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Review Article

Discovery: Reduction in Photosynthesis Correlation to Carbon Dioxide Increase

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Abstract

The correct cause of atmospheric carbon dioxide rise is deforestation of the Amazon rainforest (0.99). Since 1950, the Amazon Rainforest has been deforested at the average rate of 12 million hectares per year. This deforestation causes at least 30% of the biomass to be burned, which is adding billions of tons of CO_2 to the atmosphere. The carbon dioxide has overwhelmed the rainforest and caused plants to grow faster and topple over, causing massive decay. The Amazon rainforest is now an oxygen sink and CO_2 producer. To correct these issues, we need to stop the burning and deforestation. The burning then can continue at a rate of 10% a year for 10 years. This will heal the rainforest and bring down atmospheric CO_2 quickly. Carbon emissions correlate to 363 ppm and are not the cause of the Atmospheric CO_2 rise since 1957. This is why the minimum residence time has increased to 500 years.

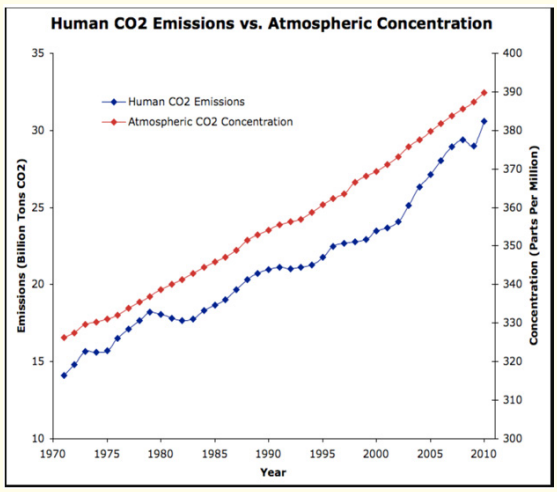
Keywords: Carbon Dioxide Increase; Carbon Dioxide Scavenging; Climate Change; Rainforest

Significance statement

Atmospheric CO_2 has two possible causes. CO_2 emissions are one. We have worked on that and have a 15% drop so far. However, the atmospheric CO_2 concentration and residence time are still increasing. The atmospheric tank model is just like a kitchen sink. When the water rises and stays in longer, we know we have a drain. In the atmospheric tank model, drain is photosynthesis. We can never bring down atmospheric carbon dioxide by working on emissions alone. We need to put even more effort into increased photosynthesis. This will reduce atmospheric carbon dioxide to 330-ppm year 2031 to 2040.

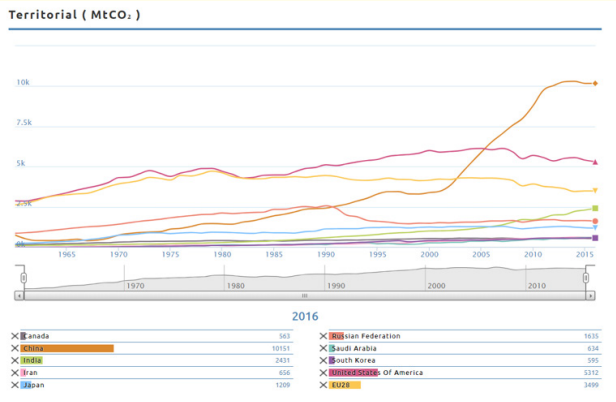
Data

For the past 50 years, carbon dioxide emissions has been said to be the cause for atmospheric CO_2 concentration increase. Many papers are published with the correlation in graph 1. This was the only one available, and it was used extensively published in journal papers and presented at conferences. The other sources of sinks for CO_2 are the rainforests and other plants that scavenge CO_2. Atmospheric carbon dioxide is a production issue. The consumers are the plants and diffusion. The producers are the CO_2 emissions. We have a 5X increase in emissions and a 20X decrease in consumption by photosynthesis. Up to 60 tons of carbon dioxide annually are removed by one hectare of rainforest [1]. However, we have burned a total of 860 million hectares in the last 70 years. At 410 ppm, we have 3501 moles of CO_2 in the troposphere (0.154 tons). If we added hectares to the rainforest instead of subtracting them the CO_2 would be consumed quickly. The older shrubs and trees are over-worked by the increase in CO_2 from local burning and are dying off causing massive decay [2].



Graph 1

The dying biomass decay has caused the rainforest to become an oxygen sink and CO_2 producer. Now producing more than 10 billion tons of carbon dioxide annually that is not accounted for. The USA Environmental Protection Agency has stated that "CO_2 enters the atmosphere through burning fossil fuels (coal, natural gas, and oil), solid waste, trees and wood products, and because of certain chemical reactions (e.g., manufacture of cement), CO_2 is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle" [3]. Since 2014, the global CO_2 emissions are decreasing slightly. See Graph 2. Since 2014 the emissions are flat and the CO_2 in the atmosphere is still increasing.



Graph 2: Global carbon dioxide emissions.

In May of 2017, I looked at how the carbon dioxide emissions were leveling off [10]. The decreasing CO_2 emissions are shown in Graph 2. Then the news came from the Mauna Loa Observatory that the CO_2 concentration changed from 405 ppm to 410 ppm [4]. I looked at many other possible causes of the Global CO_2 increase and the destruction of the rainforest to be best. I could not find any other reports on the relationship of the rainforest to CO_2 increase. However, there exists a relatively small reference to land and forest issues in the carbon dioxide emission calculations [5]. Fossil fuel emissions are only part of the CO_2 concentration. Forest cover and other land uses changes also play a role. It is a very dynamic system, and the year-to-year change depends upon temperatures and atmospheric transport, and the amount of emissions. The deforestation of the rainforest started in 1950 and continues today.

Greenhouse gases, like all gases, diffuse until they are equidistant to each other at any given pressure and temperature combination. At STP (Standard Temperature and Pressure, 25C, 1 Atmosphere), CO2 has diffusion coefficients:

In air 16 mm^2/s, and

In water 0.0016 mm^2/s.

CO_2 is more likely to diffuse in the air than the ocean [6]. The diffusion length in air is 2 cm per month toward the exosphere. The ocean-air interface diffusion is 14.8 cm per day in the direction of the atmosphere. The driving force for diffusion is much greater in the direction of the exosphere, where the concentration is 25 ppm. In 2018, one year later, the concentration has increased to 40 ppm. Flux = 2 cm per month towards the exosphere. CO_2 that goes into the ocean is from any disturbance of ocean surface (e.g. Hurricanes) that allow CO_2 to enter the ocean. We chemical engineers use this principle when designing an Industrial exhaust scrubber. Most of the ocean's surface is at standard temperature and pressure at any time.

CO_2 does not freeze in the upper atmosphere. The freezing point in the mesosphere at .14 ATM (Atmosphere) pressure is -100C, and the temperature in the mesosphere is -90C. The half-life of CO_2 in the atmosphere is 5 to 400 years [8].

CO_2 waits in the atmosphere, diffusing from the surface to the exosphere, carried by atmospheric winds to be scavenged by photosynthesis. It is easy to see why the carbon dioxide level is increasing with less photosynthesis. The more pertinent issue is loss of O_2 production. The oceans provide photosynthesis from plants living on the ocean surface.

Photosynthesis is a process where a plant consumes CO_2 then creates more plant and produces O_2 from the oxygen. This oxygenic photosynthesis. CO_2 + Photons+$2H_2O \rightarrow O_2 + H_2O + [CH_2O]$. This process is much more relevant to the atmospheric carbon dioxide rise than carbon dioxide emissions. I collected photosynthesis information from a researcher from Mongabay. They have been researching the Amazon rainforest for 20 years. They supplied me with the hectare numbers in this report. Figure 1 shows the calculation method for correlation coefficient I used, called "Pearson's Regression". The emissions data are from the well-known graph of CO_2 and carbon dioxide emissions [9]. This is the best data on CO_2 emissions as a cause of CO_2 concentration increase. The raw data used is in Graphs 1 and 3.

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

Figure 1: Pearson's Regression formula.

Atmospheric CO_2 statistically is a binary system with two causes. They are CO_2 emissions and loss of photosynthesis. For a binary system, we must have a greater than or equal correlation coefficient of 0.90. I graphed the CO_2 concentration and rainforest deforestation at 5%-time intervals and then calculated each part of the formula. The correlation coefficient calculated is 0.99. This exceeds the 0.90 threshold. The hectare value is used because each hectare of rainforest contains the same amount of CO_2 scavenging plants. Using the same method, I calculated for CO_2 emissions and CO_2 concentration increase. The correlation coefficient calculated is 0.63. Thus, we must not say it is cause and effect.

Graph 3 data came from a researcher in South America [10].

1 Hectare= 2.47 acres=ha

1950-1979

Tropics: 318M ha

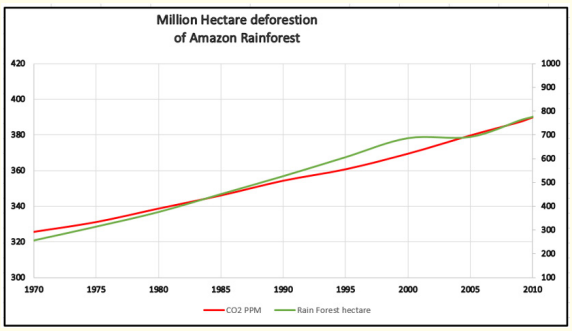
Temperate: 18M ha

1980-1995

Tropics: 220M ha

Temperate: 6M ha

226M ha total or 15.1M ha/year

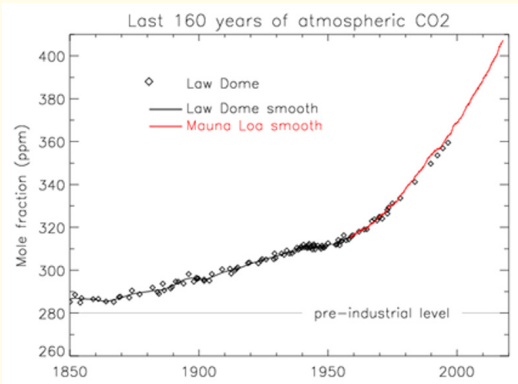


Graph 3: Million Hectare Rainforest Deforestation.

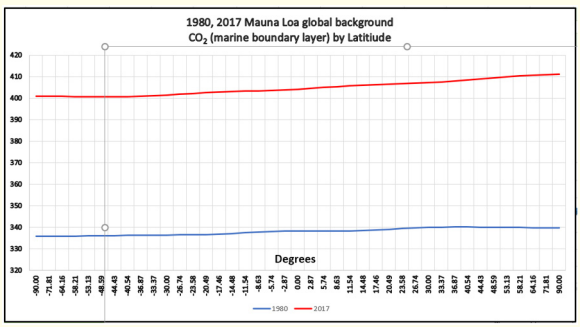
In 2011, tropical forest loss was at 11.33M ha/year, in the 1990s at 16M ha/year, and in the 2000s at 13M ha/year. This massive deforestation and burning is the reason for the rise in carbon dioxide.

The CO_2 concentration is on the rise at Mauna Loa Observatory [9] even though the carbon dioxide emissions [11] are decreasing overall. China is still flat and has not decreased its emissions yet. India is increasing its emissions. We would see a decrease in concentration if carbon emissions were the main cause of the rise since 1950. The burning of the rainforest and its resulting decay are the cause of 15 billion tons of CO_2 annually, but the global emissions annual totals show only 3 billion tons of carbon dioxide oxide from deforestation and other land use and natural causes.

Mauna Loa data prove that the rainforest is the cause of the rise in carbon dioxide since 1957. Graph 4 shows two regimes. Pre-1950 increase is one slope and post-1957 is a greater slope. Taking the pre-1950 slope to the current year, the value of 363 ppm is seen. Then using regression, I received at 0.98 coefficient. This shows the rainforest burning effect is around 48 ppm. Graph 5 from Mauna Loa data show the carbon dioxide is evenly distributed in the atmosphere.



Graph 4: Mauna Loa carbon dioxide yearly averages.



Graph 5: World atmospheric carbon dioxide by latitude.

There are two distinct regimes in the CO_2 increase in Graph 4 from Mauna Loa with. The industrial part (pre-1950) shows that without the deforestation of the rainforest, the current CO_2 concentration would have been 363 ppm. Shortly after the deforestation started in 1950, we see the current regime rise. The current regime includes CO_2 emissions plus rainforest burning. I extended the industrial line and calculated the regression; the coefficient is 0.98.

At 3 billion tons per year [13], the deforestation contribution of the 36 billion total is 12%. However, the decay contribution from the Amazon is 10 billion more tons annually. Anthropogenic forest degradation and biomass burning (forest fires and agricultural burning) also represent relevant contributions. Annual greenhouse gas emissions from agricultural in 2000–2010 were estimated at 5.4 Gt CO_2eq/yr [13].

Results

My work with the US embassies in South America, India, and China has been to increase the emphasis on photosynthesis and land use.

Amazon rainforest deforestation is slowing.

Indian rainforest deforestation has stopped.

China must renew its commitment to plant more trees to increase its forest by 2% by 2020.

Graph 6 shows that the current Mauna Loa daily data have changed [14].

Conclusion

This report has a much stronger correlation to loss of photosynthesis to the increase in Atmospheric carbon dioxide. (0.99 vs. 0.63). The Atmospheric CO_2 rises as more hectares of rainforest are destroyed.

This is the reason the CO_2 is higher now than in 1950. We need to stop the burning and deforestation of the rainforest.

A second step to atmospheric carbon dioxide reduction is to plant one billion native trees and shrubs all over the world. This will start to make a difference within a few years.

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Certainly, if the time and money were spent stopping the deforestation of the rainforest and planting native shrubs and trees the CO_2 level would soon start to retreat.

Conflict of Interest Statement

I have no conflict of interest that I am aware of.

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