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Spatial analysis of arsenic exposure and diarrheal disease risk in Bangladesh related to population pressures on groundwater resources

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The rural population in Bangladesh relies on groundwater for consumption needs. The use of groundwater increased greatly over the past two decades because of country-wide concerted efforts to install private tube wells in the hope of improving the quality of the water consumed, and consequently reducing infant mortality. The driving force for the switch from surface water to groundwater has been the concern that generally groundwater is less contaminated with human pathogens. However, this switch from surface water to groundwater has lead to an increased exposure to naturally occurring arsenic in the subsurface, which puts children at an increased risk to develop bladder cancer over their lifetime. Concurrently to the increased exposure to arsenic, diarrheal morbidity remains a severe problem, particularly for children under five for whom it is the largest cause of death. One possible explanation is that poor sanitation in densely populated villages may have resulted in microbial contamination of shallow aquifers. Hence Children in Bangladesh are at the double risk of being exposed to arsenic while at the same time still suffering from high diarrheal disease risk. Global climate changes and the resulting increased in surface water variability may only further increase the population pressure to use groundwater to meet its consumption needs. Hence it is becoming critical that we understand better the spatial distribution of subsurface arsenic concentration across the villages of Bangladesh, and that we analyze spatial patterns in outbreaks of diarrhea cases, in order to improve our understanding of their relationship in the face of increased pressure to clean groundwater resources. We address this issue in this work by performing a spatial mapping analysis of arsenic exposure and diarrheal disease risk across different regions of Bangladesh. The arsenic data we use include measurements made by the British Geological Surveys on selected wells across the entire country, as well as a near exhaustive sampling of all wells in the Matlab region of Bangladesh. The diarrheal disease data we use consist of Cholera cases reported over a 10 year period in Matlab, as well as Shigella cases reported over a three year period. We analyzed the arsenic data using the Bayesian Maximum Entropy (BME) method of modern Geostatistics to obtain maps depicting the spatial distribution of arsenic across the country, and we analyzed the diarrheal cases using the BME method followed by a detection of statistically significant clusters using a Poisson distribution test. The analysis demonstrate that the combination of BME and cluster detection provide a powerful tool for the spatial analysis of arsenic exposure and diarrheal disease risk in Bangladesh. The maps produced support that there may be an inverse relationship between arsenic and diarrhea, which will be further studied in future works.