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Distribution and Sources of Health-Related Contaminants in Private Groundwater Wells in the Gulf Coast Aquifer, Texas

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Private well owners are not protected by the United States Environmental Protection Agency's (EPA) Clean Water Act. As a result, private wells are often not tested for contaminants like arsenic (As), fluoride (F), manganese (Mn), nitrate (NO_3^-), and uranium (U). Elevated concentrations of these contaminants increase the risk of cancer, brain, heart, and kidney disease, neurological impairment especially in children, chronic illness, and early mortality.

Our objective was to determine the sources and severity of As, F, Mn, NO_3^-, and U contamination in Gulf Coast Aquifer wells using public datasets from the Texas Water Development Board (TWDB) database. We hypothesized that land usage and lithology strongly influence groundwater contamination. Contaminant concentrations, major ions, pH, conductance, temperature, and well depth were analyzed spatially and in bivariate plots. Fluoride concentrations were generally below the (2 mg/L) EPA secondary standard across the aquifer, whereas As, NO_3^-, and U concentrations exceeded primary standards in the southern region. Manganese concentrations exceeded the (0.05 mg/L) EPA secondary standard in more than 25% of wells and were highest in the northern part of the aquifer. Positive Mn and Fe correlation (R^2 = 0.54) suggests that reductive dissolution of Mn/Fe-oxides drives elevated Mn in the northern region. Median and third quartile As in the Gulf Coast aquifer were 2.0 µg/L and 4.5 µg/L respectively. For NO_3^-, the median and third quartile were 0.02 mg/L and 0.34 mg/L (mass of N in NO_3^-). The Catahoula, Oakville Sandstone, and Goliad Sand members contained elevated As and NO_3^-. The third quartiles of As for these formations were 33.0 µg/L, 15.7 µg/L, and 11.0 µg/L respectively and for NO_3^- were 4.7 mg/L, 1.7 mg/L, and 6.6 mg/L. Neither As nor NO_3^- correlated with well depth in bivariate plots. This suggests that the lithology rather than anthropogenic sources drives their concentrations. We found that most of the aquifer is below EPA primary and secondary standards with respect to health-related contaminants, but the lithology surrounding wells is responsible for locally elevated concentrations of geogenic contaminants and must be considered to limit the risk of disease or learning disabilities.