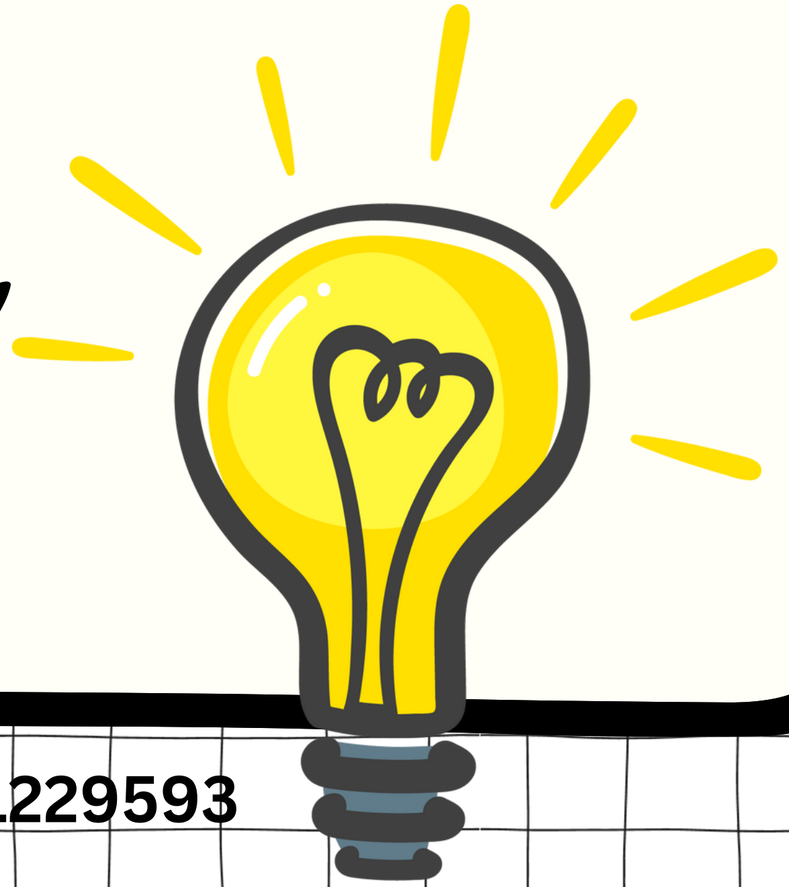
What is the relation between greenhouse gas emissions, GDP per capita, and Air Transport Freight Volume in South Asian Countries?



Bestha Hemanthini Hrushitha 21229593
Vismaya Premkumar 20224047

World Bank API

```
!pip install wbgapi
```

Libraries imported

```
import wbgapi as wb
import pandas as pd
import matplotlib.pyplot as plt
```

https://colab.research.google.com/drive/1aXvLqrGRKr_PX7ouCX6CIYGulVtgNNCa#scrollTo=2-UNWWclQwV7

```
wb.source.info()
```

id	name	code	concepts	lastupdated
1	Doing Business	DBS	3	2021-08-18
2	World Development Indicators	WDI	3	2023-10-26
3	Worldwide Governance Indicators	WGI	3	2023-09-29
5	Subnational Malnutrition Database	SNM	3	2016-03-21
6	International Debt Statistics	IDS	4	2022-12-06
11	Africa Development Indicators	ADI	3	2013-02-22
12	Education Statistics	EDS	3	2023-10-12
13	Enterprise Surveys	ESY	3	2022-03-25
14	Gender Statistics	GDS	3	2023-10-30
15	Global Economic Monitor	GEM	3	2023-07-21
16	Health Nutrition and Population Statistics	HNP	3	2023-09-21
18	IDA Results Measurement System	IDA	3	2021-07-23
19	Millennium Development Goals	MDG	3	2018-09-19
20	Quarterly Public Sector Debt	PSD	3	2023-10-25
22	Quarterly External Debt Statistics SDDS	QDS	3	2023-10-31
23	Quarterly External Debt Statistics GDDS	QDG	3	2023-10-31
25	Jobs	JOB	3	2022-06-29
27	Global Economic Prospects	GEP	3	2023-06-06
28	Global Financial Inclusion	FDX	3	2023-04-12
29	The Atlas of Social Protection: Indicators of Resilience and Equity	GSP	3	2023-05-23
30	Exporter Dynamics Database – Indicators at Country-Year Level	ED1	3	2016-03-31
31	Country Policy and Institutional Assessment	CPI	3	2023-07-24
32	Global Financial Development	GFD	3	2022-09-23
33	G20 Financial Inclusion Indicators	G2F	3	2019-02-27

To find the report about Greenhouse gas emission and GDP per capita

87 Country Climate and Development Report (CCDR)

We found the Country Climate and Development report to be the most relevant report.

To find the relevant information about GDP per capita and Greenhouse gas emmisons in CCDR

```
wb.series.info(db=87)
```

To find the right ID for GDP per capita

```
wb.search("GDP")
```

To find the right ID for Greenhouse gas emissions

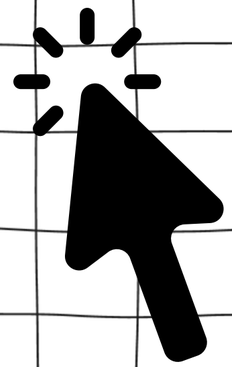
```
wb.search("Greenhouse gas")
```

To find the right ID for Air Transport freight volume

```
wb.search("air transport")
```

```
wb.economy.coder(['India', 'Nepal', 'Bhutan','Pakistan', 'Afghanistan', 'Bangladesh', 'Maldives', 'Sri Lanka']
```

ORIGINAL NAME	WBG NAME	ISO_CODE
India	India	IND
Nepal	Nepal	NPL
Bhutan	Bhutan	BTN
Pakistan	Pakistan	PAK
Afghanistan	Afghanistan	AFG
Bangladesh	Bangladesh	BGD
Maldives	Maldives	MDV
Sri Lanka	Sri Lanka	LKA



Country codes

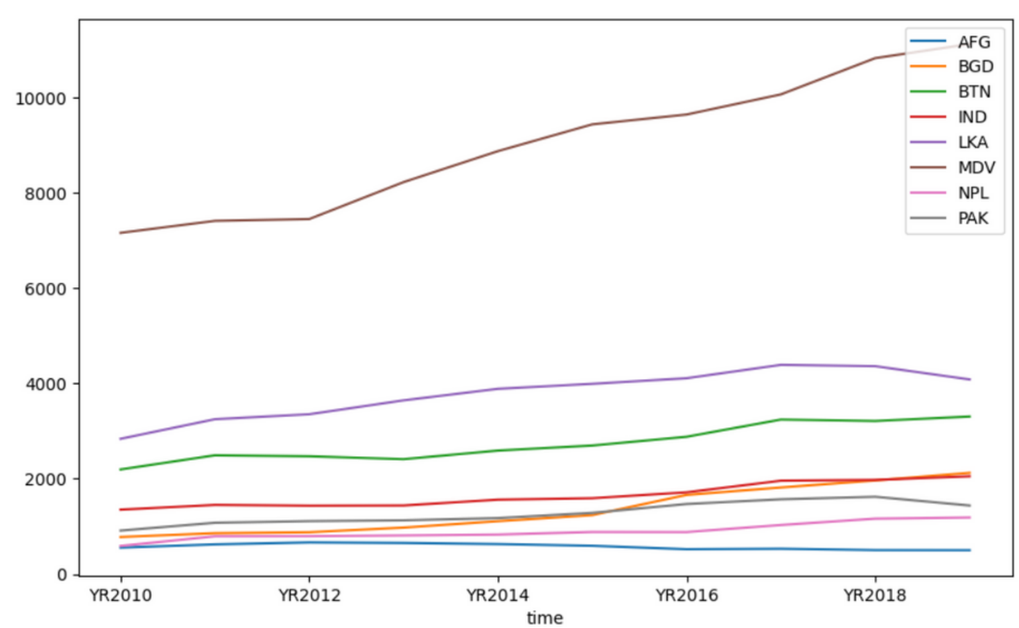
GDP per capita Data Table

```
import pandas as pd

from google.colab import data_table
from vega_datasets import data

data_table.enable_dataframe_formatter()


country_codes = ('MDV', 'IND', 'NPL', 'BTN', 'LKA', 'AFG', 'PAK', 'BGD')

pd = wb.data.DataFrame(['NY.GDP.PCAP.CD'], country_codes, time=range(2010, 2019), labels=True).transpose()
pd
```

Index	BGD	PAK	AFG	LKA	BTN	NPL	IND	MDV
Country	Bangladesh	Pakistan	Afghanistan	Sri Lanka	Bhutan	Nepal	India	Maldives
YR2010	776.859576940281	911.089996122843	554.59473461788	2836.97409785065	2194.12587023264	589.165434913038	1350.63445681517	7158.06141101431
YR2011	856.381886818701	1075.45102015496	621.912413814308	3248.04021482869	2491.27345640704	791.225576713285	1449.60330101065	7409.33170427232
YR2012	876.818006772634	1109.67873521456	663.141052810937	3351.89248871965	2470.0721358991	794.092559333496	1434.01797842656	7447.41545439203
YR2013	973.773900233539	1126.04077606401	651.987861948108	3643.83244853816	2409.43998870348	809.384457748037	1438.05699513067	8222.55802191859
YR2014	1108.51495720707	1173.39230924409	628.146803888496	3885.62360951803	2589.89914074134	827.744704916142	1559.86377161811	8872.12866368996
YR2015	1236.00439770048	1282.44302583996	592.476164793256	3990.3531233888	2695.63690417126	862.307663457577	1590.17432166504	9434.31190964075
YR2016	1659.96248898672	1468.82207690892	520.251954939821	4107.82976157993	2879.54657217991	880.224893683469	1714.2795405846	9640.31919054401
YR2017	1815.61019133661	1567.64061969895	530.14986261654	4388.20190753404	3240.70632594822	1027.96547448918	1957.96981368095	10063.0037101733
YR2018	1963.41270740562	1620.7425960251	502.057099211089	4360.58474164383	3210.70781406979	1161.5343496196	1974.37773014516	10823.6104831326

Show 25 per page

GDP per capita Line plot




```
wb.data.DataFrame('NY.GDP.PCAP.CD', ['MDV', 'IND', 'NPL', 'BTN', 'LKA', 'AFG', 'PAK', 'BGD'],
                  range(2010, 2020), index='time').plot(figsize=(10, 6))
plt.show()
```

Interpretation

The line plot shows the average income per person in South Asia from 2010 to 2020, measured in US dollars. The plot shows that the average income has been rising steadily over time. In 2010, the average income was around 1,000 USD. By 2020, it had increased to around 2,500 USD.

Greenhouse Gas Emission Data Table

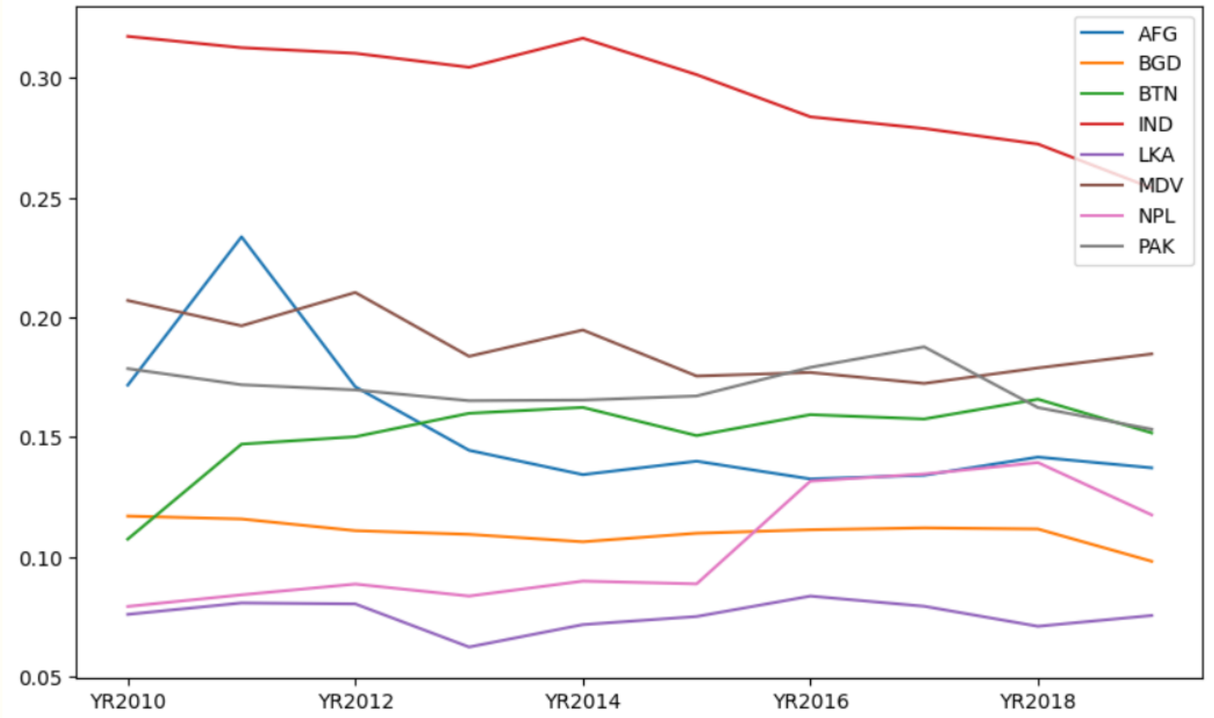
```
import pandas as pd

country_codes = ['MDV', 'IND', 'NPL', 'BTN', 'LKA', 'AFG', 'PAK', 'BGD']

pd = wb.data.DataFrame(['EN.ATM.CO2E.PP.GD'], country_codes, time=range(2010, 2019), labels=True).transpose()
pd
```

1 to 10 of 10 entries | Filter

Index	BGD	PAK	AFG	LKA	BTN	NPL	IND	MDV
Country	Bangladesh	Pakistan	Afghanistan	Sri Lanka	Bhutan	Nepal	India	Maldives
YR2010	0.117077486130155	0.178664405060651	0.17176522247664	0.0760492295644503	0.107471874613596	0.0793556515403438	0.317402011719562	0.207105907035618
YR2011	0.115886382175395	0.171937379500949	0.233702865903674	0.0808219200645335	0.14712763370062	0.0842110556525875	0.312677990852934	0.196545083843267
YR2012	0.111001088033907	0.16977925530259	0.171085011792157	0.0804133942572798	0.150224690379871	0.0887006818785651	0.310319156689881	0.21046691603288
YR2013	0.109456012835107	0.165268038468906	0.144558321172312	0.0624245369832792	0.160012493832068	0.0836980862108206	0.304503906185997	0.183793789782933
YR2014	0.106369517281348	0.165536238149882	0.134398532318261	0.0717726924687621	0.162461220394818	0.0899389863952032	0.316634720476535	0.194789092679071
YR2015	0.109923614564447	0.16723650252279	0.14001604386586	0.0751591750758438	0.150693067811389	0.0887809998962546	0.301408378049215	0.175569182161755
YR2016	0.111381409202741	0.179190642826317	0.132599158642522	0.0836858878606774	0.159451402407274	0.131712166346954	0.283807113262758	0.17705854038512
YR2017	0.112153371762906	0.18776068845624	0.134152349586293	0.0794388764994451	0.157630226646199	0.134651255221214	0.278944392662765	0.172480519164317
YR2018	0.111698118366827	0.162407930249488	0.141729244815793	0.0710706523510109	0.16588274643516	0.139438354190179	0.27243625610552	0.178950992087522

Greenhouse gas emission Line plot

```
wb.data.DataFrame('EN.ATM.CO2E.PP.GD', ['MDV', 'IND', 'NPL', 'BTN', 'LKA', 'AFG', 'PAK', 'BGD'],
                  range(2010, 2020), index='time').plot(figsize=(10, 6))
plt.show()
```



Interpretation

Greenhouse gas emissions in South Asia have been increasing steadily, with India accounting for most of the increase. greenhouse gas emissions in South Asia have increased by an average of 2.5% per year between 2010 and 2020 (CO2 Storage Resources and their development 2022)

Air Transport Freight Volume Data

```
] #airtransport - frieght volume data (remove missing data)
  import pandas as pd

  country_codes = ('MDV', 'IND', 'NPL', 'BTN', 'LKA', 'AFG', 'PAK', 'BGD')

  pd = wb.data.DataFrame(['IS.AIR.GOOD.MT.K1'], country_codes, time=range(2010, 2019), labels=True).transpose()
  pd
```

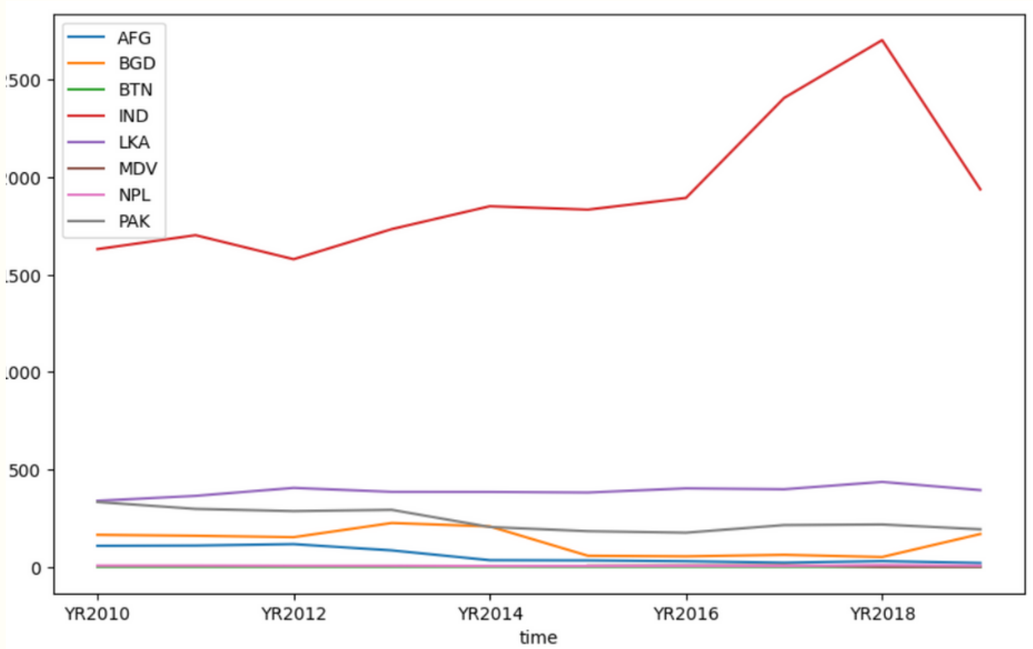
1 to 10 of 10 entries

Index	BGD	PAK	AFG	LKA	BTN	NPL	IND	MDV
Country	Bangladesh	Pakistan	Afghanistan	Sri Lanka	Bhutan	Nepal	India	Maldives
YR2010	164.424638607974	332.957297192	108.019487128	339.048919353	0.421937731663489	6.463516539	1630.96414222155	NaN
YR2011	159.692783547366	297.683519787229	109.421117469991	364.50263	0.483705822187223	6.48656488020303	1702.702702	NaN
YR2012	152.319036972822	286.075685790508	116.660723422675	405.42043	0.471	5.76237493105865	1579.229879	NaN
YR2013	225.1869	292.760800570437	84.621216	385.12	0.635292	5.759868	1733.76172	NaN
YR2014	207.73842	204.623134285262	34.283472	384.70865414	0.922884	4.5996	1851.32674	NaN
YR2015	57.0095471847824	183.17731267	33.102038592	381.6320526	0.538041372	4.536371616	1833.847614	5.87870598184376
YR2016	53.97916179	175.4744	29.010880897	403.075583974751	0.65910068	4.895080058	1893.8815	6.872800012
YR2017	61.74997781	214.52857	21.462556513	398.473464249	0.530672	4.5668399023	2407.098107	7.745645613
YR2018	50.616612	217.534134	29.5593487980126	436.198	0.690916	8.84572	2703.96417383	0

Interpretation

Greenhouse gas emissions in South Asia have been increasing steadily, with India accounting for most of the increase. Greenhouse gas emissions in South Asia have increased by an average of 2.5% per year between 2010 and 2020(Asian Development Bank, 2023).

Air Transport Frieght Volume Line plot




```
wb.data.DataFrame('IS.AIR.GOOD.MT.K1', ['MDV', 'IND', 'NPL', 'BTN', 'LKA', 'AFG', 'PAK', 'BGD'],
                  range(2010, 2020), index='time').plot(figsize=(10, 6))
plt.show()
```

Interpretation

Greenhouse gas emissions in South Asia have been increasing steadily, with India accounting for most of the increase.
greenhouse gas emissions in South Asia have increased by an average of 2.5% per year between 2010 and 2020

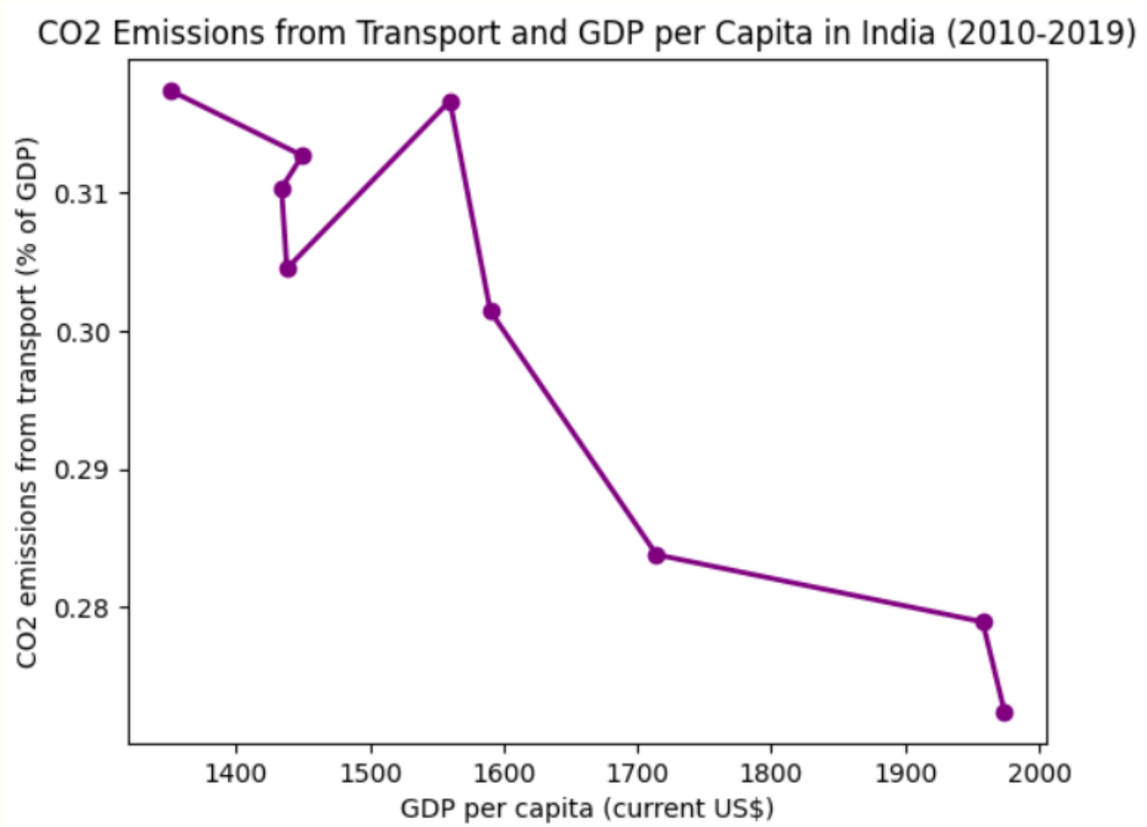
HYPOTHESIS 1

The Scatter Plot comparing GDP per capita and Greenhouse gas emission in India

```
import pandas as pd
import matplotlib.pyplot as plt

df = pd.DataFrame({'NY.GDP.PCAP.CD': [1350.63445681517, 1449.60330101065, 1434.01797842656, 1438.05699513067,1559.86377161811,1590.17432166504, 1714.2795405846,1957.96981368095,1974.3
                   'EN.ATM.CO2E.PP.GD': [0.317402011719562, 0.312677990852934, 0.310319156689881,0.304503906185997 , 0.316634720476535,0.301408378049215, 0.283807113262758,0.27894439

plt.plot(df['NY.GDP.PCAP.CD'], df['EN.ATM.CO2E.PP.GD'], marker='o', linewidth=2, c='purple', linestyle='-')

plt.title('CO2 Emissions from Transport and GDP per Capita in India (2010-2019)')
plt.xlabel('GDP per capita (current US$)')
plt.ylabel('CO2 emissions from transport (% of GDP)')

plt.show()
```

HYPOTHESIS 1

The Scatter Plot comparing GDP per capita and Greenhouse gas emission in India



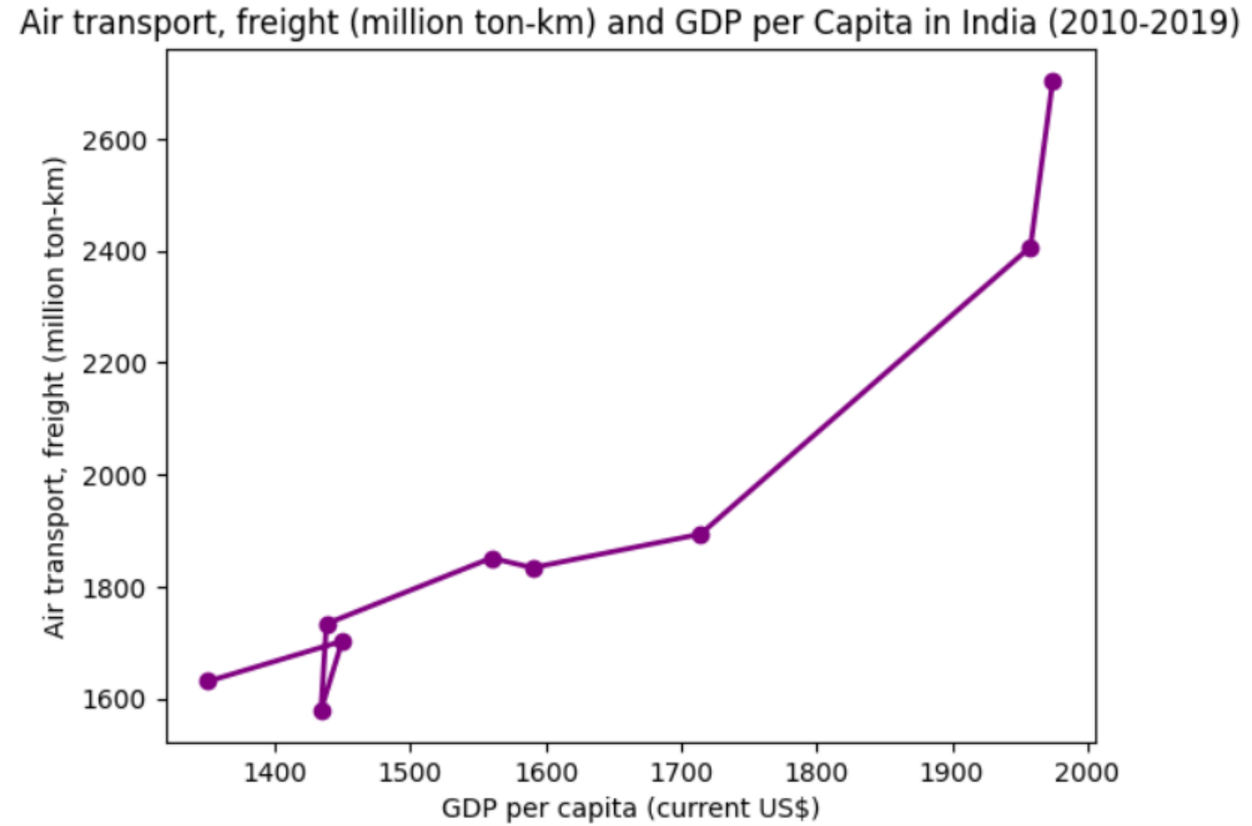
HYPOTHESIS 2

Scatter plot comparing Air transport Freight Volume and GDP per capita

```
import pandas as pd
import matplotlib.pyplot as plt

df = pd.DataFrame({'NY.GDP.PCAP.CD': [1350.63445681517, 1449.60330101065, 1434.01797842656, 1438.05699513067,1559.86377161811,1590.17432166504, 1714.2795405846,1957.96981368095,1974.3
                   'IS.AIR.GOOD.MT.K1': [1630.96414222155, 1702.702702,1579.229879,1733.76172 ,1851.32674 , 1833.847614,1893.8815, 2407.098107,2703.96417383 ]})

plt.plot(df['NY.GDP.PCAP.CD'], df['IS.AIR.GOOD.MT.K1'], marker='o', linewidth=2, c='purple', linestyle='-')

plt.title('Air transport, freight (million ton-km) and GDP per Capita in India (2010-2019)')
plt.xlabel('GDP per capita (current US$)')
plt.ylabel('Air transport, freight (million ton-km)')

plt.show()
```

HYPOTHESIS 2

Scatter plot comparing Air transport Freight Volume and GDP per capita



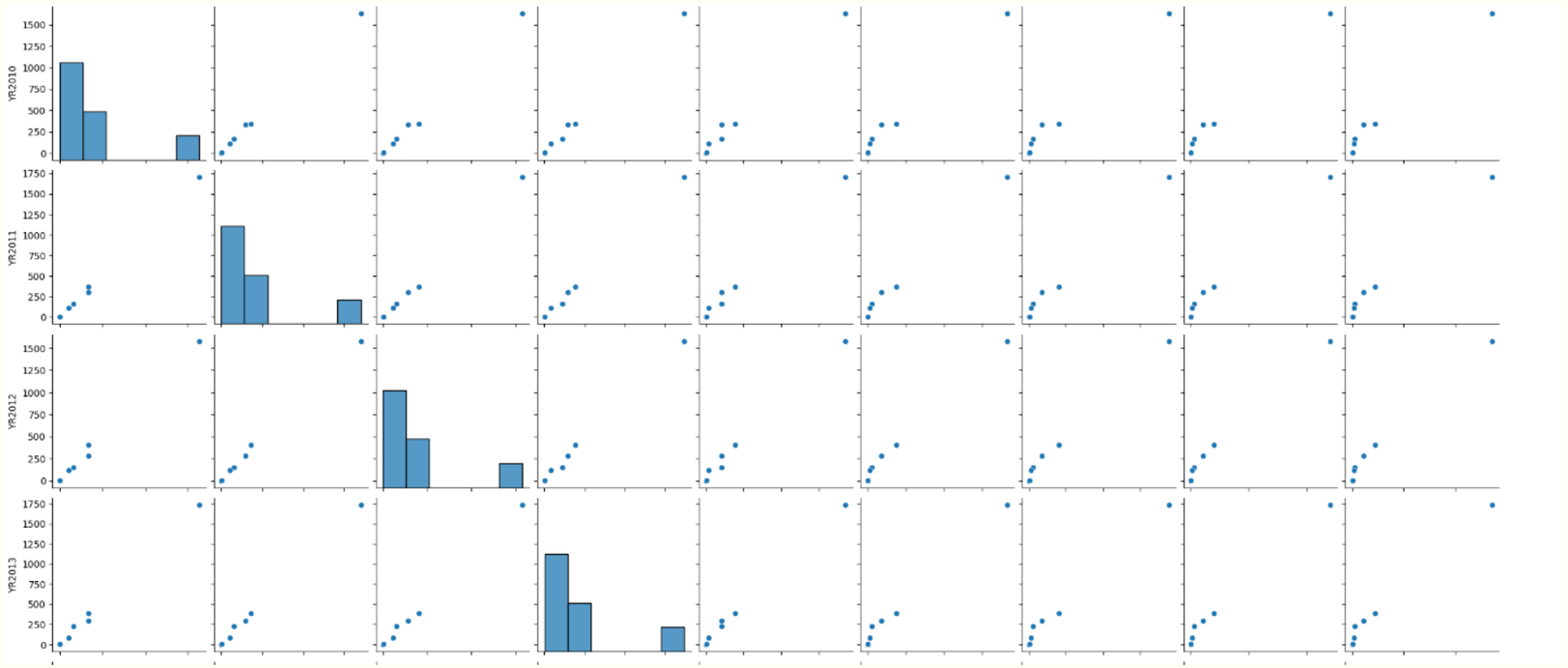
Combined Data Table

economy	series	Country	Series	YR2010	YR2011	YR2012	YR2013	YR2014	YR2015	YR2016	YR2017	YR2018
BGD	NY.GDP.PCAP.CD	Bangladesh	GDP per capita (current US$)	776.859577	856.381887	876.818007	973.773900	1108.514957	1236.004398	1659.962489	1815.610191	1963.412707
PAK	NY.GDP.PCAP.CD	Pakistan	GDP per capita (current US$)	911.089996	1075.451020	1109.678735	1126.040776	1173.392309	1282.443026	1468.822077	1567.640620	1620.742596
AFG	NY.GDP.PCAP.CD	Afghanistan	GDP per capita (current US$)	554.594735	621.912414	663.141053	651.987862	628.146804	592.476165	520.251955	530.149863	502.057099
LKA	NY.GDP.PCAP.CD	Sri Lanka	GDP per capita (current US$)	2836.974098	3248.040215	3351.892489	3643.832449	3885.623610	3990.353123	4107.829762	4388.201908	4360.584742
BTN	NY.GDP.PCAP.CD	Bhutan	GDP per capita (current US$)	2194.125870	2491.273456	2470.072136	2409.439989	2589.899141	2695.636904	2879.546572	3240.706326	3210.707814
NPL	NY.GDP.PCAP.CD	Nepal	GDP per capita (current US$)	589.165435	791.225577	794.092559	809.384458	827.744705	882.307663	880.224894	1027.965474	1161.534350
IND	NY.GDP.PCAP.CD	India	GDP per capita (current US$)	1350.634457	1449.603301	1434.017978	1438.056995	1559.863772	1590.174322	1714.279541	1957.969814	1974.377730
MDV	NY.GDP.PCAP.CD	Maldives	GDP per capita (current US$)	7158.061411	7409.331704	7447.415454	8222.558022	8872.128664	9434.311910	9640.319191	10063.003710	10823.610483
BGD	EN.ATM.CO2E.PP.GD	Bangladesh	CO2 emissions (kg per PPP $ of GDP)	0.117077	0.115886	0.111001	0.109456	0.106370	0.109924	0.111381	0.112153	0.111698
PAK	EN.ATM.CO2E.PP.GD	Pakistan	CO2 emissions (kg per PPP $ of GDP)	0.178664	0.171937	0.169779	0.165268	0.165536	0.167237	0.179191	0.187761	0.162408
AFG	EN.ATM.CO2E.PP.GD	Afghanistan	CO2 emissions (kg per PPP $ of GDP)	0.171765	0.233703	0.171085	0.144558	0.134399	0.140016	0.132599	0.134152	0.141729
LKA	EN.ATM.CO2E.PP.GD	Sri Lanka	CO2 emissions (kg per PPP $ of GDP)	0.076049	0.080822	0.080413	0.062425	0.071773	0.075159	0.083686	0.079439	0.071071
BTN	EN.ATM.CO2E.PP.GD	Bhutan	CO2 emissions (kg per PPP $ of GDP)	0.107472	0.147128	0.150225	0.160012	0.162461	0.150693	0.159451	0.157630	0.165883
NPL	EN.ATM.CO2E.PP.GD	Nepal	CO2 emissions (kg per PPP $ of GDP)	0.079356	0.084211	0.088701	0.083698	0.089939	0.088781	0.131712	0.134651	0.139438
IND	EN.ATM.CO2E.PP.GD	India	CO2 emissions (kg per PPP $ of GDP)	0.317402	0.312678	0.310319	0.304504	0.316635	0.301408	0.283807	0.278944	0.272436
MDV	EN.ATM.CO2E.PP.GD	Maldives	CO2 emissions (kg per PPP $ of GDP)	0.207106	0.196545	0.210467	0.183794	0.194789	0.175569	0.177059	0.172481	0.178951
BGD	IS.AIR.GOOD.MT.K1	Bangladesh	Air transport, freight (million ton-km)	164.424639	159.692784	152.319037	225.186900	207.738420	57.009547	53.979162	61.749978	50.616612
PAK	IS.AIR.GOOD.MT.K1	Pakistan	Air transport, freight (million ton-km)	332.957297	297.683520	286.075686	292.760801	204.623134	183.177313	175.474400	214.528570	217.534134
AFG	IS.AIR.GOOD.MT.K1	Afghanistan	Air transport, freight (million ton-km)	108.019487	109.421117	116.660723	84.621216	34.283472	33.102039	29.010881	21.462557	29.559349
LKA	IS.AIR.GOOD.MT.K1	Sri Lanka	Air transport, freight (million ton-km)	339.048919	364.502630	405.420430	385.120000	384.708654	381.632053	403.075584	398.473464	436.198000
BTN	IS.AIR.GOOD.MT.K1	Bhutan	Air transport, freight (million ton-km)	0.421938	0.483706	0.471000	0.635292	0.922884	0.538041	0.659101	0.530672	0.690916
NPL	IS.AIR.GOOD.MT.K1	Nepal	Air transport, freight (million ton-km)	6.463517	6.486565	5.762375	5.759868	4.599600	4.536372	4.895080	4.566840	8.845720
IND	IS.AIR.GOOD.MT.K1	India	Air transport, freight (million ton-km)	1630.964142	1702.702702	1579.229879	1733.761720	1851.326740	1833.847614	1893.881500	2407.098107	2703.964174
MDV	IS.AIR.GOOD.MT.K1	Maldives	Air transport, freight (million ton-km)	NaN	NaN	NaN	NaN	NaN	5.878706	6.872800	7.745646	0.000000

```
import pandas as pd

country_codes = ['MDV', 'IND', 'NPL', 'BTN', 'LKA', 'AFG', 'PAK', 'BGD']

pd = wb.data.DataFrame(['NY.GDP.PCAP.CD', 'EN.ATM.CO2E.PP.GD', 'IS.AIR.GOOD.MT.K1'], country_codes, time=range(2010, 2019), labels=True)
pd
```

Pairplotting the three factors

```
sns.pairplot(df)
```



Interpretation

We created a pairplot to find the relation between the entire data in the data set.

Final Interpretation

The pairplot shows that there is a positve correlation between the GDP per capita and Green house gas emissions and a negative correlation between GDP per capita and Air transport freight volume. A study by Harbaugh, Levinson, and Wilson (2002) revealed a pattern where air pollution initially rises with a country's economic growth, but this trend eventually reverses as the country transitions to cleaner technologies and industries. This shows the postive correlation between Gdp and Greenhouse gas emissions.

The Efficiency of Air Freight: A Global Perspective" by the World Economic Forum (2017), briefed that air freight is becoming more efficient due to technological advancements and supply chain modifications. As countries grow wealthier, they may transition away from labor-intensive industries that rely on air freight towards more capital-intensive industries that utilize air freight less.This shows the neagtive ecorrelation of GDP Per capita and Air transport freight volume.

Conclusion

Our research shows a positive relation between the GDP per capita and Greenhouse gas emissions. This leads to an understanding that with an increase in GDP per capita, there is also an increase in Greenhouse gas emissions.

After researching the World Bank CCD report, we found several reasons for this correlation:

- increasing industrial activity
- Urbanization
- Dependence on fossil fuels
- lack of investment in renewable resources

(Climate Change, n.d.)

References

Harbaugh, W., Levinson, A. and Wilson, D. (2000) Reexamining the empirical evidence for an Environmental Kuznets curve, NBER. Available at: https://www.nber.org/papers/w7711

Iea (no date) Energy efficiency 2020 – analysis, IEA. Available at: https://www.iea.org/reports/energy-efficiency-2020

Thank you