Fracking in Pennsylvania: Examining Pennsylvania's Energy Systems in the Age of Fracking

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1. Introduction

The fossil fuel industry has been responsible for an enormous amount of carbon emissions and environmental damages. In this project, we will be trying to answer the question of how is the fossil fuel industry, particularly fracking, affecting communities and the environment in Southwestern Pennsylvania? Environmental impact of fossil fuel industry is an especially relative issue in Pennsylvania, where there is an abundance of many forms of fossil fuel; coal, oil, gas, and more recently, shale gas. The infrastructure build-out of hydraulic fracturing (fracking) has been enormous in Pennsylvania, resulting in devastating consequences to local communities and the environment. There are many organizations and activist groups that are speaking out against this development. However, there is often a lack of visualizations grounded in a strong narrative that emphasizes the breadth and depth of the issues.

Most of the data that are presented by organizations in opposition to the fossil fuel industry are in text heavy reports, with simple charts depicting rather complex issues of externalized costs or other harms subject to regions of heavy extraction. There is a significant amount of effort missing in connecting these issues with places, meaning they're not contextualized geographically. As well as giving the readers access to the data through visualizations in a way that will make the reader care about these issues, it can be hard to care about a bar chart sometimes if one does not understand the implications of the chart.

Our team is going to explore these issues through an interactive article experience where the user can begin to understand the complexity of the energy infrastructure in southwestern Pennsylvania and the resulting burden it places on the local communities and environment. There is an enormous amount of data, in particular geospatial data, that will assist our research and inform our visualizations. We will organize the interactive article around mapping elements, with a collection of other media and visualizations that will support the maps.

2. Related Work

There are plenty of precedents studying abstract quantitative data of fracking, as mentioned before. For instance, U.S. Energy Information Administration (EIA) is tracking the gas production by each state and provides the visualization in choropleth map as shown in ***Figure 1*** (U.S. Energy Information Administration, n.d.). According to them, Pennsylvania has produced 21.8% of the total US natural gas production in 2021, earning the second highest across the nation. Some studies also indicate that fracking is an important topic in

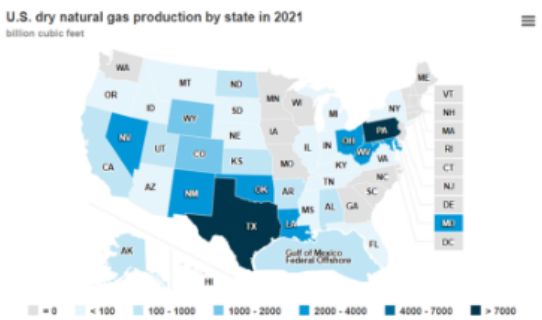

Fig.1 Choropleth map of the gas production in the US

environmental injustice. The data on strong spatial relationships shows that minorities, especially African Americans, disproportionately live near fracking wells, leaving us the motivation to provide the public interactive maps for all (Zwickl, 2019).

However, the oil and gas industry has a strong characteristic on spatial qualities that connect to the larger systems of fossil fuel and energy production, thus various charts representing quantitative data will not be enough for exploring the relationship thoroughly. And the lack of interaction leaves the studies a gap to the audience to explore the data, especially to the vulnerable communities. Thus, in order to explore the data under a holistic perspective, interactive maps showing the data located across the landscape will have a strong visual impact for engaging the audience in qualitative ways with data and thus improving awareness. One example is from Faces of Fracking which made animated maps for California fracking and its impacts on public health (Flagg et al., n.d.) which is shown in ***Figure 2***. This leads to our project on making the maps for Pennsylvania, where a more robust development of fracking happens.

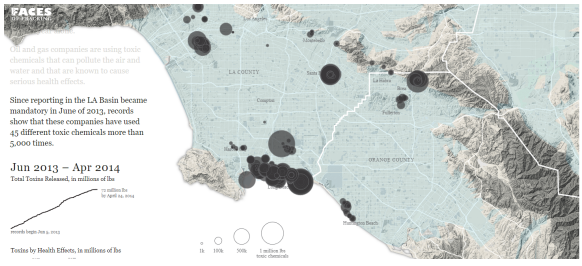

Fig. 2 California Fracking Maps, made by *Faces of Fracking*

3. Methods

We started mapping data only in SW Pennsylvania using the ArcGIS Pro platform. We were originally interested in the diametric relationship of the network of decentralized oil and gas wells, while the corporate control was centralized. As interesting as it sounds, it failed to reveal much about the environmental harms these fossil fuel systems create and was thus outside the scope of our research. Although ArcGIS Pro is quite a sophisticated tool that allows us to create beautiful and informative maps, it is in a very closed ecosystem that makes it difficult for outside user input, and the data interaction is fairly limited (with some minor interaction).

In the process of researching more about the potential technologies that could be used for the purpose of finding answers to our research questions and developing an appealing story for readers and users, we discovered Kepler GL, a front-end platform that runs off a Mapbox back-end. Kepler GL allowed for much more interaction, and more importantly, it allowed the readers to upload their own data, so that they can also explore our research questions in their preferred way. We imagine the interested individuals or perhaps policy makers could add their own data in relation with the pre-loaded oil and gas data we have provided and encoded. This makes Kepler an unmatched tool for creating interactive visualizations with a potential for high user engagement. While we also explored using other tools such as d3.js and Python, these tools cannot match the level of sophistication that Kepler has in terms of interactivity and visual appeal for map-based visualizations. We also created several complementary visualizations using Vega-Lite.

4. Results

In an effort to find out the exact locations of oil and gas wells within Pennsylvania, we loaded our data contained in a GeoJSON file onto the Kepler platform, and it yielded an interactive map that showed the locations of every oil and gas well documented regardless of their current status (some wells have been closed). Due to the interactive nature of the platform, users can hover over any marked location on the map and detailed information about each well. When the large dataset is mapped out precisely through Kepler, we see that oil and gas wells are concentrated in the Western and Southwestern regions of the state.

By overlaying the locations of fracking well buffer zones, power plants, and urban areas on the same map, we can better visualize and understand the environmental impacts of fracking: fracking can serve as the root of a chain reaction that ultimately create environmental hazards and detrimentally affect the health of people who live in the region. While fracking is banned in most urbanized areas, many of the fracking wells in southwestern Pennsylvania have a close proximity to the border of the Pittsburgh metropolitan area. Additionally, there are many fracking wells that are close to large power plants, as the latter relies on many of those wells to provide power to its facilities.

5. Discussion

Though there are plenty of visualizations on the oil and gas industry and fracking, to be more specific. For Pennsylvania, our second place of the highest gas production state, an interactive visualization of the fracking locations and its possible impacting areas can provide the local communities a better insight into how they are involved and how close they are to the fracking. It is quite invisible the distance between everyday life and industrial pollution, but interactive maps enable us to learn what is happening around us. For Pittsburgh residents, a direct interactive way is to zoom in to the Great Pittsburgh area and to explore the number of fracking wells around us and their possible impacting areas. Though the wells are usually located outside the urban areas and the audience looking for their homes on the map in a city usually find it a relief to have not been covered by the buffer areas, it is still a thrilling truth to most of our audience that we are surrounded by fracking wells that their buffer areas cover nearly every inch of the land around the city. There is a huge difference between Pittsburgh and Philadelphia.

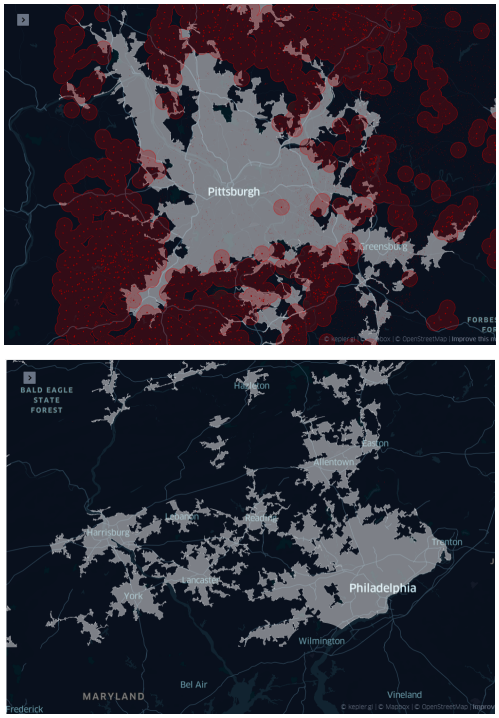

Fig. 3 The map on urban areas and fracking in Pittsburgh (Top) and Philadelphia (Bottom)

In Pennsylvania, the areas that are within the 2km buffer of fracking wells are nearly 2

times of the urban areas, and they are intensively concentrated in the north and west part of the state.

It also provides the possibility of various kinds of storytelling by adding up data. This is especially convenient for the governments and policy makers to explore the locations and the hidden issue of environmental injustice. For example, the data that we provided as an example of add-on data is the location and the types of power plants. Most of the fracking wells in Pennsylvania produce gas for utility scale power plants. The power plants are more closely located and concentrated in the urban areas. However, the difference between the number of fracking wells in Pittsburgh and Philadelphia indicates that in order to power the plants in both cities, the demand for natural gas transportation is huge, leading to more issues on efficiency and pollution. The interaction of the power plant points which shows the detailed information and the grayscale color can fix the gap of accessibility for all.

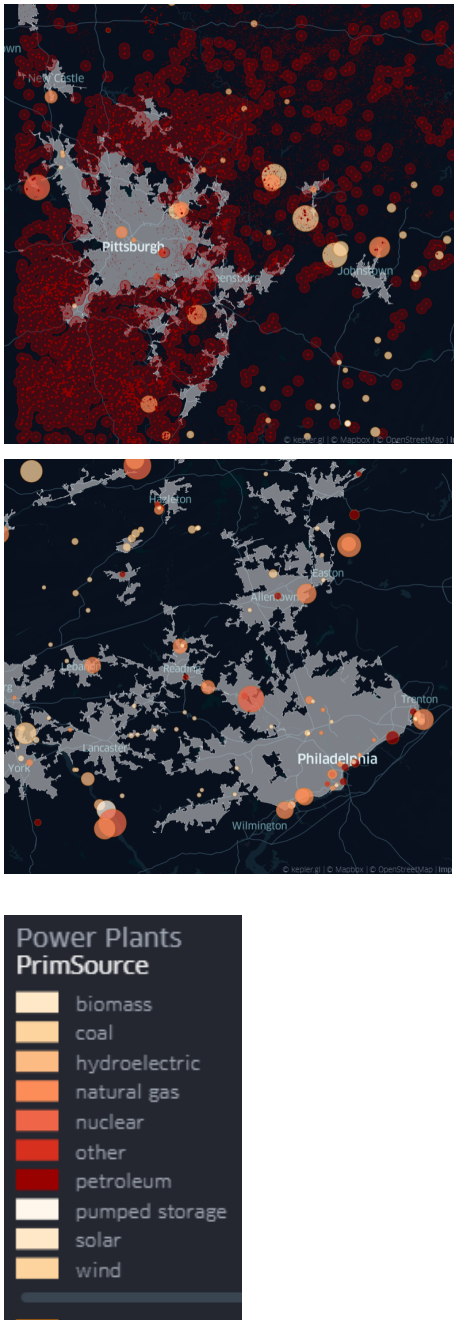

Fig. 4 The map on fracking and power plants in Pittsburgh (Top) and Philadelphia (Middle). Though they both have power plants near the cities, the numbers of their fracking wells are significantly different.

While the maps are processed and designed to convey the severity of the issue and improve public awareness, they also provide the audience with their own ability to add their data and explore more stories according to these maps. This kind of new practice will empower the state and its residents to identify the issues and speak with the data, speak with the truth.

6. Future Work

While Kepler GL has been a highly usable, customizable, and effective visualization tool, it has a number of minor disadvantages when deployed and embedded on a web application, namely the extended time (~1 minute) it takes for the API to reload the pre-configured maps. To expand the depth of our research and the scope of this project, Mapbox GL JS would be a great tool for us to take a closer look at in the future. Its software ecosystem can allow us to create an interactive, thoroughly customizable web platform that is solely dedicated to discovering and visualizing the impact of fracking on the residents of Pennsylvania. Compared to Kepler, Mapbox has a full documentation and support system for developers to create interactive vector maps based on datasets. The software suite also contains native SDKs for both mobile and desktop web applications, and that can drastically improve the loading time of maps on our web platform.

7. Reference

Flagg, A., Craig, S., & Bruno, A. (n.d.). *California's Getting Fracked*. Retrieved December 10, 2022, from http://www.facesoffracking.org/data-visualization/

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