Merging Data and Storing in a Database / Data Visualization

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In [62]:
```
# Importing required packages
import sqlite3
import pandas as pd
from matplotlib import pyplot as plt
```

Loading data into database

In [6]:
```
# Read temperature_data csv into environment
temperature_data = pd.read_csv("C:/Users/kayly/OneDrive/Desktop/MSDS/DSC540/Tem Project/TemperatureData")
temperature_data
```

Out[6]:

	City	Country	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	AvgMonthlyTemp
0	Abidjan	Ivory Coast	1	1996	Africa	1	79.6	1996-01-01	80.513774	80.754839
1	Abidjan	Ivory Coast	1	1996	Africa	2	81.2	1996-01-02	80.513774	80.754839
2	Abidjan	Ivory Coast	1	1996	Africa	3	82.2	1996-01-03	80.513774	80.754839
3	Abidjan	Ivory Coast	1	1996	Africa	4	83.0	1996-01-04	80.513774	80.754839
4	Abidjan	Ivory Coast	1	1996	Africa	5	82.1	1996-01-05	80.513774	80.754839
...	...	...	...	...	...	...	...	...	...	...
952982	Zurich	Switzerland	12	2019	Europe	27	40.8	2019-12-27	51.086908	38.848387
952983	Zurich	Switzerland	12	2019	Europe	28	35.5	2019-12-28	51.086908	38.848387
952984	Zurich	Switzerland	12	2019	Europe	29	30.4	2019-12-29	51.086908	38.848387
952985	Zurich	Switzerland	12	2019	Europe	30	29.9	2019-12-30	51.086908	38.848387
952986	Zurich	Switzerland	12	2019	Europe	31	31.4	2019-12-31	51.086908	38.848387

952987 rows × 10 columns

In [20]:
```
# Adding data from csv file to table called temperaturedata in database
with sqlite3.connect("milestonedata.db") as conn:
    temperature_data.to_sql('temperaturedata', conn, index=True)
    conn.commit()
```

In [21]:
```
# Checking that dataframe was added to database table correctly
# Prints first row of each column
with sqlite3.connect("milestonedata.db") as conn:
    cursor = conn.cursor()
    rows = cursor.execute("SELECT city, country, month, year, region, day, avgdailytemp, dateofobservation, avgyearlytemp, avgmonthlytemp FROM temperaturedata")
    for row in rows:
        print(row)
        break
cursor.close()
```

```
('Abidjan', 'Ivory Coast', 1, 1996, 'Africa', 1, 79.6, '1996-01-01', 80.5137741046832, 80.75483870967743)
```

In [9]:
```
# Read development_data csv into environment
development_data = pd.read_csv("C:/Users/kayly/OneDrive/Desktop/MSDS/DSC540/Tem Project/DevelopmentData")
development_data
```

Out[9]:

	Country	Forest Area (sq.km thousands) 1990	Forest Area (sq.km thousands) 2021	Marine protected areas (% of total territorial waters) 2022	Terresterial protected areas (% of total land area) 2022	Threatened Birds	Threatened Fishes	Threatened Higher Plants	Threatened Mammals	Change in Forest Area 1990 to 2021
0	Albania	8.0	8.0	2.8	18.6	8.0	44.0	4.0	3.0	0.0
1	Algeria	17.0	20.0	0.1	4.6	15.0	41.0	22.0	14.0	-3.0
2	American Samoa	0.0	0.0	8.7	15.8	8.0	12.0	1.0	1.0	0.0
3	Angola	793.0	661.0	0.0	7.0	32.0	53.0	34.0	18.0	132.0
4	Antigua and Barbuda	0.0	0.0	0.3	19.9	3.0	31.0	4.0	2.0	0.0
...	...	...	...	...	...	...	...	...	...	...
166	Europe & Central Asia	10232.0	10576.0	10.7	14.2	678.0	1239.0	1306.0	350.0	-344.0
167	Latin America & Caribbean	10700.0	9296.0	19.4	24.1	1117.0	1716.0	5439.0	629.0	1404.0
168	Middle East & North Africa	205.0	230.0	1.3	5.1	290.0	672.0	374.0	228.0	-25.0
169	North America	6507.0	6567.0	12.8	12.3	118.0	322.0	536.0	62.0	-60.0
170	South Asia	826.0	900.0	0.5	8.7	253.0	397.0	794.0	252.0	-74.0

171 rows × 10 columns

In [10]:
```
# Adding data from csv file to table called developmentdata in database
with sqlite3.connect("milestonedata.db", timeout=30) as conn:
    development_data.to_sql('developmentdata', conn, index=False)
    conn.commit()
```

In [11]:
```
# Checking that dataframe was added to database table correctly
# Prints first row of first two columns
with sqlite3.connect("milestonedata.db") as conn:
    cursor = conn.cursor()
    for row in cursor.execute("SELECT Country, 'Forest Area (sq.km thousands) 1990' FROM developmentdata"):
        print(row)
        break
cursor.close()
```

```
('Albania', 'Forest Area (sq.km thousands) 1990')
```

In [12]:
```
# Read air_pollution_data csv into environment
air_pollution_data = pd.read_csv("C:/Users/kayly/OneDrive/Desktop/MSDS/DSC540/Tem Project/AirPollutionData")
air_pollution_data
```

Out[12]:

	Country	Country Code	City	Quality Rating	Concentration CO	Concentration NO	Concentration NO2	Concentration NH3	Concentration O3	Concentration SO2	Concentration PM2.5	Concentration PM10	DateTime	Qualitative Name
0	Albania	AL	Tirana	1	208.62	0.00	3.90	2.95	40.41	0.30	8.70	10.92	2024-05-30 01:58:36	Good
1	Armenia	AM	Yerevan	1	175.24	0.00	6.86	5.00	38.62	0.60	6.12	15.66	2024-05-30 01:59:07	Good
2	Austria	AT	Vienna	1	216.96	0.00	7.28	3.01	28.61	0.66	5.24	6.72	2024-05-30 01:58:36	Good
3	Australia	AU	Brisbane	2	247.00	1.72	6.94	0.58	62.94	5.54	2.28	3.93	2024-05-30 01:58:29	Fair
4	Australia	AU	Canberra	1	223.64	0.09	0.39	0.13	47.92	0.23	3.46	3.73	2024-05-30 01:58:32	Good
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
113	Uganda	UG	Kampala	5	1628.88	0.09	7.45	6.59	2.48	2.27	98.01	132.54	2024-05-30 01:57:42	Very Poor
114	United States of America (the)	US	Capetown	2	196.93	0.05	0.34	0.00	87.98	0.45	0.79	2.25	2024-05-30 01:57:34	Fair
115	Uzbekistan	UZ	Tashkent	1	367.17	23.69	35.30	3.77	11.36	2.92	9.00	14.01	2024-05-30 01:58:28	Good
116	Viet Nam	VN	Hanoi	3	827.79	1.30	25.71	9.12	9.66	13.95	34.47	47.49	2024-05-30 01:50:24	Moderate
117	Zambia	ZM	Lusaka	2	1415.25	0.00	6.34	11.65	37.19	6.14	11.48	19.94	2024-05-30 01:57:44	Fair

118 rows × 14 columns

In [13]:

```
# Adding data from csv file to table called airpollutiondata table in database
with sqlite3.connect("milestonedata.db") as conn:
    air_pollution_data.to_sql('airpollutiondata', conn, index=True)
    conn.commit()
```

In [14]:

```
# Checking that dataframe was added to database table correctly
# Prints first row of each column
with sqlite3.connect("milestonedata.db") as conn:
    cursor = conn.cursor()
    for row in cursor.execute("SELECT Country, 'Country Code' FROM airpollutiondata"):
        print(row)
        break
cursor.close()
```

```
('Albania', 'Country Code')
```

Joining Datasets

In [33]:

```
# Testing join before creating dataframe
# Join airpollutiondata with temperaturedata on city by left join
with sqlite3.connect("milestonedata.db") as conn:
    cursor = conn.cursor()
    cursor.execute("PRAGMA foreign_keys = 1")
    sql = """SELECT * FROM temperaturedata LEFT JOIN airpollutiondata ON temperaturedata.City = airpollutiondata.City"""
    rows = cursor.execute(sql)
    for row in rows:
        print(row)
        break
cursor.close()
```

```
(0, 'Abidjan', 'Ivory Coast', 1, 1996, 'Africa', 1, 79.6, '1996-01-01', 80.5137741046832, 80.75483870967743, 20, "Côte d'Ivoire", 'CI', 'Abidjan', 2, 327.11, 0.0, 0.83, 1.03, 22.89, 0.43, 6.29, 25.43, '2024-05-30 01:57:20', 'Fair')
```

In [38]:

```
# Empty list to append data to
data1 = []
# List of column titles
columns = ['Index1', 'City1', 'Country1', 'Month', 'Year', 'Region','Day','AvgDailyTemp','DateOfObservation',
          'AvgYearlyTemp','AvgMonthlyTemp','Index2','Country2','Country Code','City2','Quality Rating','Concentration CO',
          'Concentration NO','Concentration NO2','Concentration NH3','Concentration O3','Concentration SO2',
          'Concentration PM2.5','Concentration PM10','DateTime','Qualitative Name']


with sqlite3.connect("milestonedata.db") as conn:
    cursor = conn.cursor()
    cursor.execute("PRAGMA foreign_keys = 1")
    # Left join airpollutiondata to temperaturedata (keeps all entries from temperaturedata)
    sql = """SELECT * FROM temperaturedata LEFT JOIN airpollutiondata ON temperaturedata.City = airpollutiondata.City"""
    rows = cursor.execute(sql)
    for row in rows:
        data1.append(row) # Appends each row to data list
cursor.close()

# Create dataframe from columns and rows
temp_pollution_frame = pd.DataFrame(data1,columns=columns)
temp_pollution_frame
```

Out[38]:

	Index1	City1	Country1	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	...	Concentration CO	Concentration NO	Concentration NO2	Concentration NH3	Concentration O3	Concentration SO2	Concentratic PM2
0	0	Abidjan	Ivory Coast	1	1996	Africa	1	79.6	1996-01-01	80.513774	...	327.11	0.00	0.83	1.03	22.89	0.43	6.
1	1	Abidjan	Ivory Coast	1	1996	Africa	2	81.2	1996-01-02	80.513774	...	327.11	0.00	0.83	1.03	22.89	0.43	6.
2	2	Abidjan	Ivory Coast	1	1996	Africa	3	82.2	1996-01-03	80.513774	...	327.11	0.00	0.83	1.03	22.89	0.43	6.
3	3	Abidjan	Ivory Coast	1	1996	Africa	4	83.0	1996-01-04	80.513774	...	327.11	0.00	0.83	1.03	22.89	0.43	6.
4	4	Abidjan	Ivory Coast	1	1996	Africa	5	82.1	1996-01-05	80.513774	...	327.11	0.00	0.83	1.03	22.89	0.43	6.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
952982	952982	Zurich	Switzerland	12	2019	Europe	27	40.8	2019-12-27	51.086908	...	198.60	0.02	6.43	1.65	21.64	0.80	2.
952983	952983	Zurich	Switzerland	12	2019	Europe	28	35.5	2019-12-28	51.086908	...	198.60	0.02	6.43	1.65	21.64	0.80	2.
952984	952984	Zurich	Switzerland	12	2019	Europe	29	30.4	2019-12-29	51.086908	...	198.60	0.02	6.43	1.65	21.64	0.80	2.
952985	952985	Zurich	Switzerland	12	2019	Europe	30	29.9	2019-12-30	51.086908	...	198.60	0.02	6.43	1.65	21.64	0.80	2.
952986	952986	Zurich	Switzerland	12	2019	Europe	31	31.4	2019-12-31	51.086908	...	198.60	0.02	6.43	1.65	21.64	0.80	2.

952987 rows × 26 columns

In [39]:
```python
# Delete repeated columns
temp_pollution_frame = temp_pollution_frame.drop(['Index1', 'Index2', 'City2', 'Country2'], axis=1)
temp_pollution_frame
```

Out[39]:

	City1	Country1	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	AvgMonthlyTemp	...	Concentration CO	Concentration NO	Concentration NO2	Concentration NH3	Concentration O3	Concentration SO2	C
0	Abidjan	Ivory Coast	1	1996	Africa	1	79.6	1996-01-01	80.513774	80.754839	...	327.11	0.00	0.83	1.03	22.89	0.43	
1	Abidjan	Ivory Coast	1	1996	Africa	2	81.2	1996-01-02	80.513774	80.754839	...	327.11	0.00	0.83	1.03	22.89	0.43	
2	Abidjan	Ivory Coast	1	1996	Africa	3	82.2	1996-01-03	80.513774	80.754839	...	327.11	0.00	0.83	1.03	22.89	0.43	
3	Abidjan	Ivory Coast	1	1996	Africa	4	83.0	1996-01-04	80.513774	80.754839	...	327.11	0.00	0.83	1.03	22.89	0.43	
4	Abidjan	Ivory Coast	1	1996	Africa	5	82.1	1996-01-05	80.513774	80.754839	...	327.11	0.00	0.83	1.03	22.89	0.43	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
952982	Zurich	Switzerland	12	2019	Europe	27	40.8	2019-12-27	51.086908	38.848387	...	198.60	0.02	6.43	1.65	21.64	0.80	
952983	Zurich	Switzerland	12	2019	Europe	28	35.5	2019-12-28	51.086908	38.848387	...	198.60	0.02	6.43	1.65	21.64	0.80	
952984	Zurich	Switzerland	12	2019	Europe	29	30.4	2019-12-29	51.086908	38.848387	...	198.60	0.02	6.43	1.65	21.64	0.80	
952985	Zurich	Switzerland	12	2019	Europe	30	29.9	2019-12-30	51.086908	38.848387	...	198.60	0.02	6.43	1.65	21.64	0.80	
952986	Zurich	Switzerland	12	2019	Europe	31	31.4	2019-12-31	51.086908	38.848387	...	198.60	0.02	6.43	1.65	21.64	0.80	

952987 rows × 22 columns

In [45]:
```python
# Checking number of NA's
temp_pollutation_frame.isna().sum()
```

Out[45]:
```
City1                    0
Country1                 0
Month                    0
Year                     0
Region                   0
Day                      0
AvgDailyTemp             0
DateOfObservation        0
AvgYearlyTemp            0
AvgMonthlyTemp           0
Country Code         11166
Quality Rating       11166
Concentration CO     11166
Concentration NO     11166
Concentration NO2    11166
Concentration NH3    11166
Concentration O3     11166
Concentration SO2    11166
Concentration PM2.5  11166
Concentration PM10   11166
DateTime             11166
Qualitative Name     11166
dtype: int64
```

In [40]:
```python
# Load new dataasaet into database
with sqlite3.connect("milestonedata.db") as conn:
    temp_pollution_frame.to_sql('temp_pollution_data', conn, index=True)
    conn.commit()
```

In [41]:
```python
# Checking that dataframe was added to database table correctly
# Prints city and one column from each of the original dataframes to make sure join actually happened
with sqlite3.connect("milestonedata.db") as conn:
    cursor = conn.cursor()
    for row in cursor.execute("SELECT City1, AvgDailyTemp, 'Concentration CO' FROM temp_pollution_data"):
        print(row)
        break
cursor.close()
```

```
('Abidjan', 79.6, 'Concentration CO')
```

In [43]:
```python
# Testing join before creating dataframe
# Join temp_polltuion_data with developmentdata on country by left join
with sqlite3.connect("milestonedata.db") as conn:
    cursor = conn.cursor()
    cursor.execute("PRAGMA foreign_keys = 1")
    sql = """SELECT * FROM temp_pollution_data LEFT JOIN developmentdata ON temp_pollution_data.Country1 = developmentdata.Country"""
    rows = cursor.execute(sql)
    for row in rows:
        print(row)
        break
cursor.close()
```

```
(0, 'Abidjan', 'Ivory Coast', 1, 1996, 'Africa', 1, 79.6, '1996-01-01', 80.5137741046832, 80.75483870967743, 'CI', 2.0, 327.11, 0.0, 0.83, 1.03, 22.89, 0.43, 6.29, 25.43, '2024-05-30 01:57:20', 'Fair', None,
None, None, None, None, None, None, None, None, None)
```

In [162…
```python
data2 = []
columns2 = ['Index1', 'City1', 'Country1', 'Month', 'Year', 'Region','Day','AvgDailyTemp','DateOfObservation',
           'AvgYearlyTemp','AvgMonthlyTemp','Country Code','Quality Rating','Concentration CO',
           'Concentration NO','Concentration NO2','Concentration NH3','Concentration O3','Concentration SO2',
           'Concentration PM2.5','Concentration PM10','DateTime','Qualitative Name','Country2','Forest Area (sq.km thousands) 1990',
            'Forest Area (sq.km thousands) 2021','Marine protected areas (% of total territorial waters) 2022',
            'Terresterial protected areas (% of total land area) 2022','Threatened Birds','Threatened Fishes',
            'Threatened Higher Plants','Threatened Mammals','Change in Forest Area 1990 to 2021']


with sqlite3.connect("milestonedata.db") as conn:
    cursor = conn.cursor()
    cursor.execute("PRAGMA foreign_keys = 1")
    # Left join temp_pollution_data to developmentdata (keeps all entries from temp_pollution_data)
    sql = """SELECT * FROM temp_pollution_data LEFT JOIN developmentdata ON temp_pollution_data.Country1 = developmentdata.Country"""
    rows = cursor.execute(sql)
    for row in rows:
        data2.append(row) # Appends each row to data list
cursor.close()

# Create dataframe from columns and rows
final_dataset = pd.DataFrame(data2,columns=columns2)
final_dataset
```

Out[162…

	Index1	City1	Country1	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	...	Country2	Forest Area (sq.km thousands) 1990	Forest Area (sq.km thousands) 2021	Marine protected areas (% of total territorial waters) 2022	Terresterial protected areas (% of total land area) 2022	Threatened Birds	Threatened Fishes	Threatened Higher Plants	Threat Mam
0	0	Abidjan	Ivory Coast	1	1996	Africa	1	79.6	1996-01-01	80.513774	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
1	1	Abidjan	Ivory Coast	1	1996	Africa	2	81.2	1996-01-02	80.513774	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
2	2	Abidjan	Ivory Coast	1	1996	Africa	3	82.2	1996-01-03	80.513774	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
3	3	Abidjan	Ivory Coast	1	1996	Africa	4	83.0	1996-01-04	80.513774	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
4	4	Abidjan	Ivory Coast	1	1996	Africa	5	82.1	1996-01-05	80.513774	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
952982	952982	Zurich	Switzerland	12	2019	Europe	27	40.8	2019-12-27	51.086908	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
952983	952983	Zurich	Switzerland	12	2019	Europe	28	35.5	2019-12-28	51.086908	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
952984	952984	Zurich	Switzerland	12	2019	Europe	29	30.4	2019-12-29	51.086908	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
952985	952985	Zurich	Switzerland	12	2019	Europe	30	29.9	2019-12-30	51.086908	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
952986	952986	Zurich	Switzerland	12	2019	Europe	31	31.4	2019-12-31	51.086908	...	None	NaN	NaN	NaN	NaN	NaN	NaN	NaN	

952987 rows × 33 columns

Data Transformation / Cleaning

In [163…
```python
# Drop repetative columns
final_dataset = final_dataset.drop(['Index1', 'Country2'],axis=1)
```

In [164…
```python
# Rename columns
final_dataset.rename(columns={'City1':'City', 'Country1':'Country'}, inplace=True)
final_dataset
```

Out[164…

	City	Country	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	AvgMonthlyTemp	...	Qualitative Name	Forest Area (sq.km thousands) 1990	Forest Area (sq.km thousands) 2021	Marine protected areas (% of total territorial waters) 2022	Terresterial protected areas (% of total land area) 2022	Threatened Birds	Threatened Fishes	Threate Hig Pl
0	Abidjan	Ivory Coast	1	1996	Africa	1	79.6	1996-01-01	80.513774	80.754839	...	Fair	NaN	NaN	NaN	NaN	NaN	NaN	I
1	Abidjan	Ivory Coast	1	1996	Africa	2	81.2	1996-01-02	80.513774	80.754839	...	Fair	NaN	NaN	NaN	NaN	NaN	NaN	I
2	Abidjan	Ivory Coast	1	1996	Africa	3	82.2	1996-01-03	80.513774	80.754839	...	Fair	NaN	NaN	NaN	NaN	NaN	NaN	I
3	Abidjan	Ivory Coast	1	1996	Africa	4	83.0	1996-01-04	80.513774	80.754839	...	Fair	NaN	NaN	NaN	NaN	NaN	NaN	I
4	Abidjan	Ivory Coast	1	1996	Africa	5	82.1	1996-01-05	80.513774	80.754839	...	Fair	NaN	NaN	NaN	NaN	NaN	NaN	I
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
952982	Zurich	Switzerland	12	2019	Europe	27	40.8	2019-12-27	51.086908	38.848387	...	Good	NaN	NaN	NaN	NaN	NaN	NaN	I
952983	Zurich	Switzerland	12	2019	Europe	28	35.5	2019-12-28	51.086908	38.848387	...	Good	NaN	NaN	NaN	NaN	NaN	NaN	I
952984	Zurich	Switzerland	12	2019	Europe	29	30.4	2019-12-29	51.086908	38.848387	...	Good	NaN	NaN	NaN	NaN	NaN	NaN	I
952985	Zurich	Switzerland	12	2019	Europe	30	29.9	2019-12-30	51.086908	38.848387	...	Good	NaN	NaN	NaN	NaN	NaN	NaN	I
952986	Zurich	Switzerland	12	2019	Europe	31	31.4	2019-12-31	51.086908	38.848387	...	Good	NaN	NaN	NaN	NaN	NaN	NaN	I

952987 rows × 31 columns

In [165…

```
# Checking number of Na values
final_dataset.isna().sum()
```

Out[165…

```
City                                                            0
Country                                                         0
Month                                                           0
Year                                                            0
Region                                                          0
Day                                                             0
AvgDailyTemp                                                    0
DateOfObservation                                               0
AvgYearlyTemp                                                   0
AvgMonthlyTemp                                                  0
Country Code                                                11166
Quality Rating                                              11166
Concentration CO                                            11166
Concentration NO                                            11166
Concentration NO2                                           11166
Concentration NH3                                           11166
Concentration O3                                            11166
Concentration SO2                                           11166
Concentration PM2.5                                         11166
Concentration PM10                                          11166
DateTime                                                    11166
Qualitative Name                                            11166
Forest Area (sq.km thousands) 1990                         279725
Forest Area (sq.km thousands) 2021                         279725
Marine protected areas (% of total territorial waters) 2022    279725
Terresterial protected areas (% of total land area) 2022     279725
Threatened Birds                                           279725
Threatened Fishes                                          279725
Threatened Higher Plants                                   279725
Threatened Mammals                                         279725
Change in Forest Area 1990 to 2021                         279725
dtype: int64
```

Due to my joins not being perfect, there are a lot of rows that do not have data. I have a large dataset right now, so for the sake of this project, I am going to drop any rows that contain Na values. In the real world, I would likely try to make my joins work a little better but I think this works for what I need to do now.

In [166…

```
# Drop all rows that contain NA values
final_dataset = final_dataset.dropna()
final_dataset
```

Out[166…

	City	Country	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	AvgMonthlyTemp	...	Qualitative Name	Forest Area (sq.km thousands) 1990	Forest Area (sq.km thousands) 2021	Marine protected areas (% of total territorial waters) 2022	Terresterial protected areas (% of total land area) 2022	Threatened Birds	Threatened Fishes	Threatenec Highe Plants
15421	Algiers	Algeria	1	1996	Africa	1	67.4	1996-01-01	63.530220	57.370968	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
15422	Algiers	Algeria	1	1996	Africa	2	60.0	1996-01-02	63.530220	57.370968	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
15423	Algiers	Algeria	1	1996	Africa	3	54.4	1996-01-03	63.530220	57.370968	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
15424	Algiers	Algeria	1	1996	Africa	4	57.7	1996-01-04	63.530220	57.370968	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
15425	Algiers	Algeria	1	1996	Africa	5	57.6	1996-01-05	63.530220	57.370968	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..
944116	Zagreb	Croatia	12	2019	Europe	27	38.9	2019-12-27	56.557103	40.554839	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(
944117	Zagreb	Croatia	12	2019	Europe	28	37.8	2019-12-28	56.557103	40.554839	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(
944118	Zagreb	Croatia	12	2019	Europe	29	35.0	2019-12-29	56.557103	40.554839	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(
944119	Zagreb	Croatia	12	2019	Europe	30	30.3	2019-12-30	56.557103	40.554839	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(
944120	Zagreb	Croatia	12	2019	Europe	31	30.2	2019-12-31	56.557103	40.554839	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(

664979 rows × 31 columns

In [167…

```
# Checking unique cities
unique_cities = final_dataset['City'].unique()
unique_cities
```

Out[167…
```
array(['Algiers', 'Almaty', 'Amman', 'Antananarivo', 'Ashabad', 'Athens',
       'Auckland', 'Bangkok', 'Barcelona', 'Beijing', 'Beirut', 'Belfast',
       'Bilbao', 'Bissau', 'Bombay (Mumbai)', 'Bonn', 'Bordeaux',
       'Brisbane', 'Bucharest', 'Calcutta', 'Canberra', 'Capetown',
       'Chengdu', 'Chennai (Madras)', 'Colombo', 'Conakry', 'Copenhagen',
       'Cotonou', 'Dakar', 'Dar Es Salaam', 'Delhi', 'Dhaka', 'Dublin',
       'Frankfurt', 'Freetown', 'Guangzhou', 'Hamburg', 'Hanoi',
       'Helsinki', 'Islamabad', 'Jakarta', 'Karachi', 'Kiev',
       'Kuala Lumpur', 'Kuwait', 'Lagos', 'Libreville', 'Lisbon', 'Lome',
       'London', 'Madrid', 'Manama', 'Manila', 'Maputo', 'Melbourne',
       'Milan', 'Munich', 'Nairobi', 'Niamey', 'Nicosia', 'Nouakchott',
       'Osaka', 'Oslo', 'Paris', 'Perth', 'Rabat', 'Reykjavik', 'Riga',
       'Rome', 'Sapporo', 'Shanghai', 'Shenyang', 'Singapore', 'Sofia',
       'Stockholm', 'Sydney', 'Tbilisi', 'Tel Aviv', 'Tirana', 'Tokyo',
       'Tunis', 'Warsaw', 'Zagreb'], dtype=object)
```

The most granular dataset I have works with dialy values. However, I have calculated averages by month and year. I will drop all data that is not Day 28 from the dataset. I chose day 28 because the shortest month on a non-leap year has 28 days. My average monthly temperature will then be calculated from the largest number of days possible in the shortest month. By doing this, I will capture all averyage monthly and yearly temperatures and significantly slim down my dataset.

In [168…
```python
# Subsetting data to contain only rows where Day is equal to 28
final_dataset = final_dataset[final_dataset.Day==28]
final_dataset
```

Out[168…

	City	Country	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	AvgMonthlyTemp	...	Qualitative Name	Forest Area (sq.km thousands) 1990	Forest Area (sq.km thousands) 2021	Marine protected areas (% of total territorial waters) 2022	Terrestrial protected areas (% of total land area) 2022	Threatened Birds	Threatened Fishes	Threatened Highe Plants
15448	Algiers	Algeria	1	1996	Africa	28	62.8	1996-01-28	63.530220	57.370968	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
15479	Algiers	Algeria	1	1997	Africa	28	50.1	1997-01-28	64.926301	55.719355	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
15510	Algiers	Algeria	1	1998	Africa	28	58.4	1998-01-28	63.619668	53.590323	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
15540	Algiers	Algeria	1	1999	Africa	28	55.7	1999-01-28	64.923626	52.280000	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
15571	Algiers	Algeria	1	2000	Africa	28	54.0	2000-01-28	64.182787	47.235484	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.(
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..
943994	Zagreb	Croatia	12	2015	Europe	28	30.6	2015-12-28	55.704945	38.223333	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(
944024	Zagreb	Croatia	12	2016	Europe	28	35.7	2016-12-28	54.832133	31.748387	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(
944055	Zagreb	Croatia	12	2017	Europe	28	43.6	2017-12-28	55.572055	39.277419	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(
944086	Zagreb	Croatia	12	2018	Europe	28	32.6	2018-12-28	56.492758	37.122581	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(
944117	Zagreb	Croatia	12	2019	Europe	28	37.8	2019-12-28	56.557103	40.554839	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.(

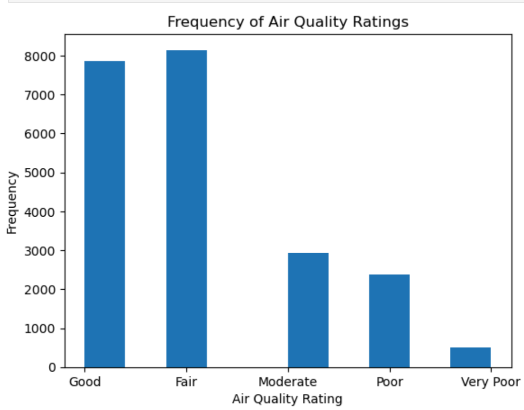
21822 rows × 31 columns

Visualizations

In [67]:
```python
# Import matplotlib package
import matplotlib.pyplot as plt
```

Visualization 1- Histogram of Qualitative Name for all cities combined

In [169…
```python
plt.hist(final_dataset['Qualitative Name'])
plt.xlabel('Air Quality Rating')
plt.ylabel('Frequency')
plt.title('Frequency of Air Quality Ratings')
plt.show()
```



Visualization 2- Line graph of average yearly temperature of Madrid

In [170…
```python
# Create a subset of the data that only shows month 12
subset1 = final_dataset[final_dataset.Month==12]
subset1
```

Out[170…

	City	Country	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	AvgMonthlyTemp	...	Qualitative Name	Forest Area (sq.km thousands) 1990	Forest Area (sq.km thousands) 2021	Marine protected areas (% of total territorial waters) 2022	Terresterial protected areas (% of total land area) 2022	Threatened Birds	Threatened Fishes	Threatened Higher Plants
23577	Algiers	Algeria	12	1996	Africa	28	43.9	1996-12-28	63.530220	55.787097	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.0
23608	Algiers	Algeria	12	1997	Africa	28	50.7	1997-12-28	64.926301	54.964516	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.0
23637	Algiers	Algeria	12	1998	Africa	28	54.6	1998-12-28	63.619668	51.348148	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.0
23666	Algiers	Algeria	12	1999	Africa	28	58.9	1999-12-28	64.923626	53.003226	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.0
23697	Algiers	Algeria	12	2000	Africa	28	57.9	2000-12-28	64.182787	55.519355	...	Good	17.0	20.0	0.1	4.6	15.0	41.0	22.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
943994	Zagreb	Croatia	12	2015	Europe	28	30.6	2015-12-28	55.704945	38.223333	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.0
944024	Zagreb	Croatia	12	2016	Europe	28	35.7	2016-12-28	54.832133	31.748387	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.0
944055	Zagreb	Croatia	12	2017	Europe	28	43.6	2017-12-28	55.572055	39.277419	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.0
944086	Zagreb	Croatia	12	2018	Europe	28	32.6	2018-12-28	56.492758	37.122581	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.0
944117	Zagreb	Croatia	12	2019	Europe	28	37.8	2019-12-28	56.557103	40.554839	...	Good	19.0	19.0	9.0	38.5	14.0	64.0	8.0

1772 rows × 31 columns

In [171…

```
# Creates a subset that contains only rows with Madrid for the city column
madrid_subset = subset1[subset1.City=='Madrid']
madrid_subset
```

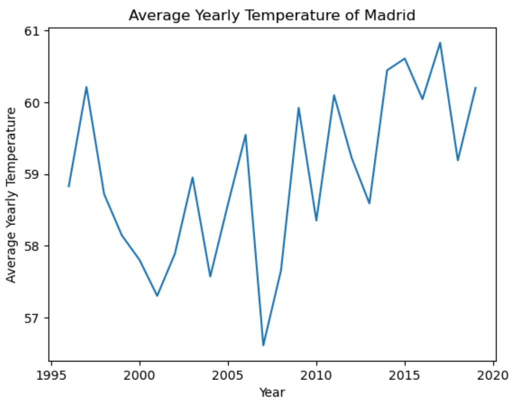
Out[171…

	City	Country	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	AvgMonthlyTemp	...	Qualitative Name	Forest Area (sq.km thousands) 1990	Forest Area (sq.km thousands) 2021	Marine protected areas (% of total territorial waters) 2022	Terresterial protected areas (% of total land area) 2022	Threatened Birds	Threatened Fishes	Threatened Higher Plants
560850	Madrid	Spain	12	1996	Europe	28	33.0	1996-12-28	58.828962	45.948387	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
560881	Madrid	Spain	12	1997	Europe	28	39.8	1997-12-28	60.210959	44.241935	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
560910	Madrid	Spain	12	1998	Europe	28	33.1	1998-12-28	58.719668	38.944444	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
560939	Madrid	Spain	12	1999	Europe	28	46.9	1999-12-28	58.146429	42.274194	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
560970	Madrid	Spain	12	2000	Europe	28	42.6	2000-12-28	57.804372	44.016129	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561001	Madrid	Spain	12	2001	Europe	28	30.8	2001-12-28	57.303562	35.096774	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561032	Madrid	Spain	12	2002	Europe	28	47.2	2002-12-28	57.889197	45.977419	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561063	Madrid	Spain	12	2003	Europe	28	44.5	2003-12-28	58.951781	42.051613	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561094	Madrid	Spain	12	2004	Europe	28	34.6	2004-12-28	57.572678	42.829032	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561125	Madrid	Spain	12	2005	Europe	28	38.8	2005-12-28	58.578630	40.870968	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561156	Madrid	Spain	12	2006	Europe	28	36.6	2006-12-28	59.545753	41.241935	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561187	Madrid	Spain	12	2007	Europe	28	37.2	2007-12-28	56.614011	39.845161	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561218	Madrid	Spain	12	2008	Europe	28	42.0	2008-12-28	57.658516	41.900000	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561249	Madrid	Spain	12	2009	Europe	28	45.5	2009-12-28	59.922253	43.700000	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561280	Madrid	Spain	12	2010	Europe	28	37.8	2010-12-28	58.352603	42.851613	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561311	Madrid	Spain	12	2011	Europe	28	37.9	2011-12-28	60.097260	41.974194	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561342	Madrid	Spain	12	2012	Europe	28	38.9	2012-12-28	59.221038	42.619355	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561373	Madrid	Spain	12	2013	Europe	28	47.7	2013-12-28	58.589863	40.512903	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561404	Madrid	Spain	12	2014	Europe	28	46.7	2014-12-28	60.443681	42.180645	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561435	Madrid	Spain	12	2015	Europe	28	46.2	2015-12-28	60.608242	45.173333	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561465	Madrid	Spain	12	2016	Europe	28	42.7	2016-12-28	60.042541	44.203226	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561496	Madrid	Spain	12	2017	Europe	28	52.0	2017-12-28	60.827123	42.474194	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561527	Madrid	Spain	12	2018	Europe	28	40.8	2018-12-28	59.189503	42.735484	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0
561558	Madrid	Spain	12	2019	Europe	28	39.7	2019-12-28	60.198889	46.080645	...	Fair	139.0	186.0	12.8	28.1	19.0	83.0	247.0

24 rows × 31 columns

In [172…

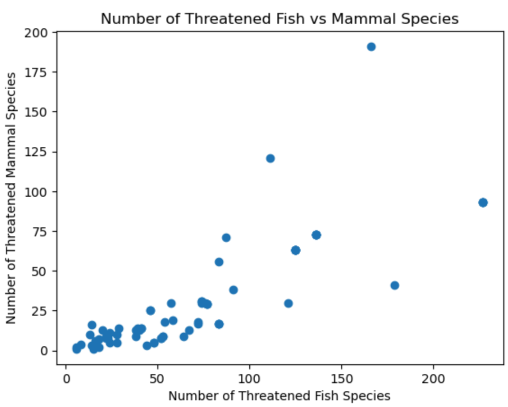
```
# Plot AvgYearlyTemp by Year for each Madrid
plt.plot(madrid_subset['Year'], madrid_subset['AvgYearlyTemp'])
plt.xlabel('Year')
plt.ylabel('Average Yearly Temperature')
plt.title('Average Yearly Temperature of Madrid')
plt.show()
```



Visualization 3- Scatter plot of Threatened Fish Species vs Threatened Mammal Species in 2020 for each City

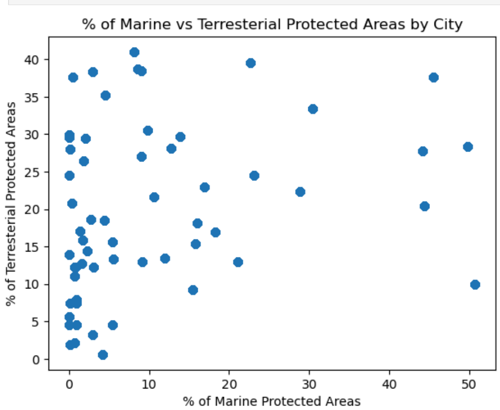
In [249…
```python
# Subset of dataframe that contains rows where Month equls 1
species_subset = final_dataset[final_dataset.Month==1]
# Subset of previous subset where Year equals 2020
species_subset2 = species_subset[species_subset.Year==2020]
```

In [250…
```python
# Plot scatter plot of Threatened Fishes vs Threatened mammals in 2020 for each city
plt.scatter(species_subset2['Threatened Fishes'], species_subset2['Threatened Mammals'])
plt.xlabel('Number of Threatened Fish Species')
plt.ylabel('Number of Threatened Mammal Species')
plt.title('Number of Threatened Fish vs Mammal Species')
plt.show()
```



Visualization 4- Scatter plot of Marine Protected Areas and Terresterial Protected Areas

In [252…
```python
# Plots scatter plot of Marine Protected areas vs Terresterial protested areas of all cities
plt.scatter(final_dataset['Marine protected areas (% of total territorial waters) 2022'], final_dataset['Terresterial protected areas (% of total land area) 2022'])
plt.xlabel('% of Marine Protected Areas')
plt.ylabel('% of Terresterial Protected Areas')
plt.title('% of Marine vs Terresterial Protected Areas by City')
plt.show()
```



Visualization 5- Bar Graph of Concentration CO for each City in 2020

In [251…
```python
# Subset1 is a subset of the final_dataset that only contains rows where Month equals 12
# Subset2 is a subset of subset1 that contains only rows where Year equals 2000
subset2 = subset1[subset1.Year==2000]

# Subset3 is a subset of subset2 that contains only rows where Qualitative Name is Poor
subset3 = subset2[subset2['Qualitative Name'] == 'Poor']
subset3
```

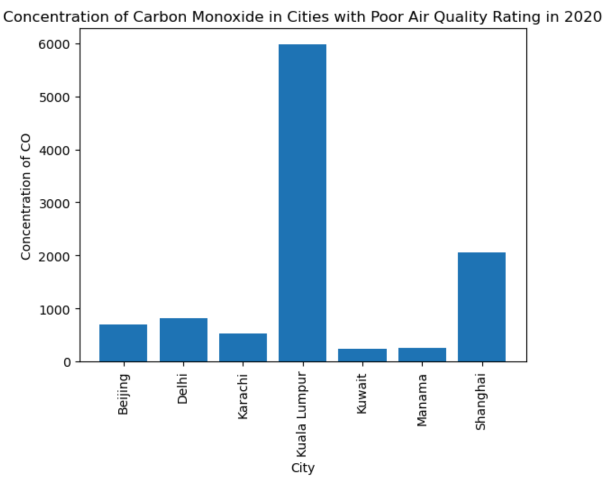
Out[251…

	City	Country	Month	Year	Region	Day	AvgDailyTemp	DateOfObservation	AvgYearlyTemp	AvgMonthlyTemp	...	Qualitative Name	Forest Area (sq.km thousands) 1990	Forest Area (sq.km thousands) 2021	Marine protected areas (% of total territorial waters) 2022	Terresterial protected areas (% of total land area) 2022	Threatened Birds	Threatened Fishes	Threaten High Pla
121861	Beijing	China	12	2000	Asia	28	23.6	2000-12-28	54.774317	29.970968	...	Poor	1571.0	2219.0	5.5	15.6	96.0	136.0	59
363836	Delhi	India	12	2000	Asia	28	55.7	2000-12-28	76.595355	58.429032	...	Poor	639.0	724.0	0.2	7.5	93.0	227.0	39
468479	Karachi	Pakistan	12	2000	Asia	28	72.2	2000-12-28	82.247557	70.361290	...	Poor	50.0	37.0	0.8	12.3	33.0	46.0	1
494146	Kuala Lumpur	Malaysia	12	2000	Asia	28	81.0	2000-12-28	81.777072	81.132258	...	Poor	206.0	191.0	5.6	13.3	63.0	87.0	72
502993	Kuwait	Kuwait	12	2000	Middle East	28	53.2	2000-12-28	80.282240	59.251613	...	Poor	0.0	0.0	1.4	17.1	11.0	18.0	
569841	Manama	Bahrain	12	2000	Middle East	28	62.0	2000-12-28	80.606011	67.248387	...	Poor	0.0	0.0	21.1	13.0	7.0	14.0	
784784	Shanghai	China	12	2000	Asia	28	47.8	2000-12-28	63.381096	47.893548	...	Poor	1571.0	2219.0	5.5	15.6	96.0	136.0	59

7 rows × 31 columns

In [248…

```
# Plots bar graph of Concentration of CO by City
plt.bar(subset3['City'], subset3['Concentration CO'])
plt.xlabel('City')
plt.ylabel('Concentration of CO')
plt.title('Concentration of Carbon Monoxide in Cities with Poor Air Quality Rating in 2020')
plt.xticks(rotation=90) # Rotate x-labels to be verticle
plt.show()
```



Ethical Implications

As in my previous steps, I avoided making any major changes to my dataset. I did choose to reduce the granularity of my final dataset because one dataset was much more granular than my others and went into more detail than was necessary. I did utilize a lot of subsetting and filtering for my visualizations. It's possible that in doing so, I lost some critical pieces of information. If I were drawing conclusions from this data, I would need to be more careful with my filtering. It would also be helpful to plot multiple variations of some of my plots. For example, my final plot is a bar graph of Concentration of CO in cities that had a poor air quality rating in 2020. It would likely be useful to also plot concentration of CO in cities that had other ratings of air quality (very poor, moderate, fair, and good). This would allow more accurate comparison to see if there is a relationship between air quality rating and concentartion of CO. I also chose to drill down on a few cities rather than visualizing all of my cities. If I were to draw conlcusions from these visualizations, I would need to be careful to note which cities the visualization represent because others could make incorrect assumptions about the data without that information.

Through this semester long project I've seen how difficult working with different data sources can be. During each step, I had to continually remind myself how I planned to join my datasets in the final step to help guide my transformations. I had a lot of difficulty with the HTML milestone, but I feel much more comfortable with web scraping now. I also now realize the importance of using a well documented API. Thankfully, I chose an API that has great documentation but I saw the struggles of my classmates who were not as fortunate. This class has been a great way to build on my foundational Python skills while building new skills such as SQL.

In [ ]: