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SESSIONAL PAPER

The importance of biodiversity risks: Link to zoonotic diseases

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Abstract

This paper follows on from the initial position paper on "The Importance of Biodiversity Risks", prepared by the Biodiversity and Natural Capital Working party, a volunteer group working under the Sustainability Board. This paper explores the link between zoonotic disease and biodiversity loss and aims to raise awareness and discussion within the actuarial community on why this should be an important consideration in risk management. This paper focuses on how zoonotic diseases emerge, how they are linked to biodiversity loss, the potential impacts in the future and progress within the financial sector. This paper forms part of a collection of papers prepared by volunteers under the Sustainability Board that focus on different elements of biodiversity risk considerations.

Keywords: Biodiversity; Zoonotic disease; COVID

1. Introduction

Zoonotic diseases are diseases that have been transmitted to humans via animals. The acceleration of the emergence of zoonotic diseases in recent times can be attributed to a number of interrelated issues such as climate change and habitat loss, to which human activity is heavily linked.

The likelihood of future epidemics and pandemics is increased by the destruction of natural habitats, leading to increased interaction between humans and wildlife. Destruction of habitats also opens up the transport pathways from remote areas to population centres, and the combination of these two factors act together to increase the likelihood of zoonotic diseases emerging. The spread of zoonotic diseases shares the same underlying causes that drive biodiversity loss, including climate change and habitat loss. Additionally, biodiversity loss can act as a proxy indicator to measure habitat destruction and climate change.

The COVID-19 pandemic has accentuated the potentially devastating impact of zoonotic ddiseases on human health and the global economy. This experience therefore highlights the urgent need to understand the challenges posed by zoonotic diseases, and in particular the relevance of biodiversity in mitigating such risks in the future.

This paper seeks to present the background on zoonotic diseases, the factors driving their emergence that link to biodiversity, as well as an overview of the response of the financial sector to date. The paper then puts forward considerations for the actuarial community in understanding and managing the risks arising from the interrelated issues of zoonotic disease and biodiversity loss.

2. Background on zoonotic diseases

Zoonotic diseases, or zoonoses, are diseases that have been transmitted from an animal source to humans. The animal population, known as a "reservoir host", houses an infectious pathogen

before then passing it on to humans (Recht, 2020). This occurrence of cross-species transmission is often referred to as a "spillover event". Once this species barrier is crossed, the spread of the disease can evolve into human-to-human transmission in approximately half of all such cases (Woolhouse, 2012). Notable examples of recent zoonotic diseases include Human Immunodeficiency Virus (HIV), Influenza, COVID-19 and Ebola.

The emergence of a zoonotic disease is by nature unpredictable, a fact that is demonstrated by the variety of pathogenic agents, animal sources, geographical locations and drivers of emergence witnessed from recent cases. A brief overview of the history of zoonotic diseases is provided in this paper.

A pathogen's route from a reservoir host to humans is inherently convoluted, depending on numerous factors pertaining to the dynamics of the reservoir host population, human exposure to infected animals and the characteristics of the pathogen itself (Plowright, 2017). However, in spite of the apparent unlikelihood of such spillover events, emergences of infectious diseases in humans are increasing, with over 70% of these estimated to be zoonotic (Wang, 2014).

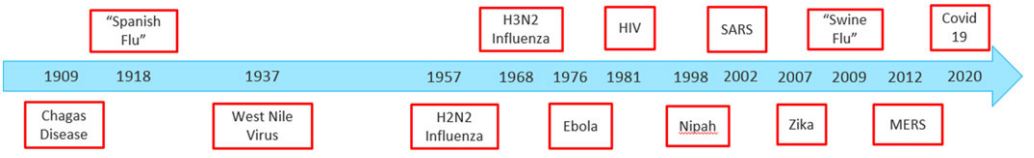
Once a new zoonotic disease emerges, the impact can be devastating. Some pathogens may contribute to substantial increases in mortality, though the effects on society can be more wide-ranging, including disruption to the economy and health services. For example, the severe acute respiratory syndrome (SARS) disease that emerged in China in 2002–2003 led to an estimated $30–$50bn USD economic cost despite causing illness in less than 10,000 people (Karesh, 2012).

3. History of zoonotic diseases

Zoonotic diseases have occurred throughout history. The first instance of the bubonic plague (or "Black Death"), for example, dates as far back as the 6th century, before multiple resurgences spanning from the 14th century to the present 21st century (Cohn, 2008).

In the past 100 years, the emergence of zoonotic diseases has accelerated. The 2020 IPBES Workshop Report on Biodiversity and Pandemics reviewed scientific evidence which demonstrated that pandemics are becoming more frequent. They found that the risk of pandemics is increasing rapidly with more than five new diseases emerging in people every year, any one of which has the potential to spread and become a pandemic (IPBES, 2020). This is being driven by a variety of factors which are discussed in more detail in the next section of this report.

The following timeline gives some indication of the zoonotic disease outbreaks that have occurred over the past century.



[Source: Authors]

Well-known modern zoonotic diseases include HIV, Influenza, coronaviruses, Ebola, rabies, tuberculosis and yellow fever. In particular, the 1918 influenza pandemic caused by the H1N1 virus, also known as the "Spanish Flu" was responsible for at least 50 million deaths worldwide (Centers for Disease Control and Prevention, 2019).

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The impact of a zoonotic disease on human health, including the symptoms caused and time taken to recover, varies and can be lethal. The West Nile virus, an air-borne virus transmitted by mosquitoes first identified in Uganda in 1937, can lead to fever, neurological disease and death (Wang, 2014). The Chagas disease, a parasitic zoonosis endemic in South America can lead to chronic disease of several body organs, including the heart, oesophagus and colon, even up to 25 years after contraction (Recht, 2020).

The extent of an outbreak and rate of transmission depends on a variety of host, pathogen, and environmental factors, including host infectiousness, host population structure and route of transmission. Mortality rates can also vary greatly depending on the disease. An extreme example of this is Nipah virus which originated in southeast Asia in 1998, closely linked to pig farming. A variant that emerged was found to have a mortality rate upwards of 75% (Gurley, 2007).

Case Study: COVID-19

The most notable zoonotic disease of recent years is COVID-19, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 was first detected in Wuhan in 2019 and is widely believed to be a spillover infection from bats (Mallapaty, 2020). It has since spread quickly across the globe and was declared a pandemic by the World Health Organisation on 11th March 2020.

Although the pandemic is still ongoing, it has become one of the deadliest global pandemics in history, with over 116 million confirmed cases and 2.5 million confirmed deaths as at 7 March 2021 (World Health Organization, 2021). The estimated mortality rate is c.1% (Elsland, 2020), though this can vary significantly by sex, age, race, socioeconomic background and country. Long-term health impacts of those who have contracted the disease are as yet unknown (Centers for Disease Control and Prevention, 2020). However, there are a growing number of people with "long COVID", displaying symptoms weeks or even months after the initial infection.

Vaccination programmes are launching worldwide, with the aim of reducing mortality and curbing the rapid spread of the disease. However, the development of new strains means that the future remains uncertain (Centers for Disease Control and Prevention, 2021).

The COVID-19 pandemic has disrupted day-to-day life on an unprecedented scale. The Continuous Mortality Investigation (CMI) has estimated that COVID-19 has led to more than 100,000 excess deaths in the UK since the start of the pandemic as of March 2021 (Continuous Mortality Investigation Limited (CMI), 2021). Another repercussion is the significant human cost of social isolation and loneliness as a result of lockdown restrictions.

The impact has also been felt across the global economy, amounting to $11.5 trillion of monetary and fiscal support needed (International Monetary Fund, 2020), and has led to COVID-19 being described as the "biggest international challenge since the Second World War" by the UN Secretary-General (United Nations, 2020). In the UK, GDP declined by c.9% over 2020, which was more than twice the next largest fall of 4% in 2009, and was driven by the impact to the services sector (Office for National Statistics, 2020).

4. Causes of zoonotic diseases

The rise in spillover events can be attributed to a variety of causes. Chief amongst these are climate change, habitat loss, animal agriculture and industrial farming, wildlife trade and exploitation of natural resources (Karesh, 2012). Human activity therefore emerges as an underlying theme in the rise in the incidences of zoonotic diseases (IPBES, 2020).

Moreover, these drivers are inextricably linked. For example, climate change and habitat loss can force or facilitate the migration of animal populations, facilitating the spread of any foreign diseases (Wang, 2014). An example of this is the predicted spread of the Zika virus caused by migration of populations of mosquitoes, facilitated by rising temperatures in other regions of the world (Tesla, 2018).

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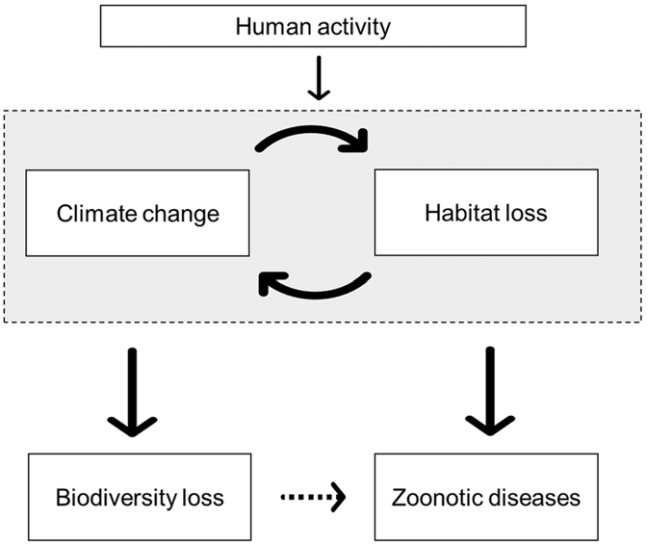
Other practices that result in dense populations of animals living in compact spaces – such as animal agriculture and wildlife trade – also increase the chances of a spillover event (Bloomfield, 2020). Almost half of the zoonotic diseases that have emerged since 1940 have resulted from change in land use, changes in agriculture and food production practices, or from wildlife hunting (Keesing, 2010). For example, a number of viruses in Australia are believed to be spread from bats after having been displaced from their habitats after deforestation and agricultural expansion and therefore coming into closer contact with livestock and humans (Jones, 2013).

Land use change is a globally significant driver of pandemics and caused the emergence of more than 30% of new diseases reported since 1960 (IPBES, 2020). Human health considerations are largely unaccounted for in land-use planning decisions (IPBES, 2020). Together with climate change, these are two of the most important direct drivers of biodiversity loss and are projected to cause significant future threats to biodiversity and continue driving the emergence of infectious diseases (IPBES, 2020).

Furthermore, antimicrobial drug resistance, stated by the World Health Organisation to be one of the most urgent threats to human health (World Health Organisation, 2020) is another phenomenon interlinked with the aforementioned risk factors. Intensive livestock farming commonly leads to the administering of antimicrobials to animals: in the United States, an estimated 80% of all antibiotics sold are used in animal agriculture (an estimated 70% of which are important for human medicine) (Martin, 2015). Animal agriculture, and its involvement in potential antimicrobial drug resistance, is therefore posited to aid the evolution of zoonotic pathogens (Jones, 2013).

It is worth considering the relationship between the risks associated with biodiversity loss and the emergence of zoonotic diseases further, as summarised in the following diagram.



[Source: Authors]

In particular, the drivers of the zoonotic diseases are the same drivers causing biodiversity loss (IPBES, 2020). These wider underlying causes, including climate change and habitat loss, also exhibit a circular relationship whereby they aggravate each other, inevitably exacerbating the circumstances. As discussed previously, these ecological changes are largely underpinned by human activity (IPBES, 2020).

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Biodiversity also arguably plays a more direct role in the transmission of zoonotic diseases. Greater biodiversity of species can potentially reduce the transmission of disease as there are several species the disease has to pass through to reach humans. This is known as the "dilution effect," which makes it more difficult for a single pathogen to spread rapidly or to dominate. However, a scientific consensus has not been reached on this interrelation (Rohr, 2020).

5. Future outlook

As established earlier in this paper, the likelihood of future epidemics and pandemics is increased by the destruction of natural habitats, leading to increased interaction between humans and wildlife.

The risk of pandemics is increasing rapidly, with more than five new diseases emerging in people every year, any one of which has the potential to spread and become a pandemic (IPBES, 2020).

This is coupled with a rising demand for meat, particularly in developed countries and emerging economies leading to an unsustainable global system of intensive production that threatens biodiversity (IPBES, 2020).

In November 2020, a new initiative involving 20 of the world's leading conservation organisations was launched. The Wildlife Conservation 20's (WC20) declaration states that, against the backdrop of the COVID-19 pandemic, building a sustainable relationship between human consumption and wildlife conservation has become crucial and provides recommendations to the G20 leaders (Wildlife Conservation 20 (WC20), 2020).

Research on zoonotic disease transmission indicates that in order to identify patterns of infectious disease outbreaks, it is crucial that human and non-human primate contact events are recorded, monitored and analysed in greater detail. Furthermore, collecting spatially explicit data on land use and human behaviour is important for prediction of physical interactions between humans and nonhuman primates given the rapidly changing landscapes across the globe (Bloomfield, 2020).

In addition, a coalition of leading health and environmental organisations has formed with a goal of preventing pandemics at the point of spillover. Their proposed solution is to coordinate dialogue between different sectors through a three-pronged strategy: a Scientific Taskforce (focused on research), a Global Action Fund for Pandemic Prevention (to drive on the ground prevention efforts) and Global and Local Public Awareness Campaigns (Preventing Pandemics At The Source, n.d.).

It is crucial that we understand and acknowledge that global cooperation and greater understanding of how these issues are interlinked is needed in order to effectively combat the threat of zoonotic diseases as nature is not bound by geographical or political borders.

6. Industry progress

The COVID-19 pandemic has highlighted the intertwining nature of zoonotic diseases, habitat loss and the global economy. The hope is that the financial industry will emerge from the pandemic with a greater understanding and awareness of these risks and that systems will be put in place to handle the impacts of future pandemics. Indeed, there have been calls for a financial system where economic activity that increases our natural assets is monetised and incentivised appropriately and where, conversely, depreciation in natural assets is also reflected within our growth and development metrics. In 2019, the world's largest banks invested more than $2.6 trillion in primary drivers of biodiversity destruction. On average, each of the 50 banks included in the research were linked to finance with biodiversity risk to the tune of $52 billion

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each. This ranges from more than $210 billion for the largest investor to $1.3 billion for the smallest (Portfolio Earth, 2020).

In 2019, the UK Chancellor of the Exchequer commissioned an independent global review on the economics of biodiversity led by Professor Sir Partha Dasgupta. The Dasgupta review establishes the relationship between global economics and biodiversity and details how human actions and inaction in certain areas is leading to a global environmental crisis with loss of biodiversity as one of the key impacts (Dasgupta, 2021).

The Dasgupta review identifies that the solution to integrating biodiversity into global economics is to understand that biodiversity and economic growth are intertwined. Most economic models identify that nature has scarce resources to offer whereby technology and innovation can help overcome this issue. The review suggests that a rethink of economic valuations is required; in particular GDP should not be considered as the key economic indicator of a nation's wealth, given it accounts only for the gross output which is often achieved by depreciation of natural resources. We should instead create new metrics to measure our economic growth which factor in our natural resources such as biodiversity and forestation levels (Dasgupta, 2021).

In doing so, natural resources and issues that cause their depreciation, e.g. habitat destruction, will be quantified within economic models thus potentially helping move economies towards an environmentally conscious measure of a nation's wealth and this could eventually help reverse the trend of biodiversity loss and therefore potentially decrease the prevalence of zoonotic diseases.

An increased effort and investment are needed to save Protected Areas. Protected Areas are areas defined by the International Union for Conservation of Nature (IUCN) as a geographical space recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (International Union for Conservation of Nature, n.d.). The Dasgupta review notes that to protect 30% of the world's land and ocean under these areas would require an annual investment of US $140 billion equivalent to only 0.16% of global GDP and less than one-third of the global government subsidies currently supporting activities that destroy nature. This will have a significant impact on improving not only the ecosystems but also limiting global social health catastrophes. Indeed, Dobson *et al.* (2020) have estimated that the associated costs of monitoring and preventing zoonotic disease spillover over a 10-year period represents just 2% of the estimated costs of COVID-19 (Dasgupta, 2021).

7. Considerations for actuaries

This paper has shown that loss of biodiversity rich habitat can lead to an increase in zoonotic diseases that pose long-term risks to the health of humanity and the global economy. Given the long-term and uncertain nature of these risks, it will be important for actuaries to build a level of understanding of the potential impacts and interconnectedness of systems in order to carry out their duties.

In many ways, this is a natural extension to the approach taken to measuring and managing climate risks faced by the financial services sector. The industry is already making progress in developing this extension: the Task Force on Nature-related Financial Disclosures is planned for early testing in 2022 which will aim to develop a framework similar to the Task Force on Climate-related Financial Disclosures. It will therefore be important for actuaries to keep pace with these developments.

Areas of actuarial work that could be impacted by both biodiversity risks and zoonotic disease include:

- Underwriting and pricing
- Mortality and morbidity
- Risk Modelling

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- Research & Development
- Developing risk management frameworks
- ESG Investing and asset management
- Governance & Disclosure
- Product development
- Education

Some firms have already started to make progress in these areas. AXA XL released a commitment to the new "Finance for biodiversity" pledge which promotes financial-sector-wide collaboration and engagement on assessing biodiversity impact and promoting enhanced disclosure by 2024 (University of Cambridge Institute for Sustainability Leadership and Deloitte (CISL), 2021). Swiss Re has developed a Biodiversity and Ecosystem Services (BES) Index to support the insurance industry in assessing and understanding the economic risks of deteriorating biodiversity and ecosystems within both underwriting and asset management (University of Cambridge Institute for Sustainability Leadership and Deloitte (CISL), 2021). The index also includes data for habitat intactness, one of the key drivers of future pandemic risk. Actuaries are well-placed to support firms and the wider industry in making further progress in this area.

In understanding these complex risks, it will be important for actuaries to take consideration of the wider picture. As well as the Biodiversity and Natural Capital working party, the Resource and Environment "R&E2: What are the consequences of ignoring the boundary between the environment and humanity" workstream are also considering the impacts to public health due to loss of biodiversity amongst other factors. They have reviewed some useful case studies which delve into the detail on the cyclical relationships between humanity and the environment. This report is due to be published shortly and will be a useful resource to be used alongside this paper.

As risk management experts, actuaries can lead the way in promoting understanding of the risks associated with both biodiversity loss and zoonotic disease. Indeed, the work of the COVID-19 Actuaries Response Group and the Institute and Faculty of Actuaries' COVID-19 Action Taskforce workstreams showcases the importance of bringing together the actuarial community to educate and inform others.

Furthermore, actuaries can inform and influence public debate by engaging with financial regulators and appropriate agencies to ensure a fairness that not only supports the growth of financial institutions but is achieved in tandem with global environmental conservation so that these risks are no longer intergenerational.

8. Conclusions

This think piece has highlighted the importance of understanding the links between zoonotic disease, habitat loss and biodiversity loss. The long-term impacts of zoonotic diseases on the economy and human health have been catastrophic and far-reaching. Moreover, the future outlook indicates that on our current trajectory, and as biodiversity loss increases, zoonotic diseases will only continue to increase, causing further disruption globally.

The recent COVID-19 pandemic has highlighted the threat of mistreating the natural world. It should therefore provide a call to action for a collaborative effort to combat such incidences from recurring in the future. While there is progress through the work of conservation organisations and the increase in education across the financial system, an important next step would come in the redesign of economic frameworks.

Actuaries can play a crucial role in providing meaningful insight on the impacts of future disease emergence and are well-placed to support a transition to a financial system that accounts for nature-related risks. We would recommend that actuaries consider the implications of this paper, and the wider set of papers on biodiversity issues that this paper is part of, for their work.

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In addition, we believe actuaries should promote understanding of these risks and relationships throughout the actuarial industry to inform and educate others and contribute to and inform public debate on recovery following the COVID-19 pandemic, including preparedness for future pandemics.

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