Wildlife conservation: a principles-based approach to prevent biological disasters

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Biological disasters can affect living organisms in the form of epidemic or pandemic and human-induced environmental changes are driving the emergence of many infectious diseases throughout the world. In recent years, viruses from wildlife hosts have caused high-impact disease outbreaks such as SARS, Ebola and the recent COVID-19 pandemic.

The importance of viral-host switching was highlighted by the avian epizootics of high-pathogenicity strains of H5N1 Influenza A in 2003, in which 'spillover' to humans caused high mortality. Fortunately, there was no human-to-human transmission.[1] However, in the COVID-19 pandemic, millions of deaths have occurred right across the globe.

Contact between donor and recipient hosts is a precondition for viral-host transfer. There are many factors such as wildlife trade, bushmeat hunting, human population expansion, deforestation and changing farming practices that can potentially facilitate the entry of viruses and spread to new hosts. Increased involvement of wildlife in livestock and human diseases is likely due to several changing anthropogenic factors such as increased interaction with the wildlife for recreation purpose and increased encroachment into wildlife habitat.

Ecotone

Wildlife is usually limited to a particular habitat. When the interface between wildlife and human or livestock is disturbed it may result in disease emergence or biological disasters. This can be understood by the concept of ecotone, which is the transition zone between 2 adjacent ecological systems. Ecotone includes zones of interactions where human settlements and accompanying cropland and pasture expand into relatively intact natural ecosystems. Human-created ecotones are presenting major issues as they extend deep into intact forest areas. Biodiversity is also being lost. Between 1940 and 2004, biodiversity loss has resulted in increased pathogen transmission and disease emergence and over 300 emerging disease events have been identified around the world.

Ebola virus disease and deforestation

Since the Ebola epidemic, investigations are ongoing to establish the network and pathways of this disaster. Most researchers have documented the significant link between forest loss and disease outbreak. Olivero and co-authors (2019)[2] observed positive human influence on 5 out of 20 fruit bat species that could be associated with Ebola outbreaks in deforested areas within the tropical forest biome in West and Central Africa. This biome was described as favourable for the occurrence of the Ebola virus in the wild. The human activities involving the cultivation of fruits for commercial purposes provided an ample year-round food supply for the bats and increased the human-bat interaction in this biome. This demonstrates the influence of human-created disturbances in the natural ecosystem on Ebola outbreaks.

AIDS and interaction with non-human primates

AIDS was first recognised in the early 1980s when an established SIV (Simian immunodeficiency virus) switched from non-human primates into humans. Although the exact conditions and circumstances of cross-species transmission remain unknown, human exposure to the secretions of infected primates through hunting and butchering of primate bushmeat, represents the most reasonable

source for human infection. Bushmeat hunting, as a source of animal proteins, is a longstanding practice in rural areas generally throughout sub-Saharan Africa. However, the use of firearms, commercial logging and road constructions penetrating remote forest areas resulted in human migration to previously inaccessible areas. This led to more exposure, amplification and establishment of the virus in the human population. With increased human mobility around the world, it is possible that recombinant SIV and HIV can emerge anywhere globally even farther away from the area of its first emergence.

West Nile virus infection and loss of biodiversity

West Nile virus was first observed in Africa, in the West Nile district of Uganda in 1937. When this virus reached the USA in 1999, the outbreak resulted in morbidity and mortalities. Then it spread further and within 5 years, West Nile virus was considered endemic. Ezenwa and co-authors (2006)[3] reveal an association between non-passerine species richness and West Nile virus infection rates. West Nile virus activity in Culex mosquitoes declined with increasing non-passerine species richness suggesting that virus amplification rates were lower at sites with more non-passerine species. That study supported the hypothesis that increased biodiversity can moderate disease risk.

Biological disasters at the wildlife-domestic interface

Lions in the Serengeti were severely affected by the outbreak of canine distemper in 1994 and the event led to the loss of one-third of the lion population. Similarly, canine distemper resulted in tiger deaths in Amur in Russia and also in big cats in India. In most of the cases, evidence and studies suggested domestic dogs, especially feral dogs living in the ecotones and peripheral villages, as the potential reservoir of canine distemper. These cases indicate that ecological disturbances at ecotones may lead to biological disasters in any species.

Human-made biological disasters

Increased human interventions in protected areas have created a reservoir that can lead to biological disasters and epidemics at any time. Nipah virus epidemic, which led to human deaths in South East Asia, was the result of integrated farming system. Fruit bats are usually sub-clinically infected but they do not infect other species until their natural habitat is disturbed. However, deforestation and intensive fruit cultivation in ecotone areas and rearing pigs on the same land led to the transmission of the Nipah virus to pigs. Rapid amplification of the virus occurred in the pig population and then to humans who came into direct contact with infected pigs.

Negative implications for the removal of wildlife reservoirs

In countries where the economy is largely based on livestock products, questions regarding the removal of reservoir species are common. It has negative implications that can be understood by the example of the culling of the European badger to control tuberculosis in farm animals. Culling was initiated because several studies on bovine tuberculosis indicated the disease was consistently higher in badgers than in other British wild mammals around the cattle farms. Badgers are social animals and culling depleted their social structure. The remaining animals started to wander and move to other burrows resulting in greater exposure of cattle to the pathogen and increased incidences of tuberculosis in the cattle population. Thus, removing a wildlife reservoir may instigate or exacerbate virus transmission.

Is wildlife in every biological disaster?

The answer is 'yes' because, in many epidemics, wildlife has been the potential source. However, wildlife is an integral part of ecosystems and is very sensitive to biological changes. Hence, wildlife can be considered as 'the canary in the coal mine'. Wildlife safeguards mankind and will be quickly affected in any disaster. Various wild species harbour pathogens and act as reservoirs but do not transmit the same to other species. Half of the disease emergence in the world is associated with biodiversity loss and biodiversity moderates disease risk via the 'dilution effect'. That is, infection rates among hosts will be very low in highly diverse communities. This is because there are 'incompetent' hosts in communities and there are reservoir hosts and dead-end hosts that will interfere with the active transmission of pathogens to a new species.

Conclusion

Biological disasters might be prevented by limiting the contact between the hosts and potential new communities. The concept of ecotone is important because the more that humans exploit their natural resources, the more they will be giving space for pathogens to thrive, as shown in the cases of Ebola and Nipah virus infections. Wildlife biological disasters could be averted by the cessation of culling reservoir species such as bats. In addition, awareness should be raised about hunting and selling wild species. Every species has a definite role in the ecosystem and their alteration or extinction will make the whole ecosystem vulnerable to biological disasters.

Endnotes

1. Murray CJ, Lopez AD, Chin B, Feehan D & Hill KH 2006, *Estimation of potential global pandemic influenza mortality on the basis of vital registry data from the 1918-20 pandemic: a quantitative analysis. Lancet, vol. 368, pp.2211–2218.*

2. Olivero J, Fa JE, Farfan MA, Marquez AL, Real R, Juste FJ, Leederts SA & Nasi R 2019, *Human activities link fruit bat presence to Ebola virus disease outbreaks. Mammal Review. doi:10.1111/mam.12173*

3. Ezenwa VO, Godsey MS, King RJ & Guptill SC 2006, *Avian diversity and West Nile virus: testing associations between biodiversity and infectious disease risk. Proceedings of the Royal Society of London, B 273, pp.109–117.*

