Insight into the Use, Perception, and Value Surrounding Domestic Water in Peru:

Envisioning Demand Management in an Intermittent, Small-City, Service Context

by

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ABSTRACT

It is increasingly recognized that in order to manage scarce water resources for the domestic sector demand management is requisite. In developing countries, demand management can help to expand service, improve water quality, and ensure the ultimate sustainability of water services. In order to manage demand, it must be measured and understood. Intermittent water services are globally common, but unmetered domestic water use under such conditions has not been carefully studied. This study conducted 1,149 household surveys in a small, growing, coastal city (population est. 35,645) in La Libertad, Peru. The objectives were to 1) characterize current household water use behaviors, perceptions and values as they vary among three distinct user groups (two different intermittent water services and well users) and reveal the existing water use and potential household demand for water, and 2) propose demand management tactics applicable to conditions of the study site. Survey results show daily per capita water use in the range of 35 to 90 L with more water being used by the group that receives water for a longer duration of time. The distribution of water was inequitable and, on average, households received water for less time than the service providers' reported duration. Demand is likely to grow due to increasing water-related infrastructure, established water behaviors, and a lack of understanding regarding regional scarcity and water conservation. Households are not satisfied with existing service conditions, particularly water quality, but due to an apparent distrust in their water providers are unwilling to pay for improvements. For domestic service to remain sustainable under the pressures of increasing water scarcity, demand management strategies, particularly education and awareness building, which have been shown to be achievable should be adopted.

CHAPTER 1: INTRODUCTION

1.1 Study Motivation

> "*When you added a couple of lanes to a freeway or built a new bridge, cars came out of nowhere to fill them. It was the same with water: the more you developed, the more growth occurred, and the faster demand grew*" (Reisner, 1993, p. 348).

Water is an essential element for life. Existing in a continuous cycle, the same amount of water that existed 4.54 billion years ago continues to evaporate, precipitate and flow in many forms across the planet. Not only a requisite for basic survival, water is necessary for growing and preparing food, adequate sanitation and hygiene, and the overall economic and social prosperity of a population and its constituents. As such, it is no surprise that water resources play a direct and/or indirect role in the achievement of all eight Millennium Development Goals (MDGs) adopted by the United Nations in 2000.

While humans utilize water in its many states, freshwater is perhaps the most useful and scarce. Globally, freshwater makes up less than 2.5% of the total hydrologic picture. Of this 2.5% only 30.5% is not bound up in ice, organisms, or soil (USGS, 2012).

Even so, if all the freshwater on the planet were divided up evenly, every person would have approximately 3,000 to 4,000 cubic meters per year in excess of what is required, directly (household water use) and indirectly (diet, consumerism, etc.), for an American lifestyle[1] (UN-Water, 2007; Fischetti, 2012). While this may sound reassuring, water remains scarce for many

[1] The United States which has the highest per capita water footprint of 2,842 m^3 per year (Fischetti, 2012) Thus, the 5,000-6000 m^3 available to everyone, every year, as reported by the United Nations would be roughly 3,000 to 4,000 m^3 in access of even the United States high standard of living. Comparitively, less than 1,700 m^3 per capita per year is the threshold at which a country would be considered to be experiencing water scarcity; resulting in a decline in economic development and the health and well being of their population.

humans. One reason for water scarcity is society grows accustomed to water being available in a certain place but then it is no longer available due to changes beyond human control. The problem with this is that shipping/transporting a large amount of water for human use is neither easy nor financially or physically sustainable; sustainable implying that the behavior could be carried out indefinitely without detriment to the resources upon which it relies (although, at the cost of $30 million, Barcelona, Spain, was scheduled to do just that for several weeks one summer before a period of drenching rain saved them (Fishman, 2011)).

In addition to being unpredictable in place and time, the polarity of each water molecule makes H_2O a great solvent. In other words, the structure of the water molecule creates the perfect binding surface for both beneficial minerals as well as harmful contaminants. As an example, in the United States, water suppliers have gone from monitoring and treating 22 contaminants in the 1980s to 90 in 2012 (Theiler, 2012).

To this matter, in their 2010 MDGs Report, the United Nations noted that while the world is on target to meet or exceed its goal to halve the proportion of people without access to safe drinking water by 2015, there is increasing degradation of the quality of freshwater resources available (United Nations, 2010). Thus, while it is laudable that by 2015 more than 86% of the developing world population will have gained access to an improved water source, the next step will be to examine the quality, quantity, continuity and reliability of the expanded water supply.

It has been “widely acknowledged that water is a major limiting factor in the socio-economic development of a world with a rapidly expanding population” (Vairavamoorthy et al., 2008). The world’s population is projected to grow to 9.3 billion by 2050 (United Nations, 2012). In order to achieve the global eradication of poverty by then, impoverished areas will need to secure water resources for uses far beyond the basic requisite of thirst.

In line with historical development and water resources management, those fortunate enough to gain a water supply of both adequate quality and quantity will likely adopt a higher per-capita consumption of water, both in terms of direct and indirect use. Not surprisingly, according to the World Resources Institute, “water use has been growing at more than twice the rate of population increase in the last century,” foreshadowing a 50% growth in demand expected to occur between 2007 and 2025 in developing countries (Zarbarenko, 2011).

Not only is the demand for water growing, it is happening in increasingly concentrated spaces. Over the next four decades, cities will absorb an additional 2.6 billion people, rising from 3.6 billion people in 2011 to 6.3 billion people in 2050 (United Nations, 2010). Paul Reiter, executive director of the International Water Association (IWA), broke it down at World Water Week 2011 closing ceremony; “We’re adding 1 million people every week times 52 weeks times 40 years. Who’s going to respond to this challenge?” (Ganter & Nadya, 2011).

Populations’ will be further challenged in the coming decades due to a climate that is changing across the globe. It is predicted that *historical* patterns in the hydrological cycle will disappear. Micro-climates will play a large role in the availability of water at local levels but the overwhelming trend will be less water in already dry areas, more water in already wet areas, and, overall, a global increase in extreme water events (Camarsa et al., 2010; UNDP, 2006).

Taken as a whole - an increasing population, that has growing aspirations, and increasing urbanization, compounded by climate change - it is not surprising that water scarcity is said to be among the main problems to be faced by the world in the twenty-first century (UN-Water, 2007). Water scarcity has been defined in many ways, none of which completely capture the issue’s complexity. One of the most popular gauges of water scarcity is the ‘Water Stress Index.’ Although it fails to take into account important factors such as regional differences and desalination, the Water Stress Index considers a country’s population to be experiencing

physical scarcity when the amount of renewable freshwater available per capita per year drops below 1,000 m^3 (White, 2012). As it stands, 1.2 billion people currently face issues of physical water scarcity, and that number is predicted to reach 1.7 billion people by 2025 (UN-Water, 2007).

In addition to scarcity arising as a direct result of water's physical absence, water scarcity can also occur as the result of mismanagement, inadequate infrastructure, and contamination (Totsuka et al., 2004). Ultimately the appropriate scale for understanding access to water is not global or even national but at the regional, local, and increasingly urban, level. Perhaps the most comprehensive measure of water scarcity, 'The Water Poverty Index,' considers not only total renewable freshwater, but the accessibility, quantity, quality, and variability of all available water. Furthermore, it takes into account the area's unique management, demand, and environmental circumstance. Under such scrutiny, even seemingly water abundant countries can have areas threatened by water scarcity. As noted in the 2007 United Nations Report, *Coping with Water Scarcity: Challenge of the 21st century,* "Water scarcity is a relative concept and can occur at any level of supply or demand." That is, while water resources are ultimately finite, "the same cannot be said of water demand" (Sullivan, 2002). Thus, in its broadest sense, water scarcity can also be defined as the point at which the supply and/or quality of all available resources does not meet demand; where, in a technical sense, demand is defined as "the quantity of water that users are expected to consume," and, in a nontechnical sense, is defined as the level of service users desire "as measured by the contribution (they) are willing and able to make to receive and sustain it" (Deverill, 2001).

In general, national water policies tend to give priority to the domestic sector above all else, regardless of the scarcity or plentitude of water resources (Vairavamoorthy et al., 2008). But, on a global level, agriculture accounts for 70% of total water usage; 82% average in

developing countries, 30% average in developed (WBCSD, 2005). As such, when faced with water scarcity, the first place countries seek to minimize their water use is within the agricultural sector.

The domestic sector makes up 8% of the global demand for water resources (WWAP, 2012). This is a proportionally small piece of the total water use picture, but managing household demand has shown to be both complicated and crucial to effectively, and sustainably, managing water resources. For many developed countries, household taps and their reliable flow made water essentially invisible as a potentially scarce resource. Essentially, the more the public consumed, the more water was supplied. Even water providers in regions that face regular or perpetual droughts fostered a false sense of security among household consumers.

Only in the past two decades has water provision for the domestic sector shifted from a historically reactive approach toward a proactive demand management program. Demand management, which will be further discussed in Chapter Two, has been defined as:

> "*the adaptation and implementation of a strategy (policies and initiatives) by a water institution to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services, and political acceptability."* (DWAF, 1999a as cited in Vairavamoorthy and Mansoor, 2007, pg 184).

In Peru, a country that has more renewable freshwater per capita than any other country in Latin America (Meade et al., 2010), people recognize that *agua es vida* (water is life). Despite an ample supply of freshwater, the country is not immune from problems of water scarcity. Due to water's heterogeneous availability in space and time, both in terms of quality and quantity, and poor governance, seven million people, or 24% of the population, are without a continuous source of clean water (Alegría, 2006).

Peru is a vast country (1,279,996 km^2 or twice the size of Texas) (CIA, 2013). The

author of this thesis was not able to comprehend the country's size until serving as a Peace Corps volunteer from September 2010 to November 2012 as part of the University of South Florida Master's International Program in Civil and Environmental Engineering. Along with 65% of the population and 1.8% of the country's freshwater resources (Alegría, 2006), the author lived on the Pacific coast (covering ~10% of the country's total area) in the town of Chao. Located north of Lima in the department of La Libertad, Chao began to rapidly develop in the 1960s due to massive investments in construction of an extensive agriculturally focused irrigation system. So, an average of 195 mm of annual rain for this desert climate was no longer a hindrance to agricultural development. The transformed agricultural oasis was expected to boast a $1,400 million a year economy in the immediate future (Chanduvi, 2006). With seemingly endless jobs available, migrants from the country's sierra and jungle regions continue to migrate to sea level in search of a better life.

This continual influx of people has resulted in rapid, and consequently chaotic, urban development. In some cases, families are settling onto undeveloped privately owned lands, a practice appropriately coined in Spanish as *invasiónes (*invasions*).* This illegal and haphazard growth places a large strain on municipalities as they struggle to provide basic infrastructure. Fortunately for the estimated 30,645 residents of Chao and Nuevo Chao, in September 2010 the Municipality of Chao proposed to develop a new water treatment plant and a series of oxidation ponds to treat wastewater.

Once complete, the project will raise both household availability of potable water, currently at 34%, and sanitation at 19%, to 97% (6,750, projected, households). Also, in contrast to the current variable chlorine treatment regimen, the proposed service features a modern, four-step, water treatment plant (coagulation, sedimentation, filtration and chlorination), that will provide better quality of water twenty-four hours a day. At the time of

this study's design households were either receiving hard groundwater every day for an average of three hours; spring water every other day for an average of one hour, or relying solely on water from unimproved household wells. Accordingly, the proposed project would appear to be an improvement compared to existing water service conditions.

The source of water for the new treatment plant is the CHAVIMOCHIC. Currently in its third and final stage of development, CHAVIMOCHIC is the acronym given to the canal that carries water from the Santa River 83.4 km up the coast of La Libertad, transforming 66,075 hectares of sandy soils with no structure into sprawling fields of green (Chanduvi, 2006; FAO Corporate Document Repository, 2004). Unfortunately, the Santa River's ultimate source is Andean, low-altitude, glaciers; glaciers that "will probably completely disappear within the coming decades," according to Antoine Rabatel, the leading author on a recently published multi-century perspective on glacier evolution and climate change in the Andean Glaciers (BBC News, 2013).

Furthermore, the Santa River's glacial melt freshwater does not stay clean for long. Due to heavy mining in the river's watershed, by the time the Santa River meets up with CHAVIMOCHIC, the water quality is "alarming" (Ministry of Agriculture, 2008). The district's only other water sources include a myriad of unmonitored and ever deepening wells. The National Water Authority (ANA) estimates coastal groundwater in Peru to be between 35 and 40 km^3, but Chao's specific data is not available. Overall, given the current intermittent service and the unknown future service, the water in Chao is arguably scarce.

To efficiently and equitably distribute scarce resources both supply and demand management strategies are essential (Deverill, 2001). This means that water services "must be planned and designed to ensure that water losses are minimized, that users understand the true value of water, operation and maintenance costs are minimized and that adequate

revenues are raised" (Mwendera et al., 2003). In the developed world, demand management was introduced as an afterthought to curb household consumption, after years of supply-orientated service had conditioned the public to use water as if it was an endless resource. In the developing world, water management is still driven by a supply side focus because large portions of the population are still without water and there is a bias for 'ribbon cutting' projects (Mwendera et al., 2003). However, demand management does not imply reducing level of service. Instead, it "focuses on measures that make better and more efficient use of existing, perhaps limited, supplies" (Vairvamoorty & Mansoor, 2007). In this regard, demand management can help to expand service, improve water quality, and ensure the ultimate sustainability of water services. In order to manage demand, however, it must be measured and understood.

Intermittent water services are globally common. So, how water is used, perceived and valued at the household level under such conditions is important. Surprisingly, this issue has not been carefully studied, especially for services that are characterized by an absence of water meters. It might be presumed that under intermittent conditions household demand, as it relates to quantity, is not being met, but personal experience gained by the author of this thesis while living in Chao suggests that whether households conserve or waste water is not necessarily a matter of having enough. Furthermore, from experience the author knew that limited quantity is only one of many aspects of intermittent services that are troublesome.

Accordingly, this study examines how demand management could be applied to a small, developing, city that recently invested in a large supply-side endeavor amidst unresolved social, financial, and technical issues. The study was designed to capture how residents of Chao and Nuevo Chao used, perceived and valued water before and after the transition to the new service. A first phase of the survey proposed to monitor water use via household surveys and

self-reported household diaries prior to the transition, and a second phase by household surveys and readings after the installation of new water meters.

Round I of surveys was completed in January of 2012. But, the new water and sanitation service did not begin as planned. Furthermore, the Municipality decided that when the transition did happen it would no longer be to a continuous, metered, schedule where households would pay according to their consumption; rather, the Municipality would continue to provide water intermittently at a flat rate per month. As a result of this change, it was no longer possible to obtain a 'before' and 'after' picture. So, the second round of surveys were used to expand and confirm Round I data and capture seasonal differences in water use.

1.2 Objectives

1. One: Characterize current household water use behaviors, perceptions and values as they vary among the area's three distinct user groups (i.e. 1) those who receive water every other day for ~ one hour; 2) those who receive water daily for ~ three hours; 3) those who rely on un-improved wells) and reveal the existing and potential household demand for water.

This objective will be achieved through the analysis of 1,131 surveys that contain data ranging from households' socio-economic situations, reported water use practices, perceptions, opinions and complaints regarding the current service and willingness to pay for various improved service scenarios.

2. Two: Demonstrate importance of demand management to the conditions of the study site (i.e., small city in a water-scarce region with intermittent, un-metered, water service) and propose applicable strategies.

This objective will be achieved through reviewing existing demand management strategies proposed in the literature for developing countries as they pertain to the conditions of the

study site. Further support to meet this objective is obtained from discussing the results of objective one.

1.3 Preview

Chapter Two of this thesis provides a specific review of the scholarly literature on demand management. It will review the state of knowledge surrounding the issue of water in the 21st century and the approaches cities around the world are taking in order to manage the demand within the domestic sector. Specifically, the review will examine what is known, and what needs to be further studied, with regard to household demand for water under an intermittent supply, un-metered, small city, context. Chapter Three provides background to the study, describes how the unique datasets were collected and outlines the statistical methods utilized to analyze the data. Chapter Four will present the results of the study as they pertain to the first objective. Chapter Five will discuss these results as they reveal the importance of demand management and what specific strategies should be applied in Chao. Chapter Six concludes the thesis and emphasizes the main findings.

CHAPTER 2: LITERATURE REVIEW

"*While global water resources may be finite, the same cannot be said of water demand*" (Sullivan, 2002).

2.1 Demand for Water

Water is essential for human life and wellbeing. Due to an increasing population and urbanization, The Water Resource Group estimates that global demand for water by 2030 will be 40% higher than it is today (UNEP, 2012) and up to 55% higher by 2050 (OECD, 2012). Meanwhile, global temperatures are predicted to continue rising and while a few degrees is seemingly small it can "seriously disrupt the natural balance of the world's climate; and thus results in changes of the water cycle" (Vairavamoorthy et al., 2008; Hadley Centre, 2013).

Whether as the result of physical absence, poor governance and/or lack of capital to clean and transport available water, the reality of water scarcity will occur in developed and developing nations alike. For example, Lebanon, unlike most Middle Eastern countries, is actually considered to be rich in water resources. Meanwhile, its capital Beirut is feeling the strain of inadequate supply (Tokajian & Hashwa, 2003). As Dr. Sheila Olmstead (2010) points out, "the barriers to efficient water use and allocation are, in large part, socially constructed." To that point, corruption and mismanagement are likely the number one reason that 1.6 billion of the world's population already face chronic water shortages (UN-Water, 2007).

Equitable distribution of water goes far beyond households' needs. Water is required for the production of food, industry, energy, and ecological balance. Agriculture accounts for an impressive 70% of total water usage (UNESCO - WWAP, 2012). As such, improving the efficiency of irrigation and the processing and distribution of food is critical. In fact, a report on

world water supply and demand from 1990 to 2025 offered a striking conclusion that around 50% of the increase in demand for water by 2025 can be met by increasing the effectiveness of irrigation (Seckler et al., 1998).

Accordingly, in Israel, a country that has been consuming water at or beyond renewable rates since the 1970s, attention began with focus on agricultural reform. Under the strain of scarce water resources, the agricultural sector adopted progressive production strategies such as the reuse of treated sewage effluent, micro-drip irrigation, and salt tolerant crops (Rosenthal & Katz, 2010). As a result, in 2002 the average requirement of water per unit of land area had fallen to 63% of what it was in 1975 (Israel Ministry of Foreign Affairs - The State of Israel, 2002).

Unfortunately, all of the freshwater freed up in Israel by technological innovation was diverted to meet the domestic sector's growing demand. As a result, water levels in Israel's rivers and lakes continue to decline (Camarsa et al., 2010). Although advances in desalination are expected to increase Israel's supply of freshwater 60% over the next 30 years, unless conservation measures are set in place for the domestic sector, demand is predicted to remain neck and neck with supply (Rosenthal & Katz, 2010).

Israel is not alone. Australia, Spain, and the United States, and many other countries, are feeling the pressure that growing, densely populated areas with high water use place on scarce, unpredictable, and/or increasingly contaminated, water resources (Fishman, 2011). Even if the agricultural and industrial sectors continue to significantly reduce their water consumption, without proper attention to the domestic sector, society will continue its struggle to find adequate water. In short, developed countries around the world are beginning to realize that technology alone will not resolve issues of water scarcity.

2.2 Demand Management

In order to properly meet the needs and aspirations of all sectors, countries agree that the management of water resources has to be viewed holistically. For example, in 2004 the European Commission formally presented this opinion in their *European Declaration for a New Water Culture*. Among many points, the declaration noted that in order to achieve sustainable management of our water resources one "must assume a holistic approach and recognize the multiple dimensions of ethical, environmental, social, economic, political and emotional values" embodied in the provision of water (European Commission, 2004). In this regard, another approach is to categorize water by function: "water for life, water for general interest purposes, and water for economic growth" (Laureano et al., 2008).

Holistic water management has been flushed out in many forms including the idea of Integrated Water Resources Management (IWRM). In 2002, at the Johannesburg World Summit on Sustainable Development, the Technical Advisory Committee of the Global Water Partnership defined IWRM as "a process, which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (Rahaman & Olli, 2005). Similar concepts include Integrated Resource Planning (IRP) and Integrated Urban Water Management (IUWM) (White & Retamal, 2011; Kayaga & Smout, 2009; van der Steen & Howe, 2009)

These systems-analysis-type approaches are in striking contrast to the way water has been managed in the domestic sector over the past few centuries. As early as the 1500's, governments dealt with the distribution of water from a supply-driven perspective. For many countries with the economy to do so, this meant that water systems, "constructed not only for their usefulness, but also for their honor," were so successful they became invisible (Sapiano et

al., 2008). Under such circumstances, it was not long before people took water for granted. In Australia, a country facing water scarcity early on, a 1987 household survey revealed that people were not actually aware of how they used water or how to save it (Thomas & Syme, 1988). In Zaragoza, Spain, a city that once faced a four-year drought, it was found that regardless of their level of education, consumers had little knowledge of the water cycle (Barberán Ortí & Salvador Figueras, 2010). The same has been shown in Israel (Rosenthal & Katz, 2010). As Charles Fishman, author of The Big Thirst states "our very success with water has allowed us to become water illiterate" (2011, p. 9). The public simply does not know the actual cost of capital investments, operation and maintenance, opportunity costs, and economic and environmental externalities associated with their water service.

Demand management does away with the blind provision of water and is one of the key tools of IWRM (Sharma & Vairavamoorthy, 2009). Rather than solely invest in the development of new sources and their subsequent infrastructure, the historically supply-side focus of water management has begun to shift (White & Retamal, 2011). With the understanding that reliable reductions in consumer demand can be considered as equivalent to increases in supply, water providers utilizing demand management strategies are now the norm rather than the exception.

2.3 Demand Management In Theory

In its most basic sense, demand management centers around two concepts: 1) doing more with what you have, and 2) doing better things with what you have" (Turton, 1999). Demand management is not an objective, but rather a strategy to meet a number of objectives including: "economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services, and political acceptability" (DWAF, 1999a as cited in Vairavamoorthy and Mansoor, 2007, pg. 184). With such objectives in mind, the effectiveness of a wide variety of demand management approaches began to be studied including: water

pricing, information and education, water conservation measures (water reuse, efficiency technologies, etc.), and legal measures (Babel et al., 2007).

Studies of existing data have been performed to see which interventions might be most effective in minimizing demand. A study in Egypt comparing demand to supply-driven management strategies found that, considering pricing, regulatory, engineering, and educational approaches, the three most cost-effective options were to minimize losses from the network, maximize end-use efficiency at the household level, and increase the water tariff (White & Retamal, 2011). With regard to tariff reform, a separate analysis of the relative merits of both coercive and market-based approaches concluded that using price to manage demand is more cost-effective than implementing non-price water conservation strategies (Olmstead & Stavins, 2009). Similarly, through using data on household occupancy, income, consumption, and billing from Kampala, Uganda, a model was created to simulate changes in consumption relative to price. The model was able to demonstrate that the introduction of an income-sensitive, increasing-block tariff, could potentially reduce demand by 15% and increase revenue by 8% above the existing situation (Motoma, 2007). That said, in part because it is highly political, most studies on tariff reform conclude that while price is an important demand management tool, in order to achieve sustainable behavior change, information and education must also be disseminated (Magnusson, 2004; Olmstead & Stavins, 2009; Zhong & Mol, 2010).

When data is available, examining the effectiveness of demand management strategies is useful to understand how past, present, and predicted demand varies within the population. A city's appetite for water is determined among heterogeneous consumers and thus it is important to explore how factors such as certain socio-demographic variables, climate, and existing policies affect demand patterns. The most commonly examined variables are population, number of households, household size, income (or other factors representing the

standards of living, price of water, educational level), and climatic factors such as temperature and rainfall (Babel et al., 2007). Some other factors that have been examined include the type of housing and land use (Shandas & Parandvash, 2010; Holloway & Troy, 2004), neighborhood density (Chang et al., 2010), landscape features (Domene & Sauri, 2006), cultural origin (Darr et al., 1975), and attitude towards conservation practices (Domene & Sauri, 2006). For example, a study using data from Kathmandu, Nepal, demonstrated through multivariate econometric modeling that the number of connections, water pricing, public education level, and average annual rainfall are all significant variables affecting household water demand (Babel et al., 2007).

2.4 Demand Management in Practice

In addition to theoretical studies, demand management interventions have also been applied in practice. Zaragoza (Spain, population ~700,000) is a city that was plagued by a four-year drought between 1991-95. Consequently, in 1997 the government began to experiment with demand management strategies of tariff reform and education. By 2008, despite a 12% increase in population, the city was able to cut demand by 27%. This reduction was achieved "primarily through a change in water use behavior among businesses and citizens as well as, to a lesser extent, the uptake of water efficient technology" (Philip, 2011). The behavior change was a result of both the switch to a price that better reflected the *true* cost of the water service as well as an educational campaign among stakeholders (Philip, 2011). Israel had similar success in 2009, when a change in water tariffs coupled with an educational campaign brought down consumption 20% (Rosenthal & Katz, 2010). In either case, the educational component seemed to be the key in raising awareness and, then, achieving public support and action. In fact, of the 400 households surveyed for Zaragoza study, the importance of water conservation education was clear. Regardless of formal schooling and income level, the group that most

significantly reduced water use post-study was the group that specifically learned about water saving behaviors and their importance (Barberán Ortí & Salvador Figueras, 2010).

Another city affected by the early 1990s drought was Windhoek (Namibia, population ~322,500). In 1994 the government turned toward demand management with the overall objective to remove water use for general interests and reduce the pressure on their primary water sources. The comprehensive strategy combined volumetric pricing and block tariffs with information campaigns, legislation, and technical measures. The results showed a visible reduction by 1996; specifically with demand falling from 201 liters per capita per day to 130 liters per capita per day in just seven years (Magnusson, 2004). A further examination of the effectiveness of the campaign's price and information messages on squatters, low-, middle- and high-income groups revealed unique differences among the groups both in terms of affect on consumption as well as awareness and perception regarding water scarcity. In particular, as the high-income groups had more ability to pay and greater access to water, they were less willing to respond to demand management. Overall, it was determined that "instead of relying on short-term effects generated by block tariffs and occasional information, it is vital for long term success of demand management to mobilize a permanent platform of individual water responsibility, especially when living under water stressed conditions" (Magnusson, 2004).

2.5 Demand Management in Developing Countries

The success of demand management in Windhoek, Namibia is one example of how developing countries are beginning to take on proactive demand management strategies (Vairavamoorthy & Mansoor, 2006). However, demand management in developing countries is inherently different from demand management strategies in developed countries. A primary difference is water providers in developing countries are simultaneously trying to manage demand and extend services so that everyone has access to water and sanitation. This issue

was identified in a study that reviewed demand management efforts in Malawi, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe. The authors concluded, "despite the potential savings that would accrue from the implementation of water demand management, the water sector across the southern African region continues to focus on supply augmentation" (Mwendera et al., 2003; Sharma & Vairavamoorthy, 2009).

Unfortunately, back in 2000 it was precisely "the dominance of wasteful and expensive supply-side solutions" that the United Nations Environmental Program (UNEP) recognized as a major obstacle in supplying water to the urban poor (Vairavamoorthy et al., 2008). Mwendera et al. (2003) describe this as a reinforcing spiral; following construction supply is temporarily abundant, but

> "*consumption quickly gets out of hand because of poor scheme design, unauthorized connections, poor credit control, a lack of maintenance and politicians insisting on low charges. As the artificial demand rises, it quickly exceeds the capacity of the pipelines, pumping plant, etc., and the net assured yield of the storage dams. There after the vested interests ensure that a new cycle of supply augmentation begins….(meanwhile)… poor service is causing customers to mistrust and have no respect for their water service providers,…feeling no obligation to pay anything of water services or even to take any responsibility for controlling excessive water usage*" (p. 770)

Such a scenario highlights why even as developing countries strive to expand coverage they must integrate demand management. In fact, a separate analysis of successful demand management strategies in eight developing cities across southern Africa found a correlation between cities using demand management techniques and higher coverage rates (Gumbo, 2004). That said Gumbo goes on to note that water providers and households continue to view demand management as being "obscure, elusive, difficult to decide on the many options available and having little impact as compared to supply-side options" (2004). This is not surprising given that in addition to struggling to expand coverage, water service providers in developing countries are often dealing with poor water quality, failing infrastructure, low cost

recovery, and an unsupportive institutional framework (Sharma & Vairavamoorthy, 2009).

These circumstances emphasize there is still much to be understood when it comes to introducing demand management strategies in developing areas. In a report titled "Urban Water Demand Management: Prospect and Challenges for the Developing Countries," Sharma and Vairavamoorthy (2009) specifically call for "different tools, techniques and measures…. adapted to suit the local conditions and requirements of the developing countries." They suggest that given the wide-range of demand management strategies possible, a demand management program should begin with the least-cost technique, implement the measure in a piecemeal approach, and take care to engage with all the stakeholders along the way. They go on to list twelve activities that should be considered covering: 1) technical measures such as assessing the condition of existing infrastructure and improving the reliability of supply; 2) economical measures such as increasing block tariffs and rebates; and 3) social measures such as public education and awareness of water conservation, and the promotion of water reuse and recycling. In particular, the authors call for "development of new techniques that are specifically tailored for water starved/intermittent supply systems" (Sharma & Vairavamoorthy, 2009). Intermittent water services are by far one of the most prevalent conditions unique to developing countries.

2.6 Intermittent Water Services

Intermittent services often arise from the perception that the available water resource is not robust enough to provide continuous water (Christodoulou & Agathokleous, 2012; Vairavamoorthy, Gorantiwar, & Mohan, 2007). By physically cutting off water for most to all of the day, households are restricted in their ability to utilize water. In this regard, intermittent water service is sometimes regarded as a demand management technique in and of itself (Iskandarani 2002; Joshi et al., 2002; Vairavamoorthy et al., 2008). However, there is no

empirical evidence to strongly support such reasoning. In fact, studies suggest otherwise.

A meta-analysis of 20 years of household water studies in developing countries concluded that although household water use increases with increased connection time, the magnitude of the effect is quite small (Whittington & Nauges, 2010). Similarly, Iskandarani (2002) found that even when piped water is households' primary water source, a high degree of interruption in supply does not significantly affect total household water consumption. In a controlled study of four Indian residential areas that measured and compared household water consumption in going from intermittent to continuous service, Andey and Kelkar (2007) found increases in consumption ranging from 10.6% to 27.5%. However, they concluded that these increases were very dependent on the duration and timing of water supply under intermittent conditions; that so long as demand is satisfied under intermittent service (quantity), water consumption does not change *appreciably* under continuous conditions. Accordingly, they also concluded that in order to arrive at a general conclusion for how intermittent and continuous water service affects households' consumption there need to be further studies on domestic water use, particularly for slum areas and smaller cities. Nonetheless, the results of these studies are interesting in that they challenge the notion that intermittent service is an effective way to limit consumption.

Whether or not intermittent services limit household water consumption, they have also been seen as a way to reduce system leakage and provide time for repairs and maintenance (McIntosh, 2003; Klingel, 2012). To that point, Andey and Kelkar's (2009) study comparing intermittent to continuous services found that under continuous service there was a significant increase in gross (system-level) consumption (i.e. greater leakage). However this was hypothesized to be the result of unmetered and unauthorized supply connections and leakages in the distribution system and suggests that the performance of water systems subjected to

both continuous and intermittent supply modes is in part dependent on the state of the infrastructure. Accordingly, a study by Christodoulous and Agathokleous (2012) found a significant 30 to 70% increase in pipe-burst incidents under intermittent conditions, concluding that such side effects could actually cause increased water loss. Other researchers are in agreement that, at the systems level, as a result of pressure surges and fluctuations, intermittent conditions leak more water than they save (Batish, 2003; Klingel, 2012; McIntosh, 2003).

Intermittent services are prone to pressure problems because they arise out of perceived necessity rather than design. That is, for continuous service, pipes are sized with the understanding that although there will be two diurnal spikes in water use (peaking factors typically 2 to 3), overall demand will be spread over a period of twenty-four hours (Andey & Kelkar, 2009). Under intermittent conditions, however, demand is uniform until the service essentially dries out and peaking factors can range from 1.7 to 6.4 depending on the duration of supply (Batish, 2003; Andey & Kelkar, 2009). Consequently, when systems intended to run continuously revert to intermittent conditions, severe pressure losses occur at the system level (Vairavamoorthy et al., 2008).

Unfortunately, the subsequent loss of pressure is distributed very unevenly and while some households can barely fill their tanks, others receive *too much* water. Furthermore, because pipes in intermittent conditions do not retain water in non-supply hours, air often enters to occupy the free space. When supply is restored, at the moment the returning water slams into these air pockets, the water's rapid deceleration causes a pressure surge that results in a severe reduction of the carrying capacity of the pipes. In some cases, the pipes become *choked,* and, unless an air release valve is available, are rendered useless until the supply period returns (Batish, 2003).

The occasional day without water is not the only cost to the consumer under intermittent service conditions. Never knowing when and if water will arrive again creates anxiety (Totsuka et al., 2004). Further, households often have to rearrange their schedules according to when the water is expected to arrive. In some cases, this means that the individual staying around to properly store arriving water misses work, school, or has to get up in the middle of the night (Totsuka et al., 2004; Madanat & Humplick, 1993).

Another downside to intermittent service is that when supply pipes are left empty for long periods of time, contaminants seeking low-pressure areas are prone to enter the system (Klingel, 2012). Accordingly, intermittent services are also associated with decreased water quality in the form of turbidity and bacteria regrowth. To combat this, providers may add higher doses of chlorine but, due to pressure differences in the network, water arriving to households has been shown to have non-uniform chlorine residuals (Tokajian & Hashwa, 2003).

As a result, if time and money permit, households usually provide point-of-use treatment before drinking their water and/or purchase alternative sources such as bottled water (Totsuka et al., 2004). In addition to investing in water treatment, households under intermittent services devote time and money to pumping and storing their water (Vairavamoorthy et al., 2008). Unfortunately, the latter can further decrease the water's quality (Klingel, 2012). In fact, a controlled study in Lebanon found a positive correlation between the heterotrophic plate count bacteria/ml and pH, temperature, and storage time (Tokajian & Hashwa, 2003). Overall, indirect health-related costs aside, a study of Kathmandu, Nepal, found that households receiving intermittent service can spend almost twice as much as their monthly water bills on coping behaviors (Pattanayak et al., 2005). Providers also incur additional costs in the form of additional manpower to open and close network valves and in increased replacement of valves and tubes due to elevated wear and tear on the system (Klingel, 2012).

Despite all the disadvantages of intermittent water services for providers and their customers, their prevalence is astounding: ~30% in Africa, ~50% in Asia, 90% in Southeast Asia, 60% in Latin America, and 100% in India (Klingel, 2012). Unfortunately, given projected scenarios of population growth and urbanization, "it is highly likely that the intermittent water supply which is already status-quo in many mega cities in the developing world is going to be more widespread" (Rosenberg et al., 2008). With that in mind, studies have begun to look at how systems can be designed for intermittency, from the onset, thus avoiding the aforementioned problems that result when systems designed for continuous operation are run intermittently (Vairavamoorthy et al., 2008; Totsuka et al., 2004; Batish, 2003).

2.7 Household Water Use in Intermittent Water Service Context

While proactively designing for intermittent supply will be a great step toward improving water quality and equity under such conditions, in the interim there is a need to understand how demand management can better address the many issues of existing intermittent services. Specifically, when it comes to successful Integrated Water Resource Management, and thus demand management, "The identification and characterization of household behaviors is regarded as a key first step" (Rosenberg et al., 2007).

A study of households in Ghaziabad and Jaipur, India, evaluated households' convenience and satisfaction under intermittent and continuous services and, in doing so, revealed many of the common behaviors that result from receiving piped water sporadically (Joshi et al., 2002). That is, under intermittent service, the timing of supply and service interruptions meant that 100% of households surveyed had elevated water storage devices. Households also reported to draw water from distribution pipes through motorized pumps. With respect to water quality, all households reported to be satisfied but 35% still provided additional treatment to their drinking water and 58% discarded stored, unused, drinking water every time

supply resumed. Interestingly, despite these seeming inconveniences, so long as there was adequate pressure, households reported to be satisfied with three to ten-hours of service. Nonetheless, households favored continuous supply and were willing to pay more for it. While these findings are interesting, there was a lack of discussion regarding why, despite being satisfied with intermittent service, households wanted continuous supply.

Domestic water use under intermittent conditions was further explored by Rosenberg et al. (2008) in a report that examined the theoretical behaviors that households in Jordan coping with intermittent water services could adopt, in both the short- and long- term, to increase their supply as well as manage their demand. Numerous examples included: installing roof or ground tanks, installing in-home treatment, installing bags or bottles in toilets, finding and fixing leaks, reducing landscape irrigation, turning off faucets while washing, partially opening faucets, reducing shower length, reducing laundry frequency, sweeping rather than washing floors, collecting rainwater, using a grey-water collection system, drilling wells, borrowing water, and buying water in bottle and tank form, etc. Using interview and survey data, the cost of each behavior, as well as the possible uses for the volume and quality of water gained, were detailed. However, because it was recognized that cost, effectiveness, and subsequent adoption of each behavior would ultimately vary depending on the characteristics of each individual household, the study was not designed to draw conclusions so much as to act as a precursor to a larger systems analysis. In particular a more detailed systems analysis would help "resolve interdependencies among actions..." as well as "integrate physical and institutional constraints affecting user decisions and help study the effects on user decisions of increased network water availability such as continuous piped supply" (Rosenberg et al., 2008).

In line with this recommendation, Rosenberg et al. (2007) developed a regression model that would estimate water demand with consideration to the aforementioned unique water-use

behaviors that result from intermittent services. The model, which used a cost-minimizing decision criterion, was tested using, again, data from Amman, Jordan. By parametrically changing base case parameters it was shown "how availability, pricing and conservation campaigns may influence water use" (2007). Interestingly, the affect of water quality on water use was not considered. One of the most interesting results suggests "that an education and awareness campaign to encourage cost-conscious decisions regarding household conservation actions may, on average, reduce municipal water consumption in Amman by about 33%.. .reduce tank truck water use by more than 60%...(and) decrease customers' overall water-related expenditures by 35%" (2007). Furthermore, the model predicted that although only a small fraction of customers adopted long-term conservation measures such as retrofitted showerheads, their water savings would greatly contribute to the populations' decreased demand. This finding suggests "a targeted conservation campaign can achieve significant water savings with concentrated effort" (2007). However, while the model is useful for beginning to explore the complex nature of household water use behavior under intermittent service conditions, because of several assumptions it makes, the authors voiced the need to empirically confirm the models' conservation predictions. In particular they cite the need for more data on 'utility' factors such as time, hassle and social desirability, which may affect the water use behaviors their model predicted (Rosenberg et al., 2007).

While the above studies suggest that intermittent services can promote water conservation behaviors among households, it is not clear whether these are born out of necessity or conscious choice. More attention also needs to be paid to understanding the motivation behind the negative behaviors that result from intermittent conditions. Batish (2003) alludes to this in his report on how to design water systems to efficiently run with intermittent service. He writes:

> *"a consumer is likely to keep the water taps open even after supply period. This may result in wastage of water once the supply is restored. Also the consumers are more likely to dispose of excess water stored earlier to fetch fresh water intake for use or storage…. The rate of water supply is highly subsidized and water metering is not very effective. Thus there is added reason to use as much water as available for consumption without costing much to the consumers….Hence on the one hand the water supply departments are designing the system based on minimum demand to cut the costs; on the other hand consumers who have easy access to more supply use it lavishly"* (p. 2).

McIntosh (2003) touches on water loss by noting practices such as throwing out *old* water to make way for storing *fresh* water. He suggests that because households without access to 24-hour supply never know when they will next receive water they tend to use more than others. As noted in the study by Joshi et al. (2002), 58% of Indian households studied discarded unused drinking water when the service resumed. Whether because they cannot be home at the established arrival time, there is no predictable schedule, or simply because they see it as a non-issue, households receiving intermittent service may also develop the habit of leaving taps open, causing storage devices to overflow (Totsuka et al., 2004; Batish, 2003). Such behaviors suggest that, beyond improving the continuity of water, consistent, reliable, services could "go a long way in reducing wastage that occurs due to unnecessary hoarding and storage" (Sharma & Vairavamoorthy, 2009). On that note, perhaps households' perceptions of water quality might also affect the degree of water wasted under intermittent services. Interestingly, such a relationship has not been critically examined or discussed in the literature. In order to understand how household demand can be managed under intermittent services there needs to be a greater understanding of what motivates existing water behaviors, particularly to the effects of duration, reliability and quality on water use.

2.8 Unmonitored Water Waste

The motivations behind coping behaviors that result from intermittent service conditions become of particular interest in areas with un-metered service. Interestingly, it appears studies

of water use under intermittent services have only been done in cities where household water meters exist to varying degrees. Although pressure and air surges common to intermittent service conditions make water meters readings generally unreliable (McIntosh, 2003), their existence is often noted as a critical component of any demand management campaign (Gumbo, 2004). To that note, a paper on the status of demand management in Malawi found that:

> *"the application of water conservation measures at household level is not an outcome of WDM (water demand management) awareness, but rather a means of reducing water bills" and that "where the provision of water has no monetary attachment, especially in the rural communities, the promotion of WDM has been minimal… Consequently, boreholes, protected and unprotected shallow wells, and gravity-fed water taps are either overused or abused"…the rural "communities still feel that water is a free commodity and this attitude leads to water wastage practices"* (Mulwafu, Chipeta, Chavula, Ferguson, Nkhoma, & Chilima, 2003, p. 795).

That is, water meters send price signals to consumers, which seem to reduce households' piped water use.

Without meters it is not only impossible to use price signals to encourage conservation, but it also becomes difficult to estimate non-revenue flow (McKenzie & Ray, 2009). Under demand management identifying non-revenue flow helps detect illegal connections and leakages within the distribution system, the latter of which can range anywhere from 20 to 70 percent in developing countries (Sharma & Vairavamoorthy, 2009).

However, the lack of accountability for water after it leaves its initial distribution point should not rule out the adoption of demand management techniques. In fact, a study that surveyed 200, rural and urban, households in Jordan found that non-price factors have a large influence on demand (Iskandarani, 2002). As previously stated, demand management must be seen in a holistic context. Although structural measures such as leakage reduction and control should eventually be incorporated into any demand management program, nonstructural

measures such as household education and awareness programs have been shown to be both effective and essential (Sharma & Vairavamoorthy, 2009; Alegría, 2006). In order for demand management efforts to be successful, households must not only understand and accept them, they need to become active and contributing participants in the program (Magnusson, 2004).

2.9 Adaptive Capacity and Small Cities

With respect to the importance of households understanding and accepting demand management efforts, Turton (1999) describes water demand management as a temple in which the 'adaptive capacity' of the society is the base. Adaptive capacity can be defined as the social resources of a given society (embodied within institutions made up of many stakeholders and rules), which ultimately determine how people will respond to natural resource depletion (in this case, water scarcity). Turton goes on to explain that the 'willingness and ability of the people' is the right hand pillar of the demand management temple. Using a community in Namibia where pre-paid meters were smashed as an example, he reiterates the importance of understanding households' perceptions in building effective demand management strategies. He stresses that without the social component of adaptive capacity, even the most well thought out and heavily financed structural measures will fail. Turton concludes that:

> *"economic development on its own is a necessary, but not a sufficient condition for the transition in water management to be made….the social dynamics at work, is likely to increasingly become of strategic significance to the governments of developing countries"* (pp. 29-30).

Social dynamics and the adaptive capacity of a population become of particular interest when looking at small cities. The aforementioned demand management in developing world studies pertained to large cities and/or their peri-urban areas, but over half of the future's 6.3 billion urban dwellers will reside in cities of less than 500,000 inhabitants (United Nations, 2012). On that note, Deverill (2001) wrote a report that specifically focused on alternative strategies for demand management in small city contexts (defined as 5,000-50,000). After

summarizing the advantages and constraints of demand management in such situations, Deverill (2001) suggests four demand management strategies, the first two of which are to 'adopt social marketing techniques' and 'establish effective partnerships.' He then goes on to detail five practical measures that may be useful to small cities including: 1) 'the adoption of a demand responsive approach to provision,' 2) 'improving the service provided by communal stand pipes,' 3) 'the reduction of revenue losses,' 4) 'the reduction of physical losses,' and 5) 'raising public awareness of the need to conserve water' (2001). However his discussion is based on several conditions including that the majority of households are still not receiving piped water, that illegal connections are prevalent, and that water meters are in place for those few households and institutions with a legal, piped, supply. Ultimately he concludes that, despite the opportunities to build demand management strategies into small cities, there is little being done. He urges that further studies are needed to understand how water is actually used in such contexts, keeping in mind not just issues of quantity but quality as well (Deverill, 2001).

2.10 Conclusion

The United Nations has projected that by 2050, roughly 70% of the world's population will live in urban areas. The literature has shown that many urban areas in the developing world have strained freshwater supplies due to rapidly increasing populations, their aspiring needs, decreasing water quality, and climate change. Not surprisingly, water scarcity is identified as one of the main problems of the twenty-first century (UN-Water, 2007).

When it comes to providing water to the domestic sector, the literature reveals that countries around the world are shifting their focus to demand management strategies. In doing so, developed countries have found that years of supply-focused service have left households water illiterate. Both theoretical and implemented studies of the effectiveness of demand management strategies have pointed to leakage management, end-use efficiency, and price as

effective management tools. However, the literature simultaneously highlights the importance of education and awareness, or the social side of demand management.

For developing countries, the literature has shown that demand management is harder to promote. This is because water service providers in developing countries are also dealing with poor water quality, failing infrastructure, low cost recovery, and an unsupportive institutional framework. In addition, because cities in developing countries are still striving to provide all residents with potable water, governments continue to focus on politically appealing supply-side solutions. While the focus remains for all households to have access to a potable water and sanitation service, the literature highlights that further expansions of water services must be paired with demand management strategies which are key to ensuring that supply is reliable and equitable.

Unfortunately, when faced with strained freshwater or financial resources, the literature notes that one of the most common ways service providers in developing countries manage demand is by running water systems designed for continuous operation intermittently. Ironically, however, the literature suggests whether households receive intermittent or continuous service does not significantly affect water consumption. That is, so long as the time and duration of intermittent service is satisfactory, households may not actually use significantly more water when it is provided continuously. However, for better understanding of how service mode affects household demand the literature points to a need for further studies on domestic water consumption patterns for slum areas and smaller cities.

Water providers also see intermittent systems as a way to reduce system leakage and provide time for repairs and maintenance. However, the literature has shown that intermittent services can waste more water than they save as a result of deteriorating infrastructure. Other downsides to intermittent services as noted by the literature are poor pressure, inequitable

distribution, decreased water quality, and higher operational costs. Poor service conditions are reinforced when intermittent services are managed from a supply and not a demand perspective.

Unfortunately, the literature indicates that, despite all of these disadvantages, intermittent systems will not be disappearing anytime soon. However, the literature has suggested that the equity and sufficiency of intermittent systems can be improved by incorporating demand management strategies. In order for demand to be managed it must be understood and, consequently, the literature highlights the importance of identifying household water behaviors as a key first step.

As households adapt to the unreliable and inadequate service of intermittent conditions they develop various coping mechanisms. The literature discusses how coping mechanisms take form in both conserving and wasteful water behaviors, although the latter receives less attention. However, there is a general lack of discussion as to what motivates these behaviors. That is, there is an apparent lack of focus as to what underlying perceptions and opinions may influence households' water use beyond availability.

Overall, the literature reveals there is still much to be understood with how intermittent water services shape households' water consumption and demand. In particular, there is an absence of information regarding household water use from intermittent water services that lack both network and household water meters. In fact, there appear to be no studies comparing household water use under varying degrees of intermittent, un-metered, service conditions.

Traditional demand management strategies such as leakage management and tariff reform rely on meters. In un-metered conditions, other strategies are needed. The literature has suggested that household education and awareness programs hold an important place in

demand management. The public's role in demand management is referred to as adaptive capacity, or the social resources of a society. Adaptive capacity may be of particular use to small cities, although there are no known case studies to demonstrate its importance and effectiveness in managing demand.

Over the next two decades 95% of the world's urban growth will occur in developing countries and half these future urban dwellers will reside in cities of less than 500,000 inhabitants (Kayaga & Smout, 2009; United Nations, 2012). Although Chao's (population ~30,645) location and culture make it unique, its situation is not uncommon. Small, but rapidly growing, cities where households rely on an unpredictable water service characterized by a lack of meters, flat or low tariffs, and management that is strained by low human and financial capital are unfortunately prevalent. The literature mentions strategies for applying demand management in developing contexts but there are no case studies of how demand management can be specifically applied to cities such as Chao. In such areas demand management is thought to be critical to ensuring 1) the entire population receives an adequate, reliable, equitable and quality supply of water and 2) that this supply remains as such into the future.

Accordingly, the following study of Chao, Peru was designed to better understand water use and demand of households subjected to varying degrees of, un-metered, intermittency. This information will then be used to highlight the importance of demand management and identify and suggest specific strategies the Municipality of Chao can incorporate in order to maximize the benefits of their transition to an improved water and sanitation service.

CHAPTER 3: METHODOLOGY

3.1 Study Location and Characteristics

3.1.1 Background - Water in Peru

Peru has the most available freshwater per capita than any country in South America; and is number seventeen worldwide (Alegría, 2006; Lynch, 2010; Meade et al., 2010). This abundance of water has been sustaining the country's population since 3,000 BC. In early time periods up through the Inca Empire (1,100-1532 AD), water was sacred and treated with respect (Alegría, 2006). But, water was also utilized. The Inca Empire is known for its extensive hydraulic infrastructure. Through carefully planned channels, aqueducts, and terraces, the Incans were able to irrigate an estimated 700,000 hectares (i.e., roughly the equivalent of three-quarters of Peru's current irrigated area (Alegría, 2006)). Such a level of productivity is prodigious considering that the same lands are cultivated today with the aid of millions of dollars in infrastructure, soil amendments and pesticides.

Unfortunately, perhaps due to colonization, sustainable uses of the country's rich resources were carelessly exploited. As a result, despite Peru's abundance of water resources (71,000 cubic meters per person per year)[2], it is currently among the top 30 countries that suffer from water scarcity (Alegría, 2006; LivingInPeru.com, 2011). As previously detailed in Chapter One, water scarcity does not necessarily imply a lack of physical resources.

Peru is a growing economy with 75% of its 27 million inhabitants now living in urban areas. Unfortunately, these urban areas primarily sprawl down the coast, the majority of which is a semi-arid desert that contains only 1.8% of the country's freshwater resources

[2] Water stress occurs when the availability of water per person per year drops below 1,700 m^3 (UN-Water, 2007).

(LivingInPeru.com, 2011). While massive infrastructure has been constructed to bring water from the Sierra down to the coastal populations, effects of climate change are already making previously abundant water resources less reliable. For example, high temperatures and reduced rainfall have left the Amazon River in Peru at its lowest level in 40 years (Circle of Blue, 2010).

Water management in Peru has gone through a tumultuous past, which has resulted in its being regulated by five separate regulatory bodies (ANA, MINSA, MINAM, SUNASS, MVCYS[3]). These five institutions have overlapping responsibilities and conflicting goals that constrain effective water resources management in Peru (Lynch, 2010). For example, according to the national water law, the domestic sector is the first priority when it comes to allocation of water resources. Unfortunately, because the National Water Authority (ANA) is still technically under the wing of the Ministry of Agriculture (MINAG), law does not dictate practice (Alegría, 2006). Consequently, millions of dollars have been invested into developing Peru's export agriculture economy as incentivized by the 2009 U.S.-Peru Free Trade Agreement (TLC) (Lynch, 2010). Meanwhile, in 2009, approximately seven million Peruvians, or 27% of the country's population, still lacked access to an improved water supply (INEI, 2011).

Such sectoral bias is a prime example of how water management in Peru is fragmented and inefficient. The 2009 water law tried to resolve some of this and called for gradual devolution of water governance to regions and to focus on the watershed level. However, the responsibilities of these new regional offices were not supported with resources for data gathering and enforcement (Lynch, 2010). Nonetheless, over a six-year period (2010-2016), according to the state news agency *Andina*, $5.2 billion will be invested to expand coverage of potable water to peri-urban and rural areas (Hackley, 2012). This will be coupled with another $521 million to improve the subsequent treatment of wastewater (Hackley, 2012). In a report

[3] ANA (National Authority of Water); MINSA (Ministry of Health); MINAM (Ministry of Environment); SUNASS (Sanitation Services National Superintendent); MVCYS (Ministry of Housing, Construction and Sanitation).

by Lima's Chamber of Commerce (CCL) that detailed the aforementioned investments, a new water policy with two principal goals was described; "first, for tariffs to reach a level that covers costs; and secondly, sustainability, so utilities can increase coverage, availability and quality" (Andina, 2012). Given the 2005 World Bank's Water and Sanitation Program reporting that no more than 5% of water providers in Peru had the financial capacity to carry out their functions, the question remains how and if local governments will have the resources and legal means necessary to attain such goals (Reuda et al., 2005).

This thesis offers insight into how one Municipality (Chao, Viru, la Libertad) can improve its water management at the local level. Effective local management is of particular interest since the Municipality of Chao recently constructed a new and improved water and sanitation service with financial support from the aforementioned national funds[4]. Financial independence and improved coverage, availability, and quality of potable water for the domestic and commercial sector are not just a matter of infrastructural capacity. By working together with the water office of SADISCHAO, household surveys were designed to gain insight on the social aspect of effective and sustainable water management as will be further discussed in Section 3.2.

3.1.2 Study Site: Chao, Viru, La Libertad

The district of Chao, Viru, La Libertad, Peru is located at 504 km along the North Pan American Highway, 08° 34' 54.25" S, as indicated by the red arrow in Figure 3.1 below. The climate is temperate with no strong distinction between seasons; temperature fluctuating between 11°C (night) and 30 °C (day). Temperature swings are dampened by proximity to the Pacific Ocean and a strong sea breeze. Days and nights are usually clear. Apart from El Niño periods, the area is very dry with on average only 195mm falling (primarily in the eastern,

[4] The total project cost was roughly $9 million (S/. 23,330,401) financed by the Ministry of Housing through the Water for All (*Agua para Todos)* program.

mountainous, unpopulated region of the district) during the summer months (November to March).

Note: Red arrow below coastal city of Trujillo indicates Chao's location in the department of La Libertad (CIA, 2012).

Figure 3.1: Map of Peru.

According to the National Institute of Statistics and Information (INEI), in 2011 there were approximately 30,454 residents between Chao and Nuevo Chao living amongst 6,750 homes (~ density of 4.5 inhabitants per household) (District Municipality of Chao, 2010). The population is young, with the majority falling within the range of 18 to 40 years of age. An estimated 60% of the population owns their own homes. Homes are primarily adobe, straw or

plywood (73%). However, as money becomes available, families are reconstructing homes and the area is rampant with ongoing construction (Figure 3.2). The average household's monthly income is S/. 520 (US $196)[5] (District Municipality of Chao, 2010).

Figure 3.2: Illustration of ongoing construction in Nuevo Chao (left) and Chao (right).

With respect to water, the study area is composed of three primary groups: 1) residents in Chao with household water service provided by SADISCHAO (*Servicio de Agua Potable y Alcantarillado*, i.e. Water and Sanitation Service for Chao); 2) residents of Chao that rely on unimproved wells; and 3) residents of Nuevo Chao with household water service provided by the Nuevo Chao's JASS (*Junta Administrativa de Agua*, i.e. Water Administration Board).

Table 3.1: Breakdown of three user groups.

Group	Location	Primary Source	Provider	Monthly Cost (S/.)		Continuity	Treatment
				S/.	$U.S.		
Chao	Chao	Groundwater via Household Tap	SADISCHAO	15.3	5.69	~ 3 hours daily	Irregular Chlorination
Well	Chao	Groundwater	-	0.00	0.00	24/7	Variable
Nuevo Chao	Nuevo Chao	Spring water via Household Tap	JASS	3.20	1.19	~ 1 hour every other day	Irregular Chlorination

Note: In Chao the water service also includes sanitation. In Nuevo Chao there is currently no sewage collection and households rely on pit or pour-flush latrines.

[5] This estimate is significantly lower than that found during the two household survey periods – See Table 4.1.

3.1.2.1 Pre-Existing[6] Water Service in Chao

From 1996 to 2012 the source for Chao's household water service was groundwater. This source was accessed via a 75-m deep well and yielded 48 liters per second (lps). The water was obtained using an electric pump that, when the power frequently went out, would result in outages to the water service. Although there is no available information regarding the pathogenic quality of the water, it has a hardness of 1,100 mg/L as $CaCO_3$. According to the World Health Organization (WHO), such water is not fit for human consumption. Nonetheless, twice a day (from 11 p.m. to 5 a.m., and then again from 9 a.m. to 4 p.m.), the Municipality would run an electronic pump in order to partially fill an 800-m^3 reservoir. The reservoir would empty about 540-m^3 for households on the west side of the Pan American highway between 5 a.m. to 9 a.m., and then again, between 4 p.m. to 7 p.m., another 540-m^3 of water would be distributed to the houses located on the east side (refer to Figure 3.3). In the summer months, roughly November to March, the pump would sometimes run for an extra hour in order to satisfy a perceived increase in demand. Residents received (and still receive) their bills under their doors and were given three weeks to pay at the Municipality.

The Municipality is centrally located and open Monday through Friday from 8 a.m. to 5 p.m. For households with water and sewage connections, the user fee was a flat S/. 15.30 (~$5.70 at the time of study) per month; S/. 12 (~$4.46) if the house had only one service or the other. This fee increased from S/. 9.57 in 2009, prior to which there were only 800 metered connections and users paid according to consumption (1996 to 2009). A few households still have meters installed and believe them to be functioning, but they are misinformed. Most of the original meters have either been stolen, lost, or fallen into disrepair.

[6] *Pre-Existing refers to the state in which study was designed. As of February 7th, 2013, the new service is providing water to the neighborhoods of San Luis, La Victoria, Las Delicias and Juan Velasco in Chao (1880 connections). In Nuevo Chao, however, the residents are still relying on their former water service run by their independent JASS – see 3.1.2.2.

SADISCHAO records all users electronically and if households do not regularly make their payments, connections are cut. While historically lax in enforcement, in the past two years SADISCHAO has become stricter at enacting this user pays policy. If a household's connection is cut, the cost to reconnect to the service is a relatively expensive, S/. 20 ($7.43) for water and S/. 35 ($13.0) for sewage.

Within Chao, a few of the relatively newer developments are not covered by the Municipal water and/or sanitation service. Consequently, households in these areas rely primarily on groundwater, be it via a household or neighbor's well. There is no available data on the biological and physical water quality of the water in these wells, but, given the majority of these wells are unprotected and water is obtained via rope and bucket, it is suspected that water quality is poor. A few wealthier families have covered their wells and use electric pumps to store water in elevated tanks. There are also households who live in neighborhoods covered by the Municipal water and sanitation service that choose not to receive water. Instead, they rely on household, or neighboring, wells. Wells are not registered and the Municipality does not have any information regarding the number in the area.

3.1.2.2 Existing[7] Water Service in Nuevo Chao*

Nuevo Chao is an isolated sector that will be included in the new water service (outlined by pink block in Figure 3.3, ~2.5 km N of Chao). In contrast to Chao, the water source is a natural spring located 8.5 km away in the nearby sector of Buena Vista (located in northeast corner of Figure 3.3). Water travels directly from the spring to households via gravity. Nuevo Chao is divided into several sectors and opening and closing networks valves distributes water among them. Households are provided water for a period of approximately one hour every

[7] At the time of writing, May 2013, the new water service is still not reaching households in Nuevo Chao. At some point, existing will become pre-existing.

other day. The water is administered by the town's JASS[8]. The monthly tariff in Nuevo Chao is almost one-fifth that of Chao at only S/. 3.20 per month. Users pay at central office located near Nuevo Chao's *Plaza de Armas* (i.e. Main Square).

3.1.2.3 New Water and Sanitation Service – As Proposed

Table 3.2: Proposed changes to SADISCHAO water and sanitation service

	Source	Treatment	Serves	Coverage	Price (S/.)	Continuity
Old	Groundwater	Chlorination	Chao	52%	15.3	~ 3 hours daily
New	Surface Water (canal via river)	Sedimentation, Coagulation, Filtration, Chlorination	Chao & Nuevo Chao	97%	TBD *w/ meters*	*24/7*

Note: the original plan for the new service was to provide water 24/7 and to meter household water use. However, both of these features are no longer considered feasible for at least the next ten years. As such, the price of the new service is still to be determined (TBD).

The 2010 project proposal commissioned by the Municipality of Chao, as based on their pre-project study SNIP No. 50360, aimed to bring together these three unique user groups beneath a unified, treated, continuous, water and sanitation service resulting in 97% coverage of existing Chao and Nuevo Chao households (District Municipality of Chao, 2010). To estimate the necessary capacity of the new system the Municipality used an annual growth rate of 5.94% (as drawn from 2005 and 2007 census data) and projected the area's population to reach 97,176 people by the year 2027 (District Municipality of Chao, 2010). Also considered in the calculation of future demand was domestic water use of roughly 150 liters per capita per day (with 4.54 people per household), growth in the business and industrial sectors, as well an anticipated loss of 25% of the total volume of water produced (non-revenue water, NRW).

[8] JASS is the name given to local water and sanitation authorities that are legally recognized by the National Water Authority (ANA).

Note: The oldest area of Chao is in yellow. The various colored blocks to the east arose as invasions and although the once barren land is now full of houses, disputes with landowners are ongoing and at the time of writing not legally resolved. The pink block ~2.5 km north of Chao is Nuevo Chao. The "invasion" that began in March of 2011 lies directly west of Nuevo Chao, sprawling along the eastern side of the Pan American highway. (@ 2011 Google).

Figure 3.3: Aerial map of study area.

The new source of water is the CHAVIMOCHIC[9] canal whose ultimate source is the Santa River. The mouth of the Santa River divides the south-bordering department of Ancash with La Libertad (Figure 3.4).

Figure 3.4: Santa River watershed and location of mines contributing to inferior water quality (Brooks, Kent, & Willett, 2004).

The Santa River is one of the few perennial rivers in Peru as well as one of the seven rivers determined to have an *alarming* quality of water; specifically, high levels of fecal coliform, lead, cyanide, copper and nitrates. Accordingly, Huaraz's Ministry of Agriculture has said the Santa River to be 'lost to contamination' (McKinney, Anderson, & Byers, 2011). Fortunately,

[9] CHAVIMOCHIC is an acronym that stands for the four valleys of Chao, Viru, Moche and Chicama that are irrigated by a major irrigation project that was financed by the National Government of Peru and inaugurated in 1994.

before water is distributed to Chao and Nuevo Chao households, it will go through a four-stage water treatment plant (sedimentation, coagulation, filtration and chlorination) that is capable of producing 60 lps. This water will then flow 10.68 Km by gravity to a new 2,500-m^3 reservoir[10] before it is ultimately delivered, via gravity, to households. Interestingly, in order to meet growing demand (anticipated to reach 107 lps by 2027), the original 2010 project report proposes to combine water from both the pre-existing and proposed sources/reservoirs. In other words, the plan suggests eventually distributing an amalgamation of poor-quality groundwater and treated-surface water.

3.1.2.4 New Water and Sanitation Service - In Reality

In October of 2012, while the author of this thesis was still living in Chao, the first trial run of the treatment plant was successful. Due to a variety of political and legal issues however, treated water was not provided to the public until November 18th, 2012.

Figure 3.5: Photographs of Chao's new water treatment plant from site visit on July 19th, 2012.

[10] Located 162.75 meters above sea level (on large dune above Nuevo Chao).

As it stands at the time of writing, the new treatment plant is providing water for 1,880 Chao households. While connections are in place to service Nuevo Chao, households are still receiving their pre-existing water service. Interestingly, the *invasión* (invasion) in which a few households began to occupy vacant land at the end of March 2010, has grown to approximately 2,230 houses (as estimated by SADISCHAO in February of 2013). This area is now being referred to as Nuevo Chao II and, as this land was not developed at the time of the study's design, was not included in the household surveys.

Figure 3.6: Photograph of development of Nuevo Chao II (invaded land) as of July, 2012.

In addition to being without electricity for the first year and a half of their existence, Nuevo Chao II households were also without water. After noticing that large amounts of water were being carted into the area on a daily basis (at the Municipality's expense of lost tariffs), in February 2013 the Municipality installed a 6" tube into the settlement and households can connect at their own expense (i.e. purchase and install piping to household). In February of 2013 SADISCHAO estimated that 1,200, or 54%, of the households have connected to the main line and are currently receiving water at no monthly cost. However, households will eventually be charged. As of March 2013 the Municipality was planning to install household water meters (as well as a district meter for the area) and charge residents $0.93 (S/. 2.50) per cubic meter consumed.

During the first month of service from the new treatment plant (December 2012), SADISCHAO reported that there were five to eight pipe bursts per day in the distribution network. This is not surprising given that the older pipes had not been replaced and/or modified to accommodate the anticipated increase in pressure. Although the new water treatment plant can run at 60 liters per second (lps), it is currently running at half capacity (30 to 40 lps). On days that the turbidity in the CHAVIMOCHIC canal is normal or low, the population is provided water solely from the new water treatment plant. However, there are days that there is so much sediment in the canal that the treatment plant can only produce 10-15 lps. On such days the Municipality distributes water from both the new and old reservoirs and households receive a mix of untreated groundwater with treated water from the plant. In January 2013 SADISCHAO estimates this combined service scenario occurred ten times. Unfortunately, the quality of water from the old source continues to degrade. That is, due to the increase in staff required to run the treatment plant, the groundwater is no longer chlorinated. Furthermore, at the end of November 2012 the well collapsed in on itself, which has increased the turbidity of the groundwater and, at the time of collapse, resulted in a *drought* for households that lasted for several days.

With regard to the availability of water, according to the 2010 Project Plan, the new water service was designed to run continuously (District Municipality of Chao, 2010). However, according to SADISCHAO, such a service will not be possible due to the existing, inadequately sized, distribution matrix, and, equally important, lack of meters. The absence of water meters calls attention to one of the most uncertain aspects of the new service, the price. In Peru, when the local government is in charge of running the water and sanitation service (as is the case in Chao) this is known as an Empresa Prestadora de Servicios (EPS). According to the World Bank's Water and Sanitation Program, in 2005 only 5% of the Peru's EPSs had the financial

capacity to comply with their duties (Reuda, Campos, Bretas, Brester, & Pérez de Castillo, 2005).

The financial reality in Chao is an example, not an exception. In February of 2013 SADISCHAO reportedly spent $30,800 (S/. 80,000) operating the new water and wastewater treatment plants, which included the salaries of nine employees, energy, and chemical inputs. Meanwhile, their income that month from household fees remained at $7,700 (S/. 20,000). Not only is the current service-related spending unsustainable, it is not even meeting the minimum operation requirements recommended by the engineering group who constructed the system (fifteen employees for the treatment plant and at least four people for the wastewater treatment lagoons). Currently, the difference between expenses and income is being subsidized from the Municipality of Chao's annual budget. This practice cannot continue indefinitely so clearly tariffs will need to increase. However, an already contentious issue is further complicated by the instability of the local government. In July of 2012, the former Mayor ousted for reasons of fraud and embezzlement and since that moment the public has not been receptive to the interim government.

Unfortunately, political instability is only one of many obstacles that have resulted in the absence of a clear management plan for the new water and sanitation service. Legal disputes with landowners, design flaws, and financial problems all highlight the absence of regular communication between all involved stakeholders (i.e. the Municipality, the national government, the regional water authority, CHAVIMOCHIC project, the design company, the construction company, and the public).

At the time of writing, the new service is serving Chao and Nuevo Chao II households. The water quality provided is inconsistent and the continuity of the water is still for *three hours*

per day[11]. The revenue is insufficient to pay for effective operation of the treatment plant and oxidation ponds, not to mention for the systems short- and long-term maintenance requirements. Meanwhile, the oxidation ponds (i.e. wastewater treatment plant) are on the verge of overflow due to the absence of an agreed upon point of discharge. Because of the aforementioned problems, informing and educating the public about the new and improved water and sanitation service has become a non issue; a task that can be done later should time and money become available.

3.2 Data Collection

In order to address the objectives of this study, information was collected by several means including: an extensive literature review; semi-structured interviews; field visits/site inspections; informal focus groups; key informant interviews, and households surveys. The key informant interviews were conducted with the former and current Mayors of Chao, the head chief of SADISCHAO, the principal engineers involved in the construction of the water and wastewater treatment plants, as well as an engineer from the regional (La Libertad) water authority (*Autoridad Nacional de Agua* - ANA).

Additional data provided by the Municipality of Chao includes SADISCHAO's income and expense reports and a digital CD that includes the original project proposal, design plans, and operation and maintenance manuals.

3.2.1 Survey Development and Design

The principal source of information for this study was data collected from two periods of household surveys. In order to gain a better understanding of households' existing water use behaviors, perceptions, and values, as they reveal the existing and potential household demand

[11] However, while three hours is the time it takes the reservoir to empty, as this study will reveal in Chapter Four, distribution of water is not equitable and some households in Chao receive less than a half hour of water daily.

for water, surveys gathered both qualitative and quantitative information. Questions solicited households' socio-economic characteristics, water sources, perceived usage, water-related knowledge, their opinions and preferences regarding their current (and hypothetical future) water service, and their willingness to pay for a variety of hypothetical improvements to their existing (non-existing) water (and sanitation) services (Appendices D and E). The questions of the first and second survey instruments both amounted to roughly four standard, A-4, sized pages, printed in double-sided fashion such that each survey was two-pages in length.

As previously mentioned in Chapter One, the original intention of the study was to capture a 'before' and 'after' picture of how the transition to an improved water and sanitation service would affect household water demand (stated versus revealed preferences). After conducting the first round of surveys it became clear that such a transition would not occur before the author of this thesis ended her two-year Peace Corps service in Chao. As such, the second round of surveys was seen as an opportunity to capture seasonal differences and enhance data collected during the first round. The original survey instrument (Appendix D) was modified and field-tested before beginning the second round of surveys (Appendix E). One principal difference to the second round of surveying was the use of visual aids for some of the more complex questions. For specific details regarding questions that were either eliminated from or added to the second survey tool refer to Appendix F.

Overall, the household surveys were designed with coastal Peruvian cultural norms of surveying and communication in mind. Specifically, throughout their development, the surveys were regularly reviewed with the head of SADISCHAO and his respective employees. In addition, the survey and consent form were reviewed with those who have significant experience conducting household surveys, SISFOH (Sistema de Focalización de Hogares), the equivalent of the U.S. Census Bureau. The surveys were then field tested amongst residents of

both Chao and Nuevo Chao. All changes that were recommended by and/or resulted from the test surveys were made prior to beginning data collection. Finally, before beginning the first data collection period, the study's protocol, survey instruments, and waiver of consent were approved by the Institutional Review Board at the University of South Florida (Appendix A).

As seen in Appendices D and E, the questions of the survey were designed to better understand the existing level of water use as well as to begin to identify whether certain behaviors were born out of circumstance and/or were the expression of underlying water-related beliefs and opinions. Perhaps the most complex portion of the survey was the willingness to pay (WTP) section. Also known as contingent valuation, WTP was utilized in both surveys as a way to measure household demand for service upgrades in the form of increased continuity, improved water quality, sewage, and all aspects coupled together. This stated preference approach was selected after a thorough review of the literature that addressed both the pros and cons of the method (Akram & Olmstead, 2011) (Whittington, 2010) (Whittington & Nauges, 2010) (Whittington, 2002). The questions and their presentation were then carefully formulated accordingly. Specifically, a close-ended, dichotomous (Yes/No), format was used where price increased according to the degree of improvement the scenario offered.

Enumerators were trained to read the various improvement scenarios verbatim. Prior to beginning the WTP section it was made clear to the respondent that the proposed tariffs were a hypothetical consideration to assess the preferences of the population, and would not result in a new, government-enforced, tariff. Then, respondents were asked (as translated to English), 'Now I will ask you if you are willing to pay a specified amount to improve some aspects of your water service. Please respond Yes or No according to your desire for, but also to your ability to pay for, a service such as I am about to describe.' While the introductory piece described above was consistent between the Round I survey instrument and the Round II survey instrument, the

scenarios and prices were slightly different. The five Round I scenarios were as follows.

Table 3.3: The willingness to pay (WTP) series offered to households during Round I.

WTP for…	I (S/.)	II (S/.)	III (S/.)
24/7 & Existing Quality	18	24	36
Existing Continuity & Improved Quality	18	24	36
24/7 & Improved Quality	24	36	48
Sewage	18	24	36
24/7 & Improved Quality & Sewage	30	42	54

Note: Enumerators would offer respondents prices from either Column I, Column II or Column III on a rotating basis (i.e. I, II, III, I, II, III, I…).

Prior to beginning each survey, households were (randomly) assigned to receive prices from Column I, II or III of Table 3.3. That is, every enumerator began their first survey using the prices from Column I, their second survey using the prices from Column II, their third survey using the prices from Column III, their fourth survey using the prices from Column I, … and so on, picking up every morning from where they left off the afternoon before. For each question respondents were asked to simply reply 'Yes' or 'No' ('Maybe' was also recorded in Round II surveys when the respondent refused to be definite in their response).

The scenarios and their associated price schemes were determined with the guidance of SADISCHAO. Specifically, the five scenarios were designed to: 1) determine whether households placed more value on a continuous service, improved water quality, or sanitation, 2) determine what aspects of the current service households were most unsatisfied with, and 3) determine if responses changed when improvements were packaged together. Given that at the time of the surveys Chao households were paying a flat S/. 15.30 fee (water and sanitation) and Nuevo Chao households were paying S/. 3.20 (just water), the offered WTP prices in Round I are quite exorbitant. However, the first column of prices (S/. 18 to S/. 30) was within the range SADISCHAO anticipated the tariff to eventually rise to. In contrast, the other two sets of offered prices (S/. 24 to S/. 54, roughly 2.5 to 3.5 times the existing tariff in Chao) were

developed with the understanding that some of the middle to high-income households were paying upwards of S/. 200 per month on their cellphone and/or electricity bills. While such expensive water tariffs are highly unlikely to occur, they were intended to act as a gauge to 1) households' underlying perceptions of what a "fair" price for water is, 2) whether households were taking the WTP exercise seriously. In Section 4.6 the data collected from Round I will be compared with the data collected from Round II, which altered the scenarios and prices of the first round as follows.

Table 3.4: The willingness to pay (WTP) series offered to households during Round II.

WTP for…	I (S/.)	II (S/.)	III (S/.)
6 hours & Existing Quality	18	24	30
12 hours & Existing Quality	20	26	32
24/7 & Existing Quality	22	28	34
Existing Continuity & Improved Quality	18	24	30
12 hours & Improved Quality	24	30	36

Note: Enumerators would offer respondents prices from either Column I, Column II or Column III on a rotating basis (i.e. I, II, III, I, II, III, I…). In contrary to Round I, all scenarios include sewage and this was clearly indicated by an accompanying visual.

With regard to the variation in scenarios, this was done because it became clearer as time went on that the new water service would not be 24/7 as the Mayor had previously suggested. Instead, it would continue to be intermittent. As such, the three continuity scenarios (six hours, twelve hours, and twenty-four hours) were used to gauge the value residents placed on continuity, and to what degree. Similar to the first round, continuity was then directly compared to water quality, and lastly, a package scenario was offered. Sewage was not separated as it was in Round I as to not confuse Chao households who assume its inclusion to be a given. With regard to prices, as shown in Table 3.4, the tariffs offered in Round II were significantly lower than those offered in Round I. With guidance from SADISCHAO Round II prices were designed to stay within the potential minimum and maximum tariff. This is not to

suggest that SADISCHAO will be using the WTP results to establish their new water tariff, simply that Round II prices were more relevant to existing norms in Peru. Consequently, the first price in each column of Table 3.4 was 1.2 (Column I), 1.6 (Column II), or 2 (Column III) times Chao's existing tariff (S/. 15.30). Another difference was the addition of a visual aid to help guide respondents along. The aforementioned changes aside, the assignment of households to receive prices from Column I, II or III and the verbatim delivery of the questions remained the same as Round I.

Before closing discussion of the WTP section, it is important to note that although Nuevo Chao households were experiencing a very different water and sanitation scenario (paying almost one-fifth (S/. 3.20) the monthly fee paid by Chao households and with no sanitation), SADISCHAO and the author of this thesis decided to offer households, regardless of their location, a uniform price scheme in the surveys. This was done because SADISCHAO anticipated that shortly after the transition to the new service, the Municipality of Chao, with oversight by the national regulatory authority SUNASS, would have to establish a universal tariff.

3.2.2 Surveying Methodology

Data collection was carried out in two periods, Round I and Round II. During each survey period, the Principal Investigator (i.e. the author of this thesis) led the survey team. During Round I the team consisted of nine individuals (the Principal Investigator, seven employees from the Municipality of Chao, and a water and sanitation Peace Corps volunteer). During the two-week survey period, on average, three of the eight trained enumerators accompanied the Principal Investigator on a daily basis. This variable enumerator participation was the result of unanticipated Municipal obligations. While the unpredictability of day-to-day fieldwork was not ideal, it was expected based on the author's prior experience. Regardless, surveys were successfully collected despite the less than ideal conditions. Round II employed

seven individuals (the Principal Investigator, two employees from the Municipality of Chao, and four residents of Chao/Nuevo Chao who had formal experience in conducting household interviews). In contrast to Round I, all enumerators accompanied the Principal Investigator on a daily basis until the calculated sample size had been collected.

Prior to beginning each data collection period, the enumerators went through a thorough training process that included a comprehensive introduction to the study's objectives, the verbal consent process, and explicit instructions regarding how to administer and record each question. For example, enumerators were told when and how to address the occasional blank stare or perhaps a respondent whose most frequent response is *no sabe* (don't know)[12]. Finally, prior to collecting actual data, enumerators practiced administering the surveys with one another as well as in the field with supervision and guidance from the Principal Investigator. During each phase of data collection, the total population was divided into two separate cohorts, Chao and Nuevo Chao, for which sample sizes were determined independently.

3.2.2.1 Calculation of Sample Size

The number of households to be surveyed was determined using data from the Municipality of Chao's water office SADISCHAO together with the MaCorr Research Solutions online sample size calculator. The online calculator calculates sample size based on the following equation (MaCorr Research, 2013).

$$\mathrm{ss} = \frac{\mathrm{Z}^2 * p * (1 - p)}{\mathrm{C}^2}$$

[12] Some questions were meant to specifically capture what a respondent knew; in these cases "don't know" is a valid, and valuable, response. In other cases, however, don't know was simply coded as a 990 (missing). For example, for the estimation of household water storage capabilities enumerators were encouraged to help respondents make their estimate. This meant using observation to know when respondents were not thinking to include all of their buckets, tanks, etc. and reminding respondents that the commonly owned *balde de aciete* (repurposed vegetable oil bucket) held 18 Liters.

In this equation ss= Sample Size, Z = 1.95 (Confidence Level), P = 0.5 (% picking a choice, where picking choice is the standard deviation for a normally distributed variable), C = Confidence Interval, and Pop = Population. Using a 95% confidence level, and a +/- 5% confidence interval, Table 3.5 below summarizes the calculated sample sizes as determined with the MaCorr Research Solutions online sample size calculator.

Table 3.5: Calculation of study's sample size.

Location	Population	No. Households	Calculated Sample Size 5% CI	Calculated Sample Size 6% CI
Chao	12,090	2,219	328	238
Nuevo Chao	18,555	981	276	210

Note: This summary of population sizes, number of residences, and calculated sample size for each community was determined from information given by the Municipality of Chao in December of 2010. An appropriate sample size was not calculated for the Well user group as the Municipality had no definitive idea of exactly how many households at the time were actually relying on wells.

The number of enumerators sought and the time frame during which the surveys were administered were determined according to the sample size calculated for a 95% confidence level and +/- 5% confidence interval. However, unanticipated events in Round I surveys resulted in a slightly smaller sample size than Round II (Table 3.6). That said, the sample size collected in the Round I was still robust exceeding the number necessary for a 95% confidence level, 6% confidence interval (Table 3.5). Data collection was as follows:

Table 3.6: Actual sample size obtained, by sector.

Survey Period	Duration	Households Visited		
		Chao	Nuevo Chao	TOTAL
I	January 23rd-February 3rd	276	224	500
II	September 17th-28th	347	302	649
TOTAL	-	623	526	1149

Note: Round I occurred over Peru's summer while Round II could be considered *winter*.

Within Chao there are houses with a water service, and houses that still use household or local, primarily un-improved, wells. Those of the latter group either reside within sectors in Chao that are still not connected to the distribution matrix or simply choose to forego the service for financial, quality and/or convenience reasons. Due to an unknown number of households in such a situation, Chao and Well users were treated as one cohort. However, when of interest, all households that still depend on wells (not including households that have both a water tap and well) will be analyzed separately. Sudman (1976) suggests that a minimum of 100 elements is needed for each major group in a sample and 20 to 50 elements is necessary for each subgroup. Given that during Round I 62 Well users were surveyed, and another 50 during Round II, the sample size is sufficient.

3.2.2.2 Survey Execution and Endorsements

Surveys were conducted over the course of two weeks (twelve days) between 8 a.m. and 6 p.m. No surveys were conducted after 6 p.m. for reasons of safety. It was found that interviewing between 11:30 a.m. to 2 p.m. was also difficult as this was the time period during which households prepared and ate their largest meal of the day. During each survey period all neighborhoods of both Chao and Nuevo Chao were covered. Blocks were selected on a random basis and, when possible, households were selected in an every-other pattern. Due to the large portion of homes left vacant during various parts of the workday, on average every six to ten households per randomly selected block were interviewed. As the majority of the population works in the fields and their days of rest are variable, the portion of the population that was captured was random. In other words, stay-at-home mothers were not the only socio group surveyed. Each surveyed household's street and house number were noted but no other identifying data such as the name of the respondent or their DNI (national identification number) were recorded.

From the very beginning of the study, the Mayor of the District Municipality of Chao acknowledged his support. In November of 2011, his verbal endorsement was solidified in a formal written agreement (Appendix B). In addition to providing personnel for the survey process, the Municipality also offered paper, access to a printer and photocopy machine, transportation, and overall guidance during the survey's development process.

To participate in the survey, a respondent had to be an adult[13] living in either Chao or Nuevo Chao. The survey was administered on a purely volunteer basis to ensure that the respondent was willing to take, on average, twenty-five minutes to thoughtfully respond to all questions. In conduct with cultural norms, surveys were conducted in the respondents' doorways unless, as often happened, the respondent invited the enumerator to come inside and sit down.

The Institutional Review Board of the University of South Florida approved a waiver of signed consent (Appendix C). That said, prior to beginning all surveys, care was taken to explain the research motivation and goals of the study in a manner that was understandable to all participants. In addition, the confidentiality of the survey was always explained to each participant before questions began. Following this explanation, time was allowed for the participant to ask, and the enumerator to answer, any potential questions and uncertainties. Finally, after informing potential participants that taking part in the survey was voluntary, participants were asked to give verbal consent. If at any time during the course of the survey the participant changed their mind, they were free to stop answering any further questions. Overall, data from such instances only made up a small 1.6% of the surveys conducted and was not used.

[13] As determined by the local culture, adult was defined to be ≥16 years old.

3.3 Data Analysis

In total 1,149 households were visited: 623 Chao (112 Well users), 526 Nuevo Chao (Table 3.26). When appropriate, the Well user group is considered separately although all households in this group lived within Chao. Households were only put into the Well user group if they did not have a household tap and their primary water source was a well. That is, if a household used a well as their primary source but also had a household water tap that they used as a secondary source, they were still coded as belonging to the 'Chao' user group.

Following each survey period one or more codes for every question were created and data from each completed survey was entered accordingly into SPSS Statistical Analysis Software (see Appendix G and H for codes) (Table 3.7). After all data had been entered, preliminary analysis was done in order to thoroughly check and correct for human error that may have arisen upon entry. Paper copies of data will be kept until the completion of the author's Master's degree thesis and journal publication, which is estimated to be no more than two years from now, after which they will be shredded and disposed of.

Table 3.7: Number of surveys entered into SPSS per user group

	Round I	Round II	TOTAL
Chao	209	295	504
Well	62	50	112
Nuevo Chao	212	303	515
TOTAL	483	648	1131

Note: Only completed surveys were entered (i.e. 1.6% of 1,149 surveys left out).

The wealth of information collected was primarily analyzed with the use of descriptive statistics. In doing so, the author could establish trends and patterns within the data, as well as important identify differences between the three user groups. In Section 4.5 estimates of household water use are presented. These estimates were obtained by summating the means of the number of liters respondents in each user group reported to use for both basic (bathing,

flushing toilet, washing hands, brushing teeth, cooking and cleaning dishes, drinking and laundry) and miscellaneous (watering street, watering plants, mopping and providing water to animals and pets) water behaviors. For behaviors that occurred at the household, not the individual, level, such as cooking, laundry and street watering, reported volumes of water used were divided by the number of individuals in the household in order to reflect per capita use. To create overall household water use estimates, per capita estimates were multiplied by the mean number of individuals reported to be living in the households of each three user groups (4.94 Chao, 4.86 Well users, 4.69 Nuevo Chao). The water use estimates combine data from both Round I and Round II. The difference between summer and winter estimates reflects reported changes in the volume of water used for laundry, bathing and drinking, as these activities were observed to vary by season.

Overall, data is presented with the study's two objectives in mind. Namely, to reveal the existing and potential household demand for water under varying degrees of intermittent service and, to use this information to discuss how the Municipality of Chao may incorporate demand management strategies in order to ensure the sustainability of their new water and sanitation service.

CHAPTER 4: RESULTS

The results of the household surveys[14] as they pertain to the first objective of this study will be presented and discussed in the following sections. Section 4.1 presents the socio-economic characteristics of the population. The first objective evaluates how the intermittent water services have conditioned the use and demand for water among the three user groups as it relates to Quantity (Section 4.2), Quality (Section 4.3), and as it is revealed through existing household water behaviors, both conserving and wasteful (Section 4.4), and overall household water use (Section 4.5). Then, latent demand as expressed by willingness to pay for service improvements will be examined (Section 4.6).

4.1 Socio-Economic Characteristics of the Population

The main objectives of this study are addressed through the examination of three distinct populations and differences in their use, perceptions, and value of water. The three groups are 1) Chao households receiving a *three-hour,* every day, service; 2) Chao households solely relying on household wells, by choice and by circumstance; and 3) Nuevo Chao households receiving a *one-hour,* every-other-day, service. Socio-economic characteristics of the respondents interviewed in each subgroup, are summarized in Table 4.1. Additional details are available in the data but are not presented here. These include: family structure (adults, youth, children), occupation, the reported monthly cost of other services, amenities (television, camera, computer, blender, refrigerator, and washing machine), reported plans to purchase amenities in the coming years, and for variables where means were reported (age, family size,

[14] For a complete understanding of the sample size used to calculate the information presented in the following tables, figures and discussion please refer to Appendix I.

income, etc.), a more detailed breakdown by categories.

As Table 4.1 shows, across all three subgroups, the majority of survey participants (74% Chao, 70% Well Users, 82% Nuevo Chao) were women. Although both men and women work, primarily in agriculture (71% average), the majority of women are also still responsible for cooking and childcare and thus are more frequently found at home on their days off. With respect to economic standing, considering the mean reported household incomes (S/. 1060 Chao, S/. 871 Nuevo Chao), housing materials (~30% brick Chao, 15% brick Nuevo Chao), and additional services, it is clear that the majority of households in Chao are more well off than households in Nuevo Chao (although home ownership is slightly higher in Nuevo Chao at 94.3%). With respect to the population as a whole, very few families have landlines (1.5%), Internet (2.8%), or a mode of personal transportation (6.8%). Aside from households that solely rely on wells, on average households in Chao have lived in the urban area of the district of Chao five years longer than households in Nuevo Chao. Roughly 54% of the population interviewed has lived the majority, or entire, of their life on the coast with the remainder hailing primarily from the mountains (~40%), with a small portion (~6%) emigrating from the jungle.

Table 4.1: Summarized socio-economic characteristics of respondents and their respective households.

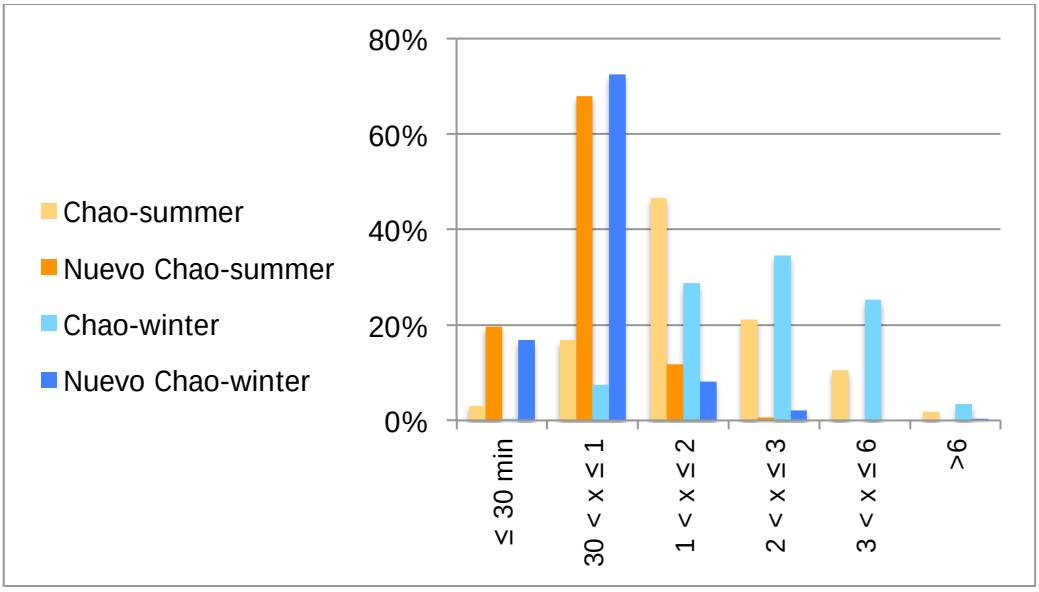
	Gender (% Female)	Age	Education			Household Ownership	Family Size	Household Income (S/.)	Years in Chao	Origin			
			None Kindergarten	Primary Secondary	Technical University					Coast	Mountains (Sierra)	Jungle	Urban
Chao – City water	74.2%	38.8	3.1%	90.7%	6.2%	85.4%	4.94	1116	15.9	55.6 %	38.8%	5.6%	58.1%
Chao – Well user	69.7%	35.6	2.2%	91.2%	6.6%	84.5%	4.86	1017	9.90	53.7 %	39.8%	6.5%	49.5%
Nuevo Chao	81.6%	35.6	6.7%	90.8%	2.5%	94.3%	4.69	871	10.9	54.8 %	39.9%	5.3%	53.1%

	Property Area (m^2)	Floor		Housing Material			Services						
		Dirt	Cement / Tile	Straw / Wood	Adobe	Brick	Electricity	Gas (cooking)	Cell Phones	Landline	Internet	Cable	Transportation
Chao – City Water	163	62.1%	37.9%	0.3%	66.4%	33.2%	98.6%	81.6%	80.1%	1.6%	3.8%	83.5%	8.1%
Chao – Well user	153	68.8%	31.3%	4.2%	70.8%	25.0%	92.0%	79.6%	82.1%	0.9%	3.6%	72.3%	8.9%
Nuevo Chao	137	82.5%	17.5%	11.9%	73.3%	14.8%	85.0%	66.2%	71.7%	1.6%	1.7%	59.6%	5.0%

4.2 Demand and Quantity

4.2.1 Existing Availability

In the absence of water meters, it is critical to determine how the water produced is actually being distributed. As seen in Figure 4.1, the distribution of available water does not reflect the previous stated service. In fact, when availability is averaged out between summer and winter months, only 29.4% of Chao's population is falling within the specified service range, as compared to 70.9% in Nuevo Chao.



Note: For Nuevo Chao reported service continuity is every other day as opposed to daily in Chao.

Figure 4.1: Reported continuity of water services – summer versus winter.

Households not within the stated service range fall either above or below it. In Chao households reported to have as little as 30 minutes of water and as much as 12 hours of water. In Nuevo Chao, the service, while shorter, appears to be more equitable. That is, reported duration of service only ranged from 30 minutes to three hours. However, it is concerning that during both the summer (19.7%) and winter (16.8%) nearly a fifth of the population in Nuevo Chao is receiving water for less than 30 minutes every other day. Overall, households in Chao

receive, on average, four times the access to potable running water as households in Nuevo Chao (assuming averages of two hours daily compared to one hour every other day).

In addition to the services duration, the hour at which water arrives may affect households' consumption. Table 4.2 outlines the hour that households' reported they begin to receive water.

Table 4.2: Reported arrival time (i.e. schedule) of water services.

	Morning (5am-11am)	Mid-day (11am-3pm)	Late Afternoon (3pm-6pm)	Evening (6pm-9pm)	Sleeping (9pm-5am)
Chao	42.8%	0.4%	50.7%	3.2%	2.9%
Nuevo Chao	29.5%	12.9%	14.4%	18.0%	25.2%

Note: Hours of 'sleeping' were determined according to two years of observing cultural norms of the study areas.

Although the duration of water provided to Nuevo Chao households is fairly equitable (Figure 4.1), as Table 4.2 shows, the time of day at which it arrives it not. That is, in Chao households primarily receive water in the morning or late afternoon. In Nuevo Chao the schedule is more variable with 25.2% of the population receiving water in the middle of the night. Affected respondents would often comment how they would sometimes not want to or forget to wake up to fill their storage devices. In addition, respondents receiving water in the evening (3.2% Chao and Nuevo Chao 18%) are less apt to take advantage of arriving water beyond storing water for the next day(s) (i.e. if they are able to fill their storage devices and there is still time remaining, they do not take advantage of the running water for laundry, a long shower, or watering the street, etc.).

With respect to these comments and observations, households were explicitly asked whether the schedules of their water service affected their daily schedule; 12.1% of Chao households, and 24.0% of Nuevo Chao households, reported that 'Yes,' the arrival time did

affect their daily schedule. When asked to elaborate how they were affected, open-ended qualitative responses can be summarized as follows (Table 4.3).

Table 4.3: How arrival time (i.e. schedule) of water affects respondents' daily routines.

	Arrives too Late	Arrives too Early	Arrives while Away	Variable Arrival Time	Inadequate Arrival Time (Duration)	Does Not Affect
Chao	2.4%	2.4%	0.7%	1.4%	5.2%	87.9%
Nuevo Chao	6.6%	4.3%	2.3%	4.3%	6.3%	76.1%

Note: This was an open-ended question and respondents' qualitative answers were coded accordingly.

As detailed above, reasons for dissatisfaction with the current water schedule are diverse. In my experience, the majority of respondents reporting to be unaffected by the delivery schedule would often accompany their answer with comments best summarized as 'we have adapted accordingly.' Table 4.3 suggests that even a portion of the quarter of Nuevo Chao households that receive water in the middle of the night are no longer bothered by their service's schedule. Overall, the existing inequities, both in service duration and schedule, appear to be widely known throughout both populations. Anecdotes in reference to the comparatively better or worse circumstances of other households were frequent throughout the author's field experience.

Beyond present availability, the length of time a household has been connected to a domestic water service may influence water use behaviors. As shown in Figure 4.2, the large majority of households in the study area have had a domestic connection for seven years or less (65.4% Chao, 85.7% Nuevo Chao). Interestingly, eighteen years was the longest any household reported having a domestic water service. This suggests that everyone over the age of nineteen has had a period in their lives where they relied on alternative water sources (wells, river, tanker trucks, etc.) and likely experienced water scarcity on a more frequent basis.

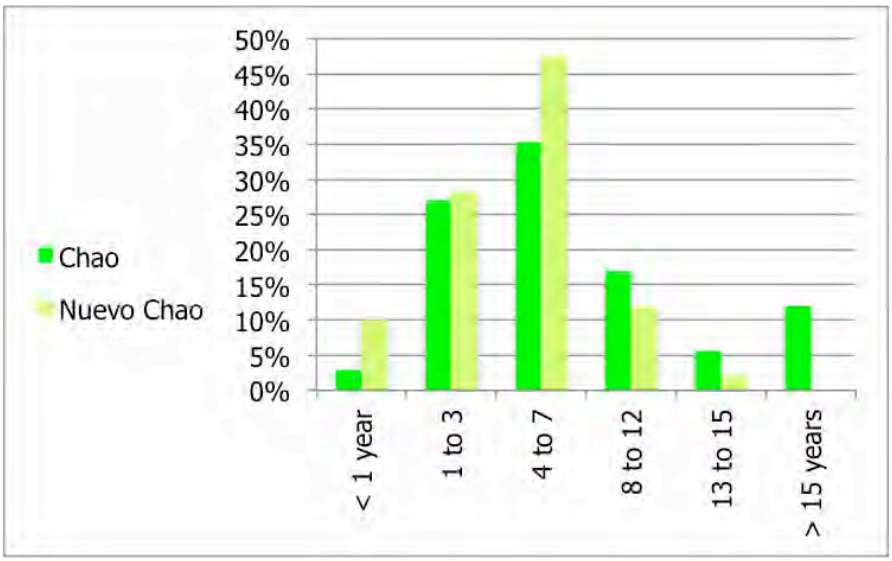
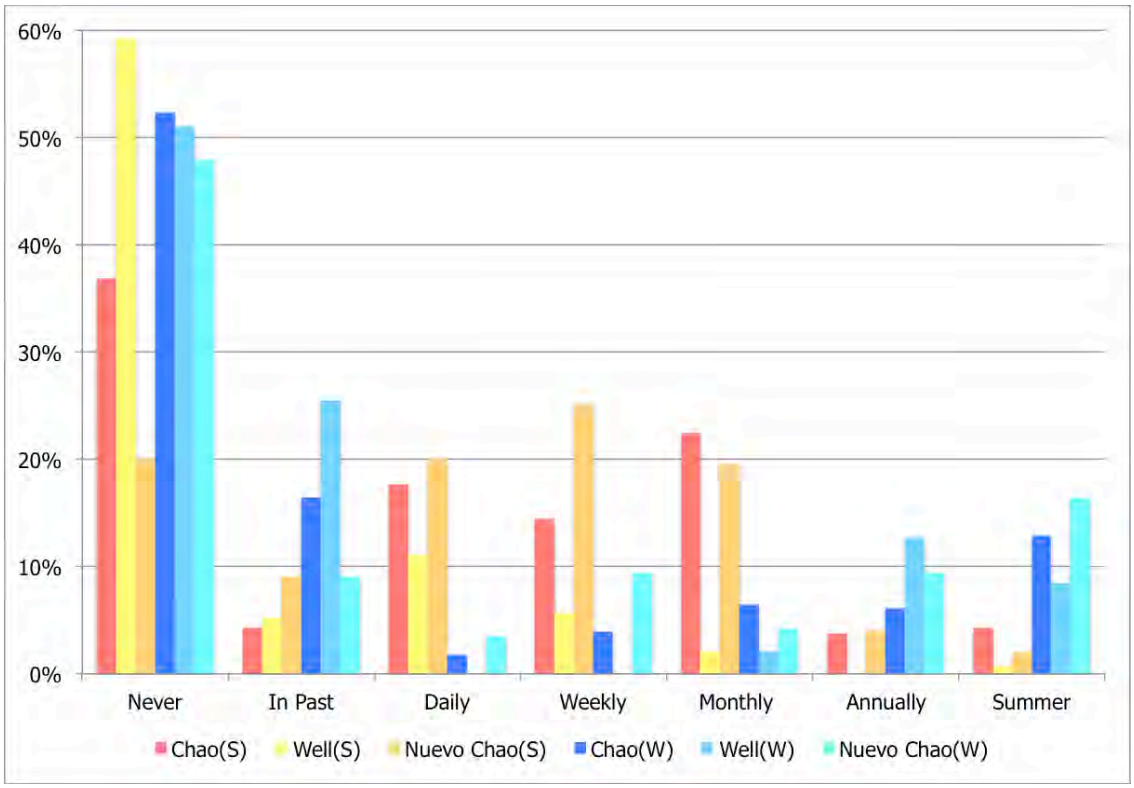


Figure 4.2: Reported length of time (years) that households have had a domestic water connection.

With this in mind, households were asked whether they had experience with water scarcity, and, if so, the frequency with which it affected them (Table 4.4 and Figure 4.3). As shown in Table 4.4, water scarcity appears to most affect households in Nuevo Chao, particularly in the summer (74.4%). Well users are the least affected with 54.7% (average) reporting to have never experienced water scarcity. While it is surprising that Well users reported scarcity at all, expressed cases of 'daily,' 'weekly' or 'monthly' scarcity only were only reported during the summer survey and substantially lower than the other groups (Figure 4.3). Well users perceived scarcity could be the result of a dip in the water table (increased effort to haul up water) combined with an increase in overall household demand (frequent bathing, street watering, etc.).

Table 4.4: Respondents' reported experience with water scarcity.

	Round I (summer)	Round II (winter)	Combined Average
Chao	61.9%	48.2%	53.9%
Well	43.3%	47.8%	45.3%
Nuevo Chao	74.4%	51.4%	61.0%



Note: (S) stands for data from Round I (i.e. summer) and (W) stands for data from Round II (i.e. winter).

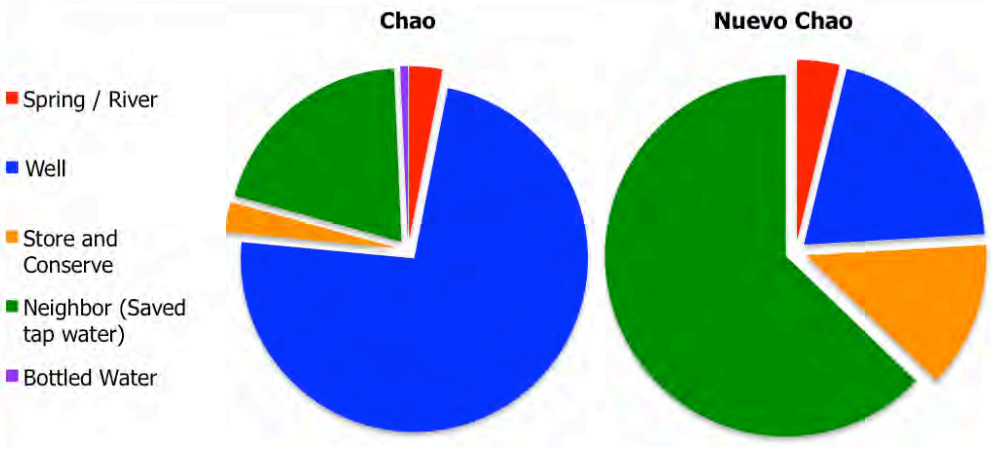
Figure 4.3: Reported experience with water scarcity.

As shown in Figure 4.3, the substantial drop in reported 'daily' scarcity[15] from Round I (summer) to Round II (winter) (and substantial increase in reported 'summer' scarcity in Round II) demonstrates that nearly 50% of respondents appear to perceive a seasonal difference in water scarcity. To this point, it seems that households are so conditioned to poor water services that having limited running water, and consequently having to make stored water last, does not equate to suffering from water scarcity, but, having a comparatively shorter service time does (recall Figure 4.1). From a developed world perspective, the intermittent service of either Chao and Nuevo Chao's water supply alone would constitute as scarcity on a daily basis.

Regardless of how water scarcity is perceived, the fact is that service cuts in Chao and

[15] Specifically, in the summer months 17.6% of households in Chao expressed daily scarcity as compared to 1.8% in the winter months. The same goes for Nuevo Chao where reported daily scarcity fell from 20.1% to 3.5%.

Nuevo Chao occur one or more times per month. Sometimes the cuts are intentional (cleaning and maintenance), but most of the time they are the result of 1) an inability to utilize pump due to loss of power or 2) a burst pipe. To better understand how households react to service cuts, the second round of surveys had a follow-up question asking respondents exactly what water sources they rely on when their stored water is exhausted.



Note: 'Store & Conserve' means that the household becomes more cautious of how much water they are using so as to make it last longer, and 'Neighbor' refers to asking neighbors for their extra tap water. If households went to their neighbors' home because their neighbors had a well this was coded as 'Well.'

Figure 4.4: Reported use of alternative water sources during periods of water scarcity.

As shown in Figure 4.4, the majority of families in Chao (73.4%) turn to wells during periods of water scarcity. Sometimes this is a household well, but more often it is a neighbor's well or Chao's community well. In Nuevo Chao, the situation is quite different with only 20.3% of families reporting to use well water (9.3% from a community well and 11% pay to transport water from wells in Chao or nearby small farms). The majority of households (62.9%) rely on their neighbors even though the neighbors are in the same situation.

Overall, alternative water sources are significantly easier to access in Chao than in Nuevo Chao (77.2% compared to 24.1%). Thus, while cuts to the water service are inconvenient in Chao, absolute water scarcity is not as great of a threat as it is in Nuevo Chao. This is reflected by 2.8% of Chao respondents reporting to be extra conscious of their water

during periods of scarcity as compared to 13.1% of Nuevo Chao respondents.

With respect to alternative sources, in comparison to other developing, water-scarce, regions of the world, residents in Chao, and particularly Nuevo Chao, do not have many options (Table 4.5). Specifically: there is infrequent rain (no opportunity for rain water catchment); there are no established water vendors (tanker trucks); only a few households can afford rooftop or underground cisterns (increased storage); and the two sources of surface water[16] are inconveniently located and suspected to be highly contaminated. For Chao this leaves the options of wells and bottled water, and, for Nuevo Chao, essentially nothing (i.e. in Nuevo Chao there are no wells and, for the majority, no money to purchase bottled water).

Table 4.5: Household use of alternative water sources.

	Tap	Well	River / Canal	Bottled	N/A
	PRIMARY				
Chao	96.3%	3.7%	-	-	-
Well	-	100.0%	-	-	-
Nuevo Chao	100.0%	-	-	-	-
	SECONDARY				
Chao	3.7%	58.0%	3.4%	13.2%	21.7%
Well	2.0%	-	4.0%	6.0%	88.0%
Nuevo Chao	-	10.9%	6.9%	2.6%	79.5%
	TERTIARY				
Chao	-	9.2%	2.7%	2.0%	86.1%
Well	-	-	-	-	100.0%
Nuevo Chao	-	0.3%	0.7%	-	99.0%

Note: The 3.7% of Chao households using a well as their primary source are not reported in the Well user group because they also have a household tap (i.e. for various reasons their preferred source was well water so tap water was noted as secondary source). N/A indicates the portion of households that did not report to use a secondary and/or tertiary source.

As Table 4.5 shows, and in line with Figure 4.4, far more Chao households (73.3%) use a secondary source than in Nuevo Chao (20.5%). Well users hardly use alternative sources

[16] A concrete agricultural canal, approximately two feet in width, runs down the southern edge of Chao and the Chao River winds down the Chao's northern edge.

(only 12% reported using a secondary source and no one reported using a tertiary source). This is not surprising given that Well users have unlimited access to the most popular alternative source, groundwater. However, despite the high number of Chao households reporting to use wells, the majority does so infrequently (Table 4.6).

Table 4.6: Reported frequency with which respondents (households) use alternative sources.

	No.	Daily	Weekly	Monthly	Seasonal	Only Use When Primary Water Source Unavailable
WELL						
Chao	146	7.5%	6.8%	1.4%	-	84.2%
Nuevo Chao	40	2.5%	2.5%	-	-	95.0%
BOTTLED WATER						
Chao	40	67.5%	27.5%	2.5%	-	2.5%
Nuevo Chao	7	57.1%	42.9%	-	-	-
RIVER						
Chao	19	5.3%	42.1%	26.3%	5.3%	21.1%
Nuevo Chao	21	14.3%	38.1%	14.3%	4.8%	28.6%

Respectively, of the 70.8% of Chao households reporting well use, only 14%[17] of them do so on daily or weekly basis (Table 4.6); of the 11.2% of Nuevo Chao households reporting well use, only 5% do so on a daily or weekly basis (Table 4.6). After groundwater, the second most popular alternative source in Chao was bottled water (13.2%), and in Nuevo Chao the Chao River (6.9%) (Table 4.5). The majority of those who can afford to buy bottled water do so frequently solely for the purpose of drinking (Table 4.6). This insinuates an unmet demand when it comes to the quality of the tap water. Dissatisfaction with water quality is further suggested by the fact that 64.3% of Chao households (excluding the Well user group) that retrieve well water do so for the purposes of drinking and/or cooking. With respect to the latter,

[17] Frequency data was only available for 146 (70.8%) of the 209 Chao households that reported to use a well.

Chao households complain that the quality of tap water is so poor they cannot cook their *menestra*. Menestra, essentially beans, is one of the main sources of protein in the Peruvian diet, especially for households too poor to regularly purchase meat or fish. While well and bottled water use is primarily for drinking and cooking, visits to the river are almost exclusively for cleaning and washing (91.7%)[18].

The use of alternative sources in Chao and Nuevo Chao is low and infrequent (Table 4.5 and 4.6). However, for Nuevo Chao households, it is unclear if low use of supplementary water sources is a matter of choice (i.e. possible indication of demand met by current service) or due to the physical and/or financial barriers to alternative water sources. The majority of Chao households turning to alternative sources on a frequent basis do so for the purpose of drinking and cooking which is likely a reflection of poor water quality. Households' opinions regarding the quality of existing tap water will be further examined in Section 4.3.

4.2.2 Existing Quantity

Beyond availability of existing water services and alternative sources, there are other factors affecting household demand under intermittent conditions. Given the absence of household water meters, data on water pressure and available storage capacity was gathered. To begin, pressure is one of the determinants of how much water a household is able to utilize. Subsequently, respondents were asked whether or not they had problems with water pressure and, if so, with what frequency (Table 4.7).

Table 4.7: Reported problems with water pressure.

	Round I (summer)	Round II (winter)	Combined Average
Chao	42.4%	10.4%	23.6%
Nuevo Chao	42.4%	21.0%	27.3%

[18] Further data regarding how households reported using alternative sources is available upon request.

As seen in Table 4.7, nearly half of Chao (42.4%) and Nuevo Chao (42.4%) households reported dissatisfaction with their water pressure during Round I. The drop in reported pressure problems in Round II is not surprising given a decreased demand for water in the winter months. When seasonal data are combined, roughly 25% of the population in both Chao and Nuevo Chao appear to be bothered by pressure problems year-round. For affected households, a lack of pressure often implies occupants are unable to fill their storage device(s) to capacity. In addition, for households with a shower, regular pressure problems prohibit them from using it for hygiene. That said, the frequency with which households report to be bothered by water pressure is variable (Tables 4.8 and 4.9).

Table 4.8: Frequency of reported pressure problems, as varies by season.

	Rarely	Daily	Weekly	Monthly	In Past
	Round I (summer)				
Chao	33.3%	48.0%	13.7%	4.9%	0.0%
Nuevo Chao	56.2%	32.9%	8.2%	0.0%	2.7%
	Round II (winter)				
Chao	16.7%	46.7%	10.0%	13.3%	13.3%
Nuevo Chao	36.6%	31.0%	9.9%	4.2%	18.3%

Table 4.9: Reported pressure problems, overall perspective.

	Never	Rarely	Daily	Weekly	Monthly	In Past
Chao	72.6%	8.1%	13.1%	3.5%	1.9%	0.8%
Nuevo Chao	64.9%	15.8%	10.8%	3.1%	1.9%	3.5%

Note: Table presents combination of data from Round I and Round II; where 'Never' reflects the portion of households not reporting any pressure problems.

Interestingly, Table 4.8 suggests that the proportion of pressure problems that are daily does not vary by season (48.0%(S) vs. 46.7%(W) in Chao and 32.9%(S) vs. 31.0%(W) in Nuevo Chao). When seasonal data are combined and expressed in relation to the total (respondents' who did and did not report pressure problems), it appears that 13.1% of Chao

households and 10.8% of Nuevo Chao households deal with pressure problems on a daily basis year round (Table 4.9). This is a significant portion of the population that is paying the same price as their peers but receiving a subpar quantity of water.

Under intermittent conditions, another key factor affecting domestic water use is the total capacity of households' storage devices. In collecting the data related to water storage capacity that is presented in Figure 4.5 and Table 4.10, respondents were asked to be as detailed as possible. Examples of water storage are shown in Figure 4.6.

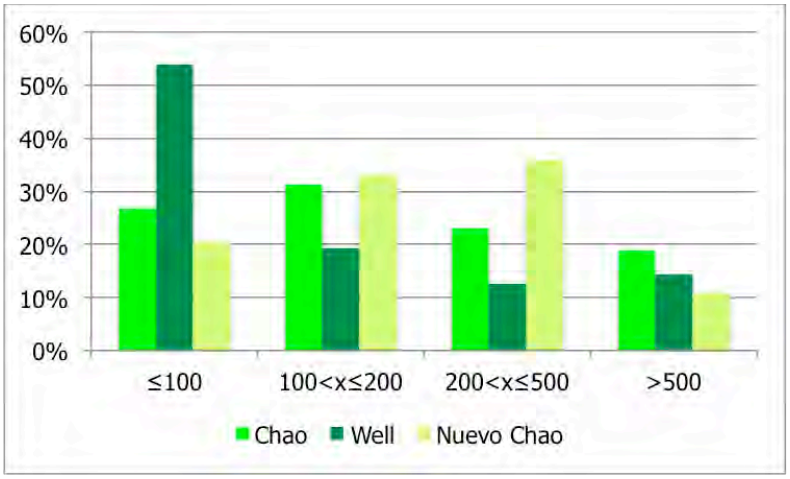


Figure 4.5: Reported amount of water households store on a daily (Chao and Well users) or every other day (Nuevo Chao) basis (liters).

Table 4.10: Descriptive statistics of amount of water households' regularly store on a daily (Chao and Well users) or every other day (Nuevo Chao) basis (liters).

	Min	Max	Mean	Std. Dev.	No.
		Round I			
Chao	10	3000	389	490	204
Well	5	1100	180	261	60
Nuevo Chao	10	2500	319	377	201
		Round II			
Chao	6	2200	307	339	284
Well	18	1200	303	382	44
Nuevo Chao	18	1300	265	236	288

Note: Unless 20 to 100-L washtubs (*tinas*) are used as principal storage devices (as is the case for extremely poor households), they were not included in the storage estimate (i.e. the means likely underestimate the absolute volume of households' storage capacities).

Note: The mix between uncovered washtubs, 18 L buckets, and larger covered *bidones* (light blue bottom left) is the most common situation. 6.0% of higher income households in Chao with sufficient pressure (and 14.7% of Well users with electric pumps) utilize the more sophisticated *Rotoplas* as shown in bottom right. Rotoplas range in size but 1,100 L are most often purchased at a cost upwards of S/. 3000 ($US 1115).

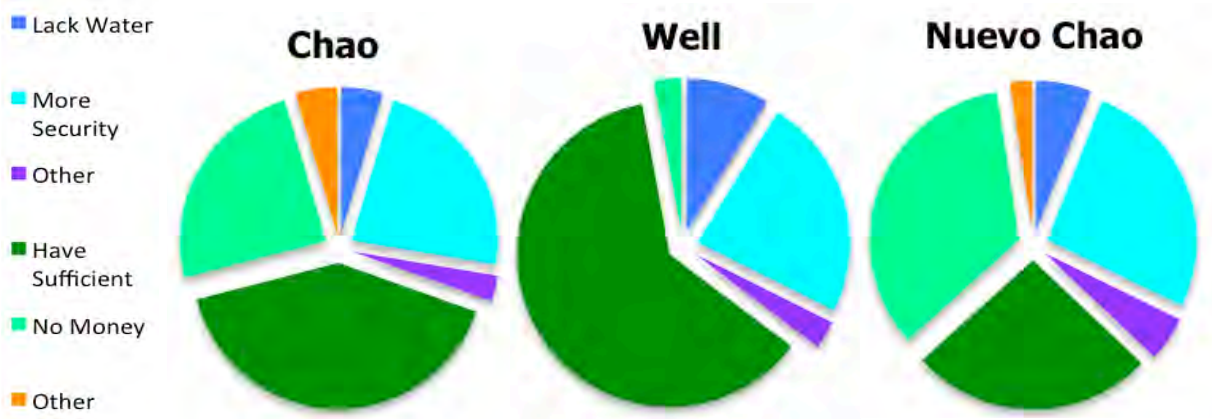
Figure 4.6: Examples of household water storage situations.

When examining Figure 4.5 and Table 4.10 remember the three user groups depend on their stored water to varying degrees. Specifically, in Nuevo Chao stored water must last two days, in Chao one day, and for the majority[19] of Well users, the concept of making water last is essentially irrelevant. In this light, it makes sense that Well users have the lowest storage capabilities (53.8% of households can store less than 100 L, Figure 4.5). Interestingly, although

[19] A few households in the Well user group rely on neighbors' wells (i.e. don't have tap water or well). In this case, the effort, and mentioned embarrassment, associated with hauling and asking for water meant these households were conscious of their water use.

Nuevo Chao households have to make stored water last twice as long, their reported storage capabilities are similar to those of Chao households (Figure 4.5). However, in comparing Chao's mean storage to Nuevo Chao's, depending on season, Chao households store 175 to 230 L more *per day* than Nuevo Chao households (derived from Table 4.10). This is possibly the result of two factors: 1) Nuevo Chao households are limited in the amount they can store given the service's short duration, and 2) regardless of need, Chao households have relatively higher incomes (Table 4.1) and thus can purchase more storage[20].

Consequently, in order to better understand the degree to which households depend upon their storage capabilities, in the second round of surveys, respondents were asked whether they were planning to buy more storage devices (Figure 4.7), why (Figure 4.7), and how much more water they would like to store.



Note: Shades of blue and purple reflect respondents intending to buy more storage, while shades of green and orange reflect respondents not planning to buy more storage.

Figure 4.7: Respondents' plans, and reasoning, for increasing water storage capabilities.

Given water availability for each user group, it is not surprising that the number of households planning to buy more storage was greatest in Nuevo Chao (34.1% as compared to 22.8% Chao, 21.3% Well users). That said, the split between households that do and do not plan to buy more storage (blue/purple vs. green/orange) in each user group is visually similar

[20] Of the 26.8% of Chao households reporting to own less than 100 L of storage, this likely reflects a single person, couple, or, perhaps, a household that also has a well.

(Figure 4.7). It is apparent that of those in each user group who want more storage, the majority desire increased water 'security' (75.8% Chao, 66.7% Well users, 71% Nuevo Chao). Increased water security could be interpreted as security from contamination as well as security from physical scarcity.

With respect to security from contamination, households reported covering nearly all of their existing storage devices (mean percentage of devices protected of 84.3% Chao, 77.6% Well users, 82.2% Nuevo Chao). Nonetheless, larger, ideally elevated, storage tanks such as *Rotoplas* are better protected from children, insects, and animals. As one respondent commented '(*Rotoplas) are more hygienic and the water lasts longer*.' However, such an assumption overlooks the possibility of increased microbial contamination in larger storage units such as *Rotoplas* due to infrequent cleaning, prolonged storage, and the hot climate (Schafer & Mihelcic, 2012).

With respect to security from physical scarcity, service cuts are more common in Chao than Nuevo Chao due to a reliance on power to access the water source (i.e. pump groundwater). Interruptions are generally forecasted, with the majority of households learning of cuts to the water services in advance by the local radio (89.5% Chao, 22.7% Nuevo Chao) and by megaphone (64.4% Nuevo Chao). Only 6.8% of Chao households and 1.8% of Nuevo Chao households reported to not receive notice prior to service cuts. That said, the occasional unannounced cuts do occur and it is possible these episodes are enough to stimulate households' to store water beyond needs in precaution. For Well users, buying more storage for 'security' from physical scarcity is possibly a reflection of a desire to spend less time hauling water.

Interestingly, when respondents were asked how much more storage they would like (Table 4.11), Well users wanted the largest capacity (approximately 831 liters) followed by

Chao households (approximately 650 liters). Comparatively, Nuevo Chao households desired 73 to 254 liters less than their counterparts (Table 4.11). Although the sample sizes may affect the means, such findings are contrary to what would be expected. That is, given existing water availability for each user group, it would seem Nuevo Chao households would want to store the most water. Findings to the contrary may suggest that much of the water stored by Well users and Chao households would ultimately be discarded before being used (i.e. they would store water beyond their needs which will likely result in wasted potable water). This reasoning is further supported by the fact that the additional volume of storage Chao households and Well users desire is roughly 230 to 550 liters above their daily household water use[21].

Table 4.11: Desired volume of additional water storage capacity (liters).

	Min	Max	Mean	Std. Dev.	No.	Missing
Chao	50	1500	650	416	57	10
Well	50	1500	831	453	8	2
Nuevo Chao	6	1100	577	391	93	10

The other motivation for purchasing more water storage devices was an explicit lack of water (16.7% Chao, 33.3% Well users, 18.3% Nuevo Chao – which is only 4.6%, 8.8%, and 6.0% of each respective user group when those who do not plan to purchase more storage are considered). Again, Well users who 'lack water' are likely referring to the inconvenience of having to haul water.

While households' reasons behind intended storage purchases were similar among all user groups, the reasons among households not planning to buy more storage were dissimilar (Figure 4.7). The overwhelming majority of Well users (95.5%) who did not plan to purchase more storage stated it was because they already had sufficient water (as compared to 58.3% of

[21] As compared to high-end water use estimates that will be discussed in Section 4.5.

Chao households and 41.8% of Nuevo Chao households). In contrast, the principal reason Chao and Nuevo Chao households gave was they had 'no money' (35.1% Chao, 54.4% Nuevo Chao). If 'no money' is considered to essentially imply an underlying 'Yes' (had the households more discretionary money available), the overall percentage of households who may want more storage is as follows: 54.8% Chao, 38.1% Well users, and 71.4% Nuevo Chao.

The notion that households receiving intermittent water supply must be struggling is challenged by their responses to whether or not they had enough water to meet all of their needs (Figure 4.8). It is notable that an overwhelming majority, replied 'Yes, they had enough water' (92.4% Chao, 94.0% Well users, 84.6% Nuevo Chao). When examined from a storage capability context, Nuevo Chao households are using, on average, 175 to 230 L less *per day* than Chao households (Table 4.10), yet only 7.9% more households are reporting insufficient water for their daily needs. However, when households were asked if they would use more water if their service were more continuous (Figure 4.9), their responses seem to contradict the high level of reported satisfaction with respect to their existing quantities of water (Figure 4.8).

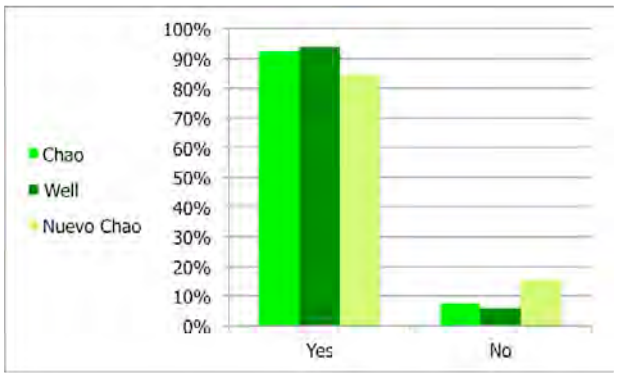


Figure 4.8: Respondents reporting enough water (quantity) for their daily needs (Yes or No).

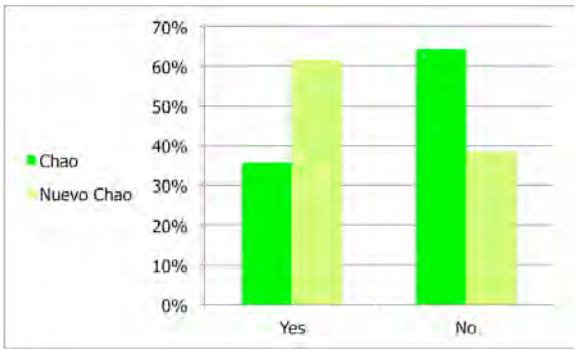
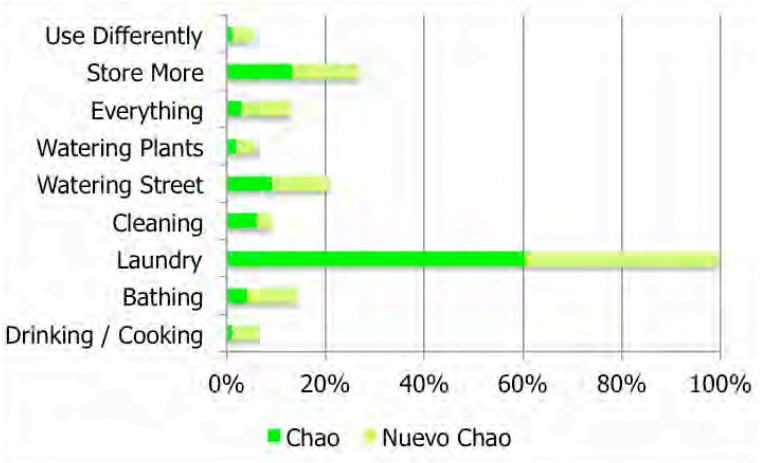


Figure 4.9: Respondents who would use more water if their water service were more continuous (Yes or No).

Specifically, 35.7% of Chao households and 61.5% of Nuevo Chao households reported that, 'Yes, they would use more water if it were more continuous.' That is ~25% of Chao households and ~45% of Nuevo Chao households were indirectly implying they would increase water use regardless of need. Such contradictory responses suggest that, regardless of necessity, the greater the availability of water in an intermittent context, the greater the quantity of water households will use.

To better understand latent demand for more water, households were asked how they would use additional water. Respondents gave open-ended, qualitative, responses, which were coded accordingly into the categories displayed in Figure 4.10.



Note: This was an open-ended question and respondents' qualitative answers were coded accordingly.

Figure 4.10: Respondents intended water use if water service were more continuous.

Aside from households reporting no intended increased usage, the most frequent responses were laundry (60.2% Chao, 39.3% Nuevo Chao), watering the street (9.2% Chao, 11.4% Nuevo Chao) and storing more water (13.3% Chao, 13.6% Nuevo Chao). This is interesting given that all three of the aforementioned activities either are, or have the potential to be, water-wasting behaviors as will be discussed in Section 4.4.

4.3 Demand and Quality

As seen in Section 4.2, availability of water is only one determinant of demand. Demand is also influenced in large part by the quality of available water. Accordingly this section will examine households' perceptions, practices, and preferences regarding water quality.

To begin, throughout the course of the surveys participants were asked to make several statements regarding their existing water quality including: to describe the quality of their water (Table 4.12), to rate the quality of their water on a scale of one to ten, and to state whether they trusted that their water was safe to drink and why (Table 4.13).

As seen in Table 4.12, Chao households used the fewest positive descriptors to describe their water (30.0%) as compared to Nuevo Chao (60.6%) and Well users (74.3%). Correspondingly, when households were asked to rate water quality on a scale of one to ten (where ten is high quality and one low quality) Chao had the lowest mean (6.06), followed by Nuevo Chao (7.15) and Well users (8.02). Consequently, it is not surprising that Chao households had the least trust in their drinking water (28.7%) followed by Nuevo Chao households (63.5%) and Well users (76.1%) (Table 4.13).

Table 4.12: Respondents' opinions of their water quality.

	POSITIVE			SO-SO		NEGATIVE		
	Clean / Potable	Sweet / Rica	Natural	Regular	Variable	Not Clean	Salty / Gross	Too Chlorinated
Chao	30.0%			27.9%		42.1%		
	25.7%	4.1%	0.2%	27.5%	0.4%	9.9%	14.4%	17.9%
Well	74.3%			16.2%		9.5%		
	54.3%	18.1%	1.9%	15.2%	1.0%	8.6%	1.0%	0.0%
Nuevo Chao	60.6%			26.3%		13.1%		
	50.9%	8.5%	1.2%	24.4%	2.0%	4.6%	1.4%	7.1%

Note: This was an open-ended question and respondents' qualitative answers were coded accordingly. For 'Chao' reported water quality refers to tap water (from system's well), for Well users reported water quality refers to water from each households' personal well, and for 'Nuevo Chao' reported water quality refers to tap water (from spring).

Table 4.13: Reasons for respondents' confidence (or lack of) in their drinking water's safety.

	YES					NO				
	Clean / Delicious	Disinfected Maintained	Chlorinated	Good Source	Good Service	Horrible Polluted	Worms Microbes	Too Much Chlorine	Not Enough Chlorine	Lack of Information / Trust
Chao	28.7%					71.3%				
	8.3%	5.8%	8.0%	0.0%	1.1%	20.7%	9.1%	25.4%	0.0%	21.7%
	35.9%	25.0%	34.4%	0.0%	4.7%	26.9%	11.8%	33.0%	0.0%	28.3%
Well	76.1%					23.9%				
	32.6%	6.5%	13.0%	19.6%	0.0%	10.9%	6.5%	0.0%	0.0%	10.9%
	45.5%	9.1%	18.2%	27.3%	0.0%	38.5%	23.1%	0.0%	0.0%	38.5%
Nuevo Chao	63.5%					36.5%				
	18.7%	22.3%	14.1%	2.1%	4.2%	5.7%	8.5%	4.2%	1.4%	18.4%
	30.5%	36.2%	23.0%	3.4%	3.4%	14.7%	22.0%	11.0%	3.7%	48.6%

Note: This was an open-ended question and respondents' qualitative answers were coded accordingly. The first row of percentages corresponds to whether respondents are confident in the safety of drinking the water, yes or no. The second row of percentages reflects respondents' reasoning why they said yes or no, and the third row presents the same data but percentages are calculated to distinguish the reasoning of the 'Yes' group from that of the 'No' group.

Interestingly, although data presented in Table 4.13 suggests that 76.1% of Well users and 63.5% of Nuevo Chao households would feel no need to treat their water, the majority of households across all user groups (62.6% Chao, 61.8% Well users, 50.9% Nuevo Chao) reported that they regularly boil their water for drinking. That is, whether or not households had confidence in their drinking water, the majority provided point-of-use treatment and/or bought bottled water (Table 4.14).

Table 4.14: Reported household treatment of drinking water.

	No Treatment	Boiled	Crude & Boiled	Chlorinate & Boiled	Bottled Water
Chao	17.4%	62.6%	15.0%	2.0%	3.0%
Well	16.7%	61.8%	16.7%	2.9%	2.0%
Nuevo Chao	27.4%	50.9%	17.4%	3.7%	0.6%

Note: This was an open-ended question and respondents' qualitative answers were coded accordingly. The small percentage of households reporting to both chlorinate and boil their water was likely referring to either 1) the chlorine the tap water comes with, or 2) their periodic addition of a few drops of chlorine to their well.

As a whole, 82.6% of Chao households, 83.3% of Well users, and 72.6% of Nuevo Chao households invest time and/or money improving the quality of their drinking water (Table 4.14). With respect to time and money, assuming that, for the average family, 1) a *valon* lasts one month (mode from data), 2) approximately 10 to 20% of daily gas allowance is for boiling water, and 3) the price of a *valon* of gas was S/. 38 in November 2012, at most the cost of treatment for households using gas stoves is around $2.82 per month (S/. 7.6). For those households who rely on open fires to boil their water, a large sack of wood costs roughly S/. 2 and lasts the average family four days, which implies a cost of roughly $1.11 per month (S/. 3). If households dedicate time to finding free wood, the value of time (outside the scope of this study), would need to be considered. A small portion of the population who thought the quality of the tap water was abysmal and had a disposable income reported only consuming bottled water (3.0% Chao, 2.0% Well users, 0.6% Nuevo Chao). Bottled water was often purchased in

the form of a 20 L reusable *bidon* (similar to a Culligan bottle) at a reported average cost of S/. 38.65 per month[22]. Overall, households' financial investment in point-of-use treatment relative to the existing monthly service fees is noteworthy; particularly for Nuevo Chao households (S/. 3.20 tariff compared to S/. 3 to 7.6 spent on treatment).

While the quality of drinking water is evidently important to households, due to a lack of time and/or money, households' treatment efforts are not consistent. For example, with respect to drinking water both crude and boiled, roughly 20 to 30% more households reported to do so during Round I (summer) as compared to Round II (winter)[23]. Similarly, the percentage of respondents who reported to only drink crude water was greater during Round I as well. Both these seasonal differences are likely reflecting increased thirst during summer months where households' supply of treated water is not able to keep pace with demand. The inconsistency of boiling water greatly diminishes the benefits that household water treatment may otherwise provide. Nonetheless, reported problems of diarrhea were low (6.5% Chao, 0.0% Well users, 6.3% Nuevo Chao).

Boiling water does more than kill harmful microbes. Many households commented that boiling their water got rid of the strong chlorine odor. In fact, in both Chao and Nuevo Chao, chlorine was both a reason for why water was considered safe to drink as well as a reason why it was not drunk without boiling, or, in some cases, at all. Such counter-intuitive reasoning was more common in Chao (25.4%, 17.9%) than in Nuevo Chao (4.2%, 7.1%) (Tables 4.12 and 4.13). Other respondents reported boiling their water to cause the excessive *sarro* (hard minerals) to settle out although whether this was motivated by taste or a deeper understanding of physical quality was unclear.

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[22] Interestingly, 61.7% reported the price of bottled water to be 'fair' (29.8% 'Expensive,' 8.5% 'Cheap').

[23] Similar to other figures and tables, seasonal data is not included but is available upon request.

To try to understand households' reasoning behind reported water treatment (or lack thereof), respondents were asked which of the following factors (appearance, taste, odor, physical security, or biological security) was the most important to them (Figure 4.11). The majority of households in Chao (34.1% Chao, 47.9% Well users) reported biological security as the most important aspect of water quality. Concern with physical quality of water (27.7% Chao, 27.9% Well users) closely followed. Comparatively, in Nuevo Chao the majority (59.1%) referred to taste and odor as the most important determinants of water quality.

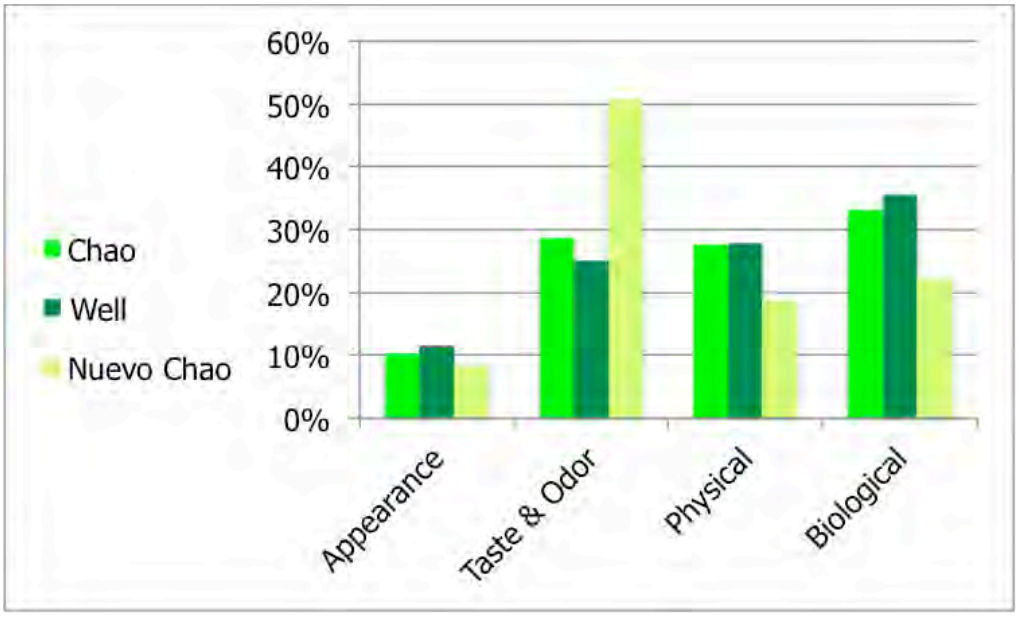


Figure 4.11: Respondents' opinion of most important water quality characteristic.

Correspondingly, many Nuevo Chao households commented that the taste of their *dulce* (sweet) spring water was far superior to Chao's *agua salada* (salty water). Obviously the taste of water is affected by its physical/chemical make-up and all of the above aspects of water quality are, to varying degrees, interrelated. It could be that while households in Nuevo Chao know the importance of biological and physical security (as demonstrated by their investment in household treatment), because they cannot determine it (i.e. lacking equipment to perform qualitative/quantitative tests), they depend on their senses. However, given that, despite the

perceived high quality of their water upon arrival, the majority of Nuevo Chao households still perform additional treatment for drinking water suggests that they ultimately recognize the importance of water's physical and biological safety.

Households' interpretations of the term 'potable water' (Table 4.15) and what their water providers were doing to make their water potable (Table 4.16) provides further insight into what may motivate regular treatment of drinking water (Table 4.14).

Table 4.15: Respondents' understanding of term 'potable water.'

	Vital for all Life	For Human / Domestic Consumption	Clean Pure Healthy	Treated Maintained Chlorinated	Comes via Tubes For Everyone	Daily / Continuous / Don't Lack	Other	Don't Know
Chao	12.0%	14.7%	19.2%	35.3%	4.1%	1.0%	1.4%	12.3%
Well	18.0%	12.0%	18.0%	22.0%	10.0%	0.0%	4.0%	16.0%
Nuevo Chao	8.0%	10.7%	19.4%	30.1%	8.0%	2.7%	3.3%	17.7%

Note: This was an open-ended question and respondents' qualitative answers were coded accordingly.

With respect to what potable water signified, responses ranged from, 'it does not exist' and is 'gross,' to 'it arrives to everyone' and is 'daily.' However, as a collective group, the most common responses were that potable implies the water is: 'treated, maintained and/or chlorinated' (31.8%), 'clean, pure, or healthy' (19.2%), and 'for human consumption' (12.6%). Accordingly, although it appears that the majority of households in all three-user groups (69.2% Chao, 52.0% Well users, 60.2% Nuevo Chao) are aware that potable implies water that is of higher quality (treated), there is a relatively large portion of each user group that reported not knowing what the word potable meant (12.3% Chao, 16.0% Well users, 17.7% Nuevo Chao). Uncertainty surrounding potable water increased when households were asked to specify what procedure(s) their service provider performed in order to make their water potable

(Table 4.16). Specifically, 56.1% of Chao and 56.4% Nuevo Chao households reported to not know what their provider does to make their water potable.

Table 4.16: Respondents' understanding of service provider's water treatment.

	Don't Know	Clean / Disinfect	Chlorinate / Add Chemicals	Provide Maintenance	Chlorinate AND Provide Maintenance	Nothing
Chao	56.1%	13.8%	26.0%	1.0%	2.1%	1.0%
Nuevo Chao	56.4%	7.1%	27.9%	3.5%	3.9%	1.1%

Note: This was an open-ended question and respondents' qualitative answers were coded accordingly.

The fact that the majority of the population does not know how, and perhaps if, their water is being treated may help to explain why so many households regularly boil their water before drinking it. For the other 43.2% (average) of respondents who attempted to explain the providers' treatment process, 31.2% mentioned the addition of chlorine (chemicals) and/or maintenance and 11% were slightly more vague noting water is *cleaned* or *disinfected*. Only 1% of the households reported that their service providers were doing nothing.

To understand just how important water quality is to households, households were asked what they thought was the most important aspect of a water service (Table 4.17). As Table 4.17 shows, the quality of water provided is very important for households.

Table 4.17: Respondents' opinions on most important aspect of a quality water service.

	Water Quality	Continuity	Schedule	Maintenance	Price	Pressure	Transparency
Chao	73.9%	6.2%	1.7%	9.3%	5.5%	2.4%	1.0%
Well	69.6%	10.9%	0.0%	17.4%	0.0%	0.0%	2.2%
Nuevo Chao	66.7%	4.9%	5.9%	10.8%	5.9%	3.5%	2.4%

Note: Categories were chosen in accord with the most common complaints SADISCHAO received; where 'mantenimiento' (maintenance) and 'transparencia' (transparency) were catchphrases that households would use in order to express their general dissatisfaction with how the service was being run.

Specifically, 73.9% of Chao households, 69.6% of Well users, and 66.7% of Nuevo Chao households reported water quality as the most important determinant of a quality water service. Maintenance was the second most mentioned but far behind water quality (9.3% Chao, 17.4% Well users, 10.8% Nuevo Chao). Price, pressure and transparency appeared to be of the least concern. With this in mind, Chao and Nuevo Chao households were asked what they would most like to change about their current water service (Table 4.18).

Table 4.18: Aspect of current water service respondents would most like to change.

	Water Quality	Continuity	Schedule	Maintenance	Price	Pressure	Transparency	Change Nothing
Chao	67.5%	4.7%	10.1%	8.7%	3.6%	4.0%	0.7%	0.7%
Nuevo Chao	20.4%	8.8%	31.6%	22.8%	2.1%	9.5%	3.9%	1.1%

Interestingly, although Nuevo Chao households believe that water quality is the most important aspect of a water service (66.7% - Table 4.17), only 20.4% of them want most to change the water quality of their existing service. This suggests that the other 80% of households in Nuevo Chao are pleased with the quality of their water in comparison to the service's unsatisfactory schedule (31.6%) and maintenance (22.8%). This is in striking contrast to Chao where nearly 70% of households would like to see an improvement in water quality (Table 4.18). Overall, despite the discontinuous availability of the water services as detailed in Section 4.2, it appears that, in the opinion of Chao and Nuevo Chao households, improving water quality, service schedule, and maintenance are more important than continuity.

4.4 Water Behaviors and Conservation

The previous sections examined existing household water demand as it relates to availability and quality. This section will break down demand as it is revealed through existing

water use behaviors. Whether or not per capita use will change under an improved service scenario is a complex issue. While all water use activities have the potential to increase under an improved service scenario, of particular interest are the high-water use activities such as street watering, bathing, and laundry (Section 4.4.1). This will be followed by an examination of existing patterns of water reuse and perceptions regarding water conservation in general (Section 4.4.2).

4.4.1 High-Water Use Activities

The discussion will begin with street watering (Figures 4.12 - 4.14). Unlike the United States and other developed countries where residents are expending vast quantities of water outside their homes to maintain lawns and gardens, the main purpose of watering in Chao is *por el polvo* (for the dust)[24].

Note: The top photograph was taken from afar because in addition to capturing the man (in the blue shirt) actively watering the street, it also shows the damp ground outside of the four neighboring households.

Figure 4.12: Photograph of street watering in Chao.

[24] Respondents were asked why they water the street but the response of 'for the dust' was so overwhelming the qualitative variable was entered into SPSS but not coded.

Figure 4.13: Photographs of residents and businesses watering street in Nuevo Chao (left) and Chao (right).

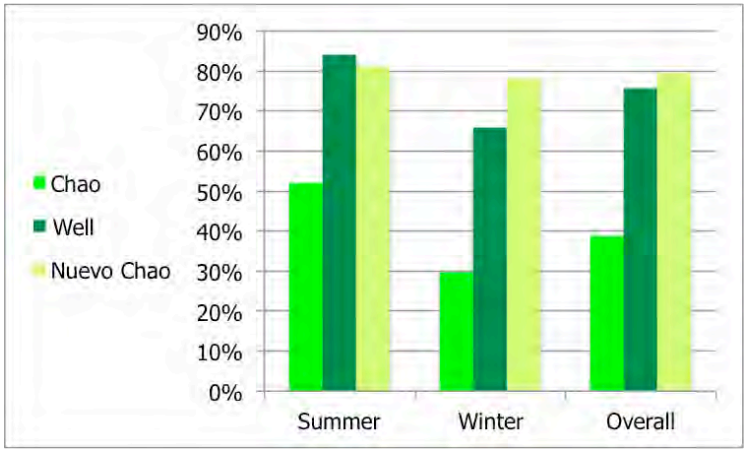


Figure 4.14: Percentage of households reporting to water the street.

At first glance of Figure 4.14 it would seem that on average Nuevo Chao households (79.3%) allocate the most water to street watering (although Well users are not far behind, 75.7%). However, there are two important factors to consider. First, roughly 70% of Chao households are located on paved roads compared to 0.0% of Nuevo Chao households, thus making dust more problematic for the latter. This may be why, after 'Water,' the most important public service to Nuevo Chao households is 'Paved roads' (as will be discussed in Table 4.36 of Section 4.6). Also, at the time of surveying, Nuevo Chao households did not have a sanitation service. Thus, aside from the 18.1% of Nuevo Chao households reporting to have a

septic tank, washwater must be disposed of either inside (predominantly dirt floors, see Table 4.1) or outside their house. Accordingly, water type must be considered (Figure 4.15). If well water is considered to be potable (direct use), there are more Chao households that reported to exclusively water the street with potable water (56.6% Chao, 47.2% Well users) than Nuevo Chao households (18.0%).

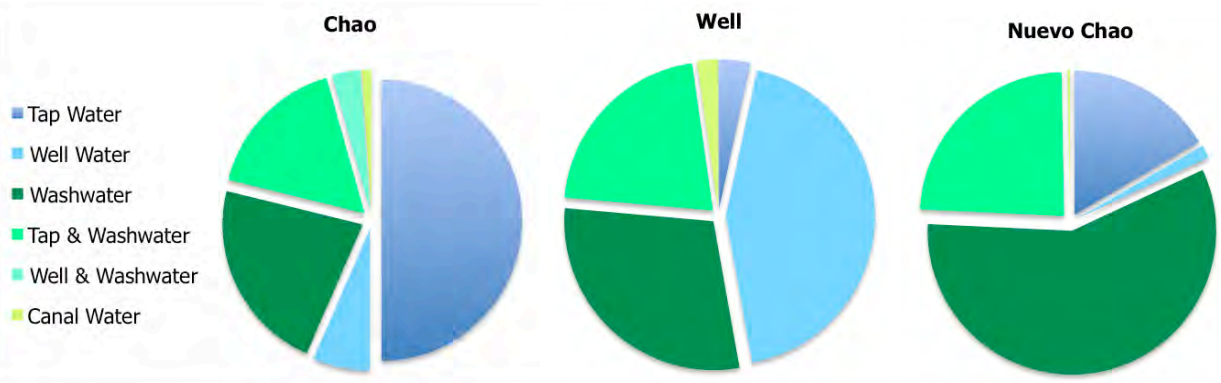


Figure 4.15: Reported type of water used to water the street.

However, in many of the neighborhoods in Chao, paved roads have significantly reduced the frequency of street watering. Unfortunately, pavement is not in the foreseeable future for Nuevo Chao[25] or for the various areas in Chao where large portions of space are still covered in dirt (particularly along the highway – Figure 4.16).

Figure 4.16: Photograph of street watering along the Pan American highway in Chao.

[25] Statement based on conversations with the Mayor of Chao and *regidores* (town councilmen).

Meanwhile, recall that 62.1% of Chao households, 68.8% of Well users, and 82.5% of Nuevo Chao households have solely dirt floors. For others reporting *piso falso* (cement) and/or tile, only a small fraction of those houses have 100% coverage (i.e. a large portion of their house is still dirt). Consequently, when considering the behavior of watering it is essential to understand that a large proportion of households reported to also water the inside of their house (62.2% Chao, 56.3% Well users, 64.5% Nuevo Chao). In some respect, water currently used to tidy up dirt within households is the equivalent of water used to wash cement and tile floors. However, a large portion of indoor watering is for the *corral* (indoor yard), which is exposed to sunlight and thus, like the street.

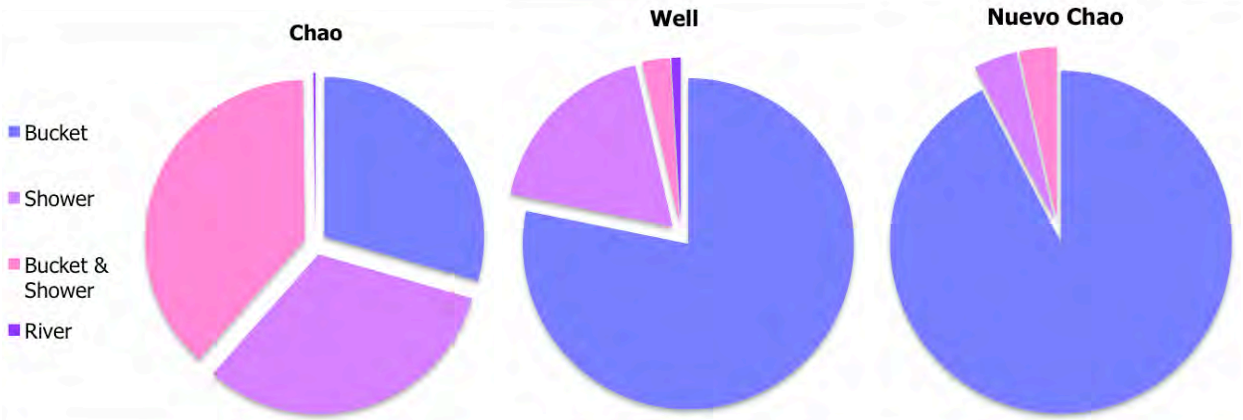
Watering the street may seem nonsensical but given the high amount of dust in the area it is understandable why the practice exists. To residents it the seemingly easiest and most effective way to get the sandy dirt to temporarily stay put. This means less dust in the house and less dust in the eyes and lungs. Unfortunately, unless streets are watered as the sun is setting the desired affect is short-lived (i.e. the dry climate causes water to rapidly evaporate, especially during the summer).

That said, an outsider observing residents watering outside and inside their homes might ask *where are the plants?* Vegetation would require some water but it would serve more than one purpose: keeping dust down (covering it), cleaning air, providing habitat, reducing ambient heat, etc. Roughly 40% of the population (34.6% Chao, 33.4% Well users, 45.1% Nuevo Chao) reported to water plants. However, only a few households maintained vegetated spaces or gardens (Figure 4.17). Although not explicitly studied, conversation with households maintaining groundcover indicated that species grown were endemic and did not require large amounts of water. In order to better understand what was preventing, as well as encouraging, landscaping, households were asked why they did or did not maintain plants.

Figure 4.17: Photographs of households in Nuevo Chao with maintained vegetated spaces.

Interestingly, the most common reason households cited for having plants was for adornment (51.0%). This was followed by: for the environment (17.5%), shade (12.9%), health (10.8%), and food (4.1%). Not one household mentioned plants as a good way of reducing dust. In contrast, the most common reasons for not having plants were: no space (59.1%), no water (12.9%), and no time (5.3%). With regard to space, households in Nuevo Chao are understandably hesitant to plant outside their homes lest pavement be laid down. In Chao, however, households on paved streets have, at least, one square meter of space that is often left bare. With respect to backyards, although these areas are often home to clotheslines, animal pens, latrines, etc., the author regularly observed ample room for plants.

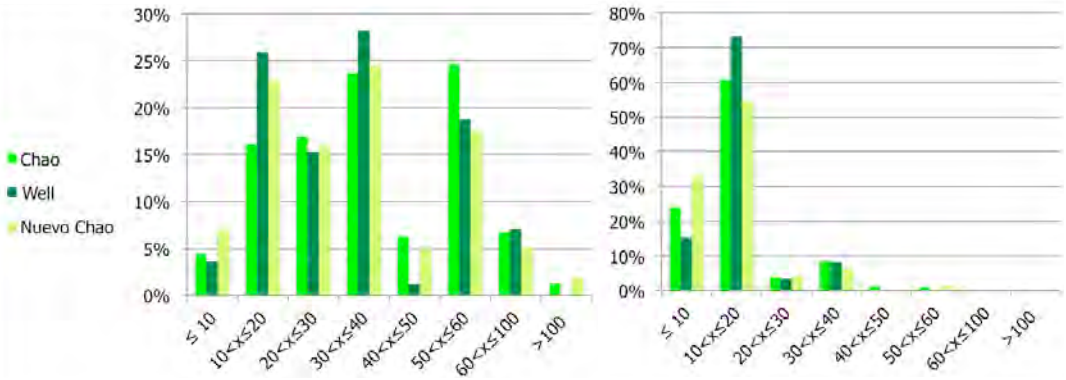
Moving on, personal hygiene is an area that utilizes a large portion of households' water and is an activity in which wasteful behaviors easily arise. However, in contrast to street watering, water for hygiene directly meets a basic human health need (Figures 4.18 and 4.19). Currently, the majority of Well users (78.2%) and nearly all Nuevo Chao households (92.4%) take bucket baths (Figure 4.18). In contrast, 70.3% of Chao households have installed showers; although only 32.1% are able to use their shower all of the time – a benefit of having elevated water storage tanks.



Note: 'River' only captures respondents who reported to bathe in the river on a regular basis.

Figure 4.18: Respondents' personal hygiene behavior.

With respect to how much water respondents use for bathing, the majority reported to use half or a full bucket[26] every time they bathed (10-20 Liters). However, Chao households, followed by Well users, reported to bathe more frequently and thus had higher total water use (Figure 4.19).



Note: This was an open-ended question and respondents' quantitative answers were coded accordingly.

Figure 4.19: Liters per capita per day for bathing in summer (left) and winter (right).

For households that only used showers, due to large variations in pressure, it is difficult to determine how much water they were using. In the author's experience, some households reported to *close the faucet while soaping* while others said they left the shower running for 20 (Nuevo Chao) to 80 (Chao) minutes at a time. That said, assuming roughly 7.5 L flows from a

[26] The standard bucket size for bathing is the 18-L *aciete* (vegetable oil) buckets. Through surveying it was apparent that nearly every household, regardless of user group, had at least one.

faucet per minute, and an average nine minute shower[27], households with showers are likely using ~68 L per capita per day in the winter and up to 204 L per capita per day in the summer[28]. If the continuity of the water service were to increase, the number of households able to use showers on a regular basis would likely increase, perhaps causing an increase in demand.

Laundry is another aspect of personal hygiene. Laundry is primarily washed by hand using washtubs. Interestingly, despite significantly variable access to water, the frequency clothes are washed (ranging from one to seven days a week in each user group) as well as the liters used per load seem to be predominantly determined by households' personal preferences. That is, the range of water use in each user group is relatively the same (Table 4.19)

Table 4.19: Liters used per-capita, per-week, for laundry.

	Round I (summer)			
	≤20	20<x≤60	60<x≤100	>100
Chao	41.4%	39.0%	14.7%	4.9%
Well	38.3%	36.2%	10.7%	14.9%
Nuevo Chao	32.8%	45.8%	13.7%	7.6%
	Round II (winter)			
	≤20	20<x≤60	60<x≤100	>100
Chao	25.8%	52.3%	14.4%	7.6%
Well	22.4%	47.0%	26.5%	4.1%
Nuevo Chao	25.6%	48.2%	16.4%	9.9%

Note: This was an open-ended question. In order to reflect per-capita water use respondents' quantitative answers for loads per week and liters per load were multiplied and then divided by the number of individuals in their family.

However, as a whole, Well users reported to use the most water. It is possible that Nuevo Chao households use less water than Chao households but were simply more accurate at estimating their usage given their limited water supply (i.e. Chao households may have been

[27]Means number of minutes per shower period ranged from 5.33 minutes in Nuevo Chao (8.95 minutes Chao) to 12.8 minutes for Well users.

[28] Comparatively, a typical shower in the U.S. uses roughly 44 liters (Vickers, 2001).

underreporting the amount of water used for laundry). In support of this inference, many Chao households often mentioned that they *approvechar* (take advantage of) the hour the water arrives to wash clothes so they can empty and fill up as many washtubs as need be.

Interestingly, in contrast to bathing, there is an apparent shift to increased water use for laundry during the winter that could perhaps be explained by more available water. Recall from Figure 4.10 that laundry was the principal activity that households stated they would do more of if their water service were to be more continuous (60.2% Chao, 39.3% Nuevo Chao). Water spent on laundry may also increase with the introduction of washing machines. At the time of surveying only 34 families (7.8% Chao, 4.0% Well users, 3.0% Nuevo Chao) had machines but when households were asked what appliances/devices they were planning to buy in the coming year, 13.4% of Chao households, 12.5% of Well users, and 6.3% of Nuevo Chao households reported they would like to buy one. Given that washing machines can free up roughly two to three hours per large load, it will remain to be seen how their added convenience affects households' water consumption. That said, households washing laundry by hand used 30 to 80 liter tubs, upwards of two times. Considering a typical top-loading washing machine uses approximately 150 liters per load, in some cases washing in tubs may be more wasteful.

4.4.2 Water Conserving Behaviors

Throughout the survey process care was taken to distinguish the degree to which water was reused. As was shown in Figure 4.15, more respondents in Nuevo Chao than Chao reported to use washwater for street watering. This difference also held true for reported mopping (2.4% Chao, 16.7% Nuevo Chao) and plant watering (2.8% Chao, 11.2% Nuevo Chao). When it comes to sanitation, unless households have overhead tanks, when water is not arriving households with toilets must manually flush them using buckets full of either potable water or greywater (Table 4.20).

Table 4.20: Greywater reuse for flushing toilets.

	Never	Sometimes	Always	No. w/ no toilet
Chao	26.0%	58.5%	15.5%	11
Well	27.8%	44.4%	27.8%	27
Nuevo Chao	38.5%	23.1%	38.5%	261

Note: Keep in mind the small proportion of households in Nuevo Chao that have toilets (i.e. percentages only reflect responses of 26 households, or 6.3% of the total number of Nuevo Chao households surveyed).

When households reporting to 'sometimes' use washwater to flush toilet are combined with those who 'always' do, Chao households are most conserving (74%), followed by Well users (72.2%), and Nuevo Chao households (61.6%). With the onset of a more continuous service, this water conserving behavior may disappear. That is, if toilet tanks were always full from incoming water it would seem less likely that households would continue to haul washwater into their bathrooms. However, for households using potable water to bucket flush their toilets, depending on the size of the average toilet tank (reported means of 4 (Well users) to 9 liters (Chao)) as compared to the average number of liters used/required for a bucket flush (reported means of 6 (Well users) to 11 liters (Nuevo Chao)), a more continuous water service could save water when it comes to sanitation.

With respect to water conservation awareness, respondents were asked 1) if they had ever heard of water conservation, 2) the source (Table 4.21) c) if they practice water conservation (Figure 4.20), d) to give an example (Table 4.22), e) if applicable, why they practice water conservation (Table 4.23), f) perceptions of local water scarcity and, g) how they feel about water meters (Table 4.25). Households' responses offer insight as to whether an improved water service would result in an increase in the use of potable water for street watering, personal hygiene, and laundry, and, correspondingly, a decrease in water reuse.

To begin, the majority of households reported to have never heard or received any information regarding water conservation (65.5% Chao, 75.7% Well users, 61.6% Nuevo

Chao). Interestingly, for those who had at some point been informed (Table 4.23), 9.0% of Chao households reported the information came from SADISCHAO compared to 42.0% in Nuevo Chao that reported to have received information from the JASS. In contrast, in Chao the health post seemed to be the more active body (32.8% Chao, 55.6% Well users, 17.3% Nuevo Chao). Others sources of information included schools (7.6%) the television (19.6%), radio (6.3%), workshops (7.0%) and, to a lesser degree, neighbors, the Internet and pamphlets. Awareness of water conservation, however, appears to not be a determinant for whether a household practiced water conservation (Figure 4.20).

Table 4.21: Where respondents learned about water conservation.

	Water Provider	Radio	TV	Internet	School	Health Post	Meeting	Neighbors	Other
Chao	9.0%	10.4%	28.4%	1.5%	7.5%	32.8%	6.0%	3.0%	1.5%
Well	11.1%	11.1%	22.2%	0.0%	0.0%	55.6%	0.0%	0.0%	0.0%
Nuevo Chao	42.0%	2.5%	12.3%	1.2%	8.6%	17.3%	8.6%	2.5%	0.0%

Note: This was an open-ended question and respondents' qualitative answers were coded accordingly.

Surprisingly, given the difference in availability of water, there does not seem to be a large difference between the reported conservation efforts in Chao and Nuevo Chao (average 73.5% Chao, 63.3% Well users, 71.4% Nuevo Chao). Well users, however, appear to be slightly less apt to conserve water in the summer months; given their "endless" supply of well water, this is not surprising. In fact, five Well users specifically stated 'there is no need to conserve water.' Also note the roughly 20% decrease in reported water conservation in the second survey round (winter). This seasonal difference suggests that perhaps households are not conserving water because it's the right thing to do so much as if they aren't conscious about their water use in the summer months they will run out of water.

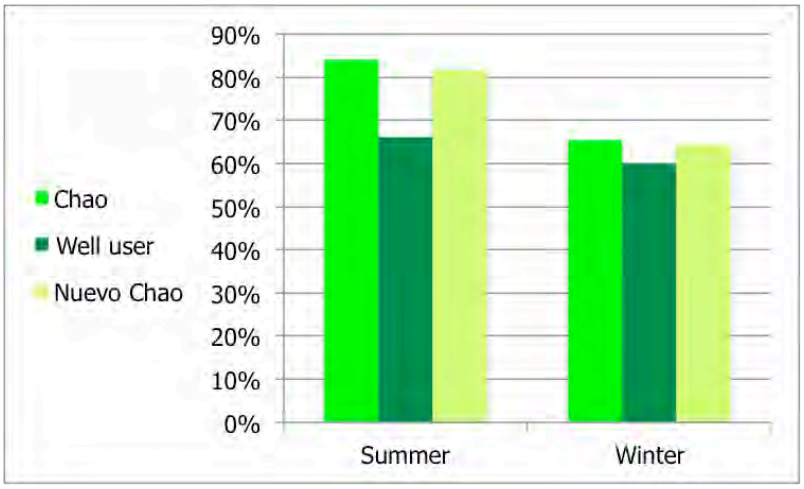


Figure 4.20: Percent of respondents reporting to practice water conservation.

To more closely examine this theory, it is perhaps important to take a step back and look at how respondents interpret the phrase 'water conservation.' Respondents were asked to give an example of how they conserve water in their house (Table 4.22).

Table 4.22: Examples of water conservation as reported by respondents.

	Use Minimum / Conserve	Boil Water	Cover Water	Don't Water Street	Reuse Water	Close Faucets	Install Water Conserving Devices	Repair Leaks
Chao	41.7%	1.5%	11.2%	10.7%	14.1%	10.2%	0.5%	5.8%
Well	40.0%	4.4%	26.7%	4.4%	20.0%	2.2%	0.0%	2.2%
Nuevo Chao	43.5%	2.6%	21.4%	7.9%	7.8%	0.5%	0.1%	1.0%

Note: This was an open-ended question and respondents' qualitative answers were coded accordingly. The table reflects the first response mentioned by respondents even if they would voluntarily list several examples instead of one.

Table 4.22 suggests that Chao households (including Well users) have the most sophisticated understanding of water conservation. That is, compared to Nuevo Chao households, they more frequently mentioned what would traditionally be regarded as water

conservation behaviors such as: 'Closing Faucets' (10.2% Chao, 2.2% Well users[29], 0.5% Nuevo Chao); 'Water Reuse' (14.1% Chao, 20.0% Well users, 7.8% Nuevo Chao); 'Repairing Leaks' (5.8% Chao, 2.2% Well users, 1.0% Nuevo Chao), and 'not watering the street' (with potable water) (10.7% Chao, 4.4% Well users, and 7.9% Nuevo Chao)[30].

On the other hand there were some interesting interpretations of water conservation including covering water (14.6%) and boiling water (1.9%). This line of reasoning suggests that some respondents did not interpret *conservación de agua* (i.e. water conservation) as reducing water use. Instead, for these individuals, water conservation seemed to imply enhancing/prolonging the quantity and/or improving/protecting the quality available to their households. Additional evidence regarding the misinterpretation of the term water conservation is revealed by respondents' answers to the question of why they practice water conservation (Table 4.23).

Table 4.23: Reported reasons why respondents practice water conservation.

	Future Generations	Neighbors	Environment	So Don't Run Out	Good Practice	Health	Financial
Chao	21.9%	19.5%	7.0%	35.9%	10.9%	3.9%	0.8%
Well	18.8%	6.3%	6.3%	50.0%	12.5%	0.0%	6.3%
Nuevo Chao	21.3%	17.0%	14.9%	31.9%	5.3%	9.6%	0.0%

Note: This was an open-ended question and respondents' qualitative answers were coded accordingly. For those reporting to practice water conservation for financial reasons, although this is illogical given the universal (i.e. flat) tariff, the reason was included and coded.

[29] These Well users have elevated water tanks that allow them to have faucets.

[30] Mention of water-conserving devices was low by all user groups likely because 1) many households still have little to no water infrastructure (refer to Table 4.26) and 2) water-conserving devices are not marketed and/or available to the public.

As Table 4.23 suggests, 3.9% of Chao households and 9.6% of Nuevo Chao households and said they practice water conservation for personal health reasons. Confusion on the concept of water conservation is further exemplified by the fact that 7.5% of Chao households and 24.7% of Nuevo Chao households reported to not conserve water because they simply did not have enough to begin with (i.e. although they did not know it, these households were likely conserving water to make the little they had last, through reuse, minimal use, etc.). Confusion is further exemplified by comments such as '*I don't conserve water because I use all the water I have every day and there is nothing left to store.'* Such reasoning indicates how respondents may have interpreted conservation as preservation (i.e. storing water) rather than using less water overall.

Interestingly, 35.9% of Chao households, 50% of Well users, and 31.9% of Nuevo Chao households that said they practiced water conservation so they (personally) did not run out of water. While not necessarily a misinterpretation of the term, this would suggest that the largest reported conservation behavior of 'Using the minimum amount of water' (41.7% Chao, 40.0% Well users, 43.5% Nuevo Chao) may not be motivated for reasons beyond ensuring adequate water at the household level.

On the other hand, Table 4.23 also reveals some deeper motivations for conservation behaviors, which suggests that at least some respondents understand the concept of water conservation (as the term is used in the developed world). For example, households practiced water conservation: 'for future generations' (average 21.4%), 'for neighboring places' (average 17.6%), 'for the environment' (average 10.1%), and 'because it's the right thing to do/good practice' (average 8.8%)[31].

[31] One of the author's most memorable conversations with a respondent regarding water scarcity was a middle-aged woman in Nuevo Chao who told me that she had heard on the radio that '*in twenty years all women were going to have to shave their heads because there would not be enough water to wash our hair*.'

When respondents' were asked to categorize the amount of water in the District of Chao as 'abundant,' 'regular' or 'scarce,' only 17.9% of Chao households, 16.0% of Well users and 13.4% of Nuevo Chao households recognized the area's actual scarcity (Table 4.24). Although not explicitly asked, many of the households the author interviewed reasoned that water was not scarce because of the number of wells or the size of the distribution pipes (i.e. referring to general access to water but not considering a declining water table or where the water in pipes was coming from). Interestingly, this suggests that households may view their service's existing intermittencies as ineptitude on behalf of the provider rather than possible indication of the region's scarcity. Overall, the data presented in Table 4.24 suggest that water conservation in recognition of a general, regional, scarcity, may only be practiced by a small percent of the population.

Table 4.24: Respondents' perception of local water scarcity.

	Abundant	Regular	Scarce
Chao	17.9%	57.5%	24.6%
Well	16.0%	62.0%	22.0%
Nuevo Chao	13.4%	57.5%	29.1%

As a further possible gauge of the motivation behind households' existing water conservation efforts, or lack thereof, respondents were asked to give their opinion on whether or not they would like their service to be metered (Table 4.25). Chao households and Well users seemed to be split down the middle whether they would like a metered water service (43.6% in favor, 56.4% not in favor – Chao, 46.7% in favor, 53.3% not in favor - Well users). In Nuevo Chao, however, a clear majority (71.8%) was not in favor of water meters. Why respondents' said 'Yes' or 'No,' is once again more telling than the dichotomous data reveal.

Table 4.25: Respondents' attitudes toward metered water service and why.

	FOR				AGAINST			
	Price According Consumption / Fair	More Reliable, Secure, Service	Minimize, Control, Water Use	Put Wasters Into Control	Price According to Consumption	More Expensive	Unreliable	Not Necessary or Feasible
Chao	43.6%				56.4%			
	13.0%	13.0%	16.1%	2.3%	6.9%	36.4%	6.1%	6.1%
Well	46.7%				53.3%			
	25.0%	10.0%	17.5%	0.0%	5.0%	37.5%	5.0%	0.0%
Nuevo Chao	28.2%				71.8%			
	6.1%	11.9%	10.1%	1.8%	12.6%	46.0%	5.0%	6.5%

Note: First row of percentages refers to whether respondents were for or against meters. The second row of percentages reflects the reasons why respondents' wanted meters (an open-ended question where respondents' qualitative answers were coded accordingly).

The most common reason why households were opposed to meters was they suspected the devices would make their water bills more expensive (36.4% Chao, 37.5% Well users, 46.0% Nuevo Chao). Opposition to water meters as reasoned by not wanting more expensive water bills could stem from distrust in the devices accuracy and/or misunderstanding of how they work. On the other hand, a portion of those who had qualms about more expensive bills may fall in line with the 6.9% of Chao households and 12.6% of Nuevo Chao households who transparently stated they did not want meters because water bills would reflect consumption (i.e. implying an underlying desire to use water freely). Interestingly, the fact that water bills would reflect consumption was also a reason given by those in favor of water meters (13.0% Chao, 25.0% Well users, 6.1% Nuevo Chao). It was likely these pro-meter respondents thought that: 1) they would be charged less than the existing tariff given their conservative water behaviors, and/or 2) that other households were using more than their fair (and necessary) share. To this point, 2.3% of Chao households and 1.8% of Nuevo Chao households specifically

stated that meters would help to curb the wasteful behaviors some households exhibit. Overall, it is noteworthy that those in favor of water meters gave reasons such as 'priced according to consumption,' 'fair,' 'more reliable,' 'minimize use,' and 'put wasters into control.'

4.5 Total Water Use

The Municipality of Chao will be unable to gauge whether household water use increases under the new service without a prior baseline of demand. Although they are essentially in control of demand given they determine the frequency with which they fill up (and empty) the 800-m^3 reservoir[32] (and future 2,500-m^3 reservoir), without network meters they cannot account for the volume being lost in transport, lost to illegal connections, and, consequently, cannot determine the volume actually being used at the household level. Accordingly, this section will discuss daily water use for households in light of respondents' reported water usage estimates and households' existing infrastructure (Table 4.26).

Table 4.26: Household water-related infrastructure.

NUMBER OF:				
Faucets	0	1	2	>2
Chao	0.4%	65.2%	24.0%	10.4%
Well	75.5%	13.6%	6.4%	4.5%
Nuevo Chao	1.4%	95.7%	2.2%	0.8%
Showers	0	1	2	3
Chao	23.0%	70.8%	4.8%	1.4%
Well	78.2%	20.9%	0.9%	-
Nuevo Chao	93.2%	6.3%	0.6%	-
Toilets	0	1	2	>2
Chao	3.6%	89.6%	4.8%	2.0%
Well	47.7%	50.5%	1.8%	-
Nuevo Chao	81.8%	18.0%	0.2%	-

[32] SADISCHAO estimates to fill the 800-m^3 reservoir to less than three-quarters of its capacity (~530-m^3).

Table 4.26: (Continued).

NUMBER OF:				
Washing Machine	0	1	2	>2
Chao	92.2%	7.8%	-	-
Well	96.0%	4.0%	-	-
Nuevo Chao	97.0%	3.0%	-	-
Blender	0	1	2	>2
Chao	46.1%	53.9%	-	-
Well	66.0%	34.0%	-	-
Nuevo Chao	61.7%	38.3%	-	-

As shown in Table 4.26, the majority of households have one (65.2% Chao, 95.6% Nuevo Chao) or zero (75.5% Well users) faucet(s); one (89.6% Chao, 50.5% Well users) or zero (81.8% Nuevo Chao) toilet(s); one (70.8% Chao) or zero (78.2% Well users, 93.2% Nuevo Chao) shower(s); and very few households in each use group have washing machines (7.8% Chao, 4.0% Well users, 3.0% Nuevo Chao). Limited household plumbing infrastructure (as revealed by Table 4.26) coupled with an intermittent water service suggests that households would be limited in their ability to use a lot of water.

'A lot' is a relative term however so water use estimates will be compared against the fifty liters per capita per day suggested by Gleik (1996) to be the basic water requirement (BWR) for a healthy and productive life. The following estimates of per capita and per household daily water consumption (Table 4.27) were created using the mean of respondents' estimates of water use per individual or household activity (see Section 3.3 for further explanation of how estimates were calculated).

Table 4.27: Estimated seasonal volume of water consumed per capita and per household[33] per day (liters).

LITERS PER CAPITA				
	Summer		Winter	
	Basic	Inclusive	Basic	Inclusive
Chao	83.3	89.9	60.6	67.2
Well	65.2	72.4	50.9	58.1
Nuevo Chao	52.2	58.8	35.1	41.8
LITERS PER HOUSEHOLD				
	Summer		winter	
	Basic	Inclusive	Basic	Inclusive
Chao	406.3	438.9	299.6	332.2
Well	316.8	351.7	247.5	282.4
Nuevo Chao	244.7	276.0	155.3	186.6

Note: *Basic* estimate does not include the following water use behaviors: street watering, watering plants, mopping, and maintaining pets and animals. These behaviors were separated due to their variance within the population as seen in Table 4.28 (i.e. the relevance of the *inclusive* estimate varies according to the percentage of the population that engages in the aforementioned additional water-related behaviors). Also, because only 6.8% of Nuevo Chao households have toilets or pour-flush latrines, this significant[34] water-related activity was not included in their water use estimate. Finally, it is important to note the exclusion from both *basic* and *inclusive* estimates of 1) reused water and 2) water that was stored, not used, and, consequently, tossed out to make way for fresh water (i.e. essentially consuming potable water although not for any purpose).

Table 4.28: Reported practice of miscellaneous water-related activities.

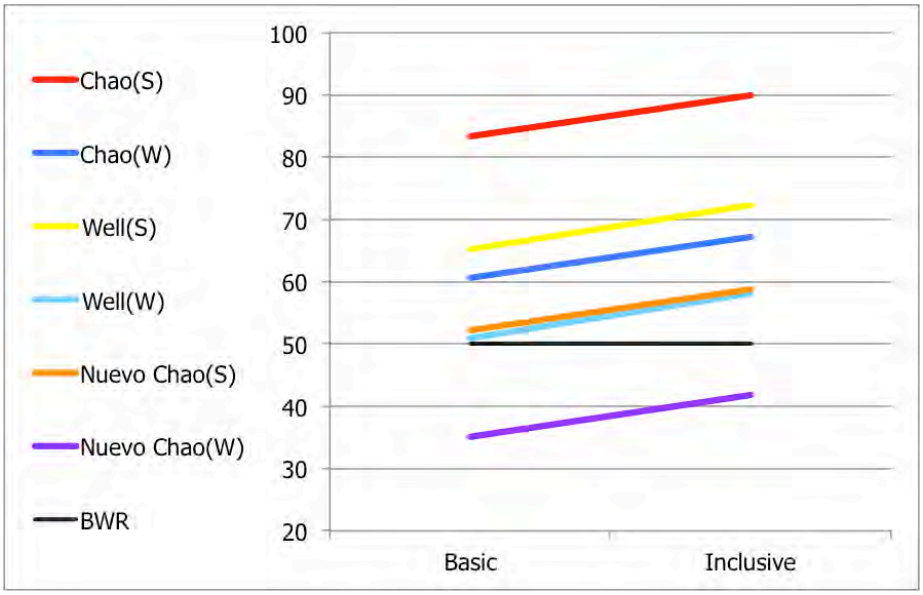
	Water Street (w/potable water)	Water Plants	Mop Floors	Water for Animals	Water for Pets
Chao	46.8%	26.0%	34.0%	36.3%	36.1%
Well	71.4%	14.0%	28.0%	23.7%	26.3%
Nuevo Chao	35.5%	29.2%	13.0%	46.4%	31.7%

In considering the *inclusive* water use estimates for each user group, it important to keep in mind the following points: 1) in some cases, water is being reused to water the street, wash toilets, and mop floors, and 2) stored (potable) water that happens to be thrown out

[33] Per-capita water use multiplied by mean household size as determined by Round II surveys (4.94 people Chao, 4.86 people Well users, 4.69 people Nuevo Chao).

[34] In United States, flushing toilets is the largest use of indoor water per capita per day at 18.5 Lpcd (Raucher & al., 2005).

before use is not being captured. Accordingly, daily per capita (and per household) water use may be lower or higher than is estimated. That being said, as Table 4.27 reveals and Figure 4.21 illustrates, in the summer months, individuals use, on average, 6 L (Nuevo Chao) to 37 L (Chao) above the BWR. In the winter months, individuals in Chao use ~14 L above the BWR while average per capita use in Nuevo Chao decreases to ~11 L below the BWR.



Note: Each line begins with *basic* water use estimate (left most data point) and works up to the *inclusive* water use estimate (right most data point).

Figure 4.21: Per capita water use, summer and winter, as it relates to the basic water requirement of 50 Lpcd.

One of the principal reasons Chao households and Well users use more water use is because they have sewage. As the majority of Nuevo Chao households currently use pit latrines or fields for sanitation (81.8%– Table 4.26) the new sanitation service will greatly increase their demand for water. The proportion of water dedicated to water-related activities demonstrates the impact of sewage on household water use (Figures 4.22 and 4.23). As shown, the volume of water required for flushing toilets constitutes almost approximately a quarter of households' daily water use in the summer (27.0% Chao, 20.5% Well users) and roughly a third of households' daily water use in the winter (35.7% Chao, 25.5% Well users). Interestingly, in the

summer months, not considering water for sanitation, per capita water use in Chao is still seven liters more than per capita water use in Nuevo Chao (while in contrast Well users use approximately two liters less than individuals in Nuevo Chao).

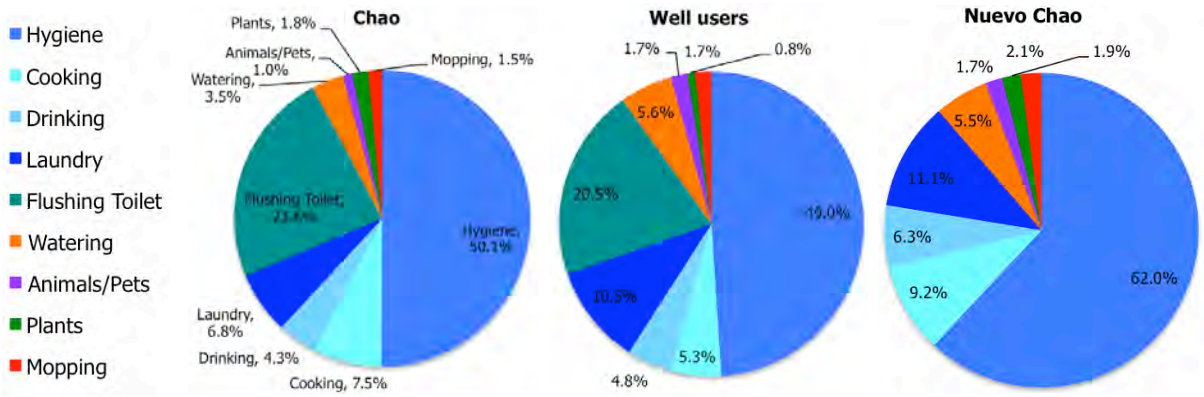


Figure 4.22: Average reported water use per activity, per household per day – summer.

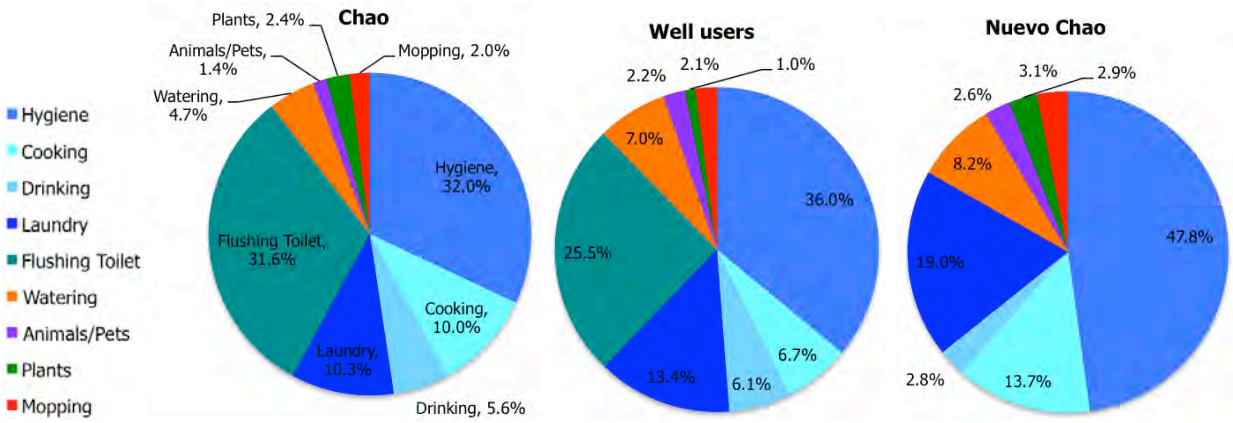


Figure 4.23: Average reported water use per activity, per household per day – winter.

Beyond water availability as determined by service duration and pressure, there is water availability as it relates to storage volume and water-related infrastructure. Households in all user groups are gradually increasing the availability of water within their homes (i.e. more (elevated) storage devices – Figure 4.7, and faucets, toilets and showers – Table 4.26). This is particularly true in Chao where households are installing not one, but two, three faucets, etc. If households aspire to *keep up with the Jones* and the convenience of water is a determinant of

use (as suggested by Well users behaviors), daily per capita and household water use is likely to increase beyond estimates in Table 4.27.

Figures 4.22 and 4.23 show the comparative volume of water households' expend on personal hygiene by all user groups. In the summer, personal hygiene is by far the largest use of water, which is not surprising given respondents reported bathing upwards of two times a day. In the course of conducting surveys it seemed no matter how scarce water resources were, water for bathing was a priority.

Interestingly, prior to asking respondents to estimate their water usage for specific activities (the estimates that were used to calculate Lpcd and Lphd shown in Table 4.27) respondents were asked to estimate how many liters of water they believed their household used daily, 'keeping in mind all the uses of water from hygiene and cooking to laundry and watering' (Table 4.29).

Table 4.29: Respondents' estimations of daily household water use, divided by household size to reflect estimate as daily liters per capita.

ROUND I (summer)					
	Min	Max	Mean	Std. Dev.	No.
Chao	0.3	275	40.0	54.2	180
Well	1	250	33.1	45.1	50
Nuevo Chao	1	500	41.4	57.6	177
ROUND II (winter)					
	Min	Max	Mean	Std. Dev.	No.
Chao	0.5	275	23.8	26.7	285
Well	3	60	20.7	11.4	49
Nuevo Chao	0.7	250	23.3	26.9	285

As the minimum and maximum values in Table 4.29 show, there was a wide range of responses. The minimum estimates of 0.3 to 0.7 Lpcd reflect respondents who perhaps misunderstood the question to be in reference to drinking water per day. The maximum estimates of 275-500 Lpcd came from households that own a large prefabricated cistern (*Rotoplas*)*;* because such cisterns are usually elevated and have an automatic shut-off valve,

respondents did not usually have an accurate idea of how often these devices fully emptied and filled. Also, because households with *Rotoplas* essentially have running water all day long, it appears occupants quickly become desensitized to the quantity of water they use. In contrast, respondents who relied primarily on water from buckets were more capable, quick, and perhaps accurate in estimating their household's daily water use. This was particularly true for highly water-stressed households. In the cases where families were barely getting by, all water-related activities appeared to be allotted calculated amounts so as to make water last. As one women said 'measuring, measuring, always measuring.'

However, in all circumstances where water arrived long enough for households to fill their available storage devices and then some, there seemed to be a common omission (from the daily water use estimate) of water used directly from the faucet. That is, during her two years of residency in Chao and through conducting surveys the author witnessed many families take advantage of the temporary service to wash laundry (filling and emptying tubs of water), water down the street (often with hoses), or take an extra long shower; all activities that use high volumes of water. Yet, when making their water use estimates the majority of respondents seemed only to consider the water they stored and then used. This may be due to respondents' inability to estimate the volume of water that flows from their faucet per minute. Specifically, when respondents were asked to estimate the number of liters that flowed from their faucets per minute, the majority reported to have no idea (60.3% Chao, 71.0% Nuevo Chao). It may also be that respondents don't even consider the volume of water used directly from the tap as it seems nominal compared to the volume they are storing.

As it stands, without consideration to water 'lost' upon arrival, respondents' upfront estimation of daily per capita water use ranges from 11 to 50 L lower than what summation of their later water use estimates per specific activity suggest (Table 4.30). This means for a

family of four the average respondent underestimated their households' water use anywhere from 44 to 200 Liters.

Table 4.30: Difference in liters per capita per day between respondents' estimated water use and calculated water use based on respondents' activity specific water estimates.

	Summer		Winter	
	Basic	Inclusive	Basic	Inclusive
Chao	43.3	49.9	36.9	43.5
Well	32.1	39.3	30.2	37.4
Nuevo Chao	10.7	17.4	11.8	18.5

Interestingly, Nuevo Chao households appear to be better at estimating water use followed by Well users (Table 4.30). Concerning accuracy in water use estimations, in Round II respondents were asked to rate their confidence in their estimate on a scale of one to ten; where one indicated that they had no idea how much water they used and ten meant they were absolutely certain. Reported confidence ranged all the way from one to ten but the means averaged out at: 6.73 Chao, 7.52 Well users and 7.29 Nuevo Chao. Accordingly, it seems Chao households were aware of their inability to estimate daily water consumption. That said, the fact that Chao respondents' reported water use estimates were, on average, 16 L lower per capita per day in the winter suggests that they were at least making a conscious effort to report daily water use as accurately as possible.

4.6 Demand and Value

In Section 4.4 households' existing water-related behaviors were examined as to arrive at an estimate for daily household water use in each user group. As was discussed in Sections 4.2 and 4.3 however, households' demand for water is more complex than what existing water use estimates reveal.

Accordingly, as discussed in Chapter Three, another way to evaluate households'

demand for water is through stated preference for service improvements, or households' willingness to pay (WTP). In other words, the value of improved quality and more continuous water can be assessed from the financial contribution households are willing and able to pay to receive such service improvements (Tables 4.31 and 4.32).

Looking at the data from Table 4.31 where respondents were first asked if they would be willing to pay S/. *X* for improved continuity (with the *existing* quality), and then immediately thereafter, whether they would pay the same amount for improved quality (with the existing continuity), Chao and Nuevo Chao households valued quality over continuity, while Well users (for the most part) valued continuity over water quality. WTP for sewage collection as a separate service was greatest for Well users and in Nuevo Chao but low compared to WTP for water service improvements. With respect to the 'package' scenario (improved continuity, quality, and sewage) the overwhelming response across all user groups and price ranges was 'No.' Overall, aside from the first scenarios offered with Row I[35] prices, the general trend of Table 4.31 is 'No.' This may be a reflection of households' inability to pay rather than unwillingness to pay and/or disinterest.

In some ways the high frequency of 'No's is indication that households were taking the exercise seriously. In comparing the frequency of Y/N responses for the same scenarios with different prices (i.e. top to bottom in Table 4.31), the fact that household WTP for the most part declines as price increases, suggests that starting-point bias was minimal. In other words, it seems households had a predetermined, underlying, threshold after which they were not afraid to say 'No.'

[35] For the purpose of presenting results various price scenarios will be referred to as Row I, II and III (in accord with Tables 4.31 and 4.32) although, in the surveys, prices varied by Column – see Appendix D and E.

Table 4.31: Respondents' willingness to pay for improved (hypothetical) service, Round I.

I	Improved Continuity (S/. 18)		Improved Quality (S/. 18)		Improved Continuity & Quality (S/. 24)		Sewage (S/. 18)		Improved Continuity, Quality & Sewage (S/. 30)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Chao	61.6%	38.4%	65.8%	34.2%	37.5%	62.5%	17.8%	82.2%	26.0%	74.0%
Well	66.7%	33.3%	55.6%	44.4%	22.2%	77.8%	35.3%	64.7%	23.5%	76.5%
Nuevo Chao	51.9%	48.1%	52.5%	47.5%	27.5%	72.5%	34.6%	65.4%	32.9%	67.1%
II	Improved Continuity (S/. 24)		Improved Quality (S/. 24)		Improved Continuity & Quality (S/. 36)		Sewage (S/. 24)		Improved Continuity, Quality & Sewage (S/. 42)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Chao	40.6%	59.4%	43.5%	56.5%	8.7%	91.3%	13.0%	87.0%	13.2%	86.8%
Well	43.5%	56.5%	43.5%	56.5%	26.1%	73.9%	21.7%	78.3%	26.1%	73.9%
Nuevo Chao	26.1%	73.9%	30.4%	69.6%	5.8%	94.2%	14.5%	85.5%	10.1%	89.9%
III	Improved Continuity (S/. 36)		Improved Quality (S/. 36)		Improved Continuity & Quality (S/. 48)		Sewage (S/. 36)		Improved Continuity, Quality & Sewage (S/. 54)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Chao	25.8%	74.2%	40.3%	59.7%	17.7%	82.3%	8.1%	91.9%	11.3%	88.7%
Well	15.8%	84.2%	5.3%	94.7%	10.5%	89.5%	0.0%	100.0%	10.5%	89.5%
Nuevo Chao	15.0%	85.0%	20.0%	80.0%	10.0%	90.0%	18.3%	81.7%	11.3%	88.7%

Note: Refer to Chapter Three, Section 3.2.1, for an explanation of survey administration. While all respondents were offered the same five scenarios, the set of prices they were offered (row I, II or III) was determined by the order of the enumerators' visits (i.e. enumerators issues house 1, prices from row I, house 2, prices from row II, house 3, prices from row III, house 4, prices from row I, and the process continued to repeat.). At time of survey one $1.00 was, on average, equal to S/. 2.69 (Yahoo Finance, 2013).

Table 4.32: Respondents' willingness to pay for improved (hypothetical) service, Round II.

I	SIX hours (S/. 18)			TWELVE hours (S/. 20)			TWENTY-FOUR hours (S/. 22)			QUALITY (S/. 18)			TWELVE hours & QUALITY (S/. 24)	
	Yes	No	M	Yes	No	M	Yes	No	M	Yes	No	M	Yes	No
Chao	31.4%	56.9%	11.8%	13.6%	16.4%	4.4%	42.2%	51.0%	6.9%	28.4%	62.7%	8.8%	21.6%	78.4%
Well	21.4%	64.3%	14.3%	7.1%	85.7%	7.1%	28.6%	57.1%	14.3%	0.0%	69.2%	30.8%	7.7%	92.3%
Nuevo Chao	22.9%	75.2%	1.9%	17.1%	80.0%	2.9%	20.0%	73.3%	6.7%	15.4%	80.8%	3.8%	19.2%	80.8%
II	SIX hours (S/. 24)			TWELVE hours (S/. 26)			TWENTY-FOUR hours (S/. 28)			QUALITY (S/. 24)			TWELVE hours & QUALITY (S/. 30)	
	Yes	No	M	Yes	No	M	Yes	No	M	Yes	No	M	Yes	No
Chao	9.2%	83.7%	7.1%	16.3%	74.5%	9.2%	20.4%	67.3%	12.2%	20.4%	64.3%	15.3%	17.5%	82.5%
Well	6.3%	87.5%	6.3%	12.5%	81.3%	6.3%	25.0%	62.5%	12.5%	12.5%	68.8%	18.8%	18.8%	81.3%
Nuevo Chao	7.8%	89.2%	2.9%	12.7%	86.3%	1.0%	6.9%	88.2%	4.9%	10.8%	85.3%	3.9%	7.8%	92.2%
III	SIX hours (S/. 30)			TWELVE hours (S/. 32)			TWENTY-FOUR hours (S/. 34)			QUALITY (S/. 30)			TWELVE hours & QUALITY (S/. 36)	
	Yes	No	M	Yes	No	M	Yes	No	M	Yes	No	M	Yes	No
Chao	9.7%	83.9%	6.5%	17.2%	82.8%	0.0%	17.2%	77.4%	5.4%	12.9%	80.6%	6.5%	17.2%	82.8%
Well	21.1%	73.7%	5.3%	21.1%	78.9%	0.0%	10.5%	84.2%	5.3%	10.5%	89.5%	0.0%	10.5%	89.5%
Nuevo Chao	6.3%	91.6%	2.1%	10.5%	88.4%	1.1%	12.6%	85.3%	2.1%	10.5%	81.1%	8.4%	7.4%	92.6%

Note: M indicates respondents' reporting 'maybe.' Refer to Section 3.2.1, for an explanation of survey administration. While all respondents were offered the same five scenarios, the set of prices they were offered (row I, II or III) was determined by the order of the enumerators' visits (i.e. enumerators issues house 1, prices from row I, house 2, prices from row II, house 3, prices from row III, house 4, prices from row I, and the process continued to repeat.). At time of survey one $1.00 was, on average, equal to S/. 2.60 (Yahoo Finance, 2013).

However, respondents' open-ended responses regarding the price they would pay for the last scenario[36] (improved continuity, quality and sewage) do seem to be affected by the aforementioned prices (Tables 4.33). As seen by how the mean offered price increases from Row I to Row II, households were likely using the prices previously offered to them as a gauge for formulating their open-ended numerical response. The influence of how previously offered prices may condition households' ultimate WTP becomes more evident in view of the open-ended responses households gave for Round II's last WTP scenario (12-hour service with improved water quality) (Table 4.34). As in Table 4.33, households' mean (open-ended) WTP for the last improved service scenario increases from Row I up to Row III.

Table 4.33: Respondents' willingness to pay for improved continuity (24/7), quality, and sewage – Round I (units of S/.).

	Chao			Well			Nuevo Chao		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
I	10	24	17.0	10	20	17.5	5	25	15.0
II	10	35	21.9	15	35	22.2	8	40	19.4
III	15	46	27.2	10	36	22.1	6	36	18.7

Note: The data only reflect the open-ended WTP of respondents that said 'No' to the final offered WTP scenario, where I, II and III indicate the minimums, maximums and means as they correspond to households that were offered prices from either row I, II, or III as shown in Tables 4.31.

Table 4.34: Respondents' willingness to pay for improved continuity (12 hours) and quality (with sewage included in all scenarios) – Round II (units of S/.).

	Chao			Well			Nuevo Chao		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
I	5	20	14.7	5	22	13.18	2	32	8.82
II	5	28	15.2	5	30	13.0	1	30	9.21
III	8	50	17.0	10	30	16.6	3	40	10.8

Note: The data only reflect the open-ended WTP of respondents that said 'No' to the final offered WTP scenario, where I, II and III indicate the minimums, maximums and means as they correspond to households that were offered prices from either row I, II, or III as shown in Tables 4.32.

[36] When households replied 'No' to the last WTP scenario enumerators were instructed to ask respondents what price they would be willing to pay (open-ended).

Recall that enumerator offered prices in Round II were, on average, S/. 5 less than prices offered in Round I (difference ranging from S/. 0 up to S/. 18). Accordingly, respondents' open-ended WTP for the last scenario in Round II is, on average, S/. 7 lower than WTP during Round I (difference ranging from S/. 2.3 to S/. 10 lower). In other words, the difference between respondents' open-ended WTP from Round I to Round II suggests that through engaging in the WTP 'game,' respondents were conditioned as to what an appropriate price for an improved water service *should* be. Then again, it is important to keep in mind that the last scenario of Round I was different than Round II. Namely, in Round I the last scenario proposed 24/7 continuity of water as opposed to 12-hour continuity proposed in Round II. Thus, respondents' open-ended WTP in Round II may have been lower simply because the final improved service scenario being offered to them was less ideal than the final scenario proposed to respondents during Round I. Overall, in both Rounds I and II, when given the chance to suggest what price they would be WTP for the final offered scenario, Nuevo Chao households are less WTP than Chao households (including Well users) (Tables 4.31 and 4.32).

Results from Round II (Table 4.32) are felt to bean improvement upon Round I in both its design (scenarios and prices – refer to Section 3.2.1) and implementation (use of visual aid). Similar to Round I, across all three user groups, respondents who received prices in Row II and III (for the most part) were less WTP than those who received prices in Row I. This was especially true for Nuevo Chao households, which, again, may sometimes be indication of inability to pay rather than unwillingness.

Given the discussion in Section 4.2, one would expect Chao households to place greater value on increasing the quality of provided water above the continuity of their service. Nonetheless, the WTP data from Round II does not appear to reveal any such patterns. That is, Chao households appear to be just as, and in some cases more, WTP for improvements to

continuity as they are for improvements in water quality. Conversely, given the poor continuity of water in Nuevo Chao, it would be expected that households would be more WTP for improvements to continuity over improvements to water quality. While this inference holds true for Nuevo Chao households that were offered Row I prices, preference for continuity over quality becomes less clear for Nuevo Chao households offered prices from Row II and III. As for Well users, similar to Round I, they appear to favor improvements to continuity over improvements to water quality. This makes sense because although Well users have 'endless' supply, the majority of these households must deal with the inconvenience of hauling water and using water from buckets. Furthermore, recall from Table 4.12 that 74.3% of Well users already rate the quality of their water positively.

As previously mentioned, none of the WTP data from Round II, including the patterns mentioned in the preceding paragraph, seen to have significance when evaluated descriptively at the user group level. This even holds true when data was reevaluated with the frequent number of 'maybe's being considered as 'yes's[37] (Table 4.35).

Although considering 'maybe' as 'yes' suggests that both Chao and Nuevo Chao households who were offered prices from Row II and III may have a slight preference for improved water quality over continuity, differences are still not strong or consistent enough to make any conclusions. On the other hand, Well users preference for improved continuity over improved water quality becomes less clear in Table 4.35 (as opposed to original data in Table 4.32).

[37] *Quizas* (maybe) was recorded when respondents' could not make up their mind as to whether they would be WTP or not; 'maybe's were often accompanied by such comments as 'well, it depends if (how much) the quality improves' or 'well, it depends on how many service interruptions there are,' etc. As the WTP activity was essentially proposing an 'ideal' scenarios, for the purpose of seeing if any patterns became clearer Table 4.35 'maybe' was considered to be 'yes.'

Table 4.35: Respondents' willing to pay for improved (hypothetical) service, Round II, where 'maybe' is considered to imply a 'yes.'

CHAO				
	Improved Continuity (hours)			Improved Water Quality
	6	12	24	
I	43.2%	18.0%	49.1%	37.2%
II	16.3%	25.5%	32.6%	35.7%
III	16.2%	17.2%	22.6%	19.4%
WELL				
	Improved Continuity (hours)			Improved Water Quality
	6	12	24	
I	35.7%	14.2%	42.9%	30.8%
II	12.6%	18.8%	37.5%	31.3%
III	26.4%	21.1%	15.8%	10.5%
NUEVO CHAO				
	Improved Continuity (hours)			Improved Water Quality
	6	12	24	
I	24.8%	20.0%	26.7%	19.2%
II	10.7%	13.7%	11.8%	14.7%
III	8.4%	11.6%	14.7%	18.9%

On that note, the only strong trend that Round II WTP data reveals is that, in light of the offered prices, households in Chao are more WTP than households in Nuevo Chao; true for both improved quality (range of 12.9% to 28.4% WTP in Chao vs. range of 10.5% to 15.4% WTP in Nuevo Chao) and improved continuity (range of 9.2% to 42.2% WTP in Chao vs. range of 6.3% to 22.9% WTP in Nuevo Chao). This trend is inconsequential when compared to the overwhelming majority, in all groups, that said 'No, they were not WTP' for improved water continuity, quality, or both. In fact, despite the more reasonable prices offered in Round II, households seem to be less WTP than they were in Round I.

After examining twenty years of stated preference research, Whittington (2010) found that, overall, households' WTP for a variety of goods and services is low. Whittington adds to his observation that researchers "have often failed to see their empirical results for what they are, that is, an indication that the hypothetical good or service was simply not a priority for

many of respondents interviewed" (2010). With this in mind, given eight public services, respondents were asked to select the service that mattered most to them (Table 4.36).

Table 4.36: Most important municipal-provided, public, service in eyes of respondents.

	Water	Pavement / Roads	Sewage	Education	Electricity	Main Square	Health	Transportation
Chao	37.5%	15.7%	1.4%	10.6%	1.4%	7.5%	25.9%	0.0%
Well	68.0%	10.0%	8.0%	6.0%	0.0%	2.0%	6.0%	0.0%
Nuevo Chao	51.5%	21.7%	6.8%	9.8%	0.7%	2.0%	7.1%	0.3%
TOTAL	46.4%	18.0%	4.4%	9.9%	0.9%	4.5%	15.7%	0.2%

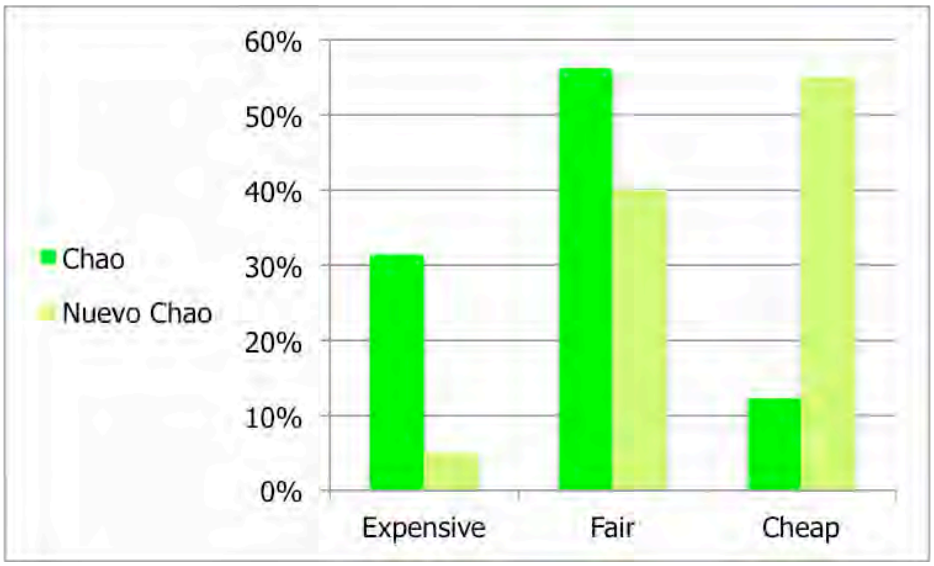
Note: 'Main Square' refers to the town's *Plaza de Armas*. Plaza de Armas are common across Latin America and essentially are popular places for public gathering.

As shown in Table 4.36, the majority of households in each user group ranked water as the most important public service. Given respondents just finished participating in a survey completely about water, there may have been a bias. However, as was revealed in Section 4.2, households are quite dissatisfied with their current water service, particularly with respect to quality (Chao) and availability (Nuevo Chao).

So, if households view water as the most important service the Municipality of Chao can provide, and they have an unmet demand when it comes to water quality and continuity, what makes their WTP so low? It may be that a *lifetime* of low water tariffs has certain price expectations among households. With this in mind, the low WTP of respondents detailed in Tables 4.31 through 4.35 is further examined through consideration of how households view the existing cost of their water services (Figure 4.24).

As Figure 4.24 reveals, far more Nuevo Chao households view their existing water tariff as cheap compared to Chao (55.1% vs. 12.3%). This makes sense given that Nuevo Chao

households pay nearly one-fifth per month of what Chao households pay. However, Nuevo Chao households also receive a considerably less continuous service, not to mention earn, on average, S/. 245 less per month than Chao households.



Note: Currently Chao households pay S/. 15.3 and in Nuevo Chao households pay S/. 3.20.

Figure 4.24: Respondents' perceptions of the cost to provide existing water services.

Regardless of existing service conditions (and income) however, attitudes toward the price of the water services can be telling. For respondents in both groups, whether they perceived their (respective) tariff as cheap or expensive, their answer was often accompanied by comments such as 'for what it is.' As such, it could be roughly 70% of Chao households and nearly all Nuevo Chao households (those who replied 'fair' or 'cheap') understand that service improvements should come with a higher price tag. Yet, even the lowest range of prices offered to households in the WTP exercise (Table 4.32, Row I, S/. 18 to S/. 24) garnered at most 42.2% of respondents' support in Chao (WTP for 24 hours) and 22.9% of respondents' support in Nuevo Chao (WTP for 6 hours). Instead of revealing disinterest in the service improvements, or even inability to pay, it may be that, to some extent, low WTP for service improvements could also be a reflection the public's attitude toward the water service providers.

To this point, Table 4.37 suggests that only half of the Chao households (51.8%) and roughly two-thirds of Nuevo Chao households (67.0%) trust their water service provider. Similarly, when asked to rate providers' performance on a scale of one to ten (where ten is perfect), the mean in Chao was 6.37 and 6.81 in Nuevo Chao.

Table 4.37: Respondents trust their water service providers and why (Yes or No).

	YES				NO			
	Trust	Communication	Good Quality	Adequate Quantity	No Trust	No Communication	Poor Quality	Insufficient Quantity
Chao	51.8%				48.2%			
	11.4%	10.6%	10.6%	11.4%	5.3%	28.0%	7.6%	12.1%
Nuevo Chao	67.0%				33.0%			
	21.0%	19.6%	12.3%	5.1%	12.3%	21.0%	3.6%	5.1%

Interestingly, when households were asked what information could be provided to increase their trust in their providers (Table 4.38), many households referred to their desire for service improvements rather than increased communication and knowledge[38]. Specifically, demand for an improved water quality (45.0% Chao, 7.8% Nuevo Chao) and improved availability (12.9% Chao, 24.8% Nuevo Chao) was once again revealed.

Lack of trust in water providers, as it explains why respondents were unwilling to pay for the service improvements they desire, is further evidenced by their low confidence that the

[38] Some respondents did answer the question directly and desired information about: the origin and quality of the water (27.5% Chao, 11.5% Nuevo Chao); the maintenance process (2.8% Chao, 3.2% Nuevo Chao); the financial situation (0.9% Chao, 9.6% Nuevo Chao); and 5.5% of Chao households and 22.5% of Nuevo Chao households cited a desire for more communication in general, possibly through meetings and/or workshops (3.2% Chao, 10.6% Nuevo Chao). Interestingly, another 9.2% of households in Nuevo Chao also said they would like the provider to be more friendly and respectful.

providers are even capable of providing the services described in the WTP scenarios (Table 4.39).

Table 4.38: What type of information respondents would like from their water provider to increase level of trust.

	No Information	Water Quality / Treatment / Origin	Maintenance Process	Financial Situation	Forewarn Service Interruptions	Increased Communication	Be more Friendly / Respectful	Give meetings / Hold Workshops	*Improve Water Quality*	*Improve Continuity*	*Improve Schedule*
Chao	2.3 %	27.5 %	2.8 %	0.9 %	1.8 %	2.3 %	0.0 %	3.2 %	45.0 %	12.4 %	0.5 %
Nuevo Chao	8.7 %	11.5 %	3.2 %	9.6 %	0.5 %	11.9 %	9.2 %	10.6 %	7.8 %	21.6 %	3.2 %

Note: Categories listed in *italics* indicate answers that did not directly address the question but revealed respondents' desire for specific service improvements.

Table 4.39: Respondents' confidence in ability of service provider to implement proposed WTP scenarios, as rated on scale of one to ten (where ten is absolute confidence).

	Min	Max	Mean	Std. Dev.
Chao	1	10	6.96	1.908
Well	5	10	6.71	1.237
Nuevo Chao	1	10	7.15	1.816

Note: In the case of Well users they were referring to their perception of SADISCHAO's competence to implement the proposed service improvements.

Interestingly, when it comes to water tariffs in the developing world, the World Bank considers a good benchmark for *affordable* around 4% of average household incomes (Akram & Olmstead, 2011). In this light, the Municipality could theoretically raise tariffs by S/. 19.5 (i.e. up to S/. 34.8) without threatening the households' right to potable drinking water (Table 4.40).

Table 4.40: Existing and potential water tariffs as they compare to each user group's mean household income.

	Household Income (S/.)	Existing Tariff:Income ratio	*Affordable* Tariff (S/.)
Chao	1,116	1.4%	44.7
Well	1,017	-	40.7
Nuevo Chao	870.6	0.4%	34.8

A S/. 34.8 tariff seems reasonable considering the indirect expenditures households make to obtain a satisfactory quality and quantity of water with their existing water services. In Chao and Nuevo Chao the most common additional expenditures households make, monetarily and in way of opportunity cost of time are: fetching or transporting groundwater, going to the river, boiling water (revealed to cost around S/. 3 to 8 per month – Section 4.3), investment in storage devices, and purchasing bottled water. Furthermore, when compared to what households are (willingly) paying for other services (Table 4.41) S/. 34.8 is not substantial. That said, ability to pay is only one factor of determining a suitable water tariff and will be further discussed in Chapter Five.

Table 4.41: Mean monthly cost of other common household services (S/.).

	Electricity	Cable	Cell Phone	Gas (cooking fuel)
Chao	43.6	11.8	34.3	38.4
Well	33.9	9.84	19.2	34.3
Nuevo Chao	28.8	15.0	27.8	33.8

4.7 Summary

Chao and Nuevo Chao water services are not being provided for as many hours per (every other) day as providers stated. Furthermore, the continuity of service is not equitable, particularly in Chao. However, arrival times in Chao are relatively convenient (morning or afternoon) as compared to Nuevo Chao where water is provided throughout the day with a

quarter of the population receiving water while they are sleeping. Not surprisingly, twice as many Nuevo Chao households reported the hour of arrival affects their daily schedule, although the majority of houses appeared to have adapted accordingly (87.9% Chao, 76.0% Nuevo Chao). Overall, Chao households have roughly four times the access to water as Nuevo Chao households.

Domestic water service is a relatively new concept for the large majority of households with most having had a water service for only seven years or less (65.4% Chao, 85.7% Nuevo Chao). Perhaps this explains why some households do not identify their existing intermittent services with water scarcity. Households reporting experience with water scarcity was higher in Round I (summer) and suggests that households perceive scarcity as a relative drop in the availability of what has become a *normal* service. During periods of scarcity (i.e. service cuts and the summer months) alternative water sources are far more accessible in Chao. There, households have convenient access to wells (personal or neighboring) and thus appear to be incentivized to conserve their water. Nuevo Chao households, however, must be extra conscious with their water use. With respect to alternative sources, households that use wells (70.8% Chao, 11.2% Nuevo Chao) do so on an infrequent basis. Aside from visits to the river, use of alternative sources (wells and bottled water) is primarily for drinking and cooking, which suggests an unmet demand in water quality. However, in both Chao and Nuevo Chao tap water is the most accessible water source and households tolerate the service despite its deficiencies.

Pressure problems are another form of service deficiency which half of Chao and Nuevo Chao households reported during Round I (summer), and roughly 13.1% of Chao households and 10.8% of Nuevo Chao households deal with on a daily basis year round. Chao households store 175 to 230 liters more per day than Nuevo Chao households. However, Nuevo Chao households reported the greatest interest in purchasing additional storage devices (34.1% as

compared to 22.8% Chao, 21.3% Well users; if lacking sufficient funds can be interpreted as an underlying 'Yes,' 71.4% Nuevo Chao as compared to 54.8% Chao, 38.1% Well users).

Despite the services' short duration, poor quality and pressure, the large majority of households (92.4% Chao, 94% Well users, 84.6% Nuevo Chao) reported to have their basic water needs satisfied. Nonetheless, 35.7% of Chao households and 61.5% of Nuevo Chao households reported that they would use more water if it were more continuous. In particular, households reported a desire to do more laundry (60.2% Chao, 39.3% Nuevo Chao), water the street (9.2% Chao, 11.4% Nuevo Chao), and store more water (13.3% Chao, 13.6% Nuevo Chao). This suggests that, regardless of necessity, the greater the availability of water in an intermittent context, the greater the quantity of water households will use.

Chao households had the least trust in their drinking water (28.7%) followed by Nuevo Chao households (63.5%) and Well users (76.1%). The majority of households in all three-user groups (69.2% Chao, 52.0% Well users, 60.2% Nuevo Chao) are aware that the term 'potable' implies water that is of higher quality (treated). However, the majority of the population does not know how, and perhaps if, their water is being treated. This may help to explain why so many households perform additional treatment. Specifically 82.6% of Chao households, 83.3% Well users, and 72.6% of Nuevo Chao invest time and/or money improving the quality of their drinking water. Treatment is done primarily by boiling water using gas or wood. Point-of-use treatment appears to be performed for both reasons of taste and health. However, due to a lack of time and/or money, households' treatment efforts are not consistent.

Overall, households' financial investment in point-of-use treatment relative to the existing monthly service fees is noteworthy; particularly for Nuevo Chao households (S/. 3.20 monthly tariff compared to estimated S/. 3 to 7.6 spent per month on boiling water). This investment highlights the importance of water quality to households. In fact, in the opinion of

Chao and Nuevo Chao households, improving water quality, the service schedule, and maintenance are more important than service continuity. It appears perceived water quality could be improved through education given 12.3% of Chao households, 16.0% Well users, 17.7% Nuevo Chao do not know what the term potable water implies and the majority of households (56.1% Chao, 56.4% Nuevo Chao) are unaware of what their providers are doing to make their water potable.

Street watering is a common behavior in the study area with the principal objective of reducing ambient dust (38.8% Chao, 75.7% Well users, 79.3% Nuevo Chao). Due to the region's climate and high rate of evaporation, street watering is an inefficient use of the region's scarce resources, especially when done with clean water (56.6% Chao, 47.2% Well users, 18.0% Nuevo Chao). Vegetation seems to be a more viable solution to managing dirt and dust. However, only 40% of the population (34.6% Chao, 33.4% Well users, 45.1% Nuevo Chao) reported to water plants, and very few households (observation) maintained substantial ($\geq$ 1 m^2) gardens/groundcover. Interestingly, the most common reason households cited for having plants was for adornment (51.0%). No households explicitly mentioned plants as a good way of reducing dust.

Another area of high water use is hygiene. The majority of households bathe with buckets most, or all, of the time (67.7% Chao, 80.9% Well users, 95.9% Nuevo Chao). However, households are beginning to acquire showers (70.8% Chao, 20.9% Well users, 6.3% Nuevo Chao) and if water service continuity increases, the number of households able to utilize them on a regular basis will likely increase. This could cause an increase in demand depending on how households transition to running water. As it stands, assuming roughly 7.5 L flows from a faucet per minute, and a nine minute shower (reported average), households with showers are likely using ~68 L per capita per day in the winter and up to 204 L per capita per day in the

summer (as compared to 20 to 60 L per capita per day for bucket bathing). Laundry is another area where water use may change in the coming years with the introduction of washing machines. Washing machines can free up time (perhaps increasing frequency of loads), but liters used per load could decrease if high-efficiency models were purchased.

Each user group practices water reuse. A primary example is households using washwater to bucket flush their toilets. This practice may disappear with the convenience of a more continuous service. However, for households currently using potable water to bucket flush their toilets, depending on the size of the average toilet tank (reported means of 4 (Well users) to 9 liters (Chao)) as compared to the average number of liters used/required for a bucket flush (reported means of 6 (Well users) to 11 liters (Nuevo Chao)), a more continuous water service could save water when it comes to sanitation.

With respect to water conservation, the majority of households reported to have never heard or received any information regarding the subject (65.5% Chao, 75.7% Well users, 61.6% Nuevo Chao). However, this did not deter households from reporting that they practiced water conservation (average 73.5% Chao, 63.3% Well users, 71.4% Nuevo Chao). Respondent provided examples of water conservation and the associated motivations behind expressed behaviors reveal that many households conserve water to enhance the quantity and/or improve/protect the quality available to them personally. Interestingly, when respondents' were asked to categorize the amount of water in the District of Chao as 'abundant,' 'regular' or 'scarce,' only a quarter of the population recognized the area's actual scarcity (24.6% Chao, 22.0% Well users, 29.1% Nuevo Chao). This may suggest that only a small percent of the population practice water conservation in recognition of a general, regional, scarcity.

Attitudes toward water meters may indiciate how inclined households are to conserve water. The population is relatively divided in Chao (43.6% in favor, 56.4% not in favor – Chao,

46.7% in favor, 53.3% not in favor - Well users) and a clear majority (71.8%) not in favor in Nuevo Chao. However, respondents' reasoning suggests that opposition to water meters is not a direct indication that households would like to use water at their own will. That is, only a small percentage of households explicitly stated they did not want meters because their bill would reflect consumption (6.9% Chao, 5.0% Well users, 12.6% Nuevo Chao). In turn, households in opposition because they believed meters would make their bills more expensive (36.4% Chao, 37.5% Well users, 46.0% Nuevo Chao) may simply fear they will be unable to pay or believe the technology is unreliable. That said, it is noteworthy that those in favor of water meters gave reasons such as 'priced according to consumption,' 'fair,' 'more reliable,' 'minimize use,' and 'put wasters into control.'

Gleick (1996) considers 50 liters per capita per day as the basic water requirement (BWR) for a healthy and productive life. Comparatively, in the summer months, individuals in the study area use, on average, 6 L (Nuevo Chao) to 37 L (Chao) above the BWR. In the winter months, individuals in Chao use ~14 L above the BWR while average per capita use in Nuevo Chao decreases to ~11 L below the BWR. Interestingly, in the summer months, not considering water for sanitation, per capita water use in Chao is still seven liters more than per capita water use in Nuevo Chao (while in contrast Well users use approximately two liters less than individuals in Nuevo Chao). Household possession of water-related infrastructure as defined by faucets, toilets showers and washing machines is low but gradually increasing. If the convenience of water is a determinant of use (as suggested by Well users behaviors), daily per capita and household water use may increase.

Respondents had trouble estimating upfront how much water they used in a day. However, when upfront estimates are compared to calculated estimates, Nuevo Chao households seem to be more conscious of their water use than Chao households and Well

users. That said, both Chao and Nuevo Chao households had trouble estimating the number of liters that flowed from their faucets per minute (60.3% Chao, 71.0% Nuevo Chao). As it stands, without consideration to water 'lost' upon arrival, respondents' upfront estimation of daily per capita water use ranges from 11 to 50 L lower than what summation of their later water use estimates per specific activity suggest. This means, for a family of four, the average respondent underestimated their household's water use anywhere from 44 to 200 Liters per day.

Household willingness to pay may have been influenced by the prices offered in the various WTP scenarios. During both Round I and Round II Nuevo Chao households were less WTP than Chao households (including Well users), which could reflect an inability to pay. Despite the more reasonable prices offered in Round II, households seemed to be less WTP than they were in Round I. Overall WTP by all three user groups in both Round I and II is low and does not present any significant trends. Despite this unwillingness to pay, the majority of households in each user group ranked water as the most important public service.

Interestingly, 65.8% of Chao households and 95.1% of Nuevo Chao households view the existing service fees as 'fair' or 'cheap,' which suggests they should be WTP more for improved services. Perhaps WTP is low because only half of Chao households and two-thirds of Nuevo Chao households trust their water service provider. When asked to rate providers' performance on a scale of one to ten (where ten is perfect), the mean in Chao was 6.37 and 6.81 in Nuevo Chao. When households were asked what information providers should share to gain their trust, a large portion of respondents listed service improvements (57.9% Chao, 32.6% Nuevo Chao) rather than address the question through responses such as information about the water's quality, origin or treatment process (27.5% Chao, 11.5% Nuevo Chao).

Ultimately, in order to be efficiently and effectively run, water services require money. Ideally, this money should come from monthly tariffs. The World Bank considers tariffs that are

four percent of average household monthly income to be ‘affordable.’ Accordingly, the Municipality could theoretically raise tariffs by S/. 19.5 (i.e. up to S/. 34.8) without threatening the households’ right to potable drinking water. Interestingly, a S/. 35 monthly water tariff would still be less than what households pay for electricity per month and around what they spend on cooking (fuel). Furthermore, if the service were improved (quality and/or continuous) households could save in way of coping costs.

CHAPTER 5: DISCUSSION

Historically, domestic water demand was viewed as a *need* and water managers would develop whatever infrastructure was necessary to meet it. While supply-driven projects must still be implemented, they are no longer considered the only solution to meeting water demand. Over the past several decades, demand-driven water management, wherein water demand is viewed as a modifiable *want*, has received increasing attention. As climate change, urbanization and environmental degradation put increasing strain on freshwater resources, there is "considerable pressure from the general public, regulatory agencies, and some governments to minimize the impacts of new supply projects" (Butler & Memon, 2006). With that said, minimizing demand is the cheapest form of readily available water (Sharma and Vairavamoorthy, 2009). In contrast to supply-driven management, which relies heavily on engineering solutions, demand-driven management examines the bigger picture and draws on strategies from technical, financial and socio-political fields.

Demand management as it pertains to domestic water resources has been very successful in developed countries around the world including Singapore, the United Kingdom, Canada, Australia, France, the United States, (Sharma and Vairavamoorthy, 2009), Spain (Kayaga & Smout, 2009), and Egypt (White & Retamal, 2011). However, nowhere is the need for demand management so great as in developing countries where populations are growing, urbanizing, and, in turn, desiring a higher quality of life (Vairavamoorthy et al., 2008). Accordingly, developing countries have begun to utilize demand management strategies as well. Unfortunately, their success has been not as pronounced. In a report titled "Urban Water Demand Management: Prospect and Challenges for the Developing Countries," Sharma and

Vairavamoorthy (2009) list some of the reasons demand management strategies implemented in developing countries have been less rewarding. Namely:

> "*water resource scarcity, poor quality, complex and aged infrastructure, high rate of growth of population and water demand, high water losses in the distribution system, low cost recovery and high subsidy, poor management and institutional framework"* (p. 214).

As such, the authors recognize that demand management strategies that are successful in developed countries cannot be directly translated to the rapidly expanding, evolving, and constrained environments found in developing countries. Subsequently, Sharma and Vairavamoorthy (2009) go on to suggest twelve demand management activities as they relate to the unique conditions of urban water systems in developing countries (Table 4.42).

Table 4.42: Twelve demand management strategies for developing countries excerpt from Sharma and Vairavamoorthy (2009).

TECHNICAL	
i	Proper assessment of the state of the water supply infrastructure and water loss level using appropriate indicators.
ii	Application of spatial analysis techniques that help decouple highly chaotic and interconnected networks that allow the development of LCZs (leakage control zones) and DMAs (district metered areas).
v	Setting up proper database systems for assets, water balance and maintenance records.
vii	Use of modern tools and software for distribution system management.
FINANCIAL	
viii	Full cost water pricing, use of increasing block tariff and water metering.
ix	Use of other economic instruments like rebates, incentives, subsidies, taxes or fines supported by rules and regulations promoting water conservation and water reuse.
SOCIAL	
vi	Promotion of water-saving devices and consumer education and awareness building on water conservation at all levels
xi	Promotion of 1) water recycling and reuse and 2) rainwater harvesting in order to reduce the demand on urban water supply systems

Note: Strategies are presented out of their original order (roman numerals) in order to group them according to whether they are primarily technical, financial, social, (or general). That said, all of the above strategies are in some way legal, administrative and institutional as well.

Table 4.42 (Continued).

GENERAL	
iii	Development of new techniques that are specifically tailored for water starved/intermittent supply systems that recognize the low pressure and short duration of supply that is common in these systems.
iv	Development of appropriate levels of service and techniques to operationalize these levels of service so that a more reliable and regular supply is provided.
x	Step-wise approaches to reduce water demand
xii	Great appreciation of stepwise/phased strategies for UWDM (urban water demand management) that recognize there is no 'quick fix' and that benefits may be slow but long term. Such a strategy should be based on technical measures coupled with institutional restructuring and capacity building and educational programs for the local communities affected.

5.1 The Case for Chao

In November 2012 the Municipality of Chao finished the construction of a costly supply-side endeavor that, when eventually running as designed, will provide coverage to 97% of the population living between Chao and Nuevo Chao. The project was designed for a lifetime of twenty years and to meet a demand of 150 liters per capita per day (lpcd)[39]. The service's new primary source is the CHAVICMOHIC canal, or, indirectly, the Santa River. Unfortunately, accelerated melting of the lower Andean glaciers may result in increasingly strained water resources in Peru (BBC News, 2013), and, specifically, the Santa River Valley (Lynch, 2010). So, if supply-enhancing solutions continue to be the sole focus of management, the Municipality may need to locate and develop a new water source in less than twenty years. Alternatively, the Municipality could begin to adopt demand management strategies and not only extend the life of the water service by maintaining household water use near or below present levels, but resolve ongoing issues of inequity and poor water quality as well.

[39] In comparison, water use in United Kingdom is 150 liters per capita per day and 300 to 600 liters per capita per day in the United States (Butler & Memon, 2006; UN-Water, 2007). Interestingly, in a 2006 report the United Nations Development Project (UNDP) estimated water consumption in Peru to be 173 liters per capita. While per capita consumption in Chao appears to be far below the national average it does not need to grow with the economy.

With respect to prolonging (or minimizing) existing water use, this study revealed existing per capita water use in the range of 35 to 90 lpcd (Table 4.27). While household water use is presently far below anticipated demand, it appears likely to increase. First, although the majority of households reported the existing water volume available to them was enough to meet their basic needs (92.4% Chao, 94.0% Well Users, 84.6% Nuevo Chao – Figure 4.8), they were planning to buy more storage devices (22.8% Chao, 21.3% Well users, 34.1% Nuevo Chao – Figure 4.7). If a lack of money is considered to suppress an underlying desire then the numbers may be closer to 54.8% Chao, 38.1% Well users, 71.4% Nuevo Chao. Additionally, respondents said they would use more water if it were continuous (35.7% Chao, 61.5% Nuevo Chao – Figure 4.9) primarily for the activities of laundry (60.2% Chao, 39.3% Nuevo Chao), street watering (9.2% Chao, 11.4% Nuevo Chao) and storing more water (13.3% Chao, 13.6% Nuevo Chao) (Figure 4.10). While the first activity is requisite for basic hygiene, the latter two are not and might be modifiable.

Evidence that water use in the area could increase under improved service conditions is also suggested through comparison of Chao to Nuevo Chao households which suggests that increased duration (i.e. hours per day) does lead to greater use; use that is, perhaps, beyond necessity. Specifically, Chao households have, on average, four times the access to potable water, report to store ~175 to 230 liters more per day, use ~60% more water per capita per day, and are more likely to use potable water for street watering (56.6% Chao, 18.0% Nuevo Chao – Figure 4.15). While Nuevo Chao households voiced the biggest desire to purchase additional storage devices, Chao households and Well users contemplating future purchases wanted the most additional capacity (means of 650 L Chao / 831 L Well users compared to 289 L Nuevo Chao – Table 4.11). It appears that although Well users have an ‘endless’ water supply, having to access it via rope and bucket means they still use less water than Chao

households. In other words, convenience appears to be a factor in water use.

Overall, it appears the amount of running water available to Chao households has conditioned them to use and store more water, the latter of which may end up being discarded before use. Findings of previous studies have suggested that household water use does not appreciably increase with (more) continuous service (Andey & Kelkar, 2007; Whittington & Nauges, 2010). However, this study suggests that household water use will increase with increased availability so long as behaviors associated with intermittent service, such as storing water, continue. Consequently, as Nuevo Chao households transition from an every other day intermittent to a daily intermittent water service, increased availability will likely lead to increased water use. This will be particularly true if Nuevo Chao households are able to fulfill their desire for increased water storage capabilities. In fact, in a study of domestic water use in India Iskandarani (2002) found that storage capacity was a larger determinant of demand than rationing.

With respect to infrastructure, water use is sure to increase in Nuevo Chao with the introduction of sewage. For Chao households and Well users, flushing toilets constitute ~25% of households' daily per capita use (Figures 4.22/4.23). Beyond toilets however, both Chao and Nuevo Chao households are gradually acquiring water-related infrastructure that provides sanitation and hygiene [shower(s), additional faucets, washing machines, etc.]. Whether such infrastructure equates with increased water use is a matter of its inherent efficiency and of how the new infrastructure is employed. For example, households with showers are currently using ~68 L per capita per day in the winter and up to ~204 L per capita per day in the summer (as compared to ~20 to 60 L per capita per day for bucket bathing).

Currently only 25% of the population views the area's water resources as scarce (24.6% Chao, 22.0% Well users, 28.9% Nuevo Chao - Table 4.24). Consequently, while the majority of

households reported to practice water conservation (seasonal averages of 73.4% Chao, 63.3% Well users, 71.4% Nuevo Chao) existing behaviors are likely motivated more by a fear of and/or actual lack of water than by concern for the greater environmental good. In fact, respondents explicitly said they practiced water conservation so their households did not run out of water (35.9% Chao, 50.0% Well users, 31.9% Nuevo Chao – Table 4.23). Reported examples of water conservation such as covering water (14.6%) and boiling water (1.9%) further suggest the term may be interpreted as enhancing/prolonging the quantity and/or improving/protecting the quality available. This likely explains why, in the winter months when water is not as scarce, there was almost a 20% dip in reported conservation efforts (Figure 4.20). Not surprisingly, Well users, who theoretically have an endless supply of water, were the least likely to conserve (Figure 4.20).

As a whole, the concept of water conservation as it is known in the developed world is not well understood by respondents. The study's results show that the majority of households do not view water as a potentially scarce resource and, consequently, it is possible existing conservation behaviors will disappear when households gain increased access to tap water and/or alternative sources. This is evidenced by how households respond to service cuts. In Chao, where there are private household wells on nearly every block, only 2.8% of households report to be extra conscious of their stored water, while the majority of households (73.4%) reported to turn to groundwater when they ran out. In contrast, in Nuevo Chao where there is an absence of accessible groundwater, 13.0% of households reported to be extra conscious of their water (or, if they ran out, their neighbor's extra tap water 62.9%).

Beyond making sure water is used efficiently and wisely, demand management can be effective at resolving existing issues of inequity, which, in Chao currently exist in terms of duration, schedule, and pressure of the services. To begin, households in Chao all pay the

same price but water can arrive anywhere from less than 1 hour (12.4%) to more than six hours (2.9% - Figure 4.1). Alternatively the majority of Nuevo Chao households receive water from 30 minutes to one hour (70.9%), but the time of arrival is variable, with 25% of the population having to wake up to store water (Table 4.2). Although not explicitly studied, from observation it was evident that the hour that households receive their water can significantly affect how efficiently and/or inefficiently they use it. While people appear to have adapted to different duration and schedules (87.9% Chao, 76.0% Nuevo Chao not affected by schedule–Table 4.3), poor pressure is another issue. This study found that pressure problems are pronounced in the summer (42.4% Chao, 42.4% Nuevo Chao) but exist in the winter as well (10.4% Chao, 21.0% Nuevo Chao) (Table 4.7). For some 13.1% of Chao and 10.8% of Nuevo Chao households pressure issues occur year round on a daily basis (Table 4.9). Fortunately, households plagued with insufficient pressure have not installed pumps (so as preferentially divert water in the distribution system). Such behavior is apparently common in other developing countries, such as India, and could create a domino effect, exacerbating the services' existing inequities (McKenzie & Ray, 2009). Unfortunately, with respect to the new service, piping was not sized with intermittent distribution in mind, so it is unlikely that inequity problems will be resolved with the onset of the new discontinuous service. In fact, due to a more extensive and sprawling network, they may become worse.

Demand management can also mitigate issues of poor water quality. Both Chao and Nuevo Chao households cited water quality as the most important aspect of a quality water service (73.9% Chao, 69.6% Well users, 66.7% Nuevo Chao) (Table 4.17). Quality appears to be defined not only by physical and biological security but also by taste and odor (Figure 4.12). It is not surprising given the extreme hardness of Chao's *former* water supply that Chao households had the lowest opinion of their water's quality (described poorly by 30.0% of the

population as compared to 74.3% Well users and 60.6% Nuevo Chao - Table 4.12; and seen as not safe to drink by 28.7% as compared to 76.1% Well users and 63.5% Nuevo Chao – Table 4.13). While Nuevo Chao households and Well users appear to be satisfied with the quality of their water, the majority of households in all three user groups reported to regularly boil their water (62.6% Chao, 61.8% Well users, and 50.9% Nuevo Chao) (Table 4.14). Overall, 82.6% of Chao households, 83.3% of Well users and 72.6% of Nuevo Chao households invest time and/or money improving the quality of their drinking water. This could suggest that while Nuevo Chao households and Well users appreciate good tasting water, they still want to make sure it is biologically and physically safe to drink as well. In fact, when it comes to determining the most important aspect of water quality, all three user groups seem to be split in varying degrees between biological safety, physical safety and taste/odor (Figure 4.11). This is not surprising given all three are interrelated. In addition to household treatment, Chao households also cope with the poor quality of their water by supplementing their tap water with well water. Interestingly, 64.3% of households that use wells as alternative sources do so exclusively for the purposes of drinking and cooking. With respect to the latter, Chao households frequently complained that the tap water's hardness prevented them from being able to prepare their *menestra* (beans). Overall, it appears that how households' judge water quality from the new treatment plant could have varying effects on water use. For example, perhaps if households perceived the quality of the water to increase, they might not be as inclined to toss it onto the dirt before using it.

Knowledge of the existing service realities and households related behaviors and opinions is extremely important. To meet growing demand the Municipality's written proposal

projected an eventual amalgamation of treated river water and nonrenewable[40] groundwater (from the old source), before ultimately needing to develop new water sources. However, although the new service has only been running for a few months, days of particularly high turbidity have limited the water treatment plant's production. At these times, the two sources have been combined. This is of particular concern because water quality, not the services' continuity, appears to most concern households. However, if the treatment plant's inability to process highly turbid water is resolved and the Municipality can maintain household water use at or below existing levels, the unadvisable step of combining waters of different quality can be avoided. If such a change were able to attract more Well users to partake in the new service, the rate of nonrenewable water depletion could also be reduced.

To provide high quality water the Municipality will need to adequately operate and maintain the new water treatment plant. This will require sufficient revenue as collected through the households' monthly water bills. With respect to operation and maintenance (O&M), recall from Chapter Three that in the month of February (2013), SADISCHAO paid $30,800 (S/. 80,000) to operate the new water treatment plant but only took in $7,700 (S/. 20,000). Accordingly, water tariffs may need to be appreciably raised, at least for households in Nuevo Chao.

Unfortunately, it appears the Municipality may face an uphill battle with respect to price increases as the public has been conditioned to pay practically nothing for water and considers the existing tariffs (which are 1.4% of average monthly income in Chao and 0.4% of average income in Nuevo Chao) to already be 'fair' or, worse, 'expensive' (87.7% Chao, 44.9% Nuevo Chao). For Nuevo Chao households in particular, a new tariff will be a drastic increase and may cause unrest, especially if the population was never willing to pay for improvements in the first

[40] Groundwater is generally considered to be nonrenewable. In many cases the period of time needed for replenishment is on the order of 100 to 1000s of years (Foster et al., 2005).

place. That is, despite the poor quality and poor availability of Chao's and Nuevo Chao's, respectively, preexisting services, very few households were willing to pay for improved service scenarios (Tables 4.31 - 4.35). Nonetheless, of eight public works projects the Municipality provides, the majority of households rated water as the most important (37.5% Chao, 68.0% Well users, 51.5% Nuevo Chao). Unwillingness to pay is perhaps not a reflection of low interest for improved services, or even inability to pay. Instead, it may be indication of household's' distrust in their service providers (48.2% Chao, 33.0% Nuevo Chao distrust their water provider; and, a mean of 6.37 Chao and 6.81 Nuevo Chao are the providers' rated performance on a scale of one to ten).

Combine threatened water supply with increasing demand, existing issues of inequity, poor water quality, and households' unwillingness to pay, and demand management, which addresses not just issues of efficiency but also water quality and equity, is all the more pertinent for Chao. Employing demand management could greatly extend the success and lifetime of the new service. Subsequently, the following discussion will examine twelve effective demand management strategies (as suggested by Sharma and Vairavamoorthy, 2009) as they pertain specifically to Chao's existing circumstances, and more generally, to small developing cities that rely on intermittent, un-metered, water (and sanitation) services.

The prevalence of such services is exemplified by Shamra and Vairavamoorthy's demand management strategy that advocates for, "development of new techniques that are specifically tailored for water starved/intermittent supply systems that recognize the low pressure and short duration of supply that is common in these systems" (2009)[41]. With this in mind, their other

[41] To this point, studies have looked at the redesign of intermittent systems (Vairvamoorthy et al., 2008; Batish 2003). Rather than have to overcome issues that arise when a system designed to be run continuously is run intermittently (such as will be the case for Chao), water systems should be planned in accord with how they will actually be operated. Proactive design for intermittent systems means recognizing that supply (pressure at outlet), not demand, is the system driver. Using mathematical

eleven suggested activities will be examined. The strategies will be grouped and discussed according to whether they are primarily technical (Section 5.2), financial (Section 5.3), or social (Section 5.4) in nature (as summarized in Table 4.42).

5.2 Technical Strategies

Beginning with technical demand management strategies, the authors suggest the "proper assessment of the state of the water supply infrastructure and water loss level using appropriate indicators" (Sharma & Vairavamoorthy, 2009). Water *losses* (i.e. the volume of water lost between production and authorized consumption) result from a combination of poor infrastructure, leaking pipes, and illegal connections. In developing countries, such losses are poorly documented but are estimated to fall in the range of 40 to 60% of produced water (Arlosoroff, 1999). Even in low pressure networks large leaks have been found (Rogers, 2005).

Ideally, water providers would like to be able to pinpoint how much water is being lost, and the location(s) and reason(s) why. With respect to how much and where, this is traditionally estimated by using district and/or household meters to identify unusually high-volumes of night flow. In contrast, in intermittent systems where pressure is not constant, leakage assessment is a more time-consuming process and can involve up to two weeks of preparatory work in the zone where the test will be carried out (a typical test area is 500 m of pipe). The actual test involves measuring non-supply flow for ~ eight hours as tanker trucks continuously pump water into the selected closed-boundary zone (Vairavamoorthy & Mansoor, 2006).

Given the water service in Chao is meterless, such a calculated assessment of the service's efficiency cannot be made without a significant investment of both time and money. However, because Chao's distribution network is still rather small and the piping relatively

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modeling and optimization tools, piping and storage units can be optimally located to provide for the most equitable service possible at the least cost.

new[42], the SADISCHAO office believes non-revenue water due to leaking pipes to be insignificant. Thus, for the time being, perhaps appropriate infrastructure monitoring could take the form of: 1) measuring the rate at which water empties from the reservoir per zone[43], 2) periodically visiting and visually and audibly assessing mains, 3) consistently recording the frequency and duration of pipe bursts, and 4) household visits to evaluate possible leaks, pressure issues, and observe household water storage and use.

The second suggested activity, the 'application of spatial analysis techniques that help decouple highly chaotic and interconnected networks that allow the development of leakage control zones and district metered areas' is related to the aforementioned strategy and, consequently, limited by Chao's lack of meters. However, all of the possible indicators discussed above (pipe burst frequencies, complaints of low and high pressure, etc.) could be recorded with GPS software so that SADISCHAO can begin to identify the system's most problematic zones.

This goes hand in hand with Sharma and Vairavamoorthy's other suggestion to develop "appropriate levels of service (which recognize the true situation on the ground) and techniques to operationalize these levels of service so that a more reliable and regular supply is provided." Given that 25% of Chao and Nuevo Chao households reported year round pressure issues (13.1% Chao and 10.8% Nuevo Chao on a daily basis – Tables 4.8 and 4.9), identifying where and why those issues are occurring is of great importance. Correspondingly, when SADISCHAO is ready to install district and/or household water meters, they could gradually phase them in, starting with these 'trouble zones.'

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[42] The oldest pipes in Chao's network date back to 1996 but a large portion of Chao's water system was recently laid and/or replaced in 2011/2012. Compare to the U.S. where 40% of drinking water pipes are greater than 40 years old (EPA, 2012).

[43] How fast water is *used up* (considering the number of connections and length of pipes) on the East side vs. the West side of Pan American highway vs. new distribution zones for Nuevo Chao I and II.

With respect to phasing in meters, careful planning that covers both the technical and social aspects of water meters must occur prior to implementation. Aspects such as where the meters should be installed, how (frequently) they will be read and maintained, and consumer perceptions all need be considered (Vairavamoorthy & Mansoor, 2006). For example, while households in Chao appear to be split on whether they favor the introduction of water meters (43.6% in favor, 56.4% not in favor), Nuevo Chao households are more strongly opposed (71.8%) (Table 4.25). Opponents seemed to have a strong preconception that meters would inherently make their bills more expensive (66.3%) and not work properly (8.9%). These beliefs are not completely unwarranted. In fact, under intermittent conditions frequent fluctuations in pressure have caused water meters to prematurely break and/or give false readings (Vairavamoorthy & Mansoor, 2006). Accordingly, it is crucial that much effort be put into garnering public support, as well as working out technical details, prior to a transition to metered service.

If successfully implemented, meters could help households better understand their water consumption. As it stands, the average respondent underestimated household water use (as compared to calculated, conservative, estimates presented in Table 4.27) by 40 to 200 L per day (Table 4.30). Respondents' accuracy in estimation appeared to decrease in accord with the overall availability of their service (i.e. Nuevo Chao households were most accurate followed by Well users, followed by Chao households). This suggests that unless actively/visually engaged in their water use (i.e. depending on allocated amounts from storage devices), households quickly become desensitized to how much water they are consuming. This theory is supported by the general water illiteracy that exists in developed countries (Fishman, 2011) and highlights an opportunity to couple the introduction of meters with education to enhance households' existing awareness.

Overall, "leak management is data hungry, and so investment in software systems and staff resources to manage the data can be significant" (Trow & Farley, 2006). This ties into Sharma and Vairavamoorthy's next suggestion, the "use of modern tools and softwares for distribution system management" (2009). Such modern tools and software are likely a long way off for Chao. This is not only due to a lack of network meters but also because the number of computer-trained staff in SADISCHAO's office fluctuates between one and two individuals (and one or two computers)[44]. Given that the new water and wastewater treatment plants currently do not have the optimal number of technically trained engineers and operators (currently employing nine of the recommended nineteen employees), increasing the number of personnel (and equipment) in the Municipal water office should not be the main priority.

Even so, SADISCHAO's office has done a good job of making do with what they have. Specifically, they have begun to set up a "proper database systems for assets, water balance, and maintenance records" (a mentioned Demand Management activity) (Sharma & Vairavamoorthy, 2009). That is, SADISCHAO currently has an electronic, organized, Excel™ database where they keep detailed records of registered users, their payments, and monthly income and expenditures. For this reason, SADISCHAO is now able to enforce payment, cutting households' connections when they fail to pay for their service three months in a row. In fact, in the last four years, SADISCHAO's increased enforcement has resulted in a 17.33% reduction in *morosidad* (late payments).

5.3 Economic Strategies

For financial measures, Sharma and Vairavamoorthy suggest "full cost water pricing, use of increasing block tariff and water metering" (2009). Price is considered a demand management tool in that a well-designed tariff should promote rational water consumption

[44] As observed during the author's two years in Chao.

among users. In fact, compared to non-price strategies, price-based tools have been shown to be more cost effective and easier to monitor and enforce (Olmstead & Stavins, 2009). Although the concept of water as an 'economic good' has grown in acceptance since first being introduced as the basis for human life and well-being (ICWE, 1992), water is, and always will be, inherently different than other goods. As such, water price is a very delicate issue and is not simply a matter of how much households could pay. Accordingly, in using price as a demand management tool, it is important that tariffs follow the 'CAFES' principles; namely that they are 'conserving, adequate, fair, enforceable and simple' (Sansom et al., 2002). Tariffs should also be designed with consideration to the cost of operation and maintenance, opportunity costs, economic externalities, and environmental externalities (Motoma, 2007).

The most popular tariff structure in developing countries is the increasing block format (Vairavamoorthy & Mansoor, 2006). Increasing block tariffs (IBT)s (as Sharma and Vairavamoorthy 2009 suggest) are a rate design that can encourage conservation while simultaneously increasing revenue (Motoma, 2007). In addition IBT structures work best when the income profile varies greatly as it does in Chao and Nuevo Chao[45]. The design of IBTs charges a low marginal price for water consumption up to a certain threshold after which the unit rate of water drastically increases with increasing usage. This design is thought to reward conserving behaviors with low rates while penalizing high water users (EPA, 2009).

However, increasing block tariffs have also been argued as disadvantageous for the poor, thus violating the 'fair' in the CAFES principles (Butler & Memon, 2006). In a paper titled "The Political Economy of Increasing Block Tariffs in Developing Countries" Boland and Whittington (2000) address five problems and limitations of IBTs and ultimately conclude that they introduce "inefficiency, inequity, complexity, lack of transparency, instability, and

[45] Reported incomes ranging from S/. 50 to 11,300 per month in Chao and S/. 50 to 4000 in Nuevo Chao.

forecasting difficulties." Since the paper was published attempts to address the common oversights of IBTs have been made. For example, Baberán and Arbués (2009) recognized the problem IBTs could create for large households (that are often poor) and proposed adopting a per capita IBT. However, as they recognized this would incur high administrative costs, they suggested the utility offer both options and only households that unfairly fall into the highest block of the general (household) tariff could opt to give the utility further information so as to be charged based on per capita consumption.

Ultimately, whether IBTs are advantageous or not, so long as the Municipality of Chao continues to operate the new water service without meters, the opportunity to manage demand through creative tariff designs (such as described above) is not an option. Essentially, the only tariff structure available in meterless water systems is a flat rate structure in which all households, regardless of size and water use, pay the same amount. SADISCHAO is currently operating at a loss of S/. 60,000 a month. Accordingly, the Municipality is faced with the difficult task of bridging the existing gap in income vs. expenditures, while also planning for future operation and maintenance[46]. Moreover, the new flat rate tariff needs to consider that the average monthly income in Nuevo Chao is 78% of average monthly income in Chao (S/. 245 less) and Nuevo Chao households were previously paying S/. 3.20 a month for water.

The only way to improve the equity of a flat rate, as well as encourage conservation, is through other financial measures suggested by Sharma and Vairavamoorthy "like rebates, incentives, subsidies, taxes or fines supported by rules and regulations promoting water conservation and reuse" (2009). Interestingly, in conclusion to the limitations of increasing block tariffs, Boland and Whittington (2000) propose a simple two-part tariff where every household would receive 1) a single volumetric charge equal to the marginal cost of water

[46] Recall that capital costs of the new water and wastewater treatment plants were covered by the National government.

coupled with 2) either a fixed monthly credit or rebate. Again however, rebates, incentives and taxes, are measures that would be difficult to design and implement without household meters. As for subsidies and fines, while politically and administratively difficult, they could be done. Because Chao's water service is still relatively small, households receive bills under their door and must go to the Municipality once a month to pay their bill in person. This process creates two opportunities in which the provider and customer have an opportunity to engage. Consequently, the Municipality could establish a fairly good idea of what households/families are deserving of a subsidy. Nonetheless, users would have to apply in order to qualify (large household size and/or low income) and this would require extra data processing and complications for SADISCHAO.

With regard to fines, a few respondents suggested that at one point there had been an ordinance issued against street watering. In contradiction, SADISCHAO confirmed that no such law was in place. However, respondents' misinformation revealed a demand management opportunity; namely, fining residents for watering their streets. With respect to implementation feasibility, 1) the wasteful water behavior is relatively easy to catch as street watering with potable water is very predictable (occurring with the arrival of water), 2) the area served is not unmanageably large, and 3) there really is nowhere to hide for abusers. An issue, however, would be the cost of hiring an employee to monitor and fine households for street watering. How long such an ordinance would need to be enforced to create lasting and sustainable behavior change is another consideration. If the answer is indefinitely, an ordinance is likely not the best use of the Municipality's time and money. Alternatively, the Municipality could offer incentives for households to adopt vegetation as a different way to manage dust. Such a practice would require education and awareness building which is the focus of Sharma and Vairavamoorthy's (2009) remaining demand management strategies.

5.4 Social Strategies

The final types of strategies for demand management can be classified as behavioral or social. The first social-oriented strategy Sharma and Vairavamoorthy suggest is the "promotion of water-saving devices and consumer education and awareness building on water conservation at all levels" (2009). With respect to water-saving devices (which are also technical), so long as Chao's water service is only provided for a few hours a day, the water saved from such devices would be small (i.e. households would still have to turn to water storage, use of buckets for flushing toilets and bathing, etc. when water is not arriving). That said, given the majority of Chao and Nuevo Chao households are gradually purchasing, for the first time, fixtures such as toilets and showers, ideally they would be the most water-efficient models available.

Low-flow showers would be of particular importance given that respondents in both Chao and Nuevo Chao reported to bathe two or more times per day during the summer months (means of 2.55 times per day Chao, 2.54 Well users, 2.42 Nuevo Chao). For toilets, the ideal for water scarce regions is waterless, composting, toilets[47]. Unfortunately, a prefabricated version of this technology is a long way from reaching Peruvian markets and, while constructing such toilets from scratch is a possibility, it is an expensive endeavor (up to S/.1000[48] compared to S/. 49 to 198 for a ~10-L flush-toilet[49]). All in all, assuming water-saving technology tends to be more expensive than traditional fixtures, if higher efficiency models were made available to residents, subsidies or interest free loans would need to be offered. In issuing subsidies and/or loans, Sharma and Vairavamoorthy (2009) highlight the need to educate the public on why, and

[47] Although, with composting toilets, thought would need to be made with respect to how an absence of feces, and reduced water volume, would affect the oxidation ponds' effectiveness at treating other wastewater.

[48] According to the material list from designs implemented in rural communities of Peru during the author's two year service.

[49] According to SODIMAC's website, http://www.sodimac.com.pe/buscar/productos/ filtro/inodoro, a leading home supply retailer located in major cities throughout Peru.

how, the additional upfront cost would save them (and the environment) in the next five to ten years. As many households live paycheck to paycheck[50], such information could be accompanied with additional resources on long-term financial planning and savings.

That being said, misunderstanding/misuse of high-efficiency infrastructure has been coined the 'rebound effect;' when people with low-flow technology increase overall use because they think their efficient fixtures will make it okay (Olmstead & Stavins, 2009). Households that acquire showers and toilets may abuse the convenience of running water if they cannot conceptualize its volume. To this point, when households were asked to estimate the number of liters that flowed from their faucets per minute, the majority reported to have no idea (60.3% Chao, 71.0% Nuevo Chao) and, consequently, did not tend to consider and/or include direct use of water at the time of arrival into their daily water use estimates. On the other hand, given the rest of households' water use was fairly calculated from various sized storage devices, residents may be more inclined to learn the volume of water each toilet flush or minute in the shower uses. Moreover, if meters are eventually introduced, the monetary value of each minute of running water should be made clear to residents.

Time and patience are two critical pieces to development of an effective education and awareness building campaign, which is the other piece of Sharma and Vairavamoorthy's (2009) aforementioned recommendation. In a report titled *The Challenges of Water Resources Management in Peru*, Alegria (2006) urges that water resource management goals will only be achieved by "shifting to a new paradigm for sustainable water resources development, which will be pursued through education and awareness." For Peru, this new water culture would include 1) 'a common vision for national identity,' 2) shared values and attitudes and 3) 'agreed core goals' of equity, efficiency and environmental conservation (Alegria, 2006).

[50] A large majority of residents work for the large agricultural export companies which pay employees twice a month. Accordingly, on these days long, two-to three-hour lines would form as residents patiently waited to get money from one of Chao's two ATMs.

In developing a public education campaign it is important to keep in mind that the households are not students but stakeholders. In fact, although the term education has traditionally been used to describe socially-orientated water management strategies, the collaborative nature of the process is better captured by terms such as 'dialogue' and 'communication' (Jeffrey & Gearey, 2006). To this point, Alegria (2006) highlights the importance of open discussion and public debates.

The effectiveness of dialogue to encourage behavioral change is based on the continually researched assumption that "beliefs determine values, values determine attitudes, and attitudes determine behavior" (Jeffrey & Gearey, 2006). With respect to value, in a report titled "Communicating the Value of Water," Means et al. (2008) state "before a utility can communicate value it has to be seen in the eyes of the public as socially responsible, fiscally prudent and environmentally sensitive." Unfortunately, many Chao and Nuevo Chao households currently distrust their providers (48.2% Chao, 33.0% Nuevo Chao) and, on a scale of one to ten (where ten is excellent), households do not seem to be impressed with the service they are receiving (means of 6.37 Chao, 6.81 Nuevo Chao). Fortunately, given the amount of time and money the Municipality recently spent to improve the quality and (potential) quantity of water available to households, they have a unique opportunity to rebrand themselves.

Accordingly, prior to an 'awareness building campaign,' the Municipality should build trust within Chao and Nuevo Chao by demonstrating its "knowledge and expertise, honesty and openness, and concern and care" (Means et al. 2009). This means opening the lines for sincere communication and not just responding to the water-related concerns of households in a reactive manner. This study has revealed specific attitudes and concerns of households regarding their water service, which the Municipality can use in order to present meaningful information regarding the new water and wastewater treatment plants. A starting point for

public dialogue could be addressing knowledge gaps such as: who is the service provider (misidentified by 11.1% of Chao households, 17.4% of Nuevo Chao), where water is coming from (misidentified by 40.5% of Chao households, 29.5% of Nuevo Chao), and how the water (and wastewater) is being treated[51]. Specifically, while a moderate majority of households know that potable water is of a higher quality (69.2% Chao, 52.0% Well users, 60.2% Nuevo Chao – Table 4.15), the majority also reported they don't know what the service providers do to make their water potable (56.1% Chao, 54.6% Nuevo Chao –Table 4.16). This information could be assembled into fact sheets that have data on basic operations, income and expenses, and the results of water quality tests (McKenzie & Ray, 2009).

With regard to the water quality, given the new source of water is the contaminated CHAVIMOCHIC canal, the Municipality of Chao could use the four-step treatment process to demonstrate its openness, concern and care. It has been shown that customer satisfaction can be increased specifically through education about water quality (Means et al., 2009). The results of this study suggest that how households assess the quality of their water is complicated, integrating both taste and odor with physical and biological safety (Figure 4.12).

There should be attention brought to why chlorine is important as households perceived it as a reason why water was not safe to drink (Chao 25.4%, Nuevo Chao 4.2% - Table 4.12 and Chao 17.9% and Nuevo Chao 7.1% - Table 4.13). Similarly, research in the United States has shown that "consumers generally have a negative opinion of chlorine tastes and odors in drinking water, causing lower satisfaction with tap water flavor, healthiness and safety" (Means et al., 2009). Recall that Nuevo Chao households were not as dissatisfied with the taste of their former water as Chao households. If the new water service is to provide chlorinated river water,

[51] When respondents were asked how to build their trust of their service providers, roughly 27.5% of households in Chao and 11.5% of households in Nuevo Chao specifically voiced their desire for information regarding the origin, treatment and quality of their water. Others mentioned they would like to know about the service providers' financial information, for the provider to hold workshops, and for the provider to be more friendly and respectful.

as opposed to *fresh* spring water, it is particularly important to convince Nuevo Chao households of the water's improved quality. If not explicitly educated, the taste of the new water may otherwise suggest poor quality to these users. Ultimately, residents "should come away thinking that the utility is the source of water quality, not where the water came from" (Means et al., 2009). Overall, engaging residents in dialogue about the quality[52] and quantity of water they are receiving will help to build trust as well as greater appreciation for the water service provider.

Trust can also be built by continuing to give the public advanced notice of when there will be service cuts. Even one to two unadvised interruptions and the public may continue the habit of storing water beyond what they need *just in case* (recall 23.0% of Chao households, 23.5% Well users, 26.3% Nuevo Chao would like to purchase more storage devices for increased security – Figure 4.7).

When it comes time to engage the public regarding water conservation, recall that in contrast to developed countries where the majority of residents have had a lifetime of continuous water supply, households in developing areas, especially those serviced by an intermittent supply, inherently develop water-conserving behaviors. Interestingly however, this study has shown that many conserving behaviors seem to be motivated by coping, not by a conscientious concern for the environment (Section 4.4.2). This is not surprising given the majority of households have never received formal information/education on the concept of water conservation (68.2% Chao, 75.7% Well users, 61.6% Nuevo Chao – Table 4.21). Thus, beyond instilling trust in the service provider and value for water received, the Municipality should aim to create mindfulness around households' existing conserving behaviors.

[52] In particular it appears households need to be educated on the practice of chlorination as residents see it as both a reason for why water quality is good and bad. Overall, the new water may not taste 'spring fresh' so it will be critical that SADISCHAO educate households to see the value of water that is biologically and physically safer for them to drink.

The Municipality should simultaneously identify and discourage wasteful behaviors. Before bad habits further develop the Municipality should leverage households' relatively short experience with running water. Perhaps a water conserving culture may be easier to form in small, growing, cities like Chao and Nuevo Chao where domestic water services are still a new concept (i.e. less likely to be taken for granted). Also, households' memories of life before a domestic water connection might be a valuable tool when it comes to managing demand. Individuals who have experienced water scarcity (53.9% Chao, 45.3% Well users, 61.0% Nuevo Chao – Figure 4.3 & Table 4.4) and are familiar with the difficulty of transporting water might have greater appreciation for service providers' efforts. Households' mutual experiences, past or present, with water scarcity could also act as common denominator in the development of a more water conscious culture. With that in mind, a good place for the Municipality to begin would be raising awareness of regional freshwater scarcity extending to the changing glacial source with the goal of making households aware of "the urgency to conserve water now to avert a crisis situation in the future" (Vairavamoorthy & Mansoor, 2007).

Ultimately, the goal of a water conservation campaign in Chao would be to prevent increased access to water (be it via more storage devices or improved continuity) from translating to thoughtless increased water use. Whether Chao will be able to achieve such an end will largely depend on how successful it is in communicating its messages. The new water and sanitation service is bringing together three user groups with unique perceptions and practices. Interestingly, in a study demand management effectiveness in Windhoek, Namibia it was found that households were less willing to respond to demand management the more money and access to water they had (Magnusson, 2004). Thus, it would be wise for the Municipality to consider Chao households, Well users and Nuevo Chao households separately when formulating its information campaign. For example, Chao households are more concerned

with water's physical (34.1%/47.9%) and biological (27.7%/27.9%) safety, and Nuevo Chao households are more concerned with the taste and odor of their water (59.1%) (Figure 4.12). And, while the majority of Chao households would most like to see the quality of their water improve (67.5%), Nuevo Chao households are most preoccupied with the water's schedule (31.6%) and maintenance (22.8%) (Table 4.18). With that said, the best messages for each user group will be those that are simple, short, focused, frequent and repetitive (Means et al. 2009). Messages should be developed with respect to citizens' core expectations and delivered regularly through multiple media channels.

Chao has a variety of media options. There are two local radio stations which have regular audiences[53] and already collaborate with the Municipality in terms of announcing when there will be cuts to the water service. Also, although Chao does not have its own television station, in line with the national *Cultura del Agua en el Perú* (Water Culture in Peru) initiative that was begun 2007[54], the Municipality of Chao could collaborate with the national government and accordingly advise residents of scheduled public information concerning water conservation[55]. As for the internet and social media, while these modern media sources still seem beyond the majority of Chao and Nuevo Chao's older population,[56] the internet cafes spread throughout the neighborhoods are filled by many of the youth (≤ 16 years old) all hours of they day. Accordingly, the Municipality could develop a Facebook™ page where it reaches

[53] People listen to the radio all hours of the day. At home, at work, and even while biking, walking, or laboring in the fields (small battery powered radios are prevalent).

[54] A joint effort between The Water and Sanitation World Bank program in conjunction with the Ministry of Housing, Construction and Sanitation of Peru.

[55] Recall from Table 4.21 that 28.4% of Chao households, 22.2% of Well users, and 12.3% of Nuevo Chao reported to have already learned about water conservation through watching television.

[56] Only 9.1% of the population owns a computer and, according to first round of surveys, only 4.3% (of those interviewed) belonged to either Facebook or Hi5 (a less popular Latin American social network).

out to youth and regularly posts information regarding community events, concerts, and environmental, water-related, facts. Another opportunity for the Municipality to communicate with customers is on the small paper bills that SADISCHAO distributes monthly. In fact, given the information the bill communicates is constant, adding in short and simple water conservation facts would improve the efficiency of the ink and paper dedicated to monthly tariff collection. Interestingly, a study of consumer outreach in the U.S. found that water bills and water bill inserts were by far households preferred method to receive water-related information (Tatham et al., 2004). A more ambitious effort could invest in the development and distribution of visual prompts and written pledges to reduce water which have been shown to be successful in developed countries (Pleasance, 2004; Graymore et al., 2010; Kayaga & Smout, 2009). Such items could be exchanged and explained when users come to the Municipality to pay their water bills. Overall however, given the Municipality's constrained resources and the difficulty of hiring personnel to run such an involved campaign, perhaps the most useful form of 'media' the Municipality has available is through collaboration with the health post, the areas' eight schools[57], and the regular meetings of *clubes de madres* (mothers clubs). Finally, the Municipality could use the common media of *chisme* (i.e. gossip). Unfortunately, right now existing water-related gossip focuses on the services inequities and likely builds distrust and animosity towards the water provider.

As far as gossip goes, in a paper titled *Environment, Scarcity and Conflict: A Study of Malthusian Concerns,* Turton (1999) concluded that knowledge of the social dynamics surrounding scarce resources is a key piece when it comes to their management in developing countries, and a piece that is not yet fully understood. In a literature review titled "Consumer Reaction to Water Policy Instruments," Jeffrey and Gearey (2006) conclude that:

[57] This study identified schools and health posts as places where residents were already learning about water conservation (Table 4.21).

> "people adapt and change at a faster rate than policies, technologies and infrastructures. The challenge is to understand this potential as it impacts on water supply, and exploit it as a beneficial tool for adaptive response." (pg. 326).

To this point, it has been shown that within small cities where social cohesion is strong, non-tariff-based strategies could successfully impact water use (Tsegaye & Vairavamoorthy, 2009). Recall that during periods of water scarcity (i.e. interruptions to service), the majority of Chao households (~90%) and Nuevo Chao households (~80%) turn to one another for help (Figure 4.4). Furthermore, when households were asked if they got along with their neighbors, only three households in Chao (1.5%) and one household in Nuevo Chao (0.5%) said they did not. This cordial cooperation has an intrinsic value that is often referred to as social capital. In a report that specifically addresses the unique advantages (as well as constraints) for demand management in small city contexts, Deverill (2001) writes, "opportunities exist to develop demand responsive services by making better use of social capital."

Unfortunately, despite its small size and high level of direct neighbor-to-neighbor cooperation, the strength of social capital in Chao and Nuevo Chao is questionable. That is, when respondents were asked to rank the level of trust they had in their community on a scale of one to ten, the majority of households in all three user groups rated their community cohesion in the 3 to 6 range (53.8% Chao, 62.9% Well users, and 52.5% Nuevo Chao). Correspondingly, when respondents' were asked how well they felt supported by their community the majority reported 'alright' or 'bad' (71.4% Chao, 66.1% Well users, 59.2% Nuevo Chao). This is not surprising given the area has grown as a migrant community and the continual and rapid influx of new people has come with high levels of gang activity and gun violence.

Nonetheless, in comparison to large cities and sprawling suburbs, daily, positive, collaboration between Chao and Nuevo Chao residents appears to be strong at the block level.

Thus, whether it is related to existing deficits of basic public infrastructure[58], or because only 3.5% of households own any form of transportation (motorcycle and motor-taxis included) and people are often out crossing paths on foot or in bus, the Municipality should not ignore or underestimate the power of *boca a boca* (word of mouth) when developing an information campaign.

That being said, in line with education and awareness building, further reduction in the demand for water can come through "the promotion of water recycling and rainwater harvesting" (Sharma and Vairavamoorthy, 2009). The idea that clean, potable, water should be provided to households for all their needs developed when supplies seemed endless and perhaps public health was less well understood. Such a one-size fits all solution is no longer reasonable. While water for consumption, and to a lesser degree hygiene, should continue to be held up to the highest standards of quality, there is no argument that water for flushing toilets and outside watering (vegetation or streets) needs to be potable. Recognizing nearly a century of oversight, water providers and consumers in developed countries are beginning to rethink the use and possible treatment of rainwater and greywater in and outside the home. Due to a lack of precipitation, rainwater harvesting is irrelevant in Chao but, as discussed in Section 4.4.2, water reuse is already a part of the area's water culture.

With the idea that different sources can be matched with different water uses, recall that a continuous water service is at least ten-years in the future for Chao[59]. In the absence of running water, households reuse washwater to flush their toilets some or all of the time (74.0%

[58] This is particularly true in Nuevo Chao where 91.5% of households surveyed that reported regular meetings with their neighborhoods in order to move political promises into action (for sewage, roads, electricity, and a vegetated Plaza de Armas*)*. In contrast, in Chao where basic public infrastructure is more prevalent, only 15.5% (16.3% Well user) reported the existence of regular meetings. Furthermore, in Nuevo Chao reported attendance of community meetings was nearly 100% (91.1%) as opposed to a small 28.3% of households in Chao.

[59] According to regular conversation with SADISCHAO and the town councilmen.

Chao, 72.2% Well users, 61.6% Nuevo Chao – Table 4.20). So long as residents continue to use the majority of their water from storage devices and buckets, rather than dumping utilized water down the drain (as is common in Chao and soon to be an option for Nuevo Chao), residents could be encouraged to begin (or continue) to use water from washing food, plates, bathing, and laundry to flush toilets and water plants. Water reuse promotion should be coupled with information on human health so that households safely practice water reuse.

The particular opportunity is to reuse water from food preparation to promote landscaping and reduce barren street surface areas. Given Chao's arid climate, its imperative to educate households on how to achieve the same end goal with different tools. Vegetation in the form of groundcover and street trees could save water while simultaneously improving air quality, lowering the heat index, and providing habitat for native birds and other local fauna. Residents could receive horticultural information on endemic species, their benefits, and perhaps even seeds or seedlings. To supplement information, demonstration projects could be done at the Municipality and along the Pan American highway. These projects could be coupled with Chao's recently developed waste management, environmental, initiative and branded; for example '*Chao limpia, nuestro orgullo, nuestro responsabilidad*' ('clean Chao, our pride, our responsibility'). In the end, in the absence of enforced penalties or education, street watering is a practice not likely to disappear. The barriers to using vegetation and plants as alternative groundcover need to be removed and the benefits emphasized.

Information campaigns are mostly seen as a second order demand management instrument because it is more difficult to measure their impacts (Magnusson 2004). Nonetheless, because all of the aforementioned demand management strategies directly or indirectly impact the public, education and awareness building are crucial to the success of any demand management program (Vairavamoorthy & Mansoor, 2006). Thus, it is recommended

that the Municipality of Chao develop Specific, Measurable, Achievable, Realistic, Time Bound (SMART) indicators to measure the success of any social-orientated demand management activities they develop (Deverill, 2001). In fact, indicators should be developed for all demand management strategies. For example, the Municipality of Chao is already accounting for the tariffs collected per month and the frequency of leaks and pipe bursts. This data could be used to report monthly indicators such as: percentage of payments received (on time), percentage of population served, number of leaks/bursts per km of pipes per month, number of complaints per number of connections (with particular attention to reduced complaints of pressure, implying improved equity), and the ratio of monthly operating costs to revenue (Gumbo, 2004).

5.5 Overview

The last suggestions Sharma and Vairavamoorthy make are not so much activities as they are overarching suggestions for demand management in developing countries; namely "step-wise approaches to reduce water demand (short- and long-term performance improvement plans)" and "greater appreciation of stepwise/phased strategies…that recognize there is no 'quick fix' and that benefits may be slow but long term" (2009).

Recognition that there are no quick fixes is perhaps the key point to managing demand under intermittent systems. Intermittent systems can 1) waste more water than they save; 2) lead to higher costs for both providers (increases in pipe bursts, excess pumping, etc.) and consumers (household water treatment, purchase of storage units, alternative water sources); 3) decrease water quality; 4) result in variable pressures and inequitable distribution; and 5) lead to low consumer expectation. However, despite these limitations, intermittent systems are commonly adopted across developing countries and switching over to continuous service is not simple. Fortunately, this study has shown that even under meterless, intermittent, service conditions, there are opportunities for demand management. In fact, demand management

must play a role if small cities struggling with scarce freshwater resources want to be ready and able to eventually transition to continuous service operations.

With that in mind, current water use in Chao and Nuevo Chao is in the range of 35 to 90 lpcd (Table 4.26). The new service was designed to provide 150 lpcd for both populations, growing at 5.94%, until the year 2027. At some point in the course of the system's lifetime, the Municipality of Chao plans to combine water from both the new water treatment plant and the old 60-m tube well[60]. Given that 1) Chao households are upset with the quality of the latter and 2) both Chao and Nuevo Chao households value quality over availability, this is unadvisable. Instead, the Municipality of Chao should incorporate demand management strategies into its approach to water management. Through the practice of demand management the Municipality can extend the lifetime of the new service, improve water quality, as well as gradually resolve existing inequities while bolstering public support and value for the service.

Ideally, a demand management program in Chao would be developed within a strong, transparent, institutional platform and incorporate the technical, financial and social measures previously discussed into a collaborative, enforceable plan. SADISCHAO is not a private, but government-run, water provider. This has both advantages and disadvantages. On the plus side, SADISCHAO has access to financial and human resources outside its own entity. However, while collaboration with economists, social scientists, biologists, and politicians (i.e. not solely engineers) should be accessed for the development of a demand management campaign, there need to be transparent plans, priorities, and goals laid out for SADISCHAO that are not subject to variables arising from other Municipal offices. The operation and maintenance of the new water and wastewater treatment plants should be financially independent of the Municipality's

[60] Recall from Chapter Three that on days when the turbidity of water from the CHAVIMOCHIC canal is high, the water treatment plant cannot run efficiently. This occurred ten times in the month of January (2013) and accordingly the Municipality has already begun to provide households an amalgamation of treated canal water and untreated, poor quality, groundwater.

overarching budget. Overall, in the development of a demand management campaign there needs to be a strong framework in place. This means that all Municipal offices are clear of their roles and responsibilities. It does not mean though that every office works in complete independence of the others. There must be regular communication to make sure efforts are mutually reinforcing and not repetitive or contradictory.

To begin, Chao appears to be a good candidate for a public education and awareness campaign. This is particularly true given 1) the public's low regard for their (pre)existing services 2) SADISCHAO's budgetary constraints and the expense of developing, operating and maintaining the new water and wastewater treatment plants 3) the lack of meters and technology and 4) the small city environment where households regularly interact with one another and share former experiences with scarcity.[61]. After garnering public trust and awareness, the economical and technical strategies of demand management, such as raising tariffs and introducing meters, will have greater success.

All of the strategies discussed in sections 5.2 through 5.4 are summarized in Table 4.43 as they pertain specifically to Chao (and small city services in similar situations). The Municipality should critically assess all options in light of their institutional capacity and available resources. Demand management cannot be treated as an afterthought but must be budgeted for like other Municipal expenditures (Gumbo, 2004). Consequently, a long-term cost benefit analysis is suggested. In outlining a strategic approach the Municipality should keep in mind that all demand management tools are mutually reinforcing and can be implemented in phases.

[61]Education and awareness building will also be crucial if the Municipality decides to go forward with their plan to implement meters in Nuevo Chao II. It is highly advised that the Municipality consider that the public's opinion on metering is divided (Table 4.25). Households will need to be educated on the benefits of meters, their maintenance, and, in doing so, resolve any uncertainties regarding their use. If not, it is likely that history would repeat itself as Chao's former metered era (1996 to 2009) ended in meters being damaged, destroyed, and stolen.

Table 4.43: Twelve demand management strategies suggested for the Municipality of Chao.

TECHNICAL	
i	Use GPS technology, or physical map, to identify problem areas by documenting the location of pipe burst frequencies, customer complaints of low and high pressure, water use rate (per number of connections), etc.
ii	Continue effort of enforcing timely payments and cutting off water and sanitation service from noncompliant households.
iii	Begin introduction of district meters with Nuevo Chao II. Incrementally increase metered areas beginning with the West and East sides of the Pan American highway in Chao and then move on to Nuevo Chao.
iv	Couple transitions to metered service with continuous service to ensure optimal performance of meters and public acceptance.
FINANCIAL	
v	Apply CAFES principles in designing the new water and sanitation tariff with consideration of the increasing block format for metered areas.
vi	Offer subsidies for water-conserving showers and toilets and increase the availability of such infrastructure in the many hardware stores throughout Chao.
vii	Establish and enforce fines on street watering wherein prominent violators such as the *Junta de Usuarios* and police station must comply and set an example for the public.
SOCIAL	
viii	Rebrand the image of SADISCHAO by promoting the new water and sanitation service. In particular, educate the public on the services four-step treatment process and, correspondingly, the water's improved quality.
ix	Collaborate with public and private institutions and organizations to develop an awareness building water conservation campaign. Communicated messages should be simple, short, focused, frequent, and repetitive. They should be tailored to each unique user group (i.e. Chao households, Well users and Nuevo Chao households). Emphasis should be placed on existing conservation behaviors such as water reuse and messages should be communicated across multiple forms of media including the monthly water bill.
x	Hold workshops and trainings on the use of native vegetation as a sustainable alternative to street watering, installing demonstration projects along the Pan American highway and other community focal points.
xi	Continually create opportunities for public engagement whereby households' perceptions and water use practices can be periodically reevaluated.
GENERAL	
xii	Develop a timeline and SMART indicators and monitoring plan for each demand management strategy chosen.

Note: Strategies are not presented in any particular order of importance. Rather, they are presented in groups according to whether they are primarily technical, financial, social or (general) in nature.

CHAPTER 6: CONCLUSION

The urban area of the district of Chao is characterized by three distinct water user groups: 1) those in Chao who receive water daily for one to three hours; 2) those in Chao who rely on un-improved wells; and 3) those in Nuevo Chao who receive water every other day for thirty minutes to an hour. Over the course of 2010 to 2012 the Municipality of Chao invested ~$9 million into the construction of new water and wastewater treatment plants with the goal to bring all three user groups under one continuous, metered, water and sanitation service. The service was designed to serve 97% of the population twenty years into the future with an assumed demand of 150 liters per capita per day and 25% of produced water being lost (non-revenue water).

Demand management was not mentioned in the project plans, which is not uncommon in developing countries where political preference is for high visibility and supply-oriented projects (Sharma & Vairvamoorthy, 2009). This is unfortunate as the literature has suggested that in developing countries, particularly in water scarce areas such as Chao, incorporating demand management strategies is key to ensuring that 1) the entire population receives a reliable, equitable, adequate, supply of quality water and 2) that this supply remains as such into the future. Accordingly, this study surveyed households' behaviors and beliefs surrounding the existing water situations (intermittent, un-metered, services), and investigated how demand management could be applied to small, developing, cities such as Chao.

The first objective was to understand how households, with varying degrees of intermittent service, used, perceived, and valued water and their water services, in order to inform knowledge of existing and potential domestic water use and demand. The second

objective was to use this information to demonstrate the importance of demand management and propose strategies applicable to conditions in Chao. Also, it is probable that these findings and recommendations are applicable to other small cities in water-scarce regions with intermittent, un-metered, water services.

In order to address these objectives data was collected via: an extensive literature review, semi-structured interviews, field visits/site inspections, informal focus groups, key informant interviews, and household surveys. Household surveys were conducted with the help of local, trained, enumerators over two twelve-day periods in the months of January and September 2012. A total of 1,149 households were interviewed about their water behaviors and underlying factors that shape them.

Survey results showed the distribution of water was inequitable and that, on average, households received water for less time than had been presumed by the service providers. However, despite the short duration of supply (not including Well users), the majority of households in each user group reported to have enough water for their needs. Estimated per capita water use ranged between 35 to 90 lpcd (seasonal average of 75 lpcd in Chao compared to 61 lpcd for Well users and 47 lpcd in Nuevo Chao). On average, in comparison to Nuevo Chao, households in Chao have four times the access to potable water, report to store ~200 liters more per day, and use ~60% more water per capita per day. This suggests that when intermittent service is available for a sufficient time (and pressure), storage devices allow households to store and use water beyond their basic needs. The fact that Well users utilize a similar volume of water as Nuevo Chao households despite their *continual* supply suggests that convenience is also a factor of water use.

Reported water conservation efforts were high (73% Chao, 63% Well Users, 71% Nuevo Chao). It is interesting that despite greater access to water in Chao, reported conservation

efforts in Chao and Nuevo Chao were relatively the same. It is possible that reported conservation efforts were the lowest for Well users as they knew their water supply, although not convenient, was essentially unlimited. In fact, seasonal differences in the data (summer to winter differences of 19% Chao, 6.0% Well users, 17% Nuevo Chao) suggest that for Chao and Nuevo Chao households water conservation is in part motivated by availability rather than for the greater good and/or the environment. Overall, reported water conservation efforts must be taken with reservation as the data shows that there was a lack of understanding concerning the term water conservation. A lack of understanding is grounded by the finding that the majority of households have never learned or heard about water conservation (68.2% Chao, 75.7% Well users, 61.6% Nuevo Chao).

The practice of street watering with potable water (46.2% Chao, 58.1% Well users, 35.2% Nuevo Chao) suggests a disregard for water resources. Roughly only a quarter of the population recognizes the region's water scarcity (24.6% Chao, 22.0% Well users, 28.9% Nuevo Chao), citing the number of wells in the area or the size of the services distribution tubes as evidence there is plenty of water. It appears households believe periods of temporary perceived scarcity (such as during the summer or service interruptions) are the result of inept service providers, not indicative of the region's scarce freshwater resources.

Household water treatment was prevalent among all user groups. Although 63.5% of Nuevo Chao households and 76.1% of Well users trusted the quality of their drinking water (compared to 28.7% in Chao), a large majority in each user group reported household water treatment (79.6% Chao, 72.0% Nuevo Chao, 81.4% Well users). This is likely a reflection of several things. First, the majority (73.9% Chao, 69.6% Well users, 66.7% Nuevo Chao) of households reported water quality as the most important aspect of a water service (as compared to schedule, continuity, maintenance, etc.). Second, data showed that water quality

is judged by taste and odor as well as in terms of physical and biological safety. So, although the taste of the water in Nuevo Chao and for Well users may have been preferable to Chao's, water treatment was common all around. Perhaps because the majority of Chao and Nuevo Chao households did not know what their providers were doing to make their water potable (56.1% Chao, 56.4% Nuevo Chao), they still provided additional treatment before drinking.

Despite the unmet need of quality water in Chao, and availability of service in Nuevo Chao, households have low willingness to pay for service improvements, both in the form of availability and quality. As the majority of households rated water as the most important public service project (of eight choices) (37.5% Chao, 68.0% Well users, 51.5% Nuevo Chao), unwillingness to pay may stem from low trust in the service providers with respect to (pre)existing services and a belief that a water service should be a certain price.

Unfortunately, the transition to the new service has been haphazard. What could have been an opportunity to highlight the Municipality's dedication to improving the quality and equity of the water and sanitation service has instead been characterized by service interruptions and inconsistent water quality. As it stands, the new water and sanitation service is not continuous, nor metered, and is costing four times its monthly revenue to operate. Although demand management strategies may seem difficult to implement under such circumstances, they are all the more pertinent.

Many of the existing demand management studies in developing countries were conducted in large cities. This study suggests that demand management is applicable to smaller urban areas as well. Whereas in large sprawling water networks focus may be placed on leakage management, in smaller cities where networks are still relatively small and new and where providers are limited both technically and financially, the nonstructural aspects of demand management are a good place to begin.

Specifically, Chao is a good candidate for a public education and awareness campaign. This is particularly true given 1) the public's low regard for their (pre)existing services 2) SADISCHAO's budgetary constraints and the expense in developing, operating and maintaining the new water and wastewater treatment plants 3) the lack of meters and technology and 4) the small city environment where households regularly interact with one another and have experience with water scarcity. After garnering public trust and awareness, the economical and technical strategies of demand management, such as raising tariffs and introducing meters, will have greater success.

As the result of this study, the Municipality of Chao now has information about unique user groups and their respective behaviors and opinions regarding water. This information can be used to develop targeted communication campaigns. The Municipality must make customers aware of their recent investment in the new and improved water and sanitation in order to shore up community trust. Public support and their willingness to pay are critical to the financial sustainability of the new system. Given Chao's small size, the opportunity to directly engage all households is realistic. Partnerships with public and private institutions should also be formed. The latter can help to shoulder the cost of such a campaign.

This study has shown that overall awareness of water scarcity and understanding of water conservation is low. For long term success, the Municipality must make consumers aware of the region's physical water scarcity and build household support toward a water conversing culture. The Municipality's combination of the new system's treated water with poor quality groundwater is a significant problem. Based on consumer preferences for high quality over high volume, this practice should be reconsidered. To begin, concentrating on achieving a reduction of potable water used for watering the dusty streets is a better goal than trying to provide a delivery of compromised water beyond per capita need.

As public support and awareness of the service provider / Municipality increases, other demand management strategies should incrementally be incorporated. These include subsidies for efficient water-related infrastructure, household metering, and creative tariff design. With respect to high-efficiency infrastructure and households meters, the Municipality would see the greatest benefit if these strategies were coupled with continuous service. Continuous service should not imply greater household water use so long as education and awareness building have been effective. Overall, by incorporating water demand management strategies, the Municipality of Chao can ensure that the public understands the true value of water and their provided service, that wasteful water behaviors and network leakages are kept at a minimum, and that adequate revenues are raised for necessary operation and maintenance. In conclusion, demand management strategies will not only address SADISCHAO'S social, financial, and technical issues, but ensure the sustainability of Chao's domestic water supply and the subsequent health and prosperity of the public now and into the future.

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APPENDICES

Appendix A IRB Letter of Approval

UNIVERSITY OF SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd. MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5613

December 15, 2011

Merril Putnam
Civil and Environmental Engineering

RE: **Expedited Approval** for Initial Review
IRB#: Pro00005713
Title: Factors influencing water demand in coastal Peru: Effect of improved water supply on water use, value and understanding

Dear Merril Putnam:

On 12/14/2011 the Institutional Review Board (IRB) reviewed and **APPROVED** the above referenced protocol. Please note that your approval for this study will expire on 12-14-12.

Approved Items:
Protocol Document(s):

Water Culture in Chao - Protocol	12/8/2011 8:19 PM	0.02

Consent/Assent Documents:

Name	Modified	Version

Wavier of Informed Consent granted for the consent forms.

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural

beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your study qualifies for a waiver of informed consent documentation based on 45 CFR 46.117 (c) which states an IRB may waive the requirement for the investigator to obtain a signed consent form for some or all subjects if it finds either: (1) That the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality. Each subject will be asked whether the subject wants documentation linking the subject with the research, and the subject's wishes will govern; or (2) That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John Schinka, PhD, Chairperson
USF Institutional Review Board

cc: Various Menzel, CCRP
USF IRB Professional Staff

Appendix B Municipality of Chao Letter of Participation

Manejo de Agua en Chao, 2011-2012

En el Distrito de Chao, siendo el 24 del mes Noviembre, año 2011, luego de haber presentado la tesis "INVESTIGACION DE COMO LOS RESIDENTES DEL DISTRITO DE CHAO USAN, VALORAN Y ENTIENDEN EL SERVICIO DE AGUA ANTES Y DESPUES DEL CAMBIO DE MANEJO DE SERVICIO Y DE FUENTE DE CAPTACION" que será realizada en las localidades de Chao y Nuevo Chao, Provincia de Virú, Departamento de La Libertad, después de haber conversado con el Señor Alcalde Distrital, Ney Gámez Espinoza, y por parte de la Universidad de Florida Sur, para formalizar el presente compromiso, bajo las siguientes cláusulas:

1. Que el estudio es apropiado para la Municipalidad Distrital de Chao y sus residentes respectivos

2. Que, si recibe el aprobación del IRB de la Universidad del Sur, la Municipalidad Distrital de Chao aportará con:

   a. los materiales necesarias para llevar a cabo las encuestas (impresor, papel, tinta)
   b. ocho personal para apoyar el investigador principal realizar los 350-500 encuestas anticipados
   c. Transporte

3. Que, por si acaso, algunos de los residentes tienen algunas dudas con la investigación, pueden hacer todas las preguntas a la Investigadora Principal, señorita Merril Putnam, o de lo contrario acercarse a pedir información en la Oficina de Sadischao ubicada en el interior de la Municipalidad Distrital de Chao.

4. Que la Voluntaria Cuerpo de Paz Perú aporta con:

   a. Su profesionalismo a dirigir el estudio según los requisitos de IRB, respetando la privacidad, derechos, y bienestar de los residentes del distrito de Chao
   b. Comunicación continúa con las autoridades designadas de la Municipalidad durante el progreso del estudio.
   c. Comunicación de los últimos resultados e informe final.

De mutuo acuerdo evaluado las partes es que se da por aceptada la presente carta convenio dado en el Consejo Distrital de Chao, siendo 24 del mes Noviembre, año 2011.

[redacted]

Ney Gámez Espinosa
Alcalde Distrital

[redacted]

Merril Augusta Putnam
Universidad de Florida Sur

Appendix C Informal Consent for Household Surveys

C.1 English

Principal Investigator: "*Greetings, my name is Merril Putnam and I am a university student working toward my masters degree in environmental engineering. I am interested in people's understanding of water and usage practices in the district of Chao and to this end am conducting a small survey. Just so that you are aware, I am not affiliated with the District Municipality of Chao, but they are supporting my study by providing me with a team of eight individuals to help me conduct the surveys. However, to reiterate, I am not affiliated with the government or any government agency; my interest is purely academic. This short interview will take up about 25 minutes of your time. Then, in a couple months there will be a follow-up interview similar to the one you are about to take. Your personal information will not be asked and your answers will remain confidential. At the end of my study, I will be sharing my findings with the District Municipality of Chao and other interested institutions. Would you like to go ahead with this interview?"*

If the answer is "yes," I would go ahead with the interview.

"*Thank you for taking time out of your day to participate. I will first ask you a few questions regarding your household, then, I will proceed to ask you a bit about your current water usage practices, your understanding of water, and the value it holds in your life.*"

Survey Team: "*Greetings, my name is _____. I am supporting a survey by a student from the University of South Florida who is working towards her masters degree in environmental engineering. She is interested in people's understanding of water and usage practices in the district of Chao and to this end she is conducting a small survey. The student has no affiliation with the District Municipality of Chao, but they are supporting her study by providing her with a team of eight people to help her conduct the surveys; I am one of these people. However, to reiterate, the student is not affiliated with the government or any government agency. This short interview will take up about 25 minutes of your time. Then, in a few months, a member of the interview team will return to conduct a follow-up interview similar to the one you are about to take. Your personal information will not be asked and your answers will remain completely confidential. At the end of my study, the student will be sharing her findings with the District Municipality of Chao and other interested institutions. Would you like to go ahead with this interview?"*

If the answer is "yes," the enumerator would go ahead with the interview.

"*Thank you for taking time out of your day to participate. I will first ask you a few questions regarding your household, then, I will proceed to ask you a bit about your current water usage practices, your understanding of water, and the value it holds in your life.*"

C.2 Spanish

Investigador Principal: "*Buenas días, mi nombre es Merril Putnam. Soy estudiante, quiero obtener mi maestría en ingeniero ambiental. Estoy interesada en el conocimiento y uso del agua de la gente en el distrito de Chao y, por eso, estoy llevando a cabo esta pequeña*

encuesta. No tengo ningún vínculo laboral con la Municipalidad Distrital de Chao, pero ellos están apoyando mi estudio con la provisión de un equipo de ocho personas quienes van a ayudarme hacer las encuestas. Sin embargo, para clarificar una vez más, no trabajo para el gobierno local, ni para ninguna otra agencia del gobierno. Llenar esta pequeña encuesta nos tomará aproximadamente 25 minutos. Luego regreso dentro de unos meses para llenar una encuesta similar a la de ahora. No anotaremos ningún dato personal, y sus respuestas serán completamente confidenciales. Al finalizar el estudio, estaré presentando un informe final a la Municipalidad Distrital de Chao y otras instituciones interesadas en el tema. ¿Gustaría ayudarme con su participación en este estudio?

Si la respuesta es "si," continuaré con la encuesta.

"*Gracias por permitirme quitarle el tiempo con su participación. Primero, le hare algunas preguntas con respecto a su vivienda, y después continuaré con preguntas sobre el uso de agua, sus conocimientos de agua, y el valor que tiene en su vida."*

Equipo de encuestas: "*Buenas días, mi nombre es _____. Estoy apoyando a la realización de una encuesta de una estudiante de la Universidad de Florida del Sur (EE.UU), que quiere obtener su maestría de ingeniero ambiental. Ella está interesada en el conocimiento y uso del agua de la gente en el distrito de Chao y, por eso, Ella está llevando a cabo esta pequeña encuesta. No tiene ningún vínculo laboral con la Municipalidad Distrital de Chao, pero ellos lo están apoyando en su estudio con la provisión de un equipo de ocho personas quienes van a ayudarle hacer las encuestas, uno de ellos soy yo. Sin embargo, para clarificar una vez más, Ella no trabaja para el gobierno local, ni para ninguna otra agencia del gobierno. Llenar esta pequeña encuesta nos tomará aproximadamente 25 minutos. Luego un miembro del equipo regresara dentro de unos meses para llenar una encuesta similar a la de ahora. No anotaremos ningún dato personal, y sus respuestas serán completamente confidenciales. Al finalizar el estudio, La señorita estará presentando un informe final a la Municipalidad Distrital de Chao y otras instituciones interesadas en el tema. ¿Gustaría ayudarla con su participación en este estudio?*

Si la respuesta es "si," continuaré con la encuesta.

"*Gracias por permitirme quitarle el tiempo con su participación. Primero, le hare algunas preguntas con respecto a su vivienda, y después continuaré con preguntas sobre el uso de agua, sus conocimientos de agua, y el valor que tiene en su vida."*

Appendix D Round I - Household Surveys

D.1 English

	DATE / Name of Interviewer _____ N° (19) HOUR ____ Water Diary? Yes No	(1) N° 19 refers to what column number was used for the WTP questions. IE. For the first interview, column I was used, the second interview, column II, the third interview, column II, the fourth interview, column I,....continuing II, III, I, II, III, etc. (2) If respondent agrees to fill out a Water Diary, mark 'Yes' so that I will know to go back to their house and retrieve it.
1	SECTOR: Man Woman Age Block N°	You do not have to ask the respondent their block and lot number; this can be noted when you hear someone coming to the door or at the end of the interview. If the block and lot number are not indicated on the door or electricity meter, note the house number and street instead.
	HOUSEHOLD CHARACTERISTICS	
2	Rent Own N° years owned N° year in urban Chao Area (m2) N° Rooms N° Animals N° Family N° Renters	(1) Write 'n/a' or '/' in the 'N° years owned' box if the respondent is renting the space (i.e. it is not their family's property); (2) N° years in urban Chao refers to the number of years the individual has been living in the Chao/Nuevo Chao area (3) Area (m2) includes the whole property, not just the floor plan of the house; (4) 'N° Rooms' implies all spaces that are utilized; (5) 'N° Animals' includes Pets. For example, if household has 1 pig, 12 guinea pigs, and 1 dog write 13/1; (6) N° in the family implies all the occupants that are family members (DOES NOT include the renters).
	Characteristics of residence prior to living in urban center of Chao: rural urban coast sierra jungle Property Area N° rooms	The definition of rural used is <5,000 habitants. This does not need to be explicitly stated to the respondent when asked during the interview. You should just know for the purposes of marking their responses correctly,
	Children (<5) Youth (5<x<16) Adults Men Women N° of residents according to current level of Education:	The division between ages and men/women should be recorded to include all the those residing in the house (family and renters).
	Kindergarten Primary Secondary Technical Univ. None	(1) Note the education according to where everyone in the family is currently studying OR studied up to. For example, if an individual went to two years of high school but did not graduate, still mark 'Secondary;' (2) For adults (the respondent and the other adults who have an income), identify their education with asterisks '*,' identify the education of other household occupants with tallies 'I'.
	N° of Income generators Monthly Income Principal Occupation	(1) When necessary (respondent hesitates to respond), repeat that everything is confidential; (2) Principal occupation refers to the occupation of the person in the household that has the highest monthly paycheck; (3) Distinguish between farmer (that works for company) and farmer (that works own land).
3	Which of the following services/artifacts do you have? Note monthly cost (S/.) Electricity S/. Cable S/. Internet S/. Cell/Landline S/. Nextel S/. Transport S/.	(1) For 'Electricity,' 'Cable,' 'Internet' and 'Nextel,' the first box is to note the number of years the person has had the service/artifact and the second box to note the cost per month of the service; (2) For 'Cell Phones,' the first box is to note the number of years the person had owned a cell phone (not necessarily their current model), the second box to note the N° of cellphones in the house, and, the third box, to note the respondent's estimate of how much they spend per month on 'minutes;' (3) For 'Transportation,' the first box is to note the number of years the respondent has had the vehicle, the second box to note whether the vehicle is a car, motor-taxi, or motorcycle, and the third box to note the monthly cost of maintaining and driving (i.e. gas) the vehicle.
4	Do you belong to a social network? (Mark all that apply) Facebook Hi5 Other _____ No	If the respondent mentions other, write their response in space provided.
	WATER	
5	Where do you get your water from? Mark all that apply according to predominance (1=largest source) Well Standing water River Spring Bottled Water Public Pump Canal Household connection	(1) Mark all the sources that the respondent uses, no matter how (in)frequently, and number according to predominance: 1=principal source; 2=secondary source, 3=tertiary source; etc.. NOTE: you only need to put numbers in the boxes next to sources that the respondent uses; (2) In case the respondent only mentions one source and is not thinking about the river, bottle water, etc., that they sometimes also use, ask them about every source separately to make sure that they voice ALL the sources they use. For example, you can say 'You never by bottled water? Go to the river to wash clothes or bathe?'
6	How do you store this water? Rotoplas L Tanks L Buckets L Washtubs L	Mark all storage devices that the respondent has; the first box is to note the number of such storage devices and second box is to note the TOTAL number of liters that storage type category can hold, For example, the household could have, 'Rotoplas' = 1, 1,100,' 'Buckets' = '3, 60 L;' and 'Tubs' = '4, 120 L' (2) The idea here is to see how much water the household has the Potential to store.
	How frequently do you wash your storage devices? daily weekly monthly annually never other _____	People would always interrupt and respond what they washed with (detergent, bleach) instead of what frequency (as if ingrained on autopilot). I would then repeat the question.

Appendix D (Continued)

	How many liters of water DO you store daily? ____ In total, how many liters of water do you believe your RENTERS consume daily? ____ In total, how many liters of water do you believe your FAMILY consumes daily? ____				(1) NOTE, now you are asking the respondent how many liters they actually store on a daily basis (i.e. not potential to store) (where in Nuevo Chao storage will be on an every other day basis); (2) if the house dot not have renters mark 'N/A' or '/'
7	*If the respondent uses more than three sources, select the top three for the following section*	Principal Source	Alternative #1	Alternative #2	(1) Use answers from question #5 to determine which source is the Principal Source, Source 2,' and Source '3;' (2) NOTE If the respondent did not mention using three separate sources of water, you don't need to fill out every column in question #7
	Of your total daily water use, estimate how many liters come from this source?				This question applies to households that use more than one source. For example, '200 L' from the faucet, another '50 L' from a well, and '20 L' of bottled water.
	With what frequency do you use this source?				Again, this question only applies to households that use more than one source. For example, 'daily' from faucet, 'only when faucet water not available' from well and 'weekly' (drink) bottled water
	IF domestic connection exists, how many hours a day does water arrive / IF no domestic connection, note the effort (time) required to obtain water				If the household had a faucet, the first column is to mark the number of hours they receive water per day. If the household used other water sources as well, in columns 2 (and 3), note the effort that is required to access this water. For example, perhaps it could be '10 minutes with a bucket' or '5 minutes with an electric pump' for a well, 'one hour walking' for water from the river, and 'no effort' for the purchase of bottled water
	How do you use water from this source? (1 - Drinking water; 2 - Bathing; 3 - Washing; 4 - Cooking; 5 - Sanitation; 6 - Watering street; 7 - Irrigation) Note all uses that apply.				Again, this question only applies to households that use more than one source. NOTE: You can note more than one number. For example, perhaps the respondent uses water from their faucet for 'bathing, cleaning, and washing clothes,' (# 2 and 3) while they use water from a well for 'drinking and cooking' (#1 y 4)
	Where does the water go once used? (1 - sewage; 2 - latrine; 3 - water street; 4 - water plants; 5 - septic tank; 6 - other (specify))				NOTE: You can write down more than one number per water source. For example, water from faucet goes to 'sewage and street' (#1 and 3)
	How would you describe the quality of water from this source?				Write down word for word how the respondent describes the quality of their water source(s)
	Do you treat this water before using it and, if so, how much does this cost you per month? (0 - crude; 1 - boiled; 2 - filtered; 3 -chlorinate; 4-coagunlant; 5-other (specify))				DO NOT FORGET to ask the respondent to estimate the cost per month of their reported treatment. For example, if the respondent boils their water, they could estimate it costs S/. 10 per month
	How much does the water cost you per month?				
	How do you perceive the price? (1 - doesn't apply; 2 - cheap; 3 - fair; 4 - too much; 5 - other (specify))				If the respondent gives a word other than 'cheap,' 'regular' or 'expensive' write the response word for word
8	What is more important for you: Quality of water / Quality of service				Read the respondent the two options
	With respect to the quality of your water, what is the most important: taste / appearance / physical safety / biological safety / other _____				(1) Read out loud to the respondent the five options, and only mark the one that is most important to them (i.e. if they mention more than one characteristic, mark the one they mention first); (2) If the respondent mentions something different mark 'other' and note their responses word for word
	With respect to your water service, what is the most important: quality / continuity / price				Read the respondent the three options, and only mark the one that is most important to them (i.e. if they mention more than one characteristic, mark the one they mention first)
	What is your opinion of the taste of chlorinated water? agreeable / disagreeable				Read the respondent the two options.
9	How many times a day do you drink water? 0 / 1 / 2 to 3 / 4 to 5 / >6 — How many times a day do you drink water in another form (tea, etc.)? 0 / 1 / 2 to 3 / 4 to 5 / >6				(1) It is not necessary to read the categories, only mark the box to which the respondent's answer corresponds; (2) NOTE: this question only refers to the liters per day the respondent drinks, not their entire family

Appendix D (Continued)

	How many liters of pure water do you drink a day? ≤0.5 | 0.5< x ≤1 | 1< x ≤2 | 2< x ≤3 | >3 How many liters of water do you drink a day in another form (juice, tea, etc.)? ≤0.5 | 0.5< x ≤1 | 1< x ≤2 | 2< x ≤3 | >3	(1) It is not necessary to read the categories, only mark the box to which the respondent's answer applies; (2) NOTE: this question only refers to the liters per day the respondent drinks, not their entire family
10	How many years have you had a domestic water connection? (If the respondent does not have, mark 'N/A' and go to question #11) N/A | <1 | 1 to 3 | 4 to 7 | >7	Do not read the categories, only mark the box to which the respondent's answer corresponds; (2) If the household does not have a domestic connection, mark N/A and move on to question #11
	Where does the water from your connection come from? spring | river | well | canal | don't know | other _____	(1) do NOT read the categories, this is an open-ended question; (2) If the respondent says 'reservoir,' make a note and then ask the respondent again if they know what the Source of the water is. If they give a different answer (well, CHAVIMOCHIC, etc.) note it accordingly
	Do you have problems with water pressure? Yes | No With what frequency? rarely | daily | weekly | monthly	
	Do you have confidence in your water provider? Yes | No Why? _____	
11	Would you be willing to pay more for your water service than what you are paying for your _____ service? Electricity Yes | No Cable Yes | No Internet Yes | No Cell phone Yes | No Nextel Yes | No Car / Motorcycle Yes | No	NOTE: You only need to ask about the services the respondent mentioned (to have) in question #3.
12	When it comes to prioritizing the distribution of water, rank the following five categories from most (1) to least important (5) Agriculture [ ] Environ. [ ] Commercial [ ] Domestic [ ] Industrial [ ]	Read the five categories so that the respondent can put them in order. You may need to read the categories more than once in order to help the respondent respond correctly, remember to emphasize that 1 is for the sector that (in their opinion) has priority
13	Number of: Faucets [ ] Showers [ ] Known leaks? [ ] Toilets? [ ] flushes per day [ ] How many liters in your toilets tank? 4L | 6L | 13L | don't know | other _____	You only need to ask about flushes per day if the household has a toilet or pour-flush latrine, where flushes per day refers to the respondent's personal use of their households' toilet.
	Does the house have sewage? Yes Go to #14 | No Go to #15	If the respondent replies 'Yes' go to question #14, if the respondent replies 'No' go to question #15
14	Where does the sewage go? Canal | River | Oxidation Ponds | Don't know | other _____	Do NOT read the options.
15	Where do you do your necessities? pit | latrine | pour flush latrine | field | other _____	
	Where does the water you use for washing, cleaning, and bathing go? septic tank | street | canal | river | other _____	Straightforward, this question only applied to respondents who did not have sewage. Often the respondent's greywater went to more than source. In the future I would probably just explicitly ask, where does your bathing water go? washing water? dish water? etc.
16	How do you bathe? shower | bucket How many minutes/liters? [ ] Times per day [ ] Summer [ ] Winter	(1) If the respondent bathes in the shower, note the number of minutes they reported to stay in the shower (with water running); If the respondent bathes with a bucket, note the number of liters they estimate to use each time they bathe; (2) NOTE: this question corresponds to the respondent's personal hygiene, not the entire family's
	How many times a day does household wash dishes? [ ] [ ] do you wash hands [ ] [ ] do you brush teeth? [ ] [ ]	(1) In the first box note the number of times per day the activity is done, in the second box note the number of liters used each time the activity is done; (2) NOTE: washing hands and brushing teeth only refers to the practices of the respondent, not the entire household
	How often do you: <8am | 8am-5pm | > 5pm water street per DAY [ ] [ ] [ ] with what type of water? [ ] [ ] [L] wash clothes and how many times a WEEK tubs [ ] machine [ ] Can you estimate how much water you use every time you wash? (L) <20 | 20-40 | 40-80 | 80-120 | >120 | don't know	(1) It is NOT necessary to put a number in every box next to 'water street per DAY.' For example, if the respondent waters twice a day, once at 6 in the morning and once at 4 in the afternoon, mark '1' in the box under <8am and '1' in the box under 8am-5pm; (2) water type refers to whether the respondent uses water from the faucet, washwater, well water, etc., if the respondent uses more than one water type, mark all that apply; (3) In the 'L' box put the respondents' estimate of how many liters of water they use a day for watering. For example, if they throw out a bucket (oil sized, 18L) in the morning and another bucket in the afternoon, it would be ~'36 L;' (4) If the respondent uses washtubs for washing clothes mark the number of times they do laundry per week in the box under 'tubs,' if they use a washing machine, mark the number of times they do laundry per week in the box under 'machine,' (i.e. you will not write a number in both boxes unless they do laundry both ways); (5) If the respondent has difficulty estimating how many liters they use every time they do laundry, you can help them make an estimate with questions like "How many tubes do you use?, How many liters does each tub hold?, and How many times do you fill and empty each tub?," etc.

Appendix D (Continued)

17	Which of the following chemicals do you use to clean your house? Mark all the apply hydrochloric acid | bleach | caustic soda | detergent | lemon | vinegar | other _____	Read the options to the respondent, if the respondent mentions something that is not a listed option, mark 'other' and write their response word for word
18	Do you currently practice a form of water conservation in your house? Yes ☐ No ☐ because... water saving devices ☐ water reuse ☐ _____ repair leaky faucets ☐ don't water street ☐ _____ reduce water use ☐ other ☐ _____ _____	do NOT read the respondent the reuse options; they are there simply to act as a guide should the respondent mention them. If the respondent mentions more than one option mark them in the order in which they were said '1, 2,' etc., if the respondent mentions something that is not a listed option, mark 'other' and write their response word for word
	OFFER PRICE OF COLUMN I, II, or III	
19	*For an uninterrupted, 24/7 service would you be willing to pay S/. X per month?* I: 18 Yes No II: 24 Yes No III: 36 Yes No *For clean, treated, water would you be willing to pay S/. X per month?* I: 18 Yes No II: 24 Yes No III: 36 Yes No *For an uninterrupted, 24/7 service, that provides clean, treated, water would you be willing to pay S/. X per month?* I: 24 Yes No II: 36 Yes No III: 48 Yes No *For a sanitation service, apart from the cost of a water service, would you be willing to pay S/. X per month?* I: 18 Yes No II: 24 Yes No III: 36 Yes No *For an uninterrupted, 24/7 service that provides, clean, treated, water AND a sanitation service, would you be willing to pay S/. X per month?* I: 30 Yes No II: 42 Yes No III: 54 Yes No	(1) ONLY READ THE PRICES FROM ONE COLUMN FOR EVERY HOUSE, in rotation; (2) For the first three questions, emphasize the scenarios do NOT include sewage; (3) For the fourth question, emphasize that the scenario does NOT include water; (4) For the last question, emphasize that the scenario includes BOTH sewage and water.
20	Do you believe water in Peru is Abundant | Scarce Do you believe water in Chao is Abundant | Scarce Have you ever experienced water scarcity? Yes | NO How often? Daily | Weekly | Monthly	(1)Say 'abundant or scarce;' (2) Only ask the respondent about the frequency they experience water scarcity if they respond 'Yes' to having every experienced water scarcity
21	What is the most gravest environmental problem facing Peru? water pollution | exploitation of natural resources | water scarcity air pollution | rapid, unorganized urban growth | overfishing endangered species | improper elimination of toxins | desertification soil erosion | deforestation | climate change	At first, do NOT read the options. If the person does not understand the question and/or begins to mention other things like delinquents, re-ask the question emphasizing concern regarding environmental issues. If the respondent continues to not have an opinion, read the list as if reading a book (left to right, top to bottom). Following the reading, if the respondent mentions more than one option, note the topics '1, 2, etc..' in the order that they were said.
22	Do you think climate change is affecting Peru? Yes | No affecting Chao? Yes | No	
23	Of all the water in the world, what percentage do you think is fresh water? ≤10% | 10<x≤30 | 30<x≤60 | 60<x≤80 | >80% a little | regular | a lot	NOTE: If the respondent does not understand percentages, read the options 'a little, regular or a lot'
24	Do you get along well with your neighbors? Yes | Sort of | No How well supported do you feel by your community? Well | Alright | Bad | No opinion	(1) It is not necessary to read the respondent the options; (2) At the end of the survey, ask the respondent if they have any comments, doubts, questions, etc. to add? Don't forget to thank them for their time and participation.

Appendix D (Continued)

D.2 Spanish

	FECHA / Nombre Encuestador _____ N° (19) ____ HORA ____ Diario de Agua? Si / No	(1) N° 19 refiere a que columna va a usar para pregunta #19. Recuerde que la primera encuesta que hace va a usar columna "I," la segunda encuesta, columna "II," la tercera encuesta, columna "III," la cuatro encuesta, columna "I,"....sigue II, III, I, II, III, etc.; (2) Si el/la respondiente acordó llenar el diario de agua, marca 'S/' para que sepa que tengo que regresar a colectarlo.
1	SECTOR: ____ Manzana ____ Lote N° ____ Hombre / Mujer Edad ____	No tiene que preguntar por la manzana y lote, si puede, nótalo cuando está esperando o al fin de la encuesta. Si no está indicado en la puerta o caja de luz, marca la dirección de la casa.
	CARACTERÍSTICA DE LA VIVIENDA	
2	Alquila / Dueño N° años propiedad ____ N° años Chao urbano ____ Área (m2) ____ N° Habitaciones ____ N° Animales/Mascotas ____ N° Integrantes ____ Inquilinos ____	(1) Pone 'n/a' o '/' en la caja de N° años propiedad, si el respondiente NO es el dueño de la casa; (2) N° años Chao urbano aplica a todos los años que la persona ha vivido en Chao o Nuevo Chao (áreas urbanos); (3) área de propiedad incluye todo el terreno, no sólo la casa; (4) Habitaciones implica todos los espacios que son separados y utilizados; (5) 'N° Animales' incluye Mascotas. Por ejemplo, si la domiciliara tiene 1 chancho, 12 cuyes, y un perro, apunta '13/1;' (6) Integrantes implica todos los ocupantes que son familiares (NO incluye los inquilinos)
	Características de su vivienda antes de venir a Chao Urbano: rural / urbano costa / sierra / selva Área (m2) ____ N° Habitaciones ____	Rural implica <5,000 gente aunque no tiene que mencionar esto al respondiente durante la encuesta. Sólo tiene esto en mente cuando está apuntando la respuesta.
	Niños ≤5 ____ Juventud 5<x<18 ____ Adultos ≥18 ____ Hombres ____ Mujeres ____	Marca edades y división entre mujer y hombre por TODOS en la casa, integrantes (familia) y inquilinos
	Educación - N° de integrantes según el grado de instrucción: jardín ____ primaría ____ secundaria ____ técnico ____ Univers. ____ ningún ____	(1) Marca las categorías dónde todo la familia en la casa pertenece ahora mismo O dónde ha dejado de estudiar. Por ejemplo, si una persona fue a dos años de secundaria pero no se cumple con todo, todavía marca 'Secundaria;' (2) Por los que son mayores (el/la respondiente más los otros adultos que perciben ingresos), identifica con asteriscos '*' Y para los otros ocupantes de la casa identifica su educación con palitos ' I '.
	N° que perciben ingresos ____ Ingreso Mensual ____ ocupación principal ____	(1) Si es necesario (el/la respondiente vacila), repita que todo es confidencial; (2) Ocupación principal refiere a la ocupación de la persona en la familia que gana lo más cada mes; (3) Distingue entre obrero (trabaja para empresa) y agricultor (propio terreno).
3	¿De los siguientes servicios y artefactos, qué tiene? Electricidad ____ S/. Cable ____ S/. Internet ____ S/. Celular ____ S/. Nextel ____ S/. Tipo de Movilidad ____ S/.	(1) Para 'Electricidad,' 'Cable,' 'Internet,' y 'Nextel' la primera caja es para apuntar el número de años que el respondiente ha tenido el artefacto y/o servicio Y la segunda caja para apuntar el costo mensual del servicio; (2) Con respecto a 'Celular,' la primera caja es para apuntar cuantos años el respondiente ha tenido un celular (no necesariamente el modelo actual), la segunda caja para apuntar cuantos celulares hay en la familia, y la tercera caja para apuntar cuánto el respondiente gasta en 'recargas' por mes; (3) Con respecto a 'Tipo de Movilidad,' la primera caja es para apuntar cuántos años el respondiente ha tenido su vehículo, la segunda caja para apuntar que tipo de vehículo (carro, moto-taxi, motocicleta, combi, etc.), y la tercera caja para apuntar el costo mensual según el mantenimiento de vehículo y combustible
4	¿Pertenece a un red social? (Apunta todos que aplican) Facebook / Hi5 / Otro _____ No	SI es "otro," apunta la respuesta del respondiente.
	AGUA	
5	¿De dónde se abastece su agua? Marca todos que aplican según predominio (1=más usado) Pozo ____ Agua Estancada ____ Río ____ Puquio ____ Agua Envasada ____ Pileta Pública ____ Acequia ____ Conexión domiciliara ____	(1) Marca todos los fuentes que aplican según predominio (1=fuente principal; 2=siguiente más usado, etc....) OJO sólo tiene que poner un número en las cajas de los fuentes que el respondiente utiliza; (2) Por si acaso el respondiente sólo menciona un fuente y no está pensando en el río, agua envasada, etc.. que a veces utiliza, pregunta de cada mencionada fuente para estar seguro antes de seguir adelante. Por ejemplo, puede preguntar al respondiente 'Nunca compra botellas de agua? Va al río a lavar o bañar?'
6	¿Cómo deposita su agua? Y nota litros en caja Rotoplas ____ Tanque ____ Baldes ____ Tinas ____	Marca todos tipos de almacenamiento que el respondiente tiene; la primera caja es para apuntar cuántos de cada tipo tiene y la segunda para apuntar el TOTAL número de litros puede abastecer con este tipo, por ejemplo, puede ser, 'Rotoplas' = 1, 1,100 L y 'Baldes' = '3, 60 L' y 'Tinas' = '4, 120 L;' (2) La idea es para entender qué volumen de agua la vivienda podría abastecer si fuera necesario.
	¿Con que frecuencia lava sus depósitos? diario / semanal / mensual / anual / nunca / otro _____	
	¿EN TOTAL, cuántos litros de agua almacena diariamente? (L) ____ En total, ¿Cuántos litros de agua cree que consume su FAMILIA diariamente? (L) ____ En total, ¿Cuántos litros de agua cree que consume LOS INQUILINOS diariamente? (L) ____	(1) OJO, ahora está preguntando el respondiente cuantos litros actualmente almacena diariamente (o cada otro día en Nuevo Chao); (2) Apunta 'N/A' o '/' si la vivienda no tiene inquilinos
7	*Si la vivienda abastece de más de 3 fuentes, coloca las tres MAS usadas en la siguiente sección. Por ejemplo, Columna 1, "Fuente Principal," pertenecería para el caño, "Fuente 2" pertenecería al pozo, y "Fuente 3" pertenecería al agua envasada* — Fuente Principal / Fuente "2" / Fuente "3"	(1) Utiliza las respuestas del respondiente de pregunta #5 para determinar que es el Fuente 'Principal,' Fuente '2,' y Fuente '3;' (2) OJO: Si el respondiente no mencionó la utilización de tres fuentes de agua, no tiene que llenar cada columna de pregunta #7.
	¿Del total de agua que consume, cuántos litros se abastece de cada fuente?	Este pregunta es sólo aplica a las viviendas (respondientes) que utilizan más de un fuente. Por ejemplo '200 L' del caño, otro '50 L' del pozo y '20 L' de agua envasada
	¿Con qué frecuencia usa este fuente?	Este pregunta sólo aplica a las viviendas (respondientes) que utilizan más de un fuente. Por ejemplo, 'diario' del caño, 'solo cuando no hay agua del caño' por el pozo, y 'semanal' de agua envasada

Appendix D (Continued)

	SI	*ES conexión domiciliara*, ¿Cuántas horas por día del servicio? *NO ES conexión domiciliara*, ¿Cuánto esfuerzo (tiempo) requerido para abastecerse de agua?				Si la vivienda tiene un caño, en la primera columna marca el número de horas que la casa recibe servicio por día. Si la vivienda utiliza otros fuentes de agua, en columna 2 (y 3), apunta la esfuerza requerido para abastecerse el agua. Por ejemplo, quizás sería: '10 minutos con balde' o '5 minutos con bomba' por un pozo, 'una hora caminando' por el río, y 'nada' por comprar agua envasada
	¿Cómo usa el agua que obtiene de esta fuente? *(1 - Tomar; 2 - Bañar; 3 - Lavar/Limpiar; 4 - Cocinar; 5 - Desagüe; 6 - Regar la calle; 7 - Regadío de Plantas; 8 - Otro (especifica)) OJO: Puede notar más de un número*					Pregunta sólo si el respondiente usa más de un fuente. OJO Puede apuntar más de un número. Por ejemplo, quizás el respondiente utiliza agua del caño para 'bañar, limpiar, y lavar ropa' (#2 y 3) y agua del pozo para 'tomar y cocinar' (# 1 y 4)
	¿A dónde va el agua que usa? *(1 - desagüe; 2 - letrina; 3 - regar la calle; 4 - regar plantas ; 5 - pozo séptico; 6 - no aplica; 7 - otro (especifica))*					OJO: Puede apuntar más de un número por fuente. Por ejemplo, agua del caño va al 'desagüe y la calle' (# 1 y 3)
	¿Cómo describe la calidad del agua?					Apunta exactamente la palabra(s) que el respondiente utiliza para describir su fuente(s) de agua
	¿Cómo toma el agua Y, SI TRATA, estima costo por mes por el tratamiento? *(0 - crudo; 1 - hervirlo; 2 - filtrada; 3 -clorada; 4-coagulante; 5-otro (especifica))*					NO OLVIDA de preguntar costo por mes del tratamiento. Por ejemplo, si el respondiente hierve su agua, puede estimar que cuesta S/. 10 mensual.
	¿Cuánto cuesta el agua de este fuente por mes? *(1 - no aplica)*					
	¿Que le parece el precio de agua? *(1 - no aplica; 2 - barato; 3 - regular; 4 - caro; 5 - otro (especifica))*					Si el respondiente le da una palabra diferente de 'barato,' 'cómodo/regular' o 'caro,' escribe la respuesta palabra por palabra
8	¿Qué es más importante para usted?	Calidad de agua	Calidad de servicio			Lea al respondiente las dos opciones
	¿Con respecto a la calidad de su agua, qué es lo más importante?	sabor	apariencia	seguridad física	seguridad biológica	otro _____
	¿Con respecto a un servicio de agua, qué es lo más importante?	calidad	continuidad	precio		Lea las tres opciones al respondiente, Y sólo marca uno (i.e. si el respondiente menciona más de una característica, apunta la característica que menciona primero)
	¿Qué opina del sabor del agua clorada?	agradable	desagradable			Lea las opciones Y sólo marca uno
9	¿Cuántas veces al día tomas agua pura?	0 / 1 / 2 o 3 / 4 o 5 / >6	¿Cuántas veces al día tomas agua en otra forma? (jugo, té, ..)	0 / 1 / 2 o 3 / 4 o 5 / >6		(1) NO es necesario leer las categorías, sólo apunta la caja dónde la respuesta del respondiente pertenece; (2) OJO: Este pregunta sólo refiere a los litros por día que el respondiente consume, no la familia entera
	¿Cuántos litros de agua pura toma al día?	≤0.5 / 0.5< x ≤1 / 1< x ≤2 / 2< x ≤3 / >3	¿Cuántos litros de agua en otra forma de bebida toma al día?	≤0.5 / 0.5< x ≤1 / 1< x ≤2 / 2< x ≤3 / >3		(1) NO es necesario leer las categorías, sólo apunta la caja dónde la respuesta del respondiente pertenece; (2) OJO: Este pregunta sólo refiere a los litros por día que el respondiente consume, no la familia entera
10	¿Cuántos años ha tenido conexión domiciliara? (Si no tiene, apunta 'N/A' y va al pregunta #11)	N/A / <1 / 1 a 3 / 4 a 7 / >7				NO lea las categorías, sólo apunta dónde la respuesta del respondiente pertenece, apunta N/A si la vivienda no tiene conexión domiciliaria
	¿Cuántos litros por minuto crees que cae del caño de agua?	N/A / ≤1 / 1<x≤5 / 5<x≤10 / 10<x≤20 / >20 / no sabe				NO lea las categorías, sólo marca dónde la respuesta del respondiente pertenece.
	¿De dónde viene el agua que está almacenada en el reservorio?	puquio / río / pozo / acequia / no sabe / otro _____				(1) NO lea las opciones; (2) Si el respondiente dice 'reservorio' apuntalo al lado y pregúntale al respondiente otra vez si sabe de dónde viene el agua que está almacenada en el reservorio (el fuente definitivo). Si le da otra respuesta como 'pozo' o 'CHAVIMOCHIC' apuntalo.
	¿Tiene problemas con presión?	Si / No	¿Con qué frecuencia?	raro / diario / semanal / mensual		
	¿Tiene confianza en su proveedor de agua?	Si / No	¿Por Qué? _____			

Appendix D (Continued)

11	¿Estaría dispuesto a pagar más por el servicio de agua en comparación a lo que está pagando por su servicio de _____? Electricidad: Si / No; Tele - Cable: Si / No; Internet: Si / No Celular: Si / No; Nextel: Si / No; Carro / Moto: Si / No	OJO: Sólo pregunta por los servicios que el respondiente mencionó (que tiene) en pregunta #3
12	Con respecto a la distribución de agua, enumera de 1 a 5 la prioridad los siguientes cinco sectores tienen, dónde 1 es lo más importante y 5 es lo menos importante Agricultura. ___ Ambiente. ___ Comercial. ___ Domestica. ___ Industrial. ___	Lee las cinco sectores para que ellos puedan enumerar. Puede leer las categorías y pregunta más de una vez para ayudarle el respondiente responder, enfatizando que 1 implicas el sector que tiene prioridad
13	Cuántos? salidas de agua ___ duchas ___ fugas conocidas ___ inodoros ___ descargas al día ___ Cuántos litros utiliza el tanque de su inodoro? 4L / 6L / 13L / no sabe / otro _____	Sólo pregunta de descargas al día si la persona tiene inodoro o baño de arrastre, las descargas refiere sólo al respondiente que está encuestando
	La casa tiene alcantarillado? Si va a #14 / No Va a #15	SI el respondiente responde "Si" usa pregunta #14, Si el respondiente responde "No" usa pregunta #15
14	¿A dónde va el agua de alcantarillado? Pozos de Oxidación / Acequia / Río / No sabe / otro _____	NO lea las opciones
15	¿Dónde hace sus necesidades? pozo ciego / letrina / letrina de arrastre con agua / campo / otro _____	No lea las opciones.
	¿Donde va el agua de su ducha y lavatorios? tanque séptico / calle / acequia / río / otro _____	No lea las opciones.
16	¿Cómo bañarse? ducha / tina ¿Cuántos minutos/litros? ___ ¿Veces por día? ___ verano ___ invierno	(1) Si el respondiente baña con ducha, apunta el número de minutos que el respondiente dice que queda en la ducha (con el agua corriendo); Si el respondiente baña con tina, apunta el número de litros que el respondiente estima que usa; (2) OJO: este pregunta Sólo corresponde al higiene del respondiente, NO de todo la familia
	¿Cuántos veces al día ... lavarse los platos? ___ L lavarse los manos? ___ L cepillarse los dientes? ___ L	(1) En la primera caja apunta cuantas veces por día la actividad está hecho, en la segunda caja apunta cuántos litros gastan cada vez que hace la actividad; (2) OJO: lavarse los platos refiere a la vivienda y lavarse los manos y cepillarse los dientes Sólo refiere a las practicas del respondiente
	Frecuencia: <8am / 8am-5pm / > 5pm ¿regarse la calle por día? ___ ¿con que tipo de agua? ___ L ¿Cómo se lava la ropa y cuántos veces a la semana? tinas ___ lavadora ___ ¿Puede estimar cuántos litros utiliza cada vez que lava? <20 / 20-40 / 40-80 / 80-120 / >120 / no sabe	(1) NO es necesario llenar cada caja de 'regarse la calle.' Por ejemplo, si el respondiente riega dos veces al día a las seis de la mañana y a las cuatro de la tarde, apunta '1' en la caja de <8am, y otro "1" en la caja de 8am-5pm; (2) tipo de agua refiere si el respondiente utiliza agua del caño, agua lavada, agua de pozo, etc., si el respondiente utiliza más de un tipo de agua, apunta todos que aplican; (3) En la caja de 'L' poner una estima de cuántos litros el respondiente utiliza al día afuera de la casa. Por ejemplo, si bota un balde (tamaño de aceite) en la mañana y otro balde (tamaño de aceite) en la tarde sería ~'36 L;' (4) Si el respondiente utiliza tinas para lavar ropa apunta las veces por semana en la caja al izquierda, si utiliza un lavadora, apunta las veces por semana en la caja derecha (i.e. no tiene que poner un número en las dos cajas al menos que el respondiente utiliza los dos); (5) Si el respondiente tiene dificultad estimando cuántos litros utiliza cada vez que lava, puede ayudarle estimar con preguntas cómo "Cuantos tinas usa?, Cuantos litros cada tina? Y cuantas veces llena y bota cada tina?, etc."
17	¿Cuales de los siguientes químicos utiliza para limpiar su casa? acido muriático / lejía / soda caustica / detergente / limón / vinagre / otro _____	Lea las opciones al respondiente, si el respondiente menciona algo que no es una opción, apunta 'otro' y escriba la respuesta palabra por palabra
18	¿Practica alguna manera de conservar el agua en su casa? Si ___ No ___ porque... artefactos de conservación / reúso de agua reparar fugas de agua / no regar la calle ahorro en el uso de agua / otro _____	NO lea las opciones de reúso, están escritos sólo para actuar como un guía, si el respondiente menciona más de una opción, apúntalas en el orden que estuvieron dichos '1, 2' etc., si el respondiente menciona un práctica que no es una opción, apunta otro' y escriba la respuesta palabra por palabra

	OFRECER PRECIO DE COLUMNA I, II, o III	
19	*¿Por un servicio de agua de 24 horas por día, estaría dispuesto a pagar S/. X mensual?* I: 18 Si / No; II: 24 Si / No; III: 36 Si / No *¿Para un servicio que provee agua limpia, tratada, sería dispuesto pagar S/. X mensual?* 18 Si / No; 24 Si / No; 36 Si / No *¿Para un servicio de agua 24 horas por día que provee agua limpia, tratada, sería dispuesto pagar S/. X mensual?* 24 Si / No; 36 Si / No; 48 Si / No *¿Por el servicio de alcantarillado, aparte de costo de servicio de agua, pagaría S/. X mensual?* I: 18 Si / No; II: 24 Si / No; III: 36 Si / No *¿Por un servicio de agua de 24 horas por día que provee agua limpia, tratada, Y alcantarillado, pagaría S/. X mensual?* I: 30 Si / No; II: 42 Si / No; III: 54 Si / No	(1) SOLO LEA LOS NÚMEROS DE UNA COLUMNA PARA CADA CASA; (2) Para los primeros tres preguntas, enfatiza que alcantarillado NO está incluido en el precio; (3) para el cuatro pregunta, enfatiza que agua NO está incluido en el precio; (4) para el último pregunta, enfatiza que hora el precio está por 'todo conjunta,' agua Y desagüe
20	¿Cree que el agua en Perú es: Abundante / Escaza ¿Cree que el agua en Chao es: Abundante / Escaza ¿Tiene experiencia con escasez de agua? Si / No Frecuencia? Diario / Semanal / Mensual	(1) Diga abundante o escaza;' (2) Sólo pregunte de la frecuencia de escasez de agua si el respondiente responde 'Si' (tiene experiencia)
21	¿Cuales de las siguientes alternativas crees que es el asunto más preocupante afectando el medio ambiente en el Perú? contaminación del agua / explotación de recursos naturales / escasez de agua contaminación de aire / desarrollo urbano desorganizado / el exceso de pesca especies en peligro / eliminación indecoroso de tóxicos / desertificación erosión del suelo / deforestación / cambio climático	NO lea las opciones al principio, SI LA PERSONA NO DICE NADA, lea TODAS las opciones como si está leyendo un libro (izquierda a derecha, arriba a abajo). Al fin de leer, si el respondiente menciona más de una opción, apunta los asuntos '1, 2, etc.' en el orden que fueron dichos
22	¿Cree que el cambio climático está afectando a Perú? Si / No / no sabe afectando Chao? Si / No / no sabe	
23	¿Qué porcentaje de todo el agua en el mundo cree que es agua dulce? ≤10% / 10<x≤30 / 30<x≤60 / 60<x≤80 / >80% poco / regular / mucho	OJO: Si el respondiente no conoce porcentajes, lea las opciones de 'poco, regular, o mucho'
24	¿Se lleva bien con sus vecinos? si / regular / no ¿Cómo percibe la organización en su comunidad? bueno / regular / mala / no sabe	(1) NO tiene que leer las opciones; (2) Al fin de encuesta pregunta al respondiente si tiene unas comentarios, dudas, preguntas, etc. No olvida de darle muchas gracias por su tiempo y participación.

Appendix E Round II – Household Surveys

E.1 English

DATE / Name of Interviewer N° (17)

N° 17 refers to the # of the column you will utilize for Question #17; At the first house you survey you will use column I. Then for the second house, column II, then column III....continuing I, II, III, I, II, etc....In other words for each house you will only offer the prices from one of the columns, where Column # I = S/.18, 20, 22, 18, up to S/. 24; Column # II = S/. 24, 26, 28, 24, up to S/. 30; y Column # III is the sequence S/.30, 32, 34, 30, up to S/. 36.

1 SECTOR: Block Lot N° Man Woman Age

Please note the block and lot number while you are waiting for someone to come to the door. If the lot number is not indicated on the door, ask the respondent and/or write down the house number.

SOCIO-ECONOMIC

2 Rent Own If rent, Cost per month and what includes? S/.

N° years in Chao Characteristics of house before living in urban: 1) rural urban (where do you come from) 2) coast mountain jungle

N° years in house Area (m2) dirt cement adobe straw brick

N° Rooms N° People in Family *Renters* N° that are in the house during the day

(1) You only have to note monthly rent if the respondent does not own their house. Don't forget to note if the price includes water, electricity, etc. (2) N° years in urban Chao applies to all those who have lived in Chao or Nuevo Chao for less than 20 years years; (3) If the person has lived in Chao for more than 20 years, it is not necessary to ask them about the characteristics of their house before coming to Chao BUT *For those that have lived in Chao/Nuevo Chao for less than 20 years, please note whether they previously lived in 1) an urban or rural area and 2) on the coast, mountains or jungle; (4) N° years in house implies how long the respondent has lived in the house in which you are interviewing them; (5) N° rooms implies All of the rooms, or separated spaces, within the house; (6) property area includes the yard, not just the house; (7) If the respondent has dirt and cement and/or tile floor in their house (not the yard), put a circle around the material that predominates, the same goes for housing material (adobe, straw, brick); (8) N° in family implies number in family (in English there is no need to clarify); (9) N° that are in house during day implies you should note the number of people that are generally in the house the whole day. For example, if the dad, oldest son and renters leave to work during the day, don't count them.

Kids ≤5 Youth 5<x<18 Adults ≥18 Men Women

Mark how many people fit into each category, the totals of Kids + Youth + Adults and Men + Women should equal the Total # in the Family. If there are renters, you do not need to include them.

Education of respondent Education of wage earner Highest education in house

(1) CODES --- Nothing = N; Kindergarten = J; Elementary = P; Incomplete Elementary = PI; High school = S; Incomplete High school Secondary = SI; Technical = T; University = U..... (2) The first box is where you note the education of the person you are interviewing; (3) The second box is where you note the education of the principal wage earner; and (4) The third box is where you note the highest education in the house. For example, if the highest education in the house is one of the kids who was the first to complete High school, mark 'S.'

Occupation(s) - Monthly Income (S/.)		*# Beneficiaries*	Other incomes		*# Beneficiaries*

(1) If the respondent hesitates in responding, repeat that their answer is confidential (2) Distinguish between agricultural worker and an agriculturalist that owns and works his own land; (3) Other incomes refers to support from family that live in other places but send money regularly; government support, income from renting rooms, etc. (4) If one of the noted incomes is not shared with everyone in the house, note the # of beneficiaries....this column is in italics because it is not necessary to put a number if the income is shared between everyone in the house

3 Of the following services and appliances: (note what have, for how many years, and what the monthly cost is)

Electricity S/. Cable S/. Gas S/. Internet S/.

Cells S/. Nextel / Landline S/. Vehicle: S/.

Computer Television Washing machine Camera Refri Blender

What appliances are you thinking about buying in the coming year?

(1) Next to every service (except for cellphones and transportation) the first box is to write the # of years the respondent has had the service and the second box is to note how much the respondent pays per month for the service; (2) if the respondent does not have the service mentioned, you do not need to mark anything; (3) For cellphone the first box is to note how many cellphones in the family and the second box is to note how many years ago they bought there first cellphone (i.e. not necessarily the model they have now) the last box is to note how many "minutes" they buy a month (or if they prepay, the cost of the service per month); (4) Because only a small percentage of the population have a Nextel or a landline, these two services share a space. Consequently, if the respondent has one, or both, of them, circle accordingly so I know how to enter; (5) the dotted line is to note what type of transportation they have (car, motorcycle, etc.), the second box for how long they have had it, and the third box for how much they spend monthly on gas and maintenance; (6) if the family has a refrigerator but they only leave it plugged in once in a while, mark "1/2"

4 What media source do you most use to obtain information/ne

Kadena 100	La Exitosa	Canal 7	Canal Vision (9)	Canal America (4)	La verdad	La industria	El Satelite	Trome	Internet	

If the respondent uses more than one media source to receive information, only mark the one they use the MOST. If they mention a source of information that is not listed, mark it in the blank box on the right. If the respondent mentions they most frequently receive information via the 'Internet' please mark the website they most frequently use in the blank box.

AGUA

5 What water sources do you utilize?

Domestic connection Own Well Neighbor's well Bottled water River /Spring Canal

(1) Mark all the sources that the respondent uses, no matter how (in)frequently, and number according to predominance: 1=principal source; 2=secondary source, 3=tertiary source; etc.. NOTE: you only need to put numbers in the boxes next to sources that the respondent uses; (2) In case the respondent only mentions one source and is not thinking about the river, bottle water, etc., that they sometimes also use, ask them about every source separately to make sure that they voice ALL the sources they use. For example, you can say 'You never by bottled water? Go to the river to wash clothes or bathe?'

6 How do you store your water?

N° storage devices

N° elevated N° Covered

Are you planning to buy more storage devices like a cistern or a Rotoplas? yes no N° liters more? L

Why?

(1) Be the most detailed you can here, note how many storage tanks the respondent has and the number of liters each one holds. For example " Tanks - (1, 100 L) (1, 50 L); Tubs (2, 40 L) - 0 elevated - 2 covered"

If have Rotoplas, ¿How frequently do you wash it? weekly monthly every 3 mont annually never other

The box below annually is to note a number in case the respondent says something like 'twice a year,' 'four times a year,' etc.

Appendix E (Continued)

7	How many liters of water do you believe your family consumes daily? thinking about all the uses of water from cooking and bathing to watering street. [ ] don't know the Renters? [ ] don't know On a scale of 1 to 10 where 10 implies absolute certainty, What level of confidence do you have with your estimate of daily water use? [ ]	(1) If the respondent has renters, clarify that the first water use estimate is only for their FAMILY; (2) if the respondent insists that they have no idea, please ask them to try and respond and that it is only an estimate. Furthermore, tell them that in the next question they can clarify that they only have '1 or 2' in terms of certainty with the number of liters they reported; (3) When the respondent is making their estimate, remind them to think to include ALL the water they use, not just the water for drinking, cooking (i.e. they should think about how much they use for washing clothes, bathing, cleaning, watering, etc. too). (4) For rating on a scale of 1 to 10, show the respondent *Visual 6* to help them better understand what a 1 means as opposed to a 10. If they have trouble understanding the scale, take the time to fully explain how to use it and give them examples. It is important the respondent understands the scale as it will be used several more times in the survey.
8	*If the house uses more than 3 sources of water, note the answers to the three the use the MOST* — Principal Source / Source "2" / Source "3"	(1) Use answers from question #5 to determine which source is the Principal Source, Source '2,' and Source '3;' (2) NOTE If the respondent did not mention using three separate sources of water, you don't need to fill out every column in question #8
	How frequently do you use *X source* and how many liters do you use/take each time?	NOTE: Ask only if the respondent uses more than one source. For example, if the respondent utilizes a household connection, bottled water, and a neighbor's well, in the first column you may note 'daily,' in the second column ';2L - once a week' and in the third column, '20 L - every other day'
	IF *they have a domestic connection*, Between what hours does the water arrive to your house? IF *they don't have a domestic connection*, How much time/effort is required to obtain water from *X source*?	(1) If the respondent has a household connection, in the first column mark the number of hours the house receives the service per day and between what hours they receive it; (2) With respect to 'effort,' if one of the columns corresponds to river, mark the distance to the river, walking, if the question corresponds to a well, note how they get the water, for example "10 minutes, rope" or "5 minutes, pump"
	How do you use the water you obtain from *X source? (1 - EVERYTHING; 2-Drinking; 3-Cooking; 4-Bathing; 5-Washing/Cleaning; 6-Watering (street); 7-Watering plants; 8 -Other (specify)) NOTE: You can note more than one #*	(1) If the respondent uses only water from the faucet, you would mark '1' to indicate they use faucet water for EVERYTHING; (2) In cases where the respondent uses more than one source and every source for different activities, note what they use each source for. For example, for the neighbor's well, you could mark '2 and 3,' which would indicate that they only utilize well water for drinking and cooking.
	How would you describe the quality of water from *X source*?	Note how the respondent values the quality of the water from each source they use, writing down the specific word they use to describe it. For example 'gross,' 'chlorinated,' 'it's fine,' etc.
	How do you drink your water? AND, *if boil*, How many liters per day do you boil? and/or *If chlorinate*, How many drops of Clorox per Liter are added? *(0 - crude)*	(1) If the respondent does not treat their water before drinking, you would note '0' to indicate they drink their water crude; (2) If the respondent boils their water or uses chlorine, DON'T FORGET to ask them how many liters they boil per day and/or how many drops of chlorine they use per liter.
	How much does the water from *X source* cost per month? *(1 - doesn't apply)*	NOTE: If there is no cost associated with the source of water (for example well water or water from the river) mark '1'
	What do you feel about this price? *(1 - doesn't apply; 2 - cheap; 3 - regular/it's fine; 4 - expensive; 5 - other (specify))*	NOTE: If there is no cost associated with the source of water (for example well water or water from the river) mark '1'
9	What does the term potable water signify?	Please write the respondent's complete response, word for word.
	Do you know what your/a provider of water does to make water potable ?	
	With respect to the quality of your water, Of the following 5 aspects, What is the most important to you? The second most? Third? (NUMBER 1, 2, 3) appearance / smell / taste / physical security / biological security	(1) Read all 5 categories to the respondent and show them *Visual 1*. Mark '1' beneath the characteristic the respondent thinks is the MOST important of all those mentioned; (2) Continue the question by reading the 4 remaining options and note '2' beneath the second characteristic they mention; (3) Finally, read the three remaining options and ask one last time 'Of the three characteristics that remain, which is the most important to you when it comes to the quality of your water?' and note 3' beneath the characteristic they mention; (4) In the case of the respondent mentioning a characteristic different than those provided, note what they say in the blank space to the right of 'biological security.' (3) NOTE: If the respondent asks, for example, 'What does physical security mean?' you can describe to them what it signifies. However, if the respondent does not ask, it is not necessary to educate them on what physical and/or biological security mean.
	With respect to a water service in general, ¿Of the following 7 options, What aspect is most important to you? Second most? Third? (NUMBER 1, 2, 3) quality / continuity / schedule / maintenance / price / pressure / transparency	This question is similar to the one above. I want to obtain the preference of the respondent with respect to characteristics of their water service (i.e. 1) the most important 2) the second most important, and 3) and the third most important). SO, first read all 7 options and show them *Visual 2*. Mark '1' beneath the first characteristic they mention. Then, ask them 'Now, of the 6 characteristics (read) that remain what is the most important to you ?' Note '2' beneath the characteristic that pertains to their response and repeat once more for the 5 remaining characteristics.
	ONLY FOR THOSE WHO HAVE A DOMESTIC CONNECTION	
10	Who provides your water and sanitation service? Municipality of Chao / SADISCHAO / JASS / Sedapal / Sedalip / Neighbor / Don't know / Other	DO NOT read the categories, only mark the answer the respondent gives.
	How many years have you had a domestic connection? <1 / 1 a 3 / 4 a 7 / 8 a 12 / 13 a 15 / > 15 / Don't Know	DO NOT read the categories, only mark the answer the respondent gives.
	Where does the water come from? spring / river / well / canal / reservoir / CHAVIMOHIC / don't know Problems with water pressure? yes / no *With what frequency?* rarely / daily / weekly / monthly / in past How does the schedule, hours in which the water arrives, affect your day? doesn't affect Do you like the way in which you pay your water bill? yes / no Why?	DO NOT read the categories, only mark what the respondent says; (2) If the respondent does NOT have water pressure problems, you do NOT have to ask 'with what frequency;' (3) If the respondent does not have any problem with the service's schedule, you only need to mark the box 'Doesn't affect.'
	Thinking about the water service you have right now, What aspect are you most dissatisfied with? quality / continuity / schedule / maintenance / price / pressure / transparency On a scale of 1 to 10, where 1 is horrible and 10 is fantastic, What level of trust do you have in your water provider? What information would you like from your water provider to increase your confidence in the water service?	Here you can read the categories once again showing the respondent *Visual 2* and *Visual 6*. With respect to what information the respondent would like regarding their current service, please take care to note, word for word, what they say.

Appendix E (Continued)

FOR EVERYONE - USES OF WATER	
11 Do you have sufficient water for all your needs? yes / no Would you use more water if the service was more continuous? yes / no How? ____ Do you want the water service to utilize water meters? yes / no Why? ____	Please, write the most detailed you can the respondent's answer with respect to how they would use water if the service was more continuous AND why they do or do not want water meters.
Do you trust/have confidence that your water is safe to drink? yes / no Why ____ On a scale of 1 to 10, where 1 indicates its gross and 10 indicates its fantastic/tasty, How would you rate the quality of your water? ____ In general, Do you have problems with diarrhea in your house? yes / no Dengue? yes / no	(1) Please write, as detailed as possible, the respondent's answer as to why they do or don't trust that their water is safe to drink; (2) Show the respondent Visual 6 so that they can rate the quality of their water (3) IF the respondent does not drink their tap water and only drinks bottled and/or well water, please make a note so that it is clear to me what water they are referring to and rating; (4) If the respondent has commentary about diarrhea or dengue, please write it on the side
12 Do you have sewage in your house? yes Use question A / no Use question B	If the respondent says 'Yes,' go to question A (i.e. skip question B). If the respondent says 'No,' go to question B (i.e. skip question A).
A - Where does the sewage go? oxidation ponds / canal / river / down there / don't know / other ____	Do NOT read the options. IF they respondent says something else, mark 'Other' and note their response.
B - Where do you go to the bathroom? fields / river / pour-flush latrine / dry well / other ____ On a scale of 1 to 10 where 1 indicates its not important and 10 indicates I want it right now, What level of interest do you have for getting sewage? ____	(1) Do NOT read the options. IF they respondent says something else, mark 'Other' and note their response; (2) Show the respondent *Visual 6* so that they can rate their desire for sewage.
13 How many..... faucets? ____ showers? ____ toilets? ____ Do you reuse wash water to flush your toilet? never / sometimes / always How do you flush toilet handle ____ L bucket ____ L N° flushes/day? ____ Do you have problems with water leaks? yes / no N° current ____ N° in past? ____	(1) Only ask the respondent how they flush their toilet and how many times a day if the person has a toilet or a pour-flush latrine; (2) flushes per day only refers to the respondent, NOT to the entire family; (3) for the fact that many people can only flush their toilet during the short period in which water is arriving, do not forget to note not only how many L they use every time they flush, but also how many L the bucket is they use when there is no water in their toilet's tank.
14 How do you bathe? bucket / shower / river N° per day in summer? ____ L winter? ____ L	(1) For the fact that many people only can use their showers during the time the water is arriving, put a circle around ALL of the ways in which the respondent bathes; 2) If the person cannot estimate how many liters they use every time they bathe in the shower, have them estimate how many minutes the shower flows (faucet open) and mark an M to signify that the number refers to minutes; (3) If the person always, and only, bathes in the river, its not necessary to note liters or minutes.
Water street? yes / no Water inside the house? yes / no With what? hose / bucket How much water do you use every time you water? ____ L o M Why do you water? n/a ____ Frequency? ____ type of water potable / well / canal / wash / other ____	(1) Similar to the other sections, if the respondent uses a bucket, a hose, or both, to water, put a circle around each option; (2) The most important piece of this question is to note, more or less, how much water the respondent utilizes every time they water, what type(s) of water, and with what frequency. For example, '2 times a week, 10 minutes, tap water' or 'every day, 20 L, wash water only.' Please distinguish between water used outside the house (i.e. the street) and water used inside the house (i.e. for the yard).
How many times a week do you do laundry? ____ Estimate how much water do you use each time. ____ L don't know How many times a month do you do laundry at the river? ____ How many liters for: cooking? ____ mop? ____ L frequency? ____ type of water ____ N° people ____ water plants? ____ L ____ Why do you have or not have plants? ____ N° Animals ____ L per day N° Pets ____ L per day	(1) Ask the respondent to please estimate how many liters of water they use every time they wash their clothes. If they say 'I don't know,' please help them estimate by asking 'How many tubs do you fill? What size are they?,' until they can make an estimate. If they still have no idea, only then should you mark the "Don't Know" box; (2) NOTE: for frequency of mopping and watering plants per week you can use the following codes - D (daily), S (once a week), 2S (2 times a week)3S (3 times a week), etc.; (3) For the question on 'Water Type' use the following codes - DC (potable water), P (well water), R (water from washing, bathing, etc.), and A (water from canal); (4) For the animal and pets section, the first box is to note how many animals and/or pets they have and the second box is to note how many liters they give the animals/pets per day.
How many liters of water do you drink per day? ≤0.5 / 0.5< x ≤1 / 1< x ≤2 / 2< x ≤3 / >3 How many liters of water in a different form (juice, coffee, lemonade, etc.) per day? ≤0.5 / 0.5< x ≤1 / 1< x ≤2 / 2< x ≤3 / >3	This number of Liters of water per day only refers to what the respondent drinks (i.e. NOT the their entire family).
Of the following six categories, number 1 to 6 according to how much water each activity requires - where 1 indicates it uses the most Cooking ____ Drinking ____ Hygiene ____ Cleaning ____ Laundry ____ Watering ____	Show the respondent *Visual 3*. The respondent should then rate the categories/activities 1 to 6, where 1 would designate the activity that uses the most water and 6 indicates the category that uses the least water.
15 Where does the water from your shower/sinks go? sewage / septic tank / yard / street / canal / river / plants / other ____	Do not read the options. Put circles around ALL of the greywater destinations the respondent mentions.

Appendix E (Continued)

16	Have you received and/or heard information about water conservation? yes / no — Where? _____ Do you do anything in your house to conserve water? Not waste it? yes / no water saving devices / water reuse / repair leaks / don't water street minimize water use / save water / other _____ Why do you practice water conservation? _____	DO NOT read the options for water conservation. If the respondent mentions something that is not on the survey, mark 'Other' and write down their response accordingly.
	WTP - OFFER PRICE FROM EITHER COLUMN I, II, or III	
17	Now I will ask you if you will pay a specified amount to improve some aspects of your water service. Please respond according to your desire for but also to your ability to pay for a service such as I am about to describe. *For a water service 6 hours per day, with the same quality of water you currently receive, would you be willing to pay S/. X per month?- VISUAL IV.1* I: 18 yes / no / perhaps; II: 24 yes / no / perhaps; III: 30 yes / no / perhaps *For a water service 12 hours per day, with the same quality of water you currently receive, would you be willing to pay S/. X per month? - VISUAL IV.2* I: 20 yes / no / perhaps; II: 26 yes / no / perhaps; III: 32 yes / no / perhaps *For a water service 24 hours per day, with the same quality of water you currently receive, would you be willing to pay S/. X per month? - VISUAL IV.3* I: 22 yes / no / perhaps; II: 28 yes / no / perhaps; III: 34 yes / no / perhaps *For a water service that provides a safe, better quality, water, but not necessarily more hours per day, would you be willing to pay S/. X per month? - VISUAL IV.4* 18 yes / no / perhaps; 24 yes / no / perhaps; 30 yes / no / perhaps *For a water service that provides a safer, better quality, water that comes 12 hours per day would you be willing to pay S/. X per month? - VISUAL IV.5* 24 yes / no; 30 yes / no; 36 yes / no	(1) Show the respondent *Visual 4*. ONLY READ THE NUMBERS OF ONE COLUMN FOR EVERY HOUSE. (2) If the respondent says 'No to the last question, ask them "How much would you pay then to have potable water, of better quality, for 12 hours a day?' Mark their response in the blank box that is to the right of the 'No' box; (3) NOTE: do NOT give the respondent the 'Perhaps' option. Only circle 'perhaps' if he/she cannot give a definite 'Yes' or 'No.'
	On a scale of 1 to 10, where 10 indicates that you are absolutely positive/sure, What level of certainty do you have for your willingness to pay responses? ____ ON a scale of 1 to 10, where 10 indicates that you are absolutely positive/sure, ¿How confident are you that a service that provides a better quality water, 12 hours per day, is even feasible? ____	Show the respondent *Visual 6* so that they can rate their confidence in their WTP answer, and, then, how confident they are the last scenario described is even feasible.
18	Do you believe that water in Peru is Abundant / Regular / Scarce — in Chao? Abundant / Regular / Scarce Do you have experience with water scarcity? yes / no — Frequency: Daily / Weekly / Monthly / Summer / Annually / in Past *If have domestic connection*, From where do you hear when there will be a cut in the service? _____ Where do you go when there is no water? What source(s) do you use? spring / river / own well / neighbor's well / water from neighbor / other _____ Does this water have an associated cost? yes / no / N/A — How many S/. _____ per liter	(1) Say 'abundant or scarce.' Only if the respondent says 'Regular' will you circle it; (2) If the respondent does NOT have experience with water scarcity, there is no need to ask them the frequency; (3) The box below annually is to note a number in case the respondent says something like 'twice a year,' 'four times a year,' etc.; (4) 'Have a cost' refers to if, when there is no water, the respondent purchases bottled water, purchases well water, or perhaps pays someone to bring them/transport water.
19	Of the following public services, number the three most important to you - NUMBER 1, 2, 3 water / paved streets / sewage / education electricity / Main Square / health / transportation On a scale of 1 to 10 where 10 indicates they are doing a great job, How would you rate the work the Municipality does? ____	(1) Show the respondent *Visual 5* so that they can order the top 3 public services most important to them (note: five boxes will be left blank); (2) Show the respondent *Visual 6* so that they can rate their confidence in the Municipality of Chao.
20	Are their community meetings? yes / no — About what? _____ — Do you attend? yes / no On a scale of 1 to 10, where 10 indicates my neighbor's are like a family, What level of trust and support do you have within your neighborhood? ____	(1) Show the respondent *Visual 6* so that they can rate the trust and support they get from their neighbors; (2) At the end of the survey, ask the respondent if they have any comments, doubts, questions, etc. to add? Don't forget to thank them for their time and participation.

Appendix E (Continued)

E.2 Spanish

	FECHA / Nombre Encuestador N° (17)	N° 17 refiere a que columna va a utilizar para pregunta #17. Recuerde que la primera encuesta que hace va a usar columna "I," la segunda encuesta, columna "II," la tercera encuesta, columna "III," la cuatra encuesta, columna "I,"....sigue II, III, I, II, III, etc....en otras palabras cada casa sólo sería ofrecido los precios de una de las columnas, dónde Columna # I es la secuencia S/.18, 20, 22, 18, hasta S/. 24; Columna # II = S/. 24, 26, 28, 24, hasta S/. 30; y Columna # III es la secuencia S/.30, 32, 34, 30, hasta S/. 36.
1	SECTOR: Manzana Lote N° Hombre Mujer Edad	No tiene que preguntar por la manzana y lote; si puede, nótalo cuando está esperando. Si la manzana y lote no están indicados en la puerta o caja de luz, marca la dirección de la casa (número y calle).
	CARACTERÍSTICA DE LA VIVIENDA	
2	Alquila Dueño Si alquila, ¿costo mensual y qué incluye? S/. N° años Chao urbano Características de su vivienda antes de venir a Chao Urbano: 1) rural urbano (de dónde proviene) 2) costa sierra selva N° años casa actual Área (m2) tierra piso adobe estera ladrillo N° Habitaciones N° Integrantes *Inquilinos* N° que paran en la casa durante día	(1) Sólo tiene que notar el costo mensual de la casa si la persona que está encuestando es un aquilante. Si el precio de alquilar incluye agua, luz, etc., no olvida apuntarlo en la línea puntada; (2) N° años Chao urbano aplica a todos los años que la persona ha vivido en Chao o Nuevo Chao (áreas urbanos); (3) Si la persona ha vivido en Chao por más de 20 años, no es necesario preguntarle la características de su vivienda antes de venir a Chao, *Por los que ha vivido en Chao por menos de 20 años, apuntar si antes vivía en 1) un área urbano o rural, Y 2) si proviene de la costa, sierra o de la selva. (4) N° años en casa actual implica la duración que la persona ha vivido en la vivienda dónde está encuestándole; (5) Habitaciones implica todos los espacios que son separados (6) área de propiedad incluye todo el terreno, no sólo la casa; (7) Si el respondiente tiene tierra Y piso EN LA CASA (no refiere al corral), pone un circulo alrededor de lo que es la mayoría, el mismo con respecto a materiales de la casa (adobe, estera, y/o ladrillo); (8) Integrantes implica todos que son familiares (9) # que paran en la casa implica que debe apuntar el # de todos que, mayormente, están permanente en la casa durante todo el día. Por ejemplo, si el papá, el hijo mayor, y inquilinos siempre están trabajando, no se cuentan
	Niños ≤5 Juventud 5<x<18 Adultos ≥18 Hombres Mujeres	Marca cuántos en cada categoría de edad y división entre mujer y hombre. Si la casa tiene inquilinos, sólo tiene que notar las características de la familia.
	Educación de respondiente Educación del ganador principal Educación más superior de la casa	(1) CÓDIGOS --- Ningún = N; Jardín = J; Primaria = P; Primaria Incompleta = PI; Secundaria = S; Secundaria Incompleta = SI; Técnico = T; Universitario (superior) = U..... (2) La primera caja es dónde apunta la educación de la persona que está encuestando; (3) La segunda caja corresponde a la educación de la persona que gana lo más por la casa (puede ser esposo, hijo mayor, etc....) (4) La tercera caja es la educación más superior en la casa. Por ejemplo, si la educación mayor en la casa es de una juventud que ha completado colegio, marca 'S.'
	Ocupación(es) - Ingresos Mensuales (S/.) *# Beneficiaros* Otros Ingresos *# Beneficiaros*	(1) Si el respondiente vacila, repita que todo es confidencial (2) Distingue entre obrero (trabaja para empresa) y agricultor (propio terreno). (3) Otros ingresos refiere de apoyo de familiares que viven en otros lados, si de vez en cuando se vende marcianos, animales, si tiene apoyo del gobierno, Alquila cuartos, etc.; (4) Si una de los ingresos no está compartido con todo la familia, apuntalo el # de beneficiarios en la tercera columna. Esta columna está en itálica porque no tiene que apuntar ningún número si el ingreso está compartido entre todos los integrantes.
3	¿De los siguientes servicios y artefactos, qué tiene? Electricidad S/. Cable S/. Gas S/. Internet S/. Celular S/. Nextel / Fijo S/. Movilidad: S/. Computadora Televisión Lavadora Cámara Refri. Licuadora ¿Qué artefactos esta pensando comprar en el próximo año?	(1) al lado de cada servicio, la primara caja es para escribir el número de años que el respondiente ha tenido el servicio, y la segunda caja es para apuntar cuánto el respondiente paga mensual para tenerlo el servicio; (2) si el respondiente no tiene el servicio mencionado, no tiene que marcar nada; (3) para "celular" la primera caja es para notar cuántos celulares en la familia, la segunda caja es para notar hace cuántos años el respondiente compró su primera celular (OJO, quiero saber cuánto tiempo en general el/la respondiente ha tenido este tecnología, no refiere necesariamente al modelo actual que el/la respondiente tiene), la última caja es para apuntar mas o menos cuánto el respondiente gasta para comprar saldo cada mes; (4) Por lo hecho que muy poca gente tiene Nextels y líneas fijas, los dos comparte una caja. Entonces, si el respondiente tiene uno de estos servicios, pone un circulo alrededor de lo que tiene para que sabré cómo entrar la información (5) la línea puntada al lado de "movilidad" es para notar que tipo de movilidad (carro, mototaxi, etc.) el respondiente tiene, en la segunda caja apunta cuántos años el/la respondiente ha tenido, y en la tercera caja, apunta cuánto gasta para mantener y comprar combustible por mes (6) si la familia tiene refrigerador, por lo hecho que muchas familias tienen pero no utilizan, pregunta al respondiente si su refri está enchufado todo el tiempo. Si el/la respondiente no utiliza todo el tiempo, apunta '1/2.'
4	¿Qué medio de información es el que MAS utiliza? Kadena 100 / La Exitosa / Canal 7 / Canal Visión (9) / Canal América (4) / La verdad / La industria / El Satélite / Trome / Internet	Si el respondiente menciona más de un medio de información, pregúntale otro vez, cual es el que MAS utiliza, SOLO MARCA UNA OPCIÓN. Por si acaso menciona algo que no está indicado, apúntalo en la última caja que es blanca; (2) Si el medio que más utiliza es 'Internet,' por favor en la caja blanca a la derecha, apuntar que sitio de red más frecuente visita.
	AGUA	
5	¿Qué fuentes de agua utiliza para abastecerse de agua? Conexión domiciliara Pozo Propio Pozo Vecino Agua Envasada Rio/Puquio Acequia	(1) Marca todos los fuentes que aplican según predominio (1=fuente principal; 2=siguiente más usado, etc....); (2) OJO sólo tiene que apuntar un número en las cajas de los fuentes que el respondiente utiliza; (3) Por si acaso el respondiente sólo menciona un fuente y no está pensando en el río, agua envasada, etc.. que a veces utiliza, pregunta de cada mencionada fuente para estar seguro antes de seguir adelante. Por ejemplo, puede preguntar al respondiente 'Nunca compra botellas de agua? Va al río a lavar o bañar?'
6	¿Cómo almacena su agua? Total N° de depósitos ¿cuántos elevados? ¿cuántos tapados? ¿Está planificando invertir en más depósitos como Rotoplas o cisterna? Si No De cuántos litros? L Por qué?	(1) Anota lo más detallado que puede, cuántos depósitos el/la respondiente tiene y el número de litros que abastece cada uno. Por ejemplo Tanque(s) - (1, 100 L) (1, 50 L); Tinas (2, 40 L) - 0 elevados - 2 tapados
	Si tiene Rotoplas, ¿Con que frecuencia lávalo? semanal mensual cada 3 mes anual nunca otro	La caja bajo de 'anual' es para notar un número por si acaso el/la respondiente dice algo cómo "dos veces al año, cuatro veces al año" etc.
7	¿Cuántos litros de agua cree que consume su FAMILIA diariamente, PENSANDO en TODO los usos de higiene y cocinando hasta lavando la ropa y regando? no sabe ¿Los Inquilinos? no sabe En una escala de 1 a 10, con 10 indicando que estás absolutamente cierto, ¿Qué nivel de certeza tiene por sus respuestas?	(1) Si tiene inquilinos, clarifica que la primera estima es sólo una estima de cuánto consume la FAMILIA; (2) Si el respondiente insiste que no tiene ningún idea, pídele por favor intenta a responder, sólo es una estima...en el siguiente pregunta el(la) puede decir que sólo tiene "2" de la certeza de la respuesta que le ha dado (3) Cuando el respondiente está haciendo su estima, recordarle que este total incluye TODO, no sólo agua para tomar, cocinar...debe pensar en cuánto utiliza para las actividades de lavar, higiene, limpiar, regar, etc. también. (4) Por el pregunta de escala, muéstrale al respondiente *Visual 6* para ayudarle entender que implica un '1' en lugar de un '10.' Si el/la respondiente tiene dificultada comprendiendo la escala, toma el tiempo para explicarla otra vez y dale ejemplos. Es muy importante que él/ella entiende la escala porque aparecerá varias veces más durante la encuesta.

Appendix E (Continued)

8	*Si la vivienda abastece de más de 3 fuentes, coloca las tres MAS usadas en la siguiente sección. Por ejemplo, Columna 1, "Fuente Principal," pertenecería para el caño, "Fuente 2" pertenecería al pozo, y "Fuente 3" pertenecería al agua envasada*	Fuente Principal	Fuente "2"	Fuente "3"	(1) Utiliza las respuestas del respondiente de pregunta #5 para determinar que es el Fuente 'Principal,' Fuente '2,' y Fuente '3;' (2) OJO: Si el respondiente no mencionó la utilización de tres fuentes de agua, no tiene que llenar cada columna de pregunta #8.
	¿Con qué frecuencia y cuantos litros se abastece de este fuente?				OJO: Pregunta sólo si el respondiente utiliza más de un fuente. Por ejemplo, si el/la respondiente utiliza una conexión domiciliara, agua envasada, y el pozo de un vecino, en la primera columna quizás apuntaría 'diaria' y en la segunda columna apuntaría '2 Litros - 1 vez a la semana" y en la tercera columna, '20 L - cada otro día'
	SI — *ES conexión domiciliara*, ¿Entre que horas llega su agua? / *NO ES conexión domiciliara*, ¿Cuánto esfuerzo (tiempo) requerido para abastecerse de agua?				(1) Si la vivienda tiene caño, en la primera columna marca el número de horas que la casa recibe servicio por día y entre que horas recibe (2) Con respecto a 'esfuerzo,' si una de las columnas corresponde al río, marca la distancia al río caminando, si corresponde a un pozo, marca cómo saca el agua, por ejemplo '10 minutos, jalea' o '5 minutos, bomba'
	¿Cómo usa el agua que obtiene de esta fuente? *(1 - TODO; 2-Tomar; 3-Cocinar; 4-Bañar; 5-Lavar/Limpiar; 6-Regar; 7-Regadío de Plantas; 8 - Otro (especifica)) OJO: Puede notar más de un número*				(1) Si el respondiente sólo utiliza agua del caño, marcaría '1' para indicar que el/ella usa agua de caño para hacer TODO (2) En los casos dónde utiliza más de un fuente y utiliza cada fuente para diferentes actividades, indica para que cosas/actividades utiliza este fuente. Por ejemplo, con respecto a un pozo de vecino, apuntaría '2 y 3,' indicando que el/la respondiente sólo utiliza agua de pozo para tomar y cocinar.
	¿Cómo describe la calidad del agua?				Apuntar cómo el respondiente describe la calidad de cada fuente que utiliza, apuntando la palabra que utiliza para describirla. Por ejemplo 'feo,' 'clorada,' 'está bien,' etc.
	¿Cómo toma el agua Y *Si hierva, pregunta cuántos litros por día hierve. Si cloro, pregunta cuántas gotas por cuántos litros? (0=crudo)*				(1) Si el respondiente no hace ningún tratamiento al agua antes de tomar, notaría '0' para indicar que toma su agua cruda; (2) Si el respondiente hierve o utiliza cloro NO OLVIDA de preguntar litros por día y/o gotas de cloro por litro.
	¿Cuánto cuesta el agua de este fuente por mes? *(1 - no aplica)*				OJO: Si no hay costo asociado con la fuente (por ejemplo por el agua de pozo o del río) marca '1' que significa que no aplica.
	¿Que le parece el precio de agua? *(1 - no aplica; 2 - barato; 3 - regular/está bien; 4 - caro; 5 - otro (especifica))*				OJO: Si no hay costo asociado con la fuente (por ejemplo por el agua de pozo o del río) marca '1' que significa que no aplica.
9	¿Que significa agua potable?				Por favor, escribe la respuesta completa del respondiente, palabra por palabra.
	¿Sabe que procedimiento hace su proveedor de agua para que su agua sea potable?				
	Con respecto a la calidad de su agua, ¿de los siguientes cinco opciones, qué es lo más importante a usted? ...segunda?...tercera? ENUMERAR 1 a 3! — apariencia / olor / sabor / seguridad física / seguridad biológica				(1) Lea al respondiente las 5 características y muéstrale *Visual 1.* Marca '1' bajo de la característica que el respondiente piensa es lo MAS importante de todas las mencionadas; (2) Sigue el pregunta leyendo las 4 opciones que queda y apunta '2' bajo de la caja dónde la segunda respuesta del respondiente pertenece (3) Finalmente, lee las 3 características que quedan y pregúntale 'De estas tres características que quedan, cual es lo más importante a usted con respecto a la calidad de su agua?" y apuntar '3' bajo de la característica que el/la respondiente menciona; (4) Por si acaso, *el respondiente menciona algo diferente, apúntalo su respuesta en el espacio al lado de 'seguridad biológica.' (3) OJO: Si el respondiente pregunta, por ejemplo, "Qué implica seguridad física?." puede describir que implica. Sin embargo, si no pregunta, no es necesario decir más de la palabra que es escrito.*
	Con respecto a un servicio de agua, ¿de los siguientes siete opciones, qué es el aspecto más importante a usted?... segunda? ....tercera? ENUMERAR 1 a 3! — calidad / continuidad / horario / mantenimiento / precio / presión / transparencia				Este pregunta es similar a lo de arriba. Quiero obtener la preferencia del respondiente con respecto a características de un servicio de agua (i.e. 1) lo más importante; 2) la segunda más importante, y 3) la tercera más importante). ENTONCES, al principio lea al respondiente las 7 características Y muéstrale *Visual 2.* Marca '1' bajo de la primera opción que el/la respondiente menciona. Después pregunta, 'Y ahora, de estés 6 características (lee) que quedan, cual es lo más importante a usted?" Apunta '2' bajo de la característica dónde su respuesta pertenece. Repita una vez más con las 5 características que quedan.
	POR LOS QUE TIENE CONEXIÓN DOMICILIARA				
10	¿Quien es su proveedor de agua? — Municipalidad Chao / SADISCHAO / JASS / Sedapal / Sedalip / Vecino / No sabe / Otro				NO lea las categorías, sólo marca dónde la respuesta del respondiente pertenece.
	¿Cuántos años ha tenido una conexión domiciliara? — <1 / 1 a 3 / 4 a 7 / 8 a 12 / 13 a 15 / > 15 / No sabe				NO lea las categorías, sólo marca dónde la respuesta del respondiente pertenece.
	¿De dónde viene el agua? — puquio / río / pozo / acequia / reservorio / CHAVIMOHIC / no sabe				(1) NO lea las categorías, sólo marca dónde la respuesta del respondiente pertenece; (2) Si el respondiente NO tiene problemas con presión de agua, NO tiene que preguntarle 'Con qué frecuencia?' (3) Si el respondiente no tiene ningún problema con el horario actual del servicio de agua, sólo tiene que apunta una marca en la caja "No afecta"
	¿Tiene problemas con presión? — Si / No; *¿Con que frecuencia?* — raro / diario / semanal / mensual / en pasado				
	¿Cómo afecta su horario la hora de llegada del servicio de agua potable? — No afecta				
	¿Le gusta la manera de pagar su recibo? — Si / No; ¿Por qué?				
	¿Con qué característica de su servicio actualmente está desconforme? — calidad / continuidad / horario / mantenimiento / precio / presión / transparencia				LEE las categorías y, otra vez, muéstrale al respondiente *Visual 2* y *Visual 6*. Con respecto a la información que el respondiente quiere obtener de su proveedor de agua, por favor apunta, palabra por palabra, su respuesta completa.
	En una escala de 1 a 10, dónde 1 es horrible y 10 es fantástico, ¿Qué confianza tiene con el manejo de su proveedor de agua?				
	¿Que información quiere de su proveedor de agua para aumentar su confianza en ellos?				

Appendix E (Continued)

	PARA TODOS - USOS DE AGUA	
11	¿Tiene suficiente agua para todo sus necesidades? Si / No ¿Usaría más agua si fuera más continuo? Si / No ¿Cómo? _____ ¿Quiere que el servicio de agua utiliza medidores? Si / No ¿Por qué? _____	Por favor, escribe lo más detallado que puede la respuesta del respondiente con respecto a cómo usaría agua si el servicio fuera más continuo y porque quiere (o no quiere) medidores.
	¿Tiene confianza que su agua es segura para tomar? Si / No ¿Por qué? _____ En una escala de 1 a 10, con 1 indicando que está feo y 10 indicando que está rico, ¿Cómo lo califica la calidad de su agua? ____ En general, ¿tiene problemas con diarrea en su casa? Si / No ¿casos de dengue? Si / No	(1) Por favor, escribe lo más detallado que puede la respuesta del respondiente con respecto a si tiene confianza que su agua es segura para tomar; (2) Muéstrale al respondiente *Visual 6* para que él/ella pueda calificar la calidad du su agua; (3) SI el/la respondiente no toma el agua del caño (i.e. sólo toma agua envasada o del pozo), por favor, escribe un mensaje para que entiende perfectamente que agua él/ella está pensando en; (4) Si el respondiente hace un comento con respecto al diarrea y/o dengue, por favor apunta al lado del pregunta su comentario.
12	¿La casa tiene alcantarillado? Si utiliza A / No utiliza B	SI el respondiente responde "Si" usa pregunta A, Si el respondiente responde "No" usa pregunta B
	A - ¿A dónde va el agua de alcantarillado? pozos de oxidación / acequia / río / abajo / no sabe / otro _____	NO lea las opciones. Si el respondiente dice otra cosa, apúntala al lado de 'Otro.'
	B - ¿Dónde hace sus necesidades? campo / río / letrina de arrastre con agua / pozo ciego / otro _____ En una escala de 1 a 10, con 1 indicando que no le importa y 10 indicando que quiere con prisa, ¿qué nivel de interés tiene por desagüe? ____	(1) NO lea las opciones. Si el respondiente dice otra cosa, apúntala al lado de 'Otro.' (2) Muéstrale al respondiente Visual 6 para que él/ella pueda calificar la su deseo por el desagüe.
13	¿Cuántos salidas de agua? ____ duchas? ____ inodoros? ____ Utiliza agua de lavar para descargar su inodoro? nunca / a veces / siempre ¿Cómo descarga su inodoro? palanca / L balde / L ¿descargas al día ____ ¿Tiene problemas con fugas de agua? si / no ¿ N° actual? ____ ¿ N° en el pasado? ____	(1) Sólo pregunta de cómo descarga y cuántos descargas por día si el/la respondiente tiene inodoro o baño de arrastre; (2) las descargas por día refiere sólo al respondiente, NO a todo la familia (3) por lo hecho que muchos sólo pueden descargar sus inodoros al momento que está llegando el agua, no deja de olvidar de notar los L utilizados por la palanca Y cuando tenga que usar un balde.
14	¿Cómo se baña? balde / ducha / río ¿Veces por día en verano? ____ L invierno? ____ L	(1) Por lo hecho que muchas familias sólo pueden utilizar sus duchas cuando está llegando el agua, pone círculo alrededor de todas las maneras el/la respondiente utiliza para bañar 2) Si él/ella no puede estimar cuántos litros utiliza cada vez que baña en la ducha, pone número de minutos (M) que el caño está abierto; (3) Si la persona sólo baña en el río, no es necesario estimar cuántos minutos y litros que él/ella utiliza cada vez
	¿Regarse la calle? si / no ¿Regarse adentro de la casa? si / no ¿Cómo riega? manguera / balde Estimar cuánto agua utiliza cada día que riega _____ L o M ¿Por qué riega? n/a _____ Frecuencia _____ tipo de agua potable / de pozo / de acequia / de lavar / otro _____	(1) Similar a los otros secciones, si el respondiente a veces utiliza balde y la manguera para regar, pone círculo alrededor de los dos. (2) Lo más importante parte aquí es averiguar, más o menos, cuánto agua el/la respondiente utiliza cada vez que riega, que tipo(s) de agua utiliza, y la frecuencia. Por ejemplo, '2 veces a la semana, 10 M (minutos), agua potable (P)' o 'cada día, 20 L (litros), agua lavada (R)'. Por favor distingue entre agua utilizada afuera de la casa (i.e. para la calle) y agua utilizada adentro de la casa (i.e. para el corral).
	¿Cuántos veces a la semana lava la ropa? ____ Estima cuánto utiliza cada vez que lava la ropa? ____ L / no sabe ¿Cuántos veces al mes lava la ropa en el río? ____ ¿Cuántos litros por cocinar? ____ N° personas ____ trapear? ____ L regar plantas? ____ L frecuencia? ____ tipo de agua ____ ¿Por qué tiene o no tiene plantas? _____ N° Animales ____ L por día N° Mascotas ____ L por día	(1) Pregunta al respondiente que por favor estima cuántos litros utiliza cada vez que lava la ropa. Por favor, si él/ella dice 'no sabe,' ayúdale estimar, preguntando 'cuántos tinas llena, de qué tamaño, etc.' hasta que él/ella pueda estimar. Si todavía dice que no sabe, Ud. puede marcar 'No Sabe.'; (2) OJO: Por el pregunta de frecuencia de trapear y regar plantas puede utilizar los códigos D (diario), S (1 vez semanal), 2S (2 veces a la semana), 3S (3 veces a la semana), etc.; (3) Por el pregunta de 'tipo de agua,' puede utilizar los códigos DC (potable), P (pozo), R (agua de lavar, bañar, etc.), y A (agua de acequia); (4) Por la sección de animalitos y mascotas, la primera caja es para notar el número de animales y/o mascotas, y la segunda caja es dónde apuntar el número de litros el respondiente estima que da a todos los animalitos y/o mascotas por día.
	¿Cuántos litros de agua pura tomaría al día? ≤0.5 / 0.5< x ≤1 / 1< x ≤2 / 2< x ≤3 / >3 ¿Cuántos litros de agua en otra forma de bebida toma al día? ≤0.5 / 0.5< x ≤1 / 1< x ≤2 / 2< x ≤3 / >3	Este número de Litros de agua por día sólo refiere a lo que toma el/la respondiente (i.e. NO a todo la familia). 'Agua pura' implica agua mismo. 'Agua en otra forma' significa té, café, limonada, etc.
	De las siguientes 6 categorías, puede enumerar según la cantidad que utiliza, con "1" indicando que este actividad requiere la más agua - ENUMERAR 1 a 6! Cocinar ____ Tomar ____ Higiene ____ Limpiar ____ Lavar Ropa ____ Regar ____	Muéstrale al respondiente *Visual 3*. Después, el/la respondiente calificaría las categorías/actividades 1 al 6, dónde 1 indica que esta categoría utiliza lo más agua y 6 indica que esta actividad utiliza lo menos agua.

Appendix E (Continued)

15	¿Dónde va el agua de su ducha y lavatorios? - MARCA TODOS: desagüe / tanque séptico / corral / calle / acequia / río / plantas / otro _____	No lea las opciones. Pone circulos alrededor de TODAS las destinaciones de agua "gris" que el/la respondiente menciona.
16	¿Ha recibido/escuchado información sobre conservación de agua? Si / No ¿Dónde? _____ ¿Practica alguna manera de conservar el agua en su casa? (para no despedirse de agua)? Si / No artefactos de conservación / reúso de agua / reparar fugas de agua / no regar la calle ahorro en el uso de agua / otro _____ ¿Por qué practica conservación de agua? _____	NO lea las opciones de reúso. Si el respondiente menciona una práctica que no está, marca 'Otro' y apunta su comentario.
	WTP - OFRECER PRECIO DE COLUMNA I, II, o III	
17	Ahora le preguntaré si pagaría un monte específico para mejorar aspectos de su servicio de agua. Por favor, responde según su deseo y disponibilidad para implementar un servicio de agua así. *¿Por un servicio de agua de 6 horas por día, con la misma calidad que está ahora, estaría dispuesto a pagar S/. X mensual? - VISUAL IV.1* I: 18 Si / No / Quizás; II: 24 Si / No / Quizás; III: 30 Si / No / Quizás *¿Por un servicio de agua de 12 horas por día, con la misma calidad que está ahora, estaría dispuesto a pagar S/. X mensual? - VISUAL IV.2* I: 20 Si / No / Quizás; II: 26 Si / No / Quizás; III: 32 Si / No / Quizás *¿Por un servicio de agua de 24 horas por día, con la misma calidad que está ahora, estaría dispuesto a pagar S/. X mensual? - VISUAL IV.3* I: 22 Si / No / Quizás; II: 28 Si / No / Quizás; III: 34 Si / No / Quizás *¿Para un servicio que provee agua segura, pero no necesariamente más horas por día, sería dispuesto pagar S/. X mensual? - VISUAL IV.4* 18 Si / No / Quizás; 24 Si / No / Quizás; 30 Si / No / Quizás *¿Para un servicio de agua segura, de mejor calidad, que viene también por 12 horas por día, sería dispuesto pagar S/. X mensual? - VISUAL IV.5* 24 Si / No; 30 Si / No; 36 Si / No	(1) Muéstrale *Visual 4*. SOLO LEA LOS NÚMEROS DE UNA COLUMNA PARA CADA CASA. (2) Si el respondiente dice "No" al último pregunta, pregúntale 'Entonces, cuanto pagaría para tener agua más segura, de mejor calidad, que viene 12 horas por día?' Marca el precio que el respondiente dice en la caja blanca al la derecha de la caja 'No.' (3) OJO: NO le da al respondiente la opción de 'Quizás.' Solo apunta 'quizás' si él/ella no quiere hacer una decisión por nada y dice esto en vez de 'Si' o 'No.'
	En una escala de 1 a 10, con 10 indicando que estás absolutamente cierto, ¿Qué nivel de certeza tiene por sus voluntad de pago respuestas? _____ En una escala de 1 a 10, con 10 indicando que estás absolutamente seguro, ¿Cuánto confianza tiene que un servicio de 12 horas por día de mejora calidad cómo he descrito sería posible e implementado? _____	Muéstrale al respondiente *Visual 6* para que él/ella pueda calificar su confianza en sus respuestas y, después, su confianza que el último escenario es posible.
18	¿Cree que el agua en Perú es: Abundante / Regular / Escaza en Chao? Abundante / Regular / Escaza ¿Tiene experiencia con escasez de agua? Si / No Frecuencia: Diario / Semanal / Mensual / Verano / Anual / Pasado *Si tiene conexión domiciliara, ¿por cual medio recibe la información de que no habrá servicio de agua?* _____ ¿A dónde va usted cuando no hay agua? ¿Qué fuente(s) utiliza(n)? puquio / río / propio pozo / pozo de vecino / agua de vecino / otro _____ ¿Este agua tiene un costo? Si / No / N/A Cuánto? S/. _____ por litro	(1) Diga 'abundante O escasez . Sólo si el respondiente diga 'regular,' apuntalo; (2) Si el respondiente responde 'No' tiene experiencia de escasez de agua, no es necesario preguntarle la frecuencia; (3) La caja bajo de 'anual' es para notar un número por si acaso el/la respondiente dice algo cómo "dos veces al año, cuatro veces al año" etc.; (4) "Tiene un costo" refiere a, cuando no hay agua, el respondiente compra agua envasada, compra agua de pozo, o quizás paga a alguien para traer/transportar agua a su casa.
19	De los siguientes servicios públicos, enumera según importancia lo TRES más importante a usted - ENUMERAR 1, 2, 3 agua / calles asfaltadas / desagüe / educación luz / plaza de armas / salud / transporte En una escala de 1 a 10, con 10 indicando que hace buenazo trabajo, ¿Qué nivel de confianza tiene con las obras que hace la Municipalidad? _____	(1) Muéstrale al respondiente *Visual 5* para que el/la respondiente pueda enumerar los 3 servicios más importantes para ellos (ojo: deja las otras 5 cajas blanco); (2) Muéstrele al respondiente Visual 6 para que él/ella pueda calificar su confianza en la Municipalidad de Chao.
20	¿Hay reuniones comunitarias? Si / No ¿Qué temas tratan? _____ ¿Asiste? Si / No En una escala de 1 a 10, con 10 indicando que sus vecinos son como familia, ¿Qué nivel de confianza y apoyo tiene con su comunidad? _____	(1) Muéstrele al respondiente *Visual 6* para que él/ella pueda calificar su confianza con su vecinos; (2) Al fin de encuesta pregunta al respondiente si tiene unas comentarios, dudas, preguntas, etc. No olvida de darle muchas gracias por su tiempo y participación.

Appendix F Primary Changes – Survey One to Survey Two

A.1: Primary differences between Round I and Round II surveys.

Changes to ROUND II	
Added	Eliminated
Socio-Economic	
housing material and floor type	water diary
number of people in house during day	area and number of room of old house
noting Incomplete primary and secondary	dividing up kids/youth/adults-men/women of renters
including space for additional incomes outside of occupations (renting rooms, pension, etc.)	use of social sites (Facebook/hi-5,etc.)
valons of gas used per month	
artifacts including: computer, washing machine, refrigerator, etc. ...and whether planning to buy anything in coming year	
preferred media source	
Water Use	
# of storage devices that are elevated and covered (entered as %)	eliminated 'standing water' and 'public tap stand' from alternative sources
planning to buy more storage? how much more and why?	destination of greywater from water source section
scale of 1 to 10 rate confidence in water use estimate	what is more important, quality water or a quality service?
between what hours water service arrives	opinion on chlorinated water
what is potable water?	times per day drink water / other drinks
what does service provider do to make water potable?	have confidence in water service provider?
added odor as option for water quality characteristics and added visual	series of would pay more for water than X service
added schedule, maintenance, pressure and transparency to water service characteristics and added visual	number 1 to 5 sector priority for water
who is water provider?	use of chemicals in the house?
expanded years with water service categories	most preoccupying environmental issue?
added 'in past' as option for frequency of pressure problems	percentage of water in world that is freshwater?

Appendix F (Continued)

Table A.1: (Continued).

have enough water for needs?	get along with neighbors?
use more water if more continuous?	how do perceive organization in your community?
hour of arrival affect daily schedule	
confidence water is safe to drink?	
rate safety of water on scale of 1 to 10	
rate performance of water service provider on scale of 1 to 10	
what characteristic of current service would most like to change?	
what information would you like from water service provider to increase confidence?	
do you want the water service to use meters and why?	
like the way pay bill and why?	
cases of diarrhea and dengue	
what type of water to flush toilet	
rate on scale of 1 to 10 desire for sewage	
liters cooking (per household per day)	
liters mopping, frequency, water type	
liters for plants, frequency, water type	
why have or don't have plants?	
liters per day of animals/pets	
number 1 to 5 water required for activities	
why practice water conservation?	
received and/or heard information on water conservation?	
adjusted WTP section - scenarios and prices	
confidence in WTP answers	
confidence in provider's ability to implement described WTP scenarios	
what alternative water source turn to when run out of water?	
top 3 (of 8) public service projects?	
community meetings and attendance	

Appendix G Round I - SPSS Codes

Table A.2: Codes used to enter Round I data into SPSS.

GENERAL LEGEND	
99	Missing
999	Does not Apply
990	Don't Know (when doing quantitative and don't want included for statistical purposes)
N°	Will perform *Optimal Binning procedure and categorize accordingly
998	Doesn't apply because said "Yes" to last WTP Question or as otherwise noted
	Despite field testing, misunderstood question, do NOT analyze
italics	*question added late on as field test for survey two, collected data not for analysis*

ROUND ONE CODES			
Q#	VARIABLE NAME	CODES	MISSING & NOT APPLICABLE
1	ADMINISTRATOR	1=merril; 2=Hilda; 3=Jacki; 4=Wilmer; 5=Miguel; 6=Yecenia; 7=Stephanie; 8=Marizedt; 9=Roxanna	
2	NUMBER	N°	
3	DATE	Day.Month.Year	
4	SECTOR	1=Nuevo Chao; 2=Chao; 3=28 de Julio; 4=Fujimori=5=San Luis; 6=Las Delicias; 7=Victoria/Juan Velasco	
4B	USER GROUP	1=Nuevo Chao; 2=Chao; 3=No water service, rely on well	
5	BLOCK OR STREET	N° or WORDS	99
6	LOT OR HOUSE NUMBER	N°	99
7	GENDER	1=female; 2=male	99
8	AGE	N°	99
8B	AGE - CATEGORIZED	1= ≤ 20 years; 2=20 < x ≤ 30 years; 3= 30 < x ≤ 40 years; 4= 40 < x ≤ 50 years; 5= 50 < x ≤ 60 years; 6= 60 < x ≤ 70 years; 7= > 70 years	99
SOCIO-ECONOMIC DATA			
9	HOUSEHOLD OWNERSHIP	1=Own; 2=Rent	99
10	YEARS OF OWNERSHIP	N°; if less than 1 year marked as .5	99,999,990
11	YEARS IN CHAO / NUEVO CHAO	N°; if less than 1 year marked as .5	99
11B	YEARS IN CHAO / NUEVO CHAO - CATEGORIZED	1= ≤ 1 years; 2= 1 < x ≤ 5 years; 3= 5 < x ≤ 10 years; 4= 10 < x ≤ 20 years; 5= 20 < x ≤ 30 years; 6= > 30 years	99
12	AREA (M2)	N°	99,990
12B	AREA (M2) - Categorized	1= ≤80; 2= 80<x≤120; 3= 120<x≤160; 4= >160	99,990
13	N° ROOMS (where rooms equals separate spaces)	N°	99
13B	N° ROOMS - Categorized	1= ≤ 2; 2= 3 to 4; 3= 5 to 6; 4= ≥7	99
14	N° ANIMALS	N°	99
15	N° PETS	N°	99
16	N° PEOPLE - TOTAL	N°	99

Table A.2: (Continued)

17	N° PEOPLE - FAMILY	N°	99
18	N° PEOPLE - RENTERS	N° (where 0 means no renters)	99
19	HOUSE BEFORE LOCATION - 1	1=Coast; 2=Mountain; 3=Jungle	99
20	HOUSE BEFORE LOCATION- 2	1=Rural; 2=Urban	99
21	N° ADULTS ≤18	N°, enter 0 if zero	99
22	N° YOUTH 5<X≤18	N°, enter 0 if zero	99
23	N° KIDS ≤5	N°, enter 0 if zero	99
24	N° WOMEN	N°, enter 0 if zero	99
25	N° MEN	N°, enter 0 if zero	99
26	N° NONE	N°, enter 0 if zero	99
27	N° KINDERGARTEN	N°, enter 0 if zero	99
28	N° ELEMENTARY	N°, enter 0 if zero	99
29	N° MIDDLE/HIGH	N°, enter 0 if zero	99
30	N° UNIVERSITY	N°, enter 0 if zero	99
31	N° TECHNICAL TRAINING	N°, enter 0 if zero	99
32	EDUCATION RESPONDENT	1=University; 2=Technical; 3=Secondary; 4=Primary; 5=Kindergarten; 6=None	99
33	HIGHEST EDUCATION MARKED (ASSUME HEAD OF HOUSEHOLD)	1=University; 2=Technical; 3=Secondary; 4=Primary; 5=Kindergarten; 6=None	99
34	N° INCOME EARNERS	N°	99
35	PRINCIPAL OCCUPATION	1=Agriculture-owner; 2=Agriculture worker; 3=Technical; 4=Business Owner; 5=Commercial Employee; 6=Healthcare; 7=Education; 8=Artisan; 9=Outside support from family; 10=Outside support from government; 11=Security / Watches over House; 12=Transport (driver); 13=Construction; 14=Rent Rooms/Property; 15=mining; 16=fishing; 17=ministry; 18=Government	99
36	TOTAL REPORTED MONTHLY INCOME	N°	99,990
36B	TOTAL REPORTED MONTHLY INCOME - Categorized	1= ≤600 Nuevos Soles; 2= 600<x≤1000 Nuevos Soles; 3=1000<x≤1400 Nuevos Soles; 4= >1400 Nuevos Soles	99,990
37A	ELECTRICITY - Y/N	1=Yes; 2=No	
37	ELECTRICITY - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, 0.5=<1 year and IF DON'T HAVE (No)=0	99
38	MONTHLY ELECTRIC BILL	N°	99,999
39A	CELL PHONES - Y/N	1=Yes; 2=No	
39	CELL PHONES - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, 0.5=<1 year and IF DON'T HAVE (No)=0	99
40	N° CELL PHONES	N°	99,999,990
41	S/. ADDED A MONTH	N° (0 implies only have cellphone for receiving calls, don't buy saldo (minutes))	99,999,990
42A	LANDLINE - Y/N	1=Yes; 2=No	
42	LANDLINE - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, 0.5=<1 year and IF DON'T HAVE (No)=0	99
43	MONTHLY LANDLINE BILL	N°	99,999,990
44A	CABLE - Y/N	1=Yes; 2=No	
44	CABLE - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, 0.5=<1 year and IF DON'T HAVE (No)=0	99
45	MONTHLY CABLE BILL	N°	99,999,990
46A	NEXTEL - Y/N	1=Yes; 2=No	
46	NEXTEL - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, 0.5=<1 year and IF DON'T HAVE (No)=0	99
47	MONTHLY NEXTEL BILL	N°, where 990=Business pays	99,999,990
48A	INTERNET - Y/N	1=Yes; 2=No	
48	INTERNET - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, 0.5=<1 year and IF DON'T HAVE (No)=0	99
49	MONTHLY INTERNET BILL	N°	99,999,990

Table A.2: (Continued)

50	TRANSPORTATION - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, 0.5=<1 year and IF DON'T HAVE (No)=0	99
51	MONTHLY SPENT GAS/MAINTENANCE	N°	99,999,990
52	SOCIAL NETWORK?	0=NONE; 1=Facebook; 2=Hi5; 3=email; 4 = two or more	99
		WATER	
53	PRIMARY SOURCE	1=Tap; 2=Well; 3=Bottled Water; 4=River/Spring; 5=Canal; 6=Public Tap Stand	99
54	SECONDARY SOURCE	1=Tap; 2=Well; 3=Bottled Water; 4=River/Spring; 5=Canal; 6=Public Tap Stand	99,999
55	TERTIARY SOURCE	1=Tap; 2=Well; 3=Bottled Water; 4=River/Spring; 5=Canal; 6=Public Tap Stand	99,999
56	TAP	1=Yes; 2=No	99
57	HOUSEHOLD WELL	1=Yes; 2=No	99
58	NEIGHBORS WELL	1=Yes; 2=No	99
59	RIVER/SPRING	1=Yes; 2=No	99
60	CANAL	1=Yes; 2=No	99
61	BOTTLED WATER	1=Yes; 2=No	99
62	USES TAP WATER	1=Everything; 2=Cooking; 3=Drinking; 4=Bathing; 5=Watering; 6=Cleaning and Washing; 7=Cooking and Drinking; 8=Cooking and Bathing; 9=Bathing and Cleaning; 10=Everything (but only when other sources not available); 11=Have but Don't Use	99,999
63	USES WELL WATER	1=Everything; 2=Cooking; 3=Drinking; 4=Bathing; 5=Watering; 6=Cleaning and Washing; 7=Cooking and Drinking; 8=Cooking and Bathing; 9=Bathing and Cleaning; 10=Everything (but only when other sources not available); 11=Have but Don't Use	99,999
64	USES RIVER/SPRING	1=Everything; 2=Cooking; 3=Drinking; 4=Bathing; 5=Watering; 6=Cleaning and Washing; 7=Cooking and Drinking; 8=Cooking and Bathing; 9=Bathing and Cleaning; 10=Everything (but only when other sources not available); 11=Have but Don't Use	99,999
65	USES CANAL	1=Everything; 2=Cooking; 3=Drinking; 4=Bathing; 5=Watering; 6=Cleaning and Washing; 7=Cooking and Drinking; 8=Cooking and Bathing; 9=Bathing and Cleaning; 10=Everything (but only when other sources not available); 11=Have but Don't Use	99,999
66	USES BOTTLED WATER	1=Everything; 2=Cooking; 3=Drinking; 4=Bathing; 5=Watering; 6=Cleaning and Washing; 7=Cooking and Drinking; 8=Cooking and Bathing; 9=Bathing and Cleaning; 10=Everything (but only when other sources not available); 11=Have but Don't Use	99,999
67	WHEN USE FAUCET	1=All the time; 2=Weekly; 3=Monthly; 4=A few months a year; 5=Only when primary source isn't available	99,999
68	WHEN USE HOUSEHOLD WELL	1=All the time; 2=Weekly; 3=Monthly; 4=A few months a year; 5=Only when the primary source isn't available	99,999
69	WHEN USE NEIGHBOR'S WELL	1=All the time; 2=Weekly; 3=Monthly; 4=A few months a year; 5=Only when the primary source isn't available	99,999
70	WHEN USE RIVER/SPRING	1=All the time; 2=Weekly; 3=Monthly; 4=A few months a year; 5=Only when the primary source isn't available	99,999
71	WHEN USE CANAL	1=All the time; 2=Weekly; 3=Monthly; 4=A few months a year; 5=Only when the primary source isn't available	99,999
72	WHEN USE BOTTLED WATER	1=All the time; 2=Weekly; 3=Monthly; 4=A few months a year; 5=Only when the primary source isn't available	99,999
73	HOURS TAP	1= ≤30 minutes; 2= 30<x<1 hour; 3= 1<x≤2 hours; 4= 2<x≤3 hours; 5= 3<x≤6 hours; 6= 6<x≤12 hours; 7= 24 hours; 8= ≤30 minutes *every other day; 9= 30<x≤1 hour *every other day; 10= 1<x≤2 hours *every other day; 11= 2<x≤3 hours *every other day; 12= 3<x≤6 hours *every other day; 13= 6<x≤12 hours	99,999
74	TIME TO RETRIEVE WELL WATER	1= <5 minutes; 2= 5<x≤10 minutes; 3= 10<x≤30 minutes; 4=30<x≤60 minutes; 5= >1 hour	99,999
75	TIME TO RETRIEVE/USE RIVER WATER	1= <5 minutes; 2= 5<x≤10 minutes; 3= 10<x≤30 minutes; 4=30<x≤60 minutes; 5= >1 hour	99,999

Table A.2: (Continued)

76	TIME TO RETRIEVE/USE CANAL WATER	1= <5 minutes; 2= 5<x≤10 minutes; 3= 10<x≤30 minutes; 4=30<x≤60 minutes; 5= >1 hour	99,999
77	TIME TO RETRIEVE BOTTLED WATER	1= <5 minutes; 2= 5<x≤10 minutes; 3= 10<x≤30 minutes; 4=30<x≤60 minutes; 5= >1 hour	99,999
78	VISITS TO NEIGHBORS WELL PER WEEK	N°	99,999
79	LITERS FROM NEIGHBOR'S WELL PER WEEK	N°	99,999
80	VISITS TO RIVER/SPRING PER MONTH	N°	99,999
81	VISITS TO CANAL PER MONTH	N°	99,999
82	LITERS BOTTLED WATER PER MONTH	N°	99,999
83	QUALITY OF FAUCET WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=Fea (gross); 11=Regular; 12=Clean but Disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected	99,999,990
84	QUALITY OF WELL WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=Fea (gross); 11=Regular; 12=Clean but Disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected	99,999,990
85	QUALITY OF RIVER/SPRING WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=; 11=Regular; 12=Clean but Disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected	99,999,990
86	QUALITY OF CANAL WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=; 11=Regular; 12=Clean but Disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected	99,999,990
87	QUALITY OF BOTTLED WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=; 11=Regular; 12=Clean but Disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected	99,999,990
88	CALCULATED STORAGE CAPACITY (*including washtubs when relevant)	N°	99,999,990
88B	STORAGE CAPACITY - Categorized	1= ≤50 Liters; 2= 50<x≤100 Liters; 3= 100<x<150 Liters; 4= 150<x≤200; 5= 200<x≤300 Liters; 6= 300<x≤500 Liters; 7= 500<x≤1,100 Liters; 8= >1,100 Liters	99
89	FREQUENCY CLEAN PRINCIPAL STORAGE DEVICES	1=daily; 2=every other day; 3=weekly; 4=twice a month; 5=monthly; 6=every three months; 7=annually; 8=when they empty; 9=never	99,999,990
90	RESPONDENT ESTIMATE OF WATER CONSUMED PER DAY - FAUCET	N° OR CATEGORIES 1= x≤500 Liters; 2= 500<x≤1000 Liters; 3= 1000<x≤2000 liters; 4= 2000<x≤3000 Liters; 5= >3000 Liters .....**According to storage, DOES NOT INCLUDE WATER THEY USE WHEN WATER ARRIVING: for calculation purposes, on 7/10/12 I recoded/entered the 30-"0"s as 990; 20-"1"s as missing, the 3 - "2"s as 750, and the 4-"5"s as 3000	99,999,990
91	CALCULATED WATER USE PER DAY - FAUCET	*N°*	99,999
92	CALCULATED WATER USE PER DAY PER CAPITA FROM ESTIMATE-FAUCET	N°	99,999
93	RESPONDENT ESTIMATE OF WATER CONSUMED PER DAY - WELL	N° OR CATEGORIES: 1= ≤500 Liters; 2= 500<x≤1000 Liters; 3= 1000<x≤2000 liters; 4= 2000<x≤3000 Liters; 5= >3000 Liters .....**for calculation purposes, on 7/10/12 I recoded/entered the 9-"0"s as 990; 2-"1"s as missing, the 1 - "2"s as 750, and the 1-"3"s as 1500	99,999,990
94	CALCULATED WATER USE PER DAY - WELL	N°	99,999
95	CALCULATED WATER USE PER DAY PER CAPITA FROM ESTIMATE-WELL	N°	99,999
96	HOUSEHOLD TREATMENT	1=Crude; 2=Boiled; 3=Crude and Boiled; 4=Multiple Treatment (Chlorated, Boiled, Filtered); 5=Only Drink Bottled Water	99
97	*BOILED WATER PER CAPITA PER DAY*	N°	99,999
98	WATER SERVICE REPORTED COST	N°	99,990
99	PERCEPTION OF COST (TAP)	1=Expensive; 2=Fair(normal/its fine); 3=Cheap	99,999,990

Table A.2: (Continued)

100	WATER SERVICE ACTUAL COST	0=0; 1=3.20; 2=10; 3=12; 4=15.30; 5=20 (commercial A); 6=other; 7=Included in Rent	99,990
101	BOTTLED WATER COST PER MONTH	N° (in this case DON'T put 0 if don't buy, simply code 999)	99,999
102	PERCEPTION OF COST (BOTTLED WATER)	0=don't know; 1=Expensive; 2=Fair(normal/its fine); 3=cheap	99,999
103	QUALITY WATER VS. QUALITY SERVICE	1=Quality of Water; 2=Quality of Service; 3=Answered both	99,990
104	MOST IMPORTANT FACTOR IN QUALITY OF WATER	1=Taste; 2=Appearance; 3=Physical Quality; 4=Biological Quality; 5=marked 2 or more	99,990
105	MOST IMPORTANT FACTOR FOR QUALITY WATER SERVICE	1 - Quality; 2 - Continuity; 3 - Price	99,990
106	TASTE - CHLORINATED WATER	1= Agreeable; 2=Disagreeable; 3=normal; 4=disagreeable but important	99,990
107	N° LITERS WATER DAILY	0=0; 1= <0.5 L; 2= 0.5<x≤1 L; 3= 1<x<≤2 L; 4= 2<x≤3 L; 5= >3 L; 6=Once in a While	6,99
108	N° LITERS OTHER LIQUIDS DAILY	0=0; 1= <0.5 L; 2= 0.5<x≤1 L; 3= 1<x<≤2 L; 4= 2<x≤3 L; 5= >3 L; 6=Once in a While	6,99
109	TIME WITH SERVICE	1= <1 year; 2=1 to 3 years; 3= 4 to 7 years; 4= >7 years	99,999,990
110	ESTIMATED LITERS PER MINUTE	990=Don't Know; 1= ≤1; 2= 1<x≤5; 3= 5<x≤10; 4= 10<x≤20; 5= >20	99,999
111	ORIGIN OF WATER	0=Don't Know; 1=Spring; 2=River; 3=Well; 4=Reservoir; 5=CHAVIMOCHIC; 6=name of place (where 998 means wrote other (filtration, canal, tubes, SADISCHAO)	99,999,998
112	PRESSURE PROBLEMS	1=Yes; 2=No	99,999
113	FREQUENCY OF PRESSURE PROBLEMS	1=Rarely; 2=Daily; 3=Weekly; 4=Monthly; 5=Once in a While	99,999
114	CONFIDENCE IN WATER PROVIDER	1=Yes; 2=No; 3=neither bad nor good	3,99,999
115	WHY CONFIDENCE OR NO CONFIDENCE	WORDS	999,99
115 B	WHY CONFIDENCE - Categorized	1=All Around Good Service-Trust; 2=Know Providers/Operators-Good Communication; 3=Treated and Maintained-Good Quality; 4=Daily, Continuous, Consistent-Sufficient Quantity; 5=Bad Service, Rob Money-NO Trust; 6=Don't Know Provider/Operator-Bad Communication; 7=Don't Treat and Maintain-Poor Quality; 8=Bad Schedule, Service Interruptions-NOT Sufficient; 9=Only Service-What Else Going to Do?	99,999,990
116	PRIORITY - ELECTRICITY	1=Yes; 2=No; 3=depends on if service of water was improved	99,999,990
117	PRIORITY - CABLE	1=Yes; 2=No; 3=depends on if service of water was improved	99,999,990
118	PRIORITY - INTERNET	1=Yes; 2=No; 3=depends on if service of water was improved	99,999,990
119	PRIORITY - COMMUNICATION (CELLPHONE/LANDLINE)	1=Yes; 2=No; 3=depends on if service of water was improved	99,999,990
120	PRIORITY - NEXTEL	1=Yes; 2=No; 3=depends on if service of water was improved	99,999,990
121	PRIORITY - PERSONAL TRANSPORTATION	1=Yes; 2=No; 3=depends on if service of water was improved	99,999,990
122	MOST IMPORTANT - 1	1=Agriculture; 2=Environment; 3=Commercial; 4=Domestic; 5=Industry	99,990
123	SECOND MOST IMPORTANT	1=Agriculture; 2=Environment; 3=Commercial; 4=Domestic; 5=Industry	99,990
124	THIRD MOST IMPORTANT	1=Agriculture; 2=Environment; 3=Commercial; 4=Domestic; 5=Industry	99,990
125	FOURTH	1=Agriculture; 2=Environment; 3=Commercial; 4=Domestic; 5=Industry	99,990
126	FIFTH	1=Agriculture; 2=Environment; 3=Commercial; 4=Domestic; 5=Industry	99,990
127	N° FAUCETS	N° - 0=don't have	99
128	N° SHOWERS	N° - 0=don't have	99
129	N° TOILETS	N° - (where pour flush latrines are counted as they utilize water); 0 = use pit latrine or fields; 10 = have toilet but only flushes when the water is arriving (aka, predominantly flushed with bucket); 11=have toilet but only flushed with bucket	99
129 B	N° TOILETS (to Match Round II codes)	N° - where pour flush latrines are counted as they utilize water	99
130	LITERS TO FLUSH (BUCKET OR TANK)	N°, where 90=broken	99,999,990
131	FLUSHES PER DAY PER CAPITA	N°, where 90=broken	99,999,990
132	N° KNOWN LEAKS	N°	999,99
133	SEWAGE?	1=Yes; 2=No	99
134	SEWAGE DESTINATION?	0=Don't Know; 1=Oxidation Ponds; 2=Canal; 3=River; 4=Ocean; 5="Down there"; 6="tubes/matrix"	99,999
135	SANITATION ALTERNATIVE (to Match Round II codes)	1=pit latrine; 2=pour-flush latrine; 3=fields/river	99,999

Table A.2: (Continued)

136	BLACKWATER DESTINATION	0=sewage; 1=septic pit; 2=ground (hole); 3=fields and river	99,999
137	HOW BATHE	1=buckets; 2=shower; 3=buckets and shower (shower only works when water is arriving); 4=river	99
138	N° - SUMMER	N° where 0.5=every other day; 0.15=once a week; 998=bathe in river	99,998
139	N° - WINTER	N° where 0.5=every other day; 0.15=once a week; 998=bathe in river	99,998
140	N° MINUTES - SHOWER	N°	99,999,990
141	N° LITERS - BUCKETS	N°	99,999,990
142	CALCULATED - TOTAL LITERS TO BATHE PER CAPITA PER DAY - SUMMER	N° - ONLY CALCULATED FOR THOSE WHO ESTIMATED LITERS FROM BUCKET BATHS....DUE TO VARYING WATER PRESSURE, CANNOT CALCULATE HOW MUCH WATER IS USED IN AN X MINUTE SHOWER; 999 when bathed in river	99,999
142 B	LITERS BATHING PER CAPITA PER DAY - SUMMER - Categorized	1= ≤10 Liters; 2= 10<x≤20 Liters; 3= 20<x≤30 Liters; 4= 30<x≤40 Liters; 5= 40<x≤50 Liters; 6= 50<x≤60 Liters; 7= 60<x≤100 Liters; 8= >100 Liters	99,999
143	CALCULATED - TOTAL LITERS TO BATHE PER CAPITA PER DAY - WINTER	N° - ONLY CALCULATED FOR THOSE WHO ESTIMATED LITERS FROM BUCKET BATHS....DUE TO VARYING WATER PRESSURE, CANNOT CALCULATE HOW MUCH WATER IS USED IN AN X MINUTE SHOWER; 999- when bathed in river	99,999
143 B	LITERS BATHING PER CAPITA PER DAY - SUMMER - Categorized	1= ≤10 Liters; 2= 10<x≤20 Liters; 3= 20<x≤30 Liters; 4= 30<x≤40 Liters; 5= 40<x≤50 Liters; 6= 50<x≤60 Liters; 7= 60<x≤100 Liters; 8= >100 Liters	99,999
144	WASH PLATES PER DAY	N°, where 999=don't wash plates	99,999
145	LITERS PER DISH WASH	N°, where 0=don't know	99
146	WASH HANDS PER DAY	N° where 990=means gave qualitative response (see 146B below)	99
146 B	WASH HANDS PER DAY (QUALITATIVE, NO # WAS REPORTED)	1=Many Times; 2=Every Moment	99,999
147	LITERS PER HAND WASH	N°	99,990
148	BRUSH TEETH PER DAY	N°, where 0=don't brush teeth	99,990
149	LITERS PER TOOTHBRUSHING	N°	99,999,990
150	*LITERS PER COOKING PER DAY*	*N° (not per capita as in Round II...started to note almost near end just as a trial for Round II)*	*99*
151	*LITERS PER CLEANING FLOOR PER DAY*	*N° where 0=don't clean floor (similar to cooking, started to note almost near end as trial for Round II)*	*99*
152	*LITERS PER CLEANING PER DAY*	*N° where 0=doesn't clean (doesn't have furniture) (similar to cooking and cleaning floor, started to note almost near end as a trial for Round II)*	*99*
153	*WATER STREET/OUTSIDE? (DAY) - DOES NOT INCLUDE PLANTS*	*0=don't water; 1=once a day; 2=twice a day; 3=three times a day; 4=every other day; 5=twice a week; 6=once a week; 50=every moment; 7=once in a while*	*99*
153 B	*WATER STREET/OUTSIDE - Y/N (to match Round II)*	*1=Yes; 2=No*	*99*
154	*WATER TYPE - STREET*	*1=Tap Water; 2=Well Water; 3=Washwater; 4=Tap and Washwater; 5=Well and Washwater; 6=Canal water*	*99,999*
155	*LITERS USED OUTSIDE PER WEEK*	*N° - LITERS (where 998 means gave in minutes (#155B), since 999 means don't water)*	*99,999,998*
155 B	*LITERS USED OUTSIDE PER WEEK - Categorized*	1= ≤20 Liters; 2= 20<x≤60 Liters; 3= 60<x≤100 Liters; 4= 100<x≤200 Liters; 5= 200<x≤300 Liters; 6= 300<x≤400 Liters; 7= 400<x≤500 Liter; 8= >500 Liters	*99,999,998*
155 .C	*MINUTES WITH HOSE OUTSIDE PER WEEK*	*N° - MINUTES (where 998 means gave in Liters (#155), since 999 means don't water)*	*99,999,998*
156	*WATER INSIDE? (DAY)*	*0=don't water; 1=once a day; 2=twice a day; 3=three times a day; 4=every other day; 5=twice a week; 6=once a week; 50=every moment; 7=once in a while*	*99*
156 B	*WATER INSIDE? - Y/N (to match Round II)*	*1=Yes; 2=No*	*99*
157	*WATER TYPE - INSIDE*	*1=Tap Water; 2=Well Water; 3=Washwater; 4=Tap and Washwater; 5=Well and Washwater; 6=Canal water*	*999,99*

Table A.2: (Continued)

158	*LITERS USED INSIDE PER WEEK*	*N° OR 50= gave in minutes*	*99,999,998*
158 B	*LITERS USED OUTSIDE PER WEEK - Categorized*	1= ≤20 Liters; 2= 20<x≤60 Liters; 3= 60<x≤100 Liters; 4= 100<x≤200 Liters; 5= 200<x≤300 Liters; 6= 300<x≤400 Liters; 7= 400<x≤500 Liter; 8= >500 Liters	*99,999,998*
158 C	*MINUTES WITH HOSE INSIDE PER WEEK*	*N° OR 998= gave in liters*	*99,999,998*
159	N° TIMES WASH CLOTHES PER WEEK	N° where 0=don't wash (send elsewhere); 0.5=every other week	0,99
160	LITERS USED PER LOAD	N° where 0 implies that they wash clothes in river or canal	99,990
161	CAC - N° LITERS WASH CLOTHES PER WEEK	N° where 0 implies that they wash clothes in river or canal	99
162	HYDROCHLORIC ACID	1=Yes; 2=No	99
163	BLEACH	1=Yes; 2=No	99
164	CAUSTIC SODA	1=Yes; 2=No	99
165	DETERGENT (Ace, Ariel, Bolivar, Ayudín)	1=Yes; 2=No	99
166	LEMON	1=Yes; 2=No	99
167	VINEGAR	1=Yes; 2=No	99
168	*OTHER -Additional Cleaning Agents Mentioned - QUALITATIVE*	WORDS	99
168 B	*OTHER - CODED*	1=Don't Use Anything; 2=water (sometimes in addition to other chemicals, sometimes as itself "pure"); 3=Broom / Take Out Trash; 4= Ash; 5=Poet / Pinesol / Room Freshener; 6=Creso	999
169	WATER CONSERVATION	1=Yes; 2=No	99,990
170	WATER CONSERVATION EXAMPLE	WORDS	99,999
170 B	WATER CONSERVATION EXAMPLE - Categorized	1=Use Bare Minimum/Conserve Water/Don't Waste; 2= Boil / Add Chlorine (Treat) Water; 3=Cover Water (so kids/bugs don't dirty it); 4=Don't Water Street; 5=Reuse Water (washwater for street, old water for laundry, etc.); 6=Close Faucets; 7=Install Water Conserving Artifacts; 8=Repair Leaks; 9=Not Possible/Not Enough Water; 10=No Need and/or Have Well	99,999
		WILLINGNESS TO PAY	
171	WTP - 24/7 - I	1=Yes; 2=No	9992, 9993
172	WTP - QUALITY - I	1=Yes; 2=No	9992, 9993
173	WTP - BOTH - I	1=Yes; 2=No	9992, 9993
174	WTP - SEWAGE - I	1=Yes; 2=No	9992, 9993
175	WTP - ALL - I	1=Yes; 2=No	9992, 9993
176	WTP - OPINION - I	N°	99,999,998
177	WTP - 24/7 - II	1=Yes; 2=No	9991, 9993
178	WTP - QUALITY - II	1=Yes; 2=No	9991, 9993
179	WTP - BOTH - II	1=Yes; 2=No	9991, 9993
180	WTP - SEWAGE - II	1=Yes; 2=No	9991, 9993
181	WTP - ALL - II	1=Yes; 2=No	9991, 9993
182	WTP - OPINION - II	N°	99,999,998
183	WTP - 24/7 - III	1=Yes; 2=No	9991, 9992
184	WTP - QUALITY - III	1=Yes; 2=No	9991, 9992
185	WTP - BOTH - III	1=Yes; 2=No	9991, 9992
186	WTP - SEWAGE - III	1=Yes; 2=No	9991, 9992
187	WTP - ALL - III	1=Yes; 2=No	9991, 9992
188	WTP - OPINION - III	N°	99,999,998
189	WATER SCARCITY IN PERU	0=Don’t Know; 1=Abundant; 2=Scarce; 3=Regular (neither one nor the other)	99
190	WATER SCARCITY IN CHAO	0=Don’t Know; 1=Abundant; 2=Scarce; 3=Regular (neither one nor the other)	99

Table A.2: (Continued)

191	EXPERIENCE WITH WATER SCARCITY	1=Yes; 2=No	99
192	FREQUENCY	1=Daily; 2=A few times a week; 3=Weekly; 4=Monthly; 5=Summer; 6=once a year; 7=a few times per year; 8=in the past	99,999,990
193	ENVIRONMENTAL PROBLEMS	WORDS (additional issues mentioned, in order they were mentioned)	99
194	ENVIRONMENTAL PROBLEMS - PROMPTED	0=Don't Know; 1=Contamination of Water; 2=Natural Resource Exploitation; 3=Water Scarcity; 4=Contamination of Air; 5=Unplanned Urban Development; 6=Overfishing; 7=Endangered Species; 8=Improper Disposal of Toxins; 9=Desertification; 10=Soil Erosion; 11=Deforestation; 12=Climate Change; 13=Contaminated Air and Water	999
195	CLIMATE CHANGE IN PERU	0=Don't Know; 1=Yes; 2=No	99
196	CLIMATE CHANGE IN CHAO	0=Don't Know; 1=Yes; 2=No	99
197	ADDITIONAL COMMENT ON CLIMATE CHANGE	WORDS	999
198	FRESH WATER - CATEGORY %	0=Don't understand percentages; 1= ≤10%; 2= 10<x≤30%; 3= 30<x≤60%; 4= 60<x≤80%; 5= >80% ; 50XX where XX = the actual % they gave	0,99
198 B	FRESH WATER - NUMERICAL ESTIMATE (%)	For when instead marking a category, enumerator wrote down respondent's numerical estimate (%)	999
199	FRESH WATER - MODIFIED	0=don't know; 1=A Little; 2=Regular; 3=A Lot	99,999
200	NEIGHBORS	1=Yes; 2=Regular; 3=No	99
201	ORGANIZATION	0=don't know; 1=Good; 2=Regular; 3=Bad	99
202	ADDITIONAL COMMENTS / POINTS OF INTEREST	WORDS	99
203	RENTERS PAY PER MONTH	N°	99
204	# IN HOUSE PER DAY	N°	99
205	GREYWATER DESTINATION	0=sewage; 1=street; 2=pit latrine; 3=inside house (corral); 4=canal; 5=septic tank; 6=street and sewage; 7= street and pit latrine; 8= street and inside house; 9=street and canal; 10=street and septic tank; 11=sewage and inside house	99
206	MENTION OF PLANT WATERING	1=Yes; 2=No	99
207	WATER TYPE - PLANTS	1=Tap Water; 2=Well Water; 3=Washwater; 4=Tap and Washwater; 5=Well and Washwater; 6=Canal / River water	99,999
208	LITERS LAUNDRY PER CAPITA PER WEEK		
208 B	LITERS LAUNDRY PER CAPITA PER WEEK - Categorized	0=Only wash clothes in River; 1= ≤20 liters; 2= 20<x≤40 Liters; 3= 40<x≤60 Liters; 4= 60<x≤80 Liters; 5 = 80<x≤100 Liters; 6= >100 Liters	

Appendix H Round II – SPSS Codes

Table A.3: Codes used to enter Round II data into SPSS.

GENERAL LEGEND	
99	Missing
999	Does not Apply
990	Don't Know (when doing quantitative and don't want included for statistical purposes)
N°	Will perform *Optimal Binning procedure and categorize accordingly
998	Doesn't apply because said "Yes" to last WTP Question or as otherwise noted
	Despite field testing, misunderstood question, do NOT analyze

ROUND TWO CODES			
Q#	VARIABLE NAME	CODES	MISSING & NOT APPLICABLE
0	ID	N°	
1	ADMINISTRATOR	1=merril; 2=margarita; 3=Melchora; 4=Deysi; 5=Eduardo; 6=Gilberto; 7=Santos	
2	NUMBER	N°	999
3	DATE	Month.Day.Year	
4	SECTOR	1=Nuevo Chao; 2=Chao; 3=28 de Julio; 4=Alberto Fujimori; 5=San Luis; 6=Las Delicias; 7=La Victoria/Juan Velasco	
4B	GROUP	1=Nuevo Chao; 2=Chao; 3=No water service, rely on well	
5	BLOCK OR STREET	N° or WORDS	99
6	LOT OR HOUSE NUMBER	N°	99
7	GENDER	1=female; 2=male	99
8	AGE	N°	99
8B	AGE - CATEGORIZED	1= ≤20 years; 2= 20<x≤30 years; 3= 30<x≤40 years; 4= 40<x≤50 years; 5= 50<x≤60 years; 6= 60<x≤70 years; 7= >70 years	99
SOCIO ECONOMIC DATA			
9	HOUSEHOLD OWNERSHIP	1=Own; 2=Rent	99
10	MONTHLY RENT	N°	99,999
11	WHAT INCLUDES	WORDS	99,999
12	YEARS IN CHAO / NUEVO CHAO	N°; if less than 1 year marked as .5	99
12B	YEARS IN CHAO / NUEVO CHAO - Categorized	1= ≤1 years; 2= 1<x≤5 years; 3= 5<x≤10 years; 4= 10<x≤20 years; 5= 20<x≤30 years; 6= >30 years	99
13	HOUSE BEFORE LOCATION - 1	1=Coast; 2=Mountain; 3=Jungle	99
14	HOUSE BEFORE LOCATION- 2	1=Rural; 2=Urban	99
15	YEARS IN CURRENT HOUSE	N°	99
16	AREA (METERS SQUARED)	N°	99,990
16B	AREA (M2) - Categorized	1= ≤80; 2= 80<x≤120; 3= 120<x≤160; 4= >160	99,990
17	FLOOR TYPE	1=dirt; 2=tile/cement	99
18	WALL MATERIAL	1=adobe; 2=straw; 3=brick; 4=wood	99
19	N° ROOMS (where rooms equals separate, utilized, spaces)	N°	99
19B	N° ROOMS - Categorized	1= ≤2; 2= 3 to 4; 3= 5 to 6; 4= ≥7	99

Table A.3: (Continued).

20	N° PEOPLE - FAMILY	N°	99
21	N° PEOPLE - RENTERS	N°, where 0=no renters	99,999
22	N° PEOPLE - TOTAL	N° (add Family + Renters)	99
23	N° PEOPLE - HOUSE DURING DAY	N° (only family)	99
24	N° ADULTS ≤18	N°, enter 0 if zero	99
25	N° YOUTH 5<X≤18	N°, enter 0 if zero	99
26	N° KIDS ≤5	N°, enter 0 if zero	99
27	N° WOMEN	N°, enter 0 if zero	99
28	N° MEN	N°, enter 0 if zero	99
29	EDUCATION RESPONDENT	1=University; 2=Technical; 3=Secondary; 4=Incomplete Secondary; 5=Primary; 6=Incomplete Primary; 7=Kindergarten; 8=None	99
30	EDUCATION OF PRINCIPAL WAGE EARNER	1=University; 2=Technical; 3=Secondary; 4=Incomplete Secondary; 5=Primary; 6=Incomplete Primary; 7=Kindergarten; 8=None	99
31	HIGHEST EDUCATION IN HOUSEHOLD	1=University; 2=Technical; 3=Secondary; 4=Incomplete Secondary; 5=Primary; 6=Incomplete Primary; 7=Kindergarten; 8=None	99
32	N° INCOME EARNERS	N°	99
33	PRINCIPAL OCCUPATION	1=Agriculture-owner; 2=Agriculture worker; 3=Technical; 4=Business Owner; 5=Commercial Employee; 6=Healthcare; 7=Education; 8=Artisan; 9=Outside support from family; 10=Outside support from government; 11=Security / Watches over House; 12=Transport (driver); 13=Construction; 14=Rent Rooms/Property; 15=mining; 16=fishing; 17=ministry; 18=government	99
34	TOTAL REPORTED MONTHLY INCOME	N°	99,990
34B	TOTAL REPORTED MONTHLY INCOME - Categorized	1= ≤600 Nuevos Soles; 2= 600<x≤1000 Nuevos Soles; 3= 1000<x≤1400 Nuevos Soles; 4= >1400 Nuevos Soles	99,990
35A	ELECTRICITY	1=Yes; 2=No	99
35	ELECTRICITY - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, IF don't have (No)=0	99,990
36	MONTHLY ELECTRIC BILL	N° (998 implies renting and cost of electricity included in rent)	99,999,998
37A	CELL PHONES	1=Yes; 2=No	99
37	CELL PHONES - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, IF don't have (No)=0	99,990
38	N° CELL PHONES	N°	99,999
39	S/. ADDED A MONTH	N°	99,999
40A	LANDLINE	1=Yes; 2=No	99
40	LANDLINE - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, IF don't have (No)=0	99,990
41	MONTHLY LANDLINE BILL	N°	99,999
42A	NEXTEL	1=Yes; 2=No	99
42	NEXTEL - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, IF don't have (No)=0	99,990
43	MONTHLY NEXTEL BILL	N°, where 990=Business pays	99,999
44A	CABLE	1=Yes; 2=No	99
44	CABLE - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, IF don't have (No)=0	99,990
45	MONTHLY CABLE BILL	N°	99,999
46A	GAS (COOKING)	1=Yes; 2=No	99
46	GAS (COOKING) - TIME	IF YES, enter years with service, with 99=didn't fill in, IF don't have (No)=0	99,990
47	MONTHLY GAS BILL	N°	99,999
48A	INTERNET	1=Yes; 2=No	99
48	INTERNET - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, IF don't have (No)=0	99,990
49	MONTHLY INTERNET BILL	N°	99,999
50A	TRANSPORT	1=Yes; 2=No	99

Table A.3: (Continued).

50	TRANSPORTATION - TIME WITH SERVICE	IF YES, enter years with service, with 99=didn't fill in, IF don't have (No)=0	99,990
51	TRANSPORTATION - TYPE	1=car; 2=motorcycle; 3=Moto-taxi; 4=combi	99,999
52	MONTHLY SPENT GAS/MAINTENANCE	N° where 0=don't have	99,999
53	COMPUTER	N° where 0=don't have	99
54	TELEVISION	N° where 0=don't have	99
55	WASHING MACHINE	N° where 0=don't have	99
56	CAMERA	N° where 0=don't have	99
57	REFRIGERATOR/FREEZER	N° where 0=don't have	99
58	BLENDER	N° where 0=don't have	99
59	PLANNING TO BUY IN NEXT YEAR	1=computer/laptop; 2=television; 3=washing machine; 4=camera; 5=refrigerator/freezer; 6=blender; 7=sound system; 8=improve house; 9=more water storage; 10=stove; 11=higher education; 12=car; 13=no money to buy anything; 14=not thinking about anything; 15=internet; 16=iron; 17=support family; 18=furniture	99
60	MEDIA SOURCE	1=Kadena 100; 2=La Exitosa; 3=Canal 7; 4=Canal Vision (9); 5=Canal America (4); 6=La Verdad; 7=La Industria; 8=El Satelite; 9=Trome; 10=Internet; 11=Nothing; 12=Cellphone; 13=Other	99
		WATER	
61	PRIMARY SOURCE	1=Tap; 2=Well; 3=Bottled Water; 4=Spring/River; 5=Canal; 6=Public Tap Stand	99
62	SECONDARY SOURCE	1=Tap; 2=Well; 3=Bottled Water; 4=Spring/River; 5=Canal	999
63	TERTIARY SOURCE	1=Tap; 2=Well; 3=Bottled Water; 4=Spring/River; 5=Canal	999
64	TAP	1=Yes; 2=No	99
65	HOUSEHOLD WELL	1=Yes; 2=No	99
66	NEIGHBORS WELL	1=Yes; 2=No	99
67	RIVER/SPRING	1=Yes; 2=No	99
68	CANAL	1=Yes; 2=No	99
69	BOTTLED WATER	1=Yes; 2=No	99
70	# STORAGE DEVICES (NOT INCLUDING WASHTUBS)	N°	99
71	# THAT ARE ELEVATED	N°	99
72	% THAT HAVE COVERS (NOT INCLUDING WASHTUBS)	PERCENTAGE	99
73	DESIRE FOR MORE STORAGE	1=Yes; 2=No	99
74	HOW MANY LITERS	N°	99
75	WHY	words	99,999
75-B	WHY OR WHY NOT - Categorized	1= Lack water; 2= For storing more / Protection; 3= For when get sewage (future); 4= For during summer; 5=For Continuous Water; 6=Fine with what have; 7=Not enough money; 8=Not their house, plan on leaving; 9=Already have one; 10=Have well; 11=No Space	99
76	FREQUENCY WASH ROTOPLAS	1=weekly; 2=monthly; 3=every 3 months; 4=twice a year; 5=annual; 6=never	99,999,990
77	ESTIMATED WATER USE - FAMILY	N°	99,990
78	ESTIMATE WATER USE - FAMILY - Per Capita	N°	99
79	ESTIMATED WATER USE - RENTERS	N°	99,999,990
80	ESTIMATED WATER USE - RENTERS - Per Capita	N°	99,999,990
81	CERTAINTY OF ESTIMATE	N° (1-10)	99
82	WHEN USE FAUCET	1=All the time; 2=Weekly; 3=Monthly; 4=Seasonal; 5=Only when primary source isn't available	99,999
83	WHEN USE HOUSEHOLD WELL	1=All the time; 2=Weekly; 3=Monthly; 4=Seasonal; 5=Only when primary source isn't available; 6=covered, not in use	99,999
84	WHEN USE NEIGHBOR'S WELL	1=All the time; 2=Weekly; 3=Monthly; 4=Seasonal; 5=Only when primary source isn't available	99,999

Table A.3: (Continued).

85	WHEN USE BOTTLED WATER	1=All the time; 2=Weekly; 3=Monthly; 4=Seasonal; 5=Only when primary source isn't available (where frequency is NOT necessarily frequency bought, but frequency used, aka, bidon bought weekly is "all the time")	99,999
86	WHEN USE RIVER/SPRING	1=All the time; 2=Weekly; 3=Monthly; 4=Seasonal; 5=Only when primary source isn't available	99,999
87	WHEN USE CANAL	1=All the time; 2=Weekly; 3=Monthly; 4=Seasonal; 5=Only when primary source isn't available	99,999
88	VISITS TO NEIGHBORS WELL PER MONTH	N°	99,999
89	LITERS FROM NEIGHBOR'S WELL PER MONTH	N°	99,999
90	LITERS BOTTLED WATER PER MONTH	N°	99,999
91	VISITS TO RIVER/SPRING PER MONTH	N°	99,999
92	VISITS TO CANAL PER MONTH	N°	99,999
93	HOURS TAP	1= ≤30 minutes; 2= 30<x<1 hour; 3= 1<x≤2 hours; 4= 2<x≤3 hours; 5= 3<x≤6 hours; 6= 6<x≤12 hours; 7= 24 hours; 8= ≤30 minutes *every other day; 9= 30<x≤1 hour *every other day; 10= 1<x≤2 hours *every other day; 11= 2<x≤3 hours *every other day; 12= 3<x≤6 hours *every other day; 13= 6<x≤12 hours	99,999
94	HOURS OF ARRIVAL	words	99,999
94B	HOURS OF ARRIVAL - Categorized	1=Morning (5am-11am); 2=Midday (11am-3pm); 3=Late Afternoon (3pm-6pm); 4=Evening (6pm-9pm) 5=Sleeping (9pm-5am)	99,999
95	TIME TO RETRIEVE WELL WATER	1= <5 minutes; 2= 5<x≤10 minutes; 3= 10<x≤30 minutes; 4= 30<x≤60 minutes; 5= >1 hour	99,999
96	TIME TO RETRIEVE/USE RIVER WATER	1= <5 minutes; 2= 5<x≤10 minutes; 3= 10<x≤30 minutes; 4= 30<x≤60 minutes; 5= >1 hour	99,999
97	TIME TO RETRIEVE/USE CANAL WATER	1= <5 minutes; 2= 5<x≤10 minutes; 3= 10<x≤30 minutes; 4= 30<x≤60 minutes; 5= >1 hour	99,999
98	USES TAP WATER	1=Everything; 2=Drinking; 3=Cooking; 4=Drinking and Cooking; 5=Bathing; 6=Cleaning and Washing; 7=Bathing, Cleaning and Washing; 8=Only watering; 9=everything except drinking; 10=everything except cooking; 11=Drinking, Cooking and Bathing	99,999
99	USES WELL WATER	1=Everything; 2=Drinking; 3=Cooking; 4=Drinking and Cooking; 5=Bathing; 6=Cleaning and Washing; 7=Bathing, Cleaning and Washing; 8=Only watering; 9=everything except drinking; 10=everything except cooking; 11=Drinking, Cooking and Bathing	99,999
100	USES BOTTLED WATER	1=Everything; 2=Drinking; 3=Cooking; 4=Drinking and Cooking; 5=Bathing; 6=Cleaning and Washing; 7=Bathing, Cleaning and Washing; 8=Only watering; 9=everything except drinking; 10=everything except cooking; 11=Drinking, Cooking and Bathing	99,999
101	USES RIVER/SPRING	1=Everything; 2=Drinking; 3=Cooking; 4=Drinking and Cooking; 5=Bathing; 6=Cleaning and Washing; 7=Bathing, Cleaning and Washing; 8=Only watering; 9=everything except drinking; 10=everything except cooking; 11=Drinking, Cooking and Bathing	99,999
102	USES CANAL	1=Everything; 2=Drinking; 3=Cooking; 4=Drinking and Cooking; 5=Bathing; 6=Cleaning and Washing; 7=Bathing, Cleaning and Washing; 8=Only watering; 9=everything except drinking; 10=everything except cooking; 11=Drinking, Cooking and Bathing	99,999
103	QUALITY OF FAUCET WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=Fea (gross); 11=Regular; 12=Clean but disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected	99,999
104	QUALITY OF WELL WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=; 11=Regular; 12=Clean but disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected - One "Tasteless" coded as 99	99,999
105	QUALITY OF BOTTLED WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=; 11=Regular; 12=Clean but disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected; 16=Other (Special/Tasteless)	99,999

Table A.3: (Continued).

106	QUALITY OF RIVER/SPRING WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=; 11=Regular; 12=Clean but disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected - One "Special" Coded as 99	99,999
107	QUALITY OF CANAL WATER	1=Clean; 2=Sweet; 3=Rico; 4=Natural; 5=Potable; 6=Not Clean; 7=Salty; 8=Very Chlorated; 9=Sometimes Dirty; 10=; 11=Regular; 12=Clean but disagreeable (cloudy/smelly); 13=Better; 14=Variable; 15=Disinfected	99,999
108	HOUSEHOLD TREATMENT	1=Crude; 2=Boiled; 3=Crude and Boiled; 4=Multiple Treatment (Boiled, Chlorated and/or Filtered); 5=only drink bottled water	99
109	BOILED WATER PER CAPITA PER DAY	N°	99,999
109B	BOILED WATER PER CAPITA PER DAY - Categorized	1= ≤0.5 Liters; 2= 0.5<x≤1 Liter; 3= 1<x≤2 Liters; 4= 2<x≤3 Liters; 5= >3 Liters	
110	DROPS OF CLOROX PER L	N°	99,999
111	WATER SERVICE REPORTED COST	N°	99,999,990
112	PERCEPTION OF COST	1=Expensive; 2=Fair(normal/its fine); 3=Cheap	99,999,990
113	WATER SERVICE ACTUAL COST	0=0; 1=3.20; 2=10; 3=12; 4=15.30; 5=20 (commercial A); 6=other; 7=included in rent	99
114	BOTTLED WATER COST PER MONTH	N° (in this case DON'T put 0 if don't buy, simply code 999)	99,999
115	PERCEPTION OF COST (BOTTLED)	0=Don't Know; 1=Expensive; 2=Fair(normal/its fine); 3=Cheap	99,999
116	MEANING OF POTABLE	words	99
116-B	MEANING OF POTABLE-Categorized	0=Don't Know; 1=Vital for all Life; 2= Human/Domestic purpose / Consumption; 3=Clean/Pure/Quality/Healthy/Good; 4=Treated/Disinfected/Maintenance/Chlorate; 5=Tubes/Connection/Faucet; 6=Daily/Continuous/Don't lack; 7=From a service provider; 8=Gross; 9=Sweet/Tasty; 10=currently potable water does not exist; 11=arrives to everyone; 12=It's fine; 13=other (from below, conserve water, etc.)	99
116-C	MEANING OF POTABLE-Condensed and Recategorized	0=Don't Know; 1=Vital for all Life; 2= Human-Domestic purpose/Consumption; 3=Clean/Pure/Quality/Healthy/Good/Sweet/Tasty; 4=Treated/Disinfected/Maintenance/Chlorate; 5=Service/Tubes/Connection/Faucet/Arrives to Everyone; 6=Daily/Continuous/Don't lack; 7=other (from below, does not exist, gross, fine, conserve water)	99
117	WHAT PROVIDER DOES TO MAKE WATER POTABLE	words	99
117-B	WHAT PROVIDER DOES TO MAKE WATER POTABLE-Categorized	0=Don't Know; 1=Clean/Disinfect/Treat/Purify; 2=Chlorate/Chemical; 3=Coagulants/Filter; 4=Put in Tubes; 5=Maintenance; 6=Tubes/Maintenance & Chlorify/Treat; 7=Extensive understanding; 8=Nothing	99
117-C	WHAT PROVIDER DOES-Condensed and Recategorized	0=Don't Know; 1=Clean/Disinfect/Treat/Purify; 2=Chlorate/Chemical/Coagulants/Filter; 3=Tubes/Maintenance; 4=Tubes/Maintenance & Chlorate/Treat; 5=Nothing	99
118	QUALITY OF WATER - ONE	0=Don't Know; 1=Appearance; 2=Smell; 3=Taste; 4=Physical Quality; 5=Biological Quality	99
119	QUALITY OF WATER - TWO	0=Don't Know; 1=Appearance; 2=Smell; 3=Taste; 4=Physical Quality; 5=Biological Quality; 6=nothing else important	99
120	QUALITY OF WATER - THREE	0=Don't Know; 1=Appearance; 2=Smell; 3=Taste; 4=Physical Quality; 5=Biological Quality; 6=nothing else important	99
121	QUALITY OF SERVICE - ONE	0=don't know; 1=Quality; 2=Continuity; 3-Schedule; 4-Maintenance; 5=Price; 6=Pressure; 7=Transparency	99
122	QUALITY OF SERVICE - TWO	0=don't know; 1=Quality; 2=Continuity; 3-Schedule; 4-Maintenance; 5=Price; 6=Pressure; 7=Transparency	99
123	QUALITY OF SERVICE - THREE	0=don't know; 1=Quality; 2=Continuity; 3-Schedule; 4-Maintenance; 5=Price; 6=Pressure; 7=Transparency	99
FOR THOSE HOUSEHOLDS WITH TAP CONNECTION			
124	WHO IS WATER PROVIDER	0=Don't Know; 1=Municipality; 2=SADISCHAO; 3=JASS; 4=Seda -pal -lip -pash; 5=Name of person; 6=other (Neighbor, CHAVIMOCHIC)	99,999
125	TIME WITH SERVICE	1= <1 year; 2= 1 to 3 years; 3= 4 to 7 years; 4= 8 to 12 years; 5= 13 to 15 years; 6= >15 years	99,999,990

Table A.3: (Continued).

126	ORIGIN OF WATER	0=Don't Know; 1=Spring; 2=River; 3=Well; 4=reservoir; 5=CHAVIMOCHIC; 6=name of place	99,999
127	PRESSURE PROBLEMS	1=Yes; 2=No	99,999
128	FREQUENCY OF PRESSURE PROBLEMS	1=Rarely; 2=Daily; 3=Weekly; 4=Monthly; 5=once in a while-summer; 6=In Past	99,999
129	AFFECT SCHEDULE	1=Yes; 2=No	99,999
130	EXPLAIN	words	99,999
130B	EXPLAIN-Categorized	1=comes very late; 2=comes too early; 3=arrives when away from house; 4=inconsistent arrival time; 5=pressure problems and/or time;6=have adapted schedule accordingly	6,99,999
131	WHAT MOST UNHAPPY WITH	1=Quality; 2=Continuity; 3-Schedule; 4-Maintenance; 5=Price; 6=Pressure; 7=Transparency; 8=don't want to change anything	99,999
132	TRUST WITH PROVIDER	N° (1-10)	99,999
133	WHAT INFO NEEDED TO INCREASE TRUST	words	99,999
133B	WHAT INFO NEEDED TO INCREASE TRUST-Categorized	1=about quality/how water treated/where comes from; 2=about how maintain/how gets there; 3=about $$; 4=about cuts to service; 5=more communication in general; 6=more friendly/respect; 7=give meetings/workshops; 8=improve quality; 9=improve continuity; 10=improve schedule; 11=no interest/nothing; 12=other	99,999,990
134	LIKE PAYMENT METHOD	1=Yes; 2=No	99,999
135	WHY	words	99,999
		FOR ALL	
136	HAVE ENOUGH WATER	1=Yes; 2=No; (3=depends on day)	99
137	USE MORE WATER IF MORE CONTINUOUS	1=Yes; 2=No	99
138	EXPLAIN	words	99,999
138B	EXPLAIN-Categorized	1=drinking; 2=cooking; 3=personal hygiene; 4=washing clothes; 5=cleaning; 6=watering street; 7=plants; 8=store more; 9=everything in general (mention of summer included); 10=no longer measure and/or store, use differently	99,999
139	USE METERS	1=Yes; 2=No	99
140	WHY	words	99,990
140B	WHY-Categorized	1=Price According to Consumption/Just; 2=More Control (in general)/More Reliable Service/ Secure; 3=Can Measure/Minimize/Control (Personal) Water Use; 4=Put Wasters into Control; 5=Price According to Consumption (Negative connotation, would have to control use like Electricity); 6=More Expensive; 7=Unreliable Technology (Measure Air, Break, etc.); 8=Not necessary/Too Little Water; 9=(Claim)Already Have/Had	99,990
141	CONFIDENCE IN QUALITY OF TAP WATER	1=Yes; 2=No	99,999
142	WHY	words	99,999
142B	WHY-Categorized	1=Rica/Natural/Healthy/Potable/Clean; 2=Disinfected/Maintained/Treated; 3=Chlorated; 4=Good Source; 5=In Tubes/Faucet; 6=Horrible/Gross/Contaminated; 7=Worms/Organisms/Dead Body/Microbes/Trash/Sand; 8=Too Much Chlorate; 9=Not Enough Chlorate; 10=Don't Know Source, Method, State of Tubes; 11=Lack of Trust/Bad Service/Have to Boil; 12=Good Daily Service/People Drink It/Doesn't Cause Harm	99,999,990
143	RATE QUALITY OF WATER	N° (1-10)	99,999
144	PROBLEMS WITH DIARRHEA	1=Yes; 2=No	99
145	HAVE HAD DENGUE	1=Yes; 2=No	99
146	SEWAGE	1=Yes; 2=No	99
147	SEWAGE DESTINATION	0=Don't Know; 1=Oxidation Ponds; 2=Canal; 3=River; 4=Ocean; 5="Down there"; 6="tubes/matrix" (where 998 indicates other)	99,999,998

Table A.3: (Continued).

148	SANITATION ALTERNATIVE	1=pit latrine; 2=pour-flush latrine; 3=fields	99,999
149	INTEREST IN SEWAGE	N° (1-10)	99,999
150	N° FAUCETS	N° - 0=don't have	99
151	N° SHOWERS	N° - 0=don't have	99
152	N° TOILETS	N° (where pour flush latrines are counted as they utilize water)	99,999
153	USE OF WASHWATER	1=Never; 2=Sometimes; 3=Always	99,999
154	HOW FLUSH	1=Handle; 2=Bucket; 3=Both	99,999
155	L - FLUSH	N°	99,999,990
156	L - BUCKET	N°	99,999,990
157	FLUSHES PER DAY	N°	99
158	PROBLEMS WITH LEAKS	1=Yes; 2=No	99,999
159	# CURRENT	N°	99,999
160	# IN PAST	N°	99,999
161	HOW BATHE - SHOWER	1=Yes; 2=No	99
162	HOW BATHE - BUCKET	1=Yes; 2=No	99
163	HOW BATHE - RIVER	1=Yes; 2=No	99
16123	HOW BATHE (PRIMARY WAY, aka, only note 4, river, if only bathe in river	1=buckets; 2=shower; 3=buckets and shower (shower only works when water arriving); 4=river	99
164	TIMES PER DAY BATHE SUMMER	N°	99
165	TIMES PER DAY BATHE WINTER	N°	99
166	N° LITERS WATER - SUMMER	N°	99,999
166B	N° LITERS WATER - SUMMER - Categorized	1= ≤10 Liters; 2= 10<x≤20 Liters; 3= 20<x≤30 Liters; 4= 30<x≤40 Liters; 5= 40<x≤50 Liters; 6= 50<x≤60 Liters; 7= 60<x≤100 Liters; 8= >100 Liters	99
166C	N° MINUTES SUMMER	N°	99,999
167	N° LITERS WATER - WINTER	N°	99,999
167B	N° LITERS WATER - WINTER - Categorized	1= ≤10 Liters; 2= 10<x≤20 Liters; 3= 20<x≤30 Liters; 4= 30<x≤40 Liters; 5= 40<x≤50 Liters; 6= 50<x≤60 Liters; 7= 60<x≤100 Liters; 8= >100 Liters	99
167C	N° MINUTES WINTER	N°	99,999
168	GREYWATER DESTINATION - SEWAGE	1=Yes; 2=No	99
169	GREYWATER DESTINATION - SEPTIC TANK	1=Yes; 2=No	99
170	GREYWATER DESTINATION - CORRAL	1=Yes; 2=No	99
171	GREYWATER DESTINATION - STREET	1=Yes; 2=No	99
172	GREYWATER DESTINATION - CANAL	1=Yes; 2=No	99
173	GREYWATER DESTINATION - RIVER	1=Yes; 2=No	99
174	GREYWATER DESTINATION - PLANTS	1=Yes; 2=No	99
175	WATER IN STREET	1=Yes; 2=No	99
176	WATER IN HOUSE (CORRAL)	1=Yes; 2=No	99
177	METHOD	1=Hose; 2=Bucket; 3=Both	99,999
178	LITERS PER WEEK FOR WATERING	N°	99,999
178B	LITERS PER WEEK FOR WATERING - Categorized	1= ≤20 Liters; 2= 20<x≤60 Liters; 3= 60<x≤100 Liters; 4= 100<x≤200 Liters; 5= 200<x≤300 Liters; 6= 300<x≤400 Liters; 7= 400<x≤500 Liter; 8= >500 Liters	99,999
179	OR MINUTES PER WEEK FOR WATERING	N°	99,999
180	TYPE OF WATER	1=potable; 2=well; 3=washwater; 4=potable and washwater; 5=well and washwater; 6=canal water	99,999
181	WHY	words	99,999
182	N° LAUNDRY "LOADS" PER WEEK	N° where 0.5=every other week; 0=don't wash (send elsewhere)	0,99
183	LITERS USED PER LOAD	N° where 0 implies that they wash clothes in river or canal	99,990

Table A.3: (Continued).

184	CALCULATED - N° LITERS WASH CLOTHES PER WEEK	N°; 0 implies that they wash clothes in river or canal	99
185	# TIMES GO TO RIVER TO WASH MONTH	N°	99
186	LITERS PER COOKING PER DAY PER CAPITA	N°; where 0=don't cook and 990=don't know	99,990
187	CALCULATED- LITERS PER MOPPING PER WEEK	N° where 0=only use washwater, w/ 000 if given in minutes	99,999
188	TYPE OF WATER MOPPING	1=potable; 2=well; 3=washwater; 4=potable and washwater; 5=well and washwater; 6=canal water	99,999
189	CALCULATED - LITERS FOR PLANTS PER WEEK	N°	99,999,990
189B	CALCULATED - MINUTES FOR PLANTS PER WEEK	N°	99,999
190	TYPE OF WATER PLANTS	1=potable; 2=well; 3=washwater; 4=potable and washwater; 5=well and washwater; 6=canal water	99,999
191	WHY HAVE PLANTS	words	99,999
191-B	WHY HAVE OR DON'T HAVE PLANTS - CODED	1= Adornment/Pretty/Enjoyment; 2=Environment (& Giving Life to Streets); 3=Health/Air/Medicine; 4=Food; 5=Shade; 6=No Time/$$; 7=No Water; 8=No Space; 9=Bad Conditions (Salty, Humidity, Rocky); 10=Animals/Kids Destroy; 11=Don't Like; 12=Already in Place; 13=Planning to Plant; 14=Not Their Home; 15=Theft; 16=Reuse Water	99,999
192	# ANIMALS	N°	99
192B	# ANIMALS -CATEGORIZED	0= 0; 1= 1 to 3; 2= 4 to 6; 3= 7 to 9; 4= ≥ 10	
193	# LITERS PER DAY (Animals)	N° where 0 means they have no animals	99.999
193B	# LITERS PER DAY (Animals) - Categorized	0=Don't Give Water (Cuys aka Guinea Pigs); 1= ≤ 0.5 Liters; 2= 0.5 < x ≤ 2 Liters; 3= 2 < x ≤5 Liters; 4= 6 < x ≤ 10 Liters; 5= > 10 Liters	99.999
194	# PETS	N°	99
194B	# PETS - Categorized	0= 0; 1=1; 2=2; 3=3; 4= ≥4	
195	# LITERS PER DAY (PETS)	N° where 0 means they have no pets	99,999
195B	# LITERS PER DAY (Pets) - Categorized	0= Don't Give Water (cuys); 1= ≤ 0.5 Liters; 2= 0.5 < x ≤ 1 Liter; 3= 1 < x ≤ 4 Liters; 4= > 4 Liters	99,999
196	#LITERS DRINK PER DAY - WATER	0=don't drink anything but water; 1= <0.5 L; 2= 0.5<x<1 L; 3= 1<x<2 L; 4= 2<x<3 L; 5= >3L	99
197	# LITERS DRINK PER DAY - OTHER	0=don't drink anything but water; 1= <0.5 L; 2= 0.5<x<1 L; 3= 1<x<2 L; 4= 2<x<3 L; 5= >3L	99
198	ORDER OF USE - COOKING	N° (1 - 6)	99
199	ORDER OF USE - DRINKING	N° (1 - 6)	99
200	ORDER OF USE - HYGIENE	N° (1 - 6)	99
201	ORDER OF USE - CLEANING	N° (1 - 6)	99
202	ORDER OF USE - CLOTHES WASHING	N° (1 - 6)	99
203	ORDER OF USE - WATERING	N° (1 - 6)	99
204	HEARD INFORMATION ABOUT CONSERVATION	1=Yes; 2=No	99
205	WHERE HEARD CONSERVATION INFORMATION	words	99,999
205B	WHERE HEARD - Categorized	1=JASS/SADISCHAO; 2=Radio; 3=TV; 4=Internet; 5=Elementary/High School; 6=Health Post; 7=Workshop/Meetings; 8=Neighbors; 9=Name of Place outside of Chao/Nuevo Chao (ex. Trujillo); 10=Pamphlets	99,999
206	PRACTICE WATER CONSERVATION	1=Yes; 2=No	99
207	WATER CONSERVATION EXAMPLE	words	99,999
207B	WATER CONSERVATION EXAMPLE - Categorized	1=Use Bare Minimum/Conserve Water/Don't Waste; 2= Boil / Add Chlorate (Treat) Water; 3=Cover Water (so kids/bugs don't dirty it); 4=Don't Water Street; 5=Reuse Water (washwater for street, old water for laundry, etc.); 6=Close Faucets; 7=Install Water Conserving Artifacts; 8=Repair Leaks; 9=Not Possible/Not Enough Water; 10=No Need and/or Have Well	99,999
208	WHY CONSERVE	words	99,999
208B	WHY CONSERVE - Categorized	1=For Future Generations/So Don't Run Out; 2=For Others Who Lack Water (neighbors and other cities/countries); 3=For Environment/Global Warming; 4=No Water/Have to Make it Last; 5=To Save in General/A Good Practice; 6=Health/Dengue Prevention; 7=Financial Reasons	99,999

Table A.3: (Continued).

		WILLINGNESS TO PAY	
209	WTP - 6/7 - I	1=Yes; 2=No; 3=Maybe	9992, 9993
210	WTP - 12/7 - I	1=Yes; 2=No; 3=Maybe	9992, 9993
211	WTP - 24/7 - I	1=Yes; 2=No; 3=Maybe	9992, 9993
212	WTP - QUALITY - I	1=Yes; 2=No; 3=Maybe	9992, 9993
213	WTP -QUALITY AND 12/7 - I	1=Yes; 2=No; 3=Maybe	9992, 9993
214	WTP - OPINION - I	N°	99,999,998
215	WTP - 6/7 - II	1=Yes; 2=No; 3=Maybe	9991, 9993
216	WTP - 12/7 - II	1=Yes; 2=No; 3=Maybe	9991, 9993
217	WTP - 24/7 - II	1=Yes; 2=No; 3=Maybe	9991, 9993
218	WTP - QUALITY - II	1=Yes; 2=No; 3=Maybe	9991, 9993
219	WTP -QUALITY AND 12/7 - II	1=Yes; 2=No; 3=Maybe	9991, 9993
220	WTP - OPINION - II	1=Yes; 2=No; 3=Maybe	99,999,998
221	WTP - 6/7 - II	1=Yes; 2=No; 3=Maybe	9991, 9992
222	WTP - 12/7 - II	1=Yes; 2=No; 3=Maybe	9991, 9992
223	WTP - 24/7 - II	1=Yes; 2=No; 3=Maybe	9991, 9992
224	WTP - QUALITY - II	1=Yes; 2=No; 3=Maybe	9991, 9992
225	WTP -QUALITY AND 12/7 - II	1=Yes; 2=No; 3=Maybe	9991, 9992
226	WTP - OPINION - III	N°	99,999,998
227	WTP - CONFIDENCE IN RESPONSE	N° (1-10)	99
228	WTP - CONFIDENCE IN FEASIBILITY	N° (1-10)	99
229	WATER SCARCITY IN PERU	0=don't know; 1=Abundant; 2=Regular; 3=Scarce	99
230	WATER SCARCITY IN CHAO	0=don't know; 1=Abundant; 2=Regular; 3=Scarce	99
231	EXPERIENCE WITH WATER SCARCITY	1=Yes; 2=No	99
232	FREQUENCY	1=Daily; 2=A few times a week; 3=Weekly; 4=Monthly; 5=Summer; 6=once a year; 7=a few times per year; 8=in the past	99,999,990
233	HEAR ABOUT CUTS TO SERVICE	words	99,999
233B	HEAR ABOUT CUTS TO SERVICE - Categorized	1=Communicated; 2=Megaphone/Charapo; 3=Visit House/Citation; 4=JASS/Municipality; 5=Neighbor/Gossip; 6=Radio/News; 7=Television; 8=Internet; 9=Don't Know in Advance	99,999
234	WHERE GO WHEN THERE IS NO WATER	1=Spring/River; 2= Own well; 3=Own well in other place; 4=Neighbor's Well; 5=Community Well; 6=Save water; 7=Neighbor's Saved Water; 8=Bottled Water	99
234B	WHERE GO WHEN THERE IS NO WATER	1=Spring/River; 2= Well; 3=Save water; 4=Neighbor's Saved Water; 5=Bottled Water	99
235	ASSOCIATED COST	N°	99,999
236	RANK - MOST IMPORTANT	1=water; 2=paved streets; 3=sewage; 4=education; 5=electricity; 6=Main Square; 7=Health; 8=Transportation	99
237	RANK -SECOND MOST IMPORTANT	1=water; 2=paved streets; 3=sewage; 4=education; 5=electricity; 6=Main Square; 7=Health; 8=Transportation	99
238	RANK - THIRD MOST IMPORTANT	1=water; 2=paved streets; 3=sewage; 4=education; 5=electricity; 6=Main Square; 7=Health; 8=Transportation	99
239	TRUST IN MUNICIPALITY - Scale	N° (1-10)	99
240	COMMUNITY MEETINGS	1=Yes; 2=No	99
241	ABOUT WHAT	words	99,999
242	ATTEND MEETINGS	1=Yes; 2=No	99,999
243	TRUST IN NEIGHBORS - Scale	N° (1-10)	99
243B	TRUST IN NEIGHBORS - Scale	same data with exclusions to enumerators	99

Table A.3: (Continued).

244	ADDITIONAL INFORMATION	words	99
245	TOTAL STORAGE	N°	99
245B	TOTAL STORAGE - Categorized	1= ≤50 Liters; 2= 50<x≤100 Liters; 3= 100<x<150 Liters; 4= 150<x≤200; 5= 200<x≤300 Liters; 6= 300<x≤500 Liters; 7= 500<x≤1,100 Liters; 8= >1,100 Liters	99
246	# OF WASH TUBS	N°	99
247	CONFIDENCE IN QUALITY OF BOTTLED WATER	1=Yes; 2=No	99,999
248	WHY	words	99,999
249	RATE QUALITY OF WATER	N° (1-10)	99,999
250	CONFIDENCE IN QUALITY OF WELL WATER	1=Yes; 2=No	99,999
251	WHY	words	99,999
251B	WHY - Categorized	1=Rica/Natural/Healthy/Potable/Clean; 2=Disinfected/Maintained/Treated; 3=Chlorated; 4=Good Source; 5=In Tubes/Faucet; 6=Horrible/Gross/Contaminated; 7=Worms/Organisms/Dead Body/Microbes/Trash/Sand; 8=Too Much Chlorate; 9=Not Enough Chlorate; 10=Don't Know Source, Method, State of Tubes; 11=Lack of Trust/Bad Service/Have to Boil; 12=Good Daily Service/People Drink It/Doesn't Cause Harm	99,999
252	RATE QUALITY OF WATER	N° (1-10)	99,999
	ADDITIONAL DATA PROCESSING		
253	AGE (BINNED)	1= <27; 2= 28<X<=35; 3= 36<X<43; 4= 44+	
254	YEARS IN CHAO (BINNED)	1= <= 6 years; 2= 6 to 10 years; 3=more than ten to 17 years; 4=more than 17 years	
255	LITERS FOR LAUNDRY PER CAPITA PER WEEK	(divided by # in family)	
256	LITERS FOR LAUNDRY PER CAPITA PER WEEK-Categorized	0=Only wash clothes in River; 1= ≤ 20 liters; 2= 20 < x ≤ 40 Liters; 3= 40 < x ≤ 60 Liters; 4= 60 < x ≤ 80 Liters; 5 = 80 < x ≤ 100 Liters; 6= > 100 Liters	
257	LITERS PER COOKING PER CAPITA PER DAY (BINNED)	1= <= 2 L; 2= 3-4 L; 3= 5-7 L; 4= 8+	
258	AREA OF HOUSE (BINNED)	1= <= 140; 2= 140<x<=160; 3= >160 L	
259	INCOME (BINNED)	1= <650; 2=651<x<800; 3=801<x<1000; 4=>1001	
260	LITERS PER DAY FOR BATHING IN SUMMER (BINNED)	1= ≤30 L; 2= 31-40 L; 3= 41-60 L; 4= > 61 L	
261	LITERS PER DAY FOR BATHING IN WINTER (BINNED)	1= ≤10 L; 2= 11-15 L; 3= 16-20 L; 4= > 21 L	
262	MINUTES PER DAY FOR BATHING IN SUMMER (BINNED)	1= ≤ 10 minutes; 2= 11-20 minutes; 3= > 21 minutes	
263	MINUTES PER DAY FOR BATHING IN WINTER (BINNED)	1= ≤ 5 minutes; 2= 6-10 minutes; 3= > 11 minutes	
264	YEARS IN HOUSE - OWNERSHIP (BINNED)	1= ≤ 5 years; 2= 6 to 26; 3= 27 to 48; 4=49 to 69; 5= more than 70 years	
265	AGE (BINNED - not equal intervals)	1= ≤ 20 years; 2= 21 to 33; 3= 34 to 45; 4=46 to 58; 5= 59 to 70; 6= 71 or more years	
266	DAILY PER CAPITA CONSUMPTION ESTIMATE (BINNED)	1= ≤ 20 L; 2= 20.1 to 73 L; 3= 73.1 to 126 L; 4= 126.1 to 179; 5= 179.1 to 232; 6= >232.1	
267	ESTIMATED STORAGE CAPACITY (BINNED)	1= ≤ 100 L; 2= 101 to 156 L; 3= 157 to 205 L; 4= 206 to 400 L; 5= ≥ 401 L	
268	DESIRED L MORE FOR STORING (BINNED)	1= ≤ 100 L; 2= 101 to 500 L; 3= 501 to 1000; 4= ≥ 1001 L	
269	BOILED WATER PER CAPITA PER DAY (BINNED)	1= ≤ .5 L; 2= .51 to 1.88; 3= 1.89 to 3.25; 4= ≥ 3.26 L	
270	# OF STORAGE DEVICES, not including washtubs (BINNED)	1= ≤ 2; 2= 3 to 6; 3= 7 to 10; 4= ≥ 11	
271	MONTHLY RENT - S/. (BINNED)	1= ≤ 40; 2= 41 to 70; 3= 71 to 120; 4= 121 to 200; 5= ≥ 201	

Appendix I Sample Size of Results

Table A.4 Sample size used to create each table and figure presented in Chapter Four.

Table / Figure	CHAPTER FOUR	Sector	Round I Sample Size	Round II Sample Size	Combined Sample Size
Section 4.1					
4.1	Summarized socio-economic characteristics of respondents and their respective households	C	209	295	295
		W	62	50	50
		NC	212	303	303
Section 4.2 Demand and Quantity					
4.2.1 Existing Availability					
4.1	Reported continuity (hours) of water services – summer versus winter	C	161	257	418
		NC	178	280	458
4.2	Reported arrival time (i.e. schedule) of water services	C	----	266	266
		NC	----	287	287
-	Affect Daily Schedule - Yes or No	C	----	290	290
		NC	----	300	300
4.3	How arrival time (i.e. schedule) of water affects respondents' daily routines	C	----	289	289
		NC	----	301	301
4.2	Reported length of time (years) that households have had a domestic water connection	C	*184*	266	266
		NC	*195*	287	287
-	Experience with Water Scarcity	C	197	282	479
		W	60	46	106
		NC	207	290	497
4.3 / 4.4	Reported experience with water scarcity; (S) stands for data from the first survey period (i.e. summer) and (W) stands for data from the second survey period (i.e. winter) / Reported experience with water scarcity	C	187	279	466
		W	54	47	101
		NC	199	286	485
4.4	Reported use of alternative water sources during periods of water scarcity	C	----	290	290
		NC	----	291	291
4.5	Household use of alternative water sources	C	208	295	503
		W	62	50	112
		NC	212	303	515
4.6	Reported frequency with which respondents (households) use alternative sources	C	----	295	295
		W	----	50	50
		NC	----	303	303
4.2.2 Existing Quantity					
4.7	Reported problems with water pressure	C	203	289	492
		NC	125	300	425
4.8 / 4.9	Frequency of reported pressure problems, as varies by season / Reported pressure problems, overall perspective	C	197	284	481
		NC	120	299	419
4.5 / 4.10	Reported amount of water households' regularly store on a daily (C) or every other day (NC) basis (L) / Descriptive statistics of amount of water households' regularly store on a daily (C) or every other day (NC) basis (L)	C	204	284	488
		W	60	44	104
		NC	201	288	489
4.6	Examples of household water storage situations	----	----	----	----
4.11	Volume of additional water storage respondents would like to have (L)	C	----	57	57
		W	----	8	8
		NC	----	93	93
4.7	Respondents' plans, and reasoning, for increasing water storage capabilities	C	----	217	217
		W	----	33	33
		NC	----	257	257
4.8	Respondents reporting enough water (quantity) for their daily needs (Yes or No)	C	----	288	288
		W	----	50	50
		NC	----	299	299
4.9	Respondents who would use more water if their water service were more continuous (Yes or No).	C	----	291	291
		NC	----	301	301

Appendix I (Continued)

Table A.4 (Continued).

4.10	Respondents intended water use if water service were more continuous	C	----	245	245
		NC	----	236	236
Section 4.3 Demand and Quality					
4.14	Reported household treatment of drinking water	C	168	292	460
		W	52	50	102
		NC	188	301	489
-	Boiled water per capita per Day	C	57	187	244
		W	21	31	52
		NC	24	166	190
-	Perceived Quality of Water - Rated	C	----	275	275
		W	----	46	46
		NC	----	297	297
4.12	Respondents' opinions of their water quality	C	197	290	487
		W	55	50	105
		NC	204	301	505
4.13	Reasons for respondents' confidence (or lack of) in their drinking water's safety	C	----	289	289
		W	----	47	47
		NC	----	301	301
4.13 (II)	Reasons for respondents' confidence (or lack of) in their drinking water's safety - WHY	C	----	280	280
		W	----	47	47
		NC	----	283	283
4.11	Respondents' opinions regarding most important aspect of water quality is	C	198	290	488
		W	58	48	106
		NC	203	291	494
-	Reported Problems with Diarrhea	C	----	293	293
		W	----	50	50
		NC	----	301	301
4.15	Respondents' understanding of term 'potable water.'	C	----	292	292
		W	----	50	50
		NC		299	299
4.16	Respondents' understanding of service providers' water treatment	C	----	289	289
		W	----	49	49
		NC	----	283	283
4.17	Respondents' opinions on most important aspect of a quality water service	C	----	291	291
		W	----	46	46
		NC	----	288	288
4.18	Aspect of current water service respondents would most like to change	C	----	277	277
		NC	----	285	285
Section 4.4 Water Use Behaviors - conserving and wasteful					
4.12 / 4.13	Photograph of street watering in Chao	----	----	----	----
4.24	Respondents' perception of local water scarcity	C	----	275	275
		W	----	49	49
		NC	----	283	283
-	Want Water Metered - Yes or No	C	----	289	289
		W	----	47	47
		NC	----	302	302
4.25	Respondents' attitudes toward metered water service and why	C	----	270	270
		W	----	41	41
		NC	----	283	283
4.21	Where respondents learned about water conservation	C	----	242	242
		W	----	37	37
		NC	----	255	255
-	Where learned about Water Conservation	C	----	236	236
		W	----	37	37
		NC	----	236	236

Table A.4 (Continued).

4.20	Percent of respondents reporting to practice water conservation	C	203	274	477
		W	59	50	109
		NC	206	297	503
4.22	Examples of water conservation as reported by respondents	C	153	120	273
		W	51	22	73
		NC	161	118	279
4.23	Reported reasons why respondents practice water conservation	C	----	221	221
		W	----	36	36
		NC	----	208	208
4.20	Greywater reuse for flushing toilets	C	----	211	211
		W	----	45	45
		NC	----	287	287
4.19	Liters used per-capita, per-week, for laundry	C	123	291	414
		W	47	49	96
		NC	131	293	424
4.18	Respondents' personal hygiene behavior	C	206	293	499
		W	60	50	110
		NC	209	301	510
4.19	Liters per capita per day for bathing in summer and winter	C	164	288	452
		W	57	48	105
		NC	198	292	490
4.14	Percentage of households reporting to water the street	C	200	290	490
		W	57	50	107
		NC	201	302	503
4.15	Reported type of water used to water the street	C	199	256	455
		W	57	48	105
		NC	199	204	403
4.16	Photograph of street watering along the Pan American highway in Chao	----	----	----	----
-	Why/Why Not Have Plants	C	----	226	
		W	----	33	
		NC	----	241	
4.17	Photographs of households in Nuevo Chao with maintained vegetated spaces.	----	----	----	----
-	Water Indoors - Yes or No	C	----	291	291
		W	----	48	48
		NC	----	296	296
Section 4.5 Existing household water use					
4.26	Household water-related infrastructure	C	207	293	500
		W	60	50	110
		NC	209	302	511
4.27 / 4.21	Estimated seasonal volume of water consumed per capita and per household per day (L) / Per capita water use, summer and winter, as it relates to the basic water requirement of 50 Lpcd	C	207	293	500
		W	60	50	110
		NC	209	302	511
4.28	Reported practice of miscellaneous water-related activities	C	variable	variable	variable
		W	variable	variable	variable
		NC	variable	variable	variable
4.29	Respondents' estimations of daily household water use, divided by household size to reflect estimate as daily liters per capita	C	180	285	465
		W	50	49	99
		NC	177	285	462
4.30	Difference in liters per capita per day between respondents' estimated water use and calculated water use based on respondents' activity specific water estimates	C	----	----	----
		W	----	----	----
		NC	----	----	----
4.22 - 4.23	Average reported water use per activity, per household per day – summer and winter	C	----	----	----
		W	----	----	----
		NC/C/W	----	----	----

Appendix I (Continued)

Table A.4 (Continued).

-	Respondent estimate of liters per minute from faucet	C	199	----	199
		NC	200	----	200
Section 4.6 Demand and Value					
4.24	Respondents' perceptions of the cost to provide existing water services	C	179	237	416
		NC	202	263	465
4.31-4.35	Respondents' willingness to pay for improved (hypothetical) service, Round I and Round II	C	204	293	---
		W	60	49	---
		NC	210	302	---
4.40	Existing and potential water tariffs as they compare to each user group's mean household income	----	----	----	----
-	Confidence in Responses to WTP Questions - Rate 1 to 10	C	----	288	288
		W	----	49	49
		NC	----	296	296
4.39	Respondents' confidence in ability of service provider to implement proposed WTP scenarios, as rated on scale of one to ten (where ten is absolute confidence).	C	----	282	282
		W	----	48	48
		NC	----	291	291
4.41	Mean monthly cost of other common household services (S/.).	C	variable	variable	variable
		W	variable	variable	variable
		NC	variable	variable	variable
4.36	Most important municipal-provided, public, service in eyes of respondents	C	----	291	291
		W	----	50	50
		NC	----	293	293
-	Confidence in Provider / Quality of Service - Rated	C	----	----	278
		NC	----	296	296
4.37	Whether or not respondents trust their water service providers and why.	C	199 / 132	----	199
		NC	197 / 138	----	197
4.38	What type of information respondents would like from their water provider to increase level of trust	C	----	243	243
		NC	----	254	254
Table / Figure	CHAPTER FIVE	Sector	Round I Sample Size	Round II Sample Size	Combined Sample Size
4.42	Twelve demand management strategies for developing countries excerpt from Sharma and Vairavamoorthy (2009).	----	----	----	----
4.43	Twelve demand management strategies suggested for the Municipality of Chao	----	----	----	----
-	Community Meetings - Yes or No	C	----	291	291
		W	----	49	49
		NC	----	302	302
-	Attend Community Meetings - Yes or No	C	----	286	286
		W	----	49	49
		NC	----	294	294
-	Trust in Neighbors - Rate 1 to 10	C	----	293	293
		W	----	50	50
		NC	----	302	302
-	Get along with Neighbors	C	205	----	205
		W	61	----	61
		NC	209	----	209
-	How Perceive Community Organization	C	199	----	199
		W	59	----	59
		NC	206	----	206
-	Social Media	C	208	----	208
		NC	62	----	62
		W	212	----	212
-	Understanding of Freshwater	C	202	----	202
		W	59	----	59
		NC	205	----	205

Appendix I (Continued)

Table A.4 (Continued).

-	Believed Origin of Water	C	193	289	482
		NC	202	300	502
-	Believed Provider of Water	C	----	287	287
		NC	----	300	300
-	Believed Destination of Sewage	C	267	306	573