Nitrate and Uranium Pollution Effects on Household Wells in Disadvantaged Underserved Communities in Stanislaus County (CA)

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Abstract

Intensive agriculture practices have caused widespread, elevated, nitrate concentrations in the aquifers below the San Joaquin Valley. The City of Modesto sources its drinking water from a mix of monitored groundwater and surface water, limiting exposure to these contaminants. Residents in disadvantaged unincorporated areas outside the bounds of the city water utility rely on unmonitored and untreated shallow wells. In collaboration with the Tuolumne River Trust, Modesto Office, and Catholic Charities of Stockton this study aims to understand discrepancies in access to safe water between the unincorporated and incorporated areas surrounding Modesto to provide recommendations that are accessible to the community.

Introduction

Intensive agriculture causes widespread nitrate contamination below the San Joaquin Valley. Disadvantaged Unincorporated Communities (DUCs) - not connected to municipal water and must source their water from elsewhere.

Research Questions:
1. What is the groundwater hydrology of Modesto and how does it impact the city drinking supply?
2. Where are the contaminants, nitrate and uranium most prevalent? What are their sources? Who is at greatest risk?
3. What information regarding water access and quality is most important to discern to the community of Modesto? What is the best way to deliver scientific information to a diverse and potentially bilingual audiences?

Methods

Spatial Analysis: We used data from the City of Modesto in conjunction with the State Water Resources Board/USGS Groundwater Ambient Monitoring and Assessment Program (GAMA) dataset and CalEnviroScreen 3.0. We used natural neighbor interpolation for the well data to predict concentrations where there we no wells.

Educational Video: We created an educational video based on our research catered to a diverse and bilingual audience. The video includes resources for well testing, long term solutions, and basic information on local hydrology.

Results

Nitrate - NO3 Occurrence in Wells 2010 - 2020

Average Conc. MG/L

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>109/777</td>
</tr>
<tr>
<td>1-5</td>
<td>152/777</td>
</tr>
<tr>
<td>5-10</td>
<td>48/777</td>
</tr>
<tr>
<td>10-20</td>
<td>10/777</td>
</tr>
<tr>
<td>20+</td>
<td>2/777</td>
</tr>
</tbody>
</table>

Well Type

- Municipal
- Monitoring
- Private
- Other

Figure 1: Average concentration (mg/L) of Nitrate in 777 wells. Well type is broken down into categories of municipal, monitoring, private, and other. Stanislaus county is outlined in blue. DUCs outlined in purple.

Figure 2 (left): Nitrate contaminants plotted against well depth. MCL is marked by a horizontal line.

Figure 3: Interpolated map showing the concentration of nitrates using GAMA well data from 2010-2020. Unincorporated areas are outlined in red, and disadvantaged unincorporated areas are outlined with a dashed purple line.

Figure 4: Interpolated map showing the concentration of Uranium using GAMA well data from 2010-2020. Unincorporated areas are outlined in red, and disadvantaged unincorporated areas are outlined with a dashed purple line.

Figure 5: Map showing the geography of the City of Modesto, Inset map depicts Modesto in relation to California’s San Francisco Bay Area.

Discussion

From 2010 - 2020 we found that 13% (99/777) and 2% (4/237) of the wells had averages at or above the MCL (10 mg/L) for nitrates and (20 pCi/L) for Uranium, respectively. Over this period, 1,603 of 12,372 samples tested at or above the MCL for nitrates, and 128 of 1,613 samples tested at or above the MCL for uranium. Results are plotted against well depth in Figure 2, nitrates tend to have higher concentrations at shallower depths. Using an interpolation, we were able to highlight potential areas of concern for both nitrate and uranium in relation to DUCs (Figures 3 and 4).

Conclusion

1. The groundwater hydrology of Modesto and the surrounding area concentrates contaminants and keeps them in the aquifer, increasing risk to the drinking supply.
2. Our analysis suggests that households not connected to the municipal supply are at risk of both nitrate and uranium pollution above the MCL. In order make a more accurate assessment we recommend the City of Modesto implement widespread testing for private wells.
3. Communicating the risk that these communities are under and providing testing resources through the CV-SALTS program is critical.

To view the entire paper, please click here

References


Acknowledgements

This project would not be possible without the support of Edgar Garibay at the Tuolumne River Trust and Miguel Alvarez from the City of Modesto. We are also thankful for the mentorship and guidance of Iris Stewart-Frey from the Department of Environmental Studies and Sciences at SCU.