11.479J / 1.851J Water and Sanitation Infrastructure in Developing Countries
Spring 2007

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Dept. of Urban Studies & Planning
Civil and Environmental Engineering Dept

MID-TERM ESSAY ASSIGNMENT

Planning a Strategy, Advocating for a Specific Remediation Solution,
or Presenting a Case Study Addressing
Arsenic Contamination in Drinking Water

Length: 2,500 words max (8 – 10 pages double-spaced)
Due in class, Tuesday, March 20, as a Hard Copy. No late assignments accepted.

Drawing on insights you have gained from class lectures, on-line and in-class discussions and from viewing the documentary "Arsenic: The Largest Mass Poisoning in History," (to be shown in class on 3/13/07 and DVD available in Rotch and for loan to Harvard students), write a reflective essay (8-10 pages) on a policy approach, implementation approach or case study (for example, a country affected by arsenic in drinking water) related to the arsenic in drinking water crisis. Below are some recommended readings detailing arsenic policies and remediation technologies being promoted in Bangladesh, Nepal and elsewhere, followed by some background information describing the challenge arsenic contamination in drinking water poses to the many stakeholders in this drama.

This essay invites you to engage with this challenge in one of three ways. You may: (1) Provide an overall planning strategy that advocates for a specific remediation solution or set of solutions, (2) Recommend a preferred technological solution or set of solutions, or (3) Present a case study (a region, country, etc.) and propose a remediation solution to address arsenic contamination in drinking water specific to the site you have selected. Your essay should engage some of the guiding questions provided below regarding the challenges to successful arsenic remediation.

See Week 6 – Recommended Readings:

Ahmed, M.F., Ahuja, S., Alauddin, M., Hug, S.J., Lloyd, J.R., Pfaff, A., Pichier, T., Saltikov, C., Stute, M., and van Geen, A. 2006. *Ensuring Safe Drinking Water in Bangladesh*. Science. Vol. 314. Dec. 15, 2006.

Environment and Public Health Organization. *Kanchan™ Arsenic Filter*. 2nd Edition. ENPHO. Kathmandu, Nepal. 2005.

Ngai, T., Murcott, S., Shrestha, R.R., Dangol, B., Maharjan, M. *Development and Dissemination of Kanchan™ Arsenic Filter in Rural Nepal* Water, Science & Technology Vol. 6. No. 3. 2006. International Water Association Publishing.

Harvard Arsenic Website Project (Remediation Page) (Prof. Richard Wilson)
http://phys4.harvard.edu/~wilson/arsenic/remediation/arsenic_project_remediation_technology.html#GOBtests

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Background Information

The issue of arsenic contamination in drinking water - "the largest case of mass poisoning in history" – attained international recognition in 1997/1998 with Canadian, BBC and New York Times coverage and is well-known today. The best remedy for arsenic exposure is to drink safe water. The range of remediation alternatives is well-understood (Figure 1), however, successful implementation of arsenic remediation policies and options has been excruciatingly slow and millions remain at risk.

There have been many legitimate challenges to successful remediation of arsenic in drinking water:

Scale: the scale of the arsenic problem is global and few actors work at this scale. Eighty-two countries have been identified as having arsenic in drinking water, with affected populations in many countries yet to be counted (Murcott, 2006). From the data currently available, we estimate that there are at least 152 million people in the world exposed to arsenic greater than 10g/L in their drinking water. Of that total, 148 million, or 97%, live in Asia. Table 1 shows these estimates.
How can you create an effective policy to address such a large-scale problem? At what level should interventions be aimed?

Table 1: Number of People affected by Arsenic in Drinking Water > 10 ug/L

Country	# exposed.>10 ug/L (in 1,000s)	Country	# exposed.>10 ug/L (in 1,000s)
Bangladesh	57,000	Mongolia	300
India	36,047	Thailand	268
Pakistan	27,680	Chile	200
Vietnam	10,000	Ghana	194
China	9,466	Guam	129
Myanmar	3,400	Taiwan	110
Nepal	1,300	Botswana	100
Argentina	1,200	Serbia	100
Cambodia	1,000	Philippines	80
Mexico	845	Dominica	69
Niger	710	Kurdistan	30
Georgia	651	Burkina Faso	28
Afghanistan	500	Australia	12
Lao	400	Finland	5
Subtotal (# in Asia)			**147,710**
Total (28 countries)			**151,824**

(Murcott, 2006)

Complexity: Arsenic in drinking water occurs in many different countries with different cultures, languages, beliefs, political systems, income levels, geologies and climates. This great diversity has a large impact on the speed of realization of solutions.
Given the number of locations affected, can large-scale solutions be effective across the variety of political, cultural, and physical environments? How can planners, policy-makers, public health workers ensure that solutions are appropriate to local conditions?

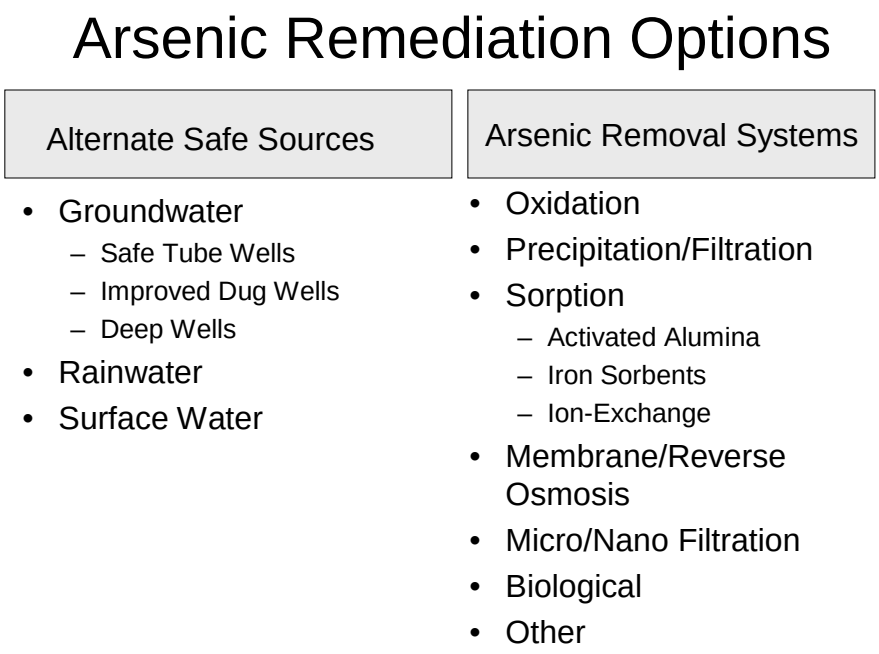
Invisibility: Arsenic is colorless, odorless and tasteless. Unlike the symptoms of infectious diseases such as malaria or tuberculosis, the symptoms of arsenic exposure take years to manifest and are not always readily attributable to the true cause.
How can innovative policies, technologies, and/or implementation strategies effectively overcome this obstacle?

Inequity: The vast majority of people affected by arsenic in drinking water lives in rural areas and earns a low-income – many live below the global poverty line of less than $1 per day. This means that, unlike in high-income countries, where arsenic contamination in drinking water is addressed and resolved by a reasonably effective regulatory system, with government, industry, municipalities and citizens collectively playing their part, this is not the case in many arsenic-affected countries.
How can planners and other actors effectively address this inequity?

Selection of Solutions Requires Stakeholder Participation, Political Will and Transparency: National arsenic testing programs, sometimes supported by international aid agencies, have sometimes communicated findings to stakeholders, for example, using media, educational campaigns, and by painting safe wells green and unsafe wells red. Through these and other means, stakeholders have become informed to varying degrees, but many feel powerless to take action, either because of confusion over their choices or lack of political voice. Arsenic contamination has not always engaged the political will of the governments in power, and when it has, there have been instances of cover-up, corruption and inaction, as well as concerted engagement on the part of multiple players.
Can planners and other actors adopt strategies that maximize the likelihood of an effective combination of stakeholder participation, political will, and transparency?

Evaluation of the Range of Solutions Requires Technical Expertise
The range of remediation solutions is extensive and requires technical expertise to evaluate. Remediation alternatives for arsenic-contaminated water falls under two broad categories: technologies that supply drinking water from an arsenic-free source or technologies that treat the arsenic-contaminated supply via an arsenic removal system. The complete set of arsenic remediation categories is presented in Figure 1.

Figure 1 [1]



The problem cannot be solved by a single brilliant plan or "silver bullet" technology. Multiple stakeholders possess multiple political, economic, humanitarian, private and vested interests.
How can planners and other actors create cogent strategies that speak to different stakeholders' interests?
Which technologies are appropriate to a given region, nation, state, or local area?

Reference: Murcott, S. 2007. *Arsenic Contamination in the World: An International Sourcebook.* Forth-coming publication. World Health Organization, Geneva.

[1] The arsenic removal systems of Figure 1 show treatment processes rather than specific technologies, because otherwise, the list would be too long. Whereas there were only a handful of arsenic removal technologies two decades ago, the list has grown. The author identified 29 arsenic removal technologies in a paper delivered in New York in 2000 (Murcott, 2001), and expanded that list to greater than 50 technologies in 2003 (Murcott, 2003). Today, there are literally hundreds of different arsenic removal technologies – a set difficult for any single expert, let alone an arsenic-affected person or community, to track.