Let’s not be Sisyphus

The data are telling us that our climate mitigation efforts up until now have been futile

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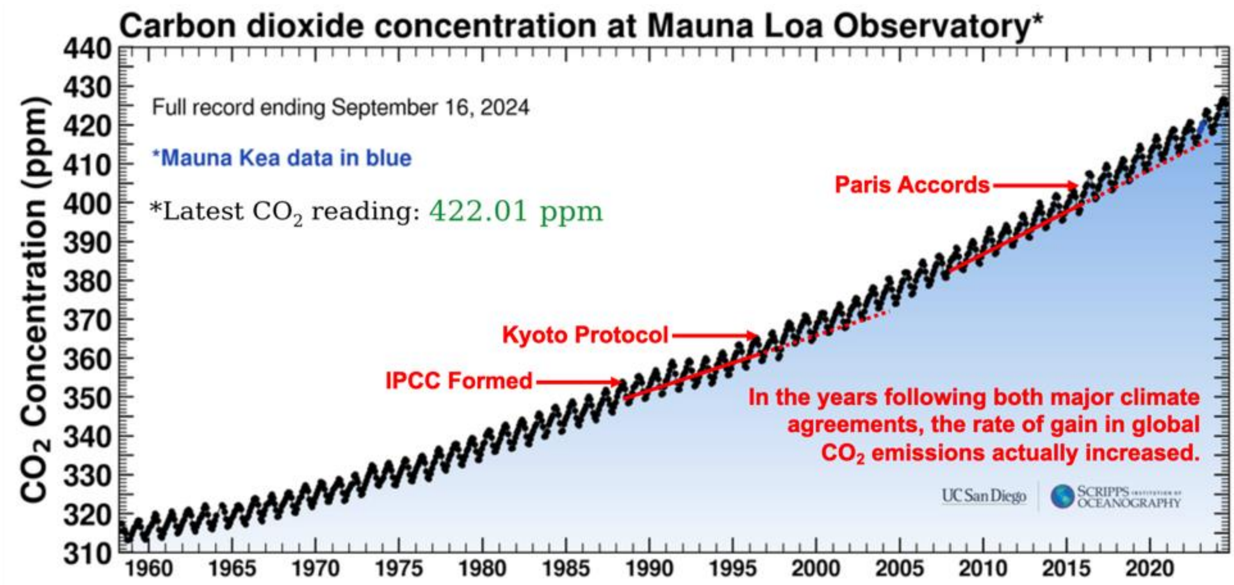
Greek mythology has handed down many fascinating stories, one of which features Sisyphus, an inhospitable and sleazy king whose eternal punishment is an infinite series of futile attempts to roll an immense boulder up a mountain – only to repeatedly see it roll back down to the bottom.

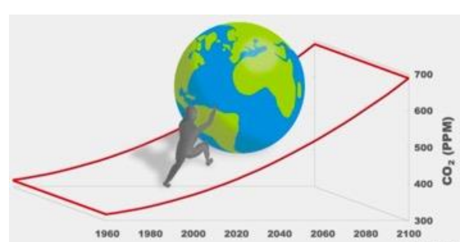
This ancient story came to mind as I contemplate the harsh realities of the “Keeling Curve,” (see **Figure 1**). Charles Keeling began his innovative monitoring study in 1958, the year I was born. He measured atmospheric CO_2 on Mt. Mauna Loa in Hawaii, far from any local sources. Keeling died in 2005, but his son has continued the work until our present day. As of September 16, the concentration was 422 ppm (nearing its annual summertime minimum), about 144 ppm higher than pre-industrial levels (278 ppm, or 0.028%), and far higher than the annual average of 315 ppm measured in the year of my birth, 66 years ago.

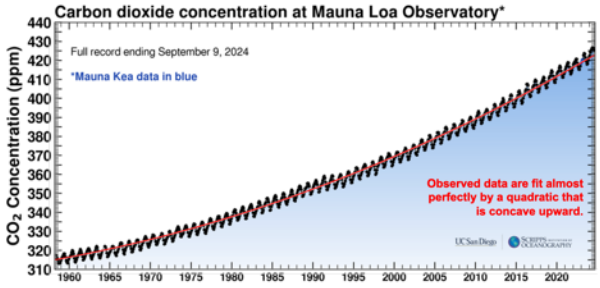


source: Keeling Curve, UCSD (2024).

Figure 1.

The levels continue to accelerate and closely track with a simple quadratic fit (**Figure 2**). This fit is essentially unchanged from when I first fit the data in 2008 (see **Figure 3**). In other words, all of the massive efforts to mitigate carbon emissions (primarily by the West) have had no discernible impact on the trajectory of CO_2, the most potent anthropogenic greenhouse gas (GHG). And unlike N_2O and methane, which are relatively transient GHGs, the average atmospheric lifetime of each CO_2 molecule is more than a 1000 years. The simple implication is that the efforts undertaken by humanity so far to reduce GHG emissions appear to have been just as futile as those of Sisyphus!





source: Keeling Curve, UCSD (2024).

Figure 2.

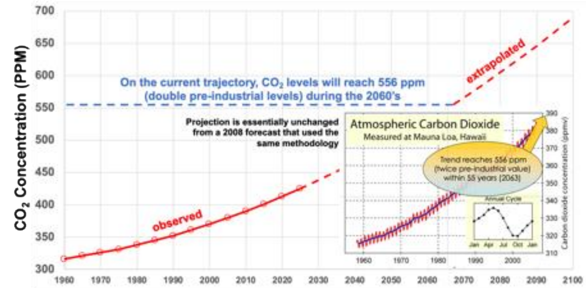
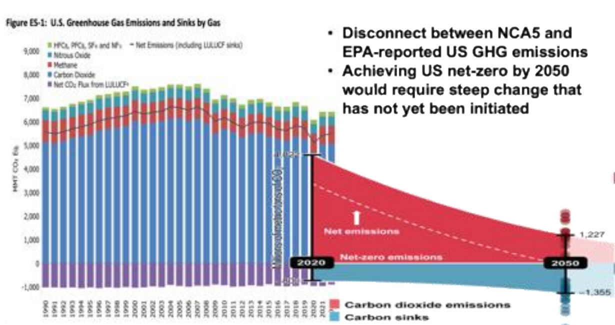


Figure 3.

I realize a few of you are dubious about the idea of man-made global warming and everything having to do with climate change. However, the basic physics are 100% settled and simple to understand. The atmospheric greenhouse effect was appreciated during the 1800's and first quantified by a fellow Swede, the Nobel-prize winning Svante Arrhenius. Without the greenhouse effect, the Earth would radiate all of its heat back into empty space, reaching an equilibrium average temperature of about 0°F – and would thus be completely uninhabitable. Diatomic gas molecules like nitrogen (N_2) and oxygen (O_2) do not absorb any of that escaping heat. However, gas molecules with three or more atoms – most importantly water vapor (H_2O) – have vibrational resonance frequencies that absorb photons in the infrared (IR) range, thereby trapping heat energy and raising the average temperature of the Earth to its current value of around 60°F.

Carbon dioxide (CO_2) also absorbs IR radiation, trailing water vapor in importance. Arrhenius, being based in Sweden, believed that the warming caused by burning increasing amounts of coal (which generates about 2 pounds of CO_2 for every pound of coal burned) would actually be a good thing. And there are certainly parts of the planet where that will be true, such as Siberia. In general, the changes should continue to be quite gradual here in the US, but certain agricultural producers are already experiencing challenges, such as the heavier spring rains that have squeezed the springtime planting window, particularly in the northeastern quadrant of the US. For more detail, read the 5th National Climate Assessment (NCA5, 2023).

Having cited NCA5, however, I must note that it contains some overly rosy claims about progress on emissions reductions (see **Figures 4** and **5**). Emissions in both 2021 and 2022 have remained stubbornly high after a brief dip in 2020 associated with the massive economic slowdown triggered by the response to COVID. Both in the US and globally, GHG emissions are tracking well above NCA5 forecasts for the current decade. As noted in **Figure 4**, achieving net zero emissions in the US by the year 2050 would require a very steep change in emissions that has not yet materialized.



source: US Greenhouse Gas Inventory (US EPA, 2024).

Figure 4.

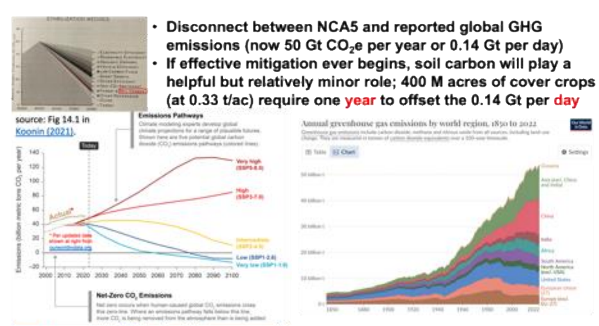


Figure 5. source: NCA5: 5th US National Climate Assessment (2023).

Why has progress been so slow? We could point fingers at any of the other 8.2B fellow inhabitants of this planet, but I personally believe that the analysis published by Pope Francis (*Laudato Si', 2015*) hit the nail on the head, when he blamed it on a weakness of the human heart – our hell-bent focus on consumerism. The rapidly burgeoning middle class in many countries of the world, particularly in India, has obviously been a very good thing – lifting many millions out of poverty – but it also brings unavoidable consequences with respect to future global emissions, unless our neighbors to the East are somehow able to avoid the high carbon intensity lifestyles of the West.

How much hotter will it get? As shown in **Figure 6**, the IPCC projections are dependent on emission scenario. Continuing on the current high-end trajectory of GHG emissions will mean a global temperature increase of at least an additional 1°C (1.8°F) by mid-century, with greater amounts of warming in the Northern Hemisphere and on land surfaces (the oceans warm more slowly due to their immense heat capacity).

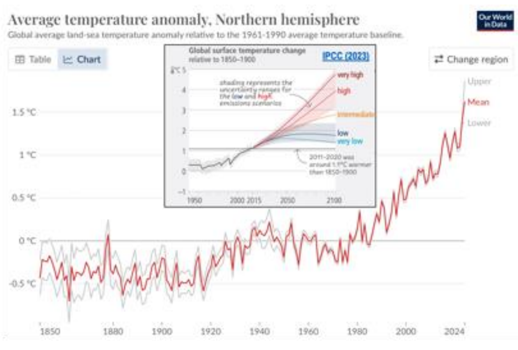


Figure 6. source: https://ourworldindata.org/co2-and-greenhouse-gas-emissions

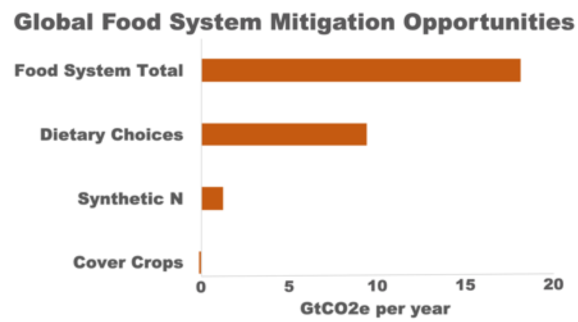


Figure 7. primary data sources: Hannah Ritchie (2021); Menegat et al (2022)

My interest in this subject began in 2007, when I co-led a panel of 30 Monsanto Fellows, who answered three questions posed by the Monsanto Board: "Is climate change really happening? Will it impact agriculture? Will it impact Monsanto?" Our team of scientists began with much skepticism. However, we eventually answered all three questions with a resounding "YES!"

In subsequent years, I began publishing my work on these subjects in the scientific literature and ended up being nominated to serve on the Executive Secretariat for the 3rd National Climate Assessment (NCA3), which was released in 2014. I have interacted with many sincere scientists who feel that the efforts being undertaken to reduce GHG emissions throughout the US ag sector (mainly on soil carbon) are sensible and worth the billions now being allocated. But is this rational?

Let's begin to answer this question by examining **Figure 7**. Estimates vary widely, but the global food system (not just agriculture) is responsible for around 25-30% of all GHG emissions (including land use change). I would assert that tweaking soil carbon sequestration rates in current agriculture settings is currently receiving an outsized amount of attention given how little it could meaningfully contribute to the overall amount of emission reduction that is required. Both dietary changes and discovering a replacement for synthetic nitrogen fertilizer have far greater climate mitigation potential. Cover crops bring a wide array of direct benefits to the farmer and environmental advantages beyond their contribution to soil carbon sequestration, but let's be honest about the size of their potential climate contribution (0.14 $GtCO_2e$ per year at 400M acres, vs. the current 18M acres in the US). That's a tiny sliver of what needs to happen.

So, let's summarize what this means for US agriculture. First, looking at the Keeling Curve and current reports on US and global GHG emissions, there is no evidence of any effective mitigation of emissions to date. This implies that US farmers will certainly be faced with increasing climate and weather-related challenges. Secondly, the current focus (within agriculture) on mitigation of climate change through enhanced soil carbon sequestration is tremendously out-sized, relative to its probability of actually causing any measurable slowing in the rate of climate change.

If we accept that these two things are true, what should we do? The first is simple. **the focus of US Ag Climate Policy should immediately shift to adaptation**: common-sense, low-cost measures that should be taken to plan for the warmer, wetter (in most places) world that is coming, due to the unknown but inevitable amount of additional climate change that has now become completely unavoidable. For instance, the soil health benefits of both cover crops and no-till make soils more resilient to both heavy rainstorms and drought. These are direct benefits to farmers and far outweigh the small amount of soil carbon sequestered. There are many other cost-effective actions that could be taken to help farmers adapt to future climate change, the effects of which will generally continue to be quite gradual and therefore quite manageable. This is where research dollars could be more sensibly spent.

Secondly, just as the Biden Administration completely excluded the US Military (i.e., anything related to national security, combat, intelligence or military training) from its 2021 Executive Order mandating that the US federal government become carbon neutral by mid-century, **US Climate Ag Policy should similarly exclude the Food Sector from any such mandates**. The two largest sources of GHG emissions in US Ag are related to methane emissions (mostly cattle and rice) and the use of synthetic nitrogen fertilizers. Yes, it may make some sense to lower these emissions, but there should be no mandates. People must eat, and healthy food has already become unaffordable for far too many Americans, let alone the hundreds of millions of others around the world who depend on food exports from the US. Mandating decarbonization of food would inevitably make it even more expensive.

Let's get ready for what's coming rather than continuing in the futility of thinking that our current efforts will stop it. Once sentenced, Sisyphus didn't have a choice. We do. Let's make the right one. And every day that we wait, another 0.14 $GtCO_2e$ is added to the atmosphere. The time to act is now.