



T H E M E



Damage to ecosystems and biodiversity: what links are there to the emergence of zoonotic infectious diseases?

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Over recent decades, there has been a marked increase in the number of zoonotic (animal) outbreaks, due in part to increased contact taking place between humans and wildlife. Whereas prior to the 20th century the world saw approximately one pandemic each century, there have already been six since the start of the 21st century: SARS, H1N1, MERS-CoV, Zika, Ebola and Covid-19. The science is increasingly pointing to the fact that this phenomenon is being accelerated because of global environmental changes brought about by human activities.

UNPRECEDENTED DAMAGE TO ECOSYSTEMS AND BIODIVERSITY

Between 1970 and 2014, the number of wild vertebrates (mammals, fish, birds, reptiles, amphibians) drastically fell by 60%. Intertropical regions throughout the world are particularly affected by this decline in numbers.

The extinction rate of species is 100 to 1,000 times higher than it was just a few centuries ago. Out of nearly 8 million animal and plant species on our planet, nearly one million of these are threatened by extinction, with many of them becoming extinct within the next few decades. The most oft-cited threat to them is the degradation of their habitats. By way of example, since 1900, the average numbers of local species in the majority of major terrestrial habitats has fallen by at least 20% on average (source: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES](#)).

Forests are home to the majority of the world's terrestrial biodiversity; they provide a habitat for 80% of amphibians, 75% of birds and 68% of mammals. Continuing to ensure biodiversity is therefore very heavily linked to the state in which forests are being preserved. Since 1990, however, almost 420 million hectares of forest have disappeared because of them being converted for other uses. The global primary forest area has shrunk by more than 80 million hectares, an area that is the equivalent of one and a half times the size of France.

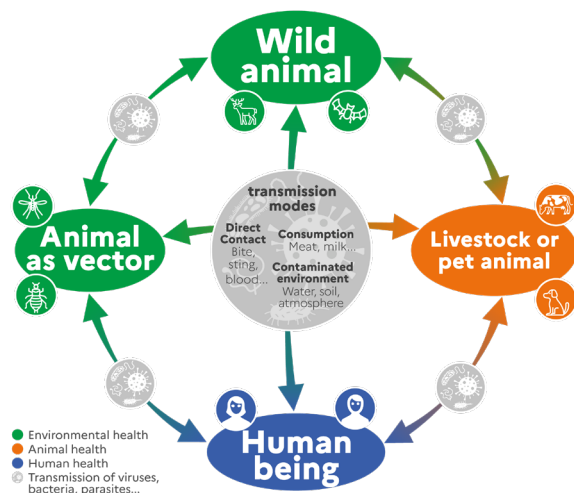
TEXTBOX 1

What is a zoonosis or zoonotic disease?

It is an infectious disease that is transmitted from vertebrate animals to humans – and potentially the other way around – and it is caused by a pathogen (bacteria, virus, parasite, etc.). Some animal species are known as “reservoirs”, as is the case with bats and the rabies virus. This means that they are mostly active within the reproduction cycle of the pathogen and have the ability to occasionally infect other species. Zoonoses are transmitted directly: this can happen through contact between an animal (a pathogen reservoir or intermediate host) and a human, or indirectly through food or a vector (mosquito, tick, etc.).

A pandemic is a disease (either infectious or not) that spreads on a global scale. The rapid increase in numbers of affected people takes place over a vast geographical area, which is international in scope, thereby affecting a significant proportion of the world's population.

Figure 1: transmission of zoonotic diseases



Source: SDES

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Wetlands are also heavily impacted, with more than 85% of them having been destroyed since the start of the industrial era.

Nearly 9% of global land-based species have seen their habitat become inadequate for their long-term survival.

The impact of human activities on biodiversity are further heightened by climate change and the invasion of non-native species. Since the end of the 19th century and the pre-industrial era, global average temperatures has increased by almost 1°C because of cumulative greenhouse gas emissions. Looking at the latest projections from the Intergovernmental Panel on Climate Change (IPCC) and the IPBES, a scenario involving a 2°C increase in global temperatures would mean that 18% of insects, 16% of plants and 8% of vertebrates would be expected to lose more than half of their geographic range and 5% of species to be at risk of extinction. At high latitudes, tundra and boreal forests are particularly vulnerable to degradation and to disappearing because of climate change; this worsens other impacts on biodiversity, such as forest fires and the spread of invasive species.

WHAT ARE THE LINKS BETWEEN ENVIRONMENTAL DEGRADATION AND THE INCREASED RISK OF A PANDEMIC?

Microbial richness is inherent in biodiversity

Biodiversity does not only relate to animals and plants but also the world of microorganisms. Bacteria, viruses or parasites are a naturally occurring part of the environment and they play an essential role in the complex balance of ecosystems.

Bacteria therefore represents the second most important component of biomass after plants, and it accounts for about 15% of the total biomass. Many of these bacteria are not harmful. Indeed, some of them – such as those that make up the intestinal microbiota – are even vital for humans. Others, on the contrary, are pathogenic and can cause serious diseases, such as plague, cholera, tuberculosis, etc.

On the one hand, the viruses can infect cells but be benign or not cause specific pathology, while on the other, they can cause diseases in humans like influenza, measles, Ebola, or AIDS. It is believed that there are somewhere between 631,000 and 827,000 viruses in nature that have the ability to infect humans.

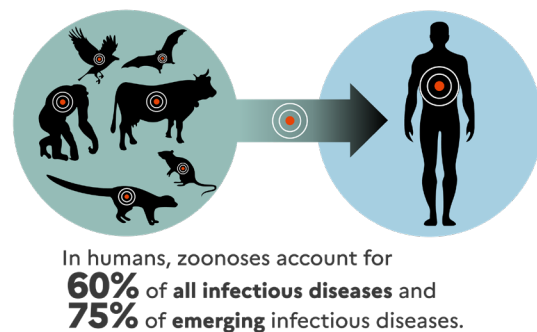
Within the same geographical area, the diversity of microorganisms, whether they are pathogenic or not, is likely to increase alongside the diversity of animal species.

Acceleration in instances of zoonoses over recent years

Over the past half century, greater numbers of new infectious agents have been observed, averaging at two to three new emerging infectious agents per year.

The frequency at which infectious diseases occur, especially those of zoonotic origin (*figure 2*), has also risen since the early 1980s.

Figure 2: zoonoses, diseases transmitted from animals to humans



Source: according to the UNEP *Frontières* 2016 report

Link between damage to ecosystems and biodiversity and increases in infectious diseases

There appears to be a correlation between the number of endangered species of mammals and birds per country and the number of reported outbreaks. Works remains to be done on fully understanding the mechanisms involved, but several factors linked to human activities may explain this phenomenon: disruption of the pathogen transmission cycle; changes to, and the destruction of the habitats of species involved in this cycle; lowering levels of health among animal populations, etc.

One of the principle factors linked to the emergence and spread of new diseases is higher levels of contact between humans, domestic and farmed animals and wild animals, under conditions that favour the spread of pathogens and infection of humans. The way in which these encounters intensify, correlates to the degradation of ecosystems and the unsustainable exploitation of resources.

THE DECIDING IMPACT OF HUMAN ACTIVITIES ON THE MULTIPLICATION AND SPREAD OF ZOOSES

The link between the impact of our activities and the risk of new, more frequent, more deadly and more costly pandemics has been thrown into focus by IPBES.

Modern farming methods as a factor in the spread of the disease

Animal production has increased sixfold in 60 years (source: Food and Agriculture Organization of the United Nations - FAO). These higher numbers are a response to an increase

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in meat consumption on a global level, which took place in developed countries in the 20th century and is now also happening in emerging and transition countries. The weight of livestock has become a key factor in biomass. Domestication has played a role in terms of the ecology and epidemiology of zoonotic diseases, but the increase in livestock farming now appears to be a major factor when it comes to the appearance of new infectious diseases.

The total mass of mammals has tripled since the start of Holocene 10,000 years ago – an increase from 40 million to 117 million tonnes – and this is predominantly because of humans and farm animals. Cattle and pigs are responsible for the greatest mass, but the total mass of domestic poultry is also 5 million tonnes, which is well above the figure of 2 million tonnes of wild birds. At the same time, the total mass of wild terrestrial and marine mammals has fallen from 20 to 3 million tonnes.

Because of the intensification of livestock production, livestock farms have therefore become increasingly significant, in terms of both size and density. This production method results in stressful rearing conditions for the animals and lowers their genetic diversity, thereby reducing their resilience to pathogens. Ultimately, despite greater biomonitoring efforts, the situation promotes the rapid and large-scale spread of zoonotic agents.

Finally, the crops needed to feed livestock and poultry drive changes in land use and deforestation. These all constitute major factors in the increase in incidences of zoonoses, along with more livestock farming in areas that lie in close proximity to wildlife and/or dense human settlements.

The major consequences of deforestation

Although the rate of deforestation has slowed down over the past decade according to the United Nations Environment Programme, deforestation overall is still experiencing a rise.

The main causes include:

- the development of commercial agriculture intended for export: soya, especially used for livestock feed in Europe, palm oil, beef and co-products, cocoa and rubber tree;
- logging activities for wood and pulp production;
- mining and quarrying: a wide variety of minerals are extracted from forested areas, such as gold, iron ore, copper, bauxite, titanium and nickel.

These activities are particularly widespread in Asia, Africa and South America. They result in humans going deeper into forests: more hunting, poaching, bushmeat consumption, etc. There are more interactions between humans, domestic animals and wild animals in forest areas.

Many habitats disappear or are broken up, meaning that the balance between species is altered.

Finally, the different active processes interact with each other, thereby influencing the dynamics of how pathogens and their vectors spread and increasing the risk of transmission.

The effects of deforestation are worsened by climate change and extreme weather events, leading to changes in

seasonal and rainfall patterns and situations that favour the proliferation of vectors.

Urban development promotes contact between wildlife, domestic animals and humans

According to the United Nations the world's population has almost tripled since 1950, increasing from 2.6 billion to 7.7 billion in 2020.

Demographic pressures are therefore particularly strong, especially in Asia and Africa, with the latter expecting to see their strongest growth over the next 30 years. Demographic change goes hand-in-hand with intense urban development, which has a detrimental effect on natural ecosystems, particularly forest areas.

Zoonotic health risks are higher in cities in the developing world where sanitary conditions are often poor and the management of waste is practically non-existent, leading to a proliferation of rodents and insects.

Animals in these densely populated urban areas can act as reservoirs or intermediate hosts for pathogens. Livestock farms are also situated close to natural habitats and it is this very proximity to wild fauna that creates a situation that promotes the adaptation of pathogens to humans via domestic species. Urban centres thus become starting points for the emergence of diseases and the multiplication of epidemics.

Development of human infrastructure that facilitates the spread of epidemics

The spread of diseases occurs from reservoirs, vectors or sick humans travelling about. The development of infrastructure, in particular air and sea transport, facilitates travel and consequently the quick spread of zoonoses throughout a much broader geographical area. At this point, an epidemic has the capacity to quite rapidly turn into a pandemic.

An important role for international trade and wildlife trafficking

Poaching and animal trafficking have become the third largest source of illegal income worldwide, with only drug trafficking and prostitution accounting for more. They result in random contact between animals and humans and the mixing of species in uncontrolled sanitary conditions, thereby creating a situation that promotes the propagation of zoonotic pathogens.

Legal wildlife farms and, to a lesser extent, zoos, could pose a risk if their populations were to become infected and transmit pathogens back to humans. In Europe, for example, employees were infected at mink farms where animals had Covid-19, resulting in the culling of animals at these farms. The intensive farming of these species is also believed to have been a factor: the occurrence of these transmission events from infected mink to humans would appear to be linked to a high viral load, which is due to the sheer numbers of animals in these farms.

PROMOTING A MULTIDISCIPLINARY AND COMPREHENSIVE PREVENTIVE APPROACH

Public health strategies are most often based on technical solutions: early detection, the search for vaccines, treatment, etc. However, looking at the more than 1,400 known pathogens that infect humans, there are fewer than 30 vaccines available.

Moreover, according to the IPBES, the current economic impact of pandemics is 100 times greater than the estimated cost of preventing them. A solution-based approach must therefore be considered.

A prevention strategy for zoonotic outbreaks involves putting in place systems for the early detection and monitoring of cases in animals and/or cases that cross the species barrier. This also necessitates rapid action to prevent the spread and outbreak of cases in animals and/or humans, as well as prevention methods upstream from the source of emergence risks. This will necessarily involve protecting ecosystems, and restoring and preserving habitats and species.

In terms of this area, there should be a focus on the need to strengthen multidisciplinary research, particularly in the field. There is a lack of studies and knowledge. Having them would enable a better understanding of the causal links between socio-economic, environmental and ecological factors and the emergence of infectious diseases.

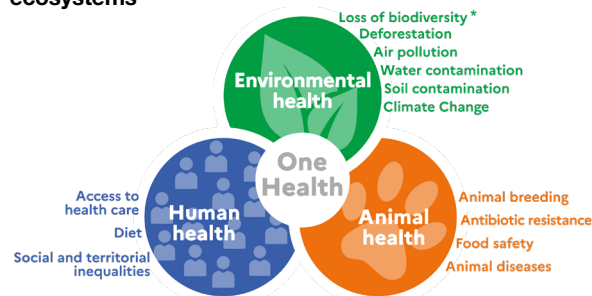
This is why the One Planet Summit on 11 January 2021 saw the launch of the international initiative PREZODE. The principal French agricultural, agronomic and development research organisations, who work in collaboration with researchers based around the world, have given their support. The aim is to better understand, detect and prevent infectious diseases upstream of their emergence, working together with key players on the ground.

It is vital to develop strategies that reduce the threats at source since these pile pressure on ecosystems and repeated contact with wildlife. This is the meaning of the *One Health* approach, involving humans, animals and the environment (*figure 3*). It has already been applied to antibiotic resistance and certain zoonoses from a medical and veterinary perspective, but it merits being widened out to also look at the functionality of ecosystems and whether biodiversity is in a good state, both at an international and at territorial levels.

It must also integrate anthropological, ethnological, cultural, historical and socio-economic reasons that result in the development of activities that run the risk of emerging

zoonotic diseases. In this way, it will be possible to regulate them or find healthier and more sustainable responses to human needs.

Figure 3: one health, one vision and understanding the interactions between human health, animals and ecosystems



* The determinants are illustrative but not exhaustive.

Source: according to ISGlobal

The *One Health* approach reflects the necessity for multiple sectors of human development and the different policies (biodiversity, health, agriculture, climate, etc.) to function in a de-compartmentalised manner so that the collateral impacts they could have on each other are limited. Climate change and shrinking biodiversity have already demonstrated this, while pandemics have now highlighted how urgent it is.

TO FIND OUT MORE

- Mobilisation de la FRB par les pouvoirs publics français sur les liens entre Covid-19 et biodiversité, FRB, 2020
- Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services, IPBES, 2020
- The Global Assessment Report on Biodiversity and Ecosystem Services, IPBES, 2019
- La situation des forêts du monde 2020. Forêts, biodiversité et activité humaine, FAO et PNUE, 2020
- The State of the World's Biodiversity for Food and Agriculture, FAO, 2019

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