

Assignment: Assessing exposure to arsenic in drinking-water in Bangladesh

Background:

Arsenic is a geogenic contaminant found in many deep groundwaters, meaning that it occurs naturally depending on the underlying geology. Typically, arsenic is present in deep groundwaters, which are pumped to the surface via tubewells, boreholes or deep wells (Smedley and Kinniburgh, 2002). Surface waters such as ponds and rivers and shallow groundwaters, accessed through hand-dug wells, are seldom affected by such geogenic contamination. Prolonged consumption of arsenic-contaminated food or water results in arsenicosis or arsenic poisoning (WHO, 2012). Arsenicosis can result in skin discoloration as well as increased risk of various forms of cancer and cardiovascular disease. Various options are available to reduce exposure to arsenic in drinking-water, including the labelling of arsenic-contaminated water sources, promotion of alternative, non-contaminated sources such as shallow wells, and the use of filtration and other treatment devices to remove arsenic from drinking-water prior to consumption. Arsenic contamination of drinking-water is a public health issue in several regions of the world, but particularly notable in the Ganges delta and Bangladesh.

Assignment:

Based on the available data (see description below), estimate the size and location of the Bangladeshi population exposed to hazardous levels of arsenic in drinking-water. You are not required to consider arsenic exposure via other routes, such as consumption of vegetables or cereals irrigated with arsenic-contaminated water.

Describe your exposure assessment methodology and findings in a report of no more than 1,500 words, using illustrations as appropriate. In your Discussion, assess the likely sources of uncertainty affecting your estimate of the population exposed to arsenic in drinking-water. To what extent do you think your findings are plausible and could form a basis for interventions to reduce population exposure to arsenic contamination?

Data:

Arsenic: British Geological Survey have made available a number of hydrochemical surveys of groundwater in Bangladesh. In particular, a national database of water quality data from 3534 boreholes developed with the Bangladesh Dept of Public Health and Environment is available here (see the first data link on this page to the *DPHE/BGS National Hydrochemical Survey*): <https://www2.bgs.ac.uk/groundwater/health/arsenic/Bangladesh/data.html>. The field As (column O in Excel) contains data on levels of arsenic.

Population: Various data sets describe the spatial distribution of population in Bangladesh. The WorldPop project (<http://www.worldpop.org.uk/>) produces gridded population estimates of the population in various years including 2010 and 2015, as does recently released data from Facebook and Columbia University: <https://data.humdata.org/dataset/bangladesh-high-resolution-population-density-maps-demographic-estimates>.

Water source use: Bundled with this exercise is a polygon shape file named **BGD_adm2**. This is derived from the Global Administrative Boundaries data set (<http://www.gadm.org/download>) and combines this with published information from the 2011 population census for Bangladesh

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(Bangladesh Bureau of Statistics, 2015). The percentage of households for each of Bangladesh's zilas (administrative level 2 or district) using tubewells / boreholes as their main water source is included as an additional attribute field named **boreh**.

Notes on processing available data:

Arsenic: Note that you will need to edit the BGS water quality database prior to importing it into ArcGIS. You should edit the file so that it has a single header row (so for example you will need to delete rows 1 to 4 and row 6). Field names will also need editing, for example to remove spaces and punctuation characters (e.g. '.'; '/' and spaces). Note also that some arsenic tests have a lower limit of detection, which means that there are some boreholes with arsenic concentration values coded as '<0.5' and '<6' ug/l. The handling of these values is not straightforward. However, one solution would be to replace the values of '<0.5' with 0.25 ug/l and '<6' with 3 ug/l.

References:

Bangladesh Bureau of Statistics (2015): 'Population Monograph of Bangladesh: Household Amenities and Assets'. Bangladesh Bureau of Statistics, Dhaka:

http://www.bbs.gov.bd/WebTestApplication/userfiles/Image/PopMonographs/Volume-8_HAA.pdf.

[Link now dead. This is about as close as we can get now:

<http://www.bbs.gov.bd/site/page/47856ad0-7e1c-4aab-bd78-892733bc06eb/Population-and-Housing-Census>]

Smedley S. Kinniburgh DG (2002): 'A review of the source, behaviour and distribution of arsenic in natural waters'. *Applied Geochemistry* 17(5): 517-568.

World Health Organization (2012): 'Arsenic'. Fact sheet no: 372. World Health Organization, Geneva. <http://www.who.int/mediacentre/factsheets/fs372/en/>