**ESS162 Lab 6: CA wildfires**

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

**Goals this week:**

We’ve been working thus far with datasets that were prepared for this class. In this lab you’ll be working with a couple of data sets related to wild fire that you will directly download from the web. You will initially download, open and convert/export these files using ArcGIS. You will then analyze these converted files in Excel and Google Earth

The key datasets are available from <https://frap.fire.ca.gov/> Mapping, GIS data

1. Fire Perimeters (Zip)
2. Fire Threat (Zip)

**Tools, steps and commands**

Download files and unzip

ArcMap

Add data firep19\_1 and fthrt14\_02

Add the NAIP image as we did last week (from USDA)

Fire layer – open attribute table and take a look

Fire layer – symbology, unique values, year, add all values, green to red scheme

Arctoolbox, Conversion tools, Excel, Table To Excel

Input Table fire19\_1, Output file Fire\_history

Arctoolbox, Conversion tools, to KML, Layer to KML

Just turn on fthrt14\_02 and zoom out and center over all CA, creation of KML file (output image properties size of returned image should be 10240)

Just turn on fire19 and zoom out and center over all CA, repeat creation of KML file (size of returned image should be 1024)

Google Earth

Download and open your kmz files and check out UCI

Excel

Open your firehistry excel file.

There may be additional info you need in the ArcGIS attribute table, such as the code for causes

Calculate annual burned area

Create a time series of years

=SUMIF(B:B,"="&U3,M:M), where B:B is the year of the fire, U3 is the year you’re looking for, and M:M is the area burned (GIS acres)

Use a similar strategy to look at the relative importance of the various causes of fire

Other useful commands are averageif and countif

Use filter to look at the time series of total area burned vs arson fires vs lightning fires

**Writeup**

**What is the closest UCI has come to burning according to the FRAP data set? Include Google earth images and information on the fire (date, ignition, etc).**

Map

Description automatically generated

The closest that UC Irvine had gotten to being caught in a fire is in 1993 with the nearby Laguna Beach Fire. This fire was caused by arson and burned over 14,000 acres.

**What is the most likely fuel path to UCI? How could a wildfire reach UCI? Was the nearest fire to UCI heading on this path? What stopped it? Include images.**

The Laguna Beach fire primarily spread through natural ecosystems (i.e. coastal sage scrub). The Ecological Preserve’s ecosystem type, aside from the invasion by mustard and other invasive species, is coastal sage scrub. Thus, the Laguna Beach fire could have engulfed the ecopreserve to enable it to reach UCI.

It appears that most of the area that the fire encompassed are natural ecosystems; very small portions of the fire consist of residential areas. Thus, it appears that the nature of residential areas played a role in stopping the fire, although it is unclear what about residential areas actually stopped the fire. Firefighters could have concentrated their efforts near residential areas. Another explanation could be that the fuels in residential areas do not fuel the fire well. However, the exact role of residential areas in stopping the fire is still unclear.

**How has the total area burned annually changed in CA?**

Graphical user interface

Description automatically generated

Figure 1. Time series of total burned area, mean fire size, and number of fires

It appears that total burned area had been increasing in California, as illustrated by the positive regression slope in the top left plot of Figure 1.

**Has the change in total burned area over time been caused by a) an increase in the average area of a fire, or b) an increase in the number of fires?**

It appears that the change in burned area is driven by an increase in the number of fires. As the Figure 1 shows, burned area and the number of fires both show an increase over time. As burned area is the product of the number of fires and the mean fire size, an increase in either the number of fires or the mean fire size will cause an increase in burned area. Burned area shows a clear increase with time. The number of fires show a clear increase with time, explaining the increase in burned area. However, there is little to no increase in the average size of a fire as shown in the bottom left plot where time explains only roughly 3.4% of the variation in fire size.

Chart, scatter chart

Description automatically generated

Figure 2. Components of burned area

This can also be seen in Figure 2. Figure 2 plots linear regressions of total burned area against either fire size or the number of fires. Both fire size and number of fires are highly correlated with total burned area, which is expected as total burned area is the product of fire size and the number of fires. However, the number of fires explain more of the variation in total burned area, as illustrated by the higher r-squared of the leftmost plot of Figure 2. Thus, the increase in total burned area is much more likely to be driven by the increasing number of fires per year.

**What are the main causes of wildfire in CA?**

**Graphical user interface, histogram

Description automatically generated**

Figure 3: Lightning vs manmade fires

I’ve distinguished between manmade fires (caused by equipment use, smoking, campfires, debris, railroad, arson, playing with fire, vehicles, powerlines, firefighter and non-firefighter training, various structures, aircraft, escaped prescribed burns, and illegal alien campfires) vs natural fires caused by lightning (which is the only natural cause of wildfires in California). It appears that the number of fires caused by lightning and by human activity are both increasing over time since approximately the 1970s. The trends in average fire size is less clear, with manmade causes showing a slight decreasing trend in fire size since the 1970s while fires caused by lightning appear to be larger since 2000 than before 2000. The increase in burned area over time by manmade fires is primarily driven by the increasing number of fires caused by human activity while being slightly offset by decreasing fire size. On the other hand, the increase in burned area by fires caused by lightning seems to be driven by both the increasing number of fires caused by lightning and increasing fire size, although these 3 trends (increase in burned area, number of fires, and size) is relatively unclear and noisy.

Graphical user interface, application, Word, histogram

Description automatically generated

Figure 4: Lightning vs arson

Comparisons between lightning and individual human activities show that the impact of individual human activities tend to be smaller than lightning. For example, as Figure 4 shows, despite similar fire sizes between lightning and arson, the much higher number of fires caused by lightning leads to much higher burned area from fires caused by lightning. Instead, the impact of the sum of human activities, rather than individual human activities, are on par with the impact of lightning. Thus, lightning is the most prominent cause compared to other individual causes, producing high numbers of fires that results in high burned area.

Graphical user interface, chart, histogram

Description automatically generated

Figure 5: All manmade causes

While it is somewhat difficult to determine the main human causes, I’ve attempted to use Figure 5 to determine what I think are the main manmade causes. I determined what causes appear to cause the highest number of fires, what causes have the highest fire size, and what causes have the total burned area. My results are illustrated in Figure 6.

Chart, histogram

Description automatically generated

Figure 6: Major manmade causes

The human causes that produces the most fires are equipment use, arson, vehicles, and power lines. Of these four human causes, arson and handmade, along with campfires, appear to produce the largest fires. The human causes that result in the highest burned area are equipment use, campfire, and arson. The high total burned area from equipment use appears to be determined by its high number of fires. Campfires, on the other hand, produces high burned area due to the large size of the fires that they produce. Arson’s burned area is driven by both the high number of fires that start because of arson and the large size of these fires. The other factors that produce high number of fires (vehicles and power lines) did not appear to have high burned area because their fire sizes are relatively small despite their high number of fires. Still, vehicles and power lines show increased burned area over time (Figure 5), which is important for explaining manmade causes in increasing burned area.

**How did the causes of fire shift from 1980-2000 to 2000-2017?**

As Figure 3 shows, lightning and manmade causes cause more fires during the period of 2000 – 2017 than 1980 – 2000. It appears that the size of lightning-caused fires are larger during 2000 – 2017 than 1980 – 2000, while the mean fire size of all manmade fires appear to be slightly lower 2000 – 2017 than 1980 – 2000. However, this minor decrease in manmade fire sizes is offset by the increases in the number of fires caused by human activity and lightning and the increasing fire size of lightning-caused fires. As a result, total burned area, as shown in Figure 1, is higher in 2000 – 2017 than 1980 – 2000.

The changes in individual manmade causes between 1980 – 2000 and 2000 – 2017 is more nuanced. Over all, the number of manmade fires and the total burned area is higher in 2000 – 2017 than 1980 – 2000 while the average fire size is very slightly lower in 2000 – 2017 than 1980 – 2000. In 1980 – 2000, the manmade causes that produces the majority of the number of fires are equipment use and arson (Figure 5). After 2000, the number of fires continue to increase despite the decreasing number of fires from arson. The increase in number of manmade fires is driven primarily by increases in the number of fires by the following manmade causes: equipment use, power lines, vehicles, and debris.

Coincidentally, these four manmade causes all have relatively constant fire size between 1980 – 2000 and 2000 – 2017; while the sizes of fires caused by arson and campfires increased between these 2 periods, the number of fires caused by arson and campfires are smaller, which, along with the constant fire size of equipment use, power lines, vehicles, and debris, explains the relatively constant to slightly decreasing average fire size of manmade fires between these 2 periods.

The increased burned area of manmade fires between 1980 – 2000 and 2000 – 2017 is explained by the rising number of fires by certain manmade causes as well as the increasing fire size of other manmade causes. Despite their constant fire size, the increasing number of fires caused by equipment use, power lines, vehicles, and debris also results in increasing burned area from these causes between these 2 periods. Furthermore, while the number of fires caused by arsons decreased and the number of fires caused by campfires stayed constant between these 2 periods, their fire sizes both increased, leading to increased burned area by these 2 causes between these 2 periods. Thus, the increased burned area of manmade fires between these 2 periods are driven by increases in the number of fires from equipment use, power lines, vehicles, and debris and increases in the size of fires caused by arson and campfires.