Comparing Results of a Survey of Well Water Quality with Archived Homeowner-Submitted Well Water Samples

- or -

“A Call to Action” × 2

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Introduce the 2017 Portage County Well Water Quality Survey: \textit{the survey’s purpose, procedures, and results}.

Discuss reporting of the survey’s results: \textit{ground-water making headlines}.

Introduce the Center for Watershed Science & Education’s Private Wells Database: \textit{an ongoing “crowdsourced” well water quality survey}.

Compare the survey and database: \textit{do differing sampling strategies, sample sizes, and sample collection periods yield differing results?}
Portage County

Part of Wisconsin’s “Central Sands” region.

Uppermost aquifer composed of unconsolidated sand and gravel; serves as the county’s primary aquifer.

Landscape primarily agricultural or forested.
Well Water Survey

- Collaboration with **Portage County** government.
- **Stratified sampling** strategy. County divided into 229 4-square-mile cells.
- Samples collected **6 to 9/2017**.
- Samples processed at **Water & Environmental Analysis Lab**.
- 6 “**Homeowners Package**” analytes tested.
Well Water Survey

- Observations: **214**
- Minimum: **<0.1**
- Maximum: **44.1**
- Mean: **6.5 ±1.2**
- Standard Deviation: **8.9**
- % Exceeding Standard: **24.3%**
- Moran’s I: **0.2265**
  Weak, but statistically significant positive global spatial auto-correlation (*pseudo p = 0.0001*).
Portage County Water Study Finds Nitrates above Safe Levels in Quarter of Wells

*Alan Hovorka.* Nearly a quarter of tested wells in Portage County exceed safe drinking water standards for nitrates, according to a new county study. ... It was the first comprehensive study of well water in the county’s history ...

Some County Wells over Safe Nitrate Levels

*Heather McDonald.* Results of the first Portage County-wide well sampling show about a quarter of those wells have higher than standard safe levels of nitrates, an element that could affect health. On the flip side, just more than a quarter had no nitrates detected. ...
Private Wells Database

- Archives samples processed at the Water & Environmental Analysis Lab.
- Contains 99,546 samples and 844,317 analyses.
- Covers 6/1972 to the present, and all 72 counties.
- Primary dataset behind the Well Water Quality Viewer.
- “Crowdsourced” dataset.
Stratified vs Simple Random Sampling

- Strategy selected for a study must yield a sample representative of the real-world phenomenon in question.
- Stratified sampling yields a sample representative of the county’s groundwater.
- Simple random sampling yields a sample representative of the county’s wells.
- In this scenario, summary statistics are higher for the simple random sample.
Stratified vs Simple Random Sampling

- In Private Wells Database, strong linear relationship between number of NO$_3$ samples from each of 17 civil towns and the towns’ populations.

- $m$: **0.102**
  Approximately 1 sample for every 10 additional residents.

- $r^2$: **0.925**
Examined the period 1/2010 to 12/2017.

Located samples to parcels (81%).

For most samples, NO$_3$ tested as part of “Homeowners Package.”

Treated samples excluded.

Results of multiple samples from single parcels averaged.
- Observations: **1,366 (1,930)**
- Minimum: **<0.1**
- Maximum: **49.6**
- Mean: **6.3 ±0.4**
- Standard Deviation: **6.9**
- % Exceeding Standard: **20.6%**
- Moran’s I: **0.2673**
  Weak, but statistically significant positive global spatial auto-correlation (*pseudo p = 0.0001*)
Mean: 6.5 ±1.2
% Exceeding Standard: 24.3%

Mean: 6.3 ±0.4
% Exceeding Standard: 20.6%
Survey and database yield effectively identical global summary statistics, despite differing sampling strategies, sample sizes, and sample collection periods, and a highly variable real-world phenomenon.

If survey results are “a call to action,” database provides another.

Future research might attempt to resolve local discrepancies between the two datasets.