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Water Access and Security for Mongolian Peri-Urban Communities in the Face of Climate Change and Development

Heather Cook
SIT Study Abroad

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Cook, Heather
Academic Director: Sanjasuren, Ulziijargal
Project Advisor: Bayasgalan, Onon
University of Denver
International Studies and Environmental Science
Ulaanbaatar, Mongolia

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Abstract

The paper attempts to assess how water access and security in Mongolian ger districts is impacted by the competing forces of climate change and development. The development of Mongolia is, understandably, a priority of the government and much of the populace, as are the impacts of climate change, which are well documented and acknowledged. Furthermore, these processes both have potentially adverse impacts on the overall well being of communities. In the context of water access and security, the need to strike this balance becomes even more acute. These factors can all be seen playing out in the city of Sainshand, in Dornogovi *aimag,* in the South Gobi. Finding this balance defines the overarching theme of the paper, and the following questions will be asked in an attempt to begin to understand how best to integrate these interests for more successful water management overall in the context of Sainshand and its ger districts – What are people's current water-related needs and concerns and are those being adequately addressed? Has there been any change seen in water access and water resource allocation in recent years? What are the existing plans for adaptation in the face of climate change and development and how are those plans being implemented? While water access is generally acceptable for ger district dwellers, issues still remain, and despite the very recent passage of a water security plan for Dornogovi *aimag*, there is still much that can and should be done to ensure sustainable water access and security. These issues are created by, namely, gaps in data created by lack of research and a high division of responsibility in regards to water resource management, both at the *aimag* level, and a lack of community participation in key decision-making.

Key Terms

Aimag: The largest administrative unit in the country. Similar to a province, the country is divided into 21 *aimags*, plus Ulaanbaatar.

Aimag center: The primary city of each *aimag*.

Soum: Aimags are divided further into these small administrative units, similar to counties. There are over 300 *soums* in Mongolia.

Ger: Traditional dwelling of the nomadic Mongolian herder; circular in shape and covered in felt.

Ger district: The sprawling districts, or neighborhoods, popping up in various cities around Mongolia as families migrate from the countryside to more urban areas; characterized by the *gers* that make up much of the district.

Ulaanbaatar: The capital of Mongolia, home to just under half of the country's population. Although it is located within the borders of *Tov aimag,* it is not under it's administration.

Dornogovi: An *aimag* located in southeastern Mongolia, it is a part of the Southern Gobi.

Sainshand: The *aimag center* of *Dornogovi,* home to approximately 15,000 people.

Climate change: Defined by the IPCC as, "A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer." Can be due to either natural processes or anthropogenic causes.

Desertification: Land degradation resulting from both climatic variations and human activities.

Zegeen Hotol: The primary water source for the municipality of *Sainshand*. Provides the majority of water for the city's citizens.

Eoxil: A second important water source for the municipality of *Sainshand*.

Bor Horoov: An underground water resource in *Dornogovi,* currently being explored as a future water resource.

Tugrug: The currency denomination used by Mongolia.

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Introduction

In recent years, steps have been taken by the government to improve water access for ger districts and to prioritize better water management and water security in Mongolia. The question of how best to ensure future water access and security in the face of climate change adaptation and encroaching development, however, has yet to be answered. While at national level the percentage of freshwater resources withdrawn is very low (1.5 percent), in several regions potential over-exploitation of water resources, as well as inadequate water supply and sanitation services, are major issues faced by Mongolia. The main causes for these are rapid urbanization, climate change and increased mining activity, along with immature policy and water resource management systems ("Mongolia: Un water country brief," 2013). By balancing these competing interests of adaptation, development, and local needs, long-term and sustainable water security for all stakeholders can be ensured. Striking this balance defines the overarching theme of the paper, and the following questions will be asked in an attempt to begin to understand how best to integrate these interests for more successful water management overall – What are people's current water-related needs and concerns and are those being adequately addressed? Has there been any change seen in water access and water resource allocation in recent years? What are the existing plans for adaptation in the face of climate change and development and how are those plans being implemented?

Mongolia: demographics and geography

Mongolia, a land-locked country located on the Asiatic continent, is bordered by China to the south and Russia to the north. At 1,565,000 square kilometers it is the 7th largest country in terms of area. At the same time, a population of just under three million makes Mongolia one of the most sparsely populated countries in the world. The landscape is characterized by the prairie-like steppe that stretches through much of the central and eastern parts of the country. Mountain ranges can be found in the north and west, while much of the south is made up of the well-known Gobi desert (Dagvadorj, Natsagdorj, Dorjpurev, & Namkhainyam, 2009). Its continental location makes Mongolia a land of climatic extremes, with temperatures dipping as low as minus 30 degrees Celsius in January, the coldest month of the year, and as high as 40 degrees Celsius in July (Bhayankaram, 2011).

Water in Mongolia

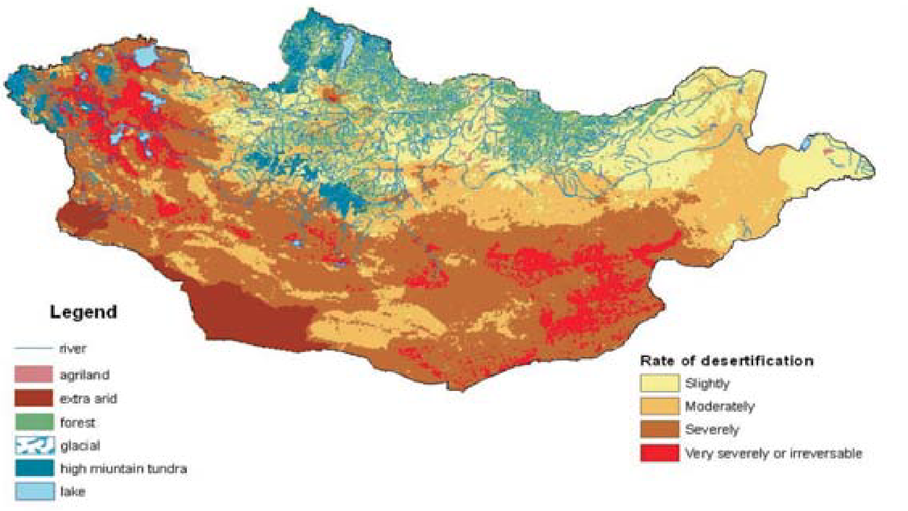
As of 2009, there were approximately 608.3 cubic kilometers of water in Mongolia. Of this amount, 500 cubic kilometers were in lakes, 63 were “locked up” in mountains, and 34.6 were underground. Mongolia, it is important to note, is one of 60 countries with limited water resources (Batimaa, Myagmarjav, Batnasan. Jadambaa, & Khishigsure, 2011). Additionally, the country’s already limited water supplies are unevenly distributed, as described by the “70-30” water distribution paradox, where 70% of the country’s water resources are held in only 30% of the country. Lake Khovsgol, for example, the second largest freshwater lake in the world, holds 68% of all of Mongolia’s lake water (Dagvadorj et al 2009). It should come as no surprise, then, that many places around the country rely on groundwater as their primary water source, especially in the more arid stretches of the country. This creates a reliance on groundwater for much of the country, one that is arguably unsustainable, as 80 percent of water consumption is drawn from groundwater, yet the renewable groundwater makes up only a fraction (approximately 10.8 cubic kilometers) of total water resources (Basandorj & Altanzagas, 2008). While most groundwater is thought to be renewable, in that the source can be recharged or replenished through natural processes, this replenishment can be cut off through geological events or climatic changes. These groundwater sources are then referred to as “fossil” or “nonrenewable” aquifers. According to Tuinhof and Nemer (2010), these non-renewable aquifers can be described in two ways, quantitatively and qualitatively. Quantitatively, “non-renewable” refers to fresh groundwater that is not replenished and results in a “continued decline of the water level (both pumping well and regionally).” Qualitatively, “non-renewable” refers to fresh groundwater that is at least partly replenished by brackish or saline water, resulting in overall lower water quality and higher salinity. Groundwater is the main source of water in the South Gobi region, and almost all of this groundwater is “fossil,” in that it receives little or no recharge. Its only replenishment comes from limited rainfall that averages between 115-150 millimeters per year. Of that precipitation, recharge is estimated to be only one millimeter per year (Tuinhof & Nemer, 2010).

Climate Change in Mongolia

Recent records show that climate change has been impacting Mongolia and will continue to do so for the foreseeable future. Countrywide, there has been a temperature increase of 2.14 degrees, almost three times the global average. While precipitation in some parts of the country, namely the Altai Gobi and the east, have seen increases in precipitation, all other parts of the country have seen decreases in precipitation. In a year, Mongolia's average annual precipitation is about 300-400mm. The Gobi region, at about 41.3% of total land in the country, sees approximately 50-100mm of precipitation each year. Additionally, as temperatures increase, the potential evapotranspiration is much higher, impacting surface water (Dagvadorj et al. 2009).

Desertification is another major climate issue facing much of Mongolia. The UN Convention to Combat Desertification defines the process as, "land degradation in arid, semi-arid and sub-humid areas resulting from various factors including climatic variations and human activities… It affects terrestrial areas (topsoil, earth, groundwater reserves, surface run-off), animal and plant populations, as well as human settlements and their amenities (for instance, terraces and dams)" ("Desertification as a global problem" 2001). While desertification is not caused solely by climate change, the effects of it can certainly exacerbate the problem of desertification. According to the Institute of Geo-Ecology, 78.2% of land in Mongolia has been affected by a middle to high rate of desertification (Dagvadorj et al. 2009). Within the South Gobi, where Dornogovi is located, some of the desertification occurring is so severe as to be irreversible (see Figure 1).

Figure 1: Map showing the rates of desertification within Mongolia.



Source: Mongolia Assessment Report on Climate Change, 2009

Climate change will have effects on most aspects of water resources in Mongolia, including surface water, precipitation, evaporation, temperature, and river runoff (Batimaa, et. al, 2008). Additionally, in arid and semi-arid regions, like Sainshand, aggravated desertification, salinization of water, and poorer water quality are all poised to become major problems (Dagvadorj, 2010). Since 2003, there has been a 30% increase in the number of dried-up streams, rivers, and lakes. In terms of groundwater and groundwater recharge, the effects of climate change have not been fully assessed, it is "inadequately known." In general, groundwater may be affected by precipitation, evaporation, and temperature changes, soil properties, and urbanization (Batimaa, et. al, 2008). "Fossil" groundwater resources, however, will not be affected by climate change as they are trapped in deep layers and not affected by changes in recharge or replenishment (Tuinhof & Nemer, 2010).

Development in Mongolia

Industry is the biggest user of water at 39.3%, followed by animal husbandry at 24%, irrigation and agriculture at 17.4%, and domestic needs (including drinking water) at 18.1%. The main water use is mining, and the majority of this water demand is for processing of the raw material (Basandorj & Altanzagas, 2008). Several water-related issues result from industrial activities. First, mining activities have been found to lead to mercury, cyanide, and arsenic pollution of the air, water, and soil (Tsogtbaatar, et. al, 2009). Second, urbanization and development has helped lead to an overall increase in the consumption and demand of water, which can put pressure on already limited resources. Third, one study found that for every 1,000 liters of water used, those in ger districts pay up to 84 times more than industry users, indicating price discrepancies for those in ger districts (Basandorj & Altanzagas, 2008).

Water Security

Safe, clean, and accessible water is a human right. Mongolia's 2008 Human Development Report stated that water security is "about ensuring that every person has reliable access to enough safe water at an affordable price to lead a healthy, dignified and productive life, while maintaining the ecological systems that provide water and also depend on water" (Bhayankaram, 2008). The first national household water use survey was conducted in 2004, and in 2006 it was found that only 39.2% of the population used improved drinking water, a number which is 20% lower than the global average (Basandorj & Altanzagas, 2008). On a national level, 31% of the country's population receives their water from a tap, 25% from a tank, and 36% from wells (Dagvadorj, 2010). Several indicators can be used to assess water access and security according to international standards. While these indicators set minimum parameters, they are also liable to change based on various climatic, cultural, and situational factors. They include an average of 15 liters of water per person per day for cooking, drinking, and personal hygiene, a maximum distance of 500 meters from the household to the nearest water source, a wait time of no more than 15 minutes at a water source, and "water sources and systems [that] are maintained such that appropriate quantities of water are available consistently or on a regular basis" ("Chapter two: minimum" 2004).

The United Nations Water Agency Country Brief on Mongolia provides an introduction to the recent and current state of water access and security in Mongolia. First, data for the period between 1990 and 2010 shows an overall increase in the use of improved drinking water, from 54% to 82%. Relative improvement has been achieved in rural areas, but these parts of the country are still significantly less likely to get water from an improved source. As for sanitation, there has been improvement in the use of improved sanitation facilities, but there remains a gap in the overall coverage of water and sanitation services. The national water quality index for 2010 gives a rating of 70.1/100. This rating indicates targets have been met for pH, conductivity, total nitrogen, and total phosphorous. In terms of wastewater treatment, data shows that all wastewater in Ulaanbaatar goes through secondary treatment. No data, however, is available for other regions. Finally, Mongolia is not on-track to achieve Millenium Development Goals targets in water supply and sanitation due to "lack of leadership and coordination, comprehensive planning and financial strategies, monitoring and regulatory control, and low institutional capacity and skills" ("Mongolia: Un water country brief," 2013).

Governance

On an international level, Mongolia has joined 14 environmentally related United Nation Convention treaties (Dagvadorj et al. 2009). In 2011, the Government of Mongolia published the second National Action Program on Climate Change. It sought to ensure environmental sustainability, reduce greenhouse gas emissions, and "establish a foundation for green economic growth and development" (Dagvadorj, 2010). The "most effective method" of adapting to climate change and water-related issues is the "formulation and stabilization of water resource management policy" (Dagvadorj et al. 2009). Water infrastructure investment has accelerated since 2005 ("Mongolia: UN water country brief" 2013). Between 2002-2010, 2.1% of government expenditures were water-related. Following the adoption of the National

Program on Sanitation in 2005, government expenditures dedicated to drinking water supply and sanitation peaked in 2007 and 2008. Additionally, water resources policy and management received increased attention in 2008 and 2010 ("Mongolia: UN water country brief" 2013).

Sainshand in context

Sainshand, the *aimag center*, or main city, of Dornogovi *aimag*, is located in the southeast of the country, in the South Gobi region of Mongolia. There are 50,000 people in Dornogovi, 15,000 people in Sainshand, and 10,000 people living in the ger districts of Sainshand. Much of the land is desert-steppe. The steppe and Gobi regions of Mongolia, which make up 69% of the total land area, lack a surface water network, and demand is mostly supplied by groundwater (Basandorj, Dalai, & Ganzorig, 2008). At least two projects are currently being explored for the potential to provide Sainshand and the surrounding areas with additional water sources. The Herlen-Gobi Project aims to divert water from the Herlen River and transport it by pipe 540 kilometers, to supply parts of Hentii, Tov, and Dornogovi *aimag* with high quality, potable water. A similar pipeline, the Orhon-Gobi River Project, supplies Oyu Tolgoi and Tavan Tolgoi, two of the biggest mining projects in Mongolia, with water. The second project being explored centers around the Bor Hovoor aquifer, located in Dornogovi. This groundwater source covers an area of 780 square kilometers, at a depth of up to 50 meters, and has the potential to provide up to 500 liters of water per second (Basandorj et al. 2008). This region of the country is known as a "continental saline zone," in that a high percentage of minerals and hardness can be found in much of the water (Basandorj et al. 2008). In Dornogovi *aimag* specifically, water quality problems include high concentrations of fluoride and arsenic (Basandorj & Altanzagas, 2008).

Any discussion of water resources in Sainshand, Dornogovi, and the Gobi region at large centers around groundwater. To that end, an important report, published by the World Bank in 2010, assesses groundwater for the South Gobi region in terms of its quantity, quality, and future management. The study found that estimated current water demand for the area is 80,000 cubic meters per day and expected to rise to 400,000-450,000 cubic meters per day by 2020. A hydrogeological survey done in Dornogovi identified 16 exploitable groundwater resources, yet there is still little known of the long-term sustainability of groundwater resources. Some of the available groundwater is only "partially renewable through recharge of rainwater," while the remainder are deep aquifers with fossil water. The study stated that the "only possible sustainable alternative" is the aforementioned Herlen-Gobi pipeline, but that requires extensive impact assessments. Finally, the study concluded that there is "sufficient" water to meet the short-term needs for economic development over the next 10 to 12 years, and that groundwater will remain the sole water resource for the area during this time (Tuinhof & Nemer, 2010).

Methods

For this project, the main methods of data collection included surveys passed in Sainshand, Dornogovi, water kiosk attendant interviews in Sainshand, and government and company official interviews in Sainshand and Ulaanbaatar. Fifty-four surveys were completed, and all were used in the final report. The surveys asked for details on household water use, as well as on the survey-taker's daily water commute. The survey contained 20 questions, including how much water was used daily, how long it took to get water, how far away the water source is, etc. Also included were several question asking about the participant's level of satisfaction with the water source and quality. Finally, the participants were asked to list any concerns they might have regarding the issues of future water access, climate change, and development. Several questions regarding cost of water, difficulties in collecting water, and future concerns were added to the survey upon arrival in Sainshand, in part because of suggestions made by the local translator. Surveys were written in Mongolian and answers translated to English. The primary goals of the survey were three-fold: first, to understand general daily water use and needs for ger-district families, second, to pinpoint any current issues or concerns people have with the way water is currently supplied, and third, to understand if people have concerns for the future in regard to water access, and if so, those concerns are. For the complete survey, in both English and Mongolian, see Appendices 2.1 and 2.2.

The second method of data collection focused on the kiosk employees. A questionnaire was developed and used to interview the attendants for each of the kiosks. The interview consisted of ten to thirteen questions, depending on whether the kiosk was supplied with water by pipe or by truck. Seven of the kiosks visited received piped water and six of the kiosks visited received water by truck delivery. Questions sought to understand how much water kiosks supplied, who they supplied water to, and any problems or issues that might currently exist in supplying water. Interviews were conducted using a translator. For the complete questionnaire and answers given, please see Appendices 1.1 and 1.2. The third method of data collection consisted of interviews with government and water company officials in Sainshand and Ulaanbaatar. These interviews primarily sought to understand the water management and supply structures currently in place at the municipal level and *aimag* level, as well as to assess adaptation plans for future changes in water supply and demand. A translator was used, and there was no strict list of questions for the interview to follow.

One week was spent in Sainshand, for a total of five working days. Three and a half days were spent interviewing various government and water company officials, for a total of ten interviews. Interviewees included representatives of the environmental department, the development department, the health department, two local water companies, the professional control office, and the meteorological office. Interviews generally ran between 30 minutes and an hour. The last day and a half was spent interviewing kiosk attendants and distributing surveys. Of the fourteen kiosks visited, thirteen questionnaire interviews were conducted. About ten to 25 minutes was spent on each kiosk visit, giving enough time to interview the attendant and distribute surveys to any customers present. An additional eight surveys were filled out by local market employees, and sixteen were filled out by university students at the local medical college. Each survey participant lived in a ger district and received water from a kiosk. Surveys took approximately five to seven minutes to complete.

The two biggest limitations to this project were lack of time and language barriers. First, a research period of three weeks is a very short time in which to tackle a topic as far-reaching as water access and security. Even at a localized level, water security involves a number of actors and stakeholders, including environmental, public health, and engineering experts, water suppliers, and, of course, the local community. The research topic is an interdisciplinary one and it is difficult, if not impossible, to touch on every desired point and to be as thorough as might be wished within the scope of the project. Because of time constraints on the part of both the interviewer, the interviewee, and even the translator, interviews could not always last for as long of a time as might be desired by the researcher. This was especially true in Sainshand, where data collection lasted five days. In the future, it might be beneficial to add a few days onto the project, so that more leeway can be made in scheduling follow-up interviews and accommodating interviewee's schedule. Furthermore, it might prove helpful, if time allows, to translate surveys and begin the preliminary analyzing of data while still conducting fieldwork, in order to assess trends earlier and conduct appropriate follow-ups. In addition, the decision was made to limit research to Sainshand, as opposed to studying multiple cities, because of the interdisciplinary nature of the project. The researcher hoped to make as clear and specific a picture as possible of one case study and how that case study might be impacted by climate change and development, as opposed to a more broad comparison of multiple locations. For this reason, 18 surveys distributed and collected in Ulaanbaatar were not used in the final project.

Second, limitations arise anytime a language barrier exists. While in Sainshand, a translator was needed for all interviews and interactions with locals. While the researcher and the translator worked closely together to review the questions and appropriate vocabulary, lack of familiarity with the research topic left a high risk of losing many nuances and subtleties in conversations and interviews. While this can be overcome by simply bringing along a more experienced translator, the fieldwork process moved along much more smoothly when working with a local translator who knew the area. By using a recording device and sitting down with the translator to go over all interviews and conversations a second time, important clarifications can be made and more accurate information gleaned from all encounters.

Data and results

Kiosk attendant questionnaire

There are sixteen kiosks, overseen by Chandman Company, that serve the ger districts of Sainshand. Ten of these kiosks are connected to the main system and they have water piped to them continuously. Six of the kiosks are not connected to the main system. Instead, they have a large tank, which is filled with water trucked out by Chandman Company. According to one kiosk attendant interviewed, the truck holds up to five tons of water and the tanks hold up to 10 tons.

Figure 3: Ger district kiosk that sells piped water.

There is no existing map of the wells and kiosks of Sainshand, and they can be difficult to spot at times, as they are usually small, nondescript concrete buildings. The only markers are the black hose that snakes out of the side, which customers use to fill their containers, as well as the small blue Chandman Company sign nailed to the building that tells the kiosk's number and the hours of operation. Inside of each kiosk sits an attendant. Their duties include controlling the flow of water and taking money from customers. All of the attendants interviewed were women, ranging in age from early thirties to past retirement. The work is not considered to be physically demanding and is therefore considered to be "women's work," according to one kiosk attendant. One man was interviewed – he was acting as a substitute for the regular attendant, who was out. Each kiosk has a chair for the attendant, as well as a small stove used to the heat the station. If the kiosk is supplied by pipe, then there is a small stand jutting out from the ground, with dials the attendants use to control the water. If the kiosk is supplied by truck, then the building includes a large metal tank used to hold the water, a small stove, and a chair. These kiosks are typically colder inside because of the tank of water, which makes the building difficult to heat. One truck-supplied kiosk visited was very smoky inside because of the coal burning in the stove. Pipe-supplied kiosks are usually smaller, with no tank of water, and therefore much easier to heat. Most stations have some addition meant to personalize the space, including rugs, pictures, and reading material. One station attendant had a bowl of candy ready for visitors, and offered us a piece when we entered. Another station attendant had hung a large poster of an ocean and an island on the wall. In the wall of the station, above the hose, is a small glass window, through which the attendant makes transactions. The stations do not have electricity, which means that most stations have no source of light, forcing them to close once it's dark.

Figure 4: The inside of a kiosk that distributes water via tank. To the left is the small stove, meant to keep the kiosk warm.

Of the fourteen kiosks visited, seven were supplied by piped water and six by truck. Thirteen interviews were given. One of the kiosks had no attendant in the station. It was learned from a passerby that the attendant lived quite close to the kiosk, and apparently there were few enough customers that if they needed water, they simply had to call the attendant. Two of the other kiosks were not manned by their regular workers. There were substitutes who knew the attendants and were filling in, so they did not necessarily have the knowledge/experience to answer all of the questions.

All kiosks operate between the hours of 9:00 am and 6:00 p.m. with a two-hour lunch break between 1:00 and 3:00 p.m. Kiosks remain open Tuesdays, Wednesdays, Fridays, Saturdays, and Sundays. All kiosks are closed Mondays and Thursdays. These were the days with reportedly the fewest numbers of customers, so the decision was made to close all kiosks on these days, giving the attendants two days off during the week. Attendants reported working at their kiosks for anywhere from three months to 15 years, for an average of 7.23 years. Kiosks provided water for an average of 98.4 families, or 323.8 people. One kiosk attendant reported serving 300 families, or 1,200 people. According to the interviewee, many people have moved to the area from the countryside since last year, increasing the number of customers the kiosk serves. Kiosks receiving piped water reported serving, on average, 56.6 customers everyday, while kiosks receiving trucked water reported serving an average of 28 customers everyday. Additionally, four interviewees reported seeing an increase of customers on weekends, and one interviewee reported seeing more customers on the days after the kiosk is closed, Tuesdays and Fridays. When averaged, the tank kiosks reportedly sell less water than the piped kiosks on a daily basis, but more water during the week overall. This discrepancy may arise from the fact that these numbers are approximations, not exact figures, and because estimations could not be collected from every kiosk. Additionally, a discrepancy may

Figure 5: Above, the small carts used to transport water jugs to and from the kiosk and the home.

be present because the number of customers tends to increase on the weekends, which is not necessarily present in the figures below.

Figure 6: Average amount of water sold every day and every week by the kiosks that receive piped water and the kiosks that receive water by truck.

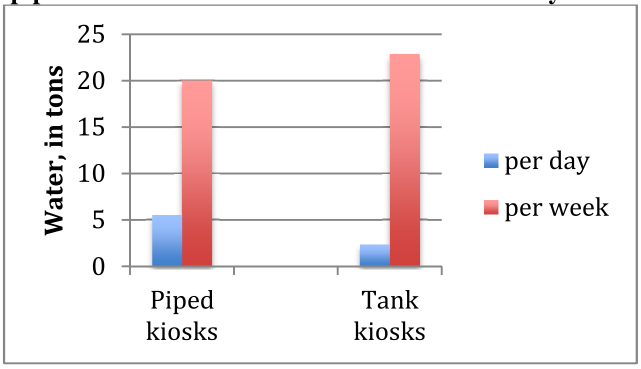


Table 1: Amount of water reportedly sold by each kiosk every day and every week.

Piped kiosks		Tank kiosks	
per day	per week	per day	per week
3.5-4.0	27	5.0-7.0	22
4	20	2	15-20
5	# not available	1	5.0-7.0
10	27-40	4.5	31.5
7.0-8.0	50-60	2	15
3	12	# not available	# not available
3.0-5.0	21		

Of the seven piped kiosk attendants interviewed, five reported no issues with water supply delivery, and one reported that government officials had come to test the water at that kiosk twice before. Two of the piped kiosk attendants reported that broken pipes occasionally disrupted water supply. The frequency with which this happens is between four times a year and once a month and increases during the cold winter months. Damages last between one and four hours, which can cause a delay for customers. One attendant reported that any damages are reported by the local media and that some people save water, minimizing the problems cause by this type of breakage. Answers for the tank kiosks differed slightly. Of the five attendants who answered the question, two reported no issues with truck delivery. Three attendants reported occasional delays when the truck was busy or broken. Additionally, there is one water delivery truck working for the company, and if the truck is busy supplying another kiosk, there is a delay there as well. It takes 40 minutes to deliver water to one kiosk, delays can create a wait of 40 minutes to one hour or more. If the truck is broken, there may a delay of up to one day. Delays are more common on the weekend, when there are more customers, more water is sold, and the truck is busier.

Household water survey

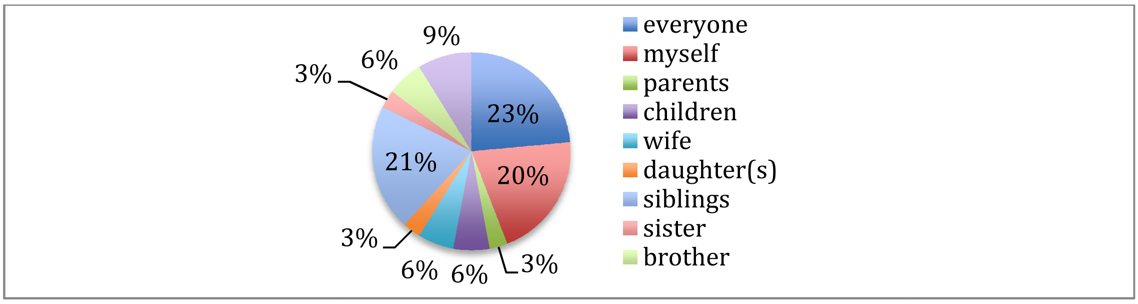
The average daily water use reported by survey takers fell between 31.74 - 34.81 liters per day. With an average family size of 3.86, this amounts to about 8.20 – 8.99 liters of water per person per day. Respondents must travel an average of 135.83 meters to reach their closest water source, although four survey-takers reported having to travel up to one kilometer, and one survey-taker reported having to travel two kilometers to reach their closest water source. Additionally, seventeen survey-takers categorized their closest water source as being "nearby" and one person categorized their closest water source as being "far." In terms of who is responsible for getting the water, most survey-takers listed, "everyone," followed by "siblings." When asked to list what their water is used for, most survey-takers reported using their water for food, followed by cleaning, drinking and making tea, laundry, and watering their trees or flowers. Fourteen respondents noted they use water for "everything." Finally, most respondents reported needing to purchase water either two to three times a week or once a day. Two survey-takers wrote that it took them between thirty minutes and one hour to purchase water.

Table 2: Daily water as reported by survey respondents.

Average family size	3.87
Water used everyday, in liters	31.74 - 34.81
Distance traveled to get water, in meters	135.83
Water uses (# times listed)*	food (36); cleaning (23); everything (14); watering trees, flowers (2); drinking/making tea (7); laundry (7)
How often water must be purchased (# times listed)	twice/day (3); once/day (11); two-three times/week (9); three-four times/week (4); once/week (3)

**question could contain multiple answers*

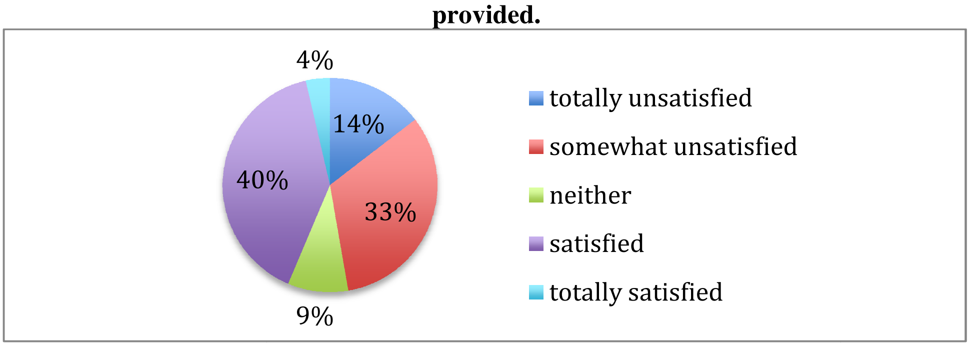
Figure 7: Overall percentages for who is responsible for getting water from the kiosks.



**question could contain more than one answer*

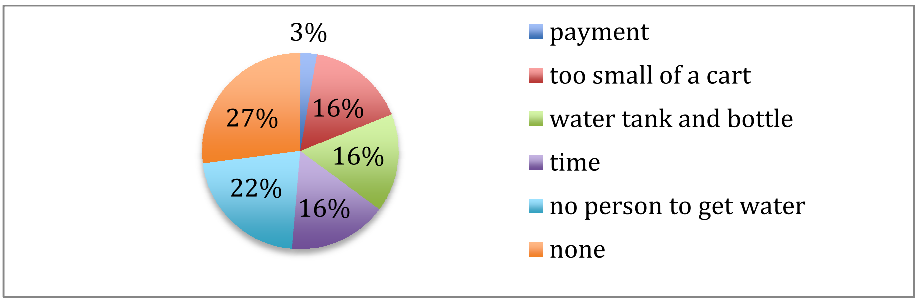
Just over half of respondents seem happy with their current water supplier, with 44% of survey-takers reporting that they are either "totally satisfied" or "satisfied" with the way their water is currently provided. A similar number of survey-takers, at 47%, reported their satisfaction as "somewhat unsatisfied" or "totally unsatisfied," and 9% reported their satisfaction as "neither."

Figure 8: Overall percentages for respondents' satisfaction with the way water is currently provided.



Survey-takers were given a list of possible difficulties in obtaining water, including payment, a small cart for transporting the water, a small water tank for storing the water, too little time to visit the kiosks for water, and no person in the household available for getting water. Twenty-seven of the fifty-four surveys completed, or 50%, chose at least one of the difficulties listed. Six survey-takers chose two or more of the difficulties listed, thirty-two chose one, eight stated that none were an issue, and eight did not answer the question.

Figure 9: Overall percentages for respondents' difficulties in getting water.*



**question could contain more than one answer*

Poor water quality and/or hard water were the problems most often expressed by survey-takers with their water source (see Table 4). When asked an open-ended question about the satisfaction with the current water source and any existing problems with the current water source, sixteen of survey-takers listed issues with the water quality, the hardness of water, water pollution, and/or bad taste of the water. When asked to rate their general perception of the water quality, 47% of responders listed the water quality as neither satisfactory nor unsatisfactory (see Figure 4).

Figure 10: Overall percentages for respondents' perception of water quality.

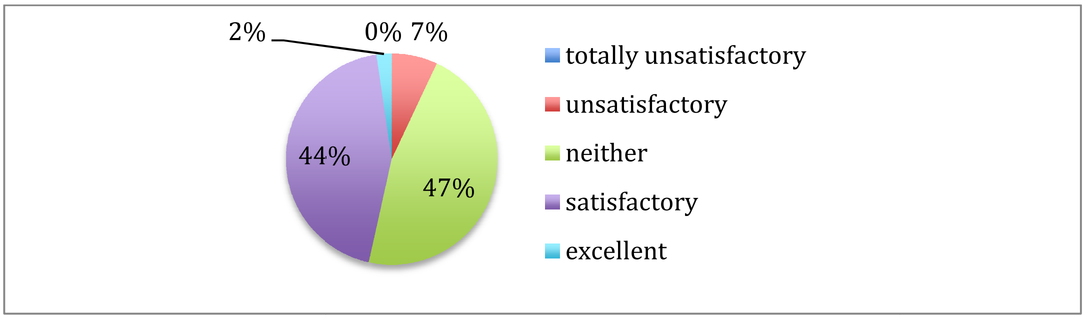
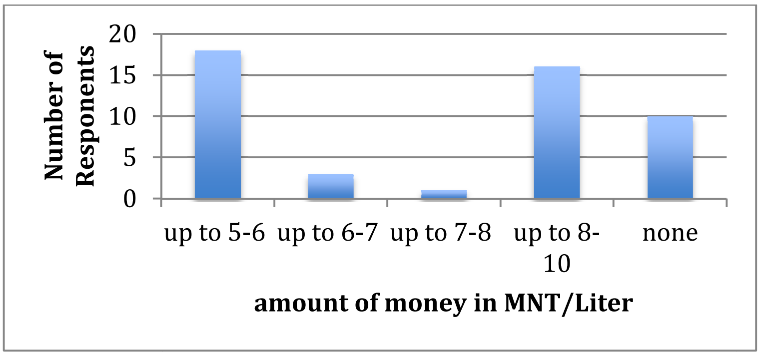


Table 3: Respondents' reported problems with their water source.

Unclean delivery truck; poor sanitation of truck, kiosk	2
pollution in water and/or kiosk location	4
Poor water quality; hard water	10
Difficulties with carrying/transporting water for long distances	2
Makes teeth yellow	3
Bad taste; salty	2
Amount of water decreasing; shallow well	2
Every family should be connected to central water supply	2

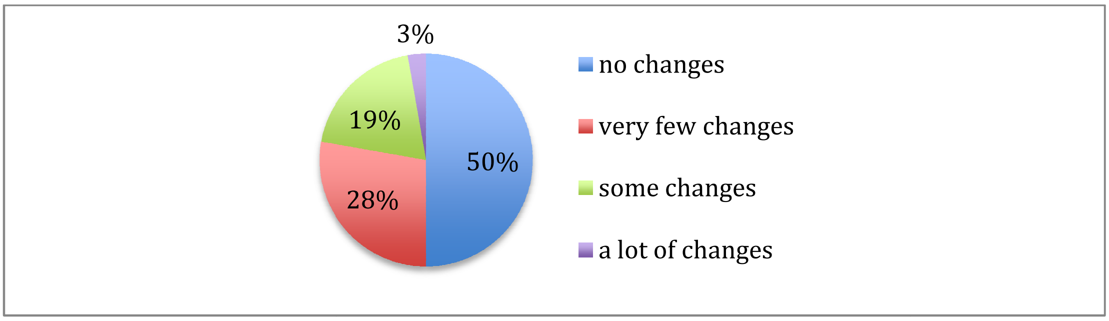
In Sainshand, ger district dwellers pay approximately two *tugrugs* per liter of water. With the average daily consumption of water for survey-takers totaling between 31.74 and 34.81liters (see Table 2), families are paying between 63.48 and 69.62 *tugrugs* per day for water. When asked if they were satisfied with the current cost of water, twenty-eight survey-takers, or 51%, responded that they were "satisfied" or "okay" with the cost of water. Seven of the survey-takers, or 12.9% wrote that "cheaper water would be better" and "water is expensive." Additionally, one survey-taker wrote that using a car to transport purchased water added to the overall costs because of gasoline that needed to be purchased in order to run the car. When asked if they would be willing to pay more for their water, survey-takers were fairly split. Of the four choices given, 16 responders, or 29.6%, stated that they would be willing to pay up to 10 *tugrugs* per liter for water, while 18 responders, or 33.3%, reported that they would only be willing to pay up to five or six *tugrugs* per liter, and ten responders, or 18.51%, reported that they wouldn't be willing to pay any more for water whatsoever.

Figure 11: Overall number of respondents willing to pay more for water.



When asked about if they had seen any changes in water access since the year 1990, respondents overwhelmingly reported seeing either "no changes" or "very few changes," for a combined percentage of 78%. One survey-taker wrote that they "didn't know." Only 3%, or two of the respondents, reported seeing "a lot of changes." Changes listed included "size of water," "price," "service," and "increasing water quality." Due to the vague nature of these survey-takers' responses, it is not known *how* the size of water, price, and service of water access has changed, only that it has, in some way.

Figure 12: Overall percentages for how many changes respondents have seen in water access since 1990.



Finally, survey-takers were asked to state whether they were concerned about water access in the future, and if so, how concerned they were, and what those concerns might be. None of the survey-takers reported that they were "totally unconcerned" about future water access, while 66% reported that they were either "very concerned" or "somewhat concerned." The most commonly listed concerns centered around increasing pollution in rivers, groundwater, and soil, as well as an overall lack of water.

Figure 13: Overall percentages of respondents' level of concern regarding future water access.

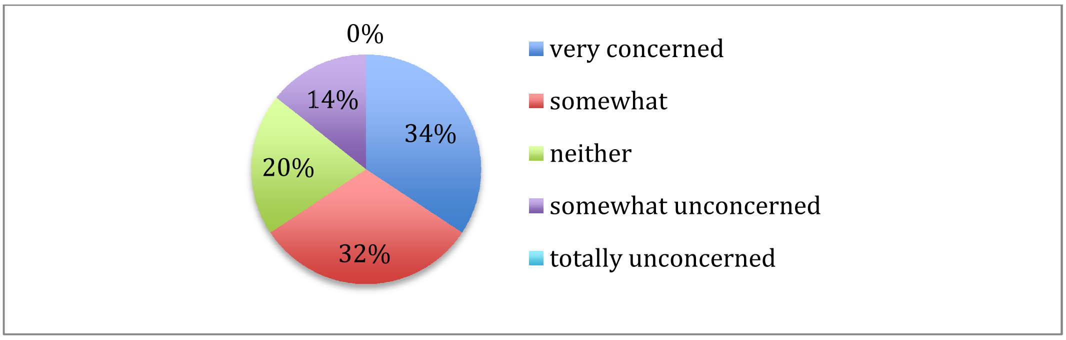


Table 4: Respondents' reported concerns about future water access.

Water needs to be conserved for the future	2
Increasing pollution of rivers, groundwater, and soil	6
Adverse environmental impacts of mining	2
Overall lack of water	5
Poor water quality/hard water	2
Poor management of water resources leading to lack of water	2
Water pipes damage leading to water pollution	1

Additionally, when asked if climate change and industrial development/mining might have any impacts on water access in the future, survey-takers overwhelmingly chose that both factors might have a "lot of impact." Further comments included concerns that "desertification causes the wells to become dry" and "mining impacts a lot, especially big factories [that] make more pollution. Because of big industries we have poor water resource."

Figure 14: Do you think climate change will have any impact on future water access? If so, how much impact will it have?

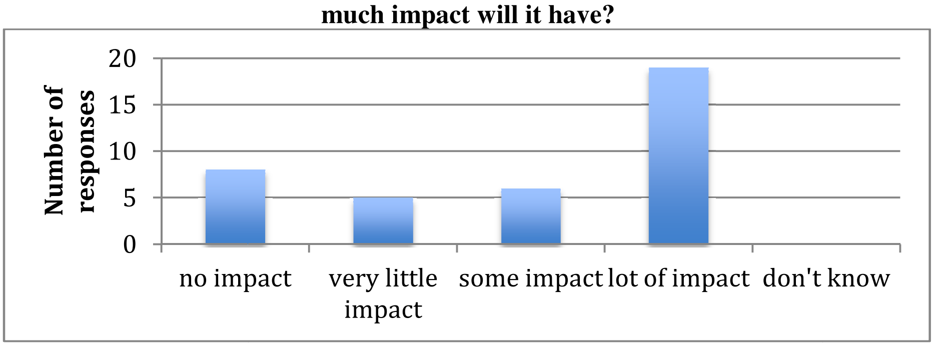
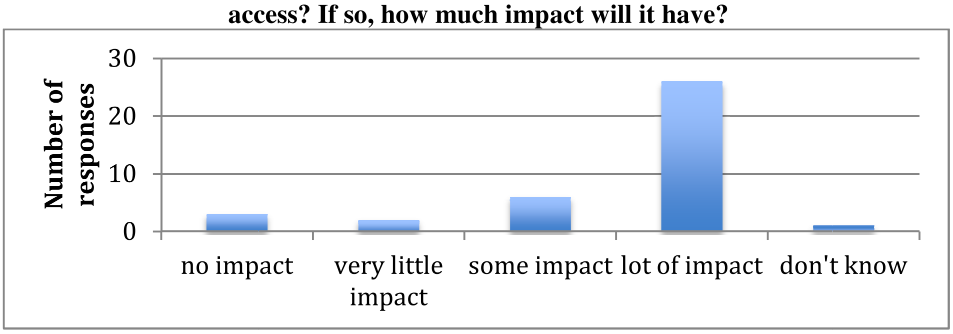


Figure 15: Do you think mining and industrial development will have any impact on future water access? If so, how much impact will it have?



Interviews – Dornogovi Environmental Office

Interviews with the environmental office sought to understand current water governance structures within the *aimag,* as well as any existing adaptation plans for the future. Multiple agencies do different things for water. There are at least five actors that have different responsibilities in terms of water. The health department does "hygiene of water," the agriculture department manages issues related to pastureland and water use, and the environmental office employees one water security specialist. The professional control office conducts water quality testing, and, finally, Chandman Company acts as the primary water supply and wastewater treatment company for Sainshand, as well as the entire *aimag.* The interviewee emphasized that water sources in Dornogovi and Sainshand center around groundwater. Surface water is negligible and provides no meaningful water source. Climate change in Dornogovi has shrunk already minimal surface water, such as small lakes, rivers, ponds, etc. There are five main underground water sources, although some people talk about piping water in from Herlen River.

When asked about what impacts, if any, mining and further development might have on water resources, the interviewee explained that mining often impacts the quantity of water as opposed to the quality of water. Mining companies will build their own wells and use so much water that it impacts the wells around it, causing those wells to shrink. In terms of the quality of water, Sainshand water has a pH of 7-7.6 and a nitrate concentration of 5mg/l.

Despite the recent passage of a water security plan for the *aimag,* there is no map of the water resources in Sainshand and Dornogovi, and the interviewee said there were no plans to map. Additionally, there is no information on groundwater, including any existing studies or research being done on the issue.

Finally, in regards to public participation and education, the interviewee reported that efforts are made to educate secondary school students about water. In March/April there is a competition between the three secondary schools with a question and answer session, an art competition, and other activities.

Interviews – Dornogovi Development Office

In her interview with the development office, the researcher attempted to determine how Sainshand is poised to grow, what assessments have been done involving water, and how future growth might impact water demand. Plans for the industrial park are in the research stage, and construction will take anywhere from 14 to 19 years, depending on the size of the project. An American company provided plans for the project. Funding is coming from both the government budget, as well as private investment. In addition to the industrial park, discussions are being held for the construction of an "eco-town." Five hundred hectares will be dedicated to it, on the south side of Sainshand, 7 kilometers from the center of the city. The eco-town will treat and recycle wastewater, though specifics on this wastewater treatment plan do not exist currently. Regarding any environmental impact assessments, including ones related to water and/or climate change, the interviewee stated that no impact assessments have yet been done. The interviewee explained that at least 11.8 million tons of water is going to be needed for industrial construction purposes. This water is most likely to come from an untapped underground water source known as Bor Hovoor, located 40 kilometers from Sainshand. The government has approved the use of 1.2 billion *tugrugs* for researching the best way to use this water source.

Interviews – Dornogovi Meteorological Office

An interview with the meteorology office was conducted to talk about possible impacts of climate change on local water sources. Three main kinds of work were mentioned for this office. First, providing weather forecasts for citizens. Second, studying climate change in the area. Third, providing weather data to the government of Mongolia for research purposes. In terms of climate change, the interviewee mentioned pasture degradation and desertification as the two most visible signs. The first climate change study began in 1938, and they have plans to continue to study the topic until 2020. When asked about impacts of climate change on water resources, the interviewee first spoke about surface water, saying there was "no possibility" of studying the surface water because there is none to study. In terms of groundwater, there is very little, if any, work being done on groundwater and climate change. The interviewee spoke of some work being done on groundwater up until 1983. She also mentioned a study being developed, but she didn't have details about the specific topic and scope of the project. Any possible effects of climate change on groundwater in Sainshand and Dornogovi *aimag* at large are virtually unknown.

Interviews – Chandman Company

Interviews with Chandman Company focused on understanding how water is supplied to ger districts. Founded in 1999, this is the main heating, water supply, and wastewater treatment company in Sainshand and all of Dornogovi, owned and operated by the *aimag* government. They're headquartered in Sainshand, with four *soum* branches. To supply water to Sainshand, they pull from Zegeen Hotol and Eoxil, two underground water sources. Zegeen hotol has two underground s, both about 18 kilometers away, and Eoxil has one underground well, at 27 kilometers away. Every three or four hours, these underground wells pump water to an underground pond, which acts as the central water supply point. There are three people on duty for each underground well. From this pond, water is pumped continuously to every building and apartment in Sainshand, as well as to ten of the sixteen kiosks that provide water for the ger districts. The other six wells are supplied with water by truck. There is a fourth well, located near the center of Sainshand, which provides water for the drivers that deliver water to the six unconnected kiosks.

Zegeen Hotol has been a "recognized" water resource for thirty years, and has been in use for fifteen. Monitoring shows that there is no decrease in quantity. It is located 75-90 meters below ground. Eoxil, which supplies the well that is 27km away, is located 50.7 meters deep. The underground wells were built in 1998. Before Chandman, there were three wells – one near the railway station, one 10-15 kilometers away, and one near the location of Chandman Company. All of these wells are now destroyed, or out of use, presumably because they ran dry. The well near the railway station is still operating, but that is under the control of the railway company.

When asked about any disruptions or issues with access to or supply of water, the interviewee mentioned that sometimes there is damage done to the pipes that transport water. If the pipe that takes water from the central pond to Sainshand is damaged, then water to the city will be cut off. If damage is done to the pipes that take water from the underground wells to the central, there will only be a water shortage in one spot. The last time major damage occurred was on 25 December 2012. The land was frozen, so it took a long time to repair, and the city of Sainshand went without water for 24 hours. These kinds of occurrences will happen about once a year, especially in cold weather. When this kind of thing happens they may truck water to every apartment and every ger district.

The interviewee expressed worry about shortages of water because of civilian migration and an increase in population. She emphasized the need to update their equipment and to make it more modern and automated, as well as the need to find new water sources and increase the number of wells pumping water to the central pond. One example was the aforementioned Bor Hovoor resource, which is currently being assessed for use. The interviewee echoed what the interviewee from the environmental office said of mining companies' impacts on water – it effects the supply. Especially as mining companies often build their own wells, which pulls from public wells.

Despite how cheap water is, there is still a price discrepancy in water price between apartments and ger districts. Apartments pay approximately 600 *tugrugs* for one cubic meter of water, while a ger district citizen will pay 2500 *tugrugs* for one cubic meter of water. This still translates to 2 *tugrugs* per liter of water in the ger districts, which is negligible at best. According to the interviewee, the tax office subsidizes the water at 150 *tugrugs* per one cubic meter of water. The company operates at a loss, and although they may want to increase the price of water, they can't because the government will not allow it.

Interviews – Dornogovi Health Office and Professional Control Office

When asked about the quality of water, both interviews spoke of the arsenic levels. Arsenic levels in the water have been found to be "twice higher" than normal. Tests were made at the Chandman Company lab, as well as labs in Michigan and Korea, and the results were similar. There is currently a study on arsenic in the water and how that impacts people's health. It is being conducted, with samples from 101 wells around Dornogovi. They've only been studying arsenic over the last two or three years, and it can sometimes take much longer (ten or twenty years) to identify the effects. They can't tell as to the exact origin of the arsenic, although it "may be the influence of mining companies." There hasn't yet been any research on "mining actions." Most mining companies build their own wells using modern equipment. Samples taken from mining wells show the water to be of normal quality.

The health office focuses specifically on sanitation and water, and to that end they look at bacteria that might be present in internal plumbing and public areas, including the tanks people use to hold water and the sixteen water kiosks. They work to educate families and students on the value of washing hands, as well as how to clean their water tanks. The interviewee mentioned how children who are carrying home the water might be dirty, and in turn dirty the water. They also teach about communicable diseases, and why hygiene is important. They work with the local medical center to do this. Because of the recently approved water security plan, the water purification system that was broken was fixed in July of 2013. Similarly, in July they educated specialists who work in their water quality lab, as well as educated workers that distribute water at the kiosks. They talk about factors like air pollution, and how it can make the water dirty as well.

Average amount of daily water consumption for a family in the ger district is 5-6L/day. For a family in an apartment it's much higher at 30-40L/day. Apartment dwellers use more water because of showers, toilets, etc. These numbers are taken from another survey, as there has been no survey done specifically for Sainshand. Some families buy from the Gallon Companies, which produce jugs of purified water. It's impossible to get water everyday from the kiosk so families will sometimes keep the water for three-five days, which is why keeping it clean is so important.

Discussion

Has there been any change seen in water access and water resource allocation in recent years?

Survey-takers reported seeing few, if any, changes in water access over the years. Only one question on the survey asked specifically about changes seen in water access since 1990, and very few respondents reported seeing any actual changes. This may be due, in part, to the fact that many of the surveys were completed by local university students and younger adults who may not have been old enough to see or understand changes occurring in water access. Only four surveys listed specific changes, but the answers were too vague to provide any meaningful qualitative data. Price and the size of water were both listed, for example, but the respondents gave no indication as to *how* exactly those have changed and impacted daily water use. Regardless, the surveys indicate that few tangible changes have occurred in how individuals and families procure water for daily use, at least at the community level of the ger districts.

On a slightly more macro-level, one interview shed light on how water supply has changed for Sainshand since the 1990s. Chandman Company as it is today began operation in the late 1990s. Before that, the government supplied water using three wells located near the railway station, one that was 10-15 kilometers away from Sainshand, and one near the location of the current Chandman Company. When asked, the interviewee did not know exactly why these wells stopped being used as the main water supply, but presumed it was because they ran dry (Sainshand interviewee 3, personal communication, November 12, 2013). These wells are no longer in existence, except for the well near the railway station is still operating, but that is now under the control of the railway company. Interestingly, the three wells in use today are considerably farther away than the wells now out of commission. Of the old wells, the farthest was 10 or 15 kilometers away from Sainshand. Today, the primary wells are 18 and 27 kilometers away from Sainshand, and additional sources being explored are as far away as 40 and even 540 kilometers, namely Bor Horoov (originally discovered by the Soviets) and the Herlen River. The present pattern of moving outwards to source water could be indicative of future trends. As Sainshand grows and requires more water, the city may have to pull from sources farther and farther away to meet their needs.

What are people's current water-related needs and concerns and are those being adequately addressed?

Survey-takers were essentially split over their satisfaction with their current water source/supply. Over half of the surveys listed at least one difficulty with how they currently obtain water. Of those difficulties identified, many were related to water quality in some way. On the open-ended questions, problems listed most often were in regards to the hardness of water, pollution in the water, bad taste, and the overall quality of the water. At the same time, when asked to rate their overall perception of the water quality, most survey-takers chose an answer of "neither satisfactory nor unsatisfactory," indicating that while water quality may be a concern for many families and individuals in ger districts, it does not create an overall hindrance to water access. Additionally, the *aimag* government built a lab this year using 60 million MNT and located in the Chandman Company building. The lab is used by specialists employed by Chandman Company, as well as government employees with the Professional Control Office, to test regularly for water quality. The lab is one of the largest and most state-of-the-art in the Gobi region, and will be a critical component of measuring water quality in the future (Sainshand interviewee 4, personal communication, November 12, 2013). Water sanitation and hygiene is monitored primarily by the Dornogovi health office. Two of their most important initiatives include monitoring the "hygiene and cleanliness" of Sainshand's sixteen water kiosks, as well educating students and families on the importance of sanitation, hand-washing, and keeping their water tanks clean. As part of the aforementioned water security plan, the water purification system that was broken was fixed in July of 2013. They also spent that month educating specialists who work in the water quality lab, as well as kiosk attendants and workers who distribute water. The education included factors like air pollution and how it can make the water dirty (Sainshand interviewee 4, personal communication, November 12, 2013). It is easy to see how this kind of education with local families and workers is incredibly important to the overall picture of water sanitation, especially when one visits the kiosks in the ger districts. All of the attendants have stoves in their kiosks in which to burn fuel for warmth. During the researcher's time in the ger districts, at least one of the kiosks visited was smoky inside due to the coal being burned for warmth. The kiosk in question was supplied via truck, and inside was a large tank to hold the water (see picture 2). Four of the five attendants who worked in the truck supplied kiosks spoke of often cold working conditions, as the large tank of cold water makes the kiosk very difficult to heat inside. There is a very real possibility that as the weather gets colder and attendants burn more coal or other fuel to keep their kiosk warm, the likelihood for the water being held in the tank to become polluted also increases.

According to kiosk attendant interviews, there are relatively few problems with water supply at the kiosk-level. Of the thirteen interviews conducted, five reported occasional issues with the water supply. Only two of the seven piped kiosk attendants reported delays when pipes were damaged. Delays in water supply seemed slightly more likely to occur with kiosks supplied by truck, as three of the five attendants interviewed reported delays when the truck was broken down and/or busy. The remaining eight kiosk attendants reported no issues with water supply. Additionally, delays rarely seemed to last for more than a few hours. Finally, reporting of damages by local media and the practices of some families to save water seems to minimize these issues and make them easily fixable.

When asked to describe any times when they might not have access to water, many of the survey-takers mentioned the kiosk schedule. Seventeen of the survey-takers wrote that they didn't have access to water when the kiosk was closed, and another eight wrote that their own schedules and busy lives sometimes prevented them from getting water when they needed it. Two of the surveys stated explicitly that the kiosk schedule and closures sometimes prevented them from access to water when they needed it, and another survey stated that because the water delivery truck doesn't come at a consistent time, it can create a delay in water access. Beyond that, it was unclear from the survey as to whether or not the kiosk schedule proved to be a real inconvenience in water accessibility on a daily basis. Another seventeen of the survey-takers wrote that there were no times when they didn't have access to water.

In terms of who is responsible for getting water from the kiosks, the survey found that 44% of responders specifically listed women and/or children, while 22% listed "everyone", as being responsible for getting the water. This is fairly similar to a report which found that in ger districts, women and children are most often responsible for handling water, including waiting in line to buy it, transporting it home, boiling it, and preparing it for use. The paper stated that this process took time and energy, and was responsible for taking up valuable time that might otherwise be spent on a child's education and schoolwork (Basandorj & Altanzagas, 2008). Twenty-seven percent of survey-takers reported an issue of having no one available to get water, and while distributing surveys in the ger districts of Sainshand, one kiosk customer was unable to stop and fill out a survey due to the fact that they had left their baby at home, alone, because they needed to get water. While this last piece of evidence happened in passing and is anecdotal at best, it is indicative of the disruptions to daily life that can occur when families have to retrieve, transport, and treat any and all water they use on a daily basis.

If ger district dwellers are dissatisfied with their current water source, they have few alternatives to buying it from the kiosks. One existing alternative comes for the so-called Gallon Companies; these are small, privately owned businesses that purify, bottle, and sell water to local residents and offices. Purchasing water from these companies can be a positive alternative as they deliver directly to customers, and the water has already been purified, so it does not need to be boiled or treated in any way. This option is decidedly more expensive, however. First-time customers must pay for a pumping tool to use on the jugs that the water comes in, which costs 8,000 *tugrugs.* After that, water costs 2,000 *tugrugs* per gallon, or approximately 529 *tugrugs* per liter. The water alone costs three times more than water from a kiosk, and for a family on a budget, this could prove a costly, and perhaps unaffordable, option, especially when one considers that approximately 38% of survey-takers indicated that they wouldn't be willing to pay more than 6 *tugrugs* per liter of water, if that.

The amount of water used by families was another interesting point raised by the survey. The average family size of responders was 3.87 people, while the average daily water use fell between 31.74 - 34.81, leading to average daily water use of 8.20 – 8.99 liters per person, per day. This average is similar to a 2008 study that took place in the ger districts of Ulaanbaatar, which found the average daily water use to be 8-10 liters per person, per day. During an interview with the Dornogovi health office, the interviewee cited water use in ger districts to fall between 5-6 liters per family per day, even lower than the aforementioned statistics. When asked where these numbers came from, the interviewee reported that the numbers were pulled from a pre-existing study from another area, as no research has been conducted on the daily water use for families in the Sainshand/Dornogovi area (Sainshand interviewee 4, personal communication, November 12, 2013). Regardless, even at 8-10 liters of water per day, these averages fall below international standards, which specify you need a minimum of 15 liters per person per day for cooking, drinking, and personal hygiene ("Chapter two: minimum" 2004). When comparing to international standards, the average distance traveled to get water (135.83 meters) falls within the 500 meter range, and only two surveys reported times of half an hour or more to retrieve water. Most survey-takers did not describe the time it took them to get water, however, so it is difficult to know whether or not most ger district dwellers are able to get water in fifteen minutes or less.

What are the existing plans for adaptation in the face of climate change and development and how are those plans being implemented?

Most survey-takers expressed at least some measure of concern regarding future water access (70%), as well as fairly serious concern over the potential impacts of climate change and industrial development on water access, although concern over industrial development and mining were a fraction higher than climate change. While the surveys show a presence of public concern regarding the potential impacts of both climate change and development, there is minimal evidence of tangible steps being taken at the governmental level to assess the potential impacts of such factors. At the same time, however, steps are being taken by the central *aimag* government to address issues of future security. Namely, a water security plan, approved just this year, aims to address the most critical areas of water security, including Sainshand's central water supply system, cleaning and purification systems, distribution, private wells, polluted water, and control and research (Sainshand interviewee 1, personal communication, November 11, 2013). There exists, however, a high division of responsibilities regarding water governance issues. At least five separate actors are responsible for carrying out various components of the water security plan, including the environmental office, the health office, Chandman Company, and the professional control office. Unclear in regards to the water security plan is how exactly these multiple stakeholders will integrate operations in order to ensure future water access and security. The *aimag's* environmental office has only one water security officer, and there is no central water management office or database where all of the information is held and is accessible. When asked how the soon-to-be established River Basin Administration for the area might play a role in water management issues, one interviewee gave an interesting answer. They said, "There is no river, so it's impossible to talk about [the] River Basin Administration. It's only in Khentii and other provinces that have rivers" (Sainshand interviewee 1, personal communication, November 11, 2013).

One area where the future River Basin Administration (RBAs) might prove important relates to data, or the lack thereof. One interviewee stated that Russian totals are currently used for water resources. When the RBAs are fully established, there will be surveys done to update the information available on water resources (Sainshand interviewee 7, personal communication, November 13. 2013). There is a noticeable lack of research done on the *aimag* level, which in turn leads to a lack of reliable data. Throughout the course of this project, through interviews and independent research, no existing studies could be found that had been conducted on household water use at the *aimag* level, either for the ger districts, Sainshand, or Dornogovi at large. Additionally, no mapping has been done of the existing wells and known water sources. Finally, there is little, if any, understanding of how climate change might impact water security for Sainshand and Dornogovi. Because all water for the area comes from groundwater, understanding how climate change might impact water security will be directly related to how climate change might impact groundwater.

Regarding development and mining, and how the growth of industry might impact future water security, uncertainty remains as well. Sainshand is poised for considerable growth over the next couple of decades as plans for construction of the industrial park moves forward, but the majority of those plans are still in the talking stages, making them, as well as any projections, tentative at best. It has been estimated that industrial construction could demand approximately 11.8 million tons of additional water each year, and this water is most likely to be piped in from Bor Horoov, an underground source 40 kilometers away (Sainshand interviewee 2, personal communication, November 11, 2013). 1.2 billion *tugrugs* has recently been committed to exploring the best way to exploit this resource. Regardless, the tenuous plans and projections mean that no definitive environmental impact assessments have yet been conducted, including ones related to water issues. Additionally, while two of the interviewees stated that mining and industrial activity was more likely to impact water quantity, as opposed to water quality, a lack of research on “mining actions” and water indicates that nothing can be definitely determined regarding mining and water-related issues (Sainshand interviewee 5, personal communication, November 12, 2013).

There are three laws currently in place that serve to protect the environment and its natural resources, including water-related issues. These include the Law on Environmental Protection, the Natural Resources Use Law, and the Water Law. On paper, these laws give the *aimag* government the power to:

> “supervise the activities of local business entities and organizations in respect of environmental protection…and to take measures to eliminate breaches and if necessary, to bring temprorary injunctions against the activities of business entities and organization which have adverse environmental impacts or to inform organizations authorized to make decisions.”

There are 310 mining companies in Dornogovi. Of these companies, 200 have permission but have not begun mining yet, 100 have begun drilling, and 10 are mining now for resources like coal and iron. Compared to how many companies have permits, there are relatively few companies in the ground doing actual mining, however, the environmental impacts of their activities can already be felt. Adverse impacts of mining activities include large quantities of dust, 190 square hectares of “broken road,” the disruption of the movements of wild animals, loss of vegetation, and the loss of small rivers and lakes (Sainshand interviewee 7, personal communication, November 13, 2013). In terms of mining companies impacting the water in the area, one interviewee spoke of Zungbayan, a district of Sainshand, where a Chinese company is using water to mine for oil. The topic has caused controversy because of issues over taxation and payment – government officials disagree over whether or not the company is required to pay for the water they are using to mine. Overall, it can be difficult to enforce the law requiring companies to pay for damage done to the environment, including water use and management (or mismanagement). One interviewee used the example of a small mining company that was operating in the Dornogovi countryside and went bankrupt. The government of Mongolia (GOM) ordered reparations to be paid for environmental damages done, but after the company collapsed, the GOM wasn't able to track down the people responsible for paying (Sainshand interviewee 7, personal communication, November 13, 2013).

Conclusion

Climate change and industrial development have the potential to severely impact water resources, in relation to both quantity and quality. While this much may be clear, what's not yet fully understood is *how* these factors will impact water security and what this means for communities who may already face certain water access and security issues, like ger districts. Sainshand is no exception, especially as a city facing major growth and change in the coming years: industrially, economically, and environmentally. While the area may be abundant in mineral wealth, its Gobi locale puts it in one of the least water-rich places in a country with already limited water resources (Batimaa et al. 2011). Understanding how the competing forces of climate change and industrial development will impact water resources is therefore critical to ensuring a holistic approach to water security.

For Sainshand, the most visible impacts of climate change include pasture degradation and desertification. Because of the general lack of surface water in Dornogovi, climate change is most likely to affect water resources by impacting groundwater, particularly groundwater recharge. Changes in groundwater recharge is thought to be affected by several factors, including precipitation, evaporation, and temperature changes, all of which are likely to be impacted by climate change. "Fossil" groundwater resources, or those that are located 50 meters or more below ground will not be affected by climate change as they are trapped in deep layers and not affected by changes in recharge or replenishment (Tuinhof & Nemer, 2010). At the end of the day, however, the effects of climate change on groundwater and groundwater recharge is "inadequately known" (Batimaa, et. al, 2008). Because of this, it is more important than ever to prioritize the mapping and study of all water resources in the area, in order to better assess which sources are shallow enough to be affected by climate change, and how those might be affected.

Sainshand, and Dornogovi in general, is an area typical to much of the rest of the country, in terms of its vast mineral resource wealth and potential for considerable industrial development and economic growth. Most notable is the large industrial park currently being planned for the city. Plans are currently in the research stage, and construction of the park could take anywhere from 14-19 years, depending on the size of the project. Industrial construction could demand up to 11.8 million tons of water annually, and with job creation bringing more and more people to Sainshand, the city's population could as much as double (Sainshand interviewee 2, personal communication, November 11, 2013). Growth in population is already being seen in the ger districts. While most of the kiosks visited reported serving between 120-300 people, one attendant interviewed stated that the kiosk served about 1,200 people, four to five times more than the other kiosks. The reason? The interviewee said that since last year, more and more people have moved from the countryside to the ger districts, for jobs and other reasons. Increasing demand and decreasing quantity is almost certainly going to be an issue of water security in coming years. In addition to the construction of the industrial park, plans are being developed to build a so-called "eco-town," using 500 hectares of land on the south side of Sainshand. Few concrete decisions have been made regarding the town and its construction, but plans do exist to treat and recycle wastewater, a potentially important strategy to dealing problems of water quantity. How much water will be treated and who will benefit from the recycled water is unknown. Additionally, two water sources are being explored for potential to supply the city with water. These sources would involve piping water south from the Herlen River 540km and from an underground source in Dornogovi known as Bor Horoov (40km away). Feasibility, environmental, and economic assessments are currently being conducted for the Herlen River project (Ulaanbaatar interviewee 3, personal communication, November 7, 2013). As for Bor Horoov, 1.2 billion *tugrugs* were recently committed to exploring the source (Sainshand interviewee 2, personal communication, November 11, 2013). Besides quantity is the question of quality. While two of the interviewees stated that mining and industrial activity is more likely to affect quantity, rather than quality, there has not yet been any research on the effects of mining on water quality (Sainshand interviewee 5, personal communication, November 12, 2013). The issue of development on water quality, therefore, is not fully understood.

Despite the very recent passage of a water security plan, there is still much that can and should be done to ensure sustainable water access and security. First, there is a lack of data and research done on the *aimag* level. No maps currently exist of all wells and water resources. While the water security plan outlines general plans for mapping, one government interviewee stated that there were no specific plans for mapping (Sainshand interviewee 10, personal communication, November 14, 2013).

In addition, no household water surveys have been conducted for the city or the *aimag,* and no plans exist for one. Finally, a lack of research has been conducted, at both the *aimag* and the national level, on groundwater, how it might be impacted by climate change, and its future as a water resource. Second, integration of water governance at the *aimag* level is necessary to ensuring all projects and plans can be carried out. There is currently a high division of responsibility in regards to water management. Chandman Company, the environmental office, the health office, and the agriculture office, for example, all deal with different aspects of water management, and there is no central authority to integrate the work of all stakeholders and make information accessible. Third, maximizing community participation at the local level is necessary to improving water management. Over half of all survey-takers were not only concerned about water access in the future, but also were concerned about the potential impacts of climate change and industrial development on water resources. While public education exists for water sanitation, overall public participation is low when it comes to water-related issues. With so much of the public voicing a concern over the future of water access and security, a place should be made for them at table of discussion on water security. By fully assessing the potential implications of climate change and development on water resources, integrating water governance, and maximizing community participation, long-term and sustainable water security can be ensured for both ger district dwellers and all stakeholders involved.

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Interviewees

Ulaanbaatar

Officer, Climate Change Office
Hydrologist, MINIS Project
Hydrologist, National Water Center
Hydrologist, Institute of Meteorology and Hydrology
Director, River Basin Administration Division

Sainshand
Director, Environmental Department
Officer, Development Office
Director, Chandman Company
Officer, Health Department
Inspector, Professional Control Office
Director, Meteorological Office
Officer, Environmental Department
Owner, Gallon Company
Water Security Officer, Environmental Department

Appendix 1.1
Kiosk Attendant Questionnaire

1. How long have you worked this kiosk?
2. What are your kiosk hours?

3. How many days a week do you work?
4. How many people does your kiosk serve?
5. How many customers do you see every day?
6. On average, how much water does each customer buy per visit? How many times a week do they come to purchase water?
7. On average, how much water do you sell in total every day? Every week?
8. Do you ever have issues with the water supply, such as delays?
9. Overall, are you satisfied with your job? What would you change about your job if you could?
10. From where do you get water for yourself and your family?

If the kiosk is supplied by truck….

11. Is there a set time that the truck comes to deliver water?
12. Are there any issues with truck delivery?

Appendix 1.2
Kiosk Attendant Questionnaire Answers

How long have you worked this kiosk?

1. ---
2. 5 years
3. 6 years
4. 7 years
5. 15 years
6. 2 years
7. 3 months
8. 13 years
9. 1 year
10. ---
11. ---
12. 6 years
13. 26 years – 16 at the kiosk, before that at Chandman Company

What are your hours?

All kiosks operate from 9:00am to 6:00pm, with a two hour break for lunch, from 1:00-3:00pm.

How many days a week do you work?

All kiosks operate Tuesday, Wednesday, Friday, Saturday, Sunday. Wells are closed on Mondays and Thursdays – this is the weekend for the attendants. These were the days with the fewest customers, so it was decided to close the wells on these days.

How many people does your kiosk serve?

1. 70 families, 300 people
2. 220 families,
3. 40-50 families, 120 people
4. 80 families,
5. 300 families, 1,200 people – Most people get their water from this well. Since last year, many people have moved here from the countryside, increasing the number of customers the well sees.
6. 60-70 families, don't know how many people
7. 30-40 families, 120 people
8. 105 families, 200 people
9. 80 families, 250-300 people
10. 80 families, 300 people
11. 60 families, 200 people
12. 60+ families, 200+ people
13. 80 families,

How many customers do you see every day?

1. 60-70 on weekdays, 100-120 on weekends
2. 30 per day
3. 20-30 per day
4. 30 customers per day, customer number increases on weekends.
5. Didn't know
6. 20 per day, increases on weekends
7. 20 customers per day
8. 10-20 per day
9. 50-60 customers per day
10. ---
11. 70-80 customers per Saturday and Sunday, customer number increases after days off – Mon, Thurs
12. 100+ customers everyday
13. 40-50 customers/day

On average, how much water does each customer buy per visit? How many times a week do they come to purchase water?

1. ---
2. 50-150 L
3. 80-100 L
4. 50-250 L, 3-4 times per week
5. ---
6. 40 L, once a day
7. 20-200 L, most customers come on Wednesdays and Sundays
8. 100-200 L, 2-3X week, usually come on weekends
9. 30-60 L, visits depend on the size of the tank, perhaps 1-2X week, increases on Saturdays and Sundays
10. ---
11. 180-300L, customers visit up to 4-5X week
12. 100-200L, 2-3X week
13. 40L, 2X week

On average, how much water do you sell in total every day? Every week?

1. 3.5 – 4.0 tons per day, 27 tons per week
2. 5-7 tons per day, 22 tons per week
3. 4 tons per day, 20 tons per week
4. 5 tons per day,
5. 10 tons per day, 27-40 tons per week
6. 2 tons per day, 5 tons Saturday and Sunday, 15-20 tons per week
7. 1 ton per day, 5-7 tons per week
8. 4.5 ton/day, 31.5 ton/week
9. 2 ton/day, 4 ton/Saturday, Sunday
10. ---
11. 7-8 ton/day, up to 10/day, 50-60 ton/week
12. 3 ton/day, 12 ton/week
13. 3-5 ton/day, 21 ton/week

Do you ever have issues with the water supply, such as delays?

1. No issues
2. See below – truck delivery
3. No issues
4. Professional Control Office has come twice to sample water, no issues with delivery of supply
5. No issues
6. No issues
7. See below – truck delivery
8. See below – truck delivery
9. See below – truck delivery
10. ---
11. ---
12. When the pipe is broken, sometimes there is no water. This can happen up to once a month, especially in winter. It will be broken for one-two hours at a time, which causes a delay for customers.
13. Broken pipes can cause delays. This happens, on average, 4X/year. Breakage will last from 1-4 hours. Some people save water, so it's not a problem for them. Breakages are also announced by the local media.

Overall, are you satisfied with your job? What would you change about your job if you could?

1. Yes, overall satisfied
2. The cold tank of water makes the place a cold one to work. Despite the stove and fire, it is still cold inside. A "difficult place to work." The salary is low – "unsatisfactory."
3. Yes, overall satisfied. Would make the building smaller and warmer – Chandman Company said they would be changing the building soon.
4. Overall, satisfied with job. There is no electricity, and it gets dark outside early – Chandman Company said they would be addressing the issue.
5. Overall, satisfied with job.
6. Cold tank of water creates cold conditions inside the well station
7. Wants a piping system for her station, not truck delivery

8. Overall, satisfied with job. Would like an increase in the number of water delivery trucks.
9. Overall, satisfied with job. Located near home.
10. ---
11. ---
12. Difficult to work in winter
13. Overall, satisfied with job.

From where do you get your water?

1. ---
2. Lives in apartment nearby – piped water
3. ---
4. ---
5. Lives in ger district, buys from another well
6. Lives in ger district, buys from another well
7. ---
8. Lives in ger district, buys from same well
9. Lives in ger district, buys from same well
10. ---
11. ---
12. ---
13. ---

If the well station is supplied by truck…

How often does the truck come to deliver water?

1. n/a
2. Everyday
3. n/a
4. n/a
5. n/a
6. three times during the week, once on Saturdays and Sundays
7. twice per week
8. truck comes once a day
9. truck comes 2-3X week
10. ---
11. n/a
12. n/a
13. n/a

Is there a set time?

If water is delivered by truck, then the attendant calls the truck when the water in the tank is low – there is generally no set time.

Are there any issues with truck delivery?

1. n/a
2. A new delivery truck was bought recently there have been fewer delays, but the old car was always broken and there would be delays in getting water to people. Once an attendant calls the truck, it takes 40 minutes to get water to

one well, so if the truck is busy with another delivery, it can take up to an hour and a half to get water to the well. This can happen on weekends when there are more customers, more water sold, and the truck is busy.

3. n/a
4. n/a
5. n/a
6. No issues with truck delivery
7. When the truck is broken down or busy, there is a delay in water delivery – it happens “rarely.” There is a 30-40 minute wait if the truck is busy. There is a one day wait if the truck is broken.
8. There is only one water delivery truck for the company, and if it’s busy, there is a 40-60 minute wait, which could cause a delay for customers.
9. No reported issues. If the truck is busy, well must wait “short time” for water.
10. ---
11. n/a
12. n/a
13. n/a

Appendix 2.1
Household Daily Water Use Survey, Mongolian

*Questions that were added to the survey while in Sainshand do not appear below.

Энэхүү асуулга нь Монгол улс тэр дундаа Сайншанд хотын усны хангамжын аюулгүй байдлын талаар судлаж буй оюутны судалгааны ажлын нэгэн хэсэг юм. Асуулгаар цуглуулж буй бүхий л мэдээлэлийг судалгааны ажилд хэрэглэх болно. Та бүхий л асуултанд хариулах албагүй хэдий ч таны өгсөн мэдээлэл бүхэн үнэ цэнэтэй байх нь дамжиггүй.

Цаг зав гарган надад туслаж буйд тань баярлалаа.

1. Та хаана амьдардаг вэ?

   a. Гэрт

   b. Орон сууцанд

   c. Хувийн байшинд

   d. Бусад: ________________

2. Таны орлогын эх үүсвэр юу вэ?
3. Танайх хэдүүлээ амьдардаг вэ?
4. Танай гэр бүл өдөрт хэдэн литер ус хэрэглэдэг вэ?
5. Усыг юунд хэрэглэдэг вэ?

6. Усаа хаанаас авдаг вэ?

    a. Худагаас

    b. Гүний худагаас

    c. Усны машинаас

    d. Голоос

    e. Бусад: ____________

7. Өдөрт хэдэн удаа усанд явдаг вэ? Ямар хугацаанд, хэдэн цагийн үед явдаг вэ?
8. Усаа авч чадахгүй үе байдаг уу (Худагийн ажиллах цагийн хуваарь)? Хэзээ, ямар хугацаагаар хаадаг вэ?
9. Усны эх үүсвэртээ сэтгэл хангалуун байдаг уу? Яагаад тийм эсвэл яагаад
10. Усны хэрэглээнд ямар нэгэн асуудал байна уу? Хэрэв тийм бол ямар асуудал байна вэ?
11. Усны чанарыг үнэлнэ үү?

    a. Маш муу

    b. Муу

    c. Дунд зэрэг

    d. Сайн

    e. Маш сайн

12. Та усаа худалдаж авдаг уу? Хэрэв тийм бол хэдээр авдаг вэ?

Appendix 2.2
Household Daily Water Use Survey, English

This survey is part of a research project designed to understand water access and security in Mongolia, focusing on Sainshand in particular. Any and all data collected from these surveys will be used for academic purposes only. You are under no obligation to complete any part of this survey, but any information you can share will be very helpful. Thank you for your time!

1. What are your living accommodations in Sainshand?
    a. Ger
    b. Apartment
    c. House
    d. Other – if so, please specify: ________________
2. What is your main source of income?
3. How many people are in your family?

4. How much water does your family use everyday?
5. What do you use the water for?
6. Where do you get your household water?
    a. Kiosk
    b. Well
    c. Tanker truck
    d. River
    e. Other – please specify: ____________
7. Describe your daily water commute? How long does it take you, what time of day do you go, etc?
8. Are there any times when you don't have access to water? If so, when and for how long?
9. Are you satisfied with your water source? Why or why not?
10. Are there any problems? If so, what are they?
11. What is the quality of your water?
    a. Totally unsatisfactory
    b. Unsatisfactory
    c. Neither unsatisfactory nor satisfactory
    d. Satisfactory
    e. Excellent
12. Do you pay for water? If so, how much?
13. Are you satisfied with the price you pay for water? Why or why not?
14. Would you be willing to pay more for water if it cost:
    a. 5-6 MNT/L: yes or no
    b. 6-7 MNT/L: yes or no
    c. 7-8 MNT/L: yes or no
    d. 8-10 MNT/L: yes or no
15. Have you seen any changes in water access for your community since 1990?
    a. No changes
    b. Very few changes
    c. Some changes
    d. A lot of changes

    If so, please describe those changes.
16. Do you feel concerned about water access for your community in the future?
    a. Very concerned
    b. Somewhat concerned
    c. Neither concerned nor unconcerned
    d. Somewhat unconcerned
    e. Totally unconcerned

    If you do have concerns about water access for your community in the future, what are those concerns?
17. Do you believe climate change has any impact on water access for your community?

    If so, how big of an impact does it have?
    a. No impact
    b. Very little impact
    c. Some impact
    d. A lot of impact
18. Do you believe mining and industrial development has any impact on water access for your community?

If so, how big of an impact does it have?

a. No impact whatsoever
b. Very little impact
c. Some impact
d. A lot of impact

Please feel free to include here any additional questions, comments, or concerns that you feel the above survey did not address: