Abstract

Climate change conditions are ultimately established and measured by the level of carbon dioxide within a biome's atmospheric residence conditions. Therefore, reducing carbon dioxide emissions and sequestering carbon dioxide are measurable in comparison when determining their climate mitigation potentials. As a result, climate-changing conditions depend more on *sequestration,* considering a biome's alteration of sequestration abilities that promote either increases or decreases of atmospheric residence time from all emission sources.

The present study further defines relationships of carbon dioxide-driven climate change by analyzing the data that established cause-and-effect in atmospheric carbon dioxide levels. Historical correlations were also applied, which revealed the biome impact of historical human demand for forestry resources, the historical and contemporary management of forestry, and historical changes in land uses.

Human domestication of forests has influenced an ongoing decline in forest maturity, which in turn results in globally "*impeded fast-cycle carbon dioxide sinks 2.5,"* leaving only 3–5% of "mature and responsive" global forestry carbon dioxide sinks. The study concludes that carbon dioxide-driven climate-changing conditions are only feasible by the globally decreasing tree maturity effect on sequestration abilities. Therefore, sequestration is critical in mitigating climate change due to the frequently overlooked, albeit regrettable, principles of emission reduction and conservation laws governing biomes.

1. **Keywords:** Sequestration, Forestry, CO_2 sink, Emission, Climate Change, Biome

2. Introduction

"Complete Mitigation Science," or CMS, is a project characterized by the inner disciplinary structure required to study climate change conditions and their impacts comprehensively. The present study examines the potential effectiveness of implementing the project's findings to completely mitigate CO_2-driven climate change.

This study aimed to analyze the conditions for climate change development due to historical and modern human domestication practices. The historical connections between global forestry and its impact on atmospheric CO_2 levels (in ppm) were analyzed in this study. The study first focused on determining the relevance of the correlations to CO_2-driven climate change. The data explored the fast-cycle CO_2 sequestration abilities within global forestry underestimated sequestration potential by ignoring the impact of maturity on forestry. With a root cause established, the study shifted into defining logic and modeling its conclusions. It then progressed to determine a measure for historical records of atmospheric CO_2 sequestration and residence time. Additional evidence further supports the correlation revealed in the initial study.

New and expanded terminologies are necessary to define the study's climate change logic and set precedence for the results obtained:

2.1. Sequestration value

Forestry CO_2 sinks and their sequestration ability are more non-renewable than renewable (see *binary restricted resource 2.2*). This generates value in climate mitigation regarding carbon credits, offsets, and *sequestration dependence* 2.7.

Herein, the ability to sequester CO_2 within climate mitigation is described as a human endeavor toward domestication, which can have an economic value. The *sequestration value* is established by considering CO_2 sequestration abilities within terrestrial sinks to prolong human domestication. *Sequestration value* is currently priceless but can be socially appraised and monetized.

CO_2 *sequestration value* is established by measuring the requirement to maintain atmospheric CO_2 and abate climate change. It can be balanced with emission input, more abundant than emissions, or deficient to a desired level, as it is globally today. The current CO_2 levels within the atmosphere are notable. (1) Therefore, removing CO_2 to achieve balance, abundance, or deficit creates a high *sequestration value* socially and economically. *Sequestration value* can be monetarily established by converting atomic mass units of CO_2 (44 amu) as the *sequestration value* or the sequestered amount as carbon (12 amu) stored within wood biomass as the result of sequestration. (2) (3) (4) (5) Thus, *sequestration value* is an amount of sequestration achievable or having occurred within sequestration-based climate mitigation that has or can be further translated into economics to facilitate human domestication that abates climate change.

2.2. Binary restricted resource – an expanded definition of a renewable resource

Trees are considered as renewable resources. Regenerated biomass from trees is only a part of this resource. They also possess CO_2 sequestration ability (serving as a CO_2 sink), which is less readily renewable. Trees replenish biomass over two to three decades; however, the duration required to be helpful as a CO_2 sink and contribute as a net CO_2 negative is much longer and cannot be easily replaced (1). In contrast, its "*sequestration value 2.1*" becomes more apparent to human domestication requirements than biomass demand.

The study's findings suggest that the sink is more essential than the biomass among the combined resources. However, unlike its biomass counterpart, the sink resembles a non-renewable crude oil. It can take lifetimes for this resource within the tree to be replenished. Thus, though renewable, its efficacy is different from biomass. The demand for biomass necessitates a shorter renewal duration, significantly suppressing the extended duration requirement of the sink as a "*binary restricted resource.*"

2.3. Unconstrained and constrained deforestation practices

The scope of "deforestation" is broadened into two factors with differing roles. The assessments oppose the conventional definition of "forest degradation," whereas forestry use is expected to result in afforestation with an anticipated return to a normal forestry state. The following two subsections are intended to set precedence for CMS logic, arguments, and conclusions:

2.3.1. Unconstrained deforestation

"Unconstrained deforestation" permanently reduces or eliminates the "*binary restricted resource 2.2*" of CO_2 sequestration by substituting land use or clearing forestry CO_2 sinks from existence. Like deforestation, clearing forests for crop production or an unintended demise from weather, fire, climate change, biome formation, urbanization, or biological effects can be classified as "unconstrained deforestation." The concept behind *unconstrained deforestation* is that the forest will never return to normal forestry under human or unintentional stewardship. In contrast, deforestation is the removal of forests but implies afforestation as a possibility. Thus, the problem is related to the inherent and enduring characteristics, such as those of urbanization and dam functions, which continue to exist despite attempts to redefine or alter their displacement of forestry.

Unconstrained deforestation is also partially responsible for increasing but unintended climate demise in an ever-expanding spiral. The more *unconstrained deforestation* occurs, the more climate degradation, which could lead to biological biome changes, forest fires, and adverse weather conditions, which in turn results in further *unconstrained deforestation*. In the end, all these factors are adjusted via climate change impacts. The action is unconstrained in creating the destructive circumstance and perpetuating its result.

2.3.2. Constrained deforestation

Constrained deforestation is the forestry practice that allows forestry to be present but physically set aside and never allowed to achieve a forestry normal or recover its "*binary restricted resources* 2.2." CO_2 sequestration is not currently considered in forest practices regarding renewability. This effect is typical because of human interference with natural biology with current and generationally applied stewardship practices. Those forestry practices comprise short-durational commercial harvest rotations that reduce tree maturity, lessen biodiversity, and increase forest impediments due to other "reoccurring" impacts like forest fires or drought.

This can be summarized as "the unnatural and inefficient use of forestry that impedes the capability and quantities of CO_2 sinks." *Constrained deforestation* practices also emit more CO_2 from forestry than the replanted sinks can sequester owing to human demands for unnatural and inefficient uses. Managing forests for product demand and not efficiently using all available resources is crucial, making *constrained deforestation* precedent in this study. The action is thus constrained by the destructive circumstances perpetuating its results.

2.4. Climate change datum, beginning of climate-changing results

The datum point of CMS is a timeline indicator at approximately 1850 CE. Precedence is established using four indicators: human and natural CO_2 emissions accelerate an upward trend in CO_2 atmospheric levels; by indicating a decline of terrestrial fast-cycle sinks shrinking over the years based on the volume of CO_2 sequestered; by establishing a downward trend in sinks available to sequester CO_2; correlation is directly linked to historically *constrained* and *unconstrained deforestation* 2.3 practices, as the last mature forests of Earth in the Americas (North, South, and Central), except the untouched portion of the Amazon forest, became marketable and subject to harvest from the 1700s and still today. The datum is notable in the correlation between historical forestry use and the acceleration of atmospheric carbon dioxide levels.

2.5. Impeded fast-cycle CO_2 sink or impeded sink

Forestry or other fast-cycle CO_2 sinks that exist as immature sinks as a *binary restricted resource 2.2* impeded from reaching their required or needed potential as mature or *sequestration valued* 2.1 sinks. Typically, forestry sinks are impeded by *constrained or unconstrained deforestation 2.3*. The result restricts the carbon dioxide sequestration of photosynthesis by limiting them to immature or non-existent levels. Impeded magnitude is measured in tonnes of carbon dioxide and obtained in the comparison of human absence in contrast to the eliminating, impeding, or decreasing the volume of a CO_2 sink's micro or macro sequestering ability constrained by intervals of past, present, or projected into a future. Impeded sequestration is also *proportional 2.8* to tree or forest maturity and complete climate mitigation.

2.6. Law of conservation

The *law of conservation* was used to estimate the carbon dioxide amount as being initially placed into an enclosed system, the same as CO_2 is present within Earth's biome. (6) Carbon quantities do not and cannot increase or decrease in any way within that enclosed system (Earth-bound); an increase is impossible without an external addition to the system, for instance, an asteroid hitting Earth. Therefore, Earth-bound systems producing or reducing CO_2 conform to a *law of conservation* that acts as a restriction. Overall, there can never be more or less of an element within a closed system like Earth. Nevertheless, an element can change forms, like elemental carbon, transforming into carbon dioxide, which can then move to a different location in a chemical reaction, such as photosynthesis, converting it into biomass.

One focus of the study was the physical movement of elements. The evidence suggests that the conversion of carbon through human domestication requires an equalizing transfer to maintain climate homeostasis, a balance acting within the *law of conservation*.

As a result, conversion (emissions) and storage (sequestration and sequestered) play a crucial role in achieving homeostasis within a closed biome such as Earth. The study establishes the constraints of the conservation law as the amount of CO_2 produced by domestication is deemed infinite. In contrast, reduction (natural sequestration) quickly becomes finite when conversion does not consider storage capacities (as sequestration or sequestered).

Furthermore, mitigation efforts that do not involve sequestration (systems that discount the significance of storage in climate mitigation attempts or emissions-only attempts) are deemed destined to fail. They violate the *law of conservation* by only partly addressing the smaller side of the smaller side of the total equation: human emissions. Therefore, emission-based attempts can never mitigate the estimated 400–750 gigatons of naturally occurring carbon that is converted to CO_2 (as CO_2 emissions). Thus, this is also implying *sequestration dependency* 2.7.

2.7. Sequestration and emission-dependent

CO_2 emissions are defined as unavoidable in human domestication goals, and therefore, humans are "*emission-dependent*." In balance, humans also are "*sequestration-dependent*." Because emissions and sequestration require balanced inputs for ongoing human domestication efforts regarding biome requirements, humans are more "*sequestration-dependent*" because of the closed system the biome exists within, as defined by the *law of conservation, 2.6*. Unbalanced interaction with CO_2 emissions allows extraneous conditions to form undesired effects on human domestication, such as climate change, associated tree and land degradation, and "*unconstrained deforestation 2.3.1*." We rely on emissions being balanced with sequestration; hence, the balance is created therein.

2.8. Application of proportionality

Evidence suggests *proportionality* in defining CO_2 sequestration from the study's multiple areas.

Proportionality occurs among positions within the study:

a. Tree or forest maturity is ∝ to sequestration ability.
    i. Increasing forest maturity increases CO_2 sequestration ability somewhat “exponentially” given enough “t” (time) to increase the forest’s age as maturity.
b. Maturity is then ∝ to sequestration ability and ∝ to atmospheric CO_2 ppm.
c. Atmospheric ppm residence time is ∝ to sequestration available in global forestry.
d. CO_2 residence time increases ∝ to global sequestration abilities decreasing.
    i. The more sequestration available, the less atmospheric residence time.
e. Global forestry area is ∝ to maturity and ∝ to atmospheric ppm reductions.
    i. The older the forest, the less forested area is required to mitigate climate change when measured in atmospheric carbon dioxide outflows.

2.9. Convenient forestry

This implies forestry resources within easy human access. Adjacent to its location, access, ample roads, railroads, low cost, lesser time required to haul resources, topographical ease to access and harvest, and the usability of the biomass available make some forestry *convenient* over other forests. In context to this study, nomadic people did not cross oceans to increase their forestry use; they primarily used *convenient forestry*. They also relocated when the resources were depleted.

Currently, all forests are made *convenient* with technology. The Amazon Rainforest is possibly the exception. As the only old-growth forests remaining at scale, the amount of CO_2 it sequesters is Earth's only viable mechanism that hasten a previous climate collapse. This is primarily due to its untouched maturity levels and subsequent unimpeded CO_2-sequestration capacities. It is however lacking in sufficient quantities (acres) to stop todays atmospheric CO_2 runaway effect and future CO_2 driven climate collapse.

2.10. Tree degradation

CMS defines *tree degradation* as contributing to the “forest degradation and *constrained deforestation 2.3.2*” effect on biomes. *Tree degradation* is brought on by *demand-driven forestry 2.11* practices.

Cutting smaller trees within a reduced duration diminishes tree maturity, biomass size, and the land’s ability to regenerate naturally due to adverse biological effects. *Tree degradation* adversely affects the tree quality and, in turn, reduces the quality of wood products, precludes devaluation of tree sequestration, ultimately creating an *Impeded fast-cycle CO_2 sink 2.5* or further impeding CO_2 fast-cycle sinks, and accelerates the land toward *unconstrained deforestation 2.3.1*.

A tree smaller at harvest becomes less valued. Therefore, more trees are often harvested sooner to compensate for the inefficiency and size lost to immaturity; as an economically inefficient practice and an unnatural occurrence biologically, *tree degradation* increases as *demand-driven forestry 2.11* increases, perpetuating the “*degradation*” effect.

2.11. Demand-driven forestry

This is defined as the forestry that is managed to supply the demand for forest products, disregarding the sustainability of its *binary restricted resources* 2.2 or as a resource in general. Historically, *demand-driven forestry* generated adverse biological effects with *tree degradation 2.10*. The practice perpetuates *constrained deforestation 2.3.2*, the study's primary consideration of climate change conditions. Therefore, such a forest physically supplies demand and is only managed to the required extent and not to others present. (7) (8) (9)

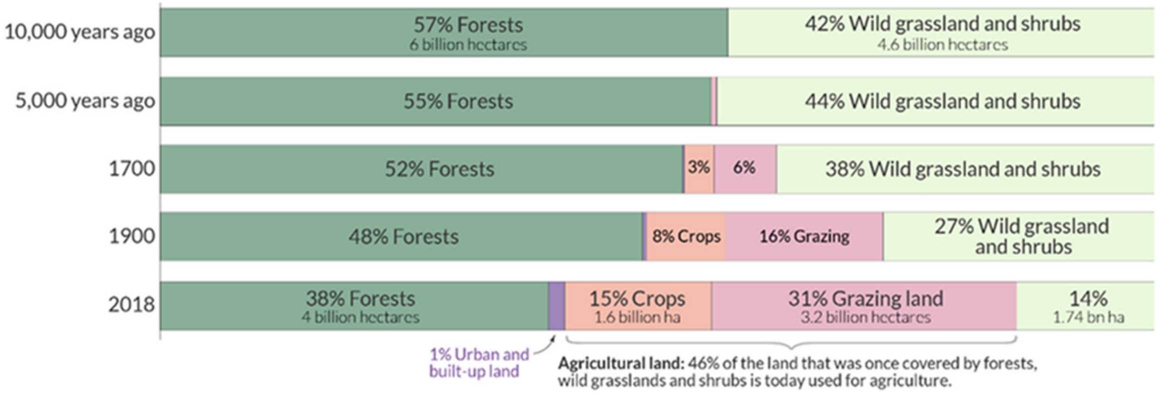
2.12. Carbon hump

After a clear cut, the grounds of a tree plot become a net CO2 positive (a CO2 and methane emissions source) due to remnants of the harvested trees, other plant life on the plot, or life that also succumbed to the practice that decays or is burned as biproduct. The *carbon hump* is added to by waste generated by harvesting or that same waste burned to produce energy or the energy consumed in order to process the harvested biomass into wood products. These *constrained deforestation* practices create an obstacle to restoring any given forestry plot back into a net CO2 negative (A CO2 sink). The *carbon hump* is created from the inability of replacement trees as being replanted, under natural regeneration, or immature in general to sequester more CO2 than the CO2 positive actions (emissions) presented.

Typical *carbon humps* persist 20-30 years on the clear-cut site while the replacement trees mature. The study's *impeded fast-cycle sink* definition includes *carbon humps* to determine percentage of sequestration impediment. (10)

3. Results

3.1. Climate change is more sequestration-dependent 2.7 than emission-dependent 2.7



Data: Historical data on forests from Williams (2003) – Deforesting the Earth. Historical data on agriculture from The History Database of Global Environment (HYDE). Modern data from the FAO.
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Figure 1: *"Humanity Destroyed One-Third of The World's Forests by Expanding Agricultural Land"*

> *"10,000 years ago, 10.6 billion hectares-71% of the Earth's land surface-were covered by forests, shrubs, and grasslands. The remaining 29% are covered by deserts, glaciers, rocky terrain, and other barren land."*

Figure 1 illustrates human domestication (Human Domestication Theory-Roger Silverstone) impact on land use is a modification, geoengineering. Figure 1 also demonstrates the significant reduction from 57% of Earth's land surface under forests 10,0000 years ago to today's 38%. Thompson suggests that land use modification is an input to a more direct correlation of forestry to atmospheric ppm when the effect of demonstration of *unconstrained deforestation 2.3.1* is added to *constrained deforestation's 2.3.2* even more significant impact (Figure 1).

Prehistoric humans moved into a geographic area and depleted the resources. Resources for heat, cooking, and, to a lesser extent, shelter building could always be obtained nomadically. CMS states nomadic actions created the first demand for forestry and began engraining them in all of us. (10) (11) (12)

Nomadic actions provided resources like game animals and forests time to recover. As human domestication gained traction, nomadic humans settled into fixed communities. Townships, roads, and trade routes expanded and lessened previous nomadic forestry recovery durations.

Resources from agriculture and animal husbandry became steady-state and were readily available. As a result, township communities matured and formed into cities, some of which we inhabit today. More populated areas created entanglements of rural regions and trade routes for resources to support the towns that became the mass population centers of today. Thompson's CMS relationship to human domestication can be argued to have begun before population centers were established. Domestication required increased resource use with populations, and forestry was the first and primary resource exploited, just as it is today.

During the millenniums of domestication, humans traded the horse for the train and later the train for the automobile but kept modifying land for food production until the 1980s. Since then, contemporary efforts in food production have created a global "mini" reversal of deforestation, mainly as a global disbanding of small farms for larger, more productive, GMO corporate-type producers and in temperate regions. Naturally, those abandoned small farms began natural afforestation while human-driven afforestation began to take shape globally (Figure 2).

Thompson classifies early human developing practices to use and manage forestry under *convenient forestry, 2.9*. Back then, forestry resources came to the cities from near first and much farther later. Today, forestry resources are entirely extracted in globally traded markets because technology has made all forestry convenient. The only apparatus making some forests inconvenient today are laws, then and now (13) (14). Moreover, those also change regularly over time.

Before 1400 CE, humans, such as Europeans and Asians, had harvested all *convenient forestry 2.9* multiple times, and it's done more intensely now. (12) Initially, regrowth or forestry recovery periods may have been hundreds of years, but as domestication proceeded, they considerably shortened.

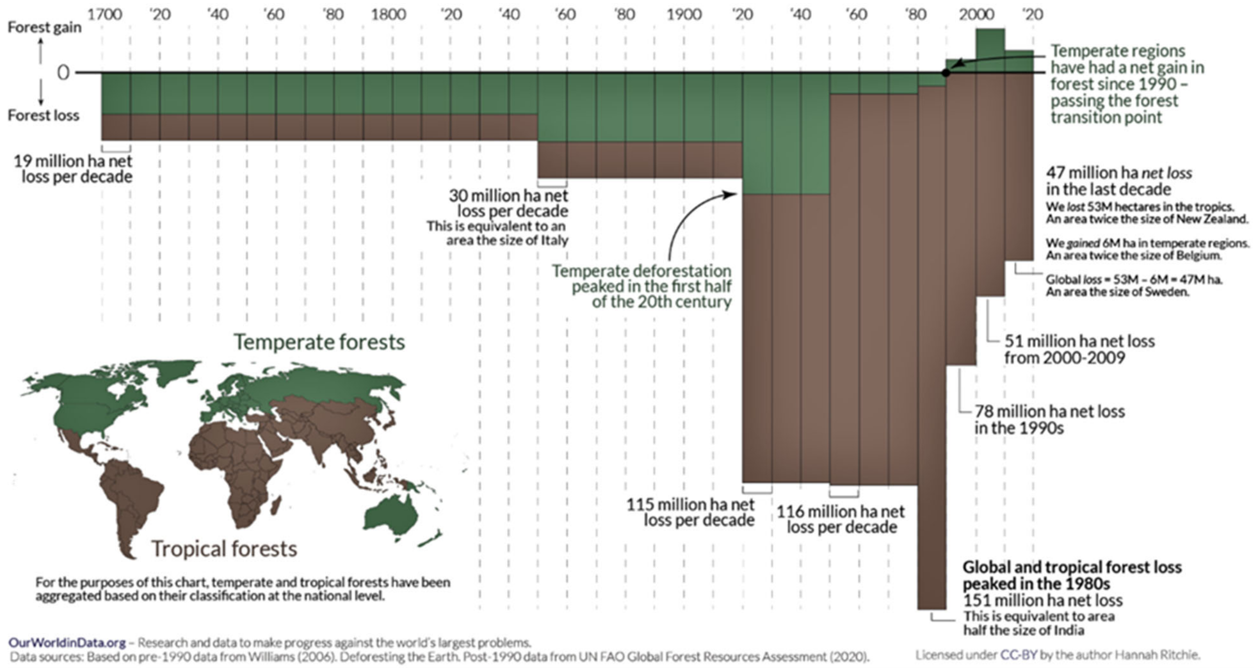
It took millenniums for the human population to develop into the masses and technology that could influence forestry globally. It was first accomplished in BCE, but not globally, because oceans stood in the way.

For the most part, before 1500 CE, the oceans had safely isolated “The continental Americas” (North, South, and Central America). In addition, the Indigenous people of those undiscovered lands lacking technology combined with many nomadic lifestyles protected it. The European discovery of the Americas opened the floodgate. Forestry made it possible for overseas travel with shipbuilding, which helped to begin using more forestry abroad. (10) (12)

3.2. Impedance of fast-cycle CO_2 Sinks: a historical precedence

As the human population increased and spread globally, forestry demand within the Americas greatly expanded. As a result, the time between forest harvests decreased as it had overseas and thousands of years earlier (2), and the replication of *demand-driven forestry* practices within the Americas was the second failure of humans in forestry management. With it, the global emissions balance with atmospheric CO_2 residence conditions and sequestration ability declined further. Before 1700 CE, mature forestry thickly blanketed the Americas, serving as healthy CO_2 sinks; however, with the arrival of Europeans, forestry practices began to fall into *constrained* and *unconstrained deforestation 2.3*. (10) (15)(6)

By 1850 CE, “*CMS’s climate change datum 2.4,”* European and Asian global expansion had firmly established within the Americas and South Pacific. They had spread *unconstrained* and *constrained deforestation 2.3* practices throughout the globe, with minor exceptions mainly due to accessibility or marketability. Humans had then “geo-engineered most global forests” to supply demand and finished that task around the 1990s. “All forests are now marketable,” The exceptions are portions of Amazonian forests and some country’s national parks; due to access, international agreements, and laws.



For the purposes of this chart, temperate and tropical forests have been aggregated based on their classification at the national level.

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Data sources: Based on pre-1990 data from Williams (2006). Deforesting the Earth. Post-1990 data from UN FAO Global Forest Resources Assessment (2020).

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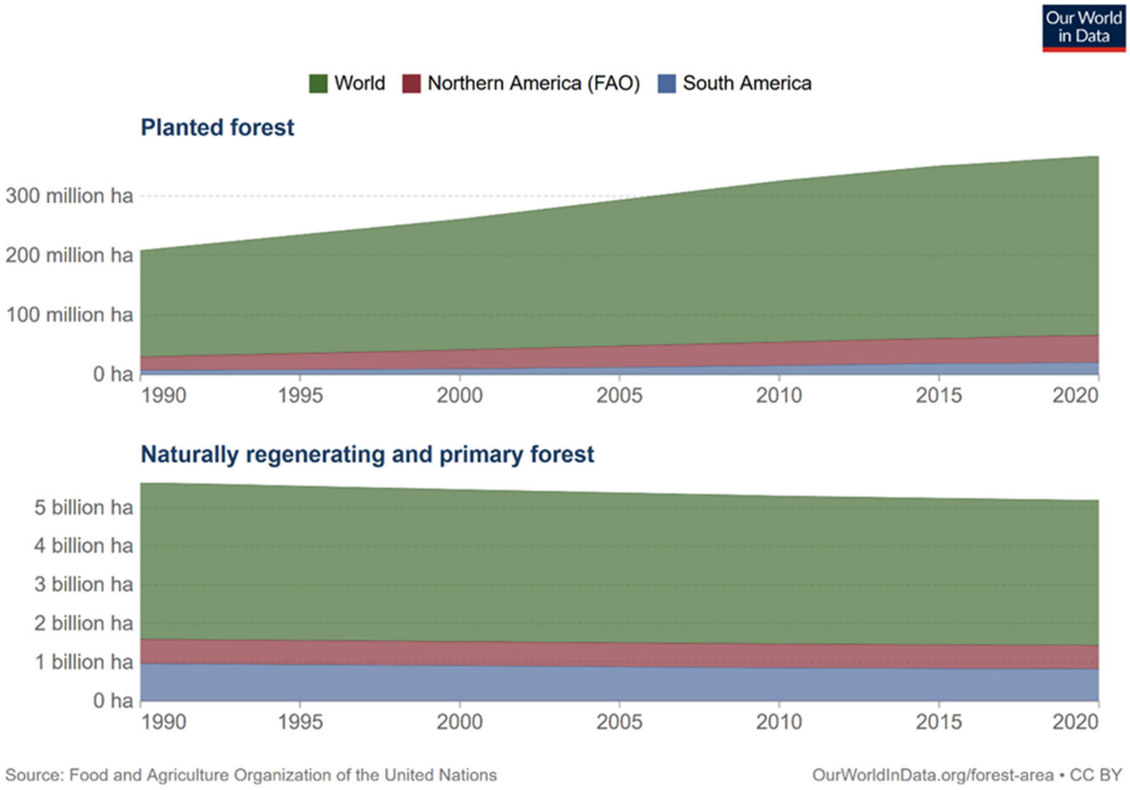
Figure 2: *"Decadal Losses in Global Forest Over the Last Three Centuries"*

"Decal loss is measured as the average net loss in hectares every ten years. This equals deforestation minus any increase in forest area through afforestation. 1.5 billion hectares were lost between 1700 and 2020 - this is equal to an area 1.5 times the size of the U.S.A."

Figure 2 represents forestry losses and forestry gain, afforestation, from 1700 CE to 2020 CE as indicated in colors as the "green" temperate and "brown" tropical forests.

From 10,000 BCE on, clearing forestry for food production and animal husbandry took priority over forest health (Figure 1). Figure 2 shows that it has only begun to change in the last 30 years. However, the contemporary afforestation shown in Figure 2 is misleading because of incomplete data. Unfortunately, most afforestation efforts mentioned in Figure 2 are offset by *constrained deforestation 2.3.2* practices implemented before and within them (Figure 3) as marketable forests as being expanded to meet forestry demand.



Source: Food and Agriculture Organization of the United Nations

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Figure 3: Forest Area by Type: Naturally Regenerating Vs. Planted

Figure 3 discloses global forestry afforestation types as "planted" or "naturally regenerating and primary forest," with the y-axis indicating the volume in hectares and the x-axis as years. The green shaded area of the graph is the world; red is North America, and blue represents South America. Volumes are documented between 1990–2020.

Key terms for Figure 3: According to the United Nations Food and Agriculture Organization:

Primary forest: "Naturally regenerated forest of native species, where there are no visible indications of human activities and the ecological processes are not significantly disturbed." Thompson notes: protected forest.

Naturally regenerated and primary forest: "Naturally regenerated forest where there are clearly visible indications of human activities. Includes selectively harvested-over areas, areas regenerating following agricultural land use, areas recovering from human-induced fires, etc." Thompson notes: These forests have been, had been, and will be harvested under *constrained deforestation 2.3.2* management.

Planted forest: "Forest predominantly composed of trees established through planting and deliberate seeding." Thompson notes: These forests have been, had been, and will be harvested to reproduce biomass under *constrained deforestation 2.3.2* management.

Figure 3 Summary

Thompson demonstrates that replants and the natural regeneration of trees in Figure 3 show that established *constrained deforestation 2.3.2 practices* are still expanding to meet demand. He speculates that Figure 3's usefulness in curing climate change depends on the landowner. Replanted acres are almost sure signs of production lands, and naturally regenerating land is an indicator of the economics involved in the global forest industry as a form of cash-in, indicating the forces influencing landowners to participate in *constrained deforestation 2.3.2* practices.

3.3. Determining Impeded Fast-Cycle Sink Basics 2.5, contemporary forestry practices results

A replanted or reproduction tree can sequester 1.5 pounds of CO_2 in its second year. In contrast, a typical thirty-year-old tree can remove 150–190 pounds of CO_2 annually (3) (for species such as the typical southern loblolly's pine tree). The difference in weight is a factor used by Thompson to describe the CO_2 sink ability of the tree as "*impeded*" as an "*impeded fast-cycle* CO_2 *sink 2.5*." Another factor is how many harvest rotations have occurred compared to human absenteeism. A total of each tree or forest harvested by the number of occurrences tallied into annual CO_2 sequestration in pounds (seq). They are placed into a ratio against current sequestration.

[(Current seq) / (seq 1 + seq 2 + seq…)] × (100) = % impeded. "t" (time) for land idling between afforestation after harvest and quantifying to apply "t" again for replants to be planted (usually 3 to 5 years). The time required after clear cut for forests to become net negatives is conversational but typically 20-30 years. (16)

In context, the sink is also impeded because it was harvested and replanted under *constrained deforestation 2.3.2* conditions and not to restore the *binary restricted resources 2.2*, meaning it was replanted to only supply biomass in the future. Therefore, if replanted by a sapling, the tree will be harvested again in 20–40 years (resupplying demand), or much longer if regenerated with seed due to additional growth time required, but still harvested in 20–40 years.

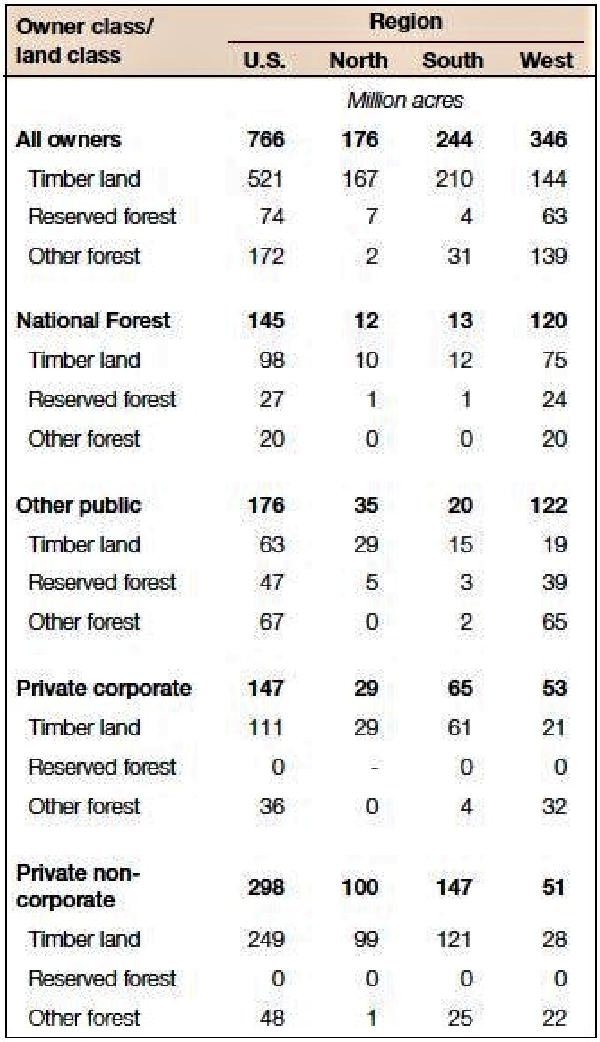
Had the original tree been left to mature, it could have sequestered thousands of times more carbon and possessed hundreds of times the annual CO_2 sequestration ability (by growing yearly at a 3–8% increase in mass) (3) (2) (17). At some point, that one tree could have possessed 1100–2400 pounds in annual CO_2 sequestration ability (5) (3). Because of premature harvest, it is now impeded to "zero" pounds annually and has no potential to recover the *binary restricted resource 2.2*. Moreover, the forest sequestration ability is further hindered by emitting CO_2 since the clear-cut or fire-damaged land the tree must grow in releases more CO_2 than the replanted can absorb for 20–30 years, known as the carbon hump. (16)

The carbon hump forces replanted or regeneration growth on clear cut land into CO_2 emissions that depend on when replanting or natural regeneration began. The carbon hump is created by CO_2 emissions exceeding the afforestation process. It further impedes sequestration and must be accounted for 20–30 years before net carbon-negative sequestration can occur. The hump's stifling effect on sequestration significantly contributes to climate change conditions forming due to repetitive harvest rotations similar in duration to the wait for trees to absorb CO_2 faster than the harvested land emits. The hump is elemental in the *constrained deforestation 2.3.2* definition.

3.4. The makeup of global forestry acres data used to estimate global sequestration

Having established the concept of impeded sequestration and how to measure the impeded portion, Thompson then demonstrates accounting for impeded sequestration globally.

Thompson's accounting is constructed in general reference using United States Department of Agriculture (7) data (Figures 4 and 5) and comparing it with United Nations data (13) (Figures 6 and 7).



Owner class/ land class	Region			
	U.S.	North	South	West
	Million acres			
All owners	**766**	**176**	**244**	**346**
Timber land	521	167	210	144
Reserved forest	74	7	4	63
Other forest	172	2	31	139
National Forest	**145**	**12**	**13**	**120**
Timber land	98	10	12	75
Reserved forest	27	1	1	24
Other forest	20	0	0	20
Other public	**176**	**35**	**20**	**122**
Timber land	63	29	15	19
Reserved forest	47	5	3	39
Other forest	67	0	2	65
Private corporate	**147**	**29**	**65**	**53**
Timber land	111	29	61	21
Reserved forest	0	-	0	0
Other forest	36	0	4	32
Private non-corporate	**298**	**100**	**147**	**51**
Timber land	249	99	121	28
Reserved forest	0	0	0	0
Other forest	48	1	25	22

Figure 4: "*United States Forestry Ownership"* (7)

Private forests provided 88% of the Nation's (United States) timber harvest in 2011 (7). *Figure 4 estimates United States forest acres into ownership categories by North, South, and West regions.*

According to Figure 4, 521 million acres of the 766 million within the United States are under contemporary forestry management labeled as "timberland." Another 172 million are classified as “Other Forest,” As stated in Figure 2, timberland and other forest can be defined as naturally regenerated, *replanted, and primary forests.* Other forest is further defined as not optimum for timber production because it takes longer to restore biomass but is in harvest rotation as marketable. (7). The combined 698 million acres are under *constrained deforestation 2.3.2*. The 74 million acres in “Reserved Forest” comprise preserves, parks, and monuments, most of which are national parks. They are protected by law and hence cannot be harvested. The significance of the observation is that up to 91% of United States forest lands are under *constrained deforestation 2.3.2* and practicing *tree degradation 2.10* to keep up with the economic demand. Yet it is intentionally made devoid of any *sequestration value* 2.1.

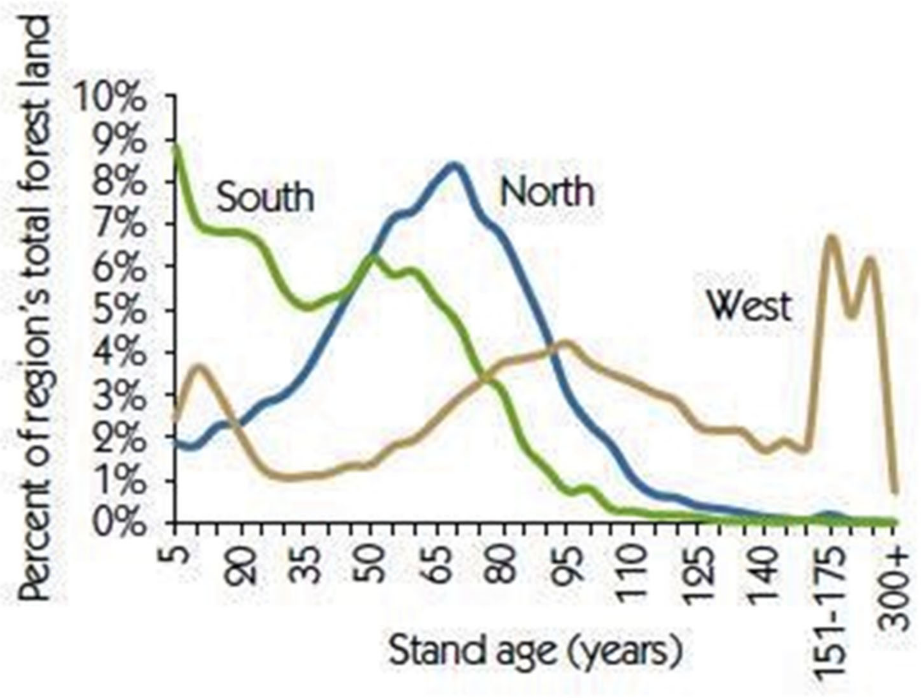


Figure 5: “*Distribution of Forest Land by Region and Stand Age, 2012*” (7)

“Predominant U.S. timber stand age varies by region. In the South, where more acres of short-rotation yellow pine trees are planted, 51% of timberland is less than 40 years old compared with 20% in the North and 22% in the West. In contrast, 56% of northern timber land is more than 60 years old, compared with 27% in the South and 69% in the West.”- United States Department of Agriculture, USDA, Forest Service, 2014

The problem with Figure 5 data and an ongoing conversation is that the USDA refrained from starting the stand ages at zero, excluding a “highly” significant percentage of trees from the graph as less than five years old. It also negates bare ground and does not provide acreages. That all skews the ratio of trees within its age brackets into a higher age and higher percentage of land than at the time of the survey. Therefore, the graph is not entirely accurate; it does serve the study’s purpose of tree age demonstration. Despite its data inconsistency, it still alarmingly demonstrates the study’s conclusion on the lack of forest maturity impeding sequestration. No calculations have been modeled from the inconsistent data presented in Figure 5.

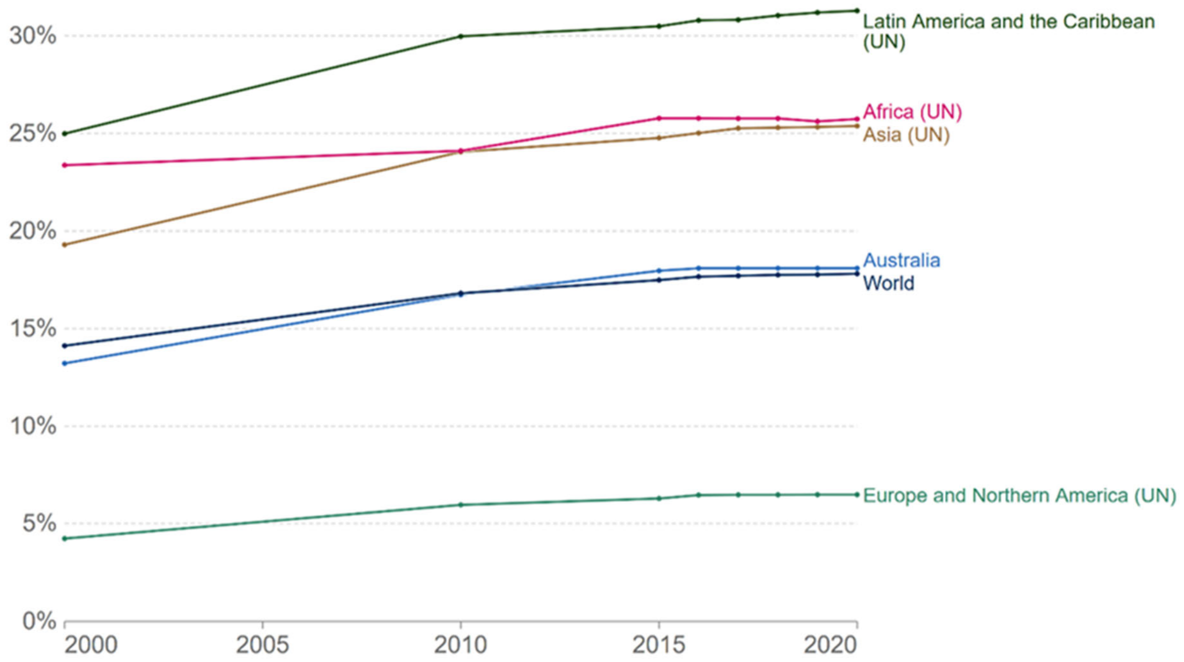
Global forest age is also an essential component of the data. The study determined that most, if not all, foreign lands to the United States are considered "much" less than or equal to the United States Department of Agriculture data shown in Figure 5. However, United Nations data is used for global calculations because it appears complete and unbiased. Again, Amazonian forests are the exception.

Today, *Demand-driven forestry 2.11* practices globally focus on growing replacement trees into usable biomass size as quickly as possible. The scheme within the process is further defined using Thompson's *tree degradation 2.10* definition*. Tree degradation 2.10* results, as depicted in Figure 5 as decreased maturity, show that immature trees are repeatedly harvested earlier. As such, immature trees dominate the world's 8.5 billion acres of unprotected forests today. (13)

Satellite pictures worldwide (may be obtained using Google Maps) confirm that forestry harvesting happens almost everywhere. It also demonstrates globally just how young trees are. For all forests globally, replants, natural regeneration (or bare ground), and *constrained deforestation 2.3.2* are present in all but minor exceptions noted previously. As difficult as this is within CMS understandings, many replanted and naturally regenerating afforestation efforts in the Americas or overseas have been, are being, or will be used to meet *demand-driven forestry 2.11* in the future. (9) (13) (8)

By 1960, finding a mature forest that had not been harvested at least once was difficult anywhere in the world and is even more challenging today. All forests would have been harvested at many sites many times over if it could be harvested. As a result, in Figure 5, less than 1% of all U.S. forests contain mature (300+) three hundred-plus years old. Thus, within the U.S., less than 1% of CO_2 fast-cycle sinks have significant maturity. Hence, the maturity required for sequestration of 1,200–2,400 pounds of CO_2 per tree per year as old growth is absent. (5) (4). Of the numerous trees on Earth, approximately 1.8 trillion, with over a trillion in Russia alone, the majority exist as highly immature > 40 years and tightly replanted. (9)

The notion that a tree can sequester 1,200–2,400 pounds plus of CO_2 solely because it is mature is also an incomplete perspective. Many marketable tree species can; however, it can take centuries of maturity within the right environment (3) (2). The trees, whose data are illustrated in Figure 5, described as "Northern Timberland," comprising 56% of the stands over 60, provide a good example. Species and the environment can hinder them. Unlike the same aged trees as the 27% in the South and 69% in the West, trees within those two environments have a good jump on restoring both biomass and "*binary restricted resources 2.2."* Species and habitats can improve biomass growth rates and sequestration faster than the trees within the northern species that thrive within harsher winters and shortened growing seasons that hinder the species in the South and West. (2) (4) This opens a conversation about a region or species having difficulty growing trees. Thompson believes that the species and geographical restrictions make impediments of some sinks scalable in forming climate change conditions. Per this study, all trees possess a *sequestration value 2.1* some posses more than others given location and species.



Source: Food and Agriculture Organization of the United Nations

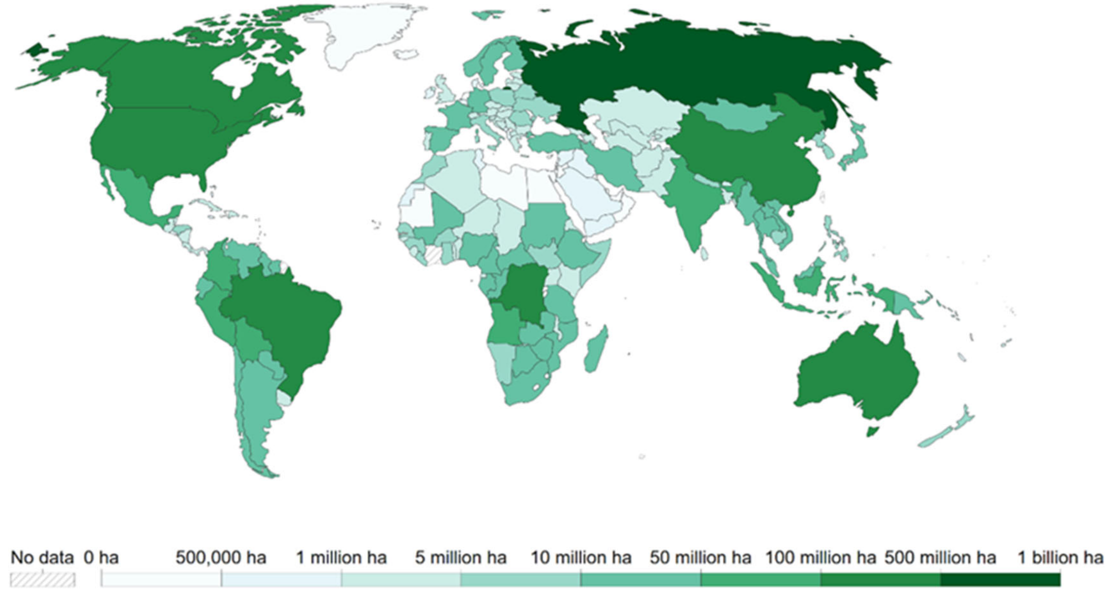
OurWorldInData.org/biodiversity • CC BY

Figure 6: *"Share of Forest Area Within Protected Areas, 2000 to 2020" United Nations Data graphed by OurWorldinData.org (13)*

*Figure 6 shows the percentage of protected forests by region and year. "A protected area is a clearly definable geographical space, recognized and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."-a*ccording to the United Nations (13)

Figure 6 depicts the world's legally protected forestry as a percent of the region's total forestry. The United States has legally protected 6.71–10.23% of its forest area. Moreover, the "World" has between 14.12–17.81%. Note: Latin America includes South America's Amazonian Forests. Per the graph in Figure 6, it can be concluded that 82.19 to 85.79 % of global forest is unprotected from harvesting per United Nations data.

Nevertheless, these figures are speculated to be too low. Even Google satellite images picture "many" other country's forests as 100% harvested and mostly in regeneration and bare land. It is logically inferred that this is probably because "protected" globally could mean laws protecting the wood industry, unlike the protection of both the forest and the wood industry in the United States. Figures 4 and 5 provide evidence of the understated United Nations data, although it is contained in U.S. data and highly skewed toward non-existent maturity. The United States, Canada, and "the free world" have laws and civil obedience protecting forests. Elsewhere, not so much. "*When a coin can be stamped out with forest, forests quickly become harvested."-Thompson.*



Source: Food and Agriculture Organization of the United Nations OurWorldInData.org/forest-area • CC BY

Figure 7: *“Forest Area, 2020”*

“Forest area is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural systems.” Figure 7 indicates hectares covered by country. The darker the green shade, the higher the forestry hectares available within that country.

According to the UN, the world has 31.04–35.52% of its land covered in forest. In contrast, Figure 1 indicates that it is approximately 38%. Both datasets seem reasonable for estimation, but the United Nations data looks logically more accurate. Using United Nations data in Figures 6 and 7, we found that this accounts for 4.06 x E9 to 4.2 x E9 ha (hectares) or 4,060,000,000 to 4,200,000,000 (billion) hectares, which is 1.00282 x E^{10} to 1.0374 x E^{10} acres or simply 10,028,200,000 to 10,374,000,000 (billion) global forestry acres. Therefore, based on his previous conversations, Thompson estimates 8.5 billion acres to be unprotected forests and subject to harvesting. These acres are under *constrained deforestation 2.3.2* practices as being resource marketable.

Therefore, a tree on those 8.5 billion acres sequesters an average of 40–50 pounds of carbon × 3.67 (carbon 12 amu to carbon dioxide 44 amu conversion) from 146.8–183.5 pounds of CO_2 sequestered that year (5). Thus, one acre of *constrained deforested* forest sequesters 16,000–20,000 pounds of CO_2 just before it is harvested between the ages of 30–40.

Allowing the tree to mature for another 20 years (age 50), when not managed for product demands, can increase the carbon sequestered 90–100 pounds from 303.3–367 pounds of CO_2 sequestered from the atmosphere (in a year), which can be 33,059–40,000 pounds of CO_2 sequestered per acre (in a year).

To establish a modest baseline below, Thompson averages the 50-year-old tree CO_2 sequestration to 335 pounds of CO_2 per tree as 36,515 pounds of CO_2 per acre sequestered that year.

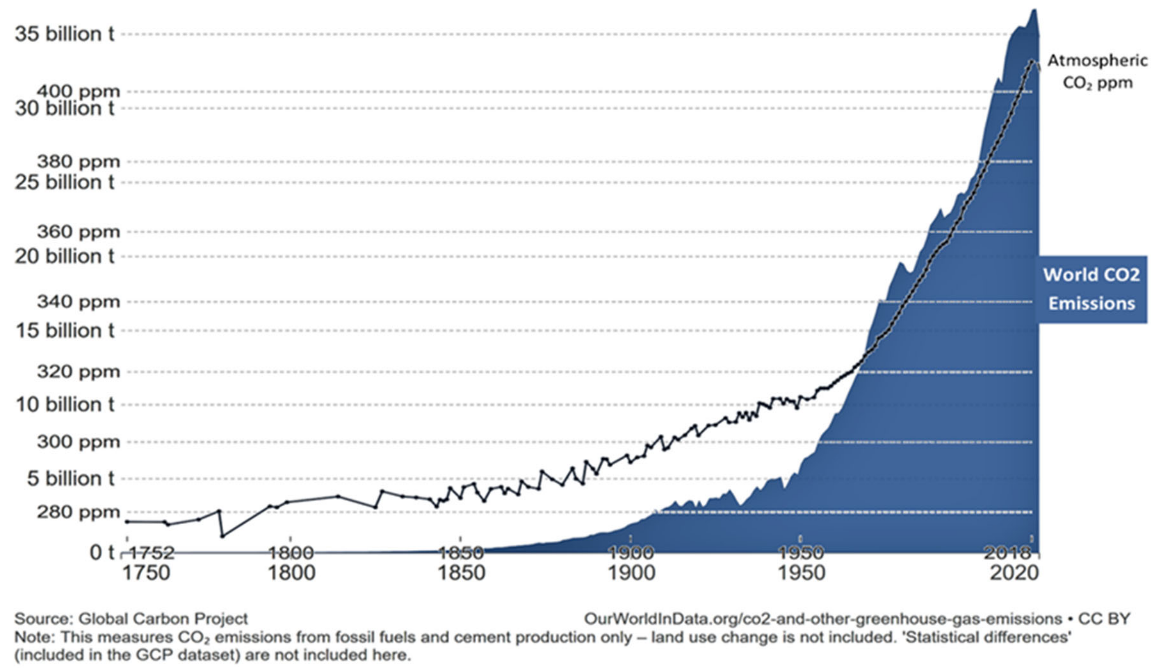
As described as 109 trees per acre. BA70-120, 20’ x 20’ spacing (18), 106 pounds carbon stored (that year), 335 pounds CO_2 per tree sequestered, age 50 years on average, a fast-growing conifer, avg diameter (DBH) 16 to 24” (5) = 36,515-pounds CO_2 per acre / 2,204.6 pounds to metric tonnes = 16.56 tonnes CO_2 is sequestered per acre (that year).

1. 8.5 billion, “unprotected” acres × 16.56 tonnes CO_2 per acre = 1.4076 x E^{11} tonnes CO_2 sequestered, or 140.76 gigatonnes CO_2 sequestered that year. This was accomplished by increasing the average tree harvest by 20 years to age 50, thus exceeding the 35 gigatonnes of human emissions by 105.76 gigatonnes.

Tree or forest sequestration rates are known to increase by 3–8% per year each year it remains unharvested. (5) (2)

2. Hence, at age 59, nine years later, the tree in the example expands to approximately 134.1 pounds of carbon sequestered from 492 pounds of atmospheric CO_2 that year. So, 8.5 billion acres × 53,628 pounds CO_2 per acre is 206 gigatonnes of CO_2 sequestered from the atmosphere that year by increasing tree maturity nine years past 50 years in the unprotected forest. A 47% increase of CO_2 sequestered is achieved in nine years.
3. Below, Thompson uses an average 6% annual tree growth rate using the 8.5 million acres:
    a. At age 66, 225 gigatonnes of CO_2 are sequestered per year.
    b. At age 71, 301 gigatonnes of CO_2 are sequestered per year.
    c. At age 78, 453 gigatonnes of CO_2 are sequestered per year.
    d. At age 84, 643 gigatonnes of CO_2 are sequestered per year.
4. Using the *proportionality* definition of 2.8, the amount of forestry acres required to mitigate CO_2-driven climate change is *proportional* to the maturity of the forest used.

Notes: Marketable tree species susceptible to harvesting practices are symbolic of this assessment. For example, although the information estimated from credible sources suggests that many tree species in good locations outperform the following sequestration evaluation. Tree CO_2 sequestration depends on many factors mentioned earlier; hence, this evaluation might be underestimated for some trees; notably, during the carbon hump, IE when the forest plot released more CO_2 than the amount that its replanted or regenerated trees could absorb. (16) Ongoing releases after 30 years of growth are conversational with future study of geographically constrained areas and tree species are implied.

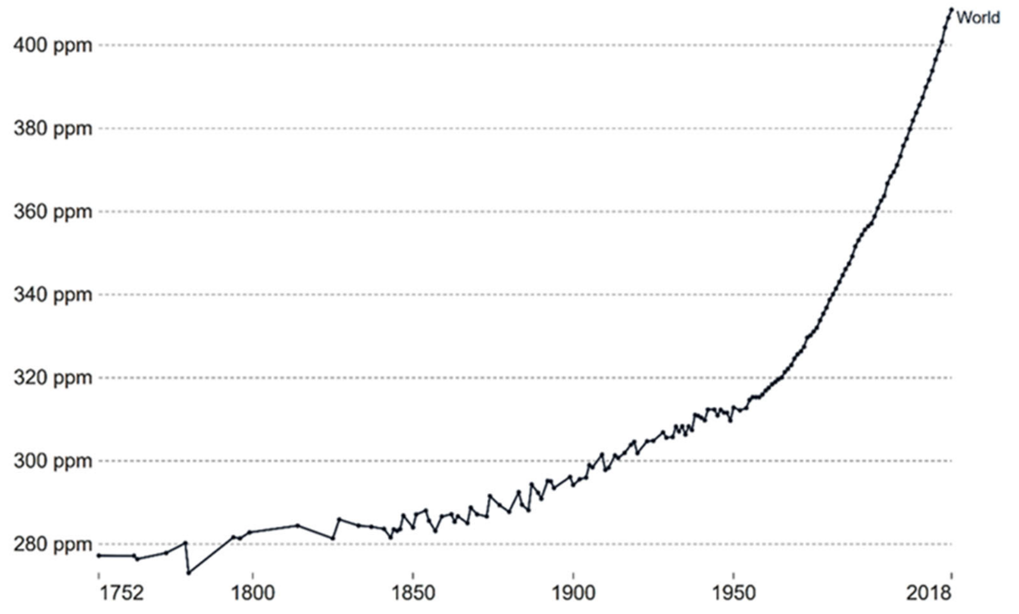


Source: Global Carbon Project OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY
Note: This measures CO_2 emissions from fossil fuels and cement production only – land use change is not included. 'Statistical differences' (included in the GCP dataset) are not included here.

Source: NOAA/ESRL Global Monitoring Division OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Figure 8: *"1750 to 2020 Human CO_2 Emissions Overlaid with Atmospheric CO_2 Levels."*

Figure 8 is an overlay resulting in a y-axis indicating both CO_2 ppm and World CO^2 emissions aligned by the x-axis year. "World CO_2 Emissions" are shown as a blue colored area beginning in 1750 and "Atmospheric CO_2 ppm" as a dark black line starting in 1752.



Source: NOAA/ESRL Global Monitoring Division OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Figure 9: *"Global CO_2 Atmospheric Concentration"*

Data extracted in 2020. Figure 9's y-axis is atmospheric CO_2 parts per million, ppm, levels in relation to the x-axis indicating the year measured. This graph is overlayed onto Figure 8 and provides a contrast between human emission levels and atmospheric CO_2 ppm levels. Although the increase of both data looks similar, no correlation between the two trends is quantitatively distinguishable. However, Figure 9 does correlate to historic forestry uses and atmospheric CO_2 levels with "demand-driven forestry 2.11" and land uses of Figure 1.

Data from Figure 8 was overlayed with data from Figure 9. Observations of this overlay include the data points from the study's 1850 climate datum. Although the y-axis is not scaled together, the x-axis is aligned to years, making the overlay accurate for years but not for ppm conversion to tonnes. Conversion is not the scope of the graph; years are.

Those years reflect the decline of fast-cycle sinks in an upward trend long before human emission expansion; additionally, see Figure S1 for increased human domestication duration data that clarifies the upward trend in ppm existed long before the expansion of human emissions. (1) (19)

Using the data from Figure 8, 1850 was approximated as a *climate change datum 2.4* for climate change, i.e., the beginning of climate-changing impacts and not the beginning of climate change demonstrated in Figure S1. The CMS *climate change datum 2.4* was established with atmospheric CO_2's relation with *demand-driven forestry 2.11* and land use effect on terrestrial fast-cycle CO_2 sinks. The datum's timeline placement is explained in the following sections.

Figure S1: Climate changes beginning following human domestication of forestry, Demand-driven Forestry 2.11

The compelling upward trend in atmospheric CO_2 ppm can only indicate that something other than non-existent human emissions (Until the Industrial Revolution) is creating climate change (Figure. S1). Thompson states, "Biome modification by humans is the only explanation; we (human population) is the only thing added to that closed system (*as a law of conservation 2.6*) nor do we introduce fossil fuel emissions until much later." He relates that upward trend to the demand on forestry and land uses as the human need for forestry resources.

3.5. Correlations to Atmospheric CO_2

The current study looks for standard atmospheric CO_2 ppm patterns as an uptick in CO_2 ppm fall through Winter, then a downtick before the beginning of the following non growth season fall. The trend indicates the planet's photosynthesis-driven growth cycle and its Fast-Cycle CO_2 sink abilities. This pattern is empirically understood and existed before humans or their emissions because of natural CO_2 emissions bulk. Thompson found the pattern was being influenced negatively, so around 1850, CMS's *Climate change datum 2.4* marked the time as human domestication crossed the threshold of climate change consequences.

Note: Natural emissions are estimated to be between 400–750 gigatonnes annually. Indeed, unreliable numbers for this topic abound and seem highly dependent on the source reporting; Thompson found no reoccurring data to compare, but, as evidence to the claim, per MIT's Climate Portal (20)*, "that total* (natural emissions) *dwarfs humanity's contribution, amounting to ten times as much CO_2 as humans produce through activities such as burning fossil fuels."* Thompson also notes that the quote does not mention details like forestry, industrial, agricultural, volcanic, animal respiration, and ocean vents contributing to natural emissions. *The conversation thus shifts to just how much CO_2 is naturally produced? Undoubtedly, hundreds of gigatonnes exist, and rationality dictates somewhere between 400 and 750 gigatonnes annually.*

Before the 1850s (*climate change datum 2.4*), Figures 8, 9, and 10 illustrate atmospheric ppm levels that suggest relatively robust global CO_2 fast-cycle sinks, indicative of a “fairly healthy” state. Notable forestry damage was noted to have accumulated in prior centuries notably in Europe and Asia (12) (14), as revealed by an upward trend in Figure S1. However, before and around 1850, the world had abundant sequestration ability that slowed the upward ppm trend with a more balanced interaction with emission’s input into Earth’s atmosphere. The trend direction shows that the terrestrial sinks were and are in retrograde because oceanographic sinks could not have been impaired or overpowered by emissions, yet.

Figure S1’s precedence in the upward ppm trend demonstrates that climate change existed long before human CO_2 emissions increased during the Industrial Revolution, and, therefore, human emissions could not be the sole cause of climate change.

Although the contours of Figures 8 and 9 look similar, their trends do not correlate even when adjusted for decades of atmospheric residence time, which also began rapidly increasing around the 1850s (*demand-driven forestry’s 2.11*). Thompson believes the growth cycle started an accelerated decline in volume sequestered around his 1850 *climate change datum 2.4*.

There exist unique sequestration signals around 1850 in the ppm data, marking the first instance wherein the global CO_2 fast-cycle deviates noticeably from a closer balanced state with emissions inputs. The somewhat homeostatic relationship between Earth and humans is believed to have been lost from then onwards. The cause lies within the yearly ppm data correlating to *constrained and unconstrained deforestation 2.3* practices, which by 1850 had begun to rapidly spread globally. (12) (14)

This demonstrates that land use modifications, such as *unconstrained deforestation 2.3.1* and the ongoing demise of the world's remaining mature trees entering into immature harvest rotations, termed *constrained deforestation 2.3.2*, have unintended climate impacts. They are geoengineering or undesired terraforming. More accessible data correlations occur from 1700 to 1920, proceed into further pinnacles around 1950 and 1990, and continue into modern times, 1700–2022. Therefore, only one conclusion can explain the upward trend in atmospheric CO_2 and its correlation to impeding sequestration. Global forestry misuse.

Thompson also notes the presence of carbon isotopes within ppm in the atmosphere. The only reliable source of C_{14} increase is fossil fuel use or atomic testing. He explains that a particular isotopes presence becomes moot because it has no other place to accumulate due to the lack of sequestration. *The conversation also becomes, can photosynthesis sequester the more complex isotopes as well, or will they continue to collect and decay within atmospheric conditions? C_{13} at 1% and C_{14} at less than 0.0000000001% of the atmospheric volume are found somewhat irrelevant to this study’s scope but concerning given enough time.*

4. *Exploring sequestration data, CO_2 ppm deltas*

The upward ppm trend accelerated around CMS’s 1850 *climate change datum 2.4* but had been occurring even before. The difference is before around 1850, ppm deltas were still mostly erratic. They exhibited large horizontal ppm swings as picturesque growth cycles, which Thompson evaluates the swings as typical indications of atmospheric residence conditions, sequestration ability as outflows, and CO_2 emissions inflows. To explain the growth cycle, Figure S2 is used.

Figure S2 is a close-up of 2022's global CO_2 fast-cycle sinks' impact on atmosphere CO_2 in residence. Atmospheric CO_2 results were measured by NOAA using the flask method at Mauna Lou Observatory and recorded in ppm. The 2022 ppm year-end readings are higher than where they started, demonstrating the upward trend in atmospheric accumulation.

Figure S2 demonstrates global fast-cycle sequestration within its atmospheric CO_2 ppm measurements. Spring and Summer extend from May through September as months 5–9, with the ppm downtick during the "fast sink cycle" or growth cycle. October through April of the following year, as months 10–4, plants cease growing (sequestrating), causing an uptick in ppm.

Specifically, down and upticks in Figure S2 occurring June-February are the northern hemisphere's growth cycle, and the minor cycle on the right expresses the southern hemisphere's opposite seasonal cycle. In contrast, the southern hemisphere is roughly 32% of Earth's total land mass, a portion of which is Antarctica and not within the scope of this study as it is devoid of trees. Therefore, the slight down and upticks transpire from approximately 90% of South America as the lower 2/3rds of South America, one-third of Southern Africa, and all of Australia/New Zealand. Therefore, most, if not all, of that smaller growth cycle downtick is created by the untouched portions of the Amazonian forests and minor forests in the southern hemisphere, not within *constrained deforestation 2.3.2*.

4.1. CO_2 ppm Deltas, Inflows, Outflows, Differences, and Combined Data

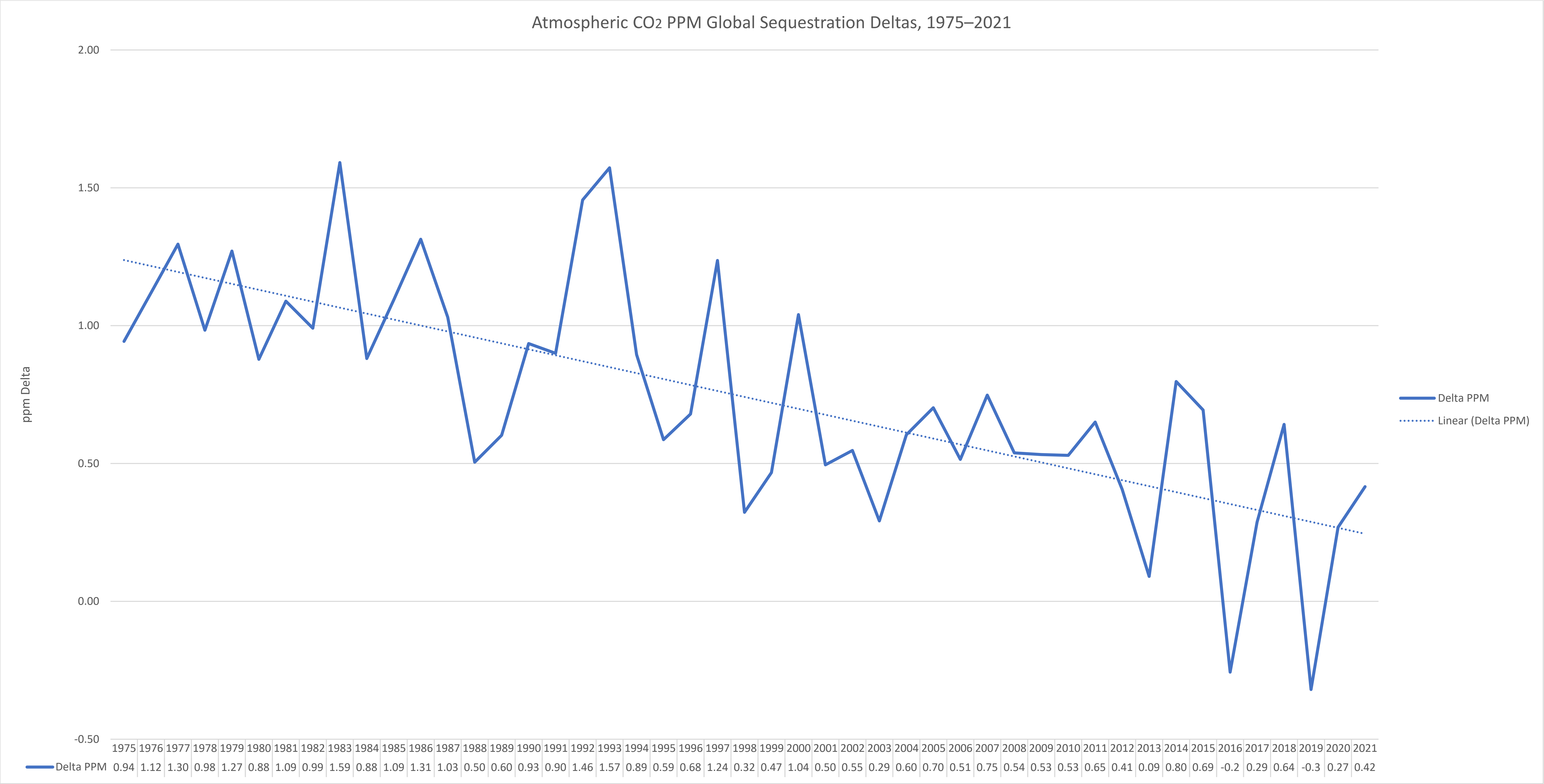


Figure 10: *“Atmospheric CO_2 ppm Deltas 1975-2021”*

The erratic blue line of Figure 10 moves from the annual growth period peak and its valley from the yearend of the growth cycle to the beginning of the following year’s growth cycle. The value for CO_2 ppm Delta is indicated along the x-axis, as is the year. The y-axis is the ppm level. The dotted blue line indicates the linear trend using the difference of squares method.

Data from Figure 9 was further disseminated to determine and provide secondary proof of Global CO_2 sequestering ability per growth cycle. The experiment was to assess *CO_2 ppm deltas,* the results of which are in Figure 10 and also defined by *sequestration value* 2.1. An expected conclusion with an unexpected result occurred. Figure 10's determination of the declining sequestration trend also offers a scale to measure sequestration-based climate modeling that gauges sequestration's health based on CO_2 atmospheric ppm.

Weekly NOAA ppm observations were averaged into ppm by month to arrive at the gauge's inflection. The month was then classified into a growth or non-growth month. Spring and Summer as May through September, growth months 5–9, followed by October to April of the following year, as non-growth months 10–4. Growth/non-growth cycles were then calculated to provide the average ppm during the cycle. The cycle offers two annual points: the highest ppm during non-growth months 10–4 and the lowest ppm point during growth cycle months 5–9. The difference from the highest to lowest point is recorded as a *CO_2 ppm Delta* graphed in Figure 10. A positive or negative Delta indicates sequestration amplitude during that growth cycle as a difference between growth and non-growth months in ppm. For example, "On average, x-amount of CO_2 ppm was sequestered from atmosphere residence during that period's growth cycle."

Thus, showing a difference as a ppm Delta, the Delta or change is recorded from the non-growth cycle's highest point to its lowest point during the growth cycle. Figure 10 demonstrates the year-over-year difference in CO_2 ppm sequestered within the growth cycle's year to the following year. Specifically, the CO_2 ppm Delta point is the "ability" of sequestration during the growth cycle.

The linear trend line established in Figure 10 indicates the sequestration capabilities of the growth cycle over time. *The study did not necessarily precisely measure how much CO_2 is being removed from the atmosphere.* Instead, the "*CO_2 ppm Delta*" focuses *on Earth's ability to remove CO_2 from the atmosphere by providing an average yearly indicator of sequestration health.*

The study's method avoids the complexity of establishing how much was sequestered in ppm, considering how ppm increased or decreased during growth/non-growth months. As a result, inflows as emissions and Earth's two growth cycles, the Northern and Southern hemispheres, are accounted for within the difference as a Delta, of the ppm accumulation peak and the ppm reduction valley floor.

CO_2 ppm Delta results are alarming. The trend indicates a quickly declining global sequestration ability to the point of negatives, first forming in 2016 and repeating in 2019.

The trend had been long in forming much earlier than Figure 10's periods (beginning in 1975). Sequestration ability declined enough around the study's *climate change datum 2.4* of around 1850 to increase CO_2 atmospheric residence time. Again, it correlates directly to human domestication's *demand-driven forestry 2.11* and land uses as *unconstrained* and *constrained deforestation 2.3* practices.

Figure 10 provides additional evidence that climate change is not entirely emissions-based. It is more *sequestration-dependent 2.7*. The trend as the decline in ppm sequestered gradually occurred over millenniums and cannot be correlated to human emissions. A relation is more evident to naturally emitted CO_2 having overrun a declining sequestration ability due to human domestication engineering the human biome. As such, natural and human emissions are a guilty input but not anywhere near the entirety.

Atmospheric ppm inflow and outflow measurements were used to check Figure 10's CO_2 ppm Delta results. Again, NOAA data used in Figures 9 and 10 was employed and disseminated in separate methodology to establish CO_2 ppm inflow and outflow in Figures S3–S6. Numbers used as real (+1) and imaginary (-1,0) were compiled to a positive integer to reflect CO_2 ppm inflow and a negative integer to reflect outflow. Each integer was determined by the weekly ppm measurement average less the next weekly ppm average and multiplied by -1 to orientate the result as an atmospheric CO_2 + inflow or – outflow. The data model for this experiment also breaks down the results by growth and non-growth months used in Figure 10. However, graphing further results beyond Figure 10 and S3–S6 were not required to check results. The slope of trend lines between Figure 10 and S5 outflows indicate a linear difference of 0.0182, indicating an acute relationship. The linear slope difference between Figure 10 and S4 is 0.0023, expressing almost perfect symmetry. Therefore, the CO_2 ppm Delta is valid for measuring sequestration.

4.2. Additional Correlation

By unintentional design, Figure 10's periods in years correlate to Figure 2's 1980s pinnacle of forestry loss. They can be observed more closely in Figure S5's 1980s, further establishing the 1990 era super declines in sequestration. Those *constrained and unconstrained deforestation 2.3* actions are not offset by replants or natural regeneration as was intended and shown in Figure 2. That correlation is also viewable from 2000 on in Figure S5, as stated in section 4. As an additional resource to claim, Figure 3 demonstrates the global expansion of wood-producing plantings and the reduction of natural regeneration. Those actions are done to keep up with demand on newly acquired lands to speed natural regeneration and expand harvestable holdings.

Therefore, the *constrained deforestation 2.3.2* effect represented as afforestation in Figure 2 is more representative of the expansion of replanted land for future harvesting than environment enhancement. (13)

4.3. Emission- or Sequestration-Dependent 2.7 Calculations

In this experiment, Thompson calculates the difference between emissions and sequestration using current emission reduction attempts and sequestration enhancement goals to mitigate CO_2-driven climate change.

Emission reduction attempts fail at curing climate change because they do not address the more critical side of the equation. The precedence formed is that humans can only influence human CO_2 emissions. Humans cannot "directly" control natural CO_2 emissions like volcanoes, annual plant die-offs, ocean vents, or animal respiration.

Human emissions are estimated at 35 gigatonnes, while natural emissions are between 400–750 (575 average) gigatonnes yearly (6) (15). In addition, emission reduction efforts do little to address the atmospheric CO_2 in residence conditions. As shown in Figure 10, atmospheric CO_2 is quickly running out of places to become sequestered, increasing ppm. Therefore, humans are *sequestration and emissions-dependent 2.7* to maintain our biome. The problem Thompson clarifies with emission reduction attempts is they ultimately add CO_2 and do nothing to sequester it. As stated, "The human domestication plight requires CO_2 emissions as much as the act of being human releases CO_2 as a significant function of the human lifecycle."

4.3.1. Estimating emissions effect on climate

1. 400 gigatonnes of natural CO_2 emissions annually. Thompson uses the smaller estimate for naturally occurring emissions.

2. 35 gigatonnes of Human CO_2 emissions annually, the more common estimate.
3. Using 5.1480×10^{18} kg as the atmosphere's mass is also a common estimate.
4. The atmosphere's composition is 28.97 g per mol, so the atmosphere consists of (28.97 g per mol / 1000) to kg) = 5.1480/.02897 = 177.7×10^{18} moles.
5. A ppm is therefore estimated at = 177.7×10^{18} moles / 10.0×10^{5} = 177.7×10^{12} moles.
   a. One mole of CO_2 has a mass of 44.01 g, so the mass of one ppm of CO_2 is 177.7 × 44.01 = $7{,}821 \times 10^{12}$ grams or 7.821 gigatonnes of CO_2 per ppm.
   b. At writing, the current global atmospheric CO_2 ppm is 421 ppm × 7.821 = 3,292 gigatonnes of CO_2 has accumulated in Earth’s atmosphere (as of writing) and is suspended within atmospheric residence conditions.
   c. Earth’s atmosphere would like to be “around” or less than 230 CO_2 ppm (@ 1,798 gigatonnes), so 3,292 gigatonnes of CO_2 currently in the atmosphere - 1,798 gigatonnes CO_2 to achieve 230 ppm =1,494 gigatonnes of CO_2 must be removed/sequestered from Earth’s atmosphere.
6. 400 + 35 + 1,494 gigatonnes of CO_2, in total, 1,929 gigatonnes of CO_2 must be addressed to mitigate or cure climate to 230 ppm od CO_2; 435 gigatonnes are reoccurring annually with the caveats described in the summary.

Summary of calculation:

As 35 gigatonnes CO_2 possible in emission reduction attempts / 1,929 gigatonnes CO_2 required sequestered, emissions-based climate curation attempts address 0.18% of the climate condition’s cause and do not address sequestration. In contrast, this study addresses 100% or, if the reader prefers, the remaining 99.82 % of climate-changing conditions. Besides, considering reduction attempts have not come close to date at reducing annual human emissions.

Calculating every year: Emissions-based reduction attempts attempt to remove 35 gigatonnes of natural plus human emissions as approximately 435 gigatonnes = 8.04%. Whereas, again, sequestration addresses 100% or, if the reader prefers a relationship from the previous calculation, 91.95%. As self-evident in both calculations and the last 50 years of reduction results historically failing, the difference in approaches appears undeniable.

Caveats: Thompson’s current discussion does not account for the current sequestration volume per year because, per Figure 10, this value exhibits a negative trend. Therefore, any improvement globally in sequestration should have an immediate impact measurable in ppm. In addition, it does not calculate percentages directly by the year with the static atmospheric ppm levels used because the percentage of usefulness highly favors sequestration. After all, emissions reduction cannot address current atmospheric concentrations. Instead, they rely on sequestration. Future conversations may incorporate durations in years, input more directly, and running totals to current sequestration rates. Nonetheless, the example provided holds firmly with the contrast and comparison from today’s highly simplified historical results and analysis combined with basic math-derived modeling. Emission reduction and sequestration enhancement were fairly made equal within the constraints of tonnes of CO_2 to be dealt with. Each of their benefits applied to that constraint is demonstrated in contrast. Therefore, the CMS study has produced a valid and highly repeatable result. The difference in emission and sequestration approaches to define and mitigate CO_2-driven climate change is undeniable, regardless of additional assumptions or time inputs.

5. Discussion

Common definitions could not describe the study's sequestration-related findings. Thompson suggested the eleven explanations in the opening of this manuscript to help define the logic of sequestration's effect on climate change. As definitions, they include specific interpretations of findings and establish precedence, perhaps solely.

Damage to terrestrial sinks is distinguished as deltas in Figure 10 during and after the planet's growth cycle. Their trend shows that lower CO_2 ppm is being sequestered. The CO_2 ppm Delta's are alarming. A steady decline and going negative in two of the past seven years indicate sequestration capacity is alarmingly decreasing per *proportionality 2.8*. CO_2 residence time is increasing as sequestration abilities are decreasing. Exploring this model, Figure 10, using higher math orders to further isolate variables is ongoing. Should this model prove further valid with its expansion and additional study, the repercussions within human domestication could prove to be, at best, grim but measurable.

The model for the emissions effect on climate compared to the sequestration effect provides a surprising contrast to address or mitigate CO2-driven climate change effectively. Sequestration is the better method by looking at the problem's entirety and not at only one input.

Thompson suggests Earth may have entered a runaway greenhouse gas effect around 1950 CE. The ongoing conversation includes exponential "like" impacts of atmospheric CO_2 residence time via sequestration impediment when compared to global temperature increases in a nonlinear form. The ongoing study's preliminary results were derived but not confirmed in time for this manuscript.

Terrestrial fast-cycle CO_2 sinks do not need more CO_2 than is available. It is more natural for plant life to lack CO_2 than to have excessive CO_2. Excessive CO_2 fertilization creates plant growth problems. The global measure of current and ongoing CO_2 fertilization is a further conversation to establish CMS precedence within another discipline-specific study.

Thompson's theory, based on CMS's manuscript, demonstrates that 3–5% of useful CO_2 sequestration abilities exist globally as mature forests; "3–5% useful sequestration further places humans at the precipice of a climate collapse due to any large-scale volcanic (VEI 7 or higher) activity, volcanic events like 536 CE or 1816 CE, "The Year without a Summer," accelerating the greenhouse gas effect." These events can change our climate overnight but now pose a more significant threat than ever before.

Climate significance is derived from the eruption's CO_2 ppm contribution to the atmosphere and the ejected debris in the atmosphere, resulting in a mini-ice age and years of drought following. The latter dramatically impedes global photosynthesis. That impediment can be defined briefly to climate, during a mini-ice age, as *constrained "global" deforestation*. Tree ring studies have shown tree growth rates collapse by 80–90% or can even succumb during mini-ice periods. (21) The global implication is that a twofold effect is documented during the mini-ice age. First, natural (or human) CO_2 emissions normally sequestered during growth cycles enter into atmospheric residence conditions during the years of mini-ice age. Second, during the mini-ice era, plant and animal "die-offs" contributed vast quantities of CO_2 into atmospheric residence conditions. Those two effects seem well documented historically, just as the decades of drought that follow mini-ice ages are.

Additional significance to Thompson's theory is that within periods of recorded volcanic effects on climate, Earth's CO_2 forestry sequestration was millions of percentiles more valuable than today. It, therefore, stands to reason should such an event occur today, the difficulty in domestication recovery may be impossible when compared to previous recoveries that are historically documented. Ultimately, the possibility of today's climate demonstrating recovery is uncertain at best.

Suppose you remove humans from forestry use, historically, but keep human's current 35 gigatonnes of CO2 emissions. In that case, there is no CO_2-driven climate change due to forestry's unimpeded fast-cycle sink maturity providing sinks in quantities and capacities. This consideration substantiates this study's evaluation and conversations.

If you eliminate human emissions today, CO_2 climate change still exists because natural emissions are the bulk of the annual CO_2 emissions. One could argue that the runaway effect and atmospheric buildup would slow; and, thus providing additional proof of this study's conclusions. That's because that exact scenario existed before the onset of human domestication expansion between 5,000 and 4,000 BCE through this study's *climate change datum 2.4* around 1850.

In the scope of the sequestration conversation, energy-consuming sequestration attempts are nullified to climate mitigation and prone to failure. Converting atmospheric CO_2 into anything or storage requires energy. It is irrelevant if the energy input is atomic, solar, wind, tide, hydro, or something not yet invented. The scheme will still leak CO_2 to process CO_2. Nothing can compete with forestry's energy advantage: photosynthesis—the most energy-efficient way to convert and store CO_2. Photosynthesis naturally expands exponentially with solar power that comes within a self-contained and permanent carbon storage. No human device yet can compete with the efficiency of photosynthesis within its quantitative configuration.

6. Materials and Methods

Compelling evidence was revealed when modeling Advanced Woody Composites (AWC) products' carbon benefits within raw material supply chains. Primarily an empirical and applied research that presented qualitative evidence of forest maturity affecting sequestration ability. That also appeared quantitative as *proportional 2.8*. An analytical approach was then adopted as follows:

Thompson theorized that if atmospheric CO_2 residence time is a symptom of climate change due to too many emissions, then sequestration, when measured quantitatively as its reduction, should not be affected by rising or decreasing emissions inputs. Many descriptive reports on the subject "implied" sequestrations' measurement should reflect an almost steady state in trend analysis with only residence time increasing and, possibly, CO_2 fertilization as a distant variable that may affect atmospheric CO_2 outflows. Thompson used applied and quantitative research to discover that "current" sequestration assumptions were not quantifiable.

As theorized, "common knowledge" implies the empirical rise and fall of CO_2 ppm within Earth's atmosphere should reflect similarities in trend (least squares method) established year after year during growth and non-growth cycles of photosynthesis. However, Thompson theorized that CO_2 ppm would fail to demonstrate a trend consistency regardless of sample sizes and durations and would do so in all applied research. Sequestration, as atmospheric outflow, would be found quantitatively in year-over-year trend analysis to be in notable retrograde and consistent. Finding his theory correct, Thompson expanded the fundamental research to apply historically documented *demand-driven forestry 2.11* practices to the retrograding timeline. By doing so, the reason for sequestration's retrograde appeared logical. Eventually, it produced the theory that climate change is an environmental impact, condition, geo-engineered, and not an effect of too many emissions (solely). What he learned in confirming that theory with empirical research applied to his forestry maturity descriptive research compelled this study's conclusion of sequestration impediment by modeling with NOAA ppm data in Figures 10, S3–S6 to forestry data from USDA and United Nations, among other empirical data cited. The result of the methods applied produced multiple interrelated quantitative and qualitative proofs for each conclusion or precedence.

This manuscript is not about Thompson's AWC work (22)**.** However, Thompson uses his AWC history as an introduction to help readers understand the more detailed climate relationship AWC's applied research underscored, along with the methodology used to form conclusions.

AWCs utilize trees more efficiently than contemporary wood-containing products due to 68–81% aeration of biomass and 8–14% of their volume composed with supplemental additives and adhesives to form recyclable structural composites. The environmental benefit calculation of AWC products compared to sawn lumber or peeled wood products produced a highly significant maturity within forestry supply models. The carbon accumulation within those forests significantly increased each thirty-year cycle completed. That result was presented due to the harvesting technique employed; forest plots were thinned of natural die offs and not clear-cut. Thinning is made possible because AWC production uses 12–18% of the forest biomass to replace 100% of contemporary wood products' clear-cut harvest. That modeling indicated a highly enhanced CO_2 negative due to increased tree maturity.

The benefit to define was the year-over-year expansion of the biomass supply; the trees were allowed to mature. Each grew bigger during each 30-year cycle, so the following cycle produced double or even triple the AWC-containing products with a decreasing percent of trees growing on the plot used and much longer durations between harvesting. Thompson determined that AWC production allowed tree plots to mature indefinitely while still answering the demand for wood products. Another relation to tree maturity that affected the CO_2 sequestration became more apparent.

The trees grow bigger and take up more space by eliminating other trees in competition for resources, primarily sunlight. Those trees confined to shadows are destined to be naturally eliminated, mainly after decades of growth. Over time, the remaining trees occupy the space the destroyed trees used. Naturally eliminated trees can be used in AWC or contemporary product production. The significance revealed within that scheme is that highly mature trees have more efficient biomass, being higher in biomass volume, so only a few per acre are needed if matured. That timed well with the natural section processes eliminating the lesser tree naturally, but now under stewardship.

Those findings provided a theory and evidence for Thompson to conduct a further analytical study to answer the question, “What caused the significant carbon accumulation that is not present in contemporary forestry use?” He knew maturity was the effect but did not see its relation to climate change until he observed it with globally accumulated data. He was the first to see climate change for what it truly is, an environmental condition.

This invites further conversation: "If one tree puts on 100 pounds of carbon within its annual growth period, it sequestered or absorbed 367 pounds of CO_2 to do so,” resulting in a 3.67:1 ratio of CO_2 44 amu to carbon 12 amu.

The evidence presented is the biomasses' ability to sequestrate CO_2, using photosynthesis, at the 3.67 ratio being empirical. Further calculation using tree growth rates and moderate basal areas (50–70) on acreages supplemented Thompson’s initial theory that global climate-changing conditions exist due to a lack of “existing” sequestration. By the same empirical standards, Thompson determined that international forestry plots’ sequestration abilities are impeded by younger trees being harvested after replacing the more mature trees that were centuries and even millenniums older. Moreover, that proved problematic for globally regulating CO_2-reliant biomes (as in Earth’s enclosed climate system).

One hundred pounds of carbon sequestered by a tree per year is a meager figure, provided it is mature or can be matured. Matured longer, a typical and considered “marketable” tree can sequester hundreds or thousands of carbon pounds yearly. Critical to this evidence’s context is that certain tree species, such as on North and South America’s Pacific Coast, can sequester well over 1000–2400 pounds of carbon dioxide per year, given maturity, location, species, and other conditions aligning. But more often than not, all marketable tree species and where they are grown currently fit that category.

More evidence is presented as global forestry harvest rotations. Spreadsheet modeling that allowed mature trees to replace contemporary tree harvest rotations occurring before 30 and with industry standards of 30–40 years validated the theory. Using United Nations data, Thompson had already documented that 80–85% (and possibly 95%) of the global forest areas are acreages that follow contemporary forest practices using immature tree clear-cuts. The model further indicates those results, allowing the tree to mature 10–20 years more, mathematically, could eliminate CO_2-driven climate change given two “primary” caveats—first, their maturity in age. Second, the amount of acreage used. Tree species and location were also determined to be significant. With the mathematical certainties from empirical references, logic became Thompson’s focus.

Thompson found logical correlations between historical forest use and contemporary climate change measurements. The correlation between historic forestry and land uses with NOAA-provided atmospheric CO_2 ppm levels leveled out the theory quantitatively. That correlation also reflected that the durations, capacities, and abilities of forestry CO_2 sinks are significant to climate-changing conditions forming.

Historical events over the years affecting forestry uses register yearly in the form of atmospheric CO_2 ppm increase. Moreover, Thompson determined that the pre-1950 CE global harvesting of the last matured trees and replacing them with replants led to less mature trees harvested in rotation and reoccurrence (harvesting smaller and smaller trees more often). Natural regeneration, being much slower in recovery duration, was also significant. In principle, all three create and perpetuate a global decrease in forestry CO_2

sink abilities and quantities. That data also proposed a *climate-changing climate change 2.4* around 1850 CE.

Thompson's graphed data in this manuscript provides evidence around 1850 of atmospheric CO_2 increasing the duration of atmospheric residence. This appeared as timed to human forestry and land uses. Thompson described it as CMS's *climate change datum 2.4* because it is a time-stamped measure of the correlation between historical forestry use and the acceleration of atmospheric carbon dioxide levels. Natural and the lesser of the two, human emissions, no longer exhibited a close to homeostatic sequestration balance. The declines existed before 1850, but 1850 stands out with known historical forestry uses, railroad and shipbuilding, and construction booms accommodating population increases.

Evidence indicates that climate change results from human biome modification, which can be seen as an undesired form of terraforming with significant environmental consequences. This implies that human emissions do not solely cause climate change. The evidence suggests that human emissions are problematic to climate but not in the way Thompson or the world had previously understood. With 1974–2022 sequestration graphing, Thompson demonstrates a declining year-over-year global sequestration Delta, in which the yearly CO_2 ppm during growth/non-growth cycles ppm is used to rate Earth's yearly growth/non-growth cycles by the average amount of CO_2 ppm sequestered annually from the atmosphere. Within those *CO_2 ppm Deltas (Figure 10, S3–S6)*, Thompson determined a scale to measure and established precedence to the importance of sequestration to mitigate CO_2-driven climate change.

His work has established precedence that emission-based mitigation as reductions is valid but is not what is required for a climate cure. Thompson has determined that we as a species fail at climate mitigation by overlooking the emissions-based inverse and, more significant, fundamental cause, CO_2 sequestration impediment.

7. Appendix

7.1. Metrics

1. The sequestration rate is measured in carbon amu or mols and is calculated by amu conversion using carbon =12 amu and CO_2 equal to 44 amu. Or 3.67 × carbon amu = CO_2 amu (C 12 +O 16 +O 16 = CO_2 44).
2. The tabulated sources and Chapman–Richards equation determine tree growth rates. (2) (3) (15) (4) (5)
3. One mole CO_2 = 44.0 g (CO_2 = 12.0 g + 32.0 g = 44.0 g)
4. One tonne CO_2 contains 22730 moles of CO_2 (1,000,000 g /44.0 g/mole)
5. One mole is 24.47 L (Boyle's law at 25 °C and 1-atmosphere pressure)
6. Volume of one ton CO_2 = 22730 moles × 24.47 L/mole = 556200 L = 556.2 mL
7. The atmosphere's composition is 28.97 g/ mol
8. 5.1480×10^{18} kg as the mass of the atmosphere
9. The atmosphere's composition is 28.97 g/mol, so the atmosphere consists of $5.1480/.02897 = 177.7 \times 10^{18}$ moles.
10. An atmospheric ppm is therefore = 177.7×10^{18} moles / 10.0×10^{5} = $\underline{177.7 \times 10^{12}}$ moles.
11. One mole of CO_2 has a mass of 44.01 g, so the mass of one ppm of CO_2 is 177.7 × 44.01 = $7{,}821 \times 10^{12}$ grams or 7.821 gigatonnes of CO_2.

12. A gigatonne is 1,000,000,000 one billion metric tonnes.
13. Linear Trends were established using Gauss's "Least Squares" method.
14. In 2021, Human CO_2 emissions were estimated at 35 gigatonnes of CO_2 per year OR, AS simplified 35,000,000,000 metric tonnes of CO_2. OR as 3.50×10^{10} tonnes CO_2.

8. Data Availability

Center for Open Sciences, https://osf.io/m28gn

https://ewc.company/downloads

https://CMS.earth/downloads

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Author contributions:

All though, the cited "public" materials and data contributed significantly. No other author contributions are warranted.

Competing interests:

The author declares no competing interests have influenced the findings. On the contrary, the manuscript's conclusions dictated the author's current employment, status, and investments toward its desired outcome, climate mitigation.

Data statement:

All data are available in the main text or the supplementary materials. Much of the data within this manuscript is publicly available and listed in the included bibliography.

Most public data rely on industrial or commercial forests rather than private ones. (8) (7) (13)

All data, code, and materials used in this manuscript are available for non-commercial uses. Any commercial uses must be licensed with the owner, Vestibule Holdings, Inc.

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Photos used for the Graphical Abstract are listed as presented left to right below.

1. Photo by Darius Kinsey (American, 1869 - 1945) Falling Redwood, Humboldt County, California is licensed under CC BY
   http://www.getty.edu/art/collection/objects/40468/darius-kinsey-falling-redwood-humboldt-county-california-american-1906/
2. Photo by Unknown Author is licensed under CC BY-NC Creative Commons Attribution-Noncommercial 3.0 License.
   https://www.forestryimages.org/browse/detail.cfm?imgnum=1200011
   Clearcut in 1952. Slash burned After 4 years to let Ribes sprout, eradicated by herbicides and hand pulling. Planted 1951 E2-2 white pine. 90% survived. North slope. Spacing test on 5 x 5 to 20 x 20 feet. Spacing test on area 5x5 and 20x20 October 1973
   Photo by
3. Photo by Velkiira, Clearcut section of Tongass National Forest
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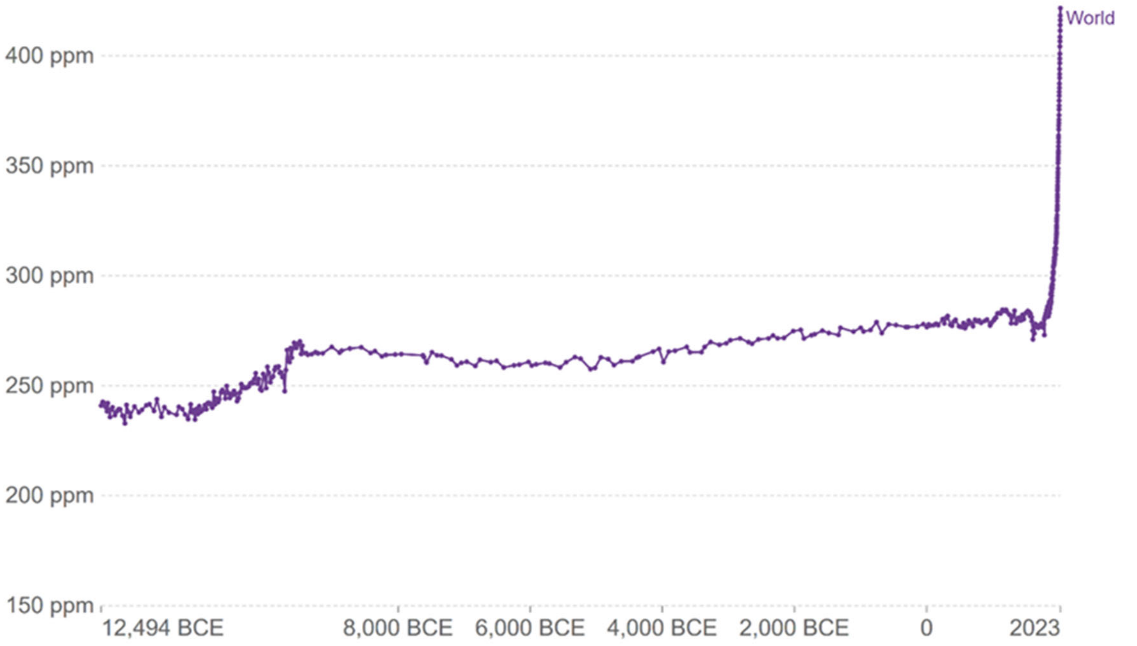

Source: National Oceanic and Atmospheric Administration (NOAA)

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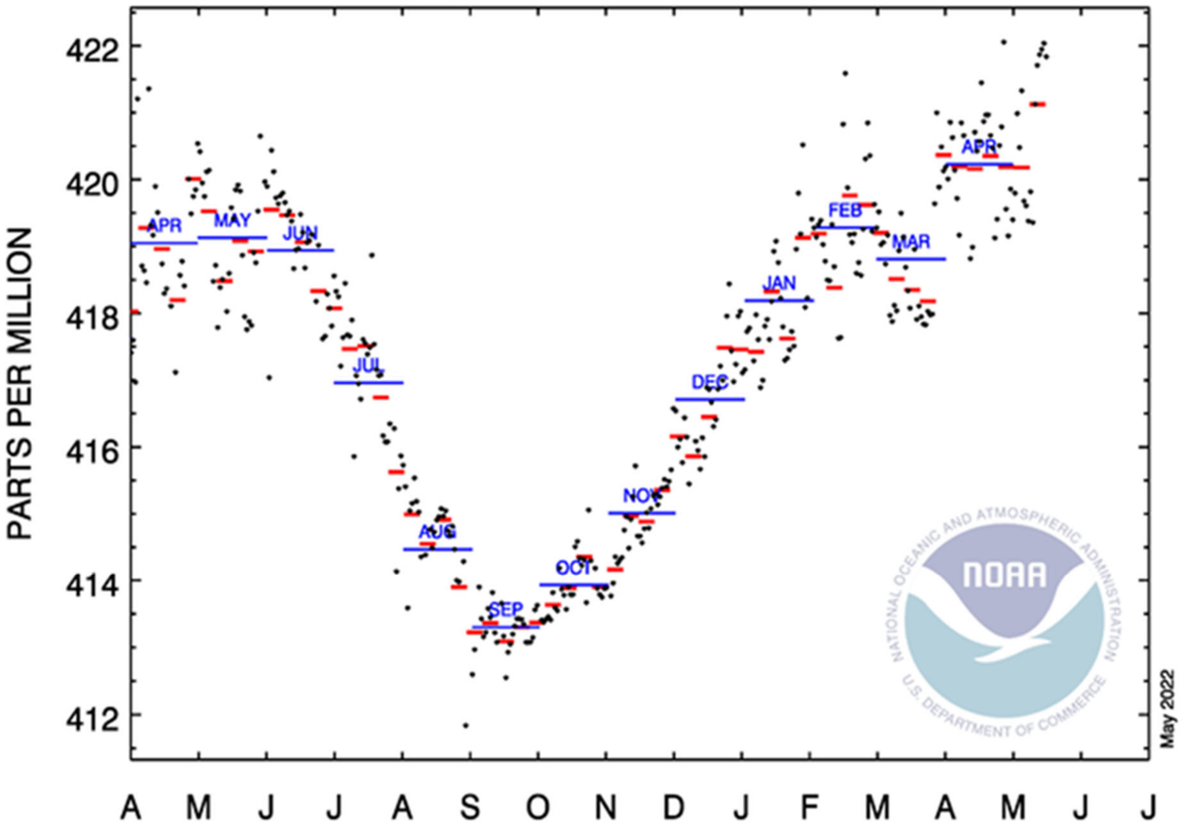
Supplemental Figure S1: *"Global Atmospheric CO_2 Concentration"*

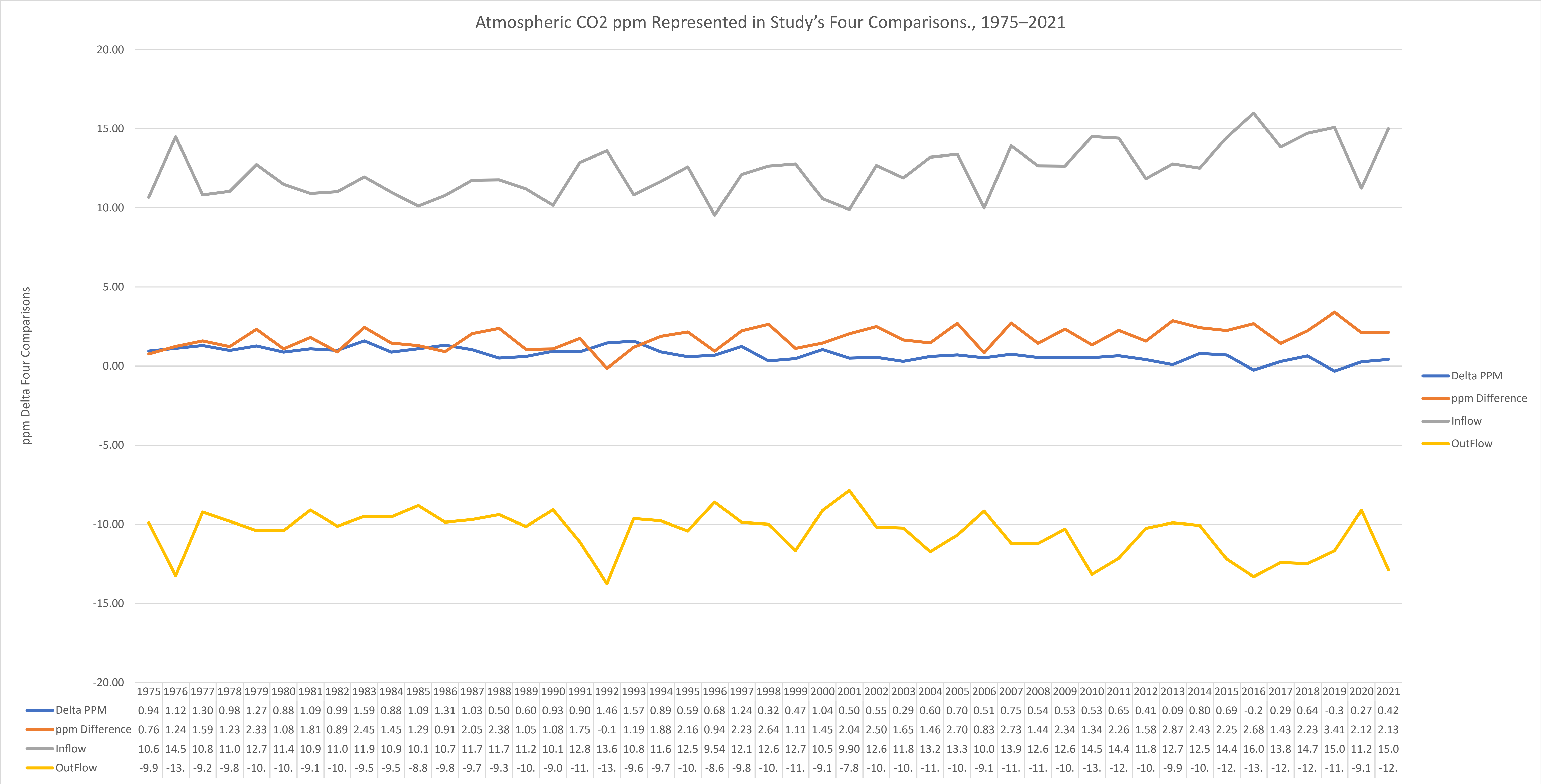
"Atmospheric carbon dioxide (CO_2) is measured in parts per million (ppm). Long-term trends in CO_2 concentrations can be measured at high-resolution using preserved air samples from ice cores."-NOAA data graphed by OurWorldinData.Org.

Figure S1's y-axis is CO_2 ppm recorded from ice core samples, and the x-axis is the measurement year. Figure S1 further demonstrates increasing atmospheric CO_2 ppm is relatable to human domestication and not the much later increases in human emissions. The increasing ppm trend is visible from around 5,000 BCE to the present and correlates to human domestication's "demand-driven forestry 2.11," the rising human population, land uses, and globally spreading "unconstrained and constrained deforestation 2.3" practices.



Supplemental Figure S2: *"One Year of CO_2 Daily and Weekly Means At Mouna Loa"*

Figure S2. A close-up and demonstration of the global CO_2 Fast-Cycle Sink up and down ticks created during planetary growth cycle(s)generated from the northern and southern hemispheres opposite months of plant growth durations. The black dots in Figure S2 are the CO_2 ppm readings as indicated in the y-axis taken using the flask method during the indicated single-lettered month in the x-axis. The months are also abbreviated and underlined on the graph.

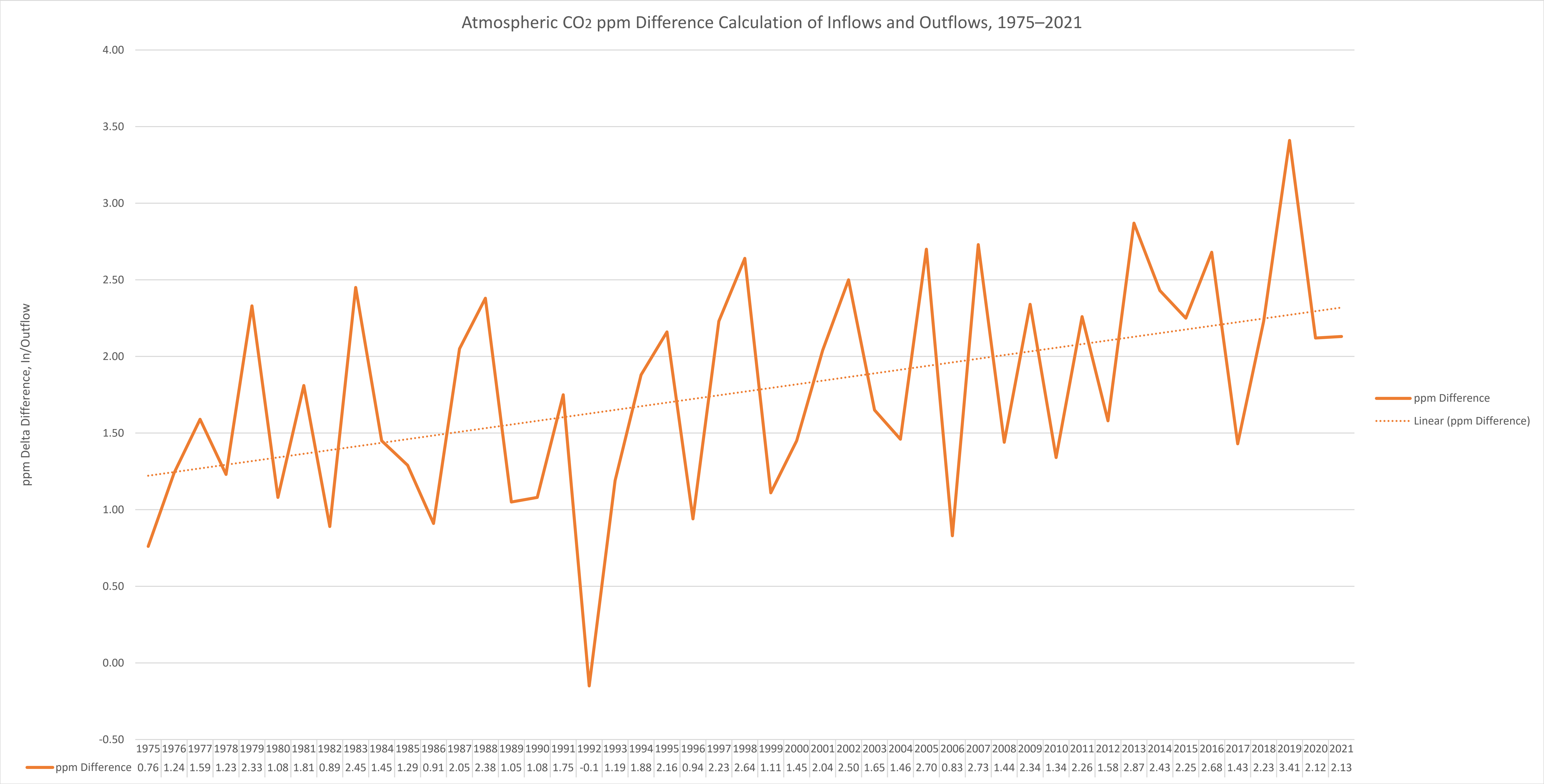


	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Delta PPM	0.94	1.12	1.30	0.98	1.27	0.88	1.09	0.99	1.59	0.88	1.09	1.31	1.03	0.50	0.60	0.93	0.90	1.46	1.57	0.89	0.59	0.68	1.24
ppm Difference	0.76	1.24	1.59	1.23	2.33	1.08	1.81	0.89	2.45	1.45	1.29	0.91	2.05	2.38	1.05	1.08	1.75	-0.1	1.19	1.88	2.16	0.94	2.23
Inflow	10.6	14.5	10.8	11.0	12.7	11.4	10.9	11.0	11.9	10.9	10.1	10.7	11.7	11.7	11.2	10.1	12.8	13.6	10.8	11.6	12.5	9.54	12.1
OutFlow	-9.9	-13.	-9.2	-9.8	-10.	-10.	-9.1	-10.	-9.5	-9.5	-8.8	-9.8	-9.7	-9.3	-10.	-9.0	-11.	-13.	-9.6	-9.7	-10.	-8.6	-9.8

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Delta PPM	0.32	0.47	1.04	0.50	0.55	0.29	0.60	0.70	0.51	0.75	0.54	0.53	0.53	0.65	0.41	0.09	0.80	0.69	-0.2	0.29	0.64	-0.3	0.27	0.42
ppm Difference	2.64	1.11	1.45	2.04	2.50	1.65	1.46	2.70	0.83	2.73	1.44	2.34	1.34	2.26	1.58	2.87	2.43	2.25	2.68	1.43	2.23	3.41	2.12	2.13
Inflow	12.6	12.7	10.5	9.90	12.6	11.8	13.2	13.3	10.0	13.9	12.6	12.6	14.5	14.4	11.8	12.7	12.5	14.4	16.0	13.8	14.7	15.0	11.2	15.0
OutFlow	-10.	-11.	-9.1	-7.8	-10.	-10.	-11.	-10.	-9.1	-11.	-11.	-10.	-13.	-12.	-10.	-9.9	-10.	-12.	-13.	-12.	-12.	-11.	-9.1	-12.

Supplemental Figure S3: *“Atmospheric CO$_2$ ppm Represented in Study’s Four Comparisons.”*

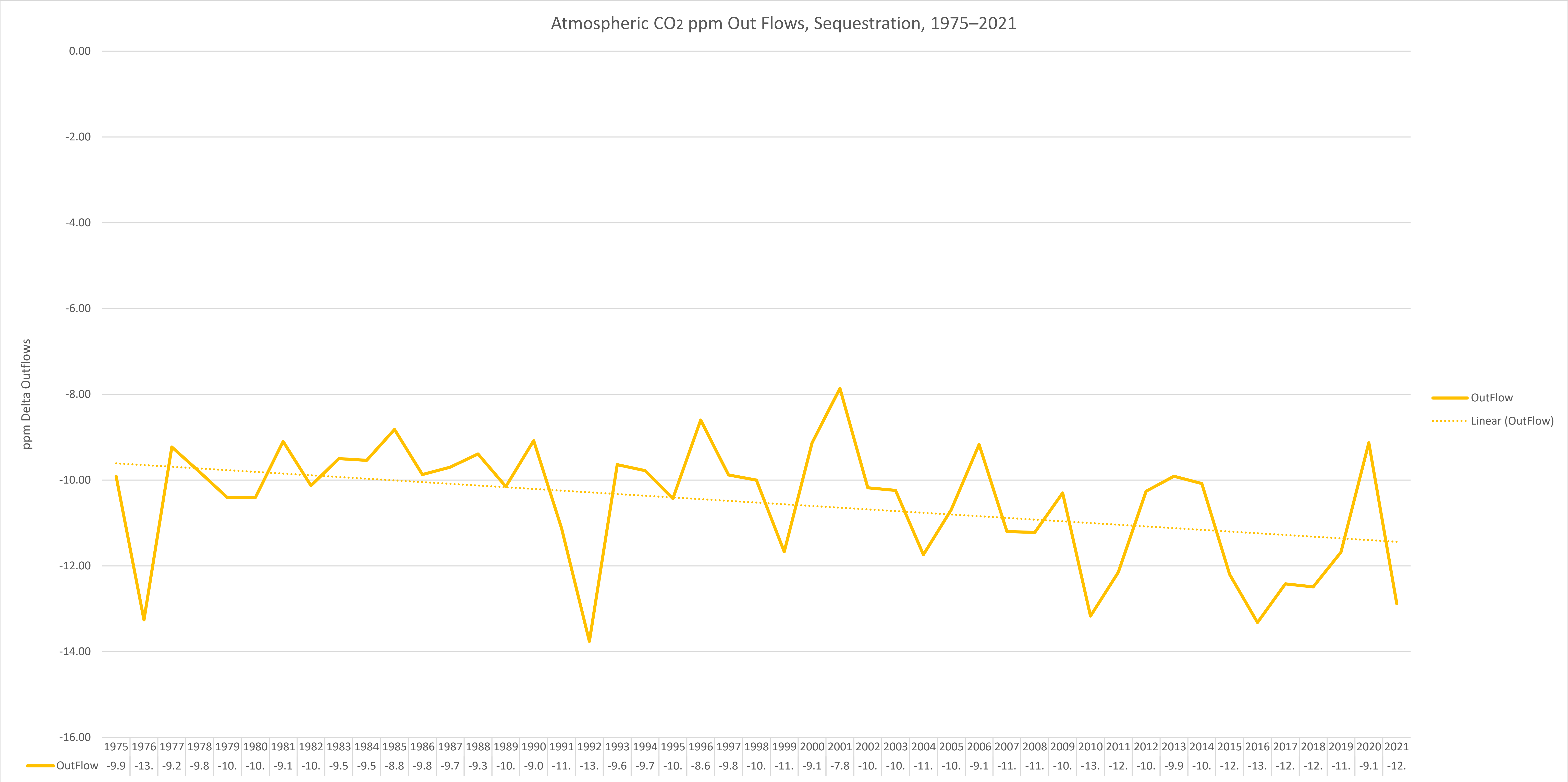
Figure S3 combines compressed views that provide a relational perspective of Figure 10 with a separate methodology to quantitate Figures S3-S6 from 1975-2021. Figure S3’s y-axis is CO$_2$ ppm levels, while the x-axis provides the year and data point table. The blue line is the CO$_2$ ppm Delta of Figure 10. The orange line in Figure S4 indicates a difference obtained between the grey line in the inflow ppm graph Figure S6 and the yellow line in the Outflow ppm graph Figure S5. A condensed view of the graphing was required to accommodate a viewable space allowance. However, the correlations and contrasts made in the study are still viewable and serve as further precedence. Note increasing inflows and decreasing outflows and historical data correlations and concepts mentioned throughout the study can be quickly checked here or further disseminated within each enlarged Figure S3-S6.



	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
ppm Difference	0.76	1.24	1.59	1.23	2.33	1.08	1.81	0.89	2.45	1.45	1.29	0.91	2.05	2.38	1.05	1.08	1.75	-0.1	1.19	1.88	2.16	0.94	2.23	2.64	1.11	1.45	2.04	2.50	1.65	1.46	2.70	0.83	2.73	1.44	2.34	1.34	2.26	1.58	2.87	2.43	2.25	2.68	1.43	2.23	3.41	2.12	2.13

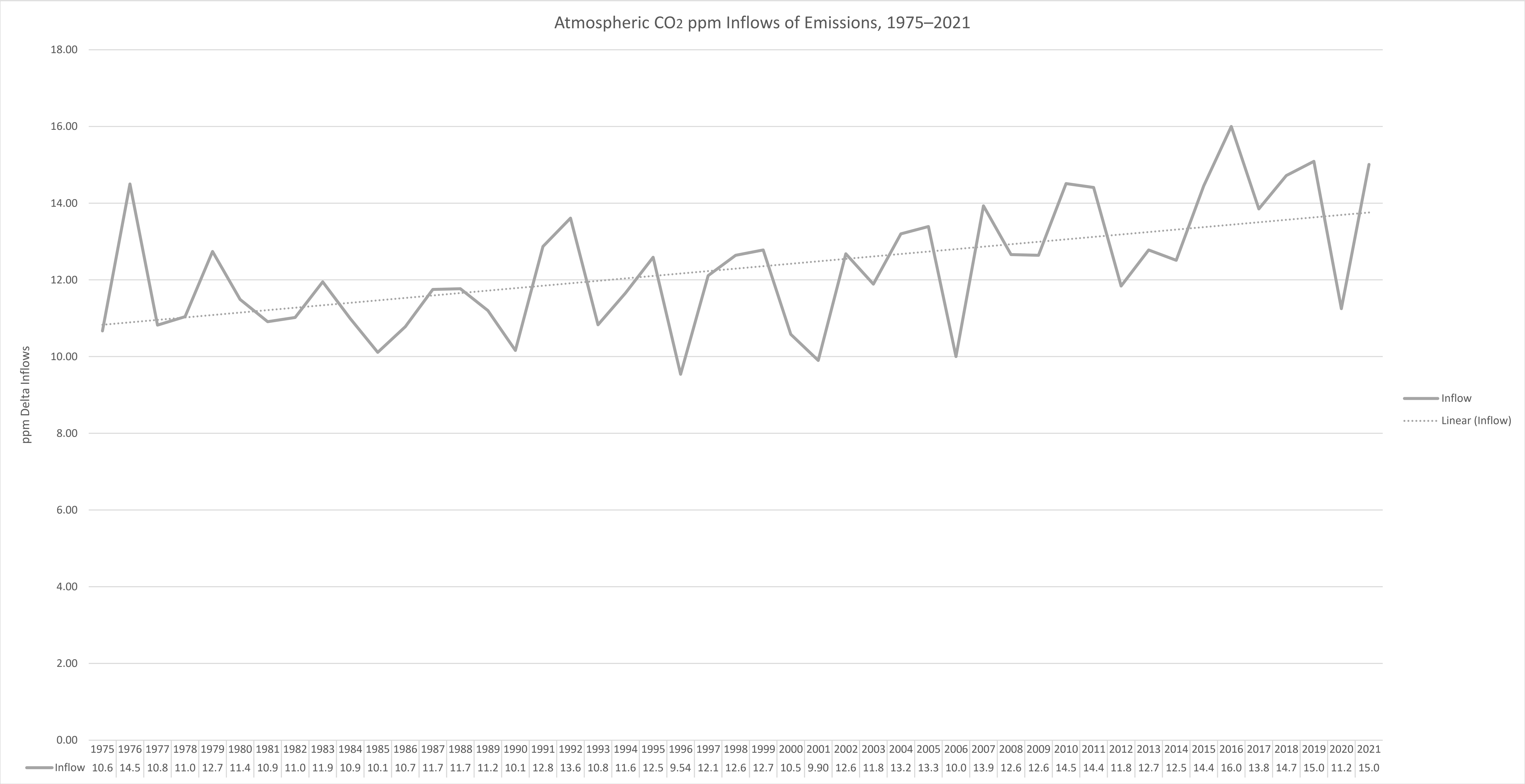
Supplemental Figure S4: *"Atmospheric CO_2 ppm Difference Calculation of Inflow and Outflows, 1975-2021"*

A close-up of Figure S3's "ppm difference" provides a less condensed view. Graphed is the difference between inflows and outflows as measured by all points of ESRL data on atmospheric CO_2 ppm from 1975 to 2021. The y-axis is CO_2 ppm plotted as the difference between Figure S5 and Figure S6, with the x-axis representing years and data table. The solid orange line moves year to year, indicating the difference in atmospheric CO_2 ppm inflow and outflow. The dotted orange line is the linear trend established by data points. The graph was populated using a different methodology explained in Figure 10 by accounting for differences within each year by creating positive and negative ppm measurements as + positive inflow or – negative outflow. The model's outcome demonstrated that increasing inflows (as increasing CO_2 residence time and emission inflow) are partially due to decreasing outflows (decreasing sequestration elaborated in Figure 10 and Figure S5). The outcomes symmetry serves as an additional check for the studies Figure 10 "CO_2 ppm Delta," which analyzes global sequestration health. NOAA ESRL Data, Measurement's used flask method, 1975-2021, Mauna Loa, Hawaii.



Supplemental Figure S5: *“Atmospheric CO_2 ppm Outflow, 1975-2021”*

A close-up of Figure S3’s “Outflow” that provides a less condensed view. Graphed is the atmospheric CO2 ppm inflow measured by all points of ESRL data on atmospheric CO_2 ppm from 1975 to 2021. The y-axis is CO_2 ppm plotted as the outflow or – negatives determined with the x-axis representing years and data table. The solid yellow line moves year to year, indicating the outflow in atmospheric CO_2 ppm. The dotted yellow line is the linear trend established by data points. The graph was populated using a different methodology explained in Figure 10 by accounting for differences within each year by creating positive and negative ppm measurements as + positive inflow or – negative outflow. The outcome of the model demonstrated decreasing outflow attributed to the studies defining decreasing global sequestration, further elaborated by Figure 10’s similar outcome. Figure 10 and this outcome also serve as a check for the “CO2 ppm Delta” studies that analyze global sequestration health. Historical land uses and forestry demand mentioned in section 4.2 can also be correlated to this graph. NOAA ESRL Data, Measurement’s used flask method, Mauna Loa, Hawaii.



	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Inflow	10.6	14.5	10.8	11.0	12.7	11.4	10.9	11.0	11.9	10.9	10.1	10.7	11.7	11.7	11.2	10.1	12.8	13.6	10.8	11.6	12.5	9.54	12.1	12.6

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Inflow	12.7	10.5	9.90	12.6	11.8	13.2	13.3	10.0	13.9	12.6	12.6	14.5	14.4	11.8	12.7	12.5	14.4	16.0	13.8	14.7	15.0	11.2	15.0

Supplemental Figure S6: *“Atmospheric CO_2 ppm Inflows of Emissions, 1975-2021”*

A close-up of Figure S3’s “inflow” that provides a less condensed view. Graphed is the atmospheric CO2 ppm inflow measured by all points of ESRL data on atmospheric CO_2 ppm from 1975 to 2021. The y-axis is CO_2 ppm plotted as the inflow or + positive differences obtained, with the x-axis representing years and data table. The solid gray line moves year to year, indicating the inflow in atmospheric CO_2 ppm. The dotted gray line is the linear trend established by the data points. The graph was populated using a different methodology explained in Figure 10 by accounting for differences within each year by creating positive and negative ppm measurements as + positive inflow or – negative outflow. The model's outcome demonstrated increasing inflow due to emissions, which agrees with Figure 10’s similar outcome when used as a variable in calculation. Figure 10 and this outcome also serve as an additional check for the “CO2 ppm Delta” that analyzes global sequestration health. NOAA ESRL Data, Measurement’s used flask method, Mauna Loa, Hawaii.