidestep the law forbidding the state to invest in private property. A company besides Duke could then be contracted by the state to perform the maintenance, which Duke agreed to so long as it maintained ownership of the discharge infrastructure at the lake (Duke 2011b).

As these negotiations over the maintenance plan were advancing, an important setback to the governance process occurred with the long-anticipated Constitutional Tribunal's ruling over the suspension of Duke's license in 2007 (Peru 2011). The tribunal's ruling failed to consider the long history of complaints against Duke's management of the lake as well as the downstream impacts of its intensive use of Parón. Nor did the tribunal acknowledge the inflexible and sectoral nature of the water license or the challenges to it posed by the variable and shifting hydrologic conditions in the basin (Peru 2011). In the end, the court upheld Duke's license and ordered ANA to restore the discharge infrastructure to the company in a period of two days. The ruling drew rejection and scorn from local actors who in a formal response

described it as "alarming that the same abuses would be permitted, a discharge of 5.5 m^3/sec would be an affront to the life and dignity of the population of Caraz" (Caraz, Mayo and Parón-Llullán 2011). Additionally, in its implicit repudiation of the tenets of the 2009 Peruvian water law and its explicit indictment of ANA's ongoing efforts to establish a more integrated, participatory governance model in the Parón watershed, the Tribunal's sentence highlighted and reinforced the inconsistencies and contradictions between the various branches of the state involved in water governance as well as the need for a high court capable of a balanced consideration of legal, hydrological, and social conditions in the arbitration of water conflicts.[33]

In the wake of this sentence, collaboration ceased for a time and the maintenance of the infrastructure lost its urgency. However, as the 2011 dry season unfolded, flows in the Santa River dropped below historic lows and both the hydropower plant and large-scale irrigators on the coast began looking to Parón as a source of relief (Duke 2011c, ANA 2011a) . In this context of water deficit, Duke offered its first public communication in months. While the proclamation referenced the Tribunal's ruling, it focused principally on the company's openness to dialogue and a collaborative solution to managing the lake and controlling the risks that came with the deteriorating infrastructure (Duke 2011a). Some local actors dismissed Duke's message as mere rhetoric and no rapprochement was achieved. Complicating matters further, in October 2011, ANA issued a resolution clarifying that the Parón

[33] The 2009 Hydrologic Resources Law mandates the creation of a Tribunal of Hydrologic Conflicts, which as of early 2013 still had not been formed.

management committee's legal standing had ended with the lapse of the state of emergency (ANA 2011c). This formal dissolution of the committee struck some local actors as an insult to the long-evolving management process at the lake and raised questions about what kind of governing entity would develop in its place.

6.4. If at First You Don't Succeed…

The Parón conflict again made national headlines in late 2011, in part because Cruz de Mayo was awarded a national human rights prize for their struggle against Duke and also because the new first lady of the Republic had taken up the case. In late November 2011 in Lima the national Council of Ministers (PCM) convened the key actors in the conflict to discuss a discharge plan for the impending rainy season. After the meetings, local actors expressed optimism about the support of the PCM, particularly from the Prime Minister who had taken an active role and firm position with the company in the meeting (Mayo 2010, Parón-Llullán 2009). Local hopes for rapid progress were dashed less than two weeks later, however, when President Humala made sweeping changes to his cabinet, including the replacement of his Prime Minister.

While the issue of the lake briefly made the spotlight in Lima, the lake itself recharged slowly over the 2011-12 wet season remaining well below its level of security and thus drawing little regulatory interest from authorities. In April 2012, the PCM finally reinitiated discussions of a plan of operations for Lake Parón, which both local residents and Duke formally agreed to support. In late July 2012, after

several months with no further progress, Duke wrote a letter to the PCM and the heads of five other state institutions on the subject of "Risks to the security of Laguna Parón…" (Duke 2012). This letter refers to the "grave risk" of Parón's discharge infrastructure due to the lack of maintenance, and goes on to call for measures to guarantee the security of the local population and the Cañón del Pato and to restore the discharge infrastructure to its rightful owner.

Although Duke's letter was not addressed to any of the local actors in the conflict, it reached them and was even posted to an internet news site for public scrutiny (Prieto 2012). The letter generated an acerbic response from the mayor of Caraz, the President of Cruz de Mayo, and the President of the Irrigators' Commission who responded together with a letter in late August defending their own concerns for the security of the region they inhabited and questioning why maintenance of the valves was suddenly so urgent for Duke, particularly after the company had failed to perform it for the 16 years prior to 2008 (Caraz, Mayo and Parón-Llullán 2012). The response also pointed to a technical recommendation for a discharge rate of 4 m^3/sec (UGRH 2011) and stated that local residents had been exposed to unnecessary risks for years through the release of up to twice this amount of water under the original water license. Last, the local actors emphasized their constant participation in the management committee's efforts, while Duke itself had chosen not to participate, and expressed a desire to work towards a collaborative solution to the maintenance of the infrastructure with the PCM and other actors.

ANA and the PCM were thus caught between both central actors' requests for concerted action, and in September the state institutions began coordinating another protracted series of meetings to formulate and implement a plan to drain the lake and undertake the maintenance. A fundamental problem with this plan, however, was the fact that the effort was beginning just as the rainy season was also getting underway. In order to expedite the maintenance program to leave time for the lake to refill, water would have to be flushed through the tunnel at volumes of up to 8 m^3/sec to counteract the input from precipitation and glacier melt; thus the Lima authorities were suddenly proposing exactly the same kind of discharge regime that had initially caused the conflict through its destructive impacts and that blatantly contradicted technical recommendations for the system. Moreover, these discharges would be flushed from the lake at a time when the flows would be useless to downstream users, both irrigators and the hydropower plant, due to the large amounts of water already in the system.

Despite these obvious contradictions, ANA continued with the proposed plan, showing no sign of having considered waiting for the following dry season when the maintenance work would be less hurried and less threatened by large precipitation events (UGRH 2011) and when the discharged water would be more far more valuable to downstream users. In mid-October 2012, the condition of the canal intakes prior to the lowering was noted and then the valves were opened. After discharges above 6 m^3/sec began to cause erosion and flooding downstream, a rate around 5 m^3/sec was established and the lake level dropped rapidly, aided by the fact

that little rain was falling. By February 2013, the lake level reached the tunnel intake, exposing the rusted steel gate and cables at the tunnel's mouth.

With the lake at its dead level in the middle of the wet season, the maintenance ought to have proceeded as rapidly as possible to seal the valves and begin recharging the lake's volume in anticipation of the dry season ahead. In the negotiations months before, Duke had agreed unconditionally to pay for the maintenance, however the contractor who took on the job would have to be approved by all the actors involved. Finding an acceptable contractor proved difficult and had still not been completed when the lake was emptied. Once a company was finally selected, there were further complications in coordinating an informational meeting between the group and the local community (Parón 2013a, Parón 2013b). Negotiations dragged on into early March and it became clear that the maintenance would not be achievable before the March 15 deadline for closing the valves and letting the lake refill. This time, the risks of water scarcity trumped those related to the tunnel maintenance and the valves were closed without accomplishing the maintenance about which so much urgent ado had been made. After the many costs incurred in the failed maintenance process, it must have been a great frustration to see the lake level rise above the still-rusted gate at the tunnel's mouth. On the bright side, the decision to close the valves in an effort to ensure some buffer of lake water for the upcoming dry season—a buffer that would potentially serve both local irrigators and Duke—finally reflected a decision made with a greater awareness of the basin's hydro-social cycle in mind.

7. Conclusions

The intransigence of the conflict at Lake Parón denies simple explanation. Its roots can be traced to the dis-embedding of the lake's waters from their existing socio-cultural and hydro-ecological contexts through technological interventions aimed at reducing GLOF hazards and, perhaps more importantly, contributing to regional and national development through hydropower production. Through this process, a water license whose details significantly contradicted the local hydro-social reality was gifted to a state-owned company in the days before EIA's, creating conditions for conflict between sectoral users with distinct logics of (re)production. Through the neoliberalization of Peru's economy, and the energy sector specifically, in the 1990's, this license became the exclusive right of Duke Energy, one of the world's largest energy producers and a faceless corporate villain in the eyes of many local residents.

Duke's entry into the local hydro-social cycle expanded the network of actors involved in the governance of the lake across new geographic and political economic scales. As local grievances increased over the downstream impacts of the company's intensified use of the waters from Lake Parón in the early 2000's, the web of actors involved in the Parón waterscape continued to grow and expand, drawing in a wide array of government agencies and civil society groups within Peru and beyond. Less obvious, but no less important I argue, were the ways in which Nature itself was incorporated into this intricate relational web, through both its material contributions

to human (re)production and through the threats the lake posed to downstream populations.

On one hand, the case of Lake Parón is a quintessential example of a Polanyian double movement: the lake is prised from its pre-existing socio-natural context through the commodification of nature, and resistance from civil society ensues in an effort to re-embed these vital waters in a system of local control. While these political economic dynamics are a fundamental part of this case, I have also tried to show how both natural processes and conditions and the socio-natural assemblages they co-produce have consistently played critical roles in the governance of Lake Parón and the larger waterscape of which the lake is a vital part. Specifically, I argue that hydrologic and ecological conditions coupled with social (technological, political, economic, etc.) processes and production strategies have given rise to socio-natural contradictions that have driven the emergence and persistence of the conflict, while, at times, also contributing to temporary advances in its ongoing resolution. Furthermore, significant differences in socio-cultural conceptions of the Lake Parón waterscape as well as differential access to information and technical expertise create opposing perspectives on risk between the key actors in the case. While collaborative regulatory processes undertaken in the wake of the conflict have helped to cultivate a broader understanding of each side's position and to bridge these opposing viewpoints, the impacts of these efforts have been limited by their minimal scope as well as by legacies of distrust and cultural difference. Continued local resentment against Duke, I argue, has also been linked to the company's lack of participation in

the ongoing management efforts at the basin level as well as to a legal ruling that utterly failed to consider the locals' grievances against the corporation.

In light of these challenges to conflict resolution at Lake Parón, future governance processes must consider the socio-natural conditions of the waterscape more fully, especially the contradictory aspects of the current water license. In a hydrologic context characterized by high seasonal and inter-annual variability that is being rapidly transformed by climatic and economic change—which together are likely to decrease water supplies while increasing water demand—the need to address the inadequacy and inflexibility in the current license is ever more pressing. Effective governance in this context will also require the crafting of both outreach and governance strategies capable of transcending the conflicted logics of production and conceptions of risk that have contributed to more than a decade of ill will between local residents and Duke Energy. Despite the scale of the challenge, directing a regulatory process that confronts entrenched corporate privileges while fortifying local and regional capacities to adapt to climatic and economic change is well within the institutional mission of ANA, especially under the 2009 Hydrologic Resources Law's mandate of Integrated Water Resource Management.

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Figure 2.1: An aerial photograph showing Lake Parón and the highest reaches of the Parón waterscape. Note the large curving moraine at the bottom end of the lake that forms much of the lake's dam. At the top of the lake, the outlet stream of Lake Artesoncocha can be seen. Source: Peru National Aero-photographic Service 1948.

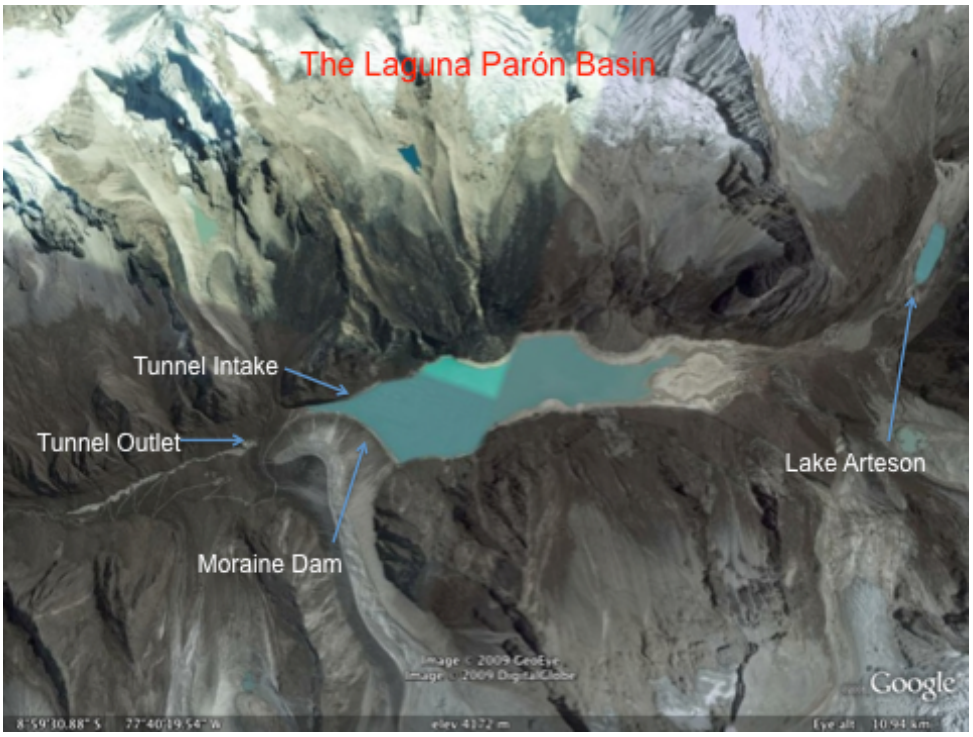

Figure 2.2: A satellite image of Lake Parón showing key sources of potential GLOF risk (Lake Artesoncocha and the morainal dam) as well as the location of the drainage tunnel. Source: Google Earth.

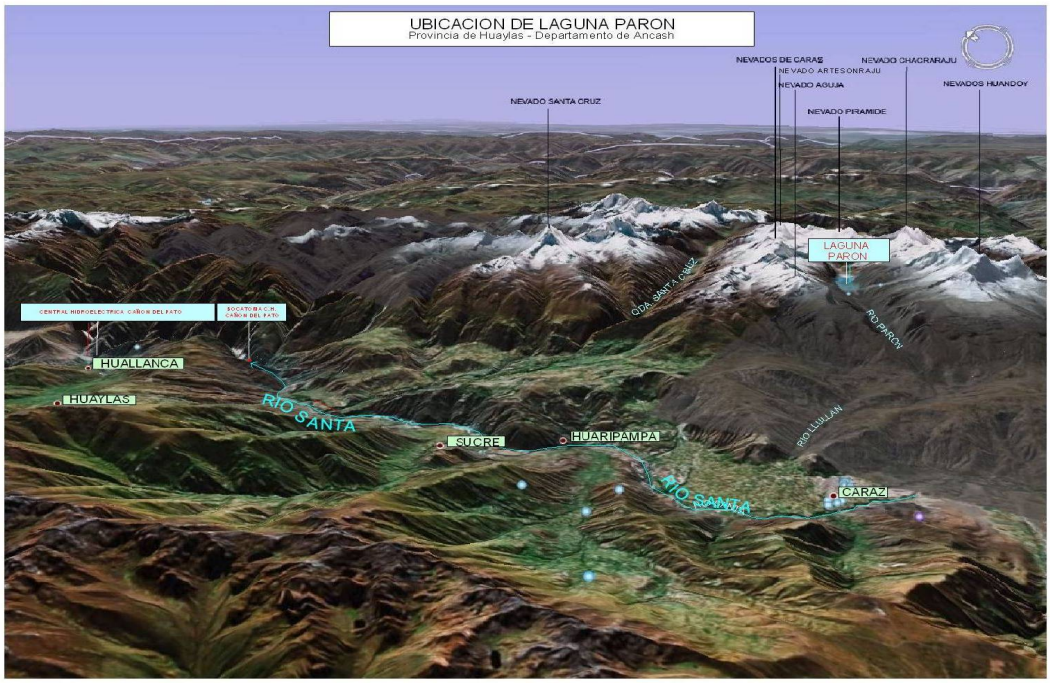

Figure 2.3: Looking east across the Santa River Valley towards the north end of the Cordillera Blanca and the Lake Parón basin. The steep catchments of the Parón and Llullán Rivers can be seen below the lake outlet and above the city of Caraz. The location of the Cañón del Pato Hydroelectric Plant at Huallanca can be seen on the left side of the image. Source: Peruvian National Water Authority.

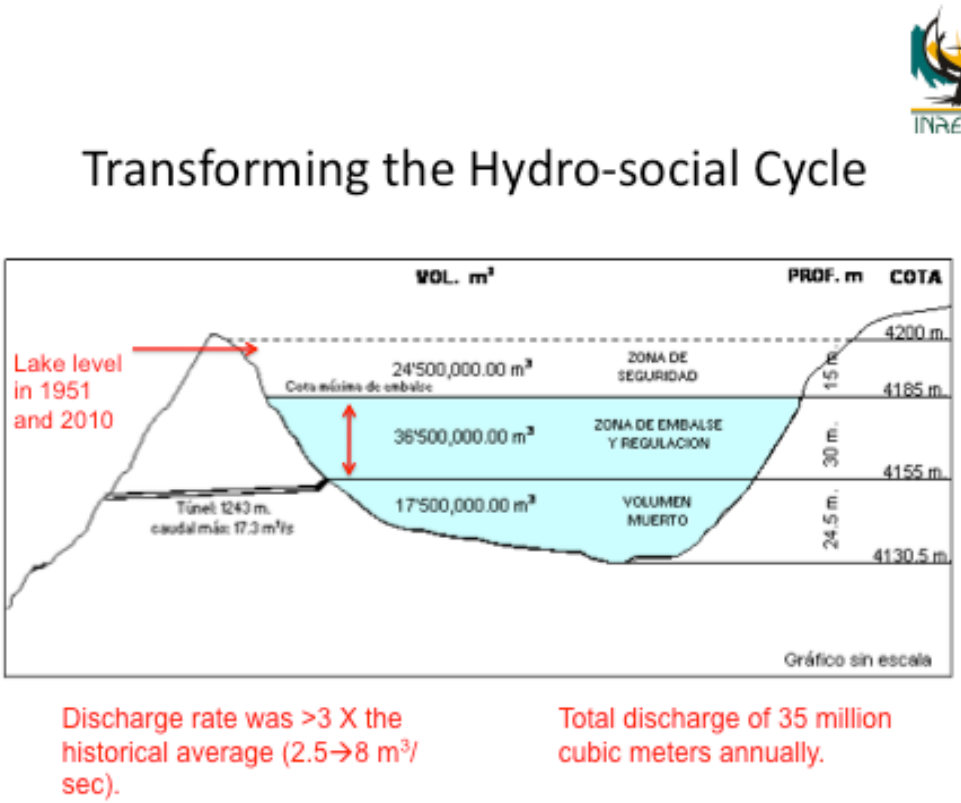

Figure 2.4: Schematic of the Lake Parón regulatory system. The total volume available between the maximum operating elevation (4185 m) and the level of the tunnel outtake (4155 m) is shown by the vertical red arrow (36.5 x $10^6 m^3$). The hydropower plant's license permitted a discharge rate several times higher than the annual average maximum before tunnel construction (2.5 m^3/sec for the period 1954-1984) as well as a total annual discharge of 35 x $10^6 m^3$. Source: Peruvian National Institute of Natural Resources (INRENA).

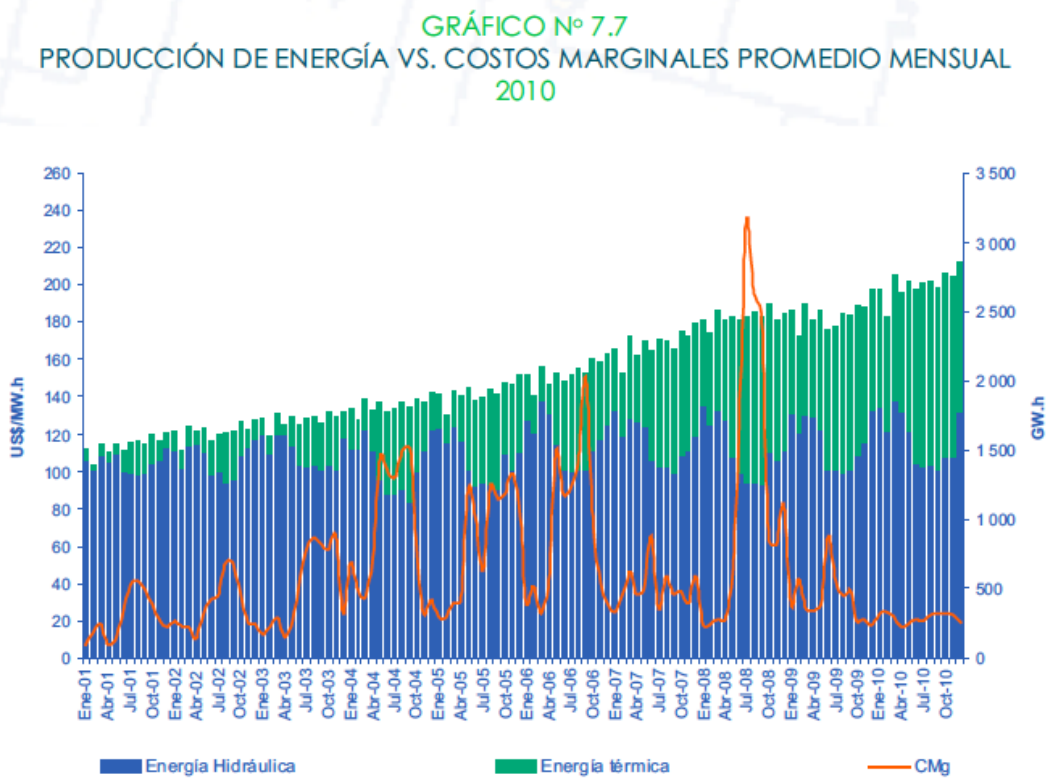

Figure 2.5: Graph depicting energy production (blue bars=hydropower; green bars=natural gas and other thermal sources) and marginal cost of energy (red line). Note the very high marginal costs for energy during the dry seasons of 2004-2006 (when Duke was intensively managing Lake Parón) and in 2008 (high costs in 2008 were likely exacerbated slightly by the fact that Lake Parón was taken offline by the infrastructure seizure). After 2008, regulating legislation was passed to control the marginal costs of electricity. The growing contributions of natural gas to the system, largely from the Camisea Project, can also be seen. Source: Peru National Interconnected Electricity Grid (COES, 2010).

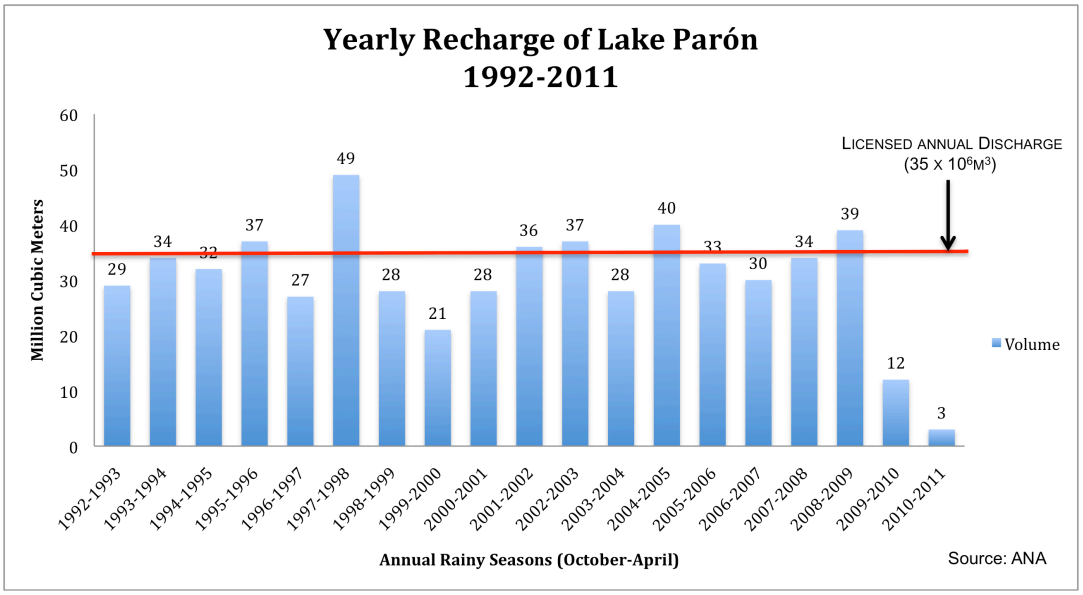

Figure 2.6: Yearly recharge of Lake Parón between 1992 and 2011. In only 6 of the 17 years during which the hydropower plant discharged water from the lake (1992-2008) did the annual recharge volume meet or exceed the volume licensed for hydropower purposes (35 x $10^6 m^3$). Source: Peruvian National Water Authority.

CHAPTER THREE

Critical Conjuncture:
Climate Change, Globalization, and Livelihood Vulnerability
in the Peruvian Andes

I. Introduction

Vulnerability to environmental and political economic conditions has long been a fact of life in the Andean highlands and on the arid coastal plain of western Peru. Cultures in this linked regions are exposed to high levels of endemic environmental risk resulting from climatic extremes and inter-annual variability, steep terrain, low soil fertility, and glacial-related hazards among other factors. Since at least the Spanish conquest, inhabitants of the region have also been drawn into supra-local economies, often in exploitative and marginalizing ways. In the face of such challenges, local cultures have developed a wide array of adaptive strategies, many of which continue to endure and hybridize in the modern context. Yet, despite this history of resilience and adaptation, the current pace and scale of the social and environmental transformations associated with climate change and economic globalization heighten residents' vulnerability to a variety of factors in ways that pose significant challenges to regional livelihoods.

In this article, I use the conceptual framework of "double exposure" (Leichenko and O'Brien 2008, O'Brien and Leichenko 2000) to explore the diverse ways in which climatic and economic change have historically impacted the Central

Andes and Pacific slope of Peru. The paper begins with a circumscribed historical overview in an attempt to provide basic contextual information for understanding important aspects of contemporary vulnerability (as well as opportunity) linked to the interaction of shifting climatic and environmental conditions. After this initial framing of the double exposure conjuncture, I draw upon empirical data from interdisciplinary fieldwork in the Cordillera Blanca to examine how these converging processes of global change are affecting access to critical resources at the community and household level in the study region. This analysis reveals key factors, synergies, and feedbacks linked to diverse aspects of climatic and economic change that, in some cases, significantly heighten the vulnerability of local agro-pastoral livelihoods to these processes, while at other times contributing to resilience and adaptive capacity. These results present and contextualize local perspectives on risk and vulnerability in a region that has been characterized as one of the planet's crucibles of rapid and transformative climatic and economic change.

The paper is developed in the following manner. I begin with a discussion of theoretical developments in the study of natural hazards, risk, and vulnerability as well as resource access from scholarship in geography, political ecology, and the human dimensions of global change. The following section then provides a historical overview of the processes and impacts of both climate change and economic globalization in western Peru in general; and, in the subsequent section, this analysis is scaled down to the level of the Cordillera Blanca. The next section then moves from historical and contextual background to a description of the study's empirical

methods and principal findings, highlighting local perspectives on the positive and negative outcomes of both climatic and economic change from two sub-regions of the Cordillera Blanca with distinct socio-environmental conditions and diverse assemblages of livelihood pursuits. A discussion section then examines the synergies and feedbacks between the converging processes of global change reported by local residents. This section underscores the heterogeneity of risk and vulnerability in the study region as well as the potential for critical conjunctures of diverse impacts that could significantly stress livelihood security in the study region as well as other locales undergoing similar processes of global change.

II. Vulnerability Frameworks: From Single Hazard to Multi-Exposure

Understanding and addressing human vulnerability to diverse processes of global change has emerged as one of society's most urgent challenges for the 21st century. With mounting evidence and growing recognition of the reality of climate change, recent attention from a range of disciplines has focused on identifying how both short and long-term changes associated with this phenomenon will impact human populations (IPCC 2007a, IPCC 2007b). There is also an enduring tradition within geography and linked disciplines interrogating how global political economy has affected particular actors, social groups, and regions throughout history, and this research focus has expanded as the transformative effects of economic globalization have become ever more pronounced and ubiquitous. Meanwhile, a small but growing number of vulnerability studies recognize the simultaneous exposure of coupled

human and natural systems to processes of both global climatic and political-economic change. In this section, I briefly summarize evolving approaches to vulnerability analysis, highlighting the argument that more detailed and critical attention must be paid to the combined and synergistic effects of climate change and economic globalization.

Analyses of the genealogy of vulnerability studies often underscore the influences of the pioneering work of Gilbert White and his colleagues and students focused on the vulnerability of human communities and systems to biophysical hazards (see e.g. Adger 2006, Eakin and Luers 2006). These studies took natural hazard events, such as floods, as their analytical focus and explored human vulnerability to these disasters in relation to the choices that people made in adjusting to risks and the technical capacity available to respond to such events (Burton, White and Kates 1978, White 1942). This rational-actor approach to vulnerability was critiqued and expanded upon by a range of scholars who argued for greater attention to the political-economic and socio-cultural factors that make certain groups more vulnerable than others through differential risk exposure and unequal capabilities to weather and adapt to shocks and stressors (Hewitt 1983, Watts 1983). Such perspectives were influenced importantly by Marxist political economy as well as by work on the causes of famine that stressed the fundamental role of social relations, institutions, and uneven "entitlements" to diverse assets and resources over exposure to specific biophysical hazards (Dreze and Sen 1989, Sen 1981, Sen 1984).

While critical work emphasizing social inequality was important in expanding earlier conceptions of vulnerability that focused on biophysical processes and technical responses to the neglect of social and structural factors, such approaches risk overlooking the importance of biophysical settings and hazards and the spatially differential risks they generate. Research situated within the broad tradition of political ecology has attempted to integrate biophysical and political-economic analyses and has produced both theoretical models and empirical investigations that illustrate the value of this approach (Blaikie et al. 1994, Bohle, Downing and Watts 1994, Liverman 1990, Watts and Bohle 1993). Blakie et al.'s "Pressure and Release" model is one of the better known of these early integrated approaches that conceptualize risk as a combination of socially generated vulnerability and exposure to hazardous events, both of which are highly dynamic and can vary significantly over space and time (1994).

Given the growing recognition of the pace, scale, and predicted impacts of global climate change, research exploring human vulnerability to this process has burgeoned in recent years. As occurred with early hazards studies, many of the pioneering efforts to analyze climate change impacts focused on measuring and modeling the extent and degree of shifts in biophysical processes or conditions while failing to account for the social and political-economic drivers of vulnerability to these changes (Liverman 2008). Despite this initial tendency, researchers within geography and sustainability science have more recently developed an array of integrative conceptual frameworks and empirical approaches for analyzing the

vulnerability of human and natural systems to the multiple stressors associated with global environmental change (Liverman 1990, O'Brien et al. 2004, O'Brien and Leichenko 2000, Pelling 1999, Polsky, Neff and Yarnal 2007, Turner et al. 2003). Most of these integrative frameworks share the perspective that human and natural systems are "intimately coupled" and that vulnerability analysis "demands a thorough investigation of biophysical, cognitive, and social dimensions of human-environment interactions" (Polsky et al. 2007, 472). Additionally, recent scholarship on vulnerability has focused greater attention on how political economic institutions and the teleconnections of economic globalization contribute to producing differential levels of risk and vulnerability across spatial and political scales (e.g. Adger, Eakin and Winkels 2008, Eakin 2006).

A conceptually elegant example of the kind of integrative approaches to vulnerability described above is the "Double Exposure" framework developed and refined by O'Brien and Leichenko (Leichenko and O'Brien 2008, Leichenko, O'Brien and Solecki 2010, O'Brien and Leichenko 2000). These authors suggest "the double exposure framework provides a generalized approach for analysis of the interactions between global environmental and economic changes, paying particular attention to the ways that the two interacting processes [of climate change and economic globalization] spread risk and vulnerability over space and time" (Leichenko et al. 2010, 964). In describing the rationale for the framework, Leichenko et al. suggest that both global environmental change and globalization have been studied separately in great detail by geographers and other social scientists, but that the "critical

linkages, feedbacks, and synergies between globalization and climate change often go unnoticed and in turn are undertheorized" (2010, 966). Despite the conceptual appeal of the model, the double exposure framework has not been widely tested in empirical settings. Indeed, as one critic suggests, "quite how one translates the meta-framework into research that can measure and explain double exposure on the ground only future researchers…will decide" (Castree 2010, 277).

In this article, I employ the double exposure framework to structure an analysis of differential risk and vulnerability in Peru's Cordillera Blanca, a region of the Central Andes deeply impacted by both climate change and globalization. I first provide a circumscribed overview of the historical impacts of climatic and economic instability and change on the broader Pacific slope of Peru, and then draw upon empirical work in two case-study communities of the Cordillera Blanca to examine local perceptions of these impacts. The survey results highlight overwhelming concern about the impacts of these processes on resource access as well as significant diversity in how and to what degree specific households are vulnerable. To examine these issues of resource access and differential vulnerability in relation to livelihood security, I return to fundamental approaches from political ecology that are well-suited to interrogating the conjunctures of double exposure.

III. Access Frameworks: Resources and Livelihoods

Of the many uncertainties linked to global climate change, questions over changing access to vital natural resources such as water and arable land are of urgent

concern. Although predictions about shifting access to critical resources have been made at a range of scales (e.g. Barnett, Adam and Lettenmaier 2005, Barry and Seimon 2000, Bradley et al. 2006, IPCC 2007a), more empirical studies of specific changes in resource access are needed to inform vulnerability assessments and adaptation measures. Yet, as noted above, while shifting biophysical conditions linked to climate change will increasingly impact a range of resources critical to human well-being, socio-cultural and political-economic factors also play a fundamental role in determining who accesses and controls resources. In the following section, I review several approaches to understanding resource access from the sub-disciplines of political ecology, development studies, and hazards analysis. Synthesizing perspectives from these distinct approaches, I argue that an expanded access framework that accounts for the ways in which biophysical and social conditions together determine who accesses what types of resources is necessary for understanding shifting vulnerability in a context of converging processes of global change.

Access to and control over resources has been a central focus of political ecology research throughout the field's development, and access struggles between small-scale (and often rural) producers and larger entities such as central governments and multi-national corporations are a common theme in much of this work (e.g. Blaikie 1985, Blaikie and Brookfield 1987, Bryant and Bailey 1997, Peet and Watts 1996, Robbins 2004, Zimmerer and Bassett 2003). This critical research is characterized by efforts to look beyond simple explanations of resource proximity

and availability as determinate of access to focus instead on the role that social, cultural, political, and economic factors (e.g. race, class, gender, power relations) as well as forms of social resistance and coercion play in determining who accesses and benefits from specific resources. Given this enduring empirical focus on access in political ecology, Ribot and Peluso's claim that the concept lacks adequate theoretical development is somewhat surprising (2003). To address this lacuna, these authors offer a theory of access that focuses on the ways in which social and political-economic contexts "shape people's abilities to benefit from resources" (Ribot and Peluso 2003, 173); and, by formulating access as the "ability" rather than "right" to benefit from resources, they draw a clear distinction between "access" and "property," opening up the analysis of access to include more diverse social relations than those associated with property. The framework they propose analyzes the broad and overlapping categories of access to technology, capital, markets, labor, knowledge, authority, identity, and social relations and emphasizes the importance of actors' positionality to power in particular political-economic moments. Moreover, while Ribot and Peluso do not focus on the concept of social capital specifically, they do discuss how "social relations of friendship, trust, reciprocity, patronage, dependence, and obligation form critical strands in access webs" (2003, 172)(172). This line of analysis connects them with growing debates about the importance of social capital in shaping resource access as well as vulnerability and adaptive capacity (Adger 2003, Bebbington 1999, Bebbington and Perreault 1999, Brondizio, Ostrom and Young 2009).

While Ribot and Peluso's (2003) framework is useful in conceptualizing the key social and political-economic factors that enable and constrain different actors' abilities to access and benefit from resources, it does not explicitly address how biophysical properties and environmental conditions fundamentally impact access conditions and outcomes. In this way, the framework does not account for the importance of environmental risks and entitlements in determining access relations and the specific resources available to particular actors and groups. Leach et al. (1999), in contrast, focus on 'environmental entitlements' to highlight the role of heterogeneous environmental conditions in shaping resource access. Moreover, Leach et al. assert that any particular environment is "characterized by high variability in time and space" (1999: 226) and therefore must be "disaggregated into its constituent parts and viewed dynamically" (1999: 232). In this paper, I argue that this attention to environmental heterogeneity—and its interplay with social heterogeneity—along with the differential and dynamic resource availability that results is fundamental to analyzing shifting resource access and linked vulnerabilities under processes of rapid global change.

Using access as a lens to analyze vulnerability is not a novel theoretical approach, nor is the careful consideration of both biophysical and social drivers of access relations and outcomes. As noted in the previous section, analyses of vulnerability to global change processes increasingly consider both environmental and political-economic factors and their combined influences on different groups. Moreover, some studies of risk and vulnerability explicitly employ access

frameworks. In the second edition of *At Risk*, for example, the 'Pressure and Release' model is complemented by a dynamic 'Access model' to "show how social systems create the conditions in which [natural] hazards have a differential impact on various societies and different groups within society" (Wisner, Blaikie and Cannon 2004 [1994], 92). This model yields a detailed 'access profile' that accounts for all of the assets and resources, both material and immaterial, available to a specific individual or household, thereby illuminating the diversity of strategies and 'income opportunities' available for securing a livelihood. Once specified, the 'access profile' can be used to help identify differential levels of risk exposure, vulnerability to particular stressors, and adaptive capacity. Wisner et al. (2004 [1994]) note the similarities between their 'Access model' and the 'sustainable livelihoods' approach that has emerged in the geography and development literature since the early 1990's (e.g. Bebbington 1999, Bury 2004, Chambers and Conway 1992). This framework envisions diverse assets and resources as various forms of capital, including human capital (e.g. knowledge and health), social capital (e.g. institutions and networks), physical capital (e.g. infrastructure and technology), financial capital (e.g. savings and access to credit), and natural capital (e.g. land and water).

In a study of risk and vulnerability in agricultural systems in rural Mexico, Eakin also uses a livelihoods framework to analyze "the interaction of multiple stressors at various scales on a household's assets and choices" (2006, 11). This approach allows her to explore the heterogeneity of vulnerability within and between her case study households and communities and to suggest that this differential

vulnerability "reflects the coincidence of climate shocks and opportunity, opportunity constrained by history, politics, economics, and the resources available to [households] before, during, and after the moment of crisis" (Eakin 2006, 13). Moreover, Eakin's empirical focus on the links between vulnerability resulting from coupled processes of global change and the assets and resources that allow households to secure their livelihoods emphasizes the importance of a household's diversity of livelihood pursuits in both agricultural and non-farm activities in buffering the negative impacts of global change.

Building upon the theoretical approaches described above, in the following sections I examine the convergence of climate change and economic globalization on the Pacific slope of Peru. I explore how the impacts of these processes are driving shifting resource access and increased vulnerability—as well as opportunity in some cases—in the households of two rural communities in Peru's Cordillera Blanca. This analysis highlights the environmental and social heterogeneity within and between these communities and the differential and dynamic resource availability to which such heterogeneity gives rise in the context of intensifying double exposure.

IV. Double exposure in western Peru: Histories of instability and change

Climate Change

Historically, climatic variability and change has played a crucial role in the development of Andean environments and civilizations. The Pacific slope of Perú, in

particular, is a region severely impacted by short-term climatic variability linked to the El Niño-Southern Oscillation (ENSO) as well as to long-term processes of desertification and glacial recession (e.g. Ortloff and Kolata 1993, Dillehay and Kolata 2004, Vuille et al. 2008a). These climatic processes have contributed to transformations in the physical environment of the region leading to both gradual impacts and sudden shocks to human livelihoods. While in some cases such change has expanded human opportunities, it is often destabilizing and destructive and contributes to heightened levels of human vulnerability, especially when coupled with endemic risk factors such as rugged topography, frequent seismic activity, infertile and saline soils, and uneven water availability (Brush and Guillet 1985).

The *El Niño*-Southern Oscillation (ENSO)

ENSO is a coupled oceanic-atmospheric phenomenon that occurs over a 2-7 year time scale and is credited as being the planet's strongest source of inter-annual climate variability (Bjerknes 1966, Tudhope et al. 2001). ENSO is best-known for the effects of its warm phase, El Niño, which is characterized by the weakening of the easterly trade winds and a marked decline in the upwelling of cold, nutrient-rich waters off the western coast of South America (Cane 2005). Peruvian fishermen have long noted the impacts of this process, which can cause the disappearance of the vast anchovy schools that support the fishery upon which their livelihoods depend. As early as 1895, the phenomenon's existence and effects were being discussed among geographers in South America, but it was not until the late 1960's that the El Niño

effect was linked to the Southern Oscillation first described by Walker in the 1920's (Bjerknes 1966, Fagan 2009). With warmer sea-surface temperatures in the eastern Pacific Ocean, El Niño often brings heavy rains and flooding to the northern Peruvian coast while causing drought conditions in southern Peru and on the Bolivian Altiplano. In contrast, La Niña, the cold phase counterpart to El Niño, is characterized by colder temperatures and above average precipitation in parts of the Andes and drought on the coast (Vuille, Kaser and Juen 2008b).

The inter-annual variability linked to ENSO has created significant challenges for Andean and coastal cultures in present-day Peru for millennia, particularly when coupled with longer-term droughts and trends towards desertification (Dillehay and Kolata 2004). These processes have also elicited adaptations from coastal and highland cultures, including shifts in principal livelihood-producing activities and the development of methods for predicting the occurrence of ENSO events (Orlove, Chiang and Cane 2000). Over time ENSO events have contributed to major upheavals in the Peruvian economy, including impacts on the 19th century's guano industry, the 20th century's anchovy catch, and coastal and highland agriculture. While these effects have most often been negative (e.g. massive seabird mortality, the flooding of agricultural lands, and extreme drought), in rare cases El Niño has also spurred economic development as occurred with the boom in cotton production in northern Perú after the heavy rains of the El Niño of 1891 (Thorp and Bertram, 1978). In recent years, the El Niño of 1997-98 was one of the strongest ever recorded and cost Peru an estimated $3.5 billion, while in 2010 El Niño-triggered rainfall led to

flooding that killed dozens, destroyed infrastructure, and temporarily shut down the archaeological site of Machu Picchu (Economist 2010).

Glacial Recession

While ENSO has long caused severe inter-annual climatic variability on Perú's Pacific slope, an overall trend towards deglaciation has also been underway in the tropical Andes since the late 19th century and is currently accelerating concurrent with rising average temperatures and a shifting humidity regime (Mark 2008, Vuille et al. 2008a). The marked decline of Andean glaciers mirrors changes in glacier cover in many other parts of the world that are raising concerns over the future availability of hydrologic resources vital to a significant portion of the world's population (Barry and Seimon 2000, Bradley et al. 2006, IPCC 2007a). In the arid landscapes of western Perú, which contain 70% of the country's population and 80% of its GDP-producing economic activity but only 2% of its freshwater, worries over disappearing glaciers and declining water supplies are particularly acute (Peru 2004). In some catchments of western Peru, decreases in river flows and water availability have already been reported by local populations, and modeling efforts suggest that the future will bring increased warming at high elevations and an intensification of the hydrologic cycle (Bradley et al. 2006, Juen, Kaser and Georges 2007, Mark et al. 2010, Bury et al. 2011, Baraer et al. 2012). In this region, where the annual hydrologic regime is characterized by marked seasonality, glaciers mete out meltwater during the dry season and drought periods that helps to regulate river flows and recharge

groundwater supplies. As glaciers decline, this critical ecosystem service and buffering effect will be reduced in the long term, though more water will be released to the hydrologic system initially (Mark, McKenzie and Gomez 2005, Baraer et al. 2012).

With rapid glacial recession, the risk of catastrophic natural disasters such as avalanches, debris flows, and glacial lake outburst floods (GLOF's) is also increasing. Throughout the tropical Andes such disasters have destroyed infrastructure and claimed thousands of lives, but, as we will explore below, perhaps no other region on the planet has been so afflicted by glacier-related hazards as Peru's Cordillera Blanca (Carey 2010).

In the Andes the impacts of ENSO and glacier recession have been observed and adapted to for years, but meteorological records, climate modeling, and recent empirical research suggest that climate change is driving more extreme temperatures (both highs and lows), shifting humidity regimes, increasing climatic and hydrologic variability, and a greater prevalence of extreme weather events (Juen et al. 2007, Perez et al. 2010, Bury et al. 2011, Baraer et al. 2012). While Andean cultures have long been forced to adapt to extreme and unpredictable conditions, the changes currently underway are generating heightened uncertainty over meteorological conditions that bear importantly on the vulnerability of human populations in general and that have particularly important repercussions for agro-pastoral producers whose livelihood security depends to a large degree on coordinating planting, harvesting, and transhumance activities with relatively predictable seasonal transitions and ranges

of climatic conditions (Slingo et al. 2005, Morton 2007). Moreover, as global warming proceeds, the distribution of a wide range of species is shifting, and pests and diseases that plague both livestock and agricultural crops are increasingly occurring in areas where they had not been observed previously (Perez et al. 2010, Bury et al. 2011).

Globalization

The economic activities and natural resources of what is today Peru have been integrated into the global economy since as early as the Spanish conquest of the Inca Empire when vast quantities of gold and silver from Incan treasure troves were siphoned off into Spanish coffers. After Peru gained independence in the early 19th century, local elites coordinated with foreign financiers to fuel a booming export sector for guano—a rich fertilizer provided by the seabirds that feasted on the rich Pacific fishery. The guano industry, however, had largely gone bust by the end of 1870's due to overexploitation of deposits and the effects of the War of the Pacific with Chile. In the late 19th and early 20th centuries, rapid growth in the sugar and cotton sectors took a more nationalistic turn; but, due to changing circumstances in the international markets for these products and a failure to reinvest profits in the domestic economy, this pattern soon lapsed into foreign-dominated investment and the repatriation of large profits abroad with the growth of U.S. and other foreign interests' control of the country's oil and mineral reserves (Dobyns and Doughty 1976, Thorp and Bertram 1978) .

With the global economic downturn of the late 1920's, the Peruvian economy was forced to turn inwards once again, though to a lesser extent than occurred in many Latin American countries during the Great Depression. This pattern of more locally fueled growth was short-lived, however, as foreign dominance of the key export sectors was reinforced through the middle of the 20th century through linkages to an enduring Peruvian oligarchy that played an important role in shaping the political and economic landscape of the country between 1948 and 1968 (Thorp and Bertram, 1978). The 1968 military coup led by General Juan Velasco temporarily shifted power away from this oligarchy and its foreign partners and instituted a sweeping program of nationalization of major industries and agrarian reform targeted at encouraging import-substitution industrialization, redistributing land resources, and reducing inequality (Lowenthal 1975, Eguren 2006). While the movement failed in many of its goals, it did achieve an important restructuring of land ownership that has had long-term impacts for rural households in the Andes. The failure of the regime's economic policies, however, set the stage for a period of economic turmoil and civil unrest that would help propel Peru into a far-reaching program of neoliberal reform (Lowenthal 1975, McClintock and Lowenthal 1983, Skidmore and Smith 1997).

Neoliberalism

As outlined above, foreign capital and the global political economy has played a critical role in the development of the "Peruvian" economy since the 16th century (several centuries prior to Peruvian independence). The notion of "globalization,"

however, is more commonly associated with the neoliberal reforms and structural adjustments that have proliferated in recent decades and that have impacted the Peruvian economy since the 1980's. As documented in many settings, the neoliberal project or "Washington Consensus" is characterized by strategies such as free markets, formal property rights, a downsizing of state expenditures, and the privatization of state-run industries and utilities (Williamson 1990). Such adjustments were underway by the final years of Alan Garcia's initial presidency (1985-90), and were then carried out more thoroughly by the Fujimori regime that ruled between 1990 and 2000 (Crabtree 1992, Skidmore and Smith 1997, Crabtree and Thomas 1998, Oré 2005).

The impacts of neoliberalism in Peru were transformative. During the early 1990's, hyperinflation was reigned in, foreign investment rebounded, and GDP began to grow albeit in a context of significant economic crisis and human suffering (Crabtree and Thomas 1998). At the same time, the hollowing of the state apparatus coupled with the corruption of the Fujimori administration led to the erosion of both civil liberties and public institutional capacities (Crabtree and Thomas 1998, Mayer 2001, Crabtree 2006). Through the control of the Shining Path (*Sendero Luminoso*) insurgency as well as improvements in rural infrastructure and redistributive programs for the poor, Fujimori was able to maintain a broad appeal to the masses throughout the 1990's that helped to keep him in power (Crabtree and Thomas 1998). Despite this popular support, especially from rural areas, in 2000 the Fujimori administration toppled under incontrovertible evidence of the regime's widespread

corruption and repression. The neoliberal economic course pursued under Fujimori's rule, however, would hold remarkably steady through the ensuing decade and beyond (Smith 2008, Bebbington 2009).

Neoliberal reforms began even before Fujimori entered power but expanded markedly throughout public sectors during his rule. In agriculture, for example, the undoing of agrarian-reform era regulations began in the early 1980's and culminated in the 1990's with laws like 1991's Legislative Decree N^{o} 653 and 1995's Law N^{o} 26505.[34] Such reforms broke down restrictions on landholdings, loosened regulations on community-held lands, and provided various incentives to entice new agro-export business to the country, especially to the arid coastal plain (Eguren 2003, Eguren 2006). This expansion hinged on state-subsidized irrigation projects and land auctions that helped to grow the agricultural frontier through infrastructure development and land dispossession and reallocation. These legal changes created new dynamics of resource access and control, connecting users across watersheds and other geographical and political scales while also raising important issues of long-term equity and sustainability (Oré 2005, Eguren 2006, Oré and Rap 2009, Bury et al. 2013).

Agricultural production in the Peruvian highlands has also been impacted in recent decades by diverse economic factors including the continued spread of Green

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[34] Legislative Decree 653 was known as the Law of Promotion of Investment in Agriculture (*Ley de Promoción de Inversiones en el Sector Agrario*) and Fujimori himself referred to it as the "reform of the agrarian reform" (cited in Eguren 2006). Law 26505 was know as the Property Law (*Ley de Tierras*) and was focused on liberalization of the property market throughout the country.

Revolution technologies, extensive road construction, and transportation and communication infrastructure improvements (Webb 2013). Together, such changes have heightened connectivity and contributed to the integration of many producers into new and more distant markets, while new demands have also shifted cropping choices and a number of non-traditional agricultural products have gone into cultivation. Despite these changes, some critics still point to the lack of efficiency and dynamism in highland agriculture, while proponents highlight the important role that rural producers play in provisioning domestic markets and contributing to national food security (Mayer 2001, Trawick 2003).

In the public utility sector, privatization rapidly restructured energy, sanitation, and telecommunications services throughout the country in the 1990's, improving access to services in many cases while also bringing powerful transnational corporations into the governance equation (Reference). Transnational corporate actors also played a critical role in the booming mining sector, which has grown prodigiously since endeavors from the early 1990's like Yanacocha illustrated the profits to be made under the revamped regulatory regime (Bury 2004). Since 1990, much of the national territory has been concessioned to mining and hydrocarbon firms (see Figure 3.1) and combined exports of these sectors have accounted for more than 50% of total exports in recent years . This rampant expansion in the extractive sector has buoyed the country's sustained economic growth over the last decade, but it has also led to increasing divisions within the country over competing models of development as well as to conflicts and violence in

many settings. Through taxation on mining revenue, redistributive fiscal mechanisms like the *canon minero* have funneled large sums of money into the regions impacted by mining, but these efforts remain challenged by corruption and low state and local capacity for implementation (Bebbington and Bury 2009, Himley 2012).

The tourism sector in Peru has also grown rapidly over the past two decades, beginning with the capture of the leader of the Shining Path in late 1992 and the improved security that resulted (Wiese 2001). Between 1993 and 2000, tourism grew at an average rate of 21% (Wiese 2001) and between 2002 and 2012, the number of foreign tourists entering the country nearly tripled from just more than 1 million to almost 3 million (MINCETUR 2012) (see Figure 3.2). Much of this visitation is concentrated on Macchu Pichu and the Cuzco region, however, and while tourism has grown significantly in many parts of the country, the industry's benefits are largely concentrated in specific regions and particular segments of the population.

Given Peru's long history as an exporter of primary products as well as the rapid neoliberalization of the economy in the 1990's, it is not surprising that the country's economic activities remain tightly bound to global markets and geopolitics. The circumscribed historical overview presented here, which necessarily omits discussion of many important aspects of the economy and its evolution, is intended to provide contextual information for understanding the aspects of contemporary vulnerability linked to globalization and political economy as well as the interaction of these aspects with shifting climatic and environmental conditions. In the following section, the paper explores the double exposure nexus as well as the vulnerabilities

and opportunities that result from the convergence of global change processes in the highlands of the Cordillera Blanca.

V. Double Exposure in Peru's Cordillera Blanca

As the highest and most extensively glaciated mountain range in the world's tropical zone, Peru's Cordillera Blanca has in recent decades become a test case for the impacts of rapid glacial recession driven by global climate change: since 1970 the range has lost approximately a third of its total glaciated area, with glacial recession rates accelerating in the final decades of the 20th century (Georges 2004, Racoviteanu et al. 2008). The Santa River, which drains the western slope of the Cordillera Blanca, is more than 300 kilometers long and connects diverse actors across geographic and political scales through its flows. With a watershed area of more than 12,000 km^2, the Santa has the second largest and—given the contributions of glacial melt during the tropical dry season—least variable annual discharge of all the rivers on Peru's Pacific slope. The perennial flows of the river and its tributaries have given rise to year-round agricultural production in the highlands as well as water-intensive development in the middle and coastal reaches of the watershed that include hydropower production and large export agriculture operations. Because these developments have been premised on the relatively abundant flow regime of the 20^{th} century, the ongoing glacial recession impacting the basin is raising concerns about future dry-season water availability and the negative impacts of water supply reduction on an array of economic activities (Vergara et al. 2007, Baraer et al. 2012, Bury et al. 2013)**.** In

addition to these concerns over water availability, glacial recession and climate change more broadly are also contributing to new and intensified natural hazards while driving meteorological changes with significant effects on regional livelihoods (French and Bury 2009, Mark et al. 2010, Bury et al. 2011).

In conjunction with shifting hydrologic and biophysical parameters in the region, ongoing economic and socio-cultural transformations linked to globalization are causing important new risks and opportunities for inhabitants of the study region. These developments include rapid growth since the 1990's in the mining and tourism sectors in the highlands as well as the expansion of regional cities like Huaraz and Caraz and their associated service economies. Increased linkages to diverse markets have spurred the cultivation of new agricultural crops in both the highlands and on the coast, and large-scale export agriculture projects have developed on the arid coastal plain with the diversion of Santa River water. Coastal cities like Chimbote and Trujillo have also grown in size and in their dependence on water from the highlands for consumption, energy production, and the labor markets it creates. Much of this development and the sustained but uneven growth it has brought to the region is, however, quite precarious, linked to either unstable global markets and trends or unsustainable natural resource use or both.

Given this context, the optic of double exposure is well suited for examining the converging impacts of climate change and globalization in the Cordillera Blanca and the Santa River watershed. In this setting, vulnerability results from exposures to diverse environmental factors as well as a wide range of socially produced conditions,

and complex cases of multiple interacting exposures and feedbacks become evident upon close study of local realities. In the rest of this section, I first describe the overarching processes leading to double exposure in the study region and then provide specific details of the ways in which local residents perceive these impacts and their implications for resource access and livelihood production.

Climate Change: Melting Glaciers, Scarce Water, and Uncertain Weather

The severity for some local communities of the risks and hazards associated with rapid glacial recession—and enhanced by the region's seismic activity—are abundantly clear from the history of glacial-related catastrophes in the Cordillera Blanca. Since the mid-twentieth century, alone, more than thirty disasters linked to glaciers, including glacier lake outburst floods and large avalanches that generated massive debris flows, have killed almost thirty thousand people and destroyed rural and urban areas and hydroelectric-power generating infrastructure in the Cordillera Blanca and in the middle reaches of the adjoining Santa River watershed (Carey 2005). Given this destructive history, an extensive program of glacial lake monitoring and threat reduction was undertaken by the Peruvian state during the second half of the twentieth century (Portocarrero 1995, Carey 2010). These disaster mitigation efforts have been important in reducing human and infrastructural vulnerability in many settings, but the state-funded program was largely discontinued with the privatization of state enterprises under neoliberal reforms in the 1990's (Carey 2010, Carey et al. 2012). Nevertheless, given the growing hazards in the region as glaciers

recede, renewed efforts to manage potentially dangerous lakes have arisen over the last decade, though decisions over who oversees and funds these efforts remain ad-hoc and uncertain in many cases.

While the direct risks linked to glacier recession have led to unpredictable and catastrophic, but highly place-specific disasters, more insidious impacts of climate change on human systems are a greater worry for many actors. As noted above, the long-term diminution of freshwater supplies in western Peru has emerged as a principal concern for local residents, international business interests, and the Peruvian government. A diversity of scientists as well as actors such as the World Bank and the UNDP have focused targeted analyses on these issues in the highly vulnerable Santa basin (Painter 2007, Vergara 2009).

Among these studies, a number of hydrologic analyses have attempted to understand the impacts of climate change and glacial recession on both contemporary and future water availability in the region. While a general consensus exists that glacial melt makes up a significant portion of annual runoff (~1/3) and, more importantly, a critical portion of dry-season discharge (Mark and Seltzer 2003, Mark et al. 2005), some disagreement exists regarding when the total amount of water in the system will begin to decline. Some researchers have argued that the melting glaciers will continue to add greater quantities of water to the system through the middle of the 21st century, after which point a gradual decline in dry-season volumes and increasing inter-annual variability will occur (Juen et al. 2007, Vergara et al. 2007). Recently, based on statistical analyses and modeling using existing hydrologic

records, our research group has argued that this tipping point for the upper and middle reaches of the Santa River system actually occurred in the 1970's, although some tributary catchments with a large percentage of remaining glaciated cover have yet to pass this inflection point and continue to experience increased discharge (Baraer et al. 2012, Bury et al. 2013). Historic discharge measurements from a station in the river's middle reach support the latter hypothesis, but questions remain about how much of the decreasing trend in the river's volume might be attributable to human uses rather than glacial decline.

In addition to growing worries of water scarcity, concerns of increasingly variable and extreme weather have become pronounced in the Cordillera Blanca. While ENSO-driven variability has long impacted the region[35], there is a strong local consensus that variations in the onset and duration of the wet and dry seasons, the frequency of precipitation, and temperature extremes (both highs and lows) have intensified in ways that challenge traditional agricultural calendars and cropping choices (Bury et al. 2011, Mark et al. 2010). While coarse trends and some extreme events have been documented by existing weather monitoring and reporting services, the heterogeneous nature of local landscapes and meteorological conditions as well as the limited number of monitoring stations present obstacles to understanding weather variability at a fine resolution.

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[35] ENSO impacts in the Cordillera Blanca typically correspond to those experienced throughout the Central Andes with higher temperatures and lower precipitation levels (more glacier ablation) during the El Niño phase and colder, wetter conditions during La Niña. Nevertheless, this pattern occasionally breaks down in the Cordillera Blanca due to the location of the upper tropospheric zonal flow (e.g. 1998-99) (Vuille et al. 2008b).

Economic Globalization: Connection, Foreign Capital, and Change

The landscapes and populations of the Cordillera Blanca and the Santa watershed have been linked to the global economy in diverse ways over a long history. Gold miners and conquistadors passed through the region as early as the 16th century, and vast tracts of land in the upper and middle reaches of the valley, the area known as the *Callejón de Huaylas*, became the cattle estancias and plantations of Spanish and later *creole* elites as the indigenous populations inhabiting these lands were relocated to regional centers through Viceroy Toledo's planned resettlements (las *reducciónes*) (Dobyns and Doughty 1976, Oliver-Smith 1986). Ironically, these relocations moved people out of the highlands and into the valley floors, where their villages were far more exposed to the glacier-related floods and debris flows that have long impacted the region.

In the early 1970's, however, under Velasco's agrarian reform many of the large estancias of the region were broken up and redistributed to employees or to organized groups of local residents that often became official *campesino* communities under state law (Del Castillo 2005). While neoliberalism in the 1990's undid many elements of the military government's reform, the broad redistribution of land that had occurred in highland regions like the Cordillera Blanca was largely maintained, while in coastal regions the state reclaimed and sold land that had been granted to *campesino* communities but left uncultivated (Eguren 2006). For many rural households, the access to both land and water received during the agrarian reform remains the foundation for livelihood reproduction through subsistence and small-

scale agriculture and pastoral activities, which provide foodstuffs and other products for household consumption and local markets. Additionally, many agrarian producers, especially those in the warmer and more fertile climes of the middle watershed, have diversified their crop choices to include non-traditional crops such as peaches, apricots, avocados, and carnations for regional and even international markets (Parón-Llullán 2009, Mayo 2010). In many cases, residents have also taken up work in sectors like service, mining, and tourism as the region's economy has continued to grow and diversify (Llupa 2008b).

With mountains rich in a variety of metals, the region has long been a center of ore extraction and processing and has experienced the typical boom and bust cycles of the mining sector. While the legacy of 19th and early 20th century mining is evident in the tailings piles that dot the upper and middle reaches of the watershed—some of them still actively growing through ongoing processing activities—large new mines have also opened up since the late 1990's and more than half of the watershed's total area is now concessioned to mining firms (Bury et al. 2013). While only a small percentage of these concessions are likely to be fully developed, the separation of surface and subsoil property rights is leading to a wide range of conflicts between local residents and the Peruvian and transnational mining corporations who own concessions in this region and throughout the Andean highlands (e.g. Bebbington 2007, Gil 2009). In addition to resisting the landscape transformations that occur with modern forms of mining in Peru (e.g. cyanide heap-leach gold mining), local residents also increasingly complain of the impacts on water

supplies, both for the large volumes that mining and ore processing operations directly consume as well as for the contamination they generate. Yet, while the political department of the region (Ancash) often registers more mining conflicts that any other department in Peru[36], it also receives a significant portion of the redistributed tax revenue from mining (*canon minero*) and many local residents labor for or receive services from entities or financing linked to the mining industry in one way or another. Mining is thus a source of opportunity for some and a risk for others, and, in many cases, is both simultaneously. As we see in more detail below, this complicated relationship between mining and society in the region is a key source of uncertainty and vulnerability for many residents.

Tourism has also grown into an important sector of the economy, especially over the last two decades. While a few international mountaineers and scientists began visiting the region in the early 20th century, the improved road access that came in the wake of the 1970 earthquake along with the Velasco government's designation of 340,000 hectares of the Cordillera Blanca as Huascarán National Park in 1975 (declared a World Heritage Site in 1985 by UNESCO) facilitated the tourism sector's development. The boom in international tourism, and ecotourism especially, that began in the 1990's led to rapid growth in the regional economy. Much of this activity, however, is concentrated between May-October, when the dry-season climate facilitates climbing and trekking in the highlands.

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[36] According to the detailed records kept by the National Ombudsman's Office (*Defensoría del Pueblo*).

The region's tourism sector, however, has proven vulnerable to aspects of both climate change and economic globalization. During the height of the recent global economic crisis in 2008 and 2009, for example, international visitors to Huascaran National Park dropped significantly (see Figure 3.3), and local service providers reported low profits and increased competition for clients (Huaraz 2010). Additionally, ongoing glacier recession has impacted the tourism sector, as many visitors come to experience the picturesque landscapes or to climb the glaciated summits—an activity that is increasingly dangerous with glacial melt and the resulting potential for avalanches and serac falls. In 2008, for example, the Peruvian government temporarily closed one of the region's primary destinations for domestic tourists, the Pastoruri Glacier, due to unstable conditions that posed a potential danger to visitors (Bury et al. 2011). This closure reportedly caused the significant decline in Peruvian visitors to the park during 2008-09 (Huaraz 2010) (see Figure 3.3). Also, in 2003 members of the tourism industry reported a significant drop in visitation, attributing the decline to a NASA analyst's flawed interpretation of a shadow on a satellite image, which was reported as a huge new glacial crevasse above an unstable lake threatening the regional center of Huaraz (Carey 2010, Huaraz 2010). The botched interpretation led to news releases and warnings that may have dissuaded many potential visitors from traveling to the area. In summary, while tourism is always a fickle business linked to the vicissitudes of the global economy, a future of increasing glacial recession and accompanying risk in the Cordillera Blanca is likely

to have negative implications on what for many local people has become a critical source of cash income and livelihood security (see Table 3.1).

While an increasingly diverse mix of traditional and modern livelihood pursuits has evolved in the highlands of the Cordillera Blanca, downstream developments have focused on hydropower, urban services and industry in Chimbote and Trujillo, fishing and fish-meal production in Chimbote, and, more recently, large-scale export agriculture focused on water-intensive crops like asparagus, sugar cane, and artichokes. This export-led coastal agricultural development has made the Peruvian desert an important source of virtual water (cf. Allan 1998) for markets in the Global North, a dynamic raising important questions about sustainable resource use and food security in this arid region (CEPES 2012). While this article does not explore the impacts of double exposure on the coastal plain in detail, it is important to note that increasing highland and lowland dependence on shared and declining hydrologic resources is an important source of vulnerability and potential conflict for actors throughout the watershed.

VI. Local perspectives on vulnerability to double exposure in the Cordillera Blanca

Given the highly varied and uncertain impacts of global change on landscapes and livelihoods in the Cordillera Blanca and the Santa watershed, the region has been designated a site of extreme vulnerability (CONAM 2001, Painter 2007), and a range

of adaptation programs have been funded by a wide array of international groups.[37] As noted above, the area has also received significant attention from Peruvian and foreign researchers, especially glaciologists and hydrologists working to understand the impacts of climate change on glacial mass balance and downstream hydrology. Social scientists, particularly anthropologists[38], also have a long history in the region and have focused attention on changing cultural practices and socio-environmental relations in the context of *longue durée* globalization as well as catastrophic natural disaster (e.g. Stein 1961, Oliver-Smith 1986, Bode 1989). Until quite recently, however, little detailed work has interrogated the linkages between climate change and globalization and the ways in which the converging impacts of these processes are leading to enhanced vulnerability for socio-ecological systems in the region (Lynch 2012). Our research team's trans-disciplinary research has begun to address this lacuna, and we have conducted a variety of linked hydrologic and social analyses in the Cordillera Blanca and Santa basin since 2006 (e.g. Mark et al 2010; Bury et al. 2011, 2013).

Our work in this region has principally focused on measuring biophysical (and especially hydrologic) change and its impacts on human communities across altitudinal and topographical gradients as well as between watersheds with varying percentages of glacial cover. While a comparative approach is important to assessing spatially variable processes and impacts, we have employed it in order to effect a

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[37] e.g. USAID/TMI, CARE International, Soluciones Practicas/ITDG, World Vision.

[38] e.g. Cornell-Peru Vicos project.

"space for time swap," whereby current conditions in less-glaciated watersheds provide insights into future conditions in more-glaciated basins that are continuing to lose glacial cover (Mark et al. 2010). Our findings have shown strong correlations between scientific analyses illustrating changes in natural phenomena and local human perceptions of these processes (e.g. glacial recession and changing temperature regimes). We have also recorded widespread perceptions of decreasing water availability in two case-study watersheds that correspond to our research team's statistical analyses suggesting that the region is transitioning into a state of diminished dry-season hydrologic flows and increasing inter and intra-annual variability (Baraer et al. 2012). We have also documented negative livelihood impacts that respondents linked to climate change including more severe temperature extremes, less-predictable precipitation regimes, new crop and animal pests and diseases, and declines in the regional tourism industry (Mark et al. 2010 and Bury et al. 2011).

In this article, I expand upon our team's previous work, shifting the focus of analysis from climate change impacts specifically to look more broadly at the outcomes of double exposure to both climate change and globalization. Such analysis is warranted by local responses to 72 randomly selected, semi-structured household surveys conducted in the Yanamarey and Quilcayhuanca watersheds during 2008 (see Figure 3.4).[39] In the course of these surveys, and despite the fact that no questions

[39] See Mark et al. 2010 and Bury et al. 2011 for further details on the surveyed population and their perceptions.

asked specifically about the effects of economic globalization, many participants described impacts to their livelihoods linked to specific processes of globalization, and in some cases these concerns were emphasized over those related to climate change. In the rest of this section, I describe the case study locations in greater detail along with their inhabitants' perceptions of the impacts of global change in their communities and the implications for the vulnerability of their livelihoods.

Catac and the Yanamarey Valley

The Yanamarey watershed, which has only 3% glacial cover, is located in the district of Catac in the southwestern foothills of the Cordillera Blanca and the upper reaches of the Santa River basin. Roughly half of the district's population (~5000 in total) resides in the small urban center of Catac, while other residents live in dispersed rural hamlets located primarily in the Cordillera Blanca's tributary watersheds to the Santa. Our survey sample was selected from a zone linking Catac's city center to the highest reaches of the Yanamarey watershed, which is the northernmost tributary watershed in the district and includes seasonally-inhabited high-altitude pasturelands within the bounds of Huascarán National Park, a small permanent settlement at Lake Querococha that benefits from seasonal tourism, and broad expanses of grassland (*pampa*) below the national park boundary (~ 4000 meters). The high-altitude climate in the region (~ 3500-5000 meters) largely restricts land-based livelihood activities to pastoralism (sheep, horses, cattle), though in the lower reaches of the Yanamarey valley aquaculture (trout farming) is important for a

small number of households as is the small-scale cultivation of tuber and cereal grain crops. Tourism is also an important source of local incomes for a small number of residents who provide meals, boat trips, and other services to tourists whose visits are largely concentrated around the major Peruvian holidays of Easter (*semana santa*) and Independence Day (*fiesta patrias*). In the lower Yanamarey valley, there are also several ore processing plants, which provide employment to some local residents.

Through 40 semi-structured household surveys as well as unstructured and key-informant interviews with local leaders and residents, we found the local population keenly aware of glacial recession in the region (100% of survey respondents confirmed this trend). More than 90% of respondents also reported significant changes in recent weather patterns that negatively affected livestock and/or crops as well as decreasing water supplies in local lakes and streams during the dry season. Notably, however, only 5% of households reported having insufficient water for human consumption while 26% reported having insufficient water for irrigation. Many respondents, however, described the development of water rationing systems over the last five years and several described the disappearance of springs. It was also clear from both conversations and the design of local canal systems that water sources were under increasing demand from many different users and that complicated social relations existed between neighboring communities and also between residents and private corporations operating in the valley. Respondents frequently expressed concerns about water availability in the future.

Despite these growing challenges around hydrologic resources, most households continued to have sufficient water for their basic needs, and, when questioned about the impacts of climate change, they often emphasized changes in weather extremes and resulting impacts on human and livestock health. Additionally, multiple respondents, especially in the urban center of Catac, described the negative impacts of climate change on tourism, which they linked to the closing of Pastoruri and the decline of the community's service sector at the glacier.

Despite our survey's lack of emphasis on non-climate-related sources of vulnerability, local perceptions of risks related to economic globalization often emerged over the course of the surveys. Most notably, numerous respondents expressed concern over the negative environmental impacts of the region's mineral processing plants and associated tailings piles. In many cases, these tailings piles are uncovered and exposed to weathering by wind and water and border watercourses and wetlands that provide resources for diverse human uses. In some cases, the processing facilities and tailings piles are in close proximity to households, elementary schools, and trout farms (see Figure 3.5).[40]

Multiple respondents, particularly those living in close proximity to the plants, complained of air and water contamination from the ore-processing operations and, several households reported decreasing pasture health on lands near to the processing plants as well as contaminated water unfit for consumption by humans or livestock

[40] As of 2013, efforts to construct additional processing plants in this area continue. How and why so many plants have located here is an important environmental justice question that was beyond the scope of this research.

(Yanamarey 2008: YK1, YU12, YS13, 28, 31, 34, 35, 36). At least three households attributed increasing human health problems including respiratory illnesses, skin rashes and tumors, and cancer to the effects of the industry (Yanamarey 2008: YS6, 13, 34).[41] One man in his late sixties recounted the changes he had witnessed in the region, stating that "more than anything, its mining that is degrading our lives here" (Yanamarey 2008: YS 13). He went on to describe how poison runoff had killed the fish while the fumes and dust blowing from one of the plants had contaminated his fields[42]. The man also expressed his frustration that the benefits of the mining industry, and specifically the funds from the *canon minero* never returned to the people in the areas most-impacted but instead were lost to corruption and bureaucracy.

Other respondents, including local officials, expressed some of these same sentiments, especially regarding the redistribution of mining profits, and Catac as well as neighboring Ticapampa and Recuay have long, complicated, and often conflicted, histories with the mining sector. While detailed examination of the impacts related to ore-processing activities was beyond the scope of our initial study in the region, our findings in the Yanamarey watershed have driven our continued inquiries into water quality in the Santa basin, and we have also focused on recent socio-environmental conflicts over mining that involved Catac residents and have

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[41] Respondents also noted rising cancer rates as a result of fertilizer and insecticide use (YU5) as well as more solar exposure (YS6).

[42] "Más que todo la minería está malogrando la vida acá."

generated violence and enduring resentment between local populations and corporations. Additional studies of the ecological and health impacts of the mining and ore processing-sectors are needed in this region, and in many other parts of Peru, where mining is rapidly transforming landscapes and watersheds. More pressing than additional studies, however, is the reclamation of the many open tailings piles in the Santa watershed and beyond that pose immediate and daily health risks to local populations and environments (CHAVIMOCHIC 2001).

Although mining was the most frequently mentioned impact of globalization, some residents of Catac and the Yanamarey basin also highlighted concerns about an overall rise in the cost of living, particularly in relation to food staples and agricultural inputs (Yanamarey 2008: YS 19, 20). One female shepherd described animal husbandry—the principal livelihood generating activity in the region —as "destitution" and "totally reliant on chemicals and medicines …" (Yanamarey 2008: YU 8).[43] Other households echoed concerns over the prices of animal vaccinations as well as of fertilizers and insecticides (Yanamarey 2008: YU 8, 3, YK 5). Unprompted by the survey, several respondents mentioned an increased dependence on purchased foods, in part because subsistence agriculture was no longer as viable as in the past due to factors like low fertility and input costs.

Yet rising market integration is also a result of shifting customs and preferences and growing access to new kinds of products and resources as the region rapidly modernizes. This transformation was highlighted by the interaction between a

[43] "[Pastorear animales] es una miseria. Es puro quimico, puro medicina…"

male respondent in his early twenties and his 73-year old grandmother. While he argued it was cheaper to buy products in the store and that people continued to farm more out of custom than necessity, his grandmother laughed and swore she would die harvesting her own crops (Yanamarey 2008: YS 6). Yet their household was supported by a municipal job as well as the proceeds of a small internet business occupying the home's front room, factors which likely made agropastoralism far less of a necessity for them than it was for many households in the region. The diverse livelihood production strategies of this household as well as the inter-generational differences betweens its members illustrate how globalization is bringing both new risks and new opportunities to the region while also suggesting that the capacity to adapt to such changes is highly variable between and, even within, households. Through the following case study, I continue to explore this variability adding the complexity of a new context and its own unique conjuncture of global change impacts.

Llupa and the Quilcayhuanca-Paria Watersheds

Approximately 30 kms north of Catac and 500 meters lower in elevation, the Santa River flows through the regional center of Huaraz (3066 meters), a growing city of roughly 120,000 residents, which has been rebuilt and expanded since being razed by the 1970 earthquake. Directly east of the city, steep foothills rise rapidly up to the divide of the Cordillera Blanca, a series of glaciated ridges and summits divided by deep east-west-trending valleys left by past glacial advances. One of the

largest of these valleys, Quilcayhuanca, is drained by the Quilcay River, which eventually becomes a principal tributary of the Santa River. Just north of the Quilcayhuanca Valley, the Cojup Valley is drained by the Paria River, which joins the Quilcay before reaching Huaraz. On the flanks of the broad ridge that divides the Quilcay and Paria rivers, there is a series of population centers, the highest of which is Llupa (~3400 meters). Our survey sample included the small *centro poblado* (town center) of Llupa and extended up the ridge above towards the mouth of the Quilcayhuanca Valley. The region surveyed is a mosaic of small, cultivated parcels and household plots, with open grasslands in the higher elevations, cut by watercourses and ravines and criss-crossed by numerous footpaths and irrigation canals as well as the region's expanding road network.

Our sample consisted of 32 households located between elevations of 3400 meters at the town center and 3800 meters adjacent to the boundary of Huascarán National Park at the opening of the Quilcayhuanca Valley. Although the upper reaches of the Quilcayhuanca watershed (17% remaining glacial cover) are part of the park, a small percentage of the local population (~240 users who belong to the campesino community) retains the right to keep their livestock within the national park. Thus in Llupa few people have access to these upper pastures, but many households nevertheless maintain a small number of livestock (especially sheep, pigs, and donkeys) near their residences. While these animals provide basic services and products to households, they also necessitate frequent trips to find fodder in the communal pastures located between town and the park boundary. In light of these

conditions and in sharp contrast to the situation in the Yanamarey valley, Llupa residents tend to earn money from the sale of agricultural products rather than from livestock and animal products. However, in both areas many residents generate cash income from a diverse mix of business ventures, contract labor, tourism, and other sectors (see Table 3.1).

To a slightly lesser degree than in the Yanamarey valley, our surveys in Llupa suggest that most local residents (94%) have observed obvious glacial recession, especially over the last decade. Notably, all respondents (100%) reported negative effects on crops and/or livestock from extreme weather phenomena including many reports of more intense frosts and hotter days (Mark et al. 2010). One respondent succinctly stated the overwhelming sentiment of interviewees: "It's strange because before you could predict a year of good harvest, now nothing's reliable, there's a lot of hail and lots of frosts"[44] (Llupa 2008a: LS 30). Complaints about the impacts of these phenomena on human health were also common. In this region, 81% of respondents (compared to 93% in the Yanamarey) reported declining stream flows during the dry season over recent years, a difference we attribute in part to the greater glacial cover and associated meltwater in the Quilcayhuanca valley and surrounding watersheds. Many residents also mentioned a dry-season reduction of water from springs on the lower to middle flanks of the western-most peaks of the Cordillera Blanca, especially during July and August (Llupa 2008a: LS4, LS12). These springs

[44] "Es bien raro porque antes se podia predecir el año bueno de cosecha, ahora ya no es nada confiable, hay mucha granizada y mucha helada."

play a critical role in local potable water systems, but there remains much to learn about how mountain groundwater systems are responding to declining glacial cover and other conditions of climate change (Baraer et al. 2009).

As we found in Catac, while a striking percentage of local residents in Llupa noted overall declines in water availability, the great majority had enough water for both consumption and irrigation. Only one household (3% of survey) reported water shortage for household needs (Llupa 2008a: LS14). Twenty-two percent of respondents, however, reported shortages in irrigation water, and several respondents mentioned the contamination of the upper Quilcay River as a factor contributing to water shortage. At least one household linked this contamination to mine runoff (Llupa 2008a: LS14), but in the Quilcayhuanca Valley there is no active mining[45]. Nevertheless, our team's research has documented low pH values (< 4) in 20 of 22 sample points in the upper Quilcay River and its tributairies with dissolved trace and minor element concentrations comparable to acid mine drainage (Fortner et al. 2011). These values are attributable to the exposure and weathering of sulfide-rich rocks, a natural process occurring in part due to ongoing glacial recession that only adds to the growing concerns over declining water quality in the region.

[45] There are some reports of mines worked by the Incas in this watershed. The mining corporation Antamina, which has a very large operation on the eastern side of the Cordillera Blanca, has also installed a water diversion in the Quilcayhuanca Valley to transport the acidic water of the Quilcay River approximately 12 km for use on the grounds of its company town of El Pinar. The construction of this diversion may have led some local residents to believe that the company was mining in the valley instead.

In regards to the impacts of economic globalization, both the similarities and differences that arose between the communities of Llupa and Catac were related to the dominant livelihood pursuits in each region as well as their specific environmental and socio-economic contexts. For example, while a number of households in Llupa mentioned mining as a general source of both environmental contamination and climate change (Llupa 2008a: LS 13, 14, 15, 16, 28), there was little emphasis on specific cases of contamination or localized health and environmental impacts of such processes, except in the case of the misunderstanding over mining activity mentioned above. This is, of course, not a surprising result given the lack of active mines in close proximity to the valley and population. Some Llupa respondents did, however, report increasing cases of cancer and other health conditions, but attributed them to fertilizers and insecticides rather than mining (Llupa 2008a: LS 2, 7).

Household responses in Llupa often brought up the impacts of market conditions for agricultural products on their livelihood security. Many households reported the production of aromatic and medicinal herbs (e.g. basil, oregano, cilantro, chamomile, and mint) for sale in Huaraz as their principal cash crop while they continued the cultivation of staples like potatoes, corn, wheat, barley, and quinoa at small scales, largely for household consumption. There were many complaints from respondents about the depressed market prices for traditional products like potatoes, especially given the price of the inputs required to produce them under local conditions. In fact, the level of concern over fertilizer and insecticide prices in the community was especially marked (Llupa 2008a: LS 1, 2, 3, 4, 5, 7, 8, LK 1) and

reflected the sharp rise in global fertilizer prices from late 2007 through September 2008 (MINAG 2012) (see Figure 3.6). Some respondents stated that the prices of fertilizers and insecticides together would prohibit them from planting the year's wet-season crop (*la campaña grande*), since the land would not provide without these inputs (Llupa 2008a: LS1, 2, 5, 8, 10). Many farmers also reported using livestock manure at least in part, and some planned to intensify reliance on natural fertilizers given the costs of synthetics. Global fertilizer prices fell sharply at the end of 2008, which helped many households in Llupa and elsewhere continue to plant a diversity of agricultural crops, particularly the many varieties of tubers that are an important staple in local diets. With the drop in fertilizer prices, the question of how many fields would have lay fallow in the wake of sustained price increases became moot. Nevertheless, given local responses near the height of the price rise, many households reportedly faced having to abandon their most important crop of the year. Given the volatility of global markets for both agricultural products and inputs, such impacts are likely to continue in the future.

Given these challenges to traditional agriculture as well as changing preferences and closer proximity to large regional markets, many residents are altering their choices about both livelihood production and consumption. Regular and relatively inexpensive transportation to Huaraz has made it easier to maintain regular work in the city (48% of respondent households provided contract labor) and to bring consistently producing crops like herbs to the public markets that occur three days a week in Huaraz. Many locals (27% of respondents) also work in the tourism sector,

most frequently as cooks, muleteers, and porters (Mark et al. 2010). This seasonal work, which varies from year-to –year, is frequently combined with agricultural work on the coast and other contract-labor during the off-season.

Yet while the residents of Llupa are increasingly connected to the outside world in diverse ways, many remain concerned about the reach of the outside world into their communities. This was evidenced by repeated concerns about the potential for water privatization (Llupa 2008a: LS8, 12, 13, 15, 17, LK1), which was likely influenced by a prolonged effort in the 1990's and early 2000's by the state and multilateral lenders to reform water governance in Peru in the style of the Chilean market model (Oré 2005, Trawick 2003, Solanes 2013). Some respondents also mentioned the water tariff (*tarifa de agua*) specifically as an important change that they had been forced to accept. While water prices remained at low levels during our surveys, there were obvious concerns over rising prices, and more importantly over restricted access, in the future.

VII. Discussion: ¡*No es como antes!*

No es como antes: it's not like it used to be. This phrase was undoubtedly our most common survey response: it appeared throughout our notes, and we often heard it in our conversations. There is no question that residents of the rural landscapes of the Cordillera Blanca perceive and are being impacted by rapid and transformative processes of global change. As highlighted in the initial sections of the paper, the impacts of global change in this region are not a recent phenomenon, but our surveys

showed unequivocally that the pace and degree of recent impacts are new and are producing unprecedented concerns. On one-hand residents note the declining glaciers and the shifting temperature and precipitation regimes accompanying climate change and are deeply worried about how these new conditions challenge their already-risky livelihoods. On the other hand, economic globalization promises new technology and diverse opportunities as well as mounting pressures on resources that residents have long relied upon but to which they often have little or no formal right or property claim. The double exposure conjuncture in which rural households of the Cordillera Blanca find themselves is thus one characterized by simultaneous risk and uncertainty but also opportunity. And while many households across our survey sites responded in strikingly similar ways to our surveys, the degree to which local residents expressed preparedness to bear new risks or benefit from opportunities proved extremely heterogeneous.

Witnessing the diverse circumstances of the different households in our survey samples, the importance of access to resources was constantly underlined. The resources of concern ranged broadly, of course, from traditional physical assets like landholdings, irrigation infrastructure, and water allotments to less concrete but still critical resources like ecological knowledge, professional skills, and human networks. As discussed in the theory section above, cultivating access to a diversity of resources and livelihood production activities has long been a fundamental strategy for managing risk and enhancing adaptive capacities, especially in contexts of uncertainty and change like those of the Central Andes and the Cordillera Blanca

specifically. That some people and households have always had greater access to resources than others is a historical fact in most settings, but current levels of household vulnerability and adaptive capacity under the novel conditions of double exposure seem to be increasingly uneven. In the rest of this section, I explore this unevenness and how feedbacks between different global change processes are amplifying both risk and opportunity in the study region.

Access to land is, of course, a fundamental element of livelihood security in most rural settings. The fact that most of the households we surveyed possessed a permanent dwelling and enough surrounding land to either grow food or maintain livestock or both obviously lent a margin of security to households under current production conditions that is an important legacy of agrarian reform in the country. Not surprisingly, respondents who rented the houses where they lived or were contracted to watch over the livestock of others often reported the greatest concerns over the impacts and uncertainties of global change. Nevertheless, the impacts of both climate change and globalization are impacting access to land in a variety of ways. Climate change is at once making some lands less productive through temperature and precipitation changes and increased pests and plagues while other zones may become more habitable or arable from the opposite effects of the same processes. Under these changes, whether one benefits or suffers from this process may depend on spatial location and the dynamics of complex Andean microclimates. On the globalization side of the double exposure, through widespread concessioning of land for mining, powerful new actors are arriving to rural landscapes to negotiate access to

sub-surface minerals, which typically necessitates control of surface lands as well. While some households may view this process as an opportunity to move to the city and start a more modern life, other households may either wish to continue their rural existence or feel unable to make a transition to some new way of life. These people are then left to defend their territory from mining or to coexist with the industry, which as we have seen can have impacts on a wide range of household resources, including the productivity of land. We have also seen how economic factors external to local dynamics can limit the productivity of land and thus the resources to which it provides access, through for example the costs of agricultural inputs necessary for ensuring production on many Andean plots.

Water is another critical resource to rural livelihoods, and given its importance across economic sectors and spatial scales it is a resource that will undoubtedly come under increasing pressure in the future. In the study region, we already are observing important changes in hydrologic supplies, in the form of both disappearing glaciers and increasingly variable and contaminated supplies. While much of the change in supply and some of the impacts on quality can be attributed to climate change, humankind is also having tremendous impacts on water availability through rapidly growing demand as well as through economic activities that degrade water quality. In the study region, mining is a sector where these impacts are obvious, if surprisingly understudied, as is agriculture, where the legacy of several decades of increasing fertilizer and insecticide use is largely unknown. Yet despite these growing challenges, sufficient access to water in the Cordillera Blanca remains the rule—in

large part because of the melting glaciers—and most water governance occurs without conflict. This situation, however, is changing, and in the Santa River watershed, water conflicts are increasingly common and will only become more frequent and difficult to resolve as hydrologic supplies grow ever more scarce.

In addition to the critical components of land and water, rural livelihoods in the study region are also increasingly dependent on an array of other resources and income-earning activities that help to buffer risk to agropastoral livelihoods. In the study region, these strategies include access to different regional economies like tourism, contract labor, mining, and urban service provision, with each necessitating their own assortment of skills and capabilities, at times gained through access to other resources like education and technical training. While access to these diverse livelihood production strategies would seemingly hinge on socio-economic factors, we find in this study that climate change is also having an important impact on access to sectors like tourism, through, for example, the current degradation of important tourist draws like the Pastoruri Glacier, which has repercussions for a wide range of local economies from the production of trout for local restaurants to cottage handicraft industries to transportation services.

Thus we find in communities like Catac and Llupa and other predominantly rural areas of the Cordillera Blanca that significant and highly varied transformations in resource access are underway as a result of both climate change and economic globalization and the interacting impacts of these processes. Moreover, we suggest that access to vital resources is increasingly dependent on an array of different factors

and on conjunctures of positive circumstances (e.g. in the case of agriculture, arable land, clean water, protection from extreme weather events, and sufficient agricultural inputs; or in the case of tourism, sufficient language or technical skills, access to the market, and the arrival of regular visitors), and similarly a lack of access may result from the interaction of increasingly contingent and unpredictable factors like global commodity prices, the presence of nearby mining activities, or an extreme frost or hailstorm outside of the normal season. The importance of specific conjunctures of risks and opportunities in influencing resource access and livelihood outcomes in this region illustrates the necessity of multi-exposure frameworks for the assessment of both vulnerability and adaptive capacity that are attentive to the linkages and feedbacks between diverse processes of global change. The importance of such conjunctures also underscores the critical need for detailed empirical fieldwork that captures the heterogeneity of risks and opportunities across households, communities and regions as well as the multi-scalar determinants of such heterogeneity.

VIII. Conclusion

In this paper, I have examined the theoretical development of multi-exposure frameworks for assessing human vulnerability to global change processes, and I suggest that a focus on access to resources for livelihood production is fundamental to understanding shifting household vulnerability under converging processes of global climatic and economic change. Using the "double exposure" framework to structure my analysis, I have provided a circumscribed overview of the historical impacts of

both climatic change and economic globalization on Peru's Pacific slope with a focus on the Cordillera Blanca region. I complement this historical analysis with the results of empirical fieldwork in two communities located in distinct socio-environmental settings in the Cordillera Blanca to illustrate how local residents of this region perceive and describe the impacts of global change on their lives and livelihoods.

Through these nested cross-level analyses, I conclude that vulnerability to (as well as the ability to benefit from) global change processes is extremely heterogeneous across and within communities and even households in the study region. This differential vulnerability is closely related to the specific resources that individuals and households can access at particular moments in time, and global change makes this resource access increasingly uncertain and volatile. Moreover, the diverse ways in which households access resources and secure livelihoods in the study region is changing markedly under shifting climatic and economic conditions, with both access and vulnerability increasingly determined by conjunctures of factors linked to both global change processes and to feedbacks between various aspects of each. These findings argue for detailed empiricism at multiple levels of analysis (e.g. individual, household, community) as well as for careful attention to the teleconnections linking global processes to local conditions and impacts, both long-established approaches within the political ecology tradition. These findings also emphasize that external efforts to address the growing vulnerabilities of doubly exposed populations require thorough understandings of local realities and the

increasingly critical conjunctures of uneven risks and opportunities that characterize our rapidly changing world.

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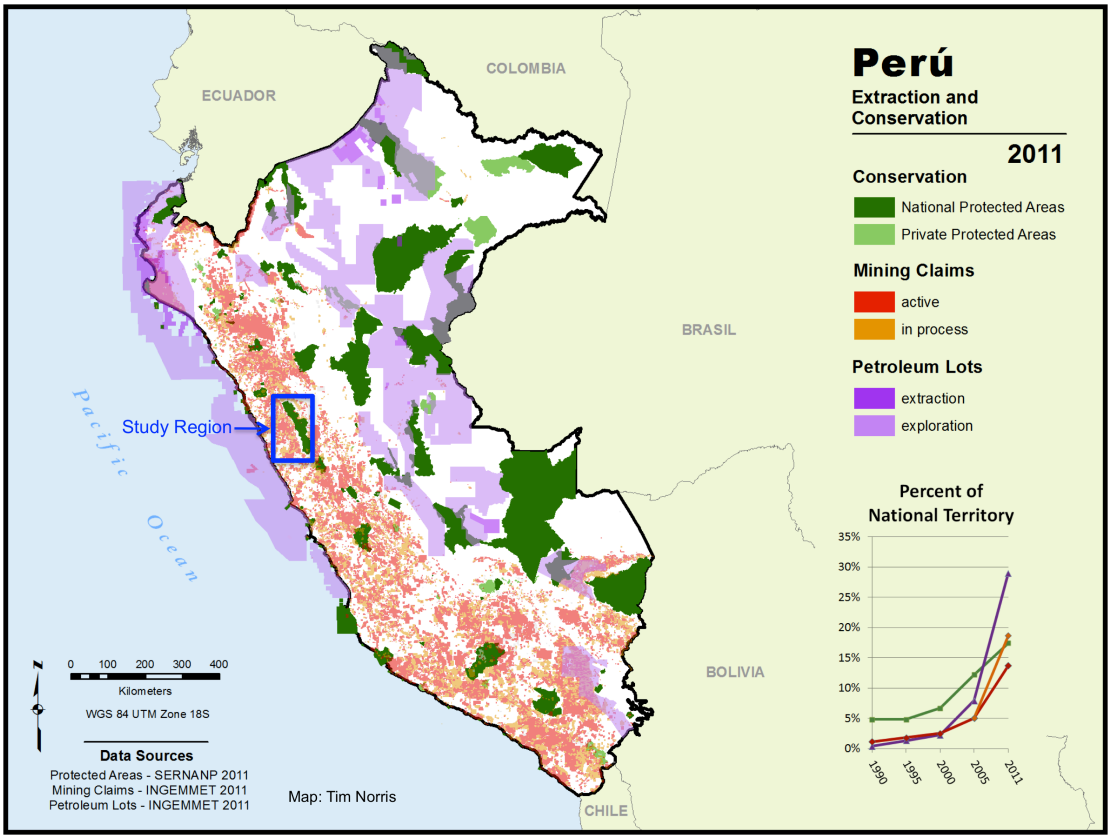

Figure 3.1: Mining and hydrocarbon concessions and conservation areas in Peru (2011). Note the graph of the percentage of national territory occupied by each zoning classification in the lower right. Source: Timothy B. Norris.

Figure 3.2: International tourist arrivals to Peru have grown consistently over the last decade. Source: MINCETUR.

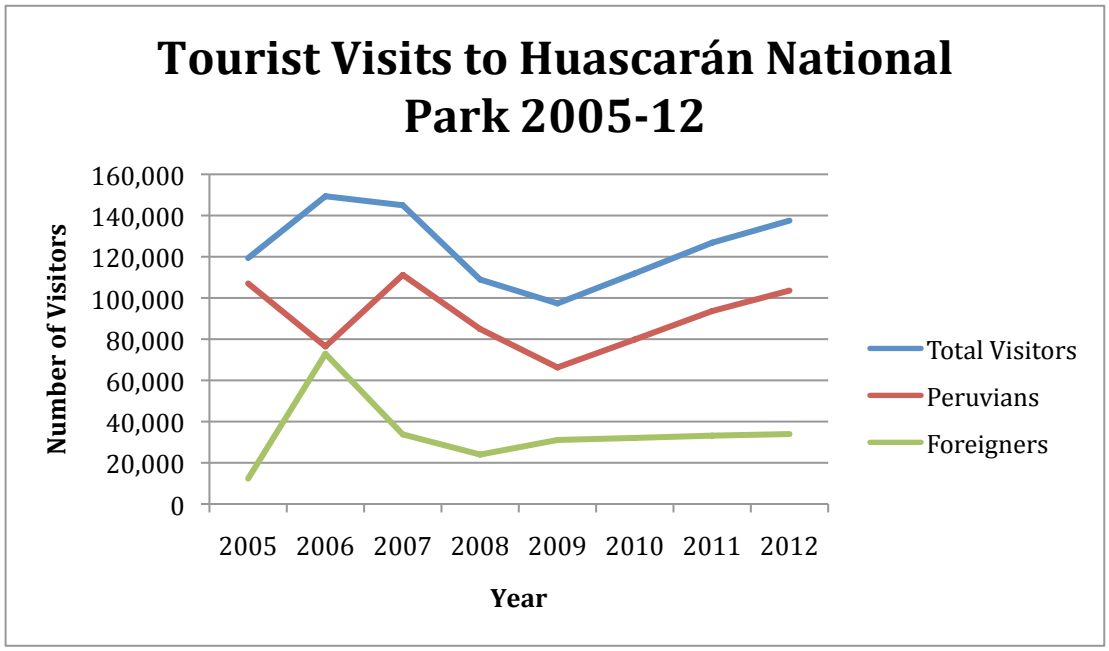

Figure 3.3: Tourist visits to Huascarán National Park (2005-12). Both the domestic and international tourism sectors show significant inter-annual variability. The significant decline in 2008-09 in the domestic sector was attributed largely to the closure of the Pastoruri Glacier, which traditionally draws large numbers of Peruvian schoolchildren. The decline in the international sector over the same period was attributed to the global financial crisis.

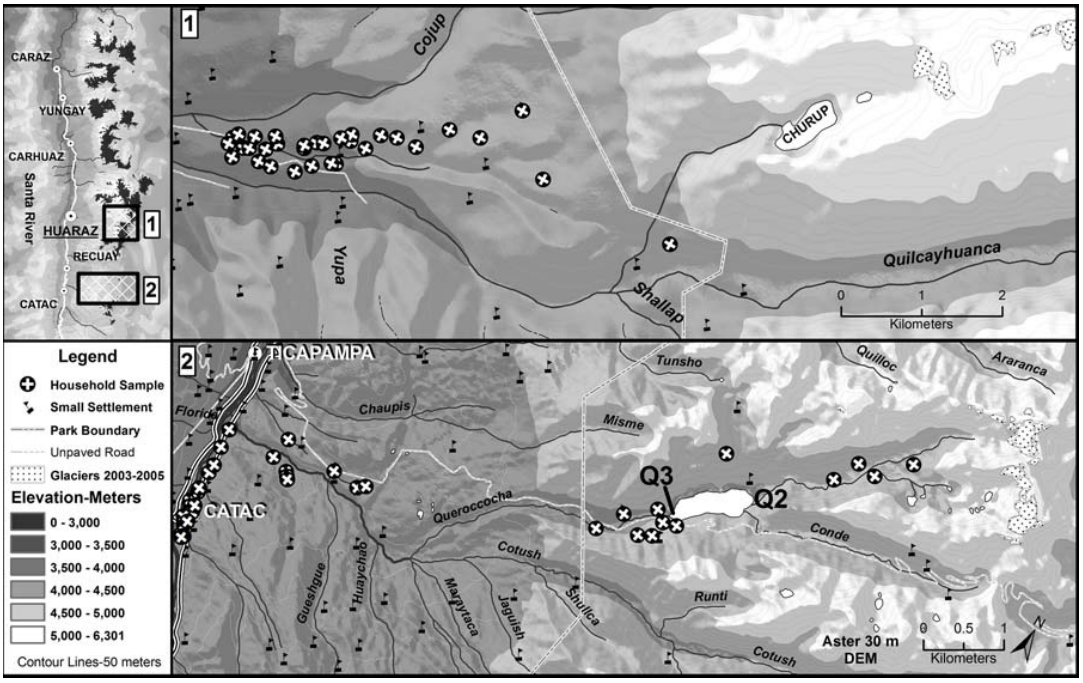

Figure 3.4: Overview of the location of the Llupa (1) and Yanamarey/Catac (2) case study populations. Source: Jeffrey Bury.

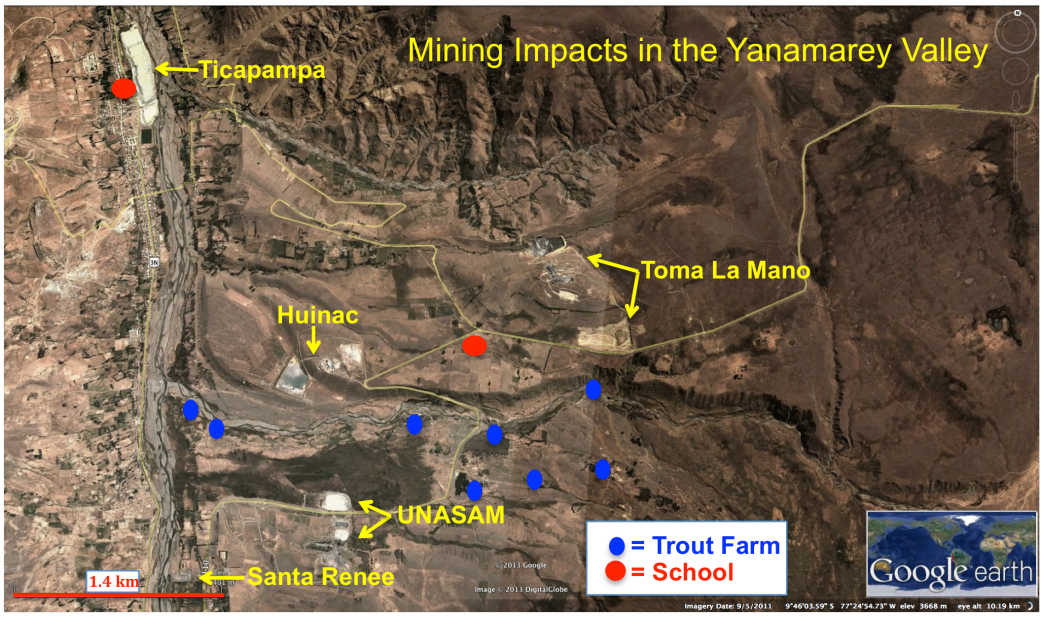

Figure 3.5: Abandoned mine tailings (Ticapampa) and active ore processing plants (Toma La Mano, Huinac, UNASAM/Mesapata, and Santa Renee) in the lower Yanamarey Valley and vicinity. Source: Google Earth.

Income Source	*Catac (n=38)*	*Llupa (n=25)*	*Pearson Chi Square Asymp. Sig. (2-sided)*
Crop Sales	4 (11%)	18 (72%)	0.001
Animal Sales	23 (61%)	3 (12%)	0.001
Business Venture	17 (45%)	2 (8%)	0.002
Contract Labor	14 (37%)	12 (48%)	0.379
Handicraft Sales	5 (13%)	1 (4%)	0.226
Dairy Product Sales	8 (21%)	3 (12%)	0.354
Tourism	9 (25%)	8 (27%)	0.877

Table 3.1: Surveyed households in Catac and Llupa (n=63) report significant differences in their principal income-generating economic activities. The results presented in the first two rows in particular emphasize the obvious importance of environmental constraints in determining the productivity of land-based livelihood pursuits. Catac, which is located at an elevation too high to cultivate most crops, focuses to a large degree on animal husbandry, while Llupa, which is located at a suitable elevation for the production of many food crops while lacking extensive highland pasturage, focuses on the sale of agricultural crops.

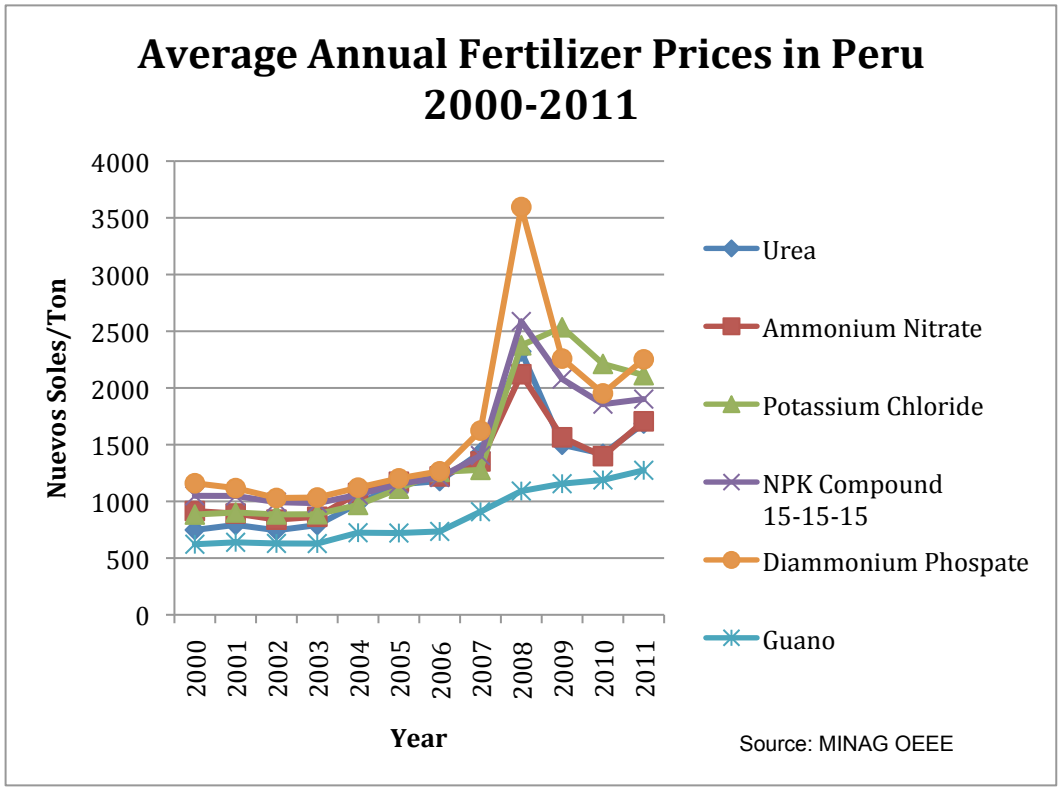

Figure 3.6: Global fertilizer prices reached all time highs in mid-2008.