Living in Utility Scarcity: Energy and Water Insecurity in Northwest Alaska

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This study explored the links between energy and water insecurity in rural Iñupiaq Eskimo villages in Alaska's Northwest Arctic Borough. High energy costs and the need for fuel-based transportation are 2 significant factors in domestic water access for these communities. Dramatic increases in the costs of energy have led to decreased domestic water access, with adverse effects on household hygiene practices. I traced the ways in which the high costs of energy determine water consumption from production to household acquisition and use. Improving sanitation and access to domestic water requires considering the water–energy nexus: the amount and cost of energy required to treat and distribute water as well as manage waste. I use the term utility scarcity to underscore the relationship between domestic water, energy, and health. (*Am J Public Health.* 2010;100:1010–1018. doi:10.2105/AJPH.2009.160846)

> Lena: "Before, there was no payments."
> Ruth: "There were no bills."
> Lena: "The lights, the toilet . . . it spoiled us. But we can't go back and unravel it."
> Ruth: "If there's no fuel, there will be no electricity, there will be nothing. It will be hard time. We'll go back to cutting wood and hauling water."
>
> —*Two elderly Iñupiaq women*

Energy is a public health issue. This is particularly evident in the Arctic, where communities cannot access sufficient clean water and wastewater services without heat, electricity, and gasoline. An estimated one third of Alaska Native village households lack running water,[1] and the ones that do have running water face periodic shortages because of frozen pipes or an inability to pay for services. As energy costs continue to soar in remote Alaskan communities, the challenge of providing clean water and sanitation has become more acute. Escalating costs deepen the problem of water scarcity, a situation more frequently studied in developing countries where inadequate access to water and wastewater management threatens human health.[2]

Inadequate clean water access results in water insecurity, with residents rationing water use in ways that compromise their health,[3] such as reusing washbasin water or limiting water used for hygiene. The term "water–energy nexus" has recently emerged to describe the reciprocal relationship between the production of energy and the production of water.[4,5] However, beyond energy involved in piped water treatment systems and irrigation, the specific mechanisms through which energy and water shortages are related remain poorly understood. Here I have described the relationship between escalating energy costs, water scarcity, and water insecurity based on ethnographic case studies of 3 remote Iñupiaq Eskimo villages in Alaska's Northwest Arctic Borough (hereafter the Borough). I have used the term utility scarcity, which I have defined as shortages in the basic utilities necessary to protect public health, to underscore this relationship.

I seek to demonstrate that sanitation, domestic water access, and hygiene practices in the Alaskan Arctic depend on the availability and cost of energy. Scholars have clearly established the link between lack of running water and infectious disease rates and other household needs.[1] I have assessed the specific factors underlying this connection by focusing on the social relations and hidden costs involved in the collection and use of water. I have described how water scarcity manifests in 3 remote Borough villages with and without piped water. In addition, I have examined how energy issues deepen and create new situations of water insecurity.

Throughout, I have identified how energy determines water access from production to acquisition and consumption, arguing that high energy costs are already reducing Iñupiaq households' access to sufficient water. This situation exacerbates existing water insecurity in communities without piped systems and thrusts others into sudden situations of water scarcity and insecurity.

The Borough's situation demonstrates the interconnection between energy issues, water access, and hygiene. It is crucial to consider these connections at a time when the nation as a whole and Alaska in particular grapple with high energy costs. The situation of utility scarcity facing remote Alaskan populations serves as a harbinger of the water insecurity possible elsewhere if attention is not paid to the energy required to produce and access water.

Studies have identified the primary economic, social, and environmental factors that hinder access to water and sewer services. These factors include remoteness of villages, small populations that increase per-household costs, poverty, cultural miscommunication between agencies and communities, and difficult geographic and weather conditions such as permafrost and seasonal flooding.[6–8] However, little is known about the specific ways inadequate water affects hygiene over extended periods of time. There is also a lack of knowledge regarding how the staggering energy costs facing rural Alaskan communities affect water access and use.

Although regulations focus on water quality, several scholars have shown that water quantity, the piping of water into homes, and sanitation may in fact be more important with respect to human health.[9–11] Residents of the Borough have sufficient access to drinking water but experience shortages of domestic water, defined as water used for hygiene and other household needs.[12] The situation facing the Borough communities is best described as one of

both natural and contrived water scarcity[2]: an inadequacy of domestic water resulting from sociostructural factors. In other words, the Borough's water scarcity today is largely a manmade problem related to economic and political factors that have shaped the community over time. These factors exacerbate the challenge of providing clean water amid a difficult environment of extreme cold, permafrost, and seasonally high turbidity.

Energy costs underlie water access from production to consumption. The energy crisis affecting Alaska, a fundamental factor not previously explored, directly relates to water's affordability, availability, and usage. The communities assessed represent a microcosm of a global issue and demonstrate that water scarcity cannot be separated from the energy issues hindering water access. This study joins a growing body of social science literature that indicates that the relationship between water and energy supplies is a globally relevant issue.[4,5,13] Eliminating water scarcity in the Arctic and elsewhere requires addressing the cost and availability of energy in addition to water.

THE IÑUPIAT OF ALASKA'S NORTHWEST ARCTIC

The Borough encompasses 11 Iñupiaq villages and spans almost 36 000 square miles of land from the northern portion of the Seward Peninsula just south of the Arctic Circle to the southern end of the Brooks Range. There are no roads connecting these communities, which are accessible only by airplane, snow machine, boat, or the occasional dogsled.

The Iñupiat once lived nomadic lives, shifting their residences with the seasons and the availability of game integral to their subsistence economy: water fowl, fish, caribou, and sea mammals. They generally stayed in 1 place during the winter, and usually several families would share a home located in close proximity to game and sources of fuel such as willows or wood.[14] Inland and coastal residents maintained sharing partners with whom they traded prized local goods such as seal oil and caribou.[15] The survival of households was largely dependent on these kinship bonds.[14] Sharing continues to be highly valued by the Iñupiat, although elders lament its less frequent practice.

Missionaries, statehood, and the passage of the Alaska Native Claims Settlement Act (43 USC §1601–1624 [1971]), along with the introduction of basic utilities, snow machines, rifles, and all-terrain vehicles (commonly called "4-wheelers" in Alaska and "Hondas" in the Borough villages), thrust the Iñupiat toward permanent settlements, wage labor, and a cash-based economy.[14,16] These new technologies improved quality of life and health but also radically changed local cultural practices and social relationships. Much of Iñupiaq life was suddenly intertwined with petroleum-dependent technologies, which contributed to changing economic patterns among the Iñupiat. The traditional economy and its associated social roles, already waning because of the many changes resulting from Russian and American contact, gave way to the mixed cash and subsistence economy necessary to support these technological changes.[17] In interviews, elders referred to the period prior to utilities as "life before bills."

The Borough's villages sit alongside bodies of water around which much of their culture and economy still revolve. The people interviewed for this study often described the phases of the year in terms of the suitability of the river for boats or snow machines, the appearance of certain fish, and the proximity of waterfowl and sea mammals. Despite this abundance, one of the biggest challenges these communities face is access to domestic water and adequate sanitation services.

WATER SCARCITY AND ENVIRONMENTAL HEALTH POLICY IN ALASKA

Rural water scarcity in Alaska is not a new problem. Early explorers' accounts of the Iñupiat and other Eskimo populations indicate the possible presence of water-washed diseases (skin, eye, and respiratory infections as well as diarrheal disease) in these groups.[18] According to Fortuine's definitive study, winter home conditions were likely disease breeding grounds because of poor ventilation and human waste in subterranean entrance passages. The semi-nomadic lifestyles of the Iñupiat, however, helped minimize the accumulation of waste.

It is clear that the shift from nomadic to permanent settlements, which occurred as a result of both economic opportunities related to mining and pressures from the government, created a need for water and wastewater management not previously experienced.[19] As part of their efforts to improve village sanitation, missionaries encouraged the Iñupiat to abandon their semi-subterranean sod "igloos" and adopt frame houses. These houses were poorly insulated and very difficult to heat, resulting in depleted wood resources.[20,21] Attempts to seal the houses and avoid drafts resulted in poor ventilation,[21] and insufficient water supplies created unsanitary living conditions.[20] These conditions, combined with the overcrowding of the dwellings, were perfect for the spread of respiratory diseases.[21]

In the 1950s, desperate to stop the high incidence of infectious diseases among Alaska Natives, the Alaska Department of Health (ADH) began installing safe water access points in rural villages and training village sanitation aides. This dramatically reduced the rates of diarrheal disease, which was one of the leading causes of death among children in some Alaska Native communities.[22] Articles published in *Alaska's Health,* an ADH journal, described deplorable living conditions and high rates of infectious disease that led to starvation when entire households fell ill. Throughout this period, ADH officials pleaded for government water and sanitation funding to curb crushing mortality and illness rates from preventable diseases.

The construction of the Trans-Alaska Pipeline in 1977 brought tremendous oil wealth to the state and helped increase the momentum toward improved rural infrastructure. In 1982, taxes and royalties from oil production accounted for 85% of state revenues, and state aid for local government operations had almost tripled since 1980. The Alaska legislature increased municipal public works funding from a few million to almost half a billion dollars. This huge influx of state capital enabled rural growth, including services and projects that would otherwise have been unaffordable in communities with limited tax bases.[23]

However, the vulnerability of Alaska's economy to the world oil market became apparent as crude oil prices began to decline in the late 1980s. The state legislature decreased aid to local governments, and rural communities with limited local revenues were left with the responsibility of operating and maintaining

expensive public works facilities,[23] including water and wastewater systems.

Despite fluctuations in funding, revenue sharing between the State of Alaska and the city governments remains vital for village operations,[6] in large part because of limited economic opportunity combined with the high cost of living that limits local revenues. Between 2000 and 2006, utility costs in remote regions rose by 50%. By 2006, the median share of income spent on utilities among the poorest 20% of households in remote areas was 33%.[24]

After decades of investment in expensive treatment and distribution systems that required costly repairs, the rationale behind project funding has refocused on a village's ability to pay for and maintain a system. Residents of communities without running water continue to be at an increased risk of lower respiratory and skin infections,[1] as well as periodic epidemics[22] and diseases transmitted fecally or orally.[25] Yet, only outbreaks of infectious diseases such as hepatitis A receive immediate attention. Here I have highlighted hidden costs of daily and episodic water scarcity not captured by the economic sustainability criteria that currently determine funding.

ENERGY AND WATER SCARCITY AT THE PRODUCTION LEVEL

Providing and obtaining water in an Arctic environment is energy intensive and expensive, particularly during the long winter months. According to municipal financial statements, water and sewer systems are the single largest energy consumer in the Borough's villages. Avoiding freeze-ups requires adequate heating fuel, glycol, heat tape, and electricity. Surging fuel prices have led to dramatically higher charges for electricity, which is produced locally through the use of diesel. Preventative maintenance during the summer requires gasoline, which is not only increasingly expensive (as much as $10 per gallon or more) but also often in short supply.

Furthermore, operation and maintenance costs depend on the cost of freight, which has risen with the price of fuel. Freight costs in turn depend on method of transportation, which is largely reliant on shifting weather and environmental conditions. For example, inland villages that in recent years have not been able to receive barges owing to low river levels and erosion now depend on more expensive air deliveries, increasing the price of critical spare parts and fuel shipments.

Many of the Borough villages face regular and costly infrastructure problems, including overflowing sewage lagoons, broken dykes, and frozen pumps and lines. In recent years, elevated expenditures amid fewer state subsidies have exacerbated the shortage of money available for critical spare parts and preventative maintenance, leading to further operations and maintenance problems that sometimes result in system failures. Across the region, city governments have fallen into crushing debt because of the high energy consumption of water and sewer systems coupled with the rising cost of diesel used in village electric plant generators. Village councils have responded by raising service rates, in some places to as much as $150 per month. Households that are unable to pay these fees are disconnected during the summer.

The Borough's villages are thus characterized by both chronic and episodic water insecurity. Households reduce water use for hygiene when adequate quantities of clean water become inaccessible as a result of system freeze-ups or disconnections. This situation places residents at greater risk of water-washed diseases related to hygiene as well as infectious diseases such as pneumonia.[1] The introduction of water and sanitation facilities during the latter half of the 20th century drastically reduced Alaska Native morbidity and mortality from infectious disease.[18,19] The current energy crisis threatens to undo this public health achievement.

CASE STUDY METHODOLOGY

I undertook an investigation involving in-depth interviews and observation to assess how Iñupiaq households experience water and utility scarcity over time. Between March 2008 and June 2009, I conducted open-ended, semistructured interviews of varying lengths with 101 residents in 5 communities, including 8 months of participant observation in 2 villages and rapid rural appraisal in an additional village.

Regional leaders helped identify case study villages. City and tribal governments granted permission to conduct fieldwork and helped identify specific research questions and objectives. Because I am non-Native, I continue to consult with village leaders to ensure that this ongoing project remains relevant to community interests and to disseminate data in a medium that is accessible to a large portion of the population.

I recruited respondents through city and tribal councils, at public gatherings, and at public laundry and shower facilities called "washeterias" (buildings that combine a water treatment plant, laundromat, and shower facilities). I attempted to inform all community members of my project objectives through local VHF radio, via the regional radio station, and at council meetings. Interviews focused on community members' concerns related to basic utilities and health, how the introduction of utilities affected the community and household social relations, and how households obtain water. In addition, I surveyed 21 households in the case study village without a piped water and sewer system (Tundra Hill) with respect to their household water consumption. I used HyperRESEARCH version 2.8 (ResearchWare Inc., Randolf, MA) to code interviews and field notes and Excel (Microsoft Corp, Redmond, WA) to analyze survey data. I triangulated these data to obtain a clear picture of water insecurity on a daily and seasonal basis.

I primarily interviewed female heads of household, village health aides, city and tribal representatives, and water plant operators. Studies have shown that women are central figures in determining household water supplies.[26] However, in Iñupiaq communities, men are more likely to be responsible for hauling water, with women generally more aware of household health. Therefore, in most cases I deferred to male respondents' reported water consumption and female respondents' health perceptions. In addition, I interviewed 20 people from various health and development agencies and attended city and tribal council meetings. Concerns about increasing energy costs emerged in these interactions, and I expanded my scope to include energy issues related to health.

The fact that, traditionally, questions are considered invasive and culturally inappropriate in Iñupiaq culture makes surveys and interviews very challenging. Furthermore, the issue of potential stigmatization of communities and households struggling with sanitation and

finances became a significant ethical concern. I therefore use pseudonyms to refer to the case study communities.

Methodologically, concerns over stigmatization meant that many of my interviews occurred "on the fly," while washing dishes in the tribal building, mopping an elderly person's floor, or doing laundry at the washeteria. These conversations yielded rich data in a comfortable setting for the informant, who often led the interview. Other people were more comfortable speaking in groups, and I found myself leading spontaneous group interviews during community events.

EFFECTS OF PRODUCTION COSTS ON HOUSEHOLD WATER CONSUMPTION

The experiences of 3 communities during the winter of 2008–2009 illustrate how escalating energy costs at the production and household levels determine domestic water access and use, as well as the effects of sudden service loss. I examined water consumption in households with 3 different types of water and sanitation services: honeybucket, flush-haul, and pressurized in-home service. Honeybucket households lack running water and use 5-gallon plastic buckets lined with trash bags as toilets. Flush-haul refers to household water and wastewater systems with a pump and large holding tank that enables running water within the home, though residents still haul their own treated water.

Case study 1 focused on 2 villages where the majority of residents have in-home running water and sewer. Case study 2 involved an in-depth examination of honeybucket and flush-haul water access and use in a village in which, although there is no in-home service and all residents haul their own water, a public shower and laundry facility (washeteria) is available. I used these data to compare water consumption across villages according to type of household system.

Case Study 1

This case study assessed 2 villages, which I call Sheefish Lake and Jade, that have in-home piped systems to illustrate how energy costs at the production level can affect household water insecurity. Most households in the 2 villages have running water and sewer services for a monthly fee ($150 and $120, respectively) regardless of consumption level. Both communities lack public facilities, so households without running water rely on kin or close friends for shower and laundry facilities.

In the winter of 2008–2009, a combination of limited revenues, increased expenditures, preventative maintenance issues, and an extremely cold winter led to the freeze-up and failure of 1 section of the water and sewer system in Sheefish Lake. The city, which runs the utility, accrued more than $250 000 in debt to the Alaska Village Energy Cooperative (AVEC), largely because of emergency efforts to thaw freezing lines using heat tape. Many residents who lost service stopped paying for water and sewer services, which contributed to the city's burgeoning debt. By June, the city council had raised water and sewer fees to $150 per month, an increase of 15%, to pay down the debt and avoid having AVEC terminate electric service to the entire village and its facilities.

At the household level, those who lost service were forced to find other sources of water. Many relied on kin for showers, laundry, and drinking water. Households supporting those who lost service suddenly experienced a surge in their electricity bills from elevated water heater, washer, and dryer usage. This situation increased their already high cost of living, making it more difficult for them to pay their utility bills. Informants reported falling into debt with AVEC, causing them to limit use of their water to immediate family members, who in turn had to restrict their use.

The City of Jade, whose system electricity costs had created almost $70 000 of debt, raised its rate to $120 per month and created a new fee of $30 per month for water hauled from the treatment plant. Several households refused to pay the new fees and responded instead by hauling untreated water from the river or hauling water from their kin. One single female head of household described the effect:

> It's getting harder to live without running water. The city is starting to charge for the water. I got no job. I told them this will be the only time I pay for water. I told them there's plenty of water in the river! . . . But I'm worried about what's in the river, though, because the sewage lagoon always flow[s] through there during spring.

Respondents in both villages reported that these events decreased their water use. Sheefish Lake residents in particular reported less frequent bathing and laundry, as little as once a week or less. The actual change in water consumption is difficult to determine without further research because respondents did not know how much water they hauled or how much they consumed before the system failure. Although the actual consumption difference is unknown, it is clear that there were differences in the ways in which the sudden decreased water access was experienced across community groups, as discussed subsequently. Both villages have considered potentially abandoning their systems because of exorbitant energy costs, which could lead to very negative health because of the lack of public laundry and shower facilities available.

Case Study 2

Households in communities without in-home pressurized water service, such as Tundra Hill, experience water scarcity on a daily basis. To understand how energy costs affect water consumption, it is first necessary to describe how the residents of the village obtain water.

Most homes in this community of more than 450 people lack in-home piped water and sewer services. Since 1987, residents have obtained most of their water at the washeteria, which, as mentioned, combines the water treatment plant, laundromat, and shower facilities and is the only treated water access point. Very few households haul water or ice from the river, and those that do use the water for drinking rather than hygiene. A few residents buy bottled water, usually for infant formula. Residents report that they have difficulty accessing adequate water to maintain a healthy home environment.

Water scarcity in Tundra Hill, characterized by a shortage of domestic water for hygiene, is compounded by inadequate wastewater disposal services and cross-contamination from sewage. Household water insecurity results from difficulties hauling and storing sufficient water. The rising cost of living, as well as limited access to showers and laundry facilities, exacerbates this problem. Furthermore, household water insecurity increases during periods of extreme cold (–40°F or lower) and during the annual flood, when the washeteria closes and people are forced to ration water.

The flood further compounds the sanitation problem by dispersing human waste throughout the village at the same time that residents have limited water access.

There are 2 showers and 5 washers at the washeteria that serve almost the entire population. Residents pay $2 for a 7-minute shower and $4 per laundry load. Female heads of household spend $20 to $80 to do between 5 and 20 loads of laundry per week, depending on the season and the size of their family. They report that family members usually shower 1 to 3 times per week at the washeteria. Thus, a typical household of 7 spends approximately $76 to $248 per month on laundry and showers alone.

Middle and high school students are able to shower at the school if they participate on sports teams, but only during specific events' seasons. Likewise, school employees are permitted to shower at the school, and their family members sometimes, but not often, use this benefit as well. Parents and teachers report that teenagers, especially girls, are more likely to shower every day if they can afford it. Adults occasionally sponge bathe, and small children are likely to have a bath at home about once a week, depending on the amount of water available in the house. Parents will sometimes make an extra trip to haul water to bathe young children, wash dishes, or clean the house.

Households use 5-gallon plastic "honeybuckets" lined with trash bags as toilets. Those who lack a separate bathroom space store their buckets in the enclosed entryway or in one of the main rooms of their house. The city provides honeybucket and trash pick-up 1 or 2 times per week, weather permitting, using 4-wheeled all-terrain vehicles. However, household members, usually men or boys, must transport the bags of sewage out to the road themselves.

During the summer months, some families use plastic containers supplied by the city to store the waste until workers haul it away. These containers crack during the extremely cold winter, so residents must store sewage bags in cardboard boxes or in nothing at all. Removal of waste depends on the weather, because vehicles do not run properly in extreme cold. Bags sometimes sit in front of households for days awaiting removal, breaking and releasing their contents along the dirt road. Children, 4-wheelers, snow machines, and dogs track this sewage around the village and into homes. The smell of raw sewage lingers in many parts of town, particularly during the spring melt. This fact is distressing to many residents who work hard to maintain healthy home environments.

In 1986, the public health system installed "flush-haul" systems in 22 households in an effort to provide a potentially cost-effective solution for water access and wastewater management. These systems use 200- or 300-gallon holding tanks for treated water attached to individual houses that have 1 or 2 in-home taps along with a shower and a flush toilet connected to a wastewater holding tank. Flush-haul households must haul their own water along with the rest of the community, but the city pumps and disposes their sewage for $50 per haul.

Tundra Hill leaders have worked for more than 13 years with state and federal agencies to design and build a piped water and sewer system. After numerous political and financial setbacks, they completed a new sewage lagoon and began installing sewage lift stations and laying pipes in 2009. However, the project continues to face funding shortages and delays.

IMAGE 1—Four-wheelers from flush-haul households in line outside of Tundra Hill's washeteria, where residents use the large access point, protected by Arctic piping, to fill tanks or buckets with water to haul to their homes.

Hauling Water in a Fuel-Based Society

Historically, refined fuel did not figure as dramatically in water access as it does today. Before washeterias, the Iñupiat hauled water from the river and collected ice for drinking water. This was done either by dogsled or by hand using containers of various sizes depending on the physical ability of the person carrying the water. Small children carried pitchers of water, and stronger adults would carry larger buckets. Those who grew up prior to the washeteria described how its introduction initially facilitated hauling water. According to one elderly female head of a honeybucket household:

> It was a lot easier, seems like. People were taking better care of themselves, their clothing. Seems like they take better care of their homes because it was easier to get water: go up to the washeteria with dogs. But today it's harder to get water without a vehicle. Back then we always use dog and sled. That was before snow machine.

Today, few families own sled dogs. Hauling water or sewage requires a vehicle, usually a snow machine or a 4-wheeler. Dogs required food, which meant fishing under the ice throughout the winter or paying for food to be shipped into the village. The introduction of snow machines initially provided an easier option for transportation and fundamentally changed how water was hauled. Families that do not have access to a vehicle and lack in-home piped water have a much

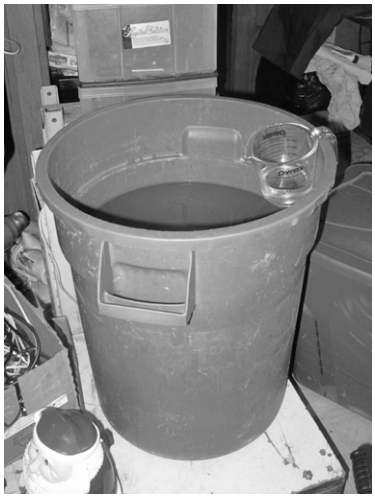

IMAGE 2—A 32-gallon container used for hauling and storing water in honeybucket households.

more difficult time accessing water, as evidenced by their lower consumption rates, as described subsequently.

Factors Determining Household Water Consumption

The World Health Organization defines sustained household water security—by both quantity and access—as 13.2 gallons per person per day and either 1 in-home tap or the ability to acquire water in fewer than 5 minutes.[12] None of the Tundra Hill households surveyed achieve this minimum standard needed to protect public health.

The specific factors determining water consumption emerged from my triangulation and comparison of survey, interview, and observational data. Regular access to a vehicle, able-bodied male kin, and washeteria access were the primary determinants of domestic water access and use under conditions in which households must haul their own water. Survey data from flush-haul and honeybucket households in Tundra Hill demonstrate the effect of vehicle access and male kin on water consumption, which was confirmed through interviews with those who lost in-home piped service in Jade and Sheefish Lake.

Based on a survey of 21 households, the average in-home water consumption in Tundra Hill was 2.4 gallons per capita per day (gal/c/d). This average falls well below the World Health Organization's definition of consumption level resulting in high health concern of 5.28 gal/c/d.[12] The largest reported volume was 7.1 gallons per capita per day in a flush-haul household with 4 adults (3 of whom were employed), 2 teenaged sons, and several vehicles. The lowest reported water consumption rate was 0.4 gallons per capita per day in a honeybucket household headed by a single employed mother living with a young child and no vehicle. Respondents noted that the amount of water they haul depends on the temperature outside, the availability of a vehicle, and whether they have male kin to haul the water. Thus, water consumption can be expected to fluctuate throughout the year.

Honeybucket households headed by single employed mothers and those without vehicles had among the lowest rates of water consumption. Of the 15 honeybucket households surveyed, 11 reported consumption rates of less than 2.5 gallons per capita per day. Within this group of lowest-consuming households, 3 reported that they did not have regular access to a functioning vehicle, and 3 were headed by single employed women with young children. Two of these female-headed households lacked a vehicle. All 4 of the honeybucket households with consumption rates of 2.5 or more gallons per capita per day owned a vehicle, and male teenagers or adult men in these households hauled water.

The 3 households with functioning flush-haul systems reported the highest consumption rates (an average of 4.8 gal/c/d) in the community. Male heads of household in these families reported hauling 200 to 400 gallons at a time using either snow machines or 4-wheelers. Flush-haul households generally had a greater storage capacity (200–300 gallons) than honeybucket households. The average consumption rate in the 3 homes that no longer used their systems due to their cost and smell (as discussed subsequently) was 2 gallons per capita per day, and these households hauled between 30 and 90 gallons at a time by vehicle.

The 3 female-headed households (all honeybucket) without male kin living at home consumed an average of 1 gallon per capita per day. The average consumption among families with male heads of household or older boys (n=17) was 2.4 gallons per capita per day. Among this group of households, those without flush-haul systems consumed 1.7 gallons per capita per day on average.

Interviews with heads of honeybucket households in Jade and Sheefish Lake and those who suddenly lost their water service as a result of disconnection or system failure confirm the importance of vehicles and male kin to water security. Furthermore, data from all 3 communities reveal that the lack or sudden loss of in-home piped service particularly affects elderly people, individuals with disabilities, and families with limited kin networks. People who fall into these categories have a more difficult time accessing water for hygiene. One disabled elderly woman described how losing her water service affected her:

> I have to do my laundry at my sisters' and sons' houses. When I have work, I help them out with fuel. But I'm 65 and I want water and sewer. I can't haul water by myself, and I have to go to their houses to do laundry and to wash. Right now my sons have to haul water for me, because I can only lift a gallon at a time. But they're not always around.

The weight of water—110.2 pounds for the World Health Organization's recommended domestic water consumption of 13.2 gallons per capita per day—accounts for the importance of a vehicle and male kin to haul sufficient water. Tundra Hill residents reported hauling water in 5- or 32-gallon containers weighing between 42 and 267 pounds each. As a result of the weight of such containers, elderly individuals, people with disabilities, and single women with young children have significant difficulty gaining sufficient access to domestic water supplies, particularly if they lack access to transportation or male kin to help them.

Flush-haul and honeybucket households headed by single women and elderly individuals (many of whom are disabled) in which an able-bodied man or older boy aged about 13 years or older is not available to haul water are more likely to experience water insecurity, particularly if they lack access to transportation. Four of the single mothers interviewed reported that they ration domestic water use. Household surveys revealed that water

consumption among this small group averaged 2 gallons per capita per day, with the lowest consumption among female-headed honeybucket households without transportation (0.4 to 1.3 gal/c/d). Many single employed women reported that they are often able to haul water only once per week, and only if they have access to a vehicle. For example, according to a single female head of a honeybucket household of 5:

> I have to run back and forth 5 or 6 times unless I borrow a larger bucket. I can do it in 15 minutes if I rush. I try to go after curfew so I can speed so that I can catch the same quarter in there . . . 30 gallons will last you for one whole week if you're careful.

Several female heads of household reported that they pay $10 to $20 for someone to haul approximately 30 gallons when they require more water than they are able to transport themselves and lack male kin to help them. Thus, the per-gallon cost for these households is greater than that among families who can haul water themselves. Many households reported that they would pay for someone to haul water only when they had enough money or in special circumstances, such as washing dishes or a child's bath. The extra costs borne by households without transportation to access water for in-home hygiene lead to rationing.

Parents with small children reported that living without running water was very difficult. One male head of a honeybucket household noted:

> Living without running water is frustrating. Having to go get water late at night is maddening, especially when a child is sick in the house.

In Jade and Sheefish Lake, a number of respondents reported that young families with small children found it difficult to adjust to the sudden loss of piped water and sewer services, particularly if the parents had grown up with running water. These families were more likely to be unfamiliar with the daily routines required to manage human waste and maintain hygiene under limited water conditions.

Fluctuations in Water Consumption

Observations and follow-up interviews revealed that water consumption in households that haul water can vary dramatically. Fluctuating factors that determine water consumption include availability of facilities, weather conditions, the intended use of the water, available household finances, and access to transportation. Furthermore, the amount of water hauled is related to the availability of male kin, which depends on factors such as longevity of relationships, employment outside the village, and illness.

Periodic service interruptions in the Borough, such as frozen lines resulting from extremely cold temperatures or insufficient water in the holding tank, are not unusual and further limit water access. In Tundra Hill, the washeteria closes during these conditions, and honeybucket households do not have access to showers or laundry facilities. Flush-haul households ration water by reducing showers and laundry and by reverting to honeybuckets. One employed female head of a honeybucket household of 5 noted:

> It was, like, 40 to 50 below for the last two weeks. . . . It was hard to haul water because the snow machines and Hondas wouldn't start. . . . People weren't washing because it was hard to get water . . . I tried to save it for cooking, so I didn't use it to clean at all. I didn't wash my hair for a long time, until my head started to hurt.

Women, particularly those who are employed, are most affected when the washeteria limits its hours of operation or closes for an extended period. Because of their combined professional and domestic responsibilities, employed mothers have few hours available for laundry and personal hygiene. With few exceptions, women and older daughters are responsible for the household laundry, often waiting in long lines at the washeteria. Employed women often must wait until the weekend to do laundry, and employed adults are less likely to bathe during the week. Some women do laundry late into the early morning hours, provided the water plant operators allow them to stay late. A number of the employed mothers interviewed reported that they often shower only once a week; others miss an hour of work to shower.

Despite these limited hours and the small number of facilities serving the population, Tundra Hill residents reported greater access to shower and laundry facilities than residents without running water in Jade and Sheefish Lake, both of which lack washeterias. The reason is that the latter rely on kin with running water, who are also providing water and facilities to other kin. Members of households who reported supporting their kin indicated that they limit access to their water to mitigate the associated energy costs.

Utility Scarcity and Water Insecurity

Soaring electricity and heating bills place a strain on household finances and deepen the situation of water insecurity. One employed mother described the per-month costs associated with accessing water in her 6-member honeybucket household:

> I figure we spend about [$]320 to [$]500 on laundry, hauling water, showering, gas to haul the water. . . . Sometimes I have to put off showers and laundry so I can pay my bills.

Likewise, energy costs affect the efficacy of flush-haul designs. Theoretically, flush-haul households would consume more water and not have to come in contact with their own waste. However, only about 7 such households in Tundra Hill continue to use their systems, and some of these households use the systems only in the summer months. The primary reasons households abandon flush-haul systems are the associated electricity costs, poor cold weather design, and unpleasant smell. According to a male head of a flush-haul household:

> We had flush hold, with a tank with heat trace around it. But the tank got filled up and couldn't get sucked clean. . . . Another problem was that they give me no high alarm to tell me that the tank was full. I had to wait until it start[ed] smelling. . . . So I stopped using it. . . . Why should I keep it heated? It's not doing me any good. . . . My electricity bill went way down after I stopped using it.

Even without rising costs, the need for vehicles makes hauling water and waste vulnerable to the inclement weather that characterizes an Arctic winter. In Tundra Hill, uptown residents are unable to dispose of their waste or use the washeteria during the annual flood, when contaminated water from the sewage lagoon makes the only road impassable. During these periods, families in flush-haul households reduce bathing and laundry and use their toilet as a honeybucket by lining it with a trash bag.

In addition, rising energy costs affect the social relationships of sharing involved in accessing water. Honeybucket households headed by elderly people, individuals with disabilities, and single mothers with young children rely on kin (often male) or neighbors

to help them haul water and dispose of the contents of honeybuckets. In Jade and Sheefish Lake, which lack washeterias, most honeybucket households and those without in-home service depend on kin to access domestic water.

Rising energy prices are further undermining the sharing networks on which these residents depend for water related to hygiene. Across the region, energy costs continue to affect many aspects of village life, from the price of food to utility bills, which consume as much as 33% of household incomes.[24] Some of the elderly people interviewed reported that the ever-rising cost of living has also contributed to the weakening of traditional sharing networks. For example, some noted that, unlike in the past, family members will sometimes now charge to haul water and wood. Those who rely on kin for help obtaining water and other necessities are particularly vulnerable as these sharing networks decline.

CONCLUSIONS

In their 2008 study, Hennessy et al.[1] demonstrated clearly that a lack of in-home piped water and sewer services is linked to higher respiratory and skin infection rates. Here I have used an anthropological focus on social relationships and hidden costs to describe how energy issues fit into the web of causality behind water insecurity and water-washed diseases.

Increased energy costs translate into water insecurity via 2 paths. In Borough villages with running water, production and distribution of clean water are energy intensive, requiring large amounts of heat and electricity. The governing bodies managing these system pass along rising operational costs to households through increased user fees that may lead to disconnections or decreased maintenance that eventually interrupts service when pipes freeze or pumps fail. The sudden loss of water and sewer services creates dramatic changes in household water use and hygiene practices.

Households without in-home piped systems that use vehicles to haul their own water directly absorb increased costs through higher gasoline prices in addition to any fee increases. Mounting energy costs deepen water insecurity in honeybucket households because of the increased cost of living that forces residents to choose between paying bills and buying domestic water. Furthermore, the health benefits possible with flush-haul systems are compromised by high electrical costs that lead residents to stop using their systems and by the need for motorized vehicles for sewage removal. Periodic interruptions in sewage removal and washeteria closures lead to water insecurity in such households.

In the case of self-haul systems such as honeybucket and flush-haul, having a sufficient domestic water supply is dependent on household access to fuel-based transportation, able-bodied male kin, and storage capacity. Thus, honeybucket households (which are characterized by a storage capacity of 32 or 64 gallons, depending on the number of 32-gallon storage buckets) headed by single mothers with young children, elderly people, individuals with disabilities, and those without a vehicle are especially vulnerable to water insecurity. The data from residents who lost service in Jade and Sheefish Lake dramatically illustrate how the rising cost of living that impedes upon traditional sharing among kin exacerbates the vulnerability of these populations.

Furthermore, these data demonstrate the importance of affordable, uninterrupted washeteria facilities to hygiene for honeybucket households and those who lose in-home services. The experiences of Jade and Sheefish Lake residents illustrate how the high cost of living, deteriorating sharing networks, and lack of a washeteria converge to create a water insecurity crisis when piped water systems fail.

Rising energy costs create and deepen water insecurity at both the production and household levels. Addressing water scarcity and insecurity requires thinking about the water–energy nexus and the possibility of utility scarcity: whether shortages in any basic utility will negatively affect access to water. It is therefore necessary to examine the social relationships and technologies involved in the production and household acquisition of domestic water. ■

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This article was accepted October 3, 2009.

Acknowledgments

The National Science Foundation (Doctoral Dissertation Research Improvement Grant 0713935), the University of California, Berkeley, Community Forestry and Environmental Research Partnerships Dissertation Fellowship, the University of Arizona School of Anthropology, and the University of Arizona Social and Behavioral Sciences Research Institute provided funding for this project.

I am indebted to my advisor Linda Green, Mark Nichter, Mimi Nichter, Susan Shaw, Thomas Perreault, Scott Whiteford, and the 3 anonymous reviewers for their thoughtful critiques and guidance. Special thanks to Sharman Haley at the Institute for Social and Economic Research in Anchorage, AK.

This research was made possible by the generosity of people across Alaska who facilitated interviews, reviewed initial reports and grant proposals, provided housing, and made sure I was always warm and fed: Alice Palen, Jennifer Cross, Sheila and John Fox, Charlotte and Lance Westing, Katherine Muns, Jane and Chris Haigh, Annabelle Alvite, Rachael Lee, Ella Derbyshire, and countless individuals in the Northwest Arctic Borough villages.

I am especially grateful to the tribal and city council members who allowed me to work in their communities. Thank you to the Maniilaq Association Environmental Health Division, the Northwest Arctic Native Association, and the Northwest Arctic Borough mayor, Siikauraq Whiting, and her staff for their generous support and guidance. The staff at the Rural Utility Business Association, the Alaska Native Tribal Health Consortium, and the Village Safe Water were invaluable sources of information regarding the health and development of rural Alaska Native communities.

Most important, thank you to all of the people in the Northwest Arctic Borough who welcomed me into their homes and hearts during my fieldwork. Aariigaa taikuu.

Human Participant Protection

The institutional review board of the University of Arizona approved this study and all of the consent documents used in the research process.

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