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| School of Geography and  Environmental Science |  |

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| GGES6016 | GIS for Analysis of Health | Assignment 2 |

Assignment 2

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 handdug 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 issues in several regions of the world, but particularly notable in the Ganges delta

and Bangladesh.

Task

**Based on the provided data (see description below), and any other relevant supplementary data, 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.

**In a report of no more than 2,000 words**:

* Describe and evaluate your exposure assessment methodology and findings, 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

**Data provided in the .zip file on the Blackboard site:**

**Arsenic**: British Geological Survey has made available a number of hydrochemical surveys of groundwater in Bangladesh. 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.

**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 (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

In the shapefile as an additional attribute field named **boreh**.

**Data which you will need to download yourself:**

**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 data from FaceBook and Columbia University: <https://data.humdata.org/dataset/bangladesh-high-resolution-population-density-maps-demographic-estimates>. You will need to decide which dataset(s) suit your needs and download them yourself.

**Hints and tips on processing the 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.

Deadline and submission arrangements

Deadline: **4pm, 21 May 2025**

Submission arrangements: Upload your assignment using **eAssignments**. Please ensure that your assignment is **anonymous** i.e. include your student number but not your name on the document.

Faculty word count policy

**Only work which falls within the word limit will be marked.** Please see the table below for confirmation of what is/is not included in the word limit:

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| **Item** | **Does it count?** |
| Title | NO |
| Abstract | NO |
| Introduction | YES |
| Methods | YES |
| Results | YES |
| Discussion | YES |
| Conclusion | YES |
| Bibliography | NO |
| Reference List | NO |
| In-text citations | YES |
| Tables – contents | NO |
| Tables – titles | YES |
| Figures – contents | NO |
| Figures – captions | YES |
| Table of contents | NO |
| Headings / sub-headings | YES |
| Executive summary | NO |

Referencing and Academic Responsibility and Conduct

Remember to use appropriate referencing techniques: Geography and Environmental Science uses the **Harvard** style of referencing, so please make sure that you familiarise yourself with this and use it consistently (useful resources can be found at: <http://library.soton.ac.uk/sash/referencing>, <http://library.soton.ac.uk/online-skills>, and <http://library.soton.ac.uk/geography>).

All submitted work must conform to the [University Academic Responsibility and Conduct regulations](https://www.southampton.ac.uk/about/governance/regulations-policies/student-regulations/academic-responsibility-conduct). All students must ensure that they read these regulations thoroughly as they will need to confirm that their work conforms to them when submitting assignments. Written assignments will be screened for plagiarism using the University’s TurnitinUK plagiarism software.

**Use of Artificial Intelligence tools**

Use of Artificial Intelligence tools for the preparation or production of materials to be submitted is NOT permitted in this module and will be considered a breach of the University’s Academic Integrity regulations. Please read the guidelines under Assignments on the GGES6013 Blackboard site on the responsible use of Artificial Intelligence tools.

Marking criteria

Assignments will be graded according to the SoGES marking criteria for Level 7 (MSc PGT). These can be found on the module Blackboard site under Assignments.

Release of grades and feedback

Provisional grades and individualised feedback will be released via eAssignments. General feedback to the class will be provided via Blackboard.

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 (2022): ‘Arsenic’. Fact sheet no: 372. World Health Organization, Geneva. <http://www.who.int/mediacentre/factsheets/fs372/en/>