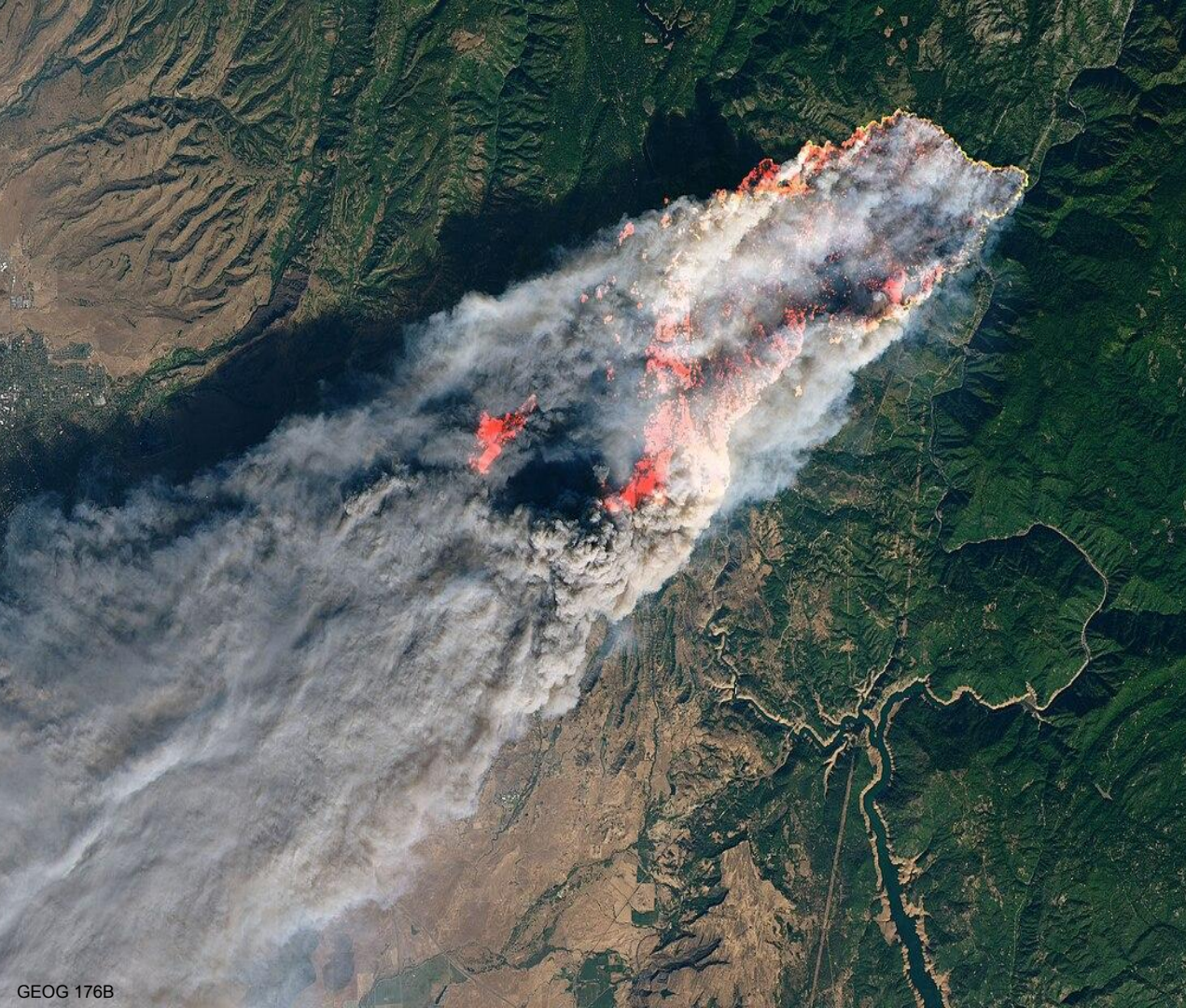




Trouble in Paradise? - The Camp fire in Butte County

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Research Question

How effectively did the existing fire stations in Butte County cover the population during the Camp Fire in 2018, and where should a new fire station be located using a land suitability analysis to improve wildfire emergency response?



Motivation and Background

Motivation:

Living in California, we have lived with wildfires and their impacts all of our lives. However, the Camp fire of 2018 was especially devastating as the deadliest and most destructive wildfire in California state history. We were motivated by the idea that analyzing and understanding the shortcomings of the fire response would allow for communities to adapt new strategies and fire preparedness.

Background:

On November 8th 2018, at approximately 6:15 AM PGE Tower #27/222, part of the Caribou-Palermo 15-kilovolt (kV) transmission line, experienced a C-hook failure causing the highly charged wires to fall upon the dry brush below.

In less than an hour, the fire had made a nearly 12 mile run to the south west, consuming the equivalent of a football field every second, according to Cal Fire, impacting the town of Paradise by ~7:45 AM.

85 fatalities - 18,800 structures Destroyed (14,000 Residential) - 153,335 acres burnt. Took nearly 6,000 firefighters, 24 helicopters and 12 planes eighteen days to fully contain the fire.



Data

Datasets Name	Data Type	Spatial Area	Attribute Fields	Uncertainties	Source
U.S. Census Block	Vector (Polygon)	Butte County	- State FIPS Code - County FIPS Code - Decennial Population Count	May not reflect actual population reducing accuracy in assessing current population vulnerability.	ESRI Federal Data
Final Fire Perimeter	Vector (polygon)	The City of Paradise	- irwinid - GISACRES	Doesn't depict the progression of the fire, and doesn't reflect the variety in intensity of the fire in different areas.	ESRI
Geofabrik - OpenStreetMaps (Roads of Northern California)	Vector (polyline)	Butte County	- fclass (primary (+link), secondary (+link), tertiary (+link)) - shape_length	Dirt roads or minor roads may have been used in the evacuation from rural residences	OpenStreetMap
Damaged Structures	Vector (points)	Paradise Fire in Butte County	damageindicator	Buildings may have not been reported in rural or secluded areas	ESRI
Population of ages 65-69	Polygon Feature Class	Butte County	F5yearincrements_POP65C10	People moving in or out would not be accurately portrayed in an 8 year old dataset.	Living Atlas ESRI Business Analytics
Geofabrik - OpenStreetMaps (POIS of Northern California)	Vector (point)	Butte County	fclass (firestation)	POI may not include all streets, or lack updates on certain streets.	OpenStreetMap
Butte County Boundary	Vector (polygon)	Butte County	- county_ID - County_Name	N/A - was only used for visual representation for dashboard	California Department of Fish & Wildlife

Analysis Framework

“Trouble In Paradise” A Case Study of The 2018 Camp Fire Butte County

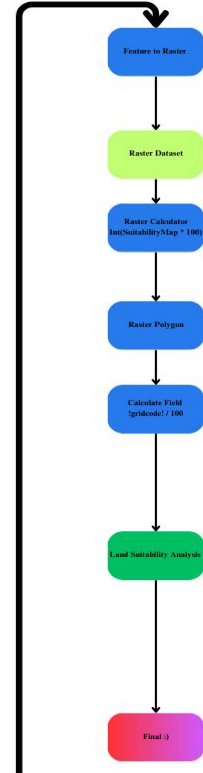
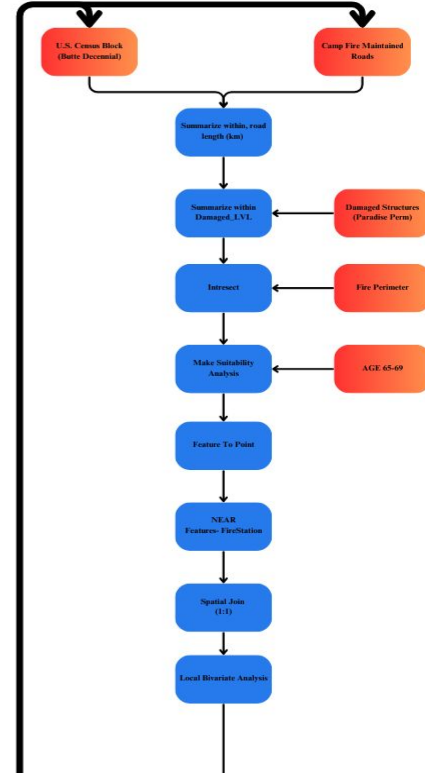
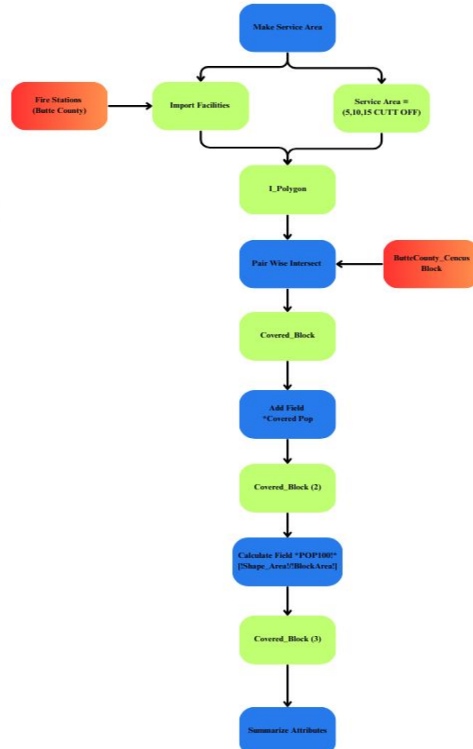
COLOR KEY

DATA SET LAYER

TOOLS

OUTPUT

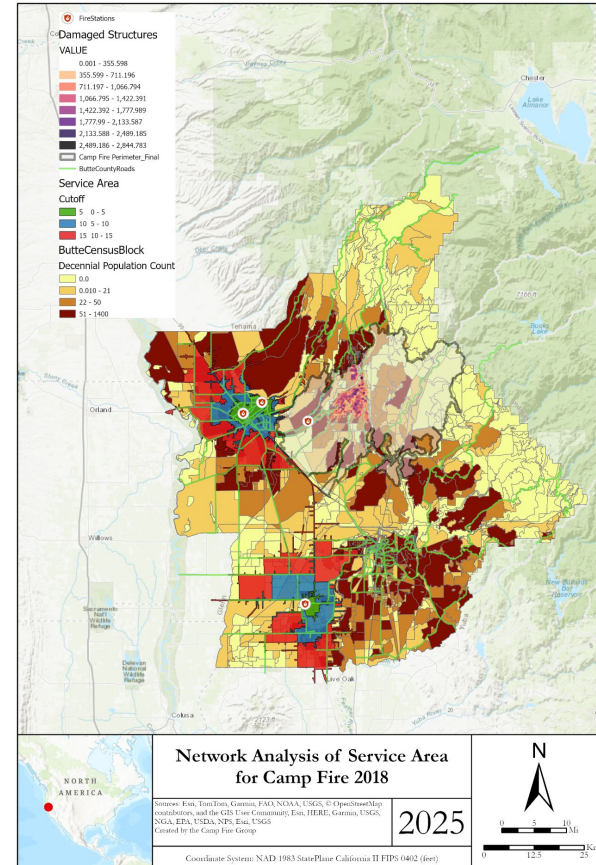
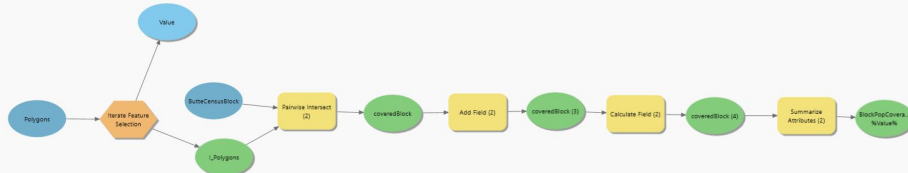
FINAL



Result Interpretation - Network Analysis

Covered Population (Butte county)

Time (minutes)	Count (people)
0 - 5	58,221
5 - 10	63,244
10 - 15	13,707

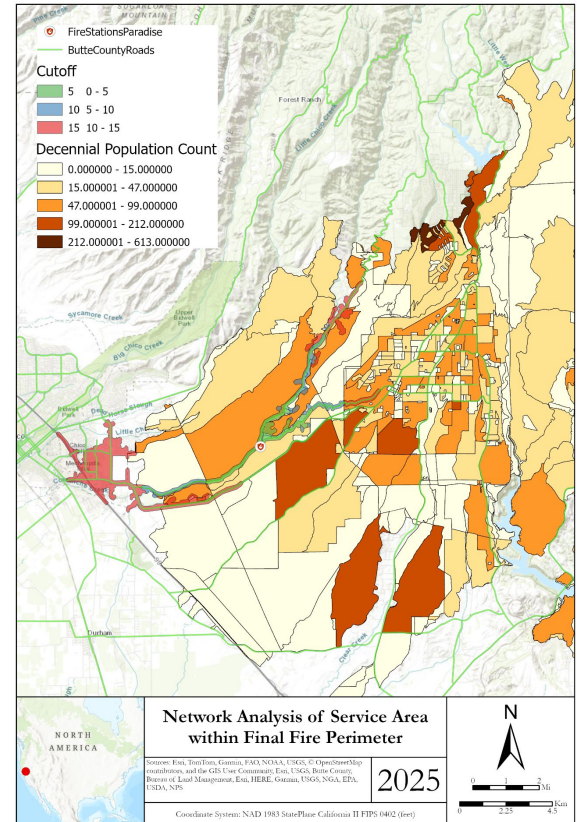


Result Interpretation - Network Analysis

Covered Population (within fire perimeter)	
Time (minutes)	Count (people)
0 - 5	93
5 - 10	48
10 - 15	171

2018 Population in Paradise was around 26,500

Source - https://datacommons.org/tools/timeline#&place=geoId/0655520&statsVar=Count_Person



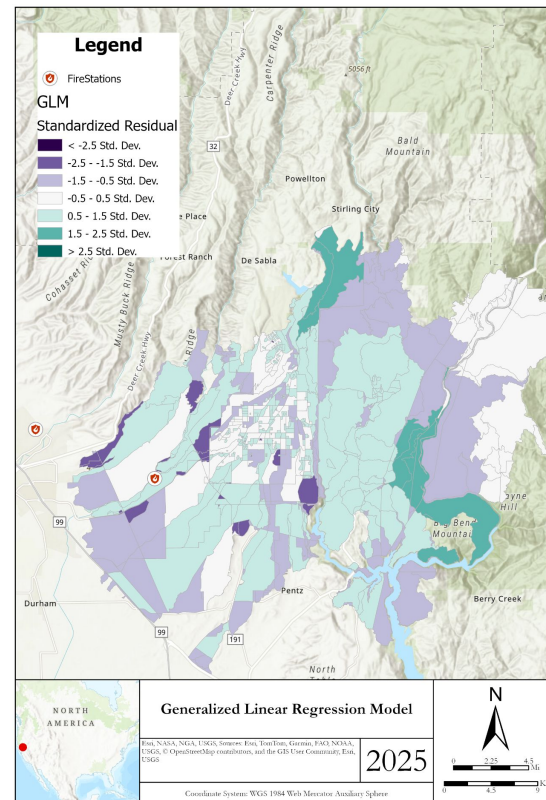
Result Interpretation - GLR

Response Variable: damageindicator

Explanatory Variables: distance from fire stations by block, age group (65-69), road accessibility (sum by block), decennial population (censusBlock)

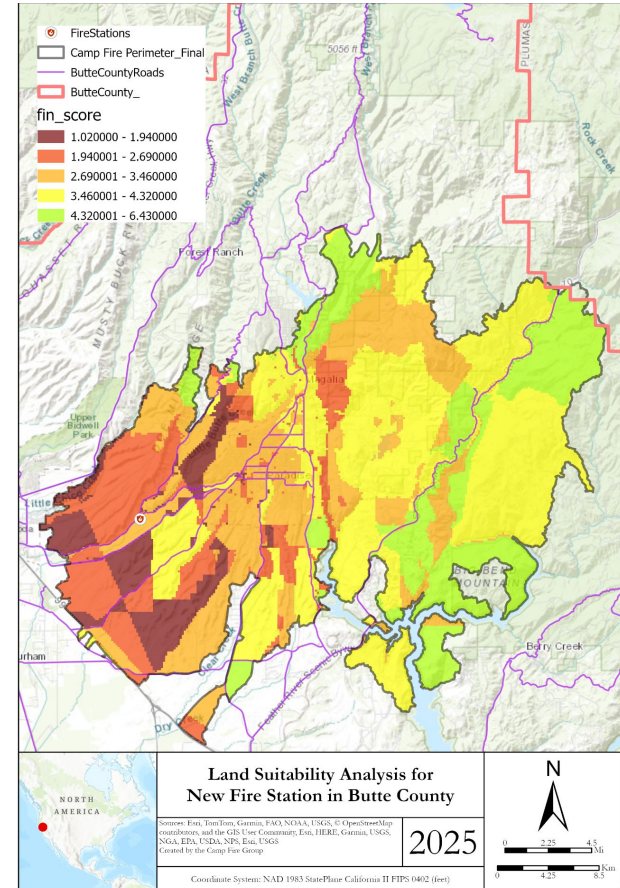
Variable	Coefficient	P-Value
Distance from fire stations	-0.02437	0.0001
Age 65-69	0.02996	0.0001
Road accessibility	-0.04516	0.031
Decennial population	-0.0009	0.025

$$R^2 = 0.248$$



Result Interpretation - Land Suitability Analysis

Weighted Criteria	
Variable	Weight (%)
Distance from fire stations	40
Age 65-69	25
Road accessibility	20
Decennial population	15



Challenges and Future work

Challenges:

Lack of slope data:

- Slope was not integrated due to time constraints and additional complexity.
 - Fire stations cannot be built on steep terrain, which limits feasible sites.

Limited road infrastructure in Paradise:

- The reality was that (found from literature review) the poor road connectivity restricted firefighter access and evacuation.
 - Without new infrastructure, emergency response will remain limited.

Relevant Gaps and Considerations

Dataset Compatibility –

- Some of the datasets were locked and were not able to change (calculate or add a field) which required lots of additional work in order to make them malleable.
- Data layers had different spatial resolutions and coordinate systems

Lack of available data :

- humidity, wind speed, and fire spread patterns limited our ability to explain why some areas experienced more damage despite station proximity.

Real world Constraints not reflected in project:

- Fire was able to spread across the river, and our models indicate that the area across the river is suitable for a fire station. In reality, a fire station would not be suitable, being separated by a town.
- Placing a fire station on one side of a river while a town needing protection is on the other indicates a gap in terrain understanding

Data Validity :

- ESRI data for the Age 65-69 was done in 2010. 8 years prior to the fire.

Future Work:

Suitability of New Roads

- With newly developed roads we could broaden the potential locations of new fire stations to more rural areas of Butte county where there is less access to areas

Expanding our vulnerable populations:

- Taking into account youth and young families, as they are also the most vulnerable
- Socioeconomic consideration since areas with lower income are more likely to have a less adequate defensible area/infrastructure

Further looking into the severity of damaged buildings:

- We could look into building materials and their associated flammability, to observe their potential impact on the vulnerability and severity of damage they received from the fire

Flammability of vegetation:

- A related project avenue that would help equip communities further, would be studying the effect that vegetation factors have on the spread and severity of the fire.
- Factors such as vegetation type, moisture, and height
- Add factors like humidity, wind speed, and vegetation type to improve predictive accuracy