Arsenic hazard in shallow Cambodian groundwaters

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Introduction

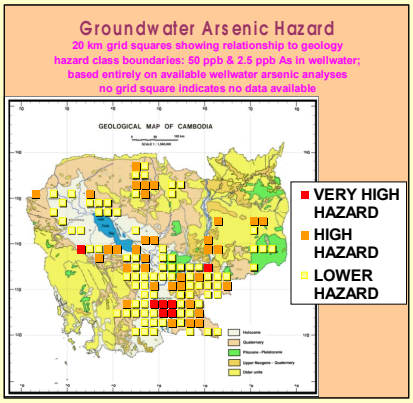
The recent discovery of elevated hazardous concentrations of arsenic in shallow sedimentary aquifers in central and southern Cambodia by ourselves[1-5] and other groups[6,7] raises the sceptre of future deleterious health impacts to a population that, particularly in non-urban areas, extensively use groundwaters as drinking and irrigation waters. This indicates the importance of rapidly producing readily visualisable information that may be of assistance to government departments, NGOs including aid agencies and local organizations in assessing the relative seriousness of the hazard in different geographic locations.

Collection, filtration and preservation of well waters
Kampong Cham Province, Cambodia, July 2002

Data Sources & Map Scale

Small scale mapping is most suitable for this purpose, particularly because of the relatively small amount of data available, and the substantive spatial heterogeneity of observed arsenic concentrations.

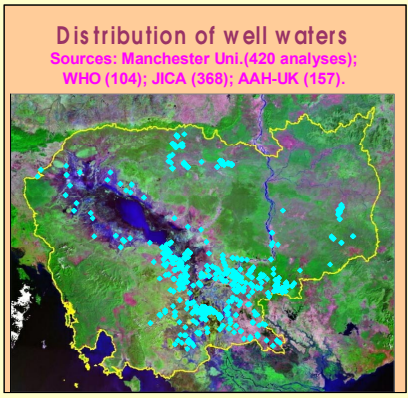
We present here a small scale hazard map for arsenic in shallow Cambodian groundwaters based upon 1049 well water samples analysed both in our laboratory (by ICP-AES, ICP-MS or IC-ICP-MS) and elsewhere[6,7]. The JICA data[7], we understand, and AAH-UK data were obtained from field test kits. Sample distribution is shown below.



Relationship with Geology

A comparison with a geological map of Cambodia [simplified by Diebe[8] after UN[9]] shows that widespread arsenic hazard in groundwaters with arsenic concentrations higher than the Cambodian guide value (50 ppb) is most commonly associated with recent sediments, in particularly sediments considered[9] to be Holocene in age.

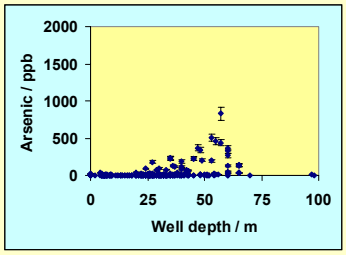
There is, however, considerable variation in well water arsenic concentrations even within the Holocene sediments – those immediately downstream of Phnom Penh exhibiting particularly high concentrations.

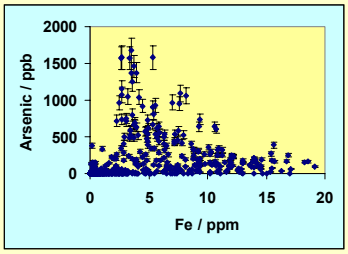


Limitations

The use of these maps for predicting arsenic concentrations in individual wells is not recommended because of (i) temporal variations in arsenic concentrations; (ii) spatial variations, including considerable heterogeneity on a tens of metre scale; and (iii) lack of explicit consideration of factors such as depth (see figure at right) , local geology and sedimentology, sediment age, geomorphology and local groundwater abstraction histories that may strongly influence local groundwater arsenic concentrations. We also note a relative paucity of available data from wells outside of Kandal province and the variable precision and accuracy of field kit analyses.

Biogeochemical, dating and other studies are ongoing to determine how arsenic hazard, including future changes, may be more accurately predicted.





Conclusions

Very high arsenic hazard in shallow Cambodian groundwaters is most commonly associated with:

[1] Holocene sediments, particularly:

- **near major modern river channels, notably those of the Mekong and Bassac Rivers**
- **downstream of Phnom Penh**

[2] Well depths of 20 to 70 m

[3] Iron rich (Fe > 2 ppm) well waters

however high arsenic wellwaters are also commonly found in wells not exhibiting all these characteristics.

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