

THE FUTURE IN PRACTICE

THE STATE OF SUSTAINABILITY LEADERSHIP



Living on a finite planet

(where no-one likes to hear bad news)

Jeremy Grantham

In the winter of 2008, ceramicist Clare Twomey planted 8,000 exquisite, hand-made, and unfired china clay flowers at the Eden Project site. Over time, they weathered and dissolved, eventually returning to the clay earth surrounding them.

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We're going through one of those very rare things indeed: a paradigm shift. Having spent the past 200 years with the prices for everything declining, around 2002 this shifted, and the price of almost everything started going up. In 10 years, without much fuss, we've given back all the price declines of the previous 100 years. That's quite a remarkable shift.

The reasons are brutally simple: the growth rate of the population, and the amazing economic growth in China and India.

We have a problem with energy, which I think we'll stagger through, though it will require a lot of painful shifts and demand a lot of extra capital to maintain any growth for the next 20–30 years. We'll have an even bigger problem with metals, which are very precious, scarce resources which we have been chewing through. It could be as little as 30–70 years until we run out, though for the foreseeable future, I think we'll muddle through, moving to iron and aluminium which are more common.

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The real problem, however, is feeding ourselves. There are four critical parameters to bear in mind: water, soil, phosphorous, and potassium. Without any one of these, you can grow nothing at all. So, you can have as much soil as you want, but if you have no potassium you get nothing; you can have as much water as you want, etc. All four of these are limiting factors, and we'll use them up. The two most dangerous ones, in my opinion, are the less obvious ones: potassium and phosphorous.

The quantity of capital that's being sucked in to keep the resource machine grinding is reducing the ability of the world to grow. Here's a concrete example: we used to have a very low-cost barrel of Saudi oil. We're replacing that now with an incredibly high-cost, offshore Brazilian barrel. The service that the barrel supplies is identical, but the cost of extracting it is dramatically different: it now requires many more people and much more capital. This is being played out for every resource everywhere. Copper ore, in the dim, distant past, produced about 8 or 9 per cent copper. In the fairly distant past, 50 years ago, it was 2 per cent, and now they mine, on average, about 0.5 per cent of copper from the ore. So, you have to handle four times as many tons of ore with energy costs that have tripled in the fairly recent past, which means 12 times the energy input for copper.

These sorts of costs play around the system, and so the growth rate of the world has started to slow, very noticeably for the developed world and not so noticeably for the emerging world – yet. But as the developed world slows down, so developing countries will lose their head of steam. The drop in the growth rate of the developed world has

been camouflaged first by the huge housing bubble in US and Europe, and then by the bust of 2007–08, both of which make it seem temporary. But under the surface, the GDP growth rate of the OECD block started to decline from about 1995 onwards.

Until then, the growth rate of the US was like a battleship. It grew at 3.4 per cent from 1895 to 1995, and even the Great Depression bounced off it; afterwards, it was as if it had never occurred. And two-thirds of the time, the growth rate remained within 1 per cent of its long-term trend; it was incredibly stable until 1995, when it began to slope off, and there has been nothing like that in modern times. By the time we get to late '07, even before the financial crash, the draw-down is 13–14 per cent from the old trend. I think the US will be lucky to achieve much more than 1.7 per cent going forward – maybe, if it's really lucky for 20 years, up to 2 per cent.

To go from 3.4 to 1.7 per cent growth in 15 years is a dramatic down-shifting. It's quite remarkable. It hasn't been talked about, any more than the rise in the price of commodities and the overall paradigm shift has been talked about much. But it's beginning to be talked about.

The problem is, capitalism can't handle shortages. There is no economic model, according to the OECD, that takes the finiteness of resources into account. Economists just assume; they reach out and take what is necessary, simple supply and demand. But it just ain't so. We live in a finite world and we've got to start thinking about developing alternative models that recognise that that is the case.

Human nature and vested interests

I've become an expert in financial bubbles. Bubbles have a long and honourable history, and they have one thing in common: no-one ever learns. They demonstrate, to a remarkable degree, our touching faith that somehow everything will always be fine.

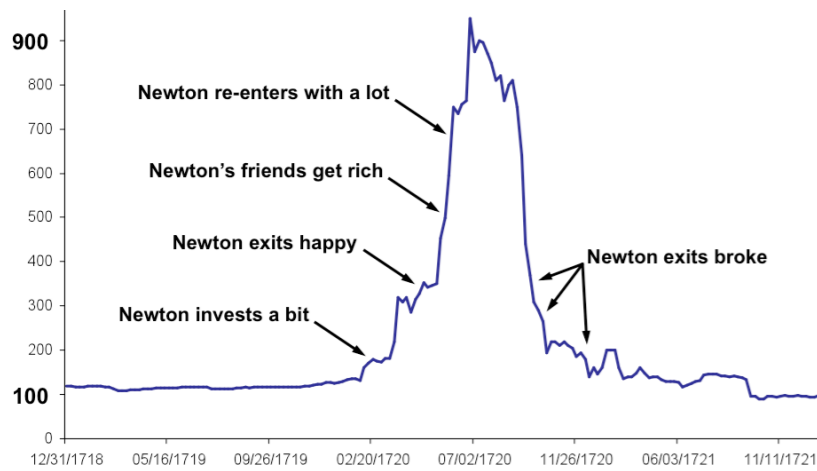


Figure 1: Isaac Newton's Nightmare. South Sea Stock, December 1718 – December 1721. Source: Marc Faber, editor and publisher of 'The Gloom, Boom & Doom Report' www.gloomboomdoom.com

The South Sea Bubble involved selling an annuity with a mathematical value, and it plays a special role in the heart of bubble experts. Fairly early on, Isaac Newton decided he would buy it. He thought it was a little cheap and might go up, and he made some good money and got out happy. And then he had this terrible experience of watching all his friends get rich. Finally his nerves cracked, and he got back in, with all his profits, plus he borrowed some money. He exited broke. You can see the story in **Figure 1**. This was a serious financial setback for him.

Newton said, "I know much about the movement of heavenly bodies, but little about human nature." One of the public letter-writers of the time, using the pen-name Cato, said after the bust that "there must be a plentiful supply of stupidity in human nature, else man would not be caught, as he is, a thousand times in the same snare... and even while reeling from the wounds, he is preparing to do

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it again." I was really feeling proud of myself that I'd rumbled this truth about 20 years ago, only to discover that it was old hat in 1721!

Anyone who knows anything knows that humans just assume the best, bubble away, and get crushed. No-one ever learns from other people's experience, and so we just carry on, with the recent example of the housing bubble in the US in 2007 precipitating the global financial crisis.

The finance industry knows about bubbles. It knew 'dotcom' in 2000 was a glorious example of a bubble, but it encouraged everyone to play along. It is so much more profitable to have a bubble than to have a boring market! The American market grows at 1.8 per cent, and at that rate, everyone dies of boredom; no-one makes a fortune. Much better to have it soar up and triple in four years, and then collapse. Then the smart people make a killing on the way up, save a decent fraction of their money on the way down, and come out far ahead.

So it's not just that people want to believe good news. They'd have bubbles without Goldman Sachs, they'd have bubbles without the finance industry; we're an optimistic species. But we're being egged on by powerful vested interests, always telling us that things are normal when they know better. Believe me, no financial advisor will ever tell you what is really the safest thing to do with your money. They're all covering their tails. They're investing to keep their job, not to keep your money. In a choice between protecting your job or your clients' money, it's no contest.

In climate change, we have the same thing. We have the energy industry – the only other vested interest as powerful as that of the financial world – egging people on to be confused about the issues. They do it very successfully, with foundations with misleading names, think-tanks like the Cato Institute and the Hudson Institute, whose job in life appears to be propagandise anything and everything that is useful for energy interests.

So, firstly, people want to believe that the climate change stuff is hocus pocus – they want to believe that everything will work out and we can grow and our children can get rich. Secondly, they are egged on by vested interest.

Why do these people work so hard to mislead us? It seems to me that either they don't have any grandchildren, or if they do, they're planning to make so much money that their grandchildren will be okay. They do it in the face of the most amazingly simple, straightforward data. One of my favourite examples is the melting of northern sea ice. Nowadays you can get through the Northwest Passage, where so many Brits froze to death in the 17th and 18th centuries. Thirty-six commercial ships have now sailed around the Russian coast; four years ago, no commercial ship had ever sailed that way. How is this possible without systematic climate change?

And yet, no Republican could get elected if he admitted that the climate was getting warmer.

Bubbles and beyond

Here's the story of how I arrived at the conclusion of a paradigm shift. **Figure 2** is twelve of the most famous bubbles. We're specialists in this, and we put this together in a desperate attempt to explain to our clients in this latest bubble that we could expect it to break. This was widely thought to be a new golden era; Greenspan kept telling us it was, and our clients, for the first time ever, really believed it. We manage money for every Ivy League school, and most of the members of most of our committees – the committees of all the august universities – believed that this time something was different.

When we said it was just another bubble they thought we'd lost the plot. We kept

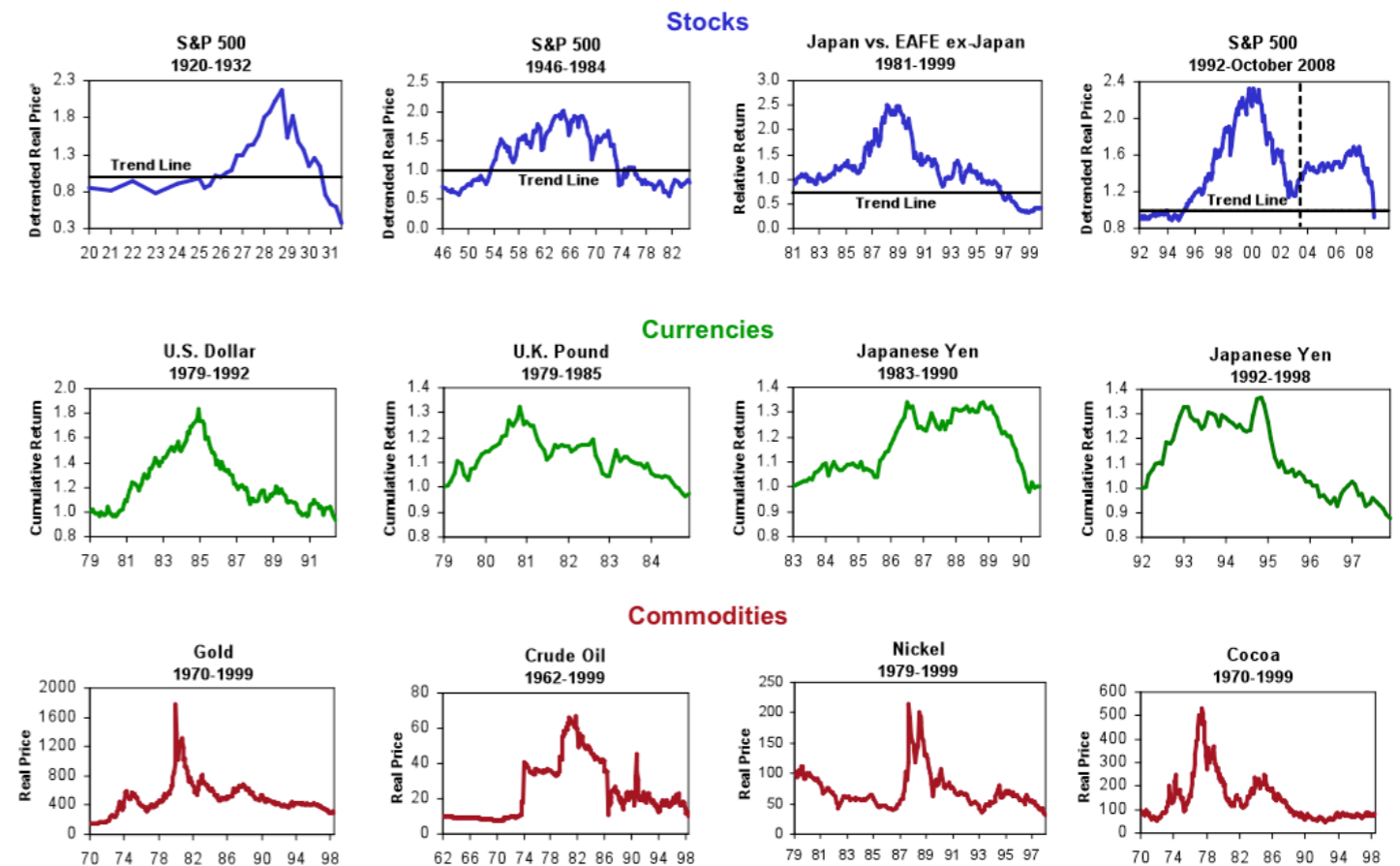


Figure 2: All Bubbles Break. For S&P charts, trend is 2 per cent real price appreciation per year. Source: GMO. Data through 10 October 2008. * Detrended Real Price is the price index divided by CPI + 2 per cent, since the long-term trend increase in the price of the S&P 500 has been on the order of 2 per cent real.

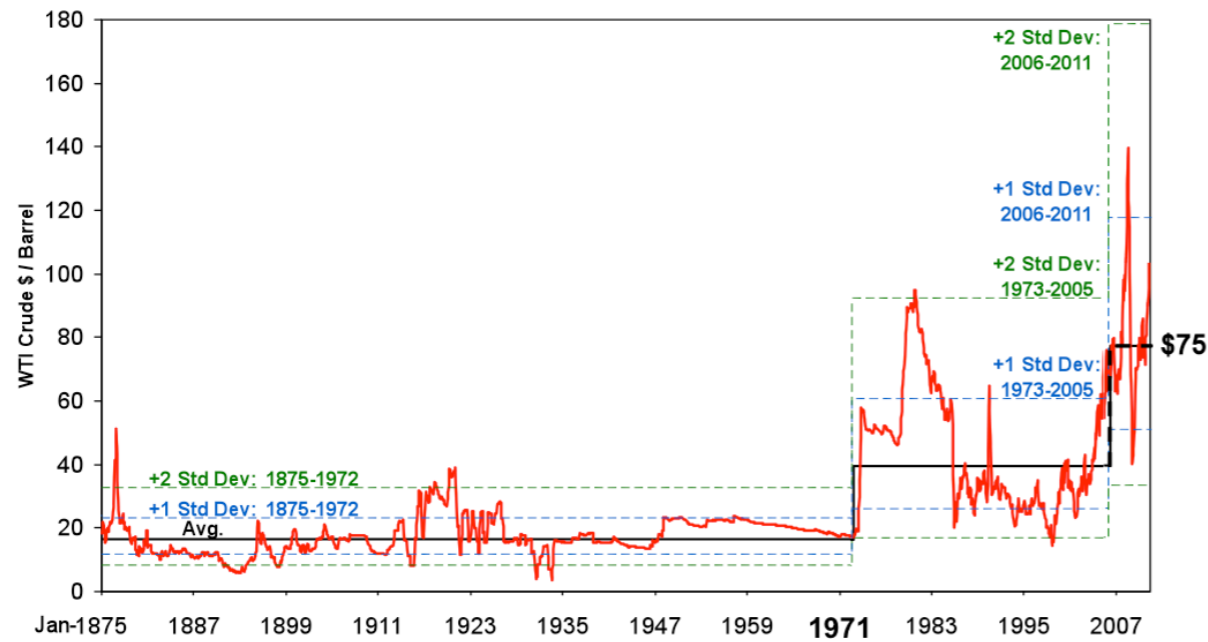


Figure 3: At last, a paradigm shift. All oil prices in 2010 dollars. Source: Global Financial Data, GMO, as of 31 March 2011.

getting fired; in the asset allocation group, to which I belong, we lost 60 per cent of our book of business in two-and-a-half years. No-one has ever lost that kind of money, before or after, but we did, because we were shouting the bad news that it was financially irresponsible, that it would all come to rack and ruin. The other people who believed as we did were hiding under the table keeping their mouths shut; that turned out to be a pretty good strategy, because we were getting fired from accounts that were doing fine.

We have a big array of products, and even where they were doing OK they were firing us because they just didn't want us in their building. It was amazing how people wanted to believe. (Fortunately, we have now gained a reputation for thought leadership. Clients actually like to deal with firms that are thinking about the distant future and what issues they should be beginning to grapple with, with plenty of lead-in time.)

Now, let me just point out that at the top, in 2000, prices were 35 times earnings. In 1929 and 1965 they had been at 21 times earnings. So, 21 was the very, very peak of

the great bubbles until now, and this one was at 35, and yet everyone wanted to believe that somehow something had happened to justify a loony price. It was two-and-a-half times replacement cost, so if you had a dollar of an asset, it became worth \$2.5.

In the process of arguing that this would not work, we studied bubbles everywhere, and then crude oil caught our attention. We slapped crude oil into our list of bubbles very happily at first. Yet another bubble; certainly not a paradigm shift. A few more years went by and this nagged at my subconscious, and I began to realise that it was not quite what it appeared to be, and that we were misrepresenting the data.

Let's look at the price of oil for 100 years (**Figure 3**). You would expect normal price volatility to cause occasional and fairly regular spikes, around every 44 years. This is true even for a very volatile commodity like oil, which had a stable average price of \$16 a barrel. The normal volatility of oil is more than a double, less than a half, so what people don't realise is that this means the price will fairly routinely go to \$35–37 a barrel, yet can still drop down to \$16 again.

Onshore, conventional oil peaked in the late 1970s. Increasingly deep, dangerous, expensive offshore oil has kept production increasing, but it's still slowing down. Since 1982, we've never come close to finding as much oil as we produce.

After the crisis in 1973–4, OPEC intervened and shifted the average price to \$36. According to the same mathematical trend for volatility, this meant the price could now be reasonably expected to jump to \$80, and it could still go back to \$16 at any point. This continues for the next 30 years. This was what allowed me to say it was just part of the old trend – a temporary shock with a stable average price.

But, actually, of course, it's not. What had happened was that a cartel was now manipulating the price and had reset the average price per barrel permanently – the first real paradigm shift. Then, in 2007, the price jumps again, making me think that the average price has risen once more. The other day I was speaking to the second-in-command at Shell, and he said he thought a reasonable price of oil per barrel was \$75–85. Bear in

mind, if the average cost per barrel is \$75, the price can jump to \$170; and it can go back, too, for a second or two, to \$30–35. We've seen this since 2007, backing up this idea that the average price has risen again permanently.

Recently, we've had a little pick-up in oil production, probably because of fracking; but we can expect it to decline again soon. Onshore, conventional oil peaked in the late 1970s. Increasingly deep, dangerous, expensive offshore oil, and 'secondary' and 'tertiary' oil from depleted fields, has kept production increasing, but it's still slowing down; it has done so for the past 30 years. Since 1982, we've never come close to finding as much oil as we produce.

This is a different world from the one we all grew up in, where every commodity was declining in price, except for oil, which was flat. After I spotted this change in the average price of oil, I began to think, is this the only commodity this is happening to? What about metals, and so on?

Figure 4 shows GMO's calculation of the price of 33 equally weighted commodities since 1900. Prices come down and then spike for World War I – why wouldn't they? – and then you can see the impact of the

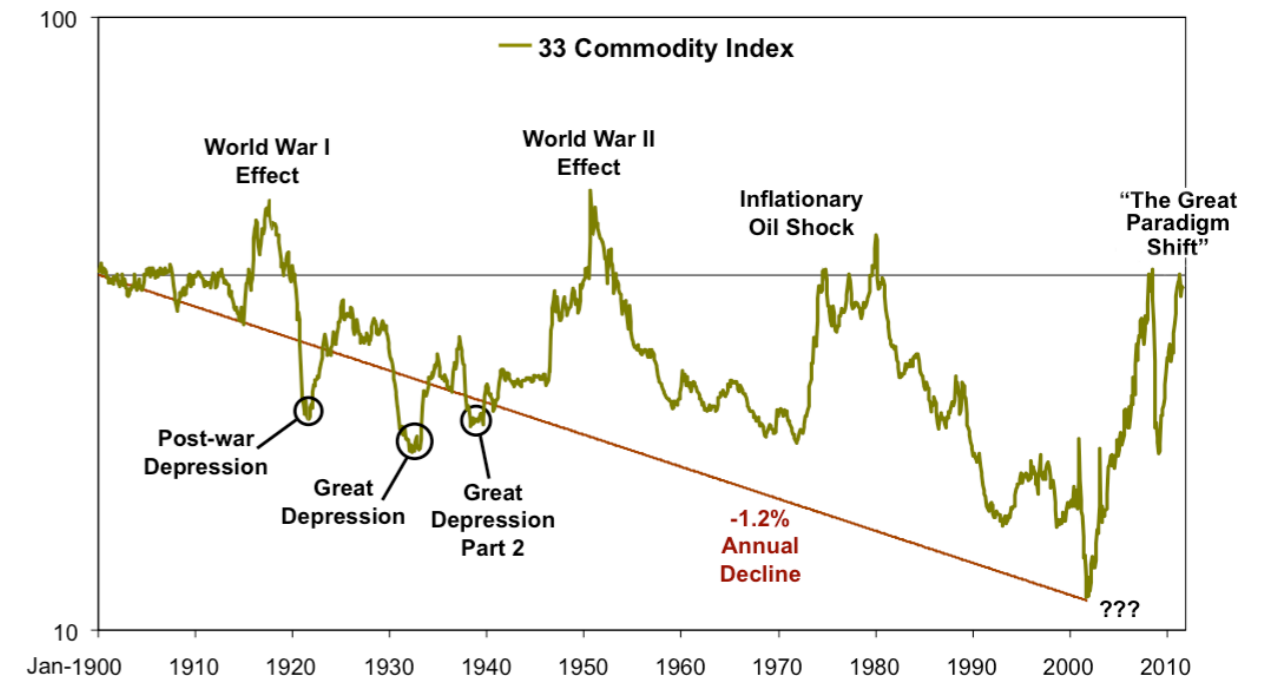


Figure 4: GMO Commodity Index – the great paradigm shift. Comprised of 33 commodities equally weighted at initiation. Source: GMO. As of 31 August 2011.

Post-war Depression, the Great Depression, the Great Depression Part Two, World War II, and the inflationary oil shocks of '74 and '79. In between, the price always wants to go down whenever it has a chance; that was a 1.2 per cent a year decline in real terms. Cumulatively, the price of a typical commodity declined by 70 per cent in real terms over 100 years – a dramatic help for getting wealthy, and that is what it's helped us to do.

Then, since 2002, prices have gone all the way back up. It's a remarkable event. So, I'm not giving a terrible forecast here. I'm saying we have had a shift. We live in a different world – a world where you expect one thing, and you get the opposite. We have given all the price reductions of the 20th century back.

What are the odds?

Then we started to get into crazy, mad details; by now we knew we had something pretty

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unusual and so we decided to analyse it as we did all our bubbles. We asked, "What are the probabilities that iron ore, which is incredibly far from its average price (4.9 standard deviations), is on its original trend, and it's just having a bubble?" The answer was that there's a 1 in 2.2 million chance that this is in any way 'normal'. We have never seen anything like that in the stock market. That is hugely unlikely.

We saw this again and again, for a large number of commodities (see **Figure 5**). The standard cut-off point for calculating whether prices are fluctuating normally is for them to sit within two 'standard deviations' of the average price. Even the four important commodities of uranium, tin, potash, zinc are at 1.9 standard deviations, right on the cusp of what we would say is a bubble. There's only a 1 in 35 chance that what's happening to their prices is a 'usual' bubble rather than a permanent rise.

What is the probability that so many of these commodities are 'bubbling' at the same time? What are the chances that this is not a giant commodity paradigm shift? Statistically, the answer is nil. There is no chance.

This just speaks for itself. It says: we live in a different world, wake up! And I think we're going to be able to say the same for growth rate. The developed world has simply slowed down. What is the effect of halving our growth rate in 15 years? What industries will it bear down on most heavily? What will it do for the aspirations of politicians who are constantly aiming for growth, far in excess of any possibility?



the fox population will explode too. And then when they have eaten up all the corn, they will implode. This has been going on for every animal species on the planet for a long time.

Mankind spent two million years living with its nose pushed up against the boundary of food. Five good harvests in a row, and people had lots of children. Five bad harvests in a row, the children died, and no children were born. That's how it was. Malthus said this was the law of nature, we'd better get used to it.

Just as the ink was drying on that report, ironically enough, coal was being dug up in Yorkshire and we were off on the Industrial Revolution; that was followed by oil and gas and so on – the hydrocarbon revolution.

A gallon of gasoline will buy you 300 hours of human labour. Hydrocarbons are prodigiously powerful: they meant that everyone had, for a few dollars, resources at their fingertips that only kings could have had in 1200. This allowed for a huge increase in wealth, science, everything – among other things, the science of growing food.

So what's caused it?

There are two reasons for the paradigm shift, as I see it: the rise in world population, and the role of China. When Malthus was born, there were a billion people on the Earth; when I was born, there were about 2.2 billion, and this has tripled in my lifetime. I've become a Malthusian after my work on bubbles; his 'Essay on the Principles of Population' simply makes the point that any animal species has a huge redundancy in its capability in growing its population. So, if you produce a huge harvest and leave it lying around, the mice population will run amok; and if there are lots of mice,

As time went by, we used the intensity of hydrocarbons to force-feed agriculture, which became a way of turning oil into food: tractors, farm machinery, delivery costs and fertiliser. It's a 250-year reprieve. From about 1800 to about 2050, we have had this hydrocarbon holiday. It's an unbelievable resource that was given to the planet, just once, and we have used it up without any regard to its preciousness.

There's a reason for this: we can't price a resource. Capitalism cannot price for finiteness. It's short-term supply and demand – or total ignorance. Anyone who is reasonable knows

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	Standard deviations from average price	Probability
Iron Ore	4.9	1 in 2,200,000
Coal	4.1	1 in 48,000
Copper	3.9	1 in 17,000
Corn	3.8	1 in 14,000
Silver	3.7	1 in 9,300
Sorghum	3.5	1 in 4,300
Palladium	3.4	1 in 3,000
Rubber	3.3	1 in 2,100
Flaxseed	3.3	1 in 2,100
Palm Oil	3.2	1 in 1,500
Soybeans	3.1	1 in 1,000
Coconut Oil	3.0	1 in 740
Nickel	2.7	1 in 290
Gold	2.6	1 in 210
Oil	2.5	1 in 160
Sugar	2.5	1 in 160
Platinum	2.4	1 in 120
Lead	2.4	1 in 120
Wheat	2.4	1 in 120
Coffee	2.3	1 in 85
Diammonium Phosphate	2.1	1 in 56
Jute	2.1	1 in 56
Cotton	2.0	1 in 44
Uranium	1.9	1 in 35
Tin	1.9	1 in 35
Zinc	1.9	1 in 35
Potash	1.9	1 in 35
Wool	1.7	1 in 22
Aluminium	1.4	1 in 12
Lard	0.9	1 in 5
Pepper	0.5	1 in 3
Natural Gas	0.2	1 in 2
Plywood	-0.1	1 in 2
Beef	-0.1	1 in 2
Cocoa	-0.1	1 in 2
Tobacco	-3.3	1 in 2000

Figure 5: The mother of all paradigm shifts. Probability: implied probability under assumption of normal distribution of valuations. Arbitrary bubble cut-off: probability of representing a new trend. Source: GMO. As of 28 February 2011.

People simply do not get the point that you can't have 'sustainable growth' forever.

that this is wrong: you know that you're getting through this precious resource, chewing it all up, and there should be some consequence. Yet there is not. There is no way of accounting for the fact that we have something now, but we will not have it in the future. It isn't an easy thing to deal with, I will concede that. Capitalism simply does not have the tools.

So, you take a population at 1 billion that was doubling every 1,000 years, and you raise it, in a single lifetime, from 2 billion to 7 billion, on its way to 10 billion. The other factor is China. Last year, China used 53 per cent of every bag of cement used on the planet, 48 per cent of all the iron ore and 47 per cent of all the coal. And these are important things, coal and iron ore. If China wanted to double its economy in 10 years (which is slower than its growth rate today, or over the past 20 years), the coal production of the world has to go up by 47 per cent. That's just to take care of China – forget India, forget everywhere else.

You can't do it. The reserves are substantial, but there are higher costs all the time; and it's not just that the cost is going up. The

resources required to get the commodities is going up, as I said, and as the resources go up, it squeezes the rest of the economy. This is happening already and not being noticed.

The real challenge

Now, I think we'll muddle through with water – it's a watery planet, and though we waste amazing quantities, water recycles unimaginably effectively. We'll get by with metals; in the long term they will come back to haunt us, admittedly, but we'll muddle through for a long, long time. But food is a problem.

In the agricultural revolution, we've increased the input of fertiliser by five times, in China by seven times. Every kilometre has five to seven times more input of agricultural resource. Yet with intensive farming, the output declines over time because the soil degrades (Figure 6). During the Green Revolution, productivity per acre was a stunning 3.5 per cent a year. This has declined, erratically, to 1.2 – still a magnificent number, but the trouble is that the red line, the global population growth, is also 1.2 per cent. We are increasing productivity per acre at exactly the same speed that we are increasing the human population. If we want to eat meat, this will break the bank. We have to increase productivity and we have to get population growth down. Otherwise, we have a crisis, fairly immediately.

People simply do not get the point that you can't have 'sustainable growth' forever. You can have sustainability forever, or growth for a few years. But you cannot have sustainable growth, in the sense of physical growth, for any extended period of time. A favourite illustration of mine is Ancient Egypt, which had the longest-lived civilisation, lasting from about 3500 BC to 500 AD. They had the same religion, the same Pharaohs, the same laws, the same culture, the same language. Let's imagine they started with 1m³ of physical possessions, and their economy grew at the rate that the global economy grew in 2006 and 2007 – 4.5 per cent GDP growth globally. If they keep that up, after 3,000 years what do you do with your physical possessions? They fill one billion solar systems.

We have no more land. We used to have a New World; we used to have the Midwest, we used to have the Ukraine. We have used them all up.

What about population growth of 1 per cent, a derisory rate? They had two million people, so after 3,000 years, their population would have grown by seven trillion times two million. You cannot grow at 1 per cent: nowhere to park people, nowhere to park physical possessions. How about 0.1 per cent population growth? 0.1 for 3,000 years is about a 20-fold increase in population. In fact, Egypt's population actually doubled, maybe tripled. Even 0.1 per cent cannot be sustained.

So, you can't have 'sustainable growth'. We have to change the system.

A crisis in arable land

Potash and phosphate, potassium and phosphorous are, as I said, limiting factors. Without them you can grow nothing. They are elements: you cannot make them, you cannot substitute for them. They are unwilling to negotiate. They are absolutes, in a world with few absolutes; and we mine them, for heaven's sake! In other words, we go into a dried-up ocean and take these conveniently concentrated, wonderful, high-grade phosphorous reserves; we dump them in a truck; and we ship them around the world. And the same with potash. We have 280 years of reserves if we don't grow, 116 years if we do grow. But 80 per cent of potash is stuck in Canada and Russia. America is okay; we have Canada, we can invade them, we can negotiate with them... but the UK might be in more trouble. Yorkshire recently had a very big potash discovery 20 kilometres under the North Sea. I am suggesting to the new Governor of Yorkshire to put up a tariff wall and not trade the stuff easily!

Very quickly, you will find that food and fertiliser is treated differently. In 2008, the Russian

Government overrode all contracts and said they couldn't export wheat. China, the year before last, said they couldn't export potash, and the WTO got in there and wrestled with them. And this year India tried to ban the export of cotton. So the world is already getting to the point where agricultural products are being banned from export all over the place; this is not a distant prediction, this is already underway. The world is beginning to react differently to these precious resources. The worst of all, and nearly a certain crisis, is phosphorous. Everyone knows about this but no-one is interested. Phosphorous is all owned by Morocco and the Western Sahara; 85 per cent of everything we know of high quality is in Morocco, which makes Saudi Arabian oil look like a two-bit player. This is much more serious.

In the end, eating is more important than heating. The only way will be to change the style of farming, and I think it's a central issue before us, the one that bites the first. Soil erosion would be worse, except it turns out that ending coal farming takes away erosion as a serious problem. But we're just running through phosphorous.

When we've used it up, we'll have to recycle. We will be back in the Middle Ages where all your cow manure and all your rotten veggies have to go back on the field, because your life depends on it. Even in the late 19th century there was periodic starvation in Eastern Europe; their soils were reaching the phosphorous limit. We can't support anything like 10 billion people with these techniques. We have no more land.

We used to have a New World; we used to have the Midwest, we used to have the Ukraine. We have used them all up. Now, we have a global system, where everything is being used. We have a hard time bringing in enough land to offset the areas taken up by new Chinese and other Third World cities. They're all built in river valleys, so they're taking prime agricultural land and we're replacing it as best we can. There has been no material increase in the land available for agriculture for a long time. One-third of our arable land, since the beginning of time

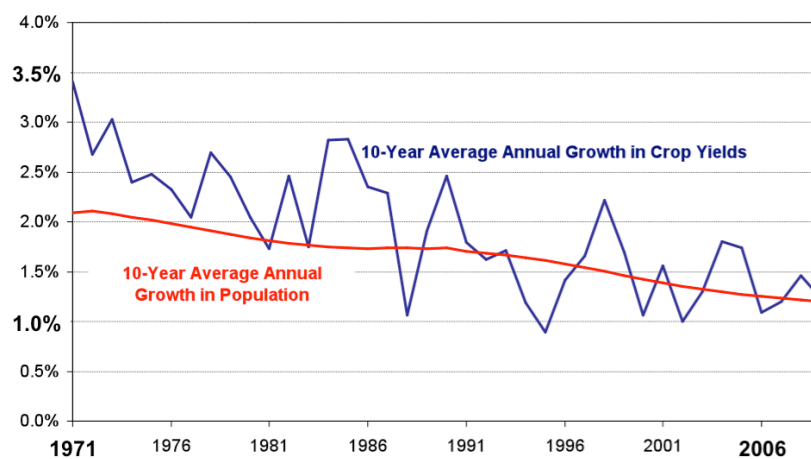


Figure 6: Ten-year average annual growth in crop yields and population. Source: Food and Agriculture Organisation of the United Nations. As of 31 December 2009.

10,000 years ago, has been turned into rubble – desert and rock that is totally irretrievable. One-third. In the past century we have been going through our soil at 1 per cent a year. You can work out how quickly that goes.

Resources, not climate change

Climate change is not the most important problem for humans: these resources are. And the most important part of climate change, for us, is how it intersects with growth. In 2100, the most optimistic assessment is that the output for grain will be down by a third, and the more pessimistic ones over two-thirds. You can work out what a terrible situation that is. So, we're recommending to people to get a good farm, and a good farmer.

Also, saving resources in the world that I am describing is going to be massive. Anyone who can steer their firm into doing more of that, or steer their investments into holding more resources, is going to do well. It's hard to persuade people to invest in order to win in the long run, when they won't know whether they will win next year. People like to think they have a higher probability of making a bet that will win next year. But if the certainties are higher out of the long horizon, that's what you should do.

Back to farming. In most areas, except for northern latitudes like the UK, you can end up with more output per acre if you use

organic farming, and this requires a very, very small fraction of the inputs, particularly phosphorous. If we use only organic farming in 50 years, we'll be able to preserve phosphorous reserves for another 500 years and, in that time, gracefully get our population down to the level that is necessary – perhaps a billion people, perhaps even 500 million. But, if we maintain 1.7 per cent GDP growth for 500 years, we're going to come up against hard limits. Gradual population decrease is not painful; in the developed world we're already on that kind of flight-path. But while the overall world population is still growing, the shock to the system is going to be severe.

Here's my illustration of the limits of capitalism (Figure 7). The Devil comes to a farmer and offers him a contract for 40 years, saying, "I will triple your profits, but in return you will lose 1 per cent of your soil." This is the deal that modern farming makes: about 1 per cent of soil is lost, which is about 10–100 times faster than it can be replaced naturally. Organic farming will replace it, but every capitalist signs the contract, because the tripling of your profits is massively more than any hit to your productivity in that first 40 years. The farmer and all his neighbours re-sign for another 40 years – it's an easy corporate decision again – and then for the third, the fourth and the fifth 40 years. It's still no contest. But at the end of 200 years, there's no soil and no food.

When the starving mob arrives, the good news for the farmer is that he dies a rich man: he's made a fortune. There is nothing, as yet, in the corporate mentality, or methodology, or discount rate structure, that would make it anything but a crazy decision not to sign each contract with the Devil.

You cannot count on corporations to get this job done. You can count on individuals to drag a whole corporation with them for a critical 10–15 years, sometimes, and it's hugely helpful, particularly if they can twist the arms of politicians. But this is a governmental issue; we must have governmental leadership, rules and

regulations. The only people looking forward at the soil erosion problem at the moment are the Chinese government. They can deal with long horizons, they have a Confucianist background for thinking long-term, they're not getting re-elected every two years, they hold all the cards and they are thinking ahead. They are worried about resources.

The capitalist model has to change, even if only little by little. The heavy lifting has to be done by government; and everyone who can help should move the government. They're very sensitive to corporations; they'll probably listen to you. In the end, we're all dependent on sensible government, and that's pretty scarce. Often, they wait until there's a crisis and then they jump.

A final picture

I want to talk about Egypt one more time. Egypt had a population of 2 million when Napoleon invaded; it has 82 million today, and it's going to rise to 120 million. It can feed about 60 million. Egypt used to feed the Roman Empire; without Egypt, the Romans would have collapsed long before they did. Egypt has been the world's bread-basket for ever, and still today it has some of the most productive acres on the planet. But it can only feed 60 million people, and it buys the rest by selling the oil it was lucky enough to find.

You cannot count on corporations to get this job done. This is a governmental issue.

But Egyptian oil has peaked, and its trade deficit is growing. Nobody is going to pay for the trade deficit to feed 120 million Egyptians. We're not going to volunteer. With the growth rate way down, we are getting to be very, very cheap about foreign aid. Any country that starts to run a food deficit, from now on, is on its own. And this will happen to Egypt next year, basically; the game is up. Every year, they'll be struggling for the resources, financial or otherwise, to feed their people, and pretty soon there will be waves of reasonably well-educated Egyptians attempting to find jobs in Europe. This goes for many other countries on the African continent, and one or two other countries, and the social pressures will be massive.

This is the thought I would like to leave you with. What is going to happen? How are we going to cope? Britain feeds 60 per cent of its people. It needs to import 40 per cent of its food. In order to do that you have to produce something valuable enough to get other people to part with their food. What is valuable enough in the crunch?

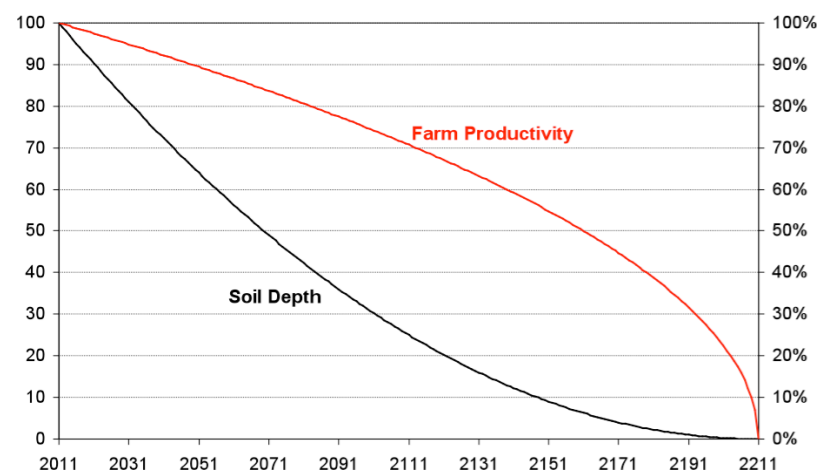


Figure 7: The Devil and the Farmer. The Devil's deal represents cumulative soil and productivity loss. Scales: Soil depth (inches); farm productivity (percentage of original level).

The State of Sustainability Leadership is CPSL's annual thought leadership report, delivering insight and challenge from our world-wide network of business leaders, policymakers and academic experts. This year's edition, to be published in full in December 2012, is focused on the theme of business and the long-term – what leaders can do to understand and shape the future. CPSL is an institution within the University of Cambridge's School of Technology. www.cpsl.cam.ac.uk



The work *Blossom* by Clare Twomey is playing with the elements of nature and our sense of what is precious. The delicate and beautiful blossoms are handmade out of clay and left in their unfired, raw state. Planting them into the soil at the Eden Project they were subjected to the elements, gusts of rain, wind and the cold, leading to their slow disintegration and return to the earth. Beautiful and beguiling as the blossoms were, they vanished, leaving just the traces of their short, startling existence. CPSL is proud to be collaborating with Cape Farewell, which works with artists and scientists on a cultural response to climate change. www.capefarewell.com