# The Effect of Arsenic on Nature

Arsenic-contaminated aquifers are currently estimated to affect 150 million people around the world. However, the full extent of the problem remains elusive. Arsenic can strongly affect groundwater quality through natural geogenic leaching processes from host rocks and sediments. Arsenic concentrations can also increase due to a low hydrological gradient, resulting in sluggish groundwater flow as well as a strongly arid environment that leads to evaporative concentration. Arsenic contaminated water is one of the most serious global health threats, with currently estimated 150 million people relying on arsenic-contaminated groundwater. To determine where best to apply the limited resources for ground- water testing, geostatistical modeling can identify areas likely to be affected by arsenic contamination by finding statistically significant relationships measured arsenic concentrations and environmental predictors. This also has the advantage of being able to use spatially continuous predictor data sets to identify areas of high arsenic hazard, where groundwater quality data are lacking. Although this method can efficiently predict the occurrence of contamination on a large scale, it is generally ineffective at the scale of individual wells due to small-scale aquifer heterogeneities that are undetectable at the surface.



The effects of Arsenic are rare in Pakistan. High levels of arsenic in blood and hair samples from people living in predominantly rural areas with high ex- posure to arsenic in groundwater. Food crops in the Sindh and Punjab provinces also indicate a potentially severe health threat due to plant uptake of arsenic via irrigation water extracted from shallow Holocene aquifers. However, lack of resources in the country has prevented the comprehensive evaluation of arsenic in groundwater. Pakistan is characterized by the flat-lying Indus Plain in the east; the Himalaya, Karakoram, and Hindu Kush mountain ranges in the north; hill regions in the northwest; and the Baluchistan plateau in the west. On account of a highly arid climate in the Indus Plain, extensive irrigation uses groundwater resources and a widespread canal system that distributes water from the Indus River and its main tributaries across the adjacent plains. A chemically reducing environment generally dominates in the aquifers along these rivers, which is generally due to an abundance of organic material along with a limited supply of oxygen, and results in the desorption of arsenic from iron oxy(hydr)oxides. The study focuses on risk determination based on our new groundwater quality data set and has produced the first-ever statistically based arsenic hazard model and health risk map for Pakistan.

Through results we came to know that High arsenic concentrations exist mainly along the Indus River and its tributaries. Very high arsenic concentrations (>200mg/liter) were measured primarily in the southern half of the Indus Plain. Overall iron concentrations are low, and not exceeding 1.9 mg /liter. The highest concentration of iron measured in a water sample with arsenic greater than 10 mg/liter is only 0.86 mg / liter. Furthermore, low nitrate levels (average, 2.7 mg /liter; median, 1.3 mg /liter) in the wells with arsenic >10 mg /liter. However, there is no statistically significant correlation between depth and arsenic concentration. Further two models were proposed; Hazard probability model and Health tusk model. The Hazar probability model tells us about with the exception of soil or- ganic carbon, the number of variables that passed the goodness-of-fit test is nearly equal. Acc to health risk model while combining the area of high hazard (?60% probability) with population figures for 2016 indicates that approximately 88 million people live within the modeled hazard area. The risk map indicates the need for widespread testing of drinking water wells in the Indus Plain to help safeguard the long-term health of its population. Because of an inherent high degree of small-scale spatial variability of geogenic arsenic contamination (61–63), wells should be tested individually so that measures can be implemented for those most severely affected. However, some areas do locally show a high correlation between high arsenic and iron, suggesting a reducing environment.

Depth is not correlated with arsenic concentration over the range of available depth measurements. Deeper municipal tube wells from Lahore, which are filtered for arsenic, also exhibit elevated arsenic concentrations. Aridity is also well correlated with high arsenic values, which is consistent with the process of evaporative concentration. These finding are consistent with arsenic release caused by oxidizing or elevated- pH dissolution, the process of reductive dissolution may be responsible locally, particularly as a result of industrial or human/animal organic waste in urban areas or intensive agricultural activity. The data set of predicted fluvisols indicates an environment similar to that of Holocene sediments but specifically in- dicates an alluvial setting. High levels of soil organic carbon are a common driver of reducing conditions resulting in arsenic release. The inverse relationship in our model appears to be a consequence of the presence of an arid climate resulting in minimal natural growth of vegetation and accumulation of organic carbon in the soil of the Indus Plain, which leaves the other factors mentioned to be responsible for the enrichment of arsenic. This further implies that reducing conditions are not predominant in the Indus Plain. These results highlight the fact that the variables used generally have their highest absolute values, and therefore greatest effect on resultant models, in the Indus Plain. However, independence and causality are not clear, particularly with regard to irrigation.

Mitigation requires action at several levels, including awareness raising, emergency solutions. support, health intervention programs, alternative resources of drinking water (for example, deep wells) and arsenic removal options. Ultimately, any treatment options must be socially accept- able and tailored to the local groundwater composition. Ground sampling was designed to be evenly spatially distributed and was based on individual union council/tehsil, for which topographical district maps obtained from the Survey of Pakistan were used. In generation of hazard and risk models, the coefficients of the final logistic regression were used to generate a hazard probability map of groundwater arsenic concentrations exceeding either 10 or 50 mg/liter.