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Pandemics, conservation, and human-nature relations

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Introduction

Recent reactions to the COVID-19 pandemic in the conservation community have centred on how proximity to wild animals and their consumption in local food circuits may give rise to the spread of infectious diseases, ultimately resulting in human transmission. This has unleashed an onrush of debate in scientific and related policy literature on nature conservation, human-nature relations, animal rights, and efforts to alleviate global poverty among forest-dependent peoples. This perspective article seeks to extract the key points from the ensuing debate and consider possible solutions.

One of the key features of this discussion is the consideration of “who is invading whom?” The constant human intervention into natural environments, the detrimental effects of tropical deforestation, overfishing of marine habitats, and humankind’s continuous assault on natural habitats and biodiversity, which forces animals into ever-smaller ecological niches, begs the question: Is the pandemic “Nature’s revenge”? We argue that the pandemic is the opposite: an opportunity to adapt and counteract human exceptionalism and disrupt dualisms so multispecies and a new type of politics (i.e. cosmopolitics) could emerge.

Figure 1 synthesizes the discussion undertaken in the remainder of the article, showing the need for integration and adaptation between practices that have led to the COVID-19 pandemic and those which rely on traditional practices and knowledge, and thus ensure that natural cycles are respected via relational and cosmological determinations.

Causes of pandemics throughout history and recent experience with SARS

The most serious pandemics in recorded history, dating back to the fifth Century BCE, originated in North Africa and Asia, becoming disastrous in their spread once they reached Europe and the Americas. The most notorious among these was the spread of bubonic ("black") plague in the 14th Century from Asia to Europe. Initially transmitted by rat fleas, the speed and severity of transmission resulted in the deaths of one quarter of the population of Europe. This origin appears to be related with the density of human and domesticated animal populations and their growing proximity to rapidly dwindling wilderness areas.² Encroachment on such areas by farmers, herders, and hunters in search of bushmeat exposed them and their domestic animals to zoonoses that facilitated the spread of infectious diseases. Emerging human infectious diseases are further characterized by novelty; for example, diseases that have undergone recent evolutionary change then enter the human population for the first time or are newly discovered. Furthermore, the number of outbreaks, like the number of emerging infectious diseases, appears to be increasing with time in the human population, both in total number and richness of causal vectors [2] (see Table 1).

For example, in 1998, the Nipah virus in Malaysia was transmitted by smog from Indonesian forest fires, combined with an El Niño drought event that had reached the country and forced fruit bats, the virus’s natural host, to seek food on mango farms. Nipah crossed over to pigs that also ate those mangos, probably in bat saliva or urine. From there, it made the leap to farmers, causing hundreds of deaths from rapid encephalitis, with a terrifying mortality rate of 40 per cent. Nipah was only brought under control by culling the pig population. The H1N1 influenza ("Swine flu"), which first hit in 2009, was also transmitted by pigs and killed as many as 575,000 worldwide. Another H1N1 flu struck in 2018, infecting as much as one-third of humanity. Although not classified as a pandemic, malaria is also a zoonotic disease, transmitted by the Anopheles mosquito; dengue and zika virus are transmitted by another mosquito – Aedes aegypti. Other infamous zoonoses originating either in wild or domestic species include rabies and hantavirus. AIDS/HIV mutated from a similar disease prevalent in chimpanzees when hunters came into proximity by killing them for bushmeat. Five species of the Ebola virus widely infect bat populations in Central Africa, from whence they were transmitted to humans, with a 50% mortality rate. Lyme disease is spread by ticks in wild animals such as deer (summarized from [3]).

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¹ The Athenian pandemic arose during the Peloponnesian war between Athens and Sparta in 430 BCE. See Annex for a brief history of zoonotic pandemics in the 20th Century.

² Wilderness areas are estimated to correspond to approximately 23.2% of global terrestrial area or 30.1 million km². Up to 10% of wilderness areas were lost in the two decades from 1996-2016, primarily in Latin America and Africa. See [1].

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Cross-species infection can originate on farms or in markets, where conditions are ideal for the mixing of pathogens, giving them opportunities to infect foreign hosts. According to data from the United States Center for Disease Control and Prevention (CDC), 11 deadly diseases have spread from animals to humans over the past century, accounting for 70% of all infectious diseases [3]. In the case of Severe Acute Respiratory Syndrome Coronavirus 2 (Sars-CoV-2), which emerged in humans as the novel coronavirus disease COVID-19, a wet market in Wuhan, China was deemed to be the immediate locus of transmission. It is not yet clear how Sars-CoV-2 made the leap and from what species (bats, pangolins, and snakes are all candidates, yet only snakes were found in the wet market of origin, suggesting multiple transmissions). Later research found that ferrets and cats are highly susceptible to Sars-CoV-2, while dogs have low susceptibility, and livestock including pigs, chickens, and ducks are not susceptible to the virus at all [4]. Sars-CoV-2 has a number of characteristics which make it difficult to identify and contain, including being highly contagious, causing asymptomatic infection, incubation delay, and neutralization of an immunological response [5]. The virus also mutates, resulting in what may be more highly infective forms of Sars-CoV-2. The ability of Sars-CoV-2 to mutate became evident with the early mutation known as the Spike D614G variant which rapidly replaced the original Wuhan form across the globe [6]. More recently, the Delta variant has become the predominant form of the virus with an 79% transmission advantage over the Alpha variant [6a].

**Bushmeat as a culprit or a benefit?**

The hunting and butchering of wildlife may be a cause of pathogens spilling over into human populations. Bushmeat harvesting is substantial in Africa due to sizeable demand. The per capita consumption of bushmeat in the Congo basin is estimated at quadruple that of the Amazon, constituting a serious threat to species survival [7]. A review of the literature on wildlife consumption for bushmeat or traditional medicine in Asia shows that it has now reached a proportion that is increasingly unsustainable [8]. As a delicacy or traditional medicine in urban areas, wildlife consumption is widely cited as a probable cause of zoonotic transmission as in the case of Sars-CoV-2.

Indigenous peoples may be less susceptible to pathogens that are associated with wildlife consumed in their proximity due to millennia of contact and consumption of wild hosts [9]. In frontier regions around the world, as settlers expanded their incursions into lands in which native fauna was new, their exposure to novel pathogens from animals they

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Table 1

| Name of pandemic       | Date/duration of outbreak              | Reservoir/transmittal; Vector                          | Mortality                  |
|------------------------|----------------------------------------|--------------------------------------------------------|---------------------------|
| Plague of Justinian    | 541-453 (12-13 yrs; intermittently for 2 centuries thereafter) | Fleas associated with wild rodents (Yersinia pestis) | ~100 million people      |
| Black Death            | 1347-1351 (recurring into the 17th century; re-emerged in 1885) | Fleas associated with wild rodents (Yersinia pestis) | ~25% of European population |
| Cholera                | 1817-1824 (recurring at approx. 3-yr intervals to 1866; re-emerged in 20th century) | Vibrio cholerae in fecal matter from animals suspended in contaminated water | Incalculable due to repeated waves, often in disaster areas |
| Russian Flu            | 1889-1893                              | Avian (?); A/H3N8 virus                                | ~1 million                |
| Spanish Flu            | 1918-19 (re-emergence in 1977)         | Avian; A/H1N1 virus                                   | 50 million                |
| Asian Flu              | 1957-59                                | Avian; A/H2N2 virus                                   | ~1 - 2 million           |
| Hong Kong Flu          | 1968-70                                | Avian; A/H3N2 virus                                   | ~0.5 – 2 million          |
| Severe acute respiratory syndrome (SARS) | 2002-2003                      | Bats, transmitted by palm civets; SARS-CoV            | 813                      |
| Swine flu              | 2009-2010                              | Pigs; A/H1N1                                          | ~148,000-259,000         |
| Middle East respiratory syndrome (MERS) | 2015-ongoing                          | Bats, transmitted to dromedary camels; MERS-CoV       | 866                      |
| COVID-19               | 2019-ongoing                           | Bats (?) transmitted to pangolins (?) SARS-CoV-2      | 4.1 million to date       |

* Adapted from data described in Piret, J. and Boivin, G. 2021. Pandemics Throughout History. Frontiers in Microbiology 11:631736.
sought for food increased. At the same time, settlers also brought novel pathogens with them, to which indigenous populations had not been exposed and were highly susceptible. Historically, such exposure has posed disastrous risks for indigenous groups, whose populations have been decimated by such pathogens since colonial times [10]. COVID-19 is currently spreading rapidly among numerous indigenous territories in the Brazilian Amazon prompting global outrage due to a lack of medical attention coupled with provocation and legislative proposals by the federal government, with the intention of opening these vulnerable areas to mineral and agricultural exploitation [11]. Such discriminatory access to medical treatment for COVID-19 is also disproportionately affecting native Americans such as the Navajo [12].

However, wildlife consumption is only one route that brought about increased exposure to such pathogens. A recent study of the drivers that have led to the spread of disease-causing pathogens from the Brazilian Amazon found the following direct and indirect pathways, among which significant dynamic interactions occur [13]: human migration, vector dynamics, roads and transportation, habitat loss and pathogen spillover, climate change and extreme weather events, flooding and water pollution, agriculture and land use, prostitution, hunting and bushmeat consumption, hydroelectric dam construction and irrigation systems, biodiversity loss, urbanization and de-urbanization, and mining. Similar studies modelling such interactions in South East Asia showed that the most prominent factors were land use change (31%), followed by agricultural industry changes (15%), international travel and commerce (13%), medical industry changes (11%), war and famine (7%) and climate and weather (6%). Bushmeat consumption was responsible for only 3% of such disease emergence [14].

Conservation and pandemics

Nevertheless, as one of the most prominent vectors of emerging disease caused by the transmission of pathogens from animals to humans, wildlife has often been the focus of proposals for policy adjustment to avert such outbreaks [15]. A wide-ranging ban on the consumption of wild meat has been proposed for public health purposes [16], and in order to increase the protection of threatened wildlife and natural resources.

Although viral pathogens are invasive species, they are an integral part of biodiversity. As Adams reminds us [17], coronaviruses that evolved in socio-ecological systems (a market in China, pig farms in Indonesia, etc.) are “a co-production of nature’s relentless capacity to innovate, and human choices in the form of consumption and trade” (Ibid). Nature is composed not only of charismatic or endangered species and carbon absorbing plants but also by pathogenic organisms whose drive for survival and reproduction often comes at the expense of their human hosts.

However, it is the human destruction of wildlife habitats and the harvesting of wildlife for bushmeat or trade that have primarily led to transmission of zoonotic pathogens [18]. Humans are thus creating conditions for the spread of diseases by reducing the natural barriers between host animals in which the virus is naturally circulating, and themselves. For example, bats, among the species most susceptible to becoming reservoir hosts for the transmission of emerging infectious pathogens, adapt by relocating to barns and other structures in proximity to humans [19]. Consequently, humans are ever more likely to be exposed to novel zoonoses.

Another concern is related to the inevitability of forest destruction, because peoples who have served as a bulwark against deforestation (as is the case with the Amazon Forest) will no longer be able to eke out a living from the protection and management of forest products, including hunting for wildlife [20]. Clearly, these forest protectors are not the only means of conserving the remaining rainforests, but indigenous and sustainable use reserves, when adequately demarcated and protected by their residents, are by far the least susceptible to deforestation in wilderness areas [21].

The urgency of practices to avoid further deforestation due to health risks

To what extent can it be argued that by avoiding the continuing destruction of intact ecosystems, we are safeguarding against the release of increasingly virulent pathogens from their natural microbial hiding places? In other words, are the arguments for extending the sanctity of protected areas, such as the minimum terrestrial and oceanic protection requirements of the Aichi Biodiversity Targets to the Convention on Biological Diversity (CBD), strengthened by the fact that they result in the distancing of dangerous microorganisms from human populations? Of course, such protection against the risk of infection is not the only benefit to humanity that is established by the conservation of biodiversity. There is a wide array of arguments to this effect in the literature on ecosystem conservation and human wellbeing [22–25]. At the root of recent advances lies an increasing regard for intrinsic, symbolic, and relational valuation of the interdependency between human and other-than-human beings [26].

While China has imposed a temporary ban on wildlife marketing after recent pandemic scares, conservationists have lent support to a blanket ban on wild meat trade worldwide and, in more extreme cases, have called for a “permanent move to end the keeping, breeding, domestication and utilization of wildlife” [27], a suggestion that has stemmed from the case of where such species were exposed in wet markets COVID-19 [28]. This would complement the existing prohibition of trade in endangered species (the Convention on International Trade in Endangered Species-CITES and related instruments). However, bans on wild meat consumption and markets are not likely to provide a solution, as prohibitions normally force traders to work illegally, thereby paying less attention to hygiene. The most significant dangers that threaten the release of dangerous pathogens, though, do not appear to be derived from the existence of “wet markets”. Rather, the pressures which drive the continuing conversion of wilderness to cropland, plantations, and pasture have been more prominent causal vectors for such releases [9].

Change must come both from rich and poor societies. Demand for wood, minerals, and other natural resources from the global north has led to the degraded landscapes and ecological disruption that drive diseases. Meanwhile, the global south is racing toward parity with northern consumption patterns, with similar consequences on the horizon. Peoples both in the northern and southern hemispheres are seeking dominance over nature in their push to satisfy needs and wants, and to accumulate goods and wealth.

Rights of forest peoples and wildlife

Traditional and informal markets are essential sources of food for hundreds of millions of poor people. What are the benefits of safeguarding forest tenure and rights of usage for those millions of people who rely on wildlife for a considerable share of their required protein and micronutrients [29]? These questions have their roots in contesting the right to food, which is an ethical issue rather than a monetary calculus. There is no doubt that the public health risk of exposure to fur-

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[3] For example, open letter to Brazilian President Bolsonaro by photojournalist Sebastião Salgado and fellow celebrities warning the pandemic meant indigenous communities in the Amazon faced “an extreme threat to their very survival”. See: Artists United for Amazonia: Protecting the Protectors.
their pandemics outweighs the local benefits derived by those who use forests to grow soybeans or plant pastures for cattle. Therefore, protecting the benefits derived from intact ecosystems and low impact wildlife exploitation, as demonstrated by forest dwelling and dependent peoples, will help us avert exposure to willier pathogens.

This issue is related to the debate in conservation circles regarding the relative effectiveness of policies that are land sparing versus those that are land sharing. There is growing evidence that areas which are considered “pristine” in terms of natural value were in fact sustainably managed by local inhabitants for several millennia. Current positions regarding protected areas tend to respect local knowledge and management roles within a framework involving both use rights and responsibilities. The right to food should also consider rights to market surplus, but when that surplus is derived from endangered wildlife species, human responsibilities should include habitat protection to guard against both incursion and pathogenic exposure. Encouraging the domestication of wild species and game ranching have had mixed results [30], but these represent additional means of avoiding overharvesting and resulting extinction.

Further discussion on the assumptions that drive such proposals from a rights perspective have been advanced, considering forest dependency and the right to food while embracing a landscape perspective in terms of the need for conservation of ecological diversity with adequate food security and nutrition [31]. However, such a solution demands that we first renew our relationship with nature, recognizing interdependence and finding ways to guard against the overwhelming pressures of human spread, while we adapt to nature’s response in the guise of the COVID-19 pandemic.

Nature’s revenge?

COVID-19 does not provide an answer in and of itself, as to what the right policy response should be. However, today’s ecological, social, and political changes enable us to reflect on some key assumptions and guiding principles of human-nature relations. Considering the unprecedented environmental change initiated and perpetuated by humans, we are confronted by two main problems: the way humans think about the rest of nature, and the way we have repressed the natural elements within ourselves. This internal and external distancing has led some societies to believe that they are separated from the rest of nature [32].

As becomes even clearer in times of crises, politicians are typically not thinking of the impact their policies will have, generations from now. The decision-making process is unfortunately commandeered and obfuscated by a short-sighted election cycle. Prevention – the ability to tackle a problem before it becomes acute – has never been a political strength. Politicians usually wait until there is no alternative, then adapt. This implies that most will end up behind the inflection point of a disease like COVID-19, though some have shown greater responsibility than others at moving beyond it. Female-led nations in particular are coping better with the demands of COVID-19 [33], suggesting that ecofeminists are right in their arguments in favour of a politics of care [34].

This “invisible enemy” of our current times leaves its victims gasping for air, but aren’t we already having trouble breathing? Coronavirus leaves us feverish, but aren’t we also running the risk of an overheated planet? To avoid its spread, the virus has forced us to stay in our private homes, raising our awareness of how important it is to preserve the health of our common, public home –planet Earth. Earth is a living system, an immense organism, still developing, regulating itself, producing its own oxygen, maintaining its own temperature, and keeping all its infinite living parts connected and interdependent, including humans. But because we see ourselves as separated from the rest of nature and we have not yet overcome the coronavirus pandemic, we see it as an enemy.

Looking at it from another perspective, the following question could be asked: What is ‘corona’ doing to us? COVID-19 is explicitly showing humanity that other-than-human beings have power, over and apart from ourselves. This challenges the idea of humanity as being endowed with a “super agency” with special capacities and rights and urges us to consider the complex connections and interrelations between humans and the rest of nature, and the unintended, unpredictable, and uncontrollable effects arising from anthropogenic interference in nature’s fundamental processes [35]. We should be able to counteract human exceptionalism and disrupt dualisms to allow multiscopic. What coronavirus is doing is making us aware of the idea that any being – human or non-human, sentient or non-sentient, biophysical or physical, macro or nano – can be truly distinct and powerful.

So, what can we do about all this?

Water, soil, and plants make up the ecosystems that support animal life on Earth. The Earth’s forests host a web of life in which there are intimate and essential relations between plants and other plants, between plants and animals, and among different parts of the whole. Any disturbance in such relations should be undertaken thoughtfully, with an awareness that what we do may have consequences that are remote, both in time and place. Yet, the rampant deforestation and associated human activity that is already underway in remote settings all over the planet demonstrate no such humility.

Different cultures in the Amazon provide us with examples that could inspire and enable a future which is rooted in a respectful and intuitive relationship with the natural world. Amazonian cosmologies provide practical insights into a politics and ethics for the future, in the sense that such standpoints include the animist assumption that ‘other beings besides humans, notably animal species, are provided with intentional-ity and conscience, and in this sense are persons, i.e., in terms of social relations’ [36]. We risk, however, losing the chance to learn from traditional practices as, at a greater rate than ever, different indigenous peoples and elders are dying [37, 38]. With these deaths, ancient knowledge of land use and animal and plant intelligence, which could help modern societies build the necessary solutions to avoid species extinctions, including our own, is irrevocably lost.

The current health, economic, and environmental crisis in which humanity is immersed demands an urgent and comprehensive rethinking of our relationships. Grounded in the discussion in this perspective article is the need to strive for a new relational (cosmo)politics in which humans and other-than-human beings are no longer seen as being in opposition, but as interdependent [39]. By co-evolving, rather than dominating and destroying, we may be able to uncover and nourish a collective instinct for the necessary preservation to keep both humans and other species alive.

Now is the time to create these new forms of relationships. Different societies need to understand that the dogma of growth has brought us to this moment [40] and that any future depends on halting the depletion of what we call natural resources, and what indigenous people call mother, father, or brother. Will we continue to be the real, self-defeating virus, capable of exterminating our own species by destroying the planet-body that hosts us? Or will we reinvent ourselves in another image, one of a species that is conscious of sharing Earth with other beings?

The coronavirus pandemic has demonstrated that we can make radical changes in record time. The virus and its vectors of transmission, also inhabitants of this planet, have reminded us of something that we had forgotten: that others exist. We are certainly maturing as a species, and this is not a consequence of revenge or punishment. It is a window of opportunity. After all, what we are facing now is just a small taste of what the climate crisis will bring. But if we are awake to the change that the pandemic has brought on a political and personal level, we may be able to establish a cleaner, healthier, more noble future.
Planning and preparedness for future pandemics

In summary, the lessons learned from this journey into the heart of human-nature relations in the face of a pandemic show that we must find solutions to resolve conflicts while assuring the safety of the ecosystem and of human health. These potential solutions indicate areas of future research as the following questions suggest:

1) What are the underlying hindrances to humans acknowledging they are a part of nature and the two are interdependent?
2) What are the motivations needed for humans to respect the intrinsic and relational values regarding conservation and the use of natural resources?
3) What are the conditions needed to assure rights of access and usufruct of wild species under sustainable harvest for food security?
4) What are the policy and practices to avoid the incursion of human settlements and resource extracting activities into wildernesses, and the consumption of wildlife in urban areas?
5) How do we change the perception of forests as only being sources of commodities?
6) What are the changes needed to create less socially and environmentally damaging pathways for the use of forest resources?
7) What mechanisms are needed to integrate indigenous knowledge with other knowledge systems?
8) What educational measurements and adaptations should be prepared to help the population at large and policy makers to recognize the inevitability of future pandemics?

To adopt such strategies implies the need for societies to prepare and adapt, to plan for further pandemics that are surely imminent as the dramatic effects of global climate change unfold. Preparedness requires that not only new forms of governance are in place but that adaptation of practices exist to allow the overcoming of current contradictions that accelerate destruction and that place human species at ever greater risk of exposure to novel organisms. Such preparedness is consistent with global commitments to both conserve vital biodiversity and to ensure the maintenance of carbon stocks in nature as a means of mitigating the impacts of climate change [41] and ensuring greater resilience within planetary boundaries [42]. But are we able to implement such commitments in practice? Last, but not least, we need to truly recognize that Indigenous peoples have highly advanced scientific knowledge. Their science is based upon thousands of years of observations of natural cycles, of other-than-human beings; and of the immense variation and diversity of nature. Why can’t these thousands of years of knowledge of natural systems become the Hegemonic science?

References

[1] Watson, et al., Catastrophic Declines in Wilderness Areas Undermine Global Environment Targets, Current Biology 26 (2016) 1–6.
[2] K.F. Smith, et al., Global rise in human infectious disease outbreaks, J. R. Soc. Interface 11 (101) (2014) 20140950.
[3] Centers for Disease Control and Prevention (CDC), 2020, Past pandemics.
[4] J. Shi, et al., Susceptibility of ferrets, cats, dogs, and other domesticated animals to SARS-coronavirus 2, Science 29 (6494) (2020) 1016–1020.368.
[5] J. Zheng, SARS-CoV-2: An emerging coronavirus that causes a global threat, Int J Biol Sci 16 (10) (2020) 1678–1685.
[6] R. Korb, et al., 2020, Spike mutation pipeline reveals the emergence of a more transmissible form of SARS-CoV-2. [6a] Altzin, S., Haim-Boukoba, S., Foulonne, V., Verdurme, L., Trombert-Paolantoni, S., Lecorche, E., Roquebert, B., Sofonova, M.T., 2021, Rapid spread of the SARS-CoV-2 delta variant in some French regions, Euro-Surveillance 26(28): 2100573.
[7] R. Nasi, et al., Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins, International Forestry Review 13 (3) (2011) 355–368.
[8] T.M. Lee, A. Sigouin, M. Pinedo-Vasquez, and R. Nasi, 2014, The harvest of wildlife for bushmeat and traditional medicine in East, South and Southeast Asia: Current knowledge base, challenges, opportunities and areas for future research, Occasional Paper 115, Bogor, Indonesia: CIFOR.
[9] C. Devaux, et al., Infectious Disease Risk Across the Growing Human-Non-Human Primate Interface: A Review of the Evidence, Public Health, Front, 2019.
[10] A.W. Crosby, The Columbian Exchange: Biological and Cultural Consequences of 1492, Praeger, 2003.
[11] NY Times, 19 April 2019, As Bolsonaro keeps Amazon vows, Brazil’s Indigenous fear ‘ethnocide’.
[12] https://www.outsideonline.com/2013593/navajo-nation-coronavirus-spread-water-rights.
[13] J.H. Ellwanger, et al., Beyond diversity loss and climate change: Impacts of Amazon deforestation on infectious diseases and public health, An Acad Bras Cienc 92 (2020) e20191375.
[14] EcoHealth Alliance: Emerging disease and economics of altered landscapes – IDEAL, EcoHealth Alliance, New York, 2019.
[15] R. Nasi, J. Fa, COVID-19-led ban on wild meat could take protein off the table for millions of forest dwellers, CIFOR Forests News, 2020.
[16] N. Yang, et al., Permanently ban wildlife consumption, Science 367 (6485) (2014) 1434.
[17] B. Adams, 2020, COVID-19 and conservation. Thinking like a human (blog).
[18] N.D. Wolfe, P. Danzak, M. Kilpatrick, D.S. Burke, Bushmeat Hunting, Deforestation, and Prediction of Zoonotic Disease Emergence, Emerging Infectious Diseases 11 (12) (2005).
[19] Scientific American, 18 March 2020, Destroyed Habitat Creates the Perfect Conditions for Coronavirus to Emerge.
[20] Mongabay, 27 April 2020, Floresta em colapso: como o coronavírus pode acelerar o desmatamento na Amazônia.
[21] V. Tauli-Corpus, J. Alcorn, and A. Molnar, 2018, Cornered by Protected Areas: Replacing ‘Fortress’ Conservation with Rights-based Approaches Helps Bring Justice for Indigenous Peoples and Local Communities, Reduces Conflict, and Enables Cost-effective Conservation and Climate Action, Rights and Resources Initiative.
[22] Millennium Ecosystem Assessment (MEA):Ecosystems and human well-being: policy responses; findings of the Responses Working Group of the Millennium Ecosystem Assessment, Island Press, Washington, D.C., 2005.
[23] The Economics of Ecosystems and Biodiversity (TEEB):Scientific and economic foundations, Oxford University Press, Oxford, 2010 P. Kumar et al. (eds.).
[24] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES):Global assessment report, IPBES secretariat, Bonn, Germany, 2019 E. Bron-dizio et al., (eds).
[25] P. Dasgupta, 2020, The Dasgupta Review – Independent Review on the Economics of Biodiversity Interim Report. UK Government.
[26] U. Pascual, et al., Valuing nature’s contributions to people: the IPBES approach, Current Opinion in Environmental Sustainability 26 (2015) 7–16 2017.
[27] https://www.bbc.com/news/science-environment-51310786
[28] The Conversation, 8 April 2020, Coronavirus: why a blanket ban on wildlife trade would not be the right response.
[29] HLPESustainable forestry for food security and nutrition. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, HLPE, Rome, 2017.
[30] Y. Nitsan-Baida, Wildlife and food security in Africa, FAO, Rome, 1997.
[31] T. Sunderland, W. Vasquez, Forest Conservation, Rights, and Diets: Untangling the issues, Front For Glob Change 3 (29) (2020).
[32] T. Adorno, Negative Dialectics, Routledge, London, 1990.
[33] NY Times, 15 May 2020, Why are women-led nations doing better with Covid-19?
[34] M. Puig De la Bellacasa, Matters of care in technoscience: Assembling neglected things, Social Studies of Science 41 (1) (2011) 85–106.
[35] A. Burke, S. Fishel, Power, World Politics, and Thing-Systems in the Anthropocene, in: F. Biermann, E. Lövbrand (Eds.), Anthropocene Encounters: New Directions in Green Political Thinking, Cambridge University Press, Cambridge, 2019, pp. 169–242.
[36] E. Viveiros de Castro, Xamanismo Transversal: Lévi-Strauss e a Cosmopolítica Amazônica, in: R.C. Queiroz, R.F. Nobre (Eds.), Lévi-Strauss: Leituras Brasileiras, UFMG, Belo Horizonte, 2008, pp. 79–124.
[37] BBC, 25 April 2019, Brazil’s indigenous people: ‘We fight for the right to exist’.
[38] The New Humanitarian, 11 May 2020, As COVID-19 takes off in Latin America, Amazon indigenous groups fear the worst.
[39] M.F. Gebara, Thinking beyond human-nature dichotomy: on the cosmopolitics of the Amazon, in: A.A.R. Ioris, R. Ioris, S. Shubin (Eds.), Frontiers of Development in the Amazon: Riches, Risks and Resistance, Lexington Books, 2020.
[40] El comercio, 07 June 2020, Un contrato social sostenible.
[41] H.O. Pörtner, R.J. Scholes, J. Agard, … S. Hashimoto, S. Lavorel, N. Wu, H.T. Ngo, et al., 2021, IPBES-IPCC co-sponsored workshop report on biodiversity and climate change; IPBES and IPCC.
[42] W. Steffen, K. Richardson, J. Rockström, V. Ramanathan, B. Reyers, … S. Sörlin, et al., Planetary boundaries: Guiding human development on a changing planet, Science, Vol. 347 (6223) (2015) 1259855.