Sonali Hossain shyly lifted her sari to expose the lesions on her left thigh, her wrinkled hands shaking slightly as she grasped the bright orange and red material.

The sores on her legs and feet are common symptoms of chronic exposure to arsenic. As Sonali sat outside with her back resting against the mud foundation of her home, her husband stood nearby, shaking his head.

“Each day it gets worse,” Jaber Hossain said. His bare legs and chest are free of any wounds. He is one of the lucky ones who somehow remain unaffected by the exposure. “We drink safe water now, and she tried the medicine from the clinic, but nothing helps.”

For nearly two decades the Hossains drank from a well highly contaminated with arsenic. They did not know they were drinking arsenic; using the clear, refreshing water from a relative’s well instead of murky surface water was an obvious choice for the couple, and they installed their own well in 1999. When Columbia University researchers tested wells for arsenic in 2000, the Hossains learned that while their new well was safe, the water from the relative’s well they had used for years had an arsenic concentration nearly seven times the national standard for drinking water.

The Hossains are only two of the estimated 35 million Bangladesh’s 130 million inhabitants at risk of being poisoned by naturally-occurring arsenic in their drinking water. Given this mass poisoning, it has the potential to be one of the greatest human health catastrophes in the last century, comparable in scale to the estimated 30 million victims of the 1918 influenza epidemic. The crisis has brought scientists from around the world, including Columbia University researchers who have been working in Bangladesh since 2000. In March they returned to their project area in Araihazar to continue work on their 6-year project: Health Effects and Geochemistry of Arsenic and Lead.

In the 1970’s international aid organizations and the Bangladesh government began installing tube wells, to permit pumping of ground water for drinking and cooking as an alternative to microbially-contaminated surface water. Well installation, rehydration programs and inoculations helped control the burden of diarrheal disease, which is the second leading cause of death in developing nations after infectious disease, and its incidence was halved. The convenience of safe water near their homes led people to install private wells, and by the 1980’s international aid was no longer necessary to fund installation. Well installation continues today, and it is believed that approximately three quarters of the estimated 10 million wells in Bangladesh are privately owned.
In the 1990’s an unintended consequence of this strategy—mass arsenic poisoning—became apparent. The scale of potential effects is staggering. Researchers estimate arsenic consumption has led to 100,000 cases of skin lesions and may cause as many as 270,000 deaths from various cancers. Other symptoms include skin discoloration, hardening of skin on hands and feet, cardiovascular disease, respiratory problems, and miscarriage.

At the time the groundwater strategy was conceived, nobody realized that arsenic occurs naturally in groundwater in various regions throughout Bangladesh, particularly in the south-central part of the country. The sediments that make up Bangladesh’s sweeping delta contain arsenic, just like any sediment. Under most conditions, the arsenic is strongly bound to the surfaces of iron oxides contained in the sediment. Most scientists believe that the reason arsenic occurs in Bangladesh groundwater dates back 20,000 years, when sea level rose by 100 m, and led to the accumulation of sediment containing organic matter. Then, as the organic material decomposed and consumed all of the oxygen in the groundwater, the reducing conditions led to the dissolution of the iron oxides, consequently releasing arsenic as well. The result is higher arsenic concentrations in younger, typically shallower, aquifers; aquifers made of older sediments have much lower arsenic levels most probably because organic matter and mobilizable arsenic has been flushed out of these deposits over hundreds of thousands of years.

Cases of arsenic poisoning did not immediately follow well installation because arsenic poisoning is cumulative over time. The first reports of arsenic-induced skin lesions appeared in 1987, but the problem was not recognized by the government until 1993, when the Bangladesh Department of Public Health Engineering officially identified the first case of arsenic poisoning and, after testing, found wells with high arsenic concentrations. In 1997, at the urging of the World Health Organization, the World Bank sent a mission to Bangladesh to investigate the arsenic problem. As a result, the Bangladesh Arsenic Mitigation Water Supply Project was created and many private and government wells were tested to determine arsenic levels in ground water. Well spouts were painted green on safe wells and red on unsafe wells.

Today, thousands of wells remain untested, and in some instances people continue to drink from wells known to be unsafe.

“A lot of people are still drinking water they shouldn’t be drinking, so I think what that reflects in part is that nobody has a really good idea of what to do,” said Lex van Geen, geochemist at the Lamont-Doherty Earth Observatory. “The news we’re getting from these big programs is essentially a menu of options and no real hard look at what works and what doesn’t.”

van Geen and the team of earth, health and social scientists from Columbia University collaborate with colleagues from the Department of Geology at the University of Dhaka and the National Institute of Preventative and Social Medicine. Together they assess the public health effects of arsenic and household responses to provision of arsenic information, investigate arsenic’s origin and distribution in ground water, and establish safe drinking water sources. The Columbia University project encompasses a 25 km²
region in Araihazar, located 20 km east of Dhaka. Of the 6,600 tested wells in the area, half contain arsenic levels exceeding the national standard for drinking water of 50 micrograms per liter—in some cases by as much as 10 times the standard, according to van Geen.

In addition to testing wells and attaching an identification tag to each well, the Columbia University team has conducted repeated surveys of well users. They’ve also installed 50 safe community wells in high-arsenic areas. Twelve thousand of the 70,000 people in the region are involved in the public health cohort project and give urine samples, allowing researchers to track the amount of arsenic in people’s bodies; the urinary data shows a decrease in arsenic levels, with the biggest decreases in areas with high levels of arsenic. Last year, the team attached to the wells new plates with the arsenic level and a picture of a hand holding a glass; unsafe wells have an ‘X’ through the illustration. From questionnaires assessing residents’ response to the arsenic mitigation one and two years after households learned whether their primary well was safe, the team determined that in one year sixty percent with unsafe wells switched to different source and after another year not only did people not return to their old wells, as some had predicted, but in fact the fraction at unsafe wells who switched to alternative wells rose to two thirds. This March, researchers are expanding their study area to the southeast.

“What we found in the last couple of years is that from our testing of the wells and trying to install community wells, and also comparing the impact of our activities on people’s behavior and their urinary arsenic levels, is that [testing wells and drilling new safe community wells is] rather effective,” said van Geen.

The interdisciplinary approach has been central to the team’s effectiveness. For instance, they can gain an understanding of factors that might prevent someone from using another well, such as religious differences, social class, personal disputes and economics. “People have to decide that they care enough to change to a different source of water,” said Malgosia Madajewicz, professor of economics and international and public affairs at Columbia University. Traditionally, Bangladeshi women collect water for their household, making multiple trips to the water source each day. “This costs, in terms of taking care of children, maybe having to pull children out of school to help with chores, or maybe a woman runs a small business for extra income, but she can’t maintain it because getting water takes too much time,” said Madajewicz.

The team’s short-term solution to the arsenic crisis is encouraging people to switch to near-by safe private wells and testing new wells. In the latter category, deeper, safe community wells may offer by far the most cost-effective broad access. According to van Geen, arsenic is distributed such that a safe well is often less than 100 m from a contaminated well. Other options do exist for safe drinking water and will be used according to local conditions. But removal of arsenic from well water has generally not fared well to this point while rainwater collection is much harder in some parts of the country than in others and requires more maintenance than does a well. Surface water remains polluted with pathogens.

“It’s ludicrous to think about going back to surface water,” said Joe Graziano, Columbia University professor of public health. “The deep well strategy is really the consensus of the Columbia faculty” to achieve rapid, cost-effective access for everybody.

Not everyone agrees that deep wells are the answer. Charles Harvey, professor of civil and environmental engineering at MIT, is concerned that basic hydrologic engineering studies have not been done and warns that overdraining deep wells in Vietnam has caused land subsidence, or sinkholes. “There are basic groundwater hydrologic issues that are usually checked out in the western world, such as: How much water can you get out of an aquifer? USGS is working on this in Bangladesh, but it will take years,” he said.

Graziano admits that the precise recharge rates of the aquifers are unknown, but emphasizes that the drinking water which must be addressed first to reduce exposure to arsenic is a very small fraction of water use. Surface water could be used for irrigation, which represents 95% of Bangladesh’s total freshwater consumption. This would remove a large strain on ground water.

Last year the Columbia University team drafted a national plan for providing rapid access to safe drinking water. The 5-year, $100 million strategy proposed using the techniques employed and knowledge gained in Araihazar and applying them gradually throughout Bangladesh. It acknowledges
that various options will be used for various reasons and calls for well testing and deeper safe community wells to assure that in the short run every household in Bangladesh gets access to safe drinking water. Community involvement in decision-making is an important aspect of the implementation of the plan. “We strongly believe that this is not a top-down solution,” said Graziano. “Each village has its own decision-making process.”

The World Bank and Bangladesh government have not adopted this backstop within the Bangladesh Water Safety Supply Program, which aims to provide safe water countrywide by 2015. The plan promotes piping water to all areas except villages of fewer than 200 households, where either surface water will be filtered or deep wells will be used. “Experience with BAMWSP has shown that a narrow arsenic-mitigation focus on rural water supply in Bangladesh is not sufficient to address the identified sector issues, which include both arsenic and bacteriological contamination of water supplies,” according to a report by the World Bank, which funds BAMWSP. The stress on bacteriological contamination only heightens the value of groundwater, and the piped water in this national plan is ground water. However, the informed broad use of this valuable resource for drinking without piping has not yet been publicly embraced.

“There’s still a strong lobby against the use of the aquifers,” said van Geen. “It’s still a red herring.” Part of the problem may be communication. The Columbia team’s findings are published in scientific journals not widely read by policymakers, van Geen said. The value of further communication to policy audiences has led the team to start drafting not only more policy oriented journal articles but also a short executive summary of the team’s results and their policy interpretation. Though disappointed in the lack of impact of past outreach, the team remains committed to its study area—for which the team is currently in the process of renewing its funding—and the larger picture of national policy.

“The arsenic problem is enormous because tens of millions of people are drinking arsenic-laden water that we know to be devastating for their health, and probably killing millions of them gradually right now,” said Jeffery Sachs, director of Columbia University’s Earth Institute.

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a point about Nexium, the heartburn pill that is advertised on television as a miracle drug. “People just want to take anything without knowing what the evidence is. They don’t even bother to look at evidence, and that’s a terrible problem in this country.” What does he want to do about it? “More scientists in Congress,” Cracraft says sternly. “Well,” he hesitates. “But Frist,” he says, referring to the lone doctor in Congress, “his agenda is so extremely conservative that he isn’t doing any good.”

Cracraft and Feduccia are icons at what for now is an apparent impasse in the scientific community. If any idea seems certain to spring from their dispute, it seems to be that looking at different evidence can lead to different solutions for the same question. Hopefully, the answer that has eluded consensus thus far will not always. “One of us is almost absolutely wrong,” says Feduccia. “There’s not much grey zone for one of us to seek refuge in. I like it like that, because we’re likely to find out what the truth is.”

Dave Epstein is a writer for the New York Daily News. He graduate from Columbia Journalism School in 2004.