

Overview

IDAHO

- The mid-sized city of Pocatello, Idaho is supplied by an aquifer system susceptible to contamination.
- similar sources for PPCPs and nitrate.
- However, nitrate concentrations did not impact likelihood to treat drinking water or concern levels.

1. Objectives and motivation



- urban to exurban areas of Pocatello, Idaho (figure to left).
- actions to treat household water.

Motivation: City growth often occurs at ex-urban boundaries that do not have centralized water treatment

systems (Wilhelm, 1994). Therefore, ex-urban, on-site sewage treatment can lead to long-term water contamination from nitrates or emerging contaminants (LaGro, 1996). Understanding pollution and growth patterns may improve planning and water management.

2. Significant increases in nitrate-N concentration over time

The nonparametric Wilcoxon test showed a significant increase median concentrations between paired wells tested in the 1990 and 2010's. However, this increase was 0.86 mg/L over 25 years, amount far less than the differences in hot vs. cold spots across t area. Therefore the temporal trend was excluded in the hotspot and the whole data set was used for spatial interpolation hot spe analysis.

3. Nitrate hotspots occur at boundaries of urban development, but do not correlate with septic density



- A significant hot or cold spot was of nitrate concentrations that occupy the tails of the standard normal distribution or z-score.
- Hot spot analysis using Getis-Ord Gi* resulted in two hot spots and a cold spot (hatched areas).
- At confidence levels above the 95% confidence, the z-scores for the hot spot fell between +3.75-7.08 standard deviations from the mean. The cold spot is -2.66-4.06 standard deviations from the mean

References and Acknowledgments

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Complex controls on groundwater quality in growing mid-sized cities: a case study focused on nitrate and emerging contaminants

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• Nitrate-N concentrations have increased over time and spatial hot spots in current levels were detected at exurban boundaries. • Pharmaceutical and personal care products (PPCPs) were detected at sites with increased nitrate-N concentrations suggesting

• Public survey results indicated citizens concerned about health due to water contamination were more likely to treat water.

1. Quantify spatiotemporal patterns of nitrate-N and potential groundwater contamination sources from

2. Use pharmaceuticals and personal care products to refine possible sources of contamination. 3. Explore correlations between nitrate concentrations, public concern about water quality, and individual

in O's, 2000's , an the study ; analysis ot	Null Hypothesis	Significance	Conclusion
	The median nitrate concentrations are similar:		
	1990's-2000's	0.025	Sig. Different
	1990's-2010's	0.036	Sig. Different
	2000's-2010's	0.001	Sig. Different

 Predicted nitrate-N across the LPRV with ordinary kriging (left figure). distinguished by spatial clustering



- Septic density is a poor predictor of nitrate-N concentration(above figure).
- Septic density was assigned for each sampling location through a cost analysis of surface water movement into the well's watershed boundary. Septic density was determined by tallying all septic systems within a 100m buffer around the steepest path to the well within a 1-km radius of the well head.







4. Significantly higher NO₃-N concentrations found where PPCPs detected in groundwater



PPCP Detec	cted	Detection Frequency (%)	Maximum Detection (ng/L)	Type of substance
Carbamazer	oine	3 %	20	Anticonvulsant and mood stabilizer
DEET		3 %	17	Insect repellent
Diphenhydra	mine	1 %	155	Antihistamine
Codeine		1 %	10	Analgesic and cough reliever
Ibuprofe	n	5 %	16	Nonsteroidal anti-inflammatory
Fluoxetin	е	1 %	152	Anti-depressant
Sucralos	e	18 %	656	Non-nutritive sweetener
Sulfadimetho	oxine 2 %		27	Antibiotic used by domesticated animals, suggests multiple sources
Sulfamethox	azole	14 %	255	Antibiotic used by humans
Test	Signi	ificance C	Conclusion	6. Future work
Mann029ModerateWhitney TestevidenceLossthat mediansdiffer		Moderate evidence at medians differ	 Fingerprint nitrate-N sources through δ¹⁵N an δ¹⁸O isotopic signatures. Identify potential recharge locations via LMW 	

Higher nitrate-N concentrations were found where PPCPs were detected,	PPCP Detected	Detectio Frequen (%)	on Maximum cy Detection (ng/L)	Type of substance
suggesting that both may	Carbamazepine	3 %	20	Anticonvulsant and mood stabilizer
derive from anthropogenic	DEET	3 %	17	Insect repellent
sources (figure below).	Diphenhydramin	e 1%	155	Antihistamine
7-	Codeine	1 %	10	Analgesic and cough reliever
	Ibuprofen	5 %	16	Nonsteroidal anti-inflammatory
	Fluoxetine	1 %	152	Anti-depressant
	Sucralose	18 %	656	Non-nutritive sweetener
	Sulfadimethoxin	e 2%	27	Antibiotic used by domesticated animals, suggests multiple sources
0 Non-Detects Detects	Sulfamethoxazol	e 14 %	255	Antibiotic used by humans
Null Hypothesis	Test Sig	nificance	Conclusion	6 Euturo work
The distribution of NO ₃ -N concentrations are the same between PPCP detects vs. non- detects.	Mann- Whitney Test	.029	Moderate evidence that medians differ	 Fingerprint nitrate-N sources through δ¹⁵N and δ¹⁸O isotopic signatures. Identify potential recharge locations via LMWL

*Spatial information not provided due to confidentiality and the small number of detections.

5. Concern about the impact of water on public health predicts household water treatment choices

Approximately 1500 surveys were mailed and ~400 responses received, representing 1% of the population of Pocatello. Note that ~70% of respondents were males over the age of 60. Survey questions included: 1. Which of the following do you do for your household water needs? (Nothing, Soften, Filter, Treat, Test, Buy Bottled Water) 2. Thinking about the Portneuf River and groundwater, on a scale of 1 (low) to 5 (high), how concerned are you with health issues from pollution?





Figure 5.1:

- Citizens who are more concerned about health issues are more likely to use softeners or filters, buy bottled water, or test their drinking water.
- However, less concerned citizens often did not indicate whether they did anything to treat their water.

Figure 5.2:

- We defined water treatment as filtering or treating tap water, or buying bottled 42° water. At the neighborhood level, water treatment was not correlated with nitrate concentration.
- In addition, the percent of concerned citizens at the neighborhood level was not correlated with nitrate concentration.

Figure 5.3:

 Neighborhoods with more concerned citizens were not more likely to treat their water. For context, the neighborhoods layer is included on figure in section 3.



and groundwater δ^{18} O and δ D.



Treatment is defined as treating or filtering water, or buying bottled water