Yo como persona: Water resource management, group theory and the tragedy of the commons in Tacna, Peru

B.Sc. thesis

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Resumen Ejecutivo

La región de Tacna, en el sur del Perú, se caracteriza por un clima excepcionalmente seco. En la cabecera del desierto de Atacama, el pequeño abastecimiento de agua de la región disminuye por las extracciones de industria, minería, y una gran población metropolitana. Los glaciares andinos que alimentan las fuente de agua en Tacna están desapareciendo, dando lugar a una menor disponibilidad de agua cada año. Además, los problemas de infraestructura ocasionan que las pérdidas de agua a través de robos, la evaporación y las fugas sean significativas. Frente a estos importantes problemas en el suministro del agua, ha habido poca acción de las autoridades de Tacna para la conservación esta misma. Hasta la fecha, la principal intervención ha sido en la educación para la conservación del agua, sin embargo, no se ha podido llegar fuera de la ciudad de Tacna y se ha mostrado poco impacto en su demanda.

Hay muchos interesados en la gestión del agua en Tacna. Los principales actores son las operaciones mineras multinacionales, la agricultura y la empresa de agua municipal (EPS Tacna). Esta tesis examina la conservación del agua como un bien público bajo el marco teórico de Mancur Olson (1971): La teoría de los bienes públicos y la acción colectiva. Según Olson, las personas de los grupos grandes no proporcionarán un bien común porque las contribuciones de un miembro determinado, o su falta de aporte, pasará desapercibido por los demás miembros del grupo. Este grupo, sin embargo, tiene el potencial para proporcionar el bien, y se llama un grupo latente. En Tacna, como grupos de individuos racionales y auto-interesados, los diferentes actores hacen muy poco para conservar el agua, pues la relación costo-beneficio de la conservación es muy alta. En cambio, existe una cultura de “culpa” en Tacna, con cada actor acusa a los otros de exacerbar los problemas de abastecimiento de agua.

Para que la conservación del agua ocurra en Tacna, es necesario que todos los actores de la región colaboren. Sólo al compartir los costos de conservación se puede llevar a cabo cualquier acción colectiva. Sin embargo, es difícil garantizar la cooperación, ya que los diferentes actores esperan retornos asimétricos. La EPS, por ejemplo, como un servicio comercial de agua, podría perder ingresos mediante la promoción de la conservación, mientras que la industria minera podría reducir su costo de tratamiento de agua. Esta asimetría desalienta la colaboración en la conservación del agua.

Según la teoría de Olson, hay dos métodos para la movilización de un grupo latente, y, en este caso, la facilitación de la colaboración. Los incentivos pueden ser desarrollados para ofrecer una recompensa positiva para la acción colectiva, sin embargo, si la concesión de incentivos no es posible, la coerción, sea político, psicológico o físico, puede forzar a los individuos a la acción. Esta coerción puede venir en forma de sanciones. Olson describe tres clases de sanciones: la auto-vigilancia, donde un individuo contribuye a la acción colectiva basada en la espera de la contribución reciproca de otros miembros; las sanciones sociales, basado en el deseo de un individuo de ser aceptado y apreciado por sus colegas; y las sanciones legales, impuesto por el estado para el control de grandes organizaciones y empresas. En el caso de Tacna, las sanciones sociales y legales podrían ser más eeficaces en el fomento de la participación activa de la sociedad, la agricultura y la industria.

La presente tesis hace recomendaciones para el futuro de la gestión del agua en Tacna, incluyendo la reestructuración de los programas de educación, la creación de programas de incentivos para la conservación del agua, y mejoras en la infraestructura. Se identifica al sector agrícola como un foco de inversión y promueve la creación de grupos de trabajo para la negociación representativa en la colaboración para la conservación del agua entre todos los actores principales de la región.
Executive Summary

The region of Tacna in the south of Peru is characterized by an exceptionally dry climate. At the head of the Atacama desert, the region's very small water supply is further stressed by extractions by industry, mining, and a large metropolitan population. The Andean glaciers that feed Tacna's water supply are disappearing, leading to less available water each year. In addition, infrastructure problems mean that water losses through robberies, evaporation, and leaks are significant. In the face of these significant supply issues, there has been little action by the authorities in Tacna for water conservation. To date, the primary intervention has been in water education, however this has failed to reach outside of the city of Tacna and has shown little impact on demand for water.

There are many stakeholders in water management in Tacna. Major players include multinational mining operations, agriculture, and the municipal water utility (EPS Tacna). This paper examines water conservation as a public good under the theoretical framework of Mancur Olson's 1971 theory of public goods and collective action. According to Olson, individuals of groups that are very large will not provide a common good, as the contributions of a given member, or their lack of contribution, will go unnoticed by other members in the group. This group, however, does have the potential to provide the good, and is said to be latent. In Tacna, as groups of rational, self-interested individuals, the various players do very little to conserve water, hindered by the high cost-benefit ratio of conservation. Instead, there exists a culture of blame in Tacna, with each player accusing the others of exacerbating water supply issues.

In order for conservation to occur in Tacna, it is necessary that all of the region's players collaborate. Only by sharing the costs of conservation can any action be undertaken. It is difficult, however, to ensure cooperation, as the various players expect asymmetric returns. The EPS, for instance, as a commercial water utility could lose revenues by promoting conservation, while the mining industry might lower its water treatment costs. This asymmetry discourages collaboration in water conservation.

Under Olson's theory there are two methods for the mobilization of a latent group, and, in this case, the facilitation of collaboration. Incentives can be developed to provide a positive reward for collective action, however, if the provision of incentives is not possible, coercion, whether political, psychological, or physical, can force individuals to action. This coercion can come in the form of sanctions. Olson describes three classes of sanctions: self-policing, where an individual contributes to collective action based on the expected reciprocation of that contribution by other members; social sanctions, based on an individuals desire to be accepted and appreciated by his peers; and legal sanctions, enforced by the state for the control of large organizations and corporations. In the case of Tacna, social and legal sanctions could be most effective at encouraging the active participation of society, agriculture and industry.

This paper makes recommendations for the future of water management in Tacna including the restructuring of education programs, creation of incentive programs for water conservation, and improvements to infrastructure. It identifies the agricultural sector as an investment focus and advocates for the creation of water working groups for the representative negotiation of collaborative action by the major players in the region.
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1 Tacna in context and motivation for this study

1.1 An introduction to this paper

From August 2010 to August 2011, I had the opportunity to live and work in Tacna, Peru as my placement for the International Development Studies Co-operative program at the University of Toronto, Scarborough. For one year, I contributed to the User Education program of the local water utility (Empresa Prestadora de Servicios de Saneamiento (EPS) Tacna). Working in water education taught me a great deal about the social and physical aspects of water management in the arid Valley of Tacna. This paper is an attempt to synthesize this learning, coupled with my own observations and primary research, to create a tool for water education in the region.

Tacna, Peru is an area that for more than a decade has been under extreme water stress, yet, even in the face of major scarcity issues, there has been little progress in the area. Instead, a culture of blame exists in Tacna, with each of the major players in water and sanitation – from providers to consumers – blaming the others for exacerbating scarcity problems. For an outside observer it is difficult to understand how there can be so much inertia regarding a problem that is so relevant to the day-to-day life of the region. This paper, thus, seeks to answer the following research question: How can we address water shortages in a politics of scarcity? Using Mancur Olson's 1971 work, *The logic of collective action: public goods and the theory of groups*, this paper will show that, as rational, self-interested groups of individuals the various players in Tacna remain latent, with the potential to provide some public good (in this case water conservation), but, unwilling to assume the costs of its provision, wait idly for someone else to do it. This study will provide recommendations for the encouragement of region-wide collaboration in water conservation, and explore options for the next steps in Tacna-area water management.

1.2 Tacna in context

The Atacama desert, stretching from the south of Peru down along the coast of Chile, is the driest place on earth. At the northern limit of the desert sits the arid valley of Tacna, a region that, for more than a decade, has experienced severe water scarcity issues. Tacna, depending on who you ask, has been declared to be in a state of ‘hydric emergency’ – very low water availability in the region, compounded by increasing migration has the city on the verge of – or, by some accounts, already suffering – a major crisis.

Tacna is a curious city near the Peru-Chile border. When first arriving in the city, one will note
two things: first, the massive proportion of taxis compared to any other vehicles on the road, and second, how dry and dusty the city feels. Normally slow on weekdays, Tacna becomes a bustling commercial centre every weekend, when hundreds of Chileans from nearby Arica descend on the city to take advantage of the economic disparity between the two nations.

If there is one word to describe the attitude in Tacna, it is 'patriotic'. The city, after having been annexed by Chile for more than fifty years after the War of the Pacific (1879-1883), returned to Peru in a plebiscite over eight decades ago and has remained fiercely proud of being Peruvian and staunchly loyal to their home country. Arica, some fifty kilometres to the south, was also originally Peruvian territory, but, following the stipulations in the Treaty of Ancón, it was never returned to Peru.

1.2.1 Geographic context

In order to properly explain where Tacna is located, one first must figure out which 'Tacna' is being referenced. The word Tacna may refer to a number of different physical and political scopes. The largest area, the Department of Tacna is located in the extreme south of Peru and occupies some 16,000 square kilometres (“Conociendo Tacna,” 1999). Tacna is south of the Peruvian departments of Moquegua and Puno, and shares international borders with Chile to the south and Bolivia to the east. Sometimes also called the region of Tacna, the department is an analogue to a Canadian province or U.S. State. Approximately one third of the district territory falls over the Barroso Cordillera, a small section of the Andes mountains, just west of the Titicaca Plateau (4000 masl) with a maximum altitude of 3415 metres above sea level (“Conociendo Tacna,” 1999). There is a sharp east-west decrease in elevation, with the other two-thirds of the department as low as 175 metres above sea level in the coastal desert in the Valley of Tacna, to the west (“Conociendo Tacna,” 1999).

The region is further subdivided into four provinces (similar to an Ontario county), one of which is the Province of Tacna. The Province of Tacna is the municipal unit, containing the urban centre of Tacna and the area immediately surrounding it. If this paper makes reference to the City of Tacna, this also refers to the Province of Tacna. Tacna is the southern-most city in Perú and houses an approximate population of 262,000 Tacñenos (citizens of Tacna; Vega Quispe, 2009).

The city is further subdivided into 10 districts, including Tacna, Alto de la Alianza, Calana, Ciudad Nueva, Coronel Gregorio Albarracín Lanchipa, Inclán, Pachía, Pocollay and Sama. The district of Tacna refers to the centre core of the city. Each district is administered independently by its own mayor.

In an effort to aid the reader, most references to Tacna in this paper will refer to the Valley of
Tacna. Encompassing the province of Tacna, as well as the surrounding areas. See Appendix 1 for a map of the study area.

1.2.2 Historical context and Tacna today

The province of Tacna shows evidence of pre-Columbian settlement by ancestral Aymara-speaking 'Changos' who were probably expelled from the region by the expansion of the Inca empire (“Conociendo Tacna,” 1999). Modern settlement of the region didn't occur until the Spanish conquest and founding of San Pedro de Tacna (Saint Peter of Tacna), named for the Aymara word takana (I hit).

Tacna was a small city, home to some 9418 inhabitants in 1895 (“Tacna,” 1911). Its primary purpose was mining, taking advantage of copper in the region. Based on its proximity to the Pacific port of Arica, and the construction of a railway between the two cities, Tacna was economically successful. The small Andean streams which fed the city were small and much of their flow was lost to the desert sands, leaving only enough water to support a small population.

The Peru-Chile war (1879-1883) saw the loss of the departments of Arica and Tacna to Chile. As per the Treaty of Ancón (1883), the nationality of Tacna was to be the subject of a plebiscite ten years after the signing of the treaty. Dispute between who could vote – with Peru insisting that only the original population of Tacna vote, while Chile wanted to include recently-settled Chilean labourers (“Tacna,” 1911) – led to a 50-year dispute over the province, which was finally reincorporated with Peru after a vote in 1929.

In the most recent census (Vega Quispe, 2009) the department of Tacna was home to 288,000 inhabitants, having grown roughly 3.11% annually from 37,512 in 1940. Population growth peaked between the censuses of 1972 and 1981, the decrease attributed to decreasing fecundity of the population. Approximately 37.2% of Tacna's population immigrated from other parts of the country or abroad, but the migration rate has also piqued, decreasing to 35.6% between the 2007 and 1993 censuses (measured as migration within the five years preceding the census).

Tacna is no longer a uni-purpose city. While mining continues in the region, it has also given rise to the development of a large commercial sector and strong agro-economy. The region is the largest source of Peruvian olives (“Perfil del Mercado y Competitividad Exportadora de Aceitunas,” 2005), and also produces other plants such as alfalfa (De Pierola, 2011). Now, water is carried through the valley in a series of long, narrow canals, preventing the sand from swallowing the rivers up, but not protecting the scare resource from evaporation or robberies.
1.2.3 Physical context

Given its location Tacna is characterized by an exceptionally arid climate, with very little annual precipitation. It is difficult to find a measure of solar intensity in Tacna, but the weather station at La Joya, located approximately 220km to the northwest of Tacna, and also in Peru's coastal desert receives 25.3 MJ of solar radiation per square meter per day, and atmospheric transmittance – that is, the amount of that energy that makes it through the atmosphere – over Tacna, ranges between 60 and 80 percent, depending on the month (Baigorria, Villegas, Trebejo, Carlos, & Quiroz, 2004). On average, the city receives an average 15mm of rainfall annually. Demand for water in Tacna is much larger than supply. The cold Antarctic Current inhibits evaporation from the Pacific Ocean, thus the rainfall that Tacna receives is what little is left from the evaporated waters of the Atlantic (Muñante et al., 1998). Much of the rainfall across the Andes to the east of Tacna is retained within the cordillera, infiltrated into the cracks and crevices caused by earthquakes and volcanism (De Pierola, 2011). The National Water Authority (ANA) shows a deficit of between 0.50 and 2.83 cubic hectometres for the region's Caplina watershed (Autoridad Nacional del Agua, n.d.). The largest discrepancy occurs in the spring and summer, between October and March, and peaks in January.

The municipal water supply in Tacna is from two rivers. The first of two, the Caplina, is fed by meltwater from the Barroso Cordillera and brings with it acidic debris from its headwaters, byproducts of the geothermal formation of the mountains it runs through (Franco, 2010). The Caplina doesn't flow naturally outside of the Andes, reduced to a trickle in the desert, and is augmented by the use of deep-drilled wells (“Conociendo Tacna,” 1999). The Ucusuma river, which runs clearer, is fed by alpine lagoons (Condorpico, Casiri and the Paucarani reservoir), as well as bofedales (alpine wetlands) in Ayro. Together, the two rivers bring less than 500lt/s of water to the population of Tacna (Huanacuni, 2010). Much of the water from the rivers is lost en-route to infiltration, evaporation, and exploitation. In the face of climate change, the glaciers that feed the rivers along the coast of Peru, including those in Tacna have been disappearing (Huanacuni, 2010 and Leon, 2012). This diminishing of water supply is not the only anticipated effect of climate change. In an unpublished study, I found that increasing temperatures in Tacna, with little incoming precipitation and constant relative humidity will result in higher evapotranspiration rates in the city (see: Anderson, 2011).

Neither of Tacna's two supply rivers naturally flow as far as the city. Long, narrow canals of less than a metre of depth and width carry Tacna's water supply from its sources to Cerro Blanco a joint project by the EPS and the Tacna Special Project (PET), an institution charged with finding new
sources of water for the city of Tacna. Due to the risk of earthquakes damaging the canals, the authorities at Cerro Blanco, have constructed three large, open reservoirs to store water in the event that the supply is cut. Unfortunately, it is rare to see even one of these completely filled. Upon arrival at Cerro Blanco water passes through *el partidor* (the separator), where it is split in equal parts between the EPS, for municipal use, and agriculturalists. EPS Tacna also has two uncovered reservoirs of between fifty and sixty thousand cubic metres for storage of water before it is treated.

The EPS receives approximately 600lt/s of water to its two treatment plants in Calana and Alto de Lima, however, the population demand for water is in excess of 800lt/s, that is to ensure 24 hours of running water to everyone in the city. At any given moment, the EPS runs at a deficit of between 150 and 200lt/s (Franco, 2011). This deficit leads to varying levels of service, between different areas of the city. Ciudad Nueva, for instance, is a young district which has developed up the slopes of the mountains in the north side of Tacna. Some parts of the settlement are at higher altitudes than the water treatment plant, forcing the EPS to switch from its gravity-fed system to the use of water pumps. Because of the high cost of electricity, the constant use of pumps could reach S/. 20,000 per month, per pump (Huanacuni, 2010). As such, Ciudad Nueva receives as little as two hours of running water per day. On the other side of Tacna, and the other side of the coin, Viñani, to the south of the city and at a lower point in the valley, receives almost 24 hours of service.

### 1.2.4 Cultural context

Not only an environmental phenomenon, the scarcity of water in Tacna is compounded by cultural factors. If you were to ask Tacneños, many will tell you that their problems are a recent issue, compounded by the misuse of water by outsiders, who have flocked to the city in recent decades.

The least detailed study of the available water in Tacna might lead some observers to ask why anyone would want to move to the city at all, and is likely a determinant in the deceleration of migration rates to the region, however the market economy in Tacna makes it a tempting place to settle. Over 61% of Tacna's migrant population comes from Puno, having immigrated over the last few decades to take advantage of the weekly commercial booms each weekend. In Peru, where the national per-capita GDP is only US$5,291 (*World Development Indicators 2011, 2011*) local purchasing power is 26.36% lower than that of their neighbours to the south (“Cost of Living Comparison Between Chile and Peru,” 2012), whose per-capita GDP is over double at US$11,888. Furthermore consumer costs are 20.99% lower in Peru than in Chile. Much like Southern Ontarians hop across the US-Canada border to take advantage of the difference in consumer costs between our countries, droves of Chileans from
Arica, a mere hours drive to the south, arrive in Tacna every weekend to take advantage of the immense difference. On a weekend shopping trip, it was not uncommon to see a single shopping cart, loaded with every package of sugar in the local Plaza Vea (a Peruvian national chain of supermarkets), destined to be re-sold at a corner store Chile.

According to Cesar Huanacuni (2010), the former quality control specialist at EPS Tacna, this migration plays a large role in the scarcity problem, as Puñenos from the Titicaca watershed, accustomed to having water to spare, have a different relationship with the water than do native Tacñenos. Meanwhile, the hotel industry, which is poorly regulated, is accused of having poorly serviced, leaking reservoirs, a network of illegal, clandestine connections, and patrons who use more of the resource than the local population (Franco, 2011).

Even though the user-education program has existed for years in Tacna, it has yet to reach much of the population. The sidewalk in front of almost every shopfront in the city, whether operated by migrants or native Tacñenos is washed with warm water every morning – water which is then swept onto the street and evaporates quickly. In addition, fountains are a popular feature in city-planning, and many new neighbourhoods request permits to operate fountains from the EPS every year. The poor micromanagement of these features means that losses of water from fountains are high (Franco, 2011). Clandestine connections are also a problem, and SUNASS, the entity responsible for managing national EPS actions highlights the identification and elimination of clandestine connections as a top priority (Torres, 2005).

The agricultural sector in Tacna plays a significant role in the consumption of water. The protection of the water supply in the region of Tacna is limited by budget constraints. Open canals are vulnerable to robberies, and often large quantities of water will be stolen by region agriculturalists and clandestine water vendors at night when the staff monitoring flow rates have retired for the evening (Huanacuni, 2010). In addition, primitive irrigation techniques, such as flooding are often used in place of technical approaches like sprinklers or drip-irrigation (De Pierola, 2011). Finally, even crop choices are poor. Many farmers grow alfalfa, which has higher demand for water and a lower sale price than crops such as oregano (De Pierola, 2011).

1.3 Tacna and the Tragedy of the Commons

This paper was designed out of a desire to identify what was really contributing to water problems in Tacna. Popular opinion in the region pins the blame on anyone from the regional government, mining, and the EPS, to migration and tourism. The common denominator in any
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explanation was the complete omission of the self. It seems as though everyone in Tacna thinks that they are already doing all that they can to resolve the water crisis. In the one year I was in Tacna, however, the most I saw being done was talking. Without introspection and working as a community, the city of Tacna will stay thirsty.

This self-interested attitude was summarized in a phrase spoken by Jose de Pierola, manager of water resources at Southern Copper, Peru, explaining the outlook of the typical farmer when asked to conserve water: “... Dice el agricultor 'Yo como persona que gano por ahorrar el agua?' (the farmer says, 'Me, as a person, what do I gain by conserving water?' (De Pierola, 2011) ” A direct answer to this question isn't very easy to give. It is hard to say exactly what the farmer will gain by conserving water. But it is this point of view that has exacerbated the physical problems in Tacna. There is no right answer to this question because this is not the right question. Tacna, while in a state of crisis, has adapted little by little, and has yet to experience any great fallout over the water shortage. Therefore, in considering the problem of water in Tacna, we need to examine not what the farmer stands to gain by conserving water, but what he stands to lose.

The Tragedy of the Commons refers to the over-consumption of a shared resource when multiple players act independently in its consumption. In Tacna, the numerous water stakeholders act independently and competitively – sometimes seeming to belligerently consume water because they are not sure 'what they gain by conserving.' There is a constant frustration between the EPS and agriculture sector, and mining and the populace. While many studies have related water scarcity to everything from climate change to mine water demands, or to a lack of education on sustainability, the particular case of Tacna experiences all of these things. In other locales, adaptation has been efficient and effective in response to worsening water availability, but in Tacna, there has been little work done towards the creation of applicable solutions.

1.4 Objectives of this study

This paper has four main objectives. They are: 1) to provide an overview of the problem in Tacna, with specific definition of Tacna's Tragedy of the Commons; 2) overview water management strategies and analyze what is being done in Tacna, evaluating the situation under Olson's framework of collective action; 3) identify the major players in Tacna, classifying them under Olson's framework; and; 4) make recommendations for the encouragement of collaborative action and future water management in Tacna.
1.5 Outline of this study

- Chapter one has explained the Tragedy of the Commons associated with water in Tacna – including the physical, and cultural context it occurs in. By summarizing the issue, this section has given the reader sufficient context to think critically throughout the proceeding chapters.
- Chapter two will review some strategies for good water management and provide a panorama of what is being done in Tacna.
- Chapter three will review my positionality, motivation and method of research.
- Chapter four will identify the major players in water management in Tacna, the role they each play with relation to water, and how they fall within Olson's framework.
- Chapter five will make recommendations for the development of collaborative, inclusive conservation action and the future of water management in Tacna.

2 A review of water management and Group Theory

This section will briefly overview technologies and methods for good water management in arid and semi-arid regions. It will also define important terms and explore issues of the tragedy of the commons, with a focus on group action and public goods, as outlined in Olson (1971).

2.1 Water management

Worldwide, water resources have been compromised by growing populations, leading to higher extraction and increased contamination (Falkenmark & Widstrand, 1992). While some relatively early studies, such as Falkenmark (1986), have identified the (then impending) problem, little has been done to control population in water-scarce regions. Already stressed by a burgeoning population, water resources face considerable variation in the years to come, affected by changes in the global climate and the depletion of current sources. Climate change is expected to affect global circulation patterns, accelerate glacial melt and increase evapotranspiration. This will result in the drying of some regions and increased precipitation in others. In much of central Latin America, increases in precipitation are expected, however the combination of increased precipitation and increased evapotranspiration would result in a net loss of water resources (Ragab & Prudhomme, 2002). Given the threats to water on a global scale, numerous methods and technologies have been developed to manage water consumption and use.
2.1.1 Conventional water management techniques

Typical water management techniques have been prospective, seeking new sources of water via the drilling of new wells or the manipulation of rivers (Ragab & Prudhomme, 2002). In many arid regions of the world, technological advances have allowed for the diversion of, and increased extraction from, rivers leading to the rapid depletion of river resources from Missouri to Australia (Kingsford, 2000). According to Kingsford (2000), the ecological consequence of such development can be insurmountable, as development around the river often makes restoration impossible.

The exploitation of groundwater resources usually provides a cleaner source of water. By filtering through the earth on its way to an aquifer, groundwater is usually free of the contaminants that affect rivers and surface water. The rapid extraction of groundwater resources, however, has led to the depletion of supply and, by modifying the water table, can lead to the contamination of aquifers by encroaching seawater (Shah & International Water Management Institute, 2000). While water is a renewable resource on a global scale, it is finite in a given location. Groundwater is particularly prone to depletion, as it is extracted at a rate much faster than it is recharged.

A key method for the conservation of water resources in agricultural communities is through the implementation of specialized irrigation technologies. In place of surface irrigation, methods such as drip irrigation and sprinklers can conserve large quantities of water by targeted water dispersal. Such technologies have been implemented in many developed and developing countries, the total cost of implementation and price of output defining what technologies are used (Green, Sunding, Zilberman, & Parker, 1996). For a given user, these 'technified' irrigation technologies represent a medium-term investment, as a given technology is estimated to be in use for twenty to thirty years before being retired (Dinar & Yaron, 1992).

2.1.2 New approaches to water management

The twenty-first century in particular has seen the development of novel approaches to water management. Scholars and practitioners, having realized the failure of the perspective of water as an unlimited resource, have begun to investigate and implement new, more sustainable technologies. This new approach involves the divorcing of water management from economic growth and refocusing management strategies with a basis upon basic human rights and ecological concerns (Gleick, 2000).

The primary focus of new age water management is through reduced demand, whether by economic incentives (or penalties) or via the better maintenance of current systems. In particular, improvements to the efficiencies of transport networks could significantly reduce physical (e.g. leaks)
and commercial (e.g. improper billing) water losses. It is estimated that in California, 10 percent of
supply water is 'unaccounted for', but this number can reach much higher quantities, with losses in
Mexico city enough to supply a city the size of Rome (Gleick, 2000). Tacna, with the best water

A final, more expensive option to source water is through the desalination of marine water.
Whether by chemically intensive process such as reverse osmosis, or by a low-capacity solar still
(Kalogirou, 1997), desalination has been criticized as an ecologically damaging process, damaging
ecosystems by non-selective inputs, and creating high amounts of waste including heavy metals or
cleaning agents (Lattemann & Höpner, 2008). It is also much too costly for application in many
developing regions such as Peru (Leon, 2012).

Aside from increased efficiencies in the use of water, without the perforation of new wells, or
the exploitation of more sources of surface water the only solution to water stress is a source of great
contention among water users: the re-purposing or re-use of wastewater. Societies spend many billions
of dollars on the extraction and treatment of water resources to provide potable water which, once used
is treated again (to reduce its impacts on human and environmental health) before it is simply dumped
into sinks such as the oceans or desert dunes (Gleick, 2000). The re-use of this treated wastewater
provides the opportunity to recharge depleting aquifers, supplement irrigation supplies, and save
potable water from industrial processes. Depending on the cost and quality of treatment, re-use of
reclaimed water can vary from very little to extensive reuse (Jeuland, 2011). In the Peel region of
Ontario, for instance, wastewater is heavily treated before being returned to Lake Ontario, which also
serves as the source of potable water for the municipality. In arid regions, extensive reuse is not only
possible, but often necessary, as the cost of finding new sources of water is higher than the cost of
water recycling.

2.1.3 Extreme measures

There are some extreme measures to increase water availability. One salient example, cloud-
seeding involves the artificial augmentation of cloud condensation nuclei (Hudson, 1993), airborne
particles upon which clouds condense. Cloud condensation nuclei can be released through aerosols in
an attempt to increase the effective cloud-formation area. Many cloud-seeding experiments have shown
a positive result, yielding larger clouds and higher quantities of rainfall in Israel (Gagin & Neumann,
1981), Texas (Rosenfeld & Woodley, 1993), and South Africa (Mather, Terblanche, Steffens, &
Fletcher, 1997), to name just a few examples.
Socially, some nations have found success by privatizing water resources. The World Bank has proposed a radical change in the governance of water resources for much of developing Latin America. Under a draft law proposing privatization (Thobani, 1995), all water users would be required to register their sources of water use, purchasing water use rights, and bidding on new sources of water. The market would thus control the use of water, as scarcity would drive up prices and cause users to be more environmentally responsible by being more fiscally responsible. This law has been a great source of contention for the people of Latin America and has been rendered abeyant in most nations around the region (Trawick, 2003).

### 2.1.4 Indigenous knowledge

A critical source of knowledge regarding environmental management that has been long overlooked are the indigenous peoples of a given region. Recently, scholars have turned their attention to the methods by which indigenous nations led sustainable livelihoods for centuries before the arrival of colonists. As described by Critchley and colleagues (1994) the end of the 20th century saw a near-reversal of prior perspective – from a top-down approach for environmental management to a focus on the land users themselves. While we have an incomplete understanding of indigenous soil and water conservation practices, many have been studied (Critchley et al., 1994).

Worldwide, various strategies for the good management of soil and water resources have existed for millennia, from terracing to prevent soil loss, to rain- and flood-water harvesting. Simple technologies like trashlines to decrease runoff have been shown to reduce erosion and boost crop yields by over 90 percent (Wakindiki & Ben-Hur, 2002). Indigenous approaches are not merely technological, however. Traditional knowledge of crop systems or of soil characteristics (example: Sandor & Furbee, 1996) can result in more efficient agricultural technique. Indigenous community structure has also been studied by scholars such as Trawick (2003), who describes an answer to the World Bank's plan for the privatization of water in Peru (Thobani, 1995), rooted in indigenous community structure and resource management, wherein local water resources are shared within a community group, as opposed to being the property of the state. Such an approach could lead to the good management of water resources at a community level, localizing responsibility and allowing the state to 'wash its hands' of the issue.

The use of indigenous knowledge is not without its complications. Briggs (2005) outlines numerous challenges facing the application of indigenous knowledge to modern development initiatives. Pertinently, the decontextualization of indigenous knowledge, combined with incompatibilities between western and indigenous approaches can hinder the applicability and
effectiveness of such action.

2.2.1 Water management in Peru and Tacna

A result of its topography, Peru is characterized by three distinct climate-zones, a coastal desert, the Andes cordillera, and a small area of the Amazon rainforest. Within these three climate zones, there are three major watersheds in Peru: that which drains to the Atlantic; that which drains to the Pacific; and that which drains to lake Titicaca. The distribution of water in the country is uneven, with some 97.81% of the country's water in the Atlantic watershed – an area home to only 34.8% of the population. Meanwhile, the coastal desert, home to 60% of the country's population has access to just 1.7% of its water (Chávez Ularte, Mazuelos Cardoza, & Escate Cavero, 2010).

Water management in Peru changed drastically in the second half of the twentieth century. According to a joint report by the World Health Organization (WHO) and UNICEF, the January 1991 outbreak of *Vibrio cholerae* in Peru led to the rapid improvement of Peru's water infrastructure. By 2004, water service provision had expanded to 62% of the population, and 30% of the population had access to sewage services; these figures are two- to three-times higher than the mid 1980's levels of 30% and 9%, respectively (WHO & UNICEF, 2010a); (WHO & UNICEF, 2010b)

The service provision model for municipal water and sewage is also relatively young. With the support of the World Bank's draft law (Thobani, 1995), the Fujimori regime moved to separate the water utilities from the municipal government, creating the EPS model in 1994. This model granted the utilities legal and financial independence from the local government. In 1995, the founding of SUNASS accompanied tariff revitalization with the aim of privatizing the EPSs. Only one concession was ever granted, however – that of Tumbes, but the project was not without controversy; its Argentine investors were unhappy with its performance (Weiner F, 2007) and eventually sold their contract to a Colombian firm (“Empresa colombiana asume servicio de agua potable en Tumbes,” 2011). Currently, some 62% of Peru's population receives water from EPSs (Vega Carreazo, Valdivia Rodriguez, & Eléspuru Nesanovich, 2006). Agricultural water is managed by various local water boards.

In Tacna, the EPS provides almost 97% of the population with potable water, as well as 94% with sewage service (“Benchmarking 2010,” 2011). Water for agricultural purposes is controlled by a number of *juntas de usuarios* (Water Users Boards – WUBs). While there is some collaboration between the EPS and the WUBs, it generally ends at Cerro Blanco.

The EPS has placed a strong focus on water education, as evidenced by its fourteen year-old user education program, however its effect is hard to measure – whereas children in the city know not
to water their gardens in the early hours of the afternoon, the municipality itself often irrigates gardens when evaporation is highest. Physically, many, if not all of the alternative approaches outlined earlier in this chapter are very important, and many can be modified to fit a Tacneño context, but few have been. EPS Tacna does treat the vast majority (87.8%; (“Benchmarking 2010,” 2011) of its residential wastewater in oxidation ponds to reduce total coliform concentrations, and all of this treated wastewater is reused for the irrigation of parks, and even some crops. The consensus in Tacna, however, has yet to catch up with the rest of the world. While globally the focus has shifted away from the creation of transnational supply lines and major infrastructure projects (Gleick, 2000) the population is still relying on PET, a regional government body charged with finding new sources of water, to generate some grand project bringing water from as far as lake Titicaca, or the Desaguadero river (Franco, 2011). The city of Tacna has been waiting for more than a decade for the ‘answer’ to their water scarcity issues, however the solution they seek might need to be homegrown.

2.3 Mancur Olson (1971) and Group Theory

Considering what we learned in chapter one, the impending crisis of water management in Tacna is a collective issue that the whole region is part of. So why is there not more being done by any of the stakeholder groups in Tacna? To understand this group dynamic we first need to understand group theory and collective action. Olson (1971) offers an analysis of group theory and collective action for the attainment of common interests, or public goods. Given the existence of a common interest, Olson argues that, while common consideration of human beings as rational and self-interested has led many to assume that individuals will work together for the benefits that arise by attaining the common interest, this theory is not robust. While rational, self-interested beings seek out the benefits of some common good, they expressly do not seek out the associated cost of attaining, or producing it. Instead of presuming that groups implicitly work together, Olson describes three types of groups worth our consideration:

• First, privileged groups are those whose members would gain more from a public good than it would cost for the group, or even a single member, to provide the good. This group would derive a net benefit from the collective action. In a privileged group, the good should always be provided.

• A latent group is a group that is large enough that the lack of contribution by any one member would go unnoticed by other members of the group. No single member will choose to assume
the cost of the collective action, as his singular contribution cannot attain the common benefit. This group is said to be latent because its members can be mobilized to common action by incentive or coercion. In this group, the good is unlikely to be provided unless by coercion or incentive.

- Finally, an intermediate group occurs where no single member will receive a share of benefits enough to provide a good themself, but where the withholding of contributions by any member of the group would cause a noticeable rise in cost, or decrease in supply of the good for other members. This group may provide a public good, but it also might not.

The scale of group action is entirely based on group size and organization. The provision of a good becomes less optimal as group size increases. In larger groups, the relative cost of organization and management increases, while the per-member share of the public good decreases. The larger a group, therefore, the less likely it is to take part in some collective action.

Finally, membership in a group is dependent on whether a good is inclusive or exclusive. An exclusive good has a limited supply, and membership in a group related to an exclusive good is likely to be difficult to obtain. Water, in the context of this paper, is a very exclusive good, and groups that work towards the attainment of more water are likely to be limited in size, however, as water is a public right, the usual forces cannot exclude the population from seeking access to water outright.

Olson describes his theory of groups based on the production of a public good which would generate a net benefit. For the purposes of this paper, I will focus on the protection of a common good – in this case water supplies in the Tacna region – and the costs and benefits associated with it. Thus, the public good that this paper will examine is the conservation of water.

2.3.1 More on group action

Collective action might be attained, or compromised by the relative composition of groups. To understand the motivation for participation in collective action by a given member of a group, we need to consider Individualism-Collectivism (Wagner & Moch, 1986). Members of a group can act either for the public benefit (if they are collectivists), or for their own benefit (if they are individualists). When an individualist derives the same benefits as other members from a group, while not bearing any of the cost, they are said to be a ‘free rider’. A study by Wagner III (1995) shows that individuals are more likely to cooperate and participate in group action when group size is small, and when their perceived identifiably is higher. A latent group, therefore, is most prone to free riding, as the withholding of contributions by an individualist will not be noticed by the other members of the group.
2.3.2 *The Tragedy of the Commons and Group Theory*

Given our understanding of group theory, we can predict that the Tragedy of the Commons occurs when a public good is consumed either by independent actors acting individualistically, or when a group's efforts at collective action are undermined by free riders. In particular, individualism in a latent or intermediate group is much more likely to lead to the depletion of a public good.

2.3.3 *Group Theory in water management*

The literature contains no study of collective action and water management. At most, a study of water management organizations (Holmes, 2000) has shown that smaller, less bureaucratic organizations are more effective at providing good water management. The same study found that water management organizations in the developing world are much less effective than their analogues in the Global North. Many factors influence the ineffectiveness of developing-world water utilities, including the cost of trying to adapt to changing priorities in water management. Often, a larger organization is more bureaucratic than a smaller one, meaning higher costs of organization. No studies have attempted to explain how Olson's theory of public goods and collective applies to water management and water scarcity. Olson's framework is particularly applicable in Tacna, where the potential for collective action is compromised by a number of very small to very large, disjointed groups who work discordantly. Chapter 4 will outline what groups exist in Tacna, the role each group plays in water management in the region, and how the latency has affected groups' abilities to protect their public good, giving rise to the Tragedy of the Commons.

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3 *Motivation and method of research*

3.1 *Motivation and positionality*

As previously mentioned, as a student in the International Development Studies cooperative program at the University of Toronto, I was afforded the opportunity to live and work in Tacna, Peru from August 2010 to August 2011. I spent 40 hours a week at the EPS, which is a public, but commercial water utility serving the entire province of Tacna. Officially, I was the 'assistant in training and communications' for the utility's user education program, which has been in execution for more than a decade, working with the regional board of education to ensure that water conservation and responsibility form part of the curriculum of primary and secondary schools. I was primarily in charge
of coordinating with university volunteers and EPS staff to suggest improvements to the program. During my placement in Tacna, I also had the opportunity to create a social-web presence for the program, a project which has unfortunately been abandoned since the end of my mandate.

Fortunately, while I was in Tacna, and driven by the efforts of another Uniterra volunteer, the user education program adopted a new focus, working with local neighbourhood organizations (*Juntas Vecinales*) and grassroots groups to reach a more mature demographic. These outreach seminars, were executed in four parts: first, the commercial department of the EPS presented regarding water tariffs and billing. Following a few weeks, the operations department delivered an overview of the situation of water in Tacna, from its sources to sewerage. A presentation by the engineering department was then followed by a tour of the treatment plants in Tacna.

The operations presentations in particular, such as that by Cesar Huanacuni (2010) or Alberto Franco (2010) unlocked a new sense of empathy in attendees. Whereas entrance surveys were rife with criticisms of the EPS and its activities, at the end of the series respondents were much happier, with one saying, that “the EPS is doing all that it can with a limited personnel and resources”. Admittedly, my contributions to this part of the program involved little more than surveying and pressing the next button on Powerpoint presentations, but it was at these meetings that I recognized a dynamic animosity between the population, agriculturalists, mining, and the government. Frustration between stakeholder groups seemed to be motivated by a simple misunderstanding of what each group was doing. I decided to investigate what the various groups in Tacna thought was contributing most to scarcity in the region.

Being a Uniterra volunteer provided me with a unique perspective. As a third-party observer I didn't only want to, but needed to understand all of the factors that were contributing to water issues in Tacna. Given that I was an outsider, I was given the opportunity to see the larger picture; friends and strangers alike assumed (correctly, in many cases) that I knew little about the historical and current factors leading to water scarcity in Tacna and, as such, I was given a greater depth of perspective; respondents saw me as a 'blank slate' and were not worried to give me their full opinions. Everyone I asked though, gave me a different story about what led up to, and what was aggravating the current scarcity issues. I soon realized that I wasn't the only person in Tacna who didn't fully understand what was happening in the region. This study is a result of my desire to dispel some of the uncertainty surrounding how social, and physical factors interact to create Tacna's water crisis, and what roles Tacna's various groups and bodies play. This study relies heavily on observation and discourse, the result of one year of ethnographic observation. Surveying and interviews were also used. In total, more
than 500 survey respondents and two in-person and ten online interviewees contributed to the project.

### 3.2 Research approach

Given limitations in both time and resources, much of the research for this study was conducted under the auspices of the EPS Tacna, through awareness workshops and within the EPS itself. Coming from the EPS, a body of the municipal government, gave me strong support and increased my credibility as a researcher. Sampling was largely done via convenience sampling, with large audiences guaranteed for surveying through EPS education programming. Some snowball sampling was used for the digital interview (outlined below) where respondents would sometimes recommend colleagues or friends with knowledge of the topic. In-person interviewees were contacted directly.

#### 3.2 Surveys

From October 2010 to January 2011, the EPS ran outreach seminars as part of the user organization program, reaching neighbourhood alliances and grass roots organizations. During these seminars, surveys were executed with the assistance of the EPS Tacna, as they were used internally by the EPS as well. In general, the survey asked respondents what knowledge they had of the water in general, within the specific context of Tacna, and about the roles that they, as users, and the EPS, as a provider played in water management in the city. As I was in charge of social networking for the EPS, I made a digital copy of the survey to try and reach youth and students. In total, the survey reached Tacneños aged twenty years and up.

Surveying was limited slightly by gender roles in Peru. While some of the outreach seminars were for grassroots women's groups, at those where there were couples, the man would often dictate to his wife what answer she should give. As some candidates were illiterate, staff from the EPS would often deliver the survey orally, however I am not convinced that their tone or intonation did not betray the correct answer in some instances. Please see Appendix 2 for survey questions.

#### 3.3 Interviews

I conducted interviews with two executives from water-related organizations, Alberto Franco, an engineer and specialist in quality control at the EPS (Franco, 2011) and Jose de Pierola, the manager of water resources at Southern Copper Peru (De Pierola, 2011). These gentlemen provided a lot of information related specifically to their respective organizations' relationship with water.

Unfortunately, the number of interviews conducted was limited both by available time and by the vagueness of Peruvian scheduling, often “next week” was months away and many interviews that
were supposed to occur never took place. In order to reach more candidates, I made a digital survey of the same questions. Unfortunately the digital interview could only provide a static forum instead of dynamic discourse, but it did reach an additional base of respondents, from recent graduates to veterans of the EPS. Some requests for interviews, particularly from government agencies were never answered. Although I made multiple requests, I was never granted an interview by PET, ALA, or the agricultural union in Tacna. Sample questions used in the interview, as well as a link to the digital interview are available in Appendix 3.

3.4 Other sources of information

I also collected data at the EPS outreach workshops and during in-house training programming. I also attended the taping of a live radio show related to the issue. This data was synthesized in my notes.

4 Groups and group action in water management in Tacna

The range of groups that interact with water in Tacna is large and varied. Whether they be users, administrators, or service providers, numerous companies, user boards, and agencies, both Peruvian and multinational, interact with the water contained in the Uchusuma and Caplina watersheds. This chapter will critically analyze each group, and determine their impact upon water management in the region.

4.1 Players in water in Tacna

4.1.1 Water Providers

Water in Tacna comes from alpine glacier melt, which reaches the city through the artificial lengthening of desert rivers in open canals. The paltry natural supply is augmented by groundwater extraction. Numerous authorities, across various levels of government play a part in the provision of water to the residents of Tacna.

4.1.1.1 PET

PET, officially el Proyecto Especial “Afianzamiento y Ampliación de los Recursos Hídricos de Tacna” (The Special Financing and Expansion Project for Water Resources in Tacna), often referred to as Proyecto Especial Tacna (Tacna Special Project), was founded in 1984 as a project of the National Development Institute (INADE). By 2005, the project had been transferred to the regional government
of Tacna. PET's mandate is to seek new sources of water and optimize those that are already in place. PET claims to have added a total of 522.85 Hm$^3$ to the supply of the region of Tacna since 1991, through the drilling of wells, improvements of canals and exploitation of the Aricota Lagoon ("Volumen incrementado por Operacion del PET," 2011). However, even though PET has brought between five and forty-five cubic hectometres of 'new water' to the region annually, their efforts have failed to impress the population, which expects one, permanent mega-project solution to water scarcity in Tacna.

PET has been largely ineffective in its role to seek new sources of funding or physical resources due to the politicization of the region. As described by Alberto Franco (2011), frequent government turnover has left seemingly viable projects abandoned.

For instance, a project is generated and approved. It's approved in the third year of the government[al term]. If they want to execute the project, they aren't allowed, and when the next government comes 'boom' everything is paralyzed. They come with other ideas. They say “no, no, no, that project's no good”. It's like this; and that's the way the years pass by. (Franco, 2011)

4.1.1.2 EPS Tacna

EPS Tacna is the municipal water utility responsible for the treatment and delivery of water to all parts of the city of Tacna. The EPS is the sole provider of municipal water and is a corporation of the municipal government, though it is legally and financially independent of said administration. EPS Tacna, like all other EPSs in Peru, is held to account by the National Superintendency of Sanitation Services (SUNASS). The cost structure for water is set out by SUNASS, and this has been a point of controversy for the EPS, who would like to charge more for those users requiring water to be pumped to their location (such as Ciudad Nueva). The EPS has been the subject of frequent frustration from the population, who hold the EPA to account for water availability problems. In my experience, most of the blame is given to the EPS, who, by treating water for residential use, are presumed to be responsible for the provision of diverse services and management. In surveys taken at the EPS outreach workshops, many respondents (72.5% of those in Ciudad Nueva, for instance) had negative feedback for the EPS, citing concerns such as poor customer service, or education as keys to Tacna's water problems. One respondent at the Jesuit school 'Cristo Rey' said the EPS “is a company that is losing control over the water problem” in Tacna.

4.1.1.3 Water Users Boards

Tacna's water supply for agriculture is regulated by a number of Water User Boards (Juntas de Usuarios). The primary boards in Tacna are Upper Caplina, Middle Caplina, Lower Caplina, Upper
Uchusuma, and Lower Uchusuma. At the time of research, an additional WUB was being organized for Vilaviñani, where, according to Alberto Franco (2011), heavy extraction of water led some to demand the formation of a WUB, which is held to some degree of accountability.

4.1.2 Water Users

Obviously water isn't just produced in Tacna. It is consumed by a number of groups, ranging from residents to industry. Each sector of consumption in Tacna represents a different use pattern, with varying habits accounting, somewhat, for the lack of cohesive water conservation efforts in Tacna, giving rise to common action problems in the region.

4.1.2.1 Agriculture

Tacna is a significant player in Peruvian agriculture. Although the region is scarce of water, Tacna is the olive capital of Peru (“Perfil del Mercado y Competitividad Exportadora de Aceitunas,” 2005), given the olive plant's incredible ability to survive prolonged periods of drought (see: Fernández & Moreno, 1999). However, Tacna is also home to plantations of Prickly Pear, grown for the propagation of Cochineal insects, which are processed to produce carmine dye. The agricultural sector in Tacna, however, is relatively unsophisticated. There is minimal use of technified irrigation and plants such as alfalfa (which has low value and high water demands) are grown where a crop such as oregano would be better suited (De Pierola, 2011). Water extraction by agriculture is generally not metered and water for irrigation is often not treated, except for sedimentation of solid particles, for instance.

4.1.2.2 Residential

The residential community in Tacna, including hotels and businesses, are the sole users of water produced by EPS Tacna. There is still a lot to be done to encourage a 'water culture' in Tacna, a city where shopkeepers still wash the sidewalks in front of their business each morning. A given house in Tacna will often have a water tank for storage of water outside of service hours. The city of Tacna also experiences significant problems with clandestine connections, particularly in the hotel industry. According to one survey respondent, clandestine connections cause huge wastage of water, as they are installed without proper procedures, allowing dirt to enter the system and often contaminating household water tanks or hotel cisterns. Hotels are very hard to monitor, as they usually have their own reservoirs, making leaks harder to detect. Less than half of the population in Tacna has a water meter; many oppose their use, as leaking household piping causes water bills to increase once metering is in place. In addition water meters are the targets of robberies and manipulation, making them difficult to
4.1.2.3 Industry and mining

Industry in Tacna includes olive oil processing, and mining. While it is difficult to find exact figures on the industrial use of water, industry in Tacna does pay a higher rate for water use than does the population. A large source of controversy in Tacna are the operations at Toquepala, a mine administered by Southern Peru, a division of Southern Copper Company, a Mexican mining giant. Controversy between the mine and the population is sensitive. The population claims that the mine uses all the region's water when, in actuality, the mine doesn't even extract water from the same sources as the population (De Pierola, 2011). However, the mine also has a license (administered by ALA, see below) to extract up to 1950 litres per second (De Pierola, 2011), more than three time the volume the EPS receives per second. The mine does have a history of providing some technical assistance to the region, mostly through consulting and advice. However, Southern Peru's manager of water resources mentioned that the disposition of some governments allows more, or less, cooperation. Under the government of Lucho Torres (until 2010), the mining company consulted frequently with the government, offering advice and resources. However, the government of Tito Chocano has been less ready to receive them (De Pierola, 2011). In fact, in September 2011, the authorities in Tacna had a very public, and ongoing, conflict with Southern Copper company, whose planned expansion to its Toquepala mine in Tacna was a source of contention, even though the mine claimed it would use no new water, using only treated wastewater for the new operations (“UPDATE 1-Southern Copper open to talks in Peru water dispute,” 2011).

It is important to note that, while mines might be seen as water providers in that they are responsible for the extraction, treatment, and regulation of water that they use, they only provide for their own functions and employees, that is, for their own benefit, and thus they are not considered a producer water for the purposes of this study.

4.1.3 Government

Numerous government bodies and authorities play some role in the regulation, and legislation of water management in Peru. Government interaction with water is mostly top-down, with the most relevant laws and regulations for Tacna coming out of Lima.

4.1.3.1 SUNASS

The establishment of SUNASS in 2005 was to create a body responsible for the regulation,
supervision, and financing of sanitation services in the country (“Acerca de SUNASS,” n.d.). SUNASS is responsible for the regulation and sanctioning of EPSs. SUNASS also sets water tariffs, with some input from the EPSs in the form of a five-year financial plan (Leon, 2012b). SUNASS is also the authority to whom complaints are directed once they have been appealed at the level of the EPS.

4.1.3.2 ANA and ALA

The National Water Authority (Autoridad Nacional del Agua; ANA) was established in 2008, with the passing of the law of the National System of Water Management, a law granting ANA supreme authority over water resources in Peru (“Conocenos,” n.d.). This law, as an answer to the poor use of water in years previous, granted ANA the right to determine the cost of the use of water and grant licenses for the use of water to public and private entities (“Ley de recursos hídricos mejorará la eficiencia en el uso del agua,” 2007).

The Local Water Administration (Administración Local del Agua; ALA) is the name applied to ANA's decentralized offices. The Caplina-Ocoña office in Tacna oversees the use of water from the Uchusuma, Caplina, and other nearby watersheds.

4.1.3.3 Government ministries

The ministry of agriculture in Peru (Ministerio de Agricultura), with its decentralized regional office contains a division of water resources, who are dedicated to the expansion of the agricultural section whilst maintaining sustainability, promoting improved irrigation techniques, and increasing efficiency in agriculture (“Dirección de recursos hídricos,” 2012).

The ministry of living, construction, and sanitation (Ministerio de Vivienda, Construcción y Saneamiento) has laid out a comprehensive plan for the expansion of sanitation coverage in all regions of Peru (Vega Carreazo, Valdivia Rodríguez, & Eléspuru Nesanovich, 2006). This ministry oversees water provision in very small, dispersed communities that are too rural for provision by an EPS (Leon, 2012b).

4.1.4 WUSC/Uniterra and NGOs

This paper could hardly be considered comprehensive if I did not evaluate my own role in the conservation and delivery of water in Tacna. For over a decade World University Service of Canada (WUSC/SUM Canadá) have worked in water and sanitation in Peru. With the entrance of the Uniterra program, the focus has shifted from infrastructure projects to education, in order to accommodate Uniterra's configuration as a volunteer sending program. Uniterra volunteers are responsible for the
development of education curriculum and communications in Tacna. I worked with elementary and high-school students, giving tours of the water treatment plant, and promoting the importance of conservation.

4.2 Common action in Tacna

The first step in this analysis of collective action and the study of groups in Tacna is to clearly define what a group is and who its members are. For the purposes of this study, a group is any collective of members, whether formally organized or not. Group members may be individual persons, or a group could even be composed of numerous groups of individuals.

Given the universal need for water, every organization in Tacna should be working towards the same goal. Water in particular is a difficult subject to approach, as it is neither strictly a market good, nor a non-market good. Indeed, water is somewhere in between, a unit volume of water has considerable value, but as a UN-declared human right, its social value and economic value are difficult to distinguish. Olson's approach to economics is not one of finite goods and services, but rather of calculative rationality by purposive action and logical choice. Olson's view is therefore that action or behaviour of any kind can be economically relevant provided that it is purposive and resources are scarce enough not to allow the achievement of all purposes (Reisman, 1990). Thus, under Olson's framework, the provision of a common good is not necessarily a tangible object, but rather any action. In the case of Tacna, this common good cannot be more water per se; without radical projects the amount of water in Tacna is more likely to decrease than it is to increase. As such, the common good provided in Tacna is the conservation of water, through better cooperation or management, or through austere water rationing, for instance. While commercial entities might seek better conservation for the common good of their employees, governments would seek better conservation for the common good of its people. Water is a universal necessity, and its preservation is necessary for continued existence in Tacna; as such, this study considers the various stakeholders in the region to be interested in the same common good.

As mentioned earlier, the above groups of stakeholders do not work together to resolve water issues in Tacna. The common response to water stress has frequently been the complete abnegation of responsibility, or the dismissal of one's own role in water stress in Tacna as being small. Each stakeholder acts as thought they were member of a latent group, wherein the lack of action on the part of one will not be apparent to the others. Indeed, the size of the population in Tacna on a whole means that inaction by any one individual will likely go unnoticed by the rest, however we cannot look at the
players in Tacna as a large group of individuals. Each of the stakeholders, their clients or constituents might form their own group. In addition, these groups of stakeholders form the basis of a collective group of groups in Tacna.

4.2.1 Privilege and the individual players

To look at the individual players as distinct entities provides insight into the motivation of each group. Individual players have differing motivations for their interactions with water. Some, such as Southern Copper or the EPS are commercially driven, while at the level of government, the interest is purely political. This subsection will briefly explore a few of the biggest players in Tacna, the EPS and its client base, Southern Copper, agriculture, and the regional government.

As it is commercial in nature, the EPS in Tacna could be seen as a privileged group – having more available water to treat and charge for means better service, better customer satisfaction, and better revenues generated from the sale of said water. This classification is complicated however, as Peruvian water utilities, including EPS Tacna, often do not achieve full cost recovery though water tariffs (Leon, 2012b). In addition, even if an increased license for extraction from ALA could provide the EPS with more treatable water, the current treatment system has been operating at capacity for the past 11 years (Zavala, 2011) and the region lacks the storage infrastructure to reserve water for treatment (Salinas, 2011). Faced with the high cost of plant expansion, the EPS could instead opt for forced conservation by its clients through service reduction, but such action would cause it to lose revenues. Thus, the EPS might not actually be privileged, as there will be significant cost associated with the provision of more water or enforcement of stringent conservation measures. In addition, the EPS can only conserve as much as its members or, in this case, clients conserve. While 92% of survey respondents recognized that Tacna will not have enough water to continue business as usual into the future, only 62% claimed to understand their responsibilities as water users, and only 23% claimed to understand the responsibilities and limitations of the EPS as an institution. Residents of Tacna will often pay lip service to conservation practice, in the online survey, 80% of respondents claimed to save water by turning off taps while lathering in the shower, while brushing their teeth, and always ensuring that taps are properly turned off – key elements of EPS Tacna's education line. However common practices still exist – such as the daily washing of sidewalks outside of convenience stores – that waste significantly more water. Whether our survey respondents really do conserve water to the best of their abilities, or whether they were simply repeating the advice of the EPS cannot be known for sure, but it is apparent that the education messaging of the EPS has been successful. The population of Tacna is
large enough however, that the cessation of any of these simple conservation actions by a given resident would go unnoticed by the other residents. So long as there is no strong incentive to conserve, nor any penalty for wastage, the population of Tacna remains a latent group.

For a mining company, such as Southern copper for instance, conservation of water is desirable, but only if it is certain that the conservation of water will not affect the company's product. The cost-benefit ratio of water for a mining company versus a water utility is vastly different, with a company such as Southern Copper earning very large revenues from the copper it produces. Given the low cost ratio of water treatment, the mine stands to gain little from conservation, however it could be at risk of losing its license if civil society were to revolt against the mine and government were to choose the side of the people. Even so, mining can make small, low-cost contributions, for instance, the expansion of the Toquepala project will re-use water already treated in the wetlands of Ite, meaning the added cost will only be the cost of pumping water back from Ite (De Pierola, 2011). Given its large license for extraction, and low cost-benefit ratio, Southern copper could be a privileged group, as the social, political and economic benefits it would derive from small conservation actions would likely outweigh the long-term cost of the project. However, any such project would need to be accompanied by a strong marketing campaign, as the mine is plagued by its negative reputation, fuelled in no small part by misinformation (De Pierola, 2011). For Southern to undertake such a project, there would need to be a guarantee of positive benefits, as such, until the reputation of Southern is repaired, it remains latent.

Agriculturalists in Tacna do not benefit from the organization of the corporations, nor do they have a single service provider such as the EPS, but are represented by various water users boards and working cohorts. Hindered by a basic lack of knowledge of low-irrigation crops, and a lack of technified irrigation, the efficiency of water use is very low in Tacna – approximately 35%. De Pierola (2011) predicts that this low efficiency results in a loss of twelve cubic metres per second. An increase of only fifteen percentage points to 50% efficiency could save between two and three cubic metres every second. While this small increase would by no means solve Tacna's water supply issues, it would be a good basis for a ten to fifteen-year plan (De Pierola, 2011). The initial cost of investment in sprinklers or drip-irrigation systems, for instance, means that agriculturists in Tacna, who play a flat rate for service, would assume a short-term, one time cost increase. As mentioned earlier, and forming the very basis of this paper, a farmer does not see what she stands to gain by improving their water consumption. Agriculture, in this regard represents a latent group in water management in Tacna. No farmer in the region wants to incur costs that could jeopardize their operations without seeing a direct
Government, in Peru and worldwide, is often motivated not only by the good service of its citizens, but in the self-interest of its leaders. This self-interest leads to the paralysis of viable projects and frequent duplication of effort between rival governments. As stated by Sonia Leon, “every mayor wants his statue” (Leon, 2012a). This phenomenon, which many in Tacna call corruption, means that the government at both the provincial and regional level has consistently failed to improve the situation of water in the region. There has also been considerable banter with regard to collaboration: the last regional government, for instance, received advice and support from Southern Copper on the improvement of networks and on the drilling of wells (De Pierola, 2011). Meanwhile the present government fought to have Southern's water license revoked (“UPDATE 1-Southern Copper open to talks in Peru water dispute,” 2011), a conflict that is ongoing. Under Olson's framework, governments can be considered collective action groups when they provide a common good for their constituents, however the government in Tacna has consistently failed to provide that common good. Clague (2003) outlines the conditions in the developing world which allow such inaction to take place: even though the population of Tacna recognizes that there is a significant problem with a governments' condemnation of viable projects based solely on their generation under a former government, the public feel powerless to do anything about it. Although all campaign on a promise of more water, vanity has led the governments in Tacna to impede progress on water issues. As such, government bodies in Tacna cannot be considered a collective action group on their own.

4.2.2 The “latent” collective in Tacna

The water crisis in Tacna is a challenge that will be faced by all players in water management, regardless of their membership or status. As such, it is not appropriate to see the 'collective' in Tacna merely as a series of individual persons, but also as a series of groups, or players. While each group, such as agriculturalists and the residential sector (represented by the EPS) need to encourage water conservation at the individual level, collaboration needs to occur between all the stakeholders. Currently, the players in Tacna generally approach the water crisis as a series of individualistic entities, each blaming another for water problems. As such, the collective of players acts as though it were a latent group, imagining that there are enough entities responsible for water management that their own role is not important.

The underlying assumption of latency in collective action, however, is that a latent group is large enough that the inaction by one member would go unnoticed by others, meanwhile contributions
by one member would not significantly improve the situation for that member. In Tacna, there is a paralysis of action, with no organization wanting to undertake any significant action, or assume any cost when another organization could do it instead. A Twitter user who asked, “Why should I conserve water when all the water goes to the mine?” adequately summarized the opinion, and general state of action in the region.

### 4.2.3 Cooperation in water management in Tacna

In order to achieve a common goal the stakeholders in Tacna need to act as mutualist, or collectivist players, working towards a common good for the shared benefit of all, rather than the few. Faced with diminishing water resources, one would assume that cooperation would be inevitable to ensure mutual sustenance, however according to Hardin (1982), asymmetries in the demand for a collective good can cause the enhancement or dissipation of collaborative action – enhancement where strongest demanders can encourage collaboration or even act extra-rationally, and dissipation where the group good could be attained more easily privately. At its core, water conservation in Tacna is characterized by asymmetric returns, and thus asymmetric demand for the various players in Tacna. The value of water conservation actions for residential society is fixed when a client is using a water meter, but negligible when they receive flat-rate service. For the EPS, which does not experience cost recovery through water tariffs, the benefit might be only a decrease in the *shortfall* per unit volume of water. In agriculture and mining, the benefit will depend on the effects the conserved water will mean for the products each produces – how will modified irrigation practices affect crop yield; how will waste-water reuse affect copper purity? It is certain that proportionally, the mine stands to gain the least financial reward from water conservation, but their social and political gains through improved corporate social responsibility could lead to more opportunities for extractive industry in other regions of Peru, or in other countries. This asymmetry would discourage cooperation, perpetuating the latent state of conservation action.

Cooperation and the sharing of advantages become *necessary* in situations of scarcity (Reisman, 1990). While there has been some history of knowledge sharing between the region and Southern (De Pierola, 2011), infrastructure advice will not be sufficient to escape the more-than-decade long water crisis in Tacna. Such cooperation could be encouraged through the simple appellation of moral obligation – a strategy which which has been particularly successful in the toppling of corruption (Clague, 2003) – or through government involvement through regulation or tax redistribution. Take for instance the example of the regional government against the Toquepala expansion project. In this case,
the national government in Peru brokered a financial support package for infrastructure projects in the region – although, the local authorities remain displeased, claiming the package from Southern is little more than a tax-deductible retitling of funds that would be destined to Tacna anyway (Mello, 2012). What is the most interesting outcome from this conflict is that the money which has been granted from Southern as compromise for a perceived threat to water security has been earmarked not for water projects, but for a region hospital.

Olson provides two methods to the activation of a latent group – coercion or incentive. Incentives for environmental initiatives are typically financial rewards for sound choices. In the case of Tacna, these incentives could be financial rewards for conservation action or simple savings on a water bill or discounts on extractive licenses with inbuilt conservation conditions. On the other hand, coercion could occur in various forms, through strict rationing of water, or by means of sanctions. Olson provides three types of sanctions (summarized in: Reisman, 1990). The first is self-policing sanctions, these occur where a member of a group self-enforces their contribution because they expect others to do likewise. This strategy however, develops where there is no incentive to deviate from expected practice. In Tacna, this is not the case in the short-term. The second form of sanctioning is through social sanctions, driven by the human desire to share in society. Such sanctions might be as simple as the condemnation of careless littering in a public place, or as extreme as ex-communication for a gave offence against a family member. This individualistic sanctioning might be enough for a member of Tacna's community to improve their at-home conservation, or enough for a farmer to trial the new technology that all of his peers are installing on their own farms, but they cannot sway the giants such as Southern Copper to action. The case of the large corporations will require Olson's third sanction: legal sanctions. Legal sanctions originate in the commons, with the example of a common pasture shared by gain-maximizing herdsmen. Each herdsman will attempt to maximize his own profits by pasturing as many cattle as possible; not all can share in this infinite growth, as there will be no more room for cattle in the common pasture. Likewise not all can use as much water in Tacna as they please, as the resource is scarce and its treatment and distribution not without cost. For the large enterprises like the EPS or Southern, however, their treatment costs do not stand to increase substantially per unit volume of water. Likewise, an agriculturalist in Tacna, who pays a flat-free for untreated water for irrigation does not stand to lose anything by using more water. In both the case of Tacna and the herdsmen, legal sanctions are necessary to impose penalties for misuse of a common commodity, or for failure to achieve a common goal.
4.5.3.1 Natural coercion to action?

While coercion in Olson's logic is of the sociopolitical sort, natural resource management is particularly sensitive to the availability of the resource. If water problems in Tacna are, indeed, the result of latency, there are various forms of coercion that could be used – riots, not uncommon in Andean Latin America, could spur government to action, sanctions could impose conservation actions on the mines – in the long term, however, no group will be able to remain latent – there simply won't be enough water not to contribute to some conservation action. The dwindling glaciers and drying creeks represent a sort of natural coercion which threatens all of Tacna, not just the major decision makers and players. Whether the pressure of water scarcity will be recognized in time in Tacna, or whether it will be too little, too late has yet to be seen. While the problems have existed for over a decade, all of the players have remained latent.

5 Conclusions

This chapter will briefly summarize the arguments made in this paper and review the outlook of water management in Peru. It will also critically evaluate the thesis itself, explaining its significance, as well as who the potential beneficiaries of this study are.

5.1 A review of this paper

The physical stresses on water resources in Tacna, from its exceptionally dry climate to the disappearance of its glacial water sources, is exacerbated by a burgeoning population with variable awareness of water issues and water conservation practices. In addition, the lack of financial resources has limited the infrastructure for water treatment and transport in the region. While many authorities and players in Tacna recognize the gravity of diminishing supply and growing demand, little progress has been made in the face of the issue.

There are many actors in water management in Tacna, ranging from the EPS Tacna, a public corporation, to mining and industry. Under Olson's 1971 theory of public goods and group action, this study looked at water conservation as the public good to be provided by the various players in Tacna. This collective of action groups is composed of latent actors which provide minimal conservation action, in some cases playing only lip service to the importance of conservation. This latency occurs because there is little to no reward for conservation for many of Tacna's players.
The only way to ensure significant conservation in Tacna would be an across-the-board commitment to collaboration and the sharing of costs, however this is difficult to achieve because there are large asymmetries in the expected returns on conservation action. Southern Copper, for instance, might do little more than improve the cost-benefit ratio of its product, while the population of Tacna could experience a significant change in their lifestyle, gaining nothing – in the short term – where water meters are not used, but saving significantly on their water bills where metering has been implemented.

Olson's theory provides two tools to activate a latent group – incentive and coercion. Incentives could be appropriate in Tacna, but would likely require state-involvement through subsidies or tax breaks. Coercion, on the other hand could come in the form of three distinct types of sanctions. These sanctions, as described by Olson are self-policing by individuals in a group, which is unlikely to occur because there is little to gain from conservation action in Tacna; social sanctions, which may be somewhat effective at the population level; and legal sanctions, the necessary avenue to reach major corporations such as EPS Tacna or Southern Copper. Finally, I suggested that the scarcity of water in Tacna is a form of natural coercion, where there will be significant consequences for the population at large should they fail to ensure conservation of water in the region.

5.2 Next steps in water management in Tacna

Faced with severe physical limitations of its water supply, the authorities in Tacna have relied on social interventions while awaiting the implementation of a life-changing super-project. The EPS in particular has, for the past fourteen years focused on education as the primary solution for water scarcity, however, as previously mentioned, their projects fail to reach those outside of their service area and, as such, fail to address concerns in agriculture, industry, and in areas outside of the city of Tacna. Overall, the impact has been less than optimum and while records of demand for water from the EPS do not actually exist, demand continues to increase. It is important to note that the population in Tacna has also increased, so one cannot comment on per capita growth. While children in the city are very well educated about water conservation and practice, there has been little apparent return on the 'future investment' started over a decade ago. Even so, in the interviews conducted for this thesis, eighteen respondents still endorsed user education as the key solution to solving water issues in Tacna. While this could lead one to question whether the very respondents, professionals and educators in water-related fields in Tacna, understand the true extent of the problem, their responses have more to do with working with the available resources that they have. One respondent (Zapana, 2011), for
instance suggests a comprehensive education program addressing all levels – from in-community workshops on best practices for water in the house and a re-enforced school-level education program, to consulting for commercial firms and industry in water conservation and on-site waste-water treatment and reuse. The potential exists for a campaign to eliminate disinformation, encourage inter-institutional collaboration, and the strengthening of institutional ties.

Outside of physical projects, there is also the potential for a branding change, or at least an alternative approach to public outreach within institutions such as the EPS. When I, as an intern, tried to bring user education to new audiences via Twitter, there was heavy criticism from university-aged users who asked why the EPS would ask the population to conserve water while giving water to large mining companies. The answer was simple, as the argument was flawed – it is in fact ALA who controls licenses for extraction from water sources, something the EPS has been fighting to increase for the population. It is important to reach the 77% of respondents who said that they did not know the roles and limitations of the EPS when it came to providing water as a service. The EPS needs to expand their education and public relations to highlight its own problems. At the outreach workshops, for instance, there was a spectacular change in survey respondents who, at the start of the series of workshops had overwhelmingly critical long-answer responses, accusing the EPS of everything from overcharging to misleading users. By the end of the sessions, the long-answer responses generally praised the EPS for “work[ing] well, despite its limitations”, for instance.

There is the potential for austere water rationing in Tacna, but while it is possible, rigidity in management is often met by conflict in Latin America. There is potential for dangerous conflict in Tacna, where mining is already poorly received for its water use. There is a long history of conflict between society and mining operations over water resources in Peru; as recently as May 2011, the region of Puno saw violent protests against the entrance of a Canadian mining operation in the area (see: Baird, 2011). Drought has been shown to have significant impacts on the social and emotional health of farmers (Alston & Kent, 2004) and it is possible that as further stress is placed on water resources in Tacna, further violence and unrest will occur. Thus, in place of coercion through water rationing, the offering of incentives is recommended, however, measurement of water consumption is necessary for the provision of incentives. While some residents of Tacna do have water meters installed, frequent thefts and tampering mean that over half of the population pays a flat-rate fee for water. In agriculture, metering is also nearly non-existent. It is difficult to provide incentives for conservation action where there are no penalties for over-consumption. Most residents are not happy to
receive meters, as the cost of their water service increases. By providing a financial reward for users who consume a given amount of less, it could cause residents to want water meters installed. In addition, legal sanctions could be implemented for industrial or agricultural users who exceed socially responsible volumes of consumption.

The key to longevity in water management in Tacna will be cooperation and collaboration – not only between institutions, but between people. The society of Tacna needs to be open to new technologies or practice – advances as simple as the installation of water meters, to more complex actions such as the adoption of technified irrigation or different crop choices in agriculture. The continual presumption that one's own use of water goes unheeded by other parties leads to inaction.

5.3 Priorities for intervention in Tacna

Olson highlights the difficulty that a large group has to achieve its common good. This difficulty is a result of the high cost of organization of large groups. In addition, smaller, less bureaucratic water management organizations have been shown to be more effective than large ones (Holmes, 2000). The issues surrounding the mobilization of large groups are apparent in Tacna, where it is difficult to reach the entire region, but neighbourhood boards (juntas vecinales) have successfully mobilized neighbourhood development projects. As such, I recommend the establishment of a Tacna water working group, where representatives for each of the major stakeholders can be granted supreme bargaining power for the negotiation of conservation alliances and concessions for the attainment of conservation action in Tacna. This working group would be representative of the entire region, allowing for the open discourse between all players in a collaborative, and transparent matter. By allowing all players equal representation, misinformation can be avoided and positions can be defended by the respective groups.

If I were to recommend immediate investment, I believe that there is the potential for the highest-impact changes in agriculture. Simple changes such as education regarding the use of higher-value, drought resistant plants such as oregano in place of alfalfa (De Pierola, 2011) can help diminish demand for irrigation water. In addition, the use of high efficiency irrigation systems, such as sprinklers, or drip-irrigation, or even Inca-inspired irrigation terraces could account for high increases in efficiency. It is important to note however, that the often-untreated irrigation water often carried high amounts of trash onto the fields of farmers and could potentially damage irrigation technologies. Such advances, then, might require the accompaniment of improved transport – pipes instead of canals – or at least macro-pore filtration. Finally, the metering of agricultural water use would allow for the
establishment of a government-subsidized incentives program for farmers who use less water. As mentioned previously in this paper, a fifteen percent increase in agricultural water efficiency could save two to three cubic meters of water a second (De Pierola, 2011), increases above this are both possible and desirable. The onus would be on the regional government, in partnership with the ministry of agriculture to implement such a program in coordination with users' boards.

5.4 An alternative future for water management in Peru

In March 2012, well into the process of writing this paper, I had the opportunity to participate in a South-North Unintera mission, during which time I accompanied Sonia Leon, the general manager of ANEPSSA Peru, to meetings and tours of various water treatment agencies and installations in Southern Ontario. While there is still great speculation about the future of water in Peru, the government of Peru is expected to move (back) towards a model of centralized service provision. There are rumours that the government intends to create a sole national utility, with 24 departmental sub-utilities, in place of the fifty EPSs and various unregulated small service providers that exist today (Leon, 2012). The end goal of the process would be to encourage private sector investment in the larger, department-sized services. Investment will not only come from outside sources, however. In fact, the current government of Ollanta Humala has pledged to invest millions into the treatment of wastewater projects and the government has opened bidding for a few water treatment utilities including in Lima and Arequipa – the first- and second-largest cities in Peru. The frequent restructuring of water in Peru has caused various changes in roles and laws surrounding water management. While it remains unclear what the future of water in Peru will be new laws should include water conservation and collaboration as primary foci.

5.5 The importance of this study

While critical, this study was by no means meant as a condemnation of the people of Peru, nor of the interactions between institutions in the region. Indeed, under Olson's assumption of rational, self-interested actors, no party is doing anything out of the ordinary in Peru. Instead, this paper was meant to serve as an exploration of inaction, the conditions that lead to inaction in the face of impending problems, and the facilitation of cooperation between players, with the goal to explore how to address water shortages in a politics of scarcity. It has also tried to offer short- to medium-term solutions to water scarcity issues in place of the unlikely arrival of a super-project solution to supply issues.

Primarily, this paper has made a novel, albeit small, contribution to the theory of collective
action by examining issues of community mobilization and water management through the lens of Mancur Olson's cornerstone 1971 work, *The logic of collective action: public goods and the theory of groups*. This paper has therefore, made a contribution to the academic literature.

For more practical uses, this paper will serve as a tool for policy-makers regarding the potential options for discussion, distribution, and, in extreme cases, sanctions to encourage or ensure the collaboration of major players for the resolution of development issues. In particular, this paper is meant to serve the authorities at both the national and regional level in Tacna, Peru as a third-party review of the current situation in Tacna, and relationships and action therein. Tacna, however, represents a very dire case study and the lessons learned there will be widely applicable to other areas of resource stress and conflict. This paper, therefore, is not limited to developing-country leadership, but globally applicable to any situation where public and private institutions share a common goal, but fail to find an avenue to collaboration.

I hope that this paper will be of use to the various players in Tacna, allowing them to analyze their role in water conservation in the region and develop strategies for the future. While there can be no black and white solution to any problem in nature, this paper can serve as a reflection piece for those who deal with water, allowing them to assess their inter-institutional relationships, opportunities for collaboration, and alliances between players in the region.

This study will also be useful for NGOs and organizations like WUSC/Uniterra, particularly those with an educational focus. The study provides a basis for curriculum development regarding shared responsibility, collective action and conservation in general. In Tacna in particular, there needs to be a shift away from a culture of blame, with an educational emphasis on the reinforcement of the universality of water issues and the encouragement of community action not as an obligation, but as a service to one's community.

This paper also provides a resource for the people of Tacna in general. It will serve as a reminder of the situation in Tacna, the sorts of decisions they will face as a society, and their responsibility to hold their authorities to account on water issues. By providing a panorama of water issues in Tacna, the people in the region can be better informed and empowered in water advocacy and conservation.

5.6 The end of this study

This study is the result of nearly two years of work and five years of scholarship at the University of Toronto Scarborough. It has helped me to hone my research skills while learning about
useful research tools and strategies. It is widely recognized by people involved with the IDS co-op program that the eight- to twelve-month work placement we students undertake is as much a learning experience for us as it is for the communities we impact. It is my sincere hope that this final product can dignify those who were so helpful in my research, my friends, and my fellow Tacneños. ¡Que viva Tacna! ¡Que viva Perú!
Works Cited


Appendices

Appendix 1: Map of Study Area

Map of the Department of Tacna (pink highlight) showing subdivision into four provinces. This study encompasses the entire region, with a specific focus on the province of Tacna to the south of the department and the city of Tacna, the small urban area in the centre of the province. Original source: http://maps.google.ca/
**Appendix 2: Survey Questions**

The following survey was distributed to the attendees of EPS outreach workshops and used as a basis for the analysis in this paper. An online version is available at the following link: [goo.gl/bQCph](http://goo.gl/bQCph)

<table>
<thead>
<tr>
<th>Original Question</th>
<th>English Translation</th>
<th>Best Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>¿Creer yque hay mucha agua dulce en el planeta?</td>
<td>Do you believe that there is much freshwater on the planet?</td>
<td>NO</td>
</tr>
<tr>
<td>¿Creer yque existe en el planeta gente que muere por falda de agua?</td>
<td>Do you believe that there exist on this planet, people that die for lack of water?</td>
<td>YES</td>
</tr>
<tr>
<td>¿Creer yque Tacna tiene suficiente agua para los proximos anos?</td>
<td>Do you believe the Tacna has enough water for the coming years?</td>
<td>NO</td>
</tr>
<tr>
<td>¿Sabia yque Tacna esta en emergencia hidrica?</td>
<td>Did you know that Tacna is in a state of hydrological emergency?</td>
<td>YES</td>
</tr>
<tr>
<td>¿Ud. conoce el proceso de potabilizacion del agua?</td>
<td>Do you know the water treatment process?</td>
<td>YES</td>
</tr>
<tr>
<td>¿Has visitado una vez la planta de tratamiento de agua potable?</td>
<td>Have you visited the water treatment plant?</td>
<td>YES</td>
</tr>
<tr>
<td>¿Ud. conoce el verdadero rol del medidor?</td>
<td>Do you know the true function of the water meter?</td>
<td>YES</td>
</tr>
<tr>
<td>¿Ud. Entiende la factura de agua?</td>
<td>Do you understand your water bill?</td>
<td>YES</td>
</tr>
<tr>
<td>¿Sabe Ud. que al ahorrar el agua en su casa ahorra tambien su dinero?</td>
<td>Do you know that by saving water in your house you are also saving money?</td>
<td>YES</td>
</tr>
<tr>
<td>Conoce Ud. sus obligaciones como usuario de agua?</td>
<td>Do you know your responsibilities as a client of the EPS¹?</td>
<td>YES</td>
</tr>
<tr>
<td>¿Creer yque es el deber de la EPS Tacna cuidar el agua, o tambien es su responsabilidad?</td>
<td>Do you believe that it is the duty of EPS Tacna to conserve water, or is it also your responsibility?</td>
<td>NO</td>
</tr>
<tr>
<td>Conoce Ud. las obligaciones de la EPS y sus limitaciones?</td>
<td>Do you know the responsibilities and limitations of the EPS?</td>
<td>YES</td>
</tr>
<tr>
<td>¿Creer poder comprometerse con nosotros sobre el tema del cuidado del agua?</td>
<td>Would you be willing to cooperate with us with regard to conserving water?</td>
<td>YES</td>
</tr>
<tr>
<td>¿Creer yque va aprender sobre el agua?</td>
<td>Do you believe that you will learn about water?</td>
<td>YES</td>
</tr>
<tr>
<td>Uno de nuestros voluntarios Canadienses esta trabajando en un proyect de investigacion sobre la sostenibilidad del agua en el Perú para su tesis universitaria. ¿Ud. Nos permite utilizar sus respuestas para esta tesis?</td>
<td>One of our Canadian volunteers is working on a research project regarding the sustainability of water in Peru for his university thesis. Do you permit us to use your responses for this thesis?</td>
<td>MUST BE YES</td>
</tr>
<tr>
<td>¿Que piensa Ud. de la EPS?</td>
<td>What do you think about the EPS?</td>
<td>N/A</td>
</tr>
</tbody>
</table>

¹: Empresa Prestador de Servicios de Saneamiento Tacna S.A. (The water treatment utility in Tacna, Peru)
Appendix 3: Interview Questions

The following are sample questions used during interviews. While most of the questions were used, they were modified and conversations deviated significantly from the below.

<table>
<thead>
<tr>
<th>Original Question</th>
<th>English Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>¿Puede comentar sobre la situación actual del agua en Tacna?</td>
<td>Please comment on the current situation of water in Tacna.</td>
</tr>
<tr>
<td>¿Qué factores contribuyen más a la escasez actual de agua en Tacna?</td>
<td>What factors contribute most to the current water scarcity in Tacna?</td>
</tr>
<tr>
<td>¿Qué impacto tiene Ud. o su organización en el gestión, disponibilidad, etc. del agua en Tacna?</td>
<td>What impact do you, or your organization, have in the management, availability etc. of water in Tacna?</td>
</tr>
<tr>
<td>¿Cuáles son sus expectativas para los próximos... cinco años? ... diez años?</td>
<td>What are your expectations for the next five years? ... ten years?</td>
</tr>
<tr>
<td>¿Qué cambios son necesarios para garantizar que Tacna pueda tener suficiente agua en los próximos años?</td>
<td>What changes are necessary to guarantee the Tacna will have enough water in the coming years?</td>
</tr>
<tr>
<td>¿En qué soluciones (si las hay) está trabajando Ud. (o su organización) actualmente?</td>
<td>What solutions, if any, are you currently working on?</td>
</tr>
<tr>
<td>¿Qué necesita Ud. para avanzar con esta solución?</td>
<td>What do you need to advance with this solution?</td>
</tr>
<tr>
<td>¿Cualquier otro comentario?</td>
<td>Any other comments?</td>
</tr>
</tbody>
</table>

A digital version of the interview was also delivered as a web-form, and is available here:
googl/uAOUI