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Using Soil Science to Remove Arsenic from Water in Asia: A Day in the Life of Matt Polizzotto

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Arsenic-contaminated water in Asia is a big problem, affecting 100 million people. As a result of the Green Revolution, millions of wells in Asia were drilled that now pump both water and poisonous arsenic to the earth's surface into irrigation channels for crops. Arsenic, which is odorless and colorless, poisons slowly and eventually may cause skin diseases, cancer, and death. It also hurts how well crops—particularly rice—grow.

Matt Polizzotto, an assistant professor of soil science at North Carolina State University, became interested in this problem as a graduate student, and now his work takes him to the other side of the globe, to places like Bangladesh, to try to find ways to remove the arsenic before it reaches the crops and poisons the very people whose lives were meant to be saved by the same water.

Soil Horizons: How did you get interested in pursuing a career in science, fieldwork, and soils?

Polizzotto: I just enjoyed being outside growing up. In high school, I liked science classes, and I especially liked chemistry. But when I went to college (University of Rochester), I think I had a pretty limited view of what people studied in college. I was going to be a chemistry major, but right before my sophomore year—the day before classes started one semester—I found a geology class. I like being in the mountains, so I just decided to take the class on a whim.

From there I learned about a geochemistry class within the Environmental Science program. And to me, that sounded like an ideal topic, where I could merge my personal interest in the environment with my more academic interests in chemistry. I started working in the lab of Ariel Anbar (now at Arizona State University), and from then on, it spurred a fascination with geochemistry and scientific research.

I think as an undergraduate, I had very little idea about lots of things that were going on at the university—like all of the research that drives a good deal of university activities. I really had no idea that existed. I worked in Ariel Anbar's lab for three years conducting analytical environmental chemistry research. I learned tremendously from Ariel and the graduate students in his group—not just about particular research topics but also how academic research worked. I have no doubt that without that opportunity, I would have been on a different career path.

Matt Polizzotto, an assistant professor of soil science at North Carolina State University, doing fieldwork in Bangladesh. *Photo courtesy of the "Soil and Environmental Hydrogeochemistry at NCSU" blog.*

Soil Horizons: Looking at the bio on your website, it says that you also majored in music?

Polizzotto: I've always played music, and it is one of the reasons I went to Rochester for college—the music program is phenomenal. I've played in bands of varying quality since high school (and still do), been a piano instructor, and played at some weddings, but I was never good enough to be a full-time professional musician. It's more of something I just enjoy.

Soil Horizons: Once you were exposed to this world of research, did you know you were headed into soil science at Stanford and a career as a researcher and professor?

Polizzotto: No, not at all. Again, as an undergrad, I don't think I really had a sense that the discipline of soil science existed; that there were even departments of soil science. You have a limited

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view of things as an undergrad, or I certainly did!

The way it happened is Ariel Anbar provided me an opportunity to attend the American Geophysical Union Meeting in San Francisco my last year as an undergrad. Someone came up to me to ask some questions at my poster and then said, 'Oh, you're an undergrad, you should work for Scott Fendorf at Stanford University, he'd be a good person to work with.' I don't think that Stanford was even on my list at that point.

Everything tied together when I visited Stanford. The work in Scott Fendorf's lab seemed to fit my academic interests and background. And more so than other places I visited, I liked how tightly the group's research was motivated by environmental problems. They still conducted basic research, but the research seemed to have more direct, real-world relevance than in some of the other labs I visited.

Soil Horizons: And when did the focus on soil emerge for you as a research topic?

I wasn't looking for a soil-based graduate program at all. I was looking for a program in environmental biogeochemistry. But the way things tied together, it became a soil-based focus—and that was perfect for me, as I became more cognizant of the critical roles soils play in a wide variety of society's grand challenges.

My dissertation was about arsenic in Asia; today more than 100 million people are exposed to dangerous concentrations of arsenic in their well water every day. When I started in graduate school, the problem of arsenic contamination of ground water in Asia was really only just being realized. And the processes controlling arsenic in the subsurface weren't completely understood. So that's what I focused on as a graduate student. Some of that work was in Bangladesh; most of it was in Cambodia.

Arsenic-contaminated hand pump in Bangladesh. *Courtesy of Flickr/waterdotorg.*

Soil Horizons: So early on, you had made an intentional commitment to have the science you were doing apply to environmental problems, and particularly issues related to human population health. How did this interest develop?

I guess I was more interested in figuring out ways that I, personally, given my skill set, could make an impact. Maybe I'm still trying to figure that out. But as a graduate student, I was frequently going to Asia, and I spent a lot of time thinking about water resources in general and also talking about the arsenic issue I was studying, where millions of people are drinking poisonous groundwater without many other drinking water options. As I read more broadly about water and water resources, one of the things I realized was that here I was thinking I was working on this really big, important arsenic problem, but there was very little mention of it in more policy-based documents. The whole field of research about arsenic in well water would be summarized in a sentence or a paragraph. This inspired me to learn how that policy sentence or paragraph was created, but it also made me aware of the frequent disconnect between science and policy.

I ended up doing a AAAS Science and Technology Policy Fellowship at USAID, and I was able to learn more about policy and how policy decisions are made regarding water resources, environmental health, and international development. That fellowship experience was very formative for me. Overall, I would say that the science I was doing kind of created broader questions about practical solutions to environmental health problems, and I became curious about how a scientist could effectively contribute to mitigation of these issues.

Soil Horizons: What has it been like traveling around the word to places like Bangladesh and Cambodia?

For me, it hits me all the time! I think in general, you go through life and you all of a sudden have moments where you go, 'What was the sequence of events that got me to this point right now?' And that really hits home when you're in a rice field in Bangladesh, arm deep in rice paddy soil and working with someone from Bangladesh who has had a very, very different life experience than you. That strikes me all the time.

Soil Horizons: Had you traveled to places like that before or had similar experi-

ences to prepare you for doing fieldwork there?

Polizzotto: No I didn't. I went to Cambodia the first time with an undergraduate from Stanford, and we kind of just showed up! We were interested in doing some longer-term research there, and we pretty much spent a couple of weeks cruising around trying to meet people. We had one initial contact—someone who ran an orphanage but had heard about the arsenic problem—and that was it. But through this person, we were introduced to other people, and they in turn put us in contact with others. From that trip, we used what we learned to start the field project in Cambodia, partnering with Resource Development International, an NGO there. And, certainly, it would be hard to recreate that initial experience now for me or for anyone. It was just a lot of chance occurrences that kind of pushed us in unexpected directions. I suppose that's actually the broader theme here.

Matt Polizzotto working in Cambodia. *Photo courtesy of the "Soil and Environmental Hydrogeochemistry at NCSU" blog.*

Soil Horizons: Why do you believe in this work so strongly and why is it an important area of research that needs attention?

Polizzotto: Well, you can start with the numbers. Arsenic in Asia affects 100 million people. Imagine if one out of every three people in the U.S. was drinking water that was poisoning them. Currently, it's even difficult to make accurate predictions about which wells are safe and which aren't.

But this type of problem isn't just confined to arsenic in Asia. Throughout the world, people rely on well water, and we don't have very good strategies for predicting and mitigating problems associated with naturally occurring contaminants in the wells. And that's one real motivating factor in my lab: What do we do about these different well-water contaminants that are naturally derived, particularly when we rely on well water for drinking or irrigation but advanced water treatment systems aren't available or feasible?

For instance, closer to home in North Carolina, there are a lot of wells that have very high concentrations of manganese, and my lab now has a project looking at those. One of the angles I've taken both in Cambodia and in North Carolina is to incorporate more of an integrated systems approach. Rather than just looking only down at the depths of wells, we look from the soil all the way down to the groundwater system to make more comprehensive assessments about processes controlling contaminant concentrations. Hopefully this can provide new insights for dealing with these different water quality challenges.

Soil Horizons: Speaking of North Carolina, you've been at NC State for almost four years now. How's the life of an assistant professor and juggling all that comes with it?

Polizzotto: I'm really, really lucky to be where I am. I have incredible colleagues—a couple chemists and biogeochemists in particular—in the soil science department and across the university who have made it as easy as possible for me to come in and begin my research program, and who have become great collaborators. I've had the fortune to interact with talented students in my lab and in my classes, and overall, my department has been very supportive of different types of research and teaching. I'm also continually amazed by the new projects that materialize, most of which I could never have predicted four years ago.

But indeed, I've found that there is a lot of juggling as an assistant professor. I've realized my challenge now is not figuring out how to keep all of the balls in the air, but just determining which balls need to be kept up in the air! My wife, Nadia Singh, is an assistant professor in Biological Sciences at NC State, and we have two wonderful, very active little girls (1 and 4 years old), so there is not much down time!