Case Study

Arsenic in the groundwater of Bangladesh

How did an entire nation come to drink water poisoned with water?
(Hint: the answer is not easy, and there are many people to blame)

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Introduction:

Outside of the people directly involved with this Herculean problem, few people are even aware of the extent of arsenic poisoning in Bangladesh and its impact across this nation. Furthermore, there is little or no connection drawn by people between numerous “outside” factors that contributed to the present situation.

Brief Timeline:

1940s – 1950s: Terrible cholera and typhoid epidemics affect Bangladesh. At this time, most people use water from surface sources (rivers, ponds, lakes, etc.)

1970s – 1980s: Campaign to stop deaths relating to surface water consumption. UNICEF was the main proponent of tube wells as the solution, creating its own designs and providing the materials to the Bangladeshi government, which, in turn, paid the drilling costs. This partnership sank 1 million tube wells; 2.5 million to 3 million more were installed privately, some with loans on easy terms from other aid agencies. At the peak of the program, it was boasted that 90% of the population was within walking distance of a safe water source. Program is claimed a success.

Late 1980s and early 1990s: Growing numbers of people begin to show signs of illness despite using tube wells. Some independent reports begin to do research into the possibility of arsenic poisoning, since the symptoms reflect this.


1995: Government and UN Agencies went to international conference in Calcutta. Again, no action is taken with regard to the situation in Bangladesh.
January 1997: Survey of 14 out of 64 districts from Bangladesh shows high arsenic toxicity. It is not acknowledged publicly by the WHO for another 3 months.

1998: Government launches Bangladesh Arsenic Mitigation and Water Supply Project. This includes a $32.4 million loan from the World Bank. (Recall their earlier involvement…)

First half of the 00s: Projects underway in Bangladesh to prevent further exposure to arsenic. Money and resources also devoted to treating those who are sick. In some instances, new technology is sought to treat water, while some times all that is done is color-code wells: green for “go” and red for “contaminated”.

2006: Tens of millions of deaths can be attributed to arsenic (at all ages). Millions of dollars have been spent, first on promoting tube well usage, and now, for treatment and disuse of this technology. It is estimated that up to 73 million people in Bangladesh are affected by arsenic to this date, and sadly, it is a number that may soon spread if nothing is done.

*Keep in mind that arsenic poisoning can take up to ten years before there are visible signs as well…

Readings:
Wherever possible, I have tried to cut and paste the most important segments of each article. If there is only a link, it is because the article is important as a whole. Skim through it, I will have notes for us to read on the specific sections in case they don’t get brought up in class.

http://www.unesco.org/courier/2001_01/uk/planet.htm

http://www.sos-arsenic.net/english/arsenicmap/bgsunderfire.html

Denis Peach, the manager of groundwater systems and water quality at the BGS, accepts that arsenic was one of the "many parameters" in the WHO's "Drinking Water Guidelines" in the early-1990s. "Nevertheless, it was and remains common practice not to measure all the determinants [sic] on the list ... for reasons of cost and/or availability of facilities," Dr Peach wrote in a statement. "Some judgment always needs to be made commensurate with the scale of the resources available and the perceived – at the time – likelihood of a problem. In retrospect, we – and others – made a mistake." The BGS said that there was no reason why it should have tested for arsenic given that the scale of the problem did not emerge until the middle of 1997 onwards. Arsenic was not routinely
measured by most water-quality labs because it was not widely thought to be a problem in groundwater, other than in mining regions, it said. However, Professor McArthur said there was no excuse for the BGS not to know about the WHO's guidelines on arsenic.

http://news.bbc.co.uk/2/hi/south_asia/2886079.stm

http://phys4.harvard.edu/~wilson/arsenic/countries/arsenic_project_countries.htm!

Prior to the 1970s, the people of Bangladesh (then only 35 million) relied on surface water for their daily requirements. The water was directly taken from ponds and shallow hand-pumped wells. But this water became increasingly polluted. The pollution stemmed from poor sewage systems in India and Bangladesh, newly established industrial plants frequently dumped their waste in the water. This ultimately made its way into the low-lying plains of Bangladesh. This contamination led to various health problems such as cholera and the extensive pollution of the environment. Western aid agencies, primarily the World Bank and the United Nations International Children's and Educational Fund (UNICEF) suggested the "solution" to the immediate problem of infection and industrial contamination. They advocated tapping the groundwater as a resource. This seemed to be a simple, cheap and effective solution to the problem. Groundwater could be easily tapped by constructing a simple steel hand pump. Soon after, millions of dollars were spent on digging shallow tube wells by western engineers and aid agencies. But no one told the government or the villagers to test for arsenic. The villagers dug more wells. Now there are over 11,000,000 wells. In the early 1990s, it was discovered that the well water, which had seemingly provided a solution to the country's water problems, came with a hidden poison. The well water was laced with naturally occurring arsenic. No one had thought to check for arsenic contamination of well water when the wells were being dug.

The arsenic in Bangladesh is the greatest case of mass poisoning the world has ever experienced. In the sheer magnitude and numbers of victims it exceeds the Chernobyl disaster nearly 100 fold. In Bangladesh 97% of the population, or 116 million people ingest well waters. An early map in 1998 by Dainichi Consultant Inc. in early 1998 shows high levels of arsenic primarily in the western part of the country. The figures are the maximum average concentrations of measurements in the particular region of the country taken from measurements from a variety of sources varying from a "field kit" (manufactured by Merck) to Atomic Absorption Spectroscopy (AAS) (see page on measurements). The "Rapid Action Program" of 1999 (report of April 2000 noted above) measured both concentrations in the wells and diagnosed chronic arsenic poisoning. As shown on the map below, most regions in the country had villages which had wells above the country standard of 50 ppb. By a rough extrapolation they estimate that half of all wells in the country exceed this limit. These
measurements were made with a Merck field kit, which cannot measure arsenic levels below 50 ppb so that it is not known how many people are drinking water with levels of arsenic above the WHO recommendation of 10 ppb. A UNDP survey indicated that 40% of all wells are contaminated. Mott Macdonald Ltd., working on behalf of DPHE and the UK Geological Survey (BGS) in summer 1998 collected all available data and surveyed another "representative sample" (although not formally a random sample) of 1,800 wells. By being representative they avoided the criticism of biasing the numbers high by only measuring in areas with known contamination. Nonetheless they estimate that 18% of all wells have levels of arsenic above 50 ppb. In May 2000 the BGS website was updated with a phase 2 report. Water quality data can be downloaded here. The fraction of wells with levels above 50 ppb for the various regions are shown in a map from that report. Thus between 20 million and 60 million people have been exposed to arsenic above the EPA regulatory limit.


The World Bank’s version:
“However, those same wells were subsequently found to be a source of unsafe levels of arsenic which, over time, can cause skin discoloration, sickness, cancer, and sometimes death. The extent of arsenic contamination of Bangladesh’s underground drinking water is unprecedented and has been called the largest natural mass poisoning in human history.”


http://ist-socrates.berkeley.edu/~asrg/00SmithContamDWBngldsh.pdf

Read the introduction

Consequently, during the 1970s the United Nations Children’s Fund (UNICEF) worked with the Department of Public Health Engineering to install tube-wells to provide what was presumably a safe source of drinking-water for the population. These wells consist of tubes that are 5 cm in diameter that are inserted into the ground at depths of usually less than 200 m. The tubes are then capped with a cast iron or steel hand pump. At the time the wells were installed, arsenic was not recognized as a problem in water supplies, and therefore standard water testing procedures did not include tests for arsenic
UNICEF has rejected claims in the past that its own encouragement of well-drilling has exacerbated the contamination of Bangladesh's groundwater by arsenic, which has been described by international officials as the biggest mass poisoning in history.

http://www.newint.org/issue332/poison.htm

...and now the World Bank loans Bangladesh 32.4 million dollars to test tube wells for arsenic.

http://www.gvep.org/content/directory/detail/10057

While some experts now fault UNICEF for failing to do exhaustive testing, there is no denying that the tube well program saved millions of lives. UNICEF was able to boast that 97 percent of Bangladeshis were now within walking distance of "safe" water. Reliable statistics are hard to come by here, but there is general agreement that mortality rates attributed to diarrhea, the nation's major killer, have plunged. Convinced with great effort that ground water is the safest to drink, villagers are now beginning to be told that this is not necessarily so. Some people react with outrage, some stoicism. Almost all are baffled.

Questions and Discussion

1. What were the roles of the following actors?

   - World Bank?
   - UNICEF?
   - Government of Bangladesh?
   - British Geological Survey?

2. What were their responsibilities? What should they have been?

3. What was the reality (of their actions, blame, etc.)?

4. What were the “successful” characteristics of diffusion in this model (i.e. what led to such widespread distribution/use of tube wells, that then led to increased arsenic exposure)?
5. What went wrong? Why was their failure on many parties’ sides to act? (Also…what was at stake? Was this a possible reason for NOT acting?)

6. How do we reverse this process?

7. What tools and methods of diffusion can be utilized here?

8. How do you regain the trust of the people? How do you get them to change their ways with water if they have already been convinced to change before?

9. Was it really worth it? If we had to choose between having people continue to drink from surface water sources or use tube wells, what would be best? (this question is meant to generate discussion)