Using Toxic Release Inventory Data for Environmental Health Applications: Research and Training

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Oral Session - ***TRI: A Tool for Policy and Education***

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Example 1: School Environmental Conditions and Links to Academic Performance in Urban, mid-Atlantic Public Schools

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School environmental conditions and links to academic performance and absenteeism in urban, mid-Atlantic public schools

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Scientific Background and Inquiry

- Children spend a lot of time at school. Small size, developing systems make them physiological vulnerability
- Environmental exposures impact adolescent health
  - Roadways
  - Industrial sites
  - School building characteristics
- A natural experiment examining if improved school buildings can help student performance/attendance

Need to Understand the External Community Environmental Factors that Influence School Children

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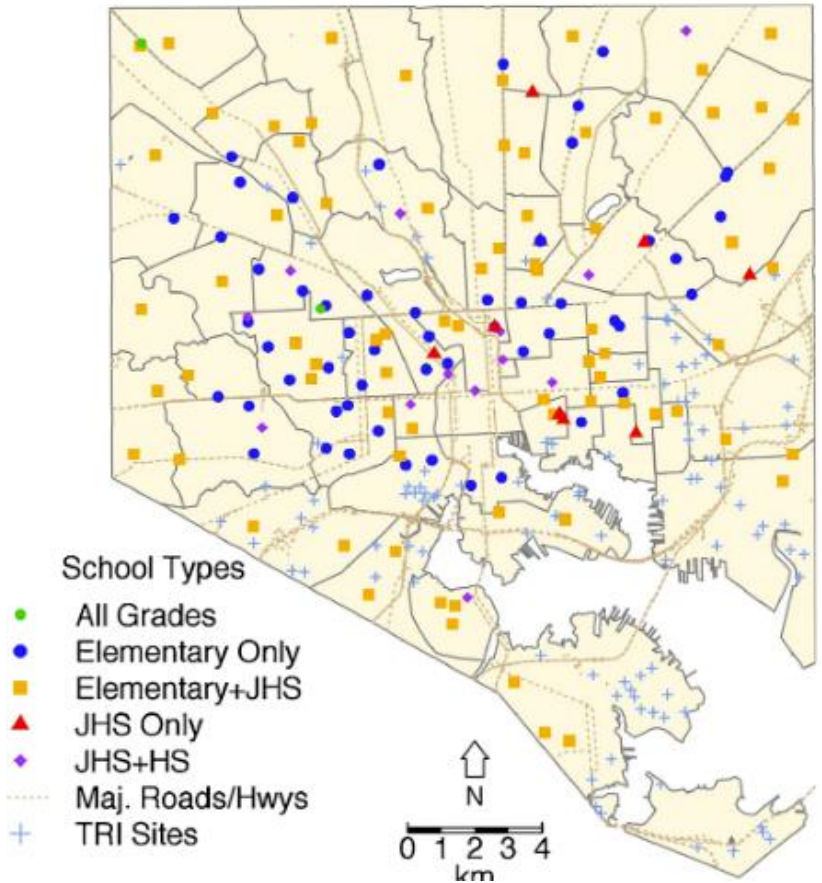
Study Area: Public Schools in Baltimore City (Grades K-8)



From Berman et al., 2018

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Environmental Conditions Nearby to Baltimore City Public Schools

- Using a GIS, characterize conditions nearby to Baltimore Schools
  - Student characteristics: demographics, poverty, special education
  - School climate: safety, teacher-leadership relations
  - School Type: elementary, junior HS, HS
  - School Environment: nearby roads, building facility, *Risk Screening Environmental Indicator (RSEI)*
  - Community Characteristics: neighborhood poverty, crime, teen birth rate, etc.

- Multivariate regression modeling to estimate associations between environment and academic performance/absenteeism

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Risk Screening Environmental Indicators Model: A TRI Based Tool

- EPA model that incorporates 1) TRI chemical data, 2) fate and transport, 3) chemical toxicity, 4) potential exposure

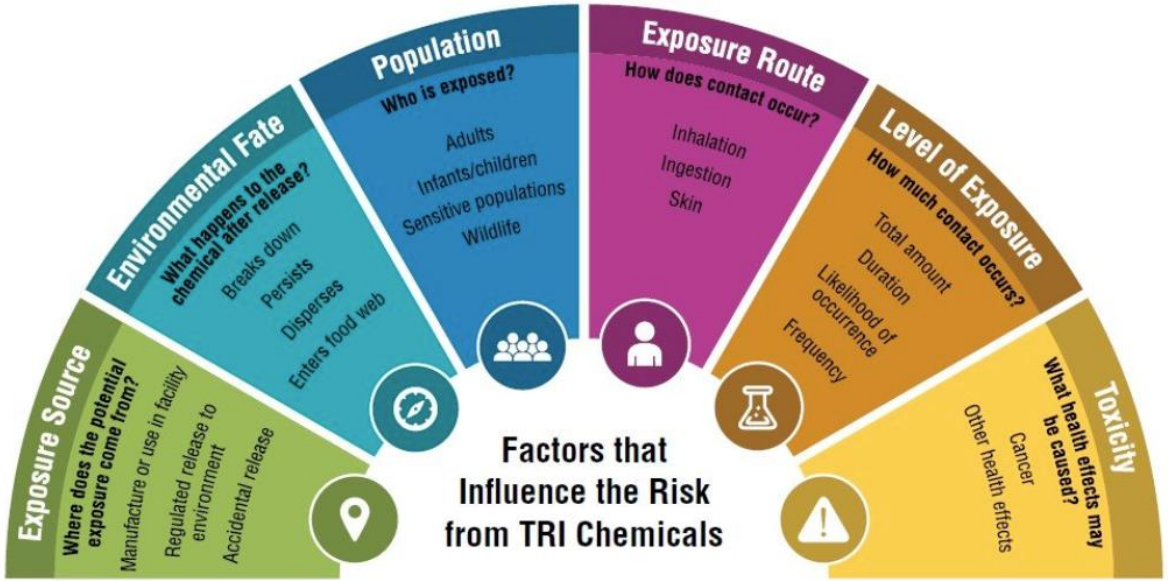
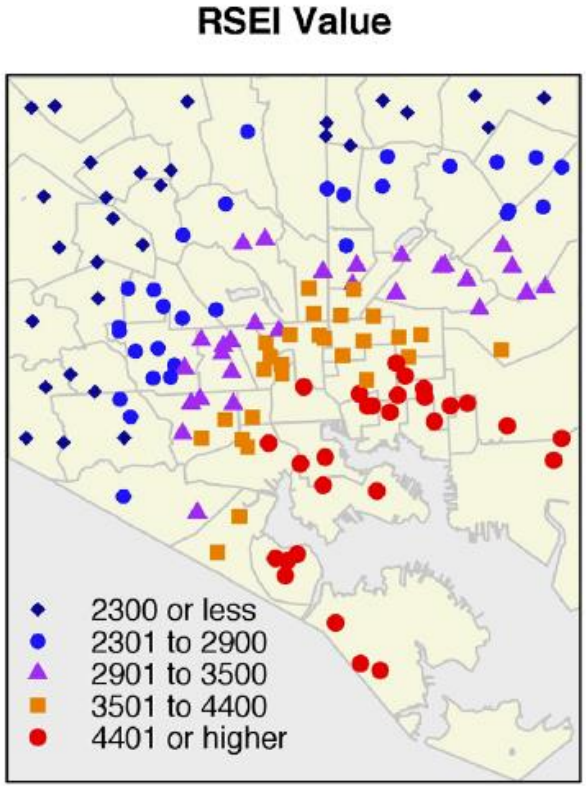


Figure borrowed from EPA TRI and RSEI for Communities (https://www.epa.gov/rsei/tri-and-rsei-communities)

Our Findings (with an RSEI focus)

- Mapped RSEI shows increasing risk towards SE Baltimore City
  - Risks nearly 5x higher in this end than the average of all other schools
- Chronic absences were marginally associated with RSEI scores
  - 3.4% increase grades K-5
  - 3.6% increase in grades 6-8
- RSEI was not associated with academic performance



RSEI values at the school locations (from Berman et al., 2018)

Conclusions and Takeaways

- Environmental conditions of schools may play a role in absenteeism and academic performance of school children
- Higher RSEI values are marginally associated with increased chronic absences among both young and older children
- Proximity to nearby industrial sites should be a consideration when building new schools
- RSEI is a useful tool to describe broad exposure to chemical toxins without having to categorize individual sites

Example 2: Using Blood Lead Concentrations in Wildlife to Identify Environmental Risk Factors for Public Health

Ecotoxicology (2023) 32:357–369
https://doi.org/10.1007/s10646-023-02642-x

Using blood lead concentrations of wildlife sentinels to identify environmental risk factors of lead exposure for public health and wildlife rehabilitation efforts

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Scientific Background and Inquiry

- Environmental lead is a major health risk, particularly for children
- Lead exposure is mostly historical: lead paints, manufacturing, automotive shops, drinking water pipes
  - Contaminated soil a substantial concern
- However, human blood lead is not well surveyed. Most screenings are targeted to at-risk individuals

Risk in the general population is generally unknown due to a lack of data

Scientific Background and Inquiry

- **Solution: Can wildlife blood lead be used as a surrogate for potential lead risk in humans? Can animal BLL help us understand environmental risk?**
  - Blood lead levels (BLL) is measured in squirrels, opossums, and pigeons delivered to the Minneapolis wildlife rehab center
  - Precise address where animals are collected
  - Characterize the surrounding areas for potential lead sources
    - Businesses with historic lead use
    - Roadways
    - Land use (current and historical)
    - Airports
    - Landfills
    - And *Toxic Release Inventory Locations (TRI sites)*

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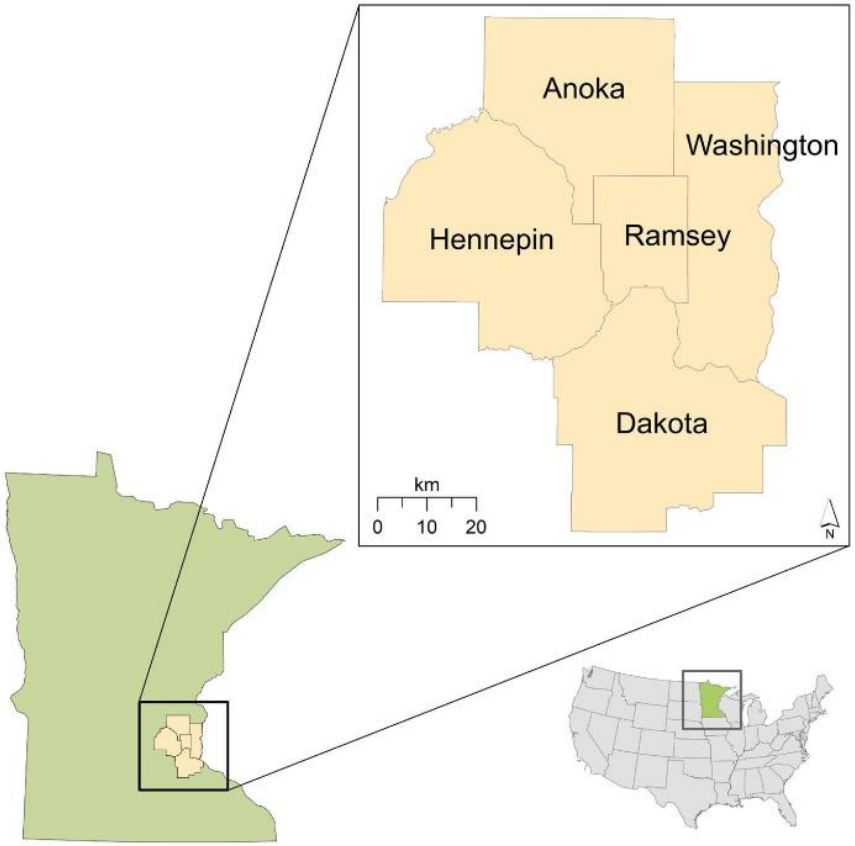
Toxic Release Inventory Data

- Preselect sites of importance:
  - Earliest date is 1987 through 2019 (latest year of animal data
  - Only TRI sites with reported “**lead**,” “**lead compounds**,” or “**lead and lead compounds**,” and on-site releases or recycling of products
- Estimated the distance from animal collection sites to nearest TRI sites
- Used multivariate regression modeling to determine which environmental characteristics contribute to BLL’s

Study Area: Twin Cities Metropolitan Region in Minnesota



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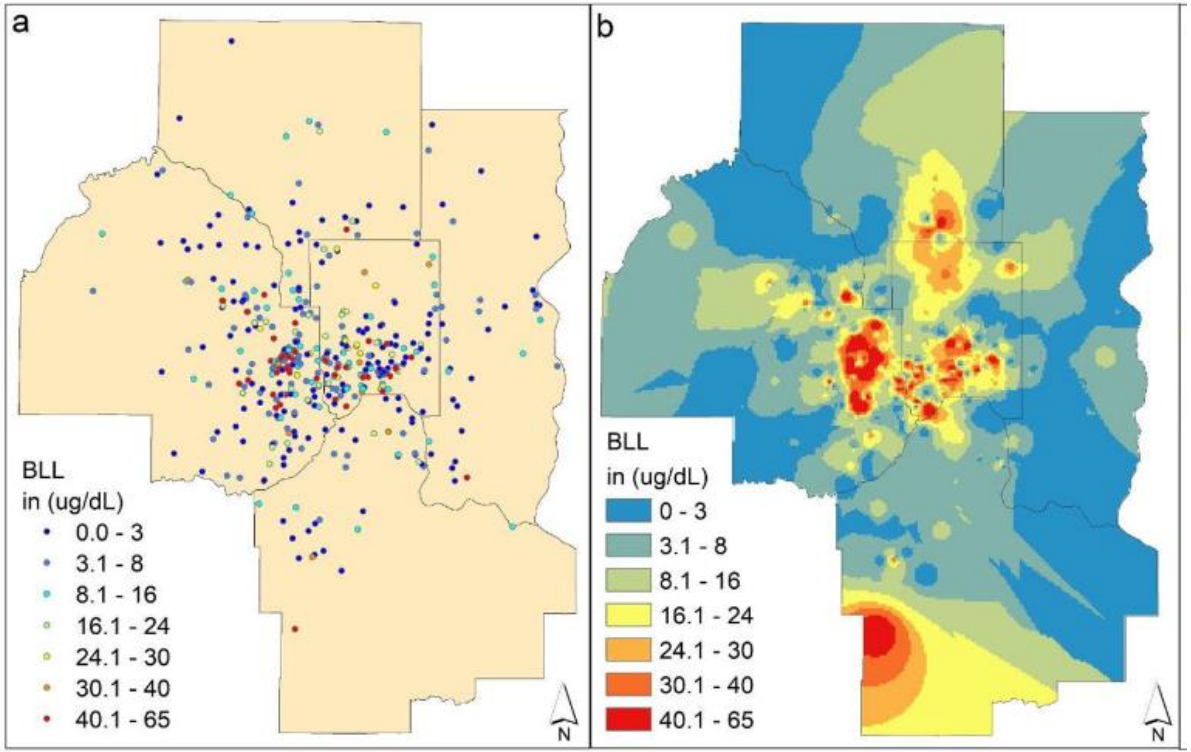
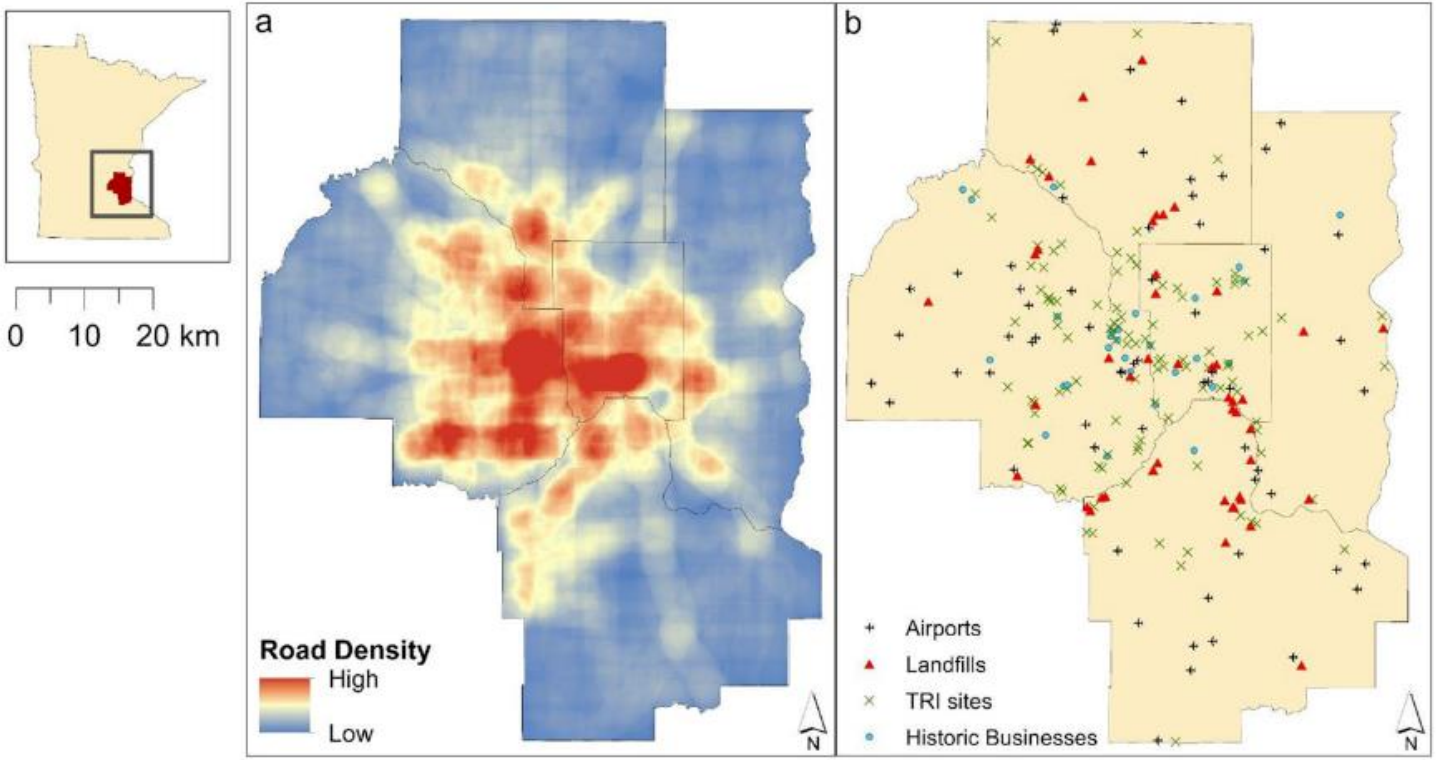
Maps of Measured BLL Concentrations and Predicted BLL Levels



Animal BLL collection sites

Predicted map of BLL concentrations

Map of Land Use Variables and Sites of Interest, Including TRI Locations



Our Findings (with a TRI focus)

- Average **distance to a TRI site** was **2.8km**
- For mammals, BLL **increased by 14.9%** (95% CI: -14.1%, 53.8%) within 2km of a TRI site
  - *Not statistically significant!*
- For pigeons, BLL **increased by 8.7%** (95% CI: -24.6, 56.7) within 2km of a TRI site
- Significant associations observed for:
  - **Population density** (5.72% per 1,000 people/mi^2)
  - **Road density** (17.1% per 1km road length per km^2)

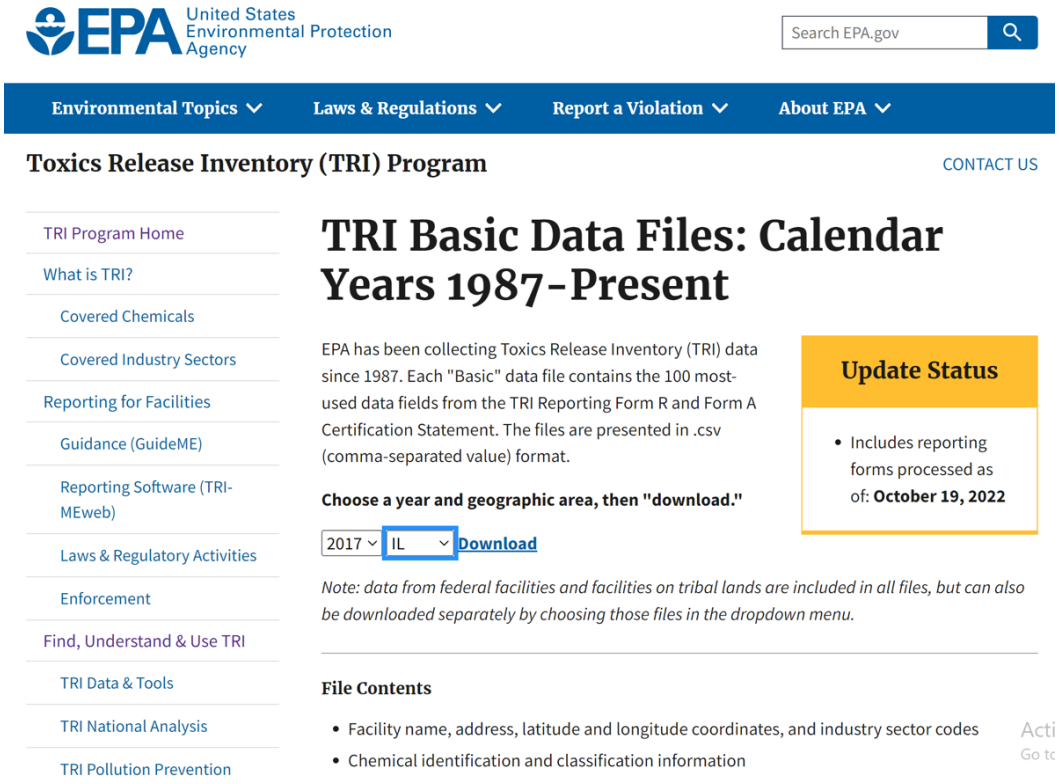
Conclusions and Takeaways

- Wildlife sentinels are a potential tool to assess environmental hazards and high-risk lead areas

- Proximity to lead TRI sites appear related to higher BLL, but not significantly
  - More data or a larger study may show different trends

- TRI data is a useful tool for assessing industrial hazards that might explain biological biomarkers of risk

Example 3: Using TRI Data in the Classroom



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PubH6141: GIS and Spatial Analysis for Public Health

- Graduate level course teaching both GIS and an introduction to applied spatial data analysis
- Hands-on exercises and modules
- Try to incorporate real-life data

TRI Data Provides a Useful Example to Demonstrate Spatial Skills with a True Environmental Health Hazard

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Lesson Objective: Illinois Schools Study to Evaluate Environmental Risk Near Schools

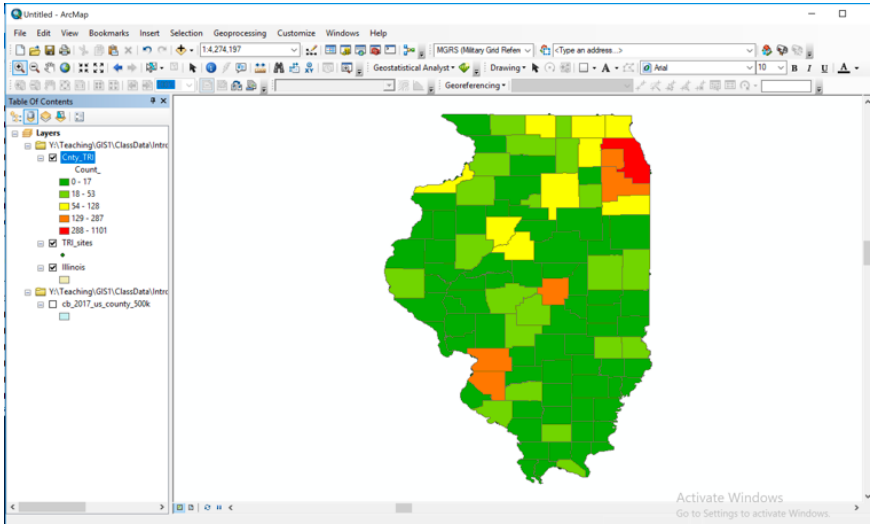
1. Download TRI data for the state of Illinois from the EPA website

2. Learn to convert a text file with XY coordinates into a spatial points shapefile
    - TRI data is useful cause sometimes there are multiple sites with the same XY coordinates. Students learn how to manage duplicates

3. Calculate the number of schools within 5km of a TRI site (hint: the answer is 1,562)

Lesson Objective: Illinois Schools Study

4. Convert TRI points into a map of total TRI sites per county
5. Use our county map to explore global clustering using Moran's-I calculation
6. Create a correlogram of spatial correlation by increasing distance measures



Distance	Moran's I Value	P-value
50km	0.272778	<0.001
100km	0.120968	<0.001
200km	0.043217	<0.001
300km	0.014949	<0.001
500km	-0.006989	<0.05

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Conclusions and Takeaways

- TRI data serves as a useful example for teaching purposes
- Data is publicly available (very important for teaching year after year)
- Easy to understand concept of a toxic site
- Just ‘messy’ enough to serve as a good learning item
  - Data duplicates
  - Many variables
  - Lots of noise to filter out

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References

Berman et al., 2018. School environmental conditions and links to academic performance and absenteeism in urban, mid-Atlantic public schools. International Journal of Hygiene and Environmental Health 221: 800-808

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