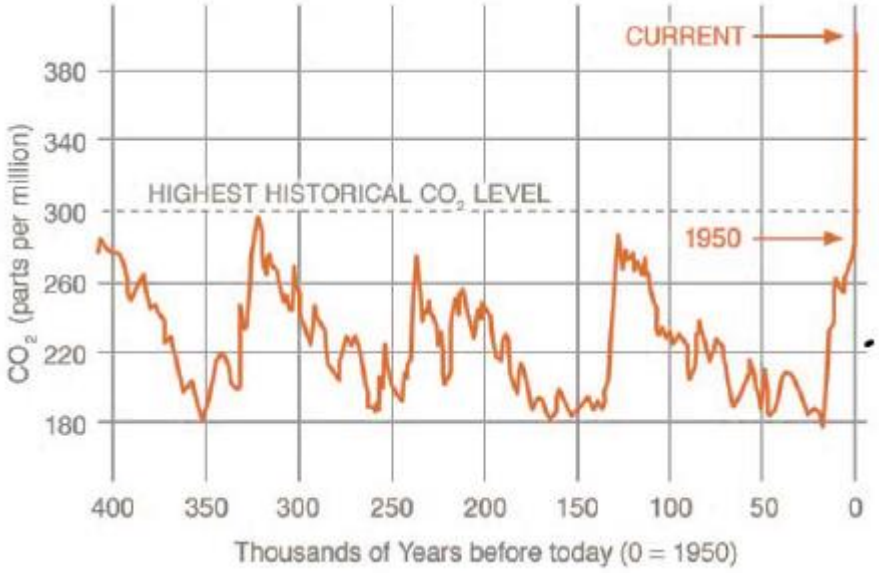
The race of our lives revisited (in a nutshell)

Jeremy Grantham | GMO | 16 May 2019 | **1.00 CE**

You could call this the story of carbon dioxide and Homo sapiens[1]. You may not know, but if we had no carbon dioxide at all, the temperature of the Earth would be minus 25°C – a frozen ball with no life with the possible exception of bacteria. That crucial 200 to 300 parts per million of carbon dioxide has taken us from that frozen state to the pretty agreeable world we have today. CO2 is therefore, thank heavens, a remarkably effective greenhouse gas.

Figure 1 is the famous chart you might have seen used by Al Gore. It shows that for hundreds of thousands of years, the Earth's atmosphere has had 180 to 300 parts per million of carbon dioxide.

Figure 1: Historical CO2 levels (reconstruction from ice cores)



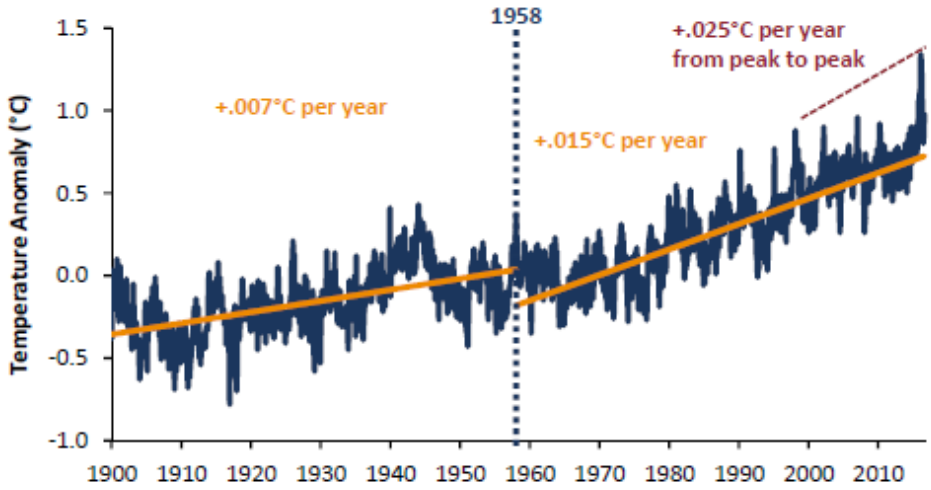
Source: NOAA

At 180 parts per million, we had ice ages. At the previous highs of 280 parts per million, we had the interglacials, where our species benefited from the temperate and relatively stable environment we have enjoyed for the last few thousand years - a remission from cold that allowed for and facilitated the growth of civilization in the last 12,000 years. In 1950, carbon dioxide levels were pretty much at the top of this historical range, and we were perhaps ready to slide into a new ice age in the next few thousand years. Then, bang, we added another 120 parts per million in the blink of an eye! We have added the same amount that separates the bottom of glacial phases from interglacials, and

we've added it in just 70 years. It is a dramatic and reckless experiment. The best word to describe it is feckless. We are going to add another 120 parts per million, I give you my personal guarantee. By the time we finish, we will have tripled the difference between an ice age and an interglacial, and we must sincerely hope it is not worse than that.

The trendline in global surface temperature through the first 50 years of last century is an increase of 0.007°C per year (Figure 2). In the second half, the trend had doubled to 0.015°C per year. Then, between the two El Niños – climate events that cause a temporary surge in global heat – of 1998 and 2016 (like lining up the top of bull markets), the temperature increased at an average of 0.025°C per year.

Figure 2: Global surface temperature compared to 1951-1980 average



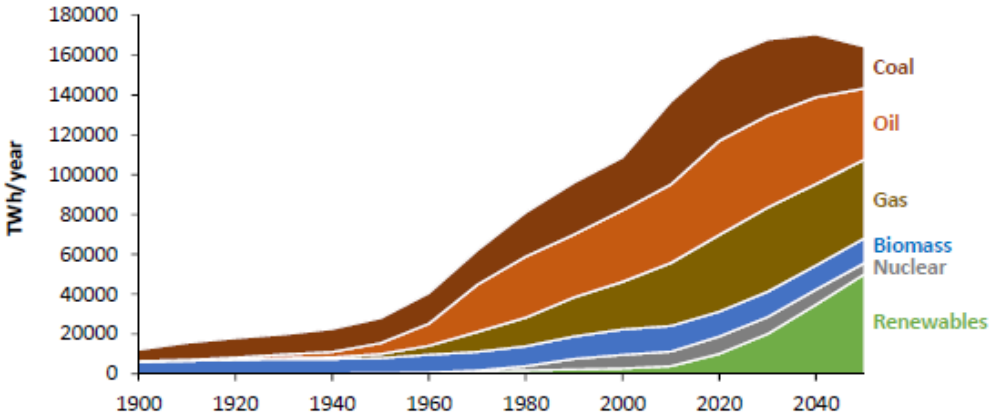
Source: NASA Goddard Institute for Space Studies, GMO. Data as at 31 August 2016.

But, technology - particularly the technology of decarbonisation - has come surging in to help us in the great battle against global warming. If we were able to look ahead 40 years, I'm confident that there would be a decent sufficiency of cheap green energy on the planet. In 80 years, perhaps it's likely we would have full decarbonisation. Lack of green energy will not be the issue that brings us down. The truth is we've wasted 40 or 50 years since the basic facts about man-made, serious climate damage became known. We're moving so slowly that by the time we've fully decarbonised our economy, the world will have heated up by 2.5°C to 3°C, and a great deal of damage will have been done.

The bad news is that, although the renewables in green are surging, by 2050, over 50% of energy consumption is projected to still be driven by fossil fuels (Figure 3). That means that even if fossil fuels were to peak in a couple of years - and I believe they certainly will peak by 2030 or 2035 - the carbon dioxide in the

atmosphere will continue to rise and rise. Climate change will not have been stopped. It will barely be slowing down.

Figure 3: World annual primary energy consumption by source (1900-2050)



Source: OurWorldinData.org, Vaclav Smil, GMO. Data as at 30 September 2017. Data from 2015-2050 is estimated or forecast.

Agriculture is, in fact, the real underlying problem produced by climate change. Climate change has two separate effects on agriculture.

One is immediate - increased droughts, increased floods, and increased temperature which together reduce quite measurably the productivity of a year's harvest.

Then there's the long-term, permanent effect - the most dependable outcome of increased temperature is increased water vapor in the atmosphere, currently up over 4% from the old normal. This has led to a substantial increase in heavy downpours. It is precisely the heavy downpours that cause soil erosion. In regular rain, even heavy rain, farmers lose very little soil. It is the one or two great downpours every few years that cause the trouble.

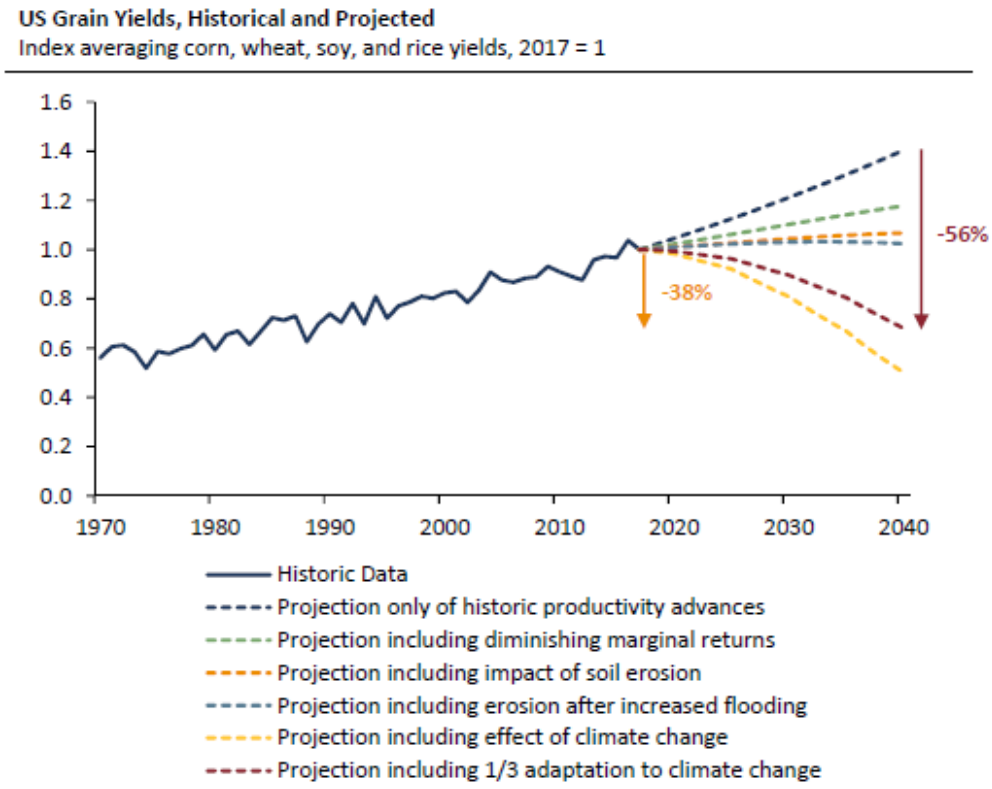
We're losing perhaps 1% of our collective global soil a year.[2] We are losing about a half a percent of our arable land a year.[3] Fortunately, it is the least productive half a percent. It is calculated that there are only 30 to 70 good harvest years left, depending on your location.[4] In 80 years, current agriculture will be simply infeasible for lack of good soil.

We must change our system completely to make it sustainable which, critically, involves reducing erosion to almost zero by using no-till or low-till farming combined with cover crops. Because these are significant changes for a conservative community, it will take decades and we've barely started.

Figure 4 shows the various projections including all these factors, one-by-one. At the top is the simple extrapolation of the historic productivity gains. The next line

down shows what happens when you build in the diminishing marginal returns that we have seen in Japan, Germany, France, and the UK. Next is the effect of erosion, and the effect of more erosion from increased downpours. Then there's the *coup de gras* from the climate change study.

Figure 4: Combined effect of climate change and soil erosion



Source: USDA NASS, Rhodes 2014, Liang et al 2017, GMO. Data as at 30 April 2018.

Give a one-third credit for adaptation to climate change - that farmers will be clever; they will change the crops they grow; they will work on building in more drought resistance or flood resistance. (By the way, you have to pick. You can't do both drought and flood resistance at the same time.) Even with adaptation, grain productivity will fall a lot. Maybe in real life, farmers will excel and deliver a two-thirds credit for adaptation. What we really need is improved policy, very productive research, and an unusual willingness to change. But, unfortunately, even with substantial adaptation, productivity will still be way down from the historic trend and very likely even down from where we are today.

We have a growing population who want to eat meat, diminishing agricultural returns, and worldwide erosion taking 1% a year of the global soil and half a percent of our arable land. Then there is urban expansion, which is nearly always in fertile river plains, taking the best arable land and concreting it over – calculated to be about two and a half million acres a year.[5]

Plus, there are water availability problems that I could spend half an hour on, and an expert could spend a week on. Reservoirs in South Africa, in Morocco, in Spain, in Nevada, are all shrinking, suffering from the increased heat. We're depleting our aquifers. In heavily irrigated areas such as Las Vegas or the Central Valley of California, well water levels have fallen by hundreds of feet. In China, parts of Beijing are sinking by four inches a year - that's how fast they're pumping out the water.[6] Over half a billion people globally totally depend on underground, very finite aquifers for their water and food.

For all these many reasons, agriculture is the key to our future success or failure. It is also where climate change has its most consequential effects. But, sadly, it is not the only problem.

Capitalism also has a severe problem with the very long term because of the tyranny of the discount rate. Anything that happens to a corporation over 25 years out doesn't really matter to them.[7] In that logic, grandchildren have no value.

Corporations also handle externalities very badly. We deforest the land, we degrade our soils, we pollute and overuse our water, and we treat our air like an open sewer. All of this is off the balance sheet and off the income statement.

Worse, any sensible response is deliberately slowed down by skillful programs of obfuscation, well-funded by fossil fuel interests and their allies. This does not happen in China, India, Germany, or Argentina. This is unique to the English-speaking, oily countries - the US, the UK, and Australia - where the power of the fossil fuel interests is used to influence both politics and public opinion.

Today, climate change is the ultimate Tragedy of the Commons. It can only be dealt with by government leadership and regulation. All this is anathema to the new regime of maximising an individual country's advantage and short-term corporate profits. Yet however much libertarians may hate regulation - and, in general, I am sympathetic - when it comes to climate change, it is simple. There is simply no other way.

INVESTING AND THE ENVIRONMENT

Climate change has moved faster than most thought possible and, as demonstrated above, is having a dramatic impact on the world. Temperatures and sea levels are rising, glaciers are melting, and extreme weather events are increasing in both severity and frequency. Massive amounts of investment are needed in order to head off climate change.

There will be exciting investment opportunities in companies focused on climate change mitigation and adaptation. As costs continue to fall for wind, solar, and energy storage, we are reaching an inflection point where renewable energy is becoming increasingly competitive with conventional energy, even in the absence of subsidies and incentives. Even James Robo, CEO of NextEra Energy (which controls Florida Power & Light as well as the world's largest trading unit for

wind and solar) has said "New wind and new solar, without incentives and combined with storage, are going to be cheaper than the operating cost of coal and nuclear in the next decade". Economics will drive the transition to a clean energy world, and the climate change sector is likely to experience strong secular growth.

Figure 5 shows a portfolio of climate change opportunities. Unsurprisingly, the portfolio has lots of clean energy stocks, copper (which is five times more heavily used by electric cars than conventional cars), masses of energy efficiency opportunities, and around 20% in agriculture. I have a very high-confidence belief that these industries collectively will have higher top-line revenue growth than the balance of the economy.

Figure 5: Illustrative climate change portfolio (global equities)

Segment	Exposure
Clean Energy	**39.4%**
Solar	9.7%
Wind	8.5%
Other Clean Energy	1.3%
Clean Power Generation	6.1%
Batteries & Storage	14.0%
Smart Grid	**6.2%**
Copper	**8.4%**
Energy Efficiency	**16.8%**
Transportation	6.6%
Buildings	0.4%
Diversified Efficiency	6.0%
Technology	1.9%
Lighting	1.4%
Recycling	0.5%
Agriculture	**19.1%**
Farming	3.8%
Farm Machinery	1.6%
Timber	0.7%
Eco-Chemicals/Seeds	1.5%
Fertilizer	5.5%
Fish Farming	5.9%
Water	**4.4%**
Cash	**5.6%**

Source: GMO

Although there will be tremendous opportunities in the climate change sector, a disciplined, value-oriented approach will be critical to navigating a sector likely to be rife with hype and stories. Furthermore, a public market approach can be

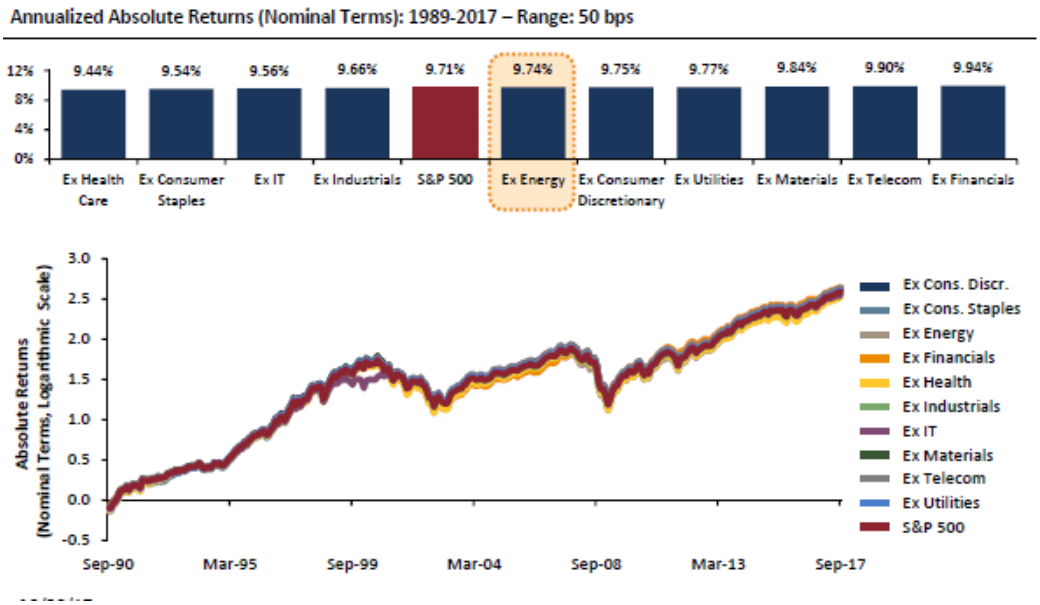
a great complement to private equity in this space, not only for the liquidity and cost advantages, but also for the increased opportunities for diversification and the ability to allocate nimbly to new technologies as they emerge.

THE ALLEGED PERILS OF DIVESTMENT

It should be pretty clear from this discussion that if you're messing around with oil stocks, you're taking the serious risk of ending up with stranded assets. Oil companies are being sued everywhere because they've been caught red-handed. They were writing for peer-reviewed journals in the late 1970s, proving that carbon dioxide was dangerous and that the ocean levels would rise. They took advantage of their knowledge - they took it into account to drill in the Arctic and to site their refineries. And, they have misrepresented the damage they knew their products would cause. They are vulnerable and face many legal battles. Yet, investment committees - the most conservative groups on the planet, as we know - maintain that if they divest from oil, it will ruin their performance. If they accept any constraint at all, they feel it will ruin their performance.

Figure 6 tests this long-held divestment hypothesis. Taking each of the 10 major groups out of the market for 30 years, leaving only nine of the 10 groups in each portfolio, didn't make any difference. The entire return range from best to worst was only 50 basis points. The return without Energy is highlighted 3 bps more without Energy. Taken together, other than IT in the 2000 bubble, they look like a single series. Even the 2000 deviation settled back as if the bubble had never occurred.

Figure 6: You can divest from oil - or anything else - without consequence



Source: S&P, GMO. Data as at 30 September 2017

This puts a more accurate price on divestment and ethics. For example, if you consider it unethical to own these oil companies whose scientists wrote, as mentioned, about the serious dangers of climate change in the 1970s only to have management later ignore it all and instead fund deniers and obfuscators, you can believe the cost of your ethics is about +/- 20 basis points.

WHAT SHOULD INVESTORS DO ABOUT CLIMATE CHANGE?

What I'm hoping you will do, first of all, is vote for green politicians. I don't care what party they belong to. It might surprise you to learn that all the great US environmental law of the past 100 years came from Republicans.

Second, lobby investment firms to be a bit greener and encourage them to lean on the companies in their portfolios to do the same. Push them hard. Cash in some of your career risk units. You will at least be able to look your children in the eye. You may even feel better. And your firm may be able to attract more of the best kind of young recruits who are beginning to care very much more about these issues than we older folk collectively do.

We're racing to protect more than our portfolios from stranded assets and other climate change impact. That I believe is easy enough. But we have a much more important job. We're racing to protect not just our portfolios, not just our grandchildren, but our species. So get to it.

CONCLUSION

It was always going to be difficult for Homo sapiens to deal with the long-term, slow-burning problems that threaten us today - climate change, population growth, increasing environmental toxicity, and the impact of all these three on the future ability to feed the 11 billion people projected for 2100.

Ten thousand years ago, or even a hundred years ago, these problems were either mild or non-existent. Today they are accelerating to a crisis.

Our one material advantage is in the accelerating burst of green technologies, which has been better than anyone expected 10 or even five years ago, and that may in the future be able to offset much of the accelerating damage from climate change and other problems. Yet, despite these surprising technological advances, we have been losing ground for the last few decades, particularly in the last few years. Somehow or other, we must find a way to do better. We must expand on our strengths in technology while fighting our predisposition toward wishful thinking, procrastination, and denial of inconvenient long-term problems. We must also find inspirational leadership, for without it, this race - possibly the most important struggle in the history of our species - may not be winnable. It is about our very existence as a viable civilisation. We will need all the leadership, all the science and engineering, all the effort, and all the luck we can muster to win this race. It really is the race of our lives.

ENDNOTES

1. This paper uses much of the same material presented at the Morningstar Investment Conference in Chicago in June 2018 and at London School of Economics in April 2018. Please make allowances for its conversational style. I have attempted to adapt and expand this version for the general public. And please remember you don't have to read this in one sitting. The original "Race of Our Lives" is part of the GMO Quarterly Letter from 26 April, 2013 and can be read at www.gmo.com.
2. D.R. Montgomery, Dirt: The Erosion of Civilizations, University of California Press, 2007.
3. Pimentel and Burgess, "Soil Erosion Threatens Food Production," *Agriculture*, August 2013.
4. 2015 International Year of Soil Conference, UN Food and Agriculture Organization.
5. Bren d'Amour et al., "Future urban land expansion and implications for global croplands," Proceedings of the National Academy of Sciences, August 2017.
6. M. Chen et al, "Imaging Land Subsidence Induced by Groundwater Extraction in Beijing (China) Using Satellite Radar Interferometry," *Remote Sensing*, 2016, 8(6) 468.
7. At a corporate discount rate of 15%, a common enough hurdle for new investments, today;s value of $1 earned 26 years from now is two and a half cents.

ABOUT THE AUTHOR

Jeremy Grantham is Co-Founder and Chief Investment Strategist of GMO (Boston).