Data Visualization

ELEMENT 2: CLIMATE CHANGE VISUALISATIONS

GROUP ID: **THE MARINES**

GHG EMISSIONS SINCE KYOTO PROTOCOL

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Introduction

This report is intended to succinctly explore the multinational initiative taken by 192 countries in 1997 to reduce Greenhouse Gas (GHG) emissions and limit the rate of climate change caused by humans worldwide otherwise known as the Kyoto Protocol. This project seeks to analyse the trends on Improvements, setbacks, and key contributions by member countries of the international treaty since it was endorsed in the year 1997. It consists of 6 main sections namely a Project brief, Data analysis, Data narrative, Data representation, Critical reflection, and the Project work plan.

All sections have been detailed to exhaustively share insight on the subject matter and of course to reflect the level of teamwork, ingenuity and devotion demonstrated by each member of the Marine team. The team is a random select of five students from various racial and ethnic backgrounds who albeit their differences have sought to devote their time, energy, and resources to make this piece of work a success. The members of the Marine team are namely:

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Project Brief

Objectives

The aim of this project is to explore the statistical properties of a GHG emission dataset gathered from a recent report on climate change. It intends to share insightful knowledge gleaned through explanatory charts, leveraging on a profound understanding of mathematical theories behind basic visualization concepts. To project the learning outcomes of this piece of work, the following questions have been crafted to enliven our infographic design:

What is the overview of global emissions?
Why are we on the lookout for Green House Gases?
What is the trend in Global emissions and temperature change after Kyoto?
What Countries are the largest contributors to global emissions?
What main sectors have a huge influence on the rate of GHG emissions in relation to top 5 emitting countries?
What are the Emission Trends by Top Countries in Relation to Population and GDP?
What is the variance between 1997 and 2018 for the Top 5 Countries?
What is the variance between 1997 and 2018 for the Top 5 Sectors?
What is the Global Impact of the 20-year Emission Changes?

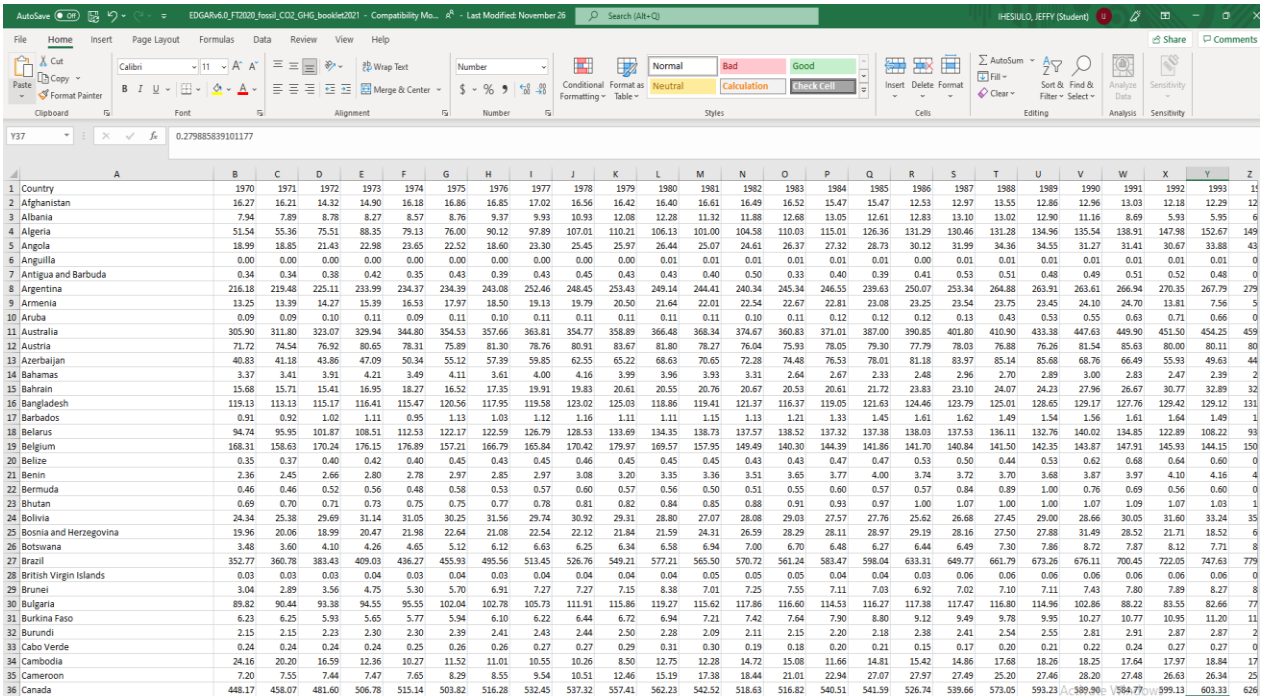
The dataset used in this project was captured from the EDGAR (Emissions Database for Global Atmospheric Research) report for GHG emissions of world countries 2021, released in October 2021. EDGAR generates an impartial assessment of greenhouse gas emissions for each nation following a rigorous and consistent approach based on the most recent IPCC (Intergovernmental Panel for Climate

Change) recommendations and activity data. However, while this repository captures C02 fossil emissions from1970 – 2020, the GHG national emissions was our focal point and was only available for a period covering 1970 to 2018. This dataset was made available in a downloadable csv format with the link: EDGAR - The Emissions Database for Global Atmospheric Research (europa.eu) on the EDGAR website referenced herein. It houses an avalanche of data on the following:

1. GHG total by Country
2. GHG by sector and country
3. GHG per capita by country
4. GHG per GDP by country

Each sheet of the dataset has a list of 208 countries in alphabetical order followed by the total GHG emissions by their reference year (1970-2018) in time series. The values of the GHG emissions and GHG per Capita are expressed in **Mt CO2eq/yr** and **Mt CO2eq/cap/yr** respectively. While Emissions per GDP are expressed in **t CO2eq/kUSD/yr.** Each sheet contains 211 rows and 50 columns.
NB: Some of the datasets in use were for a period of 1990 to 2018 while some started from 1970.
Shared in the screenshot below is an excerpt from the dataset.

Fig 1: Dataset excerpt of GHG total by Country



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1
2	Afghanistan	16.27	16.21	14.32	14.90	16.18	16.86	16.85	17.02	16.56	16.42	16.40	16.61	16.49	16.52	15.47	15.47	12.53	12.97	13.55	12.86	12.96	13.03	12.18	12.29	12
3	Albania	7.94	7.89	8.78	8.27	8.57	8.76	9.37	9.93	10.93	12.08	12.28	11.32	11.88	12.68	13.05	12.61	12.83	13.10	13.02	12.90	11.16	8.69	5.93	5.95	6
4	Algeria	51.54	55.36	75.51	88.35	79.13	76.00	90.12	97.89	107.01	110.21	106.13	101.00	104.58	110.03	115.01	126.36	131.29	130.46	131.28	134.96	135.54	138.91	147.98	152.67	149
5	Angola	18.99	18.85	21.43	22.98	23.65	22.52	18.60	23.30	25.45	25.97	26.44	25.07	24.61	26.37	27.32	28.73	30.12	31.99	34.36	34.55	31.27	31.41	30.67	33.88	43
6	Anguilla	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0
7	Antigua and Barbuda	0.34	0.34	0.38	0.42	0.35	0.43	0.39	0.43	0.45	0.43	0.43	0.40	0.50	0.33	0.40	0.39	0.41	0.53	0.51	0.48	0.49	0.51	0.52	0.48	0
8	Argentina	216.18	219.48	225.11	233.99	234.37	234.39	243.08	252.46	248.45	253.43	249.14	244.41	240.34	245.34	246.55	239.63	250.07	253.34	264.88	263.91	263.61	266.94	270.35	267.79	279
9	Armenia	13.25	13.39	14.27	15.39	16.53	17.97	18.50	19.13	19.79	20.50	21.64	22.01	22.54	22.67	22.81	23.08	23.25	23.54	23.75	23.45	24.10	24.70	13.81	7.56	5
10	Aruba	0.09	0.09	0.10	0.11	0.09	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.10	0.11	0.12	0.12	0.12	0.13	0.43	0.53	0.55	0.63	0.71	0.66	0
11	Australia	305.90	311.80	323.07	329.94	344.80	354.53	357.66	363.81	354.77	358.89	366.48	368.34	374.67	360.83	371.01	387.00	390.85	401.80	410.90	433.38	447.63	449.90	451.50	454.25	459
12	Austria	71.72	74.54	76.92	80.65	78.31	75.89	81.30	78.76	80.91	83.67	81.80	78.27	76.04	75.93	78.05	79.30	77.79	78.03	76.88	76.26	81.54	85.63	80.00	80.11	80
13	Azerbaijan	40.83	41.18	43.86	47.09	50.34	55.12	57.39	59.85	62.55	65.22	68.63	70.65	72.28	74.48	76.53	78.01	81.18	83.97	85.14	85.68	68.76	66.49	55.93	49.63	44
14	Bahamas	3.37	3.41	3.91	4.21	3.49	4.11	3.61	4.00	4.16	3.99	3.96	3.93	3.31	2.64	2.67	2.33	2.48	2.96	2.70	2.89	3.00	2.83	2.47	2.39	2
15	Bahrain	15.68	15.71	15.41	16.95	18.27	16.52	17.35	19.91	19.83	20.61	20.55	20.76	20.67	20.53	20.61	21.72	23.83	23.10	24.07	24.23	27.96	26.67	30.77	32.89	32
16	Bangladesh	119.13	113.13	115.17	116.41	115.47	120.56	117.95	119.58	123.02	125.03	118.86	119.41	121.37	116.37	119.05	121.63	124.46	123.79	125.01	128.65	129.17	127.76	129.42	129.12	131
17	Barbados	0.91	0.92	1.02	1.11	0.95	1.13	1.03	1.12	1.16	1.11	1.11	1.15	1.13	1.21	1.33	1.45	1.61	1.62	1.49	1.54	1.56	1.61	1.64	1.49	1
18	Belarus	94.74	95.95	101.87	108.51	112.53	122.17	122.59	126.79	128.53	133.69	134.35	138.73	137.57	138.52	137.32	137.38	138.03	137.53	136.11	132.76	140.02	134.85	122.89	108.22	93
19	Belgium	168.31	158.63	170.24	176.15	176.89	157.21	166.79	165.84	170.42	179.97	169.57	157.95	149.49	140.30	144.39	141.86	141.70	140.84	141.50	142.35	143.87	147.91	145.93	144.15	150
20	Belize	0.35	0.37	0.40	0.42	0.40	0.45	0.43	0.45	0.46	0.45	0.45	0.45	0.43	0.43	0.47	0.47	0.53	0.50	0.44	0.53	0.62	0.68	0.64	0.60	0
21	Benin	2.36	2.45	2.66	2.80	2.78	2.97	2.85	2.97	3.08	3.20	3.35	3.36	3.51	3.65	3.77	4.00	3.74	3.72	3.70	3.68	3.87	3.97	4.10	4.16	4
22	Bermuda	0.46	0.46	0.52	0.56	0.48	0.58	0.53	0.57	0.60	0.57	0.56	0.50	0.51	0.55	0.60	0.57	0.57	0.84	0.89	1.00	0.76	0.69	0.56	0.60	0
23	Bhutan	0.69	0.70	0.71	0.73	0.75	0.75	0.77	0.78	0.81	0.82	0.84	0.85	0.88	0.91	0.93	0.97	1.00	1.07	1.00	1.00	1.07	1.09	1.07	1.03	1
24	Bolivia	24.34	25.38	29.69	31.14	31.05	30.25	31.56	29.74	30.92	29.31	28.80	27.07	28.08	29.03	27.57	27.76	25.62	26.68	27.45	29.00	28.66	30.05	31.60	33.24	35
25	Bosnia and Herzegovina	19.96	20.06	18.99	20.47	21.98	22.64	21.08	22.54	22.12	21.84	21.59	24.31	26.59	28.29	28.11	28.97	29.19	28.16	27.50	27.88	31.49	28.52	21.71	18.52	6
26	Botswana	3.48	3.60	4.10	4.26	4.65	5.12	6.12	6.63	6.25	6.34	6.58	6.94	7.00	6.70	6.48	6.27	6.44	6.49	7.30	7.86	8.72	7.87	8.12	7.71	8
27	Brazil	352.77	360.78	383.43	409.03	436.27	455.93	495.56	513.45	526.76	549.21	577.21	565.50	570.72	561.24	583.47	598.04	633.31	649.77	661.79	673.26	676.11	700.45	722.05	747.63	779
28	British Virgin Islands	0.03	0.03	0.03	0.04	0.03	0.04	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.04	0.04	0.03	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0
29	Brunei	3.04	2.89	3.56	4.75	5.30	5.70	6.91	7.27	7.27	7.15	8.38	7.01	7.25	7.55	7.11	7.03	6.92	7.02	7.10	7.11	7.43	7.80	7.89	8.27	8
30	Bulgaria	89.82	90.44	93.38	94.55	95.55	102.04	102.78	105.73	111.91	115.86	119.27	115.62	117.86	116.60	114.53	116.27	117.38	117.47	116.80	114.96	102.86	88.22	83.55	82.66	77
31	Burkina Faso	6.23	6.25	5.93	5.65	5.77	5.94	6.10	6.22	6.44	6.72	6.94	7.21	7.42	7.64	7.90	8.80	9.12	9.49	9.78	9.95	10.27	10.77	10.95	11.20	11
32	Burundi	2.15	2.15	2.23	2.30	2.30	2.39	2.41	2.43	2.44	2.50	2.28	2.09	2.11	2.15	2.20	2.18	2.38	2.41	2.54	2.55	2.81	2.91	2.87	2.87	2
33	Cabo Verde	0.24	0.24	0.24	0.24	0.25	0.26	0.26	0.27	0.27	0.29	0.31	0.30	0.19	0.18	0.20	0.21	0.15	0.17	0.20	0.21	0.22	0.24	0.27	0.27	0
34	Cambodia	24.16	20.20	16.59	12.36	10.27	11.52	11.01	10.55	10.26	8.50	12.75	12.28	14.72	15.08	11.66	14.81	15.42	14.86	17.68	18.26	18.25	17.64	17.97	18.84	17
35	Cameroon	7.20	7.55	7.44	7.47	7.65	8.29	8.55	9.54	10.51	12.46	15.19	17.38	18.44	21.01	22.94	27.07	27.97	27.49	25.20	27.46	28.20	27.48	26.63	26.34	25
36	Canada	448.17	458.07	481.60	506.78	515.14	503.82	516.28	532.45	537.32	557.41	562.23	542.52	518.63	516.82	540.51	541.59	526.74	539.66	573.05	593.23	589.90	584.77	599.13	603.33	626

Another dataset appended to the above dataset was captured from the NASA website below with link: https://climate.nasa.gov/vital-signs/global-temperature/
This shows the global temperature variations over a period of 1880 to 2018. However, we have chosen to extract data from 1990 to 2018 given the scope of our project. This was necessary to affirm the graphical relationship between increasing temperature and global emissions.

Data Types

Our dataset consists of 3 main data types with the following data type descriptions.

EDGAR Dataset

Fig 2: Tabular description of Data types

Fields	Descriptions	Data type
Country	Geographical definition by controlled by Its government	String
Year	A period of 365 days	Date (Interval)
Emissions per Capita	Quantity of GHG (Metric Tons of Co2 equivalent per capita per year)	Float
Emissions per GDP	Quantity of GHG (Tons of Co2 equivalent per USD per year)	Float
Total Emissions per Country	Quantity of GHG (Metric Tons of Co2 equivalent per capita per year)	Float

Global Temperature Dataset

Fields	Descriptions	Data type
Year	A period of 365 days	Date (Interval)
Temperature	A degree of Hot or Cold	Float variable

Audience

This project is designed to appeal to several audiences given its versality. The use of simple and common visualizations in the infographics suggests its multipurpose appeal. Very important facts have also been highlighted in statements for an easy read. This work has a feel of both aesthetics and numerical accuracy.

With a highly recommended data source from the Emissions Database for Global Atmospheric Research - EDGAR, this project surely forms a basis for a call to action to the following audiences namely:

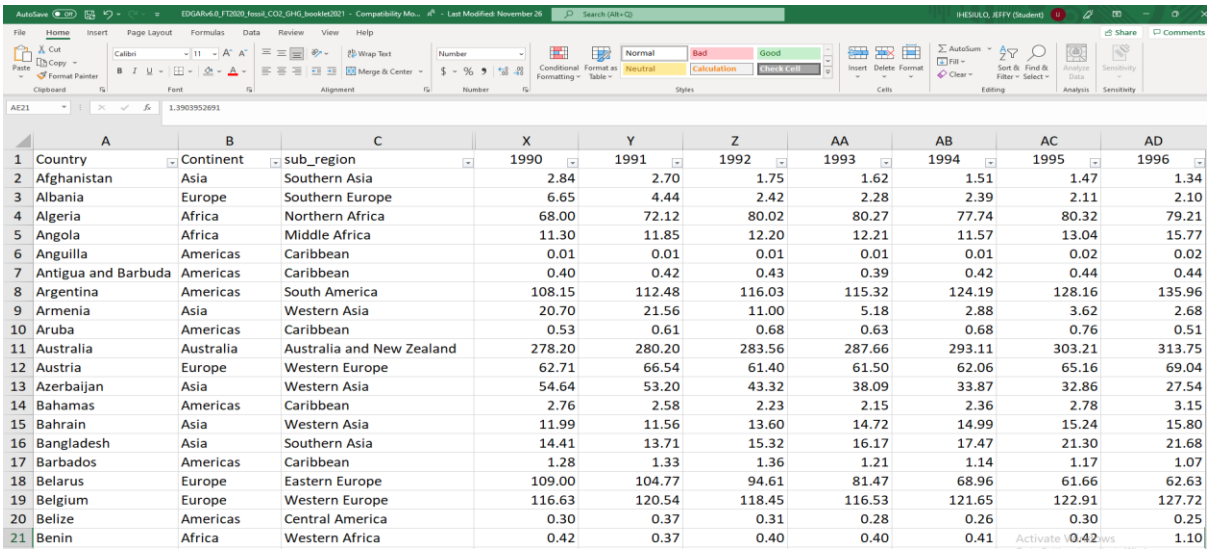
- Leaders in industries
- Environmental activists and Sustainability enthusiasts
- Researchers
- United Nations Framework Convention on Climate Change (UNFCCC)
- Political leaders/policy makers

Data Analysis

The following visualizations were put forth to demonstrate the team's skillset in applying visualization concepts while selecting appropriate charts for the project.

Question 1. Exploring world overview of global emissions

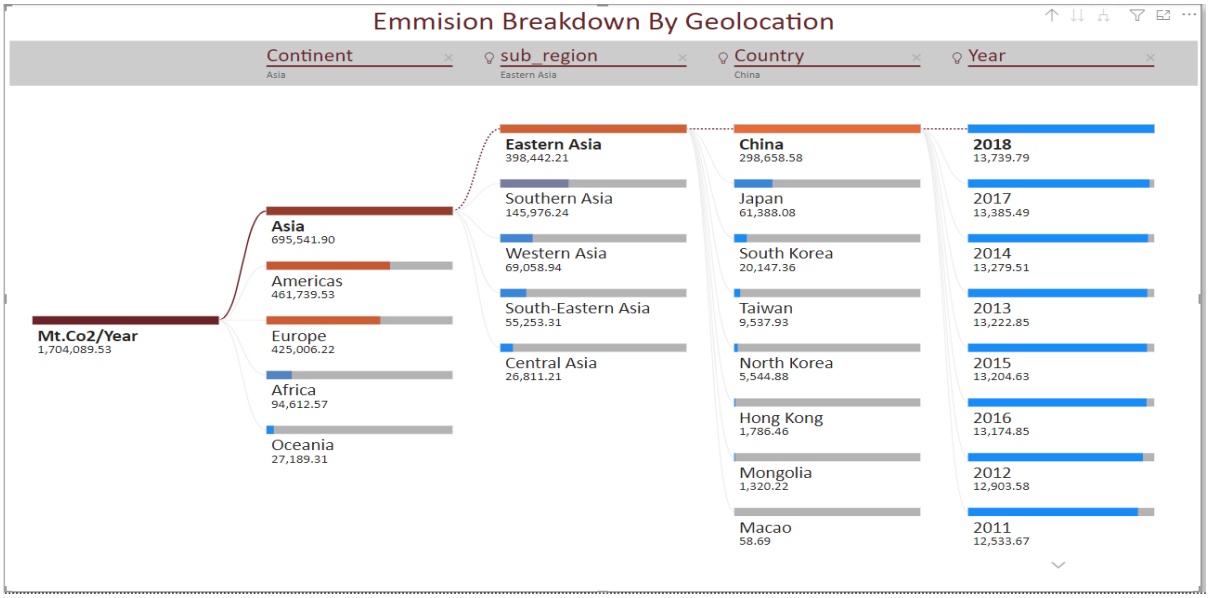
Fig 3. A sample of the GHG table augmented with Continent and sub-region groupings.



	A	B	C	X	Y	Z	AA	AB	AC	AD
1	Country	Continent	sub_region	1990	1991	1992	1993	1994	1995	1996
2	Afghanistan	Asia	Southern Asia	2.84	2.70	1.75	1.62	1.51	1.47	1.34
3	Albania	Europe	Southern Europe	6.65	4.44	2.42	2.28	2.39	2.11	2.10
4	Algeria	Africa	Northern Africa	68.00	72.12	80.02	80.27	77.74	80.32	79.21
5	Angola	Africa	Middle Africa	11.30	11.85	12.20	12.21	11.57	13.04	15.77
6	Anguilla	Americas	Caribbean	0.01	0.01	0.01	0.01	0.01	0.02	0.02
7	Antigua and Barbuda	Americas	Caribbean	0.40	0.42	0.43	0.39	0.42	0.44	0.44
8	Argentina	Americas	South America	108.15	112.48	116.03	115.32	124.19	128.16	135.96
9	Armenia	Asia	Western Asia	20.70	21.56	11.00	5.18	2.88	3.62	2.68
10	Aruba	Americas	Caribbean	0.53	0.61	0.68	0.63	0.68	0.76	0.51
11	Australia	Australia	Australia and New Zealand	278.20	280.20	283.56	287.66	293.11	303.21	313.75
12	Austria	Europe	Western Europe	62.71	66.54	61.40	61.50	62.06	65.16	69.04
13	Azerbaijan	Asia	Western Asia	54.64	53.20	43.32	38.09	33.87	32.86	27.54
14	Bahamas	Americas	Caribbean	2.76	2.58	2.23	2.15	2.36	2.78	3.15
15	Bahrain	Asia	Western Asia	11.99	11.56	13.60	14.72	14.99	15.24	15.80
16	Bangladesh	Asia	Southern Asia	14.41	13.71	15.32	16.17	17.47	21.30	21.68
17	Barbados	Americas	Caribbean	1.28	1.33	1.36	1.21	1.14	1.17	1.07
18	Belarus	Europe	Eastern Europe	109.00	104.77	94.61	81.47	68.96	61.66	62.63
19	Belgium	Europe	Western Europe	116.63	120.54	118.45	116.53	121.65	122.91	127.72
20	Belize	Americas	Central America	0.30	0.37	0.31	0.28	0.26	0.30	0.25
21	Benin	Africa	Western Africa	0.42	0.37	0.40	0.40	0.41	0.42	1.10

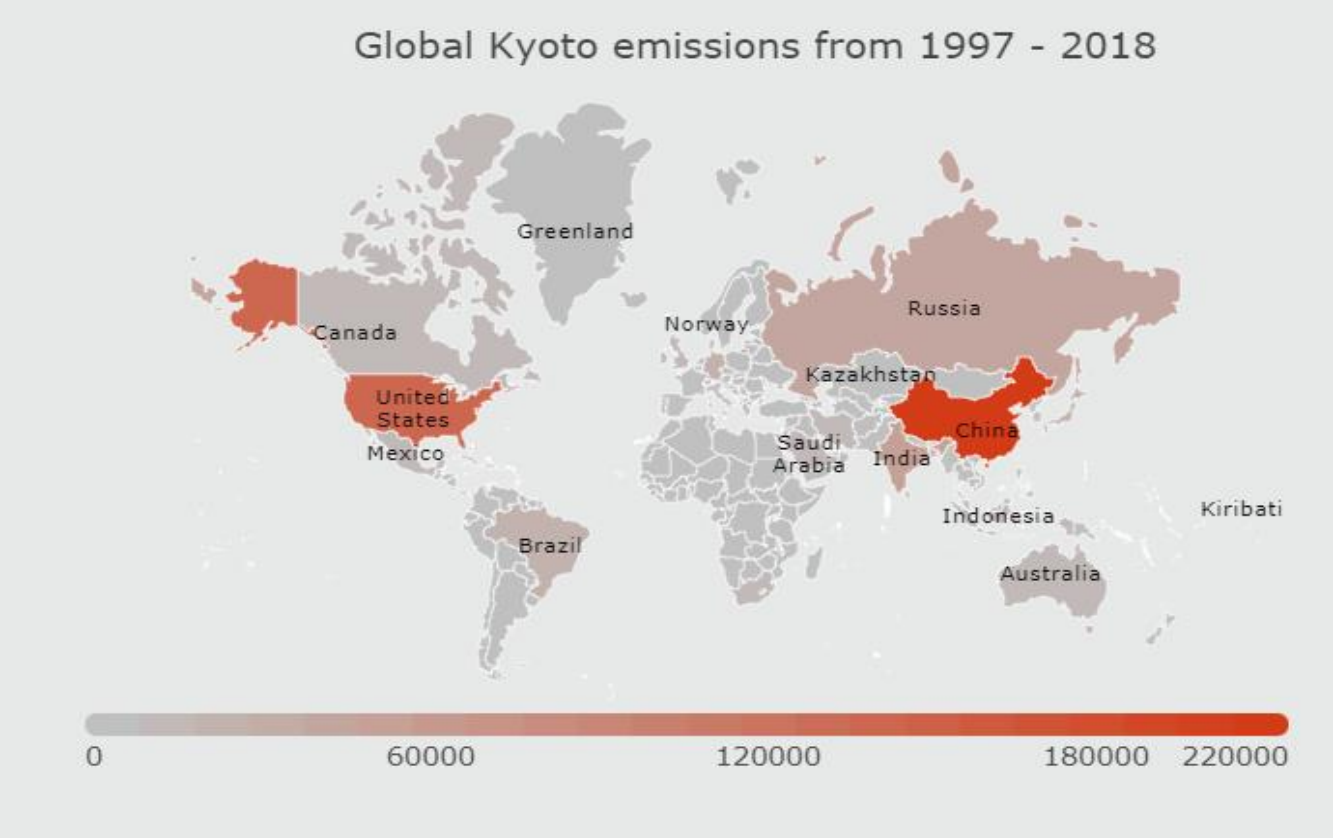
To visualize the statistical data shown in the excerpt above, there are several options that come to mind. The following set of visualizations were options for showing a global view of the reported emissions:

Fig 2. Global view of Emissions using AI decomposition Tree from Power BI:



Description: Global view of Emissions using AI decomposition Tree from Power BI showing emission breakdown in Geolocations in relation to Continents, subregions, country, and year. This was chosen as gives an instant glance of the emission volume in relation to the countries.

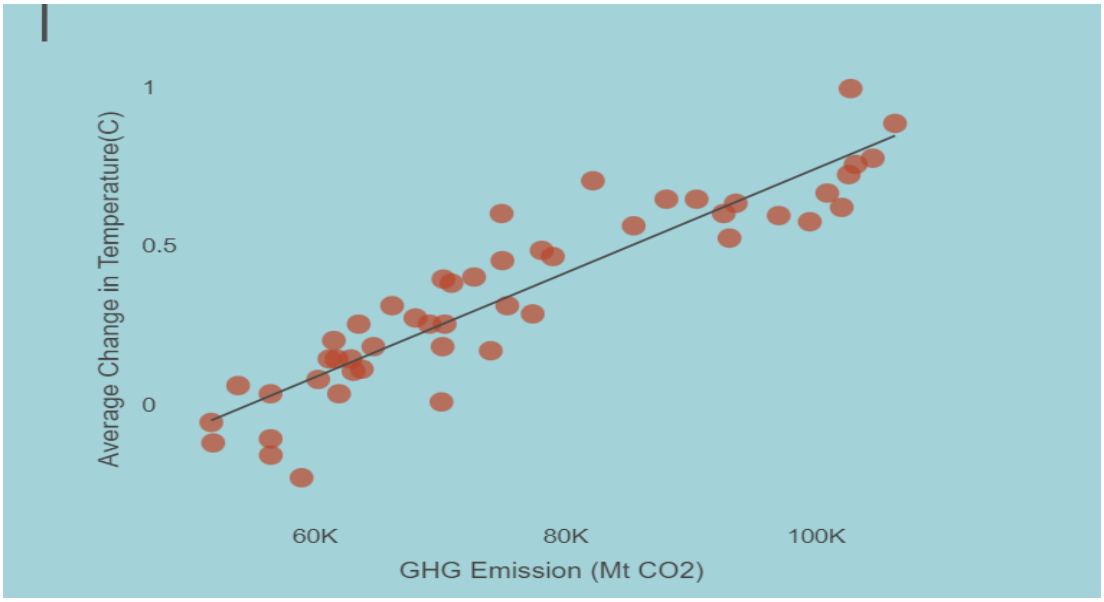
Fig 3: Global view of GHG emitters using a Heat-map on the Infogram tool.



Description: Global view of GHG emitters using a Heat-map to show emission intensity levels with changing colour hues. This was chosen as an option for visualizing an overview of the emissions with rising intensity and level.

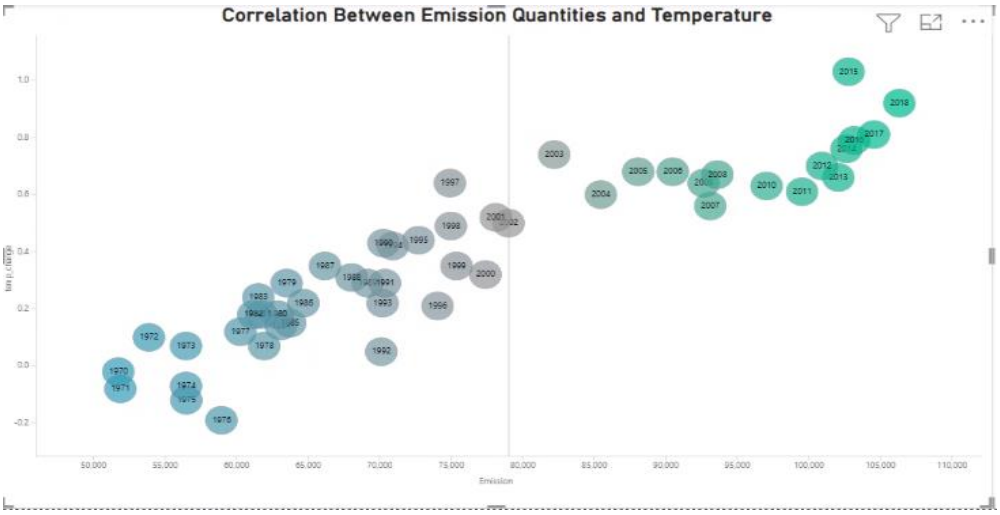
Question 2. Why are we on the lookout for Green House Gases?

Fig 4: Scattered plot showing Correlation between Emissions and Temperature



Description: The scattered plot with a reference line shows a **high positive correlation** between temperature and GHG emissions. It defines significant linear relationship between the two variables with a statistical property of **direct proportionality** and therefore, one of the options for use.

Fig 5: Bubble plot showing Correlation between Emissions and Temperature

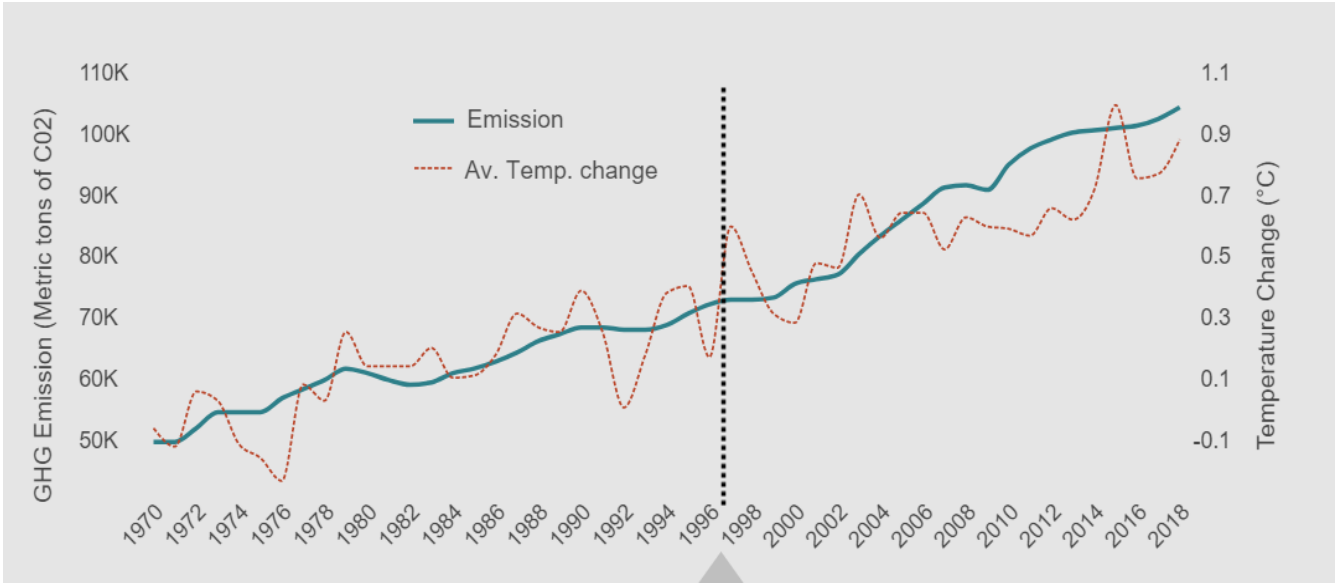


Description: The chart above is a bubble chart showing **correlation** between quantity of emissions and temperature across a period of over 20 years. Each bubble represents the year of emission while the X and Y axis shows the emission and temperature change respectively.

Question 3. What is the trend in Global emissions and temperature change after Kyoto protocol?

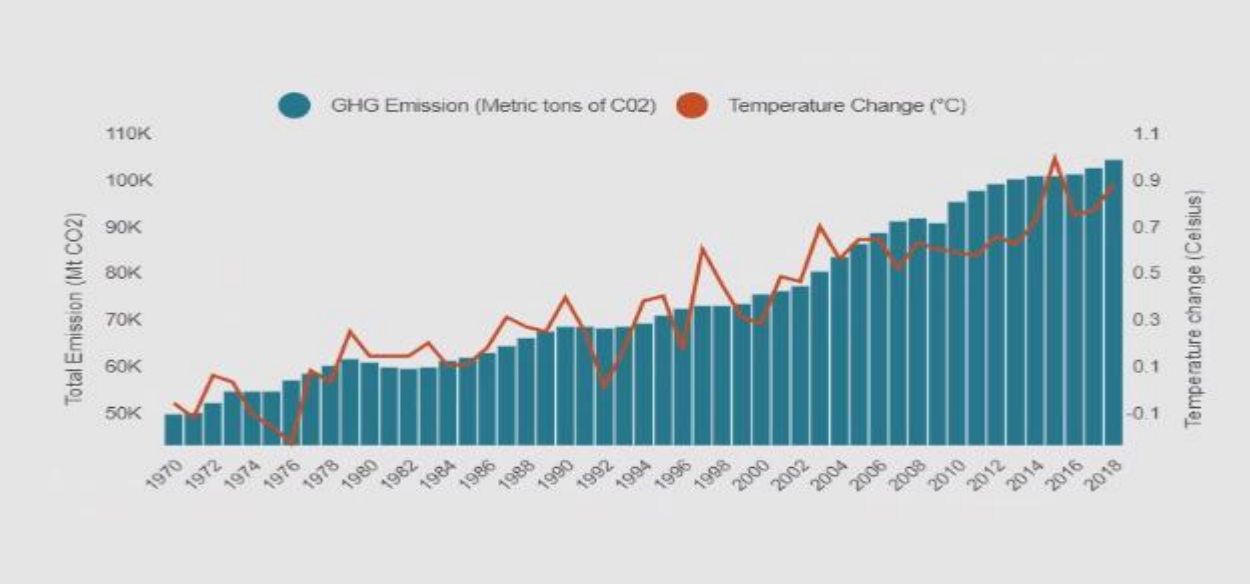
To draw insights from our datasets, there was need to review which chart would be most appropriate for showing a trend analysis of **average change in temperature and a corresponding increase in GHG in relation to time**. The following chart options were submitted for review:

Fig .6: Multiple Line chart showing Trend analysis: Emissions vs Temperature in relation to time:



Description: A multiple Line chart showing Emissions vs Temperature in relation to time was considered to show a trend of temperature and emissions. Line charts are best in the presentation of variable trends.

Fig .7: Trend Analysis with Column and line chart

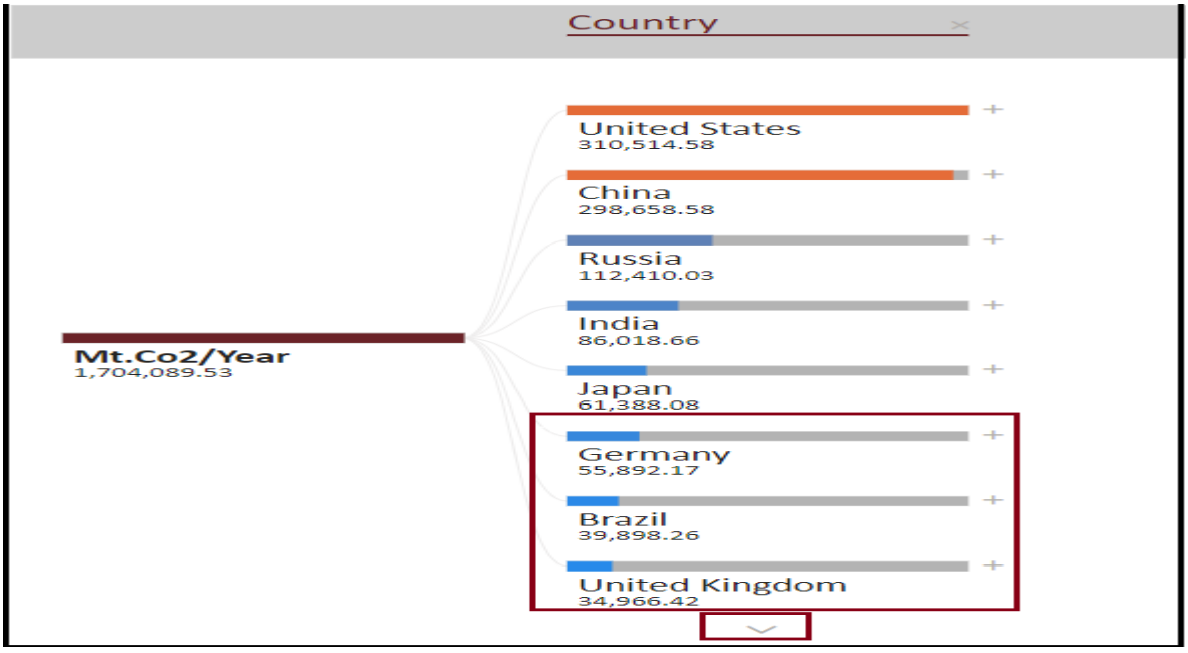


Description: A trend analysis with Column and line chart was another great option for use. The bars represented the quantity of emissions while the red line shows the average temperature rise following the emission trend.

Question 4. What Countries are the largest contributors to global emissions?

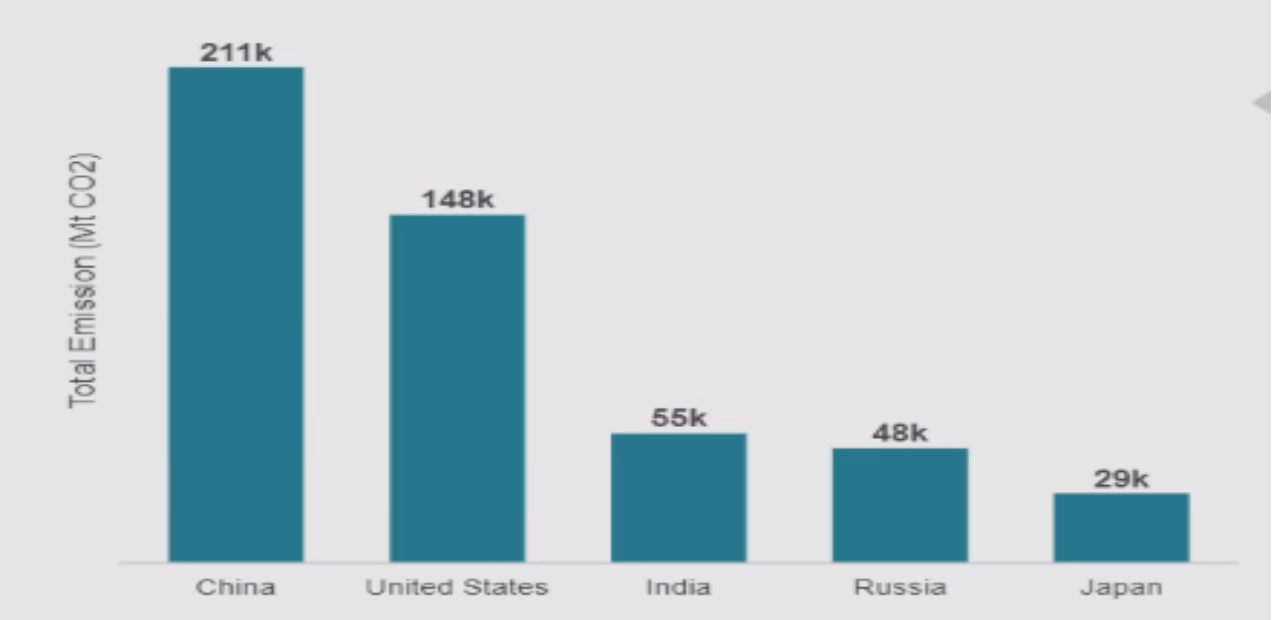
The available dataset would need to be categorised by **ranking the top 5 emitters**. Below were the options at our disposal.

Fig 8. AI analytics of the Top emitters from Power BI



Description: AI analytics of the Top emitters from Power BI to show countries according to their emission rates. An option for use as the above visualization depicts a **categorization** of **5 countries and above** in descending order namely: United states, China, Russia, India, Japan, Germany, Brazil, United Kingdom and Others.

Fig 9. Bar Chart showing Categorical Comparison of the Top 5 emitters

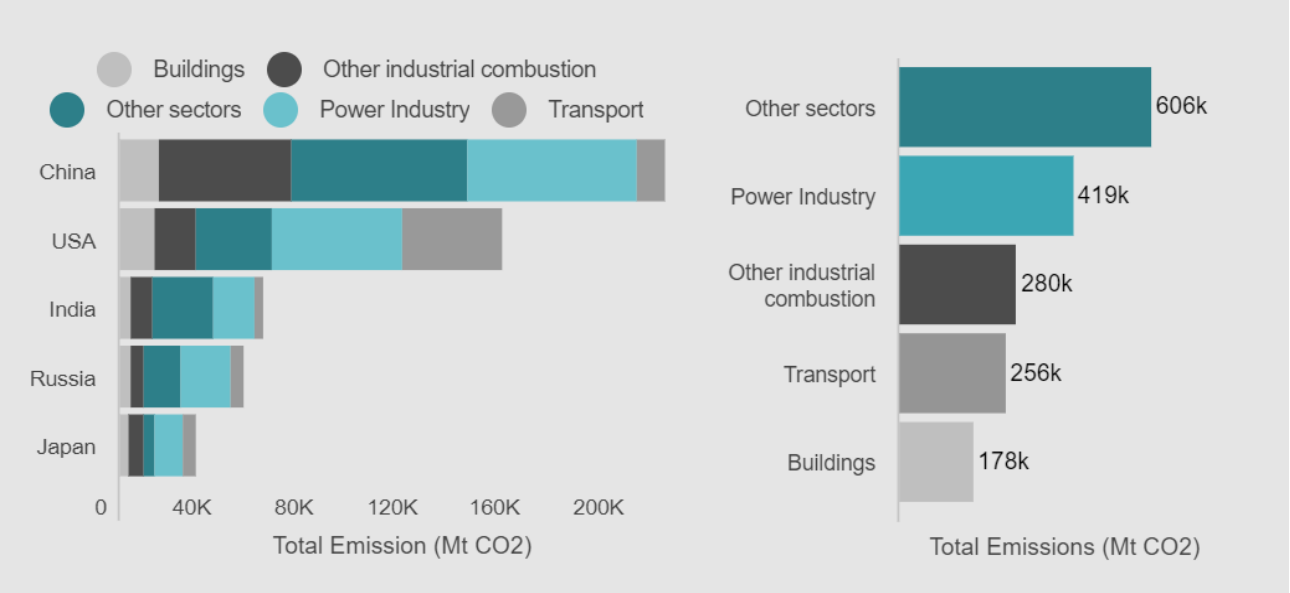


Description: Bar chart visualizing emission rates across the 5 top countries with China at the top of the categorical visualization. This was considered an appropriate chart due to **ranking** of **categorical variables.**

Question 5. What main sectors have a huge influence on the rate of GHG emissions in relation to top 5 emitting countries?

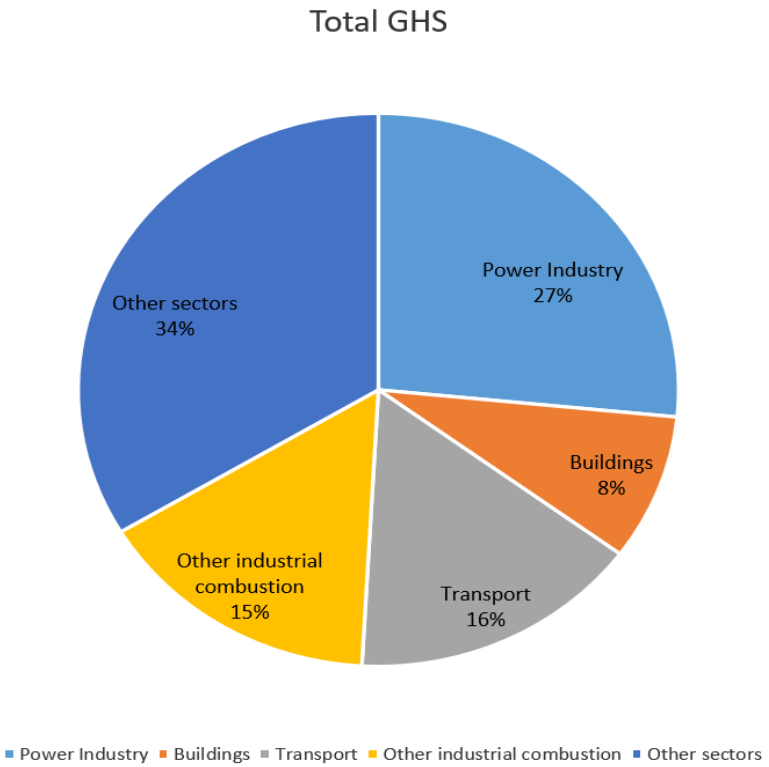
Here there was need to explore a **part-to-whole** sectoral contribution of the top 5 emitters and also check the **ranking** relationship while sorting by the magnitude of emissions. Below were our options.

Fig. 10: Stacked Bar Chart showing a sectorial view of emissions based on the Top 5 Countries



Description: Stacked bar chart showing **part-to-whole** sectoral contribution of the top 5 emitters. This also shows a sectoral relationship in emissions in relation to the following sectors namely Building, Transport, Power, Industry, Other industrial combustion sectors and Other sectors.

Fig 11: Pie chart showing Sectoral view of emissions



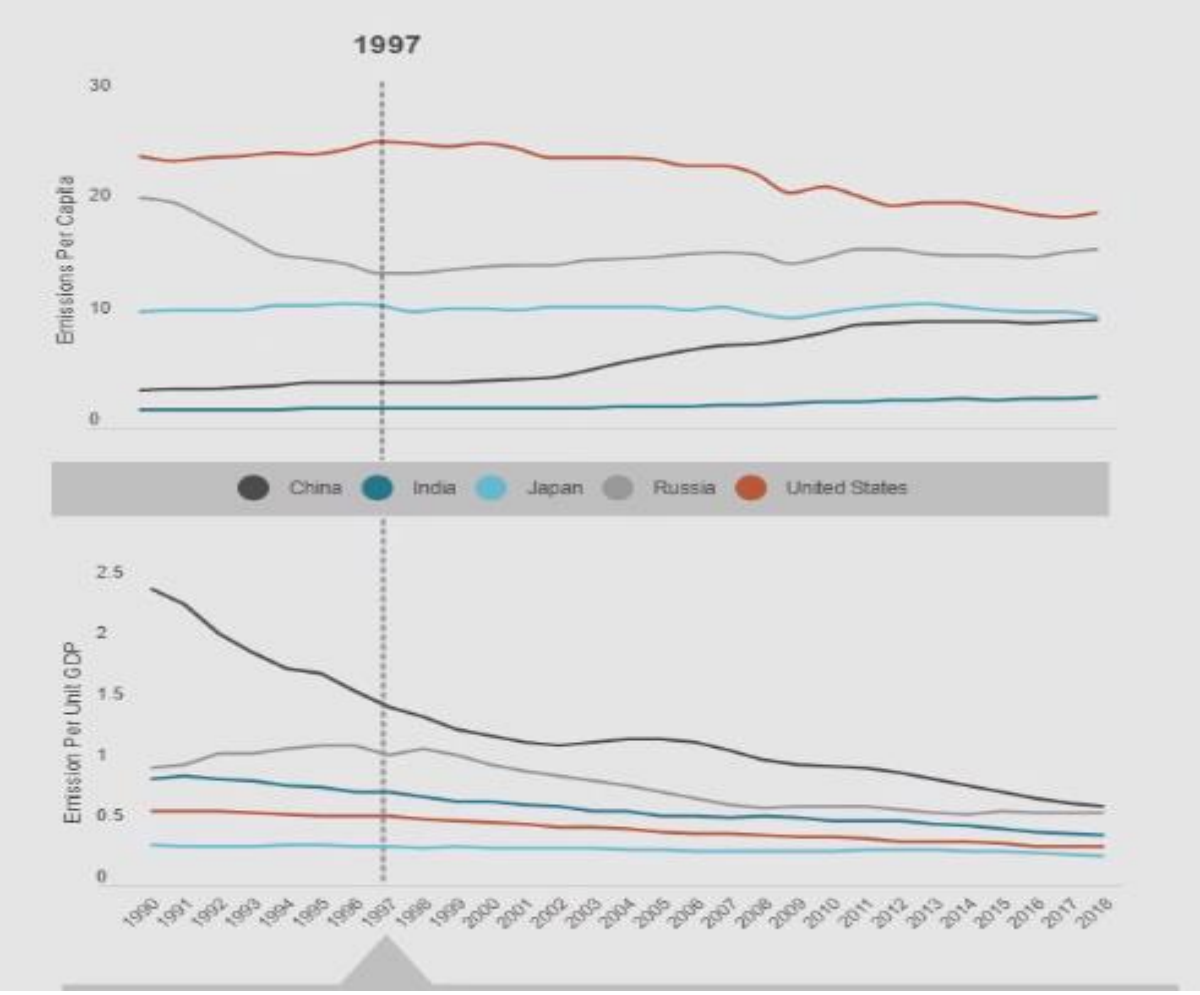
Description: A pie chart showing **part-to-whole** representation of the sectors in relation to the magnitude of emissions. These are represented with sectors in percentages all summing up to a 100%.

Question 6. What are the Emission Trends by Top Countries in Relation to Population and GDP?

NB: 1997 was a pivotal year as the Kyoto protocol agreement was endorsed same year. 2018 was the extent to which data was available given our source.

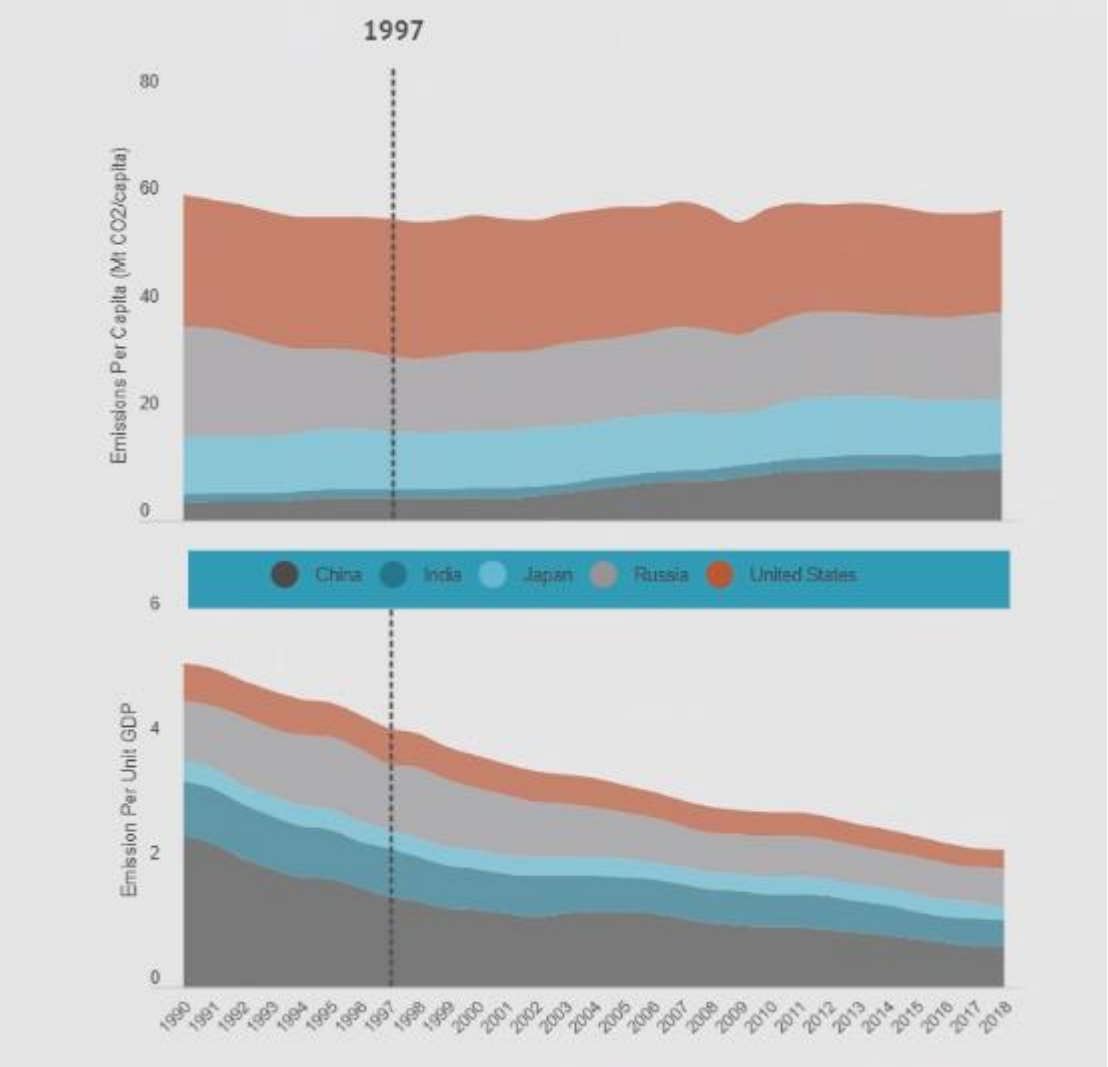
While we expect that population would be directly proportional to the quantity of emissions by top 5 countries, we explored our data and allowed its statistical features to tell the story. Below were some exploratory graphs before making a choice.

Fig 12: Multiple line chart for 5 Top Countries: GHG vs Population and GDP Trend analysis



Description: Multiple line chart showing a trend in emissions from 1990 to 2018 but with special reference to 1997 (with a vertical reference line) as it represents a pivotal year when Kyoto protocol was endorsed by member countries. This multi-line chart visualises emissions per Capita and per GDP with a common x axis showing the number of years under review.

Fig 13: Stacked Area Chart for Top 5 Countries: GHG vs Population and GDP Trend analysis

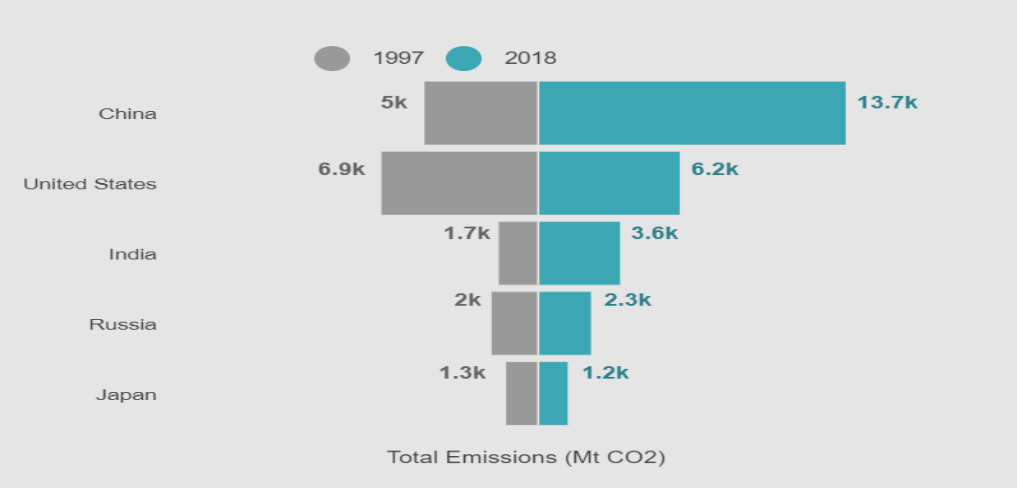


Description: The stacked area chart above is an option for a representation of a trend in emissions per GDP of the top 5 countries. The X axis shows a time series in years while the Y axis represents emission per unit GDP. The area depiction of countries shows a distinctive contrast in Gross Domestic Products for each country with the USA having the highest followed by Russia and Japan respectively.

Question 7: What is the variance between 1997 and 2018 for the Top 5 Countries

To explore the GHG variance in emissions between both years, the following graphical visualizations were options for use.

Fig 14: Variations in Country Emissions between 1997 and 2018 using a Funnel Chart



Description: The funnel chart above shows the annual emission before and after Kyoto protocol exploring the variance in emissions between 1997 and 2018. It seeks to show the percentage performance change in emissions between these years.

Fig 15: Matrix table showing Variance of Top 5 emitters

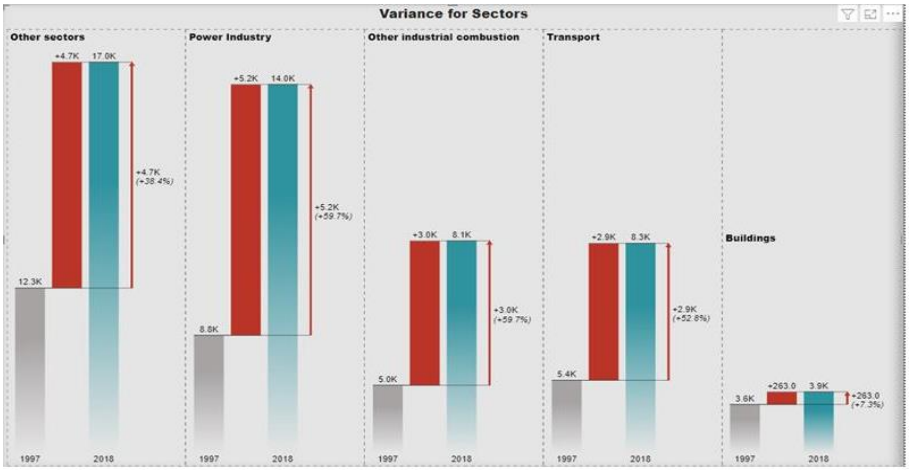
Country	1997	2018	Variance
China	5,049.73	13,739.79	8,690.06
India	1,718.39	3,619.80	1,901.40
Indonesia	564.02	1,074.19	510.17
Iran	461.25	926.37	465.12
Saudi Arabia	304.97	750.60	445.63
Total	**8,098.37**	**20,110.75**	**12,012.38**

Description: The matrix table above shows the variance across the top 5 emitters between 1997 and 2018 with China ranked the highest across 4 other countries.

Question 8: What is the variance between 1997 and 2018 for the Top 5 Sectors

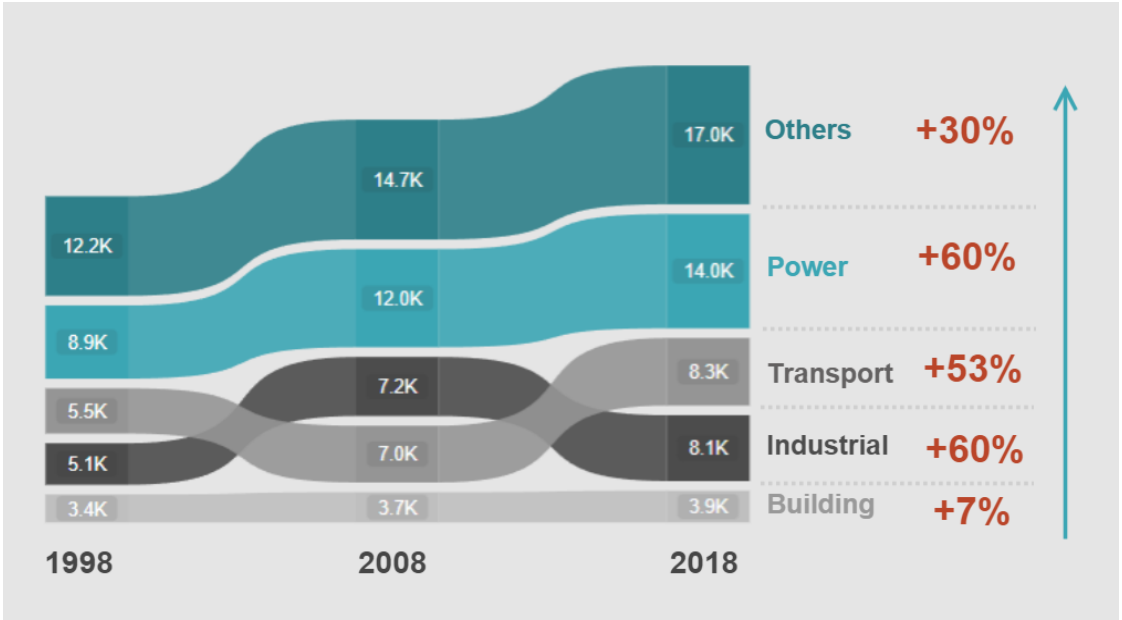
This section explores the percentage variance across 5 main sectors namely Buildings, Other sectors, Power Industry, transport, and Other Industrial combustion sectors.

Fig 16: Variance chart showing changes across 5 sectors within 1997 and 2018



Description: The depiction above shows a variance chart selected from the Power BI custom applications. It is used here to demonstrate the changes seen in emissions across sectors between 1997 and 2018.

Fig 17: Ribbon chart showing Variance across 5 sectors within 1998 and 2008



Description: The ribbon chart above depicts the percentage variance across 5 sectors showing the performance in the sectors of Power industry, buildings, and transport amongst others between 1998 and 2018.

Question 9: What is the Global Impact of the 20-year Emission Changes?

This section seeks to analyse how the performance of the top emitters have impacted the global emission indices over a period of 20 years. The following presentations were options for use.

Fig 18: Table Chart showing Global Impact of top 5 emitters performance over 20 years.

COUNTRY	GHG EMISSION (Mt CO2)	EMISSION CHANGE	GLOBAL EFFECT
United States	-683	-0.38%	-1.99%
United Kingdom	-255	-1.65%	-0.75%
Germany	-232	-1.04%	-0.68%
Ukraine	-201	-2.09%	-0.59%
Italy	-124	-1.14%	-0.36%

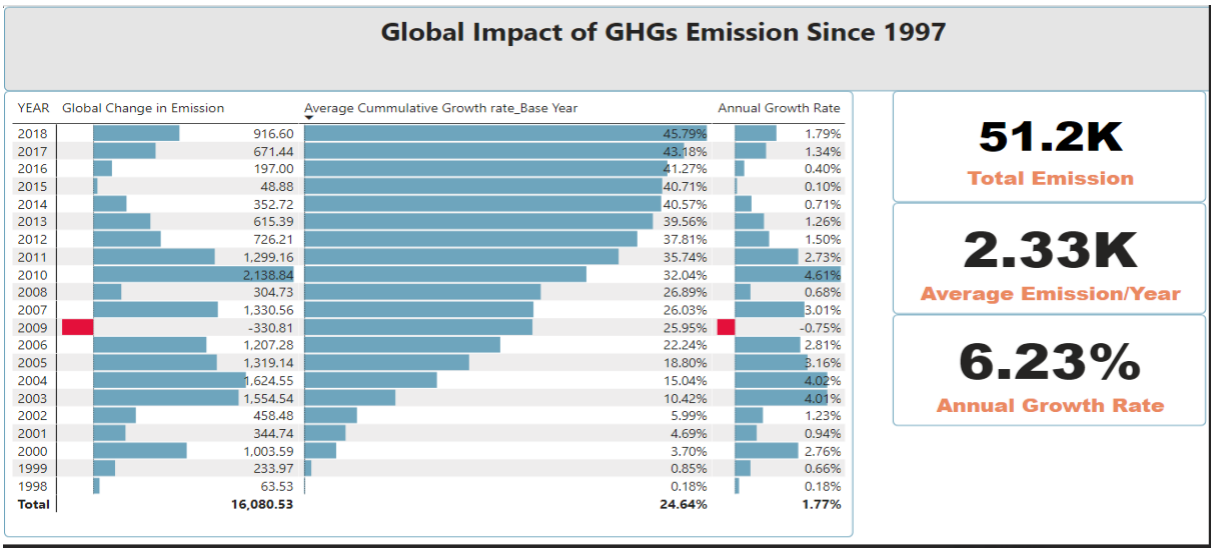
Fig 19: Table Chart for Bottom 5 countries based on global impact of emission changes

COUNTRY	GHG EMISSION (Mt CO2)	EMISSION CHANGE	GLOBAL EFFECT
China	8690	11.48%	+25.32%
India	1901	7.63%	+5.54%
Indonesia	510	6.13%	+1.49%
Iran	465	5.92%	+1.36%
Saudi Arabia	445	6.25%	+1.30%

Description: The first tabular chart shows the percentage emission change for each country and their corresponding global effect also recorded in percentage. The first tabular chart shows the USA as contributing to about 2% impact globally to the reduction of emission.

The second tabular chart shows 5 countries with the lowest improvements having a global negative impact on climate change. Here 5 countries top the list with China at the top with an enormous 25% increase.

Fig 20: Table Chart with Conditional Formatting to Show Global Impact of GHG gases Since 1997

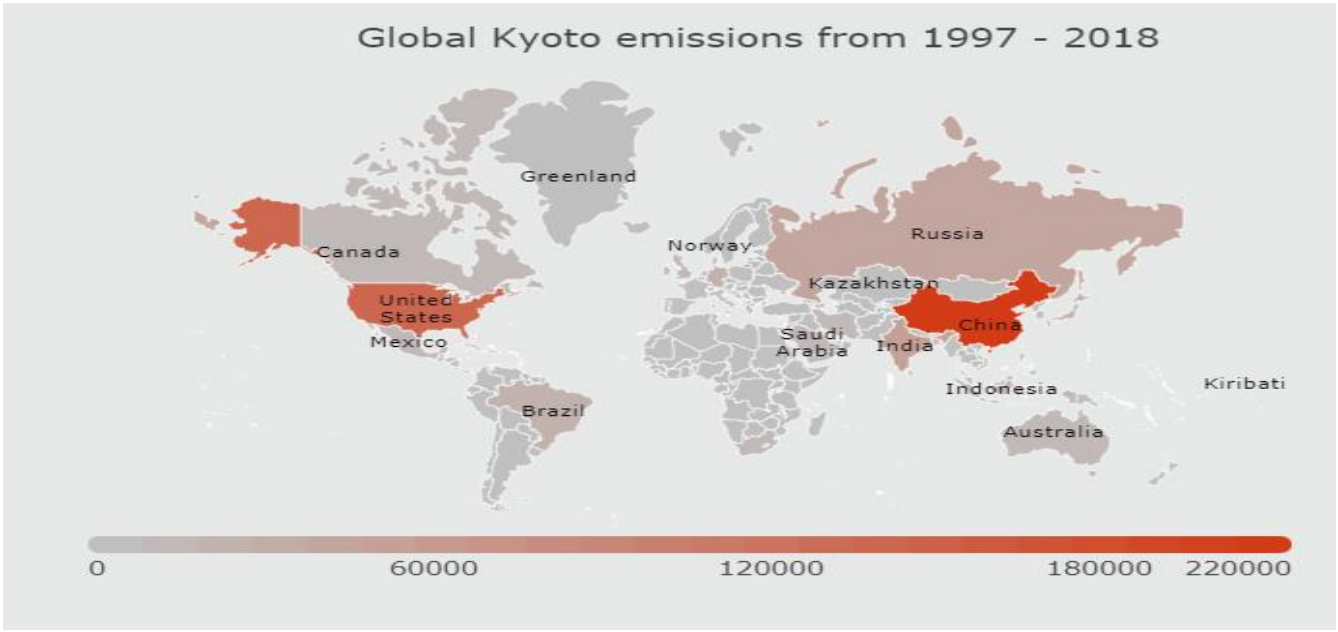


Description: The tabular chart above shows yearly percentage performance on a global scale from 1998 to 2018. 2009 was a year that recorded a negative variance when compared to the rest of the years. The graph is supported by visual cards showing key performance indices like Annual growth rate, Average emission per year and Total emission.

Data Narrative

Global view of GHG emitters using a Heat-map on the Infogram tool.

Fig.21: Heat Map



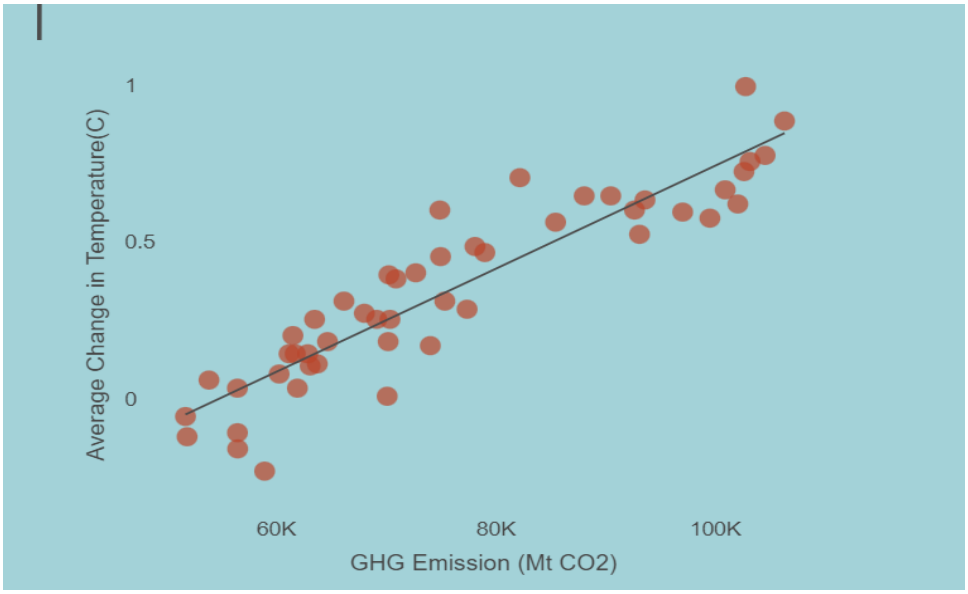
Justification: While the use of an Artificial Intelligent Decomposition Tree from the Power BI tool shows a global view of each country's yearly contribution to GHG emissions, it consisted of **several drill downs** which were not appropriate for an **overview chart**.

The heat map above was considered a better **spatial** presentation of the World emitters with each country captured with growing intensity in emission rate. With this option it was possible to represent cumulative quantities without much detail, leaving room for more drill down.

Decision: The Heat map was considered the most appropriate chart for an overview and spatial visualization.

Correlation between Emissions and Temperature

Fig. 22: Scattered Plot

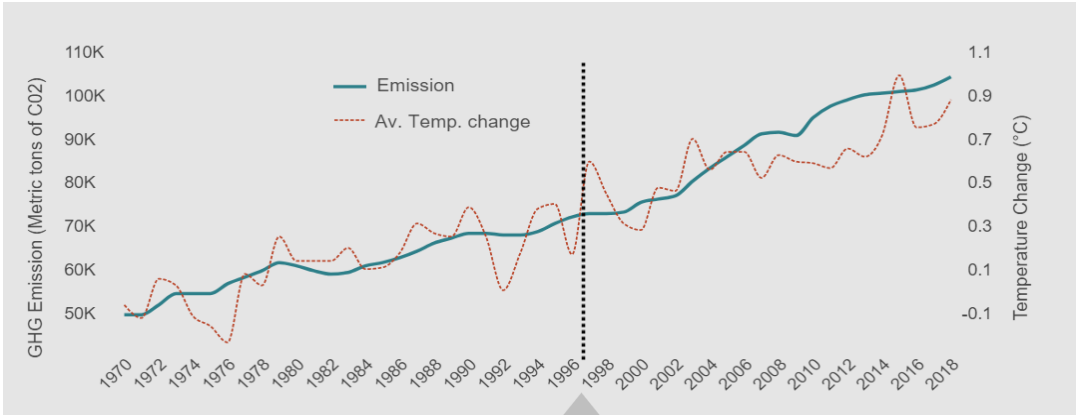


Justification: The scattered plot with a reference line shows a **high positive correlation** between temperature and GHG emissions. It defines significant linear relationship between the two variables with a statistical property of **direct proportionality** and therefore, the best of the option for use when compared to the bubble chart which does not show a certain degree of correlation between emission and temperature.

Decision: Using the **line of best fit**, the scattered plot shows a high positive correlation between temperature and GHG emissions.

Emissions vs Temperature in relation to time

Fig 22: Multiple Line chart

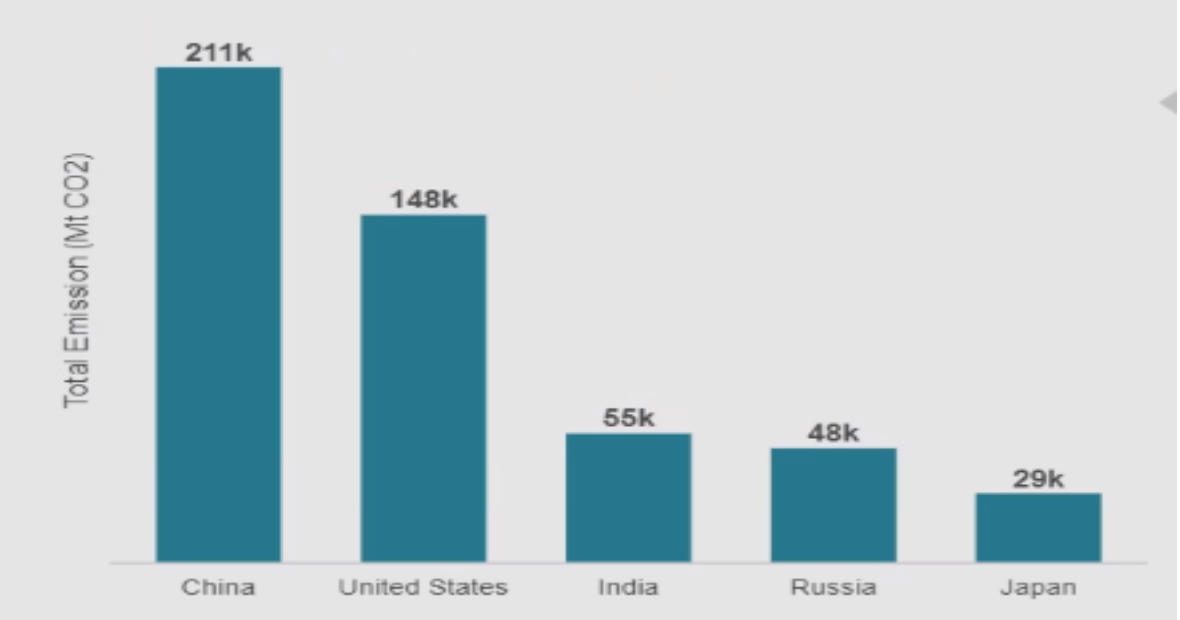


Justification: The presentation of Emissions vs Temperature in relation to time was a better presentation to show a **proportional rising trend** in both emissions and temperature.

Decision: A multiple line chart was most appropriate for a displaying a multivariable trend.

Categorical Comparison of the Top 5 emitters

Fig 23: Bar Chart

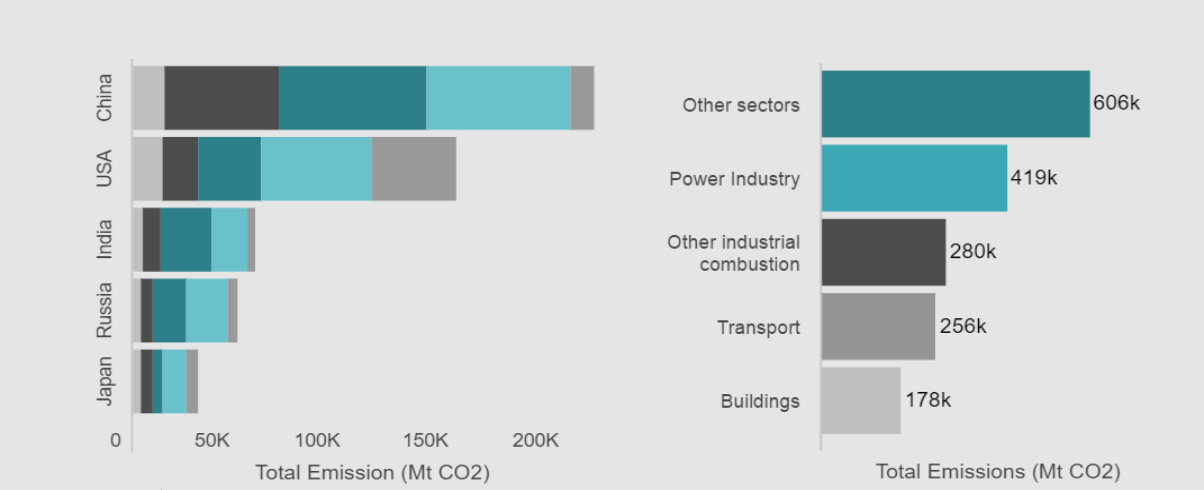


Justification: The bar chart was most appropriate for visualizing categorical variables of the top 5 emitters. China is seen to be the highest emitter with about 211k followed by the United states then India. While the AI analysis was a poor choice as the visualization had more than **5** visuals to display.

Decision: The bar chart was considered the most appropriate for ranking of categorical variables as it clearly shows the 5 top emitters ranking China as the 1st.

Sectorial view of emissions based on the Top 5 Countries

Fig 24: Stacked Bar Chart

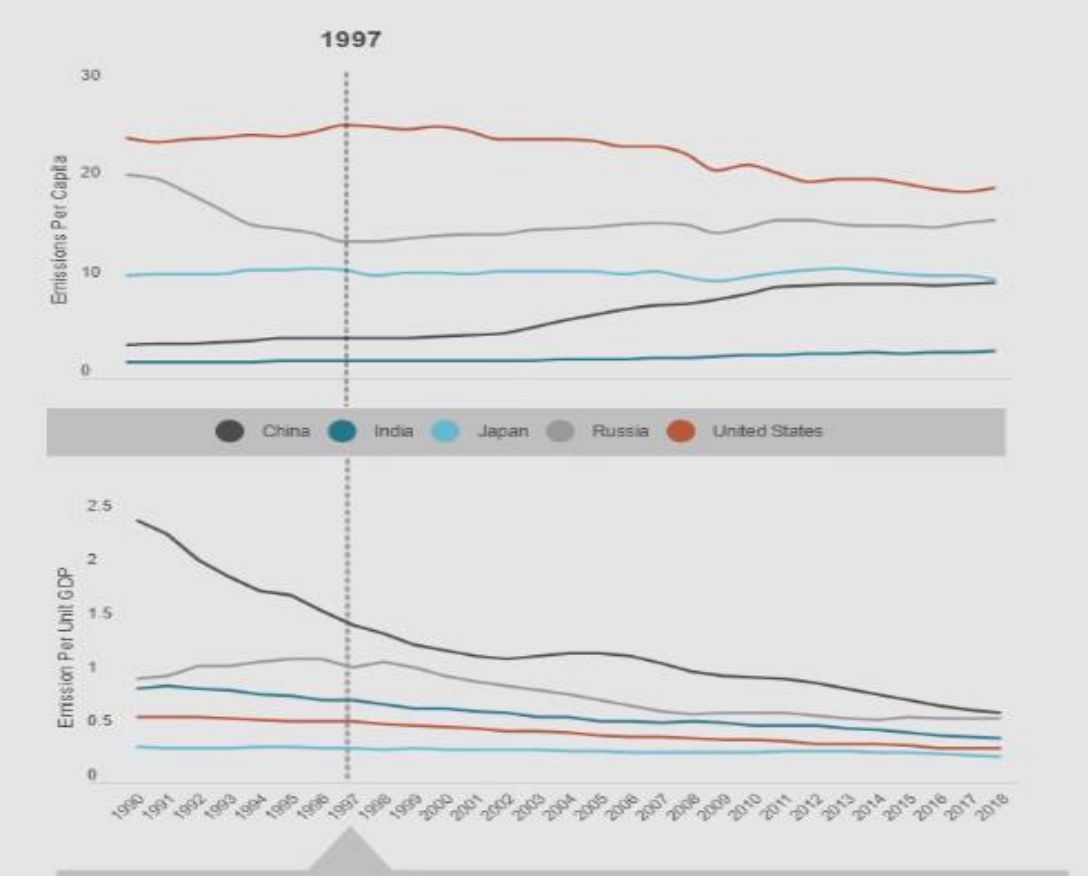


Justification: The stacked bar chart was best for presentation of a part-to-whole relationship between the top 5 countries and their emissions when compared to sectoral representation with a pie chart.

Decision: The stacked bar chart was the best choice for use it better shows an unusual increase in "Others" sector and highlights a possible grey area which must be drilled down for further analysis.

Trend analysis for GHG of 5 Top Countries

Fig 25: Multiple line chart:

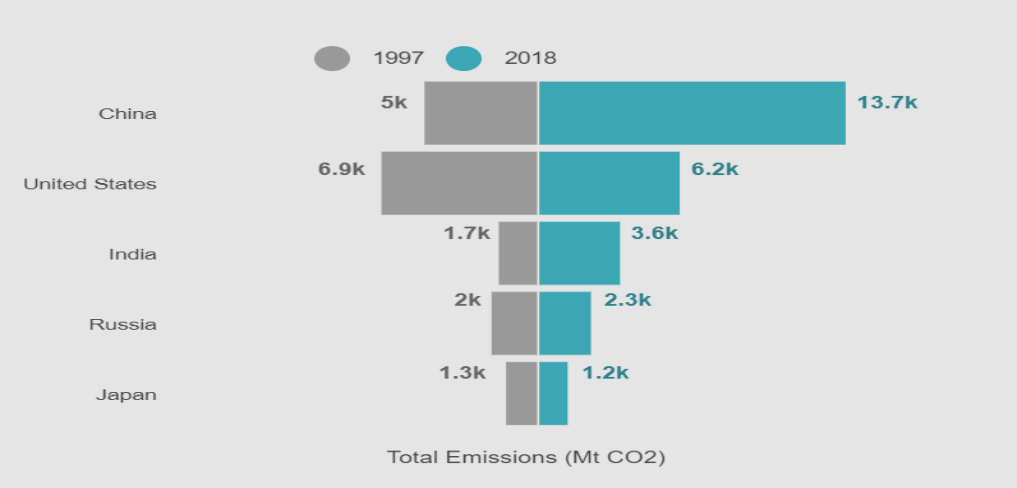


Justification: The multiple line charts depicted a better presentation of **trend** in emissions per Capita and per GDP with a common X axis when compared to a stacked area chart which does not allow for identification of trend points within its plot area when hovered with a pointer.

Decision: Best visualization for a trend was a multiple line chart.

Variations in Country Emissions between 1997 and 2018

Fig 26: Funnel Chart

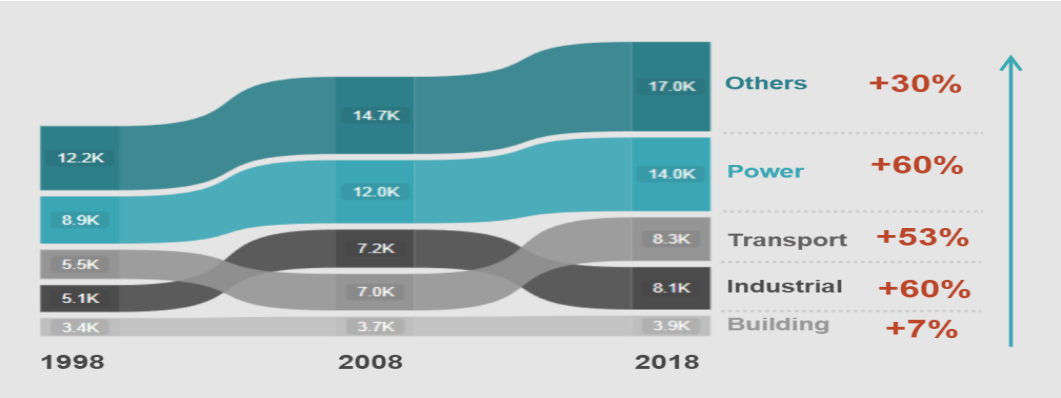


Justification: The Funnel **Comparison** Chart analyses differences in quantity of emissions between 1997 and 2018. The graphical presentation clearly depicted which countries have acted with regards to their pledges. As seen above, China had increased their emissions in 2018 by 8.7k in comparison to 1997. In contrast, the U.S had 6.9k emissions in 1997 but 6.2k in 2018 and therefore reckoned to have improved with a positive change. This chart provided an elaborate detail compared to a Matrix table.

Decision**:** A funnel chart was most appropriate given an exposure to actual variance showing performance.

Ribbon chart showing Variance across 5 sectors within 1997 and 2018

Fig 27: Ribbon Chart



Justification: The ribbon chart above depicts the percentage **variance** across 5 sectors showing the performance in the sectors of Power industry, buildings, and transport amongst others between 1998 and 2018. The sector 'Others' is seen to have the highest increase in emissions when measured over a period of 20 years. This detail is rather represented in a complex way when visualized by a variance chart from Power BI.

Decision: The ribbon chart is a better presentation of a variance information as it clearly accentuates the percentage detail is a very simple way.

Global Impact of top 5 emitters performance over 20 years

Fig 28: Table Chart showing Global impact for top 5 countries

	COUNTRY	GHG EMISSION (Mt CO2)	EMISSION CHANGE	GLOBAL EFFECT
	United States	-683	-0.38%	-1.99%
	United Kingdom	-255	-1.65%	-0.75%
	Germany	-232	-1.04%	-0.68%
	Ukraine	-201	-2.09%	-0.59%
	Italy	-124	-1.14%	-0.36%

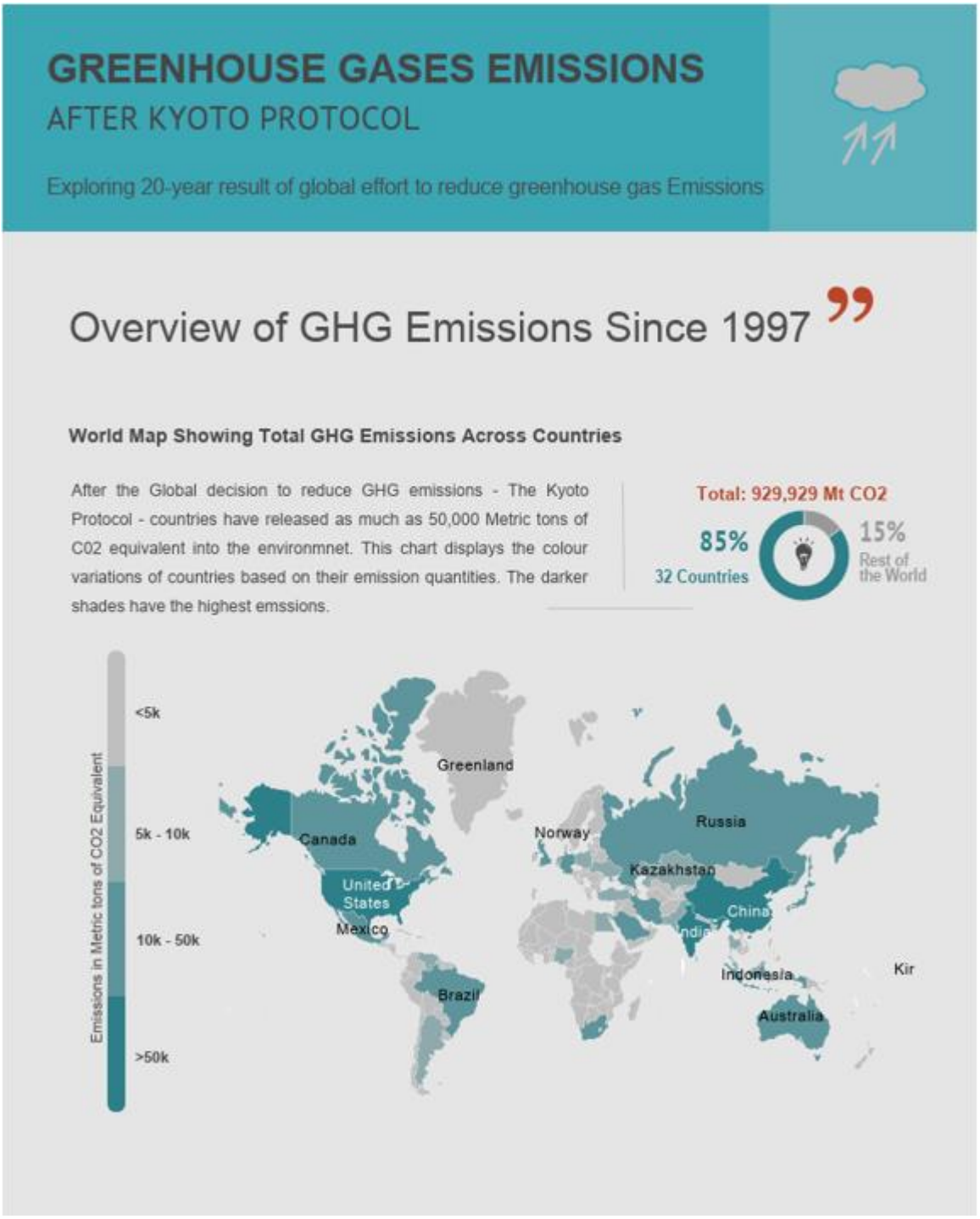
Table Chart for Bottom 5 countries based on global impact of emission changes

	COUNTRY	GHG EMISSION (Mt CO2)	EMISSION CHANGE	GLOBAL EFFECT
	China	8690	11.48%	+25.32%
	India	1901	7.63%	+5.54%
	Indonesia	510	6.13%	+1.49%
	Iran	465	5.92%	+1.36%
	Saudi Arabia	445	6.25%	+1.30%

Justification: The table charts were best in presenting the percentage improvements by the top countries. It is about the simplest and most efficient form of data presentation compared to a conditional formatted table.

Decision: The tabular charts seamlessly conveyed a need for improvement for the bottom countries and made it easy to acknowledge the efforts of top 5 performer countries in relation to their reduction of emission.

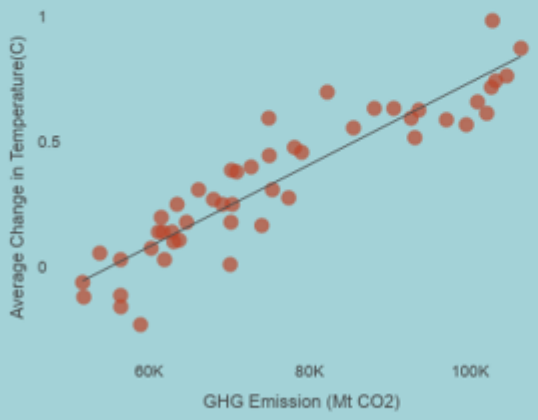
Data Representation



Why the concern about Greenhouse Gases?

The Correlation between Global GHG Emissions and Average Temperature Change

The positive correlation between emissions and average global temperture indicates a need explore the emissions trend since the Kyoto Protocol in 1997.



Key Findings

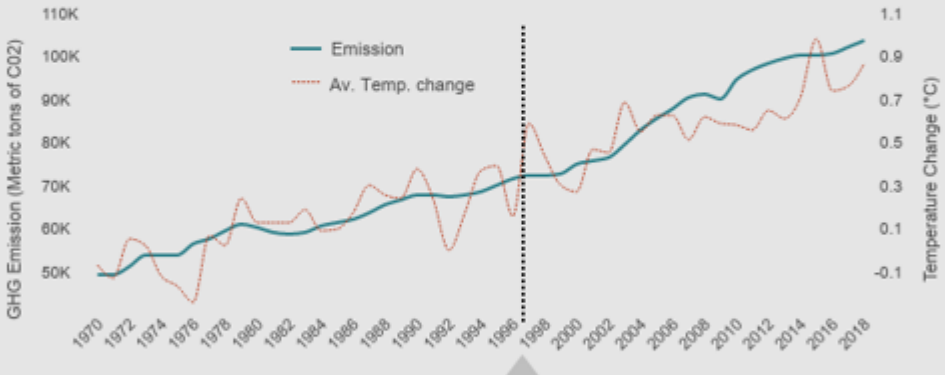
The positive correlation that exists between GHG and Temperature change indicates the need for joint global action to cut emissions - **The Kyoto Protocol 1997.**

Analysing GHG Trends could reveal the direction of emission change.

Emission Trend After the Kyoto Protocol?

Current Trend in Global Emissions and Average Temperature Change

20 years after Kyoto protocol, global emissions have contunued to rise, as well as average temperature.



Key Findings

- Despite Kyoto Protocol, emissions continue to rise at an alarming rate.
- A drill down into countries' emissions could reveal the top contributors to this rise in Global Emissions

Which Countries Contribute the Most?

20-year Emission Totals (MtCO2) by Top Contributing Countries

The column chart shows China has emitted more quantity of GHG - 211,000 Metric tons of CO2 equivalent - since 1997. USA follows with 143,000, and then India, Russia and Japan.

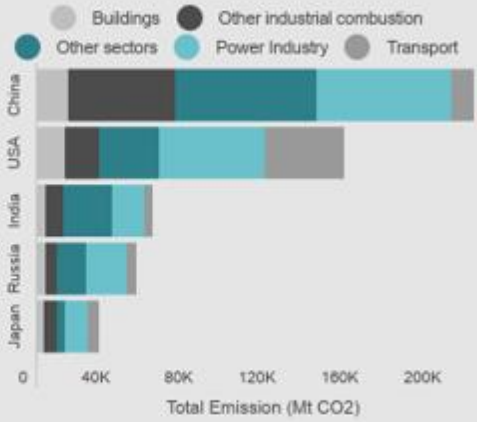
Key Findings

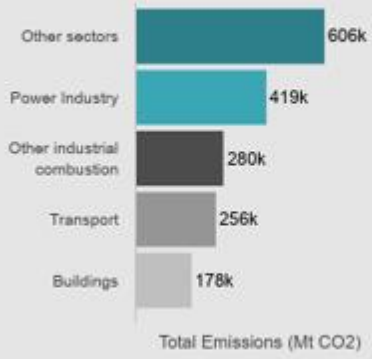
- China's emission is more than that of USA and India combined.
- USA's emission is more that India, Russia and japan combined.
- More drill down into these countries could revel the sectors that contributed the most.

What Sectors have contributed the most?

Sectors Contributing to Global Emissions Since The Kyoto Protocol

Ranking the top five contributing countries to global GHG emissions after the Kyoto Protocol, China is the top emitting country, followed by USA, India, Russia and Japan, consecutively.





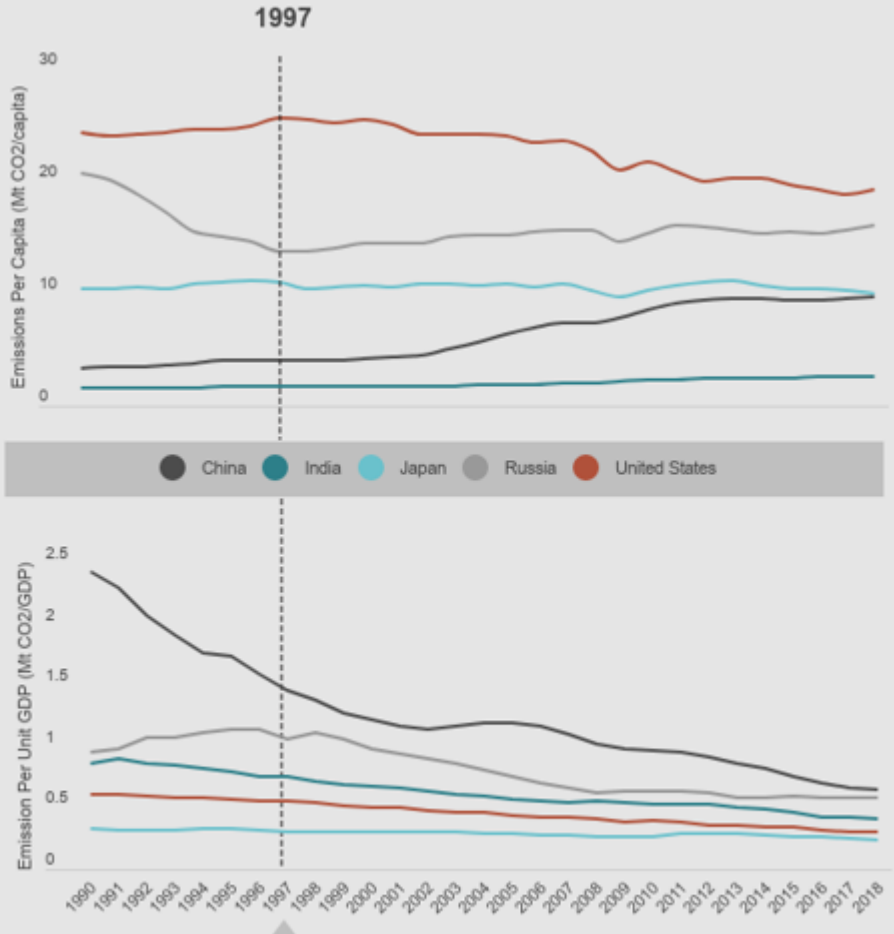
Key Findings

- Other sectors contributes more GHG emission than Power Industry.
- This is an indication that "other sectors" is a grey area which needs to be explored based on data availability for the components

Has Population and Development influenced the emissions?

Comparing Emissions per Person and Emissions Per Unit GDP

United States has the highest emission per person. However, the significant drop is a positive indicator as opposed to China's rise while the others stayed fairly constant.
The general drop in emissions per GDP indicates a drop in emission-generation production processes.



Key Findings

- In China, increasing emissions per person is an indication of increased production. Whereas the drop in emissions per GDP is an indication of good climate change practices for production.
- How much have average emissions changed after 20 years of intentional effort?

What is the difference in Average Annual Emission after 20 years?

+45% Global Change

+172% China

-10% USA

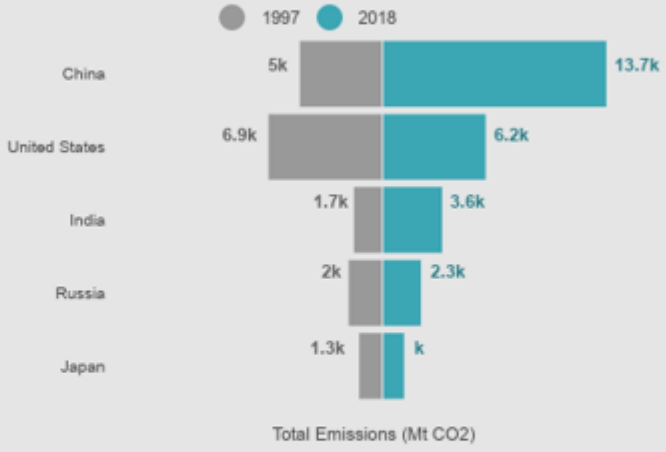
+110% India

+13% Russia

-9% Japan

Variations in Country Emissions between 1997 and 2018

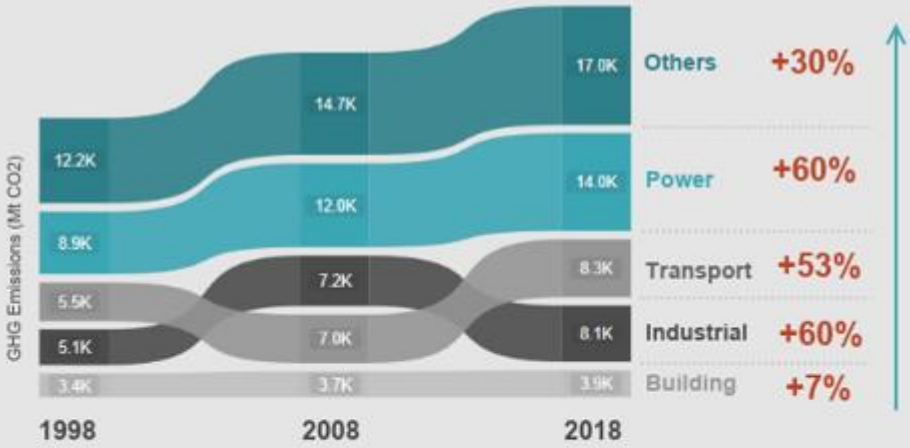
Ranking the top five contributing countries to global GHG emissions after the Kyoto Protocol, China is the top emitting country, followed by USA, India, Russia and Japan, consecutively.



What is the difference in Average Annual Emission after 20 years?

Variations in Country Emissions after Kyoto Protocol

Visualising 20-year sectorial change in GHG emissions after the Kyoto Protocol. Power, Industrial and Transport sectors have each had over 50% increase in emission quantities.

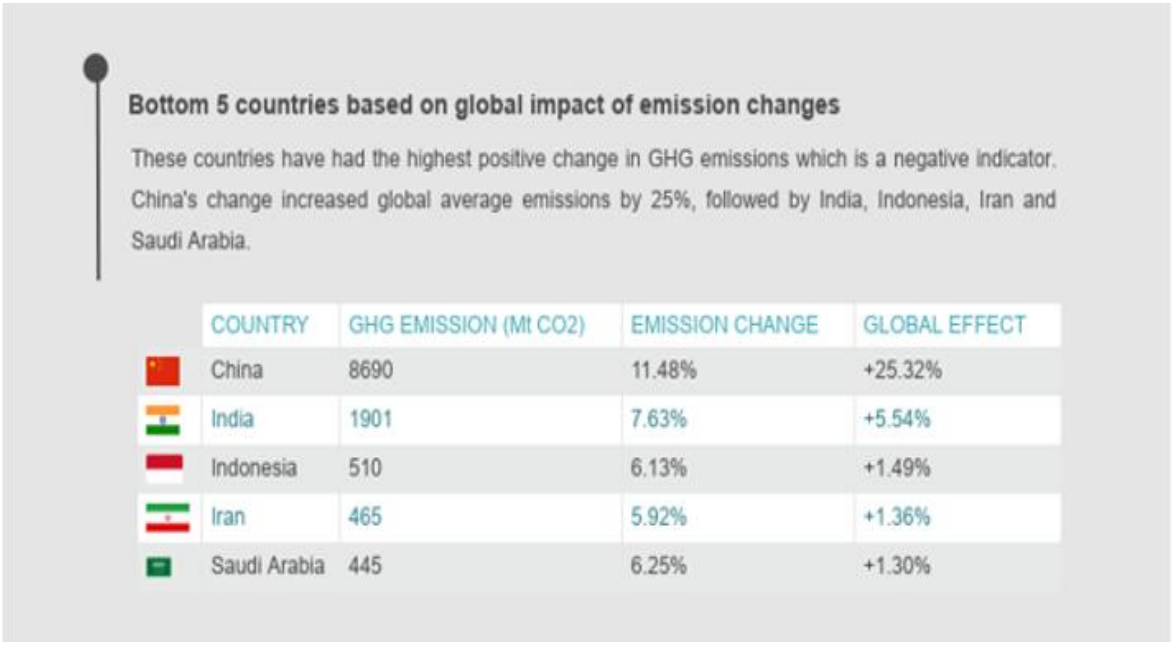


What is the Global Impact of the 20-year Emission Changes?

Top 5 countries based on global impact of emission changes

These countries have had a negative change in emissions which is a positive indicator. USA's change reduced global average emissions by 1.99%, followed by United Kingdom, Germany, Ukraine and Italy.

COUNTRY	GHG EMISSION (Mt CO2)	EMISSION CHANGE	GLOBAL EFFECT
United States	-683	-0.38%	-1.99%
United Kingdom	-255	-1.65%	-0.75%
Germany	-232	-1.04%	-0.68%
Ukraine	-201	-2.09%	-0.59%
Italy	-124	-1.14%	-0.36%



Bottom 5 countries based on global impact of emission changes

These countries have had the highest positive change in GHG emissions which is a negative indicator. China's change increased global average emissions by 25%, followed by India, Indonesia, Iran and Saudi Arabia.

COUNTRY	GHG EMISSION (Mt CO2)	EMISSION CHANGE	GLOBAL EFFECT
China	8690	11.48%	+25.32%
India	1901	7.63%	+5.54%
Indonesia	510	6.13%	+1.49%
Iran	465	5.92%	+1.36%
Saudi Arabia	445	6.25%	+1.30%

Critical Reflection

The data representation above has been achieved through an exhaustive thought process to provide answers to our project brief. After the international treaty was ratified in 1997, the final infographic sufficiently examines trends in improvements, setbacks, and major contributions by member countries. The following section highlights some quality criteria reviewed while choosing the graphical design concepts applied in the infographic design:

Graph 1: Heat Map

Chart Type: A spatial chart type was chosen as the best fit for a presentation of a global overview of country emissions as it allows room for a further drill down.

Scaling: The scale of the map was weighted by **hue variations** to visualize the top 5 countries based on colour weight.

Graph 2: Scattered Plot

Chart Type: The scattered plot remains the best chart to show a correlation between average temperature and quantity of emissions over a period of time.

Axes labelling: The x and y axes were properly labelled with each representing average temperature in degrees Celsius and quantity of emissions in MtCo2 respectively.

Graphical Component: The plot applied an appropriate **line of best fit** to demonstrate a **high positive correlation** between temperature and GHG emissions.

Graph 3: Multiple line chart

Chart Type: The multiple line chart was best in showing a multi variant **trend analysis** between total emissions and average temperature in relation to time when compared to other trend charts. The line graph was designed to have a primary and secondary Y axis in order to properly visualize both variables in relation to time on the X axis.

Axes labelling: The X and Y axes were properly labelled with the Y axes showing emissions in metric tonnes and average global temperature in degrees Celsius respectively.

Graphical Component: The plot applied an appropriate **reference line** to highlight 1997 as a pivotal year and to emphasize on the trend of emissions onward.

Legend: The applied legend was simple and appropriately positioned to avoid distractions from the coloured trend lines and any form of chart noise.

Use of Colour: The graphical variables were represented appropriately in distinct colours of red and teal green for temperature and emissions respectively.

Graph 4: Bar chart

Chart Type: To represent 5 categorical variables, a bar chart was the most appropriate graphical presentation for showing the magnitude of emissions by each country.

Axes and Datapoint labelling: Both axes were appropriately labelled with the countries labelled on the X axis and emission quantities labelled on the Y axis respectively using the same font. Each bar was labelled to show the varying emission quantities starting from zero.

Use of Colour: There was an appropriate use of a single colour which identifies with the entire theme of the infographic.

Graph 5: Stacked Bar and Vertical Column Charts

Chart type: This was appropriate in presenting a **part to whole** visualization of the sectors in relation to their **magnitude of emissions**.

Use of colour: Appropriate colours were chosen to represent difference in sectors in relation to the theme.

Axes labelling: Both axes were labelled appropriately with a harmonizing font.

Graph 6: Multiple line chart:

Chart Type: This was another multivariant chart showing different **trends** to compare Emissions per Person and Emissions Per Unit GDP in relation to time and was best represented in a line chart.

Axes labelling: The X and Y axes were properly labelled with the Y axes showing emissions per GDP and Emissions per Capita respectively with a common X axis showing the years under consideration.

Graphical Component: The plot applied an appropriate **reference line** to highlight 1997 as a pivotal year across both graphs.

Legend: The applied legend was simple and appropriately positioned to avoid distractions or any form of chart noise.

Graph 7. Funnel chart:

Chart Type: This was applied to show a **comparison** in variance of emission quantities in relation to time for the top 5 countries.

Use of Colour: For simplicity only 2 colours were used for a contrast in relation to the two years under review.

Legend: The applied legend was simple and appropriately positioned to avoid distractions or any form of chart noise.

Graph 8. Ribbon chart:

Chart Type: This was applied to show a **comparison** in variance of emission quantities in relation to time for the top 5 countries.

Use of Colour: The colour codes in use were chosen to fit the theme of the whole infographic. With dark shade of brown used to accentuate the percentage values it was easy to identify with the variances. It sure had a good taste of colour.

Graph 9: Table Chart

Chart Type: The table charts were best in presenting the percentage improvements by the top countries. It was considered the simplest and most efficient way of data display.

The tabular graphics effectively communicated the need for improvement in the bottom-performing nations while also making it simple to recognise the work of the top-performing countries in terms of reducing global warming.

Use of Colour: We employed an appropriate use of colour in projecting important percentage indices with the use of formatted rows to show grey and white only. We ensured the theme colour codes were used in all the charts to ensure uniformity to our finished presentation.

Legend: In order to identify with the countries, there was need to apply country flags in order to identify with the top 5 and bottom countries.

Project Work Plan

PROJECT PLAN

PROJECT NAME	**GHG Emissions since the Kyoto Protocol**
Group Name	**Marines**
Group Members	FITZROY ORIKONTE, KAVINILAVAN MUTHUKUMAR, JEFFY IHESIULO, NOSA OMOKARO, TAHARAT HUSSAIN

TASK NAME	CONTRIBUTORS	START DATE	END DATE	DURATION
Choosing our Story related to Climate Change	• FITZROY O. • KAVINILAVAN M. • JEFFY I. • NOSA O. • HUSSAIN T.	October 08, 2021	October 21, 2021	2 Weeks
Choosing Prefer Dataset to work on for achieving our story.	• FITZROY O. • KAVINILAVAN M. • JEFFY I. • NOSA O. • HUSSAIN T.	October 22, 2021	November 04, 2021	2 Weeks
Cleaning Dataset and assigning the different parts of story inside team members	• FITZROY O. • JEFFY I. • NOSA O.	November 05, 2021	November 18, 2021	2 Weeks
Creating Prototype Charts, to see different possibilities.	• KAVINILAVAN M. • JEFFY I. • HUSSAIN T.	November 19, 2021	November 25, 2021	1 Week
Choosing the right charts and starts	• FITZROY O. • KAVINILAVAN M.	November 26, 2021	December 02, 2021	1 Week

working on infographic.	• HUSSAIN.T			
Creating Infographic	• FITZROY O. • NOSA O. • HUSSAIN T.	December 03, 2021	December 23, 2021	3 Weeks
Writing Report and Preparing Presentation	• KAVINILAVAN M. • JEFFY I. • NOSA O.	December 24, 2021	January 06, 2022	2 Weeks

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