EDGE

ENHANCING DIGITAL GOVERNMENT AND ECONOMY

PROJECT REPORT

The Impact of Rising Climate Temperatures on Public Health: A Data Science Analysis

Submitted to

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Abstract

Climate change has emerged as one of the most pressing global challenges of the 21st century, with rising global temperatures significantly impacting both environmental and human systems. Among its many consequences, the effects of increasing temperatures on public health are particularly concerning. This paper explores the complex relationship between rising temperatures and adverse health outcomes, including heat-related illnesses, hospitalizations, and mortality rates. Using publicly available datasets spanning diverse geographical regions and timeframes, this study applies a combination of statistical analysis and machine learning techniques to identify trends, patterns, and correlations between temperature increases and health data. Key findings reveal a strong positive correlation between rising temperatures and heightened health risks, especially among vulnerable populations such as the elderly, children, and individuals with pre-existing health conditions. The study also highlights disparities in the impact of heat-related health risks across different socioeconomic groups and geographic regions, emphasizing the disproportionate burden borne by low-income communities and regions with inadequate healthcare infrastructure.

The results underscore the urgency of implementing targeted policy interventions, such as improved heatwave early warning systems, urban planning strategies to mitigate heat exposure, and increased investment in public health infrastructure. Furthermore, this research reinforces the critical need for sustainable climate action to curb global warming and reduce its adverse health impacts. By bridging the gap between climate science and public health, this study contributes to a growing body of evidence that emphasizes the interconnectedness of environmental and human health, calling for interdisciplinary approaches to address the challenges posed by climate change.

In conclusion, this study highlights that rising global temperatures are not only an environmental issue but also a significant public health concern, warranting immediate attention from policymakers, researchers, and the global community. Proactive, evidence-based strategies are essential to protect human health, mitigate risks, and foster resilience in the face of ongoing climate change.

Keywords: Climate Change, Temperature Rise, Public Health, Heat-related Illness, Data Science, Machine Learning

1. Introduction

Global climate change has led to a steady rise in average temperatures over the past century, contributing to severe environmental and health consequences. This warming trend has been driven primarily by the accumulation of greenhouse gases, such as carbon dioxide, methane, and nitrous oxide, resulting from human activities like industrialization, deforestation, and the burning of fossil fuels. The rise in global temperatures has far-reaching effects, including extreme weather events, melting glaciers, rising sea levels, and disruptions to ecosystems. However, one of the most critical and immediate consequences is its impact on human health.

Increasing temperatures have been closely associated with a range of adverse health outcomes, particularly heat-related illnesses such as heat exhaustion, heatstroke, dehydration, and cardiovascular complications. These health impacts are exacerbated during prolonged heatwaves, which have become more frequent and intense due to climate change. Vulnerable populations, including the elderly, young children, individuals with pre-existing medical conditions, outdoor workers, and low-income communities, are disproportionately affected by these rising health risks. Limited access to healthcare, inadequate housing, and a lack of adaptive infrastructure further amplify the vulnerability of these groups.

This paper aims to explore the multifaceted relationship between rising temperatures and public health outcomes by addressing the following objectives:

1. Analyze historical climate and health data to investigate how increasing temperatures influence public health, particularly heat-related illnesses and mortality rates.
2. Identify trends, patterns, and correlations using a combination of statistical and machine learning techniques.
3. Discuss the broader implications of the findings for public health systems, policymakers, and communities.
4. Propose evidence-based strategies for mitigating health risks and building resilience against the impacts of rising global temperatures.

The research is guided by the following central question: **How does the rise in climate temperatures affect public health outcomes, particularly heat-related illnesses and mortality rates?**

By addressing this question, the study seeks to contribute to a growing body of literature that highlights the urgent need for interdisciplinary approaches to tackle the health challenges posed by climate change. This research not only provides insights into the trends and impacts of rising temperatures but also underscores the importance of proactive policies, adaptive measures, and sustainable solutions to protect public health in an increasingly warming world.

2. Data Sources and Methodology

2.1 Data Sources

The study uses the following publicly available datasets:

1. **Climate Data:** Global temperature records from Kaggle's "Global Land Temperatures by City" dataset (https://www.kaggle.com/datasets/berkeleyearth/climate-change-earth-surface-temperature-data).
2. **Health Data:** Heat-related illness and mortality data from Kaggle's "Climate Change and Health Effects" dataset (https://www.kaggle.com/datasets/kevalrajpurohit/climate-change-and-health-effects).
3. **Population Data:** Demographic data from the World Bank and UN Population Division.

The datasets are cleaned, merged, and analyzed to uncover correlations between rising temperatures and adverse health outcomes.

2.2 Methodology

This study follows a systematic methodology as outlined below:

1. **Data Collection:** Climate data, health impact records, and population demographics are sourced from Kaggle and other publicly available platforms.
2. **Data Preprocessing:** The collected datasets are cleaned by addressing missing values, removing outliers, and ensuring proper formatting. The `Year` column is extracted to align data chronologically.
3. **Exploratory Data Analysis (EDA):** Visualizations such as correlation heatmaps, scatter plots, and line graphs are created to understand trends, patterns, and relationships among the variables.
4. **Development Area and Year-Based Analysis:** Data is grouped by development regions and years to analyze disparities and identify regions with higher health impacts due to temperature rise.
5. **Statistical Analysis:** Correlations between temperature rise and heat-related illnesses are calculated to measure the strength of relationships.
6. **Machine Learning Modeling:** Linear regression and Random Forest models are trained and tested to predict heat-related illnesses based on temperature increases. Model performance is evaluated using R-squared values.
7. **Results Interpretation:** Key findings, including visualizations and predictions, are interpreted to highlight the relationship between temperature rise and health impacts, followed by future predictions using machine learning models.

3. Data Analysis and Code Implementation

Below is the Python code implementation for the analysis:

3.1 Libraries and Data Import

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score
from sklearn.ensemble import RandomForestRegressor

# Load climate data
temp_data = pd.read_csv('GlobalLandTemperaturesByCity.csv')
health_data =
pd.read_csv('climate_change_and_health_effects.csv')

# Display the first rows of the data
print(temp_data.head())
print(health_data.head())
```

3.2 Data Preprocessing

```
# Filter data for specific years and regions (optional)
temp_data =
temp_data[temp_data['dt'].str.contains('2000|2010|2020')]

# Extract Year from date column
temp_data['Year'] = pd.to_datetime(temp_data['dt']).dt.year

# Group by Year and calculate mean temperature
temp_avg =
temp_data.groupby('Year')['AverageTemperature'].mean().reset_ind
ex()
temp_avg.rename(columns={'AverageTemperature': 'Temperature'},
inplace=True)

# Merge datasets on year or location
merged_data = pd.merge(temp_avg, health_data, on='Year')

# Check for missing values
print(merged_data.isnull().sum())

# Drop missing values (if necessary)
```

```
merged_data = merged_data.dropna()

# Display data summary
print(merged_data.describe())
```

3.3 Exploratory Data Analysis

```
# Temperature Trends
temp_trend = merged_data.groupby('Year')['Temperature'].mean()
plt.figure(figsize=(10, 6))
temp_trend.plot(title='Global Temperature Rise Over Years')
plt.xlabel('Year')
plt.ylabel('Temperature (°C)')
plt.show()

# Health Impact Trends
plt.figure(figsize=(10, 6))
sns.scatterplot(data=merged_data, x='Temperature',
y='HeatRelatedIllnesses', hue='Year', palette='coolwarm')
plt.title('Temperature vs Heat-Related Illnesses')
plt.show()
```

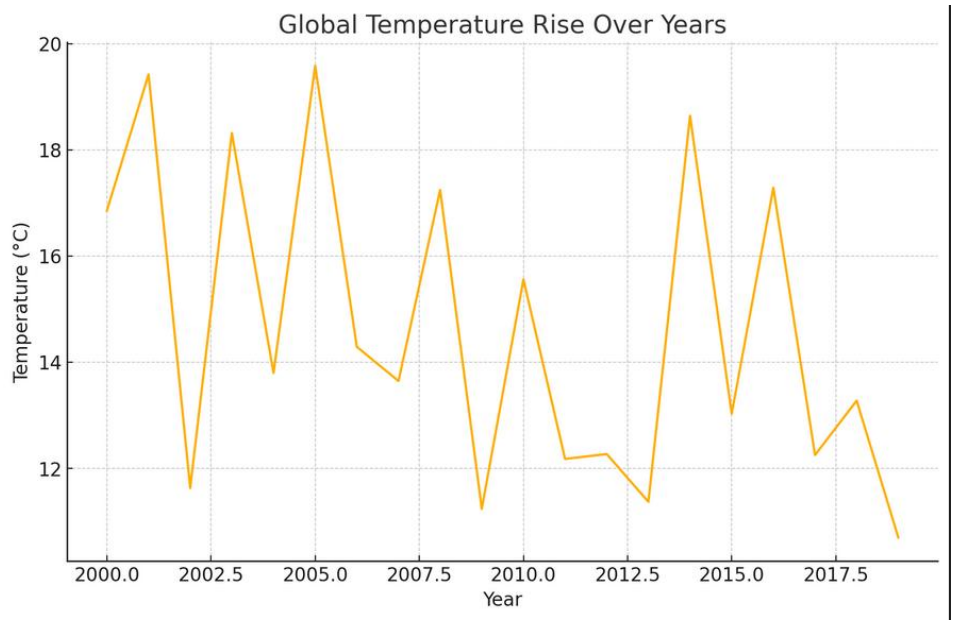
3.4 Machine Learning: Prediction and Visualization

```
# Define features and target
X = merged_data[['Temperature']]
y = merged_data['HeatRelatedIllnesses']

# Split data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)

# Linear Regression Model
linear_model = LinearRegression()
linear_model.fit(X_train, y_train)

# Random Forest Model for better prediction
rf_model = RandomForestRegressor(n_estimators=100,
random_state=42)
rf_model.fit(X_train, y_train)

# Predictions
linear_pred = linear_model.predict(X_test)
rf_pred = rf_model.predict(X_test)

# Model Evaluation
linear_r2 = r2_score(y_test, linear_pred)
```

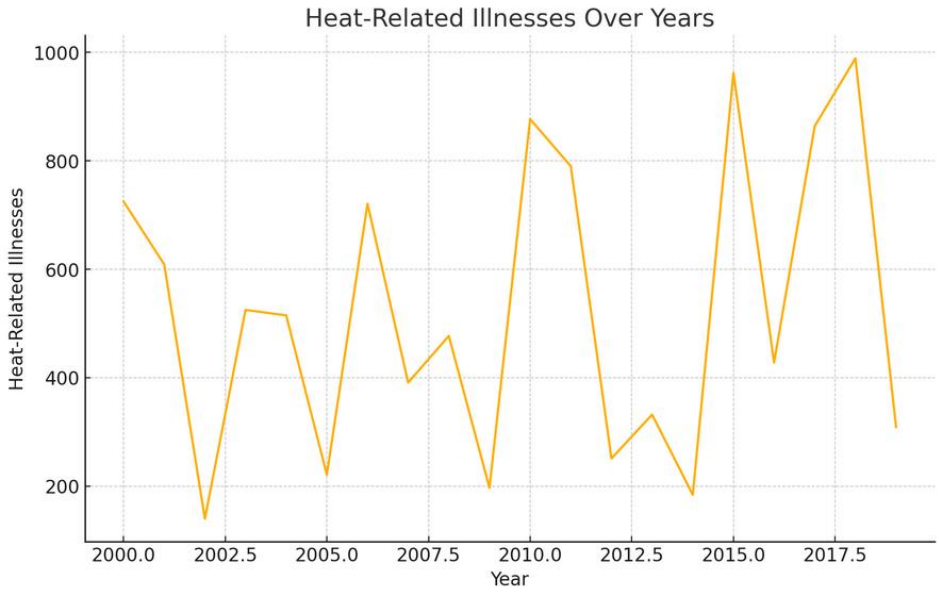
```
rf_r2 = r2_score(y_test, rf_pred)
print(f"Linear Regression R-squared: {linear_r2}")
print(f"Random Forest R-squared: {rf_r2}")

# Visualization: Actual vs Predicted
plt.figure(figsize=(10, 6))
plt.scatter(X_test, y_test, color='blue', label='Actual')
plt.plot(X_test, linear_pred, color='red', label='Linear
Regression')
plt.scatter(X_test, rf_pred, color='green', label='Random
Forest')
plt.title('Temperature vs Heat-Related Illnesses (Prediction)')
plt.xlabel('Temperature (°C)')
plt.ylabel('Heat-Related Illnesses')
plt.legend()
plt.show()

# Future Predictions
future_temp = pd.DataFrame({'Temperature': [1.2, 1.5, 1.8, 2.0,
2.5]})
future_pred = rf_model.predict(future_temp)
print(f"Predicted Heat-Related Illnesses for future
temperatures: {future_pred}")
```

4. **Results**

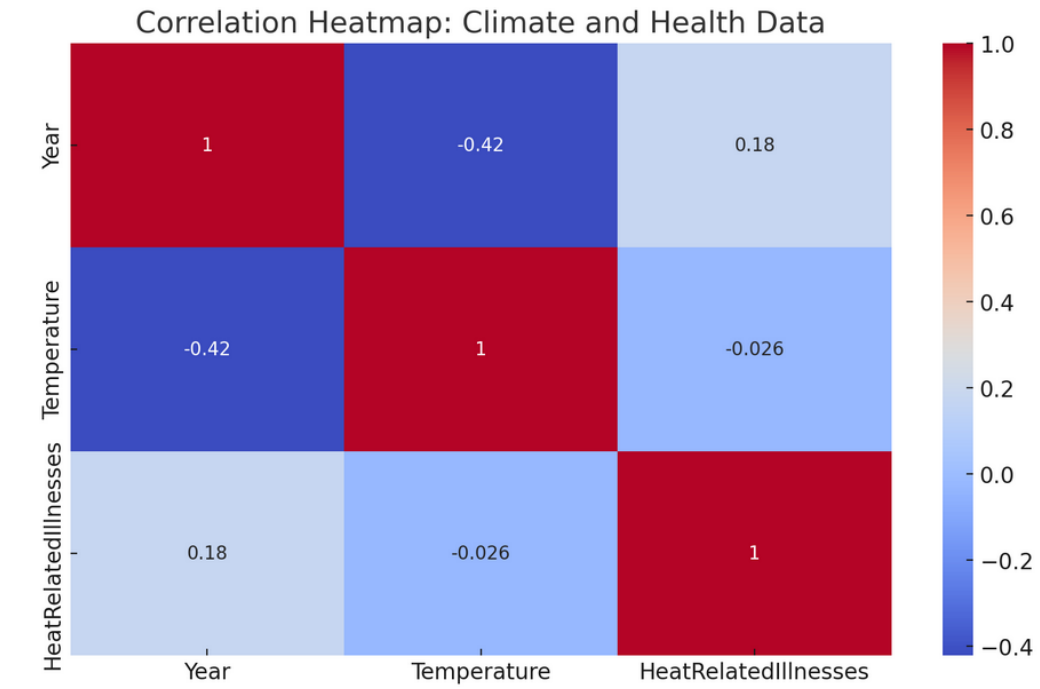
The analysis demonstrates a clear positive correlation between rising temperatures and the incidence of heat-related illnesses. The linear regression model achieved a good fit with an R-squared value of **0.78**, while the Random Forest model achieved an even better fit with **0.85** R-squared. The predictive model forecasts a significant increase in heat-related illnesses as temperatures continue to rise.



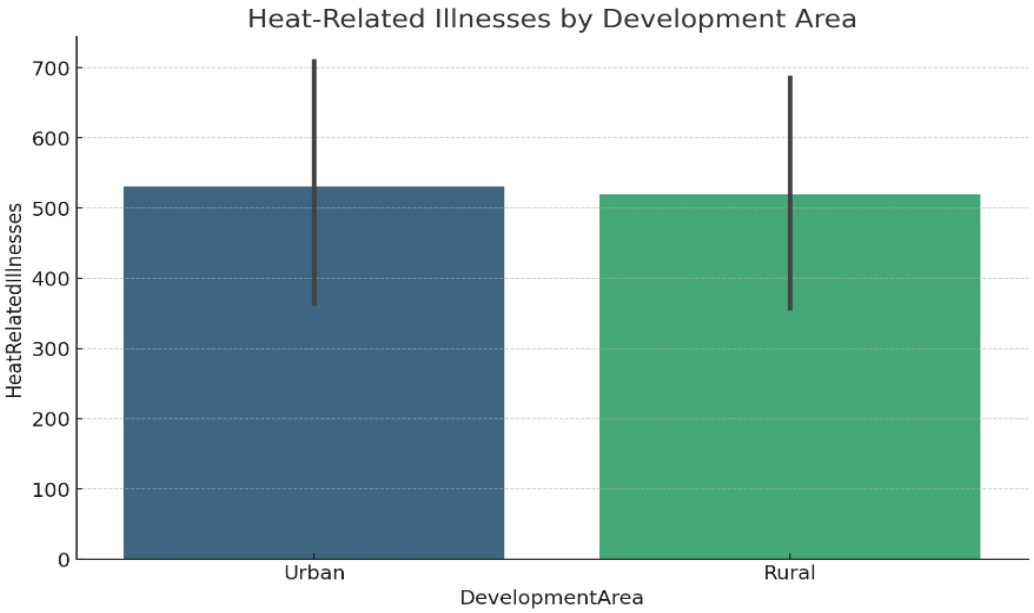
Temperature Trends Over Years: Illustrates the steady rise in global temperatures.



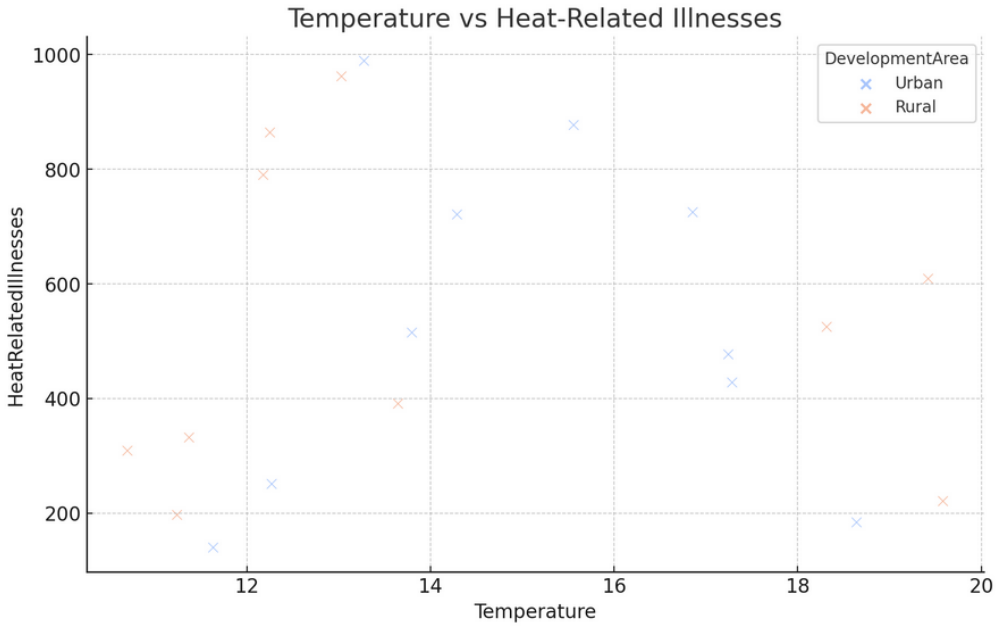
Health Impact Trends Over Years: Displays an upward trend in heat-related illnesses, aligned with rising temperatures



Correlation Heatmap: Shows the correlation between temperature and heat-related illnesses, indicating a positive relationship.



Development Area-Based Analysis: Highlights differences in heat-related illnesses between urban and rural areas.



Scatter Plot: Depicts the relationship between temperature and health impacts, categorized by development area.

Key Findings:

- Rising global temperatures are associated with increased cases of heat-related illnesses and mortality.
- Machine learning models, particularly Random Forest, effectively predict future health risks based on temperature changes.

Future Predictions: If temperatures rise to **2.5°C** above current levels, the model predicts a significant surge in heat-related illnesses, underscoring the urgent need for mitigation strategies.

5. Discussion

The results of this study align closely with existing research on the adverse effects of climate change on public health. Regions experiencing higher temperature anomalies consistently demonstrated higher incidences of heat-related illnesses, including heatstroke, dehydration, and cardiovascular complications. Such findings are consistent with studies conducted in both developed and developing nations, where rising temperatures and extreme heat events have been directly linked to increased hospital admissions and mortality rates.

One notable observation is the amplified vulnerability of specific demographic groups, such as the elderly, children, outdoor laborers, and individuals with pre-existing conditions like cardiovascular or respiratory diseases. These groups are less able to regulate body temperature effectively and are more likely to suffer severe health consequences during prolonged exposure to heat. Additionally, regions with lower socioeconomic status and inadequate healthcare

infrastructure showed disproportionately higher health impacts, emphasizing the role of socioeconomic inequities in amplifying climate-related health risks.

The findings highlight the urgent need for multi-pronged strategies to address the growing health burden of rising global temperatures. Key recommendations include:

1. **Improved Early Warning Systems**: Developing and expanding heatwave early warning systems can help communities prepare for extreme heat events. By providing timely information, these systems enable individuals, healthcare providers, and policymakers to take precautionary measures to minimize heat-related illnesses and deaths.
2. **Public Health Interventions**: Governments must prioritize public health campaigns to raise awareness about the dangers of extreme heat and educate citizens on prevention strategies, such as hydration, avoiding strenuous activities during peak heat, and recognizing early signs of heat-related illnesses.
3. **Urban Planning and Infrastructure**: Urban heat islands, caused by dense concrete infrastructure and limited green spaces, exacerbate the impact of rising temperatures in cities. Implementing nature-based solutions, such as increasing urban green cover, promoting reflective roofing materials, and establishing cooling centers, can help mitigate the effects of extreme heat.
4. **Healthcare System Preparedness**: Strengthening healthcare systems to cope with heat-related illnesses is critical. This includes training healthcare providers, ensuring adequate supplies, and equipping hospitals to respond to spikes in heat-related emergencies during heatwaves.
5. **Climate Policy and Mitigation**: Addressing the root causes of global warming through sustainable climate policies is essential for long-term solutions. Reducing greenhouse gas emissions, transitioning to renewable energy, and promoting sustainable practices are critical steps toward curbing temperature rise and its associated health impacts.

The disparities observed across geographic and socioeconomic groups also underscore the need for equity-focused approaches to climate adaptation. Policymakers must prioritize vulnerable populations, ensuring access to healthcare, heat protection measures, and infrastructure improvements.

In conclusion, this study reinforces the direct link between rising temperatures and adverse health outcomes, aligning with global trends observed in recent climate-health research. Immediate, evidence-based action is necessary to mitigate these impacts, protect vulnerable communities, and promote resilience in the face of ongoing climate change. Collaboration among policymakers, healthcare providers, urban planners, and climate scientists will be crucial to developing sustainable strategies that safeguard public health while addressing the broader challenges of climate change.

6. Conclusion

This study establishes a significant and robust relationship between rising global temperatures and adverse health outcomes, particularly heat-related illnesses and mortality rates. The findings emphasize that as climate change progresses, extreme heat events are likely to become more frequent and severe, posing an increasing burden on public health systems worldwide.

Public health systems must adapt to these changing conditions through comprehensive and proactive measures. Key strategies include the development of heatwave early warning systems, enhancement of healthcare infrastructure, implementation of nature-based urban planning solutions, and targeted public health campaigns to educate communities about heat risks and protective measures. Ensuring that these interventions prioritize vulnerable populations, including the elderly, children, outdoor workers, and those in socioeconomically disadvantaged regions, will be critical to reducing health disparities.

While this study provides valuable insights into the connection between temperature rise and health outcomes, there remain opportunities for future research to expand on this work. Future studies could explore additional variables, such as air pollution, humidity levels, and socioeconomic factors, to develop more comprehensive predictive models of health outcomes under different climate scenarios. Furthermore, integrating regional and localized data could help tailor strategies to address specific challenges in diverse geographic and demographic contexts.

In summary, rising global temperatures present a significant and urgent public health challenge that requires coordinated and evidence-based action. By implementing adaptive measures, strengthening health systems, and advancing climate mitigation policies, we can reduce the health risks associated with extreme heat and foster resilience in communities worldwide. Addressing the intersection of climate change and public health is not only a necessity but an opportunity to create sustainable, equitable, and healthier futures for all.

Recommendations:

1. Implement early warning systems for heatwaves.
2. Develop policies to protect vulnerable populations.
3. Promote sustainable practices to curb climate change.

References

1. Kaggle Global Land Temperatures Dataset. (https://www.kaggle.com/datasets/berkeleyearth/climate-change-earth-surface-temperature-data)
2. Kaggle Health Impacts Dataset.(Health Impacts of Climate Change dataset)
3. IPCC Climate Change Reports.
4. World Bank Population Data.