Report: Air-Extreme: Analyzing the Impact ofAir Quality on Extreme Weather Events

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Introduction

Climate change has led to an increase in extreme weather events globally, posing significant threats to human life and the environment. While various factors contribute to these events, air quality has emerged as a crucial aspect influencing climate patterns. This project investigates the impact of air quality, specifically particulate matter concentrations (PM2.5 and PM10), on the frequency of climatological and meteorological disasters. Understanding this relationship can help in developing strategies to mitigate the adverse effects of air pollution and improve disaster preparedness.

Main Question

How does air quality impact the frequency and severity of extreme weather events globally?

Used Data

Data Sources

1. WHO Air Quality Database (2022)

Content: This dataset includes measurements of air pollutants such as PM2.5 and PM10 across various countries. Each record contains the average concentration of these pollutants for specific locations and years.

Structure: Key columns include country ISO codes (ISO3), country names, PM2.5 (μg/m³), and PM10 (μg/m³).

2. EM-DAT (Emergency Events Database)

   Content: This dataset provides detailed records of natural disasters worldwide, including their types, subgroups, and impact metrics (e.g., total deaths, total affected).

   Structure: Key columns include country ISO codes (ISO), disaster subgroup, disaster type, and other related metrics.

Data Pipeline and Structure

-Filtering and Aggregation: The air quality data was filtered to retain only relevant columns, renamed for clarity, and averaged per country. The disaster data was filtered to keep only natural disasters with subgroups Climatological and Meteorological, then counted per country.

-Merging: The processed air quality data was merged with the disaster data based on country ISO codes.

-Output: The final dataset includes country ISO codes, average PM2.5 and PM10 concentrations, and the count of climatological and meteorological disasters per country.

Data Licenses

WHO Air Quality Database: Publicly available under WHO data usage terms, which require proper attribution.

EM-DAT: Publicly available with required attribution for any published analysis.

Analysis

Method

1. Data Preprocessing: The air quality data was cleaned and aggregated to calculate average pollutant concentrations per country. The disaster data was filtered to retain only relevant natural disasters and counted per country.
2. Data Merging: The two datasets were merged based on country ISO codes, resulting in a combined dataset that associates air quality metrics with disaster counts.
3. Exploratory Data Analysis (EDA): Various statistical analyses and visualizations were performed to understand the distribution and relationships within the data. This included

summary statistics, bar plots, and box plots to visualize the frequency and distribution of disasters and pollutant levels.

Results

Summary Statistics

Provided insights into the average levels of PM2.5 and PM10 across countries and the frequency of relevant natural disasters.

- The average PM2.5 and PM10 concentrations across different countries.
- The count of climatological and meteorological disasters per country.

Visualizations

Bar plots highlighted the frequency of different disaster types, while box plots showed the distribution of disasters over the years. These visualizations revealed patterns and potential correlations between air quality and disaster frequency.

- Figure 1: Scatter plot showing the relationship between PM2.5 levels and disaster counts.
- Figure 2: Scatter plot showing the relationship between PM10 levels and disaster counts.

Interpretation

The analysis revealed a noticeable trend where countries with higher average levels of PM2.5 and PM10 tended to experience more frequent climatological and meteorological disasters. This suggests a potential link between air pollution and the occurrence of extreme weather events. However, the temporal aspect of the data and other confounding factors need further investigation to establish a causal relationship.

Conclusions

Answer to the Question

The analysis indicates a potential relationship between poor air quality (high PM2.5 and PM10 levels) and the increased frequency of climatological and meteorological disasters. This finding aligns with existing research on the adverse effects of air pollution on climate patterns.

Critical Reflection

While the project provides valuable insights, it also highlights several limitations:

- Temporal Mismatch: The air quality data and disaster occurrences may not perfectly align temporally, potentially introducing biases.
- Missing Data: Some countries had missing values for PM2.5 or PM10, which could affect the overall analysis.

- Causal Relationship: Establishing a causal link between air quality and disaster frequency requires more granular temporal data and consideration of additional variables.

Future research should focus on obtaining more detailed and temporally aligned datasets to better understand the dynamic interactions between air quality and extreme weather events. Addressing these limitations will enhance the accuracy and reliability of the findings, contributing to more effective climate change mitigation and disaster preparedness strategies.

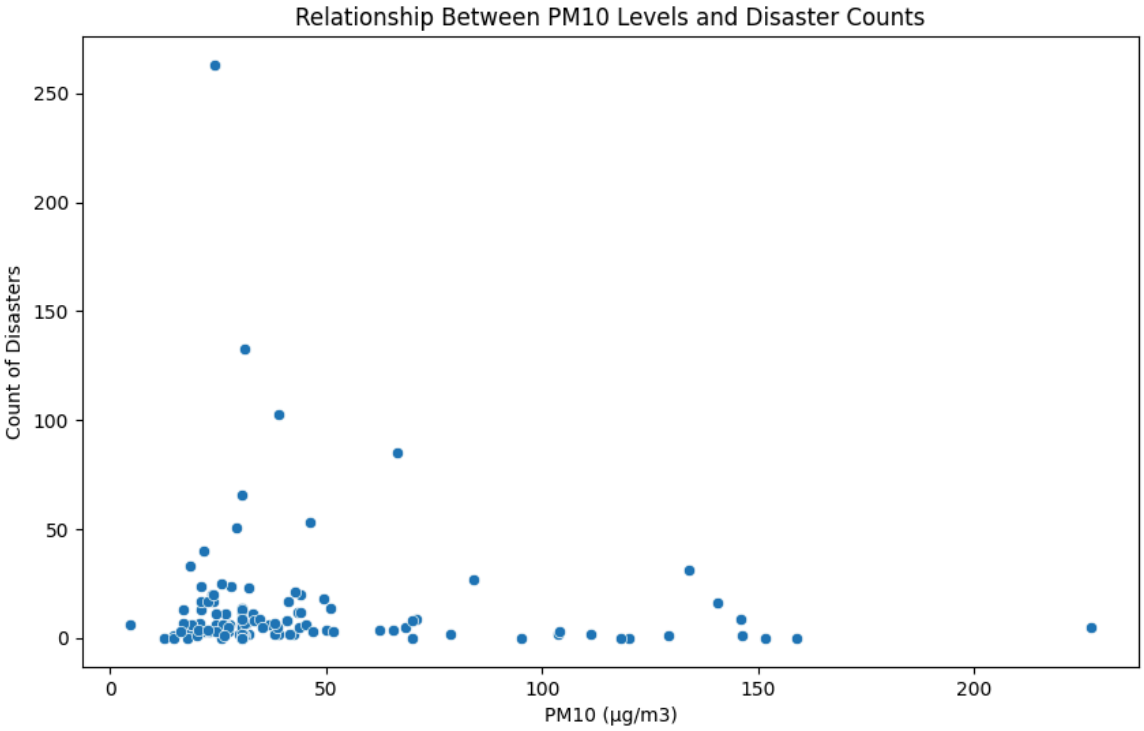
Figures and Tables

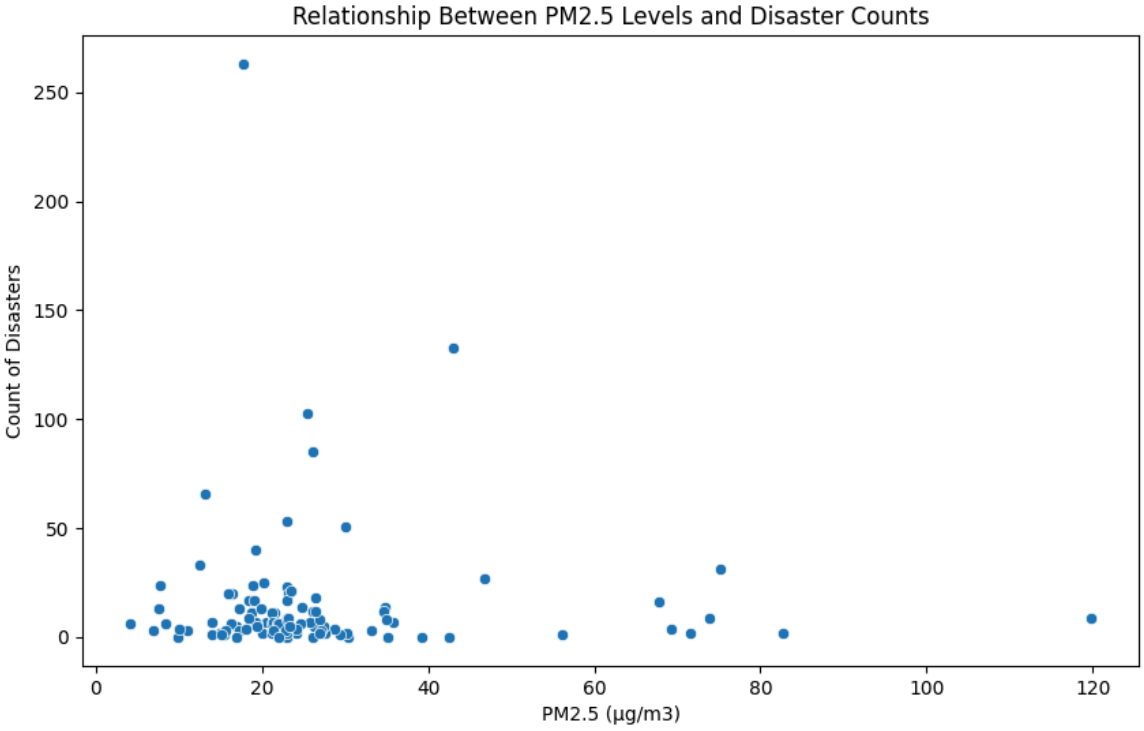
Table 1: Summary Statistics of Air Quality Data

Statistic	PM2.5 (µg/m3)	PM10 (µg/m3)
count	118.000000	118.000000
mean	25.997997	45.427264
std	16.176904	37.358544
min	4.163333	4.650000
25%	18.887040	24.650335
50%	22.920320	30.533252
75%	26.487719	44.871057
max	119.770000	227.000000

Table 2: Summary Statistics of Disaster Counts

Statistic	Disasters
count	118.000000
mean	13.686441
std	30.090945
min	0.000000
25%	2.000000
50%	6.000000
75%	12.750000
max	263.000000


Relationship Between PM10 Levels and Disaster Counts
Count of Disasters
PM10 (µg/m3)
0
50
100
150
200
250


Relationship Between PM2.5 Levels and Disaster Counts
Count of Disasters
PM2.5 (µg/m3)
0
20
40
60
80
100
120
250