Water Quality in the Darhad Valley

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Abstract

With 300 lakes, about 80 rivers and streams and a massive amount of wetland area, the Blue Valley or the Darhad Valley's water plays a big part in the local people's livelihood. The people rely directly on surface water and have no way to purify it except for wood stoves. Therefore, water quality in the Darhad Valley is a concern of the community members, health professionals and the local government. I collected samples, performed thirteen water quality tests and gathered information from surveys on water from community members. In an interview with Dr. Purevsuren, director of the Renchinlhumbe hospital, the head doctor and chief surgeon, he informed us that the top three health concerns in the valley, related to poor water quality were tooth decay, kidney disease and diarrhea in children.

Obtaining an accurate measurement of the valley's water quality involved testing every water source that was recommended by the local residents as well as areas known to be popular drinking sources. Survey responses indicated that the local residents were worried about the health of their water and didn't know what to do about it. Fifteen water sources in the valley were sampled and some were tested multiple times. In addition, an educational project demonstrated that increased boiling times are necessary to eliminate bacteria from water being prepared for human consumption.

With the information collected and the help of Tugsu Armstrong (BioRegion's translator) and Cleone Todgham (a volunteer for BioRegions), I created several items for an educational presentation on water quality. Posters summarizing the water quality measurements and the effect of longer boiling times on bacteria were displayed during a

community festival and then presented to Dr. Purevsuren. He took these educational tools to the countryside field hospitals for his community educational program. We gave a PowerPoint presentation to a crowd at the Renchinlhumbe Cultural Center two different times and gave a copy of this presentation to the doctor for educational use. These posters and the presentation backed up Dr. Purevsuren's contention that high amounts of bacteria in drinking water can lead to two of the top three health concerns previously stated.

Research Project Overview

The data collection for the project began immediately when we arrived in the Darhad Valley with BioRegions International. I collected samples from several different water resources, most of them being community water sources. Some of the sources were tested several times for accuracy and others only once due to travel limitations. Interviews were completed with a local physician, a former governor of Renchinlhumbe, town residents and some countryside herders. Hospital statistics indicated there were 50 admittances for digestive disorders in 2005. However, the hospital does not record outpatient cases in statistical reports and classifies diarrhea as a non-communicable disease rather than a communicable disease. Therefore there might be some misconception in the case numbers of occurring diarrhea. Sean Armstrong, a BioRegion's team member who recorded these hospital statistics and had many interviews with faculty members determined there are many cases of diarrhea occurrence that are not recorded. Hence, fecal coliform bacteria in the water consumed might affect many of the local residence.

With this information in mind, I tested fifteen water sources for nine to eleven different water-quality parameters. The main measurements were: temperature, pH, conductivity (total dissolved solids), nitrate, phosphate, alkalinity, fecal bacteria (including *Escherichia Coli* or E. Coli), fluoride and arsenic. The remaining two that were alternatively tested includes dissolved oxygen and biologically dissolved oxygen. Due to these test's longer testing requirements, I was not able to complete them at every site. Water sources in the area ranged from lakes, streams and rivers to springs throughout the valley. The major river that flows through the valley is the Shishhid River (please see the valley map in APPENDIX 1: Darhad Valley Map). Everything drains into this river as it flows north, then turns west and joins up with the Tengis River and heads out of the Darhad Valley into Russia. It eventually turns into the Yenisei River and flows into the Arctic Ocean.

When we arrived in Renchinlhumbe, which is the soum center of the eastern side of the valley (a soum is a county governmental area including the town and surrounding countryside, Renchinlhumbe soum includes Bag 6 and an area of 1305.5 square kilometers), I tested the Tsagaan-bulag, or White Spring, that flow along the southern side of town. This drinking water source serves about 4,614 people, 2,121 being children (according to statistical data ending on 12/31/05). Samples were collected at the mouth of the spring, about 500 yards downstream, adjacent to town and finally, downstream of town. Most people get their water adjacent to the town center unless they have access to transportation, then they retrieve the water from just downstream of the mouth of the spring. The stream initiates from the inside of a hill 5 km upstream and flows along the town's southern edge. The area's livestock herds roam freely in and around the stream and riparian areas grazing the riparian vegetation down to stubble. The entire Darhad Valley is highly utilized and manure piles reside every few feet, which make it inevitable that an abundance of manure and urine reach the water. From this information, one can infer that fecal coliform bacteria (including E. Coli) are an issue in this valley. The testing of this stream was completed three times over a month long period and the results are charted in the attached table (APPENDIX 2: Water Quality Data Table).

In addition, two streams to the north of Renchinlhumbe were tested, in Bag 3 (a Bag is a local governmental and community unit subsidiary to the soum level; even though the herders may be widely spread out, they come together for community meetings and competitions). The Zuslan-gol (gol means river) has a sandy silt bottom and runs brownish in color from "dissolved organic matter, humic substances from soils or from decaying plant material" (Campbell and Wildberger 40). The color might be due to poorly drained soils or landscapes. This stream drains through gentle topography over permafrost. The measurements indicated an unpolluted stream except for the high level of fecal bacteria in the water. The other stream tested was the Arsan-gol and it flows over an abundance of river rock. This river also has a high content of fecal bacteria living within the water.

On the western side of the valley, Bag 1 residents expressed concern about two water sources. These two sources were the Hogiin-gol and Purren Uul (uul indicates a lake). The Hogiin-gol is a wide stream flowing into a large lake and from the test results is an unpolluted stream. I was not able to test the bacteria in this stream due to lack of testing supply but most likely the bacteria level would have been similar to the other streams tested. Purren Uul was by far the worst drinking water source measured, with high levels of bacteria and high alkalinity. It is a smaller sized water body, which supplies drinking water for

the summer camps of many Bag 1 residents. The water was filled with sediment and the bottom wasn't even visible standing at the shore. These results might have been due to numerous livestock on the banks of the lake and no visible in or outflow.

Medicinal springs are a popular source of traditional medical treatment for the Darhad residents and numerous other Mongolian visitors in general. In fact, people travel from outside the valley to drink from the variety of springs there. I tested three different popular spring areas, Tsagaan-bulag, Boom-bulag and Shine-bulag. At the first two mentioned, there are multiple springs running directly from inside a hill. Shine-bulag, which is a spring that bubbles up into a lake forming wonderful wetland habitat for wildlife to reside, is used more for swimming and bathing rather than for medicinal use. All of these springs tested normal except for small traces (less than the World Health Organization's maximum contaminant level) of fluoride and arsenic. The levels are not of concern health-wise, especially since the water is consumed in moderation.

One of the most important experiments performed for educational purposes was to compare different bacteria test results using samples from different levels of boiling water. I completed four bacteria tests within this experiment, all from the same water source. These included a pre-boiled sample, a sample that was boiled for less than 30 seconds, a sample boiled less than 30 seconds then poured into a thermos and a sample that was boiled for ten minutes. The reason behind this experiment was to treat the water just as a local person might in collecting from their water source, then heating it to barely boiling and then putting it in a thermos, similar to the tea they keep hot to serve later in the day. The presentation formed from this information was very effective educationally because it provided a helpful example for people to understand the importance of boiling time. The pre-boiled sample had a significant amount of bacteria. The barely boiled sample showed less bacteria, containing no E. Coli but some remaining fecal bacteria. The sample that was taken from the thermos had even more bacteria than the sample from the barely boiled water, probably because it sat in the heated environment serving as an incubator were the bacteria were able to propagate. The sample that was taken from the water that was boiled for ten minutes had no bacteria and did not required any extra wood to keep it boiling. The following photographs are of the petri dishes these tests were completed in. The blue dots are E. Coli and the pink dots are fecal coliform bacteria. This was the amount of bacteria in 4 mL of the water source.

With all this information collected, I created a presentation for the Darhad Valley people with the help of translator, Tugsu Armstrong. The following five educational posters were created, which included the following:

- Bacteria pathway into water and human
- An explanation of the test determining the amounts of bacteria in the water
- Effects of boiling times and thermos storage on bacteria
- Prevention education on the use of fluoride toothpaste
- Table showing water quality data on all sources tested

This educational material, was initially displayed outside of Renchinlhumbe's Cultural Center for the "People of the Blue Valley Awards," hosted by BioRegions International and attended by about 300 residents. Then we gave them to Dr. Purevsuren to display in the hospital and take with the mobile field hospital for his educational presentations.

In addition to the educational posters, I also created a slideshow presentation with the help of Cleone Todgham, a BioRegion's volunteer from Royal Roads University, British Columbia, Canada and again the help of translator Tugsu Armstrong. This presentation included all of the experimental methods that were completed, why they were performed, who had asked BioRegions for assistance, information on fecal bacteria and fluoride, information on garbage in water as well as how to treat the water to be drinkable, and many other things. Tugsu and I gave this presentation at the "People of the Blue Valley Awards" as well as the next night to about 30 people. A copy was also given to Dr. Purevsuuren for his educational presentations. After I left the valley, Cleone gave the presentation to the local governor.

We also held a community "Clean up the river day." This was not well attended but did engage headway with one local boy about 11 years old, who said he was interested in having a clean river and would help with the increasing trash problem. One of the major issues in Renchinlhumbe's local river, the Tsagaan-bulag, is the amount of trash in the stream, either from the local residents or blown in from the uncovered trash dump nearby.

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Trip Experience

The culture in the Darhad Valley is said to be one of the most vibrantly traditional cultures in Mongolia. It's remote location and harsh winters are the main reasons for this assumption. The entire valley supports about 8,000 people and a little less than 200,000 animals (statistical data from 12/31/05). The nomadic lifestyle and lack of electricity allows for ample time in the winter to work on crafts, singing, dancing and artwork. The quality of this work is astounding, even to the locals. BioRegions held a festival to

promote artist and artisans of the Darhad Valley called “The People of the Blue Valley Awards.” This was a magnificent opportunity for the BioRegions group to gain a true understanding of the Darhad culture. Several craftsmen brought in leather products, traditional clothing, felt crafts, carved wooden products and artwork. There was also a performance of singers, musicians, dancers and poets. The locals were surprised at all the talent that seemed to have been hidden before their eyes. Local song and poetry were presented reflecting the traditions of the Darhad. All of this was a great experience and was a wonderful educational opportunity to learn about the nomadic lifestyle and the Mongolian Darhad culture.

The BioRegions work trip group was very diverse, ranging from 5 years old to 60, all having different professional knowledge and talents. There were thirteen of us in all, some arriving and leaving at different times. My advisor, Dr. Cliff Montagne, has been a great inspiration to me as he helped design my project and has given me advice whenever I’ve asked. It was wonderful to see the respect he has gained since his first visit to the Darhad in 1998. We were both really busy with separate areas, but still had time to talk about Darhad issues and new ideas that were forming in our heads about future projects that the locals could benefit from. One of the greatest times I had was during his birthday celebration on June 13th, when all of BioRegion’s friends came over to celebrate. I feel our relationship was strengthened throughout the trip due to the effort we put forth in completing the multiple BioRegions projects.

Personally, I learned a great deal from this trip. I was exposed to and learned from a different culture, lifestyle and people. I also was able to help the people of the Darhad Valley by giving some of the knowledge I have gained in school to people who may benefit from it. I realize that my help was minute in comparison to that in which they would like to have or need, but hopefully it helped enough to create change. BioRegions has been brainstorming on some ideas that could expand the water quality project in several ways to make a bigger impact towards getting the people of the Darhad safer drinking water and helping to conserve the health of their vast water supply. A solar powered water treatment system might be applicable rather than any type of well or pipeline structure due to the ineffectiveness and costliness of either of these (mainly due to permafrost). Another idea would be to establish an ungrazed vegetation buffer of about 50 feet alongside a water resource, especially the Tsagaan-bulag in Renchinlhumbe. This idea of a vegetation buffer is new to the Darhad Valley as well as to all of Mongolia, however would pose conflicts cultural with the nomadic lifestyle.

The common occurrence of kidney disease and liver cancers has raised the question on their relation to water quality and which, if any, data I collected may be related to them. Exposure to E-Coli can create Hemolytic Uremic Syndrome (HUS) and eventually kidney failure. E-Coli produces a toxin that affects red blood cells and the body’s organs and this is what leads to kidney failure (Shihabi, causes). I plan on doing an intensive literature review related to this topic to report back to Dr. Purevsuren and the rest of the community in the Darhad.

There were a few challenges in the testing methods, mostly the colder temperatures that fell into the low 20's (degrees Fahrenheit) at night and during the day temperatures that did not rise above 45. The bacteria tests performed were consistent in the fact that they were all grown at the colder temperatures. More glass testing containers in which to perform the experiments in would have been handy, as I would occasionally find myself having to test up to five different water sources in a day and some of the reactions were still occurring in the same containers needed to perform the next test. However, hauling the testing kits was hard enough and the difficultness of it would have been greatly increased with more glass hardware. The biggest and most significant problem was the fact that by the time BioRegions had left for Mongolia, two of the testing kits had not arrived. This inconvenience kept some of the sources from being tested for arsenic and fluoride, which explains why there are some blanks in the data table. There were only 20 bacteria test replicates and I felt this gave us a broad idea and experimental sampling of the bacteria level in the valley's water resources. Finally, the remoteness of the valley and the permafrost created a challenge in traveling and keeping the samples stable.

Overall, I felt I was successful in performing the project I had come to complete. I will try hard this next year to find funding to further the education on water quality and to hopefully initiate a water treatment method. The experience I had in the Darhad Valley was and will be irreplaceable, as it was a wonderful learning experience. I feel fortunate to have been able to be a part of the lives of the people of the Darhad Valley in Mongolia!

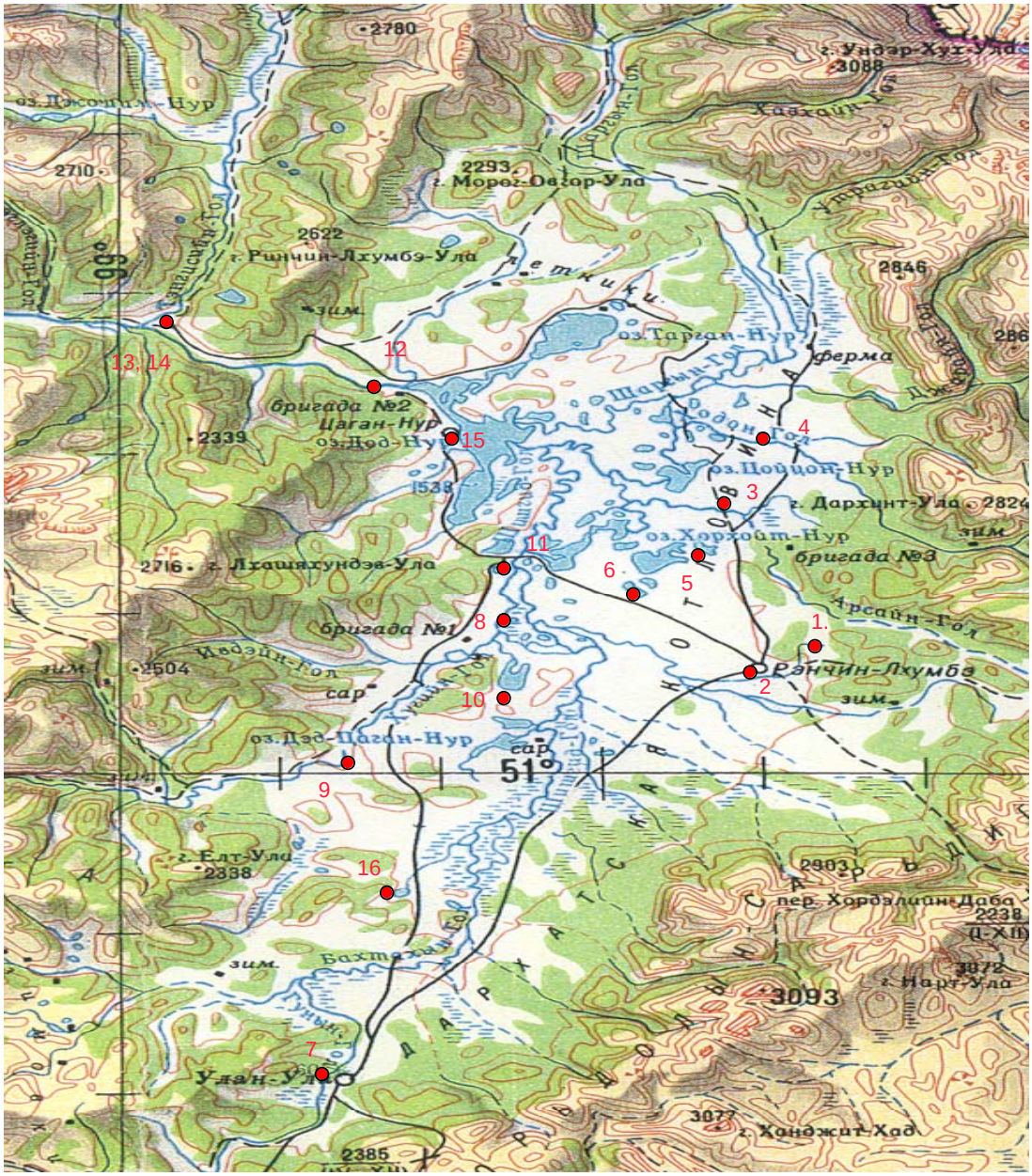
References Cited

Campbell, Gayla and Steve Wildberger. The Monitor's Handbook: A Reference Guide for Natural Water Monitoring. Maryland: LaMotte Company, 2001.

Shihabi, M.D, Samer. Medline Plus Medical Encyclopedia. 2005. American

Accreditation HealthCare Commission. 08 June 2005. http://www.nlm.nih.gov/medlineplus/ency/article/000510.htm#Causes,%20incidence,%20and%20risk%20factors.

Appendix 1: Darhad Valley Map



Locations:

1.Tsagaan-bulag (head of spring)
2. Tsagaan-bulag (adjacent to Renchinlhumbe)
3. Apcaum-tor (Arsan-gol)
4. Zuslan-gol
5. Shine-bulag
6. Evt-Uul
7. Gunin-Gol (adjacent to Ulaan-Uul)
8. Boom-bulag (medicinal springs)
9. Hogiin-Gol
10. Purren-Uul
11-13. Shishhid
14. Tengis-gol
15. Tsagaan-Uul
16. Tsagaan-bulag (medicinal springs)

APPENDIX 2: Water Quality Data Table

Results for the Water Quality In the Darhad Valley													
					Key: NT= not taken; UN= UN								
Where taken	***Temperature (*F)***	***pH***	***Dissolved Oxygen (mg/L or ppm)***	***Biologically Dissolved Oxygen (mg/L ppm)***	***Nitrate (mg/L NO3)***	***Phosphorous (mg/L)***	***Alkalinity (mg/L of methane orange as CaCO3)***	***Conductivity (ppm Total DissolvedSolids)***	***E.coli count/Fecal Coliform count(per 100 mL)***	***Arsenic (ppb)***	***Fluoride (ppm)***	***Color***	***Odor***
Normal (World Health Organization)	**varies**	**6.5-8.2**	**>5 ppm**	**< or equal 5 ppm**	**< 1 ppm**	**< .03 ppm- 1 ppm**	**20-200 ppm**	**<500 ppm**	**0 for drinkin water**	**<10**	**0.7-1.5**	**none (clear)**	**none**
Tsagaan-bulag 1 /Renchinhumbe	40	8.0	6.0	NT	UN	0.08	155	136.68	0/1155			clear	none
Downstream of Tsagaan-bulag 1									66/2178				
BAG 3 Zuslan-Gol	42	8.4	10.0	8.0	UN	UN	75	76.38	0/1950			yellowish/ brown	none
BAG 3 Family's water can	NT								250/1975			yellowish/ brown	none
Apcaum-tor	NT								0/1525			clear	none
Tsagaan-bulag 1/Renchinlhuble River (Middle)	44	8.5			UN	UN	145	171.52	0/3825			clear	manure
Tsagaan-bulag 1 (Downstream)/Rive next to Renchinhumbe	< 40	8.9	8.0		0.792		145	178.22	lost petri dishe			lightly yellow	none
Shine-bulag/ New Spring	42	8.6	20.0	negative 6 (error in experiment)	UN	UN	130	187.6	lost petri dishe			clear	none
Tsasan bulag 2/Renchinlhumble	43	8.5	NT	NT	1.496	UN	145	191.62	lost petri dish			clear	none (slight algae smell)
Downstream of Tsagaan-bulag 2	43	8.8	NT	NT	0.528	UN	145	207.7	lost petri dish			clear	algae
Bag 5 (First Family)	45	9.0	NT	NT	UN	0.32	410	526.62	NT	NT	NT	brown	sour
Bag 5 (Second Family) Evt Uul	45	8.8	NT	NT	UN	0.24	190	400	NT	NT	NT	Gray	Stagnant
Tsagaan-bulag Right	41	8.6	NT	NT	UN	0.32	150	179.56	0/175	6	0.4	clear	sulfur
Tsagaan-bulag Left	42	8.7	NT	NT	UN	0.16	145	182.91	0/0(some white spots)	NT	NT	clear	sulfur
Gunin-Gol (Ulaan Uul)	32	8.5	NT	NT	UN	UN	160	217.08	0/475			light blue	none
Boom-Rematism (Rumatism)		8.6	NT	NT	UN	0.288	150	221.1	NT	6	<.4	clear	sulfur
Boom-Uye-Moch/ Joint		8.8	NT	NT	UN	0.32	125	223.11	NT	Not enough in samlple	0.3	clear	sulfur
Boom-Hor-Shar/Heartburn		8.5	NT	NT	UN	UN	140	207.03	NT	6	<.4	clear	sulfur
Boom-Uushig/Gedes/ Stomach and Lung		8.4	NT	NT	UN	0.72	160	225.79	NT	9	0.2	Clear	sulfur
Hogiin-Gol/Bag 1	49	8.6	NT	NT	UN	UN	35	48.91	NT	4	UN	slightly brownish	none
Puuren Uur/Bag 1 Summer camp	58	9.1	NT	NT	UN	0.2	230	371.18	50/3750	6	UN	gray	stale/manure
Tsagaan-bulag collection from water container at cabin										6	UN		
Tsagaan-bulag collected parellel to town		8.9	5.0	3.0 (must have not been warm enough)	UN		155	229.81	50/1500	4	UN	light brown	none/algae
Same sample Barely Boiled									0/350				
Same as barely boiled and placed in thermos									0/1950				
Same as prior sample but boiled 10 minutes									UN				
Shishhid 1	59	9.1	NT	NT	UN	0.24	65	96.48	NT	4	UN	light brown	none
Shishhid 2	44	8.8	NT	NT	UN	0.16	75	87.1	NT	0-4	UN	brownish	none
Tsagaanuur	50	9.1	NT	NT	UN	UN	65	92.46	NT	0-4	UN	brown/gray	stale
Shishhid 3	52	9.0	NT	NT	UN	0.352	55	109.21	NT	6	UN	light brown	none
Tengis	36	8.3	NT	NT	UN	0.304	20	35.51	NT	UN	UN	light brown	none