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Mechanisms for Water Quality Degradation in Arid and Semi-Arid Parts of Northwest India

Rachel Coyte and Avner Vengosh

Duke University, Nicholas School of the Environment, Earth and Ocean Sciences, United States (rmc33@duke.edu, vengosh@duke.edu)

Water is a scarce and in many cases diminishing resource in India due to a combination of over-exploitation and changes in precipitation patterns induced by climate effects. Degradation of drinking water quality is another critical and often overlooked factor in availability of water in India. In arid to semi-arid Northwestern India, inorganic contaminants, such as nitrate, fluoride, and uranium commonly occur in groundwater at concentrations exceeding WHO drinking water guidelines. While some water quality issues may be attributed to geogenic factors, such as mobilization of contaminants from aquifer rocks and evaporation of recharge water in an arid climate, others are the direct result of human activities. Additionally, prevalence of certain chemicals in groundwater, such as dissolved organic carbon (DOC) and bromide, could promote the formation of disinfection by-products (DBPs) in water treated with disinfectants like chlorine. Using data collected from over 200 wells in the region, we report in the co-occurrence of different types of contaminates in groundwater and evaluate the sources and mechanisms that control the occurrence and distribution of the different contaminates in the groundwater. We further evaluate the risk factors that may contribute to the formation of DBPs in water that is disinfected for human consumption. Geochemical and isotopic tracers point to a combination of factors, including aquifer lithology and hydraulic permeability, water recycle through pumping and irrigation, and domestic wastewater leakage, which have contributed to the development of more saline groundwater with multiple quality issues. The results of our evaluation have important implications for the health of millions of groundwater-reliant people that live in Northwest India and have limited access to alternative water sources.