Balance on Planet Earth

What does balance with the planet look like? What about us humans? How low can we go? Are there too many of us? When was the last time we were in balance?

What Does Balance with the Planet Look Like?

One way that I like to view my life is in terms of balance. That's probably because I've spent my entire life balancing and juggling different priorities, my family with work and school, getting outside, a little alone quiet time for myself, time with friends. After all, there are only so many hours in every day and, let's face it, in life, and it's up to each of us to decide what we are going to do with that time. We all have that balancing act every day, so balancing is something we all have in common. Something we all understand. And, we don't always get to do what we want, or what we'd rather be doing. As much as I loved my career, there were definitely days when I'd rather sleep in, or take advantage of a beautiful day to garden, get outside, take a hike, but I had to be at work, since it was a workday. The point is, balance isn't always perfect, and it usually involves things we want and things we don't want, and that's a subjective decision that each of us has to make. I'm not saying that my life has always been in balance. I'm not in balance now. For me, balance is a journey, something that I strive for, because it feels more comfortable to be in balance than it is to be constantly stressed from being extremely out of balance, with either way too much work or not enough money to make ends meet, because I'm not working enough. It's always something.

And the big picture of work-life balance is just one part of balance. We also have things like balance in our diets, are we eating enough, or too much? Are we eating a good proportion of all the nutrients, and not high-loading on too much of one thing, like carbs or proteins or fats? Do we spend time walking and exercising each day, or do we constantly sit, in the car, at our desk, on the couch? Do we have quiet times where we actually stop and think, and meditate and be in the moment, or are we constantly rushing off to the next emergency? All of these balancing acts play huge in our satisfaction with daily life, the happiness and satisfaction of those around us, and our health and longevity.

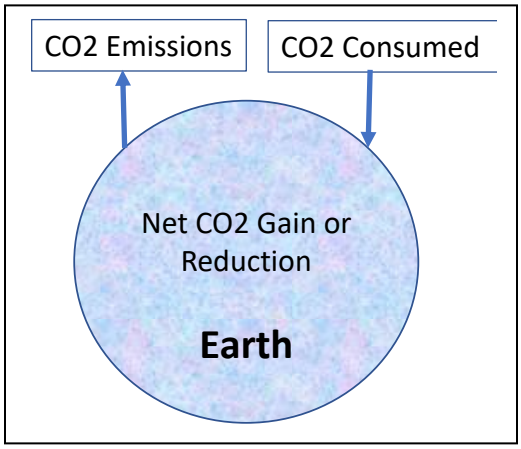
Definition of Balance:

Being in a state of balance: having different parts or elements properly or effectively arranged, proportioned, regulated, considered, etc.

Merriam-Webster

Getting back to the planet, we've looked at several indicators that show us that our planet is in trouble, and I think it's fair to say that these indicators, like loss of wildlife and higher temperatures, can be thought of in terms of balance. We know that Earth's CO_2 and temperature have been increasing and decreasing on a fairly regular cycle for millions of years, and this can be described as a balancing act, where the temperature increases to a point from natural factors, then essentially rights itself by dropping back down again, as glaciers ebb and flow. And, the recent extreme increases in temperatures can be attributed to an imbalance, with more CO_2 in the atmosphere than the planet can balance with. Something like eating too much food and gaining weight as a result. Eating more food than our bodies need or can handle causes our bodies to get fat, which is an obvious form of imbalance. And this imbalance cascades to a lot of indicators in addition to the obvious embarrassing physical appearance. It can lead to heart and circulatory problems, hormonal problems such as diabetes, and stresses on the

musculo-skeletal system, to name a just a few examples. On the other hand, if we don't eat enough, eventually our bodies will run out of fuel and we'll starve. Which is more common than we'd like to think in many parts of the world. Either way, it's not a good thing to be out of balance with food.



With all the complexities of a relatively finite human body, how do we describe balance on an entire planet? We've already dived into the imbalance of CO_2 that is driving our temperature up, and we've established that as the core driver of global warming. We've also established that human burning of fossil fuels is the main underlying cause of all that excess CO_2. We can easily make a block diagram of what that balance looks like. It's pretty basic, what goes in must either come out or accumulate. If CO_2 is in balance, the amount entering the atmosphere will exit the atmosphere. If we add too much, it will accumulate and the planet will warm up, and if the addition rate of CO_2 is reduced, or taken up, say, by forests and trees, then the CO_2 in the atmosphere will be reduced, and the planet will cool. At least, that's what's been going on for the past several million years.

What About Us Humans?

So, if CO_2 emissions are at the bottom of global warming, and humans are the reason for the high emissions, then that makes humanity complicit in global warming, right? And, if humanity is at the bottom of global warming, then how can we talk about CO_2 emissions and global warming without including humans in the discussion? And, if we bring humans into the discussion, what exactly is humanity's role in all this? It seems that we do so many things to upset the balance on our planet that it's just mind-boggling. We scrape land and forests for shelter, food, fuel and other stuff, we drill and mine for energy, we build roads, airports and infrastructure to get ourselves around and convey energy and water, and we have manufacturing plants all over the place that spew poisons into the air, on the land and into the water while they make all our stuff. So how do we measure all that?

I mentioned in Chapter 1 that it seems like every move we make disturbs the environment. But we are part of the ecosystem too, aren't we? Didn't we evolve in this world just like the wildlife, so don't we belong here too? Is it really our fault if we evolved on this planet, and we are just being humans? Just like a whale is a whale, or a bear is a bear? How can we, in particular, be throwing our planet out of balance, when we're just one species among all the diversity? We've already seen that we're emitting way too much CO_2, and it's from fossil fuels that have been stored deep in the Earth for millennia, until we drilled and mined it up and started burning it with abandon. And, we've already seen that all that CO_2 is upsetting the balance on our planet. We also know that we're the ones burning the fuel. So, I wondered if there was a way to account for humans separate from the fuel? I know that sounds strange, but I was looking for a way to account for humans in general, and all the other ways we throw the planet out of balance, with all our general life demands.

To look at this issue a little closer, I went back to my favorite thing – analyzing numbers and plotting data. It's my OCD. First, I plotted global human population [1,2] against total CO_2 emissions, from 1850 to present, in Figure 1. I plotted the total CO_2 emissions, including fossil fuels and land use. I could have focused strictly on fossil fuels, but I used the total, including land use, because humans are also responsible for changes in land use, that I mentioned earlier, for our needs as humans, like food, fuel and shelter. This graph shows that population and CO_2 emissions have clearly been running hand in hand all this time, even before we began burning fossil fuels in earnest. This is because, before we burned huge levels of fossil fuels, we were burning coal and other solid fuels, such as wood, to cook and stay warm.[3,4,5] And, the emissions in this graph are strictly for burning of fossil fuels, including oil, natural gas and coal, as well as cement production, and don't include other biofuel sources like wood or whale oil. The emissions include not only direct burning of fuels, but also the fuel use in manufacturing, that is driven by human consumption for food, housing, transportation, materials and other needs.

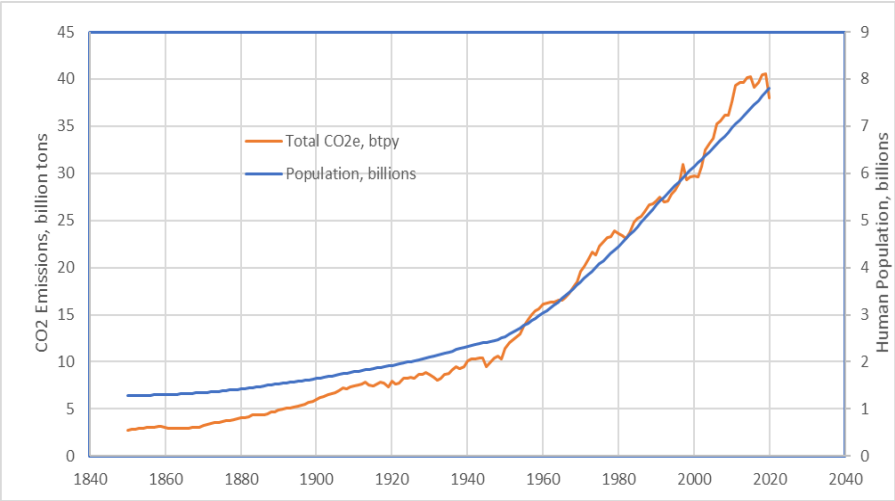


Figure 1 - CO2 Emissions and Human Population since 1850.

Figure 2, which plots the total CO_2 against human population, shows that the human population is indeed a near-perfect underlying factor of higher CO_2 emissions. This really shouldn't be a huge surprise, given that humanity is responsible for burning fossil fuels, but the fact that this is a global relationship that extends all way the back to 1850 and probably before is amazing, given the extreme differences in lifestyles and demands of people throughout the world. It really emphasizes, at least for me, the role that each and every one of us plays in the overall climate change we're experiencing. Just with our mere existence. It turns out that the minimum CO_2 emissions on the planet today are from people who live in Africa, in countries like Malawi, Ethiopia, Madagascar and Uganda, where they manage to squeeze by with an annual CO_2 emissions per capita of around 0.2 tonnes/year.[6] While that's definitely something to aspire to, the reality is that these populations are existing below the extreme poverty level of $1.90/day,[6] and they struggle constantly

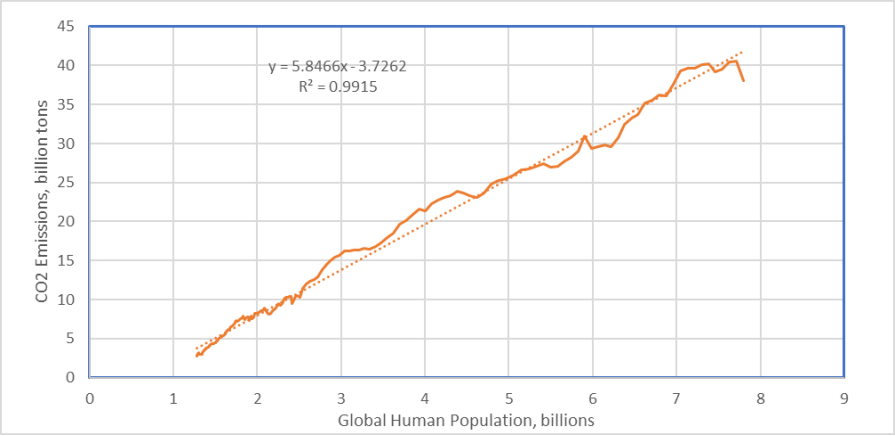


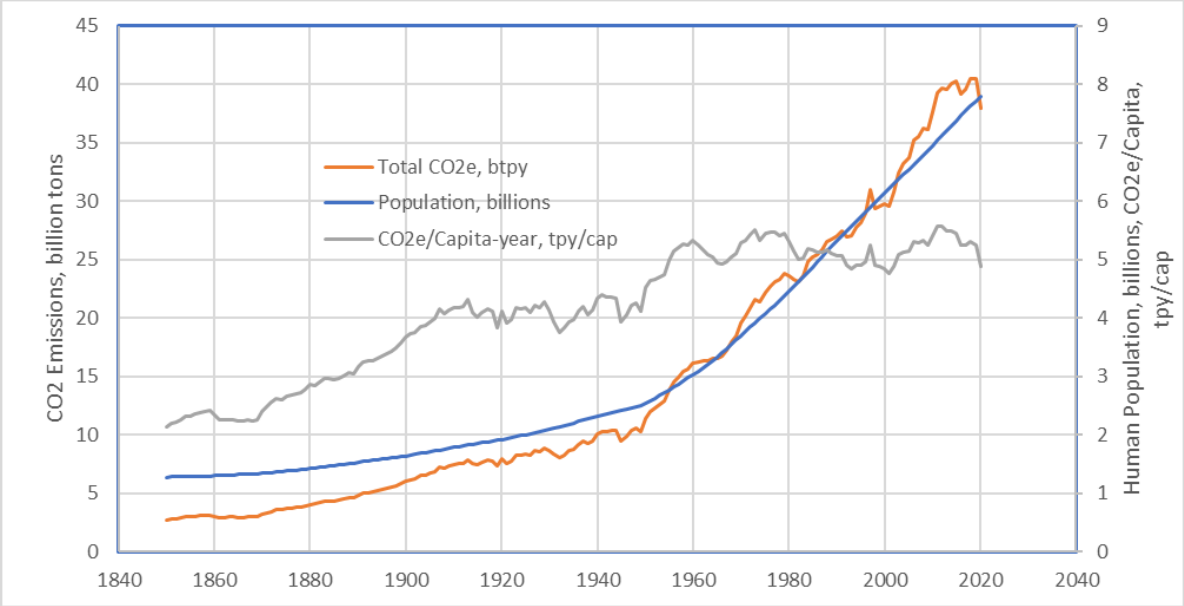
Figure 2 - Global CO2 Emissions versus Human Population, 1850 to Present

with high infant mortality, starvation and poor sanitation, leading to shorter life spans,[7] higher infant mortality[8] and higher rates of malnutrition.[9] A fairly grim picture by developed world standards for sure, and something I hope not to leave my descendants, if I can help it.

Yet, the average CO_2 emissions in the wealthiest countries, including the U.S., Australia and Canada, is around 15 tonnes/year per person, a ludicrous 75 times that of the lowest emitting countries, which is just embarrassing, at least to me. This shows that, while it's possible for a human to have a very minimal carbon footprint, the wealthy countries like the U.S. definitely have lots and lots of room to move in terms of reducing individual carbon footprint per individual, and still live a good life. It turns out that most European countries have much lower carbon footprints, approximating the global average, so there seems to be a lot of opportunity for reducing individual carbon footprint to help get our planet in balance with CO_2.

How Low Can We Go?

I took a closer look at how much carbon emissions each person is responsible for, on average, using global emissions and global population, in Figure 3. This graph is a little busier than the previous ones, with three lines. We have the total CO_2 emissions on the left axis, and the population and CO_2 per capita on the right. The CO_2 per capita is interesting, because it shows that the global average was already just over 2 tonnes per year per person way back in 1850. This is surprising, because it's just under half the global average today, which is around 5 tons per capita. This means that, way back in 1850, we were already contributing quite a lot per capita to CO_2 emissions, before we had significant fossil fuels, and before we had cars, planes and power plants. With only 1.3 billion people on the planet, which is about 1/3 of today's population, we had already scraped a large portion of global forests in order to grow food, and our demands for food and shelter were already fairly significant.



Between 1870 and 1910, emissions per capita increased as the industrial revolution took hold, and then we levelled off at about 4 tons/year/capita through the depression and two world wars, before increasing again to an average of about 5 tons/year/capita, which is where we are today. So, if total CO_2 emissions have increased for the past 50 years, since the first earth day, it hasn't been because of increased CO_2 per capita. This leaves only one other explanation. Total emissions have increased because of increased population at similar emissions per capita. One way to look at it is that, if we were at the population we had in 1970, about 3.5 billion, less than half of today's population, the atmospheric CO_2 concentration would be around 326 ppm, and the temperature would be around 57.2 ºF. Another way to think of it is, that at our current population of 7.8 billion, if we all managed to cut our CO_2 emissions per capita in half world-wide, to 2.2 tons/capita, we'd still be emitting 17.2 billion tons per year of CO_2, which is more than the planet can handle, if the last time the planet was in balance was when the total CO_2 emissions was 7.5 billion tons per year. To get down to the 7.5 billion tons per year or less with the population we currently have, we'd have to reduce annual CO_2 per capita to less than 1 tonne/year, which is less than it was in 1850. And, this is just the CO_2 balance on our planet, which does account for CO_2 emissions from land use, but doesn't account for all the other imbalances in the web of life on our planet, that is driven by all our general activities, our mere existence, with our sheer numbers, our sheet mass of humanity, at the bottom of it. So, how do we account for all that disruption, if we're already accounting for all the CO_2?

Looking back to that first Earth Day in 1970, it's probably safe to say that we would likely have lost a lot less wildlife with 3.5 billion people on the planet, if we had stopped increasing our population at that time. Although global warming is definitely causing wildlife loss, there are a lot of other human activities that destroy wildlife, either directly or indirectly. Habitat loss comes up a lot, which is a way of saying that humans are taking over more and more wildlife habitat for shelter, roads, growing food, drilling for oil and mining, etc. We also kill wildlife directly, by hunting, poaching, etc., which is basically how we took out the wooly mammoths, buffalo, passenger pigeon and dodo bird, and most of the whales, to name a few examples. Now there are so many of us that we are even competing with them for food, krill, etc. And things we do, like poisoning the air, water and land with our toxins, and microplastics kill the wildlife as they poison us humans. Some of this is because of our sheer numbers, which are also related to how much CO_2 we emit. So, how do we talk

The Elephant in the Room – Human Population

We seem to talk about human population and climate change in two separate silos, even though, if we really dig in, the two are intricately related, completely and inseparably intertwined. This should be a simple and obvious concept to understand. It's not even a new concept. To have a complete discussion about global warming and wildlife destruction, and to turn that discussion into actions that will save our planet, we can't ignore population and expect to get anywhere. This discussion has been around for centuries, and we've chosen to basically ignore it. Among numerous examples, we were warned by Paul Malthus in 1798, with his excellent and prescient "An Essay on the Principles of Population"[10], then in 1968, with Paul Ehrlich's book, "Population Bomb"[11]. Kurt Vonnegut even got into the conversation with his terrifying short stories, like "Welcome to the Monkey House"[12], and "Tomorrow and Tomorrow and Tomorrow"[12]. And there's even the Star Trek episode in 1969 about the overpopulated planet, "The Mark of Gideon", where nobody dies, and life is miserable. Or "Soylent Green", which I saw back in 1973, when I was 14 years old, probably my first dystopian movie, since I didn't watch the Star Trek episodes until I was in my 20's. But you have to admit, it's pretty gross to think that we could be so overpopulated that we have to eat ground up dead people. Yuck. If you don't think that could happen, think again. Let's try not to go there. OK?

about one without the other? How can we separate planetary destruction from human population? Truth is, we can't. Not if we want to be honest and have a complete and useful conversation, that is.

Are There Too Many of Us?

Once again, when we talk about balance on an entire planet, how can we talk about that without including human population? We could include a discussion about population of other species, except that there probably isn't a single species, other than humans, that is actually increasing at this point. So, what does that tell us? I know what it tells me. It tells me that, when we talk about balance with our planet, what we're really talking about is balance between humans and all the life on the surface of the planet. Or, more specifically, humans and our associated activities. At any rate, our sheer numbers are definitely at the bottom of our activities that are impacting the balance on our planet. If a few starving locals poach a few elephants in Chad, it's not going to do much to the elephant population, but when a huge overpopulation of desperate starving locals takes out pretty much the entire population of elephants in Chad, which is what we're seeing now, for endless human requirements of ivory, sustenance and land, that becomes an issue of too many humans pushing out other species with our sheer numbers.[13] Or if we burn off the trees in a few acres of land here and there, in order to make space for growing local populations, or to open up more land for growing food for increasing populations, it probably wouldn't be a huge deal, and would be more of a regional thing in different parts of the planet, something that has certainly been going on for millennia. But, when we're taking out forests at a rate of 12 million acres per year,[14] for our endless wants and needs, impacting entire planetary carbon sinks and taking the land from wildlife all at the same time, it becomes a global problem, and a big contributor to the demise of wildlife and to our planet. In just the past two decades, we've lost 16% of global forest cover.[15] I mean, how stupid is that? And these are just a couple examples of how our sheer masses are severely encroaching on the wildlife that we supposedly share this planet with, and messing up the atmosphere that we all share. We're doing the same thing in the oceans as on land, fishing species to extinction, one by one, from whales to salmon to krill.[16,17,18,19,20,21] The analogy that humans are a cancer on this planet appears to have some basis in fact.

When Was the Last Time We Were in Balance?

That would be a pretty important thing to get straight. After all, if we're out of balance, and if we want to get back in balance, then we need to know where we're going. We need to know what that balance looks like. We need to know what we have to do. Again, we're talking about an entire planet, and our role as humans. And, more to the point, as responsible humans who care about others besides ourselves. The others would of course include future generations and the beautiful diversity of life on this planet, other than humans. If we're currently out of balance, and moving in a bad direction towards even worse imbalance, then how can we figure out what to do to get back in balance?

The 2015 Paris Agreement set a limit on the maximum post-industrial temperature increase that the planet can endure, before we pass a truly dangerous tipping point. The limit to temperature increase was set at 1.5 ºC, or 2.7 ºF, which works out to a global average temperature of 59.4 ºF, compared to about 56.7 ºF in 1910. Sadly, we already blew that limit last year, since through the end of

2020, we reached 59.5 ºF. The IPPC Report on Climate Change[22] explains that limiting global warming to 1.5°C instead of 2°C could result in around 420 million fewer people being frequently exposed to extreme heatwaves, and about 65 million fewer people being exposed to exceptional heatwaves, limit extremely heavy precipitation events and extreme drought, limit glacial melt and associated sea level rise and ocean acidification, and species losses and mass extinctions are reduced, as a few metrics that are out of balance on our planet. In order to reach this goal, we must achieve net zero emissions within 15 years, and according to ICCP, we will have to limit CO_2 emissions to 30 Gt/year or less from then on. But the problem is, this target is waaaaaay higher than human emissions in 1910, the last time we were in balance with the planet, when we were emitting a measly 7.49 Gt/year. So, just wow is all I can say to that. I know my thinking is greatly simplified, but I'm pretty sure I'm not off by a factor of six!

Getting back to the numbers, Figure 2 in Chapter 1 shows that CO_2 emissions and temperature began to increase in about 1910, when the industrial revolution began to really take off, and the human population began to increase more rapidly. Basically, we're using 1910 as a baseline to represent the last time we were in balance with the planet, since that's when the temperature was starting to increase. Although in reality, the CO_2 emissions from our activities was probably building up long before that, and finally exhausted all the natural sinks for CO_2 at that point in time, so that the CO_2 started building in the atmosphere and causing the temperature to begin increasing outside of the normal interglacial ranges that had been going on for millions of years before that. If we take CO_2 and temperature as measures of balance with the planet with respect to the atmosphere, this feels like a decent baseline to start from.

Table 1 shows a comparison of where we were in 1910, compared to where we were as of 2019, in terms of the underlying measures we've been considering, CO_2 emissions, CO_2 concentration, temperature, forest cover and human population. I used 2019 to represent our current state, because in 2020 we had an extreme anomaly, partly because of reduced CO_2 emissions due to Covid, and partly because of the sudden increase in temperature. I've also thrown 1970 in there for the helluvit, since we were sufficiently aware of environmental problems to have the first Earth Day, after which we continued blithely along on our destructive path. It's an illustrative point in time that it would do us well to learn from, because the planet definitely won't weather yet another 50 years of our complacency. Pun intended. We haven't discussed forest cover extensively, but it's an important and measurable sink for CO_2, meaning that forests actually absorb CO_2 from the atmosphere, and the more forest we have, the more CO_2 those forests can absorb, which plays huge in the overall CO_2 balance.

Table 1 – Anthropogenic Impacts on Planet Earth from 1910 to 2019

Year	**1910**	**1970**	**2019**
Global CO_2e, billions of tonnes per year	7.49	19.61	40.53
Global Human Population, billions	1.75	3.70	7.71
Global Forests, Percent of Arable Land	56.7	41.6	37.5
Global CO_2e/capita, tonnes/capita	4.28	5.30	5.26
Atmospheric CO_2 Concentration, ppm	302	326	412
Average Global Temperature, ºF	56.3	57.2	58.5

The first thing we can see in Table 1 is that in 1910, the last time we were in balance with our planet with respect to CO_2, is that total emissions was 7.49 billion tonnes per year, with an atmospheric

concentration of 302 ppm of CO_2. The concentration of CO_2 was approximately at the upper limit of the concentration in the atmosphere for the previous several million years, at the height of an interglacial warming trend. In the natural, undisturbed cycle, the CO_2 would have levelled off around this concentration, then start trending downward towards approximately 200 ppm or lower, over the next 50,000 years. Instead, the concentration has climbed steadily, to 326 ppm in 1970, when we had that first Earth Day. At that time, there was a lot of concern among scientists that we were heading in a bad direction, but that urgency was ignored by most people, including myself, and we continued with business as usual, as we continued increasing our CO_2 emissions to the whopping 40.53 billion tonnes/year that we saw in 2019. Our atmospheric CO_2 concentration reached 412 ppm, leading to a temperature of 58.5 ºF, an increase of more than 2 ºF since 1910. This is already past the tipping point that climate scientists have been warning all along that we don't want to cross. Yet, here we are. Oh, we've crossed it. And, we're definitely experiencing the types of weather disasters that we were warned about, including extreme storms, drought, dangerously high temperatures in warmer areas and associated increased wildfires, melting glaciers, sea level rise, oceanic acidification and loss of species. It turns out the scientists were right. We're out of balance and continuing to head in a bad direction. So, now, the question is, are we going to finally do something about it? Or are we going to just keep on with business as usual and drive our planet right into the ground with our complacency?

> "Those who cannot remember the past …. are condemned to repeat it."
>
> George Santayana

Getting back to 1910, when we were emitting 7.49 billion tonnes a year of CO_2, we had 1.75 billion humans on the planet, and our average CO_2 emissions per person was 4.28 tonnes/capita. Forest cover, which consumes CO_2, was at 56.7% of available land in 1910, so forests were playing big in keeping our atmosphere in balance. By 1970, when scientists were warning us in earnest, our population had reached 3.7 billion, and we were emitting about 20 billion tonnes/year of CO_2. Annual CO_2 per capita was 5.3 tonnes, which is only about 20% more than in 1910, but the sheer mass of humanity, as we increased the population to more than double what it was in 1910, while continuing to destroy forests to satisfy our endless wants and needs, drove the CO_2 concentration in the atmosphere up to 326 ppm, and increased the temperature by 1 ºF. So, it turns out that us teeny weeny little humans can indeed change the climate on our big gigantic planet earth, much as we'd like to think otherwise.

> "The world will not be destroyed by those who do evil, but by those who watch them without doing anything."
>
> Albert Einstein

> "The greatest threat to our environment is the belief that someone else will save it."
>
> Robert Swan.

Since we didn't learn in 1970, and we still haven't learned, our population and CO_2 emissions have continued to grow, more than doubling once again in the past 50 years, doubling global CO_2 emissions and increasing the temperature by yet another 1 ºF. And, fascinatingly, most of us continue to ignore this issue, as though somebody else will take care of it, or the problem will go away by itself. The problem is that the longer we ignore the issue, the harder it will be to get back in balance with our planet, if it's not too late already. Most of us seem to get that something like cancer will ultimately kill us if we ignore it, but we don't seem to get that when it comes

to the planet. Something about the planet being just too big and too complex? Or what? Maybe it's just hard to, say, go for a hike in the woods and see all the nature there, and think that the planet is truly sick. But that's the same for an early cancer patient. When I had cancer, I looked perfectly normal and I was very active with mountain climbing and all. The lump in my breast wasn't visible to anyone but me, my husband and the doctors, but that didn't mean it wasn't growing and leaking into my lymph nodes, where it would go metastatic and kill me from there. In the end, I'm glad I took action and did something about that. I'm still here. I like life. I'm grateful for the medical technology that saved me. After that, I also changed my diet and lifestyle to keep it from happening again. So far, so good. This is what we need to do for the planet.

Once again getting back to the last time we were in balance, some quick 4th grade math can give us a little insight into how much trouble we're in, particularly if we ignore the human population piece of the equation. It's pretty simple, really. To get back to a level of balance, and to prevent total destruction of our planet and the demise of humanity within the next century, we would have to somehow get back to around 7.5 billion tonnes/year of emissions. With 7.7 billion people on the planet and 20% less forest cover, that would be quite a chore, because we'd basically have to reduce average carbon per person to less than 1 tonne/capita, while planting enough trees to replace the 20% of forest that we've trashed. The question is, how can we do that, when the basic requirement of a human being in 1910 was already more than 4 tonnes each per year, and considering the reason that we have scraped all that forest is to feed our growing population? Does that feel like we're between a rock and a hard place here? It does to me! Just saying. One thing I get from all this analysis is that we're definitely not going to save our planet for future generations if we continue to ignore population growth. Human population growth is an integral part of the equation. That is a fact that we would do well to heed. And to take action on. Sooner rather than later.

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