

An aerial photograph showing a sharp contrast between a cleared, brown, muddy area on the left and a dense, green forest on the right. A blue excavator is visible in the cleared area, and the ground is marked with tire tracks. The image is split diagonally, with the cleared area in the upper left and the forest in the upper right.

Deforestation and the Risk of Collapse: Reframing COVID-19 as a Planetary Boundary Effect

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Executive Summary and Policy Recommendations

About the author

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Abstract

The COVID-19 pandemic was a symptom of the fundamental structures of industrial civilisation, and it is an early warning signal for how this civilisation is rapidly eroding the very conditions of its own existence.

Over the last decade, environmental scientists have warned that human activities are increasingly at risk of breaching planetary boundaries, which define the environmental limits in which humanity can safely operate. As industrial civilisation increasingly encroaches on natural ecosystems, we are reducing this 'safe operating space' for human survival.

A reframing of the COVID-19 pandemic in the context of wider biophysical processes reveals that it constitutes a biophysical disruption between the Earth system and human systems, representing an intensifying violation of planetary boundaries which has escalated over a period of decades since at latest the 1970s. A signature event in this process was the 2008 financial crash, which was rooted in a fundamental geological transition into a new era of lower net energy, driving a shift to more expensive and

dirtier forms of unconventional energy financed by massive debt-expansion through quantitative easing. This in turn drove continued forms of industrial expansion which only continued to deepen the breach of planetary boundaries. One of the frontlines of this breach of planetary boundaries is the persistent impact of continuing deforestation, which increases the chance of pandemics of zoonotic diseases such as COVID-19. However, the latter appeared to originate from the hunting of bats in China, and was thus a symptom of wildlife exploitation. While the COVID-19 outbreak itself may not have been a direct result of deforestation, deforestation is part of a wider set of human activities which are increasingly encroaching on natural environments, and increasing the chance of exotic diseases jumping from species like bats to humans.

Today, COVID-19 is ushering in, at break-neck speed, the demise of the age of fossil fuels. While on the one hand, this might offer renewed hope to avert the most dangerous climate scenarios, it also poses a serious risk to the fundamental supply-chains that sustain the energy flows, manufacturing and food production activities of all societies.

That requires a dramatic shift to new forms of sustainable production across critical industries encompassing energy, mining, agriculture, transport, manufacturing and finance. This should involve a series of interlinked systemic shifts involving a transition to renewable energy systems; introducing new circular economy principles; radical monetary reform; and an economic paradigm shift away from GDP.

One of the most urgent areas for immediate mitigating action is tackling deforestation through transitioning to new modes of sustainable production. While frequent attention is often focused on palm oil, the commodity requiring the most urgent attention is in fact beef, the largest driver of climate-linked deforestation emissions. An inclusive, cooperative approaches involving standardised local regulation of all relevant commodities is recommended, and considerable progress in tackling deforestation in Malaysia is highlighted as a potential best practice case study. Yet such approaches must come in partnership with transformations in the developed world to tackle the 'endless growth' dynamic of their economies by restructuring core industrial processes through the preceding interlinked systemic shifts. Overall, the global systemic transformation called for entails a transition to a form of 'ecological civilisation' capable of functioning within planetary boundaries.

Keywords: *COVID-19; planetary boundaries; EROI; oil; transition; systemic risk; collapse; deforestation*

Executive Summary

Industrialisation and the systemic drivers behind the pandemic

The COVID-19 pandemic took all governments by surprise, but it was ultimately predictable and indeed predicted. Numerous disease experts over the last decades have warned repeatedly not merely of the growing risk of a global pandemic, but went so far as to conclude that a single pandemic would be inevitable this century, and that several pandemics would be likely.

The basis of these predictions is invariably rooted in a single broad diagnosis concerning the nature of global industrial expansion. Due to the increased contact between human settlements and wildlife in previously untouched natural ecosystems as a result of global industrial expansion, as well as the increased complex interdependence of countries, the risk of a global pandemic was considered a question of 'when' rather than 'if'.

Deforestation, of course, appears as one of the major specific crises which is a consequence of industrial expansion, and directly exacerbates the risk of exotic disease transmission due to increasing encroachment of human activities into natural ecosystems.

However, while there have been a number of recent major studies warning of the future risks that deforestation might pose in terms of the next pandemic, it is important to recall that the specific trigger of the COVID-19 pandemic was not deforestation in itself, but rather a set of intrusive human activities in China involving the hunting and consumption of wild animals for human consumption. These activities can clearly be linked to China's structure as an expanding industrial society, less so directly to deforestation.

The pandemic as a planetary boundary effect

While deforestation is undoubtedly increasing the likelihood of zoonotic diseases jumping to humans according to numerous studies, it remains one factor relating to a total of nine 'planetary boundaries' which we are in danger of breaching. Within these boundaries, subsists the 'safe operating space' for human civilisation. Beyond these

boundaries, that 'safe operating space' begins to erode. The scientific data demonstrates that we have crossed four of these planetary boundaries around five years ago, one of which concerned land-use change – a category that includes trends such as deforestation. This means that addressing the full scope of causes behind the risks of the pandemic, and future pandemics, requires full attention not solely to the singular issue of deforestation, but to understand this issue in the wider context of its interconnections with several other crises linked to industrial civilisation.

Doing so allows us to reframe the COVID-19 pandemic as a symptom of the continued 'overshoot' of planetary boundaries, and thus a direct manifestation of the shrinking of the 'safe operating space' for human civilisation. One of the clearest signals of this shrinking is the structural crisis the pandemic has generated in relation to the normal functioning of the global economy, which has been forced into a state of contraction no matter which strategy of response is undertaken (e.g. mitigation, suppression, herd immunity). The pandemic, thus, should be understood not as a single crisis, but as a convergence point occurring in the context of a continuum of crises over the last few decades associated with industrial civilisation's overshoot of planetary boundaries.

Deforestation and the risk of collapse

While deforestation was therefore not a direct trigger of the COVID-19 crisis, it remains a major risk-enhancer for future pandemics. Since the COVID-19 pandemic, a range of scientific studies have demonstrated the nature of this risk, underscoring the urgency of tackling deforestation as a principal mechanism to reduce the danger of another pandemic.

Deforestation is now widely recognised in the scientific literature as a symptom of planetary overshoot. This includes a direct role in driving up rates of carbon emissions contributing to global climate change (accounting for 15 percent of emissions), exacerbating local and regional climate volatility, and even more seriously, contributing to the near-term destabilisation of the stable resource relationships by which human societies are able to function. One recent study in particular warns of a 90 percent probability of industrial civilisation experiencing a collapse as a result of current rates of deforestation. Coupled with its role in heightening the risk of future pandemics, this data underscores the civilisational significance of developing a global strategy to defeat deforestation.

Culpability for deforestation: which commodity?

Yet this analysis demonstrates that the conventional Western approach to tackling deforestation, particularly adopted within the European Union, is deeply flawed. First and foremost, there is the question of culpability. A common narrative among Western environment movements tends to situate deforestation as the consequence principally of activities by developing nations in the Global South. But this simplistic narrative can serve to displace the assignment of responsibility onto developing nations without sufficiently acknowledging the central, driving role of Western and European nations.

It is important to note, then, that despite the EU's ostensible concern to tackle deforestation as expressed in recent legislation targeting palm oil, as well as ongoing discussions and draft proposals by policymakers in Brussels, Europe is itself a major driver of deforestation, both directly due to its own forest and agricultural practices, and indirectly due to its consumption of commodities linked to deforestation abroad.

Secondly, this analysis notes that the EU's singling out of palm oil as the locus-point of its anti-deforestation strategy is deeply questionable from a number of environmental, scientific, strategic and policy perspectives.

The number one biggest driver of deforestation in the world is beef production, which accounts for some 34 percent of carbon emissions linked to deforestation, produced largely in South America. In contrast, palm oil produced in the Asia-Pacific accounts for some 14 percent, less than half of this quantity. Yet about a third of the EU's beef imports come from illegally-deforested zones in South America. European Commission data also showed that between 1990 and 2008, soybean products imported from South America accounted for roughly 82 percent of deforestation attributed to the import of oil crops into the EU, compared to palm oil imports accounting for 17 percent of deforestation associated with EU oil crops. In this context, the focal-point of the EU's anti-deforestation policies on palm oil as opposed to commodities including beef and soy is fundamentally flawed.

The EU's specific policy prescription on palm oil has also been discredited by numerous scientific studies attempting to assess the efficacy of boycott approaches to single commodities. These have examined the potential and probable consequences of the policy option of banning palm oil, finding that the approach is liable to generate even

more devastating environmental consequences by driving greater rates of deforestation, largely by forcing consumer demand to switch to oilseed alternatives to palm oil which, however, use multiple times more land, water, fertiliser and energy. This would drive far greater rates of deforestation than palm oil. Therefore, the EU's entire policy prescription is ecologically dangerous. A different approach is required. Yet the nature of such a new potential framework to tackle deforestation can only be developed in the context of a wider analysis of systemic causes of the current crisis.

Industrial expansion and limits to growth

Focusing solely on deforestation as the key to addressing pandemic risks is a mistake given that deforestation appears simply as one frontline symptom among many others rooted in a range of processes of industrial expansion. Recognising that deforestation is fundamentally a symptom of deeper industrial processes rather than a primary driver in itself, and only one symptom among several others, underscores the need to widen the scope of our analysis toward examining the relationship between deforestation and the structures of industrial civilisation.

While the planetary boundaries framework offers a sound scientific basis to conceptualise industrial civilisation's increasingly deleterious relationship with its own planetary support systems in the natural environment, it contains an important lacuna with respect to energy systems.

The new scientific discourse on planetary boundaries of which deforestation can be understood as a key factor deforestation builds on a number of sophisticated mathematical models designed to examine industrial civilisation's relationship with the natural environment, which originated in the 'limits to growth' work originally conducted in the 1970s at MIT. Numerous studies following this work have corroborated and extended the findings of the MIT model, which identified a likely business-as-usual scenario consisting of the potential collapse of global civilisation from around the period 2030-2050 onwards.

The need for biophysical economics

A key component of this modelling work was industrial civilisation's resource requirements, including energy and mineral resources. Not only are the model's findings

consistent with the current scenario of escalating pandemics occurring as a symptom of planetary overshoot (the breaching of 'limits to growth'), but more recent modelling work confirms that one of the core locus-points of this overshoot occurs in relationship to hydrocarbon energy consumption and its relationship to a potential energy transition. This highlights a key gap in the planetary boundaries discourse, which tends to ignore the fundamental role of energy inputs in enabling the economic growth that underpins industrial societal functions.

The emerging discipline of biophysical economics helps us to fill this gap by drawing attention to the critical scientific measure of Energy Return On Investment (EROI), which compares the quantity of energy inputs to energy outputs for any resource. Studies tracking the EROI dynamics of fossil fuel resources demonstrate a consistent decline in their efficiency, with increasing quantities of energy required to extract an ever-decreasing amount of energy usable for societal functions. As this process has intensified due to the transition from conventional to unconventional fossil fuels since 2005, it has increased the energetic cost burden to our economies.

This dynamic is a pre-eminent driver of accelerating processes of industrial expansion. It compounds the endless growth imperative associated with unregulated forms of neoliberal capitalist social property relations, and led to a vicious cycle of accelerating fossil fuel consumption and production to attempt to sustain economic growth. While being a direct driver of carbon emissions responsible for a civilisational trajectory toward a dangerous climate, this fossil fuel-centred global economy is also integral to the dynamics of expanding industrial consumption and production that, in turn, driver the breaching of key planetary boundaries, including land-use change issues associated with deforestation.

Simultaneously, as the extraction and production costs of fossil fuel industries (especially the US shale sector which accounts for some 90 percent of production growth), have far outweighed profitability due to lower market price dynamics, the industry has been forced to borrow excessively. Massive quantitative easing (QE) programs have on the one hand helped to keep the market price of oil down, while also shoring up the increasingly uneconomical activities of the oil industry. Yet the very same programs have in this way created the conditions for the internal crisis in the economic fundamentals of the industry. Even before the onset of the pandemic, the most robust forecasts warned that

this predicament is ultimately unsustainable and bound to lead to both the implosion of the oil industry as well as to an economic crisis due to the industry's unrepayable debt, one that would undermine the integrity of the global economy. In other words, continued global dependence on fossil fuels, oil in particular, plays a central causal role in the breaching of planetary boundaries that began in the 1970s.

Biophysical roots of global oil sector crisis

The global oil crisis triggered by the COVID-19 pandemic, in the form of the unprecedented collapse in demand (as reflected in plummeting oil prices), was therefore part of a wider process, symptomatic of a sequence of escalating crises related to industrial civilisation's intensifying breach of planetary boundaries.

Understanding the crisis in this way provides new insights into immediate risks and longer term societal consequences. The shut-down of significant sections of the global oil industry due to the pandemic-triggered collapse in demand threatens to permanently decimate some shut-in oil reserves by up to 10 percent, implying that global oil production reached a peak in 2019 to which it is unlikely to be able to return even if demand returns. If this analysis is correct, then this reinforces the necessity for a holistic-systemic framework to understand the interconnected nature of what appear to us as separate crises. In other words, not only must the breaching of planetary boundaries, deforestation, climate change, the pandemic, and the global oil sector crisis be understood as manifestations of a single crisis, this wider ecological and biophysically-informed approach allows us to recognise how a crisis in each of these sectors will likely feedback across all of them – as identified by Thomas Homer-Dixon's 'synchronous failure' framework.

The mechanisms of collapse

As Homer-Dixon showed, it is precisely the synchronisation of these systemic failures which can overwhelm the overall system's capacity to mobilise an effective response, potentially resulting in a systemic collapse. There is a serious danger that this process can lead to a self-reinforcing amplifying feedback loop, in which episodes of Earth System disruptions (ESD) trigger the destabilisation of human systems (HSD). As that destabilisation process intensified, the capacity of human systems to address deeper causes of ESD or to respond effectively to ESD is reduced. This increases the vulnerability

of the human system to another episode of ESD. The sequence of events human civilisation has experienced over the last decades including three global financial crises, two global energy crises, major bouts of international civil unrest from Occupy to the Arab Spring to Black Lives Matter, along with the global pandemic and the continued escalation of climate change, all illustrate that civilisation is currently experiencing a self-reinforcing ESD-HSD cycle of global intersystemic crisis and breakdown.

However, while the ESD-HSD framework identifies global systemic vulnerabilities, it also highlights the scope for human agency in transforming human systems in order to minimize scope for Earth system disruption. The focal-point of action needs to be on strengthening human systems in order to mitigate and avoid Earth system disruption.

From mitigation to transformation: key policy recommendations

1. A holistic whole-systems approach is necessary to address the drivers of pandemic risk, including deforestation, by recognising their systemic interconnections.

This analysis demonstrates that several key sectors face immediate risks from the unfolding of the pandemic and its myriad intersystemic consequences, particularly, the global industrial food system, which is fundamentally dependent on oil inputs at every point; including the manufacturing of plastics, on which many industries are fundamentally dependent; transport networks which are of course currently heavily dependent on liquid fuels derived from hydrocarbon sources, principally oil. To mitigate and avoid these risks requires a sequence of deep-seated interlinked structural transformations. This must take the form of an intersystemic transition encompassing simultaneous transformation of the underlying energy system, the associated socio-economic system, and the twin paradigms of industrial extractivism and market consumerism with which the latter is indelibly linked.

2. Economic policy must shift away from market supremacism to the recognition of a need for intelligent management of markets by political stakeholders: a 'life-boat economy'

The pandemic has changed the world permanently, and is a signal that the human system has entered into a period of synchronous failure symptomatic of a wider decadal

process of breaching planetary boundaries. Traditional laissez faire market-based supply-demand dynamics and price mechanisms have proven incapable of preparing for and responding to these complex intersystemic economic consequences which often arise out of these very dynamics and mechanisms. They tend to decrease resilience, because they fail to recognise the shared global public goods that involve the most severe planetary boundary breaches, such as climate change, biodiversity loss and nutrient pollution.

This necessitates an end to the neoliberal model of economics theoretically requiring a minimisation of state-involvement in the economy, and vindicates the need for state actors and public authorities to play a coordinating role in markets. This does not mean the elimination of markets, but their recalibration to operate beyond traditional narrow concerns for shareholder profits, and instead focus on the protection and delivery of public goods.

We suggest that this be understood as a 'life boat economy', in which key actors in the system play the role of organising economic activities so that they are geared toward the wider benefit of society, through the production public goods and services rather than purely for the benefit of a few.

3. Unprecedented investments in the establishing of a new global renewable energy system are necessary to develop a new sustainable underpinning for global economic activity, but this will not be commensurate with sustaining the old model of 'endless growth'.

To avoid an escalation of the very causes behind the current crisis doubling-down on visions of a sustainable transition away from fossil fuels toward new, renewable energy systems. Such a transition needs to be integrated with emergency economic responses to the pandemic. The longer that the transition to a new sustainable industrial infrastructure is delayed, the bigger the impact of the global oil crisis on critical supply-chains across energy, food and manufacturing.

The integrated nature of the energy-economic transition is also critical. The shift away from fossil fuels entails a fundamental movement away from the traditional energetic source of industrial civilization's capacity for continuous economic growth over decades and centuries. Several studies demonstrate that while the transition to a renewable

energy system is essential due to the internal decline dynamics within the fossil fuel system, doing so does not free industrial civilization from biophysical constraints. Renewable energy has its own limitations, and cannot sustain an 'endless growth' economic paradigm due to a ceiling on EROI values which is far lower than what was achievable during the early twentieth century heyday of fossil fuel production.

This therefore requires confronting the possibility that continued GDP growth may no longer be possible in a post-pandemic context. Emerging biophysical evidence indicates that due to ESD-HSD dynamics, the global economy will inevitably experience a form of contraction. This underscores to a greater need for revised notions of prosperity beyond GDP that uphold 'well-being economies' within planetary boundaries, along with a much greater concern for the true costs of natural resource exploitation.

Stimulus packages will need to not just attempt to kickstart economic activity, but to facilitate longer-term re-designs of our economies from the ground up to enable rapid transitions to sustainable and resilient economic foundations. Such clean fiscal recovery packages can create greater resilience to looming threats like climate change, while also having the most potential in driving strong economic performance within planetary boundaries and biophysical constraints.

4. **The only viable way to tackle deforestation is by transforming production practices across all relevant commodities, rather than singling out any one in particular.**

The shift to a new economy requires a fundamental transformation in production and consumption habits to rollback patterns of activity that are bound up with processes of industrial expansion which can be traced directly to complicity in the biophysical processes driving the heightened risk of disease outbreaks.

Among the most urgent areas of transformation to reduce the risk of the next pandemic is deforestation. While commodities like palm oil have been rightly criticized for production techniques causing deforestation, in terms of practical policy, legislation and certification programmes, considerably less attention has been played to much the larger drivers of deforestation in the form of beef and soy. Such inconsistencies need to be urgently addressed and resolved. For instance, the European Union has

banned palm oil for biodiesel as part of an effort to tackle deforestation but has done little about its own consumption habits which encourage the unsustainable production of other commodities such as beef, which is implicated more than double the levels of deforestation. The EU's singling out of palm oil while giving a free-pass to other commodities is therefore misguided.

This suggests that the predominant strategy on deforestation favours Europe's domestic biofuels industries and oilseed producers while doing nothing to curtail imports of beef or soy which by far play the largest role in driving rates of tropical deforestation, principally in South America. Yet the EU strategy ignores the fact that a shift to alternative domestic sources of biofuels – such as soy and rapeseed – would still produce carbon emissions at a higher level than that of traditional fossil fuels.

5. Incentivisation structures, rather than bans, are required to accelerate the most effective forest protection approaches.

This is further complicated by the problem identified across a range of scientific studies that an outright ban on palm oil in particular – which is the EU's current policy on biofuels – would likely cause more harm to the environment by displacing global biodiversity losses instead of stopping them. Without reducing underlying sources of demand, demand would instead switch to alternative commodities which, however, use far more land and energy than palm oil, therefore potentially driving far greater rates of deforestation.

A boycott-only approach also tends to incentivise producers to find ways to circumvent the boycott, by accessing other markets (such as India and China), where environmental regulations are far less stringent. This once again undermines the entire point, and increases the risk of continued deforestation.

To stop the scourge of deforestation requires a much more joined-up approach focused on transforming production at source, which further requires scaling up successful policies through appropriate incentivisation structures. To understand what might be working, we must acknowledge the data from the 2020 State of the World's Forests report, which proves that the rate of global deforestation has been declining over the last few decades. From the 1990s to the period between 2010 and 2020, the net loss of

forest area decreased from 7.8 million hectares per year to 4.7 million hectares per year.

Part of the reason for this is that a number of tropical developing countries have recently been through a forest transition, a shifting from net deforestation to net reforestation, achieved through new land-use policies. However, in recent years this progress is in danger of coming undone. Data from the Global Forest Watch project shows that primary forest loss was 2.8 percent higher in 2019 than the previous year.

In direct contradiction to the EU's deforestation approach, we find that the country that lost the most primary forest in 2019 was Brazil. And while Brazilian deforestation has accelerated, there has been significant success in reducing the rate of forest loss in Malaysia. According to Global Forest Watch, domestic forest conservation policies and new sustainable cultivation practices for oil palm plantations have caused a decrease in the rate of primary forest loss in Malaysia year-on-year for the last 3-5 years. The absolute scale of deforestation in Malaysia is also far below the level of Indonesia's, which is a larger producer.

6. Voluntary sustainability programmes are inadequate. Enforceable, mandatory legislation within producer countries is necessary to help criminalise practices that lead to deforestation.

Malaysia's success in slowing the rate of deforestation in recent years builds on a longer-term process. Although its oil palm area continued to expand from 1973 to 2010, studies show that deforestation began to slow down from the mid-1980s, due to economic diversification as well as the potential impact of Malaysia's early pledge to protect the country's forest cover at the 1992 Rio Earth Summit.

However, most of the more recent progress has coincided with the implementation of a new national sustainable certification scheme, Malaysia Sustainable Palm Oil (MSPO) – the world's first government-backed, legally-enforceable sustainable certification programme for palm oil. Under the programme, the government would enforce a moratorium on palm oil expansion to protect forest cover at 50 percent, accompanied by enforced mandatory sustainability standards aimed at certifying 100 percent of Malaysia's palm oil production.

There is still insufficient scientific data available on MSPO. Despite this, preliminary indications from independent observers suggest that the scheme's "best of category" operations retain impressive sustainability credentials and labour rights policies. The main challenges are ensuring uptake among smallholder farmers; improving some of the technical standards; and ensuring robust local implementation which must be done in coordination across thirteen local states which have considerable autonomy on land-use policies amidst the federal government's commitment to 100 percent sustainability in the palm oil sector. These complex internal dynamics create political challenges in the implementation of federally-mandated sustainability policies.

7. Inclusive and cooperative partnerships between producer and consumer countries are critical to ensure that successful local approaches are rapidly supported and scaled.

In this context, it can be concluded that the EU approach to palm oil is a serious environmental error which has worked to eclipse and isolate important local efforts like MSPO. Instead of ignoring and alienating countries like Malaysia who have not only made a clear sustainability commitment but are also attempting to execute that commitment (imperfectly or otherwise), a more effective approach is to find ways to scale-up and support the MSPO model. This in turn could establish a framework for cooperative action that can be strengthened within Malaysia and applied to other production processes outside Malaysia in areas at risk of deforestation. The MSPO model could, for instance, provide a powerful test-case for a viable sustainable conservation approach that could be applied not only in other areas of Southeast Asia, but also in South America and elsewhere to address deforestation challenges facing other oilseeds and, of course, the biggest driver of deforestation in the world in the form of beef production. Closer independent scientific study, evaluation and monitoring of the MSPO approach, along with appropriate policy incentivisations and partnerships, will be needed to permit the model to be scaled up in regions at acute risk of biodiversity collapse.

8. The world requires a new cooperative global pact against deforestation that can empower developing nations rather than alienate them.

In this context, a major question for Western countries is how they can work with, rather than against, regional countries to support them in creating effective mechanisms to eliminate deforestation.

Recent discussions at the EU-level have moved increasingly toward this position, although this has yet to translate into concrete policy. The major opportunity is to develop a comprehensive and cooperative approach to the challenge of deforestation in which industrialised and developed economies of Europe and North America work more closely with producers in South America, Africa and Southeast Asia to develop joint monitoring mechanisms to ensure sustainable production.

Instead of an inconsistent ban on particular commodities, new regulations applied across all relevant commodities should be developed demanding that production practices adhere to government-backed, scientifically-mandated and jointly-enforced sustainability practices based on renewable energy, circular economy and forest conservation principles.

Developed nations should work urgently with producing countries to provide scientific expertise and financial support to ensure that local industries no longer operate in a way which forces animals and the viruses they carry out of their habitats and into new areas inhabited by humans. In the age of COVID-19, this is not a matter that any country can afford to simply leave to their own devices.

9. Trade deals should be re-oriented towards recalibrating markets so that they work in the public interest to protect the ecological foundations of markets.

Of course, creating such a global pact on deforestation will not happen automatically. One way of nurturing it into existence is to recalibrate existing trade agreements, or establish new ones, so that they prioritise mutually agreed ecological standards premised on forest protection and clean energy transition. This can underpin new cooperative agreements backed by legislative mandates directed to meet socio-ecological goals, rather than purely to facilitate profit-maximisation incentives.

The MSPO case provides a useful example of how this could be approached. Developed nations should be willing to open their markets to producers which meet environmental standards designed to prevent deforestation. This requires the existence of in-country transparent and enforceable conservation and deforestation standards, which are legally enforceable using national legal powers.

Incentivisation should of course coexist with the prospect of meaningful penalties. Just as there are opportunities for those who meet environmental standards, it is reasonable that there should be consequences for those who do not – loss of access to markets, and the suspension of the ability to supply commodities. But such standards should be flexible enough that they encourage compliance in order to obtain a renewal of trade relations rather than intransigence.

Such standards cannot simply be unilaterally imposed by developed nations, but have to be co-developed with producing countries as partners based on national mandatory mechanisms that are legally enforceable. They also need to be applied consistently not only toward one commodity, such as palm oil – which is the current EU approach – but to all relevant commodities in order to avoid the risk that commodity substitution would simply displace the drivers of deforestation.

This would also mean providing specific kinds of support to producer countries. In the case of Malaysia, for instance, the EU needs to do more to understand, engage with and support the country's struggle for sustainability, including consideration of: financial support for the MSPO programme allocated to local provinces required to implement them; further subsidies to smallholder farmers to cover sustainability transition costs; joint scientific mechanisms by which to advance and strengthen MSPO standards.

The ultimate goal of this approach would be the creation of a set of international and national institutional arrangements, policies and legislative instruments which can be used to effectively criminalise deforestation. Such a model could be scaled-up and applied to other regions, including Africa and South America for instance, where its implementation would, however, require a robust approach from the EU to ensure that countries like Brazil are both pressured and incentivised to fundamentally transform their unsustainable beef production practices.

10. Structural transformation is required within developed, consumer countries to create a new clean industrial paradigm that reduces the drivers of unsustainable consumption-led growth. New stimulus packages are required to kick-start productive investments in this new paradigm.

Tackling deforestation is among the critical 'frontlines' of the breaching of planetary boundaries, but it does not address the deeper drivers of this breach in the form of escalating industrial consumption. This requires deeper structural transformations spearheaded within developed nations, where demand is highest.

The required transformations need to centre around a shift to renewable energy and sustainable production systems in core industrial processes. The ultimate goal is to transition away from fossil fuels using new mechanisms which can function within planetary boundaries. This in turn means the accelerating transition away from oil must be accompanied by a comprehensive transformation of major industrial sectors to create a vibrant new sustainable infrastructure across agriculture, mobility and manufacturing. The orientation of these sectors will need to operate outside of traditional pre-pandemic economic concerns focused purely on profits for shareholders, and instead oriented toward social purpose.

To achieve this may require more extensive government partnerships with the private sector, whether through equity injections or in some cases nationalisation of key industries. In some cases, nationalisation may be the only viable solution – in others, governments may have to create incentives for the private sector to produce goods and services widely needed by society. In many cases, nationalisation of debilitated oil sectors may be the only way for governments to shield their economies as the industry winds down on a science-based timeline. At the same time, this is the occasion to protect, reskill and help transition industry workers into new sustainable and renewable infrastructure projects.

This suggests that fiscal recovery and stimulus packages should direct finances, lending and subsidies to new clean industrial and agroecological enterprises. Just as this should include tackling the core drivers of deforestation by working with producer countries to transform production practices at source, it should also include more broadly tackling industrial agriculture overall, which is responsible for over a quarter of greenhouse gas emissions. That means investing in the comprehensive redesign of global food systems

to transition rapidly to agroecological methods.

Within manufacturing and mining, this paradigm shift would require the implementation of new circular economy practices in plastics and mineral recycling to eliminate waste and ensure reuse, sharing and recycling of resources. In the context of an escalating global oil crisis, the plastics sector – which plays a huge role across multiple industries – is particularly vulnerable to disruption. Studies suggest that circular economy principles can be applied to address potential mineral supply bottlenecks in the ramp-up of renewable energy systems.

11. Monetary reform is required to generate debt-free financing capable of empowering governments to finance this great transition while stabilising the economy.

The remaining question of course is how such a vast programme of systemic transformation can be financed in a time of escalating global financial distress. The role of radical monetary reform can be instrumental here. Rather than borrowing money from the private banking sector and driving up vast levels of public debt, financing can be made available debt-free by public banks (a process that was tentatively begun in the UK by the Bank of England, and although not extended in a comprehensive fashion has retained the potential to do so in a way that would free the UK economy from unsustainable debt levels). In the context of huge deflationary pressures due to the drop in work, wages and jobs, this approach avoids inflation and helps stabilise demand and production, while creating a source of sustainable financing to fund the new infrastructure investments. The more fiscal recovery and stimulus packages can be oriented toward productive investment in the core structures of new sustainable industries, the more rapid would be the ensuing transition.

Conclusions & Recommendations

The COVID-19 pandemic constitutes a biophysical disruption between the Earth system and human systems representing an intensifying violation of planetary boundaries which has escalated over a period of decades since at latest the 1970s. One of the signature events of this process of civilisational decline was the 2008 financial crash, which was triggered by a confluence of energy and financial crises rooted in a fundamental geological transition into a new era of lower net energy, driving a shift to more expensive and dirtier forms of unconventional energy financed by massive debt-expansion through quantitative easing, which in turn has exacerbated fundamental structural vulnerabilities in both the global oil industry and the financial system. This in turn drove continued forms of industrial expansion which only continued to deepen the breach of planetary boundaries.

One of the 'frontlines' of this process has constituted continuing tropical deforestation. Despite long-term declines in the rate of global deforestation, the rate has remained particularly high in Southeast Asia. There has also been an uptick in the acceleration of the rate of deforestation over the last few years. This persistent trend in deforestation, representing the industrial intrusion into and destruction of natural habitats, has systematically increased the risks of human-animal interactions, and thus the risk of zoonotic disease outbreaks and, ultimately, the danger of a global pandemic. Simultaneous with the rising trend in deforestation has been increased human-animal interactions due to industrial expansion and associated practices of wildlife exploitation. Such practices eventually culminated in the 2020 COVID-19 pandemic. In this context, if current rates of deforestation continue, the risks of another potentially even worse pandemic will only increase. The 2008 crash and the 2020 pandemic thus comprise an accelerating sequence of events within a continuum of global intersystemic crisis, triggered by human systems 'overshooting' natural systems and breaching planetary boundaries in different ways.

By crashing economic demand, the COVID-19 pandemic has exposed the structural vulnerabilities in the global financial system rooted in the same biophysical processes of energetic decline. This is a system so addicted to endlessly increasing material throughput for its own sake that its suspension due to the pandemic has wrought massive instability across multiple, interconnected sub-systems. In order to mitigate

these instabilities, a reversion to business-as-usual 'normality' cannot work – it can only structurally reinforce the same systems which have breached planetary boundaries and triggered the pandemic. The pandemic has thus opened up not merely the opportunity but the paramount necessity of global intersystemic transformation through an integrated process of energetic, agroecological, financial, and manufacturing transition, facilitated by an associated paradigm shift in governance inspired by a complete reassessment of how prevailing human systems brought civilization to the current inflection point.

Transformative approaches on the 'frontline' of the crisis – deforestation – should be premised on a careful analysis of the available data, rather than a doubling down on previous failed policy approaches. The data suggests, for instance, that the preoccupation with palm oil as opposed to other commodities such as beef and soy is not merely deeply hypocritical, but also fundamentally dangerous given that beef production is the largest driver of deforestation-linked CO₂ emissions (particularly so when combined with soy, which is also used as animal feed for beef production).

This has resulted in a shift, especially within Europe, toward alternative biofuels to those produced via palm oil ostensibly on the grounds that these fuels are cleaner, although the evidence indicates that they are still problematic from a climate perspective. Simultaneously, the prevailing policy approach in the form of the EU's paradigmatic de facto boycott of palm oil for biofuels has received systematic scientific critique demonstrating that the approach is likely to escalate deforestation by switching demand to other commodities such as soy, rapeseed, sunflower and beyond – which use far more land, fertiliser, pesticides and water than palm oil.

This calls for a renewed approach designed to recalibrate global markets to focus on the production of ecological goods and services rather than profit-maximisation. This suggests that a more powerful framework for ending deforestation will consist of new institutional mechanisms of transnational cooperation designed to strengthen successful national efforts while generating a more targeted approach toward penalising intransigent producers.

A hub and spokes model has been suggested as a potential way to integrate nationally-mandated locally enforceable certification initiatives established in the context of transnational partnerships between national governments and external partners such

as the EU, UN or other agencies, bodies, nations or groups of nations. The recently instantiated Malaysia Sustainable Palm Oil (MSPO) standard, the world's first national legally-enforceable certification standard on sustainable palm oil, represents a compelling example of a 'spoke' in such a model, and could provide an avenue to trial this approach, considering that it already appears to have had significant success in dramatically slowing the rate of national deforestation consecutively over the last three years. This standard should be further strengthened through international scientific support as well as financial support at the 'hub' level from external partners like the EU, including for smallholder farmers, thus providing a new platform for international cooperation between a producing country and Western national governments. This model, in turn, could further be scaled up to tackle deforestation in other areas of Southeast Asia, Africa and South America.

However, tackling the 'frontline' of deforestation is only the beginning – the deeper task involves challenging the symptoms of much deeper drivers. To truly solve the crisis of deforestation and other related crises related to the systematic breaches of planetary boundaries requires transforming the fundamental structures of core industrial processes, in particular to spearhead a transition away from fossil fuels along with a shift away from 'endless growth' economics.

The failure to pursue this systemic transformation would lead to the continued escalation of the processes leading to another episode of Earth system disruption (ESD) – this could occur in the form of another disease outbreak or pandemic, a climate disaster, an energy crisis, a financial breakdown, an outbreak of civil unrest, geopolitical tensions, political collapse, or any other sub-systemic failure. Any such failure could in turn trigger a wider global level process of synchronous failure in human systems that would pave the way for further ESD leading to continued human system destabilization (HSD).

The pandemic is not only an integral symptom of an ongoing process of global systemic decline rooted in the current structure of industrial civilisation; it is an accelerant of that decline process. Yet it is also a potential opportunity to reframe and restructure the system from which this decline process has emerged. The envisaged end-result of such a reframing and restructuring is a truly 'ecological civilisation' which enables new sustainable forms of human flourishing within planetary boundaries. This is a form of social organisation which enables the conditions of life to thrive, rather than debilitates and degrades those conditions.

Key Policy Recommendations

1. A holistic whole-systems approach is necessary to address the drivers of pandemic risk, including deforestation, by recognising their systemic interconnections.
2. Economic policy must shift away from market supremacism to the recognition of a need for intelligent management of markets by political stakeholders: a 'life-boat economy'
3. Unprecedented investments in the establishing of a new global renewable energy system are necessary to develop a new sustainable underpinning for global economic activity, but this will not be commensurate with sustaining the old model of 'endless growth'.
4. The only viable way to tackle deforestation is by transforming production practices across all relevant commodities, rather than singling out any one in particular.
5. Incentivisation structures, rather than commodity boycotts, are required to accelerate the most effective forest protection approaches. Boycotts alone can escalate deforestation.
6. Voluntary sustainability programmes are inadequate. Enforceable, mandatory legislation within producer countries is necessary to help criminalise practices that lead to deforestation.
7. Inclusive and cooperative partnerships between producer and consumer countries are critical to ensure that successful local approaches are rapidly supported and scaled.
8. The world requires a new cooperative global pact against deforestation that can empower developing nations rather than alienate them.
9. Trade deals should be re-oriented towards recalibrating markets so that they work in the public interest to protect the ecological foundations of markets.
10. Structural transformation is required within developed, consumer countries to create a new clean industrial paradigm that reduces the drivers of unsustainable consumption-led growth. New stimulus packages are required to kick-start productive investments in this new paradigm.
11. Monetary reform is required to generate debt-free financing capable of empowering governments to finance this great transition while stabilising the economy.