Analysis and Visualization of Fire Statistics in California

Introduction

Recent research indicates that forest fires across the western United States have been increasing in size, frequency, and severity over the last several decades (1, 2). This increase in fire activity threatens human life and structures, and contributes to widespread forest mortality, carbon emissions, periods of degraded air quality, and substantial fire suppression expenditures (3). The 2017 California wildfire season, for example, turned out to be the costliest and most destructive on record, and accounted for $13 billion in damages, 46 fatalities, and destroyed more than 1 million acres and 10,000 structures. Understanding the spatial and temporal patterns in fire activity is important for effective resource allocation to protect lives, property, natural resources, as well as for future risk planning.

Although near real time data of fire activity is readily available through the Fire Information for Resource Management System, fire activity statistics in California are typically summarized in yearly reports and archived in the Historical Wildfire Activity Statistics (Redbooks). These resources lack spatially explicit visual representations (e.g., maps) of fire activity statistics. Furthermore, seasonal and long term statistics are not available for every location. Here, we propose to examine fire data collected by NASA's satellites to better understand spatial, seasonal, and long-term fire activity patterns in California.

Goals and objectives

The proposed study aims to expand our present knowledge of fire activity in California by examining NASA's global Active Fires dataset, a data product derived from satellite imagery and designed for operational fire monitoring. An important focus for the work will be to produce fire activity maps to show long-term (decadal) trends and seasonal statistics. We aim to address the following questions associated with fire activity in California

- Are there any seasonal trends? What is the inter-annual seasonal variability?
- What are the long term patterns in fire activity (i.e., is fire activity increasing/decreasing over decadal time scales)?
- Where is fire activity increasing/decreasing over decadal scales?
- What locations have the highest probability of experiencing fire activity as a function of time of year?

We expect a detectable increase in California's fire activity with time, as anthropogenic climate change has likely contributed to increased levels of aridity in the region and drier vegetation enhances wildfire activity. We also expect a seasonal pattern with a peak in fire activity between September-December because the hot and dry winds that are typical of fall weather have been known to play an important role in fire generation and propagation. We do not expect these trends to be homogenous throughout the state of California, however.

Methods

To address the objectives detailed above, we propose to use NASA Earth Observations (NEO) Active Fire data sets. These datasets are produced by the Moderate Resolution Imaging Spectroradiometer (MODIS), aboard Terra and Aqua satellites, and provide information about the location of a fire, its emitted energy, the flaming and smoldering ratio, and an estimate of area burned. A 17 year (2000-2017) record of daily

and monthly Active Fires data is publicly available to download via FTP as CSVs (~ 61 MB) and floating point GeoTIFFs (~ 25 MB) at 3600x1800 resolution. It is important to note that the values contained in these files have been scaled and resampled for visualization purposes in NEO and should not be considered for rigorous scientific examination. Nevertheless, these data are useful for basic analysis and trend detection.

We expect to use the Pandas and Numpy modules in Python to extract, organize, and analyze the data. We will also use Matplotlib to produce fire activity maps, climatologies, and animations to explore long-term (decadal) trends as well as spatial and seasonal statistics. The analysis will focus on the state of California and special attention will be given to regions of high population density.

Concluding remarks

The proposed work intends to explore spatial and temporal patterns and seasonal statistics of fire activity in California. Understanding the spatial and temporal patterns in fire activity in California will be necessary for effective resource allocation, fire risk management, mitigation efforts, and for responding appropriately to ongoing and future climate changes.

Timeline

Milestones	Date	Members
Download data	Feb 16	X, Y, Z
Clean and organize data	Feb 23	X, Y, Z
Data Analysis	Mar 02	Amador, Y, Z
Data Visualization	Mar 09	Amador, Y, Z
Debug errors/ refine algorithms	Mar 16	X, Y, Z