Human Health depends on Nature's Health

POSITION PAPER

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How Effective Biodiversity Conservation can Help Prevent Future Pandemics

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1. COVID-19: The wake-up call

The COVID-19 pandemic has disrupted life in Europe and the whole world in a way unseen for decades: to date, the disease has resulted in more than five million deaths, millions have been hospitalised, and hundreds of millions of people have been infected. Despite more than 10 billion vaccination shots being administered (Bloomberg L.P. 2022), the numbers of infections keep increasing and new virus variants keep on being discovered (John Hopkins Coronavirus Resource Center 2022).

The economic costs of the pandemic, including health care costs, the economic downturn ensuing the lockdown — with costs incurred and the revenue foregone — is counted in trillions (Jackson *et al.* 2021). Several lockdowns, voluntary social distancing, and associated disruptions in supply chains and lower demand led to a record collapse in economic activity. The pandemic has caused major damage to the European economy, too. The global output contracted by an impressive 3.5 % in 2020 — a setback matched only by the Depression and the two world wars — and although the recovery will probably bring most of the world back to pre-pandemic levels, in many OECD countries living standards will not be back to the previous level by the end of 2022. In addition to exceedingly high costs to economies, pandemics also have wide-ranging long-term consequences to people's health and productivity, not only directly but also by diverting resources from non-emergency health care and other public goods and services.

Disruptions in societal life and social services, like education and elderly care together with the psychological impact and disruptions in family life, have left their mark on every person's life. Unemployment, both short term and long-term, hit all major economies, with hundreds of millions of jobs lost. Close to half the world's students are still affected by partial or full school closures, and over 100 million additional children will fall below the minimum proficiency level in reading as a result of the health crisis (UNESCO 2022). While the disruptions caused by uncertainties of employment and school closures affect people across communities, their impact is more severe for disadvantaged families and children: interrupted learning, compromised nutrition, childcare problems, and an outstanding burden on the mental health of families. It is estimated that the crisis pushed additional 97 million people into poverty in 2020 (Mahler *et al.* 2021) with the impact being felt in every region of the world (CCSA 2020).

2. Diseases and nature-human interactions

The SARS-CoV-2 virus is a type of coronavirus, the seventh coronavirus type known to infect humans. While not conclusive, the most widespread hypothesis explaining the origins of the virus is that SARS-CoV-2 has naturally arisen, most likely from a bat, and was transmitted via a mammal to humans (Andersen *et al.* 2020). This *intermediate host* (also referred to as *vector species*) that transmitted the virus to humans could not have been identified to this day. Nevertheless, most reports agree that SARS-CoV-2 is almost certainly a virus of *zoonotic* origin (WHO 2021).

Zoonosis refers to an infectious disease caused by a *pathogen* (i.e., an infectious agent, including bacteria, viruses, parasites, etc) that has jumped from animals to humans. Zoonoses have different modes of transmission that can include direct and indirect contact, as well as vector-borne, foodborne, or waterborne transmission (CDC 2021). Animal pathogens can infect humans directly through contact with wild animals as natural carriers of these pathogens, or they may indirectly infect humans through an intermediate host, or vector, such as livestock, domestic or peri-domestic — such as rabbits, mice, or rats — animals that live in proximity of humans. Pathogens often mutate genetically in intermediate hosts, becoming apt to infect humans.

There are many factors involved in the emergence of new infectious diseases or the re-emergence of once disappeared infectious diseases. Some of them result from natural processes such as the evolution of pathogens over time, but many are a result of human behaviour and practices. The intensifying use of natural resources, the increasing intrusions into key, biodiverse natural areas, the perturbation of ecosystems and the human-induced changes of our environment have dramatically changed nature-human interactions on the microbial level. When an animal pathogen is transmitted to a human and overcomes its immune system is called the ***spillover.***

While humans have traded diseases with wildlife for as long as people have domesticated animals, in the past decades **we have experienced a surge in new zoonotic diseases and many of humanity's currently existing diseases are of zoonotic origin.** The emergence of new diseases has risen significantly since the 1940s: 60 % of new infectious diseases originate from animals; the majority of these, 71.8 %, originate in wildlife (Jones *et al.* 2008). This has led to a four-fold increase in the frequency of zoonotic disease outbreaks caused by spillover in the past decades. Besides COVID-19, diseases of zoonotic origin causing large epidemics in the past decades are the severe acute respiratory syndrome (SARS), the Middle East respiratory syndrome (MERS), the Ebola virus disease (EVD), the swine flu (H1N1) and HIV/AIDS — all of which have emerged from wildlife (Jones *et al.* 2008).

This trend is not separate from the destruction of healthy ecosystems around the globe. Besides clean air, water, food, medicines and climate mitigation, robust and healthy ecosystems provide another important ecosystem service to humans: disease control. Healthy ecosystems, like forests, create 'shields' for humans by limiting interactions between major population groups and wild host species (Muehlenmbein 2013). This way, pathogens remain within the natural world and circulate without transmission to domesticated animals or spilling over to humans. Areas with higher diversity of pathogen-host species reduce the probability that pathogens are transmitted to vector species, as well as the encounter rate between hosts and vectors (Muehlenmbein 2013).

Biodiversity loss due to global climate change, deforestation, the introduction and spread of invasive species, overexploitation, and other disturbances decrease this important buffer, increasing the likelihood of pathogen transmission between species (Maillard and Gonzalez 20006). Severely reduced biodiversity leads to inbreeding and a decreased genetic diversity in remaining wildlife populations that may also facilitate further outbreaks due to impaired immune functions in host animals (Pongsiri *et al.* 2009).

For instance, researchers have found that the prevalence of the hantavirus increases when mammal diversity decreases (Young *et al.* 2014); that the rise of West Nile virus is correlated with decreases in non-passerine bird richness (Ezenwa *et al.* 2006); and that habitat fragmentation increases the risk of Lyme disease (Allan *et al.* 2003).

While ecosystems with a very high level of biodiversity, like tropical forests, may host a larger pool of pathogens with the potential to infect humans (which partially explains why viruses so often emerge from the tropical region), it would be a grave mistake to view all wildlife as a source of human infections.

The diversity of pathogens and their ability to infect humans differ between different animal taxa; but the increased host diversity also reduced the probability of pathogen transmission to vectors, as well as the encounter rate between vectors and hosts.

This disease ecology dynamic is described through the above-mentioned example of Lyme disease in **Box 1.**

Box 1: How biodiversity can create buffers for diseases – The dilution effect

Lyme disease is a common vector-borne disease that occurs regularly in Northern Hemisphere temperate regions. Lyme disease is linked to bacteria that are transmitted to humans through the bite of infected black-legged ticks, the intermediate (vector) species.

In ecosystems where Lyme disease is prevalent, it has been observed that there are several host species that are reservoirs of this pathogen. However, not all hosts are equally apt to support their optimal growth and transmission — in the literature, this is referred to as *host species competence*. The more likely a certain host is to pass on the infection to ticks, the more *competent* the host species is.

It is the ubiquitous white-footed mouse that is the most able to harbour and pass on Lyme disease. In the north-eastern United States, it has been observed that species-poor areas are characterised as having more white-footed mice and, thus, increased incidence of the Lyme bacteria, while the most common non-mouse hosts are relatively poor reservoirs for the Lyme bacterium — they feed, but rarely infect ticks. Squirrels, for instance, and other less competent hosts can protect areas from Lyme disease spillover by "diluting" it and reducing the incidence of transmission to ticks.

When habitats are degraded by fragmentation or other anthropogenic forces, some host species disappear. Species-poor communities tend to have mice, but few other hosts, whereas species-rich communities have mice, plus many other potential hosts. Predatory vertebrates, who prey on rodents carrying the bacterium, help protect humans from Lyme disease (and many other infections) by keeping their abundance at bay (LoGiudice *et al.* 2003).

This **"dilution effect"** is one way in which ecosystems can create buffers and shields for disease transmission, highlighting the crucial importance of biodiversity, however, other aspects of community composition also affect these complex and dynamic relationships.

This phenomenon has long been made use of and the purposeful use of wildlife and livestock to protect against zoonotic infection has been utilised for a long time in areas with increased host diversity. Maintaining favoured hosts in an environment places a barrier against vector-borne infections. The method is called "**zooprophylaxis**" and serves to guard humans against several infections. It has been used with success against malaria — by diverting the blood-seeking malaria vectors from human hosts — as well as against encephalitis.

Given that the number of new infectious diseases has quadrupled in the last 60 years and that more than 60 % of described human infectious diseases are zoonotic, including many of humanity's most pervasive diseases, the relationship between biodiversity loss, disturbance of natural habitats and infectious disease are going to have enormous impacts on human well-being in the coming period.

Experts of disease ecology have long been ringing the alarm bells that **the destruction of ecosystems and the sharp increase in new diseases of zoonotic origin is not mere coincidence but are causally linked.** While the emergence, virulence and ensuing impact of COVID-19 have taken the world by surprise and reached us unprepared, epidemiologists, ecologists and other experts of human and ecological health have been warning about the probability of new infectious disease emergence resulting in a global pandemic (WHO and SCBD 2015). They have long been alerting the public to the increasing risks of new infectious diseases and their potential effects on global health (IPBES 2019).

3. The drivers of zoonotic disease emergence today

The risk of zoonotic disease emergence and epidemics of regional or global scope is driven by several interlinking phenomena. The ongoing population, ecological, and behavioural changes increase the contact with wildlife and exacerbate the emergence of pathogens. Land-use change, unsustainable food systems, poorly regulated wildlife trade and climate change are some of the factors driving disease emergence today.

3.1. Destruction of habitat and loss of biodiversity

Land-use change has been identified as the leading driver of recently emerging infectious diseases in humans (Figure 1). Research has shown that infectious disease outbreaks are largely driven by land-use change, including agricultural encroachment, deforestation, road construction, dam building, irrigation, wetland modification, mining, the concentration or expansion of urban environments, coastal zone degradation, and other activities (Patz *et al.* 2014).

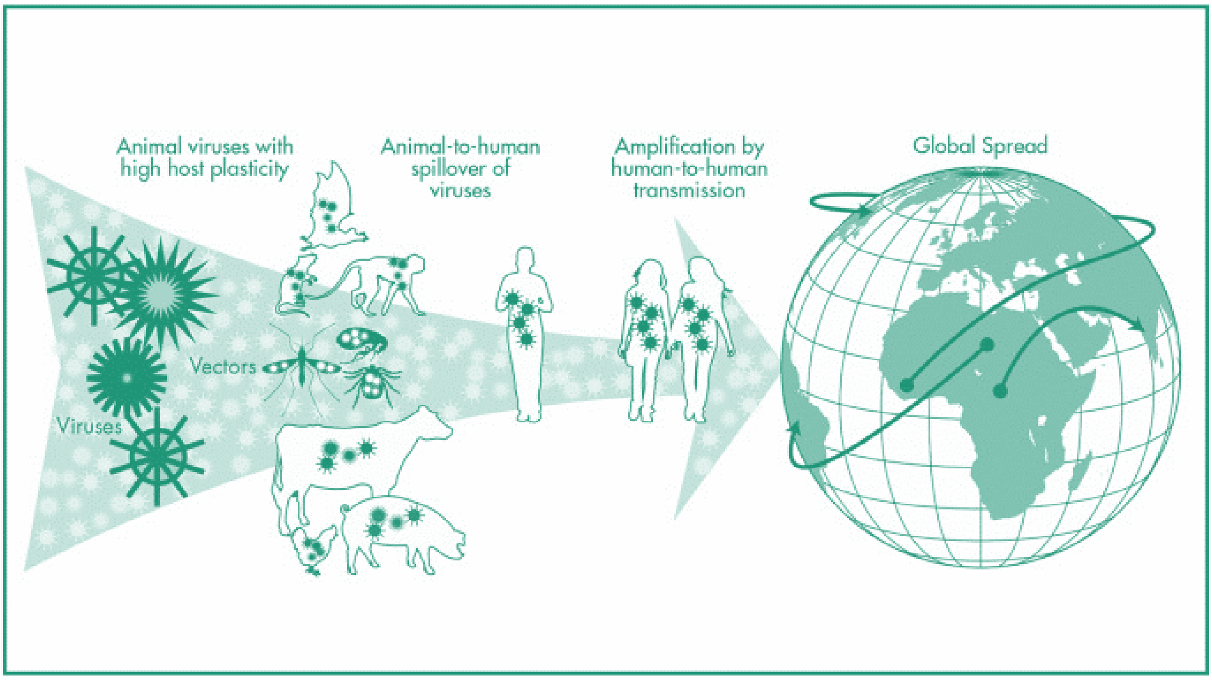

Figure 1. Pandemics of zoonotic viruses that spill over from animals to humans and spread by secondary transmission among humans. Source: Kreuder *et al.* 2015.

Widespread land conversion and habitat fragmentation have severe consequences for ecosystem overall health. Land-use change has the potential to impact disease dynamics by directly and indirectly changing the behaviour, distribution, abundance and contact between species harbouring viruses and vector species. For instance, human encroachment into forests may increase the number and density of host species in forest fragments. Extensive land conversion, deforestation and habitat fragmentation also tend to increase

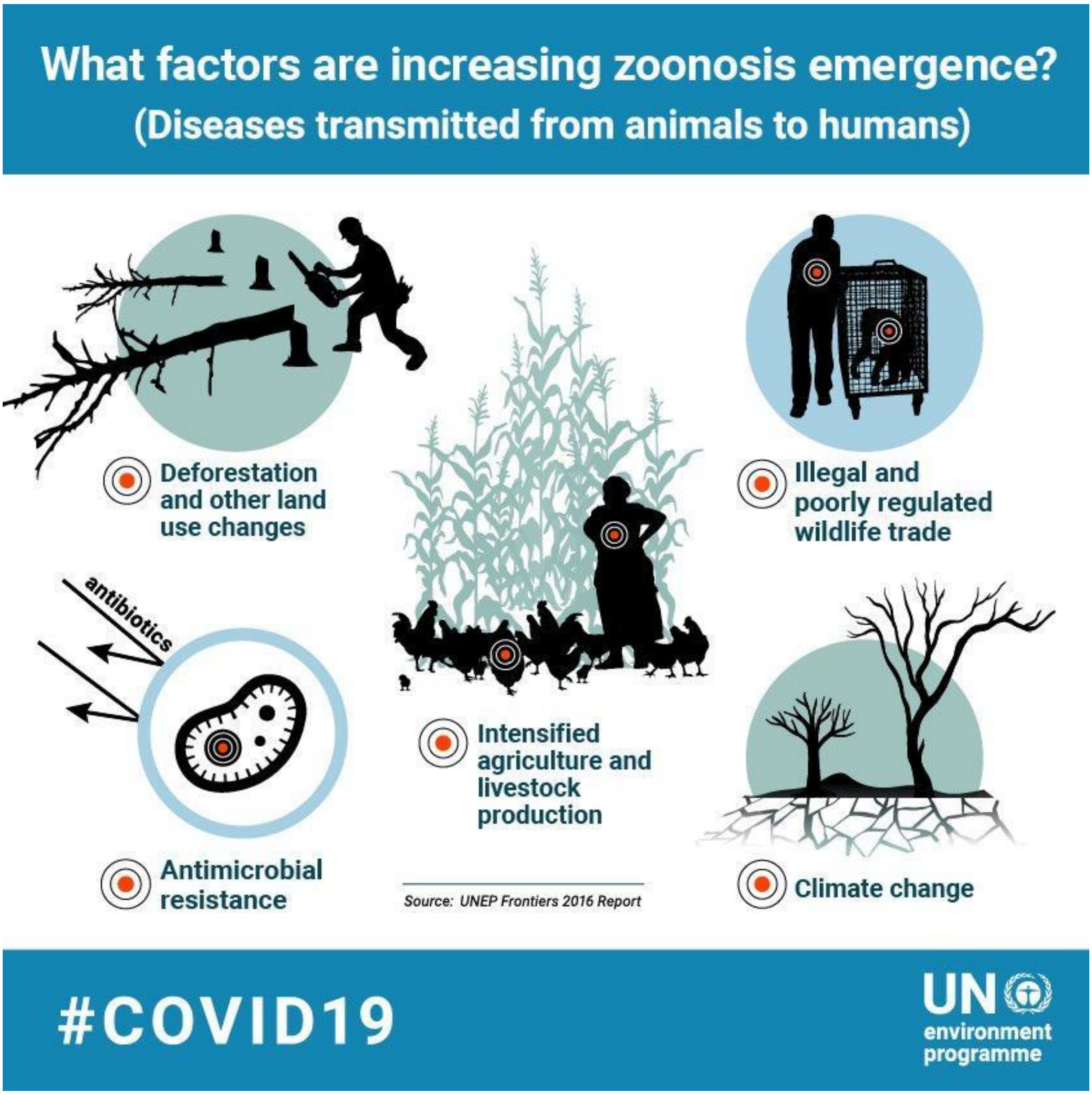

Figure 2. Factors increasing zoonosis emergence. Source: UNEP 2022.

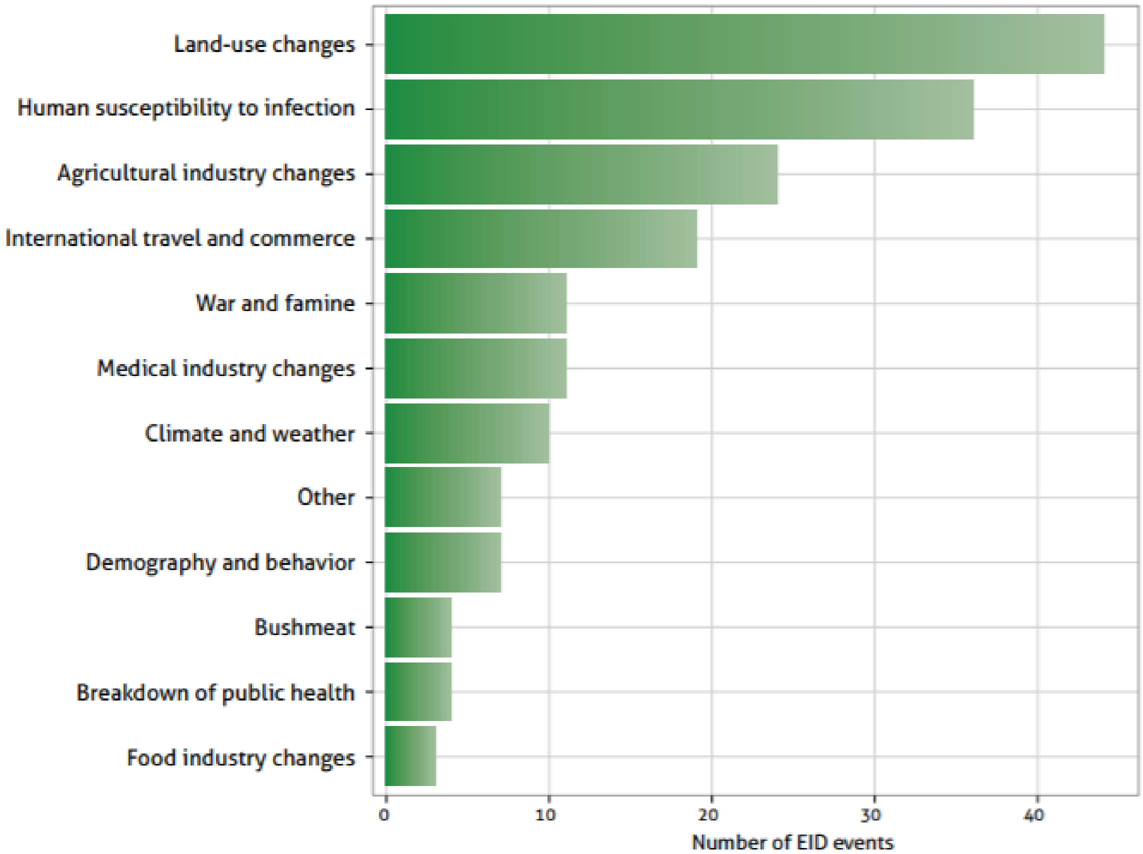

Figure 3. Drivers of emerging infectious diseases from wildlife. Source: Loh *et al.* 2015.

interactions between humans and wildlife in areas where they share the same spaces and compete for the same resources. While a generalised concept or relationship between land-use change, biodiversity and disease risk could not yet be established, overall evidence from individual cases shows that land-use change tends to increase pathogen transmission. See Box 1 for how habitat fragmentation increases the risk of Lyme disease and Box 2 for other case studies.

In the past decades, anthropogenic conversion of much of the Earth's natural ecosystems has been taking place at an accelerated pace. Currently, the most significant changes happen in developing countries, where the expansion of crop and pastoral lands — at the expense of intact tropical forests — continue to have serious negative long-term consequences for the conservation of global biodiversity (Phalan *et al.* 2013).

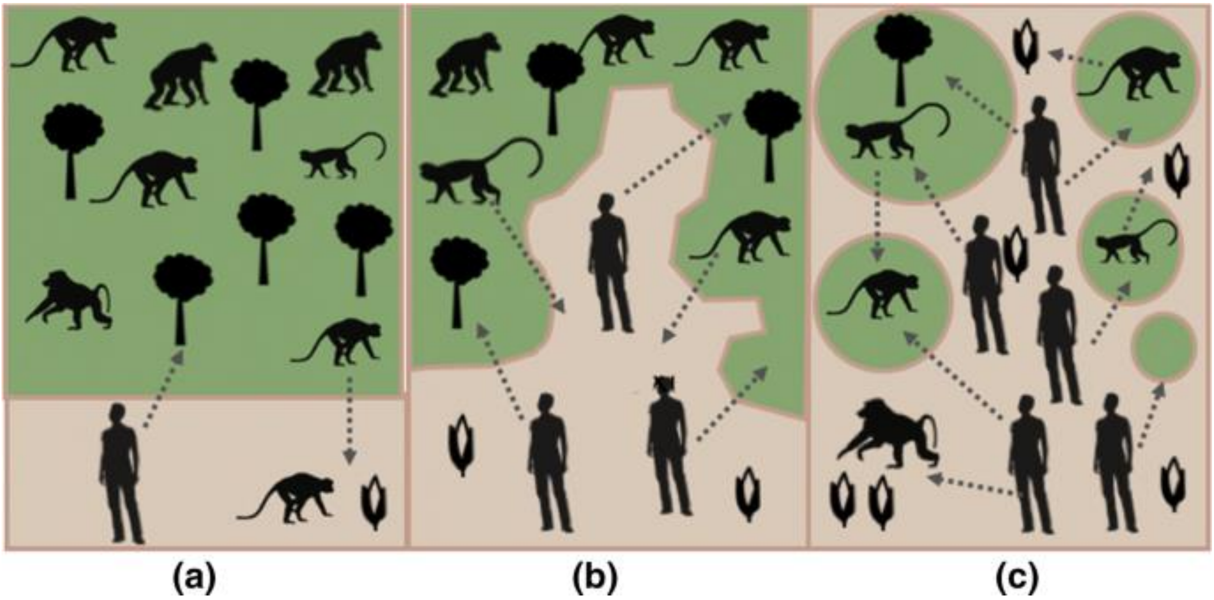

Figure 4. The fragmentation of natural areas and habitats leads to increased human-wildlife contact. Source: Bloomfield *et al.* 2020.

As presented above, disease control is a fundamental ecosystem service that can even be applied purposefully. However, **current unprecedented declines in biodiversity reduce the ability of ecological communities to provide this fundamental ecosystem service (Keesing *et al.* 2010). In recent years, a consensus has emerged among scientists that ecosystem functions decline together with biodiversity loss (Naeem *et al.* 2019). This is why biodiversity loss has now become a serious driver for public health risks. Enhancing biodiversity conservation is a win-win for humans and nature. Halting the destruction of natural ecosystems for agriculture, mining, infrastructure development and urbanisation, while restoring and rewilding nature, are essential to halt further loss, reverse the current trend, and prevent future disease outbreaks.**

Box 2: Land-use change and zoonotic disease emergence case studies

a) Deforestation and Ebola in Central and West Africa

The Ebola virus is a rare and deadly disease that can infect both people and nonhuman primates. The viruses that cause Ebola are located mainly in sub-Saharan Africa — predominantly, in the Democratic Republic of Congo, Ivory Coast, Guinea, and Sierra Leone — and, being highly disruptive in the affected regions, has been emerging and re-emerging since 1975. The disease spreads only by direct contact with the blood or other body fluids, with very high fatality rates varying from 25 % to 90 % in past outbreaks. Ebola causes a recurring public health challenge in Africa and beyond. In addition, as some great ape populations can also develop severe symptoms of the virus, it has been recognised as the cause of the decline in critically endangered gorilla populations, among others (Leroy *et al.* 2004).

While research is not yet conclusive on the exact source of the virus, fruit bats species are suspected to be the natural reservoir for the virus, while chimpanzees, gorillas and duikers may serve as intermediate hosts for potential human spillover (Leroy *et al.* 2005).

By analysing land cover change data in conjunction with Ebola outbreak records, researchers have discovered that habitat fragmentation in the tropical forests of West and Central Africa facilitates Ebola outbreaks as it may lead to increased contact between humans and wildlife hosts (Olivero *et al.* 2017).

These findings reinforce the notion that deforestation and forest fragmentation can lead to previously undetected ramifications of zoonotic disease outbreaks for global health.

b) Malaria risks in the Amazon linked to deforestation, infrastructure, and hydroelectric production

Malaria is a mosquito-borne infectious disease that affects humans and other animals and is widespread in the tropical and subtropical regions stretching around the equator. While malaria also spreads in sub-Saharan Africa, Asia, and Latin America, it takes the highest toll in Africa in terms of the number of cases, number of deaths, and economic ramifications. In the past decade, disease rates have been fluctuating; in 2018 there were 228 million cases of malaria worldwide resulting in an estimated 405 000 deaths (WHO 2019).

In the Amazon region, where most South American disease cases occur, malaria is transmitted by the mosquito *Anopheles darlingi*. High mosquito densities are recorded in areas affected by deforestation, construction of power plants, roads, irrigation, and dams, dramatically increasing the number of cases where large numbers of susceptible people have immigrated. The presence of the vector mosquito correlates with deforestation and the presence of hydroelectric facilities (Vittor *et al.* 2019).

3.2. Land-use change for agriculture and intensive livestock production

Most land-use change in the world occurs for agricultural and livestock production, which plays a serious role in disease outbreaks. When land is cleared for agriculture, wildlife and livestock come into closer proximity, increasing the likelihood of contact and of disease transmission from wildlife to livestock (the intermediate hosts).

First, food production methods — particularly, in livestock production — have shifted towards greater intensification to meet the protein demand of a growing global population. Livestock grazing and livestock-associated feed crops account for an estimated 30 % of land area use, commonly involving deforestation for

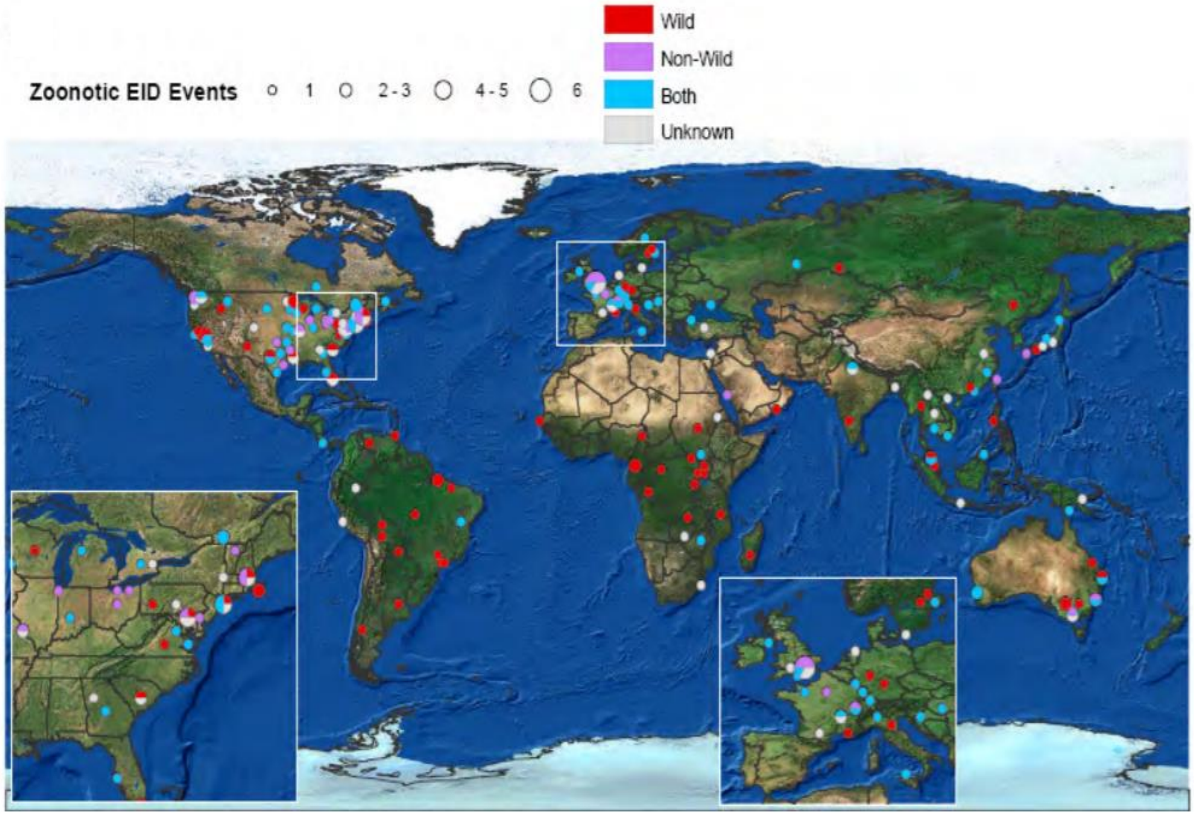

Figure 5. Events of zoonotic disease emergence by type of animal hosts. Source: McDermott and Grace 2012.

cattle farming (Pinto *et al.* 2008). Following land clearing, ecological risks relevant to biodiversity are heightened — particularly, on the peripheries of forests, wetlands, and other natural areas. Here, wildlife-livestock animal contact opportunities are heightened, increasing pathogen transmission opportunities.

Second, intensive livestock production in many parts of the world typically entails high animal density, confined spaces, and, in cases, unsanitary conditions causing stress and weak immune responses, lack of genetic diversity, and intense antimicrobial use. In such conditions, highly virulent viruses more easily emerge and spread.

Diseases continuously emerge on large-scale industrial farms. Of course, strong bio-safety regulations and health protection regimes play an important role in the prevention of the spread and human spillover after a disease has appeared among livestock. Despite such biosecurity measures, major outbreaks nevertheless occur — even in countries with strong disease-preparedness and monitoring systems. This may happen when a pathogen mutates to become more virulent, escapes the vaccine used, acquires resistance to antibiotics, or travels along the food chain; the above-described conditions make rapid pathogen spread and evolution more likely (Liverani *et al.* 2013).

Examples of zoonotic disease emergence from factory farms include the Nipah virus, avian influenza, and the swine flu, which have caused a massive economic loss in the agricultural sector. The emergence of the Nipah virus in South-East Asia, a virus harboured by the flying fox bat, was driven by deforestation and intensified agriculture. Deforestation enabled the movement and contact of bats and pigs on an intensive swine facility, while the conditions of packed pig farms, respiratory shedding and high birth rates enabled the amplification of virus transmission from pigs to humans (Karesh *et al.* 2012).

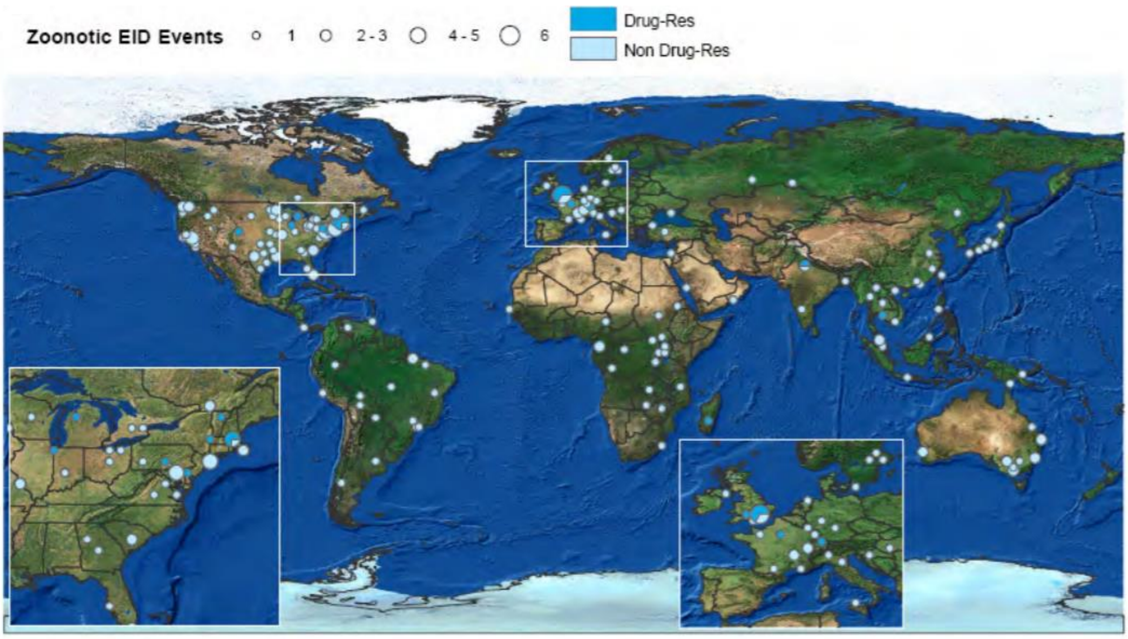

Figure 6. Events of zoonotic disease emergence classified in terms of drug resistance. Source: Mc Dermott and Grace 2012.

Box 3: Agriculture, factory farms and zoonotic disease emergence
The Nipah virus, initially isolated and identified in 1999 during the first outbreak, is a viral infection causing respiratory illness. Nipah provides a useful example of anthropogenic drivers of new zoonotic disease emergence. First emerged among pig farmers and people with close contact with pigs in Malaysia and Singapore in 1998, the disease has an average 40 % mortality rate. Flying fox bats, the natural reservoir for the Nipah virus, were relatively quickly identified as the source following the outbreak. Research suggests that infection of pigs took place through fruits contaminated with bat saliva by the domestic animals and humans on and near the pig farms (Daszak *et al.* 2013). Research has also shown that the intensification of pig husbandry and mango production had a major role to play in outbreaks. Between the 1970s and the 1990s, both pig and mango production tripled in Malaysia at the expense of natural ecosystems, including the habitats of the flying fox bats. The mango plantations situated beside the pig farms attracted the fruit bats. The dense pig housing conditions, respiratory shedding and high reproduction rate of the animals enabled the amplification of viral transmission (Pullian *et al.* 2012). Limited bio-safety regulations worsened the situation leading to multiple spillover events. In later years, Nipah emergence was associated with date palm sap consumption in India and Bangladesh. The consequences of the disease outbreaks were significant both in human and economic terms. During the 1999 outbreak, nearly 300 human cases and over 100 deaths were reported. While Nipah caused relatively mild disease in pigs, more than a million of them were slaughtered to prevent the worsening of the spread. This ended up pushing the Malaysian pig industry to near collapse and resulted in 671 million USD of economic loss, including costs incurred for control measures, the financial impact to the swine industry, and

loss of employment (World Bank 2012). In Bangladesh, Nipah has caused almost a dozen outbreaks and 260 deaths since 2001 but circulated with a much higher, 75 per cent mortality rate (Luby *et al.* 2009a).

In these countries, important preventive solutions have been put in place: some date palm sap harvesters started protecting the harvest from contamination by placing bamboo skirts over the sap collection bucket. While this approach promotes human livelihoods, it also respects bats that provide key ecosystem services, such as seed dispersal and pollination (Luby *et al.* 2009b).

3.3. Wildlife trade – legal and illegal

COVID-19 is one of several pandemics of the past decades that have been linked to the trade and consumption of wildlife in markets and restaurants (Woo *et al.* 2006). While people in all cultures consume wild animals' meat and other derivative products, it is not without risks as it increases exposure to zoonotic diseases. Wildlife markets or wildlife stalls within larger wet markets create ripe conditions for disease spillover when live wild animals are confined in proximity with live domestic animals and humans. The proximity, the cramped spaces and stressful conditions greatly increase the risks of genetic recombination and mutations of different pathogens and transmission to new species, including to humans.

Several zoonotic infectious diseases yielding disastrous consequences emerged due to the substantial human-animal contact that occurs along the wildlife trade chain, from capture to endpoint. Examples include SARS, that originated in a wet market in China; HIV, that emerged via primate bushmeat hunting; the monkeypox virus, that appeared in the exotic pet trade; as well as the H5N1 and H7N9 avian influenza viruses (Karesh and Cook 2005). MERS likely arose in the live trade of dromedaries (the putative source of the disease) from the Horn of Africa to Arabia (Müller *et al.* 2014).

Hundreds of millions of plants and animals are traded globally, driven by consumer demand for a multitude of products ranging from traditional medicines, wild meat, trophies, live exotic pets, and food. The economic value of the legal trade has been estimated between 2.9 and 4.4 trillion USD from 1997 to 2016 (Andersson *et al.* 2021). Due to its illicit nature, the magnitude and value of illegal wildlife trade (IWT) are much harder to estimate; the most common annual value is estimated at around 20 billion USD (Nellemann *et al.* 2014). Trade with wildlife is considered illegal if it is contrary to the laws or the limitations on trade of the participating nations to the Convention on International Trade of Endangered Species of Flora and Fauna (CITES).

However, it is crucial to distinguish the motives behind the consumption of different types of animals, as well as the conditions and modes of their capture and treatment. On the one hand, wild meat is often consumed as a culinary delicacy among people of high socioeconomic status. The relative price of wild meat is accordingly high. Tourism creates an additional driver for the wildlife food trade as such animals are popularised as authentic experiences based on local traditions. The trade of hundreds of thousands of tons of wild animals across borders and continents also increases the associated risk factor, as the animals are often transported and live in cramped, unsanitary conditions.

On the other hand, wild meat is also consumed in rural areas in developing countries, often providing an important source of income for the local community. Just in Africa, tens of millions of people rely on and consume bushmeat for their protein intake (Fa *et al.* 2019).

To sum up, it is important to discern different contexts, as much as it is important to delineate the risks involved with the consumption of wild meat. Not all wild species carry high risk upon consumption and those can serve as an important source of protein for communities.

Notwithstanding the protections that the CITES agreement is supposed to provide, it is estimated that illegal wildlife trade results in a mean source population decline of 60–70 % in targeted species (Ahlenius 2008). This is because wildlife trade remains a high-demand and high-profit industry interwoven by a myriad of other societal and cultural ingredients that propel the revenues: traditions, ambiguous property rights regimes in countries, negative economic incentives for bans, and inadequate enforcement all contribute to the failure of properly protecting wildlife.

Specimens that are traded illegally are more likely to cause disease spread. When the necessary buffer zones between humans and wild fauna are removed, animal pathogens come more easily into contact with people. In addition, illegally traded animals are more likely to be sold or bought where sanitary standards are inadequate. In comparison to agricultural trade, global health regulation of wildlife trade is insignificant, and regulation often falls between the authorities of national ministries and international regulatory organisations.

The current international regulatory system by the CITES agreement, as its backbone, was primarily designed to avoid the overexploitation of species but was not intended to provide solutions for the public health risks of wildlife trade — not even for cases of high-risk taxa. Wildlife trade is complex and heterogeneous and does not present an equal risk to environmental, agricultural, and human health. Different species, value chains, socioeconomic factors, and modes of utilisation pose different levels of risks with each requiring unique, targeted risk evaluation. From relatively benign commerce to high-risk activities, the spectrum is incredibly wide.

3.4. Climate change

Climate change has a myriad of implications for human health, our ecosystems, and the ecological processes that sustain them. The Intergovernmental Panel on Climate Change (IPCC) projected average global temperatures will increase between 1.8° C and 4° C over the next century (IPCC 2007) and extreme weather events and shifting patterns of disease are expected to have significant effects on global disease burden, among many others (Hajat *et al.* 2014). Disease-related direct outcomes of climate change include increased non-communicable and infectious disease burden, as well as the loss of ecosystem services — such as the access to medicinal plants — with significant effects on affected communities (WHO and SCBD 2015). Accumulating evidence has begun to show that a warming climate is altering the spread and distribution of parasitic diseases by increasing the range and abundance of host species, as well as the biting, survival, and transmission rates of vectors. Such vectors are, for instance, mosquitoes, ticks, and tsetse flies (Ostfeld 2009).

For example, climate projections based on a “business-as-usual” emission scenario suggest that the habitat of the Pteropus fruit bats, which serve as the reservoir for the deadly Nipah virus, will significantly expand (Daszak *et al.* 2013). Another example is the tiger mosquito, linked to more than 20 diseases — including yellow fever, dengue, and chikungunya fever — that is predicted to further extend its habitat range due to climate change, exposing more people to bites. Parasitic diseases pose both a direct and indirect threat to human life and human quality of life. While not always causing high mortality rates, they can be very debilitating and may increase the burden on existing social services, stifle economic opportunities, and maintain the vicious cycle of poverty and deprivation.

4. The case for a new paradigm for ecosystem and public health

The economic case for biodiversity and nature protection and for reducing infectious disease is strong. A recent policy article on Science estimated that significantly reducing transmission of new diseases from tropical forests would cost globally between 22.2 and 30.7 billion USD each year (Dobson *et al.* 2020). The World Bank estimated that prevention (i.e., system improvements in public health and animal health to meet the minimum standards of the World Health Organisation and the World Organization for Animal Health) would require 3.4 billion USD annually to achieve an acceptable level of epidemic preparedness (Berthe *et al.* 2018). These numbers show that the losses are incomparably higher than the costs that nature restoration and institutional preparedness would require.

By continuing to make wide-scale changes in land use, transforming agricultural practices without adequate biosecurity, climate change, global trade and travel, urbanization, and other activities, the occurrence and impact of known and novel disease outbreaks are likely to increase. All the above-mentioned drivers can expedite the risk of spillover and spread of diseases.

At the same time, a healthy and biodiverse nature is essential to our human activities, including the economy. Half of the world's gross domestic product (GDP) is highly or moderately dependent on nature. For every dollar spent on nature restoration, at least nine dollars of economic benefits can be expected (WEF and PWC 2020). Considering that vector-borne and parasitic diseases in areas of biodiversity decline amplify the poverty cycle, increasing disease-preparedness through nature restoration can bring multiple ecological, social, and economic benefits (Bonds *et al.* 2012). **Targeting the above drivers may generate shared benefits.**

To prevent and strengthen resilience to possible future diseases and pandemics, a new conceptual framework for policies and practice is needed. Fragmented policies and institutions have led to ignorance regarding how humans share an ecosystem, even on the microbial level, with other living beings.

> Therefore, CEEweb for Biodiversity believes that
> **we need a synergistic approach for biodiversity conservation and public health**
> to co-design and implement programmes, policies, legislation and research across sectors and scientific disciplines
> in a framework that treats humans and nature not as separate realms, but in view of their interdependencies.
>
> **To maintain a safe operating space for humanity, we need to give nature the space that it needs.**
>
> It is time for a new approach to link human and ecological health recognizing the intricate connections between the two.

In light of the COVID crisis, European countries and the EU need to step up efforts on the continent and beyond to protect people from the growing risk of emerging infectious diseases. Environmental protection and disease control and prevention need an integrated approach as opposed to siloed thinking that treats human health separately from the health of ecosystems. It requires a concentrated and coordinated effort from governments and EU decision-makers to make transformative change in the areas of land use, biodiversity protection, nature conservation, and preventive health care, and support it with adequate policies, research, and funding programs.

The COVID-19 crisis has demonstrated the power and benefits of common responses in Europe. After the priority actions (limiting the spread of the virus, ensuring the provision of medical equipment, promoting research for treatments and vaccines), the EU is instituting a comprehensive recovery and resilience programme complementing governments' own efforts. While the EU is budgeting more than 1 trillion EUR under Next Generation EU for the recovery, leading EU member states committed 7-12 % of their national GDPs for fiscal support in 2020 — and significantly more is in the pipeline (OECD 2020).

There is great value in the combination of individual, community, government, and European responses to the health and ensuing economic crises and changing behaviour, in addition to being a learning process about collective action in cases of urgent threats to human health and livelihoods. The COVID-19 crisis is offering an unparalleled opportunity to tackle the pressures on the natural world that are jeopardizing the health of humans and ecosystems.

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