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# ARSENIC POLLUTION

## A GLOBAL SYNTHESIS

Peter Ravenscroft, Hugh Brammer and Keith Richards

WILEY-BLACKWELL

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# Arsenic Pollution

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Peter Ravenscroft, Hugh Brammer
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# ***Series Editors' Preface***

The RGS-IBG Book Series only publishes work of the highest international standing. Its emphasis is on distinctive new developments in human and physical geography, although it is also open to contributions from cognate disciplines whose interests overlap with those of geographers. The Series places strong emphasis on theoretically-informed and empirically-strong texts. Reflecting the vibrant and diverse theoretical and empirical agendas that characterize the contemporary discipline, contributions are expected to inform, challenge and stimulate the reader. Overall, the RGS-IBG Book Series seeks to promote scholarly publications that leave an intellectual mark and change the way readers think about particular issues, methods or theories.

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sium/. Contributors came from several affected countries and concerned research groups, and included: George Adamson, K Matin Ahmed, Feroze Ahmed, Nupur Bose, William Burgess, Johanna Buschmann, Vicenta Devesa, Ashok Ghosh, M. Manzurul Hassan, Meera M Hira-Smith, Mohammad Hoque, Guy Howard, Jiin-Shuh Jean, John M. McArthur, Andrew Meharg, Debapriya Mondal, Bibhash Nath, Ross Nickson, David Polya, Mahmuder Rahman, Sudhanshu Sinha, Allan H. Smith, Ondra Sracek, Farhana Sultana, Richard Wilson and Yan Zheng. We are grateful for their involvement in an event designed to heighten interest in and concern for the arsenic contamination problem, and to Clarissa Brocklehurst, Ross Nickson and Oluwafemi Odediran for arranging a UNICEF meeting at the RGS on 30th August to follow up issues raised during the conference. Presentations and discussion over these two days contributed significantly to our thinking about the content of the book.

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# *Preface*

Readers may be surprised to learn that the most severe effect of human impact on environmental systems is *not* climate change. But that is what this book sets out to show.

One similarity between global warming and the arsenic crisis is that in both, human actions accentuate risks associated with otherwise natural phenomena. Another is that the consequences affect the global poor most severely. Indeed, this dimension is already obvious from the history of the arsenic crisis. Nearly 50 million people in south and east Asia have, for some decades, drunk water contaminated with arsenic at levels above the *old* WHO standard of 50 ppb. Many already have clinical symptoms of arsenicosis, leading to this being referred to as history's largest mass poisoning. By contrast, the USA has diverse sources and types of arsenic contamination in water supplies, but little evidence that this has a significant effect, because of better water treatment and better general health in the population.

What is less widely understood is the latency of the effects of chronic arsenic poisoning. Even if a solution to the problem of water supply quality is found soon, many who have been drinking contaminated water will still suffer cancer in spite of switching to clean water. Furthermore, arsenic ingestion is often estimated from water intake alone, although it is increasingly apparent that an additional loading arises from arsenic in food, especially from paddy rice grown with contaminated irrigation water. Soils thus irrigated may accumulate arsenic to phytotoxic levels, creating a problem of latent effects on crop yields.

That we find ourselves in this position reflects badly on both environmental science and the development process. Water becomes naturally contaminated by arsenic in several ways, and we must understand how this arises under different geological, geomorphological and geographical circumstances. The environmental sciences have not always successfully anticipated this sensitivity to specific circumstances, and one consequence of emphasis on climate change is a global focus that tends to avoid the issue of such sensitivity, and its potential meaning for regionally vulnerable populations. Questions that transcend disciplinary boundaries also still offer challenges; the reductive dissolution of arsenic might have been understood sooner had groundwater chemists talked at an earlier stage to marine geochemists. These shortcomings meant that science was unprepared for the consequences when development agencies sought to solve the problem of enteric disease caused by polluted surface water supplies, by providing shallow tube wells. These wells tapped aquifers in which precisely that process of reductive dissolution had elevated the dissolved arsenic concentrations to unhealthy levels.

Since these events, and the belated recognition of the consequential mass poisoning, research in the field has burgeoned, and it is now timely to synthesise the knowledge gained. In doing so, we examine the geochemistry of arsenic and its mobilisation, and the geomorphologies and geologies that define the geography of these processes. We suggest simple tools to identify areas where high levels of arsenic in groundwater might be expected, but have yet to be identified. We assess the risks for crop production and food contamination, and review the health and social effects, observed and potential. We then consider mitigation options, through water-supply substitution and point-of-use treatment; and their additional risks (e.g., drawdown of arsenic into overexploited deeper aquifers, and disposal of arsenic wastes generated by treatment procedures). And we examine these issues not only in general, but also as geographies, characterised by spatial diversity and multiple knowledge bases.

One of us, Hugh Brammer, not only contributed to the book, but also supported the research and the linked conference (see Acknowledgements, p. xxi) financially. His desire to do so arose from his experience in Bangladesh working on soils, agriculture and disaster preparedness, and his belief in the capacity of geography to facilitate better understanding of both the mobilisation of arsenic, and the cultural context of the management of its effects and their mitigation.

We hope this book will be valued as a synthesis of current knowledge about arsenic contamination and the crisis it has caused, and about what needs to be done to accelerate mitigation. We hope it will help to disseminate information and spread realisation of the nature and scale of the problem to a wider range of professionals and publics so that pressure to act on these issues will grow. We also offer it as an example of the practical value of geography in helping to tackle environmental and development problems with multidisciplinary dimensions and regionally differentiated consequences.

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