For Pastoralists the Risk May Be in the Drinking Water: The Case of Kargi, N. Kenya

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Inadequate quantity of water is a common problem for pastoral people in East Africa. For the Rendille community of Kargi in northern Kenya, however, water quality has also been identified as a critical issue. Residents report that water-borne diseases commonly affect human health in dry seasons, and livestock may die soon after drinking water from some of the older, deep wells. We collected water samples from four key wells and one earthen dam to analyze physiochemical and bacteriological quality. Preliminary results indicated that the centrally located, oldest wells tested far below technical quality guidelines in several respects. Especially notable were the very high mineral content of the water and the presence of toxic bacteria (Salmonella spp., Escherichia coli). Low concentration of oxygen in the water from old wells—in combination with the presence of Salmonella –may promote production of potentially lethal gases like hydrogen sulphide. In contrast, water quality in younger wells and the earthen dam—all further from Kargi town—more commonly met technical guidelines overall, but evidence of bacteria from fecal contamination was still detected. As settled populations of pastoralists grow in the absence of infrastructure development, dangers of water contamination and water-borne human illness increase. Community-based interventions to better manage water quality are reviewed. A simple, low cost solution is proposed.

Background

When pastoral people are surveyed and asked to rank their most important problems, lack of water is commonly mentioned (Smith et al. 2000). The PARIMA project helped coordinate an exercise in Participatory Rural Appraisal (PRA; Lelo et al., 2000) during 2001 at a Rendille community called Kargi, located about 80 km southwest of Marsabit Mountain in arid northern Kenya. The full PRA revealed that lack of safe, clean water for consumption by people and livestock was perceived to be a priority problem by the community (Desta and Godana, 2001). People reportedly commonly suffer from water-borne illnesses—especially during dry seasons—such as typhoid, cholera, and dysentery. A massive die-off of livestock was noted in 2000 when over 1,000 animals perished soon after consuming water from an old well. Community residents generally perceive a significant risk of death for animals when they drink from some of the local water sources at certain times of the year. The animals may bloat and die within an hour of drinking. The cause of poor water quality was unclear, however, and the community had many theories as to why (Desta and Godana, 2001).

Kargi was a single water point in the 1920s, but started to become a small town by the early 1970s when Rendille nomads settled (Shivoga, 2002). Kargi now has about 5,700 people living under difficult conditions that include a lack of infrastructure, high levels of illiteracy and physical insecurity, and prevalence of drought. In the past 30 years some 20 wells have been dug in and around Kargi, but today about seven remain fully functional in terms of adequate water flow or minimally acceptable water quality (Desta and Godana, 2001; Shivoga, 2002).

As a first step to address water quality problems at Kargi, we decided to analyze water samples from five key water points for physiochemical and bacteriological features during April 2002. We followed standard procedures of APHA (1992). Water samples were taken from a number of sources. Some were collected from two centrally located wells (called Kargi and UNESCO Wells) that are up to 9 meters deep and over 50 years old. The rest were collected from two younger, shallower wells (called School and Hadad) and an earthen dam (called Kuya) that accumulates surface water. In contrast to the two old wells, these three other water points are located further from the core settlement zone of Kargi.

Preliminary Findings

In general, the water quality from the older wells was revealed to be very poor in both physiochemical and bacteriological features. Results for selected parameters are shown in Table 1 along with technical quality guidelines from ACCC (1999). The full spectrum of test results is given in Shivoga (2002). Particularly notable are the very warm temperatures of well water (due to residual volcanic influences), the high mineral content

Table 1: Selected water quality values from samples collected at Kargi, northern Kenya, during April 2002[1]

	Water Point				
Parameter	Kargi Well	UNESCO Well	School Well	Hadad Well	Kuya Dam
Temperature	32.0*	31.5*	32.7*	32.8*	29.5*
pH	9.6*	9.2*	9.2*	9.5*	11.5*
Salinity	<2.5	<2.5	17.5	<<2.5	<<<2.5
Hardness	1,159**	1,572**	574*	292	70
Sulphates	941**	2,587**	3,528**	470	T
Coliform	70	0	30	700	40
E. coli	+++	+++	-	+	-
Salmonella	+++	+++	+	+	+

[1]A total of 23 parameters were evaluated. Analyses followed procedures of APHA (1992). Temperature is in degrees centigrade; pH is a measure of acidity with tabular values indicating non-acidity (base) levels; salinity was measured in salt grams per liter; hardness was measured in terms of milligrams of calcium carbonate per liter; sulphate content was measured in terms of milligrams of sulphur per liter (with T as trace); fecal coliform was measured in terms of concentration of bacteria per milliliter; E. coli and Salmonella bacteria were measured as clearly present (+++), likely present (+), or absent (-) using laboratory bacteriological assessments.

Asterisks indicate either high (**) or slight to moderate (*) variation from ACCC (1999) guidelines for domestic water. Guidelines for salinity are not given. Bacteria (fecal coliforms, E. coli, Salmonella) are not supposed to occur in domestic water under any circumstances.

of water, and presence of toxic microbes. Microbes included fecal coliforms, *Salmonella* spp., *Escherichia coli*, and possibly *Shigella* spp. Shivoga (2002) speculated that ambient conditions in the old wells could be conducive to the manufacture of hydrogen sulphide gas (H_2S), a potentially lethal compound produced by *Salmonella* microbes when oxygen concentration of water is low and free sulphur is abundant. This could explain livestock mortality risk after drinking well water, but requires further investigation (Shivoga, 2002). Low oxygen concentrations in well water can be promoted by warm water temperatures and restricted aeration.

The water quality from the younger wells and the Kuya Dam was a bit better compared to that of the old wells. Although salinity and total mineral content was often high for the School Well, only a trace of *Salmonella* was detected in bacteriological analysis. Blooms of blue-green algae (Cyanobacteria) were also visually noted on the walls of the School Well, and some species of this microbe family can be toxic (Shivoga, 2002). The younger wells and Kuya Dam exhibited evidence of fecal contamination from coliform bacteria, even though presence of *E. coli* and *Salmonella* spp. tended to be lower than values for water from the old wells (Table 1).

Practical Implications

Water quality for the old Kargi and UNESCO Wells is very poor for human—or even livestock—consumption. One factor that contributes to this situation is probably the central physical location of these wells in relation to the town and low position on the landscape. Rare but severe rainstorm events could help funnel human and animal waste into the water supply for these wells. It is doubtful whether the water quality from these old wells could ever be restored to meet minimum standards for human consumption. Catchment systems could be constructed that would help channel waste water away from the aquifers serving the old wells. Water intended for livestock consumption could be drawn from these wells and left to stand overnight in open troughs to allow evaporation of potentially toxic gases like hydrogen sulphide (Shivoga, 2002).

Water quality from the younger School and Hadad Wells and the Kuya Dam was somewhat better compared to that from the old wells, and validates why these water sources tend to be highly valued by the community (Shivoga, 2002). The improved condition of these water resources is probably related to factors that include the physical location of these water points and attention given to excluding animals from the immediate vicinity. The younger wells and Kuya dam are located away from concentrated human settlement. The Kuya Dam, in particular, is protected by a strong thorn fence to keep animals out. This also helps keep animal waste from collecting in the vicinity. The presence of fecal coliforms at each of these locales, however, means that the community must still be vigilant.

The community could be trained to monitor water quality using simple test kits and hence have an early warning system to detect problems before they overwhelm the system (Shivoga, 2002). While the high mineral content of water in general appears to be a given due to geology and is not amenable to improvement, a simple system for "pot chlorination" could be implemented to eliminate dangerous microbes, especially at the younger wells having smaller water volumes (Shivoga, 2002). That such microbes pose community health risks is an understatement. Microbes such as fecal coliforms are associated with diarrhea, vomiting, and dehydration. *Shigella* spp. can be associated with dysentery. Strains of *E. coli* are associated with acute systemic poisoning, and chronic exposure can lead to permanent health complications. *Salmonella* is a genus that leads to a variety of very debilitating ailments including typhoid fever, arthritic-like joint diseases, and severe diarrhea. Death can occur from any of these challenges.

Pot chlorination involves use of a clay pot (7-10 liters capacity) with several dozen holes, 6-8 mm in diameter, drilled in the lower half. The pot is then half filled with gravel (20-40 mm in diameter). A 1:2 mixture of bleaching powder (hypochlorite) and clean sand is placed over the gravel, and then gravel is used to cover the bleach/sand mix and fill the container to the neck. No lid is used. The pot is then lowered into the well for one week. Bacteriological tests could be carried out to assess presence of toxic microbes—if positive readings are found, then the pot chlorination treatment could be repeated. It is estimated that the cost of the pot chlorination system appears nominal compared to the potential community health benefits. The pot may cost around KSh 500 (USD 6.58), and a week's supply of bleaching powder could cost about KSh 10 (USD 0.13). The main technical constraint is the ability to reliably monitor bacteriological quality of the water.

Onset of typhoid, cholera, and dysentery reportedly occur more commonly during the later stages of dry seasons when the people of Kargi are forced to procure water from a dwindling supply of riskier sources (Shivoga, 2002). This suggests, at minimum, that pot chlorination of the younger wells may be most useful at very specific locations and certain times of the year preceding intensive use. Finally, the Kargi community could benefit from extension education that emphasizes linkages among human health, sanitation, and water resource management.

Conventional wisdom in pastoral development focuses on needs to deal with priorities such as drought, poverty, livestock management, marketing, ecological degradation, loss of key resources, and physical insecurity. While water has traditionally been viewed as a major constraint for pastoral livestock production and the balanced use of extensive forage resources, insufficient attention has been given to the problems of water quantity and quality for increasingly settled populations of pastoral people living under conditions of high human concentration and limited infrastructure. While comprehensive surveys of water quality and human health have yet to be conducted throughout pastoral areas in East Africa, we suspect that problems of water quality, like those observed at Kargi, are probably increasingly common.

References and Further Reading

American Public Health Association (APHA). 1992. *Standard Methods for the Examination of Water and Wastewater.* Eighteenth Edition. Washington, D.C.: The American Public Health Association, The American Water Works Association, and The Water Environment Federation.

Association of Canadian Community Colleges (ACCC). 1999. *Water, Sanitation and Waste Management: Water Quality Testing and Monitoring*. Ottawa, Ontario: The Association of Canadian Community Colleges.

Desta, S., and D. Godana, eds. 2001. *A Participatory Rural Appraisal Report of the Rendille Community of Marsabit District at Kargi.* Unpublished PARIMA Report.

Lelo, F., J. Ayieko, R. Muhia, S. Muthoka, H. Muiruri, P. Makenzi, D. Njeremani, and J. Omollo. 2000. *Egerton PRA Field Handbook.* Third Edition. Njoro, Kenya: The PRA Programme, Egerton University.

Shivoga, W.A. 2002. "Kargi Wells Water Quality Analysis. Report Presented to the Pastoral Risk Management (PARIMA) Project." Department of Environmental Science, Egerton University, unpublished report.

Smith, K., C. Barrett, and P. Box. 2000. "Participatory risk mapping for targeting research and assistance: With an example from East African pastoralists." *World Development* 28(11): 1945-59.

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About the Projects: The Sustainable Management of Watersheds (SUMAWA) CRSP project is a multidisciplinary research effort focusing on biophysical and human-related factors governing the watershed processes for the purpose of improving long-term sustainability of rural watersheds in Kenya and East Africa. The project is led by Dr. Scott Miller, University of Wyoming, Email contact: snmiller@uwyo.edu.

The GL-CRSP Pastoral Risk Management Project (PARIMA) was established in 1997 and conducts research, training, and outreach in an effort to improve welfare of pastoral and agro-pastoral peoples with a focus on northern Kenya and southern Ethiopia. The project is led by Dr. D. Layne Coppock, Utah State University, Email contact: lcoppock@cc.usu.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East Africa, Central Asia and Latin America.

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