

Breakthrough: Bitter Water

KARLETTA CHIEF: When the breach occurred, it was this yellow plume of water. It was just a torrent of acid, mine drainage, going into the river. It was unstoppable. People were coming to the river and just crying. It brought sadness to my heart and I just felt a sense of wanting to figure out a way that I could help the communities being impacted by the spill.

My name is Karletta Chief and I'm a hydrologist. And I study how water moves through the environment. Water-- it's a real part of my identity. The Navajo people, or Diné people, have this deep connection to their environment. I'm from the Bitter Water Clan, one of the four originating clans of the Navajo people. Growing up on the reservation with no running water, no electricity, and with a very strong cultural upbringing of where my family lived off the land, raising livestock, we just lived a simple life.

We live within an area leased to a coal company. One of the big memories I had was how my grandfather, she drank from a contaminated wash, and a hundred of their sheep died. It was traumatic because we realized how much of an impact the mine could have on our livelihoods.

I was very motivated by my desire to help my family and help my community understand the impacts of the mine and minimize those impacts. Nobody in my family had gone to college, but I got accepted to Stanford.

As a PhD student, I designed this soil core air permeameter to measure the permeability of the soil more rapidly. What hydrologists would do is use infiltrometers, measuring how fast the water goes into the soil. And that could take hours. The air permeameter just uses air in minutes.

My grandmother told me to work hard and pursue learning, but she always told me, [SPEAKING NAVAJO] And so I came to the University of Arizona with that motivation.

The Navajo Nation is a rich in natural resources. There are over 2000 mines including uranium, coal, oil, and gas. Extracting and mining, land surface mining, can contaminate water. And so, my goal was to reach out to tribes and address these impacts and the environmental challenges. Many of my elders, though they're not miners, they passed away from black lung disease and cancer. So I really relate to the impacts of mining on communities and families.

August 5th, 2015. That was the day the Gold King Mine spill had occurred near Silverton, Colorado. Three million gallons of acid mine drain was released into the Animas River. People were going into the river and just watching in horror. The geology of southwestern Colorado has rock that's rich in iron, as well as other metals. And so when water and oxygen come into contact with metals in the rock, sulfuric acid is

generated, and that starts to dissolve the metals, such as arsenic and lead, into the water, creating the acid mine drainage. And we know that arsenic and lead have a health impact at low concentrations for long periods of time.

The risk assessment that was conducted was only addressing the recreational risk. However, the Navajo people use the river in much more ways than recreational. They use the water for spiritual, cultural, ranching. When a spill like this occurs, it's devastating to the communities that view it as a sacred being. The Navajo living along this river were very concerned about using the water and they had a lot of unanswered questions.

So within the year, we surveyed Navajo households living along the river to ask them how they use the river. And what we found from that is that the Navajo community members use the river in over 400 different ways. They use the reeds for baskets. They'll put the clay on their face for prayers and for sunscreen. They'll even put the water in their mouth for prayers. And many more.

And so we needed to understand where are these metals in the environment, where did they go. In order to do that, we needed to take water samples as well as sediment core samples. And so we brought the samples back to the laboratory. The water samples are filtered and for the sediment samples, the sample has to be taken out of this PVC pipe and then categorized according to the depth. Then finally, we can take that sediment and the water sample to an analytical lab to detect arsenic and lead.

For the short term, it was good news in the results that we had. We found from this one year study low levels of arsenic and lead that are not of concern to the human health. However, we did find some spikes in manganese in concentrated pools. And this is something that should be looked at because we do know that manganese leads to some neurological impacts. During the snow melt, the river will increase in flow, and so the metals that are deposited on the sediment will be re-suspended. And we know that the spikes do occur. It's important to make sure the farmers and the committee members know that they shouldn't be using the river during these high flow periods.

We report the results to the communities through teach-ins. Sometimes, they ask me, so is it safe? And this is information that we're empowering the communities to make the decision about using the water on their own. In addition, we train the community members to take samples in areas they were concerned with. Because of that, we were able to directly analyze those samples and address their concerns.

There's actually a lot more that needs to be done long-term, because acid mine drainage is continually going into the river. Our long-term study actually tries to capture that whole exposure pathways that the Diné people may have as a result of using this river.

So right now, we're trying to collect sheep samples and corn samples.

We plan to use the air permeameter and the tension infiltrometer to take a closer look at the properties of the soil and get a more complete picture of what's going on in the sediment through space and time.

Water is very precious. It's sacred. Growing up, we had a real sense of conserving water because it was scarce. What motivates me and my work is how I can use my science to come back to my community and help my people. And also, try to understand the potential exposure pathways that people have, which can be very diverse. My grandmother charged me with this responsibility. You must come back and help our people. And help our family. It may not be exactly what she envisioned for me, but it's an honor to bring science to my community.

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