IMPACT OF CLIMATE CHANGE ON GLOBAL FOOD SECURITY

Abhinanditha Thamada, Bhargav Varidi, Durga Prasad Bukka,

Prathik Reddy Kotha, Sameer Mohammad

**Introduction**

Climate change significantly challenges global food security, influencing food production, availability, and access across different regions. This study explores how climate change affects the food security index in various countries, aiming to understand the multifaceted relationship between climatic changes and food systems. (*Global Food Security Index*, n.d.)

The central research question is: "How does climate change affect the food security index of different countries?"

**Data Exploration Variables**

Dataset Overview

The Global Food Security Index, a comprehensive and widely recognized data source covering 113 countries, will be the cornerstone of this investigation. This index provides a holistic evaluation of food security, considering affordability, availability, and quality/safety. It also incorporates metrics for natural resources and resilience, offering a robust assessment of the sustainability and stability of food systems.

**Variables**

Data source: Global Food Security Index

•Availability and Affordability: Assessed through quantitative measures.

•Quality and Safety: Combination of qualitative and quantitative metrics, including safety ratings and nutrient content.

•Natural Resources and Resilience: Analyzed through both quantitative and qualitative indicators.

**Data cleaning and Preprocessing**

Before commencing the analysis, it was crucial to preprocess the dataset to ensure data quality and consistency. We started with the examination for missing values, revealing none present. Standardizing column names for clarity and consistency was paramount, so we renamed “Quality. Safety” to Quality\_Safety.” Data integrity was ensured with this change and removing any rows with missing values. To ensure data type uniformity, numeric columns were also converted, laying the groundwork for a thorough examination.

**Analysis**

**Exploratory Data Analysis**

**Descriptive Statistics:**

Distribution of Overall Scores: A histogram is used to visualize the distribution of Overall Scores across countries, providing an overview of the variability in food security levels globally.

**Correlation Analysis:**

Pearson correlation coefficients are computed to quantify the strength and direction of associations between variables such as Affordability, Availability, Quality and Safety, and Sustainability and Adaptation.

**Box Plots**

Each box plot depicts the variability within a single category, with the box containing the interquartile range (IQR) and median score. If there are any outliers, they are shown as separate points beyond the plot's whiskers. This visualization allows for fast comparisons between categories, showing areas of strength and potential improvements in food security performance.

A diagram of a box

Description automatically generated

**Scatter Plot**

We utilized scatter plots to analyze how a country's Overall Score related to its Affordability, which is determined by how easily people can purchase food there. Each data point in the graph represents a distinct country. The horizontal line represents affordability, or how expensive or cheap food is available, while the vertical line represents the Overall Score, which indicates how well a country's food system is performing. We can see how these two things are related by examining how the data points are distributed and whether they form a line. This assisted us in identifying any exceptional situations and determining if there is a link between food security and how affordable food is in certain countries.

A graph with numbers and a line

Description automatically generated with medium confidenceA graph with red dots

Description automatically generated

We analyzed the relationship between the Overall GFSI score and Affordability using a scatter plot with a trend line. The plot illustrates a strong positive association between overall food security scores and affordability. Pearson's correlation coefficient was calculated to quantify this relationship. The scatter plot, enhanced with a linear regression line, provides a clear visualization of the trend.

**Line Plot**

We used a line plot to display how Overall Scores vary among countries. The x-axis shows the rank of countries based on their Overall Scores, while the y-axis indicates the Overall Scores themselves. The red line highlights the trend in scores, aiding in identifying patterns or fluctuations.

A graph showing a long red line

Description automatically generated

**Heat Map:**

The heatmap displays correlations between food security components, like Affordability, Availability, and Quality. Darker colors indicate stronger relationships: positive ones suggest, for instance, that higher affordability correlates with better availability. Conversely, negative correlations, like between Affordability and Sustainability, suggest that higher affordability might lead to lower sustainability in food systems.

A graph of a diagram

Description automatically generated with medium confidenceA graph of different colors

Description automatically generated

We created an interactive heat map that represents the relationship between Overall Score and Affordability across different countries. Each cell in the heatmap corresponds to a specific country and is colored based on the respective score, with darker shades indicating higher scores.

**Histogram**

We generated a histogram, illustrating the distribution of Overall Scores across the dataset. Each bar in the histogram represents a range of Overall Scores, with the height of the bar indicating the frequency of occurrence within that range.

A graph of a distribution of overall scores

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Description automatically generated with medium confidence

**3D Pie Chart**

We generated a 3D pie chart that visually depicts the distribution of food security scores among the top five countries rated by Overall Score. Each slice of the pie represents a country, and its size is proportionate to its overall score. This image makes it easy to compare food security performance across countries, allowing us to quickly determine which countries have the highest and lowest Overall Scores.

A pie chart of countries/regions by overall scale

Description automatically generated

**World Map**

By mapping the food security index or its components across different countries, we can acquire useful insights into the geographical distribution of food security. In our investigation, we used a world map visualization to show how aspects like pricing, availability, quality, safety, and sustainability vary geographically. Each country is color-coded or shaded based on its food security score or the score of certain indicators, making it easier to compare and identify regions with high or low food security.

A map of the world

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A map of the world

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Description automatically generated

**ANOVA**

ANOVA test to compare the mean food security index across different groups of countries, with significant differences found (F (2, 109) = 409, p < 0.001). Additionally, correlations between various aspects of food security were examined, revealing strong positive correlations between Affordability and Availability (r = 0.75), Affordability and Quality/Safety (r = 0.79), and Quality/Safety and Sustainability/Adaptation (r = 0.61)

**Shapiro-Wilk**

To check for normality, we carried out the Shapiro-Wilk Test. Indicating departures from normality for Quality/Safety (p = 0.001) but not for the other variables.

**Kruskal-Wallis**

Lastly, a Kruskal-Wallis test was performed to compare Affordability across different levels of Overall Score, demonstrating significant differences (χ² (2) = 90.51, p < 0.001).

**Methodology**

Analytical Approaches

1. Correlation Analysis: Initial analysis using Pearson correlation to identify climate change indicators significantly correlating with the food security index or its sub-components.

2. Simple Linear Regression Analysis: Further analyses to examine the strength and significance of relationships between individual climate change indicators and food security components.

3. Multiple Regression Analysis: This technique assesses the collective impact of various climate change indicators on food security, controlling for other variables.

4. Assumption Testing and Post-hoc Analysis: Verify the assumptions of the statistical methods, followed by appropriate post-hoc analyses.

5. Data Visualization: Using scatter plots, line graphs, and bar charts to visualize and interpret the relationships between variables.

**Modeling Population Growth**

We used advanced statistical approaches to study the delicate link between population dynamics and food security indices. We wanted to know how demographic variables like population size, growth rate, and age structure affected critical food security measures including availability, cost, and quality. Through detailed scenario assessments, we projected potential results under various population growth scenarios, providing useful insights for policymakers and stakeholders dealing with the complex interplay between population dynamics and food security."

**Practical interpretation of model coefficients**

**Expected outcomes and impact.**

The findings from this research are expected to provide comprehensive insights into how climate change affects food security in different contexts, identifying specific vulnerabilities and strengths within global food systems. This knowledge will be crucial for policymakers and stakeholders to develop targeted strategies to mitigate the adverse effects of climate change on food security.

**Conclusion**

By integrating diverse methodologies and comprehensive data analysis, this study will contribute valuable perspectives on the nexus between climate change and food security. The insights gained will inform evidence-based policies and initiatives to enhance the resilience and sustainability of food systems in the face of ongoing climatic challenges.

References

*Global Food Security Index*. (n.d.). <https://repository.gheli.harvard.edu/repository/12481/>

*Global Food Security Index (GFSI)*. (n.d.). <https://impact.economist.com/sustainability/project/food-security-index/>