Response to Comment on "Reliability of a Commercial Kit to Test Groundwater for Arsenic in Bangladesh"

Muhkkerjee et al. raise three main objections to our recent recommendation that a commercial field kit continue to be used to test well water for arsenic throughout Bangladesh (*1*, *2*): (1) our study did not have broad enough coverage to constitute a representative evaluation of the kit; (2) many wells have been and will continue to be misclassified on the basis of field kits; (3) poor training and certain types of groundwater can lead to incorrect field-kit results.

Before responding to these concerns, we wish to applaud Dr. Chakraborti and his colleagues and students for the absolutely central role they have played in documenting the scale of the arsenic calamity in India and Bangladesh over the past 20 years. Soon after the first signs of disease in West Bengal were linked to elevated arsenic concentrations in groundwater in 1984, Dr. Chakraborti started to orchestrate heroic efforts to sample tens of thousands of wells and accurately measure the arsenic content of well water in his laboratory at Jadavpur University. Without Dr. Chakarborti's tenacity in bringing to the world's attention the plight of millions of people drinking groundwater with elevated levels of arsenic, the inertia of government and international organizations in responding to the crisis might still not have been overcome. In the following paragraphs, we try to explain why, despite our enormous respect for Dr. Chakraborti's achievements, we disagree with his current stance on testing with field kits.

Was the Evaluation Representative? We believe that comparing laboratory measurements of arsenic concentrations for 799 wells that were independently tested by NGO workers is sufficient to establish the reliability of a field kit under realistic conditions. Although the geographic extend of the area where the study was conducted is limited, the highly variable geology of Araihazar upazila afforded us the opportunity to sample a spectrum of aquifers representative of much of the country.

Laboratory vs Field Tests. We evaluated the Hach kit because we felt its novel design had overcome some of the limitations of other kits and because it had been widely used by NGOs in Bangladesh. The fact that less reliable kits have also been used in the past has no direct bearing on our recommendation that the Hach kit continue to be used in the future. We realize that good laboratories will produce more accurate arsenic measurements for the foreseeable future. The main drawback of laboratory testing, however, is that it is not realistic to expect such an approach to allow testing on demand. This is very important because wells continue to be installed throughout the country, partly in response to the previous test results. Of the 6000 wells within a 25 km^2 area that we tested in 2000−2001, for instance, approximately 1000 had already been replaced privately by 2004 (*3*). The logistics of testing millions of wells by setting up a few thousand hubs of field testers who rely on a good field kit throughout the country (e.g., at the union level) are daunting but conceivable. In contrast, it would be nearly impossible to perform millions of laboratory analyses in a few centralized locations and to communicate these results back to individual households.

Training and Matrix Effects. Our results actually show that 21% of wells containing >50 ug/L As (n = 376) were misclassified by BAMWSP workers (the 12% figure quoted by Muhkkerjee refers to the entire set of 799 wells, including safe wells). The proportion of misclassified wells containing >50 ug/L As was drastically reduced to 2% for the 62 wells that we tested by increasing the reaction time to 40 min. On the basis of these observations, we believe the level of misclassification for high As wells could be reduced to a few percent if testers are properly trained and motivated. This is not ideal but, in our opinion, the lesser of two evils if laboratory testing of a smaller number of wells is the only alternative. Whenever the Hach kit or other kits are used in different environments, e.g., in Pakistan, an initial comparison with laboratory measurements is imperative (With respect to the specific interference brought up in the comment, we'd like to point out that people generally do not drink water elevated in sulfide.).

Changes in Well Arsenic over Time. Perhaps the most important unknown of the Asian arsenic crisis at this point, alluded to in the comment from Dr. Chakraborti's team, is the issue of changes in well As concentrations over time. In this context, it is worth reminding the reader that our study included a comparison of laboratory results for 344 wells sampled 2 years apart in Araihazar which showed that As concentrations did not change significantly in the vast majority of wells over this period. The finding is consistent with one year of observations for a number of wells over a range of depths in other parts of the country by BGS/DPHE (*4*) and more detailed time series data for a set of 20 wells in Araihazar containing ≤50 ug/L As that were monitored every 2−4 weeks over a period of 3 years (*5*). Two of the wells that were monitored in Araihazar, however, did show worrisome increases in As concentrations over this period, in one case most likely because disconnected pipe sections led to the entrainment of groundwater from a shallow aquifer elevated in As. Other groups working in Bangladesh, the state of West Bengal in India, and Vietnam have reported seasonally changing As concentrations or increasing As concentrations. Such observations, which in our opinion do not warrant a wholesale rejection of the exploitation of aquifers that are presently low in As, serve only to reinforce the need for making testing services available at the village level throughout the affected regions.

We conclude our response to Dr. Chakraborti's surely well-intentioned comment by pointing out that the time for strident alarms may have passed. Decisive intervention to mitigate the arsenic crisis appears to be still lacking, but the affected populations might be better served if the scientific community could constructively reach out to entities such as the World Bank and UNICEF that have the wherewithal to scale up mitigation. A concrete joint activity that would be extremely valuable would be to set up a network of wells for monitoring representative aquifers that are presently low in As in Bangladesh, India, and other affected South Asian countries over a period of at least 10 years.

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A. van Geen and Z. Cheng

Lamont-Doherty Earth Observatory of
Columbia University
Palisades, New York 10964

A. A. Seddique, M. A. Hoque, and K. M. Ahmed

Department of Geology
University of Dhaka
Dhaka, Bangladesh

A. Gelman

Department of Statistics
Columbia University
New York, New York 10027

J. H. Graziano, H. Ahsan, and F. Parvez

Mailman School of Public Health
Columbia University
New York, New York 10032

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