**ESS162 Lab 7: Predicting wildfire probability**

**You can work alone or with one other person**

**Goals this week:**

This week you will be working with the FlamMap model to predict fire spread and risk across an area of California. FlamMap was developed by the USFS to predict fire risk and spread, and to help develop land management strategies to reduce risks. It’s a nice model and interface that are used by front line land managers, fire fighters and research scientists.

<https://www.firelab.org/project/flammap> FlamMap is a good example of models that ingest and expand on the types of geospatial data sets we’ve been using in the class. It runs and produces raster files – it basically ingests several raster layers, runs that information through a model that represents the physics of wildfire spread, and then produces another series of raster and vector files that can be used to better understand the problem. FlamMap predicts fire spread based on geospatial input layers for topography and fuels, along with inputs for winds and fuel moisture. FlamMap runs on Windows and is freely available; we will be running it on Apporto.

FlamMap requires geospatial inputs on fuels and topography, which are often downloaded from the LANDFIRE project:

<https://www.landfire.gov/>

LANDFIRE is another large federal project, with the goal of providing US-wide geospatial maps of fuels and other land surface properties. We will start by downloading a Landscape (.LCP) file from LANDFIRE, which we will then use for our FlamMap run.

**Tools, steps and commands**

Get your LCP file

<https://www.landfire.gov/>

Get Data (bottom right bottom of home screen)

Data Distribution Site (DDS)

Click on area 4 (coastal Southern CA)

See lots of different geospatial data layers

Migrate to San Jacinto Mtns and leave with a layer that shows them clearly

Download Tool

LF Remap, Fuel

Check box for US\_200 LCP 40 Fire Behavior

Click on Rectangular area download tool

Highlight San Jacinto Mtns in rectangle

Download us\_200 LCP 40 Fire Behavior Fuel Models-Scott/Burgan

Unzip folder and confirm it has a lcp file that’s 10-100 MB in size

Start up FlamMap, load LCP, and Run FlamMap for a single fire

Landscape, open Landscape

Take a look at analysis area

View, Legend - Elevation, Slope, Aspect

Fuel Model - Canopy cover, Height, Base, Bulk Density

Identify a fire start location

Click on button with 5 small squares next to arrow

Click your drip torch where you want the fire to start (should create a small white diamond)

Options, Shape, Save to file

New FlamMap/MTT/TOM run

Inputs, name it whatever you want

Fuel Moisture, red plus, ok on the defaults, save it

Winds, speed 20, Azimuth 270 (this is 270 deg, or from due west to due east)

Canopy Foliar Content 100

Crown Fire Finney 2004, Apply

Minimum Travel Time

Ignitions, Load Current Shape (should load the name you used for ignition location earlier)

Inputs, 60 resolution, 2880 minute simulation time (2 days)

Rate of Spread, Major Paths, Arrival Time Contour

Apply, Launch MTT

Run it and take a look

Right click on the run name and kmz output Download and you can work with in Google Earth

Run FlamMap in ensemble model to predict fire probability

New FlamMap/MTT/TOM run

Inputs, name it whatever you want

Fuel Moisture, red plus, ok on the defaults, save it

Winds, speed 20, Azimuth 270

Canopy Foliar Content 100

Crown Fire Finney 2004, Apply

Minimum Travel Time

Ignitions, Random, 500

Inputs, 240 resolution, 1440 minute simulation time

Select All

Apply, Launch MTT

Run it and take a look

Right click on the run name and kmz output Download and you can work with in Google Earth

**Writeup**

**What types of topography was associated with particularly fast fire spread in first run (the single fire run)?**

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Figure 1. Overall map of the single fire simulation

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Figure 2. Windward slopes

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Figure 3. Leeward slopes

Map

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Figure 4. Leeward side, lower elevation

It appears that fast fire spread occurs near the ignition location and on the windward slopes near the ignition location where the fire would be traveling upslope as well as some of the leeward slopes where the fire is traveling downhill and lower elevation regions on the leeward side of the mountains. While most of the downhill slopes do not have high rates of spread, a significant portion of the downhill slopes still have high rates of spread, and it is relatively unclear why large portions of downhill slopes have high rates of spread.

On the other hand, most of the windward slopes that high rates of spread tends to be near the ignition location. As the distance from the ignition location increases, rates of spread on windward slopes tend to decrease.

**What were the main controllers of fire spread direction in the first run (the single fire run)?**

The main control of fire spread direction is the wind direction. The westerly wind during the single fire run results in the fire traveling in usually eastward direction.

Map

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Figure 5. Canopy base height and wind direction

The canopy base height also appeared to influence the direction in which the fire spreads. Areas with low canopy base height tend to be densely packed with paths through which fire spreads, indicating that low canopy base height tends to facilitate the spread of fire. In contrast, areas with high canopy base height have fewer paths running parallel to each other. As the fire travels down the eastern side of the mountain, the number of paths increased dramatically at low elevations where canopy base height is low. This relationship between canopy base height and the direction of fire spread appears to be linked to a tendency for which fuels act as ladder fuels. Where canopy base height is low, fuels tend to act as ladder fuels, allowing for crown fires to easily manifest and producing many paths for fire spread. Associated with canopy base height and fire spread direction is stand height, where lower stands also seem to better act as ladder fuels to produce high numbers of paths for fire to spread.

**What location is particularly vulnerable to this type of a fire? Why is it especially vulnerable, and why is an ignition around this location relatively likely?**

Mountain Center appears to be particularly vulnerable to this type of fire, as the unincorporated community has relatively low canopy base height that allows for crown fires to easily manifest, which allows for fires to spread rapidly towards Mountain Center.

**Include images of the ensemble random ignition/fire probability runs.**

**How does fire risk vary across the landscape? What areas are particularly likely to burn and what areas are less likely? Explain this pattern.**

**Map

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Figure 6. Fuel model

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Figure 7. Burn probability

It appears that fire frequency is mainly controlled by the fuel type. As Figure 6 and Figure 7 show, fire frequency tends to be highest in grasslands. The fuel type, in turn, is determined by the elevation, with low elevation areas associated with grasslands (Figure 8).

Map

Description automatically generated

Figure 8. Elevation

**How would you use this approach to predict the effects of climate change on fire probability?**

As climate change will inevitably affect a whole slew of fires in the future rather than a single fire, it is more useful to analyze climate change by analyzing fire frequency, which is another term for burn probability. Because burn probability is strongly associated with fuel model, the effects of climate change on fire probability likely results from the effects of climate change on the vegetation type and ecosystem. Climate change will change ecosystems, and by determining how ecosystems will change, how fire frequency varies in the future can be studied.

**How would you use this approach to predict the effects of a fuel treatment on fire probability?**

A fuel treatment is likely to start only 1 fire. Therefore, I will look at the factors that most affect a single fire. As stated above, wind direction is the primary control of fire spread direction. Thus, wind direction needs to be considered when conducting a single fuel treatment. Another factor is the ability for fuels to act as ladder fuels, which can be measured in canopy base height. As canopy base height had significant influence on a single fire, it should also be considered when conducting a fuel treatment which only deals with 1 fire rather than multiple fires.