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Nexus between Biodiversity Loss and Infectious Diseases Outbreaks

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Abstract

The role that biodiversity could play in resolving the epidemiological puzzle that confronts efforts at stemming the tide of infectious and non-communicable diseases remains contentious. However, biodiversity loss threatens the structure and proper functioning of the ecosystem, including its capacity to regulate the ecological functions of different organisms within the system and the distribution of those organisms over space and time. In the light of this, we examined the status and trend in world's biodiversity, relationship between biodiversity loss and infectious diseases and biodiversity conservation as a means for curbing infectious diseases outbreaks. It was noted that biodiversity status across the world is deteriorating more rapidly than ever. It was also noted that there is a strong correlation between low biodiversity and increased transmission risk of infectious diseases to humans and other species. can be reduced in communities with high biodiversity. Furthermore, it was shown that biodiversity conservation offers latitude of potentials for curbing the outbreak and spread of infectious diseases. Thus, policy makers must recognize the links between global biodiversity and public health goals and mainstream the protection of biodiversity into national public health programmes and other relevant sectors.

Keywords: Biodiversity conservation, infectious disease outbreak, COVID-19, public health

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Introduction

The United Nations Convention on Biological Diversity (UN-CBD, 1992) defines biodiversity as “the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Put simply, biodiversity is the variety of life on earth. It is another word for nature. There are different levels of biodiversity, viz: genetic, species, ecosystem and ecoregional. Genetic diversity is the total variety of genes within and between different populations of species. On the other hand, species diversity is the variety of species within a given ecosystem. Species include all living organisms, including plants, lichens, algae, fungi, mammals, fish, reptiles, amphibians, birds and other types of organisms. Ecosystem diversity refers to the variety of species, populations and natural communities within an ecosystem. Examples of this include marine, coastal, grassland, wetland, forest, dryland, montane and river ecosystems. Ecoregional diversity is a measure of

biodiversity at a large scale, including terrestrial ecoregions, marine ecoregions and freshwater ecoregions, all of which involve large areas of land and water with repeating patterns of ecosystems (Omernik, 2004).

Biodiversity resources are very important for the economic well-being and development of every nation. In general, the benefits derived from biodiversity resources have been broadly categorized into four, viz: provisioning; regulating; cultural and supporting services (Millennium Ecosystem Assessment, 2005). Provisioning services encompass anything relating to the production of renewable resources. In this regard, biodiversity provides food, water, medicinal resources and various raw materials for the benefits of the human society. Regulating services refer to anything that lessens environmental change and enhance stability of the planet earth. For instance, maintaining biodiversity of tree species in a forest increases the number of trees that grow there. Having more trees means they absorb more carbon dioxide, thereby reducing the impact of climate change. The cultural services of biodiversity are

anything from biodiversity that we get direct value or enjoyment from. This can be any type of outdoor recreation, tourism, aesthetic value, education, spiritual and religious inspirations. Supporting services from biodiversity relate to services necessary for the production of other ecosystem services offer by biodiversity resources. It includes ecosystem lifecycle and genetic diversity maintenance (Millennium Ecosystem Assessment, 2005).

All the above services are again closely related to four broad functions offer by biodiversity resources. These are: economic service functions; environmental and ecological service functions; socio-cultural service functions; and scientific and research service functions. It is pertinent to note that biodiversity acts as a regulator of ecosystem processes, regulating the ecological functions of different organisms within the system and the distribution of those organisms over space and time (Soliveres *et al.*, 2005). This in turn has direct and indirect consequences for human health and well-being, including the epidemiological puzzle that confront efforts at stemming the tide of infectious

and non-communicable diseases (CBD and WHO, 2015). To this end, there appears an inexorable link between biodiversity conservation, human health and outbreak of infectious diseases such as COVID-19 that is currently ravaging the entire world.

Status and Trend in World's Biodiversity

There have been different anecdotes and guesswork as to the exact quantum of living organisms on planet earth. Scientists have given estimates in the range of 5-15 million. However, a census conducted by researchers at the Hawaii University estimates that a total of 8.7 million species live on the planet earth (University of Hawaii, 2011). Out of these, only about 1.3-1.4 million, (about 15%) of have been described (Figure 1). In terms of ecosystems, the major ecosystems of the world are forest, savanna, grassland, desert, chaparral, and tundra. The forest covers 31 percent of the global land area (Figure 2) and harbours most (~ 80%) of earth's terrestrial biodiversity (FAO and UNEP, 2020).

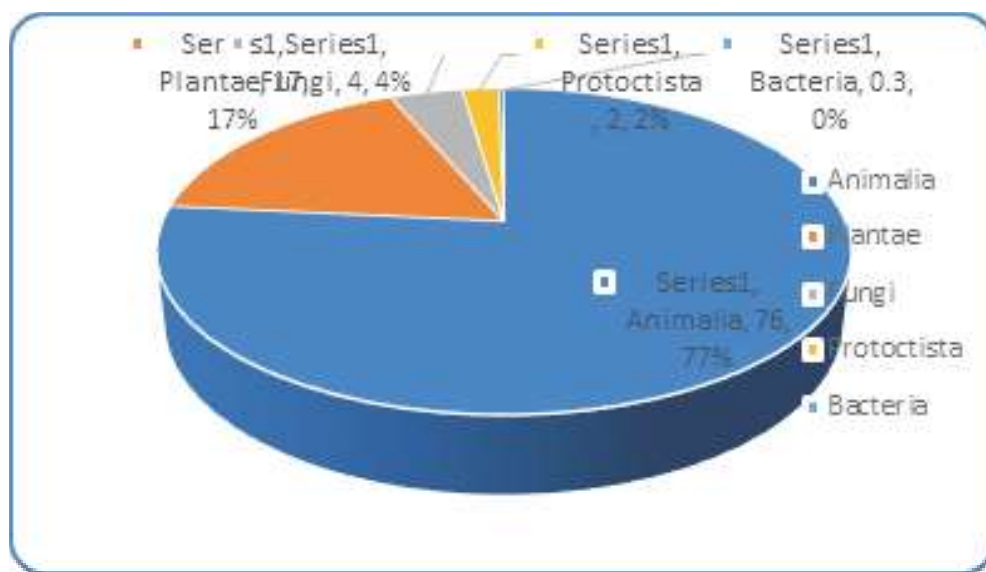


Figure 1: Distribution of known species of living organisms on Earth

Source: CBD, 2003

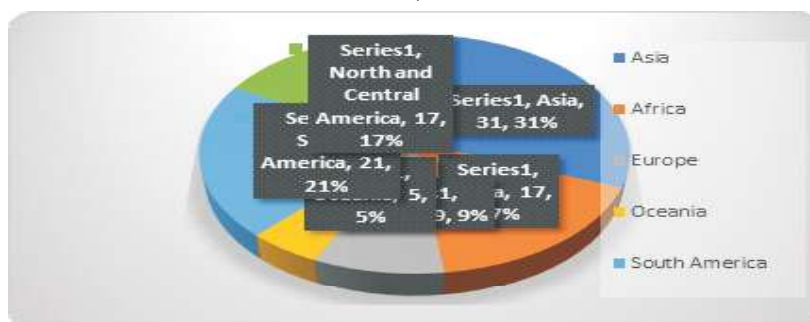


Figure 2: Global Distribution of Forest Cover

Source: FAO and UNEP, 2020

The International Union for Conservation of Nature and Natural Resources (IUCN) as at 2020 has assessed the conservation status of about 120,000 species globally. Of these more than 31,000 species, representing 27% of all assessed species, are threatened with extinction. In the same vein, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services in her 2019 Global Assessment Report (IPBES, 2019), shows that the health of ecosystems on which all species depend is deteriorating more rapidly than ever. The report shows that the average abundance of native species in most major land-based habitats has fallen by at least 20%, mostly since 1900. More than 40% of amphibian species, almost 33% of reef-forming corals and more than a third of all marine mammals are threatened. The picture is less clear for insect species, but evidence supports a tentative estimate of 10% being threatened. At least 680 vertebrate species are said to have been driven to extinction since the 16th century and more than 9% of all domesticated breeds of mammals used for food and agriculture had become extinct by 2016, with at least 1,000 more breeds still threatened. Estimates indicate that the current rate of species loss varies between 100 and 10,000 times the background extinction rate (which is roughly one to five species per year). The report noted that up to one million plant and animal species are facing extinction due to human activities.

Biodiversity loss threatens the structure and proper functioning of the ecosystem. Although all ecosystems are able to adapt to the stresses associated with reductions in biodiversity to some degree, biodiversity loss reduces an ecosystem's complexity, as roles once played by multiple interacting species or multiple interacting individuals are played by fewer or none (Jayna *et al.*, 2020). As parts are lost, the ecosystem loses its ability to recover from a disturbance. Beyond a critical point of species removal or diminishment, the ecosystem can become destabilized and collapse. Declining biodiversity also lowers an ecosystem's productivity and lowers the quality of the ecosystem's services, including its capacity to buffer us from the scourge of infectious diseases.

Nexus between Biodiversity Loss and Infectious Diseases

Disease ecologists have fervently debated whether biodiversity loss leads to an increased disease risk. Luis *et al.* (2018) showed that species diversity can have both positive and negative influences on disease transmission in the same host-pathogen system at the same time. For a number of species, a more diverse community decreases infection risk. This was termed "the dilution effect," because biodiversity dilutes infection. Meanwhile, for some systems, a more diverse community increases disease risk, and this was

termed the "amplification" effect. For other systems, biodiversity has no consistent effect, leaving its relationship to disease unidentified.

However, in their review of various studies discussing the influence of biodiversity on disease transmission risk, Pfäffle *et al.* (2015) showed that transmission risk to humans and other species can be reduced in communities with high biodiversity. In other words, biodiversity loss tends to increase pathogen transmission and disease incidence. For instance, studies in the United States have detected strong correlations between low bird diversity and increased human risk or incidence of West Nile encephalitis. Correlational and experimental studies have also shown that a lower diversity of small mammals increases the prevalence of Hantaviruses in their hosts, thereby increasing risk to humans (Swaddle and Calos, 2008; Allan *et al.*, 2009).

Diversity has a similar effect for plant diseases, with species losses increasing the transmission of two fungal rust pathogens that infect perennial rye grass and other plant species. As revealed by Pfäffle *et al.* (2015), the loss of biodiversity can affect the transmission of infectious diseases by changing: the abundance of the host or vector; the behaviour of the host, vector or parasite; and the condition of the host or vector. It is instructive to note that while emerging disease events were being identified in humans around the world, at the same time other emerging infectious diseases are also appearing in wildlife, domesticated animals, and crop and wild plants (Jones *et al.*, 2008). It is well-established that anthropogenic changes in ecosystems are increasing infectious disease transmission risks and impact. For instance, Rulli *et al.* (2017) used land cover change data in conjunction with Ebola Virus Disease (EVD) outbreak records to investigate the association between outbreaks in West and Central Africa, and patterns of land use change in the region. The authors found that EVD index cases outbreaks in humans occurred mostly in hotspots of forest fragmentation. This shows that biodiversity losses may enhance the likelihood of infectious diseases outbreaks.

Biodiversity Conservation for Curbing Infectious Diseases Outbreaks

Biodiversity protect organisms, including humans, from transmission of infectious diseases in many cases (Keesing *et al.*, 2010). Therefore, preserving biodiversity will help reduce the incidence of established pathogens. In order to improve biodiversity conservation generally, the international community will have to recommit to the global biodiversity protection goals that it has already established as part of its climate and biodiversity frameworks (for example, the Aichi Biodiversity Targets). One important policy priority will be to expand and enforce protected areas measures to

ensure that natural habitats remain intact and do not become fragmented. Policies that preserve contiguous key biodiversity areas could reduce the risk of disease transmission associated with small and scattered patches. In other words, from a public health perspective, an important goal of land-use policies should be to preserve larger tracts of healthy and biodiverse habitats, in order to reduce the potential for contact with human populations (Pongsiri *et al.*, 2009).

Similarly, there is a need for a new international consensus that recognizes the links between global biodiversity and public health goals, including the prevention of future pandemics. Biodiversity and health strategies should be developed with the aim of ensuring that the biodiversity and health linkages are widely recognized, valued, and reflected in national public health and biodiversity strategies, and in the programmes, plans, and strategies of other relevant sectors, with the involvement of local communities. Policymakers must see the link among health; development and natural resource management policies so as to take into account the long-term costs and consequences of their policies for people and nature. Supporting community-centered biodiversity conservation with an explicit goal to safeguard public health in rural settings should be a key response from national policymakers and the international donor community to the COVID-19 pandemic. The tagline should be that healthy forest and farm ecosystems with strong biodiversity support healthy communities through reduced disease transmission (Keesing *et al.*, 2010).

Biodiversity conservation efforts more broadly are critical to protecting humans from the spread of zoonotic diseases. Greater biodiversity and ecosystem integrity can help regulate diseases by supporting a diversity of species, so that it is more difficult for one pathogen to spread rapidly or dominate. As such, efforts to preserve biodiversity, enhance ecosystem integrity and protect forests are necessary steps toward reducing disease incidence and lowering the risk of future pandemics (Keesing *et al.*, 2010; UNEP, 2016).

Conclusion

There is an inextricable link between biodiversity conservation, human health and outbreak of infectious diseases. Biodiversity loss threatens the proper functioning of the ecosystem. The preponderance of evidence suggests that transmission risk to humans and other species can be reduced in communities with high biodiversity. This lends credence to the fact that biodiversity conservation may help reduce the incidence of established pathogens as well as curbing the spread of emerging infectious diseases. It is therefore hoped that the international community will recommit to the global biodiversity protection goals that it has already established as part of its climate and

biodiversity frameworks, particularly in the face of the ravaging COVID-19 global pandemic.

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