Extension Plan for Course Project – Analyzing the Impact of Wildfire Smoke on National Park Visitation

1. Motivation/Problem Statement

Motivation:
The increasing frequency and intensity of wildfires in the United States, particularly in the western regions, have not only raised concerns about public health and safety but have also impacted local economies and tourism-dependent areas. National parks, especially those located in fire-prone areas like California, draw millions of visitors each year. These visitors support local businesses, contribute to the service industry, and boost local economies. However, during high-smoke periods, air quality and visibility deteriorate significantly, which can deter tourists from visiting. The effects of smoke can range from mild discomfort to serious health risks, especially for vulnerable groups, including children, the elderly, and those with pre-existing respiratory conditions. Reduced Park visitation can impact local economies, leading to lost revenue for hotels, restaurants, tour operators, and other businesses reliant on tourism.

This analysis seeks to quantify the impact of wildfire smoke on visitation rates at selected national parks. By understanding the relationship between smoke events and visitor numbers, park managers and local governments can better prepare for these occurrences. This information could support decision-making on whether to issue health advisories, temporarily close certain areas, or implement emergency response measures to protect both visitors and the environment. Additionally, local businesses could use this information to anticipate economic downturns during wildfire seasons and adapt their strategies, perhaps by offering incentives or focusing marketing efforts on off-peak times.

Problem Statement:
This study will focus on quantifying the decrease in visitation to national parks during wildfire smoke events, using historical data on visitation and air quality from 1986 to 2020. By analyzing how visitor counts fluctuate with smoke levels, we aim to provide insights into the direct economic effects of wildfire smoke on the tourism industry. This analysis will also explore if specific demographic or regional factors contribute to varying levels of impact, allowing for a more tailored understanding of how smoke events influence tourism behavior.

Significance:
This research is crucial for communities and businesses reliant on park-based tourism, such as hotels, restaurants, and tour operators in Palmdale, California and its nearby areas. For park management and local governments, understanding these impacts is essential for planning and budgeting purposes. Additionally, if the analysis shows a substantial impact, it could spur local and state governments to take proactive measures, like investing in air quality infrastructure, creating public health campaigns, or developing alternative tourism activities to attract visitors during non-peak smoke periods.

2. Impact Focus

Primary Focus – Services and Tourism:
The main focus of this project is on the tourism and service industries. Specifically, it seeks to analyze how wildfire smoke affects visitor numbers at national parks, using them as proxies for tourism trends. A reduction in park visitors during smoke-heavy seasons may lead to a ripple effect, affecting not only the parks but also surrounding communities that rely on tourism revenue. Restaurants, hotels, and tour operators that cater to park visitors could all experience a decline in revenue during high-smoke events, impacting employment rates and business stability.

Secondary Focus – Visitor Types and Activity Categories:
As a secondary focus, the study will analyze how wildfire smoke impacts different types of park visitors, specifically by **visitor categories** such as **recreational visitors, non-recreational visitors, campers, and day-use visitors**. This focus will help determine if certain types of activities or visitor groups are more affected by smoke events than others. For instance, recreational visitors engaging in outdoor activities like hiking or camping may be more likely to cancel or shorten their stays during heavy smoke periods, whereas non-recreational visitors or short-term day users might be less affected due to shorter exposure times. Understanding these differences can provide insights into which segments of park visitation—and associated services—are most vulnerable to smoke impacts.

This analysis will be valuable for park management and surrounding communities as it allows for targeted planning and resource allocation. For example, if recreational camping shows significant declines during smoke events, parks may consider implementing more flexible cancellation policies or enhancing indoor facilities to accommodate visitors who may want to avoid outdoor exposure. Additionally, local businesses that cater to specific visitor types, such as campgrounds, gear rental shops, or day-trip service providers, can better prepare for fluctuations in demand during wildfire seasons.

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3. Data or Model to be Used

Primary Dataset:

- **National Park Service (NPS) Visitor Use Statistics (https://irma.nps.gov/Stats/), (https://irma.nps.gov/Stats/Reports/National):** These datasets provides annual visitation data for each national park, allowing us to analyze how visitation numbers change over time and across seasons. The data includes total visitor counts by month and year for individual parks, which will be essential for examining patterns during wildfire seasons.
  - **Access**: NPS Visitor Use Statistics
  - **License/Terms of Use**: This dataset is publicly available and can be downloaded in CSV format for direct use in analysis.

Modeling Approach:

- **Time Series Analysis**: Time series models, such as **SARIMAX** or **LSTM**, will be applied to examine visitation trends and forecast future patterns. By incorporating seasonality and trend components, we can better understand the relationship between smoke events and visitor fluctuations.
- **Regression Analysis**: Regression models will help quantify the effect of air quality levels (e.g., PM2.5) on visitation counts. This approach can also control for seasonality and other factors to isolate the impact of smoke.

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4. Unknowns and Dependencies

1. **Data Completeness**: Some national parks may lack continuous air quality data, particularly in remote locations with limited monitoring. For these areas, we may need to interpolate data or use nearby monitoring stations, which could introduce estimation error.
2. **Seasonal Confounding Factors**: Visitor data is naturally seasonal, with peaks during summer months. While seasonality will be controlled in the model, differentiating the effects of smoke from other seasonal factors, such as weather patterns or school holidays, could still pose challenges.
3. **Air Quality Variability**: The specific location and intensity of smoke during wildfire events can vary, and factors such as wind direction and speed may influence how smoke affects a given park. Accounting for these meteorological factors might require additional data, which could add complexity to the analysis.
4. **Economic Impact Assumptions** (if included): Isolating the impact of smoke on local economies requires assumptions about the extent to which tourism influences other economic sectors. Additionally, it may be challenging to determine if reductions in economic indicators directly correlate with changes in visitor numbers.

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5. Timeline to Completion

Milestone	Description	Estimated Completion
Data Collection and Cleaning	Collect NPS Visitor data, air quality data, and economic data (if applicable); clean for analysis.	Week 1
Exploratory Data Analysis (EDA)	Visualize trends in visitation and smoke events; check for seasonality and outliers.	Week 1
Model Selection and Setup	Choose models (SARIMA, LSTM, regression) and set up frameworks for time series and regression.	Week 1

Milestone	Description	Estimated Completion
Modeling and Analysis	Implement models to identify relationships between smoke events and visitation.	Week 1-2
Validation and Testing	Use cross-validation and error metrics (e.g., RMSE) to validate model accuracy.	Week 2-3
Visualization of Results	Create visualizations of trends, correlations, and forecast results.	Week 2-3
Interpretation and Insights	Interpret results, focusing on quantifying the impact of smoke on tourism.	Week 3-4
Documentation and Reporting	Compile findings into a formal report with clear explanations, charts, and policy implications.	Week 3-4
Presentation Preparation	Prepare materials for PechaKucha presentation, summarizing key insights for stakeholders.	Week 3-4