An Integrated Model for Financial Risk Assessment of Grid-ignited Wildfires

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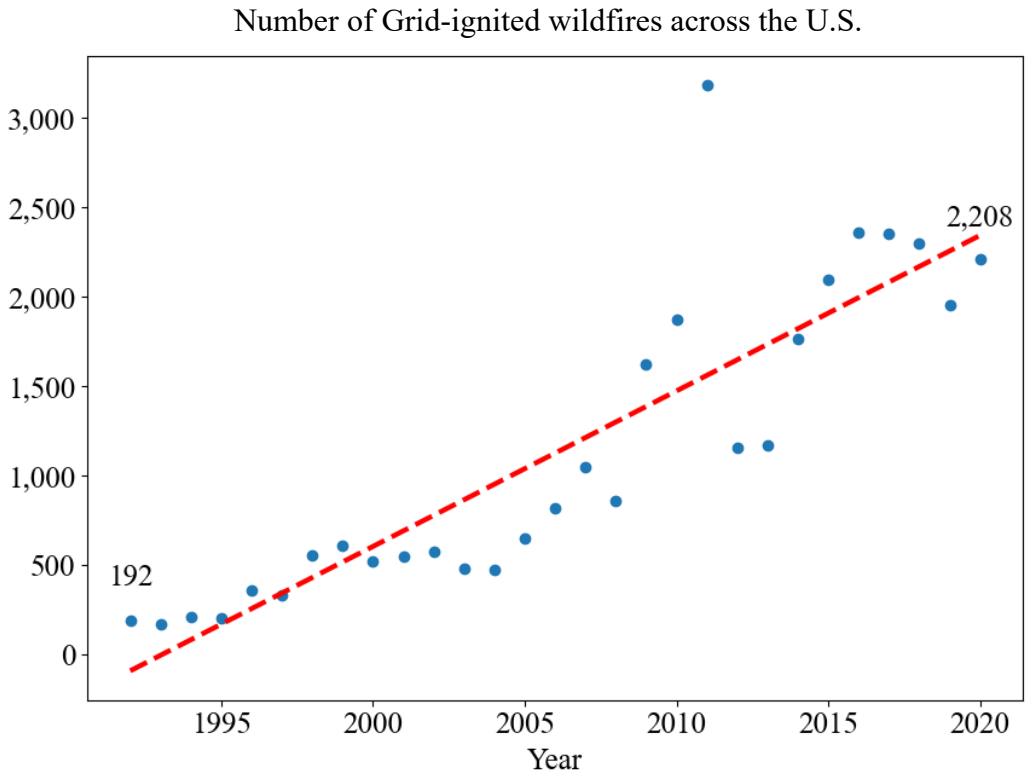
United States Department of Agriculture (USDA)
Forest Service

Grid-ignited Wildfires

- How does it start?
  - Electric arc without physical contact
  - Structural failure of grid components
  - External contact (trees, animals) with power lines

- Why is it so important?
  - Less than 2% of all wildfires in the US over the past three decades
  - 7 out of 10 costliest wildfires in US history, add up to over $40 billion



Source: USDA Forest Service Research Data Archive

Problem Statement

To effectively mitigate the risk of grid-ignited wildfires, utilities implement a range of predefined strategies, including grid hardening, enhanced monitoring, vegetation management, and proactive power shutoffs.

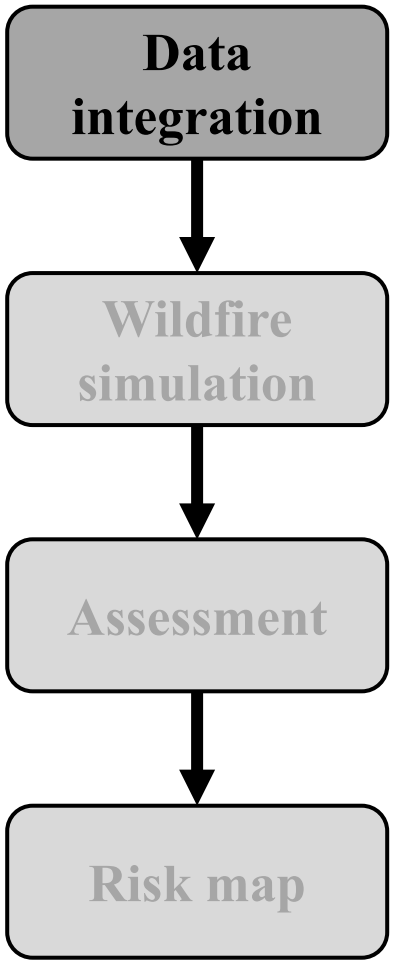
Barriers to Implementation:

- Budget limitation
- Time limitation
- Workforce shortage
- Customer unsatisfactory

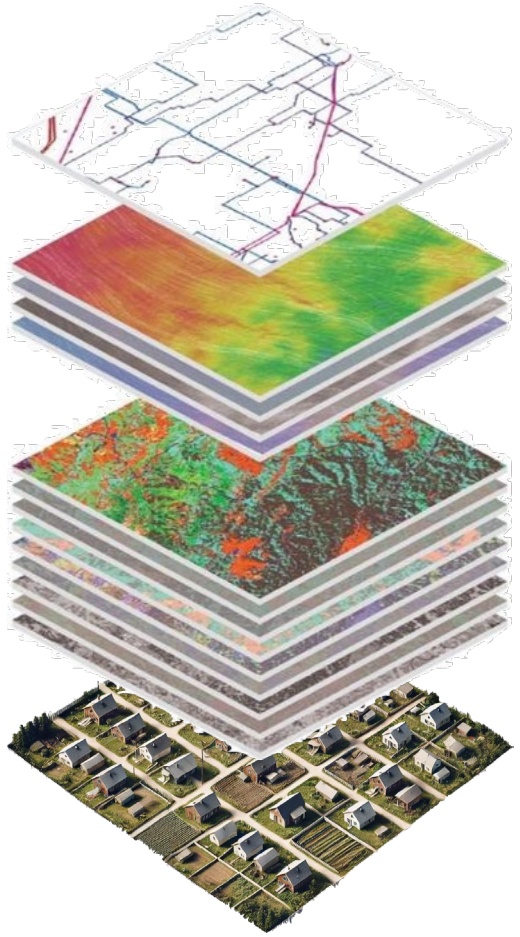
We present a systematic methodology for quantifying the potential risk of wildfire damage for each transmission line. This approach culminates in a risk heatmap, enabling electric utilities to efficiently assess and prioritize risk across the network topology with a comprehensive, at-a-glance view.

Goal:
To empower electric utilities to make risk-informed decisions and enhance resilience against grid-ignited wildfires.

Proposed Approach



- Grid data
- Weather data
- Landscape data
- Structure data



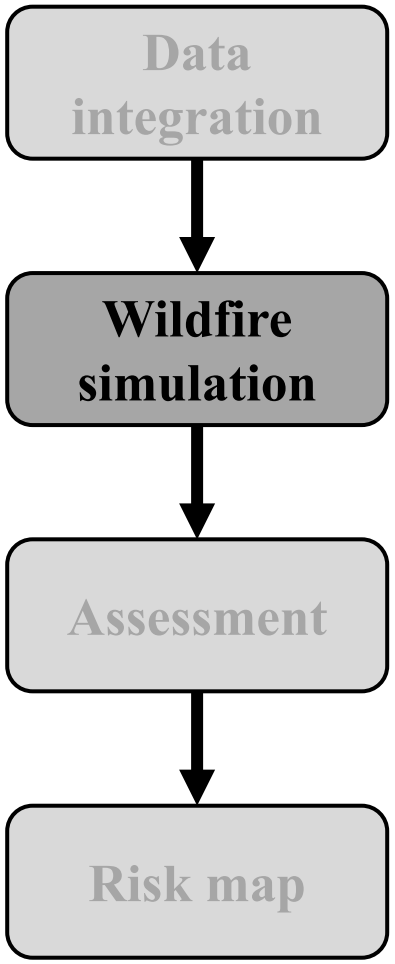
Network Topology
Transmission Lines and Nodes

Weather Data
Temperature
Humidity
Wind Speed
Wind Direction

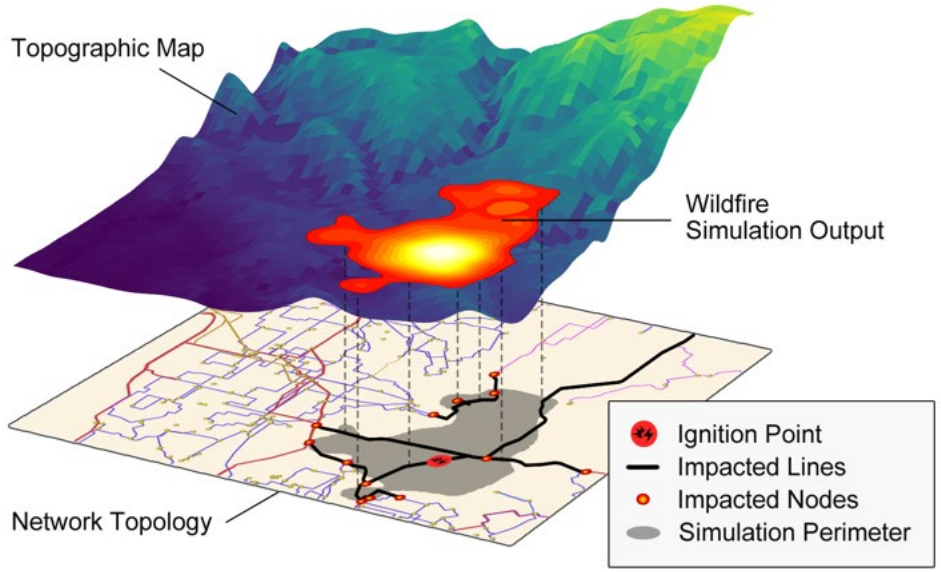
Landscape Data
Elevation
Slope
Aspect
Barriers
Fuel Model
Canopy Cover
Crown Height
Crown Base Height
Crown Bulk Density

Structure data
Houses and buildings

Proposed Approach

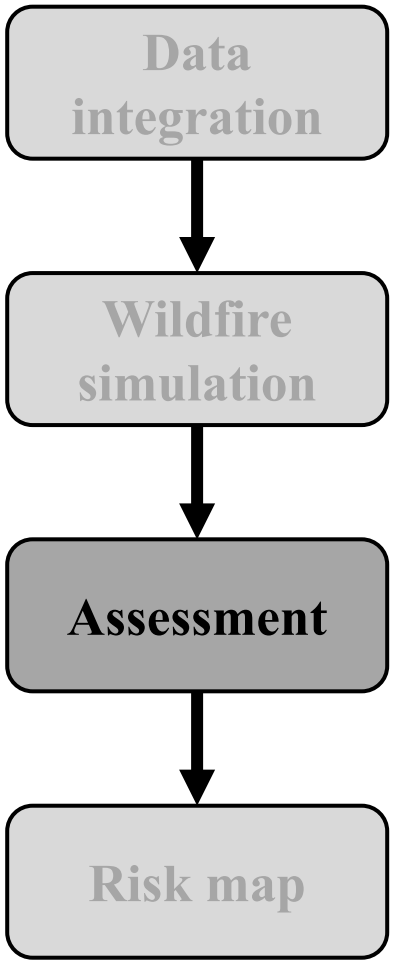


- Input the collected data
- Define ignition scenarios
- Run FARSITE to simulate the fire behavior



FARSITE is a wildfire simulation model developed by the U.S. Forest Service that simulates fire spread based on terrain, vegetation, weather, and ignition points.

Proposed Approach

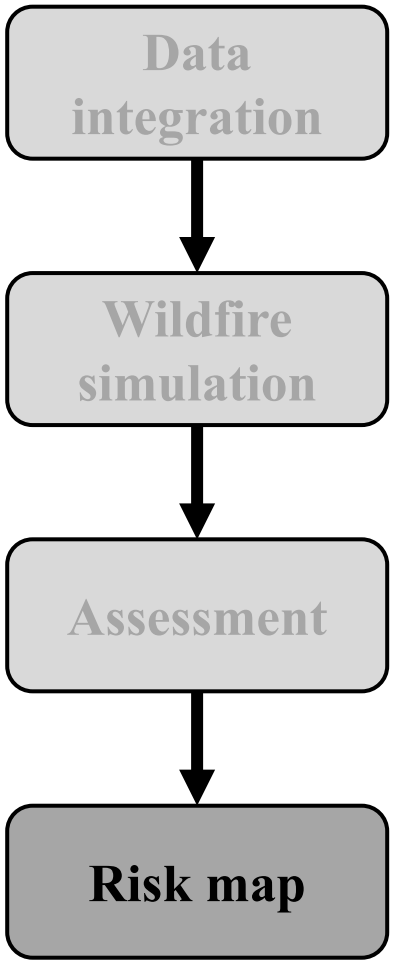


$$\textbf{\textit{Total financial loss}} =$$
$$burned\ area\ (acre) * avg\ cost\ of\ environment\ damage\ (\$/acre)$$
$$+ length\ of\ downed\ power\ lines * avg\ cost\ of\ power\ line\ reconstruction\ (\$/mile)$$
$$+ number\ of\ destroyed\ structures * median\ home\ price\ (\$)$$

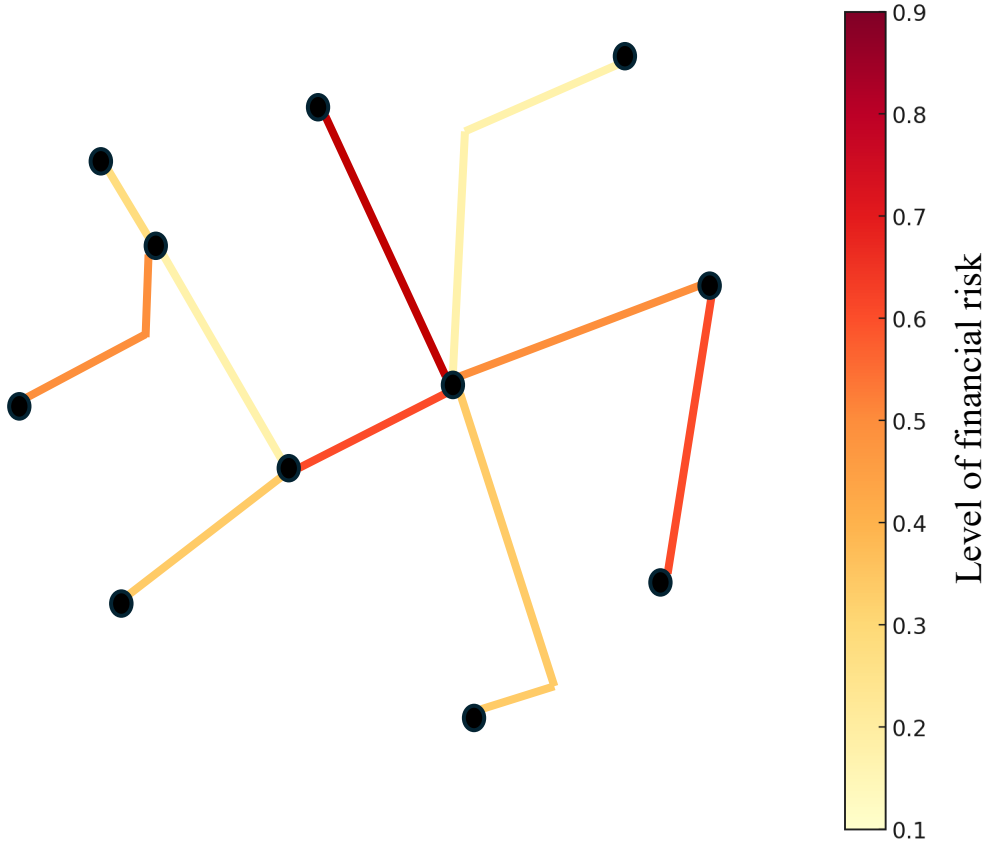
- Environmental damages
- Damage to the power grid assets
- Damage to structures

Burned area and damaged power lines

Proposed Approach



Sample of risk heatmap for a transmission network

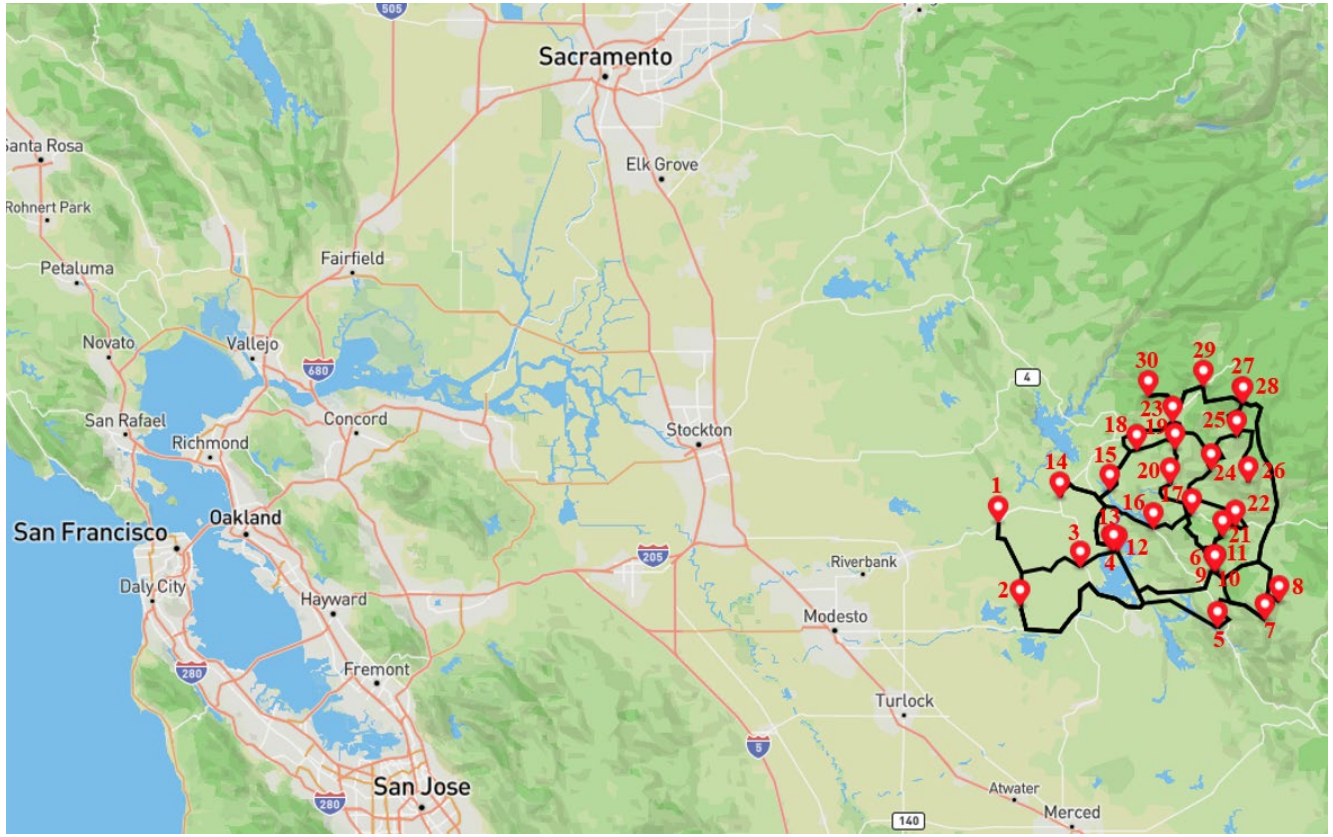


Case Study

- Location: 100 miles east of San Francisco

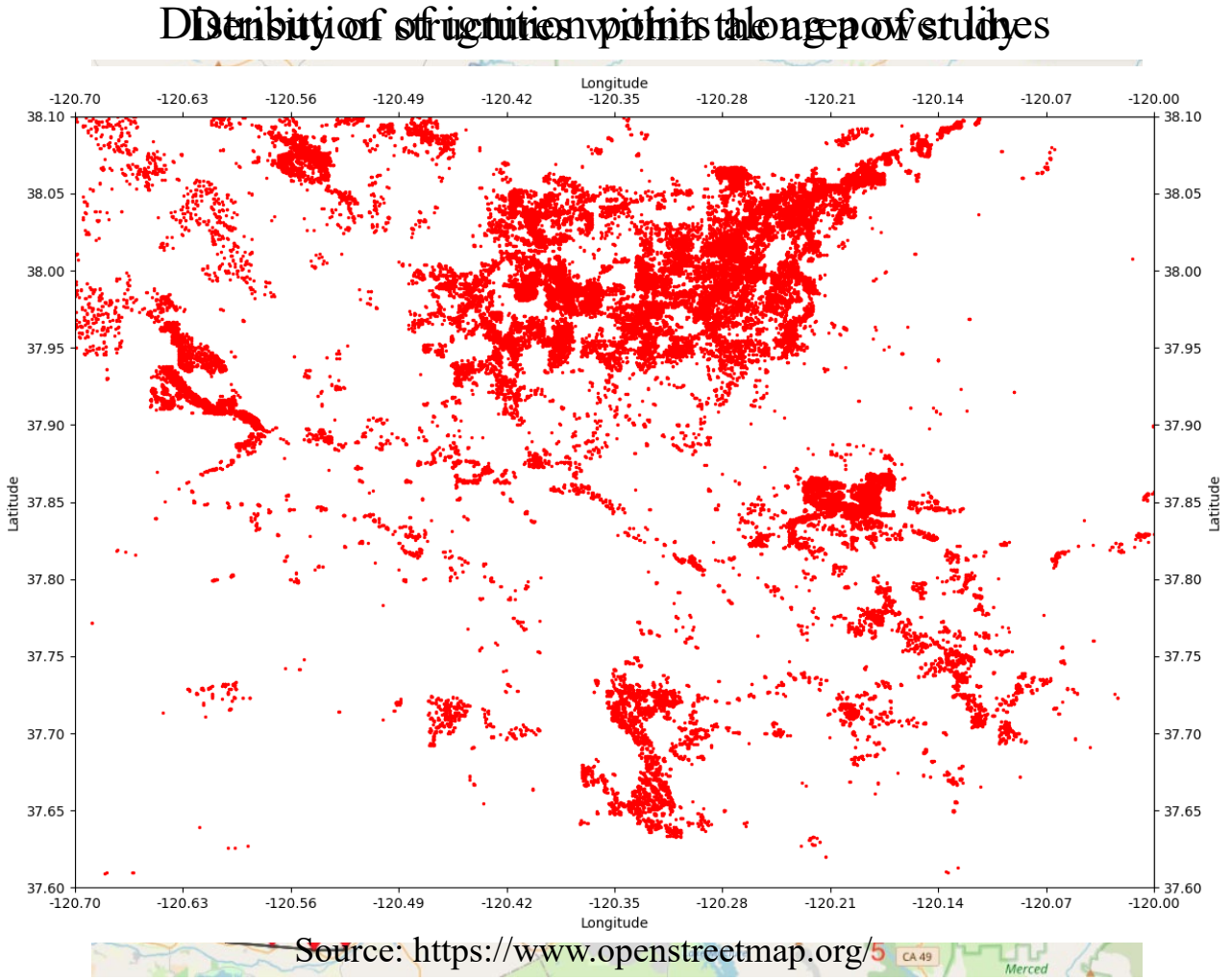
- Area covered: 800,000 acres
- Number of buses: 30
- Number of generators: 6
- Number of branches: 41

Geographic visualization of the IEEE 30-bus test system



Assumptions

- Ignition points are evenly distributed at 5-mile intervals throughout each power line.
- Single ignition points
- The actual weather data, starting from July 1st
- The number and location of structures within the area of study are extracted.

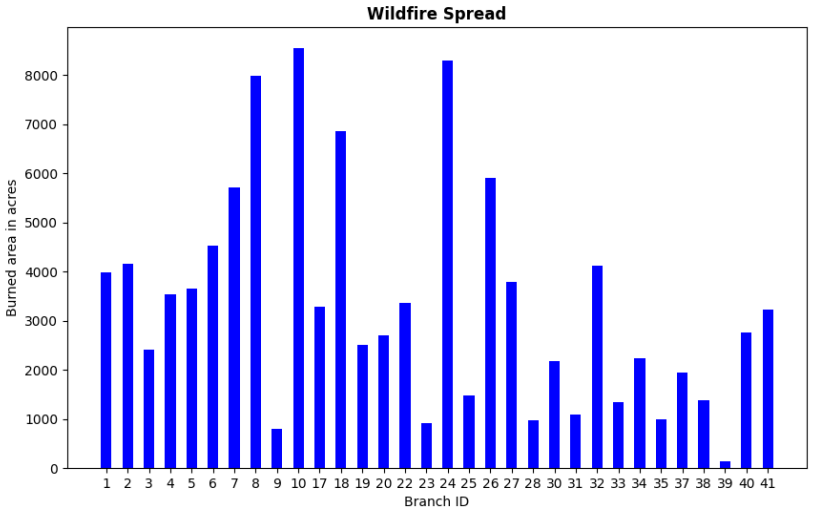


Source: https://www.openstreetmap.org/

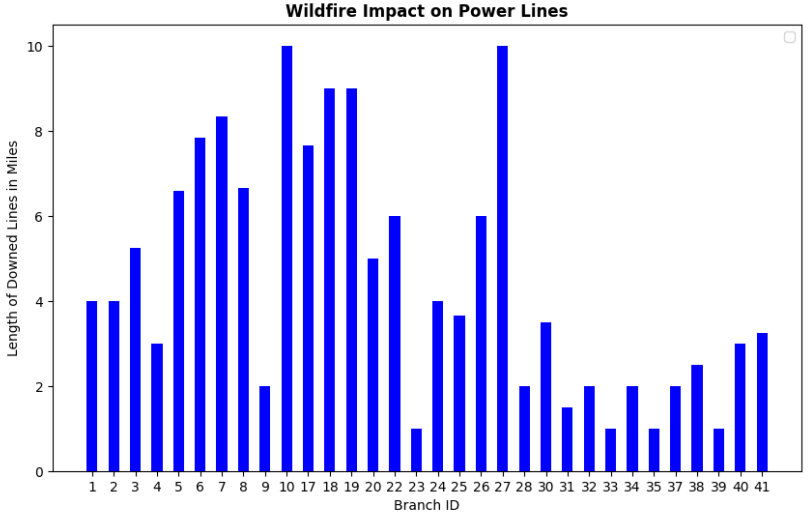
Results

Wildfire Damages

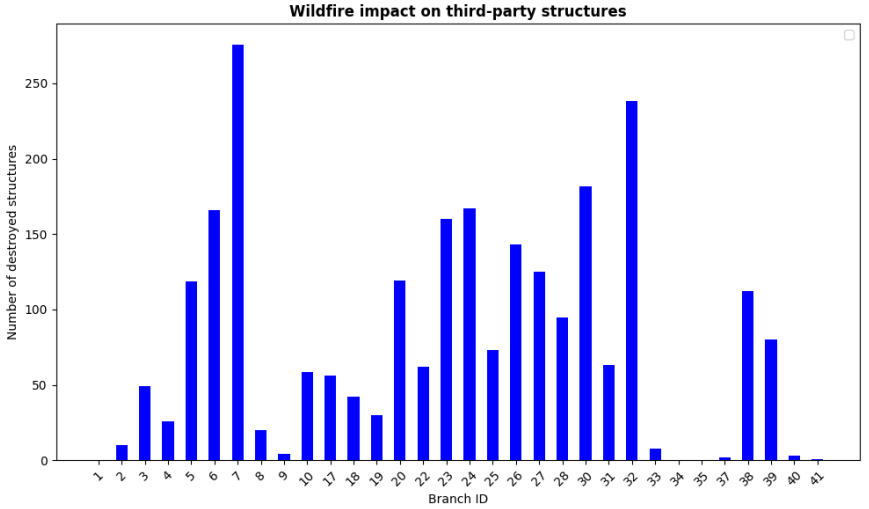
Burned area



Power lines affected

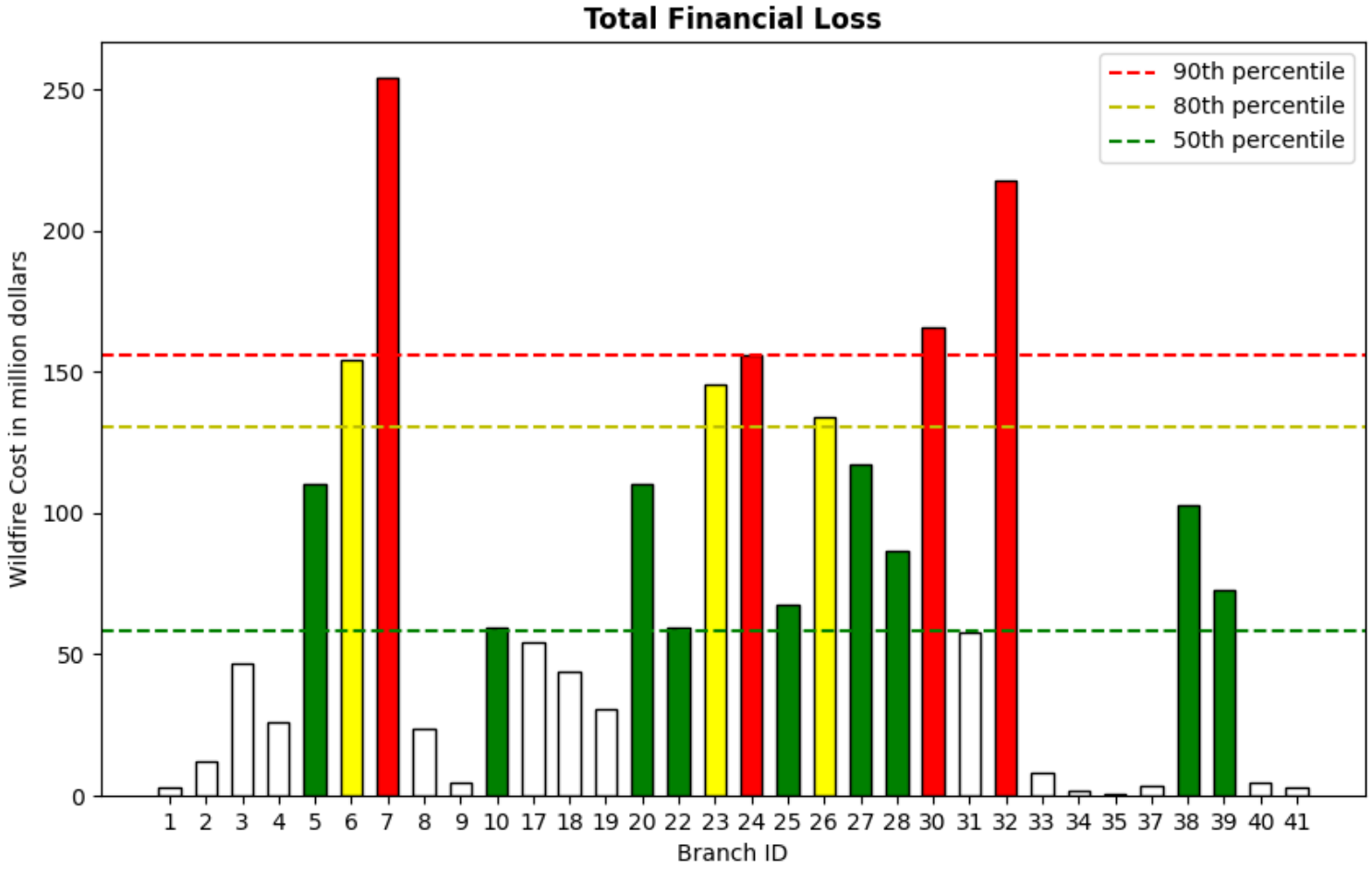


Number of destroyed structures



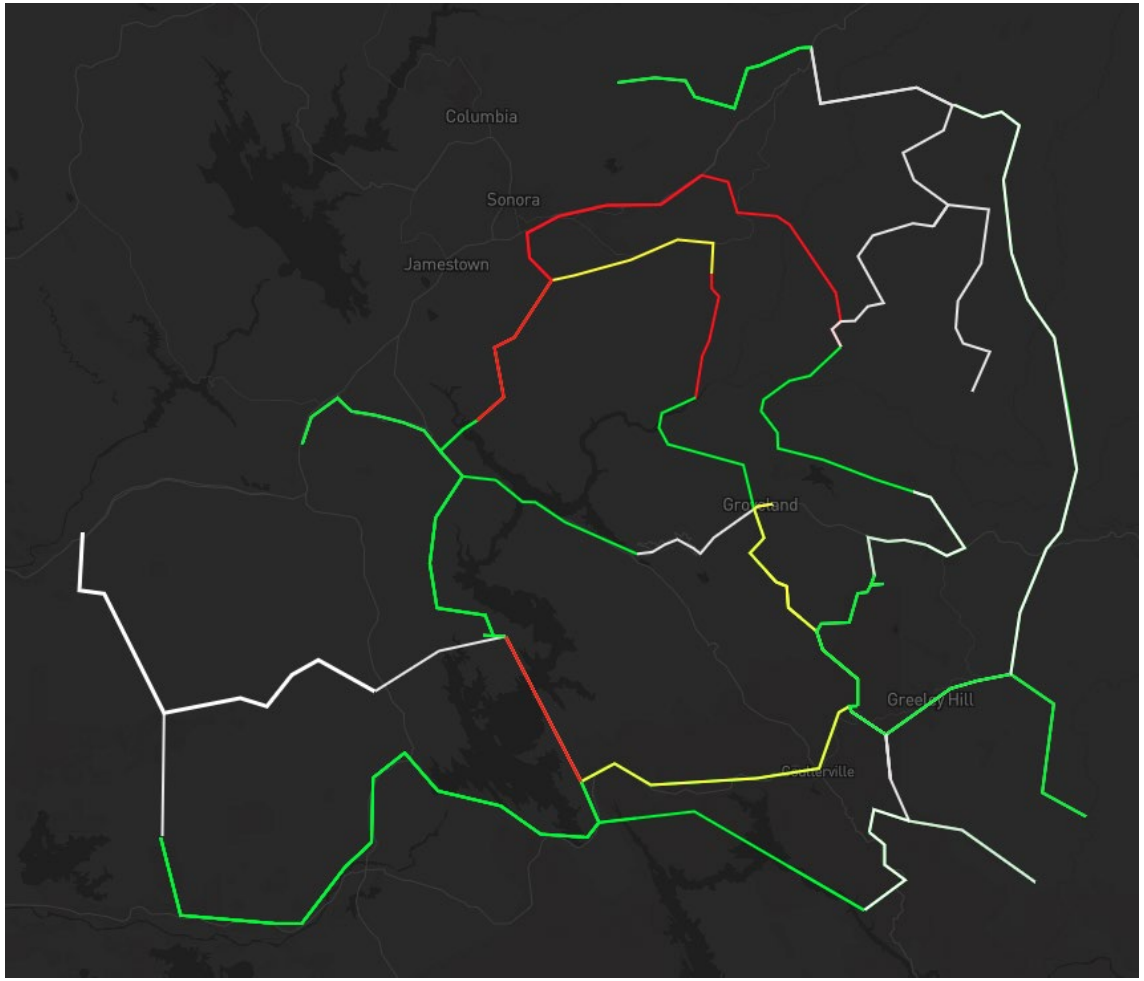
Results

Total cost resulted from grid-ignited wildfire scenarios



Results

Risk heatmap for the transmission network



Value Propositions

❖ **Vegetation management:**
Utilities can identify hotspots that require vegetation trimming.

❖ **Undergrounding and Conductor Upgrades:**
A ranked list of lines with the highest risk of damage could help create a priority list.

❖ **Public Safety Power Shutoffs (PSPS):**
By integrating online weather data with the risk map, utilities can make informed power shutoff decisions.

❖ **Early Warning Systems:**
Placing fire detectors in high-risk areas significantly enhances early detection capabilities.

❖ **DERs placement:**
Strategically locating DERs near high-risk zones enables local operation during wildfires or grid outages.

❖ **Financial Protection:**
Facilitating symmetric information for utilities and insurance companies to share the risk using insurance.

Thank You

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