Hypocrisy in climate action and accountability?

President of Brazil Jair Bolsonaro is a far-right populist and overall not good news. One of the things he is (rightly) criticized for is his relaxed attitude towards deforestation of rain forests. This is not only a problem in Brazil, countries like Indonesia are seeing large scale deforestation.

Richer (OECD) countries have rightly condemned this, citing both conservationist and environmental reasons for why the destruction of rain forests must be stopped. One of the most potent tools we as a species have in combatting climate change is rewilding large areas of land and allowing forests to regenerate, thus capturing more of the atmospheric CO2.

As right as the criticism of deforestation is, to what extent is it hypocritical? Are richer countries doing enough themselves to combat climate change?

This Jupyter notebook will look at excerpts of OECD data in an attempt to find a (short) answer to this question.

In [78]:

```
import numpy as np
import pandas as pd
import functools
import matplotlib.pyplot as plt
```

In [79]:

```
forests = pd.read_csv('/Users/anton/Desktop/MMFP/Forests.csv', sep=',')
green_growth = pd.read_csv('/Users/anton/Desktop/MMFP/GreenGrowthWorld.csv', sep=',')
ghg_emissions = pd.read_csv('/Users/anton/Desktop/MMFP/GHGEmissions.csv', sep=',')
protected_areas = pd.read_csv('/Users/anton/Desktop/MMFP/ProtectedAreas.csv', sep=',')
```

Whats is the OECD?

The Organisation for Economic Co-operation and Development - an intergovernmental economic organisation comprising 38 comparably wealthy nations (making up 62.2% of global nominal GDP in 2017).

Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

Source: Wikipedia

Data Cleanup and Preparation

CSV1 - Data on Forest Coverage

In [80]:

```
forests.head()
```

Out[80]:

COU	Country	VAR	Variable	YEA	Year	Unit Code	Unit	PowerCode Code	PowerCode	Reference Period Code	Reference Period	Value

	COU	Country	VAR	Variable	YEA	Year	Unit Code	Unit	PowerCode Code	PowerCode	Reference Period Code	Reference Period	Value
0	IND	India	FOREST	Forest	1990	1990	KM2	Square kilometres	0	Units	NaN	NaN	639380.0
1	IND	India	FOREST	Forest	1991	1991	KM2	Square kilometres	0	Units	NaN	NaN	643033.0
2	IND	India	FOREST	Forest	1992	1992	KM2	Square kilometres	0	Units	NaN	NaN	646686.0
3	IND	India	FOREST	Forest	1993	1993	KM2	Square kilometres	0	Units	NaN	NaN	650339.0
4	IND	India	FOREST	Forest	1994	1994	KM2	Square kilometres	0	Units	NaN	NaN	653992.0

In [81]:

```
#deleting non needed columns
del forests['COU']
del forests['VAR']
del forests['YEA']
del forests['Unit Code']
del forests['PowerCode Code']
del forests['PowerCode']
del forests['Reference Period Code']
del forests['Reference Period']
del forests['Flag Codes']
del forests['Flags']

forests.head()
```

Out[81]:

	Country	Variable	Year	Unit	Value
0	India	Forest	1990	Square kilometres	639380.0
1	India	Forest	1991	Square kilometres	643033.0
2	India	Forest	1992	Square kilometres	646686.0
3	India	Forest	1993	Square kilometres	650339.0
4	India	Forest	1994	Square kilometres	653992.0

Lists of different available countries and variables

In [82]:

```
country_list1 = forests['Country'].unique()
country_list1
```

Out[82]:

```
array(['India', 'Switzerland', 'Czech Republic', 'Luxembourg',
       'Australia', 'Russia', 'Norway', 'Greece', 'Turkey',
       'United States', 'Mexico', 'New Zealand', 'Canada',
       'Slovak Republic', 'Italy', 'World', 'Austria', 'Israel', 'Brazil',
       'Korea', 'Estonia', 'Poland', 'South Africa', 'Ireland', 'Denmark',
       'Portugal', 'Japan', "China (People's Republic of)", 'Belgium',
       'Netherlands', 'Spain', 'Iceland', 'Germany', 'United Kingdom',
       'Indonesia', 'Chile', 'France', 'Finland', 'Hungary', 'Slovenia',
       'Sweden', 'Belgo-Luxembourg Economic Union', 'OECD - Total',
       'Colombia', 'Saudi Arabia', 'Argentina', 'Latvia', 'Costa Rica',
       'Lithuania', 'Moldova', 'Malta', 'Azerbaijan', 'Belarus',
       'Tajikistan', 'Peru', 'Croatia', 'Cyprus', 'Armenia', 'Georgia',
       'Kazakhstan', 'Romania', 'Bulgaria', 'Kiribati'], dtype=object)
```

In order to not have this project escalate, we will not be looking at all countries. Of interest:

- **China (People's Republic of)**
- **Brazil**

- Indonesia
- India
- Germany
- United States
- OECD - Total
- World

In [83]:

```
variable_list1 = forests['Variable'].unique()
variable_list1
```

Out[83]:

```
array(['Forest', 'Other % land area', 'Land area',
       'Arable and cropland % land area',
       'Arable land and permanent crops', 'Total area',
       'Permanent meadows and pastures',
       'Meadows and pastures % land area', 'Other areas',
       'Forest % land area'], dtype=object)
```

In [84]:

```
#narrowing down - Country, Variable, etc.
forests_percent = forests[forests['Variable'] == 'Forest % land area']
forests_percent.head()
```

Out[84]:

	Country	Variable	Year	Unit	Value
420	Turkey	Forest % land area	1990	Percentage	25.705
421	Turkey	Forest % land area	1991	Percentage	25.753
422	Turkey	Forest % land area	1992	Percentage	25.800
423	Turkey	Forest % land area	1993	Percentage	25.847
424	Turkey	Forest % land area	1994	Percentage	25.895

In [85]:

```
forests_china = forests_percent[forests_percent['Country'] == 'China (People\'s Republic
of)']
forests_brazil = forests_percent[forests_percent['Country'] == 'Brazil']
forests_indonesia = forests_percent[forests_percent['Country'] == 'Indonesia']
forests_india = forests_percent[forests_percent['Country'] == 'India']
forests_germany = forests_percent[forests_percent['Country'] == 'Germany']
forests_usa = forests_percent[forests_percent['Country'] == 'United States']
forests_OECD = forests_percent[forests_percent['Country'] == 'OECD - Total']
forests_world = forests_percent[forests_percent['Country'] == 'World']
```

CSV2 - Data on Carbon Intensity of Economic Activity

In [86]:

```
green_growth.head()
```

Out[86]:

	COU	Country	VAR	Variable	YEA	Year	Unit Code	Unit	PowerCode Code	PowerCode	Reference Period Code	Referenc Perio
0	AUS	Australia	CO2_PBPROD	Production-based CO2 productivity, GDP per uni...	1990	1990	USD_KG	US dollars per kilogram	0	Units	2015	201

	COU	Country	VAR	Variable	YEA	Year	Unit Code	Unit	PowerCode Code	PowerCode	Reference Period Code	Referenc Peri
1	AUS	Australia	CO2_PBPROD	Production-based CO2 productivity, GDP per uni...	1995	1995	USD_KG	US dollars per kilogram	0	Units	2015	201
2	AUS	Australia	CO2_PBPROD	Production-based CO2 productivity, GDP per uni...	2000	2000	USD_KG	US dollars per kilogram	0	Units	2015	201
3	AUS	Australia	CO2_PBPROD	Production-based CO2 productivity, GDP per uni...	2005	2005	USD_KG	US dollars per kilogram	0	Units	2015	201
4	AUS	Australia	CO2_PBPROD	Production-based CO2 productivity, GDP per uni...	2010	2010	USD_KG	US dollars per kilogram	0	Units	2015	201

In [87]:

```
#deleting non needed columns
del green_growth['COU']
del green_growth['VAR']
del green_growth['YEA']
del green_growth['Unit Code']
del green_growth['PowerCode Code']
del green_growth['PowerCode']
del green_growth['Reference Period Code']
del green_growth['Reference Period']
del green_growth['Flag Codes']
del green_growth['Flags']

green_growth.head()
```

Out[87]:

	Country	Variable	Year	Unit	Value
0	Australia	Production-based CO2 productivity, GDP per uni...	1990	US dollars per kilogram	1.964201
1	Australia	Production-based CO2 productivity, GDP per uni...	1995	US dollars per kilogram	2.094626
2	Australia	Production-based CO2 productivity, GDP per uni...	2000	US dollars per kilogram	2.161436
3	Australia	Production-based CO2 productivity, GDP per uni...	2005	US dollars per kilogram	2.339759
4	Australia	Production-based CO2 productivity, GDP per uni...	2010	US dollars per kilogram	2.559971

In [88]:

```
country_list2 = green_growth['Country'].unique()
country_list2
```

Out[88]:

```
array(['Australia', 'Austria', 'Belgium', 'Canada', 'Czech Republic',
       'Denmark', 'Finland', 'France', 'Germany', 'Greece', 'Hungary',
       'Iceland', 'Ireland', 'Italy', 'Japan', 'Korea', 'Luxembourg',
       'Mexico', 'Netherlands', 'New Zealand', 'Norway', 'Poland',
       'Portugal', 'Slovak Republic', 'Spain', 'Sweden', 'Switzerland',
       'Turkey', 'United Kingdom', 'United States', 'Brazil', 'Chile',
       "China (People's Republic of)", 'Colombia', 'Estonia', 'India',
       'Indonesia', 'Israel', 'Latvia', 'Russia', 'Slovenia',
       'South Africa', 'World',
       'BRIICS economies - Brazil, Russia, India, Indonesia, China and South Africa',
       'OECD - Total', 'OECD - Europe', 'OECD America',
       'OECD Asia Oceania', 'Saudi Arabia', 'Argentina', 'Costa Rica',
       'Lithuania', 'Iran', 'Jordan', 'Brunei Darussalam', 'Turkmenistan',
       'Azerbaijan', "Côte d'Ivoire", 'Algeria', 'Philippines',
```

```
       'Azerbaijan', "Cote d'Ivoire", 'Algeria', 'Philippines',
       'Viet Nam', 'Egypt', 'Thailand', 'Bolivia', 'Dominican Republic',
       'Panama', 'Peru', 'Lebanon', 'Nicaragua', 'Morocco', 'Ukraine',
       'Haiti', 'Bulgaria', 'Croatia', 'Guatemala', 'Cambodia',
       'Paraguay', 'Iraq', 'Georgia', 'Tunisia', 'Jamaica', 'El Salvador',
       'Romania', 'Rwanda', 'Bahrain', 'Cuba', 'Honduras',
       'United Arab Emirates', 'Libya',
       "Lao People's Democratic Republic", 'Uzbekistan', 'Oman',
       'Syrian Arab Republic', 'Kuwait', 'Malaysia', 'Myanmar',
       'Kyrgyzstan', 'Djibouti', 'Moldova', 'Tajikistan', 'Qatar',
       'Belarus', 'Puerto Rico', 'Singapore', 'Uruguay', 'Armenia',
       'Kazakhstan', 'Malta', 'Ecuador', 'Trinidad and Tobago',
       'Venezuela', 'Senegal', 'Cameroon', 'Yemen', 'G20', 'G7',
       'Eastern Europe, Caucasus and Central Asia',
       'Latin America and Caribbean', 'Middle East and North Africa',
       'Belize', 'Uganda', 'Mozambique', 'Tanzania', 'Cabo Verde', 'Togo',
       'Nigeria', 'Niger', 'Benin', 'Serbia', 'Zimbabwe', 'Pakistan',
       'Bahamas', 'Cyprus', 'Zambia', 'Mauritius', 'Albania', 'Botswana',
       'Congo', 'Democratic Republic of the Congo', 'Eritrea', 'Ethiopia',
       'Gabon', 'Ghana', 'Kenya', 'North Macedonia', 'Mongolia',
       'Namibia', 'European Union (28 countries)', 'Monaco', 'Tuvalu',
       'Barbados', 'Bhutan', 'Central African Republic', 'Sierra Leone',
       'Tonga', 'Eswatini', 'ASEAN', 'Gambia', 'Burkina Faso',
       'Antigua and Barbuda', 'Kiribati', 'Liechtenstein', 'Bangladesh',
       'Burundi', 'Sri Lanka', 'Maldives', 'Equatorial Guinea',
       'Sao Tome and Principe', 'Bosnia and Herzegovina',
       'Turks and Caicos Islands', 'Palau', 'Somalia', 'Malawi', 'Chad',
       'Montenegro', 'Montserrat', 'Mauritania', 'Guinea', 'Lesotho',
       'Vanuatu', 'Liberia', 'Andorra', 'Suriname', 'Samoa',
       'Euro area (19 countries)', 'Micronesia', 'Mali',
       'Solomon Islands', 'American Samoa', 'Afghanistan', 'San Marino',
       'Madagascar', 'Papua New Guinea', 'Seychelles', 'Angola',
       'Bermuda', 'Aruba', 'Tokelau', 'Anguilla', 'Antarctica', 'Nauru',
       'Martinique', 'Mayotte', 'Fiji', 'Saint Pierre and Miquelon',
       'United States Virgin Islands', 'New Caledonia', 'Cook Islands',
       'Dominica', 'Faeroe Islands', 'Jersey', 'Niue', 'South Sudan ',
       'Cayman Islands', 'Saint Barthélemy', 'Marshall Islands',
       'Wallis and Futuna', 'Norfolk Island',
       'Saint Vincent and the Grenadines', 'Guyana', 'Sudan',
       'Saint Kitts and Nevis', 'Comoros', 'Clipperton Island',
       'Saint Helena', 'Northern Mariana Islands',
       'British Virgin Islands', 'Timor-Leste', 'Guinea-Bissau',
       'Curacao', 'Saint Lucia', 'Netherlands Antilles', 'Bonaire',
       'Christmas Islands', 'Saint Martin', 'Sint Maarten'], dtype=object)
```

In [89]:

```
variable_list2 = green_growth['Variable'].unique()
variable_list2
```

Out[89]:

```
array(['Production-based CO2 productivity, GDP per unit of energy-related CO2 emissions',
       'Production-based CO2 intensity, energy-related CO2 per capita',
       'Energy productivity,  GDP per unit of TPES',
       'Energy intensity, TPES per capita',
       'Renewable energy supply, % total energy supply',
       'Renewable electricity, % total electricity generation',
       'Total freshwater abstraction per capita',
       'Water stress, total freshwater abstraction as % total available renewable resourc
es',
       'Water stress, total freshwater abstraction as % total internal renewable resource
s',
       'Threatened mammal species, % total known species',
       'Threatened bird species, % total known species',
       'Threatened vascular plant species, % total known species',
       'Population connected to public sewerage, % total population',
       'Environmentally related government R&D budget, % total government R&D',
       'Environmentally related R&D expenditure, % GDP',
       'Renewable energy public RD&D budget, % total energy public RD&D',
       'Energy public RD&D budget, % GDP',
       'Development of environment-related technologies, % all technologies',
       'Development of environment-related technologies, % inventions worldwide',
```

```
       'Development of environment-related technologies, inventions per capita',
       'Environmentally related ODA, % total ODA',
       'ODA - renewable energy sector, % total allocable ODA',
       'ODA - water supply and sanitation sector, % total allocable ODA',
       'ODA - all sectors - biodiversity, % total ODA',
       'ODA - all sectors - climate change mitigation, % total ODA',
       'ODA - all sectors - climate change adaptation, % total ODA',
       'ODA - all sectors - desertification, % total ODA',
       'Net ODA provided, % GNI', 'Environmentally related taxes, % GDP',
       'Environmentally related taxes, % total tax revenue',
       'Energy related tax revenue, % total environmental tax revenue',
       'Road transport-related tax revenue, % total environmental tax revenue',
       'Real GDP per capita', 'Population density, inhabitants per km2',
       'Labour tax revenue, % GDP',
       'Population connected to sewerage with primary treatment, % total population',
       'Population connected to sewerage with secondary treatment, % total population',
       'Population connected to sewerage with tertiary treatment, % total population',
       'Demand-based CO2 productivity, GDP per unit of energy-related CO2 emissions',
       'Demand-based CO2 productivity, disposable income per unit of energy-related CO2 e
missions',
       'Relative advantage in environment-related technology',
       'Total primary energy supply', 'Petrol tax, USD per litre',
       'Value added in industry, % of total value added',
       'Value added in services, % of total value added',
       'Production-based CO2 emissions',
       'Municipal waste recycled or composted, % treated waste ',
       'ODA - environment sector, % total allocable ODA',
       'Demand-based CO2 emissions', 'Diesel tax, USD per litre',
       'Value added in agriculture, % of total value added',
       'Municipal waste incinerated, % treated waste',
       'Demand-based CO2 intensity, energy-related CO2 per capita',
       'Fossil fuel consumer support, % energy related tax revenue',
       'Biomass, % of DMC', 'Real GDP, Index 2000=100',
       'Municipal waste generated, kg per capita',
       'Total primary energy supply, index 2000=100',
       'Fossil fuel consumer support, % total tax revenue',
       'Production-based CO2 emissions, index 2000=100',
       'Non-energy material productivity, GDP per unit of DMC',
       'Municipal waste disposed to landfills, % treated waste',
       'Adjustment for pollution abatement',
       'Percentage of population exposed to more than 35 micrograms/m3',
       'Percentage of population exposed to more than 10 micrograms/m3',
       'Mean population exposure to PM2.5',
       'Contribution of natural capital',
       'Environmentally adjusted multifactor productivity growth',
       'Petroleum support, % total fossil fuel support',
       'Metals, % of DMC',
       'Energy consumption in transport, % total energy consumption',
       'Fossil fuel consumer support, % total fossil fuel support',
       'Energy consumption in other sectors, % total energy consumption',
       'Energy consumption in services, % total energy consumption',
       'Intensity of use of forest resources',
       'Total fossil fuel support, % of total tax revenue',
       'Mortality from exposure to ambient PM2.5',
       'Total renewable freshwater per capita',
       'Fossil fuel producer support, % total fossil fuel support',
       'Population with access to improved sanitation, % total population',
       'Phosphorus balance per hectare',
       'Coal support, % total fossil fuel support',
       'Energy consumption in industry, % total energy consumption',
       'Energy consumption in agriculture, % total energy consumption',
       'Gas support, % total fossil fuel support',
       'Nitrogen balance per hectare',
       'Labour tax revenue, % total tax revenue',
       'Non-metallic minerals, % of DMC',
       'Population with access to improved drinking water sources, % total population ',
       'Forest resource stocks',
       'Fossil fuel general services support, % total fossil fuel support',
       'Fossil fuel public RD&D budget (excluding CCS), % total energy public RD&D',
       'Loss of natural and semi-natural vegetated land, % since 1992',
       'Conversion of permanent water to not-water surface, % permanent water, since 1984
',
```

```
       'Gain of natural and semi-natural vegetated land, % since 2004',
       'Built up area per capita',
       'Loss of natural and semi-natural vegetated land, % since 2004',
       'Conversion from cropland to artificial surfaces, % since 1992',
       'Conversion from natural and semi-natural land to cropland, % since 1992',
       'Water, % total', 'Bare land, % total',
       'Artificial surfaces, % total ', 'New built up area, % since 2000',
       'Conversion from natural and semi-natural land to artificial surfaces, % since 199
2',
       'Permanent surface water, % total surface',
       'Seasonal surface water, % total surface ',
       'Natural and semi-natural vegetated land, % total',
       'Built up area, % total land',
       'Conversion of permanent to seasonal water surface, % permanent water, since 1984'
,
       'Cropland, % total',
       'Gain of natural and semi-natural vegetated land, % since 1992',
       'Conversion of not-water to permanent water surface, % permanent water, since 1984
',
       'Welfare costs of premature mortalities from exposure to ambient PM2.5, GDP equiva
lent',
       'Conversion of seasonal to permanent water surface, % permanent water, since 1984'
,
       'New built up area, % since 1990',
       'Mortality from exposure to lead',
       'Welfare costs of premature deaths from exposure to ambient ozone, GDP equivalent'
,
       'Diesel end-user price, USD per litre',
       'Welfare costs of premature deaths from exposure to lead, GDP equivalent',
       'Mortality from exposure to ambient ozone',
       'Mean feed-in tariff for solar PV electricity generation',
       'Petrol end-user price, USD per litre',
       'Mean feed-in tariff for wind electricity generation',
       'Welfare costs of premature mortalities from exposure to residential radon, GDP eq
uivalent',
       'Mortality from exposure to residential radon',
       'Industry electricity price, USD per kWh',
       'Residential electricity price, USD per kWh',
       'Total fertility rate, children per woman',
       'Life expectancy at birth', 'Population, ages 15-64, % total',
       'CO2 emissions from air transport per unit of GDP', 'Population',
       'Annual surface temperature, change since 1951-1980',
       'National expenditure on environmental protection, % GDP',
       'Population, ages 65 and above, % total',
       'Irrigated land, % agricultural land',
       'Sales of pesticides per unit of agricultural land',
       'Intact forest landscape, km2', 'Women, % total population',
       'Population, ages 0-14, % total',
       'Emissions priced above EUR 60 per tonne of CO2, % total emissions',
       'CO2 emissions from air transport per capita', 'Net migration',
       'Terrestrial protected area, % land area',
       'Emissions priced above EUR 30 per tonne of CO2, % total emissions',
       'Farmland Birds Index, 2000=100',
       'Marine protected area, % total exclusive economic zone',
       'Intact forest landscape loss, % since 2000',
       'Forest Birds Index, 2000=100',
       'Electricity support, % total fossil fuel support',
       'CO2 intensity of GDP, CO2 emissions per unit of GDP',
       'Renewable energy supply (excluding solid biofuels), % total energy supply',
       'Naturally regenerating forests, % total forest area',
       'Forests with long-term management plans, % total forest area'],
      dtype=object)
```

In [90]:

```
prod_gdpperco2 = green_growth[green_growth['Variable'] == 'Production-based CO2 producti
vity, GDP per unit of energy-related CO2 emissions']
prod_co2percap = green_growth[green_growth['Variable'] == 'Production-based CO2 intensit
y, energy-related CO2 per capita']
dem_gdpperco2 = green_growth[green_growth['Variable'] == 'Demand-based CO2 productivity,
GDP per unit of energy-related CO2 emissions']
```

```
dem_co2percap = green_growth[green_growth['Variable'] == 'Demand-based CO2 intensity, energy-related CO2 per capita']
ren_energy = green_growth[green_growth['Variable'] == 'Renewable energy supply, % total energy supply']
ren_electricity = green_growth[green_growth['Variable'] == 'Renewable electricity, % total electricity generation']
```

In [91]:

```
prod_gdpperco2_china = prod_gdpperco2[prod_gdpperco2['Country'] == 'China (People\'s Republic of)']
prod_gdpperco2_brazil = prod_gdpperco2[prod_gdpperco2['Country'] == 'Brazil']
prod_gdpperco2_indonesia = prod_gdpperco2[prod_gdpperco2['Country'] == 'Indonesia']
prod_gdpperco2_india = prod_gdpperco2[prod_gdpperco2['Country'] == 'India']
prod_gdpperco2_germany = prod_gdpperco2[prod_gdpperco2['Country'] == 'Germany']
prod_gdpperco2_usa = prod_gdpperco2[prod_gdpperco2['Country'] == 'United States']
prod_gdpperco2_OECD = prod_gdpperco2[prod_gdpperco2['Country'] == 'OECD - Total']
prod_gdpperco2_world = prod_gdpperco2[prod_gdpperco2['Country'] == 'World']
```

In [92]:

```
prod_co2percap_china = prod_co2percap[prod_co2percap['Country'] == 'China (People\'s Republic of)']
prod_co2percap_brazil = prod_co2percap[prod_co2percap['Country'] == 'Brazil']
prod_co2percap_indonesia = prod_co2percap[prod_co2percap['Country'] == 'Indonesia']
prod_co2percap_india = prod_co2percap[prod_co2percap['Country'] == 'India']
prod_co2percap_germany = prod_co2percap[prod_co2percap['Country'] == 'Germany']
prod_co2percap_usa = prod_co2percap[prod_co2percap['Country'] == 'United States']
prod_co2percap_OECD = prod_co2percap[prod_co2percap['Country'] == 'OECD - Total']
prod_co2percap_world = prod_co2percap[prod_co2percap['Country'] == 'World']
```

In [93]:

```
dem_gdpperco2_china = dem_gdpperco2[dem_gdpperco2['Country'] == 'China (People\'s Republic of)']
dem_gdpperco2_brazil = dem_gdpperco2[dem_gdpperco2['Country'] == 'Brazil']
dem_gdpperco2_indonesia = dem_gdpperco2[dem_gdpperco2['Country'] == 'Indonesia']
dem_gdpperco2_india = dem_gdpperco2[dem_gdpperco2['Country'] == 'India']
dem_gdpperco2_germany = dem_gdpperco2[dem_gdpperco2['Country'] == 'Germany']
dem_gdpperco2_usa = dem_gdpperco2[dem_gdpperco2['Country'] == 'United States']
dem_gdpperco2_OECD = dem_gdpperco2[dem_gdpperco2['Country'] == 'OECD - Total']
dem_gdpperco2_world = dem_gdpperco2[dem_gdpperco2['Country'] == 'World']
```

In [94]:

```
dem_co2percap_china = dem_co2percap[dem_co2percap['Country'] == 'China (People\'s Republic of)']
dem_co2percap_brazil = dem_co2percap[dem_co2percap['Country'] == 'Brazil']
dem_co2percap_indonesia = dem_co2percap[dem_co2percap['Country'] == 'Indonesia']
dem_co2percap_india = dem_co2percap[dem_co2percap['Country'] == 'India']
dem_co2percap_germany = dem_co2percap[dem_co2percap['Country'] == 'Germany']
dem_co2percap_usa = dem_co2percap[dem_co2percap['Country'] == 'United States']
dem_co2percap_OECD = dem_co2percap[dem_co2percap['Country'] == 'OECD - Total']
dem_co2percap_world = dem_co2percap[dem_co2percap['Country'] == 'World']
```

In [95]:

```
ren_energy_china = ren_energy[ren_energy['Country'] == 'China (People\'s Republic of)']
ren_energy_brazil = ren_energy[ren_energy['Country'] == 'Brazil']
ren_energy_indonesia = ren_energy[ren_energy['Country'] == 'Indonesia']
ren_energy_india = ren_energy[ren_energy['Country'] == 'India']
ren_energy_germany = ren_energy[ren_energy['Country'] == 'Germany']
ren_energy_usa = ren_energy[ren_energy['Country'] == 'United States']
ren_energy_OECD = ren_energy[ren_energy['Country'] == 'OECD - Total']
ren_energy_world = ren_energy[ren_energy['Country'] == 'World']
```

In [96]:

```
ren_electricity_china = ren_electricity[ren_electricity['Country'] == 'China (People\'s Republic of)']
```

```
ren_electricity_brazil = ren_electricity[ren_electricity['Country'] == 'Brazil']
ren_electricity_indonesia = ren_electricity[ren_electricity['Country'] == 'Indonesia']
ren_electricity_india = ren_electricity[ren_electricity['Country'] == 'India']
ren_electricity_germany = ren_electricity[ren_electricity['Country'] == 'Germany']
ren_electricity_usa = ren_electricity[ren_electricity['Country'] == 'United States']
ren_electricity_OECD = ren_electricity[ren_electricity['Country'] == 'OECD - Total']
ren_electricity_world = ren_electricity[ren_electricity['Country'] == 'World']
```

CSV3 - Data on Total Emissions of each country

In [97]:

```
ghg_emissions.head()
```

Out[97]:

	COU	Country	POL	Pollutant	VAR	Variable	YEA	Year	Unit Code	Unit	PowerCode Code	PowerCode	Refe
0	AUS	Australia	GHG	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1990	1990	T_CO2_EQVT	Tonnes of CO2 equivalent	3	Thousands	
1	AUS	Australia	GHG	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1991	1991	T_CO2_EQVT	Tonnes of CO2 equivalent	3	Thousands	
2	AUS	Australia	GHG	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1992	1992	T_CO2_EQVT	Tonnes of CO2 equivalent	3	Thousands	
3	AUS	Australia	GHG	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1993	1993	T_CO2_EQVT	Tonnes of CO2 equivalent	3	Thousands	
4	AUS	Australia	GHG	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1994	1994	T_CO2_EQVT	Tonnes of CO2 equivalent	3	Thousands	

In [98]:

```
var_list3 = ghg_emissions['VAR'].unique()
var_list3
```

Out[98]:

```
array(['TOTAL', 'INDEX_1990', 'GHG_CAP', 'WAS', 'IND_PROC', 'ENER', 'AGR',
       'OTH', 'GHG_GDP', 'ENER_IND', 'LULUCF', 'ENER_OSECT', 'ENER_OTH',
       'ENER_FU', 'ENER_MANUF', 'ENER_TRANS', 'INDEX_2000', 'TOTAL_LULU',
       'ENER_CO2', 'AFOLU', 'ENER_IND_P', 'ENER_OTH_P', 'AGR_P', 'ENER_P',
       'ENER_MANUF_P', 'ENER_OSECT_P', 'WAS_P', 'IND_PROC_P',
       'ENER_TRANS_P', 'ENER_FU_P', 'OTH_P', 'ENER_CO2_P'], dtype=object)
```

In [99]:

```
#deleting non needed columns
del ghg_emissions['COU']
del ghg_emissions['POL']
del ghg_emissions['YEA']
del ghg_emissions['Unit Code']
del ghg_emissions['PowerCode Code']
del ghg_emissions['PowerCode']
del ghg_emissions['Reference Period Code']
del ghg_emissions['Reference Period']
del ghg_emissions['Flag Codes']
del ghg_emissions['Flags']
```

```
ghg_emissions.head()
```

Out[99]:

	Country	Pollutant	VAR	Variable	Year	Unit	Value
0	Australia	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1990	Tonnes of CO2 equivalent	424998.381
1	Australia	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1991	Tonnes of CO2 equivalent	426015.210
2	Australia	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1992	Tonnes of CO2 equivalent	430216.380
3	Australia	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1993	Tonnes of CO2 equivalent	430612.556
4	Australia	Greenhouse gases	TOTAL	Total emissions excluding LULUCF	1994	Tonnes of CO2 equivalent	430653.332

In [100]:

```
country_list3 = ghg_emissions['Country'].unique()
country_list3
```

Out[100]:

```
array(['Australia', 'Austria', 'Belgium', 'Canada', 'Czech Republic',
       'Denmark', 'Finland', 'France', 'Germany', 'Greece', 'Hungary',
       'Iceland', 'Ireland', 'Italy', 'Japan', 'Korea', 'Luxembourg',
       'Mexico', 'Netherlands', 'New Zealand', 'Norway', 'Poland',
       'Portugal', 'Slovak Republic', 'Spain', 'Sweden', 'Switzerland',
       'Turkey', 'United Kingdom', 'United States', 'Chile', 'Estonia',
       'Israel', 'Russia', 'Slovenia', 'Latvia', 'Lithuania',
       'OECD - Total', 'OECD - Europe', 'Brazil',
       "China (People's Republic of)", 'Colombia', 'Costa Rica', 'India',
       'Indonesia', 'South Africa', 'Argentina',
       'European Union (28 countries)'], dtype=object)
```

In [101]:

```
variable_list = ghg_emissions['Variable'].unique()
variable_list
```

Out[101]:

```
array(['Total  emissions excluding LULUCF',
       'Total GHG excl. LULUCF, Index 1990=100',
       'Total GHG excl. LULUCF per capita', '5 - Waste',
       '2- Industrial processes and product use', '1 - Energy',
       '3 - Agriculture', '6 - Other',
       'Total GHG excl. LULUCF per unit of GDP',
       '1A1 - Energy Industries',
       'Land use, land-use change and forestry (LULUCF)',
       '1A4 - Residential and other sectors', '1A5 - Energy - Other',
       '1B - Fugitive Emissions from Fuels',
       '1A2 - Manufacturing industries and construction',
       '1A3 - Transport', 'Total GHG excl. LULUCF, Index 2000=100',
       'Total  emissions including LULUCF',
       '1C - CO2 from Transport and Storage',
       'Agriculture, Forestry and Other Land Use (AFOLU)',
       '1A4 - Residential and other sectors\t'], dtype=object)
```

In [102]:

```
ghg_emissions[ghg_emissions['VAR'] == 'TOTAL_LULU']
```

Out[102]:

	Country	Pollutant	VAR	Variable	Year	Unit	Value
22967	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1990	Tonnes of CO2 equivalent	77456.854
22968	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1991	Tonnes of CO2 equivalent	87382.505
		Greenhouse	TOTAL_LULU	Total emissions including		Tonnes of CO2	

	Country	Pollutant	VAR	Variable	Year	Unit	Value
22969	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1992	Tonnes of CO2 equivalent	82635.206
22970	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1993	Tonnes of CO2 equivalent	83596.425
22971	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1994	Tonnes of CO2 equivalent	86591.418
22972	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1995	Tonnes of CO2 equivalent	83718.472
22973	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1996	Tonnes of CO2 equivalent	96384.804
22974	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1997	Tonnes of CO2 equivalent	87226.885
22975	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1998	Tonnes of CO2 equivalent	83209.418
22976	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1999	Tonnes of CO2 equivalent	81054.777
22977	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2000	Tonnes of CO2 equivalent	77013.874
22978	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2001	Tonnes of CO2 equivalent	79033.380
22979	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2002	Tonnes of CO2 equivalent	79553.621
22980	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2003	Tonnes of CO2 equivalent	84408.064
22981	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2004	Tonnes of CO2 equivalent	77969.294
22982	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2005	Tonnes of CO2 equivalent	73483.821
22983	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2006	Tonnes of CO2 equivalent	81389.054
22984	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2007	Tonnes of CO2 equivalent	74366.444
22985	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2008	Tonnes of CO2 equivalent	66247.082
22986	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2009	Tonnes of CO2 equivalent	67664.205
22987	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2010	Tonnes of CO2 equivalent	65200.886
22988	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2011	Tonnes of CO2 equivalent	58435.170
22989	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2012	Tonnes of CO2 equivalent	55521.114
22990	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2013	Tonnes of CO2 equivalent	58479.898
22991	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2014	Tonnes of CO2 equivalent	53944.805
22992	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2015	Tonnes of CO2 equivalent	54901.411
22993	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2016	Tonnes of CO2 equivalent	57965.185
22994	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2017	Tonnes of CO2 equivalent	54164.741
22995	Denmark	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2018	Tonnes of CO2 equivalent	56289.232
23162	Italy	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1990	Tonnes of CO2 equivalent	512495.818
...	...	...	...	...	...	...	...

	Country	Pollutant	VAR	Variable	Year	Unit	Value
45746	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1990	Tonnes of CO2 equivalent	5393040.896
45747	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1991	Tonnes of CO2 equivalent	5271943.941
45748	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1992	Tonnes of CO2 equivalent	5130854.547
45749	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1993	Tonnes of CO2 equivalent	5030187.741
45750	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1994	Tonnes of CO2 equivalent	4995382.898
45751	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1995	Tonnes of CO2 equivalent	5022637.149
45752	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1996	Tonnes of CO2 equivalent	5106599.576
45753	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1997	Tonnes of CO2 equivalent	5015060.532
45754	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1998	Tonnes of CO2 equivalent	4959485.174
45755	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	1999	Tonnes of CO2 equivalent	4841530.551
45756	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2000	Tonnes of CO2 equivalent	4853553.800
45757	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2001	Tonnes of CO2 equivalent	4885499.015
45758	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2002	Tonnes of CO2 equivalent	4868897.844
45759	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2003	Tonnes of CO2 equivalent	4978836.328
45760	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2004	Tonnes of CO2 equivalent	4951297.145
45761	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2005	Tonnes of CO2 equivalent	4920179.882
45762	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2006	Tonnes of CO2 equivalent	4883767.745
45763	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2007	Tonnes of CO2 equivalent	4870413.886
45764	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2008	Tonnes of CO2 equivalent	4723716.085
45765	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2009	Tonnes of CO2 equivalent	4353894.815
45766	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2010	Tonnes of CO2 equivalent	4461844.677
45767	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2011	Tonnes of CO2 equivalent	4306776.346
45768	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2012	Tonnes of CO2 equivalent	4242724.737
45769	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2013	Tonnes of CO2 equivalent	4143426.469
45770	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2014	Tonnes of CO2 equivalent	3988440.064
45771	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2015	Tonnes of CO2 equivalent	4032128.405
45772	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2016	Tonnes of CO2 equivalent	4012230.319
45773	European Union (28 countries)	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2017	Tonnes of CO2 equivalent	4061389.641
45774	European Union (28	Greenhouse	TOTAL_LULU	Total emissions including	2018	Tonnes of CO2	3951393.907

	Country	Pollutant	VAR	Variable	Year	Unit	Value
52466	Costa Rica	Greenhouse gases	TOTAL_LULU	Total emissions including LULUCF	2015	Tonnes of CO2 equivalent	13638.000

1198 rows × 7 columns

In [103]:

```
emissions_incl_LULUCF = ghg_emissions[ghg_emissions['VAR'] == 'TOTAL']
emissions_excl_LULUCF = ghg_emissions[ghg_emissions['VAR'] == 'TOTAL_LULU']
LULUCF = ghg_emissions[ghg_emissions['VAR'] == 'LULUCF']
```

In [104]:

```
emissions_incl_LULUCF_china = emissions_incl_LULUCF[emissions_incl_LULUCF['Country'] == 'China (People\'s Republic of)']
emissions_incl_LULUCF_brazil = emissions_incl_LULUCF[emissions_incl_LULUCF['Country'] == 'Brazil']
emissions_incl_LULUCF_indonesia = emissions_incl_LULUCF[emissions_incl_LULUCF['Country'] == 'Indonesia']
emissions_incl_LULUCF_india = emissions_incl_LULUCF[emissions_incl_LULUCF['Country'] == 'India']
emissions_incl_LULUCF_germany = emissions_incl_LULUCF[emissions_incl_LULUCF['Country'] == 'Germany']
emissions_incl_LULUCF_usa = emissions_incl_LULUCF[emissions_incl_LULUCF['Country'] == 'United States']
emissions_incl_LULUCF_OECD = emissions_incl_LULUCF[emissions_incl_LULUCF['Country'] == 'OECD - Total']
emissions_incl_LULUCF_world = emissions_incl_LULUCF[emissions_incl_LULUCF['Country'] == 'World']
```

In [105]:

```
emissions_excl_LULUCF_china = emissions_excl_LULUCF[emissions_excl_LULUCF['Country'] == 'China (People\'s Republic of)']
emissions_excl_LULUCF_brazil = emissions_excl_LULUCF[emissions_excl_LULUCF['Country'] == 'Brazil']
emissions_excl_LULUCF_indonesia = emissions_excl_LULUCF[emissions_excl_LULUCF['Country'] == 'Indonesia']
emissions_excl_LULUCF_india = emissions_excl_LULUCF[emissions_excl_LULUCF['Country'] == 'India']
emissions_excl_LULUCF_germany = emissions_excl_LULUCF[emissions_excl_LULUCF['Country'] == 'Germany']
emissions_excl_LULUCF_usa = emissions_excl_LULUCF[emissions_excl_LULUCF['Country'] == 'United States']
emissions_excl_LULUCF_OECD = emissions_excl_LULUCF[emissions_excl_LULUCF['Country'] == 'OECD - Total']
emissions_excl_LULUCF_world = emissions_excl_LULUCF[emissions_excl_LULUCF['Country'] == 'World']
```

In [106]:

```
LULUCF_china = LULUCF[LULUCF['Country'] == 'China (People\'s Republic of)']
LULUCF_brazil = LULUCF[LULUCF['Country'] == 'Brazil']
LULUCF_indonesia = LULUCF[LULUCF['Country'] == 'Indonesia']
LULUCF_india = LULUCF[LULUCF['Country'] == 'India']
LULUCF_germany = LULUCF[LULUCF['Country'] == 'Germany']
LULUCF_usa = LULUCF[LULUCF['Country'] == 'United States']
LULUCF_OECD = LULUCF[LULUCF['Country'] == 'OECD - Total']
LULUCF_world = LULUCF[LULUCF['Country'] == 'World']
```

In [107]:

```
protected_areas.head()
```

Out[107]:

	COU	Country	DESIG	Designation	DOMAIN	Domain	MEASURE	Measure	CALCULATION	Calculation method

	COU	Country	DESIG	Designation	DOMAIN	Domain	MEASURE	Measure	CALCULATION	Calculation metho
0	AUS	Australia	ALL_INC_POINTS	All, including data recorded as points	TERRESTRIAL	Terrestrial	PCNT	Percent of total land/EEZ area	NAIVE	Total fo categor
1	AUS	Australia	ALL_INC_POINTS	All, including data recorded as points	TERRESTRIAL	Terrestrial	PCNT	Percent of total land/EEZ area	NAIVE	Total fo categor
2	AUS	Australia	ALL_INC_POINTS	All, including data recorded as points	TERRESTRIAL	Terrestrial	PCNT	Percent of total land/EEZ area	NAIVE	Total fo categor
3	AUS	Australia	ALL_INC_POINTS	All, including data recorded as points	TERRESTRIAL	Terrestrial	PCNT	Percent of total land/EEZ area	NAIVE	Total fo categor
4	AUS	Australia	ALL_INC_POINTS	All, including data recorded as points	TERRESTRIAL	Terrestrial	PCNT	Percent of total land/EEZ area	NAIVE	Total fo categor

5 rows × 23 columns

In [108]:

```
#deleting non needed columns
del protected_areas['COU']
del protected_areas['DESIG']
del protected_areas['DOMAIN']
del protected_areas['MEASURE']
del protected_areas['SCOPE']
del protected_areas['CALCULATION']
del protected_areas['Calculation method']
del protected_areas['Unit Code']
del protected_areas['PowerCode Code']
del protected_areas['PowerCode']
del protected_areas['Reference Period Code']
del protected_areas['Reference Period']
del protected_areas['Flag Codes']
del protected_areas['Flags']

protected_areas.head()
```

Out[108]:

	Country	Designation	Domain	Measure	Scope	YEA	Year	Unit	Value
0	Australia	All, including data recorded as points	Terrestrial	Percent of total land/EEZ area	Country	1950	1950	Percentage	0.635674
1	Australia	All, including data recorded as points	Terrestrial	Percent of total land/EEZ area	Country	1960	1960	Percentage	0.639004
2	Australia	All, including data recorded as points	Terrestrial	Percent of total land/EEZ area	Country	1970	1970	Percentage	1.100295
3	Australia	All, including data recorded as points	Terrestrial	Percent of total land/EEZ area	Country	1980	1980	Percentage	2.848027
4	Australia	All, including data recorded as points	Terrestrial	Percent of total land/EEZ area	Country	1985	1985	Percentage	3.470389

In [109]:

```
country_list4 = protected_areas['Country'].unique()
```

```
country_list4
```

Out[109]:

```
array(['Australia', 'Austria', 'Belgium', 'Canada', 'Czech Republic',
       'Denmark', 'Finland', 'France', 'Germany', 'Greece', 'Hungary',
       'Iceland', 'Ireland', 'Italy', 'Japan', 'Korea', 'Luxembourg',
       'Mexico', 'Netherlands', 'New Zealand', 'Norway', 'Poland',
       'Portugal', 'Slovak Republic', 'Spain', 'Sweden', 'Switzerland',
       'United Kingdom', 'United States', 'G7', 'NAFTA', 'American Samoa',
       'Anguilla', 'Argentina', 'Armenia', 'Aruba', 'Azerbaijan',
       'Belarus', 'Bermuda', 'Brazil', 'British Virgin Islands',
       'Bulgaria', 'Cayman Islands', 'Chile',
       "China (People's Republic of)", 'Colombia', 'Cook Islands',
       'Costa Rica', 'Croatia', 'Cyprus', 'Estonia', 'Faeroe Islands',
       'Falkland Islands (Malvinas)', 'French Guiana', 'French Polynesia',
       'Georgia', 'Gibraltar', 'Greenland', 'Guadeloupe', 'Guam', 'India',
       'Indonesia', 'Israel', 'Kazakhstan', 'Kyrgyzstan', 'Latvia',
       'Lithuania', 'Malta', 'Martinique', 'Mayotte', 'Moldova',
       'Montserrat', 'New Caledonia', 'Niue', 'Norfolk Island',
       'Northern Mariana Islands', 'Peru', 'Pitcairn', 'Puerto Rico',
       'Réunion', 'Romania', 'Russia', 'Saint Helena',
       'Saint Pierre and Miquelon', 'Saudi Arabia', 'Slovenia',
       'South Africa', 'Svalbard and Jan Mayen', 'Tajikistan', 'Tokelau',
       'Turkmenistan', 'Turks and Caicos Islands', 'Ukraine',
       'Uzbekistan', 'United States Virgin Islands', 'Wallis and Futuna',
       'World', 'Bouvet Island', 'Heard Island and McDonald Islands',
       'South Georgia and the South Sandwich Islands',
       'French Southern and Antarctic Lands',
       'British Indian Ocean Territory', 'Christmas Islands',
       'Cocos (Keeling) Islands', 'ASEAN', 'APEC', 'Guernsey',
       'Isle of Man', 'Jersey', 'G20',
       'BRIICS economies - Brazil, Russia, India, Indonesia, China and South Africa',
       'Curacao', 'Sint Maarten', 'Bonaire', 'OECD - Total',
       'OECD - Europe', 'Euro area (19 countries)', 'Saint Barthélemy',
       'OECD Asia Oceania', 'OECD America',
       'Eastern Europe, Caucasus and Central Asia',
       'Latin America and Caribbean', 'Middle East and North Africa',
       'Saint Martin', 'Clipperton Island', 'Dominican Republic',
       'Ecuador', 'Paraguay', 'Uruguay', 'OECD arithmetic average',
       'European Union – 27 countries (from 01/02/2020)'], dtype=object)
```

In [110]:

```
variable_list = protected_areas['Measure'].unique()
variable_list
```

Out[110]:

```
array(['Percent of total land/EEZ area'], dtype=object)
```

In [111]:

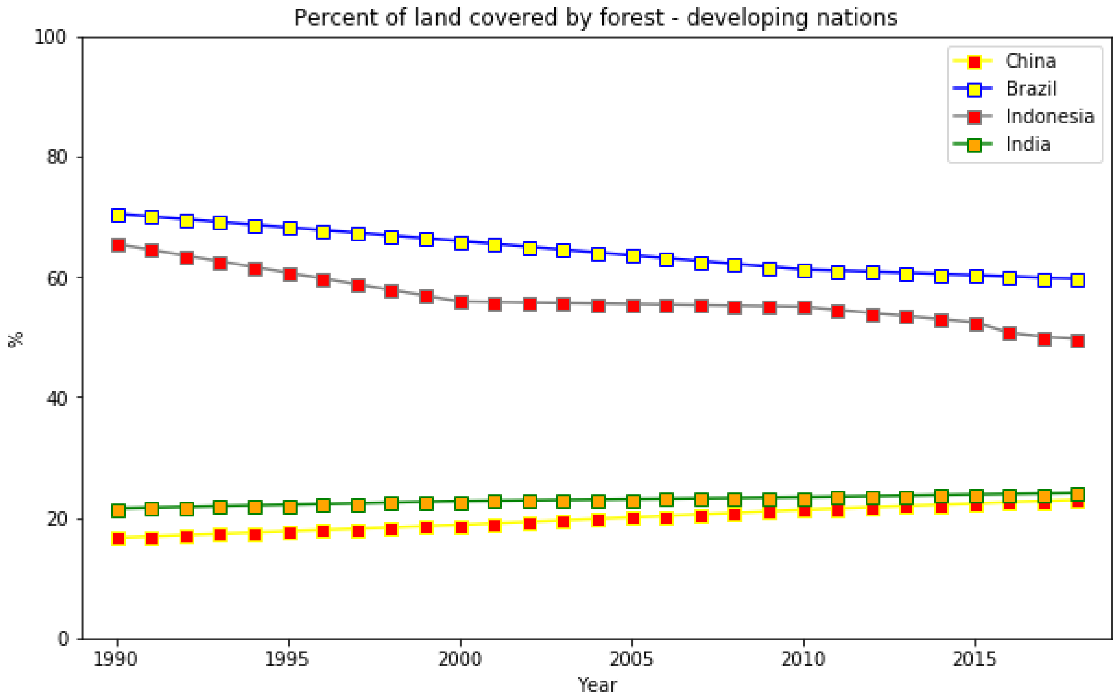
```
protected_areas_china = protected_areas[protected_areas['Country'] == 'China (People\'s Republic of)']
protected_areas_brazil = protected_areas[protected_areas['Country'] == 'Brazil']
protected_areas_indonesia = protected_areas[protected_areas['Country'] == 'Indonesia']
protected_areas_india = protected_areas[protected_areas['Country'] == 'India']
protected_areas_germany = protected_areas[protected_areas['Country'] == 'Germany']
protected_areas_usa = protected_areas[protected_areas['Country'] == 'United States']
protected_areas_OECD = protected_areas[protected_areas['Country'] == 'OECD - Total']
protected_areas_world = protected_areas[protected_areas['Country'] == 'World']
```

1. Changes in forest cover

Let's first have a look at the data to guage the accuracy of the accusations that countries such as Brazil and Indonesia are carrying out large scale deforestation. The following three graphs show the change in land covered by forests as a percentage of the total land.

In [126]:

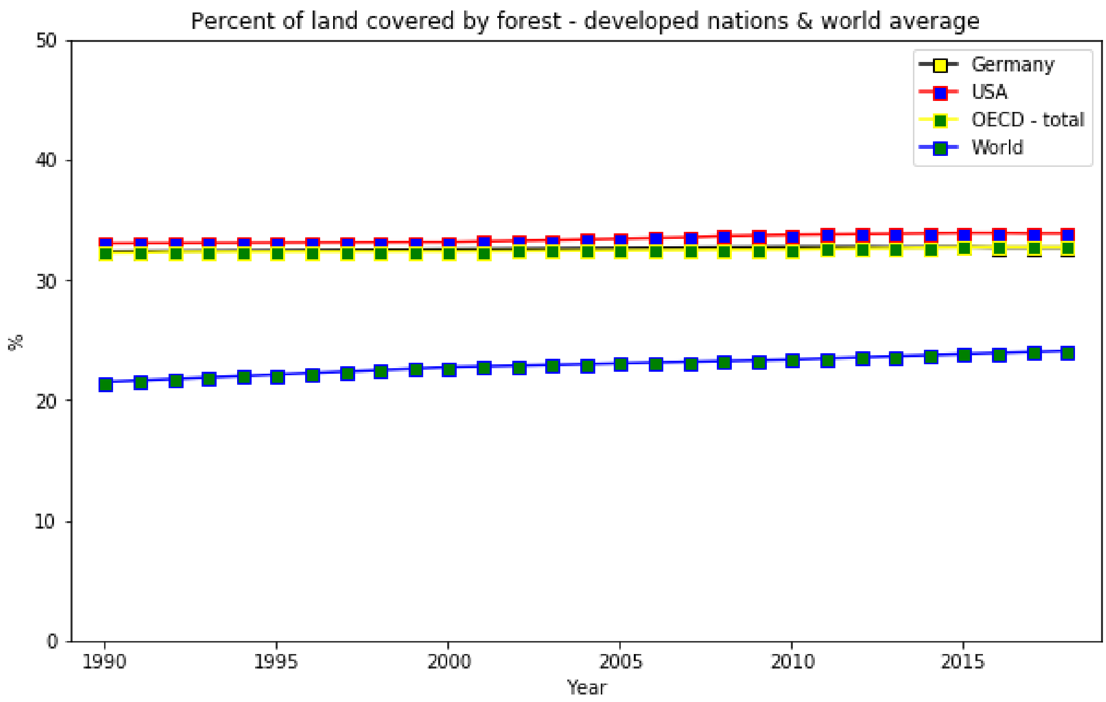
```
plt.figure(figsize=(10, 6))

x1 = forests_china['Year']
y1 = forests_china['Value']
plt.plot(x1, y1, label = "China", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=7)

x2 = forests_brazil['Year']
y2 = forests_brazil['Value']
plt.plot(x2, y2, label = "Brazil", color='blue', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=7)

x3 = forests_indonesia['Year']
y3 = forests_indonesia['Value']
plt.plot(x3, y3, label = "Indonesia", color='grey', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=7)

x4 = forests_india['Year']
y4 = forests_india['Value']
plt.plot(x4, y4, label = "India", color='green', linestyle='solid', marker='s',
     markerfacecolor='orange', markersize=7)

#axis

plt.xlabel('Year')
plt.ylabel('%')
plt.title('Percent of land covered by forest - developing nations')

plt.axis([1989, 2019, 0, 100])

plt.legend()
plt.show()
```



In [127]:

```
plt.figure(figsize=(10, 6))

x1 = forests_germany['Year']
y1 = forests_germany['Value']
plt.plot(x1, y1, label = "Germany", color='black', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=7)

x2 = forests_usa['Year']
y2 = forests_usa['Value']
plt.plot(x2, y2, label = "USA", color='red', linestyle='solid', marker='s',
     markerfacecolor='blue', markersize=7)
```

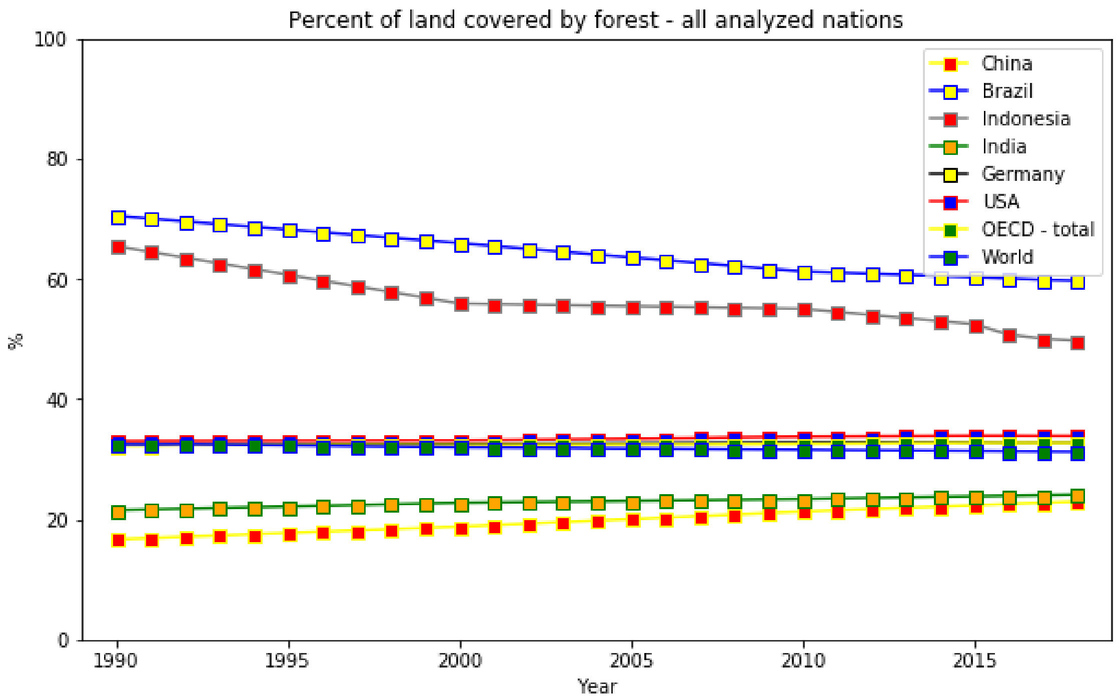
```
x3 = forests_OECD['Year']
y3 = forests_OECD['Value']
plt.plot(x3, y3, label = "OECD - total", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=7)

x4 = forests_india['Year']
y4 = forests_india['Value']
plt.plot(x4, y4, label = "World", color='blue', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=7)

plt.xlabel('Year')
plt.ylabel('%')
plt.title('Percent of land covered by forest - developed nations & world average')

plt.axis([1989, 2019, 0, 50])

plt.legend()
plt.show()
```



In [128]:

```
plt.figure(figsize=(10, 6))

x1 = forests_china['Year']
y1 = forests_china['Value']
plt.plot(x1, y1, label = "China", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=7)

x2 = forests_brazil['Year']
y2 = forests_brazil['Value']
plt.plot(x2, y2, label = "Brazil", color='blue', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=7)

x3 = forests_indonesia['Year']
y3 = forests_indonesia['Value']
plt.plot(x3, y3, label = "Indonesia", color='grey', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=7)

x4 = forests_india['Year']
y4 = forests_india['Value']
plt.plot(x4, y4, label = "India", color='green', linestyle='solid', marker='s',
     markerfacecolor='orange', markersize=7)

x5 = forests_germany['Year']
y5 = forests_germany['Value']
plt.plot(x5, y5, label = "Germany", color='black', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=7)
```

```
x6 = forests_usa['Year']
y6 = forests_usa['Value']
plt.plot(x6, y6, label = "USA", color='red', linestyle='solid', marker='s',
         markerfacecolor='blue', markersize=7)

x7 = forests_OECD['Year']
y7 = forests_OECD['Value']
plt.plot(x7, y7, label = "OECD - total", color='yellow', linestyle='solid', marker='s',
         markerfacecolor='green', markersize=7)

x8 = forests_world['Year']
y8 = forests_world['Value']
plt.plot(x8, y8, label = "World", color='blue', linestyle='solid', marker='s',
         markerfacecolor='green', markersize=7)

plt.xlabel('Year')
plt.ylabel('%')
plt.title('Percent of land covered by forest - all analyzed nations')

plt.axis([1989, 2019, 0, 100])

plt.legend()
plt.show()
```



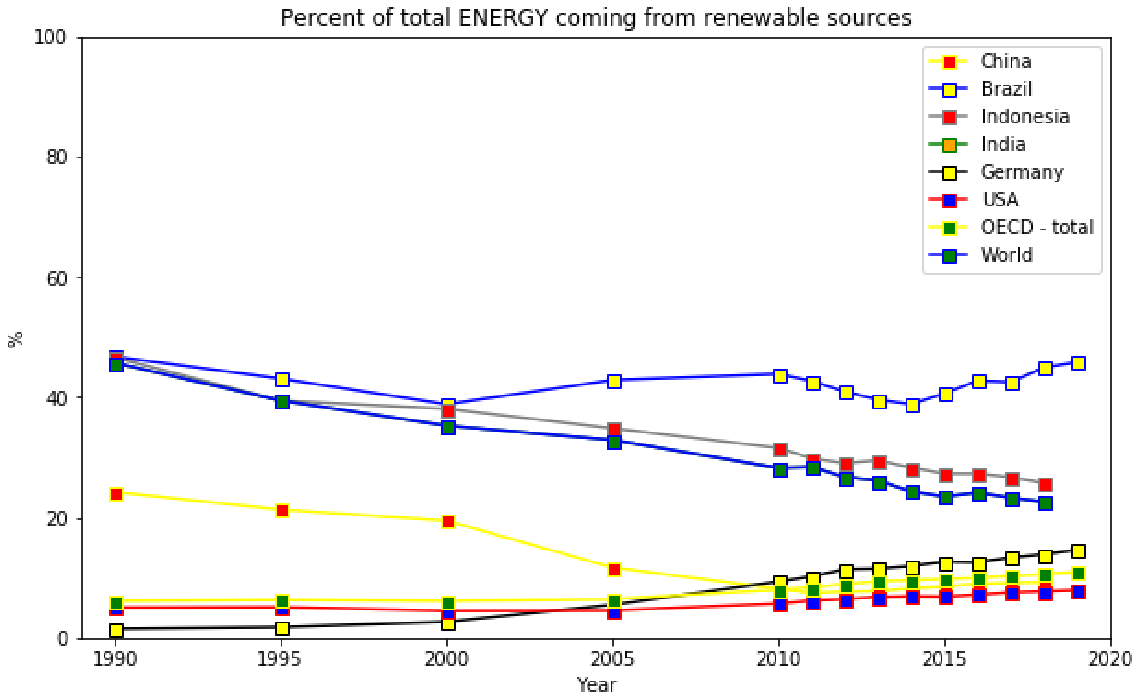
2. Renewable Energy and Electricity

The following two graphs show the trends for renewable energy and electricity as a percentage of the total energy and electricity.

In [129]:

```
plt.figure(figsize=(10, 6))

x1 = ren_energy_china['Year']
y1 = ren_energy_china['Value']
plt.plot(x1, y1, label = "China", color='yellow', linestyle='solid', marker='s',
         markerfacecolor='red', markersize=7)

x2 = ren_energy_brazil['Year']
y2 = ren_energy_brazil['Value']
plt.plot(x2, y2, label = "Brazil", color='blue', linestyle='solid', marker='s',
         markerfacecolor='yellow', markersize=7)

x3 = ren_energy_indonesia['Year']
y3 = ren_energy_indonesia['Value']
```

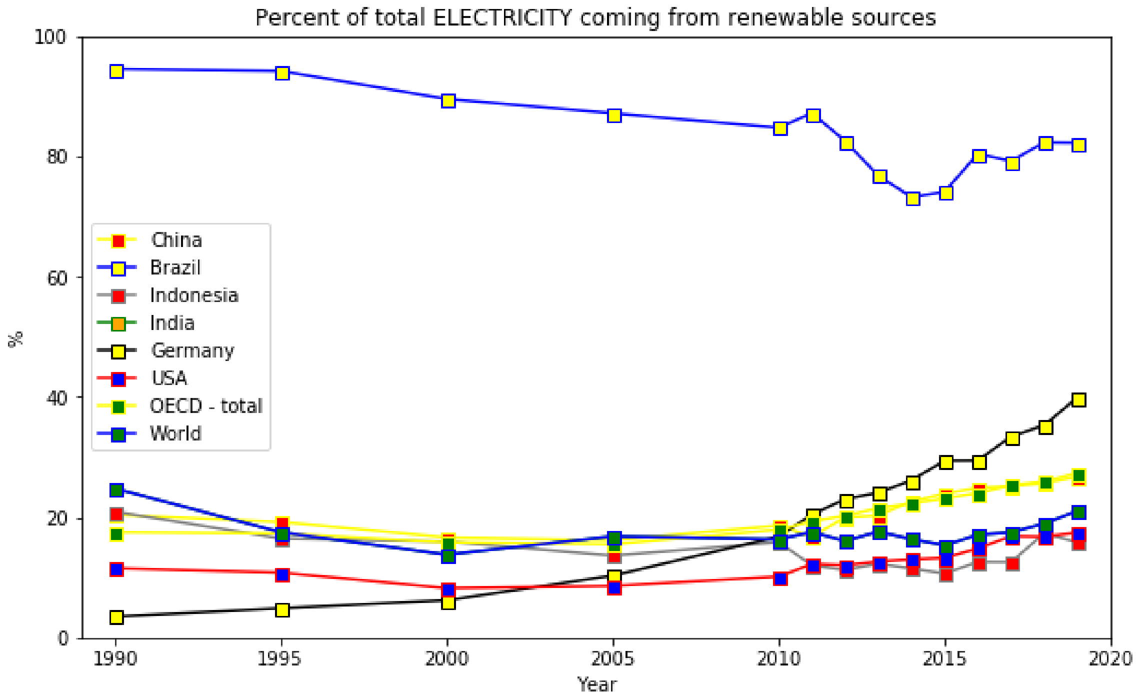
```
plt.plot(x3, y3, label = "Indonesia", color='grey', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=7)

x4 = ren_energy_india['Year']
y4 = ren_energy_india['Value']
plt.plot(x4, y4, label = "India", color='green', linestyle='solid', marker='s',
     markerfacecolor='orange', markersize=7)

x5 = ren_energy_germany['Year']
y5 = ren_energy_germany['Value']
plt.plot(x5, y5, label = "Germany", color='black', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=7)

x6 = ren_energy_usa['Year']
y6 = ren_energy_usa['Value']
plt.plot(x6, y6, label = "USA", color='red', linestyle='solid', marker='s',
     markerfacecolor='blue', markersize=7)

x7 = ren_energy_OECD['Year']
y7 = ren_energy_OECD['Value']
plt.plot(x7, y7, label = "OECD - total", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=7)

x8 = ren_energy_india['Year']
y8 = ren_energy_india['Value']
plt.plot(x8, y8, label = "World", color='blue', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=7)

plt.xlabel('Year')
plt.ylabel('%')
plt.title('Percent of total ENERGY coming from renewable sources')

plt.axis([1989, 2020, 0, 100])

plt.legend()
plt.show()
```



In [130]:

```
plt.figure(figsize=(10, 6))

x1 = ren_electricity_china['Year']
y1 = ren_electricity_china['Value']
plt.plot(x1, y1, label = "China", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=7)

x2 = ren_electricity_brazil['Year']
```

```
y2 = ren_electricity_brazil['Value']
plt.plot(x2, y2, label = "Brazil", color='blue', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=7)

x3 = ren_electricity_indonesia['Year']
y3 = ren_electricity_indonesia['Value']
plt.plot(x3, y3, label = "Indonesia", color='grey', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=7)

x4 = ren_electricity_india['Year']
y4 = ren_electricity_india['Value']
plt.plot(x4, y4, label = "India", color='green', linestyle='solid', marker='s',
     markerfacecolor='orange', markersize=7)

x5 = ren_electricity_germany['Year']
y5 = ren_electricity_germany['Value']
plt.plot(x5, y5, label = "Germany", color='black', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=7)

x6 = ren_electricity_usa['Year']
y6 = ren_electricity_usa['Value']
plt.plot(x6, y6, label = "USA", color='red', linestyle='solid', marker='s',
     markerfacecolor='blue', markersize=7)

x7 = ren_electricity_OECD['Year']
y7 = ren_electricity_OECD['Value']
plt.plot(x7, y7, label = "OECD - total", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=7)

x8 = ren_electricity_india['Year']
y8 = ren_electricity_india['Value']
plt.plot(x8, y8, label = "World", color='blue', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=7)

plt.xlabel('Year')
plt.ylabel('%')
plt.title('Percent of total ELECTRICITY coming from renewable sources')

plt.axis([1989, 2020, 0, 100])

plt.legend()
plt.show()
```



Production-based vs. Demand-based (relevant for 3. and 4.)

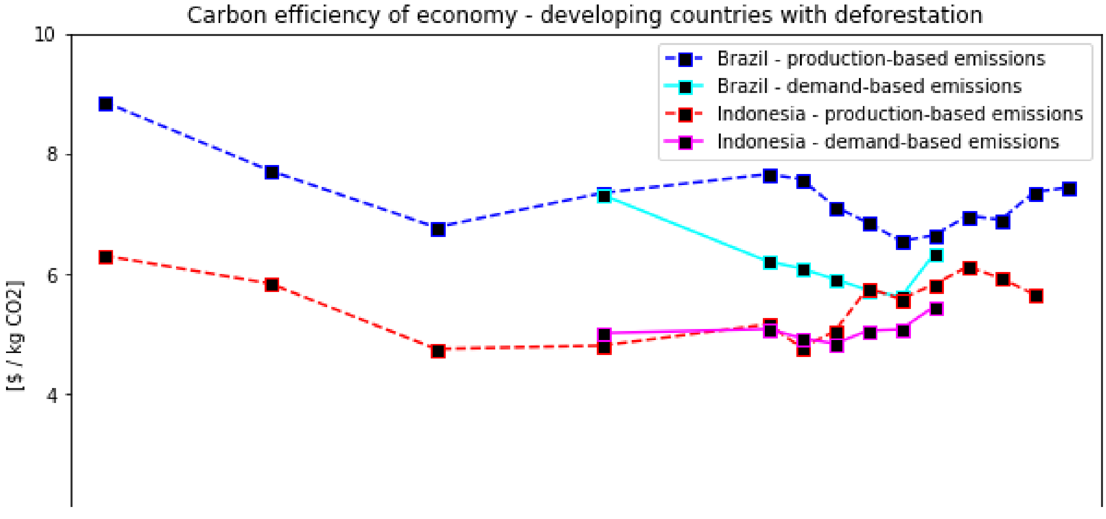
Production-based emissions describe GHGs emitted within a country. **Demand-based emissions** included GHGs emitted in other countries for products, systems etc. consumed in that country. As emissions from advanced, industrialized nations (including members of the OECD) have been stable and even in decline, emissions in developing economies have rapidly increased. Part of this increase in emissions is attributable to the shifting of production sites from richer countries with higher (labor) costs to poorer countries with lower (labor) costs. The lifestyle of people in rich countries has thus partly relied on GHGs emitted in foreign countries. The difference between production-based and demand-based emissions show to what extend this is the case. **Demand-based emissions** are thus a more honest reflection of the environmental impact of different populations.

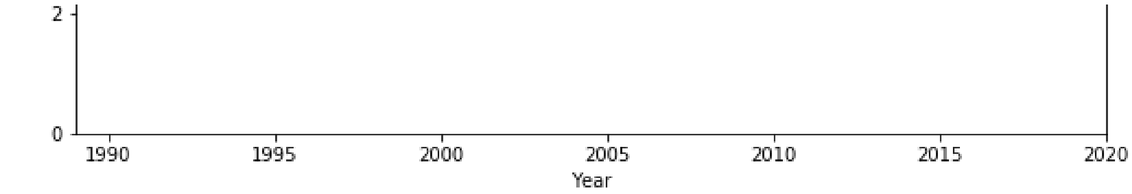
3. GDP per CO2 - a look at the carbon efficiency of an economy

More efficient technologies as well as more renewable energy and electricity sources have made economies more carbon-efficient. The amount of wealth generated per unit CO2 should increase over time. These statistic are divided into three groups - Brazil & Indonesia (developing countries with deforestation), India & China (developing countries withou aforestation), Germany & USA & OECD (developed countries).

In [131]:

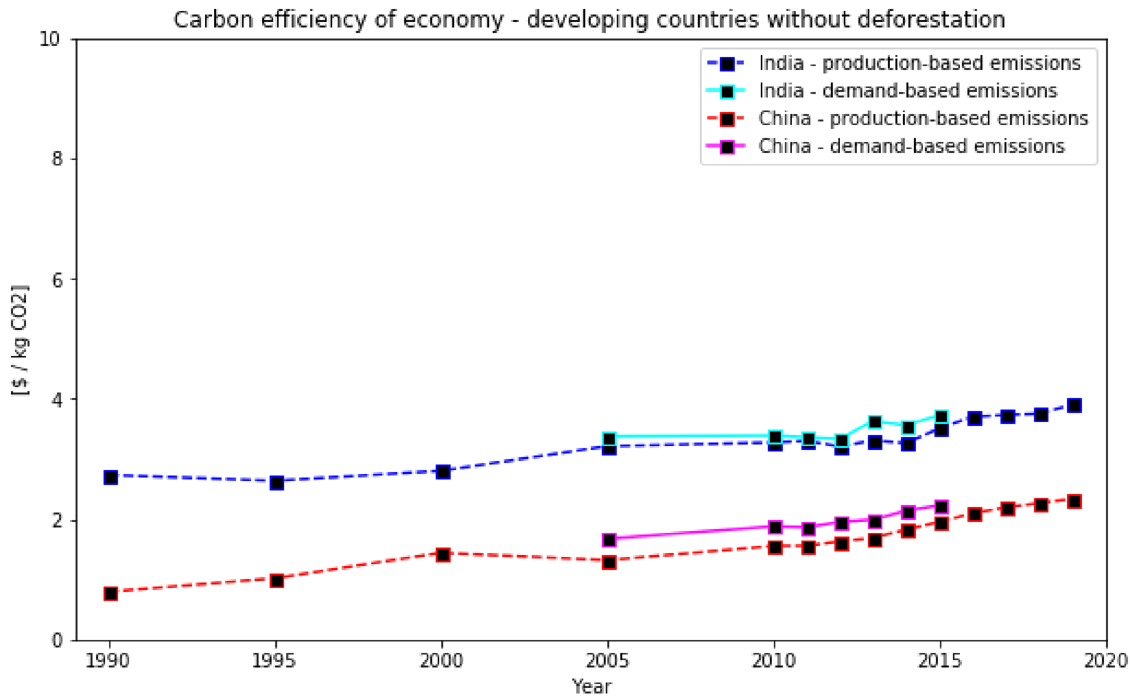
```
plt.figure(figsize=(10, 6))

x1 = prod_gdpperco2_brazil['Year']
y1 = prod_gdpperco2_brazil['Value']
plt.plot(x1, y1, label = "Brazil - production-based emissions", color='blue', linestyle=
'dashed', marker='s',
     markerfacecolor='black', markersize=7)

x2 = dem_gdpperco2_brazil['Year']
y2 = dem_gdpperco2_brazil['Value']
plt.plot(x2, y2, label = "Brazil - demand-based emissions", color='cyan', linestyle='sol
id', marker='s',
     markerfacecolor='black', markersize=7)

x3 = prod_gdpperco2_indonesia['Year']
y3 = prod_gdpperco2_indonesia['Value']
plt.plot(x3, y3, label = "Indonesia - production-based emissions", color='red', linestyl
e='dashed', marker='s',
     markerfacecolor='black', markersize=7)

x4 = dem_gdpperco2_indonesia['Year']
y4 = dem_gdpperco2_indonesia['Value']
plt.plot(x4, y4, label = "Indonesia - demand-based emissions", color='magenta', linestyl
e='solid', marker='s',
     markerfacecolor='black', markersize=7)


plt.xlabel('Year')
plt.ylabel('[$ / kg CO2]')
plt.title('Carbon efficiency of economy - developing countries with deforestation')

plt.axis([1989, 2020, 0, 10])

plt.legend()
plt.show()
```





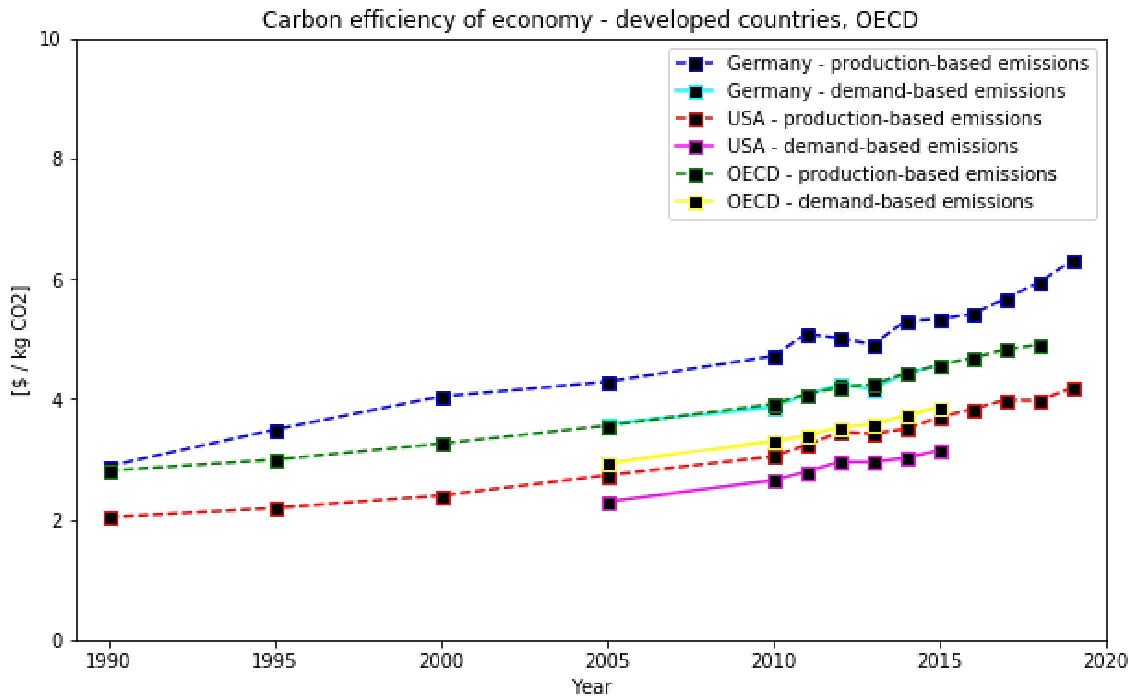
In [132]:

```
plt.figure(figsize=(10, 6))

x1 = prod_gdpperco2_india['Year']
y1 = prod_gdpperco2_india['Value']
plt.plot(x1, y1, label = "India - production-based emissions", color='blue', linestyle='dashed', marker='s',
     markerfacecolor='black', markersize=7)

x2 = dem_gdpperco2_india['Year']
y2 = dem_gdpperco2_india['Value']
plt.plot(x2, y2, label = "India - demand-based emissions", color='cyan', linestyle='solid', marker='s',
     markerfacecolor='black', markersize=7)

x3 = prod_gdpperco2_china['Year']
y3 = prod_gdpperco2_china['Value']
plt.plot(x3, y3, label = "China - production-based emissions", color='red', linestyle='dashed', marker='s',
     markerfacecolor='black', markersize=7)

x4 = dem_gdpperco2_china['Year']
y4 = dem_gdpperco2_china['Value']
plt.plot(x4, y4, label = "China - demand-based emissions", color='magenta', linestyle='solid', marker='s',
     markerfacecolor='black', markersize=7)


plt.xlabel('Year')
plt.ylabel('[$ / kg CO2]')
plt.title('Carbon efficiency of economy - developing countries without deforestation')

plt.axis([1989, 2020, 0, 10])

plt.legend()
plt.show()
```



In [133]:

```
plt.figure(figsize=(10, 6))

x1 = prod_gdpperco2_germany['Year']
y1 = prod_gdpperco2_germany['Value']
plt.plot(x1, y1, label = "Germany - production-based emissions", color='blue', linestyle
='dashed', marker='s',
     markerfacecolor='black', markersize=7)

x2 = dem_gdpperco2_germany['Year']
y2 = dem_gdpperco2_germany['Value']
plt.plot(x2, y2, label = "Germany - demand-based emissions", color='cyan', linestyle='so
lid', marker='s',
     markerfacecolor='black', markersize=7)

x3 = prod_gdpperco2_usa['Year']
y3 = prod_gdpperco2_usa['Value']
plt.plot(x3, y3, label = "USA - production-based emissions", color='red', linestyle='das
hed', marker='s',
     markerfacecolor='black', markersize=7)

x4 = dem_gdpperco2_usa['Year']
y4 = dem_gdpperco2_usa['Value']
plt.plot(x4, y4, label = "USA - demand-based emissions", color='magenta', linestyle='sol
id', marker='s',
     markerfacecolor='black', markersize=7)

x5 = prod_gdpperco2_OECD['Year']
y5 = prod_gdpperco2_OECD['Value']
plt.plot(x5, y5, label = "OECD - production-based emissions", color='green', linestyle='
dashed', marker='s',
     markerfacecolor='black', markersize=7)

x6 = dem_gdpperco2_OECD['Year']
y6 = dem_gdpperco2_OECD['Value']
plt.plot(x6, y6, label = "OECD - demand-based emissions", color='yellow', linestyle='sol
id', marker='s',
     markerfacecolor='black', markersize=7)


plt.xlabel('Year')
plt.ylabel('[$ / kg CO2]')
plt.title('Carbon efficiency of economy - developed countries, OECD')

plt.axis([1989, 2020, 0, 10])

plt.legend()
plt.show()
```



In [134]:

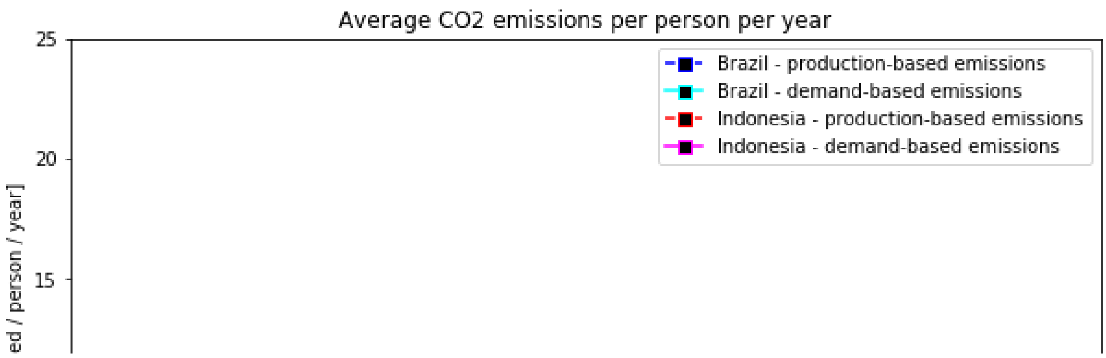
```
prod_gdpperco2 = green_growth[green_growth['Variable'] == 'Production-based CO2 producti
vity, GDP per unit of energy-related CO2 emissions']
prod_co2percap = green_growth[green_growth['Variable'] == 'Production-based CO2 intensit
y, energy-related CO2 per capita']
dem_gdpperco2 = green_growth[green_growth['Variable'] == 'Demand-based CO2 productivity,
GDP per unit of energy-related CO2 emissions']
dem_co2percap = green_growth[green_growth['Variable'] == 'Demand-based CO2 intensity, ene
rgy-related CO2 per capita']
ren_energy = green_growth[green_growth['Variable'] == 'Renewable energy supply, % total
energy supply']
ren_electricity = green_growth[green_growth['Variable'] == 'Renewable electricity, % tot
al electricity generation']
```

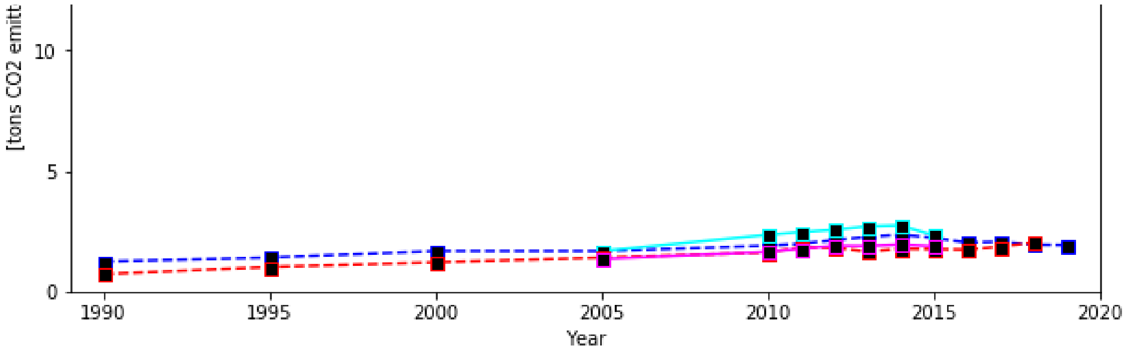
4. CO2 per capita -

Disregarding countries that have historically contributed most to climate change, CO2 per capita is the fairest method we have of analyzing who is currently contributing most the global warming. It is particularly interesting to to look at the difference between production-based emissions and demand-based emissions.

In [135]:

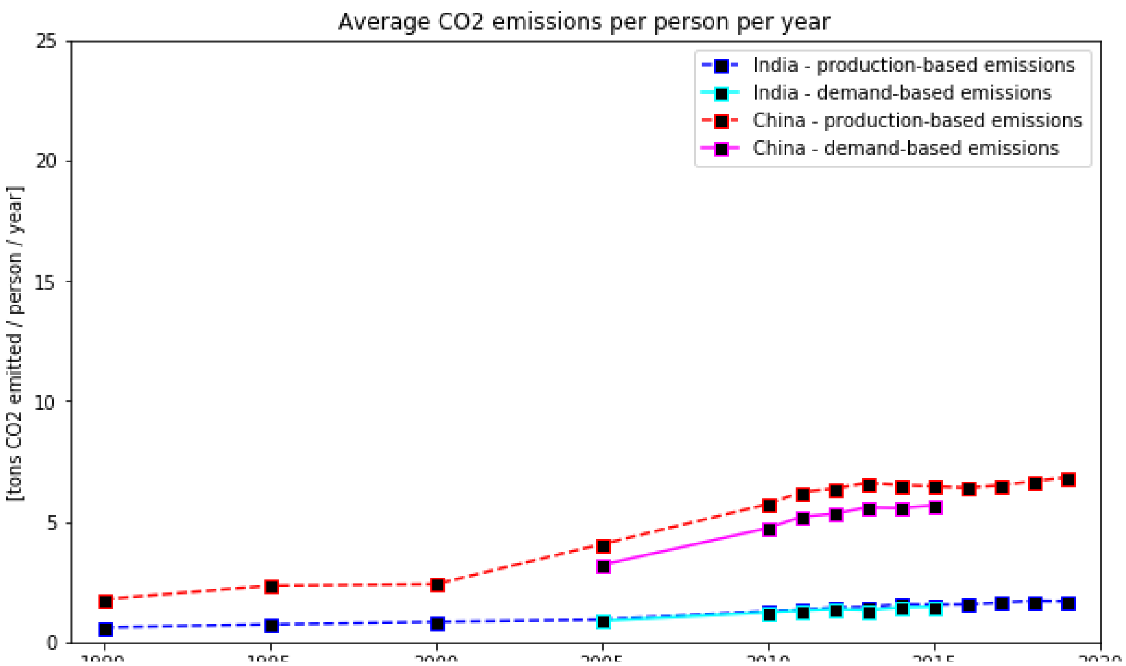
```
plt.figure(figsize=(10, 6))

x1 = prod_co2percap_brazil['Year']
y1 = prod_co2percap_brazil['Value']
plt.plot(x1, y1, label = "Brazil - production-based emissions", color='blue', linestyle=
'dashed', marker='s',
     markerfacecolor='black', markersize=7)

x2 = dem_co2percap_brazil['Year']
y2 = dem_co2percap_brazil['Value']
plt.plot(x2, y2, label = "Brazil - demand-based emissions", color='cyan', linestyle='sol
id', marker='s',
     markerfacecolor='black', markersize=7)

x3 = prod_co2percap_indonesia['Year']
y3 = prod_co2percap_indonesia['Value']
plt.plot(x3, y3, label = "Indonesia - production-based emissions", color='red', linestyl
e='dashed', marker='s',
     markerfacecolor='black', markersize=7)

x4 = dem_co2percap_indonesia['Year']
y4 = dem_co2percap_indonesia['Value']
plt.plot(x4, y4, label = "Indonesia - demand-based emissions", color='magenta', linestyl
e='solid', marker='s',
     markerfacecolor='black', markersize=7)


plt.xlabel('Year')
plt.ylabel('[tons CO2 emitted / person / year]')
plt.title('Average CO2 emissions per person per year')

plt.axis([1989, 2020, 0, 25])

plt.legend()
plt.show()
```

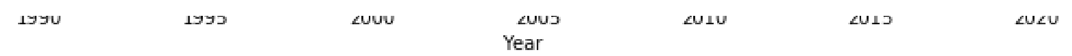




In [136]:

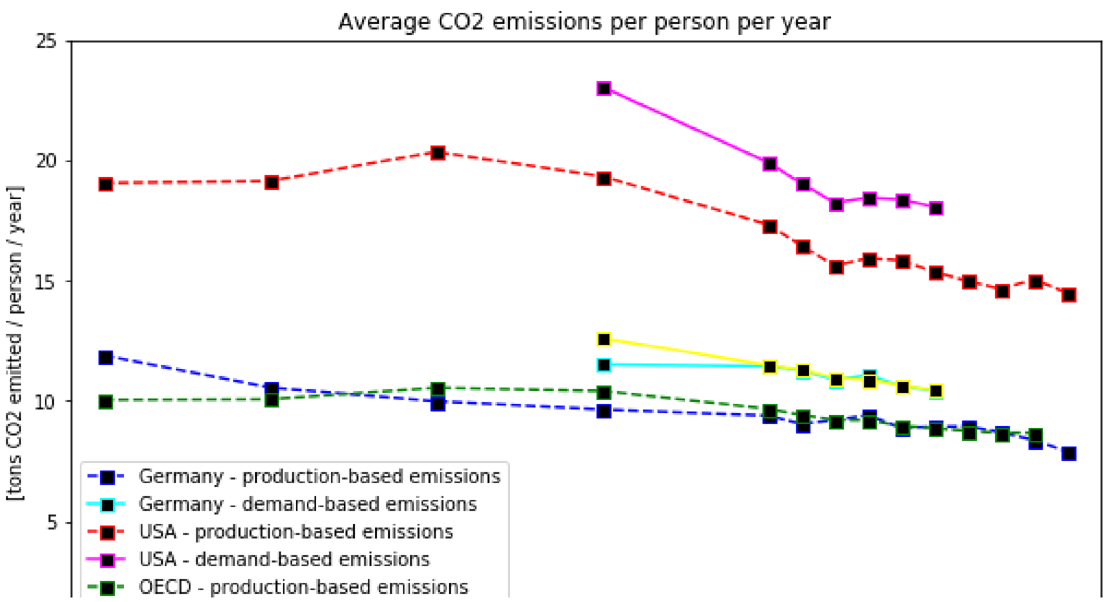
```
plt.figure(figsize=(10, 6))

x1 = prod_co2percap_india['Year']
y1 = prod_co2percap_india['Value']
plt.plot(x1, y1, label = "India - production-based emissions", color='blue', linestyle='
dashed', marker='s',
     markerfacecolor='black', markersize=7)

x2 = dem_co2percap_india['Year']
y2 = dem_co2percap_india['Value']
plt.plot(x2, y2, label = "India - demand-based emissions", color='cyan', linestyle='soli
d', marker='s',
     markerfacecolor='black', markersize=7)

x3 = prod_co2percap_china['Year']
y3 = prod_co2percap_china['Value']
plt.plot(x3, y3, label = "China - production-based emissions", color='red', linestyle='d
ashed', marker='s',
     markerfacecolor='black', markersize=7)

x4 = dem_co2percap_china['Year']
y4 = dem_co2percap_china['Value']
plt.plot(x4, y4, label = "China - demand-based emissions", color='magenta', linestyle='s
olid', marker='s',
     markerfacecolor='black', markersize=7)


plt.xlabel('Year')
plt.ylabel('[tons CO2 emitted / person / year]')
plt.title('Average CO2 emissions per person per year')

plt.axis([1989, 2020, 0, 25])

plt.legend()
plt.show()
```

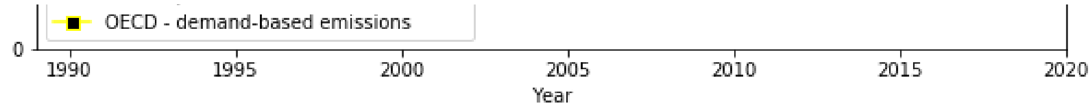




In [137]:

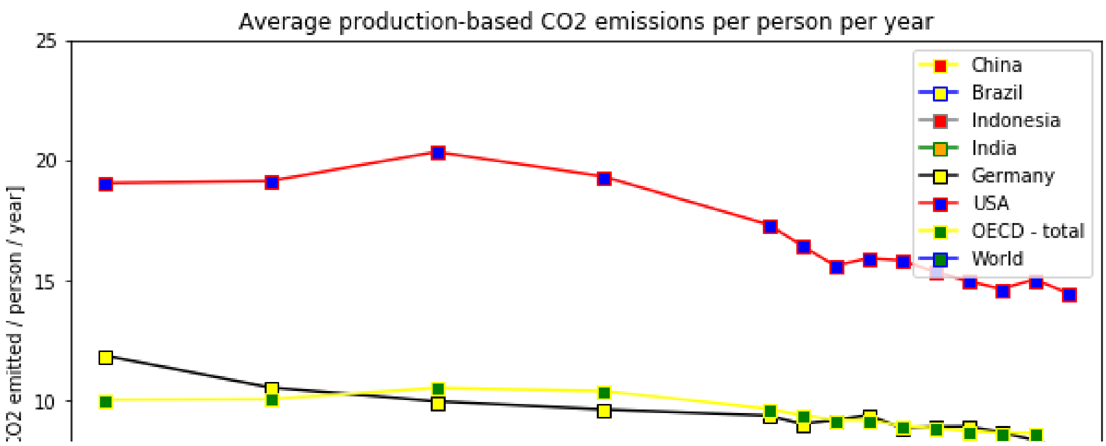
```python
plt.figure(figsize=(10, 6))

x1 = prod_co2percap_germany['Year']
y1 = prod_co2percap_germany['Value']
plt.plot(x1, y1, label = "Germany - production-based emissions", color='blue', linestyle
='dashed', marker='s',
     markerfacecolor='black', markersize=7)

x2 = dem_co2percap_germany['Year']
y2 = dem_co2percap_germany['Value']
plt.plot(x2, y2, label = "Germany - demand-based emissions", color='cyan', linestyle='so
lid', marker='s',
     markerfacecolor='black', markersize=7)

x3 = prod_co2percap_usa['Year']
y3 = prod_co2percap_usa['Value']
plt.plot(x3, y3, label = "USA - production-based emissions", color='red', linestyle='das
hed', marker='s',
     markerfacecolor='black', markersize=7)

x4 = dem_co2percap_usa['Year']
y4 = dem_co2percap_usa['Value']
plt.plot(x4, y4, label = "USA - demand-based emissions", color='magenta', linestyle='sol
id', marker='s',
     markerfacecolor='black', markersize=7)

x5 = prod_co2percap_OECD['Year']
y5 = prod_co2percap_OECD['Value']
plt.plot(x5, y5, label = "OECD - production-based emissions", color='green', linestyle='
dashed', marker='s',
     markerfacecolor='black', markersize=7)

x6 = dem_co2percap_OECD['Year']
y6 = dem_co2percap_OECD['Value']
plt.plot(x6, y6, label = "OECD - demand-based emissions", color='yellow', linestyle='sol
id', marker='s',
     markerfacecolor='black', markersize=7)


plt.xlabel('Year')
plt.ylabel('[tons CO2 emitted / person / year]')
plt.title('Average CO2 emissions per person per year')

plt.axis([1989, 2020, 0, 25])

plt.legend()
plt.show()
```

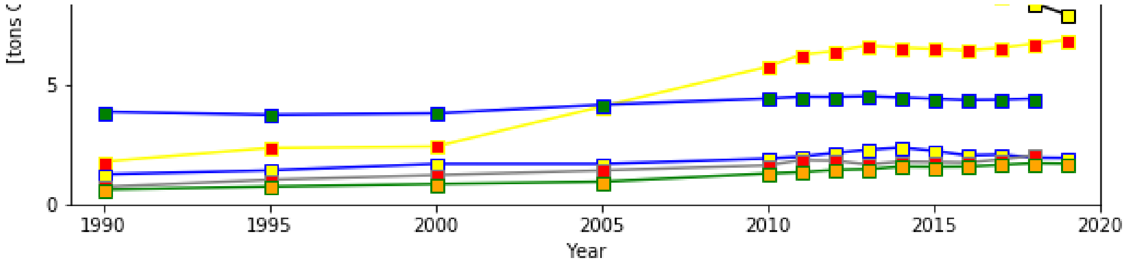




In [138]:

```
plt.figure(figsize=(10, 6))

x1 = prod_co2percap_china['Year']
y1 = prod_co2percap_china['Value']
plt.plot(x1, y1, label = "China", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=7)

x2 = prod_co2percap_brazil['Year']
y2 = prod_co2percap_brazil['Value']
plt.plot(x2, y2, label = "Brazil", color='blue', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=7)

x3 = prod_co2percap_indonesia['Year']
y3 = prod_co2percap_indonesia['Value']
plt.plot(x3, y3, label = "Indonesia", color='grey', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=7)

x4 = prod_co2percap_india['Year']
y4 = prod_co2percap_india['Value']
plt.plot(x4, y4, label = "India", color='green', linestyle='solid', marker='s',
     markerfacecolor='orange', markersize=7)

x5 = prod_co2percap_germany['Year']
y5 = prod_co2percap_germany['Value']
plt.plot(x5, y5, label = "Germany", color='black', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=7)

x6 = prod_co2percap_usa['Year']
y6 = prod_co2percap_usa['Value']
plt.plot(x6, y6, label = "USA", color='red', linestyle='solid', marker='s',
     markerfacecolor='blue', markersize=7)

x7 = prod_co2percap_OECD['Year']
y7 = prod_co2percap_OECD['Value']
plt.plot(x7, y7, label = "OECD - total", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=7)

x8 = prod_co2percap_world['Year']
y8 = prod_co2percap_world['Value']
plt.plot(x8, y8, label = "World", color='blue', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=7)

plt.xlabel('Year')
plt.ylabel('[tons CO2 emitted / person / year]')
plt.title('Average production-based CO2 emissions per person per year')

plt.axis([1989, 2020, 0, 25])

plt.legend()
plt.show()
```



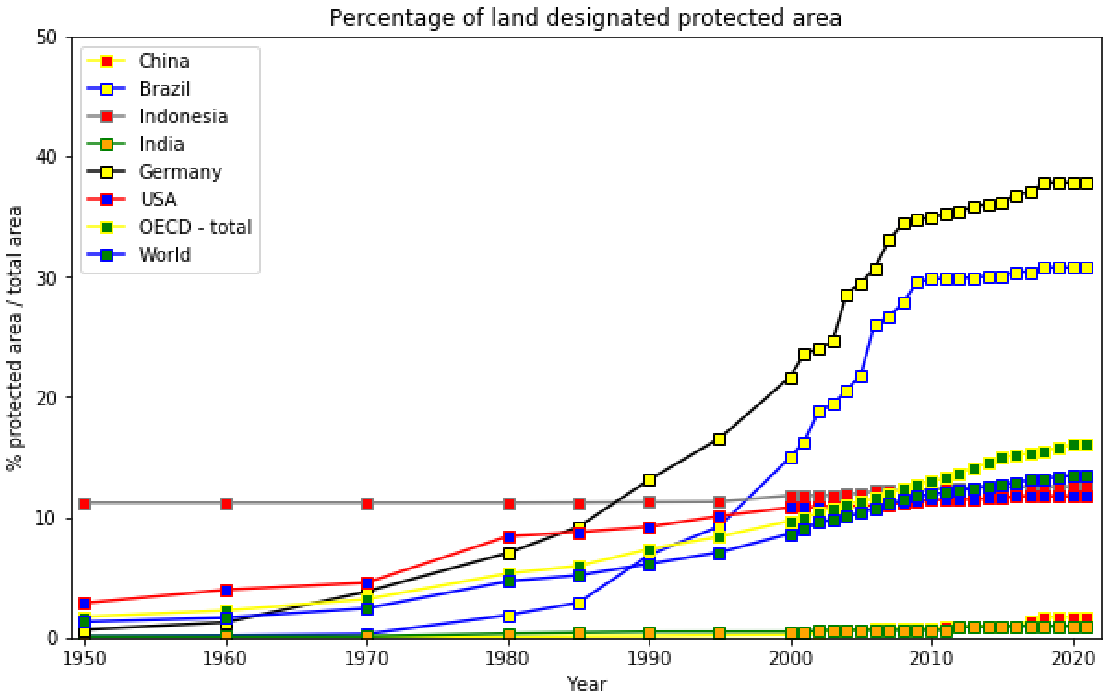


5. Friends of nature - areas designated protected areas

Although data such as CO2 emissions per capita and forest area are better indicators of actual developments of attitudes towards climate change, it is also interesting to look at the percentage of area deemed protected areas in various parts of the world. The ore land we protect, leave alone, and allow to rewild, the better for our fight against climate change.

In [141]:

```
plt.figure(figsize=(10, 6))

x1 = protected_areas_china['Year']
y1 = protected_areas_china['Value']
plt.plot(x1, y1, label = "China", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=6)

x2 = protected_areas_brazil['Year']
y2 = protected_areas_brazil['Value']
plt.plot(x2, y2, label = "Brazil", color='blue', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=6)

x3 = protected_areas_indonesia['Year']
y3 = protected_areas_indonesia['Value']
plt.plot(x3, y3, label = "Indonesia", color='grey', linestyle='solid', marker='s',
     markerfacecolor='red', markersize=6)

x4 = protected_areas_india['Year']
y4 = protected_areas_india['Value']
plt.plot(x4, y4, label = "India", color='green', linestyle='solid', marker='s',
     markerfacecolor='orange', markersize=6)

x5 = protected_areas_germany['Year']
y5 = protected_areas_germany['Value']
plt.plot(x5, y5, label = "Germany", color='black', linestyle='solid', marker='s',
     markerfacecolor='yellow', markersize=6)

x6 = protected_areas_usa['Year']
y6 = protected_areas_usa['Value']
plt.plot(x6, y6, label = "USA", color='red', linestyle='solid', marker='s',
     markerfacecolor='blue', markersize=6)

x7 = protected_areas_OECD['Year']
y7 = protected_areas_OECD['Value']
plt.plot(x7, y7, label = "OECD - total", color='yellow', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=6)

x8 = protected_areas_world['Year']
y8 = protected_areas_world['Value']
plt.plot(x8, y8, label = "World", color='blue', linestyle='solid', marker='s',
     markerfacecolor='green', markersize=6)

plt.xlabel('Year')
plt.ylabel('% protected area / total area')
plt.title('Percentage of land designated protected area')

plt.axis([1949, 2022, 0, 50])

plt.legend()
plt.show()
```



Limitation: these results do not account for the fact that even though forest areas in rich countries have recently increased and more land has been designated as nature reserves, the quality of life in OECD countries is partly reliant on imports from the countries doing the dirty work. To guage the extent to which this happens, further research is needed.

Needless to say, we need everyone on board in order to combat climate change.

Hypocrisy in Responsibility for Climate Change?

Anton Baker
From Berlin, Germany

Abstract

This research looks at datasets provided by the OECD on forest coverage, carbon efficiency, carbon emissions per capita, as well as the percentage of energy and electricity that come from renewable sources. It analyzes how these statistical parameters have developed over time, comparing poorer countries Brazil, Indonesia, China, and India with the richer nations Germany and the United States as well with an OECD and world average, considering both trends as well as absolute figures. Brazil and Indonesia have received criticism due to shocking rates of deforestation for both environmental and conservationist reasons. To what extent is this criticism justified and to what extent is it fair? This research concludes that although the criticism is justified, it is often coming from nations that have been industrialized for a much longer period of time and thus bare the brunt of the responsibility for climate change, both historically and currently.

Motivation

One of the things Brazil's president Jair Bolsonaro is (rightly) criticized for is his relaxed attitude towards deforestation of rainforests, which is also a problem in countries like Indonesia.

Richer (OECD) countries have rightly condemned this, citing both conservationist and environmental reasons for why the destruction of rain forests must be stopped. One of the most potent tools we as a species have in combating climate change is rewilding large areas of land and allowing forests to regenerate, thus capturing more of the atmospheric CO_2. Globally, it does not matter where rampant deforestation takes place, it affects us all.

As a student of 'Renewable Energy Engineering' at the Technical University of Berlin, I want to investigate whether or not the accusations towards Brazil and Indonesia hold any merit and more broadly, whether the criticism is fair.

This data science python project will look at excerpts of OECD data in an attempt to find a (short) answer to this question.

What is the OECD?

The **O**rganisation for **E**conomic **C**o-operation and **D**evelopment - an intergovernmental economic organisation comprising 38 comparably wealthy nations (making up 62.2% of global nominal GDP in 2017). The organization describes itself as committed to democratic values and open markets and helps coordinate policy and exchange ideas between its members.

The following are members of the OECD: Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

Source: Wikipedia

Dataset(s)

Four individual datasets were used for this research, all of which are from the OECD statistics webpage (link at the bottom).

1. The dataset named ‘forests’ provided data to this research on the percentage of land covered by forest over time.
2. ‘green_growth’ provided data on the carbon efficiency of economies, the CO_2 emissions per capita per year, and the percentages of energy and electricity coming from renewable sources.
3. ‘Ghg_emissions’ provided data on the total emissions with and without emissions caused or negated by land use, land-use change, and forestry. After analyzing it, it was not included in the final presentation.
4. ‘Protected_areas’ provided data on the percentage of land deemed a ‘protected area’.

Most of the data available was data between 1990 and 2020, with two exceptions. OECD statistics webpage: https://stats.oecd.org/

Data Preparation and Cleaning

Since the data on the OECD website is already wonderfully organized, the filtering of useful information from the datasets starts before they are downloaded.

To prepare the data for analysis, many smaller data frames were created, each only containing the country and variable desired later. The data frames did not need any cleaning up.

The only problems encountered were with the data from the ‘ghg_emissions’ dataset. It was realized that there was not enough data for the countries selected for analysis to compare the total emissions with and without land use, land-use change, and forestry (LULUCF). The data for emissions without LULUCF was reliably available, the data for emissions with LULUCF was not.

Research Question(s)

To what extent are rich nations justified in criticizing developing nations for deforestation for economic gain? Are richer countries doing enough to combat climate change?

Methods

This research looks at several datasets and parameters within those datasets to compare forest coverage [%], carbon efficiency of economies [$ / kg CO_2], emissions per capita [tons CO_2 / person / year], renewable energy [%], renewable electricity [%], and areas designated as protected areas [%] between different countries. Both trends and absolute values are analyzed using simple line graphs.

The methods used are:

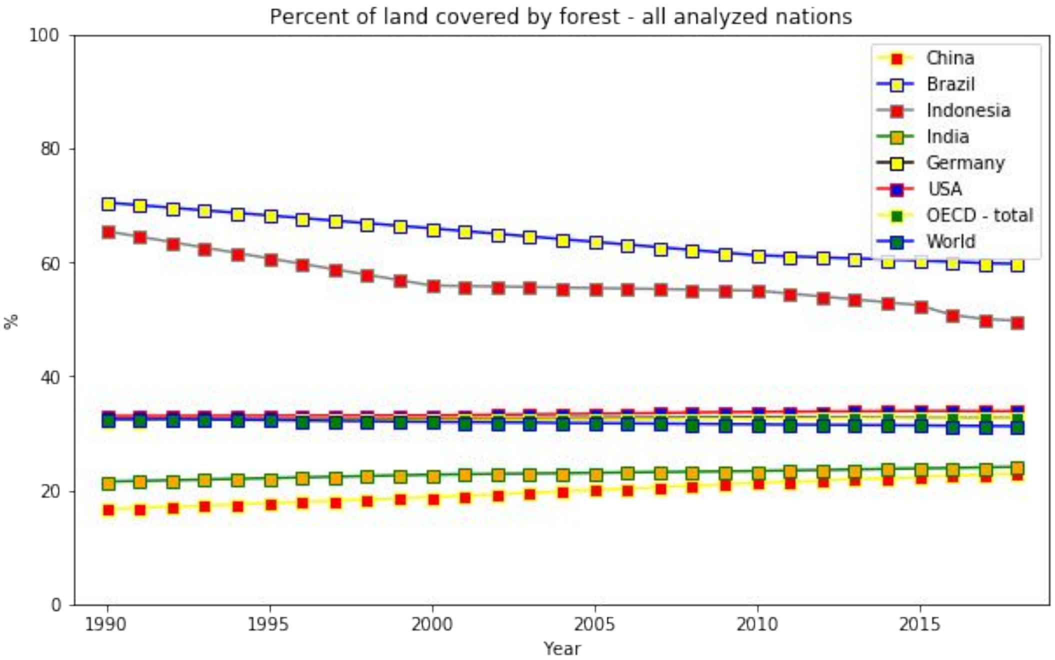
- Visualization
- Description of Statistics

By not only considering forest coverage as the only relevant parameter, this research hopes to paint a more differentiated picture about how different nations are falling short in their attempts to combat climate change.

Change in Forest Coverage

As seen in the graph, the criticism towards Indonesia and Brazil are justified. Both countries have lost significant amount of forest coverage in the past 30 years, although both countries started out (in 1990) with the two highest percentages of forest.

The forest coverage of Germany, the US, as well as the OECD have remained constant, whereas India, China, and the world as a whole have seen slow but steady increases. Deforestation in countries like Germany presumably happened long before 1990.

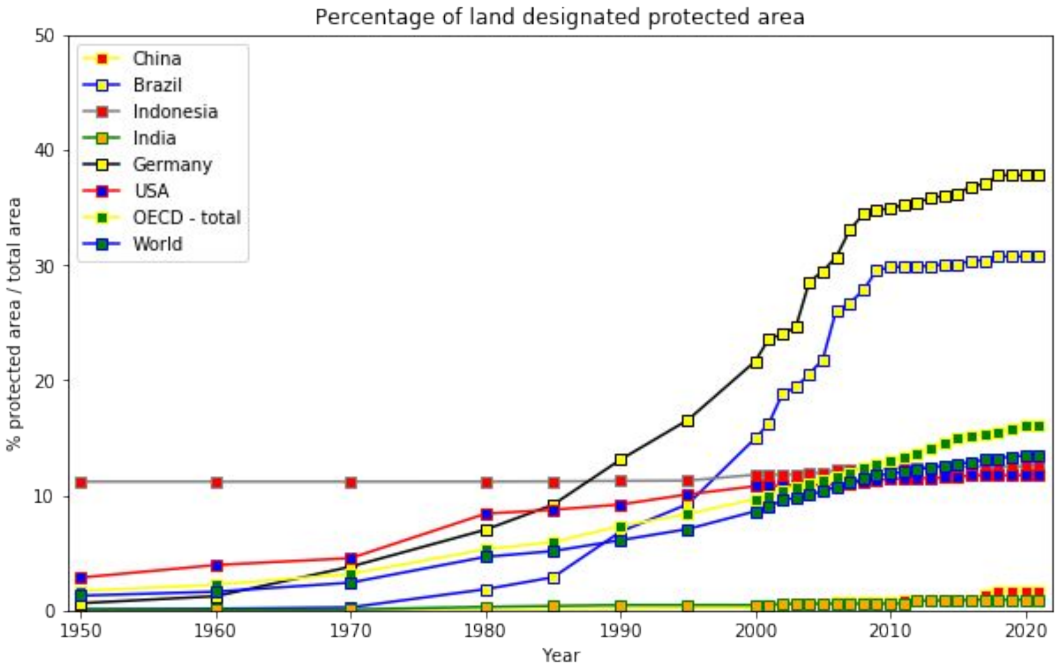


Protected Areas

One way of making sure forest areas are maintained and nature is protected is by designating areas as ‘protected area’ such as nature reserves, national parks, etc.

In this regard, the world is making progress.

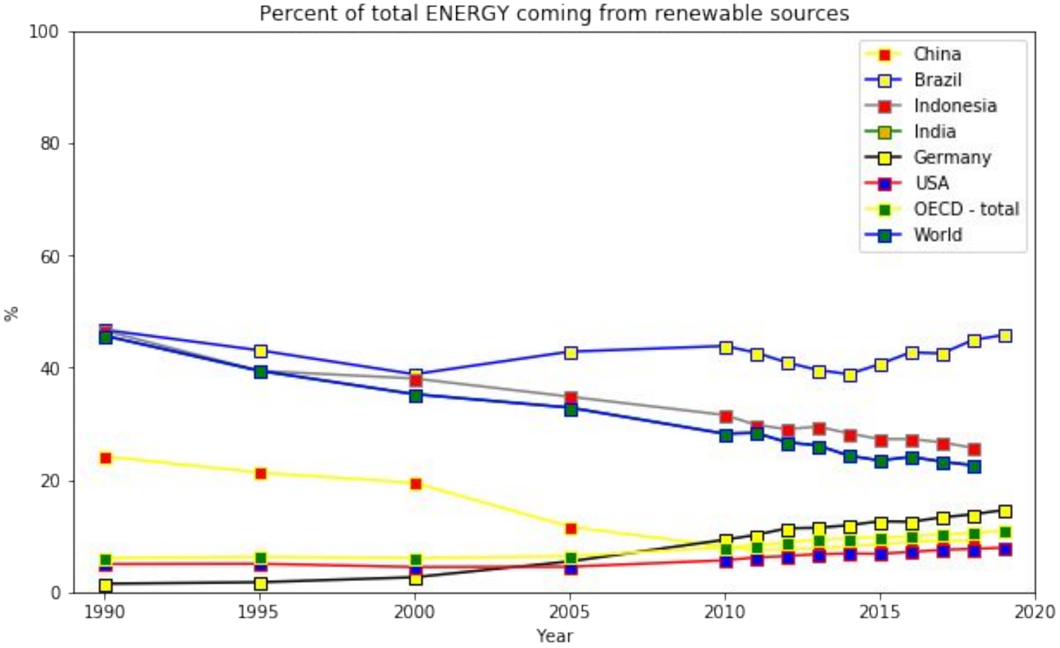
However, a ‘protected area’ designation is only of any use if it is enforced. As Brazil and Indonesia show, having more protected areas does not prevent frightening amounts of deforestation.



Percentage Renewable Energy

Although all values are far below what we would want them to be, we can see that Brazil and Indonesia get the highest percentage of their energy from renewable sources (although Indonesia’s trend is not good). They are both above the world average and well above the rich nations. The overall trend of the world is alarming and shows how much work still needs to be done.

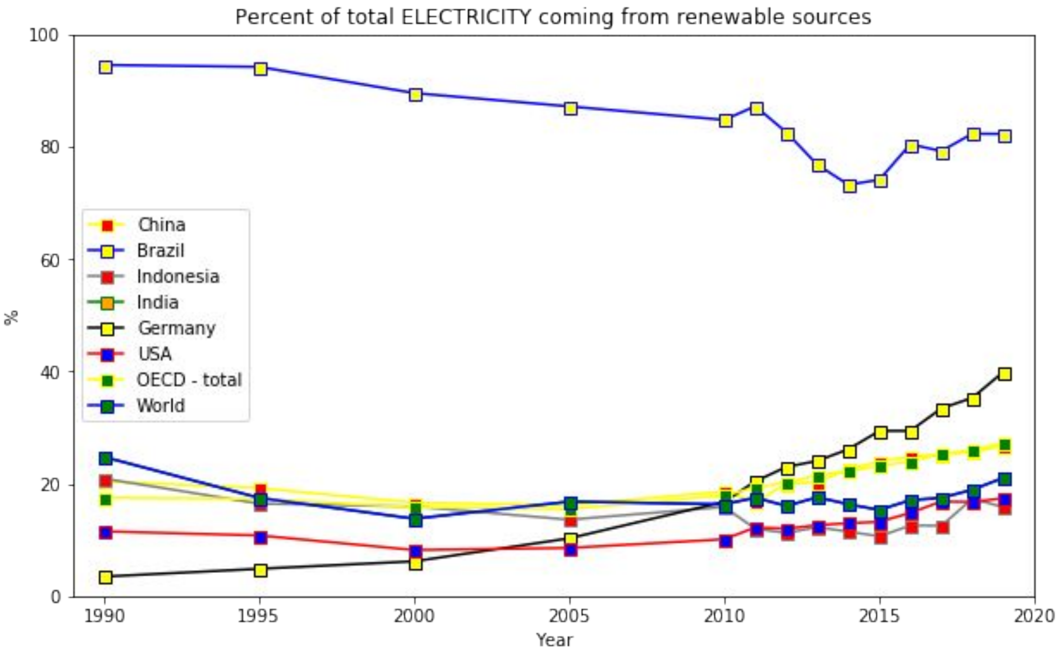
Note: energy includes but is not limited to electricity in the grid.



Percentage Renewable Electricity

Carried mainly by hydroelectric power, Brazil manages to produces most of its electricity with renewable sources. Germany is next best of the countries analyzed and has been regarded as a role model when it comes to renewable energy/electricity.

This and the previous slides suggest that Brazil might not be getting the credit it deserves on this front.



Production-based vs. Demand-based

Production-based emissions describe GHGs (greenhouse gases) emitted within a country.

Demand-based emissions included GHGs emitted in other countries for products, systems etc. consumed in that country.

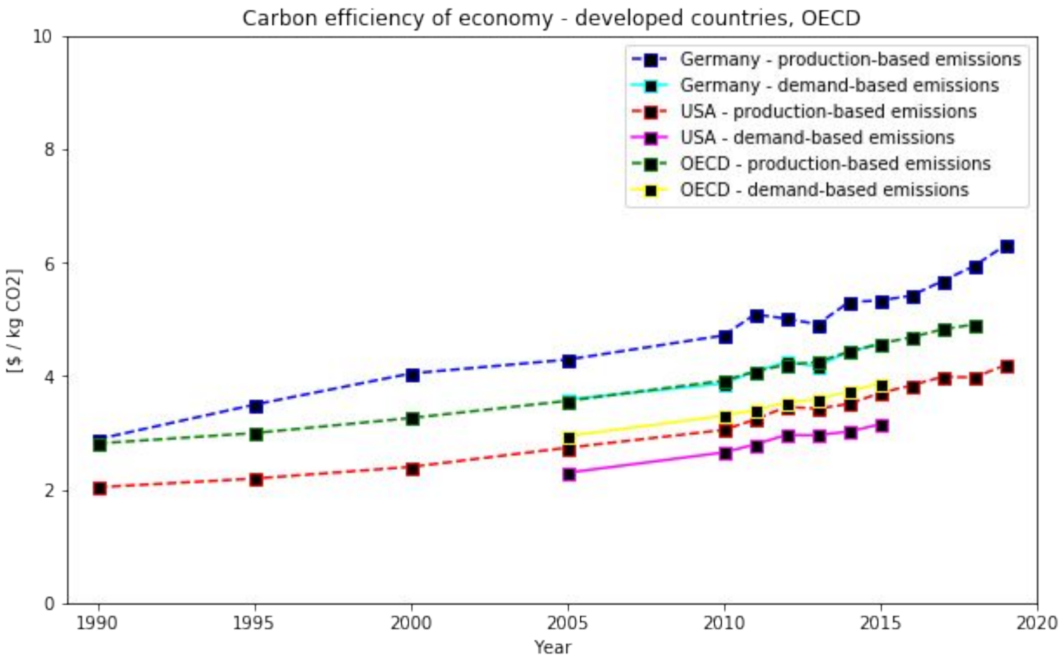
As emissions from advanced, industrialized nations (including members of the OECD) have been stable and even in decline, emissions in developing economies have rapidly increased. Part of this increase in emissions is attributable to the shifting of production sites from richer countries with higher (labor) costs to poorer countries with lower (labor) costs. The lifestyle of people in rich countries has thus partly relied on GHGs emitted in foreign countries. The difference between production-based and demand-based emissions show to what extend this is the case.

Demand-based emissions are thus a more honest reflection of the environmental impact of different populations.

Carbon Efficiency - Rich Nations

More efficient technologies as well as more renewable energy and electricity sources have made economies more carbon-efficient, increasing the amount of wealth generated per unit of GHG emissions. This increase in efficiency is clearly visible in the rich, industrialized nations.

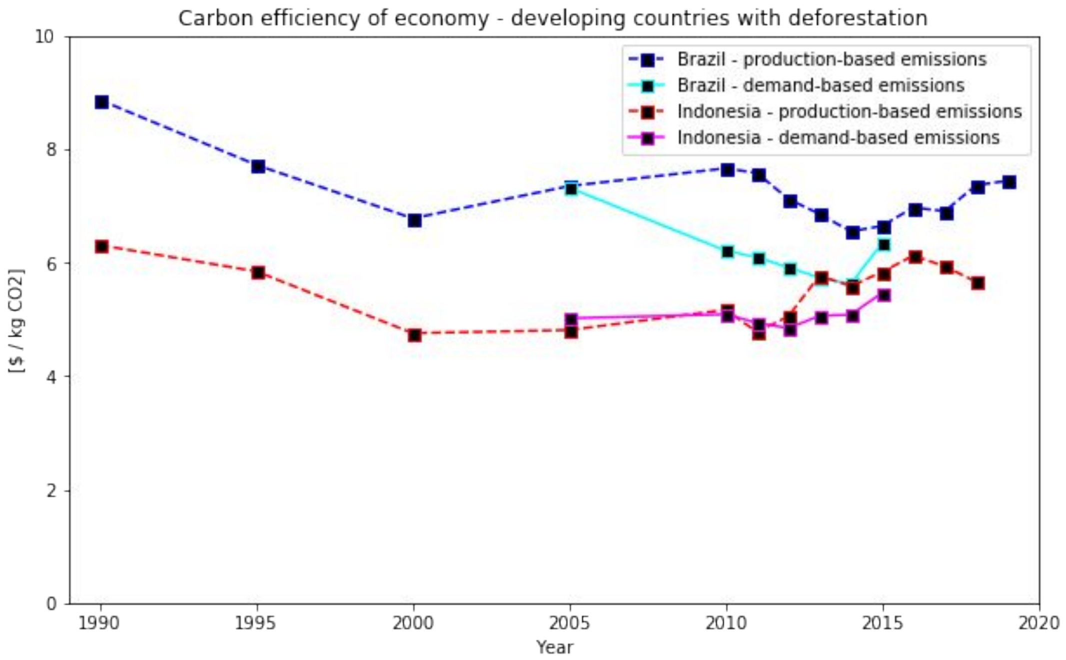
However, the production-based emission efficiency is higher than the demand-based efficiency, indicating that imports are being produced less efficiently.



Carbon Efficiency - Deforestation Nations

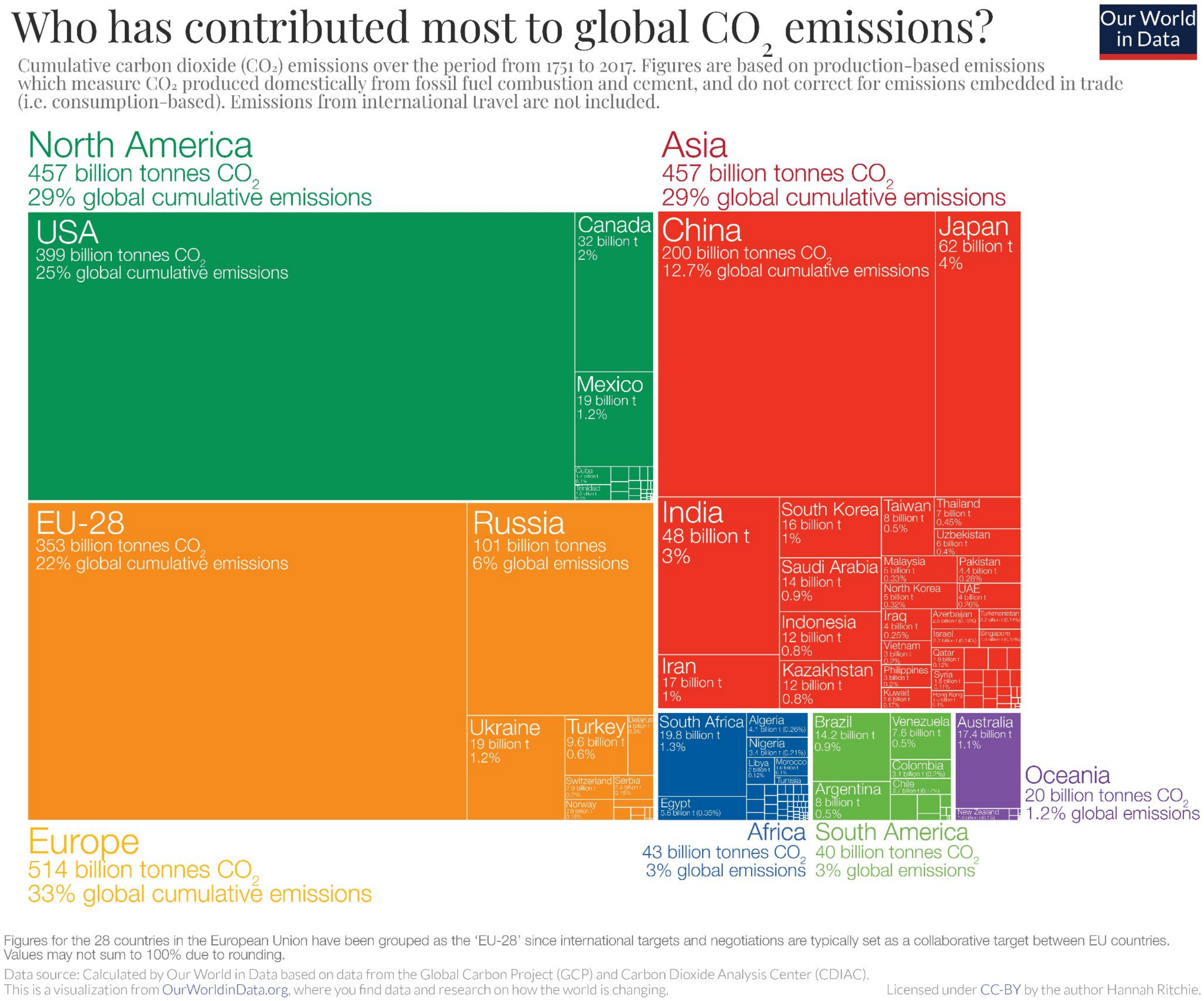
Both Brazil and Indonesia have had more carbon-efficient economies than Germany, the US, and the OECD since 1990. The overall trend is less linear and more sinusoidal.

Deforestation as well as the demands of meeting the needs of rapidly growing population has most likely hindered the economies of having similar upwards trends to the richer nations in the previous slide.



Historical Comparison

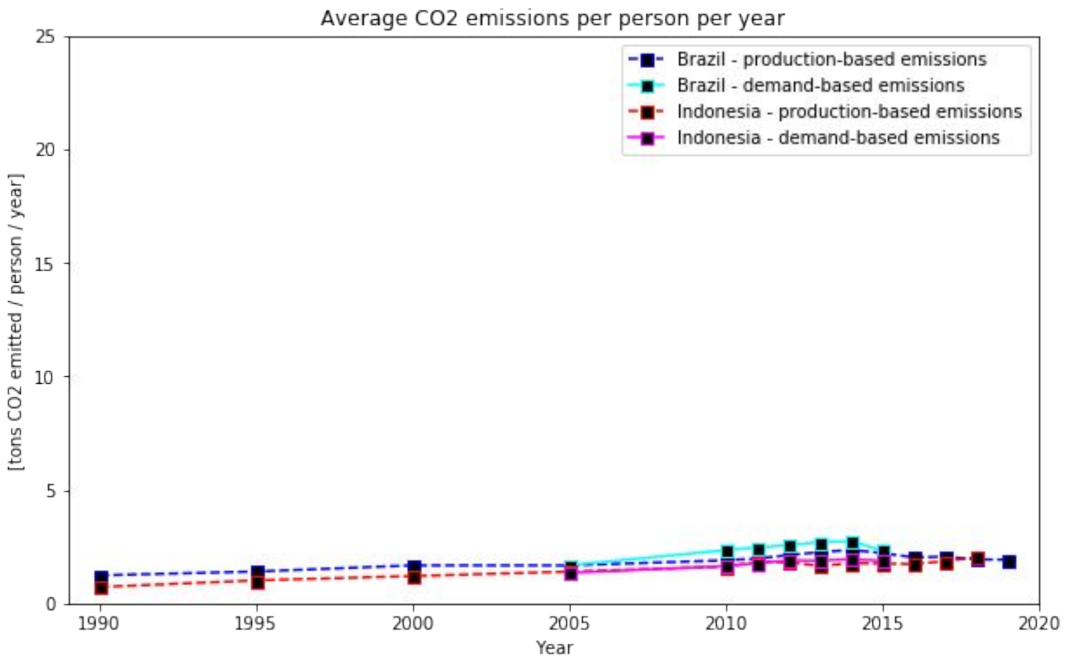
When making a historical comparison, we can see that the United States and Europe are among the historically largest contributors to GHG emissions, especially per capita. Brazil (0.9%) and Indonesia (0.8%) are not insignificantly small, but nonetheless dwarfed in comparison. Source: https://ourworldindata.org/contributed-most-global-co2



Per Capita Emissions - Deforestation Nations

Disregarding countries that have historically contributed most to climate change, CO_2 per capita is the fairest method we have of analyzing who is currently contributing most the global warming. It is particularly interesting to to look at the difference between production-based emissions and demand-based emissions.

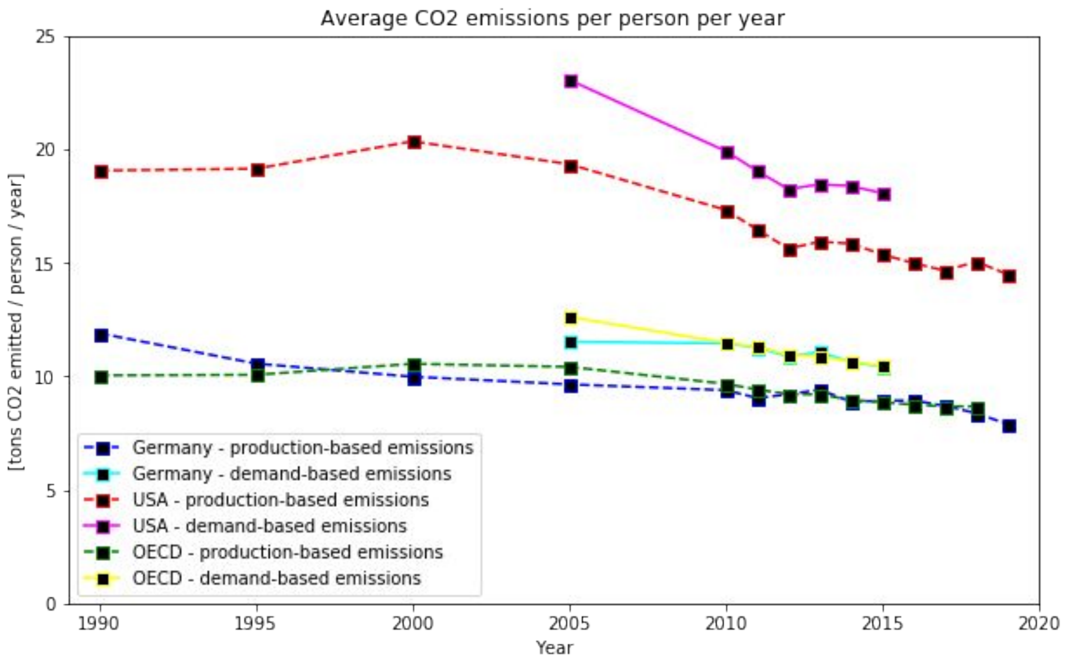
Both Brazil and Indonesia are comfortably below the world average of CO_2 per person per year, although both are also increasing slightly.



Per Capita Emissions - Rich Nations

For comparison, the y-axis has been kept constant from the previous slide. Although the per capita emissions of the United States have been declining since roughly 2000, they still represent 150% Germany's per capita emissions and roughly 600% of Brazil's.

Germany, the US, and the OECD are contributing significantly more to global warming per capita, particularly if one considers that the demand-based emissions are significantly higher than the production-based emissions.



Limitations

In order to shorten the research, only a few countries and averages were selected, mainly due to their large populations and/or geopolitical importance.

There are vast differences in emissions caused within populations, with richer people across the world usually responsible for disproportionally more emissions.

It should also be noted that deforestation was a problem before Bolsonaro became president. However, the rate has increased since he has taken office.

In order to determine which countries should aid and assist others in investing in renewable energy sources and equipping themselves to deal with the results of climate change, a far more detailed analysis is needed that looks at historical emissions, current emissions, and current wealth among many other things.

Conclusions

To what extent are rich nations justified in criticizing developing nations for deforestation for economic gain? The criticism is justified. Deforestation is happening at an alarming rate and is bad news in our fight to retard and reverse climate change. We are a global community and it doesn't matter where deforestation is happening, it is bad anywhere. The loss of natural rainforest habitats is a further tragedy. The criticism is weakened by the slow pace of climate action of the richer countries (see next answer).

Are richer countries doing enough to combat climate change? No. Countries in the OECD have both historically and currently been the worst offenders when it comes to climate change. The demand-based emissions per capita are several times higher than the world average. Technological gains that improve efficiency should be shared and investments should be made into increasing the percentage of energy from renewable sources, both in richer and poorer countries. Hardly any of us are doing enough.

Acknowledgements

The data was obtained from the OECD Statistics database. Small nuggets of information, such as the fact that most of Brazil’s electricity supply is hydroelectric, are things I have learned during my regular Master’s program. I did not get feedback on this work from friends or colleagues.

References

Sources used:

- https://en.wikipedia.org/wiki/OECD
- Ghosh, Madanmohan. (2014). Production-based versus demand-based emissions targets: Implications for developing and developed economies. Environment and Development Economics. 19. 10.1017/S1355770X13000582.
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