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Nature, COVID-19, disease prevention, and climate change

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ABSTRACT

When COVID-19 arrived, usual human activity around the world paused or slowed, and nature responded to the opportunity. Even in major urban areas, people remarked on the clearer, crisper, star-brightened night skies. When COVID-19 arrived, usual human activity around the world paused or slowed, and nature responded to the opportunity. Even in major urban areas, people remarked on the clearer, crisper, star-brightened night skies. This issue’s collection of interesting papers provides insights into ways the natural world responded, but it would seem worthwhile to take a step back and frame that phenomenon in its intellectual and epidemiological context.

1. Source of yellow fever

In 1965, the foundation gave me the opportunity to go to Belém, Brazil, a port city widely known as the gateway to the lower Amazon. There they had established one of these laboratories, the Belém Virus Laboratory. Two years later I began my PhD, conducting a major effort of bird netting and banding; in addition, I collected blood samples from these birds for antibody studies of viruses like the equine encephalitis viruses mentioned above.

I shared an office with a charismatic Colombian research MD, Jorge Boshell, who had been the second director of the laboratory at Villavicencio on the edge of the Colombian llanos (where he succeeded the legendary Marston Bates). While there, he solved the riddle of the yellow fever’s sylvan cycle (“jungle yellow fever”). That cycle occurred in the rain forest canopy where it moved nomadically infecting monkeys, particularly howler monkeys (Alouatta). Occasionally, infected people emerged from the forest, raising an important question: how could a disease agent in the canopy make its way to a person 30 m below?

Boshell was in the field one day with some woodcutters. When their axes brought down trees, the woodsmen were surrounded by a cloud of little blue canopy mosquitoes (Haemagogus). Those insects already were known to be capable of transmission to humans, but they only do so when a major environmental disturbance like tree cutting brings canopy fauna in contact with ground level. Jorge had solved the riddle (Boshell-Manrique and Osorno-Mesa, 1944).

I resurrect this bit of epidemiological history in part because of its intrinsic value, but more because it is the ultimate metaphor of human disturbance of the environment with consequent negative health impacts for people. The point of environmental disturbance leading to epidemiological consequences is generally present in historical accounts.
of epidemics (Snowden, 2020).

2. New diseases from wildlife

New disease agents with pandemic potential are discovered regularly. It is very clear that human disruption/destruction of nature (in a negative synergy with wildlife trade and markets) constitute a recipe for enhanced probability of spillover. That is multiplied by massive populations of domesticated animals and the size of the human population. (They represent 39.9% and 35.9% of mammalian biomass respectively (Bar-On et al., 2018)). The trade and markets enhance that probability not only because of greater frequency of contact with potential human hosts, but also because wild animals are enhanced transmitters with diminished capacity to resist pathogens when under stress.

One repeated aspect of history and human nature is that precautionary measures – institutional and other – usually degrade in effectiveness and preparedness over time; e.g., a world that experienced H1N1, Ebola and more wasn’t even prepared to scramble in response to COVID-19. That is not uniform, of course; for example, Taiwan did a remarkable job in resisting COVID-19, but exceptions prove the rule. It is not only epidemiologically foolish, it makes no sense economically when conservative estimates of the cost of the current pandemic are greater – by two orders of magnitude at least – than the cost of continuing preparedness (Dobson et al., 2020). As human behavior it is all too reminiscent of the tepid pace of addressing climate change or biodiversity loss.

Human intrusion in and disruption of nature are not confined to direct impacts. The various forms of pollution and climate change play a role as well. The very viruses I studied cycling through Amazon ecosystems are more likely to emerge as problems for humans in a world in which climate change provokes ripples of change through Amazonian and other ecosystems in synergy with other human disturbances.

3. Ecosystems respond to the pandemic

What is particularly fascinating, and what most of this special issue is about, is the way ecosystems and biodiversity have responded to the significant reduction in human activities during the pandemic lockdown and early recovery. It gives us a sense of how rapidly and how generally nature responds when negative pressures are reduced.

Not surprisingly, the relaxation of pressure from human activities has led to a wide variety of responses in nature, some of which are included in this special issue. Many were positive; coral reefs and beach ecosystems both demonstrated recovery in the absence of tourists (China et al., 2020; Soto et al., 2021), and leatherback sea turtles in Costa Rica had a higher nesting percentage (Quesada-Rodríguez et al., 2021). However, other impacts were more complicated. Acoustic tracking analyses in Australian marine environments showed multiple responses to the relaxation of human pressure/activity, some unexpected: for example, a 51 day cessation of cage diving with white sharks (Charharodon carrharias) had no effect on the sharks, but reduced the activity of yellowtail kingfish (Seriola lalandi) (HUVeneers et al., 2021). Seizure reports in India for pangolins tripled, a finding of concern not just for its own sake but also for the entiopathology of pandemic virus (Aditya et al., 2021).

Freshwater fisheries were examined by Cooke et al. (2021), who noted various beneficial and deleterious impacts from the pandemic. More than anything they identified the need for a much more robust and sustained system of monitoring – which even without the pandemic would be very necessary. Globally the severe curtailment of travel seriously affected protected areas and species dependent on such income (Smith et al., 2021; Miller-Rushing et al., 2021). These are but a tiny subsample of the changes that occurred, many of which are described in this Special Issue.

There remains the big question, of course: how many of the positive impacts documented here, along with suggestions for more sustainable approaches, might be captured and maintained going forward?

A big worry of course is that governments and those not attuned to the importance of nature and the living planet will default to the old models, which in part could be characterized as throwing infrastructure at the economic problem. In my experience, the economic analysis of those projects and many other elements in conventional “development” is largely poorly done. Much of it could be slowed, deflected, or transformed through better economic analysis. We need to make a serious alliance with economists to succeed in building a more sustainable future (Barros et al., 2020).

4. The growing threat of climate change

Climate change looms large over all of this and is generally not understood as being inherently biological in origin – and in solution. Not only is all the carbon generated by burning fossil fuels ancient photosynthesis trapped geologically and now being released in an ecological instant, but there is a staggering amount of CO2 in the atmosphere from razed terrestrial ecosystems (Erb et al., 2018). Setting the target limit for the amount of climate change has mostly not considered the biology of the planet so fundamental for humans and other forms of life. Even the Paris agreement revision indicating the importance of a 1.5 degree target was mostly based on physical science based sea level rise considerations of small island nations (of course very valid in itself) (Lovejoy, 2019).

Nonetheless, I believe what we have been seeing emerging in climate change biology is a sense that ecosystems, not just species, are quite sensitive to climate change. Paleontologists are clear that ecosystems do not move as units with all the component biodiverse parts, but rather the species move individually according to their own idiosyncratic rates and directions (Hewitt and Nichols, 2005; Lovejoy, 2019).

Conservation has incorporated this idea for some time. One response is to respond to where species are likely to move, for example adjusting boundaries for the Joshua Tree National Park so that it still includes the plant for which it is named. Legally, this is an important consideration for Canadian protected areas because the legislation enacting them usually refers specifically to the natural history feature being protected.

With greater climate change, ecosystems begin to come apart – it is happening already. Certainly, tropical coral reefs are the prime example: a small temperature increase – for a short period of time – causes bleaching events where the coral animal ejects the alga and severs the relationship upon which the entire ecosystem depends. The dieback in North American coniferous forests is another. Pine bark beetles get an additional generation and more survive winters, so there is major mortality in these forests from southern Alaska to southern Colorado.

It seems logical to conclude that climate change beyond 1.5 degrees would produce a biologically phantasmagorical world – one very hard to manage biologically for reasonable outcomes for humanity. That 1.5 degree world would require an atmospheric CO2 level of 350 ppm. Already we are at 420 ppm.

So, is it all over? Is it too late? It is not, because if managed properly, the biosphere can pull back 70 ppm of CO2 (equal to 154 gigatons of carbon) from the atmosphere. It is not yet widely stated this way, but the amount of CO2 in the atmosphere from destroyed terrestrial nature is roughly equivalent to what remains in extant terrestrial nature.

5. Possible solutions

About one third of that can be brought back by ecosystem restoration often termed “natural climate solutions” (Griscom et al., 2017), a subset of the more broadly termed “nature based solutions”, to get us to a 1.5 degree soft landing. All restored ecosystems also bring the benefits of various services which can be estimated economically.

Biosphere restoration has two cultural benefits beyond what it can directly do for the carbon cycle, global temperature, and biodiversity. First, it will help people realize the previously unrecognized importance
of nature and that the planet needs to be managed – that means we must manage ourselves – as a linked biological and physical system. Second, it also empowers the individual in that anyone can plant a tree (hopefully the right species in the right place and in the right way), and help restore an ecosystem.

What this Special Issue and the pandemic as a whole help us realize is how responsive biodiversity and ecosystems are when not battered by the human economic juggernaut. COVID-19 has shed some light on the way forward.

Declaration of competing interest

The work is all original research carried out by the authors. All authors agree with the contents of the manuscript and its submission to the journal. No part of the research has been published in any form elsewhere, unless it is fully acknowledged in the manuscript.

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All appropriate ethics and other approvals were obtained for the research. Where appropriate, authors should state that their research protocols have been approved by an authorized animal care or ethics committee, and include a reference to the code of practice adopted for the reported experimentation or methodology. The Editor will take account of animal welfare issues and reserves the right not to publish, especially if the research involves protocols that are inconsistent with commonly accepted norms of animal research.

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