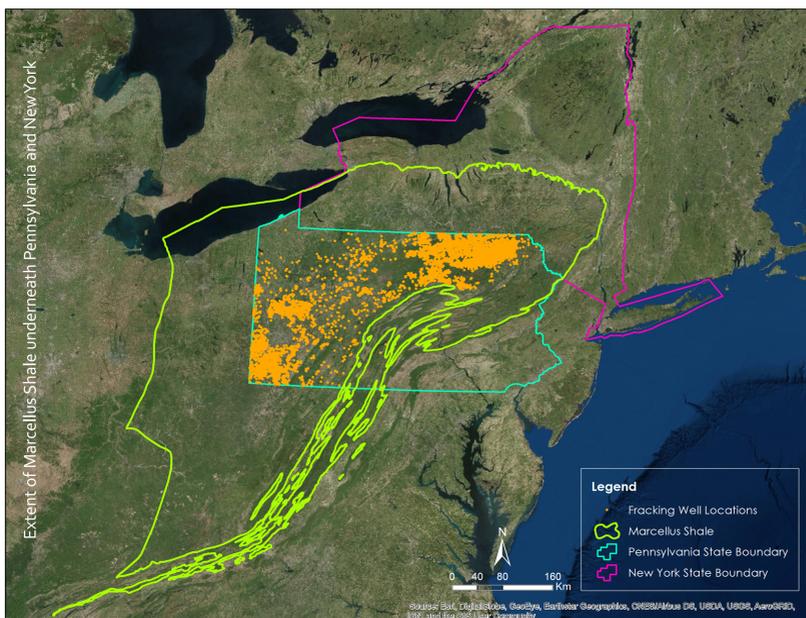
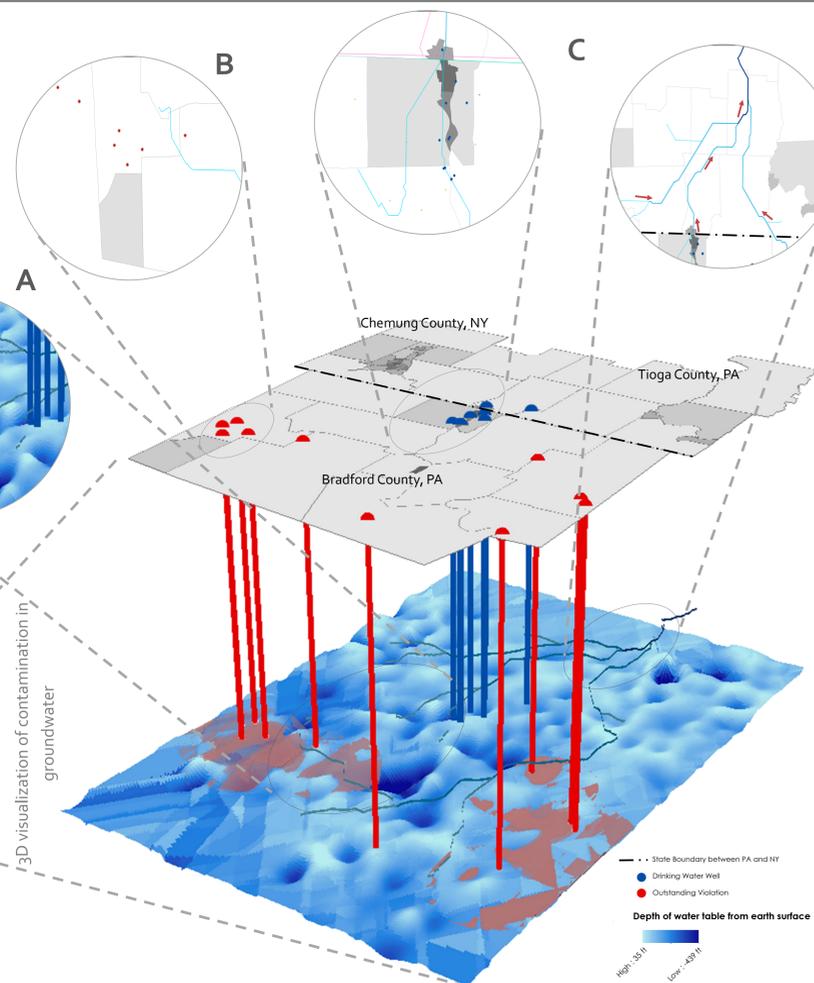


Contaminated Groundwater Flow from Pennsylvania to New York

TOXIC NEIGHBORS



- A** Chemicals seeping in groundwater from the sources of violations close to drinking water wells
- B** High number of outstanding violations near moderately dense community
- C** Dense urban area with high volume drinking water wells
- D** Groundwater streamflow from PA to NY



Findings

The violation incident projected on the population density map shows high density of violation in Tioga, Bradford and Susquehanna Counties in Pennsylvania, which share the border with Chemung, Tioga and Broome Counties in New York. The cluster map shows violation clustering near the interstate border. The quantile map shows the population density near the violations. The most densely populated area in Pennsylvania is around Philadelphia and Pittsburg. Violations seem to occur where population density is low.

The hotspot analysis indicates Sporadic and Oscillating hotspot in and around Bradford County. New hotspots emerged in Wayne county, which also shares the border with New York. Consecutive hotspots occurred away from the state border.

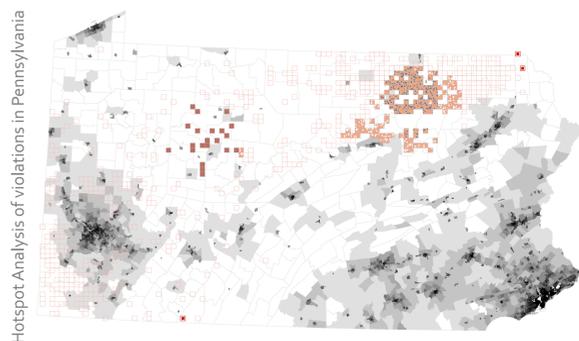
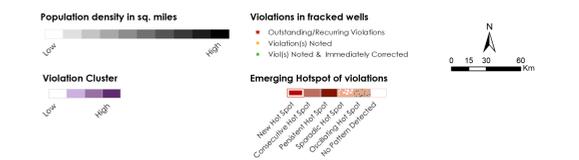
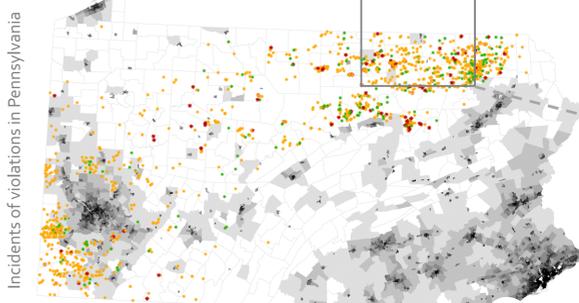
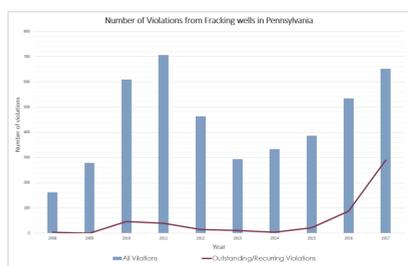
The groundwater streams produced by the hydrology tools show how the groundwater flows from high to low elevation, in this case from Bradford county towards the counties in New York. The 10 km buffers are seen to spread towards the drinking water wells in the dense urban area in both Bradford, PA and Tioga, NY.

Conclusion

Fracking is a fairly new technology, and the impact of the process on the environment is still to understand. There is lack of transparency about the composition of the chemicals used in the process. This information is needed to understand the toxicity of the chemicals involved. Data collected from private drinking water wells can give more insights on the extent of the pollution. The results from this project shows that there are some areas in New York along the interstate boundary where groundwater flows from the fracking sites and can contaminate the drinking water. The extent of the issue therefore calls for collaboration between the two states involved to contain it before it does irreversible damage to the environment.

Introduction

In June of 2015, the State of New York banned hydraulic fracturing, otherwise known as fracking, in their land considering its probable environmental impact. But unlike New York, the neighboring state Pennsylvania have been utilizing the vast natural gas resources trapped inside the Marcellus Shale using the same method, which covers 70 percent of the state. Recent studies, along with a report published by EPA, found proof of groundwater contamination from the wells drilled for hydraulic fracturing in Pennsylvania in the areas near the drilling sites. This might happen due to violations occurred on the drilling sites during the fracking process, or due to mishandling the wastewater recovered after the process. Both surface water and groundwater hardly ever remain within political boundaries. The contaminated groundwater flowing through the aquifer may eventually end up in the drinking wells in New York, the very concerned New York residents to ban the method. The scope of this project is to understand and visualize the possibility of contaminated groundwater flowing from Pennsylvania to New York.

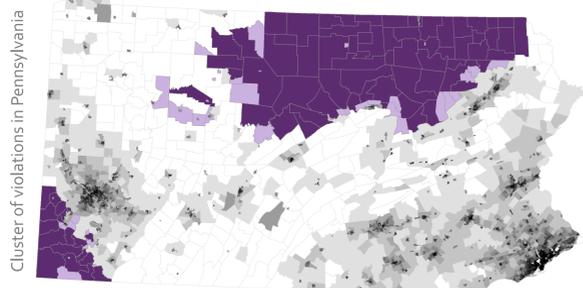


Research Questions

- How much violations from fracking wells have occurred between 2008 and 2015 near the boundary of New York?
- If the groundwater in Pennsylvania got contaminated from fracking violation, can it flow from Pennsylvania to New York?

Methodology

First, a **quantile map** of population density is produced using Geoda from US census data (2010). The locations where the violations occurred were then projected on the map. To see the clustering of violations, **Local Moran's I** was generated in Geoda. After that, a **hotspot analysis** was performed using the Space Time Pattern Mining Tools in ArcGIS. Water well data from New York and Pennsylvania State Government website were projected on the map, which contain elevation data of static water level for each well. This data was used to perform **Kriging** using **Geostatistical Analyst** tool, to visualize the groundwater table. For the scope of the study, this part of the analysis was limited within the boundary of Bradford County, PA; Chemung County, NY and Tioga County, NY. Hydrology tool from the **Spatial Analyst Toolset** was used on the raster file produced from the krigged surface, to determine the flow direction of groundwater in the respective area. **Fill**, **Flow Direction**, **Flow Accumulation** and **Stream to Feature** tools were used for this purpose. A 10 km buffer was created to show the breadth of the contamination around the place of violation. A 3D model is produced in ArcScene to visualize the occurrence and propagation of contamination.



Data Sources: pa.gov, ny.gov, US Census 2010, ESRI
 Projected Coordinate System: NAD 1983, State Plane Pennsylvania

Cartography by Emrat Nur Marzan
 Fall 2017, UEP 294
 21 December, 2017

And some insight from the Secretary of State...

