Using Geoscientific Analysis and Community Engagement to Analyze Exposures to Potential Groundwater Contamination Related to Hydrocarbon Extraction in Southwestern Pennsylvania

Samuel Shaheen[1], Tao Wen[2], Owen Harrington[1], Lingzhou Xue, Susan L. Brantley[1], Jennifer Baka[1]

[1]Penn State University, University Park, PA; [2]Syracuse University, Syracuse, NY

Background. Understanding the health effects from potential groundwater contamination related to unconventional oil and gas development (UOGD) requires identifying specific locations of contamination, the nature of the contaminants and possible pathways of contamination. Examining this relationship requires determining whether specific contaminants derive from natural or anthropogenic processes, and, if the latter, determining which process is important. This project evaluates linkages between UOGD and potential water contamination in a tri-county region of Southwestern Pennsylvania (Beaver, Greene and Washington counties) because of the region's long history of energy development in general and UOGD specifically.

Methods. We combine community focus groups and geoscientific analysis in this study. We conducted three focus groups (one per county) in June-July 2022 to gather community-level observations regarding observed changes to water quality, possible contamination pathways, associated health impacts and broader landscape transformations. These data informed a statistical analysis of a groundwater sample dataset from the region that contains over 7,000 samples, each with approximately 40 reported chemical analytes. We utilized a machine learning tool (non-negative matrix factorization) to isolate the influences of natural and anthropogenic processes on groundwater chemistry and identify potential linkages between UOGD and water contamination.

Results. Across all three counties, communities documented negative changes to water since the start of UOGD and raised concern about potential water contamination from UOGD chemical inputs (i.e. hydraulic fracturing fluids), chloride and radioactive species. Various health concerns were raised, most prominently cancers, such as Ewing's Sarcoma. We find small, statistically significant correlations in the study region between groundwater contamination from chloride and proximity and density of UOGD, particularly in regions with legacies of coal and conventional oil and gas drilling. The most likely contamination pathway is brine leaks/spills from wastewater management. Using groundwater chemistry ratio analysis, we estimate that this potential contamination pathway could elevate thallium levels above EPA contamination levels, which could increase health risks, an exposure linked to low birth weights. We observed no evidence for exposure to radioactive elements above EPA limits using the same approach.

Conclusions. The study combined community focus groups and geoscientific analysis to examine potential groundwater contamination from UOGD in a region with historic legacies of fossil fuel extraction. We find a small number of sites with presumable groundwater contamination from brine salt species, which was one concern raised by communities.Future efforts will target how species enter groundwaters.