Quality of Unregulated Rural Water Supplies in the Northern Navajo Nation

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Problem statement

The Navajo Nation is the largest land area assigned to a Native American jurisdiction within the United States. The Nation covers approximately 26,000 square miles of three states of the Southwestern US, encompassing parts of northeastern Arizona, southeastern Utah, and northwestern New Mexico. There are 270,000 federally recognized Navajo Nation members within the reservation boundaries. An issue of particular concern in the Navajo Nation is the lack of water supplies that meet U.S. Safe Drinking Water Act standards, especially in the remote and rural areas. Approximately one quarter of the dwellings on the Nation do not have utilities (http://www.ntua.com). The Navajo Tribal Utility Authority (NTUA) is only provider of drinking water supplies that are regularly tested and managed according to requirements of the Safe Drinking Water Act (SDWA). Although the NTUA is extending the utility system, in some areas the only sources of water are unregulated, often windmill driven pumps that store water in tanks designed for stock watering, which are not regulated by the Navajo Nation EPA Public Water Systems Supervision Program (PWSSP). Testing of unregulated water supplies in 2008 by Dine College and the University of Nevada found that levels of uranium, fluoride, arsenic and fecal coliform exceeded the EPA Maximum Contaminant Levels (MCL). Potential sources of these contaminants include livestock feces, urine, naturally occurring minerals, and legacy mining and milling operations.

Methods and Materials

In 2009, teams of students from Diné College, in Shiprock, New Mexico and the University of Nevada, conducted sampling in the northern agencies of the Navajo Nation, with a focus on sources used for drinking water supply. The teams relied on the close familial and neighborly relationships of the Navajo Diné College students and faculty to identify unregulated sources used for drinking water. Also, individuals were sometimes encountered at the windmill water hauling points filling up personal water tanks, which proved to be a valuable method for obtaining more information on use patterns. Additionally, wells exceeding drinking water MCL's in the summer 2008 sampling program were retested in summer 2009. All site locations are recorded using a Trimble Recon GPS unit. Formalized oral surveys administered in Navajo and English were administered to outlying rural inhabitants and individuals encountered at the hauling points, with the objective of gleaning useful information about water use habits of the residents.

Sampling

Parameters

Samples obtained from unregulated water sources were tested for chemical content (Uranium, Fluoride, Mercury, Arsenic, and Lead), bacteriological presence (*E. coli*), and physical characteristics (pH, temperature, conductivity, and dissolved oxygen percentage). The sample collection protocol is described below.

Analytic Methods

The Nevada State Health Laboratory (a certified drinking water analysis laboratory) carried out analysis for metals using USEPA methods relying on inductively coupled plasma mass spectrometry. We used the IDEXX Colisure drinking water microbiology test kit to enumerate *E. coli* in drinking water. The method employs nutrient enrichment of water samples, which were sealed into a proprietary sample tray containing multiple wells and incubated at 35 deg. C for 24 hours. Color changes and florescence indicated presence of E. coli, expressed as a most probable number of cells present per 100 mL. Field tests to obtain physical water parameters were performed using a Yellow Springs Instrument (YSI) Model 556 MPS (Multi Probe System). The YSI 556 MPS was calibrated for pH, conductivity, and dissolved oxygen according to manufacturer's instructions at the outset of a multi-day sampling period.

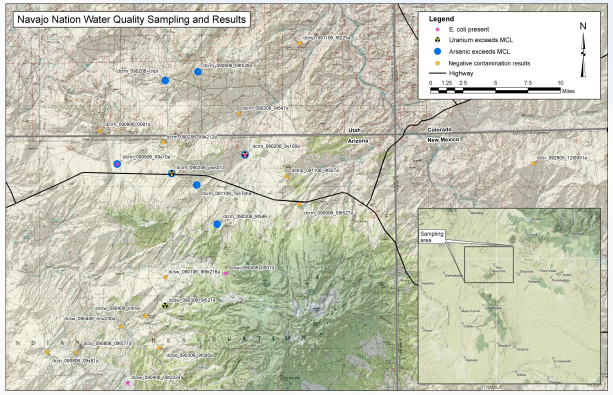
Collection protocol

Samples for metals were collected in 250 mL bottles with enough nitric acid to yield a 0.15% solution when filled with sample. The acid acts as a preservative to prevent dissolution of analytes and to extend shelf life before laboratory analyses are performed. Samples collected for analysis of fluoride are placed in clean 250 mL bottles that did not contain an acid preservative. Bacterial samples were collected in sterile 100 mL bottles prepared by IDEXX. For water sources with easily accessible spigots or valves at troughs, the water samples are collected directly by holding the bottle below the flow source and filling the bottles slowly to avoid overtopping. When the water source was not easily accessible (such as an inconveniently placed spigot or an open water source), a sterile vessel was used to collect and transfer water to sample bottles. In order to collect water for the physical analysis with the YSI 556 a 3-gallon bucket was rinsed with water from the water source several times to avoid cross-contamination between water sources. The entire probe is submerged in the full bucket and measurements were made when readings stabilized, usually within approximately 2-5 minutes.

Results

The sampling area map with chemical and biological results is shown in figure 1. Figures 2 and 3 display the cumulative frequency of the presence of contaminants arsenic and uranium in the sample set. The EPA Maximum Contaminant Levels (MCL) of arsenic, uranium and fluoride are 0.01 mg/L, 0.03 mg/L and 4.0 mg/L respectively. Thirty percent of the sample points exceeded the MCL of Arsenic, eleven percent of the sample points exceed the MCL of Uranium and three percent of the samples exceed the MCL of fluoride. Also, fifteen percent of sampling points tested contained *E. coli*.

Figure 1



Cumulative frequency of contamination

Figure 2

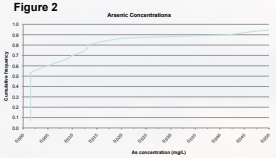


Figure 3

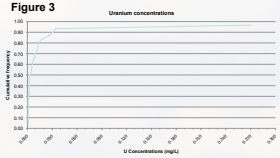


Figure 4

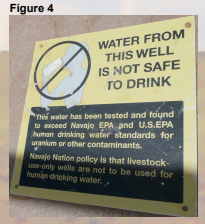


Figure 5

Discussion

The levels of contamination found in the unregulated water resources of the Navajo Nation are clearly a danger to public health. Metals of particular concern are uranium and arsenic, the most commonly occurring contaminants in the tested water. At one water source, the amount of uranium reached over nine times the MCL for drinking water. Uranium causes kidney toxicity and can significantly increase the risk of cancer. Also, uranium accumulates in bones and tissues. In three water sources, the amount of arsenic present reached over four times the MCL for drinking water. Long term exposure to high concentrations increases the risk of internal organ and lung cancer. Additionally, the presence of *E. coli* in the water indicates fecal contamination, which puts individuals consuming the contaminated water at increased risk for sicknesses related to pathogenic microbes such as *Giardia* and *Cryptosporidium*.

Compared to the United States, residents of the Navajo Nation are vastly underserved, with one in four Navajo residents lacking utilities such as clean water essential for everyday life. Clancy Tenley, associate director for tribal programs of the EPA said, referring to a meeting with rural residents on the Navajo Nation, noted that "Every single person said the same thing. The roads are not good, there is no power but what we really want is water." (Gallup Independent June 1, 2009).

One of the primary barriers to delivering clean water to all rural residents of the Navajo Nation include is the extremely high cost of construction and expansion of the regulated water distribution system. Many of the rural residents simply do not have any choice about where they obtain water and are constrained by lack of reliable transportation, poor roads, rugged geography, and health problems. It is clear that some rural inhabitants still use these unregulated water sources for cooking and drinking, highlighting this as an important public health issue.

The Navajo retain strong ties to their land, and as such, have sometimes grown up using the same water source for years, and it can difficult to give up a water source that has been relied on for so many years of everyday use. Public education is an important component for Navajo to become more aware of the potential dangers that exist in their unregulated water sources. Through education and awareness outreach at the local seats of government known as chapter houses, people are presented with basic information about water contamination. Some rural unregulated water sources that have been tested are marked with signage, warning that the water is unfit for human consumption (Figures 4 and 5), although it can also be unfit for livestock since these animals are a primary food source for many on the Navajo Nation.

Solutions to the water quality issues in the rural Navajo Nation lie with both the individuals and at the government level. Awareness of water contamination and the related health issues can empower residents to make educated decisions and find solutions to the difficulties faced in accessing clean water in the rural areas. Some rural residents obtain clean water by traveling to areas with friends and neighbors served by regulated water to fill their portable water tanks. The EPA is collaborating with the Indian Health Service to construct new rural water sources such as raised tank systems. Other potential solutions to the lack of clean water include a pilot water hauling project in which rural residents will be served by water trucks.

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