Classifying Low- and High- Risk Underground Injection Control Wells in Clark County, Washington using GIS Spatial Analysis

Maren Murphy
Trista Kobluskie
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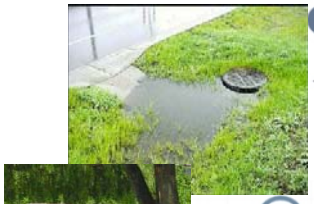
Research Questions

- Can GIS spatial analysis be used to evaluate and class the risk level of existing Underground Injection Control (UIC) wells?
- How does spatial analysis compare to manual analysis?
- Can this method be developed into a model for other jurisdictions to evaluate UIC wells?

Background

- UIC wells, like drywells, manage stormwater by discharging it directly to groundwater
- As stormwater flows, it contacts surfaces that contain pollutants and could contaminate groundwater
- New rules from the Department of Ecology in Washington state require jurisdictions to locate and retrofit high-risk UICs that they manage
- Currently, an engineer evaluates each UIC to determine risk



Datasets

- Point locations of stormwater storage-treatment locations
- Soil types polygons
- 2 foot contour elevation DEM
- Depth to water TIN
- Roads – highway, arterial, collector, local
- Groundwater table elevations polylines
- Manual high-risk UIC determinations as spreadsheet

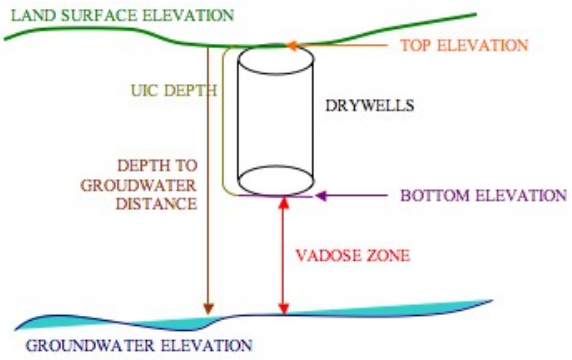
Methodology

1. Establish Criteria
2. Prepare Data
3. Analysis
4. Calibrate against sub-set already evaluated by an engineer

Preparing the data

- UICs - select subtypes from storage treatment layer; intersect with depth to groundwater
- Top elevation - use existing data; estimate by spatial join with 2ft contours
- Bottom elevation - use existing data; estimate from top elevation minus 13ft
- Soil type - assign soil types with H/M/L/NA/UNKN treatment level; convert to raster and reclassify (H=1, M=2, L=3, Unknwn=4, NA=0)

UIC Diagram



Spatial Analysis

- Depth to Groundwater distance interpolation
  - Convert TIN to raster
  - Apply Focal statistics: 5X5 neighborhood, mean
  - Extract Values to UIC Points
- Calculate vadose

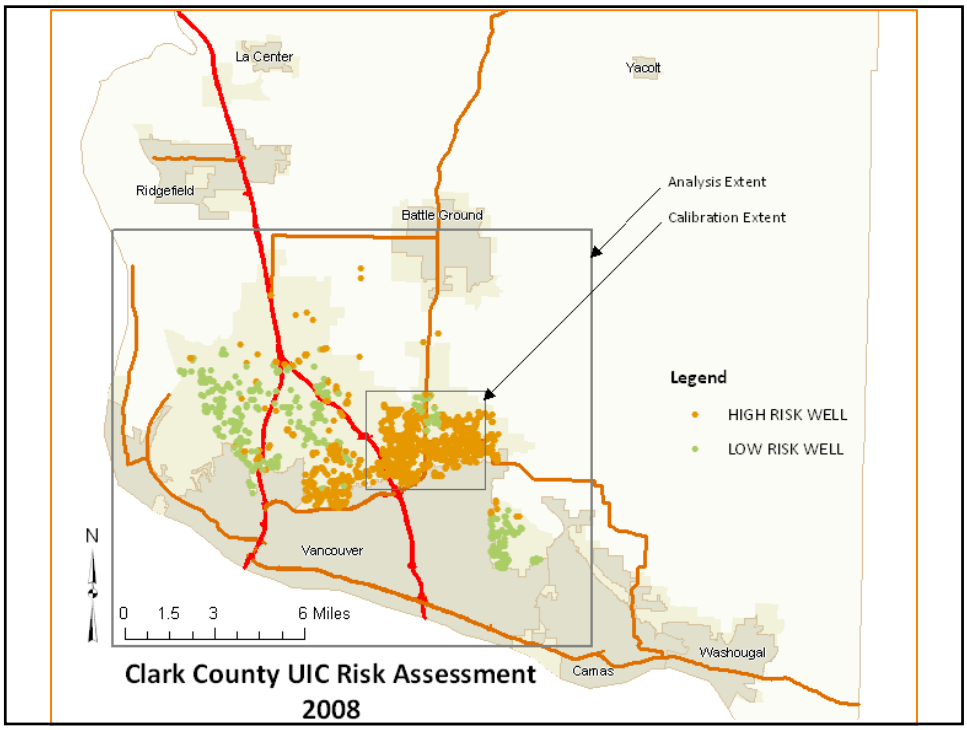
  Top Elevation – Bottom Elevation = UIC Depth

  Depth to Groundwater Distance – UIC Depth = Vadose
- UIC distance to roads
  - Near Analysis to determine distance from UIC to road layers
  - Assign pollutant levels L/M/H
  - Assign highest value using most conservative distance to highest risk load

High-Risk UIC Determination

- Export UIC shapefile to Excel
- Construct conditional statement as defined by criteria:
  - If Vadose < 6
  - If Pollutant Risk = “HIGH”
  - If Soil Type = 2 (Medium) AND Vadose < 11
  - If Soil Type = 3 (Low) or Pollutant Risk = “High” or Vadose<26
  - If Soil Type = 0 (NA) or Soil Type = 4 (Unknwn)
- Statement:

=IF(OR(VADOSE<6, POLLU_RISK="HIGH"), "HIGH RISK WELL", IF(AND(SOIL_TYPE=2, VADOSE<11), "HIGH RISK WELL", IF(AND(SOIL_TYPE=3, OR(POLLU_RISK="HIGH", VADOSE<26)), "HIGH RISK WELL", IF(OR(SOIL_TYPE=0, SOIL_TYPE=4), "FIELD CHECK", "LOW RISK WELL"))))



Calibration

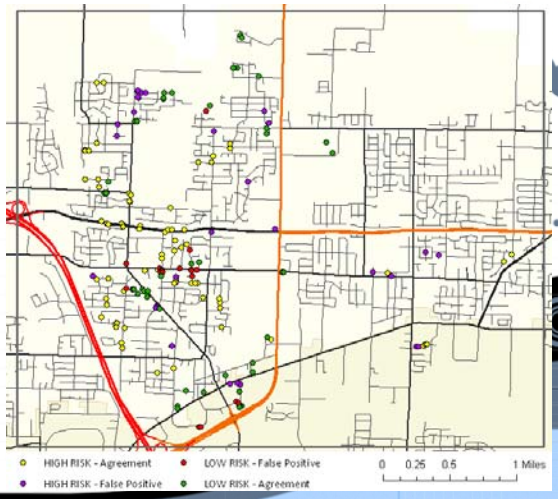
(which turned into Option 1)

Our results

- High Risk = 1280 UIC wells
- Low Risk = 568 UIC wells

Calibration comparisons

- Total = 219
- High Risk, agreement = 75
- False Positive (High Risk) = 47
- Low Risk, agreement = 79
- False Positive (Low Risk) = 18



Groundwater Calculation Option 2

- Convert water table elevation polylines to raster using Topo to Raster
  - Drainage Enforcement parameter NOT ENFORCED
- Extract groundwater elevations to UIC point values
- Subtract groundwater elevation from UIC bottom elevation to get Vadose
  - *Bottom elevation – Groundwater elevation = Vadose*

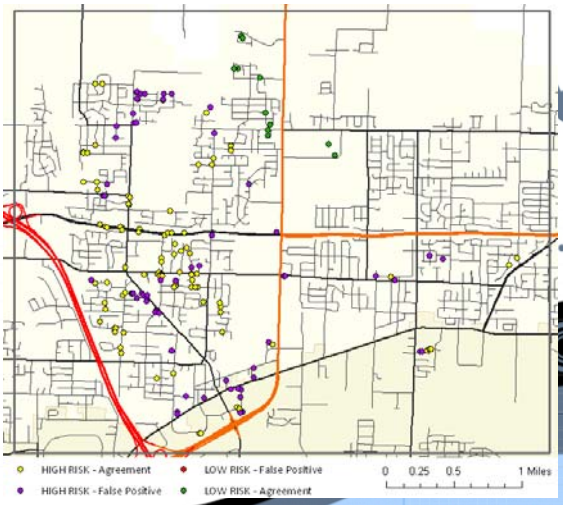
Option 2 Map and Results

Our results

- High Risk = 1,324
- Low risk = 524

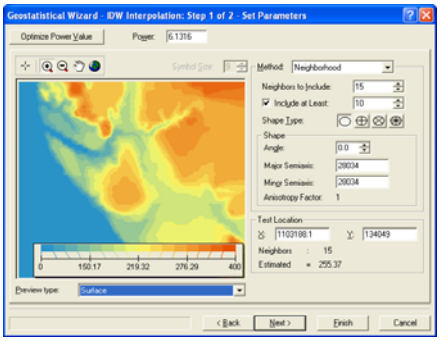
Calibration comparisons

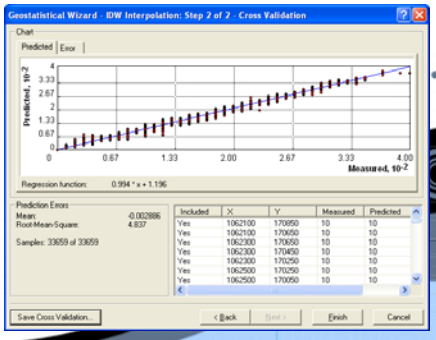
- Total = 219
- High Risk, agreement = 91
- False Positive (High Risk) = 97
- Low Risk, agreement = 29
- False Positive (Low Risk) = 2



Groundwater Calculation Option 3

- Inverse Distance Weighting to the power of 6.1316 (suggested by Geostatistical Wizard)
- Extract to UIC point values





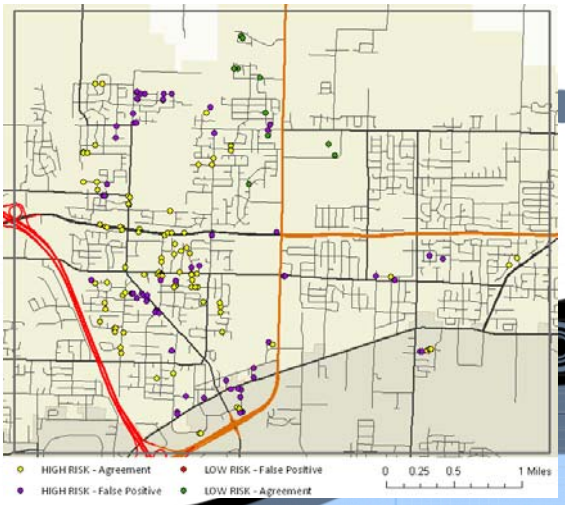
Option 3 Map and Results

Our results

- High Risk = 1,318
- Low Risk = 530

Calibration comparisons

- Total = 219
- High Risk, agreement = 91
- False Positive (High Risk) = 99
- Low Risk, agreement = 27
- False Positive (Low Risk) = 2



Conclusions

- There is potential to use this method
  - Requires further research, possibly with field verifications
- Spatial analysis is much faster
  - An engineer has evaluated 600 UICs in 6 months
  - We evaluated 1,848 in about 40 hours
- May not be able to fully substitute for engineering judgment
  - Human evaluation case-by-case
- In most cases, analysis was more conservative; therefore it could reliably be used to rule out low-risk wells that do not need further evaluation