Impact Challenge (Clurb)

Strengthening Wildfire Response

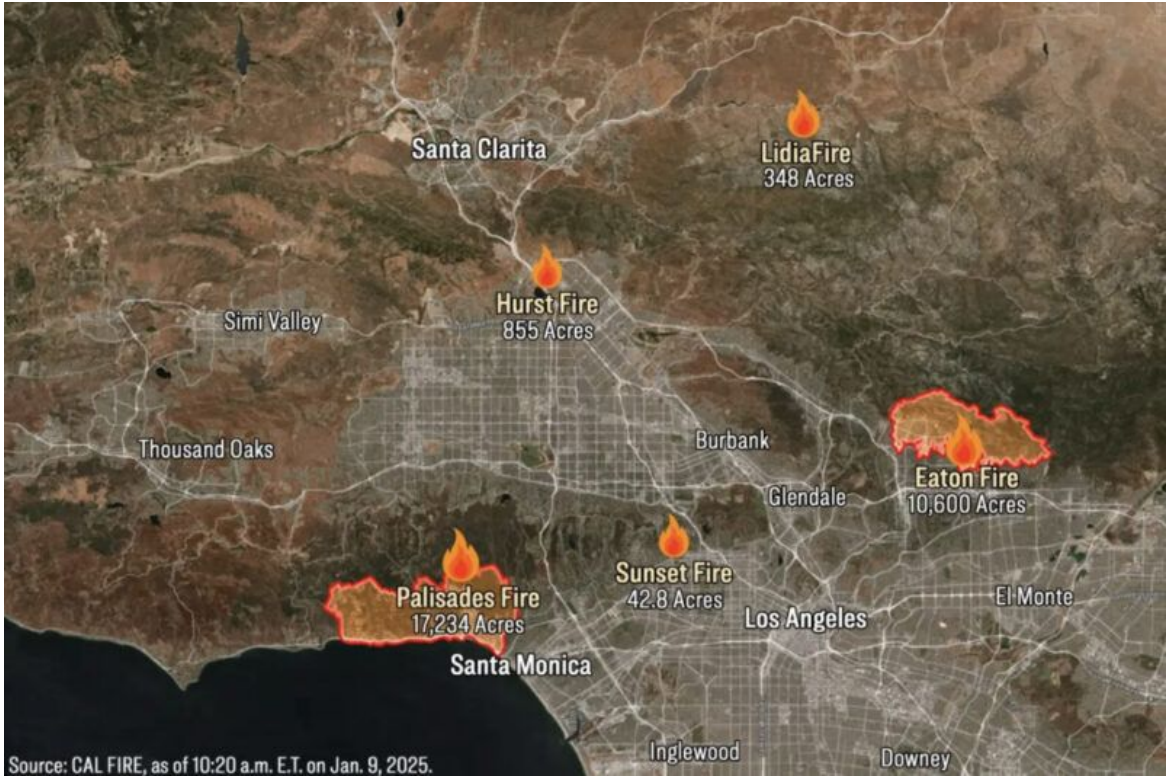
Ananya Shrimali (Sustainable Design + Architecture) + Ashay Koradia (Information Systems + Computer Science) from Carnegie Mellon University

Similar to Valparaiso (Chile), LA also experienced deadly fire spread recently.

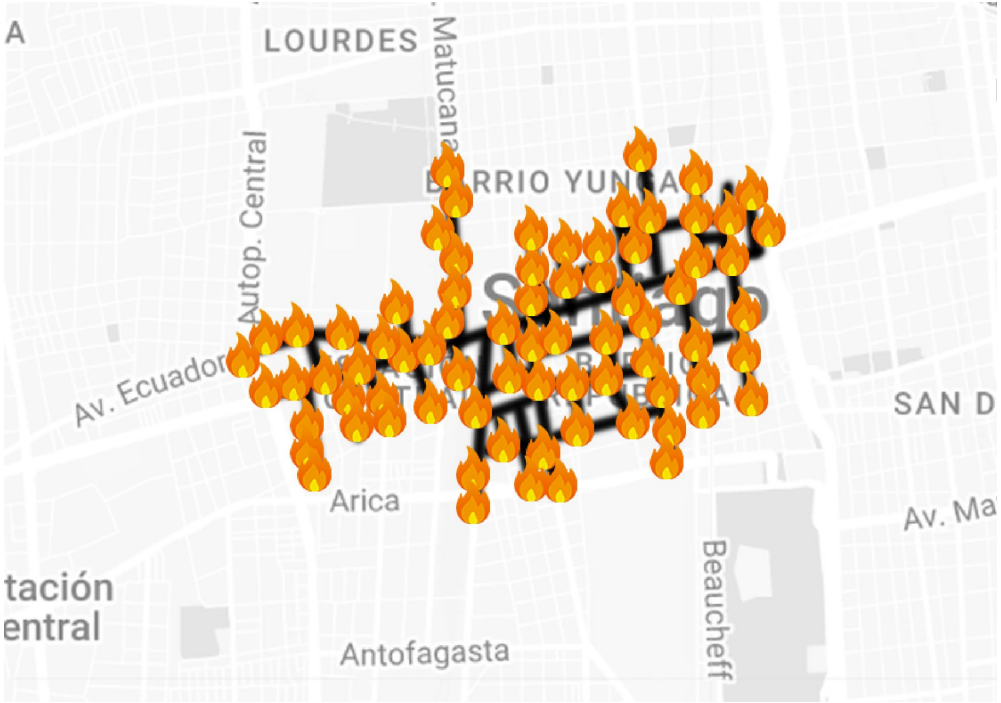
Fires start from a **small location.**

It spreads based on multiple **geographic factors**.

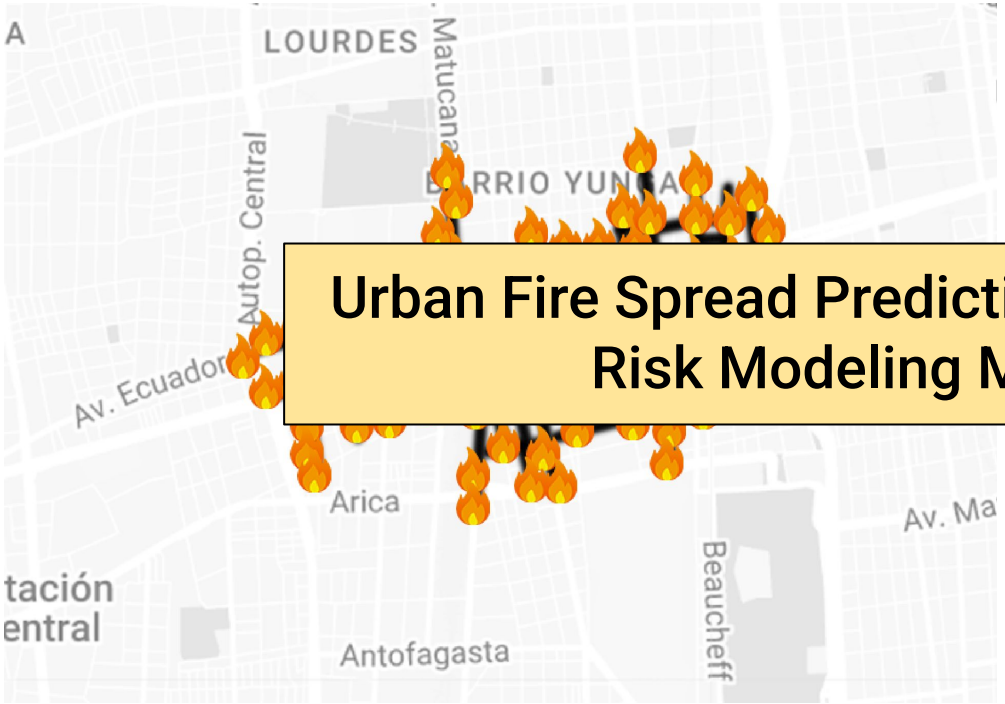
Tools exist that predict wildfires in forests.



What if your phone map can give you line map overlays that show how fire will spread if starts?



What if your phone map can give you line map overlays that show how fire will spread if starts?



Urban Fire Spread Prediction: AI-Driven Risk Modeling Map

What if your phone ive you verlays how fire will spread if starts?

User Input for start of fire location: Mouse Click / touch tap

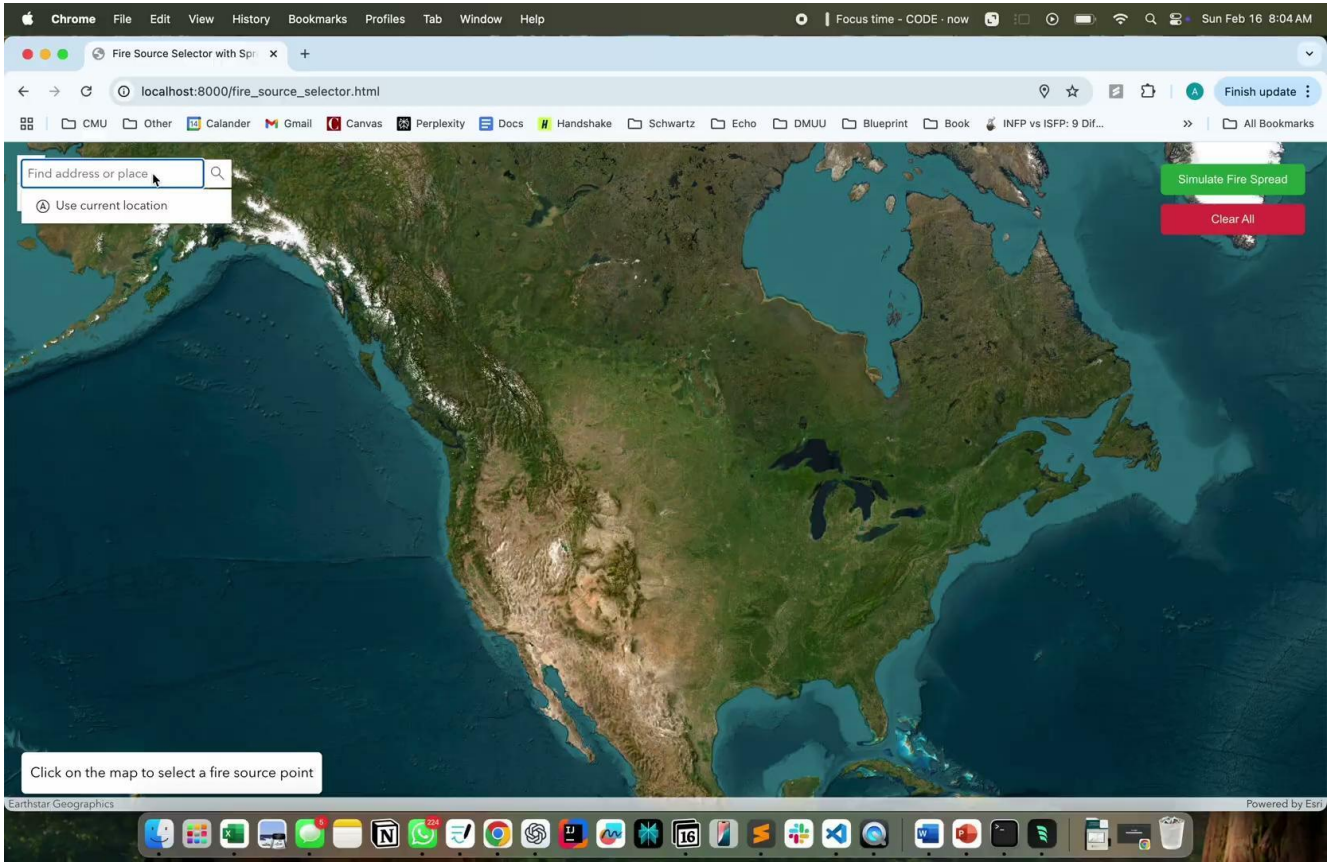
Data Pipeline (ArcGIS, ArcGIS API for Python):

1. Wind (NDFD)
2. Fire Locations (MODIS)
3. Urban Infrastructure (ArcGIS)
4. Visualization (ArcGIS)

Map showing **high-risk** zones.

- Physics based fire behavior (Rothermel Model)
- Adds urban specific factors: Building, Street and Underground Risk
- Uses real time weather data
- GIS Visualization

LINK


Chrome File Edit View History Bookmarks Profiles Tab Window Help
Focus time - CODE · now
Sun Feb 16 8:04 AM
Fire Source Selector with Spr
localhost:8000/fire_source_selector.html
Finish update
CMU
Other
Calander
Gmail
Canvas
Perplexity
Docs
Handshake
Schwartz
Echo
DMUU
Blueprint
Book
INFP vs ISFP: 9 Dif...
All Bookmarks
Find address or place
Use current location
Simulate Fire Spread
Clear All
Click on the map to select a fire source point
Earthstar Geographics
Powered by Esri

SOLUTION:

Simulate the fire spread and suggest firefighters reach high priority location

HOW:
Model use: **Refined version of Rothermel's surface fire spread model.**

Rothermel's model is based on **principle of energy conservation**
It balances the heat generated by combustion (heat source) against the energy required to ignite new fuel (heat sink)

Traditional Rothermel Models: Forest Fires Only

What it does:
Predict how fires spread in forests, grasslands, or wild areas.

How it works:
Use basic factors like wind, slope, and dry plants/trees as fuel.

Our Urban Model: Built for Cities:

Key Difference:
Adds city-specific factors that most wildfire models ignore.

How it works:
Use real time urban fuel and wind through streets to predict the fire spread information.

What Makes Our Model Unique

A. **Buildings change everything**

Factor	Traditional Models	Our Urban Model
Buildings	Ignored	Maps every building's location, height, and material (e.g., concrete vs. wood).
Streets	Treated as empty space	Accounts for "street canyons" (wind tunnels between tall buildings that speed up fires).
Underground Risks	Not considered	Includes gas pipes, subway tunnels, and electrical lines as fire fuel sources.

Constant derived computational fluid dynamics (CFD)

B Smarter Wind Calculation:

wind_in_city = wind_in_open_area * (1 + 0.22 * (building_height / street_width))

Aspect Ratio

Wind blows faster between skyscrapers, pushing fires farther.

Wind speed is the #1 driver of fire spread according to Rothermel model.

C Urban Fuel: (Fuel isn't just plants)

Example: Detect urban fuel sources
urban_fuel = detect_vegetation() + detect_vehicles() + detect_gas_lines()

Urban fuel: Adds cars, dumpsters, outdoor furniture, and even parked scooters!

How we do it: Uses AI to scan satellite images (via Google Earth/ArcGIS) to find urban "fuel":

D Real-Time City Data

Old models: Use static maps (updated yearly).

Our model: Pulls **live data**:

- **Weather**: Current wind from weather APIs.
- **Traffic**: Input to urban fuel function
- **Construction**: Input to urban fuel function

Fire Spread Modeling

urban_spread_rate = (3000 * 0.8 * (1 + (0.4 * adjusted_wind**0.02526))) / (0.035 * 2 * 780) * (1 - (building_density/100))

1. **(3000 * 0.8)** : The energy released by burning fuel.
2. **(1 + (0.4 * adjusted_wind**0.02526))** : The effect of wind on fire spread.
3. **/ (0.035 * 2 * 780)** : The resistance of fuel to ignition.
4. *** (1 - (building_density/100))** : The effect of urban density on fire spread.

FUTURE SCOPE

- Analyse the fire density and **suggest the firefighters** to prioritise the **locations** accordingly.
- Implement **AI to scan satellite images** (via Google Earth/ArcGIS) to improve urban fuel calculation.

Visualization

ArcGIS Scene Viewer: 3D visualization of fire spread predictions.

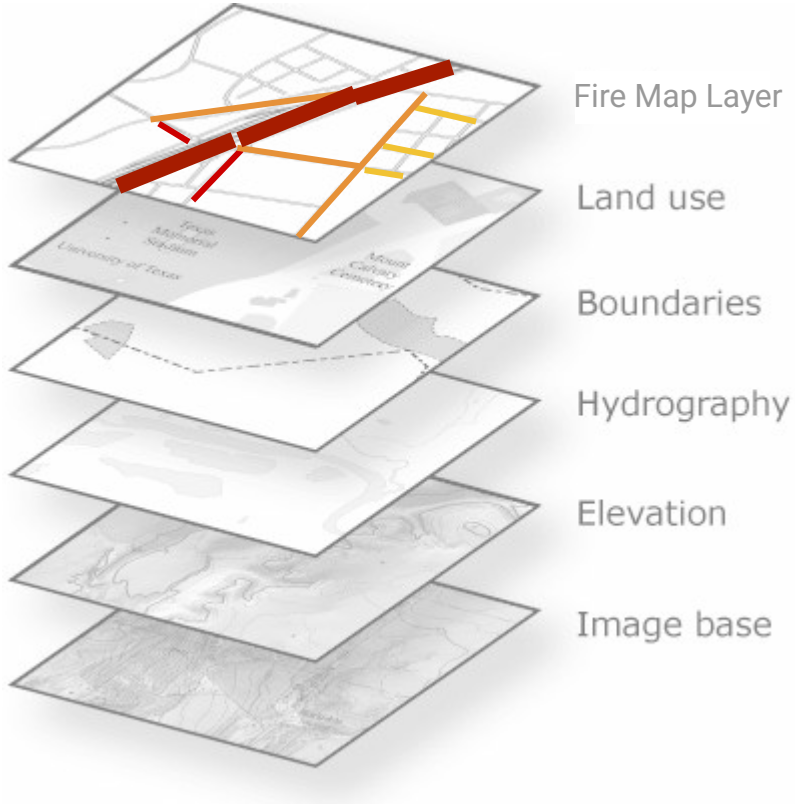
ArcGIS Dashboards: Real-time risk monitoring.

Workflow

Export predictions as a 3D Feature Layer.

Style using red-to-yellow gradients for fire intensity.

Overlay infrastructure layers (gas lines, hospitals).



1. Using Wind Data to Predict Wildfire Spread in Central California *Fang Du Department of Resource Analysis, Saint Mary's University of Minnesota, Minneapolis, MN 55404*
2. Modeling Wind Adjustment Factor and Midflame Wind Speed for Rothermel's Surface Fire Spread Model *https://gacc.nifc.gov/nwcc/content/products/fwx/publications/rmrs_gtr266.pdf*