co2 emmission(R code)

December 3, 2024

0.1 Including Libraries

[1]:
```
library(ggplot2)
library(dplyr)
library(tidyr)
library(plotly)
```

```
Attaching package: ‘dplyr’


The following objects are masked from ‘package:stats’:

    filter, lag


The following objects are masked from ‘package:base’:

    intersect, setdiff, setequal, union



Attaching package: ‘plotly’


The following object is masked from ‘package:ggplot2’:

    last_plot


The following object is masked from ‘package:stats’:

    filter


The following object is masked from ‘package:graphics’:

    layout
```

[3]:
```r
# load Data

df <- read.csv("/Users/VSR/Desktop/AR Assignment/owid-co2-data.csv")
```

0.2 Data Preprocessing

[6]:
```r
# Data grouping

special_groups <- c(
  "High-income countries", "Least developed countries (Jones et al.)",␣
 ↪"Low-income countries",
  "Lower-middle-income countries", "Middle East (GCP)", "Non-OECD (GCP)", "OECD␣
 ↪(GCP)",
  "OECD (Jones et al.)", "Panama Canal Zone", "Panama Canal Zone (GCP)",
  "St. Kitts-Nevis-Anguilla", "St. Kitts-Nevis-Anguilla (GCP)",
  "Upper-middle-income countries", "World",
  "Africa", "Africa (GCP)", "Antarctica", "Asia", "Asia (GCP)", "Asia (excl.␣
 ↪China and India)",
  "Central America (GCP)", "Europe", "Europe (GCP)", "Europe (excl. EU-27)",␣
 ↪"Europe (excl. EU-28)",
  "European Union (27)", "European Union (28)", "Middle East (GCP)", "North␣
 ↪America",
  "North America (GCP)", "North America (excl. USA)", "Oceania", "Oceania␣
 ↪(GCP)",
  "South America", "South America (GCP)", "International aviation",␣
 ↪"International shipping",
  "International transport"
)

continents <- c('Africa', 'Asia', 'Europe', 'North America', 'South America',␣
 ↪'Oceania')
income_group <- c('High-income countries', 'Upper-middle-income countries',␣
 ↪'Lower-middle-income countries', 'Low-income countries')

global_data <- df %>% filter(country == "World")%>% filter(year >= 1990)
global_data1 <- df %>%filter(country %in% income_group )%>% filter(year == 2022)
```

[8]:
```r
# Drom NA Values
df1 <- df %>% drop_na(iso_code)
```

[10]:
```r
# Remove special groups
df1 <- df1 %>%
  filter(!country %in% special_groups)
```

[12]:
```r
# Find the top 20,top 10, and top 5 polluters in the world
top20_countries <- df1 %>%
  group_by(country) %>%
  summarise(total_co2 = sum(co2, na.rm = TRUE)) %>%
  arrange(desc(total_co2)) %>%
  slice(1:20)

top10_countries <- top20_countries %>% slice(1:10)
top5_countries <- top10_countries %>% slice(1:5)
```

[14]:
```r
# Filter the dataset to include only continents

co2_2022 <- df %>% filter(year == 2022) %>%
  filter(country %in% continents) %>%
  select(country, co2)
co2_2021 <- df %>% filter(year == 2021) %>%
  filter(country %in% continents) %>%
  select(country, co2)
co2_2020 <- df %>% filter(year == 2020) %>%
  filter(country %in% continents) %>%
  select(country, co2)

co2_2022 <- co2_2022 %>%
  mutate(percentage = round((co2 / sum(co2)) * 100, 1))


co2_2021 <- co2_2021 %>%
  mutate(percentage = round((co2 / sum(co2)) * 100, 1))

co2_2020 <- co2_2020 %>%
  mutate(percentage = round((co2 / sum(co2)) * 100, 1))
```

[16]:
```r
# Calculate the percentage for each income group
global_data1 <- global_data1 %>%
  mutate(percentage = round((co2 / sum(co2)) * 100, 1))
```

[ ]:
```r

```

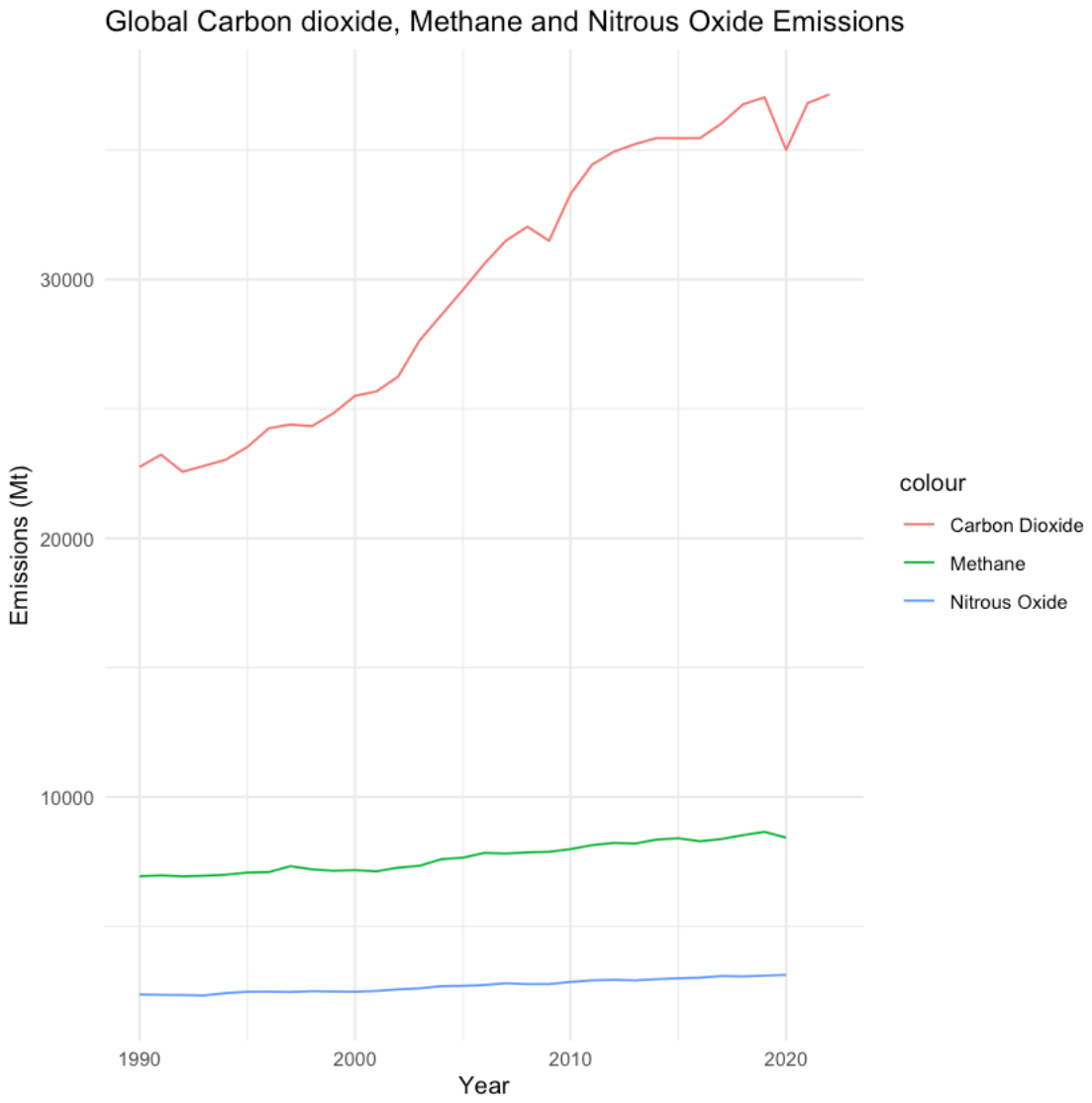
0.3 Global analysis

Global CO2, Methane and Nitrous Oxide emissions over time

[20]:
```r
# Create a line chart for the global gases emmission
ggplot(global_data, aes(x = year)) +
    geom_line(aes(y = co2, color = "Carbon Dioxide")) +
    geom_line(aes(y = methane, color = "Methane")) +
    geom_line(aes(y = nitrous_oxide, color = "Nitrous Oxide")) +
    labs(title = "Global Carbon dioxide, Methane and Nitrous Oxide Emissions",
```

```
      x = "Year", y = "Emissions (Mt)") +
  theme_minimal()
```

```
Warning message:
"Removed 2 rows containing missing values or values outside the scale
range
(`geom_line()`)."
Warning message:
"Removed 2 rows containing missing values or values outside the scale
range
(`geom_line()`)."
```

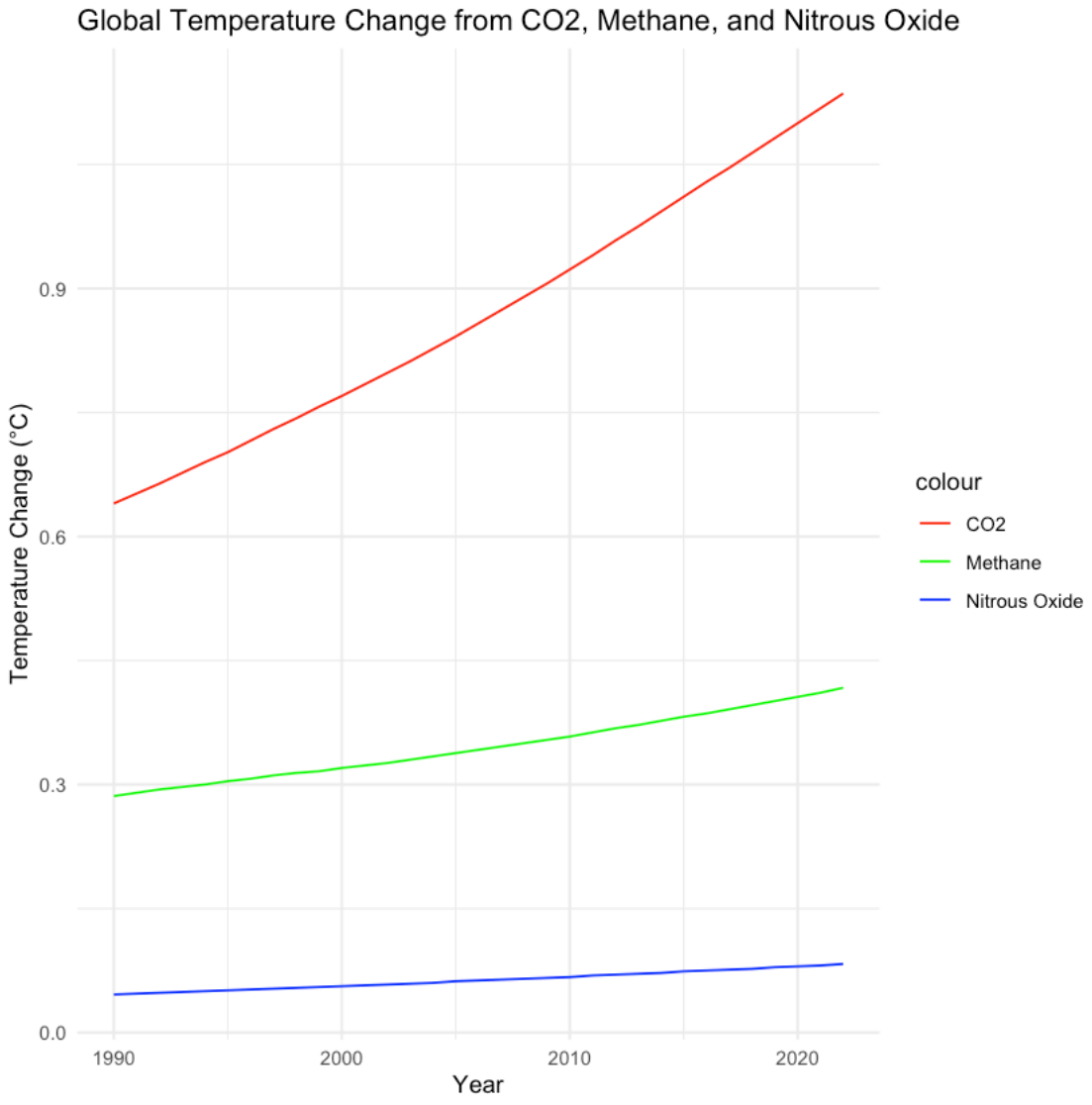


[22]:
```
ggplotly()
```

```
HTML widgets cannot be represented in plain text (need html)
```

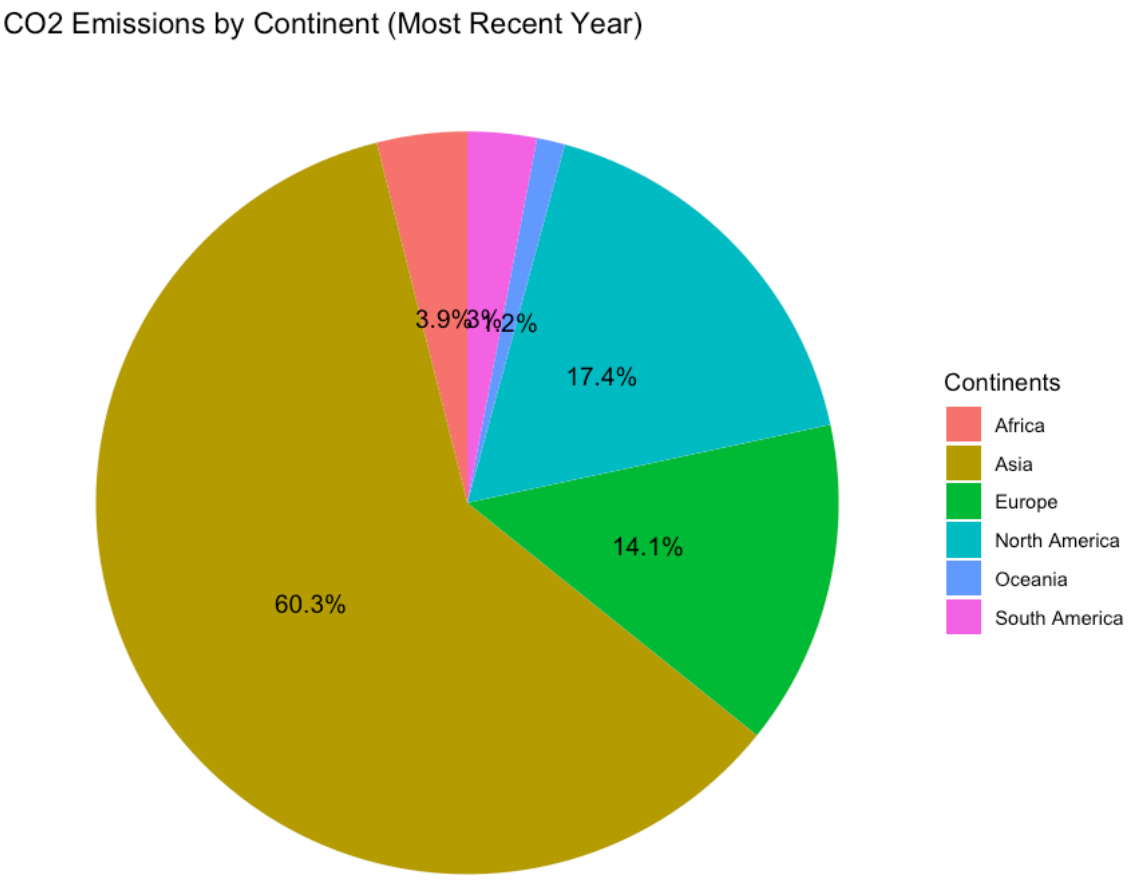
Global Temperature Change Due to CO2, Methane, and N2O

[29]:
```
ggplot(global_data, aes(x = year)) +
  geom_line(aes(y = temperature_change_from_co2, color = "CO2")) +
  geom_line(aes(y = temperature_change_from_ch4, color = "Methane")) +
  geom_line(aes(y = temperature_change_from_n2o, color = "Nitrous Oxide")) +
  labs(title = "Global Temperature Change from CO2, Methane, and Nitrous␣
 ↪Oxide",
       x = "Year", y = "Temperature Change (°C)") +
  scale_color_manual(values = c("CO2" = "red", "Methane" = "green", "Nitrous␣
 ↪Oxide" = "blue")) +
  theme_minimal()
```



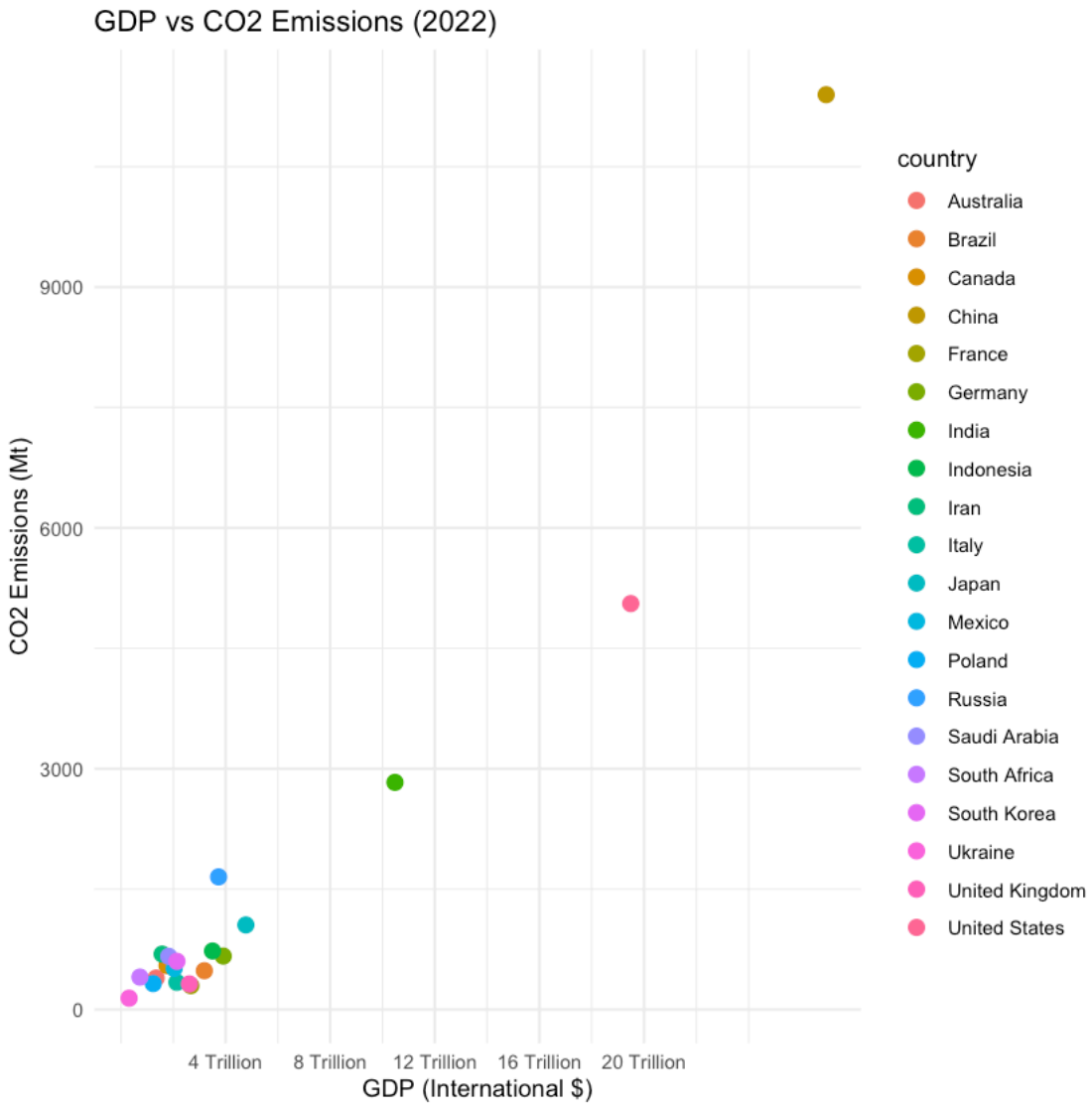
0.3.1 Contribution of Every continent to the CO2 emmissions.

[32]:
```
ggplot(co2_2022, aes(x = "", y = co2, fill = country)) +
  geom_bar(stat = "identity", width = 1) +
  coord_polar("y", start = 0) +  # This makes it a pie chart
  labs(title = "CO2 Emissions by Continent (Most Recent Year)", fill =␣
↪"Continents") +
  theme_void() +
  geom_text(aes(label = paste0(percentage, "%")), position =␣
↪position_stack(vjust = 0.5), size = 4)
```



0.4 GDP and Population relationship with emmisions

[35]:
```
# create a scatter plot
ggplot(df1 %>% filter(country %in% top20_countries$country, year == 2022),
       aes(x = gdp, y = co2, color = country)) +
  geom_point(size = 3) +
  labs(title = "GDP vs CO2 Emissions (2022)",
       x = "GDP (International $)",
       y = "CO2 Emissions (Mt)") +
  scale_x_continuous(breaks = c(4e12, 8e12, 12e12, 16e12, 20e12),
                     labels = c("4 Trillion", "8 Trillion", "12 Trillion", "16
↪Trillion", "20 Trillion")) +
  theme_minimal()
```



[37]:
```
ggplotly()
```

```
HTML widgets cannot be represented in plain text (need html)
```

The plot indicates that the relationship between GDP and CO2 emissions almost linear.

[ ]:
```
ggplot(df1 %>% filter(country %in% top10_countries$country, year == 2022),
       aes(x = population, y = co2, color = country)) +
  geom_point(size = 4) +
  labs(title = "Population vs CO2 Emissions (2022)",
       x = "Population",
       y = "CO2 Emissions (Mt)") +
  scale_x_continuous(breaks = seq(2e8, 1.6e9, by = 2e8),
                     labels = c("200 Million", "400 Million", "600 Million",␣
 ↪"800 Million",
                                "1 Billion", "1.2 Billion", "1.4 Billion", "1.6␣
 ↪Billion")) +
  theme_minimal()
```

[40]:
```
ggplotly()
```

```
HTML widgets cannot be represented in plain text (need html)
```

[41]:
```
a <- ggplot(df1 %>% filter(country %in% top10_countries$country, year == 2022),
       aes(x = population, y = co2_per_capita, color = country)) +
  geom_point(size = 3) +
  labs(title = "Population vs CO2 Emissions per capita (2022)", x =␣
 ↪"Population", y = "CO2 Emissions (Mt)") +
  theme_minimal()

ggplotly(a)
```

```
HTML widgets cannot be represented in plain text (need html)
```

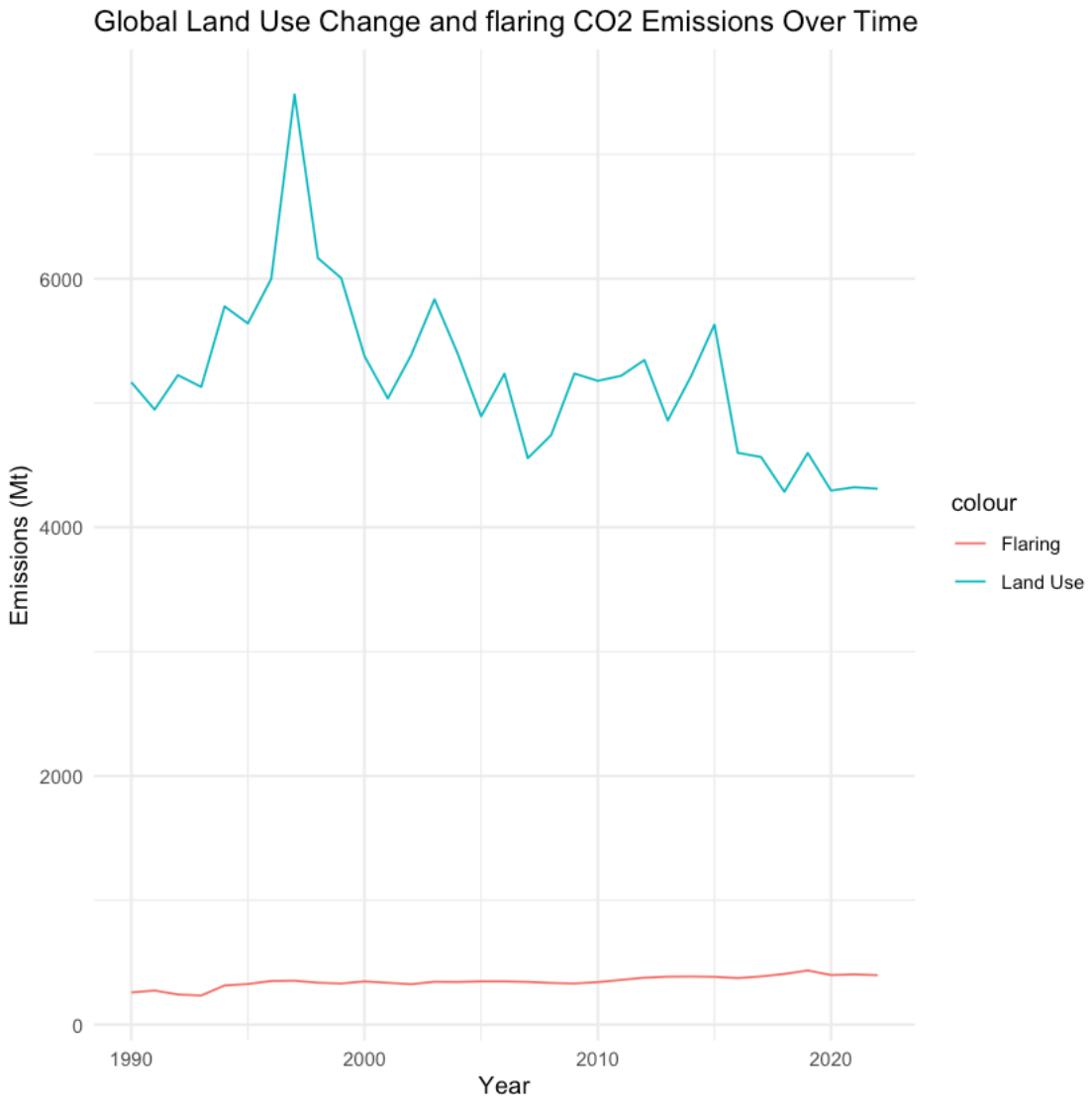
0.5 Sources of CO2 Emissions

[ ]:
```
b<- ggplot(df1 %>% filter(country %in% top20_countries$country, year == 2022),
       aes(x = reorder(country, -co2))) +
  geom_bar(aes(y = gas_co2, fill = "Gas CO2"), stat = "identity") +
  geom_bar(aes(y = oil_co2, fill = "Oil CO2"), stat = "identity") +
  geom_bar(aes(y = coal_co2, fill = "Coal CO2"), stat = "identity") +
  labs(title = "CO2 Emissions by Sector for Top 20 Countries (2022)",
       x = "Country",
       y = "CO2 Emissions (Mt)") +
  theme_minimal() +
  scale_fill_manual(values = c("Cement CO2" = "green", "Gas CO2" = "orange",
                               "Oil CO2" = "red", "Coal CO2" = "black"))+
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

```
ggplotly(b)
```

The above graph shows the sources from which different countries emit CO2 in the environment. It helps us to identify the main polluters.

[45]:
```
# Co2 emmission from land use and flaring
ggplot(global_data, aes(x = year)) +
    geom_line(aes(y = land_use_change_co2, color = "Land Use")) +
    geom_line(aes(y = flaring_co2, color = "Flaring")) +
    labs(title = "Global Land Use Change and flaring CO2 Emissions Over Time",
       x = "Year", y = "Emissions (Mt)") +
  theme_minimal()
```



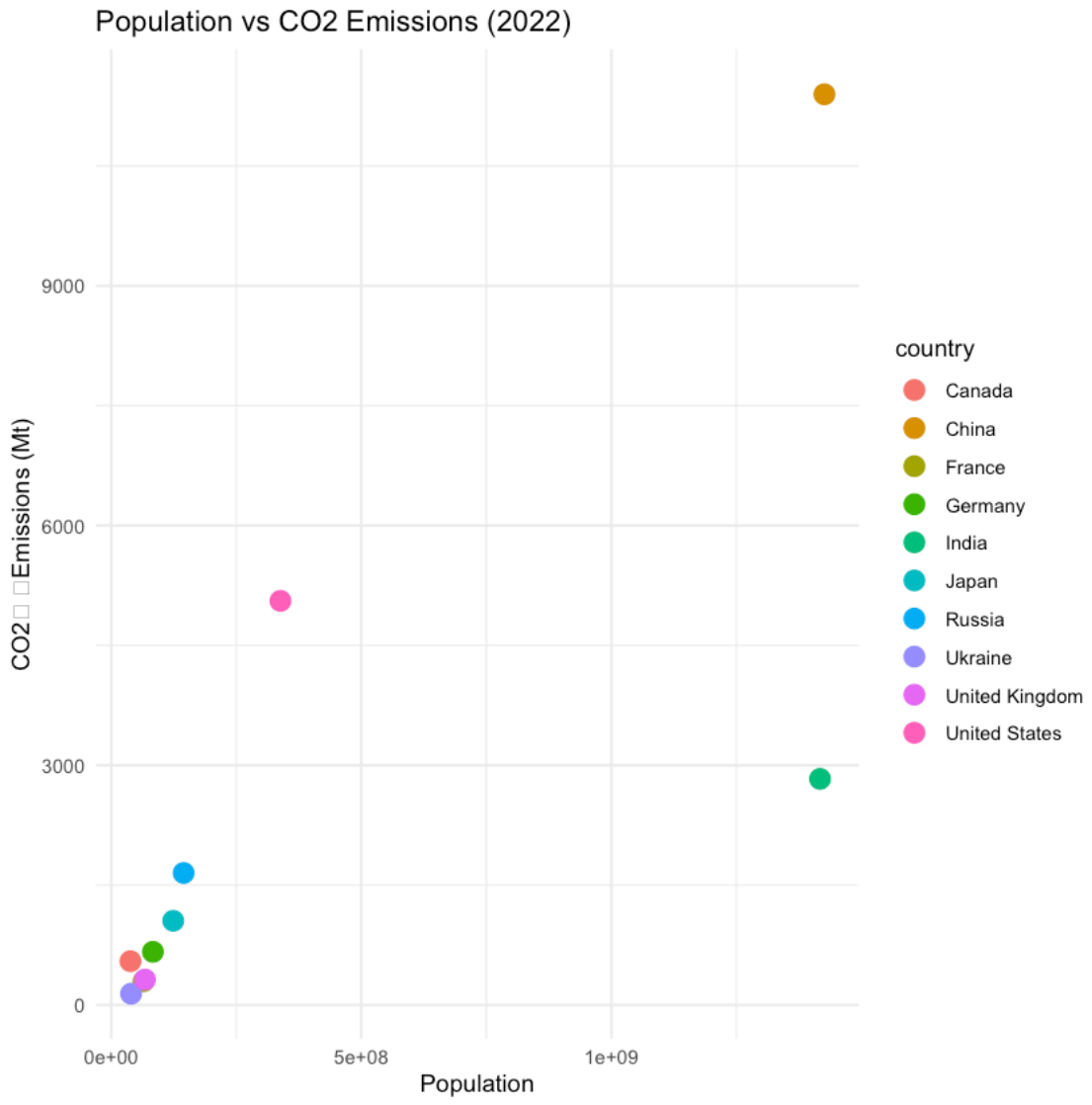
[ ]:

0.6 CO2 Emissions Per Capita

[52]:
```
ggplot(df1 %>% filter(country %in% top10_countries$country, year == 2022),
       aes(x = population, y = co2, color = country)) +
    geom_point(size = 4) +
    labs(title = "Population vs CO2 Emissions (2022)", x = "Population", y =␣
 ↪"CO2␣ Emissions (Mt)") +
 theme_minimal()
```

```
Warning message in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y,
:
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <e2>"
Warning message in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y,
:
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <90>"
Warning message in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y,
:
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <a3>"
Warning message in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y,
:
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <e2>"
Warning message in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y,
:
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <86>"
Warning message in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y,
:
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <aa>"
Warning message in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x,
x$y, :
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <e2>"
Warning message in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x,
x$y, :
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <90>"
Warning message in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x,
x$y, :
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <a3>"
Warning message in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x,
```

```
x$y, :
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <e2>"
Warning message in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x,
x$y, :
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <86>"
Warning message in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x,
x$y, :
"conversion failure on 'CO2␣ Emissions (Mt)' in 'mbcsToSbcs': dot substituted
for <aa>"
```



Above graphs show how emissions per capita differ across countries.Even though some countries emit large amounts of CO2, their per capita emissions may vary.

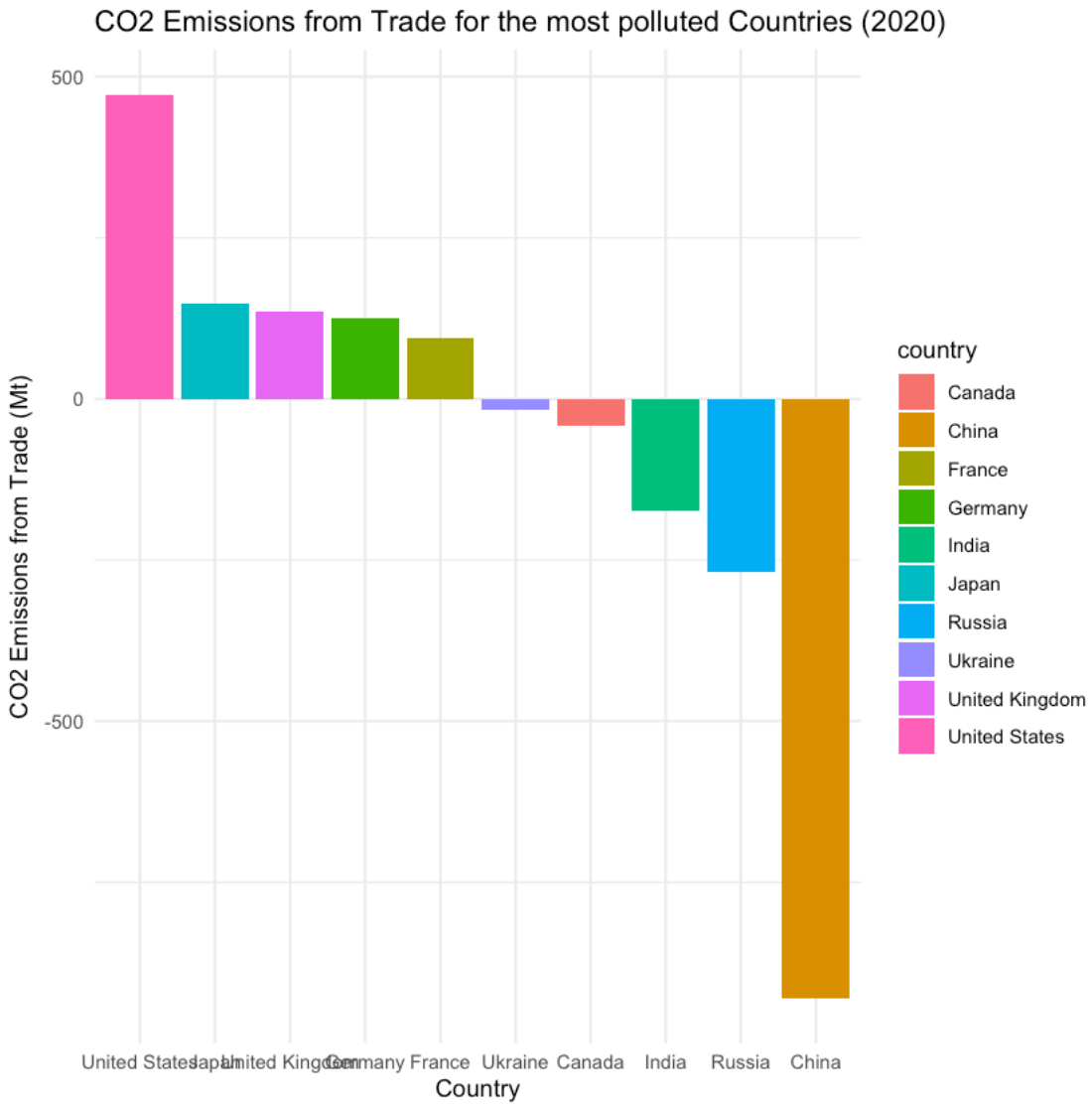
0.7 Temperature Change and Greenhouse Gas Impact

[54]:
```
# Temperature change from CO2 emissions for top 10 countries
d<- ggplot(df1 %>% filter(country %in% top10_countries$country, year >= 1950),
       aes(x = year, y = temperature_change_from_co2, color = country)) +
  geom_line() +
  labs(title = "Temperature Change Due to CO2 Emissions (Top 10 Countries)",
       x = "Year",
       y = "Temperature Change (°C)") +
  theme_minimal()
ggplotly(d)
```

```
HTML widgets cannot be represented in plain text (need html)
```

0.8 Economic Factors

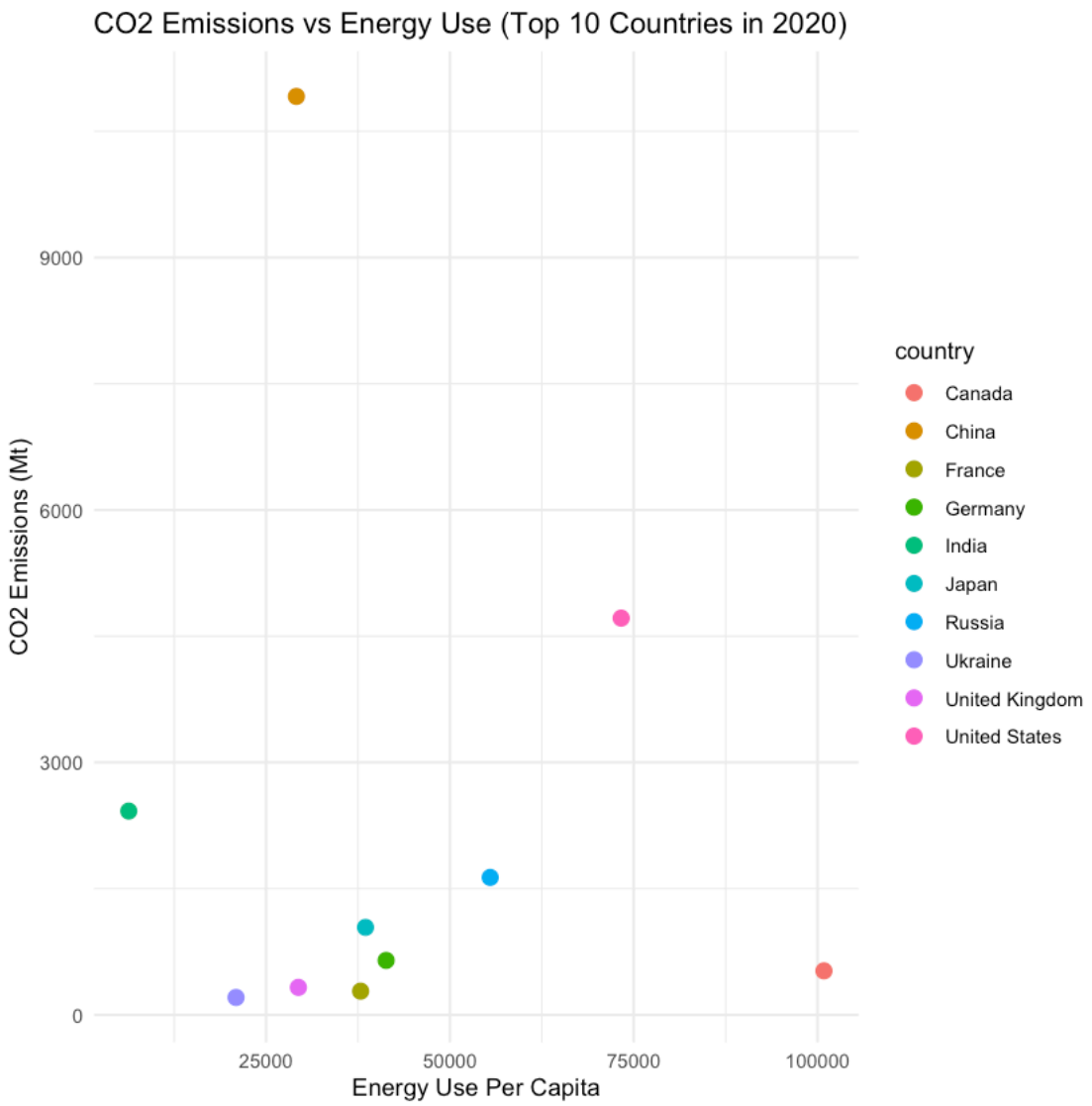
[56]:
```
ggplot(df1 %>% filter(country %in% top10_countries$country, year == 2020),
       aes(x = reorder(country, -trade_co2), y = trade_co2, fill = country)) +
  geom_bar(stat = "identity") +
  labs(title = "CO2 Emissions from Trade for the most polluted Countries␣
 ↪(2020)",
       x = "Country",
       y = "CO2 Emissions from Trade (Mt)") +
  theme_minimal()
```



[ ]:

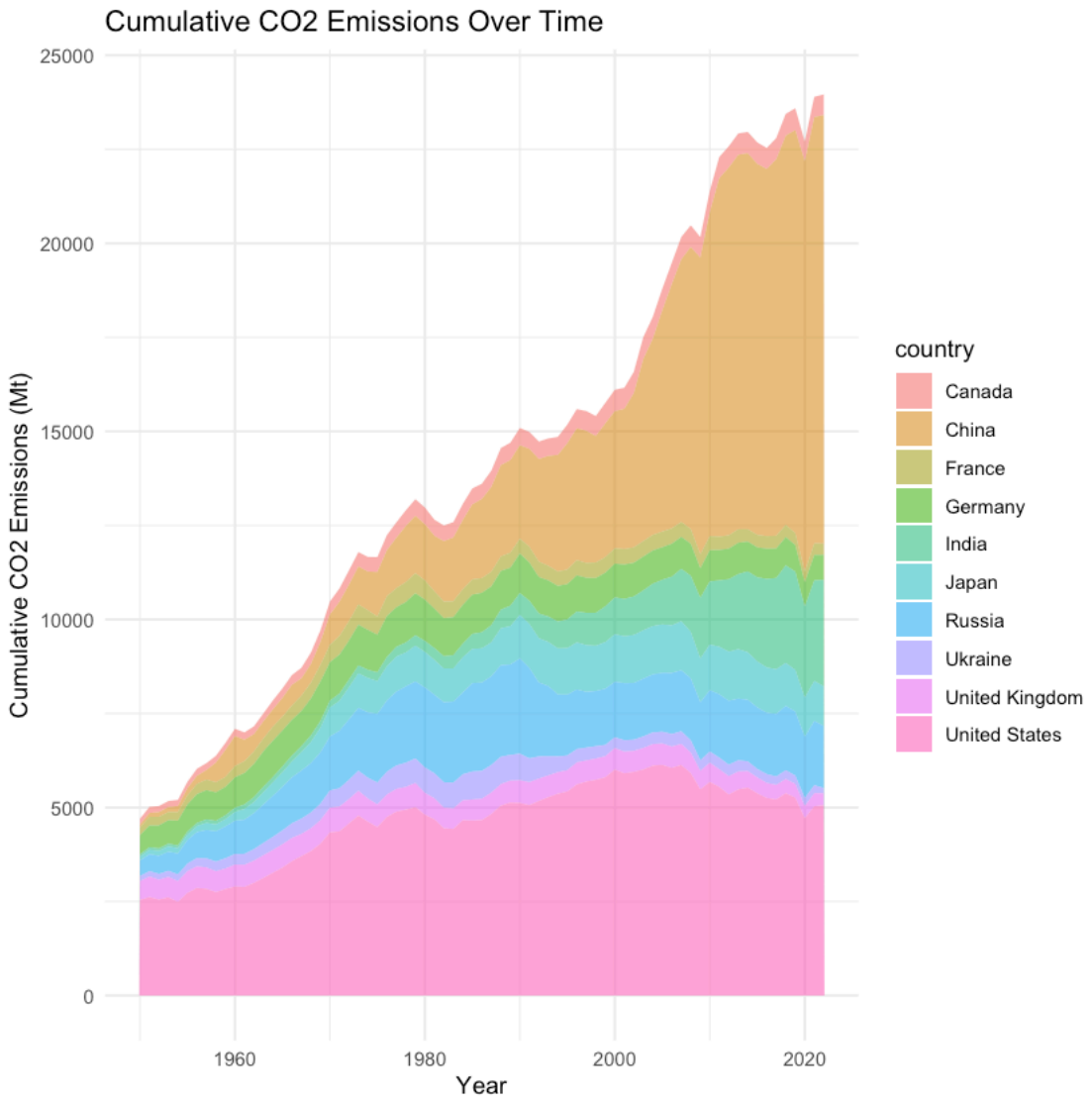
It shows emmissions are not just from domestic activity but also about import/export and supply chains.

[58]:
```
# Scatter plot for CO2 emissions vs energy use for top 10 countries in 2020
ggplot(df1 %>% filter(country %in% top10_countries$country, year == 2020),
       aes(x = energy_per_capita, y = co2, color = country)) +
  geom_point(size = 3) +
  labs(title = "CO2 Emissions vs Energy Use (Top 10 Countries in 2020)",
       x = "Energy Use Per Capita",
       y = "CO2 Emissions (Mt)") +
  theme_minimal()
```



1 Cumulative CO2 Emissions Over Time

[62]:
```
ggplot(df1 %>% filter(country %in% top10_countries$country, year >= 1950),
       aes(x = year, y = co2, fill = country)) +
  geom_area(alpha = 0.6) +
  labs(title = "Cumulative CO2 Emissions Over Time",
       x = "Year",
       y = "Cumulative CO2 Emissions (Mt)") +
  theme_minimal()
```



1.1 CO2 emmissions relationship with growth rate

[65]:
```
x <- ggplot(df1 %>% filter(country %in% top20_countries$country, year == 2022),
       aes(x = reorder(country, -co2_growth_prct), y = co2_growth_prct, fill =␣
 ↪country)) +
  geom_bar(stat = "identity") +
  labs(title = "CO2 Emissions Growth Rate 2022",
       x = "Country",
       y = "Growth Rate (%)") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
ggplotly(x)
```

HTML widgets cannot be represented in plain text (need html)

[66]:
```
# CO2 emissions growth rate over time for top 10 countries
z<- ggplot(df1 %>% filter(country %in% top5_countries$country, year >= 2000),
       aes(x = year, y = co2_growth_prct, color = country)) +
  geom_line() +
  labs(title = "CO2 Emissions Growth Rate Over Time (Top 10 Countries)",
       x = "Year",
       y = "Growth Rate (%)") +
  theme_minimal()
ggplotly(z)
```

HTML widgets cannot be represented in plain text (need html)

1.2 CO2 Emissions Growth Rate %

1.2.1 Income Groups comparision

[73]:
```
income<- ggplot(global_data1 %>% filter(year == 2022),
       aes(x = country, y = co2, fill = country)) +
  geom_bar(stat = "identity") +
  labs(title = "CO2 Emissions by Income Group (2022)",
       x = "Income Group", y = "CO2 Emissions (Mt)") +
  theme_minimal()
ggplotly(income)
```

HTML widgets cannot be represented in plain text (need html)

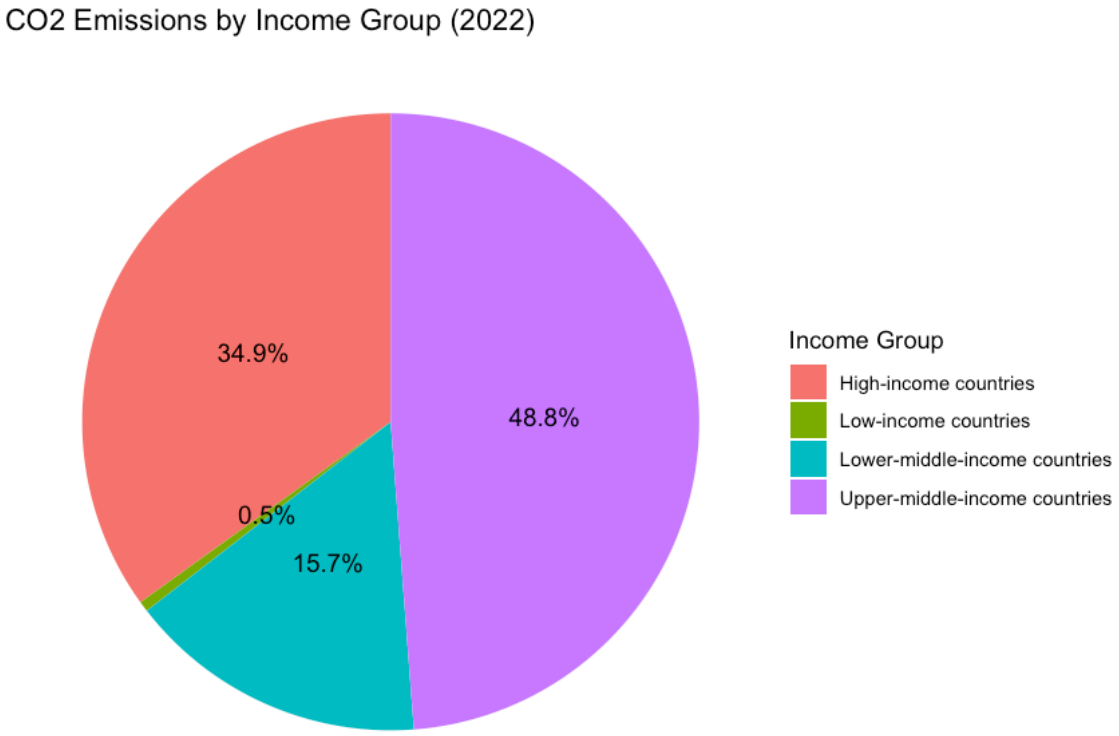
[ ]:
```

```

[ ]:
```

```

[75]:
```
ggplot(global_data1, aes(x = "", y = co2, fill = country)) +
  geom_bar(stat = "identity", width = 1) +
  coord_polar("y", start = 0) +  # This makes it a pie chart
  labs(title = "CO2 Emissions by Income Group (2022)", fill = "Income Group") +
  theme_void() +  # Removes the background grid and axes for a cleaner pie chart
  geom_text(aes(label = paste0(percentage, "%")), position =␣
 ↪position_stack(vjust = 0.5), size = 4)  # Adding percentage labels
```


CO2 Emissions by Income Group (2022)
34.9%
48.8%
0.5%
15.7%
Income Group
High-income countries
Low-income countries
Lower-middle-income countries
Upper-middle-income countries

[ ]: