Global Economic Effects on the Environment

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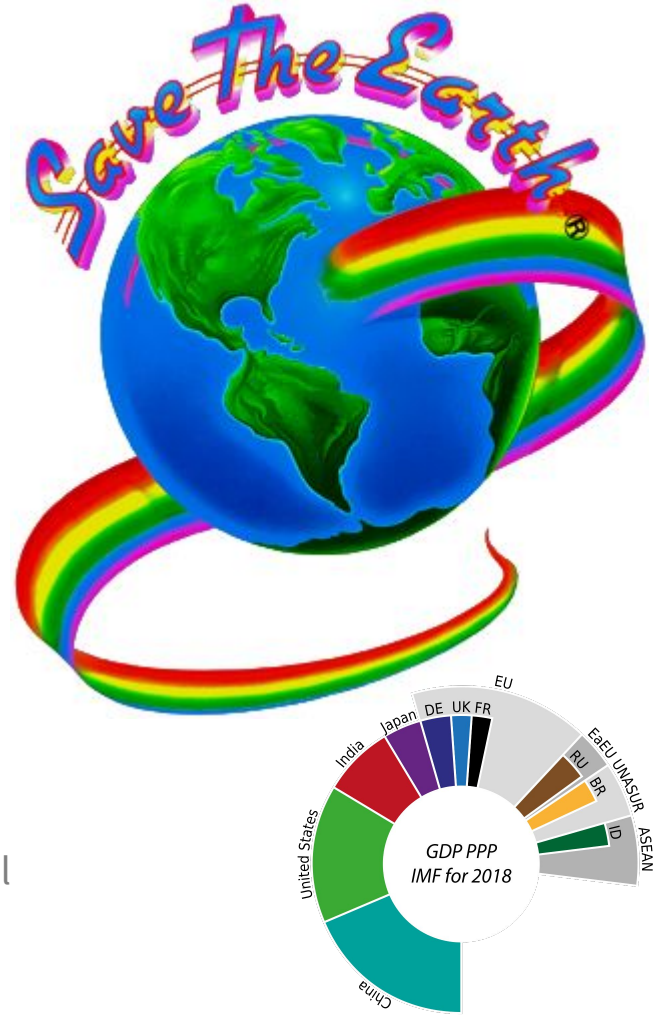
Motivation & Summary

Motivation: Understand how the trajectory of economic growth influences the environment

to shed light on profit-driven motives in place of environmental stewardship

- What are the general trends for global GDP?
- Is there a correlation between GDP and CO_2 emissions on a global level?
  - Does this mirror the trends of global land and ocean temperatures (℃)?
- How do these trends influence urbanization?

We found a strong correlation between GDP and CO_2 per capita, as well as similar trends for temperature and urbanization which appear to correlate with GDP



Questions & Data

We want to eventually plot global economic and environmental data to see if pursuit of economic growth creates significant environmental changes over time

World Bank Development Indicators

- Cross-country comparable data
- Variety of indicators
- Almost all years included
- Logical connection to gmaps
- No pay wall
- DataBank tool visualizes data and gives additional info about countries

Our main goal - find clean datasets for global economics and environment!

DataBank | World Development In...

Table | Chart | Map | Metadata | Download options

- Database — Available 79 | Selected 1
- Country — Available | Selected 217
- Series — Available | Selected 57
- Time — Available | Selected 16

Clear Selection | Add Country (217) Add Series (57) Add Time (16)

GDP growth (annual %)

- Immunization, measles (% of children ages 12-23 months)
- Primary completion rate, total (% of relevant age group)
- School enrollment, secondary (% gross)
- School enrollment, primary and secondary (gross), gender parity index (GPI)
- Prevalence of HIV, total (% of population ages 15-49)
- Forest area (sq. km)
- Water productivity, total (constant 2010 US$ GDP per cubic meter of total freshwater withdrawal)
- Improved water source (% of population with access)
- Improved sanitation facilities (% of population with access)
- Energy use (kg of oil equivalent per capita)
- CO2 emissions (metric tons per capita)
- Electric power consumption (kWh per capita)
- GDP (current US$)
- GDP growth (annual %)
- Inflation, GDP deflator (annual %)
- Agriculture, forestry, and fishing, value added (% of GDP)
- Industry (including construction), value added (% of GDP)
- Services, etc., value added (% of GDP)
- Exports of goods and services (% of GDP)
- Imports of goods and services (% of GDP)

	2009	2010	2011	2012	2013	2014	2015
	21.4	14.4	0.4	12.8	5.6	2.7	1.5
	3.4	3.7	2.5	1.4	1.0	1.8	2.2
	1.6	3.6	2.9	3.4	2.8	3.8	3.7
	-4.2	0.4	0.3	-4.4	-2.8	0.9	1.4
	-5.3	-2.0	0.0	-5.0	-3.5	2.5	1.4
	0.9	4.9	3.5	8.5	5.0	4.8	0.9
	-12.1	-7.6	-2.0	3.4	-0.6	3.8	3.8
	-5.9	10.1	6.0	-1.0	2.4	-2.5	2.7
	-14.1	2.2	4.7	7.2	3.3	3.6	3.2
	-10.5	-3.7	3.4	-1.4	4.2	0.3	5.7
	1.9	2.1	2.5	3.9	2.6	2.5	2.2

Austria	2.7	2.2	3.5	3.7	1.5	-3.8	1.8	2.9	0.7	0.0	0.7	1.0
Azerbaijan	9.3	28.0	34.5	25.5	10.6	9.4	4.8	-1.6	2.2	5.8	2.8	1.0
Bahamas, The	0.9	3.4	2.5	1.4	-2.3	-4.2	1.5	0.6	3.1	-3.0	0.7	0.6
Bahrain	7.0	6.8	6.5	8.3	6.2	2.5	4.3	2.0	3.7	5.4	4.4	2.9

Source: World Development Indicators. Click on a metadata icon for original source information to be used for citation.

Data Cleanup & Exploration

- Drop rows with no values
- Rename columns
- drop certain columns
- replace null values with spaces
- convert columns to float

```
# Remove any rows with no vlaues
Countries_gdp_clean=Countries_gdp.dropna(how='any')
```

```
# Remove Unwanted columns
Countries_gdp_clean = Countries_gdp_clean.drop(columns=['Series Name','Series Code','Country Code'])
```

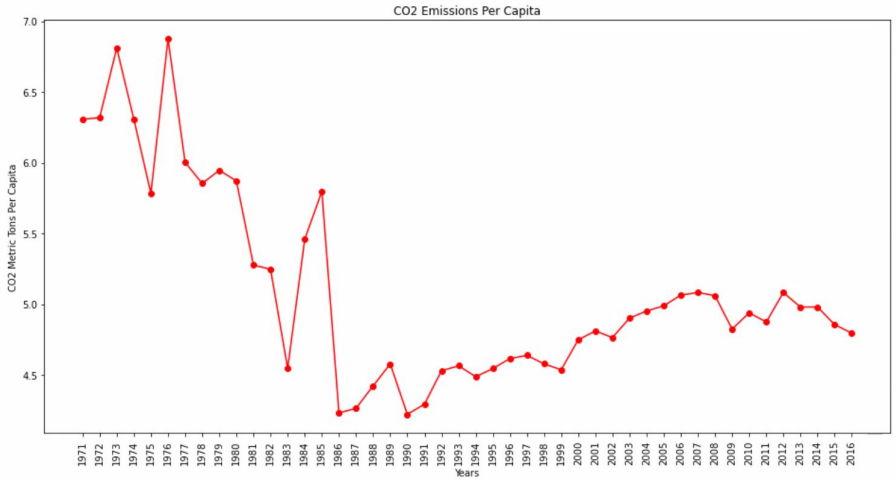
```
# Replace any empty values with spaces so it allows us to covert all columns into float data type

Countries_gdp_clean = Countries_gdp_clean.replace({'..':''})
```

```
# Convert all columns into float so we can run mathmatial calculations
Countries_gdp_clean[columns] = Countries_gdp_clean[columns].apply(pd.to_numeric)
```

Challenges during Data Exploration

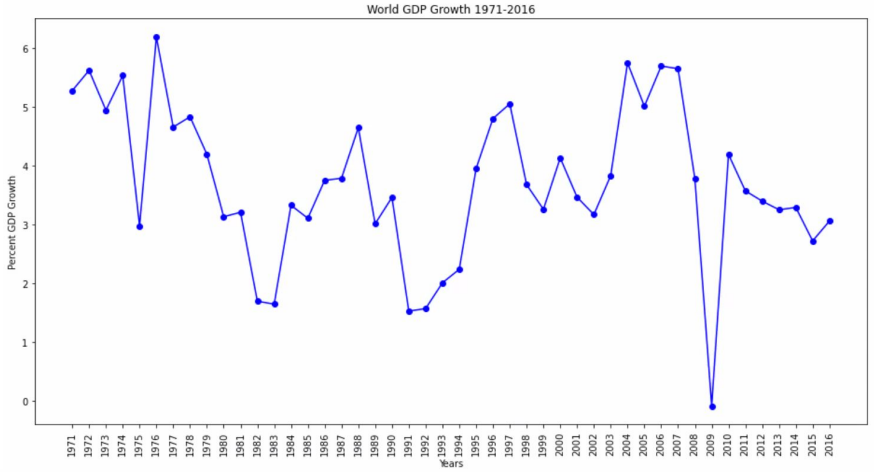
```
# Renaming Egypt and Yemen to match GMAP name
country_list[53] = 'Egypt'
country_list[197] = 'Yemen'
country_list
```

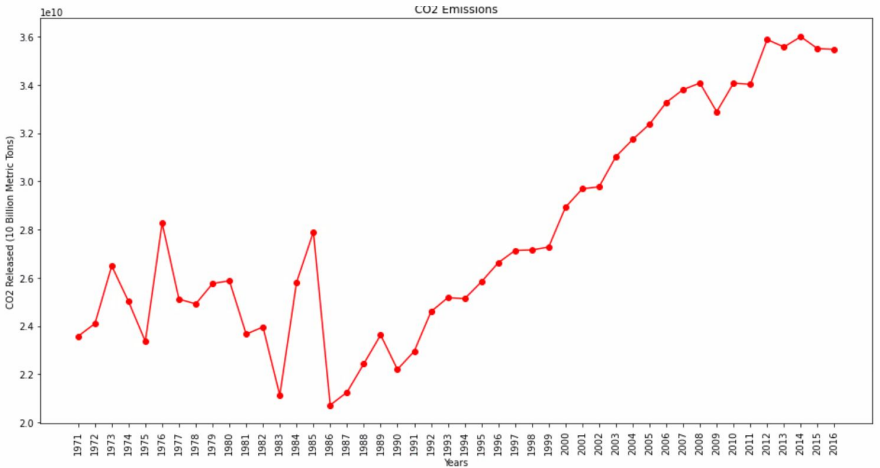
- When plotting the GDP data on gmaps, we had to hardcode the countries “Egypt” and “Yemen” into our df because their name on the WB data did not match with Google’s name for them.
- Our original CO_2 emissions dataset showed a decreased trend over time
  - The figure was plotting CO_2 per capita, which doesn’t take population into account
- After making regular figures, we decided to improve upon them:
  - Interactive maps with **Bokeh** for the temperature data
  - color-coordinated GDP gmap by mapping country (identified by lat/long using geojson) to **GINI** coefficient



Data Analysis

- GDP
  - Create line plot of year and mean GDP growth globally
  - Gmap
    - Call API to get lat & long for all countries
    - Use GINI codes to color code global map
    - Use info boxes to store GDP info
- CO_2
  - Sum of CO_2 emissions and year
  - Converted from per capita to total using population

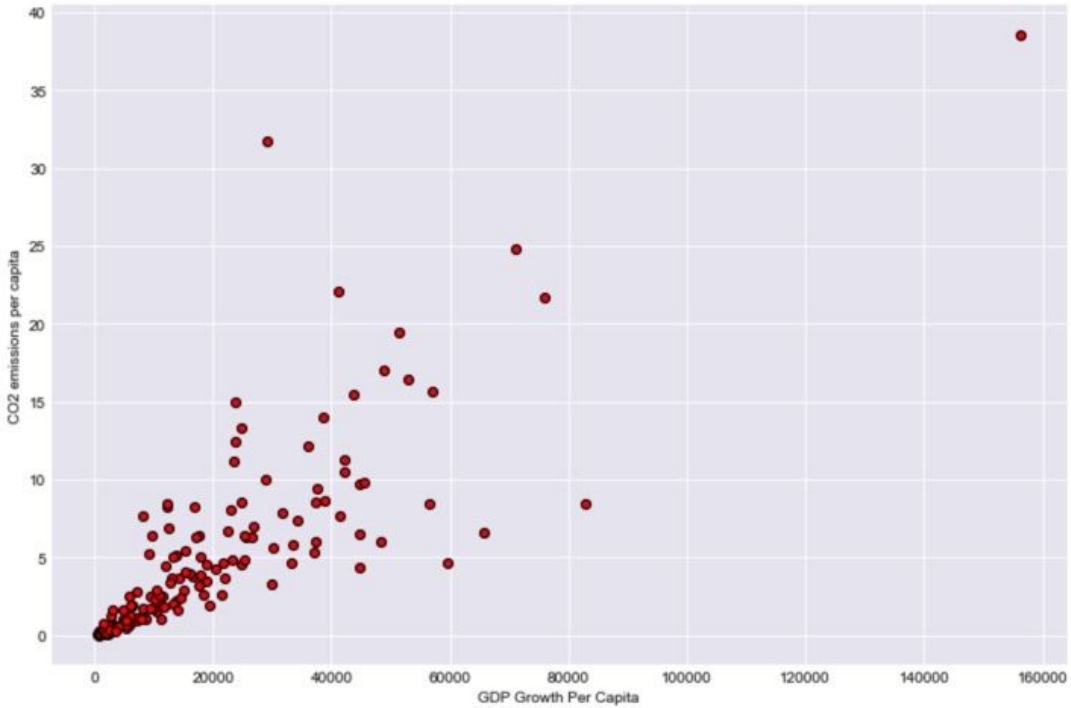




CO_2 vs GDP growth comparative figure

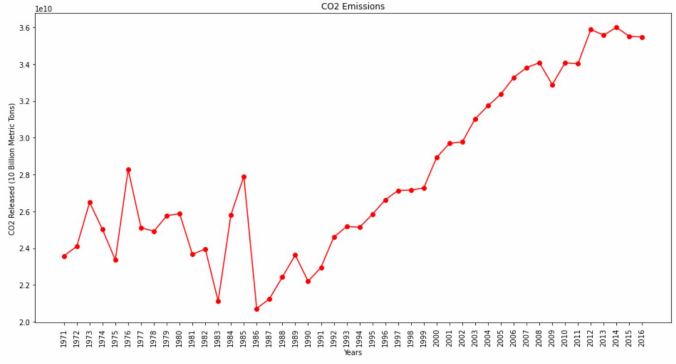
	Entity	Total_Population	GDP_Per_Capita	CO2 emissions Per capita
217	Afghanistan	35383000.0	1929.0	0.244562
620	Albania	2886000.0	10342.0	1.570467
840	Algeria	40551000.0	14331.0	3.639334
1350	Angola	28842000.0	8453.0	1.182683
1861	Argentina	43508000.0	18875.0	4.597748
...	...	...	...	...
50287	Venezuela	29851000.0	15219.0	5.467452
50507	Vietnam	93640000.0	6062.0	1.959536
51020	Yemen	27168000.0	2506.0	0.377011
51243	Zambia	16363000.0	3479.0	0.295658
51464	Zimbabwe	14030000.0	1534.0	0.770309

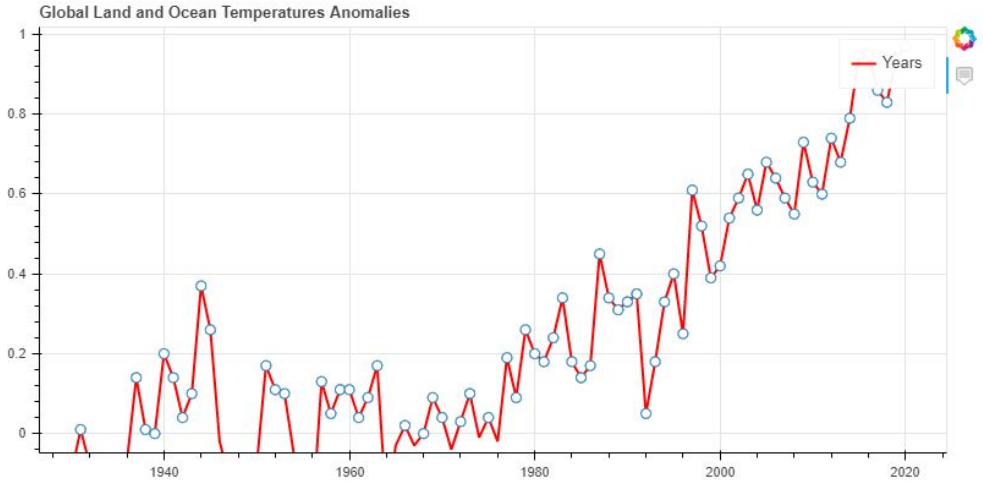
r = .81

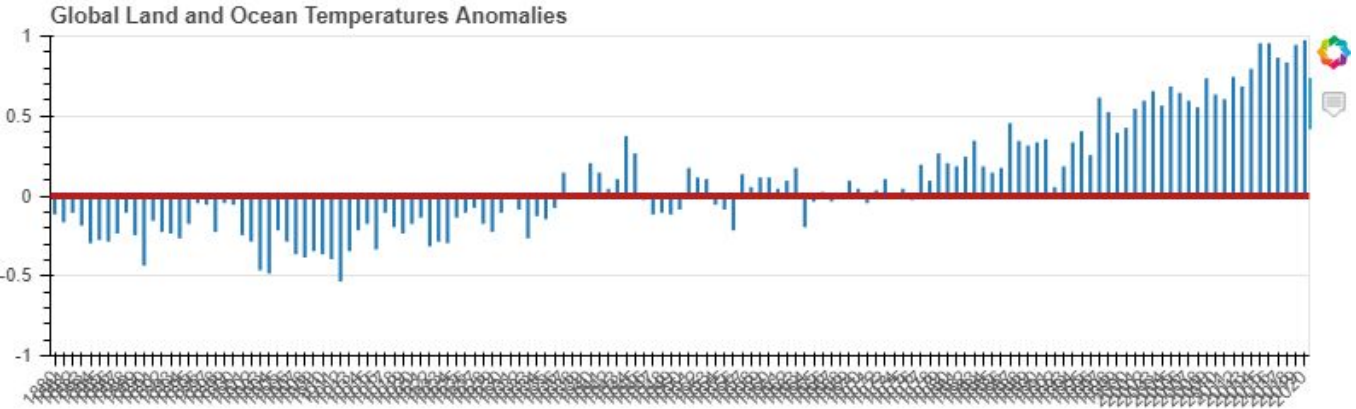


```
# Uisng GMAPS we are colouring global map using GINI codes


import gmaps
import gmaps.geojson_geometries
from config import gkey
gmaps.configure(api_key=gkey)
import pandas as pd
import gmaps.datasets
from matplotlib.cm import viridis
from matplotlib.colors import to_hex

# Get all the countries with geometry coordinates
countries_geojson = gmaps.geojson_geometries.load_geometry('countries')

# to get all the GINI values for each country
rows = gmaps.datasets.load_dataset('gini') # 'rows' is a list of tuples
country2gini = dict(rows) # dictionary mapping 'country' -> gini coefficient



# We will need to scale the GINI values to lie between 0 and 1
min_gini = min(country2gini.values())
max_gini = max(country2gini.values())
gini_range = max_gini - min_gini


def calculate_color(gini):
    """
    Convert the GINI coefficient to a color
    """
    # make gini a number between 0 and 1
    normalized_gini = (gini - min_gini) / gini_range

    # invert gini so that high inequality gives dark color
    inverse_gini = 1.0 - normalized_gini

    # transform the gini coefficient to a matplotlib color
    mpl_color = viridis(inverse_gini)

    # transform from a matplotlib color to a valid CSS color
    gmaps_color = to_hex(mpl_color, keep_alpha=False)

    return gmaps_color

colors = []
for feature in countries_geojson['features']:
    country_name = feature['properties']['name']
    try:
        gini = country2gini[country_name]
        color = calculate_color(gini)
    except KeyError:
        # no GINI for that country: return default color
        color = (0, 0, 0, 0.3)
    colors.append(color)
```

Data Analysis Cont.





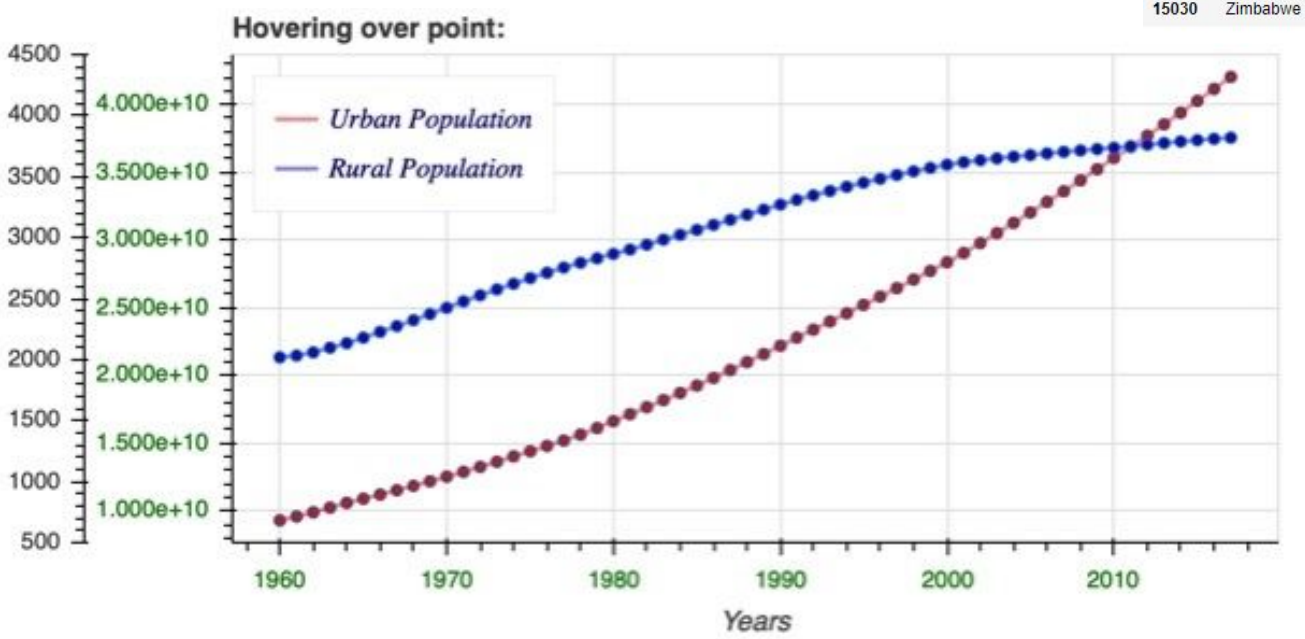


- Global Temperature
  - Use Bokeh library to make interactive graphs of land and ocean temperature anomalies

Data Analysis Cont.

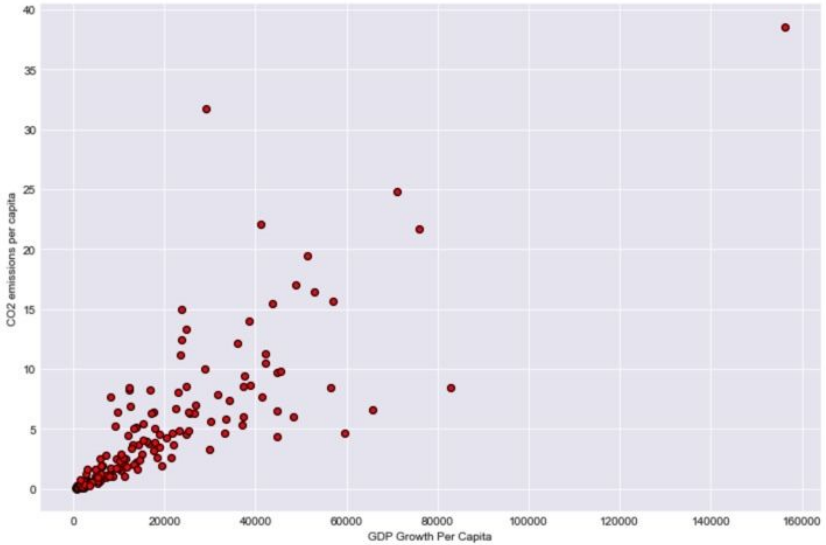
- Global Urban vs Rural population over time

	Entity	Code	Year	Rural population	Urban population
0	Afghanistan	AFG	1960	8240568	755783
1	Afghanistan	AFG	1961	8370722	796042
2	Afghanistan	AFG	1962	8506983	838885
3	Afghanistan	AFG	1963	8649584	884370
4	Afghanistan	AFG	1964	8798513	932848
...	...	...	...	...	...
15026	Zimbabwe	ZWE	2013	10138608	4915898
15027	Zimbabwe	ZWE	2014	10402264	5009411
15028	Zimbabwe	ZWE	2015	10667923	5109528
15029	Zimbabwe	ZWE	2016	10934441	5215921
15030	Zimbabwe	ZWE	2017	11201159	5328745



Discussion

- There appears to be correlations between GDP and CO_2 emissions based on alignment of specific increases and decreases
    - Global temperature seems to mirror CO_2 and urbanization trends
- Correlation between GDP per capita and CO_2 per capita is **.81**
- These trends were initially hypothesized



Difficulties and Additional Questions

- Many problems with **Git** branches
- **“Telling the Story”**
  - Our dataset gives concrete information about world trends, however we found it hard to relate them
    - Difficult to get the data into **comparative figures**
      - Probably due to the fact that we worked with multiple Jupyter notebooks
      - In the future, would include more r values and statistics
- Balance between group coding and individual work
- Future research could include more economic indices like income share held by the lower 20%
  - See how a productive economy impacts low-income members of society
  - Analyze our questions on a country/region level instead of global - multiple comparative graphs?

Gmaps mapped Jordan, Georgia, and Iran to the continental US even though their coordinates were taken directly from the API

Questions?