Planetary Health: The Tie that Binds Epidemics, Chronic Disease, Climate Change, Biodiversity and a Whole Lot More

April, 2020

“My job is not to scare you out of your wits, it’s to scare you into your wits.”

Professor Michael Osterholm - epidemiologist and director of the Center for Infectious Disease Research and Policy at the University of Minnesota.

Summary

Like all crises, the coronavirus pandemic ushers in opportunities and threats. It is a powerful reminder of the power of infectious disease to spectacularly derail business as usual, and the urgent need to develop systematic and proactive strategies to manage to infectious diseases. A danger is that the crisis will be seen in isolation from other existential threats, all of which are intimately and inextricably dependent a complex web of planetary life support systems. If these crises are treated in isolation, then it is likely that we will continually operate in reactive mode, while root causes remain unaddressed. In this article I examine some of the root causes of disease epidemics and the links between these diseases and some of the principal forces that undermine planetary health – climate change, mass animal rearing, biodiversity loss, and pollution. I also touch upon the links between infectious and chronic disease, and acknowledge the critical role of sustainable economic development in disease management. To build resilience in our planetary life support systems I propose a series of mutually supporting recommendations in seven areas: personal health, climate change, animal agriculture, biodiversity restoration, pollution, infectious diseases, and science and public communication.
Futurology Failures, Crisis Whack-a-Mole and the Panic-Amnesia Cycle

Here are a few selected quotes from the great and the good that illustrate our oh so human fallibility when it comes to the precarious process of prediction:

- In 1943, Thomas J. Watson, long-serving chairman and CEO of IBM declared, “I think there is a world market for maybe five computers.”
- In 2004, Bill Gates confidently predicted that, “Spam will be a thing of the past in two years’ time.”
- In 1962, Sir Macfarlane Burnet, Nobel laureate in medicine, stated, “One can think of the middle of the 20th century as the end of one of the most important social revolutions in history - the virtual elimination of the infectious disease as a significant factor in social life.”

With the benefit of hindsight, it is easy for us to roll our eyes when it comes to the mistakes of others. But futurology failures listed above are merely examples of the kinds of mistakes that we all continually make. Our poor powers of prediction are compounded when it comes rare and catastrophic events.

Every year since 2006, hundreds of leaders from business, government and non-profit communities participate in the annual Global Risks Perception Survey. The results are compiled in the World Economic Forum Global Risks Reports. The reports for 2007-2020 rank global risks in terms of the likelihood that they will occur and their impact on the global economy should they occur. The perceived risk of pandemic disease always rise in the charts in the wake of a previous epidemic – H5N1 (bird flu) in 2006, H1N1 (swine flu) in 2009, Ebola in 2014, Zika in 2016. The survey for the 2020 report was conducted from 5 September to 22 October 2019 before the novel coronavirus infectious disease (henceforth Covid-19) emerged in Wuhan China in December 2019. I am writing this in April 2020 from a world in lockdown and standing on the precipice of a cocktail of crises. From this perspective, there is little doubt that disease pandemics will top the 2021 charts. But, between major epidemics the perception of risk falls, only to rise again when the next epidemic occurs. This reflects our individual and collective event-driven cycles of panic and amnesia.

Figure 1: Influence of epidemic disease events on threat perceptions of pandemic disease

[Graph showing the rank of pandemics among Global risk factors over the years, with a peak for COVID-19 in 2020.]

Likelihood of occurrence

Rank of pandemics among Global risk factors

Year
The above observations are not meant as a criticism of the survey participants, whose responses reflect a natural “immediacy bias”, to which all people are prone. This tendency is driven by our evolutionary history throughout which those who responded best to urgent threats to life and limb were the ones who survived and reproduced. Better to flee right now from the sabretooth tiger who wants to have you for dinner than to contemplate the possibility of being infected by a yet to be identified disease at an indeterminate time in the future. Despite the fact that most of us in the modern world rarely encounter urgent life or death situations our brains are still programmed to prioritise what we perceive to be immediate threats. Neither is the current focus on pandemics, a reflection of immediacy bias, meant to minimise the importance of the other economic, environmental, geopolitical, societal, and technological threats identified: threats as apparently diverse as climate action failure, weapons of mass destruction, cyberattacks, illicit trade, and biodiversity loss. They are all important and where they are ranked will vary according to time, place and perspective.

Since Covid-19 has exploded into our collective conscious, many people have fallen into the trap of defending their particular perspective by stating or implying that the ‘their issue’ is more important than Covid-19 in the grand scheme of things. For instance, some activists have argued that climate change poses a greater threat to humanity than Covid-19 – a sentiment I agree with. However, I disagree with how such sentiments are being communicated for one main reason: by highlighting the primacy of any one issue we are creating distinct silos which pit one issue against another in a competitive struggle for airtime, awareness and funding. Demarcating separate issues is necessary but it is important to embed these issues in a framework of common root causes that underpin our global interacting crises. Without a more integrated approach to our interdependent crises, we will become trapped in a continual game of “Crisis Whack-a-Mole” in which chance, whim, preference, and events drive knee-jerk reactions, with funds constantly shifted from yesterday’s issue du jour to today’s in lockstep with the panic-amnesia cycle.

![Crisis Whack-a-Mole](image)

*Figure 2: Crisis Whack-a-Mole – treating individual crises in isolation leads to trade-offs and the panic-amnesia cycle*
This article situates the rising threat of global pandemics in its wider context of planetary health, to illustrate that in nature everything is connected and we cannot think or act in silos if we are to make the world a better place for humanity and the planet upon which we depend. I will explore some ways in which the impacts of infectious disease are exacerbated by chronic disease, climate change, mass animal rearing, biodiversity and habitat loss, and pollution in order to encourage a holistic or “planetary health” approach to sustainable development. This approach means looking at each threat as part of a wider system, exploring links between components of this system, and proposing solutions that strengthen resilience – the ability to bounce back after a setback. Critically, measures that build resilience in any one component, should not undermine resilience in any of the other components of what is a single planetary system.

But before exploring these components and their connections with infectious disease, I will list some reasons why there has been a rise in global disease epidemics in modern times, and introduce the “Stress Bucket” as a model for personal and planetary health and resilience.

Why has there been a rise of global epidemics?

This is really a two part question: first, has there actually been a rise in global epidemics in recent history, and if this is the case, what has caused this rise? The answer to the first question is a resounding yes. The most destructive epidemic ever in terms of lives lost was the 1918-1919 Spanish flu (which, despite the name, probably originated in a pig farming operation in Kansas). Since then there have been three major flu epidemics – the 1957 H2N2 Asian flu, the 1968 H3N2 Hong Kong flu, and the 2009 H1N1 swine flu; two coronaviruses - SARS (Severe acute respiratory syndrome) and MERS (Middle East respiratory syndrome), which burst on the scene in 2002 and 2012 respectively; and Ebola virus from 1976, with its most destructive manifestation in 2014. And it is easy to forget about diseases that have become endemic like HIV/AIDS which has probably been around for over a century but only grew explosively in the 1980s, and vector-borne diseases such as Zika, dengue, yellow fever, and chikungunya viruses, which have had major outbreaks in the past few years. A noteworthy bright spot is the recent decline in malaria, fuelled in no small measure by initiatives championed by the Bill and Melinda Gates Foundation.

Public health professionals and those familiar with the workings of the natural world have been sounding the alarm for some time, warning, in the manner of seismologists, that we are due “the Next Big One” anytime soon - it has always been a question of when rather than if. In the words of Bill Gates:

“If anything kills over 10 million people in the next few decades, it’s most likely to be a highly infectious virus rather than a war. Not missiles, but microbes. Now, part of the reason for this is that we’ve invested a huge amount in nuclear deterrents. But we’ve actually invested very little in a system to stop an epidemic. We’re not ready for the next epidemic.”

Now, to the second part of the question - what has caused the rise in epidemic diseases today? In short, pathogens multiply at a stratospheric rate compared with people. Most humans live for 20 plus years before they reproduce whereas pathogens can replicate in minutes or hours under the right circumstances. Every generation provides the pathogen an opportunity to evolve in potentially destructive ways. We are increasing our encounters with pathogens and thus providing them with a multitude of opportunities to cause us harm. We do this through the destruction of nature, by warming the planet, by keeping thousands of farm animals in cramped together in unhygienic conditions, by misusing antimicrobial drugs, by the world’s growing population, and by increasing the volume and speed of movement of people and products at the local, regional and global scale. Further heat is applied to the pathogenic melting pot by the burden of pollution and chronic diseases which help to compromise people’s immune systems thereby providing the perfect conditions for infectious disease to take hold and prosper.
The personal and planetary stress bucket

Anybody who has attended one of my health-related talks knows that I like to use the analogy of the “stress/toxic bucket” when conceptualising the development of chronic disease. The body is constantly subjected to stresses of all kinds; for example, organic and inorganic toxins, potentially stressful life events, the news which always seems to be depressing, processed foods stripped of nutritive value and loaded with synthetic additives, poor sleep quality and quantity, mold, infections, and drugs – both recreational and pharmaceutical. But the body has diverse and effective mechanisms to process stress/toxins. In fact, an appropriate amount of stress can be a good thing. Think of exercise, which exerts its beneficial effects by pushing the body just a little beyond its current limits in order to stimulate a more than commensurate recovery - a phenomenon known as hormesis. The capacity of the body to deal with stress can be thought of as a bucket. As long as the bucket has spare capacity the body does not become diseased, but if there is more stress than the bucket can hold, the stress overflows and a disease emerges as a threshold is crossed. The spare capacity of our stress bucket represents our resilience, This can be measured by a vast array of biomarkers including some commonly used metrics such as blood pressure, blood cholesterol and triglycerides, kidney function, blood sugar, inflammation markers, etc.

**Figure 3: Schematic representation of the stress and disease threshold model of chronic disease**

In a similar vein, the planetary systems that provide the ecosystem services that underpin our survival can be conceived of as the planetary toxic bucket. These systems include the maintenance of global, regional, and local climate, soil conservation, biodiversity conservation, biogeochemical cycles (the water cycle, the oxygen cycle, the carbon cycle, etc.), and flood protection.

Human pressures on every aspect of the environment have resulted in a compromised and overflowing planetary stress bucket, leading to a host of multiple planetary comorbidities, such as the shrinking of the ice...
caps and rising sea levels, more frequent and extreme weather, galloping desertification, epoch-defining species extinctions, habitat destruction and fragmentation, unprecedented biological invasions, and burgeoning disease epidemics.

We urgently need to redouble our efforts to restore our planetary life support systems if we are to navigate our way out of our interconnected crises in an orderly fashion. Half measures are not enough to restore the planet’s resilience and will result in a panicked stampede for the limited seats on board the illusory lifeboats constructed under the hubristic notions that we can invent ourselves out of the laws of nature or somehow concoct a Planet B.

**Climate change and infectious diseases**

There are many ways in which climate change can, directly and indirectly, impact the frequency and severity of infectious diseases. One of the most obvious ones is through an increase in mosquito populations - those flying syringes that transmit a host of annoying, debilitating or devastating diseases to humans and other animals. A great example to illustrate this phenomenon comes from the Big Island of Hawaii. The Big Island is essentially a giant volcanic cone with temperature falling as you go higher up the cone. A particular mosquito species, the southern house mosquito (*Culex quinquefasciatus*) is an introduced species that transmit the pathogen that causes avian malaria, one of the main reasons for extinction and population declines of native Hawaiian birds. Until recently, cool temperatures had limited mosquitoes numbers in the higher parts of the island, thus providing a high altitude bolt hole for the birds. Rising temperatures are allowing the mosquito to spread to higher ground ushering in avian malaria, forcing the birds into ever-shrinking sanctuaries, and ramping up the probability of global extinction of these precious jewels that are found nowhere else on the planet.

*Figure 4: The Hawaiian ‘i’iwi, a native forest bird species only found in the Hawaiian Islands*
Those who don’t care about the plight of a handful of Hawaiian bird species may change their tune if they thought of these birds as being the canaries in the climate change coal mine whose fate may become our fate with increases in mosquito habitat, along with other attendant consequences of climate change such as rising sea levels, mass migration, increased flooding and extreme weather events, all of which can facilitate the spread of disease.

**Mass animal rearing and infectious diseases**

“Our most dangerous adversary will not originate in the tribal areas of Afghanistan or some other remote place. It is everywhere man and animal live in close proximity.” ~ Michael Osterholm

Approximately three quarters of emerging human infectious diseases are caused by zoonotic pathogens – disease causing agents that can spread between humans and other animals. Transmission from wild animals represents one major risk pathway for the spread of zoonotic disease and intensive animal agriculture represents the other.

The world’s human population of 7.8 billion and counting is dwarfed by the billions of animals we hold captive in barbaric conditions to satisfy our lust for cheap and tasty meat. At any one time the world population of chickens numbers about 20 billion. With around ten generations per year this translates into 200 billion separate animals alive (and dead) in a single year. That’s a lot of incubators for emerging diseases. Pigs, of which about 400 million are slaughtered each year, are often confined in close proximity to intensive chicken rearing units. Pigs can be simultaneously infected by both human and bird influenza viruses, but they don’t show many symptoms, so they are rarely tested. Undetected, unaffected and in close proximity to birds and humans, pigs provide a veritable witches’ cauldron for shape shifting viruses of pandemic potential.

Another way in which intensive animal agriculture increases disease prevalence is through the massive use of antibiotics where they are administered to prevent and treat infection and to stimulate growth. About 70% of antibiotic use in the developed world is for intensive agriculture and the figures for the rest of the world are likely to be similar. The use of antibiotics in agriculture along with their overuse and misuse in health systems worldwide combine to drive the growth of global antibiotic resistance. Many sober commentators are warning of an impending post-antibiotic era in which diseases such as tuberculosis, plague, syphilis and cholera, hitherto kept in check, will re-emerge as global scourges, and in which routine surgical procedures will pose life or death risks. In case you think this is alarmist hyperbole, growing antibiotic resistance is already leading to thousands of deaths through the rise of “superbugs” such as C. diff *(Clostridium difficile)* and MRSA (Methicillin-resistant *Staphylococcus aureus*).

Our lust for meat is fuelled by the myth that human beings require animal protein to be healthy. The reverse is actually the case, with a whole food, plant rich diet being the best diet for longevity and minimisation of disease risk as illustrated by a plethora of studies. The people of the “Blue Zones”, those parts of the world with a disproportionate number of centenarians (people who live long and die short) all eat diets which are low in animal products and high in vegetables, whole grains, fruits, nuts, and beans. A whole food, plant-rich diet is also shown to protect people from the west’s biggest chronic disease killers such as cardiovascular disease, diabetes, cancer, liver disease, kidney disease, COPD and even depression. Less attention has been focused on the fact that those eating this diet and undertaking other healthy lifestyle habits such as sufficient sleep, stress management, and frequent movement have had access to supportive communities are also less vulnerable to infectious diseases.

So eating low on the food chain is good for the planet in terms our carbon footprint, works for animal welfare, reduces the potential development of deadly zoonoses and increases our resilience in the face of infectious diseases. What’s more the food is delicious, once you’ve kicked your meat addiction and learned some creative cookery.
Biodiversity, habitat loss, and infectious diseases

“Zoonotic or agricultural bridging of novel pathogens from domestic and captive wildlife needs urgent attention, along with attention to the human appetite for meat. This approach is easily achieved for coronavirus threats—e.g. by substantially reducing the trade of risky species of wild caught animals for food or other purposes, and a culturally sensitive ban on the sale of these animals in wet markets.” ~ Kock et al (2020).

The wild animal to human zoonotic disease pathway has received a lot of publicity recently in light of the probable origin of Covid-19 from bats infecting an unidentified animal species sold in Wuhan’s live-animal markets. Such outbreaks are likely to become more frequent if the practice of consumption of wild animals continues. Other biodiversity-related threats that increase the likelihood of pandemics include habitat loss, species extinctions, the wildlife trade, and biological invasions.

The blurring of lines between human and non-human habitat creates a spillover of wild animals and their diseases into humans. Poverty and food insecurity increase the demand for the consumption of wild animals, which shortens the odds of viral transmission through infected bodily fluids. Deforestation for timber, mining, ranching and other forms of economic activity fragment the natural world and brings humans into more frequent contact with the reservoir of pathogens that reside in animals such as monkeys, bats, and rodents. Some of these pathogens will come to infect humans. It is as if we are sitting under a tree, violently shaking that tree, letting all the creatures in the tree rain down on us, and seeing what will stick. With all that detritus raining down upon us it is inevitable that some will stick. Forest fragmentation is accompanied by road building and increased mobility, so disease transmission, which hitherto would have been localised, now has a chance to take hold in faraway densely populated settlements. This was the case with the 2014 Ebola virus outbreak which began in the tiny remote village of Meliandou in the forest region of southern Guinea and rapidly spread to teeming urban settlements in Western and Central Africa, from which it had the opportunity hitch hike a ride by plane to any location in the world. In this era of global travel what goes on in Meliandou no longer stays in Meliandou just as surely as what goes on in Wuhan no longer stays in Wuhan.

Habitat destruction and fragmentation, climate change, selective logging and hunting, introduced species, pollution and other anthropogenic threats all contribute to species rarity and extinction. Predators such as big cats and birds of prey are often the first to go and, in their absence, the populations of their erstwhile victims can explode. Predators are nature’s quality control officers, weeding out the injured and infirm while leaving the healthy to survive and reproduce. This double whammy of growing numbers and decreased fitness among disease-transmitting animals ramps up the risk for animal to human disease transfer. Loss of other species also has human disease implications. For example, reduced numbers of amphibian species in the wake of the global spread of amphibian chytrid fungus disease may help to fuel an explosion in mosquito numbers. As people destroy more and more wild places, the web of interactions that made these ecosystems stable gradually unravels with a multitude of consequences.

Legal and illegal trade in wildlife and wildlife products in the form of pets, trophies, crafts, food, clothing and medicines is a multi-billion dollar industry; with the profits from illicit wildlife trafficking comparable with those from the drug trade. The consequences of wildlife trade for species rarity and extinction are well known, as illustrated by ivory and rhino horn trafficking. Less publicised, is the fact that wildlife trade poses significant risks for the release of pathogens of importance to humans, domestic animals and other wildlife. A 2011 survey of found that nineteen of thirty-four (56%) of documented diseases transmitted through the
movement of wildlife were linked to wildlife trade. The list includes leprosy, tuberculosis, SARS and rabies, as well as a host of animal diseases.

Invasive species are defined as species that are not native to a specific location and have a tendency to spread to a degree to cause damage to the environment, economy or health. As a group, invasive species are responsible for the second highest number of extinctions after habitat loss. Pathogens can be considered to be invasive species with their ability to rapidly colonise much of the globe given sufficient hosts and effective modes of transmission. Invasive species that are not directly pathogenic can facilitate the spread of diseases by harbouring pathogens, disturbing habitats and making them more vulnerable to disease and creating favourable conditions for the emergence of new pathogens or re-emergence of pathogens that had been under control. In many instances, the destructive impact of an invasive species is due to the fact that species in the newly invaded ecosystem have not evolved effective defence mechanisms against the new invader – a phenomenon known as “ecological naivety”. Think of Mauritius’ flightless dodo, the poster child for extinction, that had no defence against the introduced monkeys, rats, cats and pigs which accompanied the Europeans when they first landed on the island.

A dramatic disease-related example of ecological naivety shaping the course of history was the decimation of populations of Native Americans from smallpox (which originated in and other maladies that hitchhiked across the Atlantic in the bodies of the European conquistadors and colonisers in the 15th and 16th centuries. Smallpox was a devastating disease in Europe, but its effects were even more catastrophic on the Native Americans whose immune systems were naïve to the new pathogens, due in no small part to their lack of domesticated animals – llamas and alpacas are the only examples of successfully domesticated animals from the Americas. Smallpox (likely to have originated in camels), along with other novel pathogens such as measles (from cows and sheep), whooping cough (from pigs), typhoid (from chickens), influenza, (from domesticated ducks), and leprosy (from water buffalo) may have been responsible for wiping out 90% of all Native Americans.

**Pollution and infectious diseases**

It will come as no surprise to learn that people are more susceptible to both chronic and infectious disease in polluted environments. There have been many studies on the effects of individual pollutants on health, but it is very difficult to study the impacts of a cocktail of pollutants because of the vast numbers of potential interactions between each of the cocktail’s ingredients. It is likely that each pollutant increase total body burden (fill up the stress bucket), thus increasing the likelihood of developing a chronic disease which enhances vulnerability to infections.

There are well established links between air pollution and chronic diseases, such as first-hand and second-hand smoking and atmospheric pollution inducing respiratory and cardiovascular morbidity and mortality, and extreme air pollution conditions adversely affecting blood pressure and insulin resistance.

Domestic water sources in many parts of the world are polluted by a thousands of synthetic and natural contaminants including metals and metalloids, pesticides, industrial chemicals, pharmaceuticals, personal care products, hormones, and pathogens. The problem is most acute in the developing world but domestic water supplies in the developed world are not as pure as many people think. The figure below of risk for arsenic contamination in drinking water illustrates this reality.
Following the discovery of intersex fish in English rivers downstream of municipal wastewater discharge in 1978, there has been growing concern about chemicals that disrupt hormonal function - endocrine disruptors. Studies suggest that these chemicals contribute to obesity and diabetes, independently of poor diet and physical inactivity. Many pollutants act as endocrine disruptors including oestrogen from the contraceptive pill, and oestrogen mimics such as bisphenol A (BPA) found in many plastics and plasticised materials such as the lining of tin cans. These compounds stimulate fat cell production and exposures across the lifespan are well documented to contribute to obesity and diabetes, which in turn enhances vulnerability to infections.

The nefarious effects of plastic pollution on our waterways, oceans and protected landscapes has been highlighted in recent years by Sir David Attenborough among others, but less well known is the part played by plastics in exacerbating the impacts of chronic and infectious diseases. Toxic compounds in plastics such as BPA and phthalates concentrate as they go up the food chain (a phenomenon known as bioaccumulation) with health impacts of the types outlined above. Like BPA, phthalates are endocrine disruptors, but they exert their effects in a different way to BPA.

Yet another way in which pollution contributes to disease is via the growth of mega cities in the developing world and the accompanying spread of unplanned slums with their open dumps in which nonbiodegradable plastic and rubber waste is left to accumulate. This waste provides ideal mosquito breeding grounds, notably for Aedes aegypti a vector for yellow fever, dengue fever, chikungunya and Zika virus. Aedes aegypti is known as the cockroach of mosquitoes for its ability to thrive in the human environment.

### Chronic and infectious diseases

In most circumstances, those with chronic diseases are at the greatest risk of catching infectious diseases. These diseases, which can be merely an inconvenience for the healthy, can be life-threatening for those in poor health. This statement is broadly correct, makes intuitive sense and chimes with the notion of epidemic disease as an evolutionary selective force that weeds out the vulnerable while sparing the healthy. And, the relationship between chronic and infectious diseases goes both ways, with infections in younger life often Predisposing people to chronic diseases later in life.

But there are exceptions to the general rule, and having a specific chronic condition will not necessarily enhance somebody’s vulnerability to any one particular infectious disease. Paradoxically, the Spanish Flu of 1918-1919 appeared to be somewhat anti-Darwinian in nature and disproportionately targeted young adults.
There has been a great deal of discussion about the vulnerability of certain groups to Covid-19, especially men, the elderly and those with pre-existing conditions such as chronic respiratory disease, cardiovascular disease, diabetes, cancer, and obesity and its complications. These groups are also vulnerable to seasonal influenza. However, there are exceptions. Children under five years old appear to be hardly affected by Covid-19 and those on immunosuppressive treatment for transplantation, chemotherapy or other conditions do not appear to suffer any increased risk. Despite these exceptions, countless studies make it clear that adhering to a healthy lifestyle will appreciably enhance your chances of fighting off most infectious diseases.

Some might say that in view of the fact that the major risk factor for infectious diseases is aging and as aging is inevitable, all you are doing through a healthy lifestyle is delaying the inevitable. Indeed, the total mortality rate has been and always will be 100%. But, as previously outlined, we have lots of room to manoeuvre in terms of the number of years that we can spend in good health. There are many hallmarks of aging, such as DNA damage, exhaustion of stem cells, and systemic inflammation. Collectively these tell us our biological age which is related to but not entirely determined by our chronological age. A single marker, the “Horvath Clock” is spectacularly accurate at estimating our biological age. The test is falling in price and will soon be readily available as an objective way to measure how healthy lifestyle practices can reverse the hallmarks of aging and maintain youthful vigour into old age.

**Unsustainable economic development and infectious disease**

“It’s the economy, stupid” was the slogan that helped propel Bill Clinton to the White House in 1992. Clinton knew that the party or leader who is trusted the most on economic issues is the one who is likely to carry the polls. But a healthy and sustainable economy is ultimately based on a planetary life support system so at the most fundamental of levels “it’s the ecology stupid.” However, in emphasising ecological issues in this article I am not blind to the importance of the socio-economic dimensions of epidemic disease initiation, spread, and management. So, while it is critical that we get the economics right so that the economy supports the ecosystem services upon which it depends. It is also imperative that the economy functions efficiently have to enable effective management of the natural world and that the economy works for social justice. In other words a strong economy, society and planetary support system are inextricably linked.

The importance of these linkages is vividly illustrated in times of conflict and economic collapse, which are often accompanied by a resurgence of epidemic diseases. This has been the case in Venezuela in recent years. In 1961 Venezuela was the first country to be certified malaria-free. With the economic chaos of the past decades, thousands of destitute people have taken to the rainforest in search for gold, transforming forest into swamp, thus providing the perfect breeding grounds for malaria-transmitting *Anopheles* mosquitoes. Returning to urban squalor, and ravaged by disease, hapless miners have reintroduced malaria into the welcoming arms of a system ripe for its resurgence – high density housing, poor sanitation, poor healthcare and no mosquito control. By 2016 malaria was back in Venezuela with a vengeance. This serves as a timely reminder that the natural and human spheres are bound together, and that individual and planetary health is a casualty if we fail to respect this reality.

**The way forward - building resilience at the individual, community and planetary level**

The Covid-19 pandemic has functioned as a global pause button, providing us with the opportunity to reflect on how we got into this situation and on possible ways in which we can move forward once the immediate crisis has passed. As practically everybody is saying “the world will never be the same”. Business as usual cannot be an option if we are to live in harmony with the planet. But that does not mean that positive change is inevitable. If recent history is a guide, there is likely to be strong impetus to return to the status quo. Casting our minds back to the immediate aftermath of the 2008 financial crisis, there was a lot of discussion about systematic economic and financial reform, but this reform never materialised, due in no
small measure to the power of vested interests. It was supposed to be a global wake-up call, but we just hit the collective snooze button.

Below, I provide a few suggestions of ways in which we can integrate measures to heal individuals and the planet upon which we all depend. The list is far from exhaustive. It is not a vainglorious attempt to replace the Sustainable Development Goals (SDGs) adopted by all United Nations Member States in 2015. Nor is it a “Marshall Plan for Planetary Health and Global Resilience”. Such a plan, if it is to fly, will take a great deal of collective reflection, discussion, negotiation and time. My humble and far from comprehensive suggestions fall into seven interconnected categories, all of which ultimately help to promote personal and planetary resilience.

- Personal health
- Climate change
- Animal agriculture
- Biodiversity restoration
- Pollution
- Infectious diseases
- Science and public communication

**Personal health**

- Shift focus from a symptom alleviation approach to a wholistic body-mind health system that focuses on root causes, behavioural change, and comprehensive and regular tests of health biomarkers for all, as a means toward the prevention, arrest and reversal of chronic disease while not ignoring acute care issues.
- Provide support for implementation of healthy behavioural change in the home, work and social environment such as classes in healthy cooking, subsidised gym membership and exercise classes, flexitime and working from home to minimise commuting time, etc.
- Provide sufficient support to existing global initiatives for infectious disease prevention, eradication, mitigation, and early detection and rapid response.

**Climate change**

- As a matter of urgency, prioritise all necessary steps to stay within the 1.5 °C or 2 °C warming thresholds that scientists have identified as key to the future safety of the planet. These include:
  - Increased emphasis on the role of animal consumption as a driver of climate change.
  - Removal of subsidies on activities that contribute to climate change.

**Animal agriculture**

- Phase out the barbaric, unsustainable and disease-promoting practice of intensive animal agriculture by, for example, imposing minimum welfare standards, limiting the use of antibiotics and hormones, and implementing good practice for hygiene and waste management.
- Accelerate the development of healthy, low environmental footprint meat substitutes and synthetic meat products.

**Biodiversity restoration**

- Urgently prioritise ecosystem restoration to secure biodiversity and safeguard ecosystem function, e.g. through the development of well-funded marine parks, rewilding of areas that have lost critical ecosystem components, and development of larger and more connected protected areas with zonation in line with ecosystem function.
• Plan settlements which integrate safe and accessible contact with nature that enhances health and does not threaten biodiversity.
• Impose punitive sanctions on those benefitting from the illegal wildlife trade.
• Phase out the consumption of wild animals and invest in alternative livelihoods and sustainable development in affected communities.
• Adopt an integrated approach to biosecurity at the local, national, regional and global, levels to minimise the risks posed by invasive species that threaten the environment, economy and health.

Pollution
• Phase out known toxins in plastics such as BPA and phthalates and develop safe, biodegradable substitutes.
• Implement measures to ensure that producers pay the full economic cost of pollution.
• Promote international good practice in domestic water treatment.
• Ensure that manufactured goods are fully recyclable.

Infectious diseases
• Adopt and go beyond a One Health approach to human animal diseases to take into account the ecology of disease formation, and spread.
• Increase investment in a safe universal influenza vaccine.
• Invest heavily in managing antibiotic resistance by optimising use in humans, minimising use in animals and developing new generation antibiotics.

Science and public communication
• Monitoring – what gets measured gets done. The scope of accurate, useful, participatory and timely monitoring of personal and planetary health parameters is immense.
• Promote high quality science that is free from compromising conflicts of interest.
• Strengthen public-funded international science and technical support networks.
• Develop a sustainably funded open access model for scientific publications to broaden dissemination of science which should be recognised as a global public good.
• Double down on fake news and false equivalence, e.g. stop giving disproportionate media coverage to climate change sceptics despite the vast preponderance of evidence.
Epilogue – Pandora’s Box

Half fearfully and half eagerly she lifted the lid. It was only a moment and the lid was up only an inch, but in that moment a swarm of horrible things flew out. They were noisome, abominably coloured, and evil-looking, for they were the spirits of all that was evil, sad and hurtful. They were War and Famine, Crime and Pestilence, Spite and Cruelty, Sickness and Malice, Envy, Woe, Wickedness and all the other disasters let loose in the world.

At the bottom of the box was a quivering thing. Its body was small; its wings were frail; but there was a radiance about it. Somehow Pandora knew what it was, and she took it up, touched it carefully, and showed it to Epimetheus. “It is Hope,” she said. “Do you think it will live?” asked Epimetheus. “Yes,” answered Pandora. “I am sure it will. Somehow, I know that it will outlive War and Sickness and all the other evils. And,” she added, watching the shining thing rise and flutter about the room, “it will never leave us for long. Even if we lose sight of it, it will be there.”

From Pandora’s Box, Retold by Louis Untermeyer
References

Bjerke, W., 2011. The Impact of Infectious Disease on Chronic Disease: A Review of Contemporary Findings. PTHMS Fac. Publ. 5. https://doi.org/10.5590/JSBHS.2011.05.1.05


Quick, D.J.D., 2018. The End of Epidemics: the looming threat to humanity and how to stop it. Scribe UK.


Image Credits

Coronavirus Structure: Scientific Animations (Public Domain)

Blue Planet: NASA (Public Domain)

Plastic waste: CNN (Public Domain)

Hens in a battery farm: Maqi (CC-BY-SA 3.0)

Hawaiian 'I'iwi bird: Robby Kohley (Public Domain)

Okinawan Centenarian Farmer: Brenda Davis

Bushmeat market, Makokou, Gabon: ©Natalie van Vliet / TRAFFIC

Estimated risks for arsenic contamination in drinking water: Schwarzenbach et al. 2010

Pandora’s husband, Epimetheus opening the fateful jar: Giulio Bonasone (Public Domain)

All other graphics by John Mauremootoo (Public Domain)