The deeper meaning buried in the data on carbon emissions – *A Data Blog*

Looking at the ‘dangerous exponentials’ inside the data on carbon emissions, to find explanations as to why ‘change’ is so hard

Paul Mobbs, *The ‘Meta-Blog’*, issue no.20, 23rd March 2022

Rarely is there such a thing as, ‘just numbers’. Too often people look at statistics and just see the ‘magnitude’ of the numbers, not the ‘meaning’ that those numbers convey. In this next part of my ‘data blog’ series, I explain how a simple graph can show far more than just the raw numbers for carbon emissions – and what this tells us about why changing that trend is so hard.

If there’s one thing that really annoys me about ‘public’ debates today – i.e., when different interest groups shout numbers at one another – it’s when the meaning or context of a number is lost in its usage. Numbers are not meaningless. From the scientific (SI) units[1] they are expressed in, to the series of data which they form a part of, they express far more than just a magnitude. Too often that deeper meaning is lost, and with it, the more informed message that the data is able to give.

The purpose of this blog post is not to quote you the awful figures on carbon emissions from fossil fuels. It’s to tell you the detail, or the reality, that is too often left unstated when quoting numbers – and how the data show that.

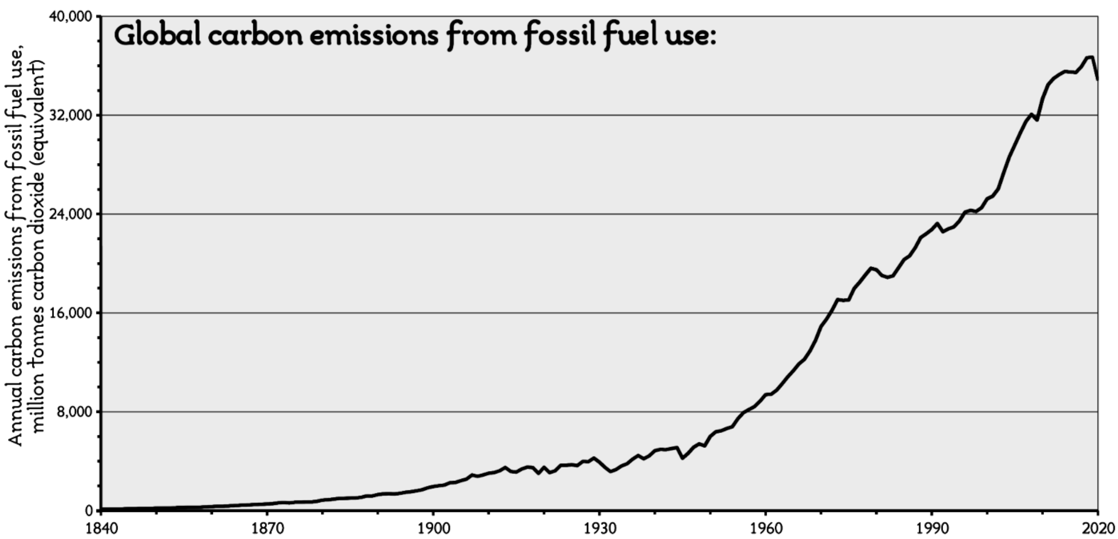
‘To begin, take some data...’

You want some data on carbon emissions. *Whose data?* The source matters.

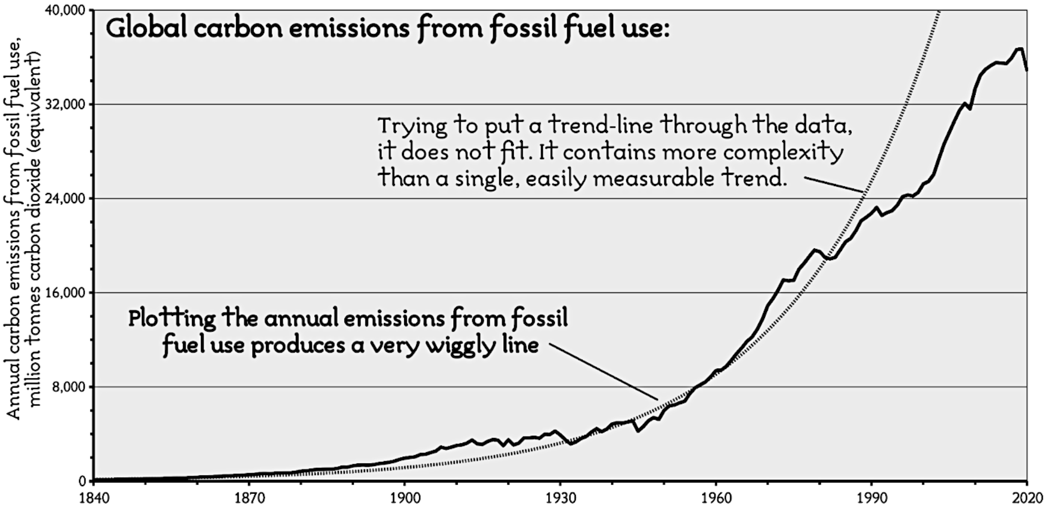
Problem is, data carries with it the baggage or limitations of the group who collated it. International agencies may ignore certain effects (such as when the UN climate change agencies exclude the impact of carbon emissions by the military); or may use certain data sources because that’s what is politically expected of them (such as when governments and UN agencies use data produced by the lobby group, the International Energy Agency).

Until a few years ago I used data collated by the US Carbon Dioxide Information Analysis Center (CDIAC); part of the US Department of Energy. They were axed as part of Trump’s destruction of US climate research. Luckily a new source has come along which takes CDIAC and other data and combines it into a coherent data set (saving me the hassle of doing the same exercise).

The Global Carbon Project (GCP)[2] is a collaboration of academics[3] who want to find and curate the best data on carbon emissions. They publish their data regularly as part of academic studies. Their data includes[4]: Measurements from the latest release inventories; recent data on fossil fuel consumption to turn that into emissions estimates; and they use historical data to project back to the start of the Industrial Revolution, tracking the use of coal.



‘The Graph’ – a single data series that says so much



Pretty much all data is imperfect. There are always issues about the accuracy of collection, and how that may be skewed by the methods chosen, or the restrictions on how that takes place.

Generally, though, for all the known 'problems' about collecting data, often imperfect data is all we have – and those imperfections have to be part of the debate about how we make decisions using it.

Data (ideally) represents reality

The best data is 'empirical': It should measure real-world things using demonstrated, reliable and verifiable methods. By measuring phenomena, we can use that numeric information to mathematically demonstrate – with a known certainty – what is happening and what are the causal factors.

The graph on the previous page shows the global emissions from fossil fuels – in millions of tonnes of carbon dioxide equivalent – listed in the GCP's data set[5]. The data set stretches back to 1750, and the beginning of the large-scale use of coal in industrial processes. Even so, these graphs start in 1840 as the earliest data is so small as to be practically 'invisible' – so it is excluded from the graph.

GCP's recent data is 'empirical' because it measures fossil fuel use, and that can be matched by real-world observation of carbon emissions.

The older, historic data in the GCP's data set isn't 'empirical'. We can't go back in time and do those measurements. Instead GCP uses 'proxy data'[6] – records of coal or petroleum production in those years – and from those records they assume the amount of carbon emissions that resulted from the use of those fuels. But as noted above, the contribution from this the 'proxy data' is, overall, minimal compared to the recent emissions data.

Carbon emissions are growing exponentially[7]. That means the rate of increase is increasing with time. We can see this in the graph on the previous page. The line curves gradually upwards as the rate of change increases with time.

To know how fast that trend is changing an exponential curve can be plotted through[8] the data to accurately estimate the rate of change. This is shown in the graph above...

It doesn't fit!

The problem is that the data on carbon emissions are 'complex' information.

Yes, the thing being measured – *carbon emissions* – is simple; but the human system that is working to generate those emissions is far more complex. The effects of that complexity are buried in the the way the data changes over time, which means it doesn't submit to a simple analysis.

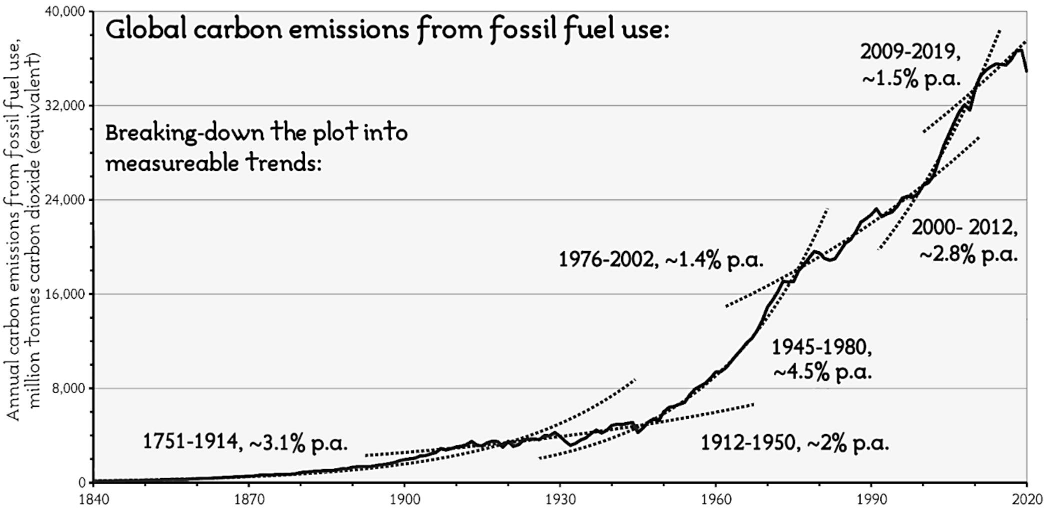
Now turn that problem on its head:

If the rate of change is changing, because of the underlying complexity of the human system, if that variation itself can be measured, it will tell us far more about the human system than just the rate of carbon emissions. It can tell us what is driving the changing trend in emissions; and from that we might find what is more likely to reduce this trend in the future.

Reality is, 'complicated'

One single trend-line won't fit neatly through the graph. That's because the trend is not constant. Instead the graph must be broken down into smaller sections where, for a time, the trend is roughly constant. Then the trend can be accurately measured from the data each time it changes.

The graph at the top of the next page breaks the whole curve into six sections, and then separately matches a curve into that small section of the data:



- From 1751 to 1914, growth is 3.1%;
- From 1912 to 1920, that falls to 2%;
- Then from 1945 to 1980, it jumps to 4.5%;
- Then from 1976 to 2002, it slumps to 1.4%;
- Then from 2000 to 2012, it jumps up to 2.8%; and finally
- In the last decade it falls to 1.5% again.

Compared to the previous graph, it's possible to see how much better each small curve fits through the carbon emissions data. What this shows it that the rate of change in carbon emissions changes according to definable, time-limited phases. These phases don't have neat boundaries because the change isn't sudden, from one year to the next.

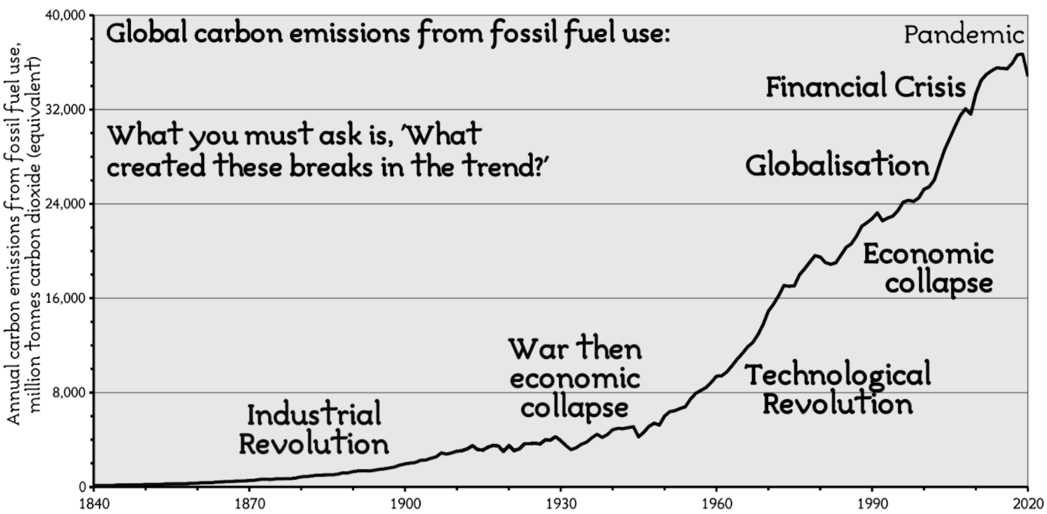
Of course, for those who study energy and economics, the dates where the trend changes leaves little doubt as to the likely cause. The graph below labels the different sections with the observable cause of these changes.

Very simply, when the global economy fails, carbon emissions fall; and when the global economy is boosted, carbon emissions rise.

The unwelcome message

The world must cut carbon emissions as quickly as possible. Full stop. The basis of current policy is to replace fossil fuel energy with renewable or nuclear energy – creating the energy the world requires without carbon emissions. The problem is this has a questionable efficacy.

As outlined in recent research[9], adding renewable energy to the global economy isn't really reducing carbon emissions noticeably. At best, renewable energy meets the annual growth in energy demand, meaning that the level of emissions stays the same.



This brings us to the deeper message within the data – about those 'dangerous exponentials':

In the 270 years from 1750 to 2020, roughly 1,696 billion tonnes of carbon dioxide (equivalent) have been emitted from the use of fossil fuels: It took 220 years to emit the first quarter; it took 22 years to emit the second quarter; it took 16 years to emit the third quarter; and, it took 14 years to emit the last quarter.

In fact, since 1750, half of all the carbon dioxide emitted from fossil fuels use has taken place since 1992, when the world agreed a treaty that pledged action to curb emissions.

The fact is, the scale of new non-fossil fuel capacity required reduce emissions is so much greater than what is actually being built. Practically, under the current policy, the time taken to achieve the required transformation of the world economy is far longer than we have available. Simply changing energy sources is insufficient – we must directly cut energy use significantly at the same time.

The affluent elephant in the room

If the only time the global economy reduces emissions significantly is during a recession (or a pandemic), then what we need to engineer is the same kind of collapse in consumption, but without the negative social consequences those past recessions created. That, of course, is not on any mainstream agenda – not even of the leading environmental groups.

This same trend – of impacts rising when the economy grows, and falling when it collapses – is seen across many other environmental issues too: *Recession is good for the environment!*[10] And therein lies the deeper truth in the data.

The fact that the global governance system can only consider options which reinforce economic growth – and will veto any option contrary to that – condemns the global community to failure. We will not be able to solve global ecological issues where the kinds of action which work are deemed 'unacceptable' – because they deleteriously affect the abstract economic interests of a tiny proportion of the global population.

In the last 'data blog'[11], I outlined how half of climate impacts are attributable to just 10% of the global population; and 10% of the impact is caused by half the global population.

The results of this analysis reinforce that message. It shows that, historically: It is the pursuit of economic policies which benefit this globally affluent minority which lead to the largest increases in carbon dioxide emissions; but the rate of emissions falls when this globalised economy contracts.

Only when this minority accept that they must shrink the economy, to contract the ecological demands of the modern lifestyle, will we solve these critical problems. The maintenance of a high-consuming lifestyle for a minority is not compatible with the maintenance of a liveable Earth system.

The impacts of 'dangerous exponentials' – that even some in the finance world[12] now seems to accept might be unsustainable – are an issue that the environment movement has failed to address. Yes, some may euphemistically talk of 'degrowth' or 'circular economies'; but they fail to acknowledge how the data which describe our most pressing ecological problems is writ-through with a message critical of affluence, the dominant consumer culture, and the global minority who 'enjoy' it. Only by explaining and openly discussing how the data describe this phenomena, irrespective of the short-term political consequences, will we be able to tackle the obstacles to real, effective change.

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