

Abstract

One potential health disparity facing rural families is their reliance on private wells for their drinking water supply as water quality testing is typically not required for private groundwater wells. In the state of Nebraska, potentially 80% of private water supply wells could exceed the drinking water standard for nitrate of 10 mg/L. One potential risk to groundwater supplies in rural areas is nutrients from fertilizer application. In this project, we will use community-based participatory research or 'citizen science' to identify areas of elevated nitrate in private groundwater wells used for drinking water. We will perform this work in collaboration with our community-based partner, GC Resolve, as well as our University of Nebraska Lincoln, University of Nebraska Medical Center and University of Nebraska at Omaha partners, with expertise in environmental engineering and water quality, public health, and information science and technology, respectively. We will recruit community members to test their drinking water quality for nutrients in a 20 county region in Nebraska. If their water supply contains elevated levels of nutrients (nitrate or phosphate), we will conduct a second-tier water quality sampling and analysis. If the water quality is also identified as being impaired after the second-tier testing, then we will develop and supply educational materials as an intervention to encourage families to obtain treatment to remove nitrates from their water supply. These activities will increase awareness about degraded water quality in rural communities.

Purpose

Rural communities, including farm families, face a variety of health disparities based on social determinants and geography. One potential health disparity is their reliance on private wells for water. Although it is common in rural areas to use private wells for the drinking water supply, there are no regulations requiring water quality testing for private groundwater wells. A recent report by the State of Nebraska found that potentially 80 percent of private water supply wells may exceed the drinking water standard for nitrate of 10 mg/L.

As our global population continues to grow, a corresponding increase in agricultural production of 60%-100% is needed to nourish more than 9 billion people by 2050, implying that application of nitrogen fertilizers and animal manures on agricultural land is likely to grow. In addition, nitrate can signal contamination by other contaminants, including pathogens, pesticides and veterinary pharmaceuticals, which can result in significant human health impacts. Contaminated well water on farms will be a growing concern.

Large-scale geospatial problems, such as groundwater contamination, necessitate novel approaches, such as community-based participatory research or 'citizen science' to identify and address areas of concern. We propose to use evidence-based citizen science methods to identify possible contaminated farm wells and provide interventions to mitigate this problem.

Background and Aims

This project builds upon our prior work indicating that citizen scientists can accurately measure water quality parameters, after appropriate training is provided. Data collected by citizen scientists are valuable in that they spark community awareness regarding environmental issues and empower greater participation in decision-making efforts. This proposed work adds value to the use of citizen science data for environmental education by using this data to conduct scientific research over a geospatial scale that would otherwise be very difficult to evaluate. In addition, the use of citizen science allows us to access samples that may otherwise be very difficult to obtain (i.e. from private water supply wells across the state of Nebraska) This model also provides an opportunity for educational outreach to individuals and rural communities who might not otherwise receive this information. This is a novel health initiative in this often-underserved population.

A novel Information Technology (IT) system will be used to submit and retrieve data. The IT system will include a web interface, a database to support citizen scientists' participation, browser-based data entry of water quality results, and web-based geographical map visualizations of the data.

The aim of the project is to address health impacts due to elevated nitrates and other agricultural contaminants in private water supply wells across the eastern part of Nebraska. In addition, we will monitor surface water quality, as human health can be impacted by exposure to this water through recreational activities.

Approach

- **First-tier screening:** We will work with our community partner, GC Resolve, to identify agricultural producers and other individuals who obtain their drinking water from private water supply wells. We will work with Natural Resource Districts and the Farmer's Union for participant recruitment. The Central States Center for Agricultural Safety and Health (CS-CASH) at UNMC also will supply names of farmers. We will focus on individuals located in the following Nebraska counties: Burt, Cass, Colfax, Cuming, Butler, Dakota, Dixon, Dodge, Douglas, Lancaster, Madison, Platte, Polk, Sarpy, Saunders, Seward, Stanton, Thurston, Wayne and Washington. We plan to recruit at least 100 participants from across this 20 county region.
- **Citizen Science Approach to Water Monitoring:** We will train participants to measure the concentration of nutrients (i.e. nitrates, nitrites and phosphates) in well-water and surface water. Science based educational materials and resources relevant to increasing awareness of contaminants of water resources and their risk to health will be provided to all participants. We will conduct water sampling training through the development of web-based resources (training videos), as well as selected in-person training. We will ask each participant to measure water quality in duplicate sampling of both well or surface water during a single week period in May, Aug and Nov. GC Resolve has volunteers who are willing to assist citizens in collecting water samples. Citizen scientists will then report their result using either our IT database website, or by mailing in pre-stamped postcards. Data on nitrate and phosphate will be collected using test strips, methods we have utilized in our prior work with citizen scientist collected water quality data.
- **Second Tier Screening and Intervention:** For wells that test above the EPA and State permitted concentrations of any water quality parameter, we will conduct a second-tier assessment. Second tier assessment will be conducted by a contract laboratory to more completely quantify the concentrations of nitrates, nitrites, coliforms, and *E. coli* bacteria. If the water is confirmed by the second tier testing as not meeting water quality standards, we will provide the individuals with information and educational resources on the lowest cost approaches to treating their water. We will remain in communication and after the water treatment technologies have been implemented, we can re-test their water to ensure it is meeting drinking water standards.

Future Direction

We anticipate extending this partnership into the future, to farm communities in other areas of Nebraska, as well as using the partnership between UNL, UNMC, UNO and GC Resolve to tackle other safety and health issues affecting Nebraska farm families. In addition to this project, the University partners and GC Resolve share significant interactions concerning the possible effects of the coming Costco chicken processing plant in Fremont, which will process 340,000 chickens per day. The University partners are already gathering baseline data from the Elkhorn River for comparison with data collected after the plant is operational. Through GC Resolve we will also be able to collect data from waterways in the area where the chickens will be raised. This other project will lead to more interactions with the farm communities to be served in this project proposed here and more interactions between GC Resolve, its volunteers and the University partners. The activities will increase awareness about degrading water quality issues for rural communities.

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