Food for healing

The Covid pandemic highlighted for me just how precarious our civilization has become, a timely reminder of how temporary and insecure past human civilisations have been. Looking back to the earliest civilisations we know of, have arisen and then collapsed. What makes those other civilisations different from this one is that they were geographically constrained and overlapped in time. The scale of this one is unique. Never has a civilisation been so immense, extensive, and interconnected. The pandemic highlighted how globalization has made us one big precarious, interconnected, interdependent population, and especially how central food and water security is to our predicament.

Right now, we face an unprecedented storm of imminent existential threats. Climate and biodiversity crises threaten the life supporting capacity of the planet and more human-centered issues like antibiotic resistance, pandemics, and inequality directly threaten human lives.

Almost all our planetary life support systems that have not already hit tipping points are teetering on the edge of them. Frustratingly, these crises are not broadly surprising, unexpected, or unpredictable; they take us by surprise only in their details, or via our willingness to stay deaf to the accumulating warnings from relevant subject experts. They are the known symptoms of a civilization that has overshot its biophysical boundaries. Humankind has far exceeded limits to growth, almost exactly as modelled on the very early computers in the 1970s by Donella Meadows and her team at Massachusetts Institute of Technology and described in their report 'Limits to Growth'.

Recently tens of thousands of scientists teamed up to put out a series of 'World Scientists' Warnings to Humanity'. These are warnings about everything from collapse of food webs and microorganisms to freshwater biodiversity declines. Their common conclusion is, "If human behavior the world over doesn't change soon there will be catastrophic biodiversity loss and untold amounts of human misery".

A useful way to conceptualise the exceedance of limits to growth is the concept of planetary boundaries. Researchers at the Stockholm Institute calculated safe limits for a set of life-supporting planetary processes like biogeochemical flows, ocean acidification, atmospheric carbon and methane, genetic diversity, biosphere integrity, and landuse systems. Their study revealed that we have exceeded most of these boundaries.

The most extreme over-shoots were those related to food production: landuse systems, freshwater use, and biogeochemical flows, particularly nitrogen and phosphorus. The core driver of these food production planetary boundary exceedances was the dominance of animal agriculture.

Exceeding all these biophysical limits could never have happened without reckless overindulgence, a spree of fossil fuel burning to achieve the growth of almost everything human centered. In the blink of an eye on a human existence time scale, we consumed the easily accessed part of our one-off fossil energy inheritance. We were bequeathed this priceless legacy of accumulated solar energy. This inheritance was charged up over millennia, like a geological battery, giving us a fuel that then allowed us an amazing set of technological advancements. The problem is that we exploited it as if it would never run out, and in doing so went way beyond the point where we can continue current lifestyles without all that cheap energy.

We could have judiciously used it to create a sustainable future, but instead we squandered it. I am sure if humans are around in a hundred years, they will look back on this time the way we look back on the aristocrats of pre-revolutionary France: they will see us as the architects of our own ruin, via a heedless orgy of criminal and suicidal indulgence.

Our global food system exemplifies the dangers of opting for unconstrained growth using non-renewable resources. We live right now in a world built by an energy trove that is on the decline, and that in any case we can no longer afford to exploit if we wish to have a livable atmosphere.

The decline in available energy has profound implications for the way we live and produce food. It's not that we're running out of fossil fuels *per se*, it's the fact that we have used up all the easily obtained fossil fuels, so that now it takes more and more energy to extract a given quantum of energy, so that means more and more energy must be found and extracted and processed to have the same amount of net energy. Similarly, all the easily extracted materials have been mined and require more and more damage and energy to extract. All this simply means that the amount of energy available for humanity to use is declining and will before long drop precipitously. In any case we must stop using it for the sake of the atmosphere, let alone all the other excess exploitation environmental impacts that fossil energy allows us to commit.

The demand for energy, material and food keeps increasing as population continues to climb. While the rate of human population growth has halved since the 1960s, the actual number of humans added to the planet per year is much higher now than then. We currently add 80 million people every year: 80 million extra mouths to feed and supply with extra energy and extra raw materials.

Meanwhile we also have declining amount and quality of land for each person on the planet. This is simply because the planet is finite. As we add people the available land area per person declines.

Eating oil

The biggest technological change that drove and enabled our colossal human population growth was a scientific breakthrough from early last century. The Haber-Bosch process, named after the men who discovered it, is a process powered by fossil fuel that enables the fixing of atmospheric nitrogen to create nitrogen fertilizer. This is the industrialisation of a natural process: whereas nitrogen is captured naturally from the atmosphere by some plants (pasture clover, for example), the Haber-Bosch does this synthetically using fossil fuels (mostly fossil gas). The scale of the exploitation of this process has become so extreme that humans have completely altered a global biogeochemical cycle. Humans now synthetically produce more nitrogen than all the natural earth systems combined.

This mechanization of the food system has put us in a catch-22 situation. Our current food system could not support the population we now have without the contribution of fossil fuels for fertiliser, processing and transportation, but the decline of energy availability and the harm done by its use means we must stop using it. As an indication of just how far fossil fertiliser alone has driven us past reality, without synthetic nitrogen fertilizer, contemporary food production and distribution systems could not feed more than three billion of the 7.8 billion people currently alive.

While the introduction of this ‘fossil food’ enabled exponential population growth, the growth was not evenly spread across the globe. Of the current population of close to eight billion, nearly two billion people are moderately or severely food insecure, and at the other end of the scale two billion people are obese or overweight. (This latter figure has tripled since the 1970s).

The synthetic nitrogen fertilizer that enabled this human population growth has had enormous negative implications for the living world because of the extent of the human perturbation of the nitrogen cycle. Humans now produce more nitrogen synthetically than all the natural systems combined. The process of creating synthetic fertilser also requires large amounts of energy and adds significantly to the energy footprint of food.

The reason that the synthetic nitrogen food explosion is so harmful is because less than one-fifth of the synthetic nitrogen applied as fertiliser ends up in the food. The rest leaks out to the environment in different forms, most of it causing harm. Some of the nitrogen ends up in the atmosphere as nitrous oxide, which is three hundred times more potent as a greenhouse gas than carbon dioxide and is the most ozone-depleting gas. The increased levels of nitrogen in the atmosphere can be measured just as carbon can; the preindustrial level was in the range of 270 ppb and that has now risen to above 328 ppb.

Much of the remaining nitrogen that is lost from agricultural systems ends up in freshwater, either directly through leaching of fertilser or via animal urine, passing through soils to water where it drives excess aquatic plant growth. Given the right conditions, including warmth and sunlight, the excess shows up as plant and algal blooms in rivers, lakes, estuaries, and oceans. These blooms then cause extreme fluctuations in the dissolved oxygen available to the life in rivers, lakes, estuaries, and oceans and the low points are lethal to aquatic life. There are now more than four-hundred known offshore dead zones where there is no little or no aquatic life because of lack of oxygen. These dead zones cover more than two hundred and fifty thousand square kilometers and are mostly off the mouths of rivers with high nutrient inputs. On top of oxygen depletion in many places these algal blooms in rivers, lakes and oceans can also become directly toxic to aquatic and even terrestrial life.

The increase of nitrogen from synthetic production has impacts not only on ecosystems but directly on human health and associated economic costs. A recent study showed that the environmental and human health impacts of synthetic nitrogen use in the EU was many times greater than the long-term benefits. Here in New Zealand, with colleagues we have published articles showing that the negative impacts of intensive farming match or outweigh any economic gains. It is important to note that the costs to society are not being paid. They are accumulating as ecological debts in the atmosphere and water and are thus, left for future generations to pay.

On top of the well-known impacts on aquatic ecosystems, recent research has highlighted the link between nitrates in drinking water and multiple negative human health outcomes, particularly colorectal cancer. Evidence is also accumulating which links nitrates in drinking water with thyroid disease and neural tube defects. Worldwide colorectal cancer is the third most prevalent cancer and the second highest contributor to cancer deaths.

In New Zealand, this link between nitrogen and cancer is emerging as a critical issue, because most drinking water comes from groundwater, rivers and lakes where nitrate levels are high and on the rise. New Zealand has some of the highest colorectal cancer rates in the world. Within the country, rates vary significantly, but the highest incidences are in South Canterbury and Southland, both also areas with high levels of nitrate in aquifers.

Livestock's long shadow

The rapid industrialization and growth of fossil food production, with the concomitant rise in the human population, has had dire consequences for wild animals on the planet. To give a sense of the scale of this issue, ninety seven percent of the mammal biomass on the planet is now made up of humans and the animals we eat. The reciprocal and equally startling fact is that wild mammals make up just three percent of the biomass of mammal life on the planet. This domination has happened very rapidly. The current ratio is almost the reverse of what it was before industrialization, and it has ominous implications for biodiversity

The extent and intensity of animal agriculture globally is only made possible by cheap non-renewable fossil energy creating fertilser and is the second largest contributor to human-made greenhouse gas emissions after direct use of fossil fuels. Animal agriculture is also a leading cause of deforestation, water and air pollution and biodiversity loss. Half of the sedimentation of waterways globally is through accelerated erosion due to livestock. Intensive livestock farming is responsible for one-third of all pesticide use, half of all antibiotic use and one third of all anthropogenic nitrogen and phosphorus losses to freshwater. Livestock farming occupies the largest share of usable land globally, amounting to roughly one third of the land surface of the planet. One third of that agricultural land is used for animal feed and forage, and livestock expansion is a major driver of landuse conversions, especially forest destruction. Finally, the health and welfare of farmed animals is becoming a controversial issue in developed countries, meaning that the social license of animal agriculture is being lost.

Over the last century, as the agricultural food production has become increasingly dependent on fossil fuels, the energy efficiency of food production has declined. While yields increased there has been a concurrent decreasing energy efficiency, since the 1970s the fossil fuel percentage of agriculture has gone from 43% to 62%. The USA example is extreme, n average for every unit of energy in food consumed, twenty-one units of fossil fuel energy were expended on fertilser, transportation, packaging, processing, and distribution. Furthermore, much of the gain in yield from fossil energy was used to feed animals for the increasing demand for meat, the energy losses in growing animals for meat means even less energy efficiency.

In most of the developed world we have fallen into a progress trap, a food production system based on the mechanisation and industrialisation of earth systems. This was driven by a surplus of cheap fossil energy and an economic system that rewarded short-term financial gain and ignored environmental impacts. This myopic drive for economic growth led to a system that the process of food production destroyed the self-organising ecosystems that had co-evolved over millennia and replaced them with energy intensive fossil-fuelled farming and processing systems dependant on mechanical and chemical intervention. While claimed as great technological progress, feeding more people, the time scale was misinterpreted and now we can see that it was an illusion because in reality it was a move from stable, renewable and resilient to fragile and harmful and self-destructive. We have the model of natural systems to base our future food production on, our only future will be one where we mimic these systems.

Solutions

To have sustainable food production in the future we must immediately break our fossil fuel addiction. Clearly, we should have started this transition a long time ago, but we still have time. We can have food production models that close nutrient cycles, ensuring nutrients are cycled at the farm scale. We must protect and nurture soils and not mine them, and urban wastewater systems must capture and cycle nutrients for food production, and so much more. The simple answer is that we must mimic natural processes.

To be sustainable food production must be in balance and not need the intervention of the addition of anything that is non-renewable. We know how to produce food this way, agricultural production systems known variously as regenerative, closed loop or biological can feed all the humans on the planet without harm to the living world. One thing is clear though and that is animal agriculture will have to be drastically reduced to achieve this as the human population has been artificially boosted with energy stored over millennia – fossil fuels. Thus, to make up the shortfall animal agriculture must become a very much smaller part of future diets.

We will never reach the requisite zero-carbon and sustainable food transition until we accept the necessity for urgent change and reduction in consumption and growth. This will require measuring the things that matter to people not to financiers. The only way forward is some form of true-cost accounting, one where all the externalities of what we do in food production in almost everything in our lives is accounted for. Thus, gross domestic product must never be the goal.

Undoubtedly animal agriculture and animal product domination of diets will have to change whether voluntarily or through the impacts of climate change and reducing energy. But at the most basic level it is the growth obsession that must be challenged and done away with. The growth paradigm while imbedded in almost everything we have and do was only made possible by fossil energy and so must end. Thus, our acceptance of the fact that we have already far exceeded our planetary boundaries and de-growth is our only possibility is a must and it is crucial that we share this knowledge. If we do not manage our way down from the extreme consumption of a proportion of the human population then the consequences as we have been warned of by tens of thousands of scientist's is inevitable; catastrophic biodiversity loss and untold amounts of human misery

Conclusion

The realisation for me of our predicament does not depress me because, and this was reinforced by the Covid response, I know that the changes we must make to survive will be positive. I realise that this perception comes from a privileged viewpoint, and that our transition away from fossil energy must be done ensuring equity, but what we give up will makes us happier and healthier. It will be messy and hard I am sure, but messier and harder the longer we leave it. The lifestyles we must adopt for a truly sustainable future will inevitably be built around small communities, with much more community interaction. Our food, fibre, and energy systems will be localised, and community oriented and a much more sharing economy. Without our fossil energy slaves we will have to put more effort into almost everything we do, but we will be happier for it.

Like passengers on the Titanic who believed the ship was unsinkable most people on the planet believe that the civilisation we are part of will never sink, and like the Titanic there are not enough lifeboats for all of us if we do. The difference is we are still just afloat, and we can save the ship, we have the knowledge and capability. The solutions will come from the bottom up, not from government. It will take awareness and education, and must come through grassroots actions from civil society supported by science.