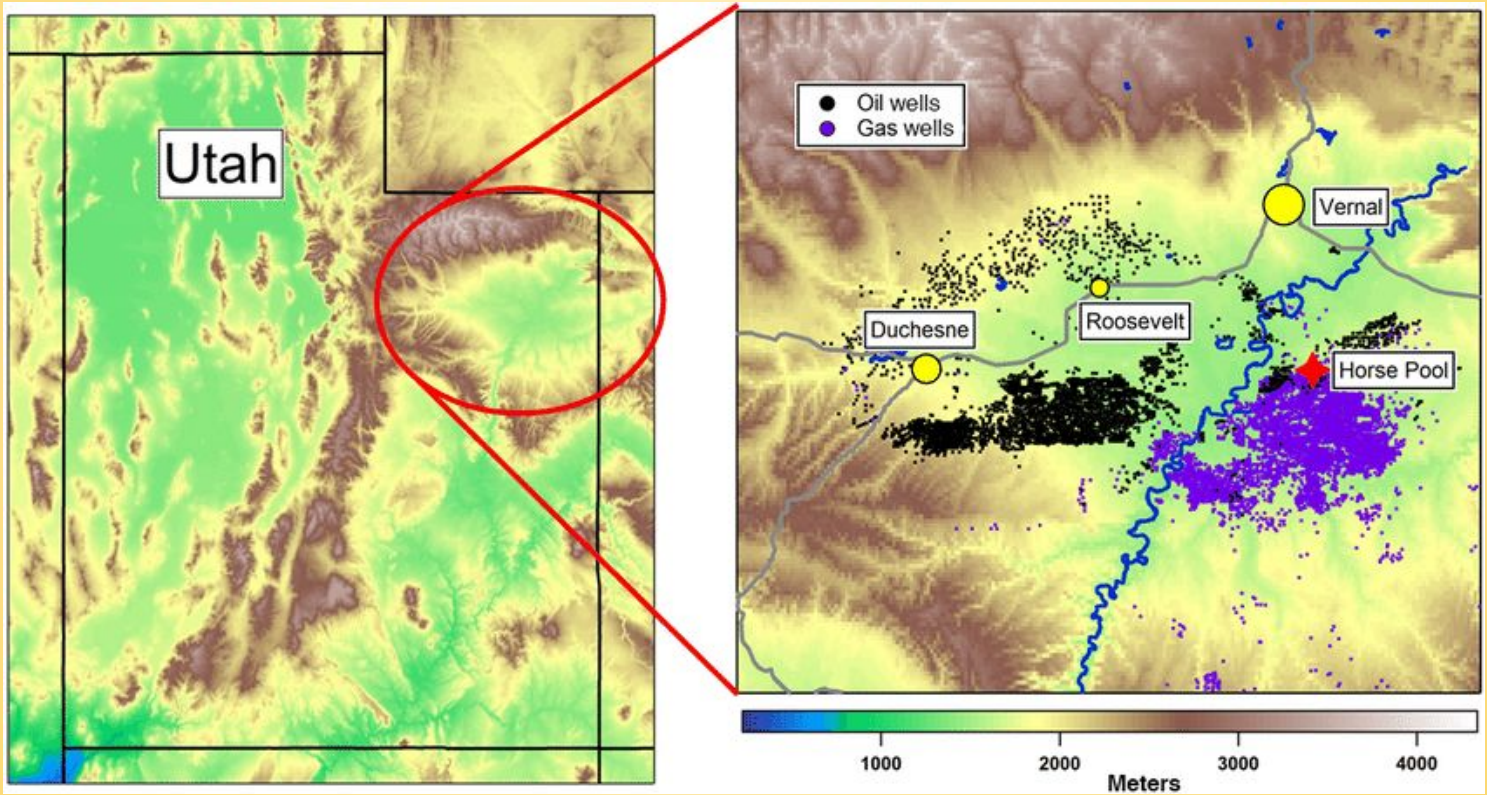
Spatial Impact Analysis of Hydraulic Fracking on Federal Land: Utah

By Justin Fraser

Uintah Basin, Utah

- Recently, in December, 2020, a federal judge rejected the approval of a 2018 federal proposal to introduce large scale fracking and fossil fuel extraction to over 60,000 acres in Northern Utah in the Uintah Basin. This included 59 parcels near Dinosaur National Monument, which happens to include pristine and untouched land that is visited by over 300,000 people every year. As stated, this proposal was recently overturned as it was deemed that the Bureau of Land Management violated the law by not considering all alternatives to leasing the land. This essentially prevented over 2,800 wells to be drilled in the region.
- This capstone will be taking a scenario-based approach to see how the protected land in the Uintah basin and Utah as a whole would be affected by hydraulic fracking if it was introduced.

Current oil and gas wells in the Uintah Basin



Research Questions:

- Area of Interest: Utah (More specifically, the Uintah Basin)

- What are the impacts of hydraulic fracking to surrounding communities and how can spatial analysis be used to generate and interpret them?

- How are these impacts affecting federally protected land (including, but not limited to the Uintah Basin)?

- What is the trajectory of these impacts if nothing is changed?

- How severe would these impacts be if new wells had been introduced to the area such as in the case of the 2020 federal proposal?

Protected lands and the uncertain future

- Protected Land is often protected because:
  - Abundance of Natural Resources
  - Abundance of Cultural Resources
- Resources cannot currently be extracted from protected land.
- PADD = protected area downgrading, downsizing, and degazettement
- 62% of PADDD event are associated with industrial-scale resource extraction and development.

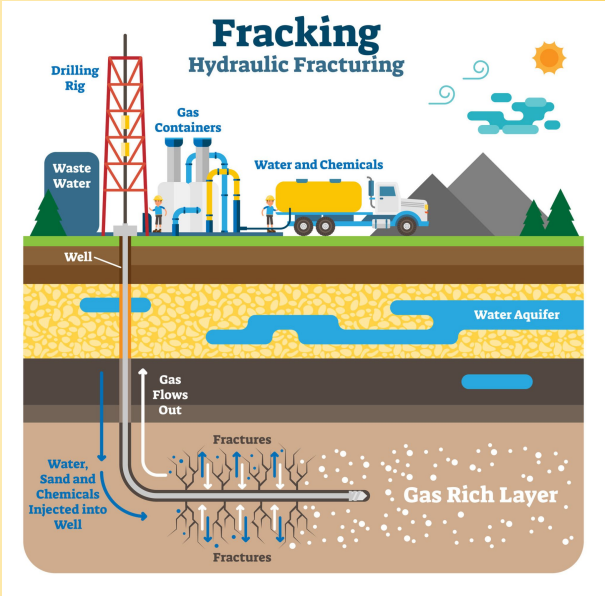
What is Hydraulic Fracking?

- Hydraulic fracturing is a technique used to enable the extraction of natural gas or oil from shale and other forms of “tight” rock.

- Fracking chemicals are pumped down the well and then sucked back up so the loosened gas/oil can be harvested.

- Hydraulic Fracking is fairly new, and we still don't understand the full impacts just yet.

- EPA has named fracking one of the least sustainable forms of energy.



What are the impacts of Fracking?

The impacts of Hydraulic Fracking can be broken down into three categories. These three categories make up the “Three E’s of Sustainability”.

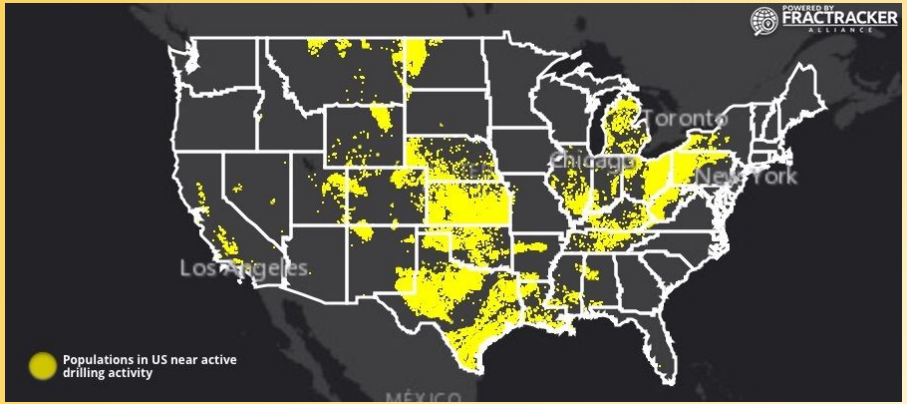
- Environmental

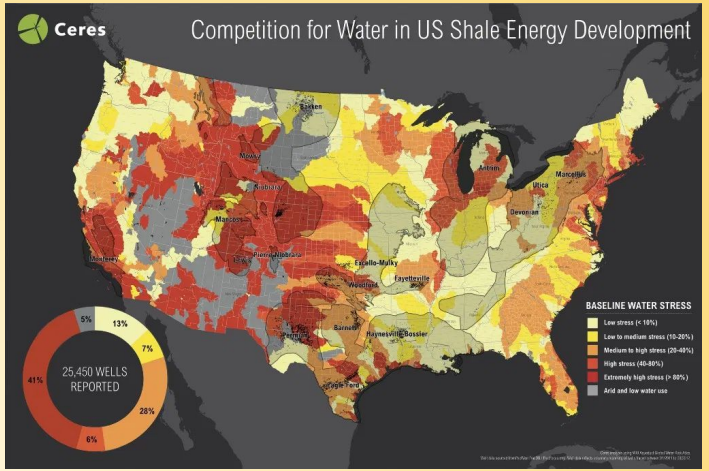
- Economic

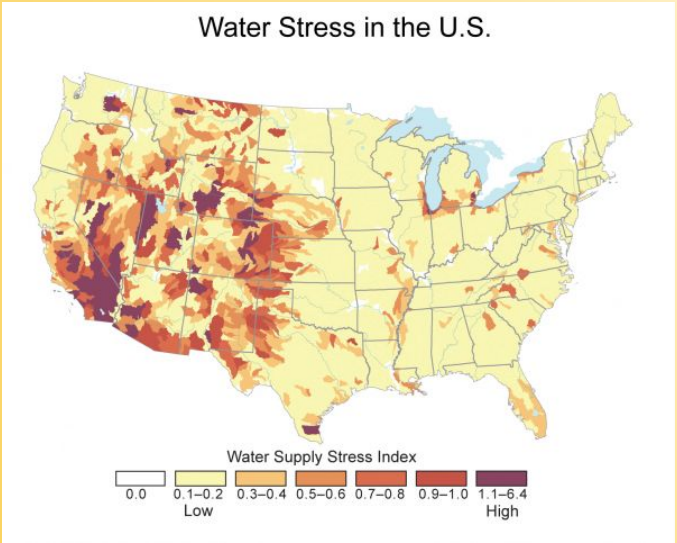
- Ethical

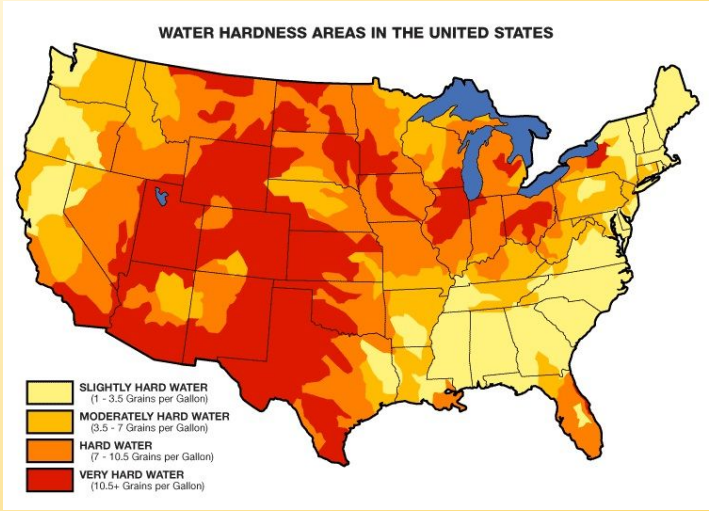
The Environmental Impacts of Hydraulic Fracking:

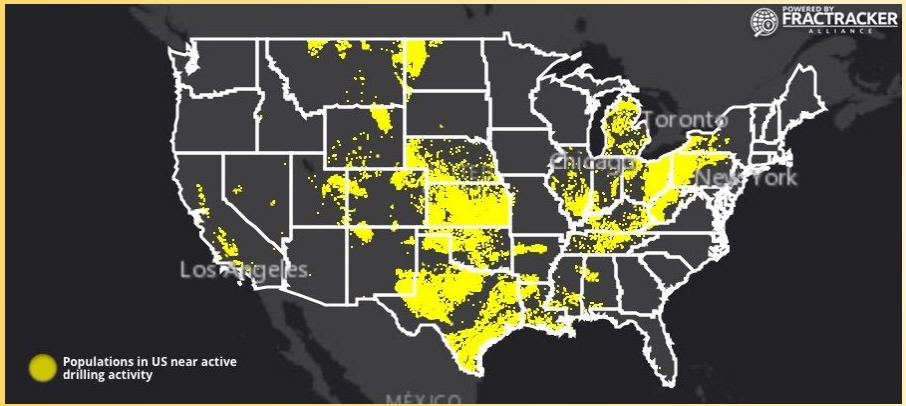
- Water Supply
- Water Quality
- Methane Gas


POWERED BY FRACTRACKER ALLIANCE
Toronto
Chicago
New York
Los Angeles
MÉXICO
Populations in US near active drilling activity


Ceres
Competition for Water in US Shale Energy Development
Bakken
Niobrara
Anadarko
Marcellus
Utica
Devonian
Eagle Ford
Barnett
Haynesville/Bossier
BASELINE WATER STRESS
Low stress (< 10%)
Low to medium stress (10-20%)
Medium to high stress (20-40%)
High stress (40-80%)
Extremely high stress (> 80%)
Arid and low water use
25,450 WELLS REPORTED
5%
13%
7%
28%
6%
41%


Water Stress in the U.S.
Water Supply Stress Index
0.0
0.1–0.2
0.3–0.4
0.5–0.6
0.7–0.8
0.9–1.0
1.1–6.4
Low
High


WATER HARDNESS AREAS IN THE UNITED STATES
SLIGHTLY HARD WATER
(1 - 3.5 Grains per Gallon)
MODERATELY HARD WATER
(3.5 - 7 Grains per Gallon)
HARD WATER
(7 - 10.5 Grains per Gallon)
VERY HARD WATER
(10.5+ Grains per Gallon)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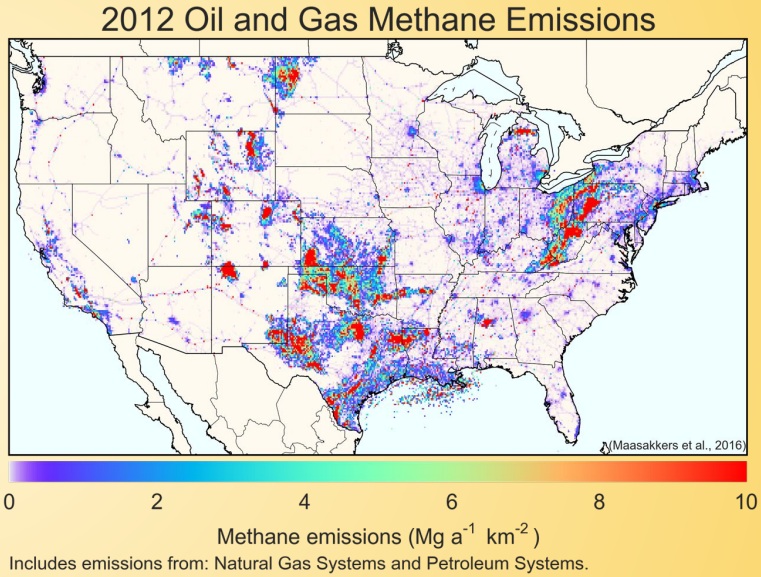
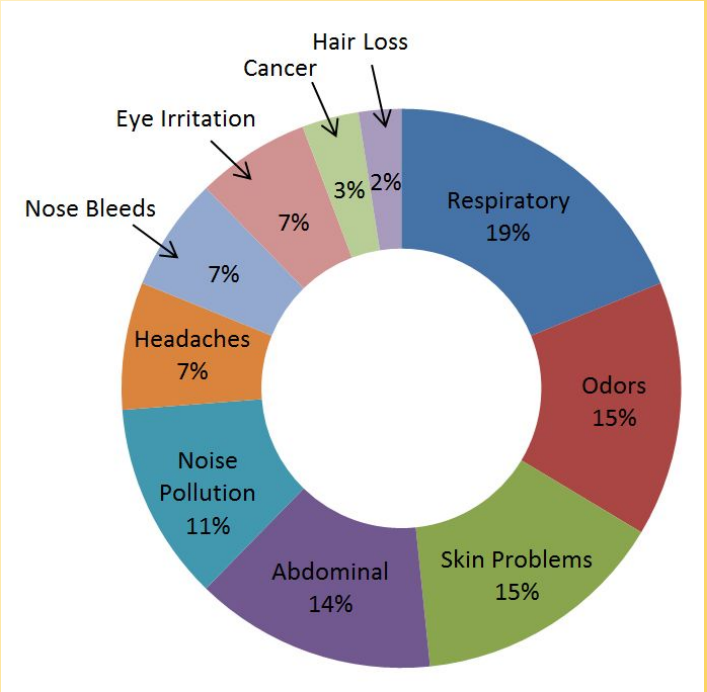

2012 Oil and Gas Methane Emissions
(Maasakkers et al., 2016)
0
2
4
6
8
10
Methane emissions (Mg a-1 km-2)
Includes emissions from: Natural Gas Systems and Petroleum Systems.

The Ethical Impacts of Hydraulic Fracking:

- Hydraulic Fracking often impacts lower income communities and often contributes to health conditions such as:
    - Severe headaches
    - Asthma like symptoms
    - Cancer and childhood leukemia
    - Birth defects



The Economic Impacts of Hydraulic Fracking:

- In 2005, hydraulic fracking was exempt from federal reach.

- Results with less than effective state standards that are often swayed by lobbying corporate entities.

Spatial Analysis of Environment and population at risk of natural gas fracking in the state of PA

- As stated previously, studies have found that hydraulic fracking threatens water resources, harms air quality, changes landscapes, and damages ecosystems. However, there is minimal research focusing on the spatial study of environmental and human risks fracking, which is necessary for state and federal government to administer, regulate, and assess hydraulic fracking.
- In this study, by the Department of Geosciences at Mississippi University, GIS and Spatial Kernel Density functions were implemented to analyse the risk/impacts associated with these wells across the Marcellus Shale Region in PA.
- The data needed for an analysis such as this includes:
    - Hydraulic Fracturing Well Locations
    - Parcels
    - Urbanized Region Data
    - Railways
    - Local/Regional Roads
    - Hydrography
    - Wetland

Technical Methods

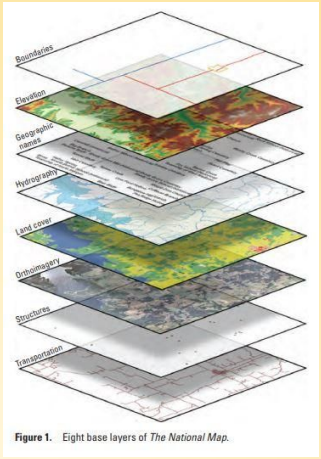
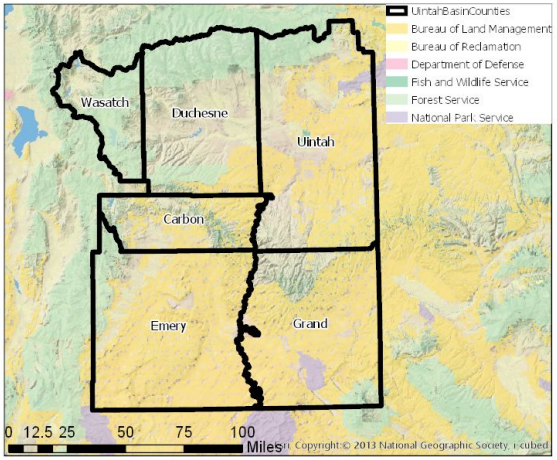


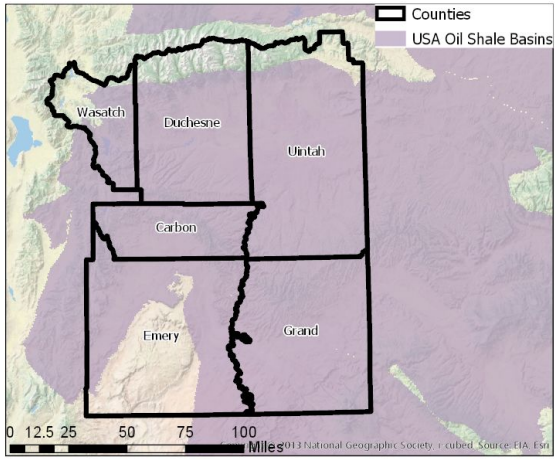
Figure 1. Eight base layers of *The National Map*.

- Data Needed:
    - Hydraulic Fracturing Well Locations
    - Parcels
    - Urbanized Region Data
    - Railways
    - Local/Regional Roads
    - Hydrography
    - Wetland
- Implement Spatial interpolation and density methods to analyse the risk/impacts associated with these wells across the Uintah Basin Region and greater state of Utah.
- Perform Overlay analysis to measure how much of this impacted land is federally protected.
- Approach using scenario based methodology to see how surrounding areas would have been impacted if the federal proposal was approved for the addition of the fracking wells in the Uintah Basin.

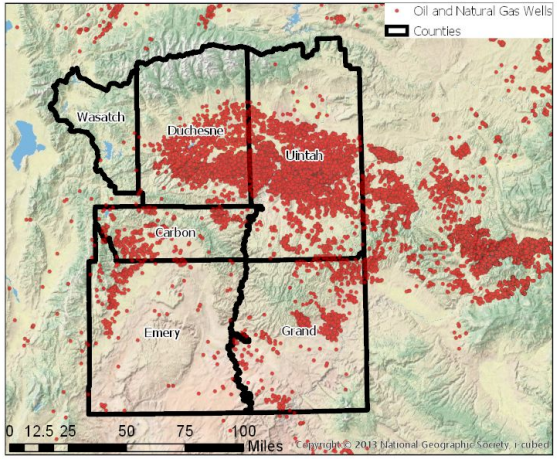
Federal Land



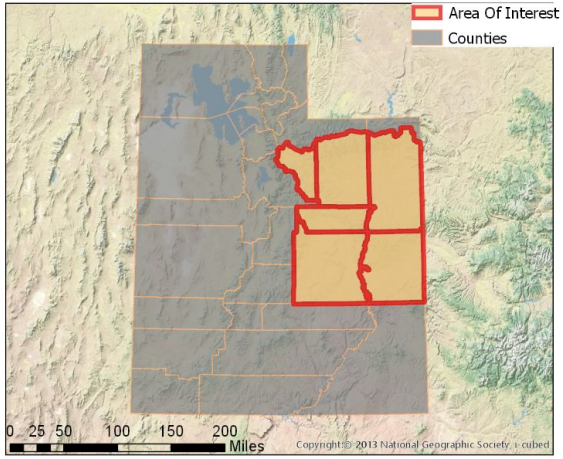
Shale Basins



Existing Wells



Inset



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