wbcsd

COVID-19: a dashboard to rebuild with nature

Table of Contents

Executive summary

The COVID-19 pandemic has raised significant challenges for policy-makers, business and the public and there is little alignment on the pathways to recovery. Yet one thing is sure: nature plays a key role in this pandemic's emergence and recovery.

Yet there is a way to measure how we build forward better for both human health and nature. There is a dashboard which should be used based on the two core planetary boundaries of climate change and biodiversity/nature loss to guide a truly sustainable transformation. Research shows that 61% of emerging diseases over the past 15 years originated from regions where remaining natural habitat has shrunk to 20% or less.

A priority is transforming the global food system, which is a major driver of nature loss – species and ecosystems on land and in the oceans – and a major threat to the stability of the climate and Earth systems. Production and consumption in the global food system directly affect human health and well-being, for example through declines in food production and freshwater availability or land degradation. They also present key levers in protecting the biosphere and climate and in building resilience against future shocks, including new pandemics.

This calls for actions at policy, consumer and business levels that combine food system transformation with nature restoration and regeneration and climate action. It is necessary in order to safeguard and strengthen the planet's resilience, defined as the capacity of the Earth system to buffer future shocks and stress and thus avoid or reduce the impacts of future infectious disease outbreaks like COVID-19.

The role of nature in Earth systems

The effective functioning of the Earth systems is fundamentally reliant on nature. The Earth's climate has co-evolved with nature over the history of the planet[1] and they continue to shape each other through a complex pattern of interactions.[2] Climate produces the conditions for nature to thrive, while nature regulates climate through the carbon and water cycles. In recognition of this importance, biosphere integrity – roughly speaking, the intactness of nature – is one of two core "planetary boundaries", alongside climate change.[3]

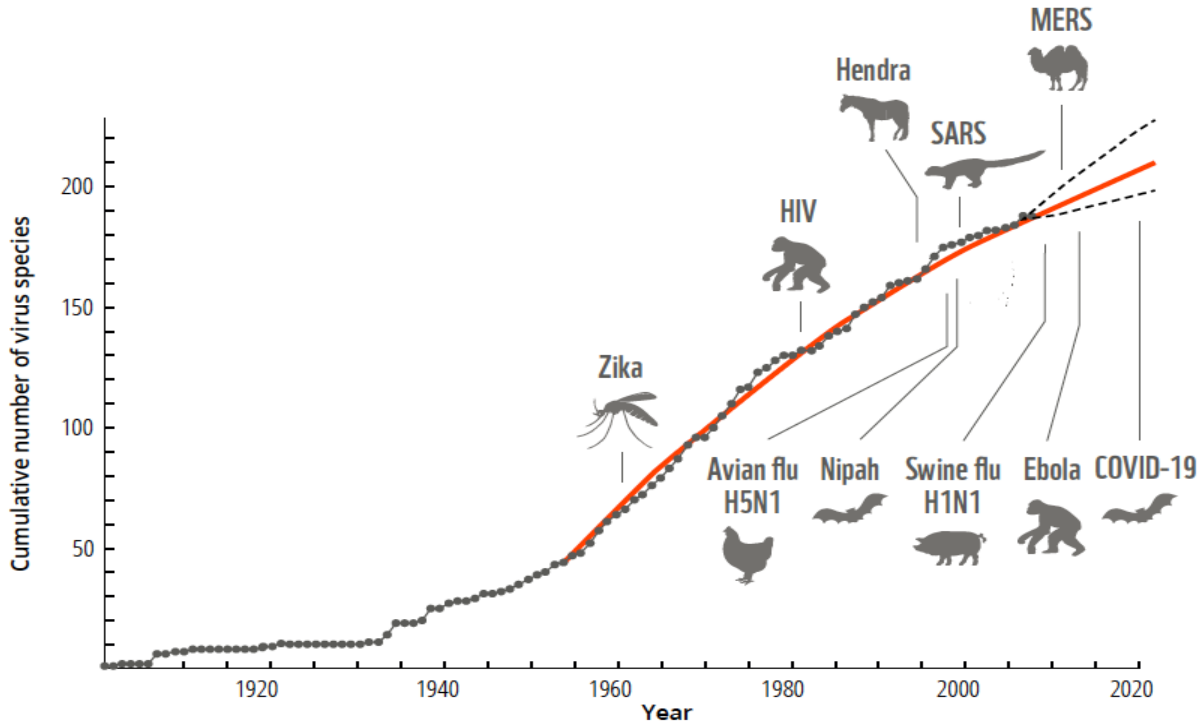
The causes and effects of the COVID-19 pandemic result from new Earth system interactions that human action has introduced. There is evidence that human interference in nature and climate, in particular through the food system, has increased the rate at which zoonoses emerge. (Zoonoses are infectious diseases that jump from non-human animals to humans). The link in the other direction – the effect of zoonoses such as COVID-19 on Earth systems – is far less certain. In the short term, reduced economic activity, including reduced travel and other transport, have had some benefits for nature and climate, as a side effect of the enormous disruptions of social and economic systems and human suffering and deaths. Beyond these short-term effects, it is up to businesses, consumers, governments and society at large to use the crisis as a catalyst for a sustainable transition, for example exploring social tipping points that could lead to new behaviors, consumption patterns and business models.

The emergence of zoonoses driven by nature loss and climate change

To those who have been observing emerging infectious diseases (EIDs), this crisis has not come as a surprise, except possibly in its intensity and impact on the global economy. Indeed, in recent decades, three to four new human infectious diseases (parasites, bacteria and viruses) have emerged each year and the majority of these are zoonotic, originating from wildlife[4] (see Figure 1).

A 2012 World Bank report on the economics of One Health[5] even used as a "normal assumption" a severe influenza-type pandemic costing USD $3 trillion, or 4.8% of global GDP, that may occur on average once in 100 years. The latest World Bank *Global Outlook* (June 2020) report predicts that the pandemic will have a cost of 5.2% of global GDP (USD $4.5 trillion); this could reach up to 8%, should COVID-19 outbreaks persist, and governments extend or reintroduce restrictions on movement.[6]

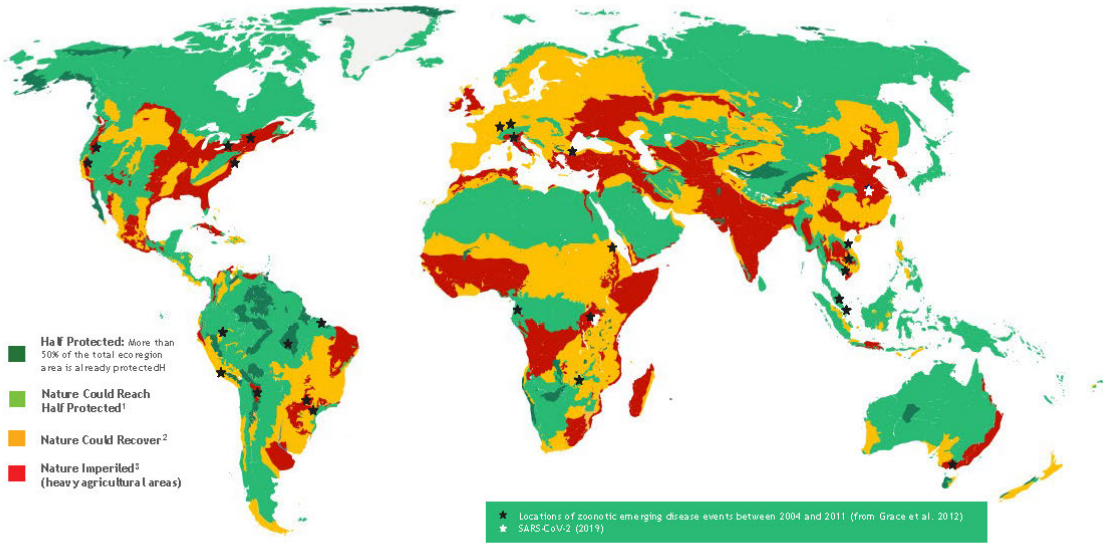
Figure 1: The cumulative discovery of virus species known to infect people (WWF Global Science, 2020)



There has been earlier evidence of correlations between such emergences of zoonoses and nature loss. In 2014, research in the Asia-Pacific region concluded that "the loss of biodiversity or its regulation, as measured by forest cover or threatened species, seems to be associated with an increase in zoonotic and vector-borne disease outbreaks," with the strongest correlation observed with deforestation.[7] Another study in Africa associated Ebola virus disease outbreaks with forest fragmentation.[8] More recent global studies have confirmed that outbreaks of human infectious diseases are linked with threatened biodiversity[9] and that global changes in land-use mode and intensity are expanding hazardous interfaces between people, livestock and wildlife reservoirs of zoonotic diseases.[10]

When superimposing the locations of zoonotic EID events between 2004 and 2011[11] and of COVID-19 with the map of terrestrial ecosystems protection used in the Half Earth Strategy approach[12] (see Figure 2), 61% of emerging diseases over the past 15 years originated from regions where nature is "imperiled" (red areas where the amount of protected and unprotected natural habitat remaining is less than or equal to 20%).

Figure 2: Locations of zoonotic EIDs events between 2004 and 2011 (from Grace et al. 2012[13]) and of COVID-19 as per the level of terrestrial ecosystems protection[14]



1. Less than 50% of the total ecoregion area is protected but the amount of remaining unprotected natural habitat could bring protection to over 50% if new conservation areas are added to the system.
2. The amount of protected and unprotected natural habitat remaining is less than 50% but more than 20%; ecoregions in this category would require restoration to reach half protected.
3. The amount of protected and unprotected natural habitat remaining is less than or equal to 20%.

In its recent *Manifesto for a healthy recovery from COVID-19*, the World Health Organization considers that "land use change is the single biggest environmental driver of new disease outbreaks."[15] And as per a 2020 WWF Science Report,[16] nature loss is now recognized as the main direct (or indirect) driver in recent emerging diseases, mostly through:

- land-use change that exacerbates EID risk by the expansion of human activities in natural ecosystems, hence increasing human-wildlife-domestic animal interactions and cross-species transmission of pathogens – in a sequence that usually combines the expansion of road networks with greater access to natural ecosystems (logging and/or mining) and human settlements, closely followed by subsistence and commercial agriculture; and
- intensification of agriculture that promotes encroachment into wildlife habitats, bringing humans and livestock into closer proximity to wildlife and potential zoonotic pathogens, creating transitional landscapes where wildlife species thrive and become reservoirs for disease in livestock and humans.

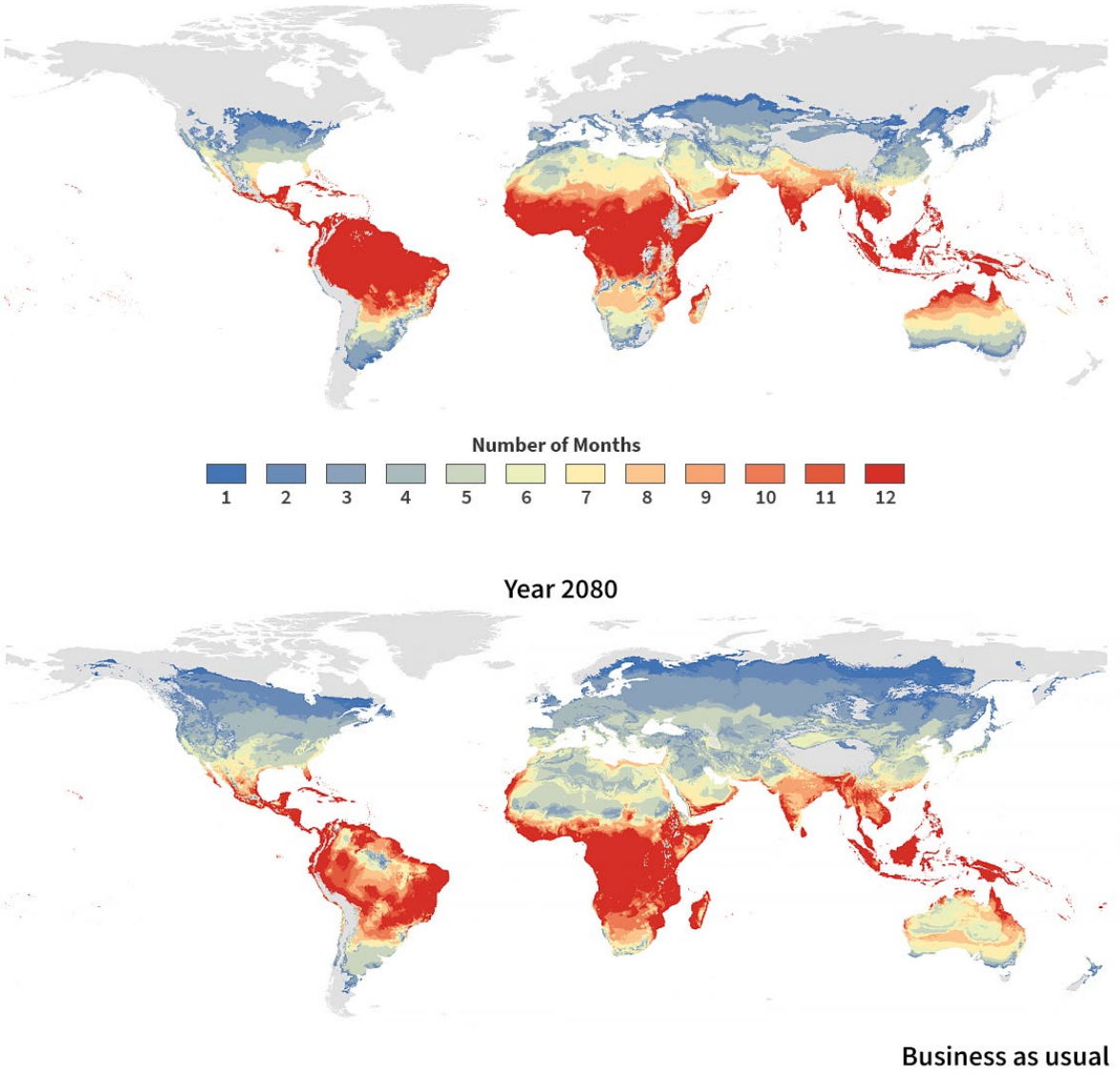
As a recent IPBES workshop[17] concluded: "There is no great mystery about the cause of the COVID-19 pandemic – or of any modern pandemic. The same human activities that drive climate change and

biodiversity loss also drive pandemic risk through their impacts on our environment. Changes in the way we use land; the expansion and intensification of agriculture; and unsustainable trade, production and consumption disrupt nature and increase contact between wildlife, livestock, pathogens and people. This is the path to pandemics."

Climate change also increases the occurrence of many infectious diseases in two ways:

- through increased climate variability that tends to strengthen the impact of EIDs, as evidenced with the strength of the 2017–2018 influenza epidemic which was attributed to abnormally high rapid weather variability;[18] and
- by expanding the geographic ranges of parasites such as the tiger mosquito (*Aedes aegyptii*) that transmits dengue fever, zika virus, chikungunya and yellow fever to humans, as shown in Figure 3.

Figure 3: Current worldwide distribution of the mosquito Aedes aegypti by duration of time in each region (top) and predicted range in 2080 if there is no change to global greenhouse gas emissions (bottom) (from Jordan, 2019[19])



Multiple stressors, including nature loss, climate change and other environmental, economic or social pressures, have an impact on humans and ecosystems, as experienced this year on the West Coast of the United States with both wildfires and COVID-19 at the same time. If, for example, an extreme climatic event has hit a region, its social, ecological and socioecological systems may be more vulnerable to the effects of a disease (or vice versa) or other shocks. Unhealthy diets and other food-related risks (for instance, exposure to environmental pollution from pesticides) also leave people more vulnerable to new diseases.

The combination of nature loss and climate change plays a critical role increasing emerging infectious diseases observed over the past 60 years, as further loss of nature imperils the capacity to mitigate climate change. The role of nature loss is very likely more important in the case of the COVID-19 pandemic as coronaviruses tend to spread from transitional landscapes where nature loss happens and wildlife species thrive, becoming reservoirs for viruses.[20]

The global food system: a main driver of nature loss, climate change and emerging infectious diseases

At the heart of the increase in emerging infectious diseases is the **food system**. It is responsible for 23% of greenhouse gases emissions[21] – meaning eating is the human activity that has the greatest impact on climate change. However, as described above, both agricultural expansion (which goes with land-use change) and agricultural intensification play a critical role in creating transitional landscapes in which zoonotic diseases can move from animals to people. Moreover, food system diversity, redundancy and modularity are decreasing, all of which are key elements of resilience against shocks and surprises. Agricultural expansion and intensification, and the globalization of the food system, reduce landscape and value chain diversity. The current food system relies on a small number of crops, often grown in large monocultures.[22] Livestock populations and cultivated crops are becoming increasingly homogenous genetically. There is a consolidation and concentration of market power with fewer and larger producing, processing and trading companies.[23] Traditional diets are being lost or heavily modified, which is reducing the diversity of products and nutrients available to people, both within and between food groups.

International trade provides opportunities for diversification in terms of sourcing of feedstocks and food, and thus for mitigating the effects of local shocks. However, it also provides transmission pathways for disease vectors (and other shocks and disruptions) upstream and downstream along increasingly longer food supply chains. This causes rippling or cascading effects through these chains from what begin as local shocks. Other food system-related drivers of emerging infectious diseases include, for example, the density of livestock rearing, the co-location of different livestock species, and the large concentrations of livestock which can become breeding grounds for diseases and genetic modifications of viruses and their cross-species transmission.[24]

The United Nations Environment Programme's *2016 Frontiers Report*, reviewing 75 years of scientific evidence, shows that 51% of emerging communicable diseases were related to the global food system (Figure 4), with the other main drivers being the health services and industry (14%), international travel and trade (13%) and climate change (6%).[25]

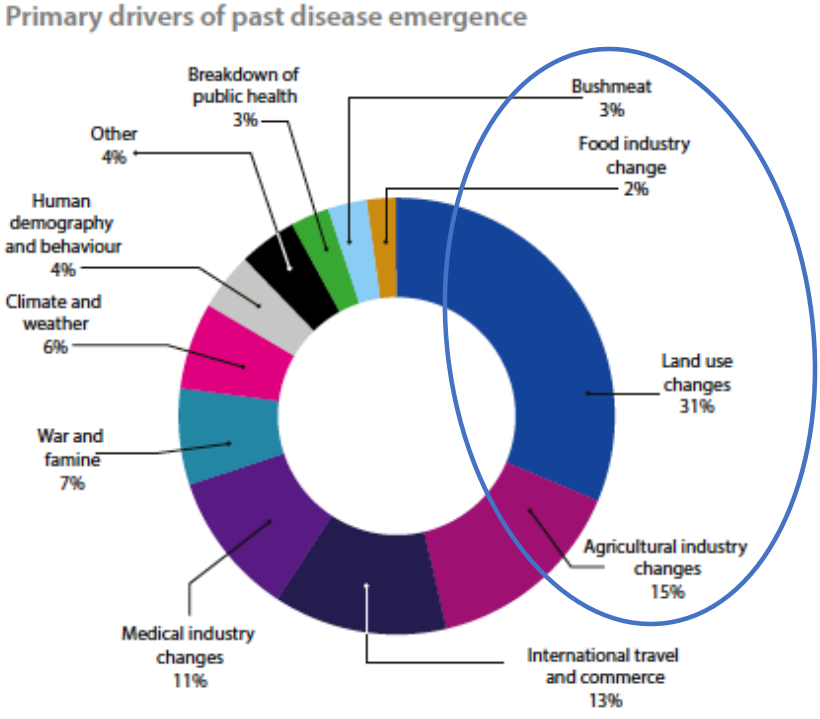


Figure 4: Primary drivers of past (1940-2015) emerging infectious diseases.
The blue ellipse circles the drivers related to the global food system (from UNEP 2016 Frontier Report)

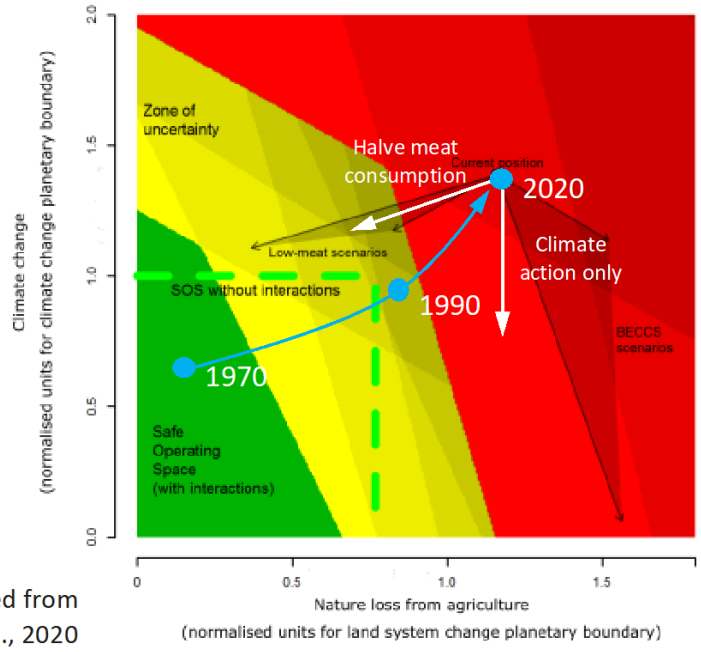
The planetary boundary framework as the dashboard for solution areas

At WBCSD, our vision is a world where, by 2050, over 9 billion people are all living well and within planetary boundaries – a framework developed by Johan Rockström and colleagues[26] in 2009 that defines a "safe operating space for humanity" where civilizations have flourished and thrived for the past 10,000 years without harming the Earth's natural systems (a geological period called the Holocene).

Today, experts increasingly see large-scale changes, such as the melting of Greenland and Antarctic ice shelves, the bleaching of the Great Barrier Reef or the loss of Amazon rainforest, as the signs of a planet in transition from the global "safe operating space" to the "zone of uncertainty". Entering this zone, Earth systems would start changing dramatically and some systems could pass "tipping points" where changes would be irreversible.[27]

COVID-19 could well be another sign of such tipping points. Indeed, in addition to the measurable environmental tipping points, there are also some invisible socioeconomic ones, such as how a virus like COVID-19 can spread rapidly around the world, potentially irreversibly changing air traffic or some consumption patterns.

This adds more complexity and urgency because each Earth system interacts with the others. For instance, land-use changes, for which humanity transgressed the safe operating space several years ago, entering the "zone of uncertainty" can have major impacts on other boundaries, such as climate, biodiversity and biochemical cycles. These last cycles also have a strong impact on biodiversity; in return, biodiversity losses weaken the productivity of land systems, which yield further land-system changes. These interactions nurture the loop cycles that damage Earth systems. A recent study unravels the effects of interactions between the planetary boundaries and the shape of the "safe operating space."[28]



Adapted from Lade et al., 2020

Figure 5: Effects of interactions between planetary boundaries on the shape of the safe operating space for human impacts on the Earth systems. The X-axis roughly corresponds to terrestrial impacts of agriculture and the Y-axis to climate change. Blue dots and arrows describe the positions of the successive states of the Earth in 1970, 1990 and 2020. White arrows illustrate two possible global-scale transitions: halving meat consumption and climate action only

The two axes shown on Figure 5 summarize these interactions between systems and boundary transgressions. The first accounts for the direct impact of greenhouse gas (GHG) emissions, which principally act on climate change and ocean acidification (named “climate change” in the figure). The second accounts for the terrestrial impacts of agriculture, such as land-use changes, nitrogen and phosphorous flows, and freshwater use (named “nature loss from agriculture” in the figure). The green region defines the safe operating space; the yellow region is where at least one Earth system is beyond its planetary boundary; the red region is where at least one Earth system is beyond its zone of uncertainty.

Using Lade et al.’s original figure, we have reconstituted the positions of the successive states of the Earth in 1970 (still in the safe operating space), 1990 (zone of uncertainty) and 2020 (beyond the zone of uncertainty) from the original planetary boundaries paper.[29] We also added the white (indicative only) arrows to illustrate two possible global-scale transitions: halving meat consumption and climate action only. Indeed, Lade et al. noted that policies addressing a specific planetary boundary often lead to impacts on other planetary boundaries, and therefore investigated two climate mitigation measures that involve changes in agricultural activity: large-scale bioenergy production with carbon capture and storage (BECCS[30]), where carbon dioxide from the combustion of rapidly growing crops is geologically sequestered, and a global transition to low-meat diets, using published scenarios to estimate the effects of these measures. Typically BECCS would even be worse off through the pressure it would add on nature.

Considering the interactions between Earth systems, there are two main observations:

- The “safe operating space” is smaller than initially thought. The large green rectangle shrinks to a mere green triangle. This is not only like being swept away on a raft; it is as if the island we wanted to reach had become smaller.
- Second and most importantly, planetary boundaries and interactions between Earth systems constitute a good *framework* to represent how our civilization has entered an unsafe operating space, one not experienced over the past 10,000 years, where two of the main drivers of emerging diseases – land-use change and climate change – are “beyond boundaries”. This framework shows that fixing the food system could be an effective pathway to navigate the planet to, or close to, a safe operating space, a result confirmed by a recent study using a mix of land-use and biodiversity solutions.[31]

We therefore propose to use **planetary boundaries** (in this simplified bidimensional representation) as a *dashboard for recovery* and navigation back to the global safe operating space. Such a dashboard calls for actions that combine food system transformation with nature restoration and regeneration, both including climate action.

Long-term recovery from the pandemic – build forward better with nature

Using such a dashboard for recovery to build forward better aims to safeguard *Earth resilience*, meaning the capacity of Earth systems to: (i) buffer shocks and stress and (ii) avoid or at least reduce the impact of future zoonotic disease outbreaks. In other words, to have a reasonably good chance of managing the future economy, markets, population health, and wealth, all stakeholders must invest in nature to build resilience that reduces risks of disease, extreme events and crossing tipping points.

As the way to use such a dashboard depends on who uses it, we propose directions for:

- Policy-makers who will have to make bold decisions on recovery and transformational changes in the coming months and agree upon a common direction in the forthcoming large international, all of which have been postponed to 2021 (IUCN World Conservation Congress, United Nations Convention on Biodiversity (CBD) 15th Conference of the Parties (COP15) and United Nations Framework Convention on Climate Change 26th Conference of the Parties (UNFCCC COP26);
- Businesses, which will need help to drive the transformation needed over the next decade, developing innovations to achieve full circularity and new business models, supporting sustainable consumption and production (Sustainable Development Goal (SDG) 12); and
- Consumers, among whom many are now wondering how the way they live, consume and engage will change in the post-COVID-19 world.

Policy makers

As COVID-19 is having lasting effects and imposing a one-year delay on the international policy calendar, there is a unique opportunity to step back and reintroduce nature in political and economic models. This also creates the opportunity to better acknowledge interlinkages in the food system and with environmental, climate and health objectives and policies. A recent economics publication shows that "the main obstacle to the fight against the environmental crisis is financial, hence political."[32]

During the COVID-19 pandemic, we have seen important political steps towards greening the economy. These include the European Union's Green Deal, which comprises a "Farm to Fork Strategy"[33] and a "Biodiversity Strategy for 2030".[34] The EU Green Deal focuses more on decarbonizing the economy than protecting nature. It may also have limited impact when dividing economic incentives by the number of member countries, or without a meaningful carbon price.[35] Yet, will there be policy-makers brave enough to propose to embark on a more regenerative or "frugal economy"[36] or to address planetary boundaries in combination with social thresholds as proposed several years ago by the "doughnut economics" approach,[37] as the City of Amsterdam recently did[38] and several other C40 cities are considering?

Very recently, a group of 21 non-governmental and intergovernmental organizations with mandates at the nexus of environmental protection, nature conservation and the promotion of sustainable development issued a series of recommendations for a nature-positive COVID-19 economic recovery[39](Schwab et al., 2020). These groups are calling for stakeholders to "build back better" from the present crisis by protecting nature and making nature-positive investments that will ensure sustainable economic recovery and secure people's livelihoods.

They put forward a series of bold measures, including:

- avoiding relaxation of environmental regulations in the name of COVID-19 stimulus and recovery and attaching green conditions to corporate bailouts;
- providing income support to reduce the risk of poverty-induced encroachment into nature;
- repurposing subsidies and other public support for activities that conserve nature and incentivize nature-based solutions to post-pandemic economic recovery and restructuring;
- private sector investment and innovation in nature-based solutions.

Consumers

Eating is the human activity that has the greatest impact on climate change, nature loss and human health. A wide range of literature highlights the co-benefits of reducing the amount of meat humans consume on planetary (see Figure 5) and human health.[40,41] Moreover, there is ample evidence that being overweight or obese or having a non-communicable disease, which are often related with poor diets, increases the risks associated with COVID-19, including severe and fatal forms.[42] In parallel, recent science suggests that some particular foods may dramatically reduce COVID-19 mortality.[43,44]

Various signals in consumption patterns seem to indicate that some consumers have changed their habits due to COVID-19. A recent Rabobank FoodBytes! trend report[45] shows that due to COVID-19, consumers are buying directly from farmers more often. The health risk of going to the supermarket, more time at home to cook (in relation with lockdown and remote working) and increasingly broken supply chains has led to this rise. Similarly, there is strong interest in community-supported agriculture.[46] Consumers are increasingly requesting transparency from business in terms of the environmental and socioeconomic footprints of specific products and thus indirectly of contributions to planetary boundary transgressions.

However, it is too early to conclude if these recent trends will be lasting and will spread. Moreover, not all consumers have the capacity to choose the food they want to eat, especially those with the lowest incomes, be they in developing countries or in wealthier countries, and strongly hit by the economic crisis resulting from the pandemic. This year's United Nations report on the *State of Food Security and Nutrition in the World* highlights this.[47]

Business

Business has a critical role to play alongside governments and consumers in navigating Earth systems back to their safe operating space. This became obvious after the Paris Climate Agreement in 2015. For businesses, building back better is about much more than corporate social responsibility: it is about truly aligning markets with the natural, social and economic systems on which they depend. It is about building real resilience, driving equitable and sustainable growth, and reinventing capitalism itself.

By adopting the planetary boundaries to define our revised Vision 2050, WBCSD recognizes that human societies must build sufficient capacity to adequately respond to the planetary emergency. This means that business must work to mitigate additional climate change and loss of nature while also learning to thrive on a dynamic and more volatile planet. By 2050, we envision a world in which

- "global warming is stabilized at no more than a +1.5°C and clean air is available for everyone;
- the biosphere is protected and restored;
- healthy land and soils are stewarded in an equitable and sustainable way;
- the oceans and cryosphere are protected and restored;
- the freshwater cycle is safeguarded and clean water is available for all;
- land, oceans, waterways and coastlines are free from waste and pollution;
- natural resources are consumed sustainably; and
- nature is valued."[48]

Using the planetary boundaries as a dashboard to rebuild with nature implies immediate transformation of the systems on which human beings depend, especially food systems,[49] in a way that nature restoration and regeneration are central and combined with climate action. Nature-based solutions, which deliver value to society by addressing societal challenges and benefit nature by enhancing ecosystem services,[50] will be key enablers of such transformations. Through the Business for Nature coalition, more than 600 companies with revenues of US$ 4.1 trillion are calling on governments to adopt policies now to reverse nature loss in this decade.[51]

As transforming the food system and its supply chains is the most effective pathway to navigate the planet back into the safe operating space, the table below shows examples of how business can translate the planetary boundaries framework into action along the food value chain.

Table 1: Business action benefits and hurdles from using a planetary boundaries dashboard

Value chain level	Business action	Benefits	Hurdles
Production	Halt land conversion and deforestation Adopt regenerative practices (soil carbon sequestration, cover crops, reduced agro-chemicals, farm biodiversity), helping farmers transition by applying agro-ecological principles Adopt circular farming systems Reduce food losses	Enhanced ecosystem services (soil water and carbon retention, soil fertility, pollination) More resilient farming systems in face of climate and market shocks	Perverse public incentives slowing down farmers' transition Business and farmers risk aversion in face of transition (incl. repurposing, phasing out) Lack of access to credit & insurance needed for change of practices
Manufacturing	Source products from regenerative agriculture and ban those resulting in deforestation/loss of other ecosystems Reduce food losses Reuse and recycle	More resilient procurement in face of climate and market shocks Efficiency gains Improved consumer image (consumer facing brands)	Perverse production incentives Challenges to reorganizing procurement and ensuring diversity, redundancy and modularity
Food service and retail	Source products from regenerative agriculture and ban those resulting in deforestation/loss of other ecosystems Make supply chains more resilient and reduce associated environmental and socioeconomic footprints Reduce food waste Reuse and recycle	More resilient procurement in face of climate and market shocks Increase transparency and potentially shorten and regionalize supply chains Efficiency gains Improved consumer image Faster transition to true value of food	Consumer capability (i.e., accessibility, affordability awareness) to select more resilient products (cultural habits, economic and social limitations) Lack of supply chain transparency and the associated footprints True value of food masked by perverse incentives

A next step could be to revisit the innovation areas that could shape and transform the next decade, which WBCSD outlined in the 2020 report on *Innovations that could shape and transform 2020-2030*.[52] This includes three types of innovations:

- 5 business model shifts – changes in key aspects of the contemporary approach of business-making (value creation, value delivery or value capture);
- 12 emerging technologies – devices or processes originating from research developments or technical knowledge that could make an impact in markets or societies;
- 8 social innovations – ways of interacting that could alter social systems and overcome one or several challenges faced by society.

Using the planetary boundaries dashboard would be a strong tool to identify the innovations needed to help create a more resilient future.

Those identified in this study are:

- Business model shifts: the **circular/regenerative** shift where business strives to minimize the resources used in the creation of a product or service, as well as extending and closing a product's life cycle. Regenerative goods and/or services are those that not only benefit the individual customer but also provide a benefit to the whole of society.
- Social innovations:
    - **Self-sustaining neighborhoods**, where a geographically defined community strives to achieve some level of economic independence or self-sufficiency; and
    - **Citizen science**, where members of the public conduct scientific research activities, a movement that has already started in some places to shift food consumption towards patterns that respect human and planetary health.

Conclusion - Using the dashboard to achieve the safe operating space

The global food system is a major driver of nature loss – species and ecosystems on land and in the oceans – and a major threat to the stability of the climate and Earth systems.

The Earth's best bet for the coming decades is the dashboard based on the two core planetary boundaries of climate change and biodiversity/nature loss as it can help rebuild the post-COVID-19 world differently with nature.

Using this dashboard can help assess the level of effort required and prioritize political, business, social measures that combine both nature-positive and climate-positive measures, as well as ban any other measures that would keep pushing Earth systems further from the safe operating space. For example:

- Prioritize nature-based solutions, including ecosystem-based climate adaptation and mitigation that, at a minimum, ensure net-zero loss for biodiversity and that, as much as possible, are net-positive for nature, biodiversity and climate;
- Ensure that the substitution of animal protein by plant protein does not locally result in further loss of natural ecosystems or deforestation to produce protein crops;
- Avoid deforestation or plant trees while intensifying crop production, avoid using agro-chemicals for fertilization and pest control that would in turn damage terrestrial and water ecosystems.

The challenge this dashboard helps address is to stop thinking in terms of trade-offs (climate-positive solutions tolerating some negative impact on nature or vice versa) and to prioritize synergies between nature-positive and climate-positive actions.

Acknowledgements

Alain Vidal (WBCSD and AgroParisTech), Steven J. Lade (Future Earth, Stockholm Resilience Center, Stockholm University, and Fenner School of Environment & Society, Australian National University), Holger Hoff (Stockholm Environment Institute and Potsdam Institute for Climate Impact Research), and Johan Rockström (Potsdam Institute for Climate Impact Research) authored this report.

Endnotes

[1] Lenton, T. (2016). Earth System Science: A Very Short Introduction. Earth System Science: A Very Short Introduction. doi:10.1093/actrade/9780198718871.001.0001.

[2] Lade, S. J. et al. (2020). Human impacts on planetary boundaries amplified by Earth system interactions. Nat. Sustain. 3, 119–128.

[3] Steffen, W. et al. (2015). Planetary boundaries: Guiding human development on a changing planet. Science (80-.). 347, 1259855–1259855.

[4] WWF Global Science (2020). Beyond Boundaries: Insights into emerging zoonotic diseases, nature, and human well-being.

[5] World Bank (2012). People, Pathogens and Our Planet : The Economics of One Health. Retrieved from: https://openknowledge.worldbank.org/handle/10986/11892.

[6] World Bank (2020). The Global Economic Outlook During the COVID-19 Pandemic: A Changed World. Retrived from: https://www.worldbank.org/en/news/feature/2020/06/08/the-global-economic-outlook-during-the-covid-19-pandemic-a-changed-world.

[7] Morand, S., Jittapalapong, S., Suputtamongkol, Y., Abdullah, M. T. & Huan, T. B. (2014). Infectious diseases and their outbreaks in Asia-Pacific: Biodiversity and its regulation loss matter. PLoS One 9, 1–7.

[8] Rulli, M. C., Santini, M., Hayman, D. T. S. & D'Odorico, P. (2017). The nexus between forest fragmentation in Africa and Ebola virus disease outbreaks. Sci. Rep. 7, 1–8.

[9] Morand, S. (2020). Emerging diseases, livestock expansion and biodiversity loss are positively related at global scale. Biol. Conserv. 248.

[10] Gibb, R. et al. (2020). Zoonotic host diversity increases in human-dominated ecosystems. Nature 584, 398–402.

[11] Grace, D. et al. (2012). Mapping of poverty and likely zoonoses hotspots. Zoonoses Proj. 4, 1–119.

[12] Dinerstein, E. et al. (2017). An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm. Bioscience 67, 534–545.

[13] Grace, D. et al. (2012). Mapping of poverty and likely zoonoses hotspots. Zoonoses Proj. 4, 1–119.

[14] Dinerstein, E. et al. (2017). An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm. Bioscience 67, 534–545.

[15] World Health Organization (2020). WHO Manifesto for a healthy recovery from COVID-19. Retrieved from: https://www.who.int/news-room/feature-stories/detail/who-manifesto-for-a-healthy-recovery-from-covid-19.

[16] WWF Global Science (2020). Beyond Boundaries: Insights into emerging zoonotic diseases, nature, and human well-being.

[17] IPBES (2020). IPBES workshop on biodiversity and pandemics - Executive Summary. https://ipbes.net/sites/default/files/2020-11/20201028 IPBES Pandemics Workshop Exec Summ Laid Out Final.pdf

[18] Liu, Q. et al. (2020). Changing rapid weather variability increases influenza epidemic risk in a warming climate. Environ. Res. Lett. 15, 044004.

[19] Jordan, R. (2019). How does climate change affect disease? Stanford Woods Institute for the Environment. Retrieved from: https://earth.stanford.edu/news/how-does-climate-change-affect-disease#gs.7ku3vh.

[20] WWF Global Science (2020). Beyond Boundaries: Insights into emerging zoonotic diseases, nature, and human well-being.

[21] Intergovernmental Panel on Climate Change (IPCC) (2019). Special Report on Climate Change and Land. IPCC. Retrieved from: https://www.ipcc.ch/srccl/chapter/technical-summary/ doi:https://doi.org/10.4337/9781784710644.

[22] Khoury, C. K. et al. (2014). Increasing homogeneity in global food supplies and the implications for food security. Proc. Natl. Acad. Sci. U. S. A. 111, 4001–4006.

[23] The Economics of Ecosystems and Biodiversity (TEEB) (2018). TEEB for Agriculture & Food: Scientific and Economic Foundations.

[24] Morand, S. (2020). Emerging diseases, livestock expansion and biodiversity loss are positively related at global scale. Biol. Conserv. 248.

[25] United Nations Environment Programme (UNEP) (2016). Emerging zoonotic diseases and links to ecosystem health – UNEP Frontiers 2016. UNEP - UN Environment Programme. Retrieved from: https://www.unenvironment.org/resources/emerging-zoonotic-diseases-and-links-ecosystem-health-unep-frontiers-2016-chapter.

[26] Rockström, J. et al. (2009). Planetary Boundaries. Ecol. Soc. 14.

[27] Lenton, T. M. et al. (2019). Climate tipping points — too risky to bet against. Nature vol. 575 592–595.

[28] Lade, S. J. et al. (2020). Human impacts on planetary boundaries amplified by Earth system interactions. Nat. Sustain. 3, 119–128.

[29] Rockström, J. et al. (2009). Planetary Boundaries. Ecol. Soc. 14.

[30] Gough, C. & Upham, P. (2011). Biomass energy with carbon capture and storage (BECCS or Bio-CCS). Greenh. Gases Sci. Technol. 1, 324–334.

[31] Leclère, D. et al. (2020). Bending the curve of terrestrial biodiversity needs an integrated strategy. Nature 585, 551–556.

[32] Giraud, G. (2020). Financer la décarbonation. Rev. Esprit 3, 71–81.

[33] European Commission (2020). Farm to Fork Strategy. Retrieved from: https://ec.europa.eu/food/sites/food/files/safety/docs/f2f_action-plan_2020_strategy-info_en.pdf.

[34] European Commission (2020). EU Biodiversity Strategy for 2030 - Bringing nature back into our lives. Retrieved from: https://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm.

[35] Claeys, G., Tagliapietra, S. & Zachmann, G. (2019). How to make the European Green Deal work. *Bruegel Policy Contrib.* 21.

[36] Radjou, N. (2020). The Rising Frugal Economy. https://sloanreview.mit.edu/article/the-rising-frugal-economy/.

[37] Raworth, K. (2017). A Doughnut for the Anthropocene: humanity's compass in the 21st century. *The Lancet Planetary Health* vol. 1 e48–e49.

[38] Raworth, K. (2020). *Introducing the Amsterdam City Doughnut*. https://www.kateraworth.com/wp/wp-content/uploads/2020/04/20200416-AMS-portrait-EN-Spread-web-420x210mm.pdf.

[39] Schwab, N., Berger, E., Sanjayan, M., Gough, M., Rogers, K., & Rodriguez, C. M. (2020). *COVID-19 response and recovery. Nature-based solutions for people, planet and prosperity. Recommendations for policymakers.* https://files.wri.org/s3fs-public/covid-response-recovery-joint-policy_Recs_OCT23_FINAL.pdf

[40] Willett, W. et al. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet* vol. 393 447–492.

[41] Springmann, M. et al. (2020). The healthiness and sustainability of national and global food based dietary guidelines: modelling study. *BMJ* **370**, m2322.

[42] Kassir, R. (2020). Risk of COVID-19 for patients with obesity. *Obesity Reviews* vol. 21.

[43] Bousquet, J. et al. (2020). Cabbage and fermented vegetables: from death rate heterogeneity in countries to candidates for mitigation strategies of severe COVID-19. *Allergy*. doi:10.22541/AU.159611484.40009356.

[44] Bousquet, J. et al. (2020). Is diet partly responsible for differences in COVID-19 death rates between and within countries? *Clin. Transl. Allergy* **10**, 16.

[45] Rabobank (2020). The New Normal for the Food System in the Wake of Covid-19. *FoodBytes! Trend Report*. Retrieved from: https://www.foodbytesworld.com/foodbytes-trend-report-the-new-normal-for-food-system-in-the-wake-of-covid-19/?utm_source=newsletter&utm_medium=email&utm_campaign=food&utm_content=2020-08-20&mkt_tok=eyJpIjoiWm1Wak56STRNek16Wm1SaiIsInQiOiJrZ2I2anRteUp1UHIrc.

[46] Worstell, J. (2020). Ecological Resilience of Food Systems in Response to the COVID-19 Crisis. *J. Agric. Food Syst. Community Dev.* **9**, 1–8.

[47] Food and Agriculture Organization of the United Nations (FAO); International Fund for Agricultural Development (IFAD); UNICEF; World Food Programme (WFP); World Health Organizatin (WHO) (2020). *The State of Food Security and Nutrition in the World: Transforming food systems for affordable healthy diets*. Retrieved from: https://doi.org/10.4060/ca9699en doi:10.4060/ca9699en.

[48] WBCSD (2020). *Vision 2050: Time to Transform*.

[49] WBCSD (2019). *CEO Guide to Food System Transformation*.

[50] IUCN, International Union for Conservation of Nature (2020). *IUCN Global Standard for Nature-based Solutions: a user-friendly framework for the verification, design and scaling up of NbS: first edition*. *IUCN Global Standard for Nature-based Solutions: a user-friendly framework for the verification, design and scaling up of NbS: first edition*. doi:10.2305/iucn.ch.2020.08.en.

[51] Business for Nature (2020). Call to Action. https://www.businessfornature.org/call-to-action

[52] WBCSD (2020). *Innovations that could shape and transform 2020-2030*. Retrieved from: https://www.wbcsd.org/Overview/About-us/Vision-2050-Refresh/Resources/Innovations-that-could-shape-and-transform-2020-2030.

World Business Council for Sustainable Development

Maison de la Paix
Chemin Eugène-Rigot 2B
CP 2075, 1211 Geneva 1
Switzerland
www.wbcsd.org