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Short Communication

Extreme water conservation in Alaska: limitations in access to water and consequences to health

T.K. Thomas[*], *K. Hickel*, *M. Heavener*

Alaska Native Tribal Health Consortium, USA

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Many people living in rural Alaska have very limited access to water. If water is not piped to the home, then it must be collected from the community dispensing point or another source, which is time consuming, costly and may be impacted by seasonality and extreme weather. This paper will expand on the current estimates of the quantity of water that people are able to access if water is not piped to their home, why there may be limited supplies of water available, the challenges in accessing it, the constraints on distribution and the consequences to health that have been observed.

The principal law regulating drinking water for all public water systems in the USA is the Safe Drinking Water Act which was enacted in 1974 and most recently amended in 2002.[1] By definition, 'a public water system is any system that provides water through pipes or other conveyances for human consumption and has at least 15 service connections or regularly serves at least 25 individuals daily for 60 days out of the year.' Nearly all rural communities in Alaska have a public water treatment facility; however in many communities the water is not distributed to the homes and is only available at a central watering point. The responsibility for provision of safe water ends at the watering point. In these un-served communities (i.e. those that do not have complete plumbing, defined as running water service to a sink, a toilet and a shower or bathtub), residents must haul this water (usually by an All-Terrain Vehicle [ATV], snow mobile or by hand) and store it in the home, often in a 33 gallon (125 l) or 55 gallon (208 l) plastic container. Five gallon buckets or 'honey buckets' serve as toilets. These buckets are emptied by the residents directly into a community sewage lagoon or into collection containers located around the community that are then hauled to the sewage lagoon. These communities are often referred to as 'self-haul' or 'honey bucket' communities. As of 2013, approximately 22% of rural Alaskan homes, amounting to approximately 20,250 people living in 4500 homes, lacked in-home piped water.[2]

Hauling water requires manpower, time and money, and the amount of water that can be transported and stored in the homes is limited. A survey of 21 homes in a Northwest Alaskan community estimated average in-home water consumption was 2.4 gallons per capita per day (gpcd).[3] Households headed by single mothers living with young children and who had no vehicle used considerably less water. Anecdotal reports from residents in one rural community without piped water mention that transportation issues severely affect water haul routines and that elders and those with disabilities often must pay someone to haul water unless they have a family member able to haul. A study conducted in four rural Alaskan communities without piped water in the home indicated a mean household water use of 1.5 gpcd.[4] This is equivalent to the estimates of water use in the country of Mali in Saharan Africa. By comparison, the average person in the United States uses 156 gpcd (Fig. 1).[5]

* *Corresponding author*. Alaska Native Tribal Health Consortium, Division of Community Health Services, 3900 Ambassador Drive, Anchorage, AK 99508, USA. Tel.: +1 907 729 3905; fax: +1 907 729 2924.
E-mail address: tkthomas@anthc.org (T.K. Thomas).
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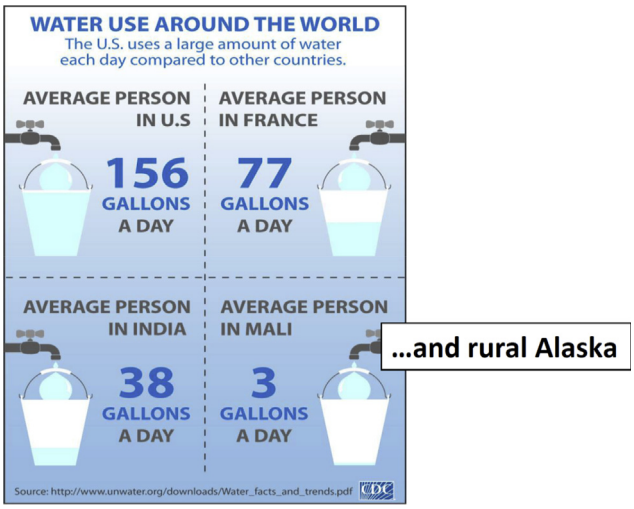

Fig. 1 – Average water use around the world.

Aside from hauling water from a water treatment facility, other sources used in rural Alaska include collecting rainwater or water from natural bodies of water such as streams, rivers, ponds or lakes. Besides rainwater, these sources are restricted by the same constraints that arise when hauling water, such as the lack of able bodies and working transportation. All of the alternative sources are more difficult to access in winter due to freezing. In some communities, individuals will collect ice which must be cut, hauled and melted to provide water for the home.

Many residents of rural Alaska do collect rainwater, which is the only water that does not require hauling to the home. However, rainfall is limited in much of the Arctic, and most homes do not maximize on collection and storage. The average annual rainfall for the hub communities of Bethel, Nome and Kotzebue in Western Alaska are 18.6, 16.8 and 11.0 inches respectively,[6] which is equivalent to the annual rainfall in desert cities like Los Angeles, California (18.67 in) or Tucson, Arizona (10.7 in), except that 40% of the rainfall in Alaska occurs in winter months (October–April) when collection is complicated by freezing temperatures.

Additional challenges are faced in obtaining, treating and distributing water from water treatment facilities. A number of community water systems in rural Alaska obtain their water from open sources such as rivers or lakes. During winter, these sources are either not available or are very limited as they are either frozen or the water lines to the community are drained due to risk of freezing. These communities will fill storage tanks during the summer for use during the winter months. That water then must last until the source is once again available.

Some communities obtain water from wells. While less susceptible to freezing, a number of communities have wells that freeze or have wells where the output during the winter is diminished. Other challenges faced with well water include contaminants particularly arsenic, iron and manganese which impact taste or salt water intrusion for those communities close to the ocean.

Distribution of water in the Arctic is a costly undertaking, not only to initially construct, but to operate and maintain. Water distribution pipes often must be built above ground due to the permafrost, and they must be insulated and heated. In addition, the widespread impacts of climate change such as the subsidence of permafrost soil pose challenges to the installation and continued operation and maintenance of piped infrastructure. While these are technical challenges that can be overcome, the solutions are not considered viable given the associated costs. The cost per foot of pipe above ground is estimated to be $250–$350 USD per foot (30.5 cm; M Heavener, personal communication, January 22, 2016). The 2012 capital cost for first time installation of piped water for communities in Alaska was estimated to be $300 USD million, with an additional $400 million USD for upgrades to failing systems. The total funding available in 2012 was only $66 million USD. Projections for 2017 demonstrated increased needs and no increase in funding.[7] The estimate for one community in Western Alaska of 100 households is that it would cost more than $40 million USD or more than $400,000 USD per home— not a feasible option in the near future.

The discussion of capital costs does not address the average monthly water bill that some residents face. The US Environmental Protection Agency has recommended that residents do not spend more than 5% of their monthly income on their water and sanitation bill. A review of five rural Alaskan communities and four urban centres in Alaska found that all five rural communities were above the 5% threshold whereas the urban communities were below 2%.[7]

Limited water availability results in extreme water conservation practices, including multiple uses of the same basin of water for hand-washing and reuse of laundry water for multiple laundry loads in non-piped portable machines[8] and places communities in a World Health Organization (WHO) category of very high health concern. The Sphere Handbook, a guide on minimum standards for humanitarian response, recommends a minimum of 2–4 gpcd (7.5–15 l) in an emergency situation,[9] and the World Health Organization recommends 13.2 gpcd (50 l) to achieve a low level of health concern.[10]

The health consequences of limited access to a sufficient quantity of water have been described in several recent epidemiological and prospective studies. A 2008 analysis[11] of rates of infections in Western Alaska showed that communities where <10% of homes were served had significantly higher infant hospitalization rates for pneumonia and respiratory syncytial virus, higher rates of hospitalization for skin infection among all ages, and higher rates of outpatient *Staphylococcus aureus* infections, compared to communities where >80% of the homes were served. These findings were reinforced by two other studies of respiratory disease in Alaska Native children.[12,13] The recent prospective study of four rural Alaskan communities that transitioned from self-haul to piped demonstrated significant declines in infection visits overall. Comparing the three years prior to three years postinstallation of piped water, respiratory, skin and gastrointestinal infection clinic visits declined 16%, 20% and 38% respectively, with the largest declines being observed in the younger age groups.[4]

The Safe Drinking Water Act has resulted in an 'all or nothing' choice for rural communities in Alaska. They either have to choose to have an expensive economically infeasible system where ample quantities of potable water are available and used for drinking, bathing, flushing toilets and all other uses or they are faced with hauling and storing limited water in the home and using a honey bucket and a handwashing basin. This limitation on access to water places them at the extreme end of the water use spectrum, equivalent to living in a desert. As government funding for community water systems is tied to meeting the requirements of the Safe Drinking Water Act (i.e. the provision of potable water upon entrance to the home), the regulations have hindered innovation and the development of more cost-effective solutions such as point-of-use treatment in the home. Consequently, there is a need to think 'outside the pipe' and explore alternative ways for households to have *potable* water for consumption (e.g. point-of-use treatment, rain catchment) and an adequate *quantity* for personal hygiene and household uses[4]. Various initiatives are being supported through the State of Alaska Department of Environmental Conservation 'Water and Sewer Challenge,'[14] the US Arctic Research Commission Alaska Rural Water and Sanitation Working Group,[15] the Alaska Native Tribal Health Consortium and other Alaska Native Tribal Health Organizations, but major efforts and funding are needed to address this disparity.

Author statements

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