PURDUE GIS DAY

Spatial Pattern of Air Quality and Power Plants in California: Mapping and Analysis Using GIS Approach

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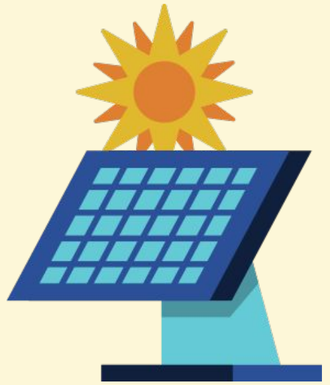


Why is this research significant?

BACKGROUND

- California is the most populous state in the United States (United States Census Bureau, 2023).

- Its GDP (Gross Domestic Product) ranks as the 5th largest in the world (California Department of Finance, n.d.)

- However, the high population and massive human activities in the area lead to air pollution consequences.

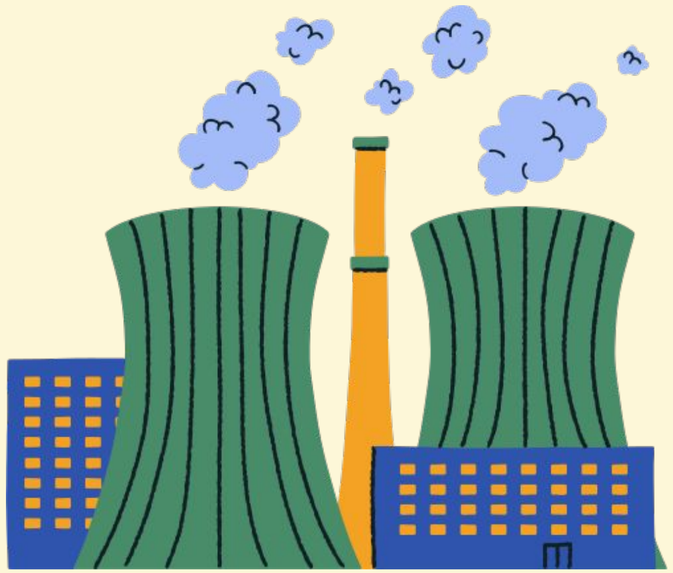
- The average percentage of days with good AQI is only 63%, and some locations have AQI over 300, indicating hazardous levels (EPA, 2022)

- California is the state with the highest death rate from Chronic Respiratory Diseases, reaching over 11,562 cases (CDC, 2022).

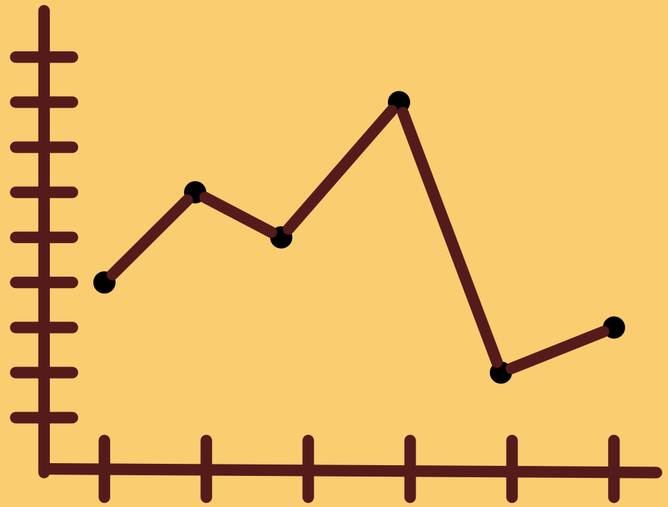
- These conditions highlight the importance of identifying air quality factors to determine priority areas and strategies for pollution reduction.

OBJECTIVES

to study the spatial patterns of air quality conditions



to analyze the distribution patterns of power plants



to determine the correlation between air quality conditions and power plants

LITERATURE REVIEW

Air Quality Index/AQI

- The air quality index is an indicator of air pollution level.
- It is classified into six categories with different levels of health concern.
- The higher AQI value indicates greater air pollution and health concerns.
- AQI value of 50 or below represents good air quality, while an AQI value over 300 represents hazardous air quality.

Categories of Power Plants

- Renewable sources can produce energy with zero emissions of air pollutants. Some sources that can be classified as renewable are solar energy, hydro-energy, wind energy, bioenergy, geothermal energy, and hydrogen energy (Ang et al., 2022).

- For non-renewable sources, the main supplies are limited and cannot be used sustainably. These power plants include coal, natural gas, petroleum, and nuclear.

AQI Classification (AirNow, n.d.)

Good (AQI = 0 to 50)

At this level, the air quality is acceptable and air pollution presents minimal or no risk to health.

Moderate (AQI = 51 to100)

At this level, air quality is good enough, but it can be risky for some people who are unusually sensitive to air pollution.

Unhealthy for Sensitive Groups (AQI = 101 to 150)

At this level, air pollution can affect sensitive groups, but it may not affect individuals without health issues.

Unhealthy (AQI = 151 to 200)

At this level, people will have health effects and members of sensitive groups may experience more serious health effects.

Very Unhealthy (AQI = 201 to 300)

At this level, the risk of health effects is increased for everyone.

METHODOLOGY

Data for analysis

- Number of days with good air quality/good days (AQI = 0-50).
- Number of days with AQI measurements (344-365 days)
- Number of power plants (renewable and non-renewable).

Percentage of days with good air quality =

$$\frac{\text{Number of days with good air quality} \times 100\%}{\text{Number of days with AQI in a year}}$$

Data Sources

- United States Environmental Protection Agency (EPA).
- Energy Information Administration (EIA).

Study Scope

- This study is a comprehensive regional analysis of 51 counties in California.

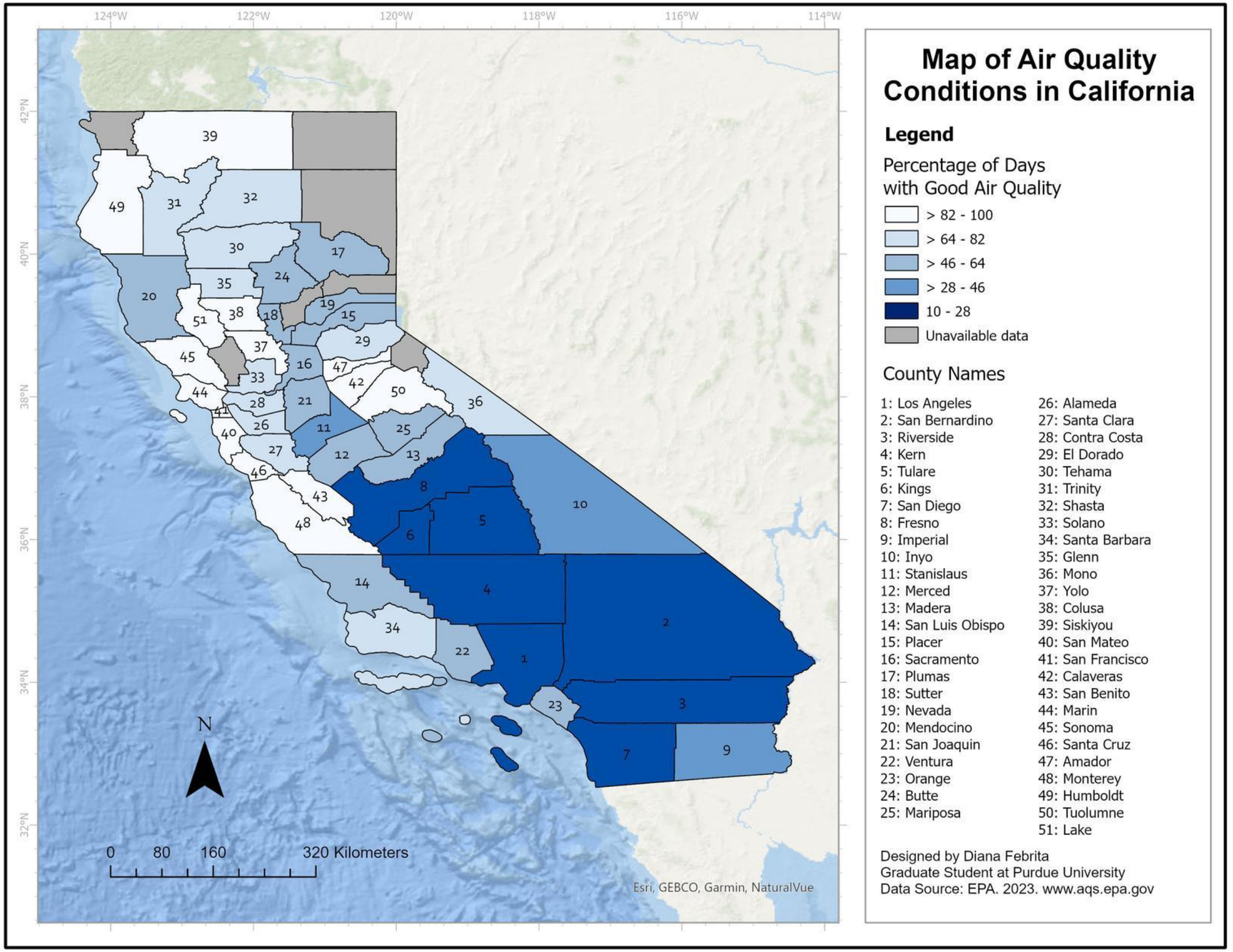
Analytical Techniques:

- Equal Interval Classification: used to split the data into equal-sized intervals.
- Pearson Correlation Coefficient Analysis: Applied to evaluate the strength of relationships between variables.

Results & Discussion

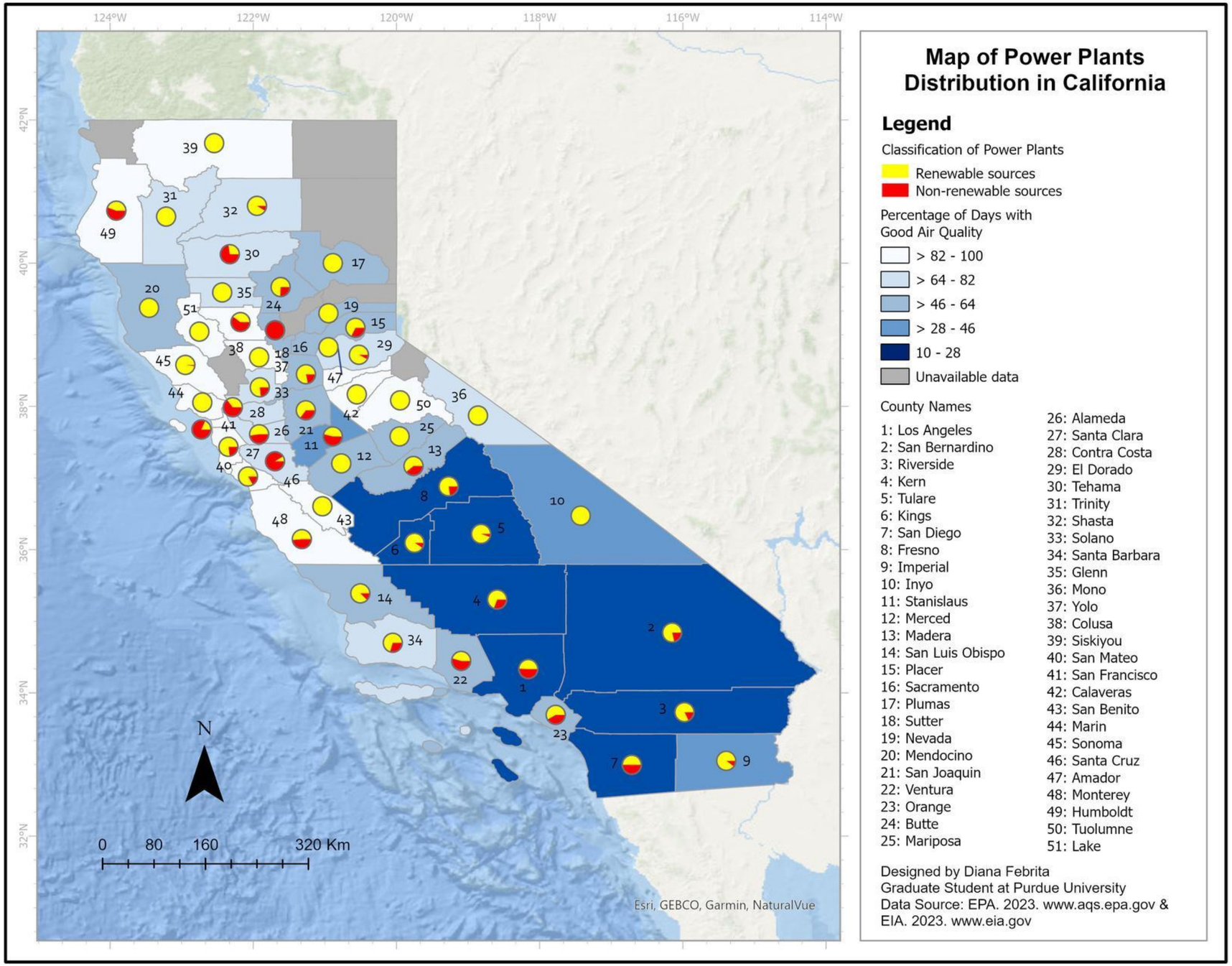
Spatial Pattern of Air Quality in California

- The darker color represents a lower percentage of days with good air quality.
- **Air quality in Northern California is generally better than in Southern California.**
- The percentage of days with good air quality in some counties in Southern California is less than 50% (between 10 to 27 percent), such as Los Angeles, San Bernardino, Riverside, Kern, Tulare, Kings, San Diego, and Fresno.

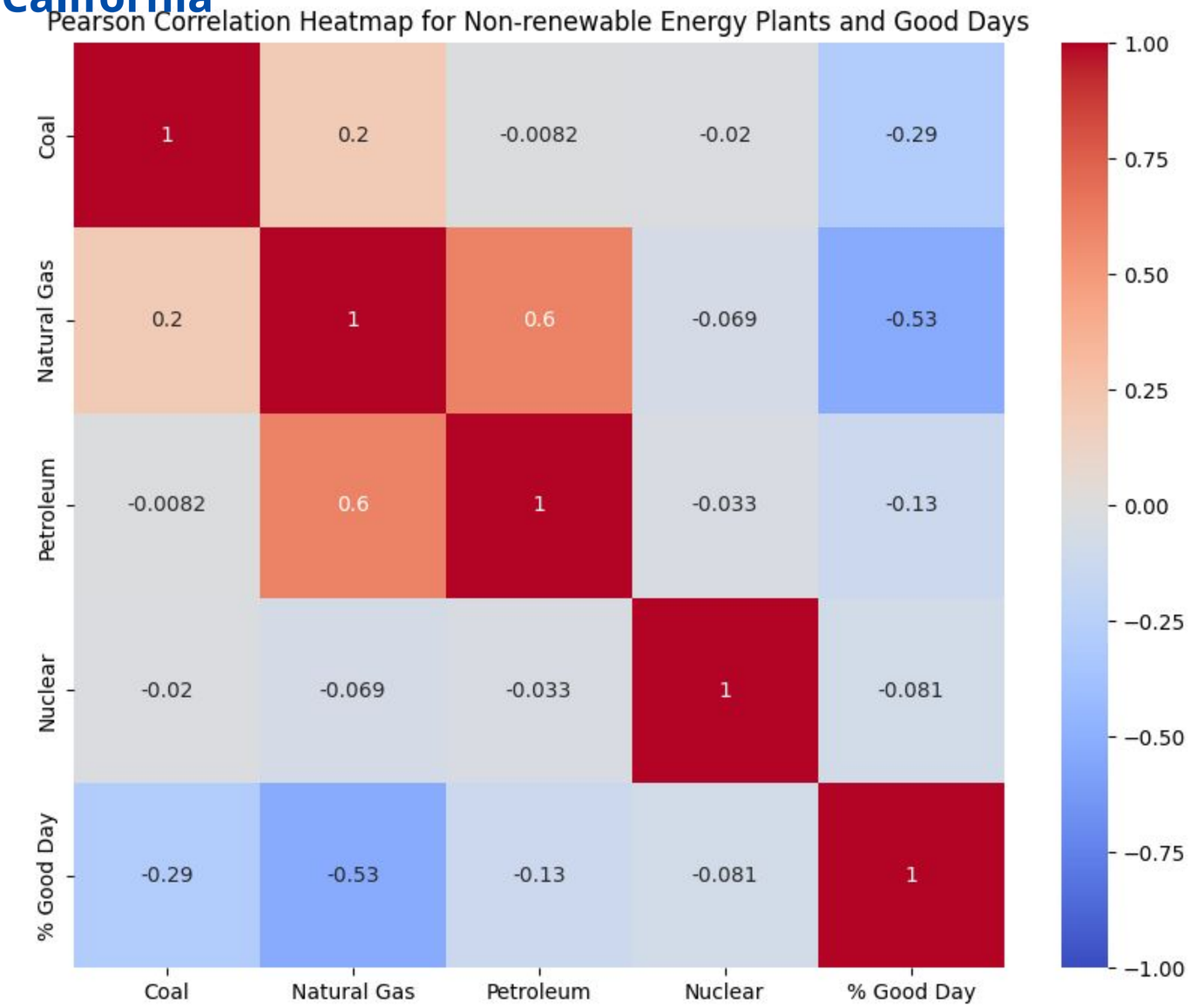


Distribution of Power Plants in California

- 98% of counties in California have power plants that generate renewable energy.
- **However, only 33% of counties in California have fully adopted 100% electricity from renewable energy sources, and these are mostly located in the northern part of the state**
- The percentage of days with good air quality in the northern area is quite high, generally above 80%.



Correlation Between Air Quality Conditions and Non-renewable Energy Sources in California



- The Pearson correlation heatmap shows a value of -0.53 between the percentage of days with good air quality and the number of natural gas power plants.
- The findings **indicate a significant negative correlation.**
- A low percentage of days with good air quality in certain areas correlates with a high number of natural gas power plants.

Classification:

- Perfect correlation: values near ±1.
- Strong correlation: value between ±0.50 and ±1.
- Moderate correlation: value between ±0.30 and ±0.49.
- Low correlation: value below +0.29.
- No correlation: a value of zero implies no relationship.

CONCLUSION

- In California, air quality is generally better in the northern regions compared to the south, suggesting that the **southern area can be prioritized for pollution reduction.**
- This state has used renewable energy plants extensively. However, only 33% of counties have used 100% renewable energy plants. **To improve air quality, the percentage of counties that use 100% renewable energy sources should be increased.**
- Natural gas has a significant negative correlation to air quality. **Reducing reliance on natural gas could be a key strategy for improving air quality.**

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Spatial Pattern of Air Quality & Power Plants in California

Mapping and Analysis Using GIS Approach