Part 1 - Common Analysis Written Report

Through the project, we are to answer the question: What are the estimated wildfire smoke impacts on your assigned city each year for the most recent 60 years of wildfire data? To answer the question, we focus on Odessa, TX and wildfires near the city. Importantly, The estimate only considers the last 60 years of wildland fire data (1964 - 2024).

1. The estimate only considers fires that are within 650 miles of Odessa, TX.
2. Defines the annual fire season as running from May 1st through October 31st.

In part 1, we produced 3 visualizations that aided us in understanding the *Combined wildland fire datasets for the United States and certain territories* and the Air Quality Index (AQI) data from the US Environmental Protection Agency (EPA) Air Quality Service (AQS). The three visuals produced each convey different information of understanding the wildfire data.

The first visualization (Fig. 1) is a histogram, which displays the spatial distribution of wildfires relative to Odessa, TX.

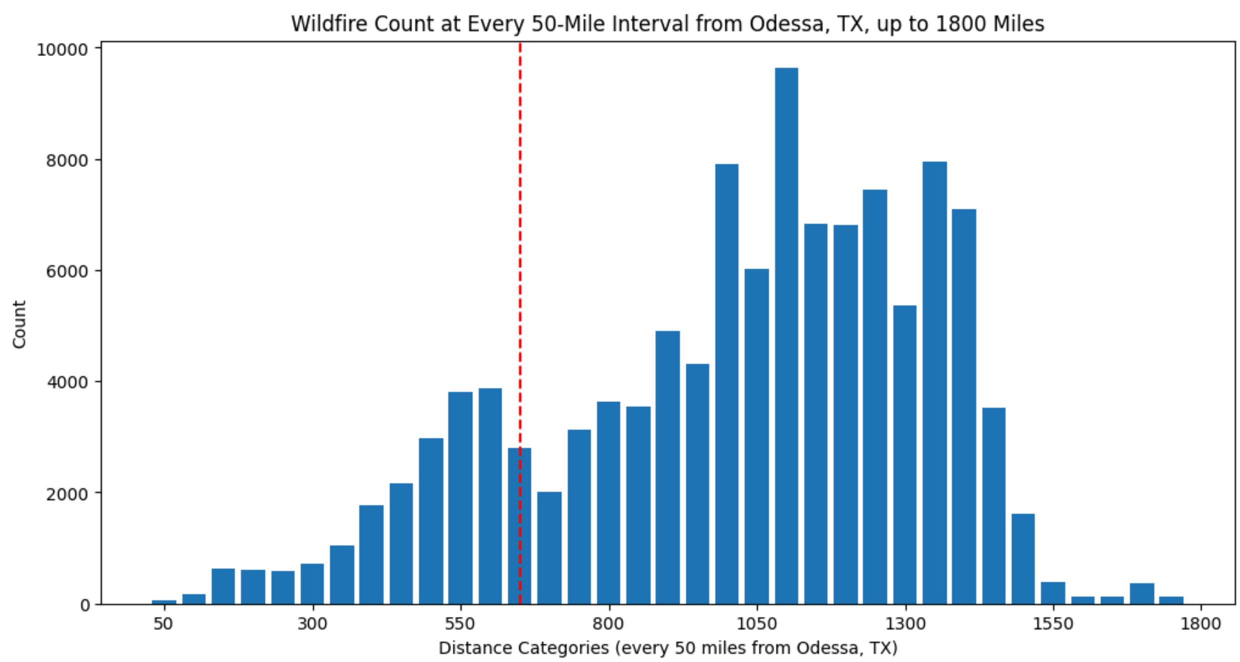

Fig. 1

Specifically, it quantifies the frequency of wildfires occurring at varying distances from Odessa within a range of 0 to 1800 miles. The x-axis represents distance from Odessa, TX, segmented into 50-mile intervals, while the y-axis indicates the number of wildfires observed within each interval. This histogram offers insights into the geographic spread of wildfires in relation to a specific location, Odessa, TX, and helps identify if certain distances have higher wildfire occurrences than others. To construct this visualization, we began by calculating the average distance between each wildfire event and Odessa, TX. These distances were then organized into 50-mile buckets, enabling us to tally the wildfire frequency within each bucket and subsequently plot this count as a bar on the histogram. This approach allows viewers to quickly interpret wildfire proximity to Odessa and observe trends in fire occurrences across the distance spectrum.

The second visualization (Fig. 2) is a time series graph that illustrates the annual total acre burned by wildfires within a 650-mile radius of Odessa, TX, spanning the years 1964 to 2020 (no wildwire data after 2020).

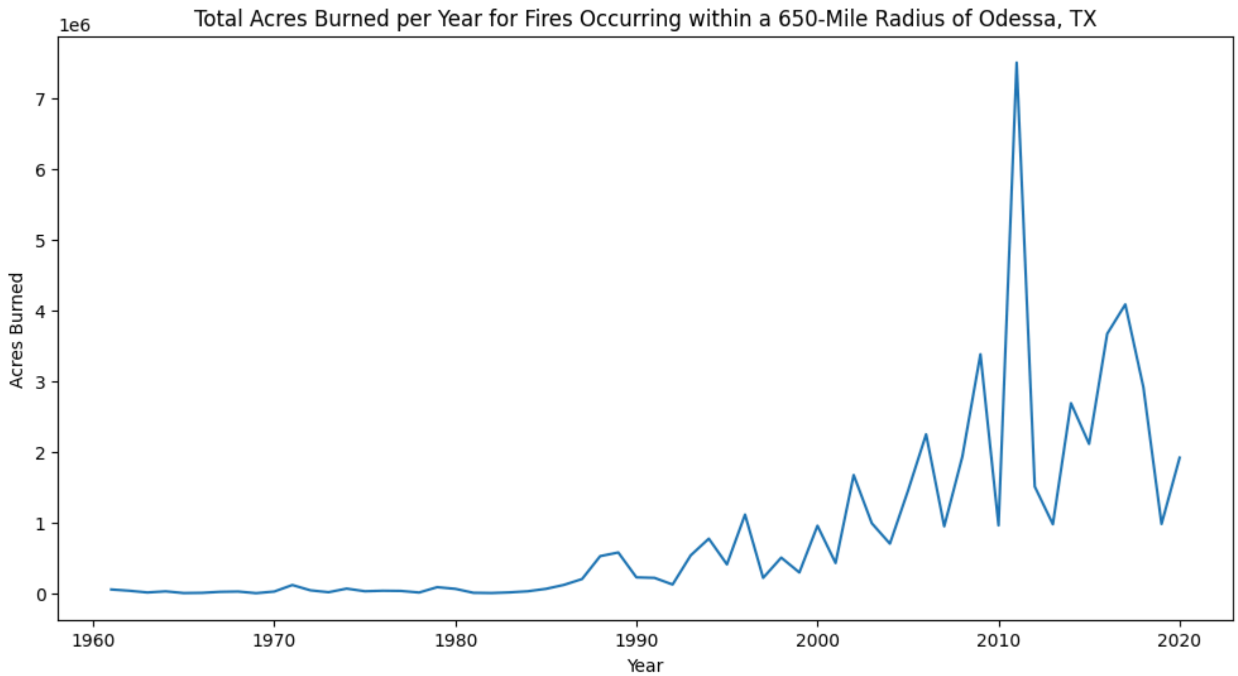

Fig 2.

On the x-axis, each year is represented from 1964 to 2020, marking the time dimension of the data, while the y-axis quantifies the cumulative acres burned each year, offering insight into the severity and variability of fire impact over time.

To construct this graph, the wildfire data were filtered to include only those fires within 650 miles of Odessa, TX. For each year, we aggregated the total acres burned by summing the size of each individual wildfire. This time series analysis allows us to identify patterns, trends, and outliers in wildfire behavior across the decades. A notable peak occurred in 2013, with a recorded 7,504,385 acres burned, indicating an exceptionally high level of wildfire activity for that year within the specified distance from Odessa. This peak, alongside other fluctuations over the years, provides a temporal perspective on the environmental impact of wildfires near Odessa, highlighting periods of increased fire severity.

The third visualization (Fig. 3) is a time series graph comparing estimated smoke density from wildfires and the Air Quality Index (AQI) for Odessa, TX, across various years.

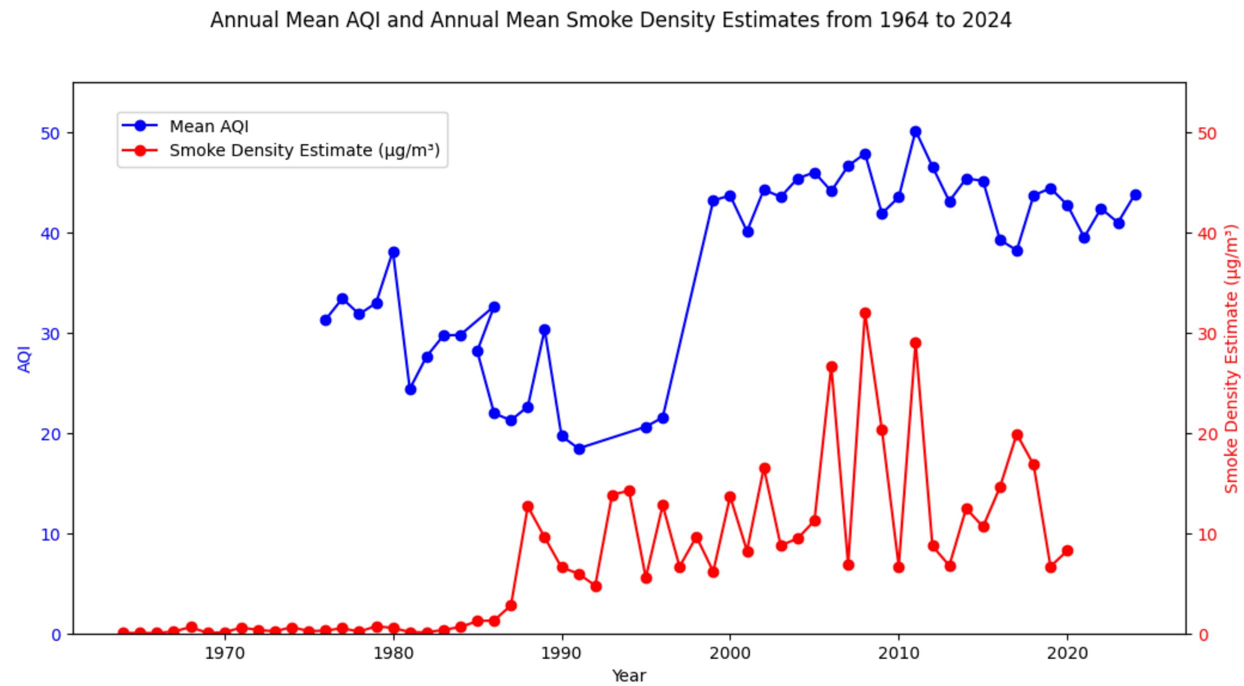

Fig. 3

The x-axis represents time in years, while the y-axis reflects both the estimated smoke density (derived from wildfire size and distance) and the AQI levels, with each metric scaled to facilitate direct comparison. Importantly, there's some missing AQI from the data (ex. No data between 1964 to 1975 and some missing data in the 1990s).

$$S = k * (Fire\ size_{acres}) * 0.0015625 * \frac{1}{(Distance_{miles})^2} * \alpha(1 + (Y - Y_0))$$

where:

- k is a coefficient representing smoke emission intensity in μg/m³.
- Y_0 is set to 1964, the baseline year, and Y is the year of the fire we want to estimate the smoke for.
- The constant 0.0015625 converts acres to square miles, given that 640 acres equal one square mile.

This formula uses the inverse-square law of distance, reflecting that smoke density decreases with the square of the distance from the fire source. It also accounts for a positive correlation between smoke density and wildfire size, meaning larger fires produce more smoke. Furthermore, the factor $(1 + (Y - Y_0))$ accounts for potential variations in smoke characteristics over time due to global warming and the increase of greenhouse gasses in the atmosphere. Tentatively, since we don't have smoke data to facilitate in choosing the constants k to be 5 μg/m³ and α as 5 as well. For visual 3, we calculate the smoke estimate for each wildfire and calculate the mean smoke density by year to get the estimated smoke impact of that year near Odessa, TX.

As for collaborating with my classmates, I gained a clearer understanding of the wildfire data structure and how GeoJSON was applied in the example code. Initially, the example Jupyter notebooks were confusing, but discussing them with peers clarified how the code operated and allowed us to identify and develop the missing code components relevant for part 1 of the project.

Working together also helped us approach smoke density estimation creatively. Since the assignment didn't provide specific resources on this, we researched different approaches and settled on the inverse-square law, which seemed effective for accounting for distance in smoke density calculations.

In terms of code, I primarily used content from the example notebooks or code I developed independently. Collaboration with my classmates was mainly conceptual, helping us refine our understanding of the research question, interpret the example code, and strategize an approach for estimating smoke density. Overall, these discussions broadened my perspective, illustrating the benefits of shared insights on challenging tasks.