

## **Submission to COP30 Presidency Roadmaps**

**From: José Miguez (Academic Submission as part of the PHD thesis from PUC Minas – International Relations Doctorate Program, sponsored by FAPEMIG)**

Date: 31 March, 2026

### **Contextual Framework**

Drawing directly from the 2026 study “Revisiting the 1997 Brazilian Proposal after 28 years”, this submission anchors its recommendations in two pillars derived from the original proposal’s legacy:

- Historical Responsibility Principle: Cumulative emissions (1750-2022) define differential obligations (Developing vs. Developed Countries).
- G20 Mechanism: A targeted platform for high-emission economies to coordinate mitigation.

In response to the invitation by the COP 30 Presidency this submission includes:

Part I: Executive Summary of the Revisited Brazilian Proposal (2026)

Part II: Full PhD Thesis (Revisiting the 1997 Brazilian Proposal after 28 years, available only in Portuguese at the moment)

### **SECTION I: Elements to be used as inputs to the Fossil Fuel Transition Roadmap (Aligned with GST paragraph 28.d)**

#### **Key Recommendations:**

➤ Data-Driven context:

Insert and apply the revisited Brazilian proposal’s results to be used as the basis for the context of the Roadmap, including CO<sub>2</sub> emissions from all sources presented in the Part I and Part II of this document, as well as the removals by Land Sinks and by Oceans sinks framework.

➤ Differentiated Timelines:

- The roadmap need to reflect the differentiation of Annex I countries and Non-Annex I in cause global warming;

➤ G20 Mitigation Platform:

- Operationalize the revisited proposal’s "triple-platform" model:
  - ✓ Voluntary Target Setting: 5 periods of 5-year voluntary target mitigation plans for G20 members.
  - ✓ Matchmaking Project Pipeline: To certify high-impact mitigation investment projects;
  - ✓ CDIM Investment Fund (AAA-rated facility).

## **SECTION II: Elements to be used as inputs to the Deforestation & Forest Degradation Roadmap (Aligned with GST1 paragraphs 33 and 34)**

### **Key Recommendations:**

➤ Data-Driven context:

Insert and apply the revisited Brazilian proposal's results to be used as the basis for the context of the Roadmap, including emissions and removals by Land Sinks, as well as by Oceans sinks framework.

➤ Differentiated Timelines:

- The roadmap need to reflect the differentiation of Annex I countries and Non-Annex I in cause global warming;

➤ G20 Mitigation Platform:

- Operationalize the revisited proposal's "triple-platform" model:
  - ✓ Voluntary Target Setting: 5 periods of 5-year voluntary target mitigation plans for G20 members.
  - ✓ Matchmaking Project Pipeline: To certify high-impact mitigation investment projects;
  - ✓ CDIM Investment Fund (AAA-rated facility).

### **CONCLUSION**

The revisited Brazilian Proposal (2026) provides a scientifically rigorous framework for implementing GST outcomes. Its core innovations - historical responsibility metrics and G20-focused cooperation financial mechanism - offer actionable pathways for both Roadmaps. We urge COP30 Presidency to formalize these mechanisms under the Presidency's Mutirão approach.

Respectfully submitted,

Prof. José Domingos Gonzalez Miguez

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## **PART I - REVISITING THE 1997 BRAZILIAN PROPOSAL AFTER 28 YEARS.**

By José Domingos Gonzalez Miguez

First of all, I would like to thank PUC Minas and, in particular, FAPEMIG, which made the elaboration of this doctoral thesis possible. I also thank my advisors, Prof. Dr. Leonardo César Ramos and Prof. Dr. Thiago de Araújo Mendes, for the ideas and revisions that improved the work.

The idea of the thesis was to revisit, after 28 years, the 1997 Brazilian proposal, within the framework of the Berlin Mandate, which led to the Kyoto Protocol, aiming to evaluate the evolution of the responsibilities of the countries of the United Nations Framework Convention on Climate Change in causing global climate change in the period from 1750 to 2022 and to present how the situation has changed.

The idea of the 1997 Brazilian proposal arose from several interventions by Prof. Dr. Luiz Gylvan Meira Filho, who in several interventions by the Brazilian delegation at the 1994-1996 Convention, stated that it would be possible to approximate the results of supercomputer models on climate change by simply calculating the double integral of CO<sub>2</sub> emissions from countries, which in the case of discrete annual values is equivalent to calculating the accumulation of CO<sub>2</sub> emissions.

The Brazilian proposal for the Berlin Mandate was prepared from October 1996 to May 1997. The difficulty at the time was that there was little data, basically only CO<sub>2</sub> emission data per country for the energy and cement sectors for the period from 1950 to 1990, available in 1996 on the Oak Ridge National Laboratory website, collected by Dr. Greg Marland. Furthermore, the series covered a very short period and, moreover, included two oil shocks in 1973 and 1979, which meant that to extrapolate backward to 1750, less data from the series was needed. To allow this retroactive extrapolation, data from 1950 to 1972 were used. Therefore, the series used was quite limited for the extrapolation.

Additionally, there was no data for CO<sub>2</sub> emissions from deforestation, which led to criticism that the Brazilian proposal was omitting these emissions from these sectors. Furthermore, there was questioning of the use of only CO<sub>2</sub> emissions by country, given the absence of disaggregated data by country for methane and nitrous oxide emissions, which were the other main greenhouse gases.

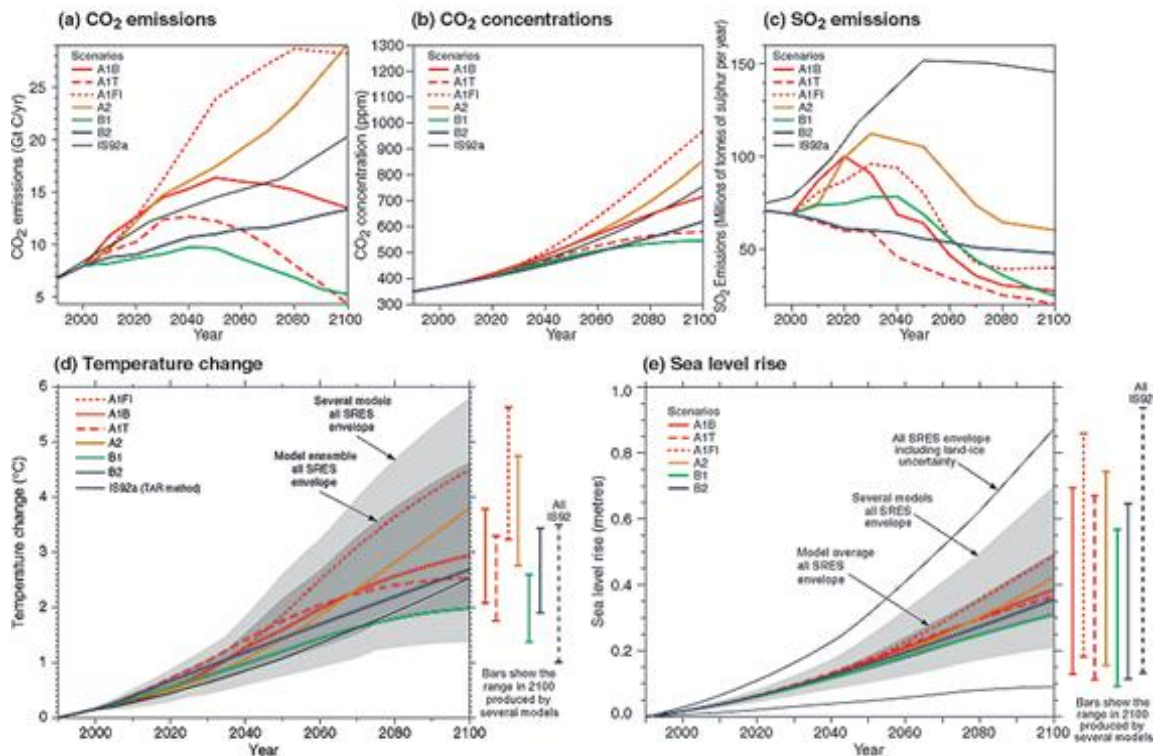
Dr. Gylvan Meira spoke about this double accumulation of CO<sub>2</sub> emissions to calculate the average increase in Earth's surface temperature, which would also allow the attribution of each country's responsibility for global warming, but since the proposal was presented as a submission of a Party to the Convention under the Berlin Mandate and not for a scientific publication, it was not mentioned by the Intergovernmental Panel on Climate Change, the IPCC.

The idea of the double accumulation of CO<sub>2</sub> emissions to calculate the temperature increase was that annual emissions in a given year accumulate in the atmosphere, increasing the concentration of CO<sub>2</sub> in the atmosphere, taking into account the emissions of previous years and the decay of these past emissions each year. Dr. Gylvan's idea was presented in the IPCC's Third Assessment Report in 2001, in the form of a graph on the world's climate in the 21st century, presented by Sir John Houghton, who was the co-chair of the IPCC Working Group I on climate science, along with Dr. Gylvan Meira.

The graph below showed CO<sub>2</sub> emissions in (a), which accumulated increases the concentration of CO<sub>2</sub> in (b). The temperature change in (d) would be the result of the annual accumulation of the increase in CO<sub>2</sub> concentration, and the accumulation of the temperature increase would lead to the rise in sea level in (e).

It is important to note that Dr. Gylvan's idea is confirmed by this graph. The concentration graph in (b) is visually the accumulation of CO<sub>2</sub> emissions. Each year, new emissions are added, and this is compounded by the decay of CO<sub>2</sub> emissions from previous years, due to removals in both the terrestrial biosphere and the oceans. The same accumulation occurs with concentration. Each year that the concentration of CO<sub>2</sub> in the atmosphere increases, more infrared radiation is trapped by CO<sub>2</sub> molecules, and the average temperature of the Earth's surface increases. Similarly, sea levels rise. As temperatures increase, there is greater melting of ice on land, primarily in the mountains, the Alps, Andes, Himalayas, and mountain ranges. This also occurs in Greenland and parts of Antarctica, mainly in the western region, which is melting. In all these cases, the ice anchored to the land contributes to the rise in average sea level. Although Dr. Gylvan has presented this idea orally at the Convention's plenary sessions since 1994, due to the inherent scientific complexity of the topic of CO<sub>2</sub> accumulation in the atmosphere, the Brazilian submission of 1997 also aims to clarify this for the general public and for the delegations of the Parties in particular.

## The global climate of the 21st century

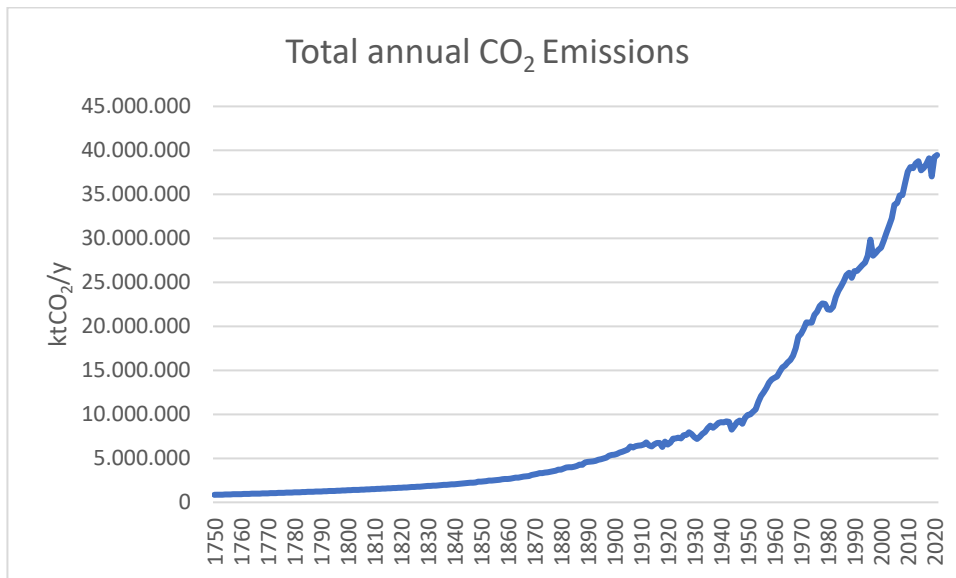


Source: IPCC (2001).

Therefore, this thesis sought to revisit the Brazilian proposal of 1997, after 28 years, updating it with recent data to reflect what has changed over those 28 years. Initially, in terms of data, there was an update of CO<sub>2</sub> emission data by country for the energy and cement sectors, by Greg Marland and Hefner, available at Appalachian University, a state university in the United States, with the series expanded to cover the period from 1750 to 2022. In parallel, the Global Carbon Project was established through articles by Friedlingstein et al. (2023) and others, which presented new data, including three scenarios of CO<sub>2</sub> emissions from forests by country from 1850 to 2022, which was one of the criticisms of the Brazilian proposal from 1997. And, in an innovative way, it presented an estimate of CO<sub>2</sub> removals by terrestrial and ocean sinks from 1959 to 2022, however without attributing it to countries, as if the removal did not happen in a specific territory, but was done by nature.

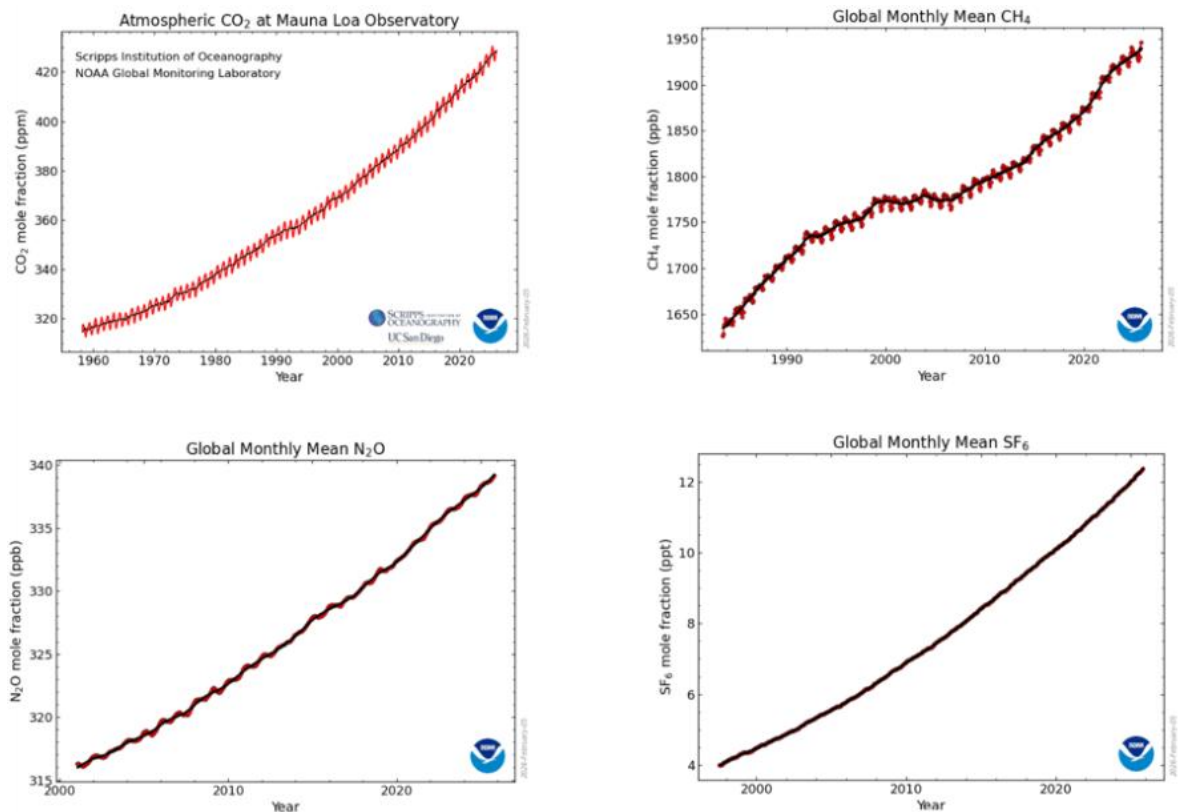
The data used in this thesis include the new data from Greg Marland and Hefner, of CO<sub>2</sub> emissions by country from 1750 to 2022 and, in addition, the deforestation data from the three scenarios of CO<sub>2</sub> emissions from forests in the Global Carbon Project. In terms of the three scenarios for CO<sub>2</sub> emissions from forests, only the positive data were used. When there was a negative net removal from the countries, the CO<sub>2</sub> emission from the forest was considered to be zero, which was the closest approximation possible given the presentation of net forest emissions by the Global Carbon Project.

The aggregated data for these CO<sub>2</sub> emissions worldwide are presented in the graph below, representing the sum of CO<sub>2</sub> emissions from the energy and cement sectors and removals and emissions from the forestry sector.



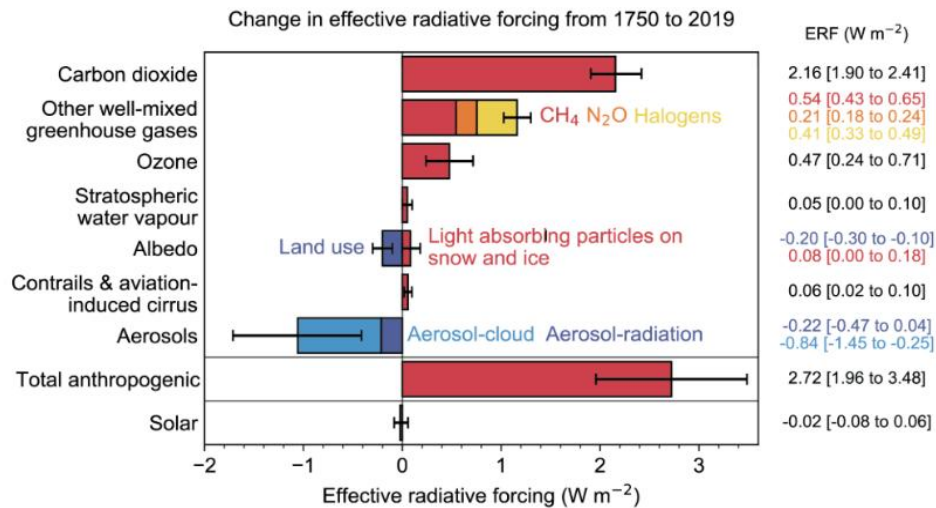
Source: Prepared by the author.

A second criticism leveled at the 1997 Brazilian proposal is that it only calculated results for CO<sub>2</sub> emissions and did not address methane, primarily, and other greenhouse gases. As can be seen in the IPCC graphs, the concentration of CO<sub>2</sub> is given in parts per million, while the concentration of methane and nitrous oxide is given in parts per billion, meaning that the quantity of methane and nitrous oxide molecules in the atmosphere is much smaller than the quantity of CO<sub>2</sub> molecules, and the concentration of SF<sub>6</sub>, another important greenhouse gas, is given in parts per trillion. This means that the annual volume of emissions of these greenhouse gases is much smaller than the annual emissions of CO<sub>2</sub>.



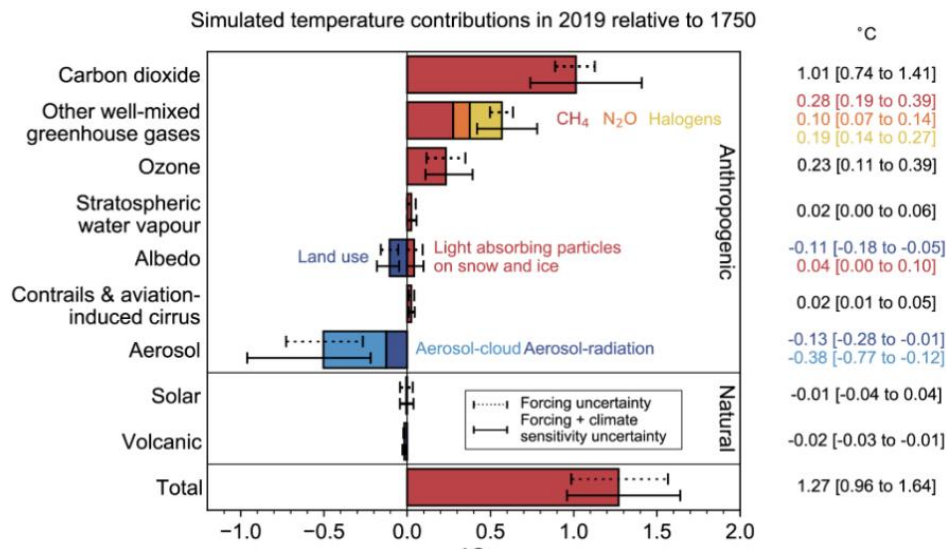
Source: Global Monitoring Laboratory – NOAA (2025)

The importance of CO<sub>2</sub> emissions can also be seen in the variation of radiative forcing from 1750 to 2019 in the IPCC graph, from the Sixth Assessment Report in W/m<sup>2</sup>. Radiative forcing due to CO<sub>2</sub> emissions represents about 80% of the total anthropogenic radiative forcing.



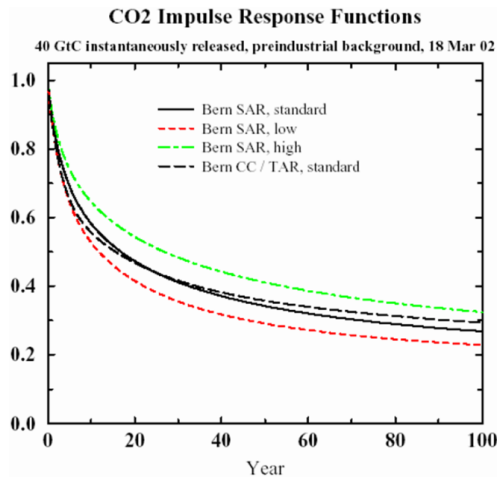
Source: IPCC (2023).

The importance of CO<sub>2</sub> emissions compared to other gases can also be seen in the simulated contribution of over 80% to the temperature increase due to CO<sub>2</sub> in 2019 relative to 1750, compared to other anthropogenic contributions.



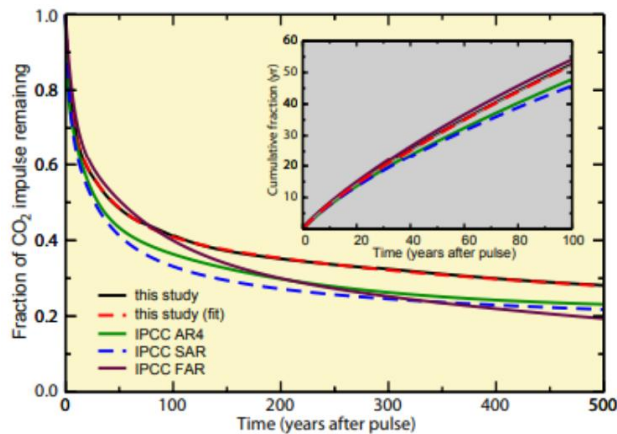
Source: IPCC (2023).

Finally, another characteristic of CO<sub>2</sub> is that, according to the Berne models, led by Fortunat Joos, while all greenhouse gases decay exponentially to zero, CO<sub>2</sub> does not decay to zero, as can be seen in the following graphs. Additionally, in Joos (2002) it is evident that a portion of CO<sub>2</sub> emissions, on the order of between 25 and 30%, remains for more than 100 years.



Source: Fortunat Joos (2002)

Joos (2013) also presents the idea that approximately 35% of CO<sub>2</sub> emissions remain in the atmosphere for 500 years due to asymptotic decay. According to Joos (2013), the decay of CO<sub>2</sub> emissions would take more than 300,000 years.

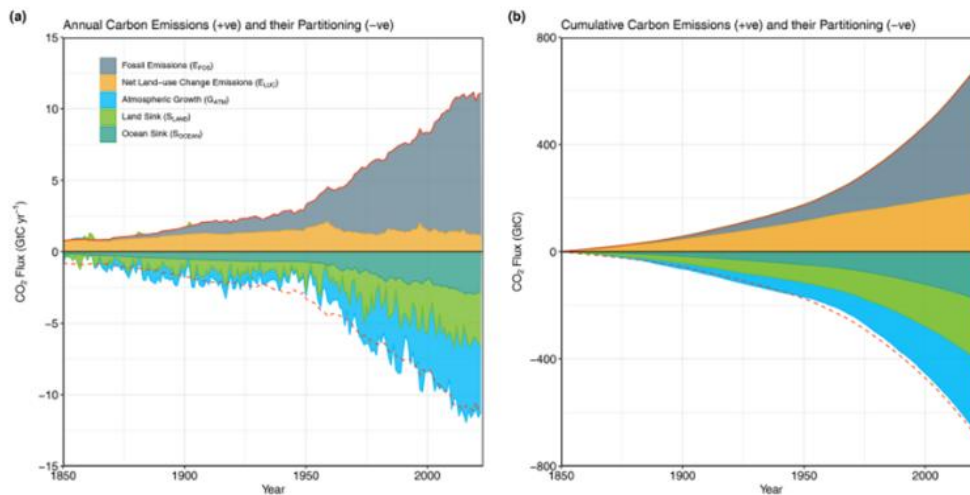


Source: Fortunat Joos (2013)

Therefore, this would be a third observation that shows the importance of considering CO<sub>2</sub> emissions, the problem of ancient emissions since 1750, which still persist over time in the atmosphere, for decades and thousands of years. So, these problems are what lead to the approach of only using CO<sub>2</sub> emissions as a basis for decision-makers to address global warming.

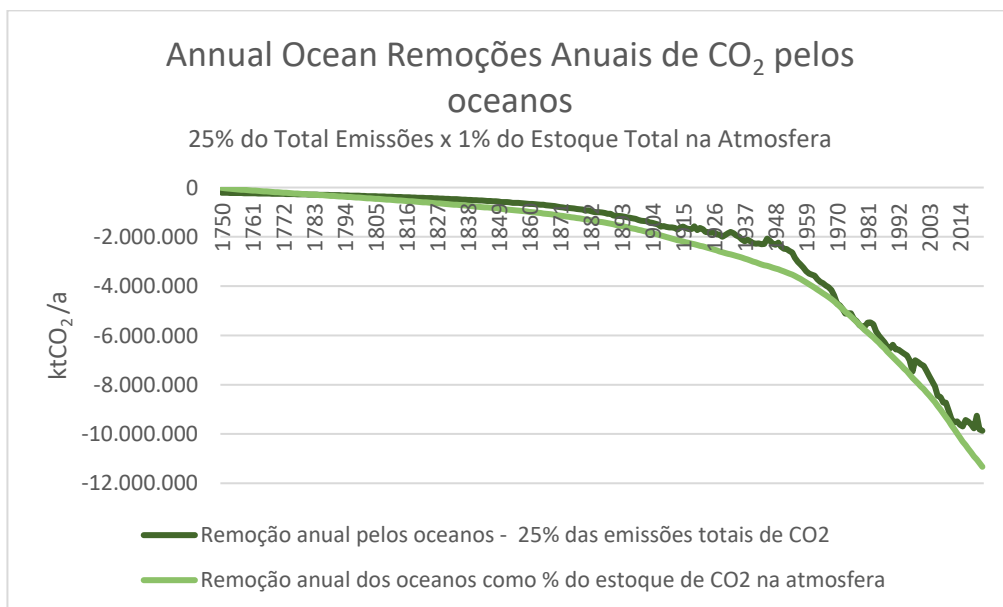
Attributing responsibility for causing global climate change based solely on CO<sub>2</sub> emissions data is due not only to the importance of CO<sub>2</sub> in radiative forcing and temperature increase, but mainly to the existence of data that allows attributing responsibility for this climate change to countries. The lack of data on methane and other gas emissions by country would be difficult to solve at present. Although the Global Carbon Project represents a major advance by presenting total CO<sub>2</sub> emissions and their destination, as shown in the following graphs from Friedlingstein et al, 2023.

However, two serious problems were identified when analyzing the data. The first problem is that CO<sub>2</sub> emissions from forests are not gross emissions from forests, deforestation, clear-cutting, and selective logging. The Global Carbon Project presents net CO<sub>2</sub> emissions from forests, including CO<sub>2</sub> absorption by afforestation, reforestation, and other types of absorption by vegetation and soil. When presenting the destination of emissions, they are separated into three parts. The first represents what is absorbed by terrestrial sinks, the second represents what is absorbed by the oceans, and the third is what remains in the atmosphere, which would be the remainder of CO<sub>2</sub> emissions. When considering net CO<sub>2</sub> emissions from forests, part of the absorption that should be at the bottom of the graph is at the top, discounted from CO<sub>2</sub> emissions by forests.



Source: Global Carbon Budget 2023 (Friedlingstein et al, 2023).

A second problem is that the calculation of CO<sub>2</sub> removal by the oceans is based on 25% of total CO<sub>2</sub> emissions. This is clearly a problem, assuming a zero-emissions policy, CO<sub>2</sub> removal by the oceans would be zero. A better solution would be to correlate the annual CO<sub>2</sub> stock remaining in the atmosphere with the annual removal of CO<sub>2</sub> from the oceans, which would be estimated to vary from 1.6% in 1750 to 1% in 2022. However, the thesis maintained the assumptions and data of the Global Carbon Project.



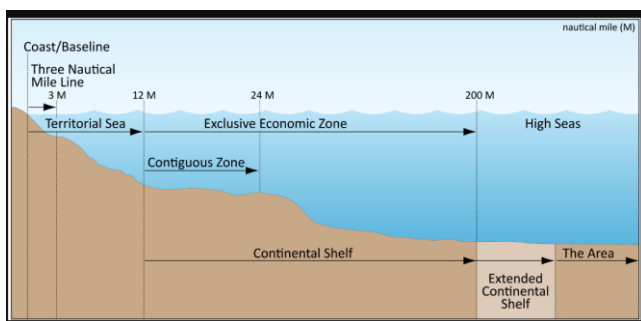
Source: Prepared by the author.

Thus, the great innovation of the Global Carbon Project was to consider CO<sub>2</sub> removals. The problem is that the Global Carbon Project only presents total CO<sub>2</sub> removals by oceans and forests from 1959 to 2022 and does not attribute them by country, unlike CO<sub>2</sub> emissions from forests and energy, which the Global Carbon Project attributes by country.

CO<sub>2</sub> removals are presented only as the aggregate by oceans and forests. It is as if removals were not attributable to a country, as if they were simply from nature. The thesis work attributes CO<sub>2</sub> removals by country, both by forests and by oceans. CO<sub>2</sub> removal by the terrestrial biosphere occurs in the specific territory of countries with forest areas, and CO<sub>2</sub> removal by the oceans occurs either in the exclusive economic zones of countries with ocean coastlines or in international waters.

For the attribution of CO<sub>2</sub> removals by the oceans, the 200 nautical mile exclusive economic zone of countries was used as an approximation. There is no precise definition of

economically exclusive zone (EEZ) for each country, but as a first approximation, the country's EEZ area as presented on Wikipedia in 2025 (on the English website) was used.



Source: Wikipedia (2025).

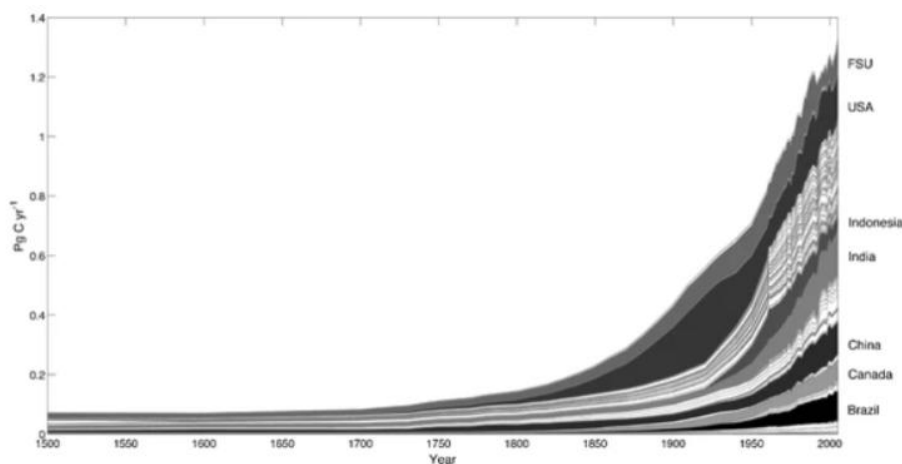
Therefore, the allocation of CO<sub>2</sub> removal by the oceans is made as 25% of total CO<sub>2</sub> emissions, and the allocation by country is proportional to each country's EEZ areas, kept constant from 1750 to 2022. The result presented in the following table expresses, for the main countries, only the removals achieved for the year 2022.

Country	Ocean Removals in 2022 ktCO <sub>2</sub> /y	% of the World
INTERNATIONAL WATERS	6.052.237	61,33%
FRANCE	318.756	3,23%
UNITED STATES OF AMERICA	309.486	3,14%
AUSTRALIA	231.899	2,35%
RUSSIAN FEDERATION	206.306	2,09%
UNITED KINGDOM	185.555	1,88%
INDONESIA	167.926	1,70%
CANADA	152.659	1,55%
JAPAN	122.131	1,24%
NEW ZEALAND	120.527	1,22%
BRAZIL	104.451	1,06%
CHILE	100.390	1,02%

Source: Prepared by the author.

Land covers approximately 29% of the world's surface, while ocean waters represent about 71%. Thus, 61% of CO<sub>2</sub> removal is done by international waters, that is, waters not classified as an integral part of any EEZ of the countries Party to the Convention. Among the countries that have large oceanic areas, classified as exclusive economic zones, we can mention France, the United States, Australia, the Russian Federation, the United Kingdom, because of the still existing insular colonial territories, which are small islands, with a large territory of 200 miles around each island, Indonesia, Canada, Japan, among others. Brazil appears in tenth place, with a removal of 1% of the total CO<sub>2</sub> removal by the oceans.

The calculation of the attribution of total CO<sub>2</sub> removal by forests is made from the total removal of the Global Carbon Project, retroactively extrapolating the data from 1959 to 2022, based on the curve presented by Hurtt et al. (2011), shown in the figure below:



Source: Hurtt et al. (2011).

As can be seen in the figure above, CO<sub>2</sub> emissions from forests occurred before the Industrial Revolution. According to the estimate by Hurtt et al. (2011), CO<sub>2</sub> emissions in 1500 would already be on the order of 0.1 Petagrams of carbon per year.

To attribute removals by forests to the countries of the Convention, an approximation of the growing forest stocks was made, given by the national reports submitted to the FAO. The problem is that the FAO presents data by country from 1990 to 2020, and from 1990 to 2015, the data are presented every five years, and from 2015 to 2020 the data on the growth of forest stocks are presented annually. Then, the proportion of growing forest stocks for each country from 1990 to 2022 was applied and calculated by retroactive extrapolation, taking into account the distribution of countries in 1990. The following table presents the largest removers with the growth of forest stocks.

Country	Land Sinks Removals in 2022 ktCO <sub>2</sub>	% of the World
BRAZIL	3.058.319	21,39%
RUSSIAN FEDERATION	2.084.541	14,58%
CANADA	1.137.876	7,96%
UNITED STATES OF AMERICA	1.051.240	7,35%
DEMOCRATIC REPUBLIC OF THE CONGO	776.498	5,43%
CHINA	507.587	3,55%
COLOMBIA	374.110	2,62%
AUSTRALIA	339.287	2,37%
INDONESIA	321.053	2,25%
PERU	290.739	2,03%
VENEZUELA	259.062	1,81%

Source: Prepared by the author.

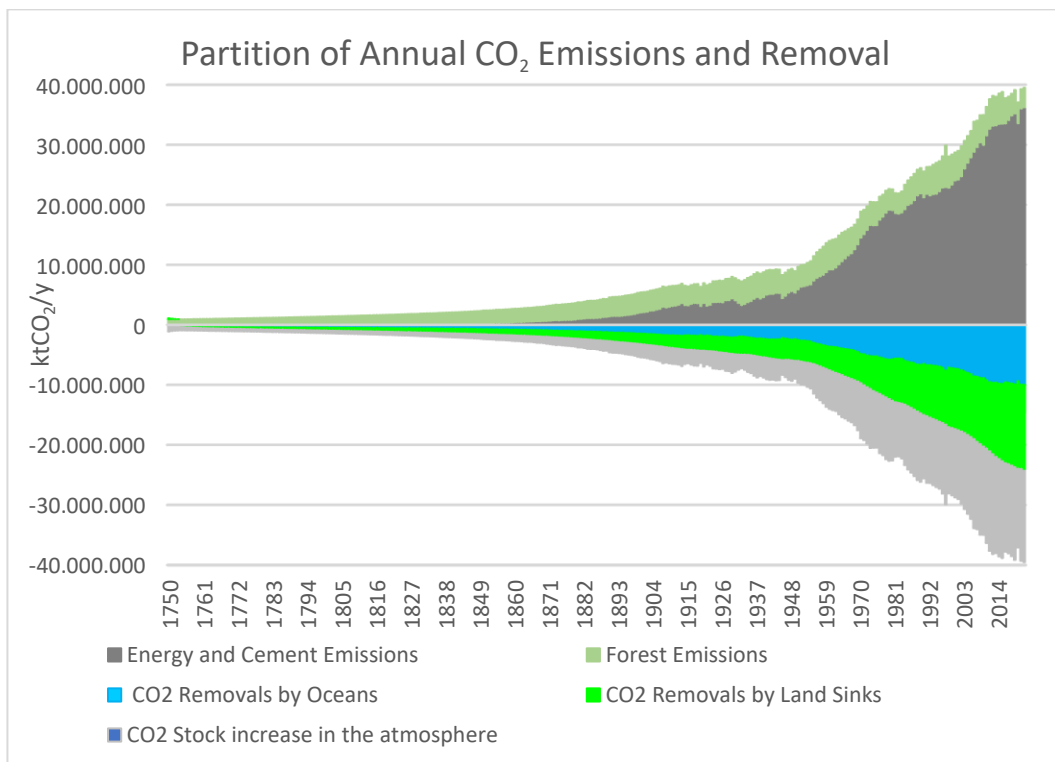
Brazil is the largest remover of CO<sub>2</sub> through terrestrial sinks, accounting for over 21% of CO<sub>2</sub> removal by forests. After Brazil, the Russian Federation is the second largest remover of CO<sub>2</sub> through forests, with over 14% of CO<sub>2</sub> removal, followed by Canada with approximately 8%. The United States removes 7% of the total CO<sub>2</sub> removed by forests, followed by the Central Democratic Republic and China. Note that Australia appears as 2.37% in our estimate, but does not provide data to the FAO. Australia appears as a major remover of CO<sub>2</sub> through forests in eighth position.

Ranking	Country	Growing stock (million m <sup>3</sup> )
1	Brazil	120 358
2	Russian Federation	81 071
3	Canada	45 108
4	United States of America	41 269
5	Democratic Republic of the Congo	30 782
6	China	19 191
7	Colombia	14 830
8	Indonesia	12 727
9	Peru	11 525
10	Venezuela (Bolivarian Republic of)	10 254

Source: FAO (2020)

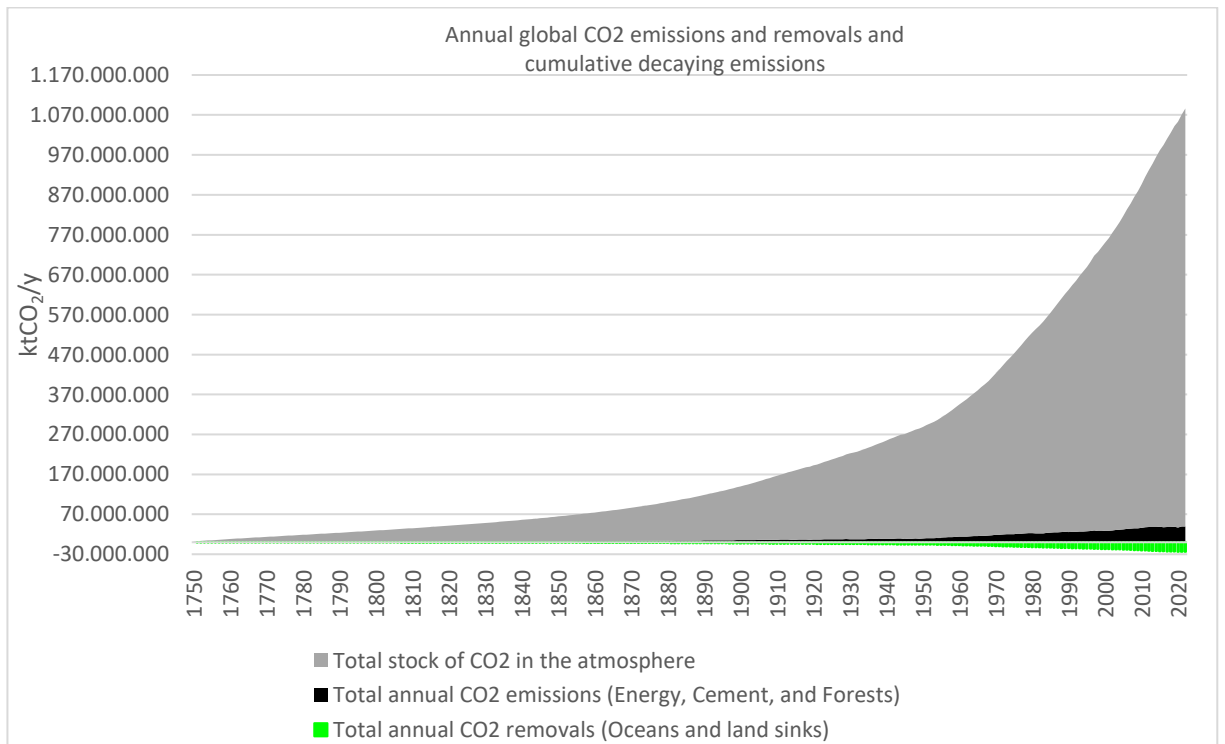
Based on estimates of CO<sub>2</sub> emissions from forests and CO<sub>2</sub> removals from forests and oceans, the partitions presented in the Global Carbon Project are reproduced, but with disaggregation by country from 1750 to 2022.

The thesis reproduces the series of CO<sub>2</sub> emissions and also the destination of these emissions over time, from 1750 to 2022, but with a major advantage of being associated with countries. So, both the emissions and the destination of these emissions are associated with countries and can be attributed to each country, as can be seen in the graph below.

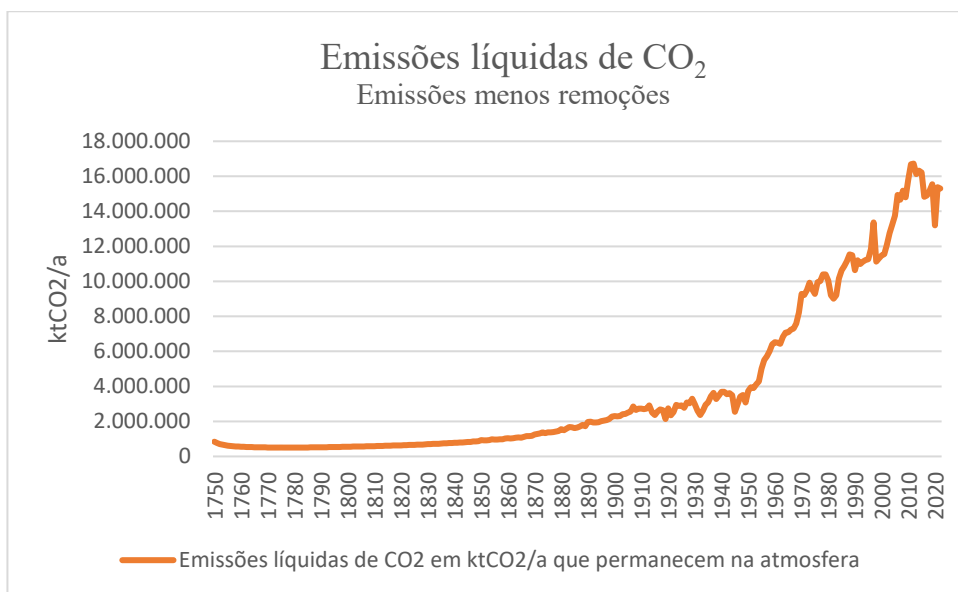


Source: Prepared by the author.

Additionally, it was calculated that the stock remaining in the atmosphere each year, which would be the difference between emissions and removals, also reached an accumulated amount of 1.07 trillion tons of CO<sub>2</sub> by 2022. Comparing annual emissions of approximately 39.5 billion tons of CO<sub>2</sub> in 2022 with annual removals of 24.2 billion tons of CO<sub>2</sub>, or a net annual emission of 15.3 billion tons of CO<sub>2</sub>, it is observed that the existing stock in the atmosphere is of a much larger order of magnitude than the annual emissions or removals of CO<sub>2</sub>, and that net annual CO<sub>2</sub> emissions, despite recently decreasing, continue to increase the stock of CO<sub>2</sub> in the atmosphere.



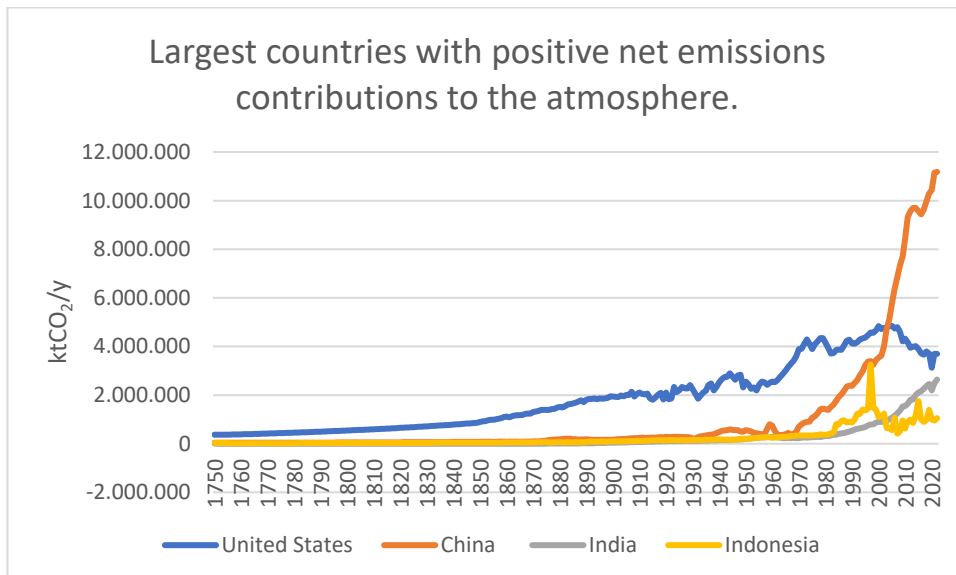
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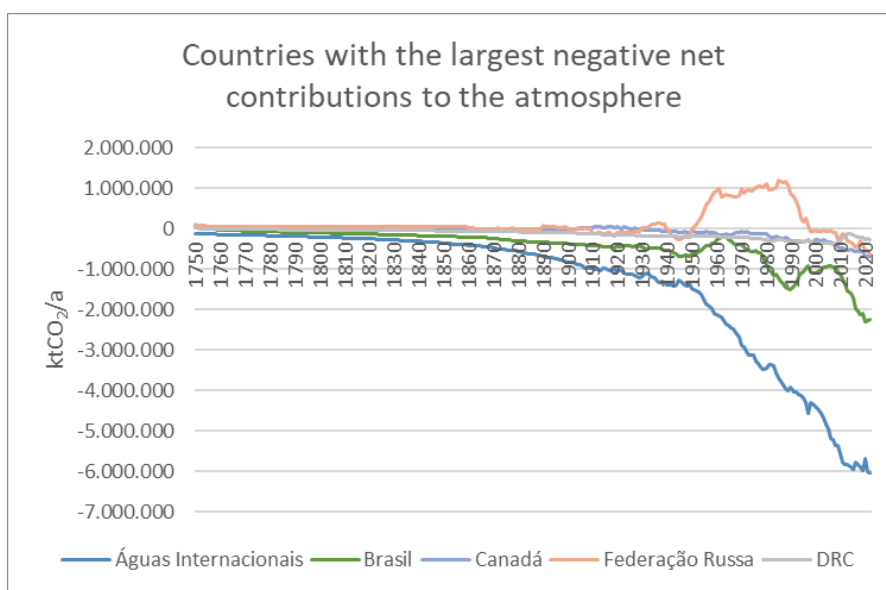
Based on the data analysis, it is interesting to note that it is possible to classify countries into two main types: those with positive contributions in terms of net emissions to the atmosphere (GHeaters), that is, those with  $\text{CO}_2$  emissions greater than the  $\text{CO}_2$  removals identified in their territory; and those countries with negative contributions in terms of net emissions to the atmosphere (GCoolers), with  $\text{CO}_2$  removals greater than  $\text{CO}_2$  emissions.

The graph below shows the countries with the largest positive contribution to the atmosphere in terms of annual emissions. The United States, historically the largest contributor, along with China, which has recently greatly increased its contribution, reaching almost 11 billion tons annually, followed by India and Indonesia.



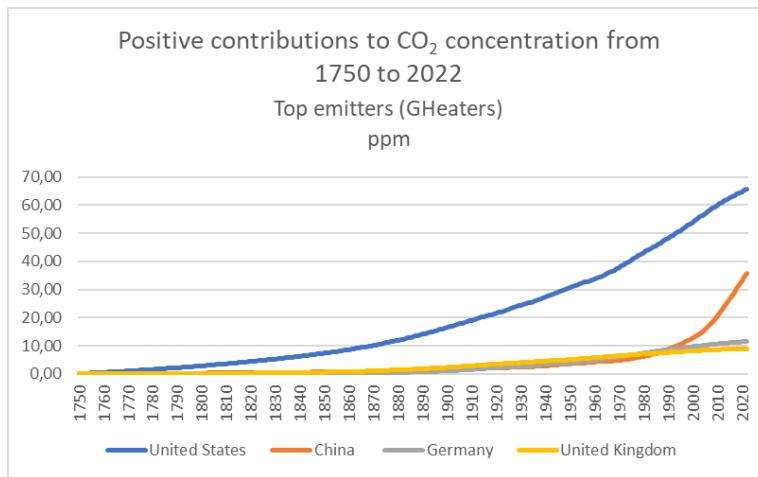
Source: Prepared by the author.

On the other hand, the graph below shows that the countries with the greatest negative contribution to the atmosphere would be Brazil, historically the largest contributor, followed by Canada, the Russian Federation, which has recently greatly increased its contribution, followed by the Democratic Republic of Congo.



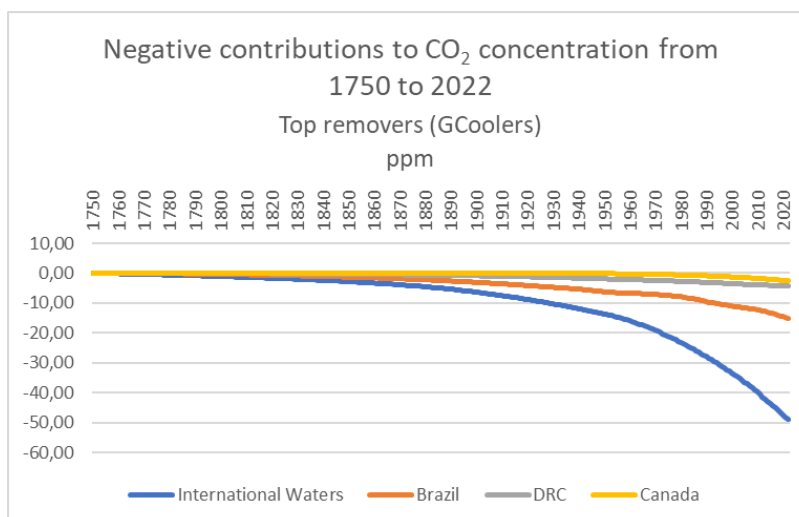
Source: Prepared by the author.

In terms of concentration, when calculating the accumulation of these net emissions and considering decay, the countries that have a positive contribution to the increase in CO<sub>2</sub> concentration in the atmosphere are shown in the figure below. It is interesting to note that the United States continues to increase its positive contribution to the increase in concentration, despite China having recently increased its emissions significantly; historically, China had relatively low emissions. When compared to the United States, China's accumulated net emissions are still lower than those of the United States, but are already growing rapidly. China's positive contribution to the increase in CO<sub>2</sub> concentration is substantially greater than that of Germany and the United Kingdom, the next two countries.



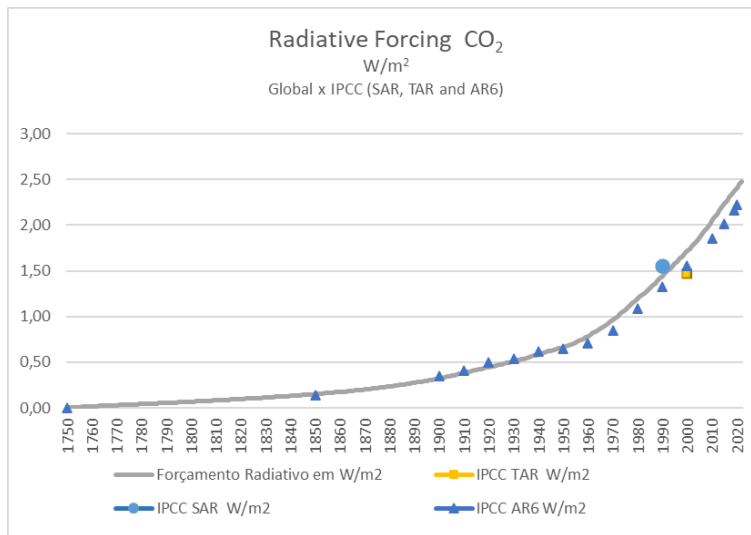
Source: Prepared by the author.

In terms of negative contributions to the increase in CO<sub>2</sub> concentration, the same logic applies. International waters continue to increase their negative contribution to the increase in concentration. Brazil is the second largest remover and the largest country with a negative contribution to the increase in atmospheric CO<sub>2</sub> concentration. Following Brazil, the countries with negative contributions to the increase in concentration are the Democratic Republic of Congo and Canada. So, these are the major liquid removers that contribute negatively by removing CO<sub>2</sub> from the atmosphere. If it weren't for these countries and international waters, the concentration of CO<sub>2</sub> in the atmosphere would be even higher.



Source: Prepared by the author.

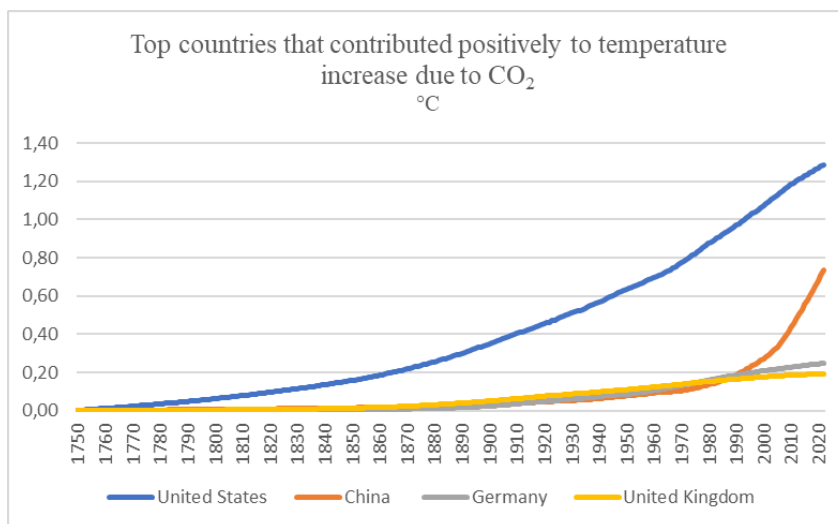
To convert from CO<sub>2</sub> concentration to temperature increase, the IPCC calculates the radiative forcing in W/m<sup>2</sup> resulting from the CO<sub>2</sub> concentration in ppm. The figure below shows the radiative forcing estimated in the thesis, comparing it with the values from the Second Assessment Report in 1990, the Third Assessment Report in 2000, and the series of radiative forcing due to CO<sub>2</sub>, presented for some years, from the Sixth Assessment Report.



Source: Prepared by the author.

The continuous curve is the result of the thesis, and the more detailed curve presented in the IPCC Sixth Assessment Report coincides with the research trajectory up to 1940, and the IPCC curve is slightly below the research from 1940 onwards. In fact, the research underestimates forest emissions, especially those from developed countries, due to the previously explained problem of net emissions in the chosen scenario (Houghton and Castanho) of the Global Carbon Project, meaning the thesis curve would be even larger than that of the IPCC Sixth Assessment Report.

From radiative forcing, the contribution of each country to the temperature increase is estimated, following the estimate of what the radiative forcing and temperature would be if the CO<sub>2</sub> concentration reached double the pre-industrial concentration. Again, there are two groups of countries: those that are contributing positively to the temperature increase and those that are contributing negatively to the temperature increase, that is, those that are decreasing the temperature increase.



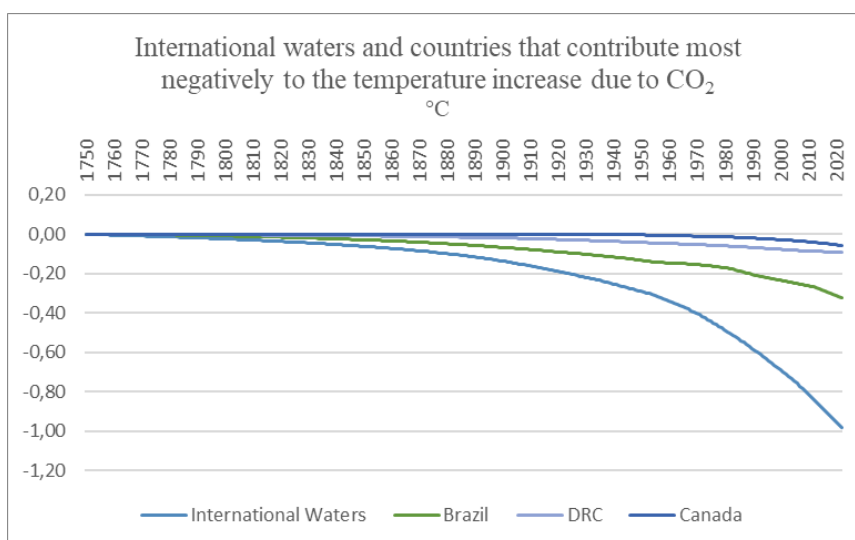
Source: Prepared by the author.

Among those contributing positively, the largest is the United States, with almost a degree increase of 1.3°C, followed by China with an increase of 0.7°C, and Germany and the United Kingdom with increases of around 0.2°C each.

Country	Temperature Increase °C	% of the World
UNITED STATES OF AMERICA	1,2860476	45,82%
CHINA	0,7351141	26,19%
GERMANY	0,2472473	8,81%
UNITED KINGDOM	0,1916941	6,83%
INDONESIA	0,1798508	6,41%
INDIA	0,1728687	6,16%
JAPAN	0,1557795	5,55%
UKRAINE	0,1110298	3,96%
RUSSIAN FEDERATION	0,0925131	3,30%
ARGENTINA	0,0869927	3,10%

Source: Prepared by the author.

In the case of a negative contribution to the temperature increase, international waters can reduce the temperature increase by almost 1°C, Brazil by more than 0.3°C, the Democratic Republic of Congo by almost 0.1°C, and Canada by almost 0.06°C.



Source: Prepared by the author.

Therefore, the largest negative contributions to the temperature increase come from international waters, accounting for almost 35%, followed by Brazil with over 11%, the Democratic Republic of Congo with over 3%, and then Canada, Peru, Guyana, Suriname, Colombia, and Gabon – countries that have large forested areas or large territories that combine forest and oceanic territories.

Country	Temperature Increase °C	% of the World
INTERNATIONAL WATERS	-0,9808378	-34,94%
BRAZIL	-0,3209350	-11,43%
DEMOCRATIC REPUBLIC OF THE CONGO	-0,0925451	-3,30%
CANADA	-0,0563575	-2,01%
PERU	-0,0350358	-1,25%
GUYANA	-0,0261454	-0,93%
SURINAME	-0,0228207	-0,81%
COLOMBIA	-0,0220429	-0,79%
GABON	-0,0209610	-0,75%
CHILE	-0,0194427	-0,69%

Source: Prepared by the author.

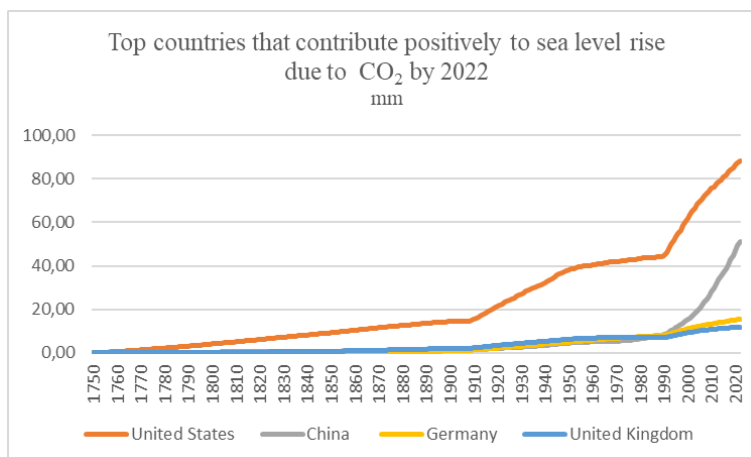
Finally, based on the logic of the Brazilian proposal, accumulated emissions lead to increased concentration, considering the decay of previous emissions, the accumulation of concentration leads to increased temperature, and the accumulation of temperature leads to increased sea level.

The IPCC does not present a continuous description of historical sea level rise. The IPCC presents average increases in mm over three periods, considering the thermal expansion of the oceans due to increased temperature, the melting of glaciers, snow-capped mountains, and also Greenland and the western part of Antarctica. The first presents the annual average up to 1910; the second the annual average from 1910 to 1990; and the third, the historical average from 1990 and projected until 2040.

Therefore, to estimate the temperature increase in degrees Celsius, the resulting radiative forcing in  $W/m^2$  was estimated according to the IPCC, based on the  $CO_2$  concentration, and using the IPCC estimate of the temperature increase and radiative forcing in the case of doubling the pre-industrial concentration (560 ppm), the temperature increase until 2022 was estimated from the radiative forcing.

For the attribution of the average sea level rise, logic analogous to that of Dr. Gilvan's original proposal of the third accumulation of emissions from the temperature increase was used. Recalling that, in this updated proposal, net  $CO_2$  emissions (emissions minus removals) were used instead of  $CO_2$  emissions. Thus, the first accumulation of net  $CO_2$  emissions from countries corresponds to the contribution to the increase in  $CO_2$  concentration, the second accumulation of net  $CO_2$  emissions from countries corresponds to the increase in average temperature, and the third accumulation of net  $CO_2$  emissions from countries corresponds to the rise in sea level.

Similarly, among the countries that have contributed most positively to the rise in sea level up to the year 2022 are the United States, China, Germany, and the United Kingdom.

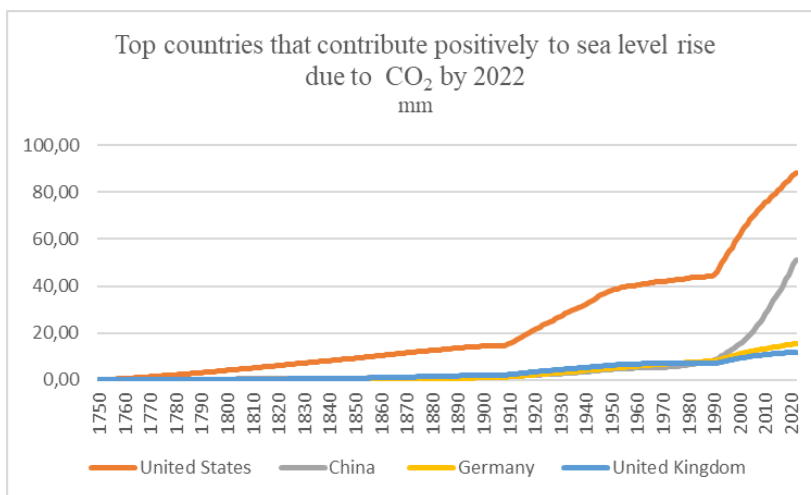


Source: Prepared by the author.

The United States, contributing almost 88 mm to sea level rise, is followed by China with 51 mm of sea level rise, followed by Germany, the United Kingdom, Indonesia, India, Japan, Ukraine, the Russian Federation, and Argentina among the main countries with positive contributions.

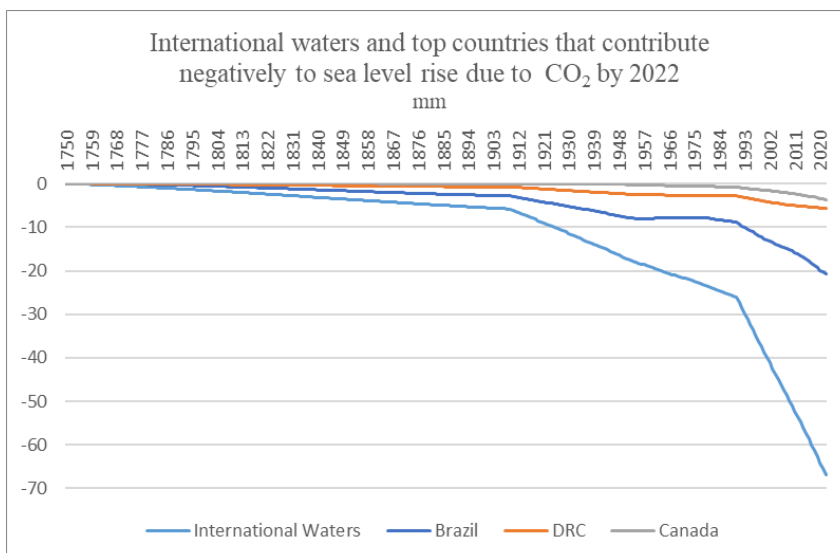
Country	Sea-level Rise mm by 2022	% of the World
UNITED STATES OF AMERICA	88,30686	48,23%
CHINA	51,28604	28,01%
GERMANY	15,52684	8,48%
UNITED KINGDOM	11,87411	6,49%
INDONESIA	11,44876	6,25%
INDIA	11,55107	6,31%
JAPAN	9,85927	5,38%
UKRAINE	6,83497	3,73%
RUSSIAN FEDERATION	5,44711	2,97%
ARGENTINA	5,35164	2,92%

Source: Prepared by the author.



Source: Prepared by the author.

Similarly, the largest negative contribution to sea level rise comes from international waters and from countries that would have a negative contribution to sea level rise. The main countries with a negative contribution to sea level rise are Brazil, the Democratic Republic of Congo, and Canada.



Source: Prepared by the author.

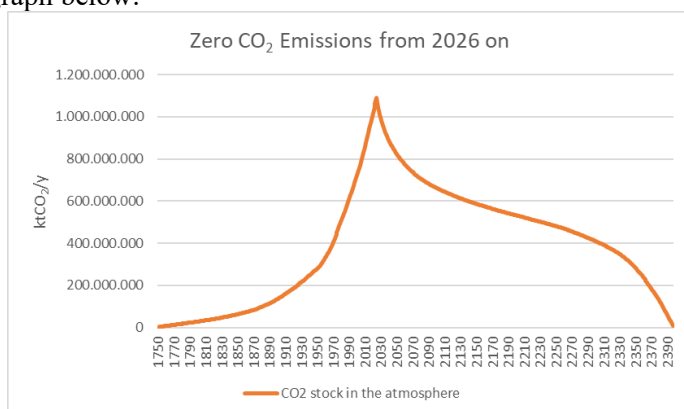
International waters receded by approximately 67 millimeters, representing more than 36% of the negative contribution to sea level rise. Brazil reduced its water level by about 21 millimeters, the Democratic Republic of Congo by about 6 mm, and Canada by almost 4 millimeters. Without these countries, the sea level rise would have been greater.

Country	Sea-level Rise mm by 2022	% of the World
INTERNATIONAL WATERS	-66,74479	-36,45%
BRAZIL	-20,78676	-11,35%
DEMOCRATIC REPUBLIC OF THE CONGO	-5,75512	-3,14%
CANADA	-3,67245	-2,01%
PERU	-2,20576	-1,20%
GUYANA	-1,64990	-0,90%
SURINAME	-1,43653	-0,78%
COLOMBIA	-1,41596	-0,77%
GABON	-1,32084	-0,72%
CHILE	-1,22710	-0,67%

Source: Prepared by the author.

Since the responsibility for all climate change was attributed to all countries, two additional investigative scenarios were carried out. First, a net-zero emissions scenario was investigated. As net-zero emissions equate annual CO<sub>2</sub> emissions to annual CO<sub>2</sub> removals, the CO<sub>2</sub> stock in the atmosphere remains constant. The CO<sub>2</sub> stock would be maintained at a value above 1 trillion tons. Then a more radical scenario was made, which would consider a zero CO<sub>2</sub> emissions scenario from 2026 onwards. In this scenario, the decay of CO<sub>2</sub> emissions is simply carried out for the entire period from 2026 onwards, assuming that there are no more CO<sub>2</sub> emissions. Then the decay of the stocks in the atmosphere would be estimated, using the impulse response function of Fortunat Joos (2012).

The conclusion reached, even in this extreme analysis of Zero Emissions, is that the same stock that existed before the Industrial Revolution, in 1750, would only be reached in 2390, meaning there would still be 370 years of global warming before reaching the historical value of 1750. As can be seen in the graph below:



Source: Prepared by the author.

The second investigative scenario for understanding climate change was to estimate the contribution of each negotiating group of the Convention to CO<sub>2</sub> emissions, to the increase in CO<sub>2</sub> concentration, to the increase in temperature, and to the rise in sea level. The objective was to assess the participation of the negotiating groups in the UNFCCC to see the importance of the groups in terms of responsibility for causing global climate change.

So, it is important to note that the largest emitting group is the G20, followed by Non-Annex I, BRICS Plus, LMDC, the Non-Annex I countries of the G20, and BRICS, the latter groups involving

developing countries. This shows that developing countries are increasing their emissions and developed countries are either stabilizing or decreasing their CO<sub>2</sub> emissions. The groups of countries that are smaller CO<sub>2</sub> emitters in terms of the Convention's negotiations are the Small Island Developing States, ALBA, AILAC, Lusophone Cluster and Environmental Integrity Group (EIG), the Sur group (Argentina, Brazil, Paraguay, Uruguay) and the LDCs, least developed countries.

Group	2022	Energy &		Total Emissions	
		Cement ktCO <sub>2</sub> /y	Forest ktCO <sub>2</sub> /y	ktCO <sub>2</sub> /y	
WORLD		36.126.717	3.345.875	39.472.592	100,00%
G20		30.276.514	1.387.366	31.663.880	80,22%
NON-ANNEX I		23.311.357	3.209.208	26.520.565	67,19%
BRICS PLUS		19.693.963	1.289.819	20.983.782	53,16%
LMDC		18.534.099	1.032.278	19.566.376	49,57%
G20 NAI		18.133.931	1.267.323	19.401.254	49,15%
BRICS		17.088.079	435.860	17.523.939	44,40%
ANNEX I		12.815.360	136.667	12.952.027	32,81%
G20 AI		12.142.583	120.043	12.262.626	31,07%
OECD		11.478.963	217.490	11.696.452	29,63%
ANNEX II		9.574.627	125.881	9.700.508	24,58%
G7		8.291.850	62.873	8.354.723	21,17%
UMBRELLA		7.921.982	72.848	7.994.830	20,25%
EU		3.094.403	55.900	3.150.303	7,98%
EIT		2.804.521	10.786	2.815.307	7,13%
AGN		1.323.928	1.359.778	2.683.707	6,80%
OPEC		2.256.520	231.931	2.488.451	6,30%
ARAB GROUP		2.106.803	65.025	2.171.827	5,50%
LDC		392.308	1.296.785	1.689.093	4,28%
SUR		693.757	517.504	1.211.261	3,07%
EIG		1.160.498	0	1.160.498	2,94%
LUSOPHONE		556.333	603.248	1.159.581	2,94%
AILAC		295.373	132.313	427.686	1,08%
ALBA		255.975	79.437	335.412	0,85%
SIDS		173.725	47.872	221.597	0,56%

Source: Prepared by the author.

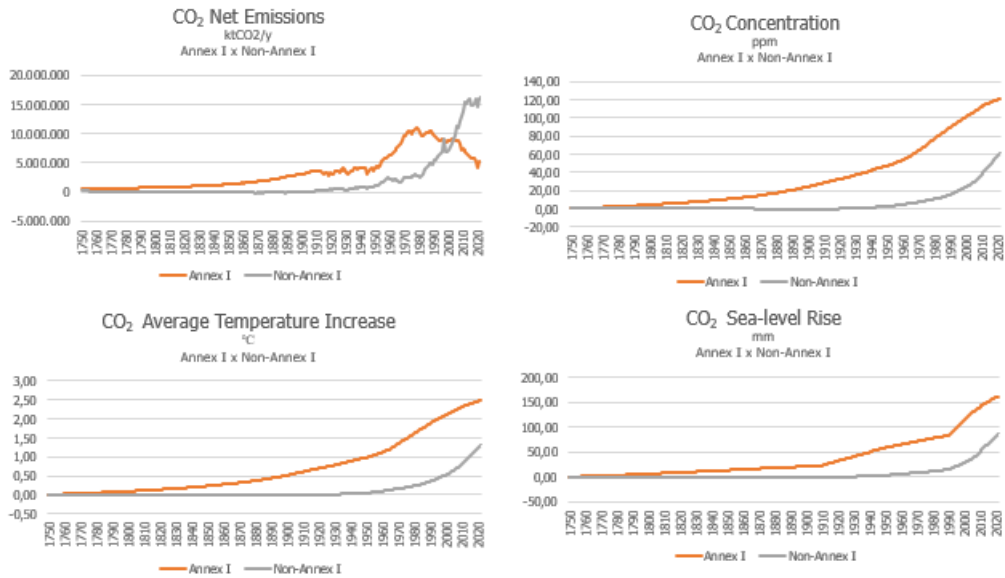
However, when analyzing temperature increases using the country-by-country allocation for the groups, the situation is reversed. The largest contributors to global climate change, in terms of temperature and sea level rise, are mostly groups of developed countries. The first remains the G20, a group that brings together the world's largest economies, followed by the Annex I group, OECD, Annex II, G20 Annex I countries, G7, and the Umbrella Group. In other words, all the largest contributors to temperature and sea level rise are developed countries, while the smallest contributors are international waters, obviously, followed by Portuguese-speaking countries, the Southern group, Small Island Developing States, and least developed countries. These are the countries that contributed the least to temperature and sea level rise.

Group	Net Emissions in 2022 ktCO <sub>2</sub> /y	Incremental Concentrations by 2022 ppm	Temperature Increase by 2022 °C	Sea Level Rise by 2022 mm
<b>WORLD</b>	15.309.209	134,40	2,81	183,10
G20	18.813.733	151,95	3,11	207,53
ANNEX I	4.898.423	121,42	2,49	162,38
OECD	5.969.880	112,12	2,28	150,28
ANNEX II	4.626.196	101,26	2,05	135,60
G20 AI	4.212.097	101,06	2,04	135,20
G7	4.637.622	95,66	1,93	128,20
UMBRELLA	3.899.404	86,26	1,73	115,50
NON-ANNEX I	16.282.374	61,21	1,29	86,55
LMDC	16.571.530	56,65	1,18	80,62
G20 NAI	14.601.636	50,89	1,06	72,32
BRICS PLUS	13.501.536	48,67	1,02	69,01
BRICS	11.279.471	36,03	0,74	51,53
EU	1.533.610	31,24	0,67	41,87
EU MINUS EU EIT	1.105.680	23,04	0,50	30,88
EIT	143.899	21,56	0,47	28,59
EU EIT	427.930	8,20	0,18	11,00
ARAB GROUP	2.051.247	7,88	0,17	11,12
OPEC	1.757.840	7,49	0,16	10,51
EIG	914.050	4,92	0,11	6,82
AGN	682.094	3,23	0,07	4,50
ALBA	-204.613	0,17	0,004	0,16
AILAC	-618.687	-3,72	-0,08	-5,14
LDC	-228.378	-4,14	-0,09	-5,56
SIDS	-940.688	-6,54	-0,14	-9,16
SUR	-2.114.705	-10,48	-0,22	-14,59
LUSOPHONE	-2.243.910	-15,79	-0,34	-21,67
INTERNATIONAL WATERS	-6.052.237	-48,87	-0,98	-66,74

Source: Prepared by the author.

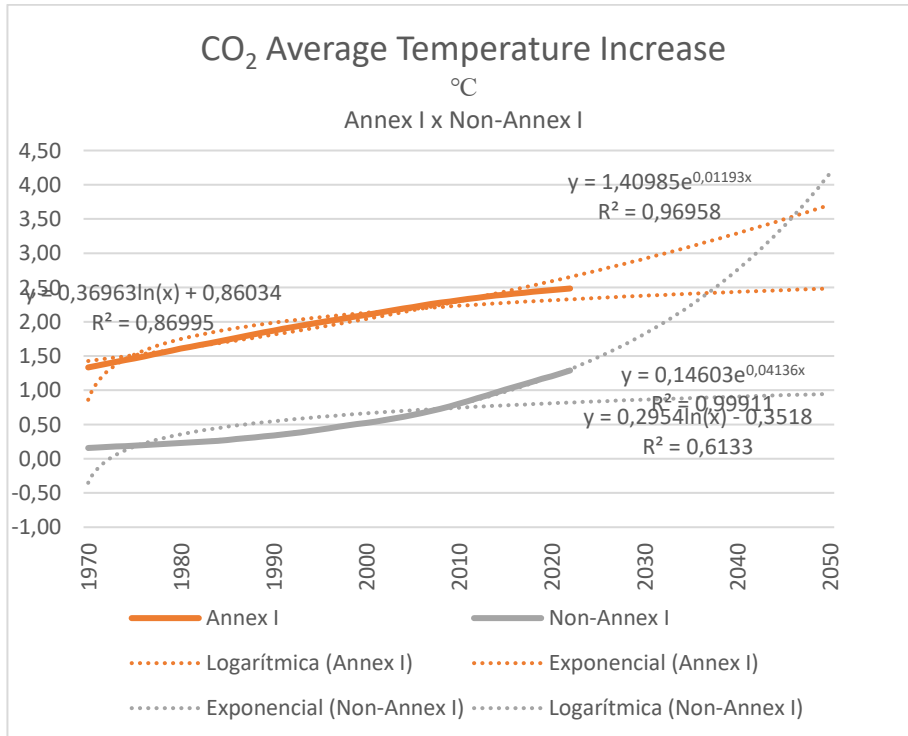
Furthermore, among the negotiating groups, it is important to analyze the group of Annex I countries (developed countries) with those of Non-Annex I countries (developing countries).

The figure below shows that although the net CO<sub>2</sub> emissions of the Annex I group of countries are decreasing, from around 1990 to 2022, and the emissions of the Non-Annex I group of countries are increasing, having crossed the net emissions of Annex I around 2005, the responsibility of the Annex I countries is always greater in terms of CO<sub>2</sub> concentration, with Annex I contributing more than 120 ppm and Non-Annex I contributing about 60 ppm; in terms of average temperature increase, with Annex I contributing about 2.5°C and Non-Annex I contributing less than 1.5°C; and in terms of sea level rise, contributing an increase of over 150 mm, whereas Non-Annex I contributed less than 100 mm.



Source: Prepared by the author.

The figure below shows that, after 28 years, the responsibility of non-Annex I countries would only equal that of Annex I countries between 2038 and 2048, even under these extreme assumptions, since the United States is not reducing its CO<sub>2</sub> emissions (logistics would be an extreme assumption for Annex I) and there is no certainty that Annex I countries, as a group, will stabilize their emissions in the future. Similarly, the assumption that non-Annex I countries would continue to grow exponentially indefinitely is an extreme assumption. It should be clear that this is not a prediction, but only a trend line.



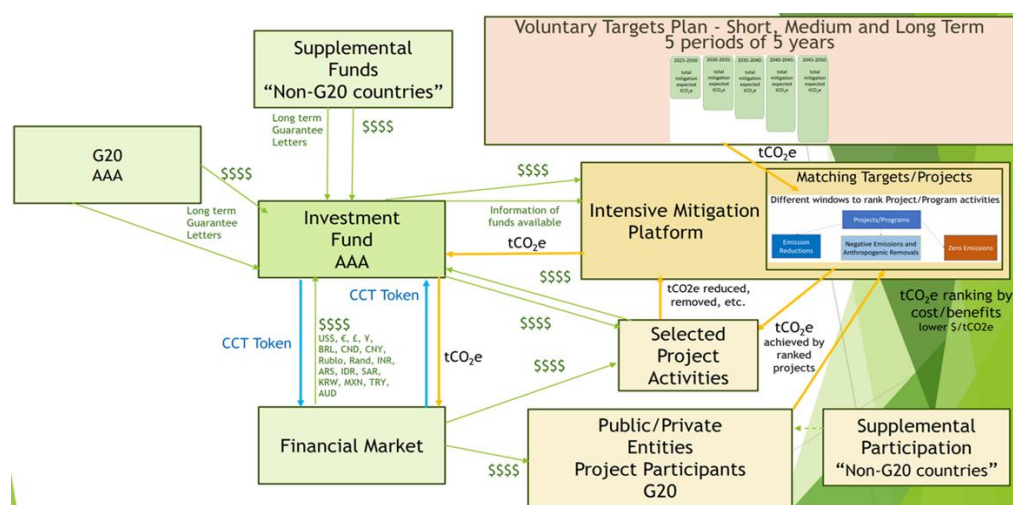
Source: Prepared by the author.

In the 1997 Brazilian proposal, this value was only considered in 2147, the year in which this intersection of historical responsibility for global warming would occur in the original Brazilian proposal, a year that varied in the revisited proposal due to increased CO<sub>2</sub> emissions, mainly from China

and India. Even so, the responsibility of developed countries is much greater than the responsibility of developing countries for the temperature increase, as shown in the figures above.

Finally, in terms of compatibility with the 1997 Brazilian proposal, a mechanism is proposed that would no longer be based on a clean development fund, as proposed in the original Brazilian proposal, which evolved into the CDM mechanism in the Kyoto Protocol.

In the revisited Brazilian proposal after 28 years, an innovative mechanism is proposed for the G20 countries. The mechanism would only be among the G20 countries and would consist of three different platforms, one platform that would be a mitigation platform, where countries' target plans would be presented for five five-year periods; The mitigation platform, based on these goals, would implement projects presented to the platform by G20 countries with the best cost-benefit ratios to achieve these proposed targets. An investment fund would finance the implementation of these projects, and supplementary funds could be provided by G20 members, provided the triple-A investment fund is maintained; these funds could come from other countries, not just the G20. Therefore, this would be a proposal for a fund to increase international cooperation and develop a mitigation plan among the largest emitter countries, as presented in the UNFCCC negotiating groups. The G20 countries would form the executive board of this mechanism, with less political influence from smaller emitter countries and greater ease in reaching consensus on decisions.



Source: Miguez; Mendes; Schweizer (2025).

Finally, I would like to express my deepest gratitude to PUC Minas and FAPEMIG for funding the project and, once again, to my thesis advisors, Professor Dr. Leonardo César Ramos and Thiago de Araújo Mendes, for their suggestions and comments. Thank you very much.