CRITICAL META-ANALYSIS OF COMMUNITY WATER MANAGEMENT OUTCOMES
IN PERU: IDENTIFYING CAUSES OF SCARCITY AND THE EFFECTS OF
ADAPTATION

A thesis submitted to
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Fulfillment of the requirements for the
Degree of Master of Arts

by

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# Table of contents

Table of contents......................................................................................................................................... iii

List of Figures.................................................................................................................................................. vii

List of Tables.................................................................................................................................................. viii

Acknowledgements ......................................................................................................................................... ix

Introduction .................................................................................................................................................... 1

Definitions ....................................................................................................................................................... 4

  Water Management..................................................................................................................................... 5

  Water Governance ...................................................................................................................................... 7

  Water Scarcity and Water Security ............................................................................................................. 8

Community ...................................................................................................................................................... 13

Modernization ................................................................................................................................................. 15

Background ..................................................................................................................................................... 18

  Understanding Andean Communities: Identities, Struggles and History ................................................. 18

  Andean Identity, Tradition, and Belief Systems .......................................................................................... 21

  Pre and Post-Colonial Histories in Andean Communities ......................................................................... 25

  Peruvian Water Law .................................................................................................................................... 27

  Political Boundaries and Scale .................................................................................................................... 30

  State-Imposed Water Management Hierarchy ............................................................................................. 31

Climate ......................................................................................................................................................... 33

  Climate ...................................................................................................................................................... 33
Water Availability in Peru ................................................................. 33
Anthropogenic Water Use ............................................................... 35
Significance of Climate on Agricultural and Irrigation Practices ............. 36
Water Availability and Climate Change ........................................... 38
Climatic Variation in Peru ............................................................... 41
Climatic Zones of Peru Represented in this Study: Rationale for Inclusion of La Costa and La Sierra Zones and Exclusion of La Selva............. 42
Natural Scarcity in La Costa and La Sierra ........................................ 43
Incorporating Köppen Climate Classification ..................................... 43
Köppen Zones in Peru ..................................................................... 46

Literature Review ............................................................................. 54
Overview ......................................................................................... 54
Existing Literature .......................................................................... 57
Trends in Urban Water Management Studies in Peru ......................... 61
Limitations in Urban Water Management Studies ............................... 62
Trends in Rural Water Management Studies in Peru ......................... 63
Limitations of Water Management Studies in Peru ............................ 65
Justifications for Study ................................................................... 66
Motivation for Study ....................................................................... 67

Methodology .................................................................................. 71
Outline ............................................................................................ 71
Chosen methods: ............................................................................ 72
Geographic Area and Climate .......................................................... 78
<table>
<thead>
<tr>
<th>Summary/Analysis</th>
<th>Title/Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Paerregaard, 2013: Cabanaconde</td>
<td>128</td>
</tr>
<tr>
<td>2</td>
<td>Paerregaard, 2013: Cabanaconde</td>
<td>131</td>
</tr>
<tr>
<td>3</td>
<td>Swiech, Ersten and Pererya, 2012: Yarabamba</td>
<td>134</td>
</tr>
<tr>
<td>3</td>
<td>Swiech, Ersten and Pererya, 2012: Yarabamba</td>
<td>136</td>
</tr>
<tr>
<td>4</td>
<td>Vos and Vincent, 2011: Chancay-Lambayeque</td>
<td>138</td>
</tr>
<tr>
<td>4</td>
<td>Vos and Vincent, 2011: Chancay-Lambayeque</td>
<td>143</td>
</tr>
<tr>
<td></td>
<td>Delgado and Vincent, 2013: Corporaque</td>
<td>146</td>
</tr>
<tr>
<td>5</td>
<td>Delgado and Vincent, 2013: Corporaque</td>
<td>151</td>
</tr>
<tr>
<td>6</td>
<td>Trawick, 2001: Huaynacotas</td>
<td>154</td>
</tr>
<tr>
<td>6</td>
<td>Trawick, 2001: Huaynacotas</td>
<td>158</td>
</tr>
<tr>
<td>Discussion</td>
<td></td>
<td>160</td>
</tr>
<tr>
<td>Outline</td>
<td></td>
<td>160</td>
</tr>
<tr>
<td>Social Equity to Water Access Results</td>
<td></td>
<td>162</td>
</tr>
<tr>
<td>Equity and Inclusion in the Decision-Making Process Results</td>
<td></td>
<td>164</td>
</tr>
<tr>
<td>Environmental Outcomes Discussion</td>
<td></td>
<td>172</td>
</tr>
<tr>
<td>How Much Fluvial Modification is Too Much?</td>
<td></td>
<td>175</td>
</tr>
<tr>
<td>Hybrid Community Trends</td>
<td></td>
<td>175</td>
</tr>
<tr>
<td>Further Observations</td>
<td></td>
<td>176</td>
</tr>
<tr>
<td>Critical Meta-Analysis Summary</td>
<td></td>
<td>179</td>
</tr>
<tr>
<td>Future Implications</td>
<td></td>
<td>183</td>
</tr>
<tr>
<td>Conclusion</td>
<td></td>
<td>186</td>
</tr>
<tr>
<td>Works Cited</td>
<td></td>
<td>197</td>
</tr>
</tbody>
</table>
List of Figures

Figure 1 ................................................................................................................................. 40
Figure 2 ................................................................................................................................. 40
Figure 3 ................................................................................................................................ 48
List of Tables

Table 1 ................................................................................................................................. 161
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Introduction

Peru has a long history of hydraulic innovation allowing for human settlement even in extremely water scarce environments. Some water management systems have had more positive outcomes and some more negative- the same can be said of the water management systems operating within the country today. Communities in the arid regions of Peru have always had to make a conscious effort to adapt lifestyles to local climatic and ecological constraints and to adjust the use, procurement, storage, and dispersal of water accordingly. No system has been perfect, all have had various biogeomorphological effects on local ecology and the potential for exclusion of certain individuals from anthropogenically controlled water resources and the decision processes relating to access and control. Waves of and colonization have influenced certain water governance and management practices, and these effects have heterogeneous effects on each water management system in Peru. At present, climate change, population migrations, and demographic change continue to shape the ways in which various decision makers and institutions attempt to adapt water management systems within the country. Some communities maintain more traditional practices, some have adopted fully technocratic systems, and others remain a hybrid of the two. Though the recent modernization efforts are poised to divert water from more seasonally water abundant areas to more water scarce, economically productive, and urban areas, these technological advances have not been able to create water management systems that are any more socially or environmentally just than other systems throughout history.
Within the arid regions of Peru, some struggles related to water management within the region have been universal throughout time, namely struggles related to adapting to natural causes of water scarcity and seasonal aridity. Other struggles related to water management throughout time have been created entirely by humans, especially pertaining to particular decisions and practices relating to water governance, management, access, and control. This thesis is engaged with concerns related to natural water scarcity as well as human-produced scarcity. While natural scarcity requires biological adaptation, there is nothing that can be done to prevent the occurrence of climatic phenomena. On the other hand, human produced scarcity can be ameliorated, and in certain cases, prevented. As quoted by Barbara Lynch Deutsch, “people are vulnerable to outcomes rather than hazards: the root causes have more to do with social structure than natural processes or events” (Lynch, 2012; Suarez, Ribot, & Platt, 2009; Ribot & Peluso, 2003; Ribot, 2009; Mearns & Norton, 2010). Working with this notion, this thesis is engaged with identifying and discussing causes of both naturally occurring and human-induced scarcity. In order to create a comprehensive analysis, this work includes a critical meta-analysis of water management systems in the arid regions of Peru. Studies for the analysis were chosen regarding the amount of information presented regarding a holistic set of social and environmental variables that may pertain to outcome. Outcome, in this case, is three-fold, relating to access to water resources at the community level, equity and inclusion in the decision making process, and the ecological consequences of the system. In order to be comprehensive, this work only analyzed community level studies, as outcomes can vary greatly between, and even within this scale. As there has yet been a comprehensive study analyzing
social and environmental variables pertaining to community level outcomes throughout the arid regions of Peru, this thesis seeks to explore these relationships in order to produce a better understanding of what struggles related to water scarcity can be mitigated. Centrally, this thesis asks, in the arid and semi-arid regions of Peru, how do the combination of social and environmental variables at the community level affect water management outcomes as they relate to social equity, environmental wellness, and long-term sustainability.
Definitions

It is essential to define and explain certain concepts related to the diction frequently used in water management literature, specifically in Peru, to provide an understanding of the conceptualizations within this work. There is a vast array of literature written on these subjects, each offering unique descriptions and explanations for certain terms, some concrete and others more abstract. In this chapter, certain concepts commonly used in water management studies will be defined. This chapter will also provide a nuanced conceptualization of certain terms, some of which differ from the existing literature. This chapter provides definitions for water management, water governance, water security and insecurity, modernization, and community, and will offer a new conceptualization of ‘water scarcity’.

The existing definitions of these terms are often suitable for the literature they are used to support, however not all of them are inclusive or critical enough to fit the purposes of this work. The new conceptualizations provided here are meant to fit the purpose of this research, but I offer that they may also benefit future water management research as well. In this meta-analytical study, the multiple case studies used involve many heterogeneous geographies and community structures. As such, certain definitions must be made more malleable to include all facets of the intricate nature of water management at the community level in Peru. In addition to broadening certain terms for the goal of inclusivity, there are several dictions common in water management literature that I find to be either counterproductive or limiting to the discipline including typical connotations of “water scarcity”. It is for these terms that I
offer more critical and comprehensive definitions, both for the purposes of this study and for water management studies as a whole. Primarily, it must be stated that within this work, no definition should be seen as concrete. As different phenomena represent multiple things to different people throughout space and time, all conceptualizations should be viewed as both relative and malleable. The definitions offered herein serve the purpose of providing an understanding to how this study conceives of the following concepts and phenomena which should serve to provide a better understanding of how certain themes were related to within this work.

*Water Management*

In order to create a meta-analytical study of water management systems in Peru, it was first necessary to create a basic definition of water management. Not all communities require or utilize an anthropogenically-contrived form of water management. For example, nomadic communities migrate with the shifting availability of fluctuating resources necessary for survival, including water. This lifestyle is arguably linked with sustainable species survival\(^1\). Biologically, the survival of many different species depends upon migratory patterns and habitat adaptability, and the same was true for early and some contemporary communities (Verzijl & Quispe, 2013; Thomson, 1939; Warren, 1995). As water resources are prone to great fluctuations in availability

\(^1\) Nomadic anthropogenic movements are often viewed as a sustainable adaptation to fluctuating resource availability (Steinmann, 1998). This type of lifestyle is arguably more finely tuned to natural ecological changes; perhaps minimizing anthropogenically-induced biogeomorphic impacts on local ecologies in comparison to settled communities.
(and quality), a spatially fixed community requires some type of water management to ensure that in times of naturally occurring fluctuations in availability or quality, enough water can be provided to maintain the endurance and survival of the community at some level of reproduction. Members of a spatially fixed communities are dependent (and thus vulnerable to) a method of provision. This being stated, water management occurs within spatially fixed, though dynamic, communities and involves the decision making process of different actors to create a framework for water provision.

The actors involved in water management decision making processes vary by place and type of governance, and can include (but are not limited to) decision making by some sort of governing body, open groups of community members, selected community leaders, actors from agricultural and or industrial sectors, actors from privatized water resource corporations, non-governmental organizations (etc.) or some sort of combination (Sultana & Loftus, 2012). Within a spatially fixed area, the type of water management is not fixed and will often change over time. Decisions in water management created by the governing actors most basically involve a framework regarding how water resources are to be provided for and/or procured by recognized members within the jurisdiction of the spatially fixed community. Water management often extends to also involve methods of how water and wastewater may be treated for quality purposes, infrastructure technology, and formal (or informal) legislation and administration (Zarkadoulas, Koutsoyiannis, Mamassis, & Angelakis, 2012). The actual methods of how water is secured and delivered vary widely and are prone to frequent changes, as the needs of populations, ecosystems, and the water systems themselves are not constant. As such, no concrete definition of water management can or should be
created, but the basic components lending to a water management system have been
outlined.

Water Governance

As the purpose of this study is to provide insights between the intricacies of how
water is managed at the community level and outcome relating to social equity,
environmental wellness, and the sustainability between these relationships, water
governance is an essential part of the discussion. Karsten Paerregaard, author of one of
the six main case studies in this thesis, defines water governance as “the bureaucratic
management of the water infrastructure and the social control of water within an
irrigation system” (Paerregaard, 2013). Though in the case of Peru, where all water is
legally controlled by the state, the remoteness of certain communities consigns that
local water governance is not always top-down and bureaucratic and can even be
regarded, outside of legal terminology, as autonomous (Trawick, 2001a; Trawick;
2001b). Though water governance in Peru does not always involve irrigation, nor is it
always hegemonic, as one of the case studies analyzed in this work will exemplify, this
thesis acknowledges that water governance does relate to the management of present
infrastructure and control of water resources. Tom Perrault, an academic specializing in
Andean water management studies in Bolivia states that, “water governance, in short,
should not be understood as a monolithic or homogenous set of policies and practices
as competing institutional arrangements and values… may coexist or compete”
(Perrault, 2005, p. 55). Indeed, the conceptualizations of how water should be
governed do differ in space or time and often, competing ideals can exist within the
same community, as certain case studies used in the analysis (Swiech, Ersten, & Pererya, 2012; Paerregaard, 2013; Delgado & Vincent, 2013; Boelens & Gelles, 2005) and in the larger body of literature (Verzijl & Quispe, 2013; Crawford & Bell, 2012; Hogue & Rau, 2008) on the subject highlight. When competing water governance and management ideals exist, either a hybridized governance system is agreed upon, or else informally recognized governance exists, peacefully or otherwise, alongside formal bureaucratic institutions. For an inclusive understanding of water governance that fits the needs of this study, the conceptualization of water governance within this work will utilize a mixture of these two definitions. As such, water governance relates to the control and management of water within a community, recognizing that different governance structures, ideals, and policies may exist within a single community (Paerregaard, 2013; Perreault, 2005).

**Water Scarcity and Water Security**

The UNDP Human Development Report of 2006 defines water scarcity as “both a natural and a human-made phenomenon. There is enough freshwater on the planet for seven billion people but it is distributed unevenly and too much of it is wasted, polluted and unsustainable managed” (Human Development Report 2006, 2007). This definition acknowledges both the human and natural components that can lead to water scarcity, but also seems to suggest that a main issue in water scarcity is that the resources themselves are too scattered, rather than suggesting where humans have
decided to settle permanently is too scattered\(^2\). This diction perhaps suggests that control over nature is a solution rather than suggesting human adapting to nature as a solution. As there are two recognized causes of water insecurity, natural and human induced, it would be beneficial to have two definitions of water scarcity.

This work seeks to redefine the typical notion of water scarcity. Throughout this work, two distinct types of water scarcity will be identified: natural water scarcity and human-induced water scarcity. It was determined to use these two terms to reference different sources of water scarcity as it was found that there is a distinct disparity between causes of water insecurity. Water scarcity, seemingly referring to a lack of availability toward a particular quantity of water, is too vague a term on its own. The

\(^2\) There is a large human component to the term water scarcity. For example, deserts aren’t necessarily water scarce. However, if humans create permanent settlements in a desert, they might refer to it as a water scarce location. Plants and animals are generally adapted to the ecosystems they inhabit. If a plant or animal is introduced to a foreign ecosystem, that plant or animal will have the option to adapt to local conditions or to perish. It is not a factor of the ecosystem not being hospitable for or adaptable to the organism, but of the organism not being suitable or naturally adaptable to the ecosystem. This definition for water scarcity by the UNDP seems to suggest that certain natural environments or ecosystems are not adapted to human settlements, imposing the false logic that each environment should be suitable for human settlement and also assuming that humanity can trump nature when this is not the case. This thesis is working with the notion that not all ecosystems are compatible for human settlement, nor are all types of human settlements suitable for certain ecosystems. This is not a fault of nature, but largely a fault of man’s ideal to control the natural world when it does not naturally suit certain desires of humanity, for which this work argues is largely not desirable for the fate of humans or for nature. Humanity is dependent on and part of the ecosystems we inhabit.
terms natural water scarcity and human induced water scarcity serve the purpose to 1. Broadly identify the apparent source of water insecurity (in a particular region or community) 2. Distinguish anthropogenic and environmental contributions leading to water insecurity and 3. Create a term (natural water scarcity) that unites each study in the analysis (as each community analyzed experiences permanent or periodic aridity).

As is true of anywhere in the world, water availability in Peru is contingent on oscillations of climatic processes. There are many naturally occurring fluctuations that affect water availability in Peru including regional warming trends, seasonal variability in temperature and precipitation, rapid glacial melt and the El Niño phenomenon, among others. While some of these processes are abated or enhanced in terms of scale or frequency by anthropogenically-induced agents of climatic change, these events are not solely caused by, nor can any individual climatic event be abated by, human ends. As such, water scarcity that occurs primarily due to these (naturally-occurring) events will be defined within this work as natural water scarcity.

There is a vast amount of literature that provides new insights to the notion of water scarcity and others that critique the limited nature of the typical definition. In “A Simple Approach to Assess Water Scarcity Integrating Water Quantity and Quality” by Zeng, Junguo and Hubert, the authors address the fact that typical water scarcity assessments are too reliant on measures of a specific quality, forgoing the equally important issue of water quality. Additionally, the authors’ stress that water scarcity is something that can be anthropogenically mitigated, adding a more comprehensive component related to the origin of water scarcity (Zeng, Junguo, & Hubert, 2013). A separate definition of water scarcity that relates to issues of the available amounts of
water quantity for ecological purposes can be seen in the article “Global Monthly Water Scarcity: Blue Water Footprints vs. Blue Water Availability” by Hoekstra et al., 2012. In this article, water scarcity relates to the “flows needed to sustain critical ecological functions” in terms of water quantity on a monthly basis (Hoekstra, Mekonnen, Chapagain, Mathews, & Richter, 2012). This definition differs from the UN definition of water scarcity in that it places major emphasis on the impacts of water variability on the environment and ecological processes. Whereas, it seems, most definitions of water scarcity relative to quantity focus on human water needs, this definition\(^3\) inserts the more comprehensive notion of ecology. Additionally, the article goes on to discuss outcomes of water scarcity related to biodiversity loss as well as negative economic effects in the anthropogenic social sphere (Hoekstra, Mekonnen, Chapagain, Mathews, & Richter, 2012). The article continues by addressing the recent metrics that have been created to better quantify and understand global water availability with global water needs as they relate to “food, poverty and human development, economics and business prospects, and ecological health” (Hoekstra, Mekonnen, Chapagain, Mathews, & Richter, 2012). While this definition is more comprehensive than that provided by the UN (as it touches on both ecological impacts and anthropogenic prospects and consequences to changes in water availability), the conceptualization of water scarcity in this thesis relates to social wellness within ecological wellness. Instead of focusing on

\(^3\) This work recognizes that humans are a part of, and not separate from, ecology. Whether the definition by Hoekstra et. al. intended this definition to include all species, including humans, is unknown. As this thesis is focused on the ecological “web”, including humans as a part of ecology, this definition by Hoekstra et. al. is much more comprehensive than those definitions solely focused on human needs.
quantitative metrics, the idea of water scarcity in this work also relates to the concept of adaptation. Society must adapt to environmental changes just as ecosystems must adapt. The ability to persist (both as an individual species as well as an ecosystem web) has less to do with a particular quantity of water as it does to the ability to adapt to changes in the natural availability of water. More often than not (especially in the anthropogenic sphere) when more water is available, more water will be used. Therefore, the notion of a particular quantity of water is negligible in the definition of water scarcity as it relates to anthropogenic as well as ecological concerns.

In agreement with Barbara Deutsch Lynch, who states, “I argue that for Andean water users vulnerability in the face of climate change is not a simple function of water scarcity, poverty or a lack of entitlements. It can be produced by a water regime that favors some users and uses over others or heightens competition by encouraging new demands.” (Lynch, 2012, p. 364), I also argue that water scarcity should be understood in a broader context so that the causes are more easily identifiable. Distinguishing two types of water scarcity, natural water scarcity and human-induced water scarcity, allows for a more comprehensive understanding of the particular causes of water scarcity and insecurity in a particular community. By relating to the cause of scarcity, rather than focusing on a particular quantity, the definitions can operate at any scale. If the cause of community-level scarcity is determined to be human induced, it will be easier to identify what changes need to occur at the anthropogenic level in order to produce better social and environmental outcomes related to water management. If the cause of community-level scarcity is determined to be natural, it can be decided that anthropogenic actions
(outside ecological control) should be explored to minimize environmental consequences while pursuing social wellness.

Community

Though this work involves water management studies at different scales throughout la costa and la sierra regions of Peru, the analysis of this work is primarily focused on community-level studies. The analysis incorporates multiple variables directly or indirectly related to the outcome of water management at the community level. None of the variables themselves are viewed as binary or deterministic of a particular outcome; instead this study works with the notion that the unique combinations of variables in a particular community are together what lead to the production of a particular outcome. While studies beyond the community scale offer important insight, they are often limited in their description and analysis of the effects of social cohesion, participation, stratification, marginalization, and efficacy as they relate to particular individuals or groups within the study. Without this type of information, it is difficult to comprehend the intricacies of what social variables may contribute to the outcomes of water management as they relate to social equity, resource access, and inclusion. As an article by Catherine Crawford and Sarah Bell demonstrates, outcomes of water management within the city of Cusco vary greatly once broken down to community level

4 It is also for this reason that it was determined to not include studies from Lima in the formal analysis. None were composed entirely on the community or neighborhood level while also focusing equally on social and environmental variables determined necessary to meet the inclusion criteria for this work.
analysis (Crawford & Bell, 2012). This example demonstrates that studies at the community scale are better suited to creating a more comprehensive understanding of how different social parameters at smaller scales can create vast differences in water management outcomes. In the study by Crawford and Bell, each of the three communities within the city limits of Cusco had the same set of geographic, climatic, and hegemonic management variables, but the slight variations in community-level social variables were enough to generate very different water management outcomes.

As the articles that met the inclusion criteria for analysis are all community-level studies, many of the authors provide insight as to the benefits of studies at this scale. Swiech et al. offers that top-level governance institutions are often unaware of particular issues at the community level, arguing that the hierarchical disinterest results from the values associated with limited economic capacity of such communities (Swiech, Ersten, & Pererya, 2012). Similarly, Jeroen Vos and Linden Vincent argue that studies should be location-specific, as one can only understand an outcome of a specific water management system as it relates to intricate details at the community scale including variables such as local water users, conceptualizations of water rights, climate, agriculture, water supply and demand, financial structure, and the skills of the water managers (Vos & Vincent, 2011). These authors provide strong arguments for conducting water management studies at the community scale.

How, then, are we to conceive of the term ‘community’? Andres Verzijl and Silvano Guerrero Quispe define community as “a group of people linked to a land unit whose territorial boundaries are locally recognized and contested” (Verzijl & Quispe, 2013, p. 282). While this definition does not provide terminology related to a particular
scale, a community cannot be confined to the boundaries of a particular scale, either. A community can exist at any scale, so long as its members recognize it to be so. Though this definition is broad in nature, it remains inclusive, and will be the working definition by which my references to ‘community’ within this work will relate.

Modernization

In many areas of the world, poor resource management, demographic growth, increases in agricultural production, industrial demand and the effects of climate change all put pressure on the management of water resources, Peru is no exception. In many of the case studies read for this analysis, the term ‘modernization’ is used to relate to how different governments or organizations⁵ are attempting to improve their water management systems in order to cope with these concerns. On the subject of modernity in Peru, Astrid Bredholt Stensrud declares, “The idea of modernity is deeply embedded in the neoliberal project of creating a free market and in the ideal of progress, and from the government's point of view, the rural indigenous peoples in the Andes should be included in this modernity as a way out of "backwardness" and as a solution to poverty. One way of doing this is to change the campesinos' water practices and introduce new technologies for efficient irrigation” (Stensrud, 2013, p. 32). As the articles in the analysis of this work will demonstrate, many modernization efforts in Andean communities do attempt to act as solutions to “backwardness”, to create economic and

⁵ Such as the World Bank.
agricultural surplus along the coast, yet rarely consider the environmental and cultural consequences of such projects.

A paper by Swiech, Ersten, and Pererya used in this analysis states that the majority of modernization efforts in Peru, and elsewhere, are introduced in more traditional systems (Swiech, Ersten, & Pererya, 2012). What exactly is ‘modernization’? Then again, what are ‘traditional’ systems? Swiech et al. further offer that the conception of modernization itself has evolved over the last two decades. In the past, the term referred to the introduction of new structures and equipment, but now the term refers to transforming water management practices with the goals to improve utilization and service of water resources (Swiech, Ersten, & Pererya, 2012; Playán & Mateos, 2006).

Many of the articles used in the analysis did conceive of ‘modernization’ as a change to ‘traditional’ management and infrastructure from hegemonic or major institutional organizations. It is necessary to note that while the terms ‘traditional’ and ‘modernization’ are often contrasted in the literature, so called ‘traditional’ systems have been adapting their own water management systems to social, political, and environmental changes throughout time. It is a grand over-generalization to assume that an indigenous, Andean, or campesino community has maintained the same water management and governance practices throughout the entire history of their existences. While certain belief systems, rituals, and water management practices do percolate throughout time, these communities have adapted to geographical changes, to which effect, this work argues, results in their continued presence today.
The case study in the analysis with the least bureaucratic influence involves the Huaynacotas community of the Cotahuasi Valley. Even though this settlement has remained virtually autonomous, they too have adapted their water management systems throughout time, having made changes to their geographic location and water distribution techniques\(^6\) (Trawick, 2001). It is with this evidence of adaptation in all types and scales of water management systems that this work seeks to critically question the difference between ‘adaptation’ and ‘modernization’. For the purposes of this paper, any reference to ‘modernization’ will refer to the term only as it relates to the common understanding in the literature, as a top-down governmental or organizational attempt to alter existing water management systems in order to produce different outcomes, often relating to increased use of highly-technological systems for the purpose of increased agricultural yields and economic production.

\(^6\) The Huaynacotas moved their geographic location and likely also stopped using the dual-division moiety system, common in the valley, and started developing the system they use presently (Trawick P. B., 2001).
Background

Understanding Andean Communities: Identities, Struggles and History

As is true of most countries, what it means to identify as ‘Peruvian’ differs in space and time, within and across different communities, and at the individual level. The modern state was colonized by the Spanish early in the 16th century. Until the Agrarian reform of 1969, national water governance was based on the dominant methods of water management in Spain (Delgado & Vincent, 2013). National Law still largely reflects the influence and belief systems of the Spanish colonizers. In the words of Barbara Deutsch Lynch, “In large part, the product of each nation’s colonial and postcolonial history, national irrigation institutions and policies in the Andean region are tied to an international bureaucratic tradition of development” (Lynch, 1988). This colonial influence has percolated through many layers of politics, governance, social interactions, and personal identity, though the extent of these effects is not universally felt or experienced in all corners of the country. Prior to the Spanish Invasion, the Inca – hailing from modern-day Cusco, set out through the region to exert their own political and social dominance over communities throughout la costa and la sierra. Prior to the rise of the Inca as a major political power in the region, there were several distinct and important societies in the region, namely the Moche, Sicán and Chimú (Vos, 2002).

7 Once the Spanish Colonizers had set up a water management system, prioritization of water (both connections and delivery –being based on Spanish water management), was given to Europeans and any citizens wealthy enough to live in the city center (Delgado & Vincent, 2013).
In theory, Peru’s National Law ultimately holds power over all communities and citizens within the nation, however the governance of these laws varies widely at the community level. While most urban areas certainly feel the full effects of centralized Peruvian law, there are many small, rural, and not easily accessed communities that remain semi-autonomous (Trawick, 2001). While the Peruvian government ultimately can control the land and resources in these communities, many communities still create and abide by their own sets of policies and governance, largely outside of national law. Other communities have hybridized structures with elements of local and national top-down governance.

As can be expected, there are many different social structures and belief systems in communities throughout the country. Every single community in Peru is unique, different elements of these historical powers have percolated through social customs, beliefs, and governance in different ways, and waves of adaptations and migration in a globalizing world have equally had different effects on each community (Eda & Chen, 2010). As such, in the analysis portion of this work, each community is treated as unique to avoid sweeping generalizations that would undermine the heterogeneous nature of what it means to be a community within Peru. This being stated, there are some social, cultural, and political similarities between certain communities within Peru which should be stated to provide a better understanding of how certain histories or belief systems may have (or have not) contributed to the dynamic nature and operation of certain communities.

Many individuals in Peru would claim to have ‘Andean’ identity, while others would prefer to self-describe, and be described by others, as white-mestizo as
historically, this title has been associated with certain privileges (Boelens & Gelles, 2005). Those that do, or would like to self-identify as white-*mestizo*, are more highly concentrated in the urban areas of Peru, where the highest amount of post-colonial influence can be felt (Espinosa, 2009). Individuals living in the areas that have had the least amount of colonial influence -those that tend to function or have long functioned as semi-autonomous communities- are more likely to self-identify as ‘Andean’ or ‘campesino’. In an increasingly globalizing world, people and ideas are transferring between communities at an ever-increasing speed. The effects of these migrations have palpable effect on individual and community identity, policy, governance, technology, tradition and beyond. While this study recognizes each community within Peru as both unique and dynamic, this chapter serves the purpose to outline certain components of Peruvian history and identity. This information is intended to be slightly generic, and is not meant to universally describe individuals or communities. Instead,

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8 Esbinosa discusses the influence of mestizo culture in the urban areas of Peru, stating that “Mestizo-Western culture… might displace or redefine “traditional” values, knowledge, and practice” (Espinosa, 2009, p. 40)

9 These communities also tend to be the most marginalized. In reference to the Peruvian Andes, an article by Prokopy et. al declares that “this region of the country consists of the most marginalized sector of Peruvian society - Quechua-speaking peasants who live in isolated rural areas (Youngers, 2006). The majority of rural people in Peru have not been able to improve their living conditions with modernization and agrarian reform (Eguren, 2006) and Peru lags behind other counties in the provision of water and sanitation services (Tamayo, Barrantes, & Bustamante, 1999)”. (Prokopy & Thorsten, 2008).

10 For example, the Andean community of Cabanaconde, Peru, has migrant communities in Lima, Peru, as well as Washington, DC (Prokopy & Thorsten, 2008).
this information is provided to offer some insight into the heterogeneous nature of Peruvian governance and society.

Andean Identity, Tradition, and Belief Systems

There are several terms used to represent Peruvian communities and individuals that do not identify with the notion of ‘white-mestizo’. These individuals and groups may adhere to what is typically considered to be more traditional beliefs and practices, some of which date back to Inca or pre-Inca rule, and may resonate much deeper, historically, than the post-colonial ideologies that take central hold of much of the rest of the country. Such communities or individuals may self identify (or be identified by ‘others’) as campesinos\(^{11}\), indigenous, or Andean, among other terms. Generally, it seems

\(^{11}\) ‘Campesinos’ roughly translates to ‘peasant’ or agrarian. Emily Hogue and Pilar Rau state, “leading a traditional subsistence agriculture-based lifestyle is part of what legitimates the special legal status and collective land titles of campesino communities (formerly comunidades indios). The difference between indigenous customs and those of the dominant society are enshrined into law and has been the basis for neglecting to provide public services such as potable water and sewage systems to campesino communities. These legislative moves challenge the relationship of indigenous people to the environment, undermining legislation that protected the “uses and customs” of indigenous and tribal peoples in Peru. The privatization of natural resources relies on a worldview that assumes their alienability. However, many indigenous societies regard such natural phenomena as a type of commons, and “inalienable,” sacred, and/or as entities endowed with a subjectivity of their own, and do not necessarily objectify them in ways compatible with their commodification (Gose, 1986) (Munn, 1970) (Myers, 2000) (Nash, 1979) (Partridge & Uquillas, 1996) (Taussig, 1980). The “environment” in this sense is socially produced (Myers, 2000)(Turner, 1980) (Trawick P., 2001) (Hogue & Rau, 2008) (Ioris, 2012).
individuals and communities that fit this construct prefer the term campesino to indigenous, likely to avoid notions of backwardness and racism\textsuperscript{12\textsuperscript{13}} (Hogue & Rau, 2008; Prokopy & Thorsten, 2008). All three terms will be used throughout this work, and it is important to state that while one community or individual may self identify with one of these terms, an outsider, or ‘other’, may identify that same community group or individual by another of these terms. The term ‘indigenous’ is the most politically charged of the three, both in Academia as well as within Peruvian politics. The term ‘campesino’ is often used as a sort of euphemism for ‘indigenous’ as Peru’s Andean community does not have a unified and politically active indigenous group in the political sphere, as Bolivia and Ecuador do. (Ioris, 2012; Trawick, 2005). Within this chapter, the term ‘Andean’ will be most frequently used to represent this identity, noting that this

\textsuperscript{12} According to Hogue and Rau, “Structural adjustments further isolated and impoverished the more vulnerable segments of the population: rural agrarians, rural-urban migrants, and the indigenous, and Afro-Descendant peoples” (Martínez, 2005) (Gonzales, 2000) (Loker, 1999) (Fernández Poncela, 1996) (Birdsall & Londoño, 1997) (Hogue & Rau, 2008) As certain policies exclude groups of people in Peru, including indigenous, it is apparent why other terms are frequently preferred.

\textsuperscript{13} Indigenous or Andean communities have justified reasons for wishing to be portrayed in a certain way as it can have a great impact on their outcome. Prokopy et. al. state that “Racism is still very prevalent in Peru and it has been argued that there is a perception that poverty and political inequalities are inevitable and even desirable (Drinot, 2006). This is evident in the rural Andes where there are two classes of people, as Trawick (2003) documents based upon extensive ethnographic work. Trawick observed that low-ranked people have to press harder to get their fair share of irrigation water while high-ranked people automatically get their share. In this setting it is particularly important to explore how participation occurs.” (Prokopy & Thorsten, 2008) (page 1165) (Drinot, 2006)(Trawick, 2003).
term is not universally used, and its definition holds different meaning to separate communities and individuals that either use or choose to be represented by this term.

Though each community is unique, communities within Peru that identify as Andean do share, to a certain extent, certain similarities in history, beliefs, governance, resource management (including water), and traditions, though what is described here is not intended to be a universal representation of all Andean communities within Peru.

One of the most special characteristics of Andean communities is the relationship between community members and the environment. Whereas much of the world has come to view the earth and its components with a sense of ownership; viewing resources as commodifiable goods for capitalistic pursuits, in an Andean context, the earth and it’s resources are viewed in a much more reciprocal manner. This is much more than a worldview, it percolates through every layer of community life. Andeans “believe their relationship with the natural world, primarily in the forms of land, water, plant and animal life, is essential to their spiritual, social, and economic well-being” (Hogue & Rau, 2008). It is clear that the Andean worldview greatly contrasts with the capitalist-oriented views present with Peruvian national law which is heavily influenced by colonizers, and when Andean communities cannot operate in an autonomous or semi-autonomous manner, the clash in ideologies initiates the potential to create a great rift between Andean and non-Andean ideologies with respect to natural resource commodification, amongst other concerns.

Well illustrating this worldview is a quote from Emily Hogue and Pilar Rau from their article “Troubled Water: Ethnodevelopment, Natural Resource Commodification, and Neoliberalism in Andean Peru”
This view of people’s fundamentally social and reciprocal relationship with natural phenomena, which are seen as subjects, contrasts sharply with the notion that they are objects that can be commodified. For example, many Andean peoples regard the mineral fruits of mines as living things growing inside of and belonging to a mountain, a living, volitional being (Abercrombie, 1998; Nash, 1979; Taussig, 1980). In exchange for the privilege of extracting inalienable parts of the “devils” of the mines, indigenous miners engage in sacrifices and exchanges to placate and recompense them. Such rituals also ensure the safety of the miners whose lives can be taken by the mountains as compensation… this conception of the activity of mining differs enormously from the capitalist logic of natural resource extraction, both logics have nevertheless conflictually coexisted in the Andean mining industry since Andeans were first forced to extract resources in ways they found culturally unacceptable (Hogue & Rau, 2008, pp. 291-292).

It can be said that Andeans do not view elements of the natural world as static, but rather as sentient beings to be respected, cherished, and even feared. For example, the Andes are much more than a mountain range to the Andean community. The mountain’s glaciers provide water, revered as lifeblood of sorts, the interior of the mountains provide minerals useful for creating certain goods within the community. In exchange for utilizing the fruits of the mountains, Andean people often provide offerings or sacrifices in thanks for the mountain’s generous provision (Hogue & Rau, 2008).
There are a number of rituals found in many Andean communities that are viewed as essential to community life. One of these rituals is *Yarqa Aspiy*, the annual water festival in which the entire community (not just the water distributor, emphasizing the importance of shared responsibilities in Andean communities) celebrates the cleaning of the irrigation canals (Trawick, 2001).

The nature of reciprocity between Andean communities and the earth for providing materials necessary for community life seems to trickle down to the community level as well, as many community interactions and governance systems seem to be based on the principles of equitable division (Boelens & Gelles, 2005). In regards to water management, Paul Trawick states that many Andean communities view “equity in water sharing as the moral foundation for village life” (Trawick, 2001). Though different Andean communities throughout Peru each have unique water management and governance systems, Anthropologist Paul Trawick believes the water management and governance systems of all Andean communities evolved from a distinctly Incan\(^\text{14}\) tradition which has shaped the evolution of water management and has governed water resource views in many Andean communities.

*Pre and Post-Colonial Histories in Andean Communities*

Though there were several cultural hearths in the Andean region, including the Moche, Chimú and the Sicán, the most well known civilization is perhaps the Inca. Originating in the Cusco region, the Inca came to dominate many of the Andean communities.

\(^{14}\) While other experts offer that the origins are in fact, pre-Incan (Boelens & Gelles, 2005).
communities throughout what is recognized today as Peru. In some communities, the Inca built on existing local water management and governance traditions (Boelens & Gelles, 2005), yet many ethnologists declare the practices that have evolved within Andean communities as a distinctively Incan tradition (Trawick, 2001). Trawick states that despite all the influences of colonization and peripheral modernization, many Andean communities continue to manage water in a distinctive, locally-derived tradition focused on principles of equity and social organization in managing the often scarce and highly fluctuating water resources in the region (Trawick, 2001). In a country with a recognized national water law, to retain locally-derived resource management and community governance structures means that such communities have retained or regained semi-autonomous governance, likely due to being located in remote, difficultly accessed areas whose water resources have yet to be diverted or tangibly claimed by Peruvian top-down governance. This is not to say all semi-autonomous Andean communities have the same water or community governance structures, as each has evolved and adapted independently due to peripheral influences (including cultural, political, and environmental stimuli), rather it is suggested that the Andean communities that continue to operate semi-autonomously have retained a certain independence, for the meantime, from Peruvian water law, and the relative levels of autonomy indeed have a great impact on how water is managed at the community level. As such, these clearly distinctive water management systems in Andean communities are noticeably different from Peruvian communities whose water-management systems are completely influenced and managed by the national top-down water management systems. This thesis is engaged with how these different governance styles relate to outcome.
Peruvian Water Law

Many communities throughout la costa and la sierra regions of the Western side of South America share similar climate zones, geographies, elements of pre and post-colonial histories, and currents of Andean identity (though Andean Identity is felt more strongly in some communities than others). Many communities throughout these regions also share similar historical trends of water management, some of which continue to operate in a similar manner today. Though this study could feasibly seek to include communities throughout these regions (including Ecuador, Bolivia, Peru, and Chile) and produce very interesting results, it was determined to include only studies within Peru in the analysis\textsuperscript{15}.

While there are communities throughout these regions with distinct similarities, political boundaries have a great effect on the national water law of these countries that trickle down to influence community-level water management. In addition to the differences in National Water law between these countries, there are other factors that differentiate how community-level water management may operate differently between these countries. Authors Emily J. Hogue and Pilar Rau discuss the importance of dialectics of ethnic identity in the political mobilization of Andean communities. According to the authors, very few Andean communities within Peru have decisively utilized their unique ethnic identities as a means for political advocacy (Hogue & Rau, 2008). Within Peru, it seems, the term “indigenous” holds a negative stigma of separation from what is considered ‘normative’ in Peruvian society, and thus Andean or

\textsuperscript{15} See chapter on Methodology and Inclusion criteria for more information on this decision.
campesino communities in Peru tend to avoid using claims of indigenous identity to self-advocate in politics beyond the community level. This differs greatly from Andean communities in Ecuador and Bolivia who seem to use the term “indigenous” to intentionally separate themselves from ‘normative’ white-mestizo society (Hogue & Rau, 2008). The differences in dialectics prove to work in the favor of Andean communities in the later two countries wherein indigenous movements have had a good amount of successful political mobilization.

As there seems to be a vast difference between the political identity of Andean communities in Peru than in the other countries within the region as well as the differences in national water law between each country, it was decided to use only communities within Peru in the analysis. Many of the case studies used within the analysis relate to the water management activities of self-identified campesino communities and it is important to understand their (similarly, but not universally) shared history of self-identity and dialectics involved in attempts for self-advocacy and political mobility.

Peru has a unique history of water management and national water law distinctive from other countries within the region. The current national water law in Peru is deeply rooted in post-colonialism. Until the Agrarian reform of 1969, national water governance was based on the dominant methods of water management in Spain (Delgado & Vincent, 2013). Prioritization of water (both connections and delivery) was given to Europeans and any citizens wealthy enough to live in the city center (Ioris,
This history of prioritization to white, white-\textit{mestizo}, or otherwise wealthy individuals has permeated through subsequent water management reforms. At present, citizens without access to affordable, clean water resources largely continue to be the urban and rural poor and those that identify (or are stigmatized) as Andean, indigenous, or \textit{campesinos}, despite certain additions to national water law that state otherwise. The first Peruvian Water Code (1902) explicitly favored white landlords, providing them with private ownership. In the capital of Lima, the provision of public water services was formally recognized as a metropolitan utility in 1962. However this ruling did not discuss water provision in rural areas and arguably did nothing to cease the trend of water marginalization in urban peripheral and \textit{barriada} neighborhoods of the capital (Ioris, 2012; Ioris, 2012). The Agrarian Reform (1969) incised the diction that water was a property of the state (Delgado & Vincent, 2013). This reform failed to recognize the importance of local water management strategies and also the ability of these communities to do so successfully. Within this reform, the ATDR was created (\textit{Administración Técnica de Distritos de Riego}) which prioritized irrigation needs along the coast using quantitative methodologies. The formation of ATDR opened the door for

\footnote{Describing the initial construct of water-management post Spanish invasion, Antonio Ioris states that “the low rates of rainfall along the semi-arid Peruvian coast… were a matter of concern for the colonial authorities already at the foundation of the capital in the early 16\textsuperscript{th} century. Public water supply was restricted to the manor houses, convents and official building that controlled the production and export of precious metals… water was… distributed through a combination of public fountains and private water vendors” (Ioris A., 2012).}
the redistribution of water sources towards the coast. Consequentially, many Andean community settlements (and the ecosystems they reside in) located away from the coast were negatively affected by water diversion strategies as it was made difficult to make claims over water rights. Additionally, the strong ties between Andean identity and water management were compromised in the affected communities, irrigation was made more difficult, and cultural practices were negatively affected (Delgado & Vincent, 2013). The 1979 Constitution declared water was part of national heritage and as such could not be privatized. This was contested and later overruled during Alberto Fujimori’s presidency between 1990 and 2000.

Political Boundaries and Scale

The state-controlled water management institutions are based on a hierarchical division of governance. Various governance entities are present at different scales in relation to the geographic divisions of the country. The largest politically imposed boundary (after the nation) is the Region (or Department), roughly serving a similar function as states. Regions are further divided into provinces, of which Peru has 195. Every province is further divided into districts. To meet the criteria for political distinction, a district must have a certain population of inhabitants. As the population of Peru is unequally distributed throughout the country, there are different population requirements for political recognition of districts in la selva, la sierra and la costa. In la selva, a region must have at least 3,500 inhabitants to meet the criteria of a district. A population of 4,000 is required for district status in the Andes or la sierra, and a population of 10,000 is necessary for this status along the coast. Due to high inmigration and population
growth along the coast, many districts have many more than 10,000 inhabitants. Additionally, there has been a slight but steady population decline in the Andes, one of the reasons why many Andean districts have fewer than 3,500 inhabitants (Comision Economica Para America Latina y el Caribe, 1999; PERÚ Instituto Nacional de Estadística e Informática, 1996).

Where a specific community lies in relation to these boundaries will affect, to a certain extent, how it is affected or controlled by regional and national government entities. For this reason, many smaller communities located a distance from regional government entities, are able to operate in an autonomous or semi-autonomous manner, as they are largely unaffected by national, regional, or other local government structures. Often, it seems, in the cases of semi-autonomous communities, members do not always necessarily want government interaction. Additionally, claims have been made in the field that the government is not always keen on enforcing their policies within these communities unless there is a political or economic gain to be made (Swiech, Ersten, & Pererya, 2012). Communities not seen as economically profitable are often not the primary concern of top-down management within Peru. In some cases, the desire not to interact is mutual.

State-Imposed Water Management Hierarchy

Within state-imposed water management, there is a hierarchy of organizations that each have a different function related to the management and governance of water resources. These entities will be mentioned throughout this work and an overview of their functions and purpose as imposed by the state will be provided here. Peruvian
national water law is enforced and structured within a top-down hierarchy. At the top is the ATDR, whose employees train the next lower tier, the *junta de usuarios*, or water users board. The *junta de usuarios* exist at the irrigation district level and are in charge of implementing national water law that is legally prioritized over community-level water management systems (Delgado & Vincent, 2013). Underneath the *junta de usuarios* is the *comisión de regantes*, or irrigators commission at the primary canal level of an irrigation system. Below the *comisión de regantes* is the *comité de regantes*, formed of water users at the secondary canal level. Depending on the size of the community irrigating at the primary or secondary canal level, the *comisión de regantes* or *comité de regantes* may represent a single community. Though national water law is prioritized above all else, members of the *comisión de regantes* often work in tandem with water authorities at the local community level.
Climate

Water Availability in Peru

It has been stated that due to a combination of climatic effects and social practices, Peru is South America’s most water-stressed country (Bebbington & Williams, 2008). Additionally, it has been stated that Peru is “one of the most vulnerable countries in the world to climate change” (Andersen, Suxo, & Verner, 2009). The unique geography of the country divides Peru into three main ecological zones including the coast, or la costa, located along the Pacific. This zone contains all of the Atacama Desert and continues to the Western slopes of the Andes mountain range, known as la sierra. To the East of the Andes lies la selva, which includes the Amazon River basin and rainforest. The majority of Peru’s available water resources are located in la selva region as the Amazon River basin contains 5% of the world’s freshwater resources (Eda & Chen, 2010). This region is the least densely populated by humans. The high availability of fresh water available offers that in terms of natural resources, the region is not water scarce. La sierra contains the vast majority, or 71% (Eda & Chen, 2010), of South America’s tropical glaciers whose flows are the main water resource for Peruvians living in la sierra and for many living in la costa region, where certain glacially fed rivers flow downslope towards the Pacific Ocean. Of the country’s approximately 17,322,099 residents, almost 60% live along la costa region where the main urban areas are located, notably in the primate city of Lima (Eda & Chen, 2010). The water availability in la costa is the least of the three regions, and with such a high population density, there is the lowest amount of water availability per capita in this region as well.
There are drastic differences in natural water availability per person in each of the three zones with 2,938.00 m$^3$ available per person in \textit{la costa} compared to 37,196.79 m$^3$ per person in \textit{la sierra} and 641,954.44 m$^3$ per person in \textit{la selva} (Eda & Chen, 2010). Despite the disproportionate relationship between water availability and population distribution, the urban areas of \textit{la costa} region are experiencing faster population growth due to a combination of internal movement and external immigration to these cities in addition to demographic growth. In fact, many smaller communities in \textit{la sierra} and \textit{la selva} regions are experiencing outmigration to the extent with which community size is steadily decreasing.

As can be expected, when a settlement hosts a large population in a naturally arid region, there is the potential that the population can experience great conflicts over water resources, inequalities in distribution, environmental stress and degradation, and health concerns among the population. Although it seems Peru is highly water abundant between proximity to the Amazon basin and Pacific Ocean coupled with the abundance of tropical glaciers and the river flows they produce, many areas in \textit{la costa} and \textit{la sierra} experience naturally occurring water scarcity$^{17}$. Though some areas of Peru do experience seasonal rainfall or have access to ground water, lakes and glacially fed streams provide the majority of anthropogenic water resources used in \textit{la costa} and \textit{la sierra} regions. Desalinizing ocean water is incredibly expensive, and transporting resources from the water dense \textit{selva} is impractical due to distance and topographic barriers. This means that for the most part, Peruvians living in the highlands and along

$^{17}$ Following the definition provided in the Definitions Chapter.
the coast tend to "make do" with the water resources in their proximity, namely the glacially fed rivers, as inhabitants of the region have done for millennia.

**Anthropogenic Water Use**

Flows from the glacially fed rivers can be highly unpredictable and are seasonally variable. The flows they produce are greatest in the warmest months, typically from October through April (Mark, Bury, McKenzie, French, & Baraer, 2010) for which locally-derived traditions of agriculture and irrigation have adapted to. In an age where man's control over nature is often seen as the ideal, certain modern water management practices in Peru have forsaken these more ecologically sensitive traditions and instead try to utilize consistent amounts of water year round. As certain human demands for water are not consistent with the seasonality of natural water availability, technologies, infrastructure, and diversion schemes have been created to allow for consistent availability despite natural water availability. As the highest amount of water use per capita is in the densely populated cities along the coast, consumptive demands are rapidly increasing. In addition to domestic needs, certain industries located along the coast, primarily agricultural and industrial activities, also place a consistent demand for water resources generally out of sync with seasonal water availability. These activities can reduce water availability for human and other ecological needs, in terms of available quantity, and can also pollute available water resources, providing further concern of quality.

This thesis recognizes that water can only be useful, or beneficial, for most domestic, agricultural, industrial, and ecological needs if it is of a certain quality. If the
available water in the country becomes increasingly polluted, irrigation, storage, distribution and management will no longer be the only central concerns, but water treatment could become one of the most important, and expensive, water management concerns in the nation (Lin, 2005; Oswald, Lescano, Bern, Calderon, Cabrera, & Gilman, 2007; Bebbington & Williams, 2008). Additionally, the effects of climate change in the country are expected to increase occurrences of water-borne and vector-borne diseases, which would produce a great social toll in addition to increased economic strain (Hunter, 2003).

*Significance of Climate on Agricultural and Irrigation Practices*

As climate conditions are related to seasonal and annual temperature and precipitation variability which influence things like vegetative cover, wildlife, conditions for glaciers, certain soil properties and more, a climate zone will have a great deal of influence on what sources and what quantity of water may be available in a given location in a given time period. Not only are climate zones significant in representing how much rainfall tends to occur on a monthly and annual basis, they also represent whether a location experiences wet and dry seasons, periodic droughts, or consistent periods of aridity. Additionally, agricultural production is greatly influenced by climate zones\(^\text{18}\) as what can naturally be grown in an area depends on seasonal and annual

\(^{18}\) Wladimir Köppen creator of the first Köppen classification system, was a plant physiologist and understood that certain types of plants can only grow in specific climatic conditions. In this way, the climate classification system he created was based off of five vegetation groups, defined by De Candolle,
rainfall, temperature, and sunlight factors, in addition to several other variables including soil.

Large-scale industrial agriculture for domestic consumption and export and local-level subsistence-based agriculture are both very prevalent in Peru. In campesino or Andean villages, agricultural production for local consumption is at the heart of community life. The production of crops either requires seasonally reliable rainfall patterns, (which do not occur in some coastal or highland regions of Peru) or the capture, storage and distribution of water through a variety of possible mechanisms. Different forms of irrigation are used in subsistence farming in Peru. Irrigation techniques are also used in the country’s industrial farming efforts. To highlight the significance of agriculture in Peru, more than a quarter of the country’s labor force is in the agricultural sector (Central Intelligence Agency). Fruits and vegetables, especially asparagus, are some of the country’s main exports. The amount of irrigated land in the country is estimated to be 11,960 km$^2$ of a total 1,279,996 km$^2$ square kilometers of land, though it must be noted that not all of this land is arable.

The agricultural footprint of Peru is highly linked to its water footprint. In different slopes in Peru, it is estimated that water use for agriculture accounts for between 69 and 86% of total anthropogenic water use (Eda & Chen, 2010). While there are many

a French Botanist (whom based his groupings off of the ancient Greek’s climate zones) (Kottek, Grieser, Beck, Rudolf, & Rubel, 2006) (Sanderson, 1999). As such, the Köppen climate classification (used in this thesis) is strongly related to vegetation zones and therefore agricultural production (though admittedly, improvements technology and dispersals throughout time have led to an increase of crop planting outside of the zones they would more naturally inhabit).
native and climate sensitive crops that can be grown in different regions of Peru, industrial agriculture, and even some communities utilizing subsistence agriculture are increasingly planting non-native, water intensive crops due to increasing popularity\(^\text{19}\). This shift in planting places increased pressure on local water availability and is arguably a source of human produced water scarcity. These trends, coupled with climatic change predictions of a more naturally water scarce future, magnify the significance and timeliness of water management studies within Peru.

**Water Availability and Climate Change**

As anthropogenic demands for water in the highland and especially coastal regions are increasing, the future of water availability in the region appears grim. The tropical glaciers located at high elevations in the Andes ablate more than they accumulate each year. While increased melt rates have the potential to provide seasonally increased flows for anthropogenic means (temporarily easing water stress in some areas), it ensues that at current melt rates, glaciers will continue to shrink at alarming rates. It is expected that most tropical glaciers in the Andes will be gone by 2030 (Painter, 2007). While ice accumulation will continue to occur in the Andes in colder months, the complete melt-out of glaciers in warmer conditions means that the majority of glacially fed rivers in Peru will have flows reduced by up to 40% in the dry

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\(^{19}\) These crops include cotton, sugarcane, coffee, maize, potatoes, rice, asparagus, mangoes and citrus fruits. Some of these crops are commonly grown for export, but some are becoming increasingly popular for local consumption as well, including certain campesino communities. (Carpio, Loayza, & Datar, 2011) Carpio et. al. note that this increase is common in communities with a Water User’s Association (WUA).
season, and between 10-20% in the rainy season (Painter, 2007). It is expected that in a matter of a few decades, the cost of water within the arid regions of Peru will likely trump the cost of oil. The effects of climate change on glacial melt rates will continue to have consequences on the ecologies of Peru as well as on cultural practices, lifestyles, economies, and governance of the people in each community. In a changing climate, all species, including humans (and their systems), will have the choice to adapt or perish. Water management systems and their users will have the choice to increase competition over water or to increase cooperation.

Though much of the water used in the coastal and highland regions comes from glacial melt\textsuperscript{20}, there are some lakes in Peru that are utilized as the main water resources for certain communities. Peru’s largest lake, Lake Titicaca, is a major water resource for the Southeastern corner of Peru, for cities such as Juliaca and Puno. Though the lake is not glacially fed, poor management of the resource and overutilization coupled with climate change has resulted in major abatement of the lake’s levels (Revollo, 2001). Levels within Lake Titicaca have declined so much that the surface area occupied by the lake has visibly changed. As lake levels have dropped, more highly elevated topographic sections of earth underneath the lake are now exposed, meaning that what used to be the body of the lake is now fragmented, as evidenced in figures one and two.

\textsuperscript{20} Additionally, approximately 80% of Peru’s electricity is generated from hydro-electricity. The expected reduction in flows due to climate change will not only impact water availability for industrial, agricultural, and domestic use, but will impact the methods and perhaps the cost of generating power as well. (Painter, 2007)
Figure 1: This image depicts a fragmented body of water that was once part of the main body of Lake Titicaca. Photograph taken by the Author in May, 2010.

Figure 2: This image also depicts a fragmented body of water that was once part of the main body of Lake Titicaca. Due to a combination of climate change and pumping for anthropogenic use, lake levels have been depleted. This has resulted in the fragmentation depicted. Photograph taken by the author in May, 2010.
Nothing about Peru is homogenous, and the climate is no exception. Variety in the climatic and ecological zonation in the country is due, in part, to the great topographic variation from the presence of the Andes mountain range\(^{21}\), proximity to the coast, and subsequent climatic and weather effects from the Humboldt Current and El Niño teleconnection, among multiple other factors. Located in the Southern tropical latitudes, Peru contains the Atacama Desert, one of the driest regions in the world, the Andean mountain range extending beyond the country’s Northern and Southern borders, the Amazon River basin and rain forest. Along the Pacific coast, the cold Humboldt Current greatly affects temperature and (lack of) precipitation trends along the coast, instead providing the region with a constant cover of fog and mist suspended in the air, providing the coast with a great amount of water vapor, but no precipitation (Gaia, 2010). Additionally, the Humboldt Current is affected by the El Niño phenomenon, which can create excessive rainfall or drought in different locations within the country. The El Niño phenomenon has been observed and experienced by inhabitants of modern day Peru for over 5,000 years, for which early fisherman noted a change in catchments at semi-regular intervals. In Peru, occurrence of the El Niño phenomenon can be accompanied by increased rainfall, flooding, runoff, drought, high potential for crop loss, changes in natural vegetation, decreased species count, increases in certain diseases, and can be a great financial burden (Jaksic, 2001; Warner & Oré , 2006). Away from the coast and into the highlands, many microclimatic variations exist due to the extreme changes in

\(^{21}\) With a topographic variation ranging from -122 feet to 22,205 feet (Helman, 2005).
topography (Trawick, 2001). Glaciers exist within some of the highest peaks and valleys of this region. Each of these factors, and many more that I will not focus on here, cause Peru to have a multitude of incredibly diverse climatic and ecological zones.

Climatic Zones of Peru Represented in this Study: Rationale for Inclusion of La Costa and La Sierra Zones and Exclusion of La Selva

To be utilized in the analysis, the inclusion criterion specifies that communities must be located in regions that experience natural water scarcity (those that experience year-round or seasonal aridity). The informal climatic zones of Peru with either year round or seasonal aridity are la costa and la sierra. Communities in la selva may experience human-induced water insecurity, but lack naturally occurring aridity (an element of natural water scarcity) and thus were not relevant to this study as it's purpose is to observe how different combinations of climatic and anthropogenic elements in arid regions affect water management outcomes related to ecological wellness, and social equity to resource access. Additionally, this thesis is attempting to observe the effect to which humans manage water resources, either producing (further) scarcity or adapting to (naturally occurring) scarcity, in regions of naturally occurring, or climatically produced water scarcity. As such, it was decided that communities in la selva were not significant to the purpose of the research question.
Natural Scarcity in La Costa and La Sierra

Communities in the coastal and highland regions of Peru are all linked by what this study defines as natural water scarcity, referring to annually or seasonally experienced aridity in a location. This similarity aside, there are still many microclimatic variations between and within these two generically labeled regions. Topographic variation, proximity to the coast, elevation and other variables create a great deal of climatic variation in these regions. Microclimatic variations can even occur over swaths of land occupied by small-scale communities (Trawick, 2001).

This thesis is working with the notion that climate does affect certain social elements at the community level. Holding this belief, it was decided that a variable would be included in the analysis that would speak to the climatic variations between the communities analyzed in this meta-analysis. Incorporating climate zones was useful to view similarities and dissimilarities between social customs and water management practices between communities in the same or similar climatic zones. Additionally, incorporating climate classification assists in the observation of patterns in water management as they may relate to the outcomes of a particular water management system at the community level.

Incorporating Köppen Climate Classification

Given the variety of climate zones within Peru and the significance of these distinct zones on monthly and annual temperature and precipitation averages, it is important to incorporate climate classifications within the analysis of this work. The climate classification determined for a particular community will relate to certain
components of water availability\textsuperscript{22}, which in turn affects livelihood strategies including local irrigation and agricultural practices. It is these very connections between climate and social practices that can blur the line between what is being defined as natural water scarcity and human produced scarcity, though it remains important to make this distinction. It is clear that the location of a community within a particular climate zone not only affects the local environment, but can also affect social structures, practices and belief systems of a community as well. In this way, management of natural resources, including water, is inextricably linked to climate.

As this thesis is working without any predetermined or preconceived notions about the linkages between climate, social organization, and water management practices, climate classification was used as an independent variable within the analysis\textsuperscript{23}. One of the inclusion criteria for the analysis in this work states that the author must describe the local climate and geography in detail, including discussion of things like elevation, rainfall, general precipitation and temperature trends and other physical elements. With this criteria included, all of the studies in the analysis do have a

\textsuperscript{22} Pertaining to annual and seasonal precipitation levels. Further studies could also look at more finely tuned climatic information at the community level such as humidity levels and evapotranspiration rates on water needs, availability, adaptation, and outcome.

\textsuperscript{23} It should be noted that all variables within the analysis are considered independent for each separate case study. This was done in order to remove the possibility of falsely assuming any component or variable as deterministic of another, or as deterministic of a potential outcome. Each variable, and each case study was seen as individual, unique, and independent with a unique set of variables that together seem to relate to a particular water management outcome.
substantial amount of local climatic information. However, it should be noted that none of the case studies utilized in the analysis used any type of climate classification. As such, it was necessary to determine the climatic classification for each community used in the analysis with an existing climate classification method.

While it is beneficial to have the authors’ written descriptions of the local climates in each case study, it would be difficult to accurately compare and contrast this information, as it is not standardized. Incorporating climate classification into the analysis provides a mechanism allowing for the comparison of the similarities and dissimilarities between water management strategies and outcomes of different communities within comparable climatic zones. It is with this rationale that Köppen climate classification was incorporated into the analysis.

While several climate classification systems exist, the Köppen classification system is the most commonly used, making it the most familiar classification system (Peel, Finlayson, & McMahon, 2007). For this study, it was determined to utilize Köppen-Geiger classifications, one of the more updated classification systems based on the one initially created by Wladmir Köppen. Wladmir Köppen created this climate classification system based on monthly temperature and precipitation averages in the late 19th century (Institute for Veterinary Public Health; Kottek, Grieser, Beck, Rudolf, & Rubel, 2006). As the climate has changed, the initial classification system has been modified by Köppen’s successors. Researchers have utilized temperature and precipitation data sets to create their own classification models based on Köppen’s, and his successors, classifications. The Köppen-Geiger climate classification system used within this study has been formatted by Franz Rubel and Markus Kottek and reflects
climatic data relative to the time period of my study (Rubel & Kottek, 2010; Rubel & Kottek, 2011).

Köppen Zones in Peru

According to the most recent data presented in this classification, Peru has 11 distinct climate zones. In la selva exist Af, Am, and Aw climates. Climates beginning with the letter A are considered “Equatorial” within the Köppen-Geiger classification system utilized. Af is an equatorial fully humid zone. Aw is an equatorial winter dry climate\textsuperscript{24}. Am is an equatorial climate with monsoonal properties. Am and Af climates lack the component of natural water scarcity and do not fit the inclusion criteria for this thesis as they do they fit the purpose of the research question. As such, communities located within the ‘A’ climate classification zones of Peru will not be utilized within this study. In la sierra exist Cfb, ET, Cwb and Cwc climate zones. The letter ‘C’ represents “mild mid-latitude’ climate zones. Cfb is a Warm temperature fully humid warm summer zone. As it is defined as fully humid, communities located in this zone did not meet the inclusion criteria and were thus omitted from the analysis. Cwb climates are described as warm temperate winter dry climates with warm summer temperatures. As this classification is considered seasonally dry, it meets the criteria for inclusion in the analysis. Cwc climates are warm temperate winter dry climates with cool summers.

\textsuperscript{24} While Aw is a seasonally arid climate zone, which would by definition fit within the inclusion criteria of the analysis, no studies were found in this climate zone and as such nothing from this climate zone was analyzed within this work.
Again, with seasonal aridity, community studies in these zones were eligible for inclusion in the analysis. The letter ‘E’ represents Polar zones, ‘ET’ referring to polar tundra conditions. The ‘polar’ zones, in this case, are not truly polar considering the tropical latitude, however they are defined in this manner due to the weather and climate conditions at the high altitudes in the Andes where glacial conditions exist. In la costa exits BWk, BWh, BSk, and BSh zones. ‘B’ climates are “Arid” and as such, any community in a ‘B’ climate would fit the climate zone inclusion criteria. BWh is an arid desert zone with a hot arid temperature, BWk is an arid desert zone with a cold arid temperature, BSk is an arid steppe zone with a cold arid temperature, and BSh is an arid Steppe climate with a cold arid temperature. (Institute for Veterinary Public Health).
Figure 3: This map depicts Köppen-Geiger climate classifications within Peru as well as the locations of the case studies.
As can be seen in figure 3, there are many climatic variations, even within the arid and semi-arid coastal and highland regions. For the analytical portion of this study, providing the climate zonation for each community allows for the climatic comparison of the communities analyzed. Additionally, this comparison allows for further observation into the similarities and dissimilarities in outcomes between communities pertaining to human produced scarcity (as all communities considered within the analysis fit into a seasonally or annually arid Köppen-Geiger zone experience natural water scarcity).

It is predictable that as most studies used in the analysis were either single-case studies or were observations of multiple communities in the same general area, climate classifications were not necessary for the authors’ purposes (as the communities in each study used had the same climatic principles). As this thesis ponders the effects of climate on the social variables and water management practices at the community level, the Köppen-Geiger classification system provided a standardized method for such observations. Once the classification system was determined, a map layer for Google Earth presenting the distribution of climate zones throughout the globe was accessed and utilized. Next, the climate zones located in la selva, la costa, and la sierra were determined. Focusing on the climate zones present in la costa and la sierra, particular attention was paid to what climate zones were present in these regions and also how they were identified. Climate zones experiencing of year round or seasonal aridity were left for inclusion in the study. These were ‘B’ and ‘C’ climates. According to the classification system, there are also ‘E’ climates within Peru, which are located in the upper reaches of the Andes where the glaciers are located. ‘E’ climates are

25 And ‘Aw’, though no ‘Aw’ studies were found.
representative of conditions in polar climate zones within the Arctic and Antarctic circles. The climatic conditions within certain areas of the Andes do share some common elements with polar regions, explaining the occurrence of this classification within tropical latitudes. Taking note of this, some Köppen classification systems include the letter ‘H’, to represent highland climates distinctive from polar climate classifications (Pidwirny, 2011). Such a system would have been ideal to use within this study, however a Köppen map layer utilizing ‘H’ climates was not located. As such, the Köppen-Geiger classification system was utilized because a map layer was available, allowing for the plotting of study locations on the map layer. The location of each community used in the analysis was located on Google earth, placed on top of the Köppen-Geiger climate zone map layer. According to the scale of the map layer, it appears that certain communities analyzed within the study are located on the margins of the ‘ET’ climate zone, which in fact, represents a seasonally arid highland region. These highland communities depend on glacial melt as a primary water resource. As glaciers do not continuously melt (rather, they melt seasonally), these highland populations do in fact experience seasonal water scarcity and are thus located in semi-arid highland, and not polar, zones. As such, these highland communities were included in the study.

Once it was determined what studies met the inclusion criteria for the analysis, save for the climate zone classification requirement, it was necessary to determine what communities did fit the climate criteria according to the chosen classification method. As a requirement stated in the search criteria, all of the case studies utilized in the analysis needed to include the name of the community and information regarding the department,
province, and/or district level related to the community. Map layers were found for Google Earth that provided the departmental, provincial, and district boundaries in Peru. These layers were uploaded to Google Earth to help locate each community within the study. The location-name information provided in each study was used to locate each individual community on the Google Earth map. Some of the authors of the case studies analyzed in this work included geographic coordinates of the location of the communities. In such cases, the communities were first pinpointed by the methods stated above and then a search for the geographic coordinate information was performed to ensure the location pinpoints were consistent. In each case, the geographic coordinates matched with the locations found by name alone, with only a small fraction of error. Most of the articles used in the study also provide maps that show the location of the community (or communities) analyzed either within a district, valley, watershed or some other large-scale map. For these communities, it was possible to crosscheck the map location from the articles with the name-based pinpoints located on Google Earth. Each time, the locations were consistent. With these thorough location methods, it can be stated with confidence that each community within the study was accurately located on Google Earth within an insignificant margin of error.

26 Although Google Earth was able to pinpoint the communities correctly by name alone, the located pinpoints were cross-checked with the departmental, provincial, and district information provided in each article to increase assurance of correct location and classification.

27 The margin of error was not enough to warrant concern. When using both sets of information, the pinpoints were always contained within the same community, district and climate zone.
Once the community pinpoints were located, they were overlaid on the map layer that showed the distribution of the Köppen-Geiger classifications (shown in the graphic above). Zooming into Peru, it became easily visible which climate classification each of the communities belonged to. As expected, after conducting this step there were a few communities that were not located in semi-arid or arid climate zones and therefore were excluded from the analysis according to the inclusion criteria. After removing the pinpoints for the communities that did not meet the climate classification inclusion criteria (but met the other inclusion criteria), only the six studies that met each step of the inclusion criteria remained.

A limitation of this step is related to the resolution of the Köppen-Geiger climate zones as it is not very fine. As deciding the climatic zonation for each community is not the primary focus of this work, small margins of error due to the resolution of the data were forgiven. However, the map shows a large range of ‘E’ climate zone throughout the Andes, referencing the high peaks where the glaciers are located. As there are communities apparently scattered throughout the ‘E’ zone, several of which were articles that otherwise fit the inclusion criteria for the analysis, this posed an issue. It needs to be stated that there are no true ‘E’ climates within Peru as Peru does not exist at Polar latitudes. The communities appearing to exist in the ‘E’ climates do not live in the glacial zones, either. Rather, these communities are located in hospitable highland zones. As these communities all depend on the headwaters of these glaciers as their primary water resource, and glacial melt is dependent on melt season, these communities certainly experience periods of aridity based on glacial melt seasons and corresponding water availability. Between this climatic rationale that these communities,
apparently located in ‘E’ climates on the Google earth map in fact do experience naturally occurring water scarcity, it can be safely assumed that these communities are in fact located in arid or semi-arid climate zones. With the support of the authors’ stated climatic descriptions of the communities (another requirement for inclusion) as arid supported the intuition that all six communities are in fact located in arid climate zones.
Literature Review

Overview

Peru is unique in that it is one of the original hearths of hydraulic civilization (Trawick, 2001). Despite its variable climate in which water resource availability is often limited, scarce, and unpredictable, early settlements in the region such as the Moche, Inca, Chimú, Sicán28 and Chavimochic, hosted large populations through pre-capitalist notions of surplus production which required intricate systems of agricultural and irrigation management (Stumer, 1954; Vos J. M., 2002). Such examples demonstrate that despite concerns of naturally occurring water scarcity, these societies were able to construct irrigation technology while managing and governing the limited water resources available to them. Some of these early infrastructural systems are still in use today (Boelens & Gelles, 2005; Crawford & Bell, 2012; Delgado & Vincent, 2013; Gelles, 2000; Hogue & Rau, 2008; Paerregaard, 2013) (Vos & Vincent, 2011) (Trawick, 2001). Additionally, certain cultural and religious beliefs centered on traditions and rituals related to water management have percolated through the generations and can be observed in many Peruvian communities today29.

28 Also known as the Lambayeque (Vos, 2002)

29 As will later be discussed, the management principles of the Huaynacotas have been passed down for generations and remain relatively unchanged over many centuries (Trawick, 2001). Some ancient spiritual beliefs that affect how water is managed in certain communities of the Colca Valley, such as the worship of Mount Hualca Hualca, are still practiced (Boelens & Gelles, 2005). In many Andean communities, dual
Arguably, what is key to remember about the beliefs and traditions regarding water management that have persisted, is that many of the communities from which these practices originate still exist and continue to practice these traditions today. Though history has shaped the beliefs and practices within these groups, the communities that have persisted throughout time manage to operate as they do today through the ability to adapt to climatic, environmental, social, and political changes throughout time (Trawick, 2001; Trawick, 2001; Gelles, 2000; Boelens & Gelles, 2005; Lynch, 2012; Vos, 2002; Vos, 2005). It would be a grand oversight to believe that these communities have operated the same way throughout time, an oversight too often made in the study of local-knowledge and indigenous systems. Even the most ‘traditional’ system included in this study, the Huaynacotas, has undergone several adaptations related water management throughout time, including the removal of the typical dual-division water management and the geographic relocation of the community (Trawick, 2003; Trawick, 2001; Trawick, 2005; Trawick, 2001). Though some communities, such as the Huaynacotas, have remained virtually autonomous, the majority of water users within Peru either rely on or are partially subject to state controlled water management systems.

Since the central Peruvian government was established, state appointed agencies have come to govern, at least in part, water management systems at national, regional, and local levels. Some communities, typically located outside of the more division moieties, and annual cleaning of the canals, known as yarqay aspiy are other examples of traditional practices that have been continually used to the present day (Trawick, 2001) (Boelens & Gelles, 2005) (Delgado & Vincent, 2013) (Paerregaard, 2013).
urbanized areas, have managed to retain a certain level of autonomy from the centralized government and thus oversee their own water management systems (Verzijl & Quispe, 2013; Trawick, 2001). A great deal of academic literature has been written about the many varied water management systems within the country including state-controlled systems, relatively autonomous or Andean systems, and systems that are considered to be a ‘hybrid’ of the two. There are many ways in which these systems can be analyzed. Some authors focus on economic outcomes (Platt, 2012; Corton, 2003; Goland, 1993; Szaleniec, 2012; Aguayo, Saskia, & Pilar, 2001), others on environmental outcomes and climate-related concerns (Condom, et al., 2012; Buytaert, 2012; Guevara & Milla, 2007; Baraër M., 2012; Read & McKinney, 2010; Loredo, 2009; Verones, Barti, Pfister, Vilchez, & Hellwig, 2012; Lynch, 2012), historical outcomes (Palerm-Viqueira, 2010; Trawick P., 2001; Treacy, 1987; Galán, 2012), management outcomes (Bernauer, Rieckermann, Helge, & Ronteltap, 2009; Dorcey & Northcote, 1988; Revollo, 2001; Trawick, 2003; Trawick, 2001; Turin, 2009; Warner, 2006), modernization outcomes (Swiech, Ersten, & Pererya, 2012; Eda & Chen, 2010; Gaia, 2010; Paerregaard, 2013; Prokopy, Thorsten, Bakalian, & Wakeman, 2008; Delgado & Vincent, 2013), or social outcomes (Gelles, 2000; Boelens & Gelles, 2005; Carpio, Loayza, & Datar, 2011; Hubbard, Sarisky, Gelting, Baffigo, Seminario, & Centurion, 2011; Bebbington & Williams, 2008; Delgado & Zwarteveen, 2008; Fernandez-Maldonado, 2008) (Fernandez-Maldonado, 2006).
Prior to analysis, a vast amount of quality academic literature written about the different water management systems within the arid regions of Peru, rather, the areas experiencing natural water scarcity, was collected and studied. Though studies related to water management systems within the tropical regions of Peru also exist, natural water scarcity is not a concern there, and as such collection of this data was not necessary to fit the purpose of the research question\textsuperscript{30}. The main types of data collected for the initial purposes of this work included academic articles and books, written in both Spanish and English, as well as Peruvian census and water management data made available for public use.

Most research either focus on urban water management or rural water management in Peru, but few focus on both. Many studies have been conducted related to community-level water management in more rural or Andean communities in Peru. The Huynacotas community, located in the Arequipa district in South Western Peru, is one such autonomous group with tremendous levels of water security compared to many other Peruvian communities in arid climates. The Huynacotas follow traditional water storage, delivery, and irrigation technologies (Trawick, 2001). In addition to full

\textsuperscript{30} To reinstate, the thesis question asks: "In the arid (and semi-arid) regions of Peru, how do the combinations of social and environmental variables at the community level affect water management outcomes as they relate to social equity, environmental wellness, and long-term sustainability".  

57
transparency of local water governance between the water management actors and the community, several other principles have been identified that lead to the great success of the community’s water management: 1. Each irrigator is responsible to assist with the upkeep of the water management system in proportion to the amount of water needed for irrigation, 2. Sanctions to offenses such as water waste or taking water out of turn are graded by severity of the offense (and are enforced), 3. The entire community is fully engaged with the system’s operation and regulations, and 4. Upkeep of the system regulations is positively reinforced—everyone taking only what they need, in turn, means each community member will receive more water throughout the year (Trawick, 2001; Trawick, 2003). Despite the highly fluctuating water resources in the arid Huaynacotas region, the community has historically maintained great levels of water security and equality among its members. The significance of the study on the Huaynacotas to the formation of the research question in this thesis will be discussed in a further section.

The Colca Valley, also located in the Arequipa District, is home to multiple Andean communities such as Corporaque, Lari, and Cabanaconde, among others, that also use traditional water management technologies, though alongside state governance systems (Boelens & Gelles, 2005; Delgado & Vincent, 2013; Paerregaard, 2013; Treacy, 1987; Guillet, 1992; Delgado & Zwarteveen, 2008). This mixture of partial state control alongside traditional management will be referred to within this work as hybridized governance. The communities within the Colca valley differ in area, population, and elevation, but each manage their water in traditionally derived ways, and are often able to achieve positive outcomes relative to water security (Delgado & Zwarteveen, 2008; Guillet, 1987; Trawick, 2001; Treacy, 1987). The aforementioned
communities all depend primarily on Andean River systems for local water supply. These rivers are composed of alpine melt and can be supplemented with high altitude seasonal rainfall.

Some Andean communities in North Western Peru reside in areas where glacially fed rivers are the sole water source. As Peru’s glaciers are rapidly melting with climate change, these communities, located primarily in the Rio Santa river valley are being forced to move away from practicing traditional Incan, pre-Incan, or post-colonial water management technologies (though most ‘traditional’ or ‘Andean’ systems reveal influence from each of these periods) in order to sustain their livelihoods (Baraër, 2012; Buytaert, 2012; Condom, et al., 2012; Lynch, 2012; Read & McKinney, 2010; Bury, et al., 2013; Baraër, et al., 2012). These communities are altering their water management practices in different ways in order to cope. Thus far, the literature has demonstrated that certain communities’ hybridized management methods\(^{31}\), in the valley and beyond, are proving to lead to greater water security while others have been less successful. While there are many studies about the water management methods of communities with Andean and hybridized water management systems, as referenced above, there is also a great deal of literature written about urban water management systems within the arid and naturally water scarce regions of Peru, particularly within Lima.

Lima, Peru is home to the vast majority of Peru’s population and is located in one of the climatically driest locations within the country. The great increase in the amount of literature produced in the last several decades about water management in Lima is likely due to the fact that water security in Lima has been at the forefront of media

\(^{31}\) Referring to the shared water management and governance between state systems and local models.
attention and political platforms since the 1980s, including a political shift towards neoliberalization (Isarra & Donner, 2004/2005; Ioris, 2012; Ioris, 2012). The increasing severity of the clear lack of fair access to clean water in Lima has become the central issue of political campaigns in recent years. To highlight the severity of the issue, the campaign slogan of 2006 presidential candidate Alan Garcia was, “without water, there is no democracy” (Ioris, 2012). In the past several decades, there have been multiple high stakes water reform projects, often costing upwards of two billion dollars. Despite these efforts, at least 15% of Lima’s citizens still do not have access to clean water, while other estimates claim this number may be much higher (SEDEPAL, 2005; Bonfiglio, 2002). Though water connections in more wealthy and tourist-dense areas of the city have steadily improved with recent reforms, most citizens, especially those living in barriada communities, do not have constant access to water (if any) as the taps and public pumps may only flow for several minutes per day in some low-income areas (INEI, 2007). As the government’s water management reforms continued to fail, water resources were privatized in the mid 1990s. Water privatization entails that private or corporate owned water resources can be sold at high cost to citizens lacking adequate access to clean public water resources. Due to record-high inflation, and the high cost of privatized water resources, low-income citizens in Lima spend, on average, half of their annual salaries on food and water (Saravia, 2005). Thus, the citizens most well equipped to afford privatized water services are those that are provided with an abundance of low cost public water services. Low-income citizens, in contrast, are not
provided with low cost water from public water services and their only legal option is to spend a large percentage of their incomes on privately owned water resources.

As water security in Lima is clearly exacerbated by inefficient water management, perpetuating human-induced scarcity, there is often a new water management regime in Lima with each presidency. Fortunately, there is a great deal of literature written about each subsequent water management regime within the capital (Bárdossy & Chamorro, 2009; Chamorro & Bárdossy, 2010; Platt, 2012; Ioris, 2012; Ioris 2012; Szaleniec, 2012; Fernandez-Maldonado, 2008; Fernandez-Maldonado, 2006; Eda & Chen, 2010).

_Trends in Urban Water Management Studies in Peru_

Over the last several decades, there has been an increase in water management studies in Peru focused on water politics and economic development (Ioris, 2012; Warner, 2006; Stensrud, 2003; Lin, 2005), technocratic solutions to water supply issues (Gaia, 2010; Ventura & Olcese, 1996) and water access and inequalities (Ioris, 2012; Ioris, 2012). These articles often tackle the correlation between water and sanitation services and health outcomes, the effects and promises of government changes to national water policy, and the proposals and effects of institutional reforms by organizations such as the World Bank (Saravia, 2005; Trawick, 2003). Many of these larger scale studies reflect the top-down hierarchy of water governance in Peru, focusing on the changes and proposals to national water management as dictated by the national government as they effect primary population centers, especially Lima, and

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32 Due to limited or inefficient infrastructure in low-income areas, such as Barriada neighborhoods.
outwards. Despite the wealth of literature available pertaining to water management within Lima, there are few studies examining particular community-level water management outcomes within Lima itself, a limitation that will be discussed later on in this text.

Limitations in Urban Water Management Studies

While it is clear that obtaining socially equitable and environmentally sustainable water management in Lima is a critical and time sensitive concern, there are certain gaps in the existing literature that limit what can be done with secondary data of community level water management analysis. Some studies have mentioned neighborhood level effects of water management in Peru, though these studies do not often provide detailed information about social and environmental variables related to community level outcome of water management, an issue that is described in the inclusion criteria section in the methodology chapter.

It was surprising studies were not found within Lima that had a primary focus of conducting community or neighborhood level research related to both social and environmental factors that contribute to differential outcomes of water management. Many of Peru’s citizens live in Lima, and many reside in barriada or otherwise lower-socioeconomic status neighborhoods that are largely considered to have poor access to affordable and clean water resources. A potential explanation for this could be that Lima is so large and its water management problems are so vast that community level studies within the city could be difficult to construct. However the accessibility of data and the ability for researchers to access these communities is so great, that the lack of
this type of research is concerning. Given the vast inequalities of water management outcomes within Lima, and the argument that community-level studies are imperative to create lasting change for improved social equity towards resource access while also improving environmental wellness at the community level, it is imperative that more comprehensive community level water management studies are conducted within the city, especially given the time sensitive nature of the dilemma. It was decided that despite this realization, water management studies within Lima\textsuperscript{33}, would be excluded from this work and saved for future research endeavors.

While the majority of urban water management studies in Peru are focused within Lima, there have been many water management studies in other urban centers of Peru as well including studies in Ica, Pisco, Aymara, Juliaca, Puno, Arequipa, and Nazca, among others (Dorcey & Northcote, 1988; Goland, 1993; Revollo, 2001; Stumer, 1954; Turin, 2009; Warner, 2006; Verones, Barti, Pfister, Vilchez, & Hellwig, 2012; Bernauer, Rieckermann, Helge, & Ronteltap, 2009) Though the literature related to Lima was not considered for formal analysis in this work, urban water management studies in other locations were reviewed and considered for analysis.

\textit{Trends in Rural Water Management Studies in Peru}

In addition to an academic increase in urban water management studies in Peru, there has also been an increase in the number of studies in more rural communities, notably including studies of communities with so-called “local-knowledge based”,

\textsuperscript{33} No articles were found within Lima that met the inclusion criteria stated for analysis within this work.
“traditional”, or “Andean” water management systems. This is part of a larger trend in the increase in local-knowledge based studies on a global scale, for which Peru is no exception (Gilchrist, Mallory, & Merkel, 2005; Kloppenburg, 1991; Batheil, Malmberg, & Maskell, 2004; Thrupp, 1989; Trawick, 2005). Pioneers of community-scale water management studies in Peru include Rutgerd Boelens, Paul H. Gelles, David Guillet, Paul Trawick, Margreet Zwarterveen, Jeroen Vos, Linden Vincent, and William P. Mitchell among others (Boelens & Gelles, 2005; Delgado & Vincent, 2013; Delgado & Zwarterveen, 2008; Gelles, 2000; Guillet, 1987; Guillet, 1992; Trawick, 2003; Trawick 2001; Trawick, 2001; Trawick, 2005; Trawick, 2001; Vos, 2002; Vos, 2005). Academics focusing on water management studies in Peru come from a variety of disciplines including Anthropology, Biology, Forestry and Natural Resources, Geography, Geology, International Studies, Irrigation and Water Engineering, Community Development Specialists, and water resource specialists (Boelens & Gelles, 2005; Prokopy & Thorsten, 2008; Raben, 2007). Collaborative work between disciplines is common and leads to unique and multidisciplinary perspectives of water management outcomes and issues from multiple vantage points.

The larger trends in water management studies in Peru were initially centered around more concrete and objective presentations of political processes and decision making, and infrastructure and technology but have increasingly moved towards more critical observations of the linkages between society, policy and the ethics of the actions centered around these relationships (Trawick, 2001). Increasing concerns about the effects of climate change on Peru’s main water resources, namely the many tropical glaciers in the Andes and the river, groundwater, and lake systems these glaciers
produce and recharge, have lead to a great increase in the amount of studies focused on the proposed effects of climate change on current and future water availability within Peru (Bury et al., 2013; Mark, Bury, McKenzie, French, & Baraer, 2010; Bury, et al., 2011; Carey, French, & O'Brien, 2012; Bury, French, McKenzie, & Mark, 2008; Carey, et al., 2013; Baraër, Hydrology in the Cordillera Blanca, Peru: Significance, Processes and Implications for Regional Water Resources, 2012; Baraër, et al., 2012; Condom, et al., 2012).

Sometimes concerns of these climatic trends are paired with predictions of demographic growth, agricultural forecasting (Swiech, Ersten, & Pererya, 2012), economic trends (Platt, 2012), and the projected effects of climate change on adaptations to social and cultural practices (Mark, Bury, McKenzie, French, & Baraer, 2010; Carey, French, & O'Brien, 2012; Carey, et al., 2013; Gaia, 2010).

Limitations of Water Management Studies in Peru

Although there has been a positive increase in studies related to the intricate nature of the social variables in community level water management systems and their outcomes in addition to an increase in studies concerned with the environmental impacts of water management systems and the future sustainability of these systems in relation to predicted climate change, there are few studies that are equally concerned with environmental and social variables related to water management at the community level. Additionally, despite the increasingly comprehensive nature of water management studies in Peru, there is not a holistic overview that compares and analyzes the work that has been done on this subject so far. There have been studies looking at multiple
communities within the country in the same work, but a wider analysis observing the trends in the literature related to this topic, as a whole, has not been conducted. At present, there is a wealth of ad-hoc literature related to water management in Peru, but there has been no organization or analysis of this information, a task that could prove very useful to inform future water management studies and policy revisions.

**Justifications for Study**

Despite the common concern of natural water security found within all communities in the arid regions of Peru, no body of work has holistically compared the diverse water management types (and what factors contribute to their varied levels of success) found within the great body of research on the subject of water management systems within Peru.

A better understanding of the existing water management studies in Peru will provide valuable information as to how the gaps in the existing literature can and should be filled in order to make more informed decisions regarding how to analyze water management systems within the country. Additionally, this type of study could aid in the production of better-informed decision-making related to water management. Considering the frequently ill-informed policy decisions made by the state controlled hierarchical water governance system in Peru, which often ignore community practices, customs, beliefs, desires, and needs or ignores environmental concerns or limitations, a study related to the observation of both social and environmental variables at the community scale (pertaining to outcome) is essential. Creating an overview of the existing literature to determine the foci of existing research in addition to analyzing the
existing data with a meta-analytical framework will serve two purposes. The first purpose relates to locating the gaps and trends in the existing literature and the second is to provide a better understanding about how the study of both social and environmental variables at the community level is essential to formulate an understanding about how the relationships between those variables produce a particular outcome within a specific community.

**Motivation for Study**

The critical use of water for survival and the variable relationships between access and control of water resources within communities inspired the first biopolitically-driven questions related to this topic. The literature demonstrates that despite naturally occurring water scarcity, human mechanisms have the capability of producing either water scarce or water secure outcomes within different communities. As the literature provides an array of examples demonstrating both positive and negative water management outcomes related to social equity and environmental wellness, this study is primarily concerned with exploring the various relationships between social and environmental factors that produce these outcomes. While naturally occurring water scarcity cannot be avoided, the mechanisms by which humans procure, allocate and govern water resources can result in extremely positive or extremely negative outcomes.

A critical meta-analysis allows for the comparison and analysis of the existing community-level water management systems in the naturally water scarce regions of Peru. If meeting inclusion criteria related to having enough relevant data for comparison,
the relationships between social and environmental variables and water management outcomes can be produced and critically explored.

One author was particularly influential in creating the research question. Paul Trawick, an anthropologist, has primarily conducted his studies within lesser known, more remote, and less bureaucratically influenced communities such as Huynacotias, Pampamarca, and Cotahuasi (Trawick, 2003; Trawick, 2001; Trawick, 2005; Trawick, 2001). His studies show how communities with the least amount of influence from the central government manage their water and how they have transformed their community and practices over time. Trawick also delves into the specific water management principles and community structures that allow for such equitable management of their water resources. His studies provide a diversion from other community-scale studies in the Peruvian highlands as the Huynacotias in particular have remained an (unofficially) autonomous community throughout time. His studies of the Huynacotias provide a relative paragon for how water management can optimally operate in regards to social equity over a resource, inclusion and transparency in the decision making process, and in equitable division of responsibilities. It is with the model of the Huynacotias that initially inspired the further study what particular sets of variables in other communities lead to less positive outcomes in their water management systems.

To reinforce the research question, this study is interested in the environmental and social outcomes of community level water management systems. In the conclusive remarks of the existing literature focused on these outcomes, some water management systems are deemed to have positive outcomes regarding the ecological and social
environments, while others are regarded as having more negative outcomes— not meeting the needs of the populace while also causing harm\textsuperscript{34} to the natural environment. The analysis of the rest of the water management systems fall somewhere in between.

Despite the common concern of natural water security found within all arid communities in Peru, no study has holistically compared the diverse water management types (and what factors contribute to their varied levels of success) found within the great body of research on water management systems within Peru.

Though they are located within the similar arid environments, the water management systems of some communities in Peru lead to considerable levels of water security, while others experience great deals of water insecurity. It is likely that certain asymmetrical factors between different communities (whether pertaining to physical or social differences) contribute to the disparities between the varied levels of water security in different water management systems. A holistic overview of the known literature on water management systems in Peru, identifying and analyzing geographic, social, and managerial differences between communities could be incredibly beneficial in determining what parameters lead to water security or water insecurity. This type of overview would also be useful to identify specifically how water scarcity within some arid Peruvian communities may be human produced and thus avoidable.

\textsuperscript{34} The word ‘harm’ here refers to governance or management that, while not necessarily intentionally harming social or environmental wellness, is ill-conceived in the manner that the system is not actively set up to minimize and avoid such harms. All water management systems will have certain environmental, and likely some social, consequences, however some systems actively attempt to minimize as many negative consequences as possible.
Within the analysis of this thesis, examination of the social and environmental variables of water management at the community level as associated with outcomes was viewed as an incredibly informative tool to examine how the relationships between variables were found to contribute to levels of environmental sustainability and social equity as they relate to water management strategies. Ideally, this analysis can promote a discussion related to the insights found by comprehensively analyzing community level water management outcomes within the existing literature on the subject.
Methodology

Outline

The document search and analysis for this thesis were conducted between May 2013 and April 2014. All of the data collected were from secondary sources and no primary data were collected. The articles determined to fit the inclusion criteria for this work were written by secondary authors. To reinstate the purpose of this thesis, the research conducted evaluates, in the arid and semi-arid regions of Peru, how combinations of social and environmental variables at the community level effect water management outcomes as they relate to social equity and environmental wellness. A vast array of studies have been produced in the last few decades that examine scale, community structure, climate, and water management techniques throughout the arid regions (rather, regions with naturally occurring water scarcity) of Peru. At present, there has not been a large-scale analysis comparing the vast amount of research available on the subject. From the data available, it was possible to create an analysis of these secondary data sources in order to create a unique overview that examines the relationships between different environmental and anthropogenic factors that may or may not contribute to different outcomes in terms of social equity regarding water resources and environmental wellness within a particular community.

The purpose of this thesis question is to explore the relationships between local climate and ecology, scale, community structure, economy, conflicts over water resources, division of and access to water resources, government influence, and other
particulars of local water management systems with outcome. It is believed that the interplay between the specific combinations of these variables within each community in the arid regions of Peru may contribute to varying levels of water security. This thesis is also interested in uncovering any relationships between these variables and water management outcomes across communities of varying geographic locations, scales, and governance styles within Peru.

While all of the sites included in the analysis are united by similar concerns of natural water scarcity (as all the communities selected for analysis, by definition in the inclusion criteria had to be located in a climatic zone determined by Köppen classification to be arid), they are separated by varying levels of water security. The purpose of performing this comprehensive analysis is to contribute to a better understanding of why such disparities in water security outcomes exist. Additionally, the results of this research could contribute to more informed decisions regarding water policy while also outlining the similarities and disparities regarding water management outcomes between all Peruvian communities.

**Chosen methods:**

As this study serves as an overview of community level water management studies in Peru, it lends itself to a critical meta-analysis. A qualitative meta-analysis of the existing literature was produced in the vein of a critical analysis. This type of analysis fit the purpose of the research question and allowed for the critical review and

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35 Including, but not limited to: socioeconomic stratification and marginalized communities.
comparison of the existing literature related to community-level water management outcomes in the arid regions of Peru. Peter Newell argues that any analysis of environmental governance “has to operate across a number of sites” (Newell, 2008, p. 525), complementing the purpose of this work to create a better understanding of water management disparities throughout the arid regions of Peru, further justifying the use of analyzing multiple case studies across a variety of sites. The results of the analysis also uncovered, outside of the tangible variables included in the analysis, other factors that may contribute to varying levels of water security including themes that were related to more positive outcomes and themes related to more negative outcomes.

Though not often used in geographical studies, a critical meta-analysis lends itself well to the comparative study of water management outcomes at the community level in Peru, allowing for an effective evaluation and comparison between outcomes and the variables that lead to them. The SAGE definition of meta-analysis states the research method is a “distinctive category of synthesis in which findings from completed qualitative studies in a target area are formally combined. Both an analytic process and an interpretive product, qualitative meta-analysis intends to ascertain systematically, comprehensively, and transparently the state of knowledge in a field of study” (Sandelowski, 2004). Further, Ladislav Timulak defines meta-analysis as “an attempt to conduct a rigorous secondary qualitative analysis of primary qualitative findings… its purpose [is] to provide a more comprehensive description of a phenomenon and an assessment of the influence of the method of investigation of findings is discussed” (Timulak, 2008). As stated in the book, Introduction to Scientific Research Methods in Geography, meta-analysis is underused in the geographic discipline (Montello & Sutton,
Meta-analysis is most often used in medical studies, combining many smaller studies for a more comprehensive outlook of a particular medical condition or treatment option, providing a synthesis of all the known research on the subject (DerSimonian & Laird, 1986; Glass, 1976; Stroup, et al., 2000). Though not as commonly used as in medical or clinical studies, biologists also frequently use meta-analysis. Within the field of biology, meta-analysis can analyze secondary data sources to evaluate the effects of different phenomena, such as (but not limited to) the health of different populations of a specific species, the effect of a virus or parasite on different types of trees, outcomes of a virus on different communities of fish and beyond (Chalfoun, Thompson, & Ratnaswamy, 2002; Hartley & Hunter, 2008; Rohn & McCoy, 2010). In recent years, meta-analysis has been used more extensively in other fields including education, economics, and on occasion, geography, in order to holistically explore the connections between complex problems (Bernard, et al., 2004; Holger & Strobl, 2008; Rustad, et al., 2001).

Meta-analysis has proven to be useful in particular geographic studies and related fields. There has been an increase in the use of meta-analysis in community-scale studies. A specifically relevant example of meta-analysis in geography is a study involving measures that contribute to food security in different communities within South Africa. The author of the paper, Alison A. Misselhorn, from the school of Geography, Archaeology, and Environmental Sciences at the University of the Witwatersrand in South Africa published the article “What Drives Food Insecurity in Southern Africa? A Meta-Analysis of Household Economy Studies” in the geographic journal, Global Environmental Change, in 2005. Misselhorn stated that food insecurity is experienced
asymmetrically between different communities in Southern Africa (just as water security or insecurity is experienced asymmetrically between different communities within Peru). The author recognized that environmental stressors alone are not the sole cause of food insecurity\textsuperscript{36}. Within the study, the author used meta-analysis to compare multiple factors in different food-insecure communities in South Africa such as socioeconomic factors, poverty, conflict, methods of livelihood, and prevalence of medical issues (among others) to ascertain what anthropogenic parameters lead to food insecurity (Misselhorn, 2006). The author compared these underlying issues of insecurity in different communities to parse out the common factors present in food-insecure areas.

In a somewhat similar manner, this thesis used meta-analysis to identify common factors, themes, and sets of variables relating to social and environmental water-management outcomes at the community level in Peru.

The paper “What Makes Community Forest Management Successful: A Meta-Study from Community Forests Throughout the World” by Adcharaporn Pagdee, Yeonsu Kim and P.J. Daugherty in 2006 utilized meta-analytical methods to explore the relationships between community-level resource management and outcome on a global scale. In this study, 31 articles composing 69 case studies of different sized communities were analyzed to determine what parameters lend to successful community forest management. As the studies used in the analysis were written by

\textsuperscript{36} Similarly, this thesis is also suggesting that resource insecurity is not solely caused by environmental stressors, previously defined as ‘natural insecurity’ in the definitions chapter of this work, but can be exacerbated or abated by human ends. Misselhorn seems to be suggesting a similar idea.
different authors\textsuperscript{37}, methods were used to account for the differences in availability of information (Padgee, Kim, & Daugherty, 2006). After identifying the parameters that may lead to success or failure of community forest management, the study classified the separate case studies as ‘successful’ or ‘not successful’ based on the conclusions of the authors. Finally, the factors contributing to success or failure of community forest management were dichotomously coded (large/small, severe/not severe, presence/absence etc.) in order to quantify the qualitative information. Chi-square tests of independence were then used to statistically identify how each parameter led to the success or failure of a particular community forest management (Padgee, Kim, & Daugherty, 2006).

This thesis does not have the data consistency of the study by Misselhorn, nor does it utilize quantitative methods similar to Padgee, Kim, and Daugherty, however these studies exemplify the usefulness of meta-analytical studies to analyze factors that contribute to different outcomes at the community level. This thesis introduces a different way to utilize meta-analysis to analyze community level factors as they relate

\textsuperscript{37} Like the study by Pagdee, Kim, and Daugherty, each study in the meta-analysis of this thesis was written by different authors. While Misselhorn’s study utilized information from the same source within her study (and as such had consistent information available for each community within the study), many meta-analyses use a variety of studies written by many different authors. In these cases, there are often gaps of information between the studies, because different authors naturally have different perspectives or agendas in composing research on the same subject. There are various ways in which authors can cope with missing or inconsistent information between studies. For example, in this thesis, the inclusion criteria were made rather strict to avoid gaps in information and to ensure a comprehensive analysis.
to outcomes. This thesis used meta-analysis to create a critical, qualitative analysis of the known literature of water management studies within Peru. Additionally, utilizing NVivo software provided a supplemental discourse analysis that aided in further exploring themes within water management studies since 1990.

By utilizing meta-analysis to analyze different parameters that may lead to more positive or more negative outcomes at the community level, this thesis could potentially inform policy-makers on the critical educational capacity of community-scale meta-analytical studies to improve social and environmental outcomes related to resource management. Meta-analysis has been used successfully to compare the relative outcomes of different policies on certain phenomena and has also been used help policy makers identify effective solutions and management styles of different issues including agricultural methods, social policy, environmental policy and environmental equity (Ringquist, 2005; Groot, Poot, & Smit, 2007; Hunter & Schmidt, 1996; Mann, 1994). The use of meta-analysis in the aforementioned comparative policy studies and resource scarcity studies demonstrate that meta-analysis is an effective tool when comparing the effectiveness of different management/policy types as well as to determine underlying causes of resource scarcity.

The aforementioned meta-analytical studies in this section provide examples of how meta-analysis is currently being used in academia. Though meta-analysis is slowly becoming more widely used in the social sciences, the method can be applied to many studies in various fields that seek to comprehensively explore the correlations between variables and outcomes within and between different scales, places, or time-frames in order to deepen the level of understanding of a particular area of interest. This thesis
uses meta-analysis in this way to expand the current knowledge base of water management studies in Peru, suggesting what trends are visible, what areas of study are missing, and possible directions the research on this subject can go.

**Geographic Area and Climate**

Peru is ranked highly in terms of global water availability, however it’s water resources are extremely unevenly distributed. Of the three major climate zones in Peru, the Amazonian region of Peru, *la selva*, contains the majority of Peru’s water resources and is the least densely populated. The arid coast, *la costa*, contains the fewest water resources and the vast majority of the country’s population. Communities located in the Andean highlands, *la sierra*, experience fluctuations in water resources due in part to seasonality and glacial melt (Higa Ida, Chen 2010). Communities located within *la selva* do not experience natural water scarcity, only experiencing scarcity due to anthropogenic interactions with the hydrosphere. This thesis excluded water management studies conducted in *la selva* as they lack naturally occurring water scarcity and are also not considered to be permanently or seasonally arid by Köppen climate classifications.

In order to study water security outcomes as they relate to navigating concerns of natural water scarcity, a primary component of the question central to this thesis, it was necessary to only include water management studies of communities located in the areas of Peru that experience permanent or periodic aridity. Such communities must rely heavily on carefully calculated anthropogenic water management strategies in order
to maintain community life. Therefore, all communities within this analysis will be located entirely within la costa and la sierra regions of Peru.\(^{38}\)

Though the majority of the population in these two regions experience permanent or periodic aridity and therefore natural water scarcity, it seems some communities are able to maintain relative levels of water security while others experience chronic water insecurity. This means that despite the naturally occurring water scarcity that affects communities in the more arid regions of Peru, anthropogenic water management strategies have the potential to achieve fair levels of water security, though others experience insecurity. The literature has demonstrated that despite presence of natural water scarcity (which cannot be controlled), certain community-level water management systems (and the unique composition of variables associated with them) can result in social equity towards water resources and environmental wellness even in more water scarce regions.

While natural aridity cannot be controlled, the human factors that lead to various levels of water security can be studied to determine how anthropogenic factors can produce scarcity.

Source Materials and Language

With intermediate working knowledge of written Spanish, articles in both English and Spanish languages were examined for inclusion in the analysis, though it should be

\(^{38}\) Additionally, within these regions, only communities located in Köppen zones classified as permanently or seasonally arid would be considered for analysis.
noted that there were far more sources found in English than in Spanish. Additionally, the studies that fit each aspect of the inclusion criteria were all written in English. The data collection portion of this work constituted searches for academic articles. Scholarly books and data made available by various institutions of the Peruvian government (such as the Peruvian government’s statistical office, Instituto Nacional de Estadística e Informática – INEI) were also consulted, though were ultimately not included in the analysis as they did not fit the inclusion criteria. The search for academic articles included utilization of the Academic Search Complete database and OhioLINK’s Electronic Journal Center. Scholarly books were located with searches through OhioLINK and CLEVEnet library databases. The search strings performed for academic journal articles were the same as those performed in searches for scholarly books. After careful examination, none of the book sources met the inclusion criteria and thus book results were only used as supplementary information.

Timeline of Sources

As the central Peruvian government decided to neoliberalize many of Peru’s natural resources in the early 1990s, materials were only considered for review if they were published between 1990 and the present. Increased scholarly research has been published in the past several decades related to ancient irrigation systems within Peru, as many ancient irrigation systems continue to be used today. In order to eliminate any articles discussing historical water management systems, all the materials analyzed were required to have collected data between 1990 and present as well. This decision was created to ensure that all studies within the analysis would reflect community-level
water management after the important neoliberal shift, an important marker in Peru's political and economic history, had taken place.

**Search Strings**

In any field or topic of study, different authors describe the same phenomena in unique ways. While each source examined for inclusion in the analysis discussed some form of water management within what was determined to be an arid area of Peru, there are many different phrases that correspond with water management because there are different types of water management and also because there are many unique conceptualizations of what ‘water management’ actually means. As such, a keyword search in Academic Search Complete for ‘Peru’ and ‘Water Management’ would be bound to leave out many studies that also relate to water management in the country.


In each search, the term ‘Peru’ was set as a geographic term. The search strings for ‘Peru’ AND ‘water efficiency’, ‘Peru’ AND ‘irrigation scheduling’, ‘Peru’ AND ‘public water’, ‘Peru’ AND ‘private water’, ‘Peru’ AND ‘water conservation’, ‘Peru AND ‘water policy’ did not result in any studies that met the inclusion criteria for analysis. While each of the other search strings produced at least one result that met inclusion criteria, many of the search strings produced overlaps in results. Interestingly, the search strings for ‘Peru’ AND ‘water management, ‘Peru’ AND ‘Irrigation’ and ‘Peru’ AND ‘water supply’, (some of the more comprehensively titled search strings), together contained all of the articles that met the inclusion criteria. The searches resulted in a total of 340 academic articles, though some were repeated as results for multiple search strings. The abstracts of each of the 340 results were read to determine whether or not the articles related to water management studies in Peru. Those that did were read to determine whether or not they met the inclusion criteria for the analytical portion of this study.

Inclusion Criteria

After completing the search strings which resulted in 340 sources, the results were further filtered by eliminating all studies that did not meet specific criteria necessary to be included in the analysis. Some results (of the initial 340 findings) were irrelevant due to location, climate, timeline, repetition, or content that would make them irrelevant for the purpose of the analysis. The inclusion criteria specified includes:
A. Located within Peru:

There are many similarities between the water management techniques of many communities throughout Ecuador, Bolivia, Peru, and Chile as there are some overlaps in cultural history, climate, terrain, water sources, challenges and solutions to natural water scarcity. These similarities exist specifically in the Atacama Desert and arid highland Andean regions that extend throughout much of the Western Coast of South America. However, each country has distinct national water laws. Although some communities within Peru are not associated with the central government and thus operate their own local government in a semi-autonomous matter, the national government still has the potential to influence or affect any community within the nation’s borders. In order for this study to remain geopolitically consistent in terms of political ties, it was decided to only include case studies describing the water management of communities within Peru’s borders.\(^39\)

B. Located in climatic zones that experience permanent or seasonal aridity and fall into Köppen climate classifications BWh, BWk, BSh, BSk, CWb, CFb:

The climatic element was included to ensure the communities considered in the analysis were comparable in terms of having naturally occurring water scarcity. Even though there have been many water management studies in all areas of Peru, those written about communities in the water abundant Amazonian regions do not experience

\(^39\) It can be noted that it would be beneficial to conduct a similar study observing community-level water management outcomes within and across the four countries mentioned as well.
naturally occurring water scarcity as previously defined in the definition section. Utilizing such studies would not contribute to a better understanding of the disparities in water security outcomes experienced by communities in arid regions, and thus do not fit the purpose of this study.

C. Discuss a water management system as it operates/operated between 1990 and the present:

While data searches in Academic Search Complete and the Electronic Journal Center were selected to only find sources written between 1990 and the present, this specification alone did not filter out papers written during this period about historical water management systems within Peru. As Peru has a long history of water management including ancient irrigation systems that continue to be used in the present day, academic interest in the field has persisted and research regarding these important historic developments in Peru’s water management and irrigation history continue to be produced. Though these papers are important for developing an understanding of Peru’s climatic and social history as it pertains to adaptations to community structure, irrigation and agricultural practices, cultural and colonial influence (which indeed greatly contribute to modern political, social, and managerial structures regarding water), they do not discuss the current and recent disparities in water security between communities and thus would not be useful for the analysis.

D. Discusses the local population in detail.

As this study aims to discover more about the relationships between social and environmental factors that lead to varying outcomes in terms of water security, a study
can only be useful to this analysis if it includes adequate details about both. The important factors related to the population include population size, and if also available, the size of the area occupied by the community. If the community economy and local water management is based around farming and irrigation scheduling, the number of smallholders within the community was also included. Additionally, to explore gender disparities, the number of female smallholders was included if provided. The main sources of income, common forms of employment, and local economy regarding the specific community, local agriculture, as well as any levels of social unrest, social marginalization, stratification of wealth, disparities regarding access to resources or education were all considered to be anthropogenic variables that could impact the outcomes of water management at the community level. Though each study did not have to discuss each of the above criteria to be included in the analysis, inclusion required that at least half of the above criteria be recorded somewhere within the article. Without an intimate look at social life within the community, it would be difficult to determine the interplay between social and environmental variables as they relate to water security outcomes.

E. Discusses the local climate and geographic environment in detail:

Again, to analyze the relationships between social and environmental factors and water management outcomes, each article needed to discuss both in detail in order to be useful. A description about the climate, annual rainfall, elevation, main water sources, local watershed, groundwater use, average water flows (if the main water source is a river or stream), teleconnection influence (El Niño effects, etc.), and other variables that reflect the degree of natural water scarcity in the particular community.
F. Discuss local water management system/strategies.

As previously stated, all documents in the analysis must discuss local water management. Although water management can be conceived of in many different ways and can take on many different forms, this thesis is defining local water management strategies as the community-level managerial (whether hierarchically or horizontally governed) platform by which rules regarding (including, if applicable, but not limited to): water allocation, distribution, prioritization, cost or payment information, storage mechanisms, structural maintenance, penalty, levels of transparency, the rules themselves\textsuperscript{40} and the level of community satisfaction (or dissatisfaction) with the system, obedience or disobedience of the rules, ability to participate in the managerial platform if desired, level of social inclusion or exclusion\textsuperscript{41}, how adaptable the system is, what have been the historical influences or major changes to the system (and whether any major changes are expected: i.e. Majes Project, preparation for loss of glacial melt sources etc.) What types of water are used (are they local, irrigated, piped from city water/infrastructure, whether trucked water is used, and whether local water quality is a concern, etc.)

A discussion of the local water management system is essential to understand how a community interacts with their local water source as this can affect what types of industry and agriculture are possible, the types of jobs available, the ‘carrying capacity’ ______________

\textsuperscript{40} Rules relate to the ‘official’ or ‘unofficial’ rules regarding water management, whether they are willingly followed or enforced, what rules (if any) are commonly broken, and also relate to the environmental or social consequences of the rules or operation of the system as a whole.

\textsuperscript{41} If exclusion exits, it was noted what types of marginalization occur.
of the community based on local water sources and much more. It would be nearly impossible (and certainly not recommended) to discuss the relationship between anthropogenic and climatic factors at the community level as it effects local water security if the local water management system is not also discussed in detail. Different communities will have greatly varying water management systems (for a variety of social, political, cultural, historical, geographic and climatic reasons), so each study will not discuss all of the factors listed above, and it is unlikely that any particular study will include all of them. This was not of consequence to the analysis as the author(s) of each study included in the analysis provide an in depth look at how local water is managed in each community to the effect that it is clear how certain local environmental and anthropogenic characteristics affect local water management strategies, and in turn, how local water management strategies affect the people and the environment within (and perhaps beyond) the community.

G. List the sources of water available to the community.

Natural water sources in Peru can include groundwater, glacial melt, rivers, streams, rainfall, and lakes. Anthropogenic modifications to procure these water sources include storage mechanisms, diversion infrastructure (canals or pipes), pumped water, 

42 Here, ‘carrying capacity’ does not refer to Malthusian principles or even a ratio of population levels to available water resources. Instead, the term used here relates to population demand and source recharge. If ground water is used, only so much water can be withdrawn before the source becomes overdrawn and is no longer able to replenish itself naturally, putting excess stress on the natural fluvial system and the ecosystem it supports. Likewise, a river can also be overdrawn more to the point where natural flows are greatly diminished, though river flows can fluctuate a great amount every season of each year.
boreholes, and water trucks, among others. Depending on what resources the community has access to determines what sources of water can be relied upon for continued sustenance of the community. What resources are available, how much is available for particular uses, and how much is available in terms of seasonal variability are all related to availability\textsuperscript{43}. None of these factors related to water availability alone will determine what level of water security a community can or will achieve\textsuperscript{44}, but available water sources are certainly related to concerns of water scarcity in the arid regions of Peru. Even though all the regions within this study require a specific climatic classification related to aridity (and thus concerns of naturally induced water scarcity), there are regional differences in particular water sources for each community. It is thus important to have an understanding of what water will be available for use within the community, mandating available water sources as an inclusion criteria for this study. Additionally, if information was available regarding for whom the water was available and by whom, this information was included as well.

*Organizing Data*

Once the studies meeting the inclusion criteria were selected, they were organized within a matrix for the purpose of data organization. In this matrix, each case

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\textsuperscript{43} Causes of natural variability generally include drought, variance in glacial melt or river flow, and variations caused by El Niño.

\textsuperscript{44} No variable in the study should be seen as a singular determinant of outcome. This study is more interested in how variables, relating together in a specific community, uniquely lead to certain outcomes.
study was organized in rows along the Y-axis. The columns along the X-axis included the variables utilized within the study. Each variable was treated as independent to avoid making deterministic, universal claims that do not exist. Instead, this analysis was formed with the notion that the particular set of variables in each community together contribute to the water management outcome in a particular place at the particular time of study. A combination of variables that leads to a relatively positive water management outcome in one particular community at the time of study could lead to a relatively negative water management outcome in another community or at a different time. As such, none of the variables are seen as deterministic, positive, negative, or neutral. Instead, it is thought that the unique combinations of particular variables together are what may lead to a particular outcome.

Limitations

A challenge faced by this study is that most case studies were written by different authors. Although each case study met the inclusion criteria, the researchers present information in various ways, emphasize certain portions of the study, and used the information for different purposes. As such, the types of data available to use were not consistent throughout the study. Each study has gaps of information within the columns, making it difficult to compare each column between each case study. This is a challenge faced by meta-analytical research, however it can be dealt with in several ways.

Due to the strict inclusion criteria, each case study that met the requirements for inclusion is rigorous enough to approach questions of why certain combinations of
variables at the community level may impact water management outcomes within that particular community at the time of study.

While each and every factor related to a community, at a variety of scales, from the most human to the most physical characteristics are important to what determines a particular outcome of water management at the community level, it is impossible to be aware of each individual influence on a water management system, and additionally impossible to define every single factor that may be included. While there are certainly variables important to the outcome of water management systems this study failed to recognize, it also remains true that certain data for such variables were not available, and were therefore impossible to include. Without data for a particular variable, that variable cannot be analyzed. It is true that there are oversights herein, but to compensate, the inclusion criteria was very strict to ensure the analysis could be as thorough and comprehensive as current research has allowed this study to be.

Selecting Variables

As the literature review returned no meta-analytical studies regarding water management, there wasn’t a direct model with which to base the analysis. As such, the variables were determined independently. The decisions regarding which variables to include came from reading many studies related to water management in Peru. Once it was understand what types of information were frequently discussed in these studies, these variables were recorded and considered for the other articles analyzed. These frequently cited variables included population size, altitude, water sources, information about the local water management system, history of the community, recent or
proposed changes to the system, climatic information and others. Each type of information found that could be relevant to water management outcome was included in the columns within the matrix as an independent variable. While the variables included in the matrix were not universally discussed in all studies, as much information was extracted from the articles as possible if related to the chosen variables.

The variables selected are a mixture of environmental, geographical, climatic, social, historical, political, and cultural information about each particular community. This thesis considered each type of information to be important in its potential contribution to water management outcomes. As stated in the inclusion criteria, both social and environmental information were required for a case study to be included in the analysis, as a solely anthropogenic or solely environmental study of water management in a community would not truly represent why a particular outcome occurs.

NVivo Variables

The goal of this critical meta-analysis is to provide an overview of the existing literature related to water management systems at the community level in the arid regions of Peru. It demonstrates certain themes consistent within the literature relating to how water management is studied, analyzed, and perceived. The discourse related to these studies can provide an important vantage point into perceptions of certain themes related to water management, commonality of certain themes and phrases, and also how authors’ relate to certain subjects. In this way, the NVivo coding informed certain areas of the discussion portion of this work.
NVivo software is a tool that allows for manual coding of academic texts. By performing coding related to themes seen as essential to water management studies, the software has the capability to allow the researcher to perform text queries to further explore themes and discourse within the manually coded text. This thesis utilized NVivo software for two purposes. The first was to create nodes for the themes considered important to this work. These themes were (alphabetically) titled agriculture, author’s stated outcome, climate and geography, community identity, community social composition, conflict, economy, environmental issues, history of the community, history of water management within the community, local belief systems and local perceptions of water resources, main water resources, water governance, and water management systems.

The nodes that were created and the text that was coded for these nodes was based off of extensive research and reading of the literature. Text was selected for the ‘agriculture’ node when the local agricultural practices, including social, cultural, environmental and geographic parameters related to agricultural practices, were discussed. The ‘climate and geography’ node included the author’s description of the local community in terms of things such as altitude, weather patterns, proximity to important geographic features, seasonality and water availability, precipitation patterns, and beyond. Text was coded for ‘community identity’ that related to how the members of the community seemed to identify themselves; whether as urbanites, peasants or as Andean, or a variety of other terms. The node for ‘community social composition’ related to authors’ references to any divide in identity, socioeconomic stratification, or any apparent inter-community marginalization. Text was coded for the ‘conflict’ node that
related to any anthropogenic conflict related to water or other resources. Such conflicts could be present within the community, between communities, between local and national government and often included conflicts relating to water competition or prioritization, access and control, conflicting governance ideals between local and government management strategies, and upstream-downstream competition. The ‘economy’ node related to the main sources of income for community members. Text was coded for ‘environmental issues’ relating to any natural or anthropogenically induced environmental concerns. These concerns could relate to climate change, glacial melt, El Niño, droughts, floods, salinization, upstream/downstream competition, pollution, agricultural runoff, and the like. The ‘history of the community’ node was a parent node and coded text that related to when the community was established, the cultural and historical milestones within the community, and in what ways the community had evolved, and what traditions had remained over time. ‘History of water management within the community’ was a child node to the ‘history of the community’ node. While there were many overlaps in coding for the two nodes, ‘history of water management in the community’ related to information provided regarding the historical origins of water management in the community and transformations to the system to the present day. This node also coded for recent and proposed changes to the water management system in discussion. Text was coded for the ‘local belief systems and local perceptions of water resources’ node that related to how community members regarded water resources, and whether a local belief system influenced certain practices regarding water management. Such text could relate to whether water was seen as a right, as a good, as a shared resource, as a gift from nature or anything in
between. Some Andean communities' local belief systems are firmly rooted in spirituality related to a belief in mountain origin, and therefore view water as sacred (Trawick, 2001; Hogue & Rau, 2008). This node included any discussion of local water beliefs and their origins. The 'main water resources' node related to where community members get their water, whether from a stream, river, lake, diversion mechanism, or through privatization. 'Water governance' related to how water was governed in the particular community, and what ties, if any, were influenced by the national or regional Peruvian government. Any text related to governance or responsibilities, voting, or decision-making in the governance process was coded within this node. Text was coded for the 'water management' node as related to the specifics of how water is stored, diverted, managed, discussed within the community, and the decision making process related to these choices. Anything related to access and control over water resources was also included in this node. Altogether, these nodes were seen as providing a comprehensive overview of the important themes related to water management in the arid regions of Peru. The majority of text in each article meeting the inclusion criteria was coded and placed in one or more nodes within the NVivo software.

After meeting inclusion criteria for analysis, articles had to include only one community-level water management study in Peru in order to be coded in NVivo software. There was an additional limitation that provided that only searchable PDF documents could be uploaded into the software for coding. By this token, one of the articles (Hogue & Rau, 2008) could not be found as a searchable PDF document and thus could not be coded in the software. There were other articles that met the inclusion criteria that could not be uploaded into the software because they contained more than
one case study (Lynch, 2012; Crawford & Bell, 2012; Vos, 2005). As the software is set up to code for each document related to one outcome, the articles that presented two or more outcomes would be easily misconstrued by the software: the software wouldn’t be able to distinguish what codes were associated with an outcome for one of multiple case studies within a single document. The articles that met the inclusion criteria but could not be coded in NVivo (for one of the previously stated reasons), were manually coded following the same procedures, though were left out of the analysis and left for future study. The coding was systematic and the principles for coding each node were followed in the same manner for each case study. By remaining systematic, it was easy to follow the same principles for manually coding the articles that could not be uploaded.

The themes that were coded for were the same themes that were observed in the literature on water management at the community level within Peru and were the themes that were critically explored within the text in order to observe how these variables may relate to water management outcomes. Coding for these themes in NVivo allowed for manual organization of the themes within the text. Aside from aiding organization, NVivo also permitted query searches for certain discourses commonly found in the literature. These query searches allowed for an opportunity to critically examine important discourses related to water management in Peru to discover what terms and themes were frequently used, in which case studies they appeared, and in what context they were used. These queries aided in performing a critical discourse analysis for the six coded articles. While the NVivo query searches were limited to the six documents that were coded for in NVivo, certain themes emerged and it was possible to detect how certain terms were treated in the analyzed literature, and how
they may relate to larger themes in water management studies. Though common themes in the literature and of the discourse used in the literature was manually conducted, including NVivo as a supplementary aid was helpful to rectify and complement the analysis conducted in this study.

**Discussion of NVivo Query Results**

NVivo text queries were performed to enhance the analysis and discussion chapters within this work. The results of these queries are presented here in order to address certain themes in the sources used in this work to build a better understanding of the analysis. The first text search term queried for was ‘modernize’. It was queried for all sources and included stemmed words. Modernization is often seen as a solution to improve current water management systems throughout the country. These efforts are often used to supplement water availability along the coast or to support market-oriented, water intensive agriculture (Swiech, Ersten, & Pererya, 2012). This government solution often greatly affects communities in areas where water transfers (or other modernization efforts) either result in the provision of more or less water for the community. Four of the six case studies coded for in NVivo were about to undergo, or had already undergone, a modernization effort at the time of study. These were the communities of Cabanaconde (Boelens & Gelles, 2005; Paerregaard, 2013), Yarabamba (Swiech, Ersten, & Pererya, 2012), and Corporaque (Delgado & Vincent, 2013). The search for this term was conducted to view in what ways the discourse was used to discuss these efforts. The term was utilized in five of the six sources coded for in NVivo, each except for the study of Huaynacotas by Paul B. Trawick. The term was
found for Boelens and Gelles, 2005, as related to irrigation or agricultural modernization in ‘traditional’ systems, often referred by the government as being more ‘efficient’, ‘rational’, ‘coherent’, and ‘modern’ (Boelens & Gelles, 2005). Their descriptions of the term ‘modernize’ or ‘modernization’, do reinforce their claims that the state-implemented water management plans do in fact utilize inclusion-oriented strategies to convince ‘traditional’ communities that their systems are inferior to a modernized system. For the article by, Swiech et. al., 2012, terms stemmed from ‘modernize’ were related to ‘improve’ existing systems and ‘increase’ ‘high value crops’, with the end result of ‘optimizing’ the systems (Swiech, Ersten, & Pererya, 2012). The search for Delgado and Vincent returned that modernization can lead to ‘exclusion’ and ‘resistance’ for traditional water management systems (Delgado & Vincent, 2013). From these results, it can be asserted that the Peruvian government views modernization as an efficient and effective solution to improve water management, irrigation, and economic profits from increased agricultural yields. The authors reinstate that the process typically affects more traditional or Andean communities, the state often views traditional systems as inferior to modernized systems45, and that modernization efforts do not always produce more beneficial water management outcomes for the communities they affect. These query results rectify the findings and themes related to modernization discovered in the analysis.

In reference to the section on understanding Andean communities, it has been stated that there are several terms often used in the literature and in policy to describe Andean communities. This section also stated that some communities prefer certain

45This discourse demonstrates the government’s marginalization of traditional or Andean communities.
words to others to avoid being perceived as “backwards” and to avoid exclusion. The preferential terms differ in space and time. Additionally, certain terms are more effective than others in producing community advocacy and justice claims based on identity. As such is the case, it was important to run queries to see what terms related to Andean communities are used in the literature, how they are used, and in what contexts they are used to see how these discourses may effect outcomes as certain terms are clearly preferred by some communities, and political mobilization can be swayed by the use of different terms. The umbrella set of terms used to describe Andean communities include, in addition to the term ‘Andean’, campesino, indigenous, rural, traditional, and subsistence. For the NVivo queries, each of these terms was searched for in all nodes and sources, and stemmed words were included. These queries also support the definitions of the terms provided in the definitions chapter.

The term ‘Andean’ (and stemmed words) appeared 41 times in the coded material from Boelens and Gelles, 2005, 25 times in the coded material from Paerregaard, 2013, 14 times in the coded material from Trawick, 2001, 20 times in the material coded for Delgado and Vincent, 2013, and 1 time in the material coded for Vos and Vincent, 2011. The term did not come up in the material coded for in the article by Swiech, Ersten and Pererya, 2012, which is curious as the community was determined to be a hybridized community between ‘traditional’ Andean practices and state-governed system. The other hybridized systems and the autonomous system all had frequent use of the term, and the state-controlled system, discussed by Vos and Vincent, only used the term once, which was fitting related to the type of governance described in the system.

Discourse of the coded literature related to the term Andean was shown to be related to a unified group of people with particular sets of practices and livelihoods related to irrigation and farming. Descriptions associated with ‘Andean’ can be related to a particular territory, group, landform, resource or way of life. It does not appear that there were any negative connotations on behalf of the authors’ use of the term; rather the term was more frequently used to describe a particular way of community life.

In the coded NVivo articles, the term campesino was used by Paerregaard, 2013 three times and Delgado and Vincent, 2013 one time. The term was used in reference to the “riego”, a traditional style of water turns, and in reference to indigenous communities. It is interesting that this term wasn't more frequently used, considering the term campesino is meant to refer to subsistence-based or peasant communities. It is also interesting that the two articles using the term were published in the same year in the same journal, though this could be absolutely irrelevant.
The term ‘indigenous’ was found in the coded material 48 times in the article by Boelens and Gelles, 2005, two times in the article by Paerregaard, 2013, six times in the article by Trawick, 2001 and six times in the article by Delgado and Vincent, 2013. It was not used by Swiech, Ersten, and Pererya, 2012\textsuperscript{46}, or by Vos and Vincent, 2011. In the work by Boelens and Gelles, 2005, the term ‘indigenous’ was used in reference most commonly with ‘water control’, ‘peasants’, ‘empire’, ‘models of resource management’, ‘colonial contexts’, ‘peoples’, ‘leaders’, ‘communities’, ‘residents’, ‘organization’, ‘irrigators’, ‘informant’, ‘peasant organization’, ‘ways of life’, ‘beliefs’, ‘norms’, ‘practices’, ‘struggle’, ‘rights’, and ‘cultural framework’ (Boelens & Gelles, 2005). In the coded material for the article by Paerregaard, 2013, the term ‘indigenous’ was used in the context of ‘knowledge’, ‘citizens’ and ‘identity’ (Paerregaard, 2013). In the article by Trawick, 2001, the term ‘indigenous’ was used in reference to ‘systems’, ‘Andean’, ‘irrigation system’ and ‘irrigation’ (Trawick, 2001). In the use of irrigation systems, Trawick described indigenous irrigation systems as being “relevant”. In the article by Delgado and Vincent, 2013, the term ‘indigenous’ was used in the context of ‘communities’, ‘ethnopolitical arenas’, ‘people’, ‘model’, ‘rights’, and ‘struggles’ (Delgado & Vincent, 2013).

From these word associations, it can be seen that in the coded literature, the term ‘indigenous’ was associated with a group or community of people and a way of life with particular practices and beliefs with historical and modern significance. Often, the

\textsuperscript{46} It could be that, given the purpose of the article written by Swiech, Ersten, and Pererya, 2012, the objective of providing information regarding the proposed reservoir, was less concerned with nuances in discourse in a subjective or critical sense.
term was used in the context of particular sets of knowledge related to the practices undertaken by those described as ‘indigenous’. The associations for ‘indigenous’ were similar to those for ‘Andean’, though perhaps the term ‘indigenous’ had more of a historical context (exemplified with the word pairings with ‘empire’, ‘colonial context’ and also with some interpersonal and community level commonalities of those described as ‘indigenous’, such as belief systems, struggles, and identities).

The query search for the term ‘rural’ produced seven results in the text coded for the Boelens and Gelles, 2005 article, twice each for the text coded for the articles by Paerregaard 2013, and Swiech, Ersten and Pererya, 2012, once for the text coded for the article by Trawick, 2001, and three times in the text coded for the article by Delgado and Vincent, 2013. For the article by Boelens and Gelles, the term ‘rural’ was used in reference to ‘elites’, ‘communities’, ‘indigenous’, ‘organizations’, ‘population’, ‘livelihood’, ‘highlands’, and ‘lives’ (Boelens & Gelles, 2005). In the article by Swiech, Ersten and Pererya, 2012 the term ‘rural’ was used alongside ‘areas’ (Swiech, Ersten, & Pererya, 2012). In the article by Trawick, the term was also used with ‘areas’ (Trawick, 2001). In the article by Delgado and Vincent, the term was used with ‘communities’ (Delgado & Vincent, 2013). While not the most frequently used term to describe communities, the word ‘rural’ indeed had connotations with community populations, and groups of people in areas described as ‘rural’. Additionally, the term was used to describe a particular way of life and the structures and organizations associated with this particular lifestyle.

Though Andean communities can be described as ‘traditional’, creating a query for this word did not omit use of the word in relation to things outside of descriptive word use for particular communities. Regardless, this section remained consistent with the
formatting used to describe the other query results. The term ‘traditional’ was found six times in the coded text for the Boelens and Gelles article, three times for the article by Paerregaard, twice in the article by Swiech, Ersten and Pererya, 11 times in the article by Trawick, and nine times in the article by Delgado and Vincent.

In the article by Boelens and Gelles, the term ‘Traditional’ was used along with ‘bureaucratic’ and “‘backward’ technology” (in reference to inclusion-oriented strategies) (Boelens & Gelles, 2005). The article by Paerregaard was found to use the term in relation to ‘irrigation’ and ‘water source’ (Paerregaard, 2013). The article by Swiech, Ersten and Pererya used the term in relation to ‘irrigation systems’ and ‘agriculture’ (Swiech, Ersten, & Pererya, 2012). Trawick’s article used to term related to ‘local’, ‘procedures’, ‘respect’, ‘modes of operation’, ‘locally derived’, ‘equitable and efficient’ (Trawick, 2001). The article by Delgado and Vincent was found to use the term in relation to ‘moiety’, ‘community water governance arrangements’, ‘authorities’, ‘local crops’, ‘irrigation patterns’, ‘norms and authorities’, ‘customary’, and ‘water authorities’ (Delgado & Vincent, 2013).

In summation, the term ‘traditional’ was used to describe a specific type of community structure, just as the terms ‘Andean’, ‘indigenous’, ‘rural’ and ‘campesino’ have also been used, thought it was more often used describe the specific operations of certain communities, or in a historically significant descriptive sense of these operations and their significances to the communities.

Communities described as Andean also often have subsistence-based agriculture, for which their irrigation systems are often well suited and designed for. In addition to the previous queries for which descriptive community terms were searched
for, a text query was performed for the word ‘subsistence’ as well. This term showed up in the coded material one time each in three of the articles coded in the NVivo software. In the article by Boelens and Gelles, the term ‘subsistence’ was used to describe agriculture (Boelens & Gelles, 2005). Paerregaard used the word ‘subsistent’ in relation to the self-subsistence of households and the relationship of this lifestyle with low socioeconomic status (Paerregaard, 2013). Swiech, Ersten and Pererya used the term subsistence as a noun, meaning the way in which one makes an income (Swiech, Ersten, & Pererya, 2012). Though the case studies analyzed in this work closely relate to subsistence style agriculture, the term was not frequently used to describe the agriculture of these communities in this way. Subsistence-based lifestyles, by nature, are not driven by the market, and thus subsistence-based agriculture is usually more related to local production than to market-oriented production for export, which can be more water intensive (Vos, 2002). As such, the subsistence based-agriculture in certain communities may have some influence in more positive water management outcomes, as water conservation, due to planting of local crops, is often present. Due to the limited appearances of this term within the coded literature, it can be questioned to the degree of which the authors’ considered certain trends among subsistence-based agriculture and irrigation as having the potential to influence water management outcomes.

One of the main components of this thesis was to analyze water management outcomes at the community level, as studies far beyond the community scale may miss out on the intricacies of the needs and particular management preferences of a particular community, leading to marginalization or dissatisfaction in representation. Thus, in the inclusion criteria for the work, only studies composed at the community
level were considered for the analysis. This study was further interested in how the authors’ utilized the term ‘community’ within these works for the possibility of exploring how community-level water management research is conceived and carried out within the selected works.

The query for ‘community’ appeared multiple times in five of the six works, excluding the article by Vos and Vincent. The term ‘community’ appeared 65 times in the coded text for the Boelens and Gelles article, 54 times in the coded text for the Paerregaard article, twice in the Swiech et. al article, 60 times in the Trawick article, and 97 times in the article by Delgado and Vincent. These results make the term ‘community’ the most prolific of all the queried terms in this analysis, associating that the term held significance for the purposes of the majority of articles analyzed in this work, aside from Vos and Vincent and possibly Swiech, Ersten, and Pererya as the term was only found twice in the coded material.


The word ‘community’ was most often used to describe spatially linked people, tied to a specific unit of land or geographic location. It was also used in context with the beliefs and practices shared by a group of people, outsider’s perceptions of a group of people, the policies, governance, representation, organizations, and resource management of a group of people and also to describe lifestyles, struggles, and goals shared by a group of people. Though all six articles coded for had to meet the inclusion criteria, which allocated that they must be community-level studies, the ‘community’ query demonstrated that the four articles with the greatest use of the term also seemed to be more deeply invested in exploring the daily lives of community members, their perceptions, actions, struggles, beliefs, goals, and methods of securing and maintaining their lifestyle. These four articles seemed to be more invested in community life, sometimes, perhaps more than describing the community water-management system. It could be that for the authors of these four articles, that in order to understand the outcomes of water management at the community level, it was first considered equally, if not more important, to understand the intricacies of community life. These authors made it a priority to understand and explain community level intricacies to the reader.
Indeed, it seems, that the term ‘community’ was used in association with the names of the community types that were queried for, including ‘Andean’, ‘traditional’, and ‘indigenous’, as there were positive trends associated with use of these words together with ‘community’.

As contestations over water resources can be common, even occurring in communities with very socially equitable access to water resources, text queries were also performed for the phrases ‘conflict’ and ‘competition’ in order to have a better understanding of the array of community-level struggles over, or related to, water. In the text query performed for ‘competition’, results were found in five of the six articles coded. The article by Boelens and Gelles included two, with the word ‘competition’ associated with ‘water mayors’ and ‘Andean’ (Boelens & Gelles, 2005). The article by Paerregaard had four, related to ‘regidores’ (part of the dual-division system of water division in traditional moieties), ‘conservation’ (as in the moiety system, conservation is a result of competing to irrigate), ‘dual-division’ and in the title (Paerregaard, 2013). Interestingly, the uses of the word ‘competition’ in the article by Paerregaard were all positive word associations, even though the word was initially coded to supplement the text search for ‘conflict’. The initial thought when creating the query was that the words ‘conflict’ and ‘competition’ could be interchangeable, or rather that the term competition would be used to explain competing interests or claims related to water resources allocation and management. Instead, use of the term ‘competition’ by Paerregaard focused on the competitions held in traditional dual-division systems, by which two water mayors, one in charge of each side of the system, compete to irrigate their own side in a fast, equitable, and waste-free manner (Paerregaard, 2013). The word competition, in this
sense, is positive because it contributes to the positive water management outcomes related to the traditional mode of water management in the community of Cabanaconde, by which social equity to resource access and inclusion and environmental outcomes are all traditionally more positive. Likewise, the word ‘regidores’ associated with the word ‘competition’ in the article by Boelens and Gelles also related to the positive associations with the word ‘competition’ as associated with the traditional dual-division system (Boelens & Gelles, 2005).

The article by Swiech, Ersten and Pererya. used the word ‘competition’ three times. The first was used with ‘between various institutions’, relating to competing interests related to water use, with ‘for the water resources’, with ‘spatial’ (relating to spatial competition between irrigating sectors) (Swiech, Ersten, & Pererya, 2012). Unlike Paerregaard, the terms ‘competition’ as used by Swiech, Ersten, and Pererya were all negative associations with the word relating to competing interests. These results were more typical of what was initially expected of the query search for the word ‘competition’, as use of the word was more closely related to the word ‘conflict’. The article by Trawick used the word once, in association with ‘upsetting the power balance’ (Trawick, 2001). Again, this is using the word competition in a negative sense. Delgado and Vincent’s article used the word twice in relation to ‘scarce water’ and ‘conflict’, other negative word associations (Delgado & Vincent, 2013). The article by Vos and Vincent did not make use of the word ‘competition’ in any of the coded text.

Interestingly, the word ‘competition’ was used by Boelens and Gelles and Paerregaard in a positive association with the dual-division water management system utilized in moiety systems in which fierce, but culturally significant and well-calculated
competition is associated with more positive outcomes. In this sense, ‘competition’ was used to describe a beneficial part of the water management system. The uses of the word ‘competition’ by the other authors were utilized more in association with competing interests over water management and resources. In these instances, ‘competition’ is an unintended effect of human-produced scarcity, as natural water scarcity alone does not produce competition.

The text query performed for ‘conflict’ had 14 total references across the coded material for three of the six articles. The word ‘conflict’ was used more times than the word ‘competition’, though it appeared in fewer articles. Boelens and Gelles used the term ‘conflict’ in association with the words ‘solve’, ‘normative frameworks’ (not associated with water management, rather with conflicting frameworks used to study water management) and ‘competition’ (Boelens & Gelles, 2005). ‘Solve’ is a positive word association, as it rectifies that there are attempts or desires to remove water conflicts. Paerregaard used the term in association with ‘water… daily’, ‘growing water scarcity’, ‘users’, and ‘new’ (Paerregaard, 2013). In this sense, Paerregaard used the term ‘conflict’ to describe conflicts over water resources, and between water users, indicating that they occur on a daily basis and new water conflicts have emerged or are about to emerge in the water management of the community. Delgado and Vincent used the term ‘conflict’ in association with ‘processes of cultural politics’, ‘normative frameworks’, ‘within and among communities’, ‘experiences and negotiation’, and ‘irrigation’ (Delgado & Vincent, 2013). The results for ‘irrigation’ and ‘normative frameworks’ were from the coded references to the titles of other works, and did not reflect the internal document’s diction choices of the authors, though do show discourse
associated with other water management studies. The use of the term ‘conflict’ with ‘processes of cultural politics’ is interesting as it indicates that water is culturally significant, though this significance differs between cultures and the division of beliefs can result in conflict. The association ‘within and among communities’ means that conflicts over water resources and governance exist at many scales, can exist between communities and within an individual community. Although the community was the set measure of observation for water management within this thesis, this type of discourse analysis provided further insight that while community-level studies are more likely to express the particular water needs of a location, attention must be paid to whether there are conflicting ideas within a community regarding how water should be managed. It is imperative to study and represent conflicting ideals over water management within the community scale as failure to do so will result in further marginalization of a particular group. The use of the term ‘conflict’ with ‘experiences and negotiation’ reflect that conflicts over resources are a platform for building knowledge, at the most basic level, to become aware of competing interests, and if pursued, to mobilize towards equitable sharing of the resource in a sustainable manner.

Water scarcity and water security are common phrases used in water management literature to describe conditions related to availability versus particular desire for water resources. Both of the terms are subjective and therefore can serve many different purposes and are utilized in various contexts with different meanings. For the purposes of this thesis, it was decided that the term ‘water scarcity’ was too limiting, as water scarcity can refer to a naturally induced deficit of available water resources (in reference to things such as drought) or can be created by human ends. Water security,
on the other hand, relates to how comfortable a particular group or area is in relation to ease of access to what is perceived to be a sufficient amount of water to regenerate and sustain the particular group or area. To explore how water scarcity and water security are utilized in the articles coded for in this study, text queries were performed for the words ‘scarcity’ and ‘security’.

The text query for the word ‘scarcity’ resulted in one use by Boelens and Gelles in reference to ‘overcoming’, pertaining to the ideal that overcoming scarcity is possible, perhaps further referencing that humans do play a part in producing water scarcity, and that human ends can also play a part in overcoming the issue (Boelens & Gelles, 2005). Paerregaard utilized the word four times in relation to ‘growing’, ‘consequence’, ‘climate change’, and ‘recurrent periods’. Paerregaard's use of the term relates to increased water scarcity, in part perpetuated (semi-naturally) by climate change, and that water scarcity does occur through natural fluctuations in water availability (in reference to ‘recurrent periods’) (Paerregaard, 2013). These uses of the term recognize that water scarcity is partially naturally occurring, that it will continue to occur and increase. Swiech, Erste, and Pererya used the term ten times in reference to ‘issues’, ‘increase’, ‘constant’, ‘crops resistant to’, ‘induced by’, and ‘created by’. These uses of the term demonstrate a knowledge that human actions can prevent some further issues of water scarcity, such as by utilizing planting techniques that use crops with minimal water needs, that water scarcity can be viewed on a temporal scale, that water scarcity has multiple triggers, and multiple consequences (Swiech, Ersten, & Pererya, 2012). Trawick used the term 11 times in reference to ‘share’, ‘prevailing’, ‘water’, ‘extreme’, ‘conditions’, ‘foster’, and ‘exacerbating’. These uses of the term allocate that according
to Trawick, water resources can be shared despite the scarcity, water scarcity is not a concrete term and can be viewed on a graded scale (by use of the words ‘extreme’, and ‘exacerbating’), that water scarcity has consequences (‘conditions’), and that certain actions can increase water scarcity (with ‘foster’ and ‘exacerbating’) (Trawick, 2001). Delgado and Vincent used the term four times within the coded material to relate to ‘precipitation’, ‘obliged’, ‘improvements may have lessened’, and ‘equity’ (Delgado & Vincent, 2013). These uses of the term recognize both natural sources of scarcity (precipitation), and human ends that can reduce scarcity (‘improvements may have lessened’, and ‘equity’). Also, that water scarcity can necessitate certain social parameters to cope with the condition of scarcity.

The term ‘security’ was not used as frequently as the term ‘scarcity’, perhaps because in the arid regions of Peru, ‘scarcity’ is perceived as a greater issue and many communities are not viewed as having particularly high levels of water security, though these ideas are subjective. Additionally, unless creating a study to understand why a particular community is considered to be water secure, most water management studies tend to focus on particular themes or issues, and the study of water scarcity may have more perceived applications than studies of water security. The term ‘security’ was used in three of the six articles: by Delgado and Vincent, Paerregaard, and Swiech, Ersten and Pererya. Delgado and Vincent used the term to relate to ‘researcher’, ‘threatened water rights and’, ‘collective identity, increase their’, and ‘ethno-politics’ (Delgado & Vincent, 2013). These terms relate to the studies of water security, the politics, identity, and rights claims associated with water security and the struggles, or mobilization, to maintain water security. Paerregaard used the term ‘security’ in association with
‘sufficient’, as relating to producing adequate crop yields. In this sense, the term was used to relate to the ability of the community discussed to utilize water in a way to ensure that lifestyles could be maintained, which relates to the human aspects of water security. Swiech, Ersten and Pererya used the term four times in relation to ‘food’, ‘absence’, and ‘more’. Though the previous uses of the term ‘security’ have been associated with water, Swiech, Ersten and Pererya used the term twice to relate to food security, an important reminder of how intricately connected water and food production are, and by the same nature, water security and food security are also intricately related.
Analysis

Overview

In the Analysis of this work, the case studies that met the inclusion criteria will be discussed. The first portion of the analysis for the six articles that met the inclusion criteria will include a summary of each system analyzed to provide the reader with an understanding of how the water management systems operate at the community level in addition to providing a background for the resulting outcomes of the analysis. The summary of each case study will include the elements that were viewed as potential influences of water management outcomes at the community level, relating back to the thesis question. These elements were included in the matrix that was manually conducted and were subsequently added as elements to code for with NVivo. Additionally, these elements reflect the inclusion criteria, as this information was considered necessary to discuss water management outcome at the community level and were therefore present in all of the articles utilized. The elements included are the years of the study, the purpose of the study, the name and relative location of the community, the size of the community, the climate of the community (reflecting the Köppen classifications as described in the climate chapter), the economy of the community, the main source or sources of water within the community, the main uses for water in the community, reflection of any conflict or competition over water resources or within governance or operation of management, detailed description of the operation and rules of the water management system within the community and how the system is
governed, and will also include the level of state-imposed government involvement in such communities. After this summary is provided, the outcomes of the analysis for each case study will be presented.

In any system where a selective group of individuals is in charge of providing a resource for a large group of people, especially in a top-down governance system, chances arise for the inequitable distribution of said resources. When community members live in a settled space, are distributed in different orientations, and have different mechanisms for producing self or family level sustenance (whether self produced or through larger capitalistic systems based on a market economy), there lie challenges related to how certain resources should be governed, produced, and procured. In any such system (within which a bureaucratic system dictates how resources, such as water, are to be obtained) it is unlikely that all citizens of a particular community will receive equal access to the procurement of certain resources, nor will they have equal access or opportunity to participate in the decision making process of such decisions.

Many case studies examining the effects of resource management at the scale of the community (or larger) describe the management of these systems in binary ways, as either being successful or not successful (or a ‘failure’). (Guevara & Milla, 2007; Trawick, 2001; Ioris, 2012; Whittington, et al., 2009), positive or negative impact (Carpio, Loayza, & Datar, 2011), as working or broken down (Whittington, et al., 2009), functioning or not functioning (Prokopy, Thorsten, Bakalian, & Wakeman, 2008), adequate or not adequate (Hubbard, Sarisky, Gelting, Baffigo, Seminario, & Centurion, 2011), or by quantitative level of vulnerability (Crawford & Bell, 2012). While these terms
may fit the purposes of the research they accompany, this meta-analysis is using a comprehensive approach within which the term "success" would be rather limiting to the analysis. In any particular community, the type of policies and governance institutions that suit a particular group of people may not suit another. In any heterogeneous society, it cannot be assumed that benefits are distributed, received, or perceived equally among all citizens. By this logic, this analysis evaluates each case study utilized in this meta-analysis not by using the term ‘success’, but rather by using the term outcome.47 While stressing that each case study, and corresponding outcomes, are seen as unique, this study analyzed the outcomes of the particular water management strategies at the community level based on the authors’ stated outcomes as well as based on how a more positive or more negative outcome would be defined by the research question in this thesis. For the purposes of this study, it is understood that no outcome related to water management at the community level will be completely positive or negative for all members of the community. As such, outcomes will be analyzed by whether the particular water management system at the community level produces a more positive or more negative outcome for the majority of the population. While the conceptualizations of ‘more positive for the majority’ and ‘more negative for the majority’ are indeed binary, this particular discourse offers more room to question and analyze why a particular system is considered to be more positive or more negative, can include a gradient of outcomes within and between these terms, and can also question for

47 Use of the term “outcome” also relates to the research question, which states “In the arid and semi-arid regions of Peru, how do the combinations of social and environmental variables at the community level affect water management outcomes".
whom these results do and do not apply within each community, revealing deeper sociopolitical structures of inequality that perpetuate human induced water insecurity.\footnote{This thesis argues that in any top-down governance system, some level of human produced resource insecurity will inevitably occur, as ‘successfully’ providing for all individuals and needs within a community is not possible. The majority of needs can be met, often with a good deal of participation, organization, and the intention of equitable distribution, but in the realization of provision, not all needs can be prioritized. Additionally, is it likely that the entire community will perceive the actualization of governance and management of resource distribution in an equal way, leading to some level of dissatisfaction in the public sphere. The term “success” is highly subjective, and a more malleable definition of “outcome” with use of the terms more positive or more negative, though still regarded as subjective, allows more room for the discussion of the intricate nature of resource management outcomes.}

Here within, an outcome stated as ‘more positive for the majority’ or ‘more negative for the majority’ will be based on evidence from each case study in addition to the three components of water management that this thesis considers necessary to make claims regarding outcome. First, this analysis regards social equity toward water access as one of the primary determinants of a more positive or more negative outcome. This aspect relates to, but is not limited to the ease and ability of citizens at the community level to access clean and affordable water resources. The second aspect related to determining a more positive or more negative outcome relates to equity and inclusion in the decision making process. Analyzing this outcome includes determining the ease of ability to participate in the decision-making process as certain social situations may prevent one from being able to participate. Barriers to participation can include factors such as, but not limited to, proximity and ease of access to participation (if there are location-based or temporal barriers), political barriers, and social barriers...
including time commitment and availability, level of education, or socioeconomic status. The third outcome analyzed relates to environmental wellness. Though all water management systems will impact the environment through modification of local hydrology, environmental wellness outcomes were evaluated based on the scale of local hydrological modification, the intent to conserve water and reduce waste within the system, and an active concern within the rules or policies of the management regime to impose the lowest environmental impact while maintaining or improving local ecology.

As such, for each case study analyzed, there are three separate outcomes relating to: 1) Social equity to water access, 2) equity and inclusion in the decision making process, and 3) environmental wellness. Regarding 1) Social equity to water access and, 2) equity and inclusion in the decision making process, these facets were analyzed and determined to have a ‘more positive outcome for the majority’ or ‘more negative outcome for the majority’ for each individual case study. The third outcome, relating to environmental wellness, will be shortened as having a ‘more consequential’ or ‘less consequential’ for each individual case study. The evaluations were made based on careful examinations of the text within each case study and were as objective as possible. For each case study, the analysis was based on text solely from the case being studied and information from other articles or sources was not used to determine the analysis. As each case study in this analysis met the inclusion criteria, it was considered that each, on it's own, would have enough information to conduct such an analysis.

Additionally each case study was analyzed for what type of water management system was present at the community level. This was done in order to compare
elements and outcomes of communities with the same type of water management. Communities were determined to have one of three types of systems including: 1) Traditional, Andean or autonomous management. These three terms are used to reflect the discourse of the authors within this case study. Though the terms are not necessarily interchangeable in a broader context, within the case studies utilized herein, “traditional” refers to traditional Andean management, and autonomous management refers to a ‘traditional’ or Andean system that operates outside of state involvement. A second system type is a 2) ‘state controlled’ system. With this categorization, it is understood that the state has full authority over water governance in the community. Typically these systems incorporate modernization efforts. In these systems, the state has full control over the water management in the community and often utilizes technocratic mechanisms to control, store, and disperse water resources. The third categorization is a 3) ‘Hybrid’ system by which the state does have a presence in the water management at the community level, but ‘traditional’ or ‘Andean’ water management customs are still used. Hybridized systems can either have coexistence between Andean and state governance models, or can have competing systems. Within communities determined to have hybridized models, the distinctions are stated.

It can be argued that due to an increasingly globalized and mobile Peru, all systems are at least a bit hybridized, as the state technically has control of water

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49 It should be noted that the fully state-controlled system analyzed in this thesis, the Chancay-Lambayeque system, does not use any major technocratic system, but instead uses ancient irrigation networks. While this occurs in other state-controlled systems, many large-scale state-controlled systems do utilize or intend to implement technocratic systems.
resources throughout the country and because remnants of local traditions can be found in almost all areas. For the purposes of this study, the water management systems in communities that are almost completely dictated by the state will be called ‘state controlled’, and those that are almost completely dictated by local customs will be called Autonomous/Andean.

**Summary 1: Boelens and Gelles, 2005: Cabanaconde**

The first article meeting the inclusion criteria for analysis was “Cultural Politics, Communal Resistance and Identity in Andean Irrigation Development” by Rutgerd Boelens and Paul H. Gelles. The Peruvian community analyzed in the study was that of Cabanaconde, a historically Andean community that distinguishes itself ethnically from other communities in the region (Boelens & Gelles, 2005). The community of Cabanaconde is located in the Colca Valley in the Department of Arequipa. The size of the community is approximately 5,000 individuals, making it the largest community in the Colca Valley, though there is a good amount of outmigration from the community to migrant colonies in Arequipa, Lima, and Washington D.C. (Boelens & Gelles, 2005). The outmigration patterns have caused outside influences to further percolate into the community. Cabanaconde was formally established during colonization as a Jesuit Mission town. This lineage undoubtedly influenced the way water in the community was managed, though strong Andean water management elements persisted historically to the present day. The people of Cabanaconde practice worship of mount Hualca-
Hualca,\textsuperscript{50} *pachamama*, and also Catholic figures. In the climatic analysis of this thesis, the climate of the region was determined to be BWk. The main use for water in the community is for irrigated agriculture, around 1,200 ha in total. Agriculture is the main economy in this campesino community. The primary water source for the community had solely been snowmelt and flows from mount Hualca-Hualca, but at the time of the study all water for irrigation purposes comes from the Majes Canal in addition to any snowmelt from Hualca-Hualca.

The purpose of the authors' study was to demonstrate the political and social ways in which Andean communities are transforming in response to increased involvement in the communities by state-imposed entities designed to implement new water management strategies, such as with the Majes canal. The authors are concerned with the often-utilized ‘inclusion-oriented’ strategies that state forces use in order to gain control over Andean communities. These ‘inclusion-oriented’ strategies are created to make the members of Andean communities feel as though their systems are backwards or inadequate, and offer them a promise of inclusion, progress, and equity within the state system\textsuperscript{51}. According to the authors, once ‘included’ the state exerts full
\begin{itemize}
  \item \textsuperscript{50} Melt from Hualca-Hualca provides the natural source of water for the community. Historically, the people of Cabanaconde worship Hualca-Hualca as they believe their ancestors came from the mountain. Colonizing influences have contributed to the presence of certain elements of Catholicism now embedded in the local belief system (Boelens & Gelles, 2005).
  \item \textsuperscript{51} Referring back to the definitions chapter in this work, there are several terms that can be used to describe Andean communities, including ‘indigenous’, ‘traditional’, ‘campesino’, and ‘peasant’ among others. While Andean communities in other countries assert cultural significance with the term
\end{itemize}
control and attempts to force the communities to leave behind their traditional customs. Instead of implementing the future as was proposed, these ‘inclusion’ strategies often result in disappointment among community members in addition to “social and cultural disintegration” (Boelens & Gelles, 2005, p. 316). The mixture of historical influences over time, from pre-colonial domination, to Spanish colonization to the present state system, have created a very unique combination of social and political influence in many highland communities, including their irrigation systems. Many communities affected by these regimes continue to be considered distinctly Andean, both by the communities themselves as well as by outsiders. Cabanaconde is one such community that defines itself as distinctly Andean despite centuries of political influence by different regimes. The study demonstrates how the community of Cabanaconde continues to counteract the state system and exert as much of their own political will as possible, especially regarding water management.

The traditional dual-division water management in the community revolved around two elected water mayors, whom according to custom hold snake-ended staffs to signal authority and are in charge of managing the distribution cycle (Boelens & Gelles, 2005). These men take turns spending four consecutive days and nights along the irrigated fields for monitoring purposes and also for spiritual reasons. In the dual-division system, based on the ‘anansaya’ and ‘urinsaya’ moieties, each moiety is represented by one of the water mayors. Equilibrium is achieved through this dualism in ‘indigenous’, using the term for political mobilization many communities in the Peruvian Andes use other terms that are less likely to lead to social exclusion as the term ‘indigenous’, within many Peruvian social contexts, is typically associated with “backwardness”.

121
a metaphysical sense as dualism is strongly rooted in the spirituality of the Cabanaconde community, and this process also ensures the conservation of water. Not obeying the proper rituals regarding water management is in extreme opposition to the community’s traditional spiritual beliefs, as water has the power to take the lives of those not behaving in accordance of the water management rituals (Boelens & Gelles, 2005).

The Peruvian state legally owns all the water resources in the country and has the power to impose any water management regime it chooses, and as such is usually more concerned with servicing economic ends and urban areas along the coast rather than concerns of the spiritual, social, and environmental well being of communities in the highlands. Since the imposition of the Majes canal, many of these traditional practices (such as the water mayors) are no longer necessary and may soon be perceived as irrelevant within the community despite long-standing cultural and spiritual significance. For example, instead of the traditional water mayors, a new type of repartitioner controls the distribution of water following the state-imposed ‘de canto’ model of distribution, in which water is distributed sequentially, rather than by the traditional practice of dual-division. These repartitioners are paid in money and the position is considered to be servicing a minor civic duty. Traditionally, water mayors receive gifts of coca and liquor for fulfilling an important cultural, social, and spiritual task (Boelens & Gelles, 2005). The focus on monetary payment has reportedly caused a more self-serving motivation to collect more money at the sake of maintaining an equitable system. Despite this, the author’s report that community members continue to practice mountain worship. As with many dual-division systems, the binary mechanism
of irrigation is more of a fierce but well-intentioned competition, and the nature of this system minimizes fights over access to water resources. As such, competition under traditional dual-division water management system, prior to hybridization, was not reported as a major issue in the community of Cabanaconde. The main conflicts at the time of the study, post-hybridization, were stated to arise from the state-imposed hierarchical ‘de canto’ system’s opposition to the traditional water management system in the community (Boelens & Gelles, 2005).

In summation, the authors’ argue that although the state-imposed model has become a significant part of water management within the community, community members still recognize that the state’s interests are more firmly rooted in serving urban communities along the coast and commercial interests. As such, the community is adamant to retain many elements of the local model as a form of discreet resistance. Interestingly, the authors’ note that this local model is firmly entrenched in the colonial legacy of the community- elements of the same system that was forced upon the community centuries ago have now become so culturally entrenched that they form the model with which to resist the present day state model. Community members continue to claim water rights and fight for equality and demand greater justice in the decision making process (Boelens & Gelles, 2005). Arguably, the impetus for the rather cooperative hybridized water management model has partially stemmed from the continued practice of the spiritual tradition by most of Cabanaconde’s citizens. In recognition of the need for resistance, community members have gained social mobility, assert their presence at local meetings, and have gained more headway regarding
cooperation with the state as they absorb, at their own accord, the forces of the state into their own unique system (Boelens & Gelles, 2005).

**Analysis 1: Boelens and Gelles, 2005: Cabanaconde**

After carefully reading the text, the water management of the community was identified as a ‘hybrid’ system as it combines rules locally derived by the community alongside state imposed forces. Regarding the three components related to outcome, social equity to water access in the community was found to be at similar levels both before and after the state’s intervention and imposition of the Majes project. The local model of water management produced by the people of Cabanaconde, prior to state intervention, revolved around the equitable and rather sustainable method of dual division. As the local people have fiercely resisted total state control, they have ‘absorbed’ the state model into their own system, and retain use of their dual division model alongside traditional mountain worship (Boelens & Gelles, 2005). It is partially thought that because the people of Cabanaconde continue to utilize dual division at the time of the study, that the water access remains rather equitable for the majority of the population. Though outcomes were similar before and after imposition of state control, the outcome related to social equity was determined to be more positive for the majority, as the majority of citizens have equitable access to water resources.

Regarding equity and inclusion in the decision making process, the state initially attempted to created hegemonic control over the community through an “inclusion-oriented” strategy, however the local people recognized that the interests of the state are firmly rooted in economic benefits and international power holders and are not for
the local people, who traditionally are excluded from the decision making process related to state control of water management. To resist exclusion, the people of Cabanaconde fought to practice their local model of water management as much as possible. Though not explicitly included in the decision-making process of the state, the resistance of the people of Cabanaconde was so strong that they remained major power players in the realization of how water is managed at the community level. As the community members of Cabanaconde have slightly less control over the decision making process despite similar outcomes related to equity, also considering that the state does not necessarily make it easy for members of the community to participate, the outcome related to equity and inclusion in the decision making process was determined to be more negative for the majority. The community members who perhaps do benefit from the inclusion are those chosen as repartitioners who greatly value the economic benefits, though arguably at the sake of slightly corrupting the system for self-serving interests.

Regarding the third principle related to outcome, the outcome was determined to be more consequential as the fluvial impact post-hybridization was substantially greater than it was pre-hybridization, affecting local ecology. In summation of the outcomes related to social equity to water access and equity and inclusion in the decision making process, it remains at the time of the study that despite strong attempts at total interference by the state, the people of Cabanaconde actively resist state methods of control and retain many aspects and customs related to their local model of water management. Due to this conclusion, it was determined that within Cabanaconde at the time of the study conducted by the authors, the hybridized water management
system is more equitable, or more positive for the majority of the community members in terms of social equity, but more negative in terms of equity and inclusion in the decision making process, and more consequential regarding environmental outcome. That is not so say that the community members do not have to actively fight for their water rights and traditional maintenance of the water management system, rather, that the outcome of the fierce resistance of the state model by the people of Cabanaconde results in a more positive outcome for the majority of the community regarding access, though the results pre- and post-hybridization are similar. While many other communities facing similar situations give way to the bureaucratic dominance of the state and adopt a modernized, completely state-controlled water management system, what is it that makes the people of Cabanaconde so resistant to the full imposition of state control? This will be a topic of further analysis in the discussion section, but it must be questioned whether the citizens of Cabanaconde’s extreme local pride in their cultural differences, separating them from other communities in the region, could be a catalyst for the strong resilience to maintain local customs, identity, and water management systems as much as possible alongside the imposition of the state-controlled system.

*Implications of Two Studies Within Cabanaconde*

A second case study that met the inclusion criteria for use in the meta-analysis also analyzed the water management of the community of Cabanaconde. This study is titled, “Governing Water in the Andean Community of Cabanaconde Peru: From Resistance to Opposition and to Cooperation (and Back Again?)” by Karsten
Paerregaard. The author collected data in Cabanaconde in 2011. While the article by Boelens and Gelles never states when the data was collected, it was published in 2005 meaning that the study by Paerregaard was collected at least six years after that done by Boelens and Gelles. With two articles fitting the same inclusion criteria for the same community in this sense, allows an exploration into how the community of Cabanaconde has changed within a decade. It was previously stated in this thesis that a limitation of meta-analysis is that using sources from different authors will produce some inconsistencies in the type of data presented. Having these two articles provides insight into how different two sets of authors, even when examining the same community, can interpret and record the same phenomena in different ways. While the majority of the information interpreted between the two articles (while allowing room for differences that may have arisen in the gap of time between the collection of data for the two studies), was quite consistent, certain phenomena were given more or less importance, or may have been excluded altogether despite potentially being a factor that can alter water management outcomes. This exemplifies an issue that can be faced with meta-analytical studies. When a meta-analysis is relying on comparing data on a single subject by multiple authors, there are bound to be gaps in information in addition to the important realization that not all authors or researchers will place equal importance on different aspects of the study. Additionally, bias, familiarity with the subject, and assumptions not explicitly stated to the audience may sway the reader’s understanding and interpretation of each work, which can add an element of difficulty to this type of broad scale analysis. For example, while the article by Boelens and Gelles states that the community of Cabanaconde retain good levels of equity to water access, they did
discuss many details about how the local people and the state manage to coexist or compete. Paerregaard provides more details regarding how the community members collaborate with the state, providing insight as to how the water management outcomes in Cabanaconde are realized. The discrepancies in information did lead to a different outcome classification for one of the categories, which will be further emphasized in the discussions section.

The effects of the gaps in information exemplify that all knowledge is partial and that no two authors, even when discussing the same community, will describe the community in the same way. Rather than viewing the discrepancies and gaps between the two articles in a negative context, it can be regarded instead that more knowledge is always beneficial to provide additional insight to a subject as well as to remind the reader that any case study must be analyzed with the notion that any study only provides a partial description of phenomena within a place.

That stated, the article by Paerregaard was treated as unique (as all of the articles within the analysis were) and the description of water management type and of the three concepts related to outcome herein will proceed without infiltration of knowledge or statements made about Cabanaconde in the previous article, and will relate only to how Paerregaard describes the case study.

Summary 2: Paerregaard, 2013: Cabanaconde

The second study in the Analysis is titled “Governing Water in the Andean Community of Cabanaconde, Peru: From Resistance to Opposition and to Cooperation (and Back Again?)” by Karsten Paerregaard. The data for the study was collected in
2011 with the purpose to examine how state water governance affects water management in the Andean community of Cabanaconde, especially as it relates to the Majes project. The author took careful examination of the role of resistance by members of the community, and the role of the state’s eventual acquiescence to these requests in shaping the current relationship between the state and the community regarding local water management, and how this could be an example for shaping positive outcomes in other communities undergoing the transition towards hybridized water management.

The community of Cabanaconde is located in the Department of Arequipa within the Colca Valley and consists of approximately 5,000 individuals within 549 households. Most households also claim land ownership for irrigation purposes. The community is a campesino, meaning that agriculture is the main occupation of the residents, who retain a mainly subsistence-based economy based on farming and herding. The majority of water use is for irrigation purposes, and traditionally the majority of water resources come from melt of the Hualca-Hualca Mountain. No groundwater is used, but there is a short, yet unpredictable rainy season from January to March, though rainfall is not enough to suit irrigation in the community (Paerregaard, 2013). As part of the author’s interviews, community members perceive the climate to be warming. In the climatic analysis portion of this work, the local climate was determined to be a BWk. The traditional system of water management in the community consisted of a ‘saya’ dual-division, a water management style found in many other Andean communities. Each ‘saya’, hanansaya and urinsaya, elect water distributors for the coming year. These distributors, called regidores, competed to irrigate their moiety first. This competition allowed for minimization of water waste and ensured equity in the delivery of water. The
author notes that in community interviews, elders note that despite the equity and sustainability promoted by the dual-division system, there were still some fights over even tiny amounts of water (Paerregaard, 2013). Many of the traditions associated with dual-division are no longer necessary with the imposition of the Majes project, however water users in the community continue to claim ownership of their system and make use of communal participation to continue to exert this tenure despite the state’s presence. (Paerregaard, 2013). Due to the hybridized nature of the current system, water management now operates on a system more closely related to a payment and delivery scheme. While the majority of community members initially opposed the state’s presence in the system, their resistance led to a unique type of cooperation where community members were given allowance to actively participate in the water management of their system post introduction of the state’s modernization efforts. The community members still regard their management as semi-autonomous, and even though water is now paid for and the traditional regidores are no longer necessary, members continue to participate in irrigation committees and actively maintain the canal system.

While the author states that there is more cooperation between the community and the state in Cabanaconde, the relationship is not perfect. As the Majes project is set to expand, community members already claim that upon the expansion, they will have the right to more water. Paerregaard claims that due to the project’s implementation, citizens have fewer water disputes, water is distributed more sequentially, and in general, equity towards water resources have improved (Paerregaard, 2013). Community members seem poised to confront the state again once the project derives
more water, arising concerns that more protest and disputes could occur in the future. In summation, the author concludes the community members’ initial distrust of the state was mended once the state allowed the community to have an active role in their system. Further, the people of Cabanaconde have received certain benefits from the imposed hybridized system, though some longstanding cultural traditions have been lost. Overall, the relatively positive outcome in the hybridized system, Paerregaard claims, shows that cooperation between Andean communities and the state are possible in relation to water management, noting that the state’s recognition of Andean communities in shaping their water futures, allowing for participation, and providing benefits to these communities regarding the modernization efforts are all essential to achieve positive cooperation between Andean communities and the state in hybridized systems.

Analysis 2: Paerregaard, 2013: Cabanaconde

As stated above, the type of water management used in the community was determined to be a hybrid system. The community has adopted a state model after years of resisting state control. They type of resistance enacted by the community included continuation of the practice of local water management traditions. Eventually the state gave local water rights to the community members and allowed for inclusion in the water management process. Without the active local resistance in Cabanaconde, the state-imposed model would be running exactly as the state had planned. Through resistance, the people of Cabanaconde have successfully achieved their demands. Though local demands have been met, the author stated that some cultural traditions
have been lost and no longer have meaning when water is procured through solely modernized mechanisms. (Paerregaard, 2013)

Relating to outcome, Paerregaard states that post the hybridization of the water management system, the community members experience fewer disputes over water resources, have adopted a system in which water is distributed sequentially, and the local people continue to view water as a common property (Paerregaard, 2013). With these distinctions, it can be stated that social equity towards water resources has remained consistent and may have in fact improved in certain regards since the hybridized system has been imposed. Regarding equity and inclusion in the decision making process, it seems the state recognized that in order to gain the trust of the residents of Cabanaconde, who had for decades resisted any state interference, the state would need to allow members of Cabanaconde to have an active role in their own water management. As such, the people of Cabanaconde continue to claim ownership of their irrigation system, retaining this through continued communal participation. Additionally, collaboration between state and community members, created through the community members active call for such an alliance, the people of Cabanaconde claim rights over the water management system. Many community members participate in the regional water user association, exemplifying local participation in a state-endorsed water management hierarchy, and it is stated that nearly 40% of water users in Cabanaconde participate in irrigation committees at any given time (Paerregaard, 2013). Regarding environmental wellness, the state imposed Majes canal, a highly contested modernization effort, is stated to expand in order to provide more water to the communities within its service area. The expansion of the Majes requires further water
diversion from another area in the country, providing the opportunity for negative social and ecological consequences in that region. Additionally, diversion schemes also harm the natural fluvial environments and ecologies in areas where that water would otherwise naturally flow. Some citizens from Cusco are adamantly opposed to this expansion, as they firmly believe that it will negatively affect the social and environmental well-being of the area, and their concerns are not unjustified (Paerregaard, 2013). While the expansion of the Majes project may indeed have brought more water to the people of Cabanaconde (though only after their demands for it) and others in the service region, more water does not equate to more water security. When water is diverted, the potential consequences can quickly escalate. While the Majes project has already resulted in certain environmental consequences, especially relating to water deficits in other areas, the expansion may bring even more concerns. As such, it seems that even though the state system has brought more water resources to the community of Cabanaconde, it does so at the expense of the environment. Although these consequences may not be visible to the community of Cabanaconde, meaning that the environmental outcome of the system within Cabanaconde at the time of the study is more positive for the majority, this may quickly and drastically change in the near future. Additionally, the project creates a more consequential outcome for the majority outside of the community in areas negatively affected by the Majes project. As the project does not aim to be environmentally or socially sustainable into the future, the environmental outcome of the water management system, as it relates to the Majes system, is more consequential. In summation, outcomes related to equity and inclusion in the decision-making process and in social equity towards water resources, the water
management system in Cabanaconde at the time of the study is more positive for the majority within the community.

Summary 3: Swiech, Ersten and Pererya, 2012: Yarabamba

The third article that met the inclusion criteria for analysis is by Theoclea Swiech, Maurits W. Ersten, and Carlos Machicao Pererya titled “Estimating the Impacts of a Reservoir for Improved Water Use in the Yarabamba Region, Peru”. The data for the study was collected in 2009. The community of Yarabamba consisted of approximately 4,000 individuals at the time of study and is located in the Department, Province, and District of Arequipa. (Swiech, Ersten, & Pererya, 2012). The author’s describe the climate as “dry” and according to the climate classification modeling for this study, the area fits into a BWk classification. Though the purpose of this study was to estimate the potential impacts of a modernization effort in the region- the construction of a reservoir for the purposes of increasing market-oriented agricultural production- the study was very comprehensive regarding the obtainment and presentation of data about the local community, its climate, and the ways within which water is traditionally managed. The study utilized WEAP modeling to determine the potential effects of the reservoir on water availability and how this change may affect economic activity, conflicts, and community life within Yarabamba. This was the only future-impact study that met the

Many water management studies are conducted after a modernization effort is implemented. This study by Swiech, Ersten, and Pererya estimates impacts prior to implementation. Perhaps more studies of this type should be conducted to increase awareness of potential consequences and more adequately prepare for the mitigation (or elimination) of negative consequences.
inclusion criteria for this thesis, offering unique insight into the potential benefits of combining comprehensive and often critical community-level water management studies with future scenario modeling. As evidenced by the case study, the main economic activity in Yarabamba is irrigation, meaning that the members of the community largely rely on subsistence techniques to make a living. Additionally, competing economic interests do not exist within the community, reducing the potential for conflict as the main use for water revolves around irrigation. The authors' stated that the traditional water management system of the community is based on utilizing whatever water is available, and as reported by interviews, there are usually no local water conflicts. The reported conflicts arise between community interests and competing state interests as the water management is hybridized.

As can be seen in many systems where water supply is based on river discharge as it flows along a mountainside, upstream-downstream competition can be an issue. The community of Polobaya also depends on the same river as Yarabamba but is located higher in elevation. This advantage point allows the community of Polobaya to derive a great amount of water directly from the source, reducing flows downstream and often angering the communities at lower elevations that also share the source (Swiech, Ersten, & Pererya, 2012). Though part of the traditional water management of the community, the hydrology of the area is based on both natural hydrology as well as anthropogenically created canal systems that redistribute water flows in order to assist local irrigation practices (Swiech, Ersten, & Pererya, 2012). Though the community generally manages and oversees its own water management system, the state-imposed hierarchical model of water governance also influences the local system. Within
Yarabamba, there are four Comisiones De Regantes\(^{53}\). Additionally, the Autoridad Local de Agua and Junta de Usario are also in charge of governance and management of the water in the sub-basin of Yarabamba.

**Analysis 3: Swiech, Ersten and Pererya, 2012: Yarabamba**

Though local water management is largely controlled by the community, the system was determined to be a hybrid between an Andean and a state-controlled system. Water management within the community was determined to be hybrid because members of the community participate in a Comision de Regantes, part of the top-down hierarchical model of water governance as set by the state. Additionally, the presence of the Junta de Usario and Autoridad Local de Agua further demonstrate the state system’s strong influence in the area. The traditional water management, though strongly regulated by the state-imposed hierarchy, was described as somewhat detached from state influence. The authors’ describe that as the community of Yarabamba is not considered to be economically profitable, the top-down governance institutions pay little attention to the concerns of the water users at the community level. When political changes are made within the hierarchy, the community members of Yarabamba are often not aware. This exemplifies a lack of communication, involvement,

\(^{53}\) Comisiones de Regantes are in charge of infrastructure maintenance, allocating water, and resolving conflicts.
and inclusion between the state imposed hierarchy and the community of Yarabamba and also a lack of self-advocacy on behalf of the community.\footnote{According to the authors, in comparison with the other communities analyzed in this work, it seems as though the community members of Yarabamba are not as concerned with or engaged in self-advocacy and inclusion, especially in contrast with Cabanaconde and Corporaque.}

The state’s plans for modernization (through building the reservoir in the sub basin) mean that soon there will be even more state presence in the community, at least in terms of infrastructure construction and related maintenance concerns. Regarding outcome related to equity and inclusion in the decision making process, there are more negative outcomes for the majority, as there is very little interaction, communication, or involvement between the state system and the community members. Despite this, it appears that the traditional water management practices within the community, as they operate around the amount of water available and result in few conflicts, result in more positive outcomes for the majority in regards to social equity to water access at the community level. There was little discussion of the environmental outcomes of the current water management system, and as the future modeling results are not definitive, making a conclusive argument about the environmental outcome related to the water management system is difficult. That said, the authors’ noted that even though the proposed modernization effort would have greater environmental impacts, the current system is by no means ‘natural’ as the local hydrology is already altered to fit human needs in terms of canal building, diversion, and storage methods to suit irrigation.
needs. The author’s additionally state that the proposed reservoir’s increased storage capacity sounds reasonable, but may not solve any tangible problems associated with water management in the area (Swiech, Ersten, & Pererya, 2012). Related to current environmental concerns regarding water management, the author’s state that the water management system, at the time of the study, had a great impact on local groundwater recharge, as ‘water savings’ at one location proportionally disrupt flows for users downstream. The canal system is also set up in a way that can cause local flooding. Though all water management systems affect local hydrology, the manner in which the current system negatively affects groundwater recharge for users downstream was determined to be more consequential.

Summary 4: Vos and Vincent, 2011: Chancay-Lambayeque

The fourth article that met the criteria for inclusion in the meta-analysis was “Volumetric Water Control in a Large-Scale Open Irrigation System With Many

55 Truthfully, all water management systems in spatially fixed communities, even the most “traditional”. are far from being consequence-free to the environment as they involve the modification of natural systems in order to serve anthropogenic wants and needs. There is a danger in romanticizing ‘traditional’ systems as ‘natural’. While some may have fewer environmental consequences than certain technocratic systems, this is not always the case. All anthropogenic modifications exert biogeomorphological consequences on the ecosystem.

56 An emerging pattern appears that it seems water users will use what water is (or is made) available. When more water is present, more water will be used. Similarly, more water does not guarantee an increase in water security.
Smallholders: The Case of Chancay-Lambayeque in Peru" by Jeroen Vos and Linden Vincent. The study was published in 2011 and the data was collected between 1998-2000 with updates recorded in 2010. This is the only study in the series looking at a system with Volumetric Water Control as the mechanism for water management. Additionally, this is the largest study, in terms of population size, in the series that met the inclusion criteria. The water management system described in this case study includes approximately 22,000 smallholders. Without any exact figures as to the size of the population, it can be assured that the population contained by the water management system described herein is larger\(^57\). As stated in the definitions section, the term community cannot be defined by having a certain amount of people, instead, a community is a group of people that recognize themselves as such. As the majority of the community of Chancay-Lambayeque is serviced by the water management system described here, it is clear they are related by this common unit and operate as a community.

The area of Chancay-Lambayeque is located in two departments along the North Coast of Peru. The coastal portion is located within the department of Lambayeque and the upper catchment is located in the department of Cajamarca. Climatically, the region is described as “extremely arid” (Vos & Vincent, 2011, p. 706) and in the climate classification portion of this study was determined to be a BWh climate. The primary water sources in the community are Andean fed rivers. There are few supplements to these flows as there is no use of groundwater and no rainfall in the area except in

\(^{57}\) As children are often not smallholders, and usually there are more male smallholders than female smallholders (Zwarteveen, 1997).
certain El Niño years (Vos & Vincent, 2011). The area occupied by the community has a long history of water management and is considered to be an area of cultural and historical significance within Peru as the pre-Incan Sicán culture had occupied the area. The main irrigation canal used by the community was constructed more than 1,000 years ago. The majority of water use in the community is for irrigation and agricultural purposes. Three large estates near the head of the system have sizeable landholdings for the production of sugarcane, but the majority of smallholders have approximately 5 ha of land in which rice, cotton, maize, and beans are grown (Vos & Vincent, 2011). The water management in the region operates through Volumetric Water Control, or VWC, which functions as a large-scale open canal irrigation system in which management principles equally include water allocation, delivery, metering and charging. Within these pillars, there is some flexibility regarding scheduling and timing of water turns (Vos & Vincent, 2011). In such a system, the water users request water turns for the following day, and the volume of water requested must be only what a smallholder's crops would require, and never more\textsuperscript{58}. The manually operated gates are adjusted each day according to the volumes of water requested and also depend upon the natural amount of water available from the river sources. The system also requires collection of water fees for the requested volumes of water to improve fee recovery as the Ministry of Agriculture, which publically managed the system between 1969 and 1992, no longer participates in local management affairs nor continues to give subsidiary aid.

\textsuperscript{58} Members of the WUA’s are in charge of defining the maximum amount of water each landowner could be entitled to depending on the type of crop planted. (Vos & Vincent, 2011)
The authors’ state that often it is believed that VWC would not work in a system with many smallholders or in a large-scale open canal irrigation system (as is the situation in Chancay-Lambayeque). The purpose of their paper is thus to determine why the system seems to be in good working order with relatively high satisfaction amongst the users, and also to advocate that when done in the correct way, VWC can be a potentially beneficial strategy to improve water management in other large-scale systems (Vos & Vincent, 2011).

Governance of the Chancay-Lambayeque system was overseen by the Ministry of Agriculture but turned over to the Water User’s Association (WUA) in 1992. The WUA continues to oversee the water management system and is in charge of the main canal (Vos & Vincent, 2011). According to the authors, this shift in governance from the Ministry to the WUA has caused an increased sense of local ownership over the system. The WUA directs the Junta de Usarios and their operation agency, “COPEMA”, which oversees the Volumetric Water Control present in the system. The Chancay-Lambayeque command area also consists of 13 Comisiónes de Regantes, each representing a sub-sector and secondary canal system. While the Comisiónes de Regantes hires employees to ensure the correct distribution and scheduling of the water, the board for each Comisión is elected by users of the system. (Vos & Vincent, 2011). At the tertiary block level, users organize themselves into informal Comités de Regantes. Leaders from each comité are in charge of maintaining equitable distribution and maintenance of the canals by community members. The water management system has gradually evolved to its present mode of operation after the land reforms of 1969.
technocratic systems, the water management in the Chancay-Lambayeque community mostly utilizes unlined canals and manually operated undershot gates by which the location and duration of water flows can be determined (Vos & Vincent, 2011). The system is set up so that in times of low river flow (as river discharge is highly variable), each water user will receive a portion of the water requested, a system known as rangos, and as such, users will often choose to purchase less water when less is known to be available.59

The authors’ state that in years where river flow is abundant, about 80% of agricultural water demand is met. In years when the river flow is scarce, approximately 60% of demand is met (Vos & Vincent, 2011). Each year prior to the planting season, members of the WUA and local irrigation agency attempt to forecast the river discharge for the following year. With their results, they determine what crop zones should be planted and how much of each zone should be planted in order to be consistent with the amounts predicted to be variable (Vos & Vincent, 2011). These predictions are difficult, and when done incorrectly, can be detrimental to the landholders. In times of water abundance, excess water is sold. All of the money collected by the systems goes directly into system maintenance, for which the water users hold the WUA highly accountable.

In summation, the authors’ state that the Volumetric Water Control system works well in the community of Chancay-Lambayeque because allocation, scheduling, 

59 The permanent rights of water users are known as licencias. In times of low water availability, rather, when availability is less than the requested demand, the system is set up to employ rangos. In the rangos system, users with licencia rights will receive a portion of the water requested (Vos & Vincent, 2011).
distribution, metering, and pricing are all carefully organized (Vos & Vincent, 2011). Even though this type of system can have its challenges, mainly in metering, potentials for corruption in fee recovery and stealing, and canal maintenance, the system is fairly equitable in the community of Chancay-Lambayeque despite its large size. The turn of the system from the Ministry of Agriculture to the locally elected Water User Association (which is farther down on the state-imposed hierarchical management system) increased sense of ownership of the system in the community, perhaps because their own water request fees were directly used for further maintenance and improvements within the systems, and because they can directly work and participate with members of the WUA.

Analysis 4: Vos and Vincent, 2011: Chancay-Lambayeque

The Chancay-Lambayeque water management system is a state-controlled system as the government’s management hierarchy directly controls the system, as evidenced by the high level of involvement by the Water User’s association, Junta de Usarios, and the 13 Comisiónes de Regantes. It must be stated that community members still have a great amount of interaction with the system as each landholder is in charge of communication with their corresponding comisión on a daily basis in order to request the next day’s water allocation. Though an ancient canal continues to be utilized in the community, the mechanisms for allocation are recent and derived from political changes only over the past 50 years. There is communication and involvement between community members and the hierarchy, and in this case, is positively reinforced.
Regarding social equity, the authors’ state that the system, despite its challenges, achieves good water delivery and also performs well financially (Vos & Vincent, 2011). While fluctuating water availability may alter whether or not a water user will receive the amount of water requested, the system is set up to operate in times of both scarcity and abundance so that all water users can request and receive at least some water, and no type of unfair representation or provision seems to be present. The authors’ additionally stated that socioeconomically speaking, there is very little variance between users of the water management system, an element of social equality meaning that many of the users have similar incomes with which to purchase water, an element that may pertain to outcome. Additionally, there are incentives present to obey the rules and the system runs so that water use is transparent and any who disobey the rules are immediately identifiable. Though there are many areas in which Volumetric Water Control is far from perfect: flows are difficult to measure, many small holders make metering difficult, water stealing and trading have potential to occur; none of these threats seem to overburden the system and the occurrence of these issues is minimal. With all of these elements in place, it seems that the system has a more positive outcome for the majority with regards to social equity towards water access. Though not everyone in the community has a water right, the smallholders who do have relatively equitable ability to purchase water use due to the even socioeconomic field shared by community members.

Relating to equity and inclusion in the decision making process, the authors state that irrigators have a good level of control of water management within the system. Users have the electoral power to nominate and choose the committee members and are also active in the local board meetings regarding water management. It does not
seem that the water users have any mechanism to directly participate in the decision making process, though they do have direct say in the elections and have the opportunity to participate in the meetings. This type of involvement does not guarantee that the needs of the water users will be heard or met, and does not determine how influential their voice will be in the decision making process. However, it was stated that the water users hold the WUA to an extremely high level of accountability, and with their strong electoral power, the authors’ state that the WUA generally follows through with their responsibilities. Though there is room for contestation, as it seems the community members could have much more room to participate in the decision making process, it seems that their demands are generally heard and met. Additionally, there is daily communication between water users and elected members of the hierarchy. Also, unofficial comités are allowed to exist in order to increase user’s participation in monitoring the system. The outcome related to equity and inclusion in the decision making process is thus more positive for the majority. The ease of participation in the electoral process, the responsibilities associated with elected positions (meaning that concerns are heard and demands are often met in order to secure votes) and the ease and necessity for water users to communicate with members of the hierarchy on a daily basis mean that the hierarchy is aware and involved in any issues that may occur for the water users.

Regarding the environmental outcome of the system, the canals and drains are well maintained which minimizes environmental concerns of salinization and waterlogging (though these issues occasionally do occur). The system also limits the amount of rice and other water-intensive crops that can be grown in the region as
watering these crops would not be sustainable in water scarce years and it is stated that
the volumetric charging is successful in eliminating water waste and improving water
conservation efforts. The irrigation agency and WUA utilize long-term forecasting to
predict what should be grown in specific years in order to make the most of predicted
water abundance, or to make sure what is needed can be produced in predictably
water-scarce years (Vos & Vincent, 2011). Climate forecasting is not a perfect science
and certainly mistakes could be made in the annual predictions. Despite the flaws of
these preventative measures, it can be noted that those involved in the governance and
management of the system are aware of environmental concerns related to water
management activities and actively attempt to avoid any actions that could exacerbate
human-induced water scarcity. As such, the environmental outcome was determined to
be less consequential.

Summary: Delgado and Vincent, 2013: Corporaque

The fifth article that met the inclusion criteria is “Community Irrigation Supplies
and Regional Water Transfers in the Colca Valley, Peru” by Juana Vera Delgado and
Linden Vincent. The study was conducted between 2005 and 2007 and describes the
water management of the community of Corporaque, consisting of at least 490
smallholders, located in the Colca Valley, the same valley where Cabanaconde is

60 This figure is not given within the article, however in Corporaque there is a 1ha maximum allotment per
smallholder, and 490 ha are irrigated. With this information, it can be stated that there are at least 490
smallholders.
located (Delgado & Vincent, 2013). The climate of the area is described as an arid pampas or plain and in the classification portion of this analysis was determined to be a BWk. The article sets out to describe how the people of the community of Corporaque attempt to secure their water rights. Though Corporaque is an Andean community, influence by the state has increased within the community, related to the Majes project. According to the authors, the goals of the state are to service the regional and national water needs and are not necessarily concerned with the water needs at the scale of individual communities, arguably especially not the many community water management systems in the highlands that are not viewed as economically profitable. The article also describes what areas of water management and governance need to be improved upon in order to better complement optimal water management in Corporaque (including but not limited to increasing representation, participation, and transparency) (Delgado & Vincent, 2013). As the state is not primarily concerned with the wellbeing of small communities, it is no surprise that water transfers from highland glacier and wetland sources have increased. The Majes project is one of the most highly profiled water transfer projects in Peru. The catchment it targets would naturally flow through the Colca Valley, where Corporaque and other highland communities (such as Cabanaconde) are located. The main water resource for the community is now the Majes canal, though some (typically) marginal amounts of rainfall do occur each year\textsuperscript{61}. Within the community, water is primarily used for irrigation and agricultural activities. The authors’ describe the community as Andean and note that until the state interfered with local management practices, the water management rules within the community

\textsuperscript{61} On occasion, flooding can occur in the valley.
had been practiced prior to the colonization of Peru, though were in part influenced by Spanish rule as well (Delgado & Vincent, 2013). The water management system, like many others in the valley, was structured to manage water through times of water scarcity and was of pre-Incan origin. As the state currently has a strong presence in the community due to the location of the Majes, the authors’ describe the governance style of the community to be semi-autonomous with centralized management influence in the form of Junta de Usarios, the Water User Board of the Colca Valley Irrigation district, and 36 Comisiones de Regantes which have since been renamed to Comisiones de Usarios (Delgado & Vincent, 2013).

The traditional water management practices in Corporaque allow that each water user can irrigate only 1 ha of land, despite how much land he or she owns. This ruling is in place for the purpose of conserving water. The authors’ state a great amount of participation and collaboration among community members to ensure that the assignment of duties for agricultural planting times, system maintenance, and elections for officials are kept in good order. The water management is based on a traditional dual-division moiety system. Elements of the traditional water management system in the community result from pre-Inca times, and some of these elements are present in agricultural, sociocultural, and political dynamics within the community (Delgado & Vincent, 2013). The local agricultural system is set up to grow crops that are compatible with the elevation and climate of the community, though increased tourism to the region had slightly bolstered the production of some more water-intensive, market-oriented crops. The traditional system seemed to result in little conflict and its principles were centered on equity and conservation (Delgado & Vincent, 2013).
Upon introduction of the Majes canal, all communities in the Colca Valley, including Corporaque, were denied access to the transferred water. The Majes was set up to promote water-intensive, market-oriented agriculture and increase water service along the coast. No government-endorsed studies were held to explore the environmental impacts of the project or to predict how highland communities would be affected by the project.

Members of the Colca Valley, including Corporaque, protested their exclusion from the water that had been transferred away from them. In order to speak to representatives, community members of Corporaque (and those from other villages in the valley) had to travel great distances, participate in complex political environments, and go through a series of administrative paperwork in order to speak with politicians and representatives. Direct participation was not offered, and communication was made as challenging as possible. The strong Andean identity of the valley, the authors’ note, was a key component of mobilization for the community of Corporaque to so actively protest their exclusion. Corporaque, along with several other villages in the right bank of the Colca Valley, mobilized to create an agreement with AUTODEMA\textsuperscript{62} to negotiate allowances to the transferred water. The community determined that 1000 L/s of water delivery was the minimum requirement to maintain their traditional irrigation networks. AUTODEMA denied this amount of water, and instead declared they could allocate 680

\textsuperscript{62} The \textit{Autoridad Autónoma de Majes}, or Majes autonomous authority, is a water control company created by the government to oversee the maintenance of the Majes project. This agency is in charge of deciding water allocations, distribution from the canal, and the promotion of market-oriented agriculture along the coast, which is produced year-round (Delgado & Vincent, 2013).
L/s, an agreement signed upon by AUTODEMA as well as community members from Corporaque. This amount was considered to be insufficient to retain the necessary irrigation requirements of the community landholdings, at least as the system operated prior to introduction of the Majes canal, but was more than what was initially given post introduction of the Majes. The water was set to be delivered to the ancient canal system so that the community could continue to practice their traditional moiety dual-division water management system. Though Corporaque was the only community in the Colca Valley that continued to pursue further water justice after the initial protests (through the pursuit and creation of the plan), the agreement was ultimately not actualized by AUTODEMA.

Currently, the water that arrives to Corporaque comes from seepage flows from the Majes Canal, though Corporaque was the only community in the Colca Valley to successfully claim and divert water directly from the Colca River in order to supplement local irrigation practices (Delgado & Vincent, 2013). The primary conflicts regarding water management revolve around conflicting interests between the community and the Majes project, including the many issues resulting from the government’s marginalization of Andean communities from national water management plans. Irrigation in the community continues to be practiced in the traditional manner, but now local governance operates in collaboration with the ATDR63, part of the state hierarchy.

63 Administración Técnica de Distritos de Riego is a regulatory authority in charge of creating procedures to allocate water rights and allowances based on amounts needed for irrigation along the coast. It enables justifications for transfers from Andean communities to the coast and often creates difficulties for Andean communities to maintain their traditional water management practices and additionally creates difficulties.
of water management. New laws have been created by the state that appear to address highland communities, but the authors state these laws fail to recognize community level water practices and needs (Delgado & Vincent, 2013). For example, at the time of the study, AUTODEMA stated that water delivery had increased in the community of Corporaque, despite conducting any studies or providing any actual data to prove this claim. The authors’ stress that increased transparency of government data needs to be provided and agencies need to perform more environmental and irrigation studies to better evaluate water needs and impacts of the project. Additionally, communities within the Colca Valley need to receive greater recognition as the Majes project is too heavily focused on market-oriented goals, and less on the welfare of the communities negatively affected by the transfer (Delgado & Vincent, 2013). The authors’ stress that the community of Corporaque has strengthened their cultural identity and have essentially become empowered to defend their water claims and to mobilize on issues of water justice, and are poised to continue to self advocate into the future.

**Analysis 5: Delgado and Vincent, 2013: Corporaque**

Regarding the management type, the community of Corporaque is a hybridized system, both for the purposes of definition set within this study and also by the authors’ definition. There are clearly strong elements of the Andean history in the traditional system and community unification is centered on the historically practiced water

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for Andean communities to access increased water resources in times of natural scarcity. (Delgado & Vincent, 2013)
management system. The state has a strong presence in the community due to the imposition of the Majes project and subsequent centralized hierarchical agencies such as the *Junta de Usarios* and *Comisiónes de Regantes*.

Relating to outcome, social equity to water access has traditionally been a pillar of Corporaque’s water management system. The community continues to manage water and irrigate in the traditional way. Though the Majes project has resulted in different power struggles relating to obtaining water, water management has remained roughly the same. The Majes project did not improve social equity to water access in the community of Corporaque, meaning that the outcomes of the project are more negative for the majority of the community, due to the increased struggles to obtain and access water. It must be stated that the community members’ audacity to retain the traditional system means that division within the community itself has not become less equitable.

Relating to the outcome regarding equity and inclusion in the decision making process, the genesis of the Majes project in the area has resulted in more negative outcomes for the majority. As stated above, the system makes it very difficult for members of the community of Corporaque to even discuss matters of their water needs with political figures in ATDR or AUTODEMA. These community members have to travel to the politicians, located in the cities of Lima or Arequipa, which is not an easy feat noting the topography of the country and the limited transportation links between certain highland communities and cities. Even when members of the community achieved communication and collaborate to create and draft for plans for improvement at the community level, they were not followed through by the state-appointed political
agencies. Additionally, these politicians do not seem to take the needs and requests of the community members seriously, as new laws often make oversights to the highland communities, despite making claims otherwise. Without the persistence of the people of Corporaque, plans for increased inclusion wouldn’t have been attempted.

Relating to the environmental outcome of the current water management system, it must be noted that the system in Corporaque prior to the Majes was indeed a system that transferred Colca River water into the canalways for irrigation practices. The Majes project essentially does the same thing, though on a much grander scale and for much more water-intensive purposes, noting the market-oriented agriculture the project intends to expand. Both have impacts on natural hydrology, but the traditional water management practices of Corporaque seem more concerned with conserving water and producing agriculture that fits with the local climate. The Majes project, on the other hand, is not concerned with environmental and social consequences and is only using water for intensive purposes without caution for the local ecology. Additionally, despite the vast funding used to create the project and the many amenities available, no studies were conducted to evaluate the environmental impact of constructing the Majes canal. At one point, heavy rains damaged a large portion of the canal, further injuring local irrigation. Though water transfers clearly would reshape the local ecology of a region, these types of results were not presented by the paper. As the Majes project further alters local hydrology without any clear environmental benefits, the environmental
outcome of the current water system in Corporaque was determined to be more consequential\textsuperscript{64}.

**Summary 6: Trawick, 2001: Huaynacotas**

The sixth article that met the inclusion criteria is “Successfully Governing the Commons: Principles of Social Organization in an Andean Irrigation System” by Paul B. Trawick. The study examines the unique water management system of the Andean community of Huaynacotas in the Cotahuasi Valley in the La Union province of Arequipa, and describes the community-level principles related to water management that produce such a positive and equitable water management outcome. The author’s goals are to discover why the community has such a positive outcome, with intentions of using the results to inform policy revisions (Trawick, 2001). The study was conducted over three and a half years and was published in 2001. The population of the community is just over a thousand people. Huaynacotas is a subsistence-based peasant, indigenous community lacking a focus on market-based economics. Water in the community is primarily used for agriculture, and the main water resource is two alpine springs. The author states there is virtually no competition over water, or anything else, within the community. The Huaynacotas are described as being effectively autonomous. Though the state legally controls all water in the system, throughout history the Huaynacotas were never influenced by the policies of outside forces, and as such, have adapted their water management system to changes in the environment, \textsuperscript{64}

\textsuperscript{64} Corporaque is the only community in this study for which all three outcomes were negative.
climate, and surrounding social sphere all on their own accord, internally. In comparison to the dozens of articles analyzed prior to conducting this study, the Huynacotas system truly appears to be the most equitable towards water access, inclusion in the decision making process, and have some of the least environmental degradation. The author’s sentiments reflect a similar opinion, though Trawick states there are other Andean communities that operate roughly in the same way, with similar results, though no further studies were found for similar systems, and perhaps they do not exist. In the work, Trawick mentions that the Huynacotas were never influenced by bureaucracy, whereas areas such as the Colca Valley were influenced by colonization early on, meaning communities similar to the Huynacotas have been autonomous for longer periods of history. Trawick further notes that while there are many studies in the Colca Valley, this does not mean that the majority of Andean communities are undergoing modernization efforts at present, and that there are, indeed, other communities in the highland that operate in similar manners to the Huynacotas, only that these more autonomous systems, save for the Huynacotas, have largely not been studied.

So what is it, in fact, that makes the water management system of the Huynacotas have such a positive outcome? What is it that can be learned from the positive outcomes of this system that could be possibly learned from and applied to other resource management studies?

Climatically, the author states that the location of the community is actually less water abundant than many communities in the periphery and is more vulnerable to droughts. In the Köppen climate analysis portion of this work, the climate of the region occupied by the community was determined to be BSk. Though the main water
resources are two alpine springs, there is no dual social organization or saya system, such as moieties, which is commonly found in other indigenous communities in the region. The author notes that the community may have had such a system at one time, but this cannot be confirmed (Trawick, 2001). Aside from having more autonomy than most other highland communities, certainly more than any other community in this analysis, there is another factor that separates the community of Huaynacotas from elsewhere in the region. The landholdings within the community are scattered due to the microclimatic variations of the area. Agricultural plots are evenly scattered so that each landholder will have plots all along the hillside. In this way, each landholder will have a small bit of land in each type of microclimate in order to make the best use of the microclimatic variations to grow particular crops best suited to them. Because of this, there are no landholders located exclusively at the beginning or end of a canal or water diversion system, sometimes referred to as head-landers or tail-landers (Trawick P. B., 2001). In this manner, there is no upstream/downstream competition because everyone has some plots closer to ‘upstream’, and everyone has some plots closer to ‘downstream’. Everything is evenly dispersed. This practice is known as minifundia.

The water management in the Huaynacotas community is unique, and Trawick outlines the main principles that govern the water management system. The first pillar of the system is proportionality among water rights within the community, noting that this principle is essential to minimize conflict. The community also limits water waste in ways that many other Andean communities do not. Part of this conservation emerges from the practice of the minifundia irrigation scheme, and also due to the obedience of the other pillars. The people of Huaynacotas fully govern their own water management...
system, and have made it completely transparent and public. In this manner, everyone knows the rules, knows their own responsibilities, and also knows how to upkeep the system. Because the responsibility of maintaining the system and its policies is up to the members of the community alone, they strictly adhere to these rules to a point at which these rules appear as basic as any other necessary daily activity. As everyone knows the rules and knows whose turn it is for what responsibilities, it is immediately apparent to everyone in the community when something is not occurring according to plan. Due to this transparency, Trawick argues, everyone obeys the rules. Water is received by everyone with the same frequency and everyone irrigates using the same techniques; no one can receive any more water than anyone else. Additionally, everyone is responsible for the upkeep of the system with proportionality to how much irrigated land they have. The more water any individual uses, the more he or she is responsible for system maintenance. Sanctions do occur for offenses, and they are graded based on the severity of the offense. Finally, the system is unique in that there are positive incentives to obey the rules, which are much stronger than negative consequences of disobeying the rules. The incentive is that when everyone follows the rules set up by the system, the system runs much more efficiently, and this results in everyone receiving more water turns throughout the season (Trawick, 2001).

It is by these principles, Trawick argues, that the system maintains a more positive outcome. Though the area occupied by the community is highly vulnerable to drought and naturally occurring water scarcity, the water management system is set up so that there is virtually no human-induced scarcity, which is arguably rare in the majority of water management systems. The author states that people are much more
likely to obey rules when they themselves set them, and this does seem to hold true for the community of Huaynacotas as rules are almost inherently followed, and the outcomes are quite positive.

**Analysis 6: Trawick, 2001: Huaynacotas**

Regarding the type of system, the community of Huaynacotas is a fully autonomous Andean system as they operate, and throughout history have operated, as an entirely self-governed community. Indeed, the state legally has claims to the water and water management of every community in Peru, but there is not any interaction between the state hierarchy of water management and the community. Of all the case studies analyzed for this work, the community of Huaynacotas is the only truly Andean, autonomous system.

Regarding the outcome of social equity to water access, the main pillars of water management in the community are set to give everyone equal access to water resources, equal responsibility to upkeep the system, and also equal distribution of land plots so that everyone can benefit from the microclimatic variations for agriculture (this also helps to ensure that there are no head or tail-enders in the system). In totem, the social equity to water access in the community of Huaynacotas is more positive for the majority.

Relating to the outcome of equity and inclusion in the decision making process, the author notes that the rules of the water management system are so well understood
and obeyed by the members of the community that meetings are not even necessary. The system is set up so that everyone is an active and integral part of the system, each an important cog that must continue to work efficiently for the system to operate. There is no differentiation between status, order, access, or control, and everyone is equally responsible to upkeep the system and to follow the water laws. There is virtually no decision making process because the system is effective and efficient. Though there is no formal council within the system, equity to access in the decision making process is more positive for the majority in a way that no other system in this analysis is because every member of the community is equally part of the governance and management of the system.

Finally, regarding environmental outcome, the system is set to make use of the microclimatic variation and to plant crops in areas where they will require the least amount of water and have the least environmental impact. This type of planning conserves a great amount of water. No system is without environmental degradation, but the Huaynacotas system is set up to produce social equity in extremely water scarce conditions, and does so with as little disruption to the local ecology as possible. By this token, the environmental outcome is less consequential, and if maintained, should be sustainable into the future as well.

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65 Most Andean communities, and more urban communities as well, have fairly regular meetings regarding water management, proposed changes, elections, concerns, etc. The Huaynacotas system works so efficiently, Trawick argues, that these meetings are not needed at all. (Trawick, 2001)
Discussion

Outline

The critical meta-analysis demonstrated the range of outcomes for the works analyzed in this series. It is clear that positive outcomes can occur regardless of governance style or community size. In addition to the main findings, certain themes emerged upon further critical review and will be discussed in this section. It must be reinstated that no particular variable utilized in this study was considered to be deterministic of outcome, rather, this study was curious to uncover how the particular combination of variables within each individual community interplayed to create the particular set of outcomes within each specific community and case study. The themes introduced in this chapter will be discussed relating to how influential particular variables may be in helping to shape (but again, not determining) particular water management outcomes in individual communities. The first set of themes and discussion points herein will relate to the emerging questions that resulted from critical reading and review of the text. Some points emerged through cross-comparative analysis between texts, and other points emerged from suggestions made by the authors who wrote the case studies included in this work.
<table>
<thead>
<tr>
<th>Governance Type</th>
<th>Social Equity to Water Access</th>
<th>Equity and Inclusion in the Decision-Making Process</th>
<th>Environmental Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporaque (Delgado and Vincent, 2013)</td>
<td>Hybrid</td>
<td>more negative for majority</td>
<td>more negative for majority</td>
</tr>
<tr>
<td>Yarabamba (Swiech, Ersten, Pererya, 2012)</td>
<td>Hybrid</td>
<td>more negative for majority</td>
<td>more negative for majority</td>
</tr>
<tr>
<td>Cabanaconde (Boelens and Gelles, 2005)</td>
<td>Hybrid</td>
<td>more positive for majority</td>
<td>more negative for majority</td>
</tr>
<tr>
<td>Cabanaconde (Paerregaard, 2013)</td>
<td>Hybrid</td>
<td>more positive for majority</td>
<td>more positive for majority</td>
</tr>
<tr>
<td>Chancay-Lambayeque (Vos and Vincent, 2011)</td>
<td>State-controlled</td>
<td>more positive for majority</td>
<td>more positive for majority</td>
</tr>
<tr>
<td>Huaynacotas (Trawick, 2001)</td>
<td>Autonomous/Andean</td>
<td>more positive for majority</td>
<td>more positive for majority</td>
</tr>
</tbody>
</table>

Table 1: This table depicts the results of the analysis.

Above is a graphic demonstrating the results for each case study analyzed. Within this graphic, results are depicted regarding whether the governance in each case study was autonomous (an Andean system operating outside of state control), controlled by the Peruvian state (state controlled) or a hybridized system. The first column shows whether an individual community had more positive outcomes for the majority or more negative outcomes for the majority related to social equity to water access. The second column shows whether an individual community had more positive outcomes for the majority or more negative outcomes for the majority related to equity and inclusion in the decision-making process. The third column shows whether there was a more consequential or less consequential outcome related to the environmental impact of the water management practices of the particular community of study.
Social Equity to Water Access Results

There are many results that can be visually observed through this graphic. It is apparent that four of the six results related to social equity to water access were more positive for the majority. This was the only column where the majority of results were ‘more positive’. Though the analysis only provides a limited sample of community-level water management systems in Peru, this finding does assert that at least within most of the communities studied, equitable access to water resources was achieved for the majority of the community. This finding is not to say that ensuring equitable access to water resources within these communities is an easy task, rather that the efforts of community members may in fact be primarily concerned with producing equitable access to water resources for the majority of the community, and these efforts are then manifested in positive outcomes. Huaynacotas, the two studies from Cabanaconde, and the study from Chancay-Lambayeque were each determined to have more positive outcomes related to water security. These results are interesting as Cabanaconde is a hybridized system in which the community members actively engage in ensuring their traditional water management practices (which indeed promote equity) proceed as much as possible, alongside state influence. The community of Huaynacotas is autonomous, and the water management system is largely concerned with producing equitable distribution of water resources. Chancay-Lambayeque, by contrast, is a fully state-operated system. The community members of Chancay-Lambayeque achieve

66 The Huynacota's practice of minifundia, the agricultural layout that prevents upstream-downstream contestations produces equitable water distribution.
such high levels of social equity to water access, in part, because of the pay-per-volume requests dictated by VWC and also due to the policy that every landowner will get an equal percentage of the water requested depending upon daily water availability (Vos and Vincent, 2011). As the three communities (represented in four case studies) exemplify one of each governance type, the distribution of results demonstrates that social equity to water access can occur in any of the three styles of governance. In this sense, governance style (and community scale) is not deterministic of outcomes related to socially equitable access to water resources. More positive outcomes can be achieved at any scale or in any governance type so long as the other variables that influence water management are also congruent to meet this goal. The specific set of variables at the community level required to achieve particular outcomes will vary within and between specific communities in space and time.

The communities of Corporaque and Yarabamba, both hybridized communities, had more negative outcomes related to equitable social access to water resources. While the traditional water management practices of Corporaque are set up to distribute water evenly throughout the community, the great reduction in water availability upon introduction of the Majes project is responsible for producing less equitable outcomes as human produced water scarcity was exacerbated through the water transfer. Water distribution continues to be as equitable as possible, following the continual use of most of the community’s traditional water management practices, however the hybridized system and subsequent transfer have made access a very serious challenge.
Equity and Inclusion in the Decision-Making Process Results

The results related to equity and inclusion in the decision making process were equally stratified. Three of the six results were more positive for the majority and the other three were more negative for the majority. Of notable interest, the study of Cabanaconde by Boelens and Gelles, 2005 was determined to have a more negative outcome for the majority while the study by Paerregaard, 2013 regarding the same community was found to have a more positive result for the majority. How did two separate case studies, observing the water management systems of the same community, produce two different results? One possibility could be that the study by Paerregaard was conducted more recently, meaning enough changes could have been made in local policy and/or procedure to procure more equity in the decision-making process for Cabanaconde’s citizens. While this possibility could be have affected the results slightly, it is also possible that the two studies presented slightly different facets of information and the difference in results was related to distinctive interpretations. Having different results does not objectively mean that one case study was ‘more true’ than the other case study, rather that the respective authors’ had different purposes for writing each study, and therefore focused on different facets of information as presented to the reader. As the analysis was intent on eliminating possible causes of bias, this study analyzed each and every case study as unique and did not cross-pollinate information from any of the articles in a way that could affect the analysis of another study. In this way, the outcome decisions were based solely on what information was presented within the article being analyzed.
All knowledge is partial, and all studies can only provide partial knowledge of a situation. By this accord, it can be assumed that if there were multiple studies available for analysis for each community in the study, different results could be found for those as well. The possibility for conflicting results in this way was not considered to be a limitation to this meta-analytical study because knowledge is always partial, whether through the interpretation of secondary sources or as subjective ‘truth’ is interpreted by creators of primary studies. The partiality created through presentation, representation, or interpretation affects all sectors of academic research. Instead of viewing the potential for conflicting results as a major limitation of this work (or as a critique of meta-analytical studies), it was viewed that the conflicting results provide a unique insight into how the management outcomes in the town of Cabanaconde can be interpreted in multiple ways.

It was decided that the outcome related to equity and inclusion in the decision-making process for Cabanaconde in the article written by Boelens and Gelles in 2005 was more negative for the majority for several reasons. The state's involvement in the community attempted to be an “inclusion-oriented” strategy, a mechanism by which marginalized communities are coerced to accept state control due to being told they are backwards or different. Though the community of Cabanaconde was able to successfully absorb the state model (Boelens & Gelles, 2005), the imposition of the state system made it more difficult for community members to participate in the decision making process. The community continues to manage water in a similar manner as before, though it requires a more active effort on their behalf to do so. As the state initially planned to exclude the people of Cabanaconde from the decision-making
process (under the guise of inclusion), and due to the new challenges faced by the community to continue to assert their traditional mechanisms of water management, it was determined that outcome related to equity and inclusion in the decision making process was more negative with respect to how water management decisions were made prior to state-involvement.

Alternatively, the analysis for the outcome related to inclusion in the decision making process in Cabanaconde as discussed by Paerregaard 2013 was determined to be more positive for several reasons. The purpose of this article was to showcase that when the state acknowledges the importance of including local people in the decision making process, and by allowing and encouraging them to actively participate in this process, positive water management results can be achieved. In this sense, the information was presented in a slightly different manner than the previous article. Both articles state that members of Cabanaconde actively had to assert their presence in the newly appointed state project. Both articles also presented that due to these efforts, more water was brought to the community. While Boelens and Gelles focused on the negative aspects of the hybridized system on governance and decision-making, Paerregaard asserted that the positive outcomes related to improved water access were directly correlated with the decision-making process that had become hybridized. Rather, through the interaction and communication between community members of Cabanaconde and representatives for the state system, these positive results were achieved. Paerregaard notes that the state encouraged community members to participate in the WUA and in local irrigation committees, at which any given time 40% of Cabanaconde’s water users now participate (Paerregaard, 2013). With this type of
information presented, Paerregaard effectively demonstrated a positive example of collaboration in governance between the state and community members in achieving more positive water management outcomes.

Neither article is 'right', nor 'wrong', rather the differences in results simply exemplifies that any type of outcome is open to interpretation, and that all data should be held as subjective instead of concretely objective. Depending on the purposes of any given work, the information gathered and presented will fit the purposes of the study. It would be beneficial for all research to be as comprehensive as possible (and integrative research can help achieve this), but it is important to remember that the presentation and interpretation of any study is partially subjective.

This work sees no purpose to justify which of the two results more accurately reflects the situation of participation access in Cabanaconde, rather it is understood that both are correct in relation to the justifications provided by the authors. The results for equity and inclusion in the decision making process in Cabanaconde are more negative in certain aspects and more positive in others, and these results are satisfactory for the purposes of this analysis. This thesis intends to provide an overview of the existing literature on the subject and is not intended to make any definitive claims about causation. Instead, this work seeks to demonstrate certain themes that are present across the existing literature and assert that through observation of these themes, light can be shed on the future of the direction of water management studies in Peru (and elsewhere) and can also inform policy intervention.

The results for Yarabamba and Corporaque related to equity and inclusion in the decision making process were found to be more negative. Both communities have
hybridized governance. In each case study, the authors’ presented that communication between community members and state-appointed water managers was made incredibly difficult for community members. Additionally both cases asserted that the needs of the local people were disregarded by state officials, perpetuating their marginalization and continuing to exclude them from assistance in shaping their own futures in a positive way.

Huaynacotas, the smallest and only autonomous case study included in this work, and Chancay-Lambayeque, the largest and only state-controlled system in this work were both found to have more positive outcomes for the majority related to equity and inclusion in the decision making process. As previously stated, every community member of Huaynacotas equally participates in the decision-making process, as within the community, governance is horizontal rather than top-down\textsuperscript{67}. Therefore, inclusion and equity in the decision making process are inherent to the community’s water management system (though the same cannot be said for all horizontal governance systems). Chancay-Lambayeque, while retaining use of the ancient canals present in the region, is completely state-controlled, and the community composition is not considered to be ‘traditionally’ Andean (though elements of Andean heritage are present, as they are throughout Peru). It was determined that equity and inclusion in the decision making process was more positive for Chancay-Lambayeque for a multiplicity of reasons. Though the traditional state system is imposed in the community, members of

\textsuperscript{67} The vast majority of governance systems that have been studied throughout the world involve some sort of top-down governance. Horizontally governed systems, such as the Huaynacotas, are quite rare. (Hill & Lynn Jr., 2005) (Bulkeley, 2005) (Phillips, 2004) (Eda & Chen, 2010).
the community play a highly active role in their water management outcomes and in the decision making process. The authors’ report that there is very little socioeconomic stratification between community members of Chancay-Lambayeque\(^{68}\), a principle that may increase the equitable outcomes related to both equity towards water resource access and equitable inclusion in the decision making process as the majority of community members are equal along that front (Vos & Vincent, 2011). The authors state that community members have an incredibly influential role in the electoral process, perhaps because the nominated officials depend on securing the majority of votes within the community. As class issues do not affect the community, those campaigning have to appeal to the vast majority of the community. The most influential mechanism with which members of Chancay-Lambayeque are included in the decision-making process is related to how water is managed. Volumetric Water Control as practiced in Chancay-Lambayeque allocates that each landholder must communicate directly with members of the elected committees on a daily basis in order to request the next day’s requested volume of water\(^{69}\). In this sense, communication between water

\(^{68}\) In addition to Chancay-Lambayeque, citizens within Huaynacotas have relatively similar socioeconomic status. It is possible that the more positive outcomes in these places could be influenced by the even socioeconomic distribution experienced within each community. It is suggested that more water management studies should consider this factor to analyze this relationship with outcome.

\(^{69}\) In many developed countries, Volumetric Water Control involves highly technocratic mechanisms to meter the amounts of water being transported and delivered, which can be submitted electronically and monitored by officials in charge of the governance of the system. In Chancay-Lambayaque, the canal system used is an ancient one, and manually operated undershot gates are utilized in order to divert and
users and those in charge of operation is mandatory. The needs and wishes of the community members are well understood by the committees through the social interactions required by volumetric water control in this scenario. Additionally, many community members play an active role in *comités* in which levels of user participation in monitoring of the system is very high. These unique combinations within Chancay-Lambayeque contribute to the more positive outcome for the majority of community members in relation to equitable inclusion in the decision-making process.

There were two unique observations between the more positive outcomes shared by Huaynacotas and Chancay-Lambayeque. The first is that both communities control allocation of requested water to landholders (Vos & Vincent, 2011). Use of the ancient nature of the system (in addition to monetary constraints) prevents more technocratic systems to be put in place for more precise measurements and metering. While the authors of the study note that the manual metering done in the water management system is a potential limitation of the system, I offer that perhaps the need for manual metering could be a potential benefit as to why outcomes within Chancay-Lambayeque are so positive. Manual operation requires direct communication between the water users and the system operators on a daily basis within the community. I believe this direct and frequent link of necessary daily communication facilitates cohesion between users and managers of the system in such a way that management controllers do not see the users as ‘others’, but can put a face to and a story behind each individual user, facilitating understanding of the water users’ individual situations and needs. The closeness and communication required between users and operators, I believe, may lead to more positive outcomes. This commentary is based on Volumetric Water Control within this specific community using their particular management methods and technologies. I question whether more technocratically operating VWC systems have such cohesion between operators and users, and whether there is a link between this communication and outcome.
were the only two case studies in which water management required daily interaction and communication between water users and water monitors. While the governance of Huaynacotas is horizontal and autonomous and the governance of Chancay-Lambayeque is top-down and state controlled, the act of this interaction results in cohesion and familiarity, rather than separation and anonymity, between water users and water governors. Perhaps the necessity of daily communication between users and governors is part of the reason why both communities have more positive outcomes.

The other observation was that community members within Huaynacotas and Chancay-Lambayeque had equal levels of socioeconomic stratification. It could be that when this type of status is shared equally among community members, there are fewer competing interests over water resources, or that interests regarding water resources are more universally shared. Shared interests, in this way, may coerce cooperation and therefore promote equity relating to equitable access and equity in the process of inclusion. It is arguable that an increase in competing sectors requiring the use of water could also increase conflicts over the use and distribution of water resources. On the contrary, the presence of fewer competing sectors would thus result in fewer conflicts over water resources and more equitable outcomes. By a similar token, perhaps when socioeconomic status is shared, mutual, rather than competing, interests exist, and more positive outcomes may be a result.

It seems possible that having a small socioeconomic range within a community may lead to more positive outcomes, though this relationship would be dependent on the other variables present in the community. Instead of being rooted in natural water scarcity, the sources over water conflicts seem to be rooted in competing interests at
different scales, whether over use, cost, amount, order and time of distribution or a host of other variables. Future water management studies would benefit from further exploring the root causes of water conflicts instead of or in addition to exploring the results of the conflicts, which is usually the sole focus. It is essential to better understand the root sources of water conflicts in order to uncover the causes of human-produced water scarcity, which unlike natural water scarcity, can be avoided.

Environmental Outcomes Discussion

It is notable that the environmental outcomes section is the only column from the analysis where the majority of the results are more negative, deemed ‘more consequential, with four of the six branded with this result. None of the hybridized systems were stated to have less consequential outcomes meaning that the two case studies with the least consequential environmental outcomes were Huaynacotas, the smallest (population-wise) case study which was also the only fully Andean, autonomous system in the analysis, and Chancay-Lambayeque, the case study with the largest population and the only state-controlled system in the analysis. Both of these communities’ environmental outcomes were found to be more positive, or less consequential because an important part of the water management in these communities revolves around ensuring the system is set up to produce equitable water division in times of water abundance as well as in times of water scarcity (as opposed to the push for more constant water flows as are attempted to be made available in each of the hybridized communities through a modernization effort). The modernized efforts discussed in the analysis are not environmentally sustainable for purposes of the
transfer, local ecologies, nor the vast amounts of market-oriented agriculture the transferred water is set to supplant. The increases in market agriculture, supported by transfers, lead to vast amounts of environmental degradation.

Chancay-Lambayeque’s water management includes forecasting the following year’s expected environmental conditions. This activity is carried out to minimize the planting of water-intensive crops. The payment scheme associated with Volumetric Water Control also eliminates water waste, as users do not want to pay for more water than necessary to irrigate their land, in this way they also may choose less-water intensive crops. The money earned from these payments goes directly back into the upkeep and maintenance of the system. This is vastly different from privatization efforts which claim charging for water teaches users to conserve because outside of the delivery of privatized water, no benefits of the exorbitant water fees are received by the users. Additionally, managers of the Chancay-Lambayeque system limit the amount of rice and other water-intensive crops that can be planted each season (Vos & Vincent, 2011). The forecasting is not perfect, but it shows an active attempt to reduce any actions that would increase human-induced water scarcity. It seems systems that are set to manage water in times of abundance and scarcity (in tune with the natural climatic fluctuations in the region that produce what was earlier defined as natural water scarcity), are indeed more poised to operate in accordance with the natural climate, a certainly more environmentally-friendly practice. This finding is in accordance with the previously stated claim that systems that create mechanisms for equitable water distribution in times of natural scarcity and abundance, that is, those systems with
greater adaptability to the natural environment, may be linked to having more positive outcomes, less consequential outcomes.

Huaynacotas has a more positive, less consequential environmental outcome because its irrigation is also set up to work in accordance with what can and should naturally grow with consideration of the local climatic and environmental conditions. Like Chancay-Lambayeque, Huaynacotas water management system is geared to produce equitable water division in extremely scarce conditions. By this token, the question is raised whether more water availability (produced through human interference as modernization efforts attempt) truly leads to more water equity. The communities of Huaynacotas and Chancay-Lambayeque both seem to get by, even thrive as all outcomes were determined to be positive. Whether there is water abundance or extreme scarcity, the systems persist, are mostly self-sustaining, and achieve equitable access and division of resources. In the hybridized communities, the modernization efforts that produce more water all the time despite natural fluctuations, do not necessarily produce more water equity. On the contrary, the increase in water availability may increase contestations and conflicts over water.

Additionally, Huaynacotas makes use of local microclimatic variations in order to require the least amount of water use for irrigation (doing the least to disrupt natural ecology as possible). By these efforts, and for the reasons stated above, it can be stated that both Huaynacotas and Chancay-Lambayeque have more positive, less consequential outcomes related to the environment because they are set up to operate around (rather than trying to control) natural climatic limitations, and are also set up to
minimize human-induced water scarcity unlike the modernization efforts present in the hybridized communities.

*How Much Fluvial Modification is Too Much?*

It must be stated that none of these systems should be romanticized as being entirely environmentally friendly. Each of these systems is responsible for modifying local hydrology; some just do it to a greater extent than others. No matter how modern or how ancient, all water management systems have environmental consequences. As a species, what right do humans have to modify natural systems? All species modify the ecosystem to some extent, but humans are perhaps the only species aware of the consequences of the biogeomorphological actions on natural processes. For the purposes of this study, more negative outcomes were associated with systems with the potential to harm the environment beyond basic security for survival, assuming that all species have the ‘right’ to survive through coexistence.

*Hybrid Community Trends*

It was noted that the majority of outcomes in the hybridized communities were negative. In the twelve outcomes for the hybridized communities, nine were negative. Though unfortunate, it isn’t shocking that the state does not make a great effort to include and actively involve community members in the decision making process within a recently hybridized system. In fact, some of the more negative results in the hybridized communities were determined to be so because the traditional systems operated more positively prior to state involvement. Clearly, it is important when a state
does involve itself in an Andean, or any other, community it much realize that positive and sustainable outcomes on behalf of the community, and in a larger perspective for the Nation outside of short term economic benefits, market oriented and temporary needs, the community’s water related needs, cultural practices, spiritual beliefs, must all be carefully taken into consideration. Additionally, it was noted that there should be an increase in environmental impact studies as few were noted within the hybridized community studies.

Further Observations

It was noted that two of the case studies had more positive outcomes for each outcome category. These were the state-controlled system, Chancay-Lambayeque, and the autonomous system, Huaynacotas. All of the hybridized communities had a mixture of positive or negative outcomes. For the three case studies from the Colca Valley, the outcomes were generally more positive prior to the hybridization of the communities, meaning each community would have had more positive outcomes before state interference for each column. It should be noted that Cabanaconde has received more water after the transfer, slightly improving ease of access at the time of study. The other hybridized community, Yarabamba, is intended to have more state control after implementation of the proposed reservoir, which is supposed to increase water availability. Yarabamba has negative outcomes for each column, and the proposed reservoir might improve quantity of availability, however this does not mean any of the negative outcomes will be alleviated because the community already has a poor record
of equitably managing water resources and of communicating with the state (and vise versa).

The communities that became hybridized that retained positive outcomes for certain categories, such as Cabanaconde, are those that had positive outcomes for those categories prior to state involvement. Cabanaconde only retained positive outcomes for certain columns after protesting and negotiating with the state systems. If these negotiations had not taken place, all of the columns for Cabanaconde would have been negative. This poses two questions: can hybridized systems only achieve positive outcomes (for any category) when those very categories were positive prior to hybridization? Additionally, would hybridized systems ever achieve positive results without self-advocating on behalf of the community members? Do positive results only occur if and when the community makes demands for certain requirements to be met? As indicated by the case studies analyzed, community efficacy and self-advocating seem to play an essential role in securing more positive outcomes. Therefore, there is a strong role played by Andean communities in shaping their own water futures, whether or not they become hybridized. Community efficacy plays a large role in shaping water management futures. As Corporaque demonstrated, even strong advocacy on behalf of the community does not guarantee that a positive outcome in hybridization will be achieved (that is, if the state does not acquiesce to the needs of the community). It can be stated that perhaps without advocacy on behalf of marginalized communities (in addition to positive outcomes prior to hybridization, as previously mentioned), positive outcomes post hybridization will not be easily achieved.
According to the authors, the community of Yaramamba does not pursue community advocacy. Additionally, the community did not have a positively operating water management system at the time of study. Based on the findings highlighted above, it is uncertain whether it would be possible to achieve more positive outcomes post implementation of further modernization efforts70. Citizens of Yarabamba, unlike Corporaque and Cabanaconde, do not seem poised or willing to mobilize and work together to advocate for enhanced representation, communication, or other improvements to the current water management system. Though each outcome was determined to be more negative for the majority, it does not seem like there was any motivation or effort among community members to alter these outcomes. In communities such as Cabanaconde, Corporaque, and Huaynacotas it seems that members take deep pride in their water management systems and are highly invested in the traditional maintenance of their water management systems71. When presented with a need to self-advocate, as Corporaque and Cabanaconde have experienced, ________________

70 It seems positive social or environmental outcomes -post modernization or hybridization efforts- can only be achieved if the social or environmental outcomes were more positive prior to modernization or hybridization.

71 Other studies that did not meet the inclusion criteria also noticed a trend between the strengthening of ethnic identity in the wake of increased state involvement. The article “Troubled Water: Ethnodevelopment, Natural Resource Commodification, and Neoliberalism in Andean Peru” by Emily J. Hogue and Pilar Rau states that in the district of Combapata, facing state imposed resource commodification, the “cultural connection to the land has facilitated a framework for ethnodevelopment and intensified ethnic identity” (Hogue & Rau, 2008). There are many such examples within the literature of communities strengthening their ethnic identities in the face of increased state involvement.
these communities are poised to mobilize and in the case of Cabanaconde, can achieve positive results. This does not mean positive results are easy to achieve, as these results are adamantly fought for, but it does seem that community members of Cabanaconde, Corporaque, Huaynacotas and Chancay-Lambayeque are more invested in their water management system than community members of Yarabamba, and these communities were also observed to have more positive outcomes.

Critical Meta-Analysis Summary

Paul B. Trawick, an anthropologist who wrote the article on the water management system of the Huaynacotas, stated that people are more likely to obey the rules if they set them themselves (Trawick, 2001). This statement indeed seems true for the autonomous community of Huaynacotas, wherein the water management system is completely created and managed by the community members without outside influence. As such, Trawick claims, the rules of the system are so well followed that meetings regarding water management are not necessary. Community members obey the rules earnestly, Trawick argues, because they want to - they created them. Trawick goes on to describe the Huaynacotas water management system as close to perfect as any researcher is likely to find.

Huaynacotas was the only autonomous system that met the inclusion criteria for analysis, and therefore the only community that entirely sets its own rules and regulations regarding water management (all other communities in the analysis were either hybrid management systems or state-controlled systems). Additionally, even though there were other systems with “more positive” outcomes, the Huaynacotas
system seems to be the one that operates the most efficiently and produces the most water resource equity and satisfaction among the vast majority of community members. While there are many other variables at the community level that lead to the very positive water management outcomes for the community of Huaynacotas, it does reason that perhaps the fact that the rules are set entirely by community members could be correlated with why the outcomes of the water management system are so positive, especially regarding equity to resource access and inclusion in the decision making process. The system is so unique that the decision making process isn’t inclusive in the sense that community members are allowed to participate in discussions in a top-down manner, rather, community members are the decision-making process, and each community member is equally important. Within the community of Huaynacotas, management decisions are truly horizontal. Without other autonomous communities in the analysis, it is not known how many other self-managed community water management systems have an entirely positive set of outcomes as well, but the convincing case of the autonomy of Huaynacotas as influencing positive water management outcomes remains quite persuasive. From the evidence presented in the analysis, it does seem that Trawick’s claim- that when community members set the rules themselves, they are more likely to obey them- is true for the autonomous community of Huaynacotas.

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72 More studies should be conducted relating to the outcomes of community level water management in entirely autonomous communities, as horizontal and equitable management and governance could potentially be a significant aid in procuring more positive outcomes at the community level.
While there aren’t any other fully autonomous communities in the analysis, there are four separate articles, encompassing three communities, with hybridized systems. In these hybridized systems, the state does influence community-level water governance and management, but members of the community retain certain critical aspects of water management decisions that enable them to set at least some of the rules. The community of Cabanaconde, discussed by Boelens and Gelles in 2005 and by Paerregaard in 2013, is a hybridized community. Cabanaconde is hybridized because the community members refused to fully relinquish control of their socially, culturally, and historically significant water management system to the state. At the time of each study, by Boelens and Gelles in 2005 and Paerregaard in 2013, the authors’ state that despite giving up the traditional water mayors and water resources due to state interferences, the people of Cabanaconde ensure that the distribution of water remains the same as before state intervention. Essentially, the community of Cabanaconde is retaining the rules for water management they had set for hundreds of years, though are practicing these rules at present alongside certain measures imposed by the state. By this token, the community of Cabanaconde is also setting some of their own rules, not to the extent of Huaynacotas, but retains as much of the traditional water management practices as possible. Both Huaynacotas and Cabanaconde have more positive outcomes related to equity to water access. Could the self-imposed water distribution rules play a role in leading towards a positive outcome? On the other hand, the hybridized community of Corporaque, located in the Colca Valley on the opposite bank from Cabanaconde, also refused to relinquish their traditional water management practices to the state. Corporaque, like Huaynacotas, continues to irrigate in the
traditional way (essentially, continuing to set these rules themselves), though was found to have a more negative outcome related to equity to water access. The difference between these outcomes in Corporaque and Cabanaconde, both affected by the Majes project, is that the state increased flows to Cabanaconde (though only after fierce protesting by the people of Cabanaconde), but greatly decreased flows to Corporaque (despite equally strong efforts by the people of Corporaque to demand water justice and fair flow returns from the project to the community). By this effect, the people of Cabanaconde were able to continue to practice their traditional water management practices as much as possible with ‘fair’ water returns provided by the state. The people of Corporaque were not given equitable return flows and although they continue to practice their traditional water management practices as much as possible, the outcomes are more negative post imposition of the Majes project. Even though both Cabanaconde and Corporaque set many of their own rules related to water management within their respective communities, the varied responses by the state have created very different outcomes in terms of social equity to accessing water resources. In this sense, Trawick’s claim of self-set rules relating to outcome is not always true relating to hybridized communities.

Another similarity between Cabanaconde and Corporaque, despite geography and history, is that both fiercely contested state presence and demanded justice related to accessing resources from their transferred water source upon imposition of the Majes project. Both communities demonstrated a strong will to seek justice and also to retain traditional forms of water management. While other communities in the valley joined in the protests against the Majes, the authors reported that these communities did not
have equally strong resistance or persistence (Delgado & Vincent, 2013; Paerregaard, 2013; Boelens & Gelles, 2005). While unfortunately, the community of Corporaque was unsuccessful in achieving their demands regarding access to the transferred source, it must be questioned to what extent community efficacy and assertion play in the outcomes related to power struggles over resources. Boelens and Gelles state that the strong, unifying pride related to the cultural and spiritual history of Cabanaconde was a motivating factor for the community to resist state control so adamantly, and to demand justice once the state finally entered the scene (Boelens & Gelles, 2005). As such, if Cabanaconde’s citizens had not asserted themselves in the situation, they would not have received additional water transfers from the project at all. Corporaque’s citizens were equally adamant in asserting justice claims, though unfortunately theirs were ultimately not met. It is clear that the social mobilization at the community level, especially for communities that are often marginalized, can play a major role in outcome. In contrast, the community of Yarabamba, another hybrid community, is entirely disconnected from the state and communication between the state and the community is rare despite the hybridized nature of the system. As the people of Yarabamba were not reported as making any attempts to assert justice claims related to the state’s interference, it is unknown whether such actions would result in more positive outcomes related to water management in the community.

**Future Implications**

Into the future, it is expected that Peru’s glaciers will melt out, the population will increase, and by this token, water resources will become scarcer. What effect will this
have on modernization efforts set up to make equal amounts of water available year round without regard to what is natural (or ideal) for the local ecology? The systems set up to take advantage of these transfers are incredibly water intensive and will not be sustainable into the future. When local economies become based on these activities related to a perishable source, what will the social and economic consequences be?

Communities without modernization efforts that are set up to handle times of extreme water scarcity and continue to survive while also ensuring equitable distribution for water are perhaps the best poised to handle the expected climatic changes. If the government does not heed caution now, these traditional systems may become the models for re-appropriated water management systems in the future. The government is currently trying to impose diversion projects within these communities, causing loss of local-knowledge related to the efficient management of a scarce resource. The government is currently operating as if there are no natural confines for water in the country, and that the transferred sources will perpetually be able to support current flows.

More research should be conducted related to the role of community efficacy within marginalized communities in seeking justice and equity in participation inclusion and access to water resources. Though, in an ideal world, such claims wouldn’t be necessary, it seems that in Peru, where traditionally marginalized communities are increasingly being affected by state control over water governance and management, certain regulations should be set to give these communities a choice in their involvement with the state, and to avoid the consequences of inclusion-oriented strategies. Communities should be made aware of the potential positive and negative
consequences of adopting a hybridized system, without using ‘inclusion-oriented’ coercion strategies. Additionally, if communities cannot legally be given a choice regarding whether or not their water resources should be transferred (to which more studies need to be conducted to analyze the potential social, cultural, and environmental outcomes of such transfers and their future effects with predicted climate change), as Peruvian law dictates the state has ultimate control, they should be given vast opportunities to participate and be allocated water with the same amount and or frequency as was present prior to state interference. In addition to being viewed as equal contenders in the decision making process, the government should be more aware of the operation of traditional water management systems, as there is much that could be learned from these systems. Certain elements of traditional water management systems could even be applied to state-controlled systems in order to create better informed policy and management decisions that are more attuned to the needs of the many different community structures within the country as well as to produce more environmentally sound policy.
Conclusion

Every water management system is a form of adaptation. Communities have to adapt their practices involving water to social and cultural influence, environmental constraints, and often to limitations placed by a formally or informally recognized governing body. The results of this critical meta-analysis demonstrate that social and environmental outcomes relative to water management can be more positive in both autonomous and state controlled systems within Peru. Additionally, the analysis demonstrated that hybridization efforts are likely to result in less positive (more consequential) environmental outcomes, and often less positive social outcomes post implementation of modernization. This finding does not mean that hybridized systems are a poor solution to water management, rather, that certain parameters linked to the hybridization efforts in the case studies together lead to less positive outcomes post implementation. Through observation of the community level changes in these hybridized systems, it is possible to form a better understanding of the ecological constraints and anthropogenic factors that together create less positive outcomes. Through improving understanding of the interaction of these parameters, the causes of human produced scarcity and inequality can be better understood, facilitating positive changes to hybridized community water management schemes.

Certain themes were discovered which may show a link between particular parameters and outcome. Though these themes were not in any way meant to be deterministic of water management outcome at the community level, they provide a sort of platform which can be used to inform what areas of water management studies need
to be improved upon in order to better understand the relationship between social and environmental variables, access, control, participation, and outcome.

The initial search for potential documents to include in this analysis resulted in 340 articles. It was determined that articles must have a wealth of information regarding social and environmental variables at the community level in the arid regions of Peru in order to produce an even plane for a comprehensive analysis. With the inclusion criteria in place, 340 articles were rapidly whittled down to 6, a figure incredibly smaller than was initially anticipated for the meta-analytical objective of this thesis. The majority of articles fit most of the inclusion criteria, however many articles did not include adequate information about environmental characteristics and ecological constraints of the communities alongside adequate information regarding social activities, cultural practices, management and governance at the community level. In order to uncover the distinction between natural scarcity relating to outcome and adaptation and human induced scarcity relating to outcome and adaptation, this thesis considered it necessary that all articles for inclusion had comprehensive information about both. While this thesis recognizes the importance of environmentally focused or socially focused water management studies, this work is also operating with the notion that water management outcomes can vary vastly within a region of similar ecological constraints relative to water availability due to the combination of both environmental and social variables at the community level. In order to create an adequate analysis, it was therefore required that articles included adequate details about both.

It was considered a significant finding in itself that so few articles met the inclusion criteria for analysis. This finding demonstrates that more comprehensive water
management studies in the arid regions of Peru need to be conducted in order to form a better understanding of how social and environmental variables together produce a particular outcome. By separating the solely environmental variables (such as those that lead to natural scarcity), it becomes much more apparent what anthropogenic factors lead to more negative management outcomes. As throughout history, communities within Peru have been able to sustain societal life despite vast environmental constraints related to water availability, it is clear that environmental constraints alone do not themselves lead to the water crisis in Peru. That is to say, this study found that social factors related to water management are perhaps the core of what may lead to more positive or more negative outcomes as positive outcomes can be found in even very water scarce environments. This was an assumption at the heart of the initial motivation to conduct this thesis as review of the literature demonstrates that social equity to water access, participation, and general environmental wellness can be achieved in naturally water scarce regions of Peru, yet more negative outcomes can occur in similar environmental regions or even more water abundant regions. This notion relates back to a similar finding by Barbara Lynch Deutsch, who states “people are vulnerable to outcomes rather than hazards: the root causes have more to do with social structure than natural processes or events” (Lynch, 2012; Suarez, Ribot, & Platt, 2009; Ribot, 2009; Mearns & Norton, 2010).

It seems appropriate to state that adaptation is key to ensure social equity to resource access and inclusion in the decision-making process, such as can be

\[73\] As adaptation is necessary for survival of all biological beings, working within the framework of humans as part of nature, humans therefore must also adapt.
exemplified in the Huaynacotas community and in Chancay-Lambayeque, which each have positive outcomes (Trawick, 2001; Vos & Vincent, 2011). Additionally, findings within this work demonstrate that greater access to water does not necessarily lead to greater equity with water access as top-down parameters largely determine who can access these resources whether by cost, quantity, or other forms of exclusion and inequality. Several case studies demonstrated that even if modernization efforts produced more water, this leads to an increased use of water, often for more ecologically consequential or capitalistically driven pursuits that undermine both community-level social and environmental wellness (Swiech, Ersten, & Pererya, 2012; Paerregaard, 2013; Delgado & Vincent, 2013). This finding also bucks the semi-prevalent notion in water management studies that the “right to water” involves a certain quantitative element. This thesis instead operates under the notion that water scarcity has less to do with the amount of water available, and more to do with how humans adapt to ecological constraints and manage the resource. In this sense, water is not an anthropocentrically given right, but a spatiotemporally dynamic resource that biological beings must also dynamically adapt to in order to ensure the wellness of species and also to work within, instead of against, local ecology.

While the analysis did demonstrate that modernization efforts do not always result in more positive outcomes in the studies of the hybrid communities, this does not equate to the often-misunderstood rationale that more traditional systems are essentially more “pure” or should be romanticized as universally leading to more positive social and environmental outcomes. Instead, this thesis acknowledges that more traditional cultures also have or have historically had elements of capitalism,
forced labor, inequalities in access and control, environmental degradation, and cultural imposition. For example, the Inca, hailing from modern day Cusco, Peru colonized certain regions and communities of Peru not unlike the Spanish. In the 15th century, the Inca conquered the Chimú culture, building temples on top of existing Chimú pyramids to assert cultural and political dominance. Systems of excess and inequality have occurred throughout time and no period should be considered as a paragon for water management. All communities and their water management processes act as biogeomorphological agents influencing natural fluvial ecology and therefore local biological factors, no matter the era or type of technology used. It would be an oversight to assert that more traditional systems are holistically more socially just or completely ecologically sound.

However, the persistence of certain traditional water management systems in the arid regions of Peru do demonstrate that social life can be maintained in what might otherwise be considered a hostile environment with which to cultivate civilization. There are certain local-knowledge based water management methods from these communities that can be studied to perhaps inform and improve certain existing water management schemes in communities with less positive outcomes in order to produce more positive social and environmental outcomes. Many modernization efforts, through inclusion-oriented dynamics (Boelens & Gelles, 2005) are poised to intentionally or unintentionally erase local-knowledge as often, certain traditional practices related to local knowledge become irrelevant post-technocratic implementation. It is important that hierarchical management structures within Peru recognize the importance of many local-knowledge practices within Peru throughout history as they can indicate the
principles of social and environmental interactions, at a variety of community scales\textsuperscript{74}, have led to both more positive or more negative outcomes. Early ‘traditional’ communities that have dissipated or perished should be studied to understand the role of environmental and social variables that led to poor management and societal collapse, and those communities that persist today can be further studied to provide a better understanding of certain social and environmental variables that have led to more positive and sustainable community level outcomes. While traditional systems are or were by no means perfect, the importance of the local-knowledge of these systems needs to be better understood by the hierarchy of water managers in Peru. Inclusion-oriented strategies need to come to an end in order to preserve and maintain the knowledge that could prove to be critical to inform adaptation efforts in communities with less positive outcomes (especially in urban areas), and to better understand how to create and maintain locally derived agricultural practices that operate within the confines of local water availability.

While this work does not seek to critique modernization efforts as a whole (especially in realization that fundamentally, modernization efforts have occurred throughout time), this work does demonstrate that despite the advances present day modernization efforts are boasted to have, these recent endeavors have not been able to create systems that are any more socially just or ecologically sound than the operation of water management systems prior to state modernization. It is essential that

\textsuperscript{74} Some early communities occupying arid regions of what is modern-day Peru hosted populations in the tens of thousands. It is evident that to sustain such large populations in a fixed space, these communities managed water in a way that would allow for the creation of agricultural surplus.
actors in charge of implementing and studying these efforts create more long-term impact studies on ecological, cultural, and social consequences, and to recognize the rationality of environmental constraints.

This study demonstrates that many current hybridization and modernization efforts do not always consider the cultural impacts of these efforts nor do they consider the potential for loss of local knowledge systems that may indeed produce more positive outcomes relating to water management. It is imperative that state appointed water management officials take note of local knowledge systems, as technocratic solutions alone cannot always produce more positive social and environmental outcomes. This thesis recognizes that technocratic operations may possibly lead to more positive outcomes elsewhere, but this thesis did not find evidence of a technocratic or state appointed modernization effort that resulted in more positive outcomes, possibly due to the fact that the actors in charge of these decisions were primarily focused on immediate economic ends and were less concerned with long-term sustainability, cultural awareness, or environmental consequences. Is also imperative that state officials become more aware of the significance of cultural beliefs regarding water and its management, as many communities are being forced to modernization with the implementation of hybridized systems. While this is a moral injustice of cultural imposition, it also signifies the potential to lose significant local knowledge systems that could otherwise be studied in order to create more socially and environmentally just water management systems that are sustainable into the future.

The meta-analytical portion of this study also created a platform with which to observe what types of studies regarding water management in Peru are lacking. An
increase in comprehensive water management studies in Peru could be integral for a better understanding of water management practices and results and could inform decision makers how to holistically understand and analyze water management systems in order to produce and maintain more equitable systems. This study found that in addition to creating few to no cultural impact studies, it seems that the state also creates very limited environmental impact studies especially in relation to diversion schemes. More studies should be created to explore immediate and future impacts of technocratic modernization efforts on local, regional, national and even global ecologies, resource access and equity, and cultural studies. Additionally, the consequences of inclusion-oriented strategies should be exposed and ceased in practice. It would additionally be beneficial for more studies to be created that cross analyze the social and environmental outcomes of multiple community level water management studies within the arid regions of Peru, and throughout the Andes and Atacama desert regions as well. Such comparisons can help to expose commonalities in communities with less positive outcomes, similarities in the practice of traditions and local-knowledge, the effects of modernization and privatization efforts on social and environmental wellness, and can thus expose the anthropogenic means that lead to vulnerabilities. Such comparative studies expose what water management and adaptation struggles have been universal throughout time, and also what struggles have been entirely created by social mechanisms. Though natural stressors cannot be ceased, it must be critically recognized that anthropogenic means that lead to inequalities and injustices, both socially and environmentally, can indeed be avoided. Through a better understanding of how different groups have avoided such anthropogenic barriers to more positive
outcomes, mechanisms that can lead to improving upon social and environmental outcomes can be further studied and pursued.

The results of the analysis demonstrate that there are multiple combinations of social and environmental variables at the community level that can lead to successful outcomes. Clearly, the ways in which to manage and govern resources have to be adaptable and malleable throughout time to fit the dynamic nature of social and ecological situations. As the analysis demonstrated, communities with similar scales, locations, climate, economies, and cultural practices may have vastly different outcomes, as can be exemplified by the impact of the same modernization effort on the communities of Cabanaconde and Corporaque within the Colca Valley (Boelens & Gelles, 2005; Delgado & Vincent, 2013; Paerregaard, 2013). The combination of variables that lead to positive outcomes vary throughout time and space and cannot universally be applied to all communities and be expected to result in the same outcome.75 The variables outlined that seemed to be frequently related to more positive or more negative outcomes in the discussion and analysis sections should be further explored to discover the potential role of these variables as agents. Through further study of these human and environmental interactions with outcome, the critical nature of human and environmental relationships pertaining to water management outcome can be better understood. With such an improved understanding, perhaps the study of the relationship of these variables, together working as actors76, can be used to modify

76 Again, recognizing that no variable in and of itself is responsible for creating a specific outcome, but the combinations of variables in a community are what lead to a particular outcome.
existing laws and practices in the water management of communities with less positive outcomes in order to improve environmental outcome, strengthen the capacity for local involvement and inclusion, and improve resource access.

As this critical meta-analysis of water management at the community scale within the arid regions of Peru is the first of its kind, there are several ways in which it could be improved upon. It would be beneficial to alter the inclusion criteria to include more water management studies in order to create a larger sample. While shortening the inclusion criteria would allow for the introduction of less holistic studies that are more difficult to compare, it would still provide a larger picture of the situation of community-level water management within the desert and highland regions of Peru. Though the small sample size only provides a small picture of water management studies in Peru, the methods used provided an integrative platform that allowed for a comprehensive comparison of both social and environmental variables that lead to outcome. This method could be applied to community level resource studies in other areas around the world, as community level studies, critical comparisons, and meta-analysis together provide a much more holistic observation of the realities of resource management and outcome, can provide a distinction between ecological limitations, and expose the anthropogenic variables that produce inequalities. The methods used within can be used to further expand upon this study, and can be applied to a variety of other studies related to the sociopolitical and environmental causes and effects of nature-society relationships. From the results of this study, it seems that more positive water management outcomes result from the ability to adapt to social and ecological dynamisms while striving to maintain equity in resource access, widespread community participation and dialogue,
and an active maintenance with preserving environmental wellness and maintaining a low biogeomorphological footprint. Ultimately, this comprehensive thesis supports the need to study and understand the variety of situations and outcomes in water management, including long-term social and environmental impact studies and local knowledge. This work also forms a means with which to advocate for the capability of traditional and Andean communities to self-govern. Additionally, this thesis advocates for the importance of community-wide participation, involvement, and self-advocacy in governance, and the responsibilities of political institutions to create and maintain social equity and environmental wellness related to resource governance and management, as causes of insecurity and degradation are not naturally induced.


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