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Decreasing arsenic exposure through drinking water by utilizing biogeochemistry in groundwater filters in Bangladesh

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Arsenic (As) exposure via drinking water is a major health threat in Bangladesh. Many households use sand filters to treat As-contaminated groundwater. As removal occurs through adsorption to iron (Fe)-oxides, which form when Fe(II) in groundwater oxidizes. Since As(V) has a higher affinity to sorb to Fe-oxides than As(III), effective removal requires two steps: first, oxidation of As(III) to As(V), and second, oxidation of Fe(II) to form Fe-oxides. As-oxidizing bacteria can catalyze As(III) oxidation, which is particularly interesting as oxidation with oxygen is slow. Here, we assessed As removal efficiency and the presence of As-oxidizing bacteria in five community-scale filters in Kolaroa and three household-scale filters in Manikganj.

In Manikganj, backyard treatment plants serve single households. However, treated water quality was unstable, often containing high Fe and sometimes As concentrations due to inadequate oxidation. A key issue observed was the removal of aeration trays by users when clogged or broken, as they were unaware of its importance. Consequently, Fe-flocs were visible in the treated water, discouraging people from using it for drinking. These outcomes highlight the importance of maintenance manuals and user trainings. Geochemists can provide technical solutions for society but should also collaborate with social scientists about proper implementation of sustainable solutions.

In Kolaroa, around 99.8% of Fe and 75% of As was removed in the treatment plants. However, effluent As still exceeded the WHO norm of 10 µg/L. The plant consisted of three sequential stone or sand filters; each preceded by an aeration step. Half of the As and almost all the Fe was removed in the first filter. The limited overall As removal was due to low Fe/As ratio observed in the second and third filter. The treatment plants in Kolaroa were well maintained and regularly cleaned, and customers were satisfied with their performance.

As-oxidizing bacteria were present in all the treatment plants. Our role as geochemists is to further explore how to harness their power to improve As removal in these systems. Additionally, geochemists must team up with designers and social scientists to ensure a sustainable and robust solution for the communities in Bangladesh.