ZOONOSES

Joining the dots between people, animals and the natural world

FACT SHEET

Human beings are intimately connected with the natural world - we depend on other species and the environment we share for our health and survival. Yet over the last century, we have disrupted and degraded ecosystems, undermining the ability of nature to support us.

Increasing human encroachment on natural habitats and exploitation of animal species have created unprecedented opportunities for infections to pass between animals and humans. So-called "zoonotic" disease outbreaks are on the rise, posing major risks to human populations.

Successfully addressing this requires attending to the root cause - our relationship with nature

What is a zoonosis?

A zoonosis is an infectious disease that can be passed from an animal to a human. Zoonoses can be caused by viruses, bacteria, parasites and fungi. About 60% of all infectious diseases and 75% of emerging (newly appearing, or reappearing) infectious diseases affecting humans are zoonotic[1].

Often, the animal involved is not affected by the infection but instead acts as a 'host'. Zoonotic infections can be transmitted to humans directly from the host animal or via an intermediary animal or insect. It is also possible for some zoonotic infections to survive outside host animals in soils or water and later be transmitted to humans[2].

While most emerging zoonoses do not cause severe illness or spread rapidly, some can, with enormous impacts on global health and economies. Collectively, zoonoses are responsible for about one billion cases of human illness and millions of deaths each year[3], while over the last twenty years, emerging zoonoses have had direct costs of more than US$100 billion[1].

When an infectious disease spreads across countries or continents and affects large numbers of people, it is declared a pandemic. COVID-19 is a pandemic that has spread around the globe, impacting the lives, livelihoods and futures of billions[4]. Its cumulative costs are expected to reach many trillions[5].

Zoonotic diseases are on the rise

The number and diversity of emerging infectious disease events has been increasing over the past 30 years, a trend that is expected to continue over time[1,6]. This increase is closely linked to intensifying human impact on natural systems.

Deforestation and land use change

When we clear forests and remove natural habitat, wild animals are displaced and their behaviour is altered. This increases the likelihood of contact between wildlife and people and therefore the risk of cross-species infection transmission[1].

Doctors for the Environment Australia

Today, less than a quarter of all land on earth remains undegraded by human activities, with this figure predicted to fall to 10% by 2050[7,6]. We have converted over 1/3 of all land surface to farmlands, destroyed 68% of global forests and 85% of wetlands[9]. In Australia, approximately 600,000 hectares of forest and bushland are logged or cleared each year, with 40% of Australia's total forest cover lost over the past 40 years[10].

Land use change has been identified as responsible for almost half of all documented past emerging zoonotic disease outbreaks[11]. Examples of viral zoonoses emerging when land use has been altered by humans can be found in many world regions; for instance, Ebola in central and West Africa, Nipah virus in Malaysia, Hantavirus in Central America and Hendra virus in Australia (see Box 1)[12-17].

Hunting and trading of wildlife

Wildlife hunting and trade also increase interaction between wildlife and humans. If hunting is for food or traditional medicine, both the hunter and consumer will come into close contact with the animal. Where wildlife passes through crowded trading centres and markets, large numbers of other people, domestic animals and wildlife may also be exposed, creating ideal conditions for the spread of infection between species. In such situations, animals are kept in poor conditions for long periods of time which can weaken their resistance to disease.

While quantifying the global wildlife trade is almost impossible because it ranges in scale from local to international and much of it is illegal, it has been estimated that somewhere in the order of 40,000 live primates, 4 million live birds, 640,000 live reptiles and 350 million live tropical fish may be traded annually[18].

Wildlife hunting and trade have been linked to numerous zoonotic infections. Human immunodeficiency virus (HIV) is believed to have originated in chimpanzees and been transferred to humans when these were hunted and eaten. The virus causing severe acute respiratory syndrome (SARS), though originating in bats, passed through an intermediary animal (possibly the civet cat) to reach humans via a wildlife market in China[19,20]. Similarly, it has been postulated that a wildlife market in China may have been the place of first transfer of the COVID-19 virus to humans[21].

Livestock practices

Livestock production is the largest user of land on earth[22]; thus, it increases risk of zoonotic diseases by driving natural habitat loss. In addition, while wild animals are the most common source of emerging infections, livestock often form the bridge between them and humans[23].

Global consumption of animal food products has increased rapidly over recent decades, with the human population now consuming four times more meat and double the amount of eggs and dairy than it did 50 years ago[24]. Meat consumption is projected to rise by another 73% and dairy consumption by 58% percent by 2050[25].

This rising demand for animal foods has driven a shift to more intensive farming practices. These typically involve large numbers of animals reared together in confined spaces. Both lack of genetic diversity and high levels of stress in the animals increase their susceptibility to infection. The close contact between them also creates opportunities for the rapid spread of infection and for viruses from different species to mix to create new and potentially more infectious viruses[1,26].

The highly infectious strains of bird flu (avian influenza) that have caused human illness and deaths first circulated in wild birds, before infecting intensively farmed poultry, then humans. The swine flu pandemic of 2009 (H1N1 influenza) was caused by a hybrid of human, bird and pig flu viruses that combined in farmed pigs, before spreading to humans[27,28]. The emergence of

Nipah virus in Malaysia has been causally linked to intensification of pig production at the edge of tropical forests near fruit bat habitat [16].

Intensive farming methods also often involve widespread use of antibiotics, both for disease treatment in animals, and in animal feed for growth promotion, improved feed conversion efficiency, and for disease prevention[29]. This favours the emergence of more antibiotic resistant pathogens which can then be passed on to humans[29,30].

Climate change

Alongside habitat loss, climate change is causing the migration of animals to new locations, resulting in altered species interactions[31]. Climate also has a major influence on the behaviour, reproduction and geographical distribution of many of the organisms which cause infectious diseases and the insect vectors through which they spread[1].

The Lyme disease bacterium, Borrelia burgdorferi, is spread from small mammals and bird species to humans through ticks, which themselves thrive in warmer, more humid environments[32]. Increases in daily average temperatures from climate change are believed to have contributed to the almost three-fold rise in cases of Lyme disease in the United States over the last 30 years, and are expected to account for a further 20% increase in the coming decades[32].

Murray Valley Encephalitis, Rift Valley Fever, West Nile and Zika are all viral diseases which spread to humans from animals via infected mosquitoes [33-36]. At warmer temperatures, mosquitoes feed more frequently and produce more offspring[37]. Viruses also replicate faster within the mosquito, and all these factors together contribute to more mosquitoes capable of transmitting infection. Heavy rainfall can also increase mosquito abundance, while droughts can reduce mosquito predators and competitors, allowing mosquitoes to thrive[37,38]. Modelling suggests that changes in climatic conditions over coming decades, particularly increased temperatures, heavy rainfall events and drought, are likely to increase the burden of all of these diseases in endemic areas and lead to disease outbreaks in new areas[33,39-42].

Globalisation

While human-animal interactions lead to the emergence of infectious diseases, numbers and movement of people help determine their reach.

In the last century, the human population has expanded four-fold to almost 8 billion, with vast numbers of people moving to urban centres. Over the same period, globalisation has led to the unparalleled passage of people, animals and goods across national borders, which in turn has fuelled the international spread of zoonotic infections.

Within months of its appearance, the SARS virus had spread to more than two dozen countries in Europe, North America, South America, and Asia. By the time the global outbreak was contained, it had infected over 8,000 people worldwide and killed almost 800[43].

Within just one month of the COVID-19 virus appearing, it had spread to 18 countries, and by August 2020 there were over 20 million cases of infection and 700,000 deaths across most world regions, with case numbers continuing to rise[4].

The future

It is estimated that more than 700,000 undiscovered animal viruses exist that humans could potentially contract[44]. Any one of these could prove to be more infectious, have a higher fatality rate and inflict worse economic damage than have emerging zoonoses to date.

While attention must be paid to improving surveillance for emerging infections and immediate response capabilities, these alone will be inadequate to protect our health. We must simultaneously address the processes driving zoonotic disease emergence, which all stem back to the lack of priority

Case study: Hendra virus

Hendra is a virus that infects flying foxes (also called fruit bats) of the Pteropodidae family[45]. The virus can spread from flying foxes to horses, horses to horses and from horses to people.

Flying foxes appear to carry the virus without suffering any ill effects. How the virus is transmitted to horses is not conclusively known, but it is likely this occurs when horses eat food contaminated by flying fox urine, saliva or birth products[46]. In turn, the virus can be transmitted to other horses or humans following exposure to the body fluids of an infected horse.

The first documented outbreak of Hendra virus disease occurred in 1994 in the Brisbane suburb of Hendra. Since then, there have been more than 90 confirmed cases of Hendra virus infection in horses and 7 in people. Of the seven cases in people, four died from their infection[46].

Before human settlement, flying foxes moved over large areas of continuous coastal forest in eastern Australia feeding on a broad range of flowering and fruiting trees and vegetation[47]. The emergence of Hendra virus has been linked to extensive destruction of these forests which has forced fruit bats into human areas in order to avoid starvation[48,49]. In some parts of subtropical Australia, more than 95% of winter foraging area of fruit bats has been destroyed.

Outbreaks of Hendra and other bat-associated infections have repeatedly prompted calls for flying fox colonies to be relocated or culled. However, these strategies may in fact amplify the risk of disease spill over to humans by forcing populations of bats to migrate and establish in new areas closer to horses or humans[50]. It is also postulated that the stress imposed on flying foxes by these strategies may increase the amount of virus they excrete[51].

These measures also ignore the vital role flying foxes play as pollinators and seed dispersers for crops and native forests. In many environments, they are better at these tasks than birds, insects and the wind. Without flying foxes, we wouldn't have our eucalypt, melaleuca or rainforests.

In turn, these forests regulate our air quality and soil fertility, act as carbon sinks and stabilise our river systems and water catchments. They also serve as places for human recreation and restoration, both physical and psychological.

Over the last decade, heat, drought and bushfires have compounded the impacts of habitat destruction on flying fox populations. It is estimated that in the 2019-20 summer bushfires, up to 30% of remaining flying fox habitat was destroyed[52], while extreme heat over the same period directly caused tens of thousands of flying foxes to perish[53].

Three of seven flying fox species are now listed as critically endangered, endangered or vulnerable to extinction in Australia[54].

placed on protecting natural systems and the extreme pressures we are exposing them to.

This means stopping the destruction and degradation of forests and other habitats, and unsustainable land conversion. It will also require us rethinking our exploitation of wildlife and livestock, taking urgent action to mitigate climate risks and revising the way we travel and trade.

In short, we must start protecting and preserving nature so that it can protect us.

What can be done?

Actions we can take as individuals include:

•Consumng less animal products (i.e. eating less meat and dairy – see DEA's fact sheet on Food for Health People, Healthy Planet)

•Supporting organisations that protect animals from illegal hunting and wildlife trade (for instance The Thin Green Line, Humane Society International, World Wildlife Fund)

•Conserving local habitat via planting local species and opposing unsustainable developments

•Voting for candidates that support conservation of the natural environment

•Divesting personal funds from companies that destroy the natural world

•Joining and working with organisations to reduce land degradation and improve animal wellbeing

At a societal level, DEA supports:

•An end to old growth and native foest logging – see DEA's fact sheet on land clearing

•Strengthening and enforcement of environmental regulations that protect vulnerable habitats including wetlands, mangroves and coastal forests

•Reductions in and increased oversight of the use of antibiotics in farming

•Strong action on climate change

•In the recovery period from the COVID-19 pandemic and beyond, the deployment of economic stimulus measures and the creation of jobs that protect and promote environmental and human health.

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