**Lab Report**

Title: Better Title TBD: Power Grid Vulnerability and Marginalized Communities

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**Project Repository:** *<weblink to public repository>*

**Abstract**

*<Delete this text in light grey throughout>*

*250 words max. Clearly summarize the following major sections. Each gets one or two sentences.*

For my project, I will be analyzing American electrical grids. The storms in Texas have led to a surge of articles on this topic lately (Douglas, 2021), but the knowledge that our grids are vulnerable to climate change has been studied for many years (Weiss, 2019). On top of this, not all areas of the grid are protected or maintained equally. Marginalized communities are more likely to be impacted by power grid failure (Plumer, 2021). I will be looking at the ownership and maintenance of our grids against Census data on race, income, and female-headed households, likely at the tract level.

**Problem Statement**

*Describe the specific problem and the context. Provide an illustrative figure and/or context map here. In the table, translate the qualitative problem statement elements into specific requirements for the analysis.*

This lab’s problem is to download the data through a Python script, import it onto a map, and search for connections between the data. The first level of analysis will be straightforward: the electrical grids can be symbolized by owner and overlaid on polygons showing the distribution of marginalized communities. After this visual analysis, I will use use ArcPro tools to analyze these relationships to pull out spatial patterns not immediately apparent upon visual examination.

*Table 1. Methodology Outline*

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| --- | --- | --- | --- | --- | --- | --- |
| **#** | **Requirement** | **Defined As** | **Spatial Data** | **Attribute Data** | **Dataset** | **Preparation** |
| 1 | Electrical grid shapefile; symbolized by vulnerability and possible ownership | Vector dataset; features also have associated substations | Polyline network dataset of the entire US | Service status, ownership | https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-power-transmission-lines?geometry=-102.431%2C44.299%2C-86.819%2C46.986 | Possibly clip to study area; possibly run analysis to discover most vulnerable areas |
| 2 | Control Areas, along with electrical line ownership, to help determine responsibility of grids in various regions | Vector dataset | Polygons of retail service areas of energy providers | Websites, peak months, unplanned outages, peak capacity | https://hifld-geoplatform.opendata.arcgis.com/datasets/control-areas | Possibly symbolized separately, or possibly joined with grid data (or both) to give a complete picture |
| 3 | Represent marginalized communities | Census demographic numbers symbolized by tract | Polygon |  | https://www.nhgis.org/ | Possibly calculating columns to get ratios per population |

**Input Data**

I will be using publicly available census and electrical infrastructure data. I believe census data at the tract level will be a sufficient level of granularity, but I will be researching further before downloading. Two shapefiles will come from Homeland Infrastructure Foundation-Level Data (HFILD) Open GP – Energy: polyline data on electrical lines, and control areas, which is polygon data that shows which parties are responsible for energy supply of the electrical grids in the area. The electrical line data also shows ownership of the grids. HFLID also has point data for electric substations, but I don’t know yet if that will be relevant, since it contains much the same information as the electrical line shapefiles.

*Table 2. Data*

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Title** | **Purpose in Analysis** | **Link to Source** |
| 1 | Control Areas | Energy stakeholders in various regions of the US | https://hifld-geoplatform.opendata.arcgis.com/datasets/control-areas |
| 2 | Electric Power Transmission Lines | Shapefile of the energy grid network; will be analyzed for vulnerability; attribute data includes power company ownership | https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-power-transmission-lines/data?geometry=-102.431%2C44.299%2C-86.819%2C46.986 |
| 3 | Electric Substations | Shapefile of the energy stations; not sure yet how relevant it will be since the information is the same as the power line data | https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-substations?geometry=-110.440%2C43.508%2C-79.920%2C48.828 |
| 4 | Census Data | Not downloaded yet since I haven’t decided which datasets; demographic data at the tract level of marginalized communities; will be used to analyze intersections of these communities with weak infrastructure | https://www.nhgis.org/ |

**Methods**

*Include a data flow diagram or screenshot from model builder. Do references in line (Rammankutty, 2033). Document any and all steps that you did to the input data in the data flow diagram. Provide natural language description of the most important steps, giving a narrative arc and provide well formatting screenshots with a boarder and centered throughout.*

*Resources on Data Flow Diagrams:*

* [*https://www.visual-paradigm.com/tutorials/data-flow-diagram-dfd.jsp*](https://www.visual-paradigm.com/tutorials/data-flow-diagram-dfd.jsp)
* [*https://www.lucidchart.com/pages/data-flow-diagram/how-to-make-a-dfd*](https://www.lucidchart.com/pages/data-flow-diagram/how-to-make-a-dfd)

*Figure 1. Data flow diagram.*

**Results**

The results will hopefully address the problem statement by showing a spatial pattern. It is my hypothesis that more vulnerable grids will overlap with vulnerable communities, since this pattern is well-established in other studies into infrastructure (for example, the Flint water crisis). I am also interested in seeing how private energy corporations play a role in grid upkeep and if there is a pattern of negligence for any one company.

To this end, I will be producing several maps as my output in order to tell a visual story about the state of our energy grids. At this time, I am planning on writing in a blog or Story Map so the content is accessible to audiences without previous in-depth knowledge.

**Results Verification**

I am not sure how to verify the results of an original study. If my results match up with similar studies on vulnerability of electrical grids and marginalized communities, that will be one angle. However, I have not yet found a study exactly like my project idea, only tangential research. Another possible way to verify my results is to create a reproducible workflow so others can test my conclusions.

**Discussion and Conclusion**

*What did you learn? How does it relate to the main problem?*

In conclusion, I do not yet know what spatial patterns will be

**References**

Erin Douglas, Kate McGee, Jolie McCullough. (2021, February 17). Texas leaders failed to heed warnings that left the state’s power grid vulnerable to winter extremes, experts say. *The Texas Tribune*. <https://www.texastribune.org/2021/02/17/texas-power-grid-failures/>

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King, L. (2021, January 28). *How America’s Power Grid Is Vulnerable To Undetected Cyberattack*. <https://www.forbes.com/sites/llewellynking/2021/01/28/how-the-supply-chain-in-heavy-bulk-power-equipment-is-vulnerable-to-undetected-cyberattack/?sh=ae9ae027213a>

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Mike M. McMahon. (2017, November). *Mapping the Vulnerability and Strength of the Power Grid*. <https://isen.northwestern.edu/mapping-the-vulnerability-and-strength-of-the-power-grid>

Brad Plumer, Hiroko Tabuchi. (2021, February 17). The Far-Reaching Effects of the Storm, on Power and People. *New York Times*. <https://www.nytimes.com/2021/02/17/climate/storms-power-outage-newsletter.html>

**Self-score**

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Description** | **Points Possible** | **Score** |
| **Structural Elements** | All elements of a lab report are included **(2 points each)**:  Title, Notice: Dr. Bryan Runck, Author, Project Repository, Date, Abstract, Problem Statement, Input Data w/ tables, Methods w/ Data, Flow Diagrams, Results, Results Verification, Discussion and Conclusion, References in common format, Self-score | 28 | **28** |
| **Clarity of Content** | Each element above is executed at a professional level so that someone can understand the goal, data, methods, results, and their validity and implications in a 5 minute reading at a cursory-level, and in a 30 minute meeting at a deep level **(12 points)**. There is a clear connection from data to results to discussion and conclusion **(12 points)**. | 24 | **24** |
| **Reproducibility** | Results are completely reproducible by someone with basic GIS training. There is no ambiguity in data flow or rationale for data operations. Every step is documented and justified. | 28 | **28** |
| **Verification** | Results are correct in that they have been verified in comparison to some standard. The standard is clearly stated **(10 points)**, the method of comparison is clearly stated **(5 points)**, and the result of verification is clearly stated **(5 points)**. | 20 | **20** |
|  |  | 100 | **100** |