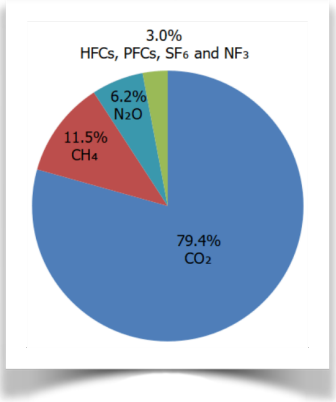
GREENHOUSE GAS PREDICTIONS ON CONTINENTS BASIS

Introduction

This report aims to provide a comprehensive predictive analysis of Greenhouse Gas (GHG) emissions across different continents. It further provides insights into the environmental impact of various sectors, making this information accessible to both technical and non-technical audiences. Though GHG was given in the dataset as a combination of other gases including CO2 and NO2, we are reporting it as a group and reporting CO2 as a separate group. However, one must note that CO2 is a part of GHG, though a huge contributor. By exploring GHG emissions in sectors like energy, industry, and transportation, we can better understand the environmental footprint of each continent.



Interesting Thing About This Analysis...

A key part this analysis that distinguishes it from the other ones we've researched is that it's done mostly on a **continent level**. We took a trip to the website of the primary data source (EDGAR) as well as other sources like world bank climate data. Though some regional analysis were conducted there, our focus was not stands out by considering the impact on the 6 continents of the world.

And Then The Fun Begins...

ASIA

5,573,657 Mt CO2eq/yr

Okpo 12-12-2023

AFRICA. →

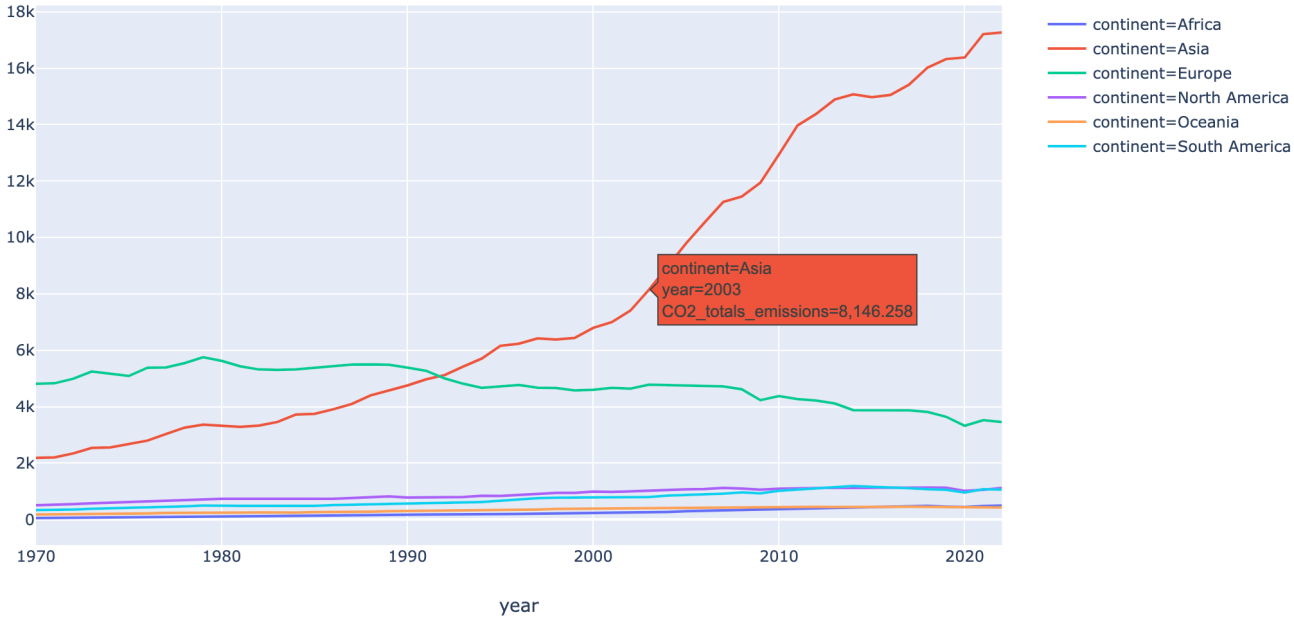
863,323 Mt CO2eq/yr

Asia and Africa stand out in our analysis like a tale of two *continents*. Asia on the one hand, has lots of large stats which can be called outliers. **China** in particular contributes the highest in this continent. Africa on the other hand gains recognition with lots of small emission statistics. To understand what this value means take a look at the table and plots below below which are products of this analysis:

A. **GHG Total Emissions (Mt GHGeq/yr):**

Continent	Count	Mean	Std	Min	25%	50%	75%	Max
Africa	265	863,323.44	828,849.19	0.0	241,041.47	567,010.06	1,276,218.38	3,345,606.0
Asia	901	5,573,657.0	16,883,888.0	0.0	543,794.56	1,204,677.5	2,890,110.5	137,209,120.0
Europe	1696	1,607,697.63	2,240,081.75	0.0	272,081.16	665,747.78	1,835,814.28	12,532,723.0
North America	212	2,731,918.25	2,701,641.75	0.0	266,565.42	553,125.5	5,389,681.63	7,172,248.0
Oceania	106	2,395,870.75	1,940,173.63	0.0	659,573.97	773,010.03	4,269,468.13	5,321,305.0
South America	477	1,676,670.13	2,406,960.75	0.0	355,034.53	769,782.0	1,979,739.75	11,749,798.0

Temporal Trends in CO2 Emissions by Continent

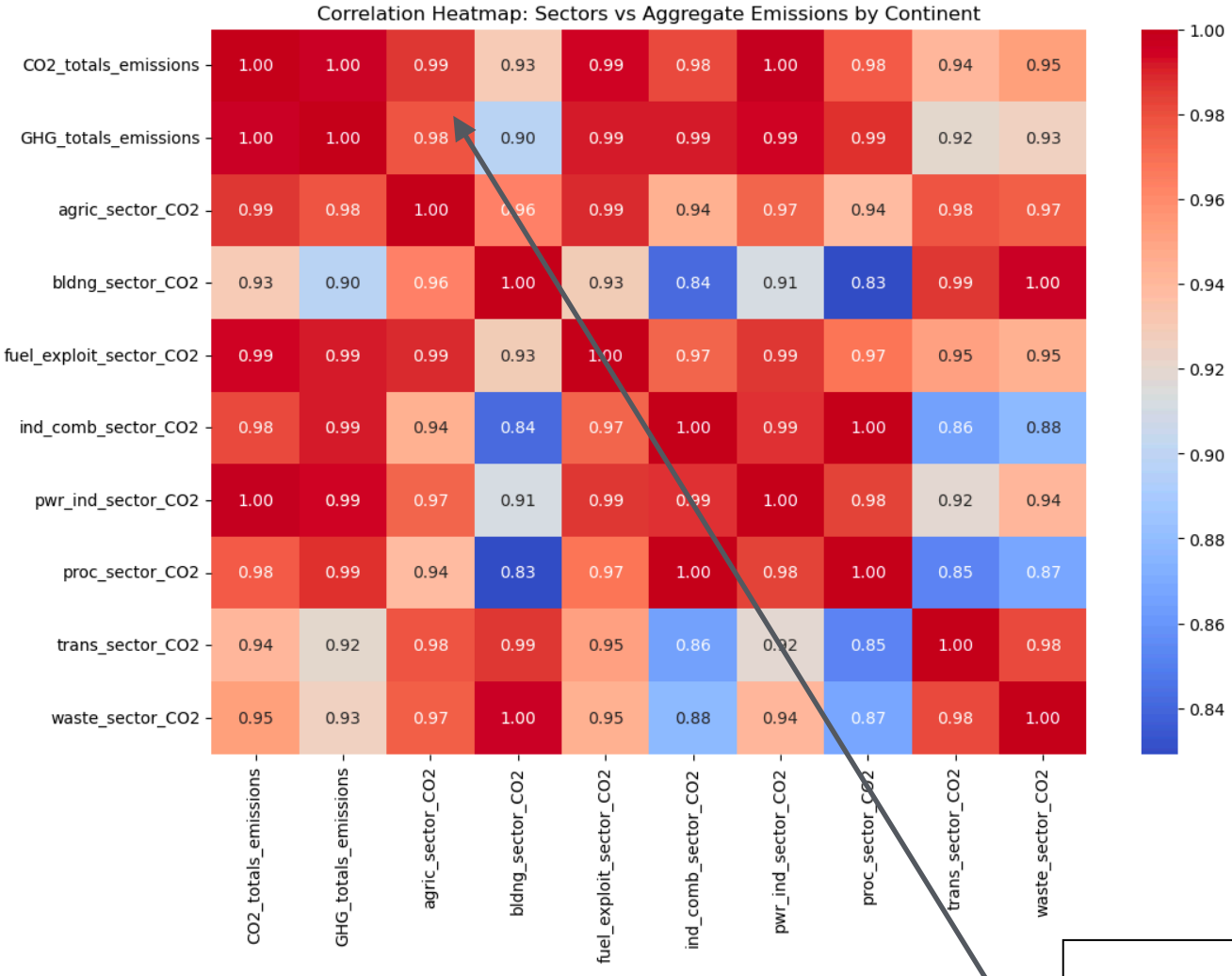


Fun Fact 1:

1. Asia or China are having a steady growth in GHG and CO2 emissions
2. Europe appears to be winning the fight against emissions, as their is going downwards
3. North America has had a steady win in this regard maintaining a low overall variability

★ What About Sector Contributions & Relationships?

AGRICULTURE
BUILDINGS
FUEL EXPLOITATIONS. + GHG/CO2
INDUSTRIAL COMBUSTION EMISSIONS
TRANSPORTATION.
WASTE
PROCUREMENT

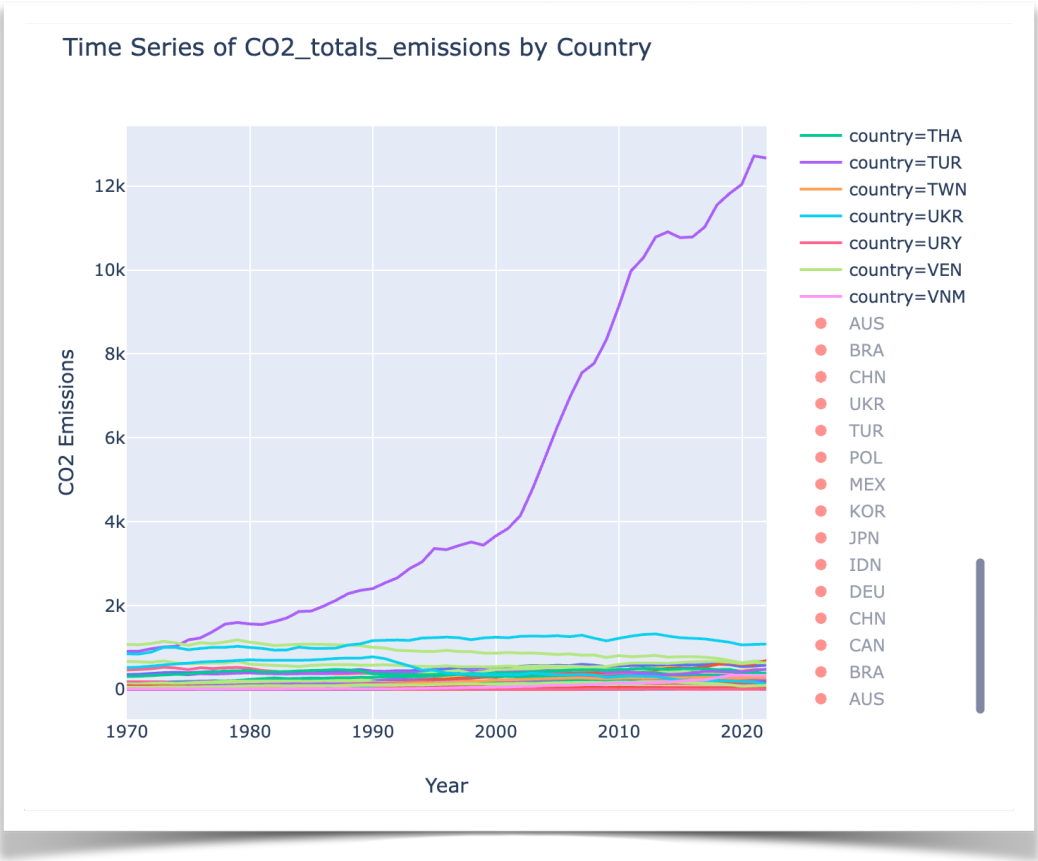


The Intersection point or box show the ratio of the relationship, on the matrix below.

Fun Fact 2: All sectors have a positive relationship with the emissions

★ And Country Specific Contributions & Relationships?

While there were noticeable positive relationships, we noticed some excessively high emission numbers across some countries, one of them we've already mentioned (China). Others though not as noticeable as China (CHN), were AUSTRALIA (AUS), Brazil (BRA), Canada (CAN), Germany (DEU), Indonesia (IDN), Japan (JPN), South Korea (KOR). Mexico (MEX), Poland (POL), Turkey (TUR), Ukraine (UKR). In the time series chart below these countries are shown as ***red dots*** *in the legend.*

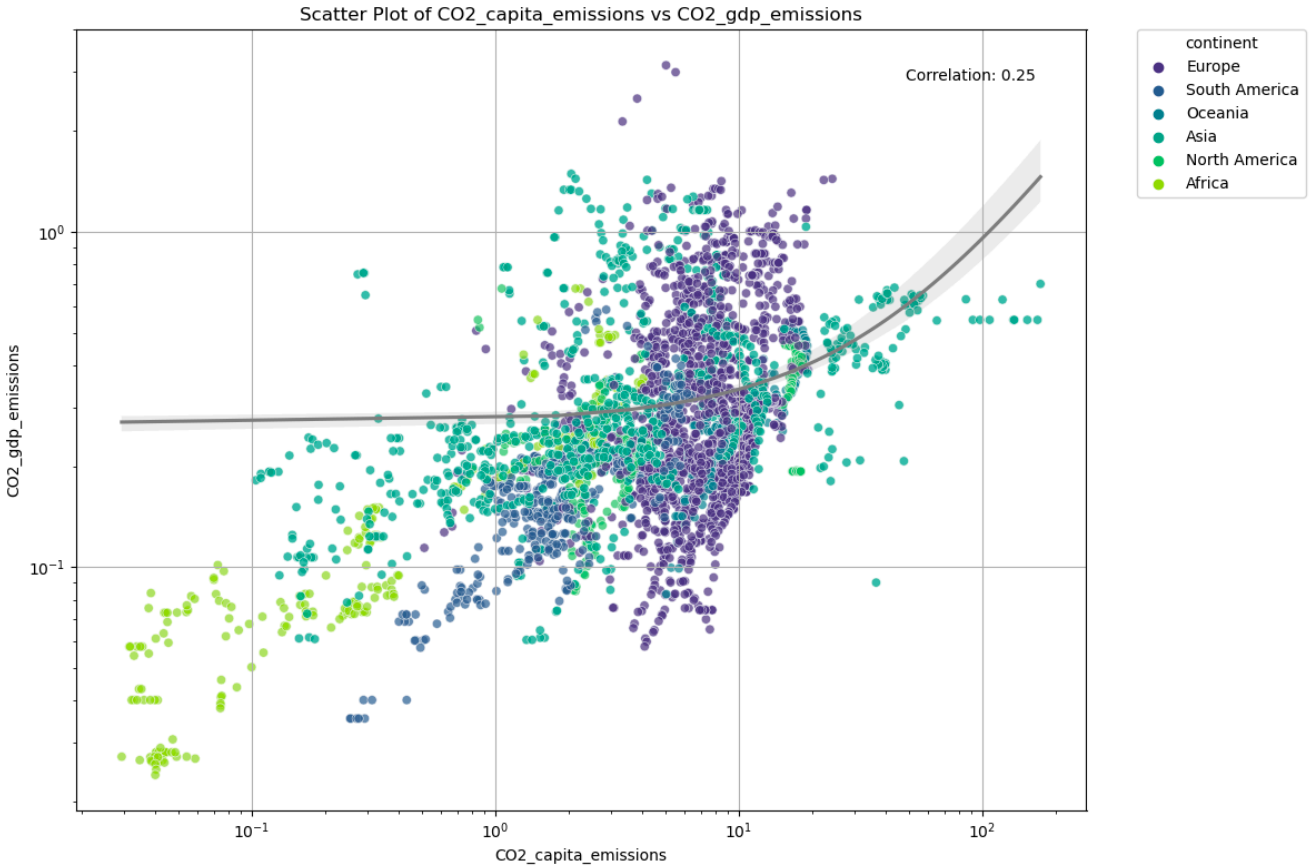


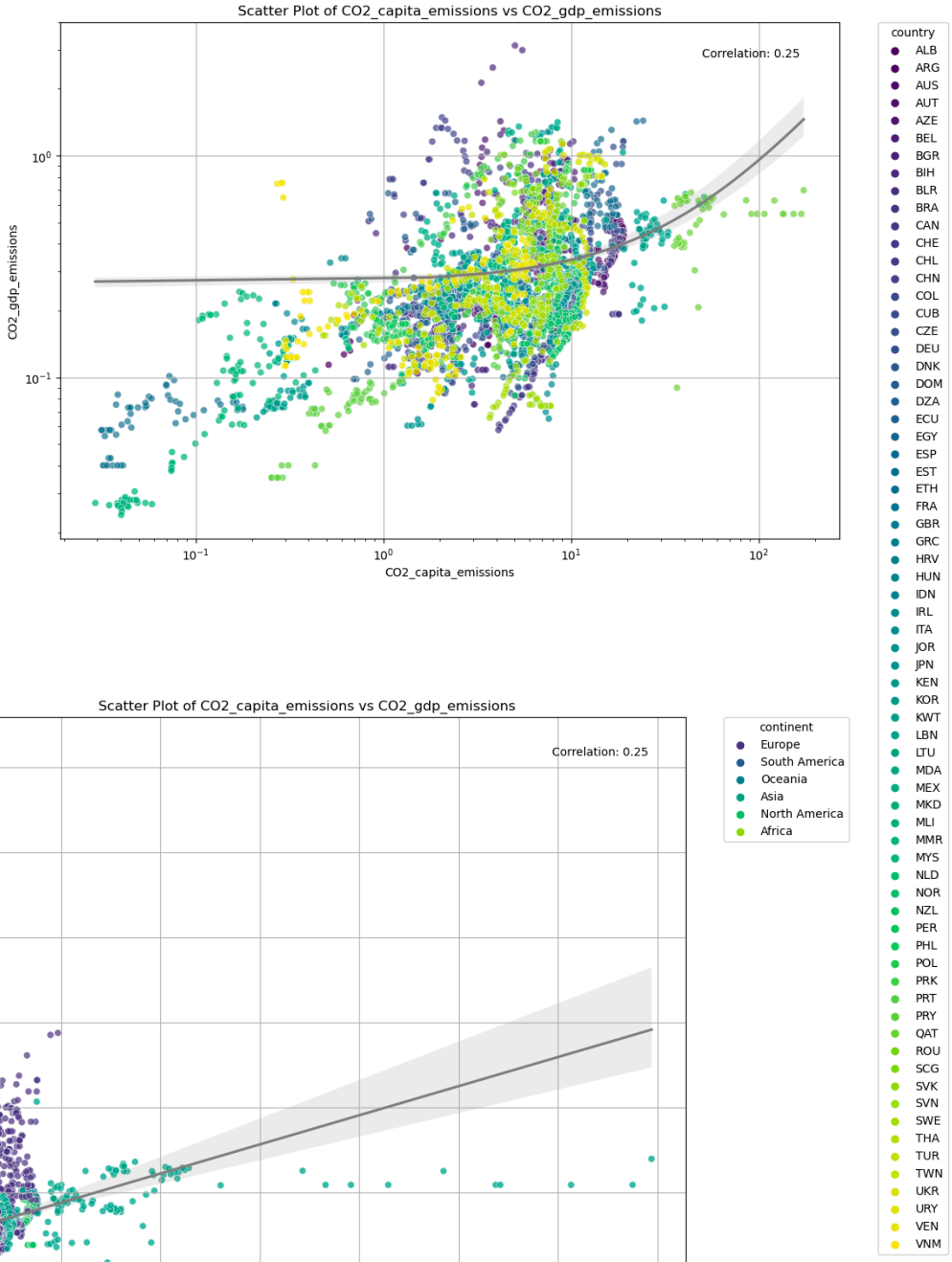
Fun Fact 3:

1. Country-specific emissions can be driven by a combination of factors including economic, industrial, energy-related, and environmental factors
2. Additionally, policy decisions, technological advancements, and global events can contribute to the observed variations in emissions over time.

How GDP Related Emissions Shapes the Future

Some contents like Europe and their countries lead the pack in the influence of GDP related emission on the aggregates. The relationship, though positive is on the low side.



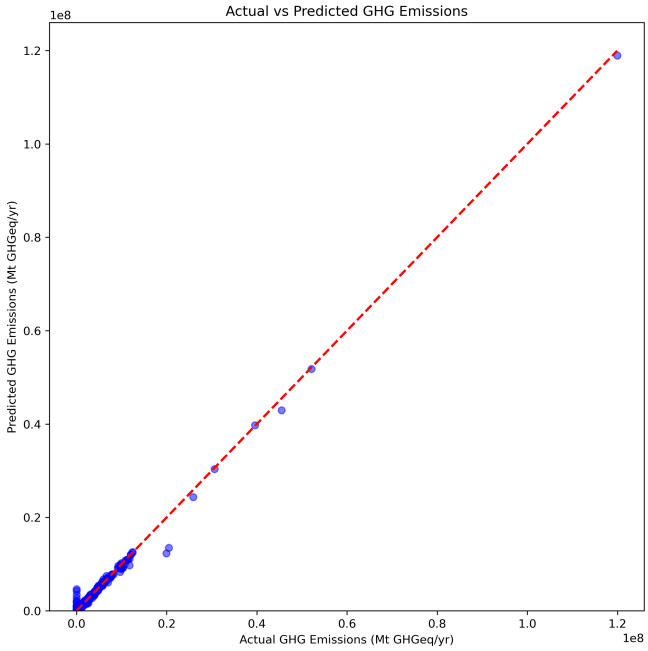

Scatter Plot of CO2_capita_emissions vs CO2_gdp_emissions
Correlation: 0.25
CO2_gdp_emissions
CO2_capita_emissions
country
ALB
ARG
AUS
AUT
AZE
BEL
BGR
BIH
BLR
BRA
CAN
CHE
CHL
CHN
COL
CUB
CZE
DEU
DNK
DOM
DZA
ECU
EGY
ESP
EST
ETH
FRA
GBR
GRC
HRV
HUN
IDN
IRL
ITA
JOR
JPN
KEN
KOR
KWT
LBN
LTU
MDA
MEX
MKD
MLI
MMR
MYS
NLD
NOR
NZL
PER
PHL
POL
PRK
PRT
PRY
QAT
ROU
SCG
SVK
SVN
SWE
THA
TUR
TWN
UKR
URY
VEN
VNM

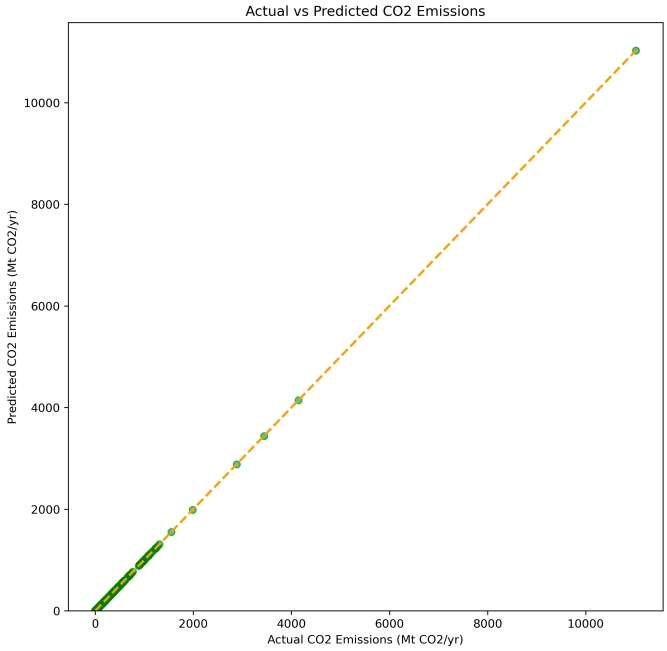
Scatter Plot of CO2_capita_emissions vs CO2_gdp_emissions
Correlation: 0.25
CO2_gdp_emissions
CO2_capita_emissions
continent
Europe
South America
Oceania
Asia
North America
Africa

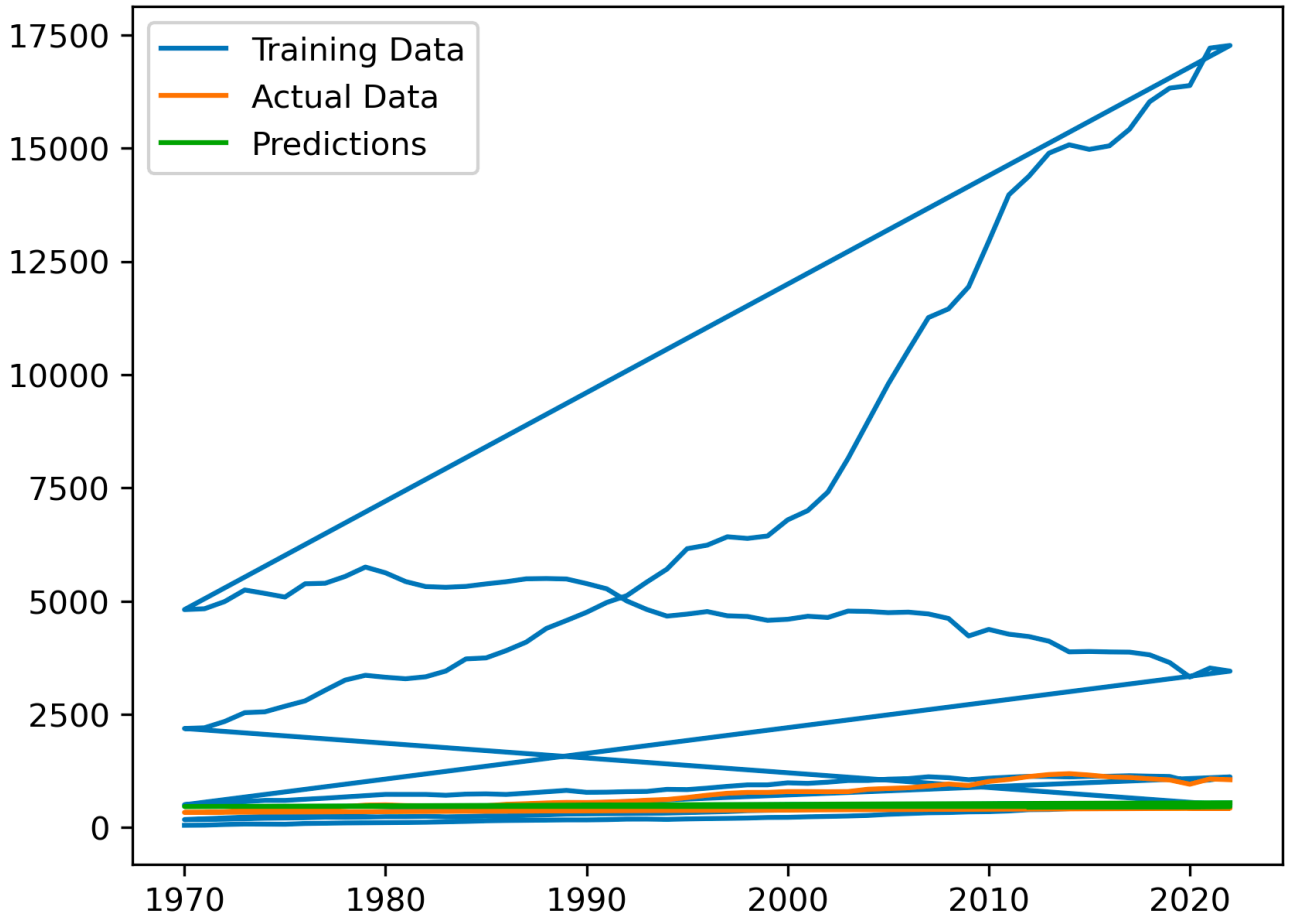
What Does The Future Look Like With These Stats

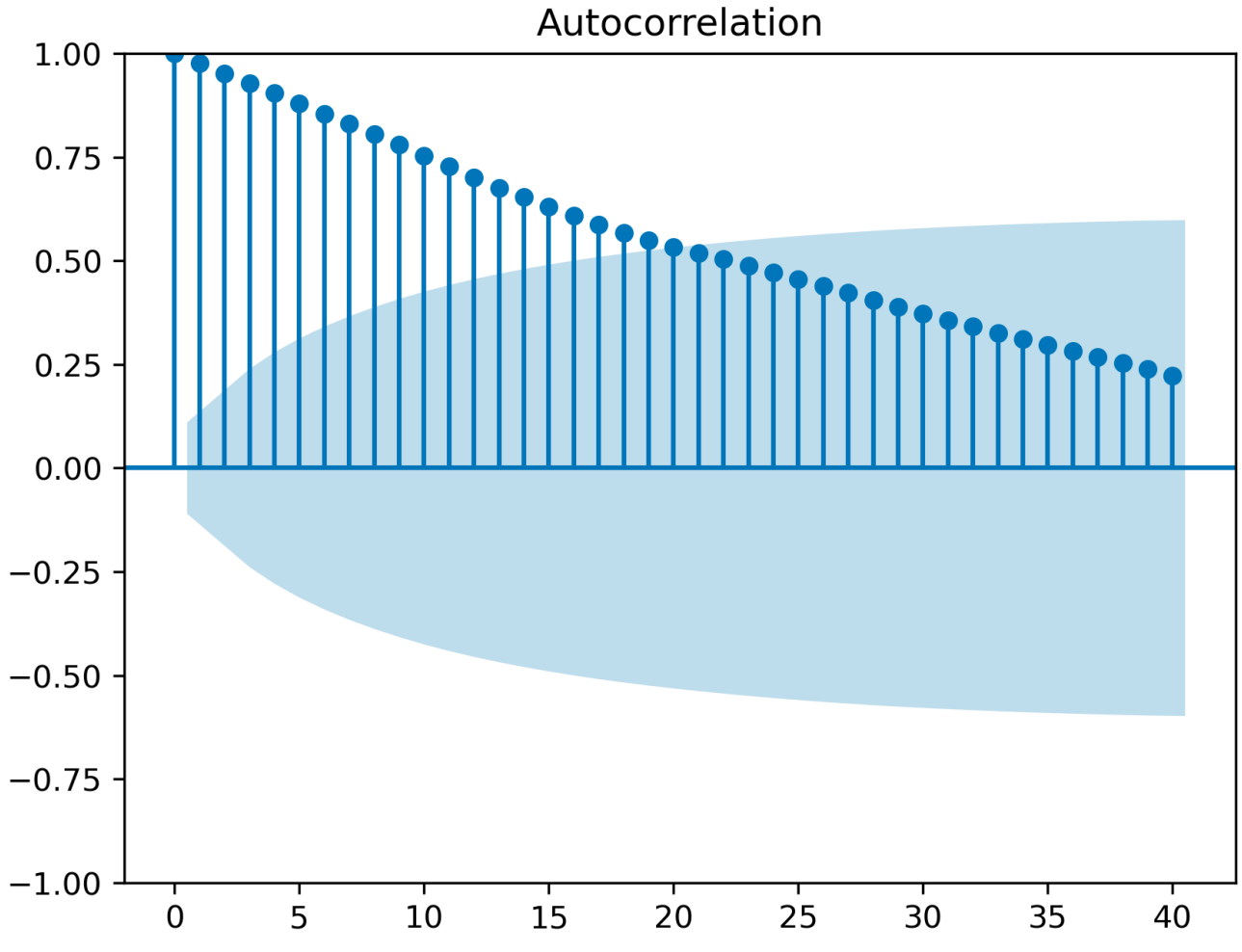
In preparing the data for prediction, a lot of work was done to make it ready to capture the present situation, feed it with the necessary inputs so it can predict adequately. Since the data had so many outliers, and missing values, we explored various techniques ranging from backward filling to advanced KNN. Eventually, we went with the base data that wasn't transformed because we needed to predict with the outliers mostly intact as required by the challenged task.

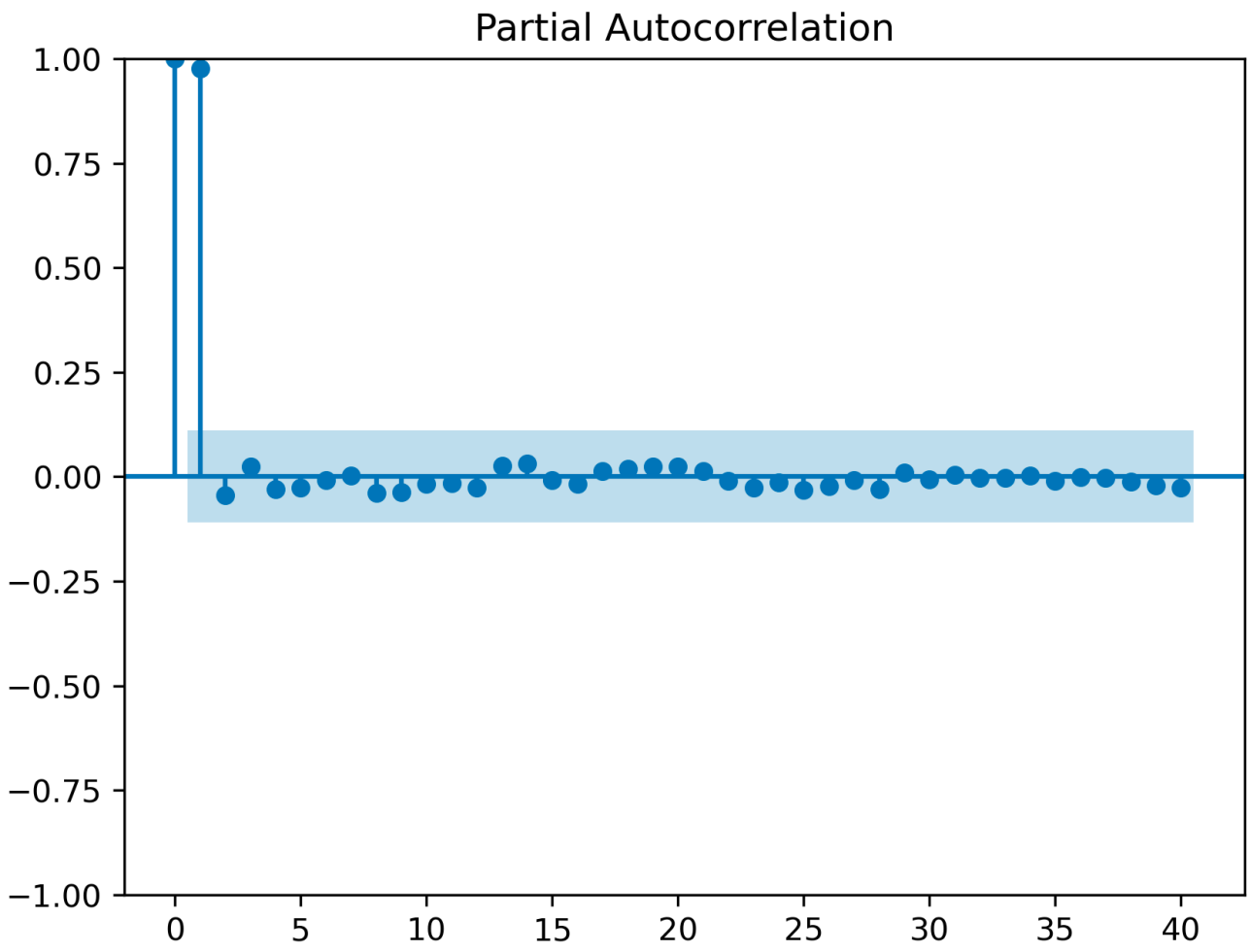
We predicted with Linear Regression and ARIMA using time series for a period of 3 years from 2023 to 2026. Before proceeding with the prediction, we confirmed the correlation between the variables.

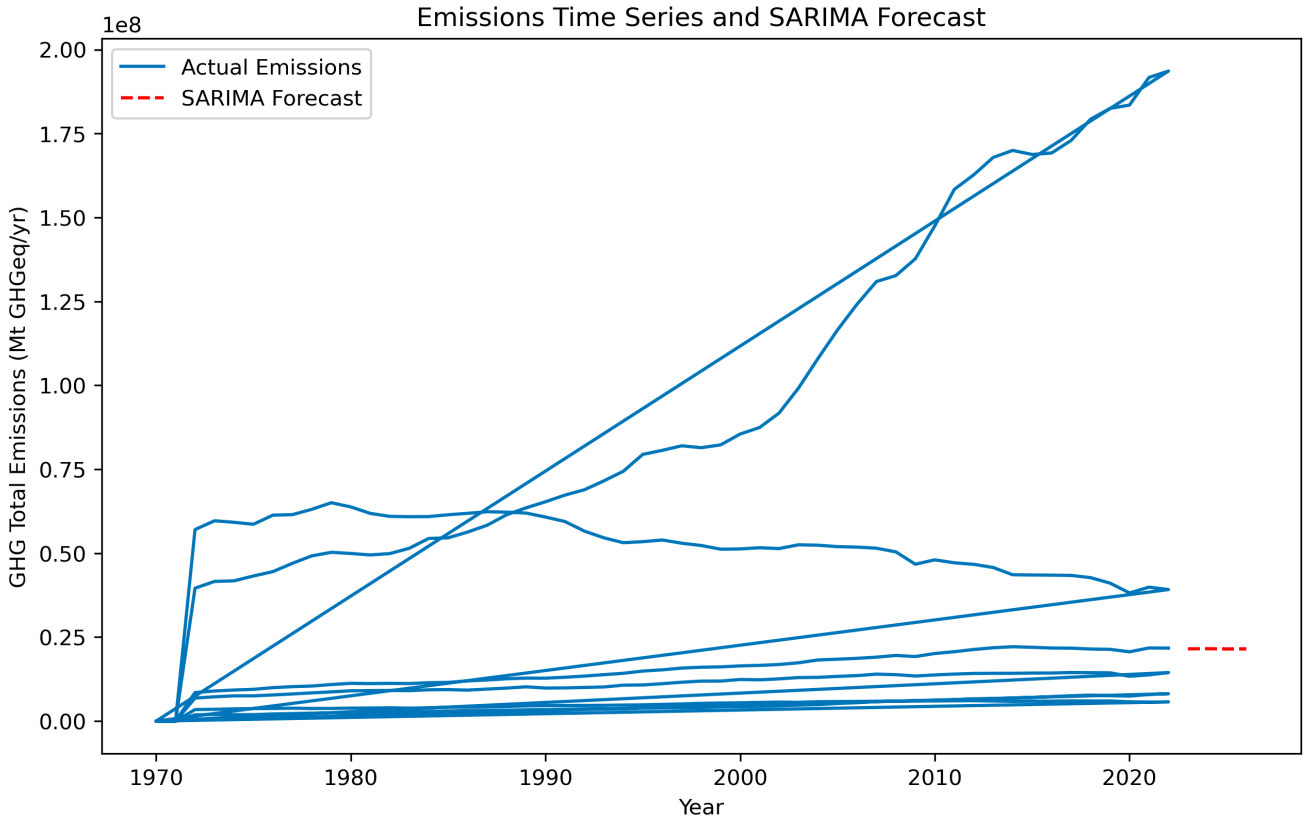


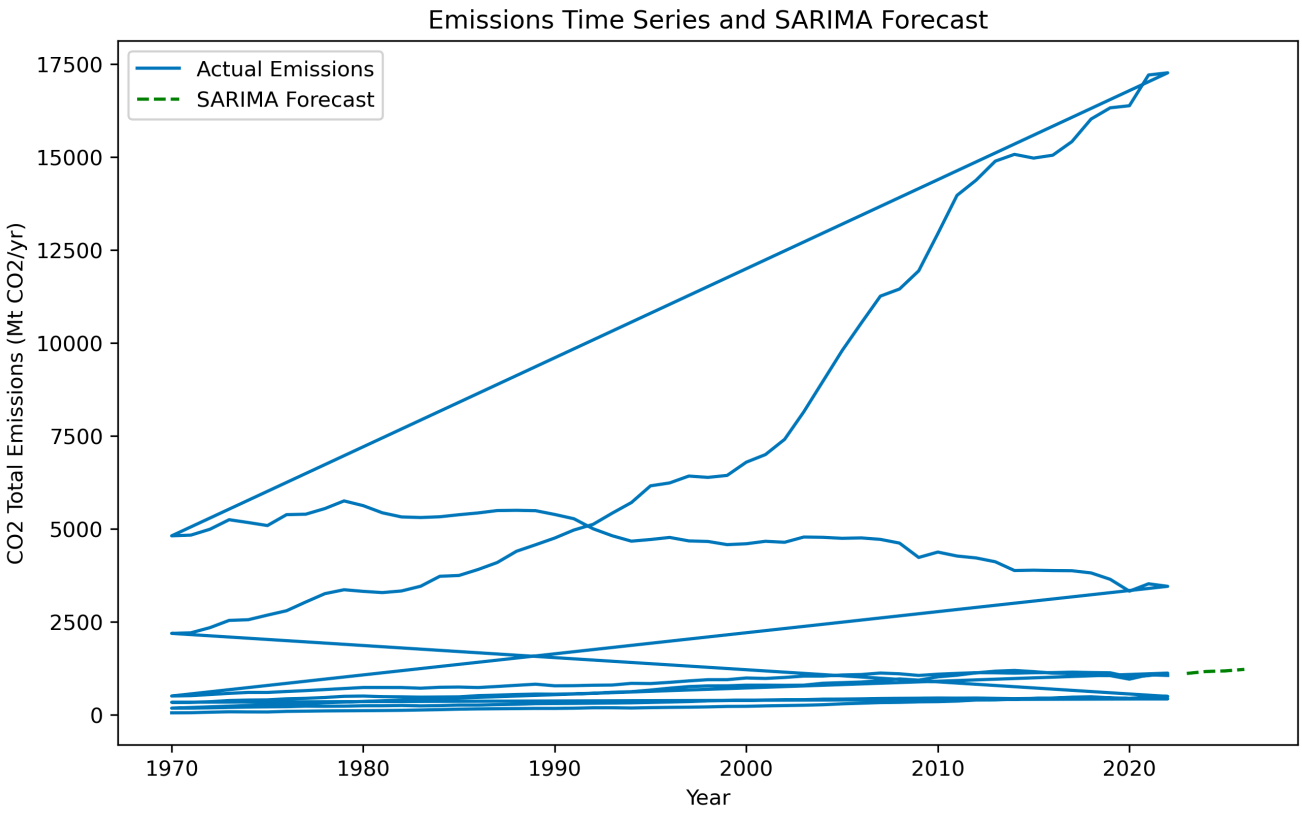



Training Data
Actual Data
Predictions
17500
15000
12500
10000
7500
5000
2500
0
1970
1980
1990
2000
2010
2020


Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25
30
35
40

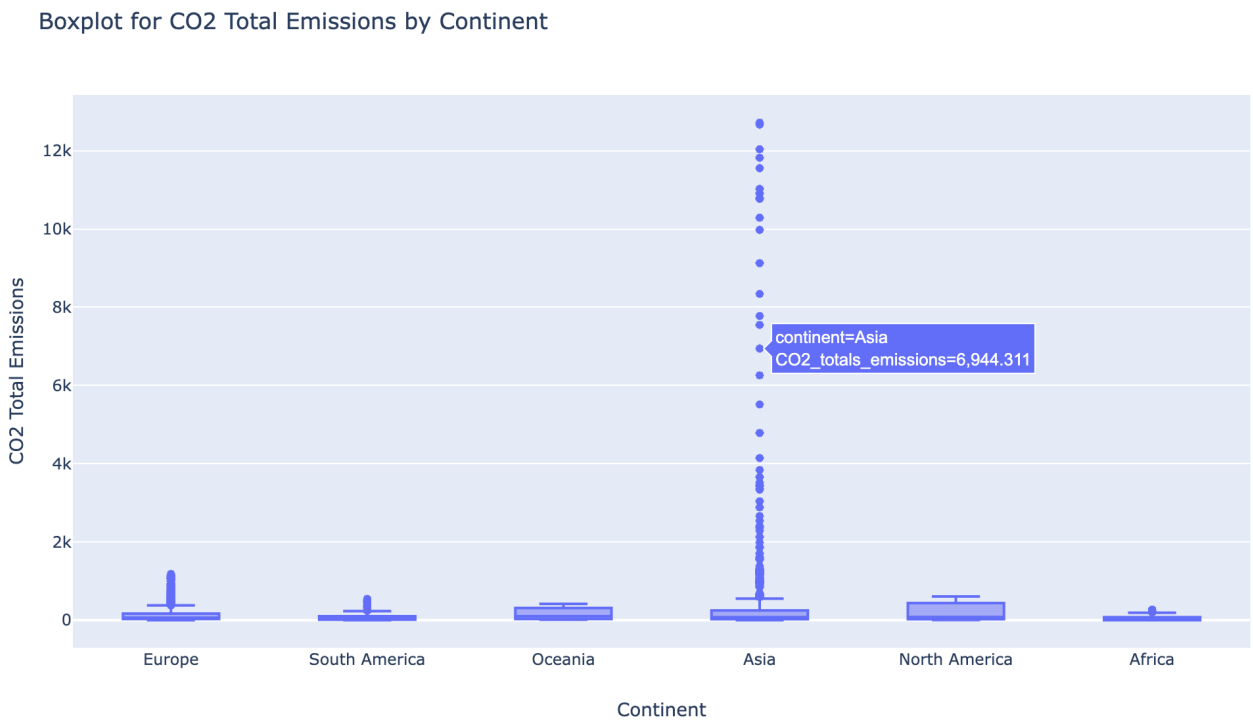

Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25
30
35
40


Emissions Time Series and SARIMA Forecast
1e8
Actual Emissions
SARIMA Forecast
GHG Total Emissions (Mt GHGeq/yr)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
1970
1980
1990
2000
2010
2020
Year


Emissions Time Series and SARIMA Forecast
Actual Emissions
SARIMA Forecast
CO2 Total Emissions (Mt CO2/yr)
17500
15000
12500
10000
7500
5000
2500
0
1970
1980
1990
2000
2010
2020
Year

★ Other important visualizations:

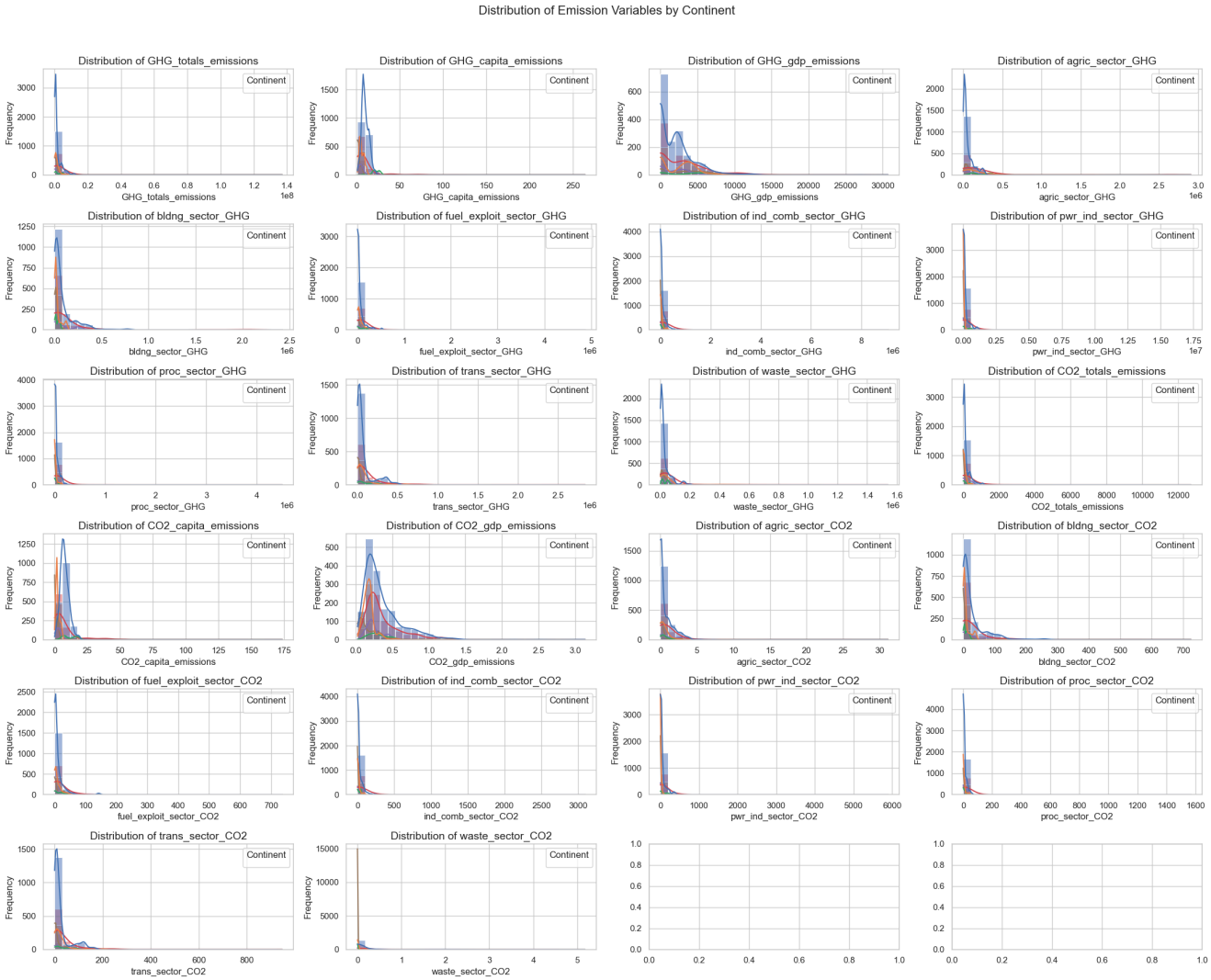
Asia had enormous number of outliers as shown the box plot below.



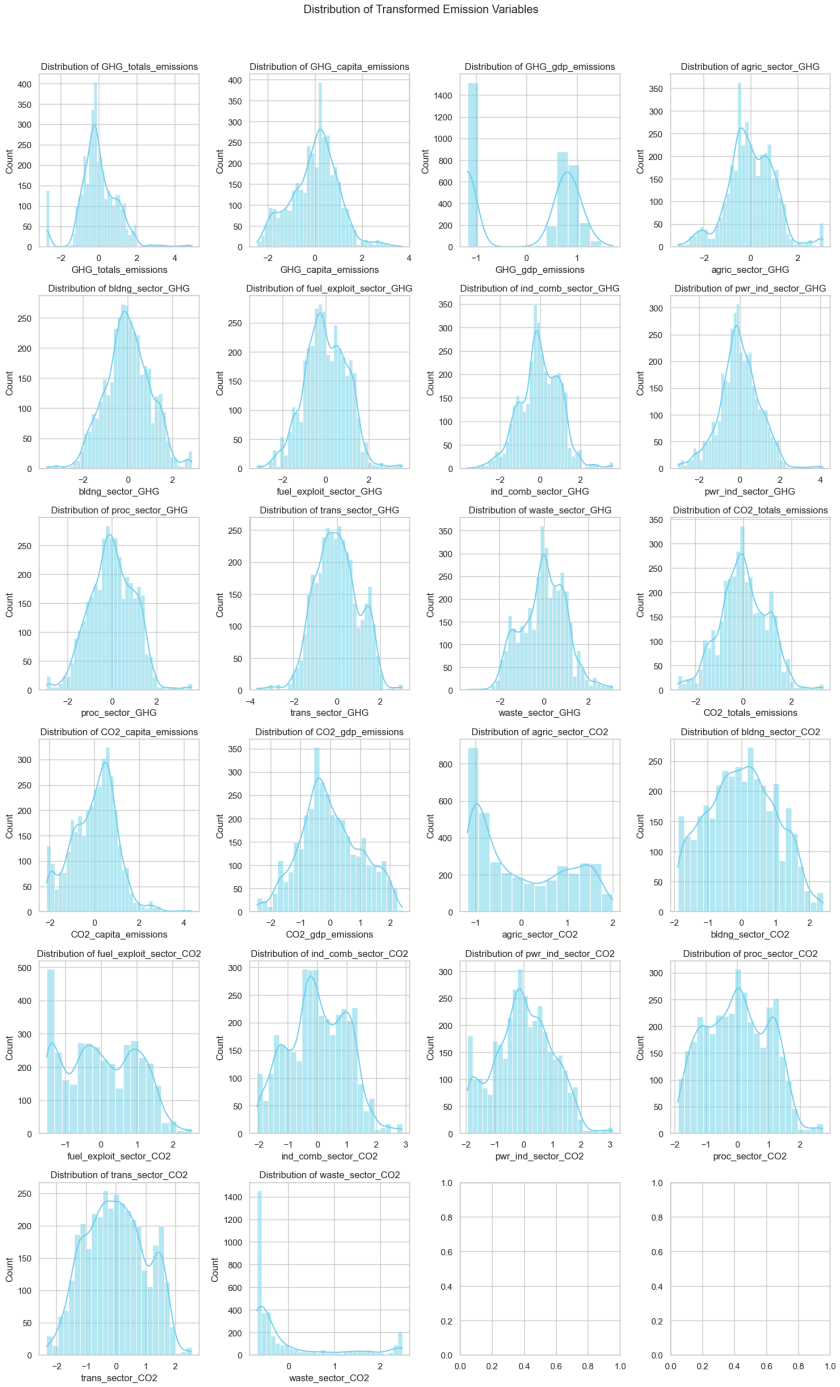
The various time series plots indicates a declining pace of emissions across the continents except China.

The entire features data were filled with outliers as shown by the box plot plots below:

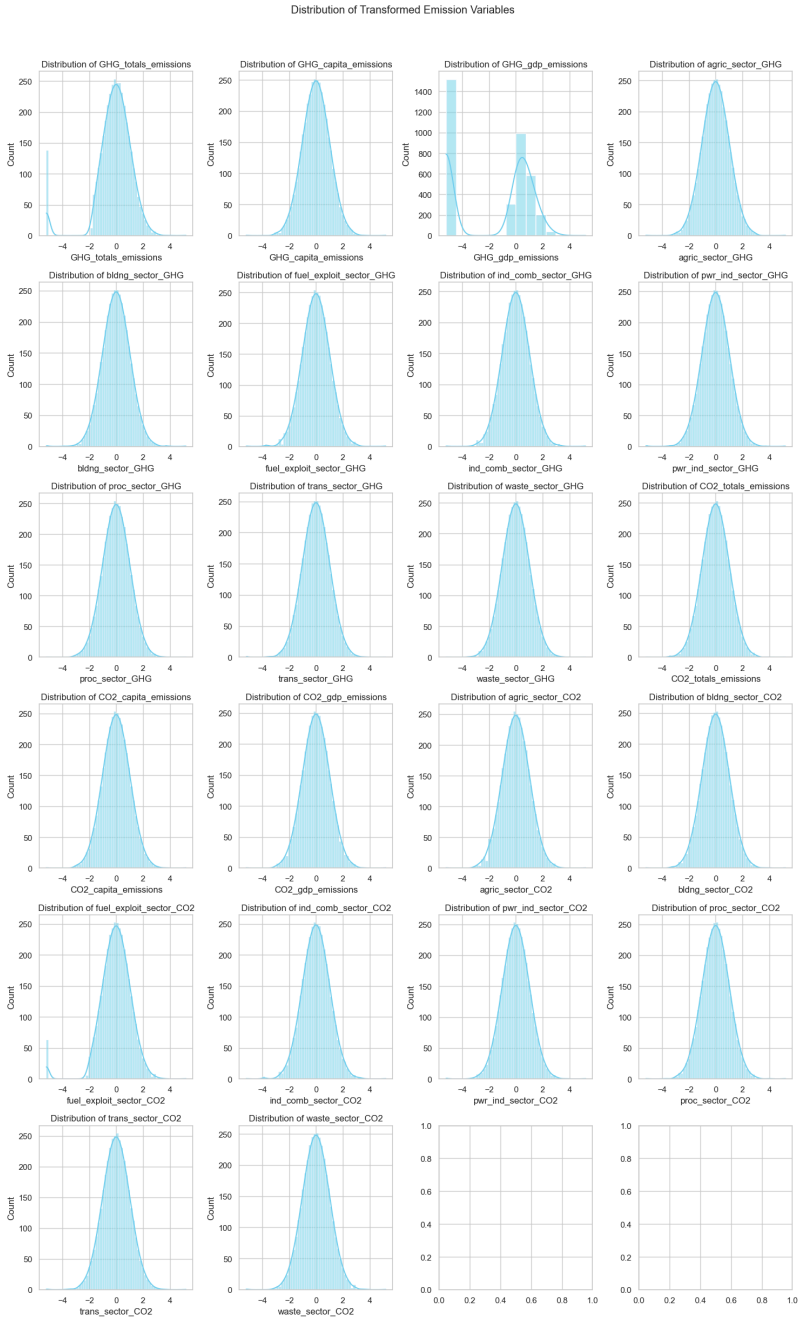
The entire dataset features were skewed to the right at the initial stage before I performed some series of transformations to remove the skewing, some zeros, and outliers.



After power transformation some normality was achieved as shown below..



A greater degree of success was achieved in removing skewing using quantile transformation:



The box plot below should the improvement in the dataset:

Conclusions

In conclusion, our analysis of Greenhouse Gas (GHG) emissions across continents has revealed valuable insights into the environmental impact of various sectors. Understanding these findings is crucial for formulating sustainable practices and policies. Here are the key takeaways:

1. **Total GHG Emissions:**
- Asia exhibits the highest total GHG emissions, indicating a substantial environmental footprint.
- Europe and North America contribute significantly, emphasizing the need for continued efforts in sustainable practices.
- South America shows diversity in emissions, suggesting tailored strategies for each country.

2. **GHG Emissions per Capita:**
- Asia has a higher individual impact, highlighting the importance of addressing lifestyle and consumption patterns.
- Europe serves as a benchmark for more moderate individual impacts, suggesting potential best practices.
- Oceania's elevated per capita emissions indicate opportunities for sustainable lifestyle changes.

3. **Sector-wise Analysis:**
- The agriculture sector is a significant contributor globally, necessitating sustainable farming practices.
- The building and fuel exploitation sectors call for energy-efficient construction and cleaner energy sources.
- Industrial combustion and the power industry sectors require enhanced regulations and adoption of cleaner technologies.
- The waste sector demands improved waste management globally.
- The transportation sector emphasizes the urgency of sustainable mobility solutions.

Recommendations:

Based on our findings, we propose the following recommendations:

1. **Promote Sustainable Farming:**
- Encourage the adoption of eco-friendly and sustainable farming practices in all continents to mitigate the impact of the agriculture sector.

2. **Energy Efficiency in Construction:**
- Implement energy-efficient construction practices and promote the use of renewable energy sources in the building sector.

3. **Transition to Clean Energy:**
- Facilitate the transition to cleaner energy sources in the fuel exploitation and power industry sectors to reduce carbon emissions.

4. **Regulations for Industrial Emissions:**
- Strengthen regulations and standards for industrial combustion, ensuring industries adopt cleaner technologies and reduce emissions.

5. **Comprehensive Waste Management:**
- Develop comprehensive waste management strategies globally, including recycling programs and waste-to-energy initiatives.

6. **Sustainable Mobility Solutions:**
- Promote sustainable transportation solutions, such as electric vehicles, public transportation, and biking, to reduce emissions from the transportation sector.

7. **Public Awareness and Education:**
- Increase public awareness about individual carbon footprints and the importance of sustainable practices through educational campaigns.

8. **International Collaboration:**
- Encourage international collaboration to share best practices, technologies, and policies to address GHG emissions collectively.

By implementing these recommendations, we can work towards a more sustainable and environmentally conscious future, mitigating the impact of GHG emissions on a global scale.

1. Picture Credits:

Mollyroselee from Pixabay
https://www.epa.gov/ghgemissions/overview-greenhouse-gases

2. Data Credits:

EDGAR (Emissions Database for Global Atmospheric Research) Community GHG Database, a collaboration between the European Commission, Joint Research Centre (JRC), the International Energy Agency (IEA), and comprising IEA-EDGAR CO2, EDGAR CH4, EDGAR N2O, EDGAR F-GASES version 8.0, (2023) European Commission, JRC (Datasets).

3. Special Thanks:
- Ocean Protocol Foundation
- Desights