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Installing arsenic-safe drinking water wells in Matlab, Bangladesh – A novel concept for sustainable mitigation

Prosun Bhattacharya (1), Mohammed Hossain (1), Shaun K Frape (2), Gunnar Jacks (1), K. Matin Uddin Ahmed (3), M. Aziz Hasan (3), and Mattias von Brömssen (4)

(1) KTH-International Arsenic Research Group, Department of Sustainable Development, Environmental Science and Engineering, KTH Royal Institute of Technology, Stockholm, Sweden (prosun@kth.se; mohhos@kth.se; gunnjack@kth.se), (2) Department of Earth and Environmental Sciences, University of Waterloo, Waterloo, ON N2L 3G1, Canada (shaun@uwaterloo.ca), (3) Department of Geology, University of Dhaka, Dhaka 1000, Bangladesh (kmahmed@du.ac.bd; mahasan@du.ac.bd), (4) Department of Water Resources, Ramböll Water, Ramböll Sweden AB, Stockholm, Sweden (mattias.bromssen@ramboll.se)

Since the discovery of Arsenic (As) in Bangladesh groundwater in 1993, there has been a limited success in mitigation and several millions of people are at health risk. Tubewell has been recognized as widely accepted option due to its easy operation, almost no cost for maintenance and the availability of year round water. Since a significant proportion of shallow wells (usually $<$ 80m) are at risk with As-contamination, deep wells are drilled to depths of around 250 m as a mitigation option. Compared to safe water demand, the number of deep wells is still very low, as the installation cost is beyond affordability of the local community.

Hydrogeochemical characterization of shallow, intermediate deep and deep aquifer systems were performed through monitoring of groundwater using depth-specific piezometers (n=82) installed in 15 locations in Matlab area of Bangladesh. Monitoring was done over a 3 year period (pre- and post-monsoon for 2009-2011 period). Results from additional 87 existing drinking water supply tubewells were also considered for the study. For the installation of shallow drinking water wells, one aim of this study was to develop a sediment color tool on the basis of local driller's color perception of sediments (Black, White, Off-white and Red), As concentration of tubewell waters and respective color of aquifer sediments. Average and median values of As, less than the WHO guideline value of 10 μg/L observed from 39 wells installed in red sands gave strong evidence that red sediments provide As-safe water. Arsenic concentrations in more than 90% of the 66 shallow wells installed in black sands were high with an average value of 239 μg/L. Therefore, it is recommended to avoid installation of shallow wells in aquifers consisting of black sands. The use of Munsell Color Chart for the characterization of 2240 sediment samples collected from each of 1.5 m section up to a depth of 100 m from 15 locations spread over 410 km^2 area led to identify 60 color shades. In the narrow down process, each shade was eventually assigned with four colors through a participatory approach taking the opinions of local drillers, technicians, and geologists into account. Comparison with Munsell color rendered them distinctive from each other which reduce the risk for misinterpretation of the sediment colors. This study shows the potential for educating local drillers to identify and target safe aquifers in shallow horizons for tubewell installation. This study also pioneered Intermediate Deep Aquifer (IDA) as a potential source for As-safe and low Mn drinking water. Installation of 245 Intermediate Deep Tubewells (IDTW) at a depth of 120 m provided promising results (99% As-safe and 91% low Mn) which supports the strategy of exploiting IDA as safe aquifers for installation of drinking water wells almost at half of the deep tubewell installation cost.

For scaling-up safe water access in a methodical way, this study also included social mapping and this strategy is recommended for the relevant stakeholders in planning and implementing safe tubewell installation.