REVIEW ARTICLE

Biodiversity Loss and its Impacts on Human Well-being

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Abstract

Biodiversity loss is one of the major concerns of today's world. It refers to the mass extinction of different species. Various anthropogenic activities and environmental pollution are major contributors to biodiversity loss. From agricultural activities to various industrial activities contributes greatly to degrading biodiversity. This paper reviews multiple literature sources that deal with the biodiversity loss and explain the various factors affecting biodiversity. It also reviews the impact of biodiversity loss on the well-being of the human population. Biodiversity loss does not only affect human health but also other animals and species. Biological imbalance gives rise to several diseases that create a harmful threat to human beings. In recent decades, we have observed a great deal of newer zoonotical diseases, which are triggered by biodiversity loss. Thus, preserving and managing biodiversity should be our priority and by doing this we would also create a safeguard overall for a well-being of human beings and nature.

Keywords: Biodiversity, Biodiversity loss, human health, zoonotical diseases, inflammatory diseases

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Introduction

"Biological diversity" popularly referred to as biodiversity is the variety and variability of species present on the earth at all levels from genes to ecosystem level. Biodiversity includes all the aspects of life from evolutionary and ecological to cultural aspects from all sources including terrestrial, marine and other aquatic ecosystems and ecological complexes. Biodiversity consists of every living thing on earth from microorganisms to animals to humans and every flora and fauna. It is the combination that possesses the ability to prevent and recover from a variety of disasters.

We, humans, are dependent on biodiversity to sustain our lives. It not only provides us with food, shelter and fuel but it also plays a very important role in activities like climate regulation, control of pests, nutrient cycling, water purification, soil formation and protection, pollution breakdown and many such natural processes ("Biodiversity," 2021) species, and ecosystem level. Terrestrial biodiversity is usually greater near the equator, which is the result of the warm climate and high primary productivity. Biodiversity is not distributed evenly on Earth, and is richer in the tropics. These tropical forest ecosystems cover less than ten percent of earth's surface, and contain about ninety percent of the world's species. Marine biodiversity is usually higher along coasts in the Western Pacific, where sea surface temperature is highest, and in the mid-latitudinal band in all oceans. There are latitudinal gradients in species diversity. Biodiversity generally tends to cluster in hotspots, and has been increasing through time, but will be likely to slow in the future as a primary result of deforestation. It encompasses the evolutionary, ecological, and cultural processes that sustain life.\nRapid environmental changes typically cause mass extinctions. More than 99.9 percent of all species that ever lived on Earth, amounting to over five billion species, are estimated to be extinct. Estimates on the number of Earth's current species range from 10 million to 14 million, of which about 1.2 million have been documented and over 86 percent have not yet been described. The total amount of related DNA base pairs on Earth is estimated at 5.0 x 1037 and weighs 50 billion tonnes. In comparison, the total mass of the biosphere has been estimated to be as much as four trillion tons of carbon. In July 2016, scientists reported identifying a set of 355 genes from the Last Universal Common Ancestor (LUCA. We believe that we are independent of nature or that nature exists only for us. We take the diversity of the ecosystem for granted and exploit the natural resources till our heart desire. The imbalance created due to the greedy exploitation of biological diversity is affecting us in many ways and is hindering our day-to-day lives. E.O. Wilson once said about ants, "We need them to survive, but they don't need us at all." This statement is applicable to a number of fungi, bacteria, insects, plants and other organisms. This truth is largely lost to most of us. We do not accept the fact that we are more dependent on nature than nature is on us. We treat biodiversity as an infinite source of products and services and an infinite sink for our wastes. In the past 50 years, we have destroyed one-fourth of the world's topsoil, one-fifth of its agricultural land and one-third of its forest area. Many species have gone extinct and many are on the verge of going extinct. We are losing biodiversity and ecosystem at an alarming rate. These are all the consequences of environmental change, triggered by the human population.

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Biodiversity Loss

Above figure shows the various divers of biodiversity loss, there are so many drivers that impact on biodiversity losses including

climate change, habitat change, introduction of invasive species over exploitation of resources and pollution. All these drivers are interconnected with each other there are so many articles available that indicates about losses of diversity species (Fig. 1). Decades ago, at the first Earth Summit, the vast majority of the world's nations declared that human actions were dismantling Earth's ecosystems, eliminating genes, species, and biological traits at an alarming rate (Cardinale *et al.,* 2012). Although some loss of biodiversity is normal, the current rate of extinction is unprecedented being up to 1000 times higher than natural background rates (Roe, 2019). This is mainly due to growing human population and human activities. Causes of biodiversity loss can be divided into direct; such as land use, pollution or climate change, and indirect, including demographic factors as well as economic and governmental issues. To avoid a further decline in biodiversity, nature conservation is undertaken, which plays a key role in preserving natural ecosystems (Soler Luque and Kostecka, 2018).

In research by Hautier *et al.* (2015), it was stated that human-driven environmental changes may affect the biodiversity, productivity, and stability of Earth's ecosystems, but there was no consensus on the causal relationships linking these variables. But later in a study by García *et al.* (2018)land-use change, pollution, invasive species, they found that temperature changes systematically altered the relationship between biodiversity and ecosystem functioning. As temperatures departed from ambient conditions, the exponent of the diversity-functioning relationship increased, meaning that more species were required to maintain ecosystem functioning under thermal stress. There can also be numerous other factors that affects the diversity of the ecosystem. In a research based on sustainable agriculture by Erisman *et al.* (2016), it was illustrated that agriculture is one of the major drivers of biodiversity loss.

Biodiversity loss due to habitat destruction by conversion of natural lands into agriculture, intensification of agriculture has led to a strong decline of specific farmland biodiversity. Furthermore, many agricultural landscapes face pollution by pesticides and fertilizers, and encounter depleted soils and erosion due to unsustainable farming practices. This is threatening not only biodiversity but also complete ecosystems and the ecosystem services on which agriculture itself depends. The wildlife of marine systems is also heavily affected by fishing and in various ways by fish and shellfish farming.

Over the past 50 years, the biggest driver of habitat loss has been the conversion of natural ecosystems for crop production or pasture. The area of land occupied by agriculture has increased by around 5.5 times since 1600 and is still increasing. Currently, cropping and animal husbandry occupy about 50 per cent of the world's habitable land (Benton *et al.,* 2021).The trend is unmistakable that the human domination of ecosystems leads to a clear decline in biodiversity within many habitats and accelerates the process of extinction throughout the world (Martens *et al.,* 2003). Ehrlich, *et al.,* (1994)evaluated that rate of population and species extinction can be assessed by using an indirect measure: total consumption of energy (industrial plus traditional) by man.

We can say that biodiversity loss impacts the ecosystem and it can be concluded in these six statements based on the study done by (Cardinale *et al.,* 2012):

- Biodiversity loss reduces the efficiency by which ecological communities capture biologically essential resources, produce biomass, decompose and recycle biologically essential nutrients.
- Biodiversity increases the stability of ecosystem functions over time
- The impact of biodiversity on any single ecosystem process is non-linear and saturating, such that change accelerates as biodiversity loss increases
- Diverse communities are more productive because (a) they contain key species that have a large influence on productivity, and (b) differences in functional traits among organisms increase total resource capture
- Loss of diversity across trophic levels has the potential to influence ecosystem functions even more strongly than diversity loss within a trophic level
- Functional traits of organisms have large impacts on the magnitude of ecosystem functions, which give rise to a wide range of plausible impacts of extinction on ecosystem functions.

Biodiversity Loss and its Impact on Human Health

The diversity of genes, species, and ecosystems altogether constitutes biodiversity. Biodiversity is essential for our survival. Biodiversity and human health are intimately linked to each other, human beings are an integral and inseparable part of the natural ecosystem as human health depends ultimately on the health of its species. Anthropogenic biodiversity loss is due to reasons such as unsustainable production and consumption, human population growth, and poverty (Mandal, 2011).

Human well-being is a human experience that includes the basic materials for a good life, freedom of choice and action, health, good social relationships, a sense of cultural identity, and a sense of security. The sense of well-being is strongly dependent on the specific cultural, geographical, and historical context in which different human societies develop, and is determined by cultural-socioeconomic processes as well as by the provision of ecosystem services. However, the well-being of the vast majority of human societies is based more or less directly on the sustained delivery of fundamental ecosystem services, such as the production of food, fuel, and shelter, the regulation of the quality and quantity of water supply, the control of natural hazards, etc (Díaz *et al.*, 2006).

The Millennium Ecosystem Assessment and other commentators have warned about the impacts that biodiversity decline will have on human health. There is no doubt that the natural world provides mankind with most of the resources required to sustain life and health (Hough, 2014). Biodiversity loss affects the spread of human diseases, causes a loss of medical models, diminishes the supplies of raw materials for drug discovery and biotechnology, and threatens food production and water quality. Biodiversity and Human Health brings together leading thinkers on the global environment and biomedicine to explore the human health consequences of the loss of biological diversity (Grifo and Rosenthal, 1997). There has been an emergence of previously unknown infectious diseases which has been high on the medical and political agendas in recent years, as evidenced by the global responses to the severe acute respiratory syndrome, bird flu and swine

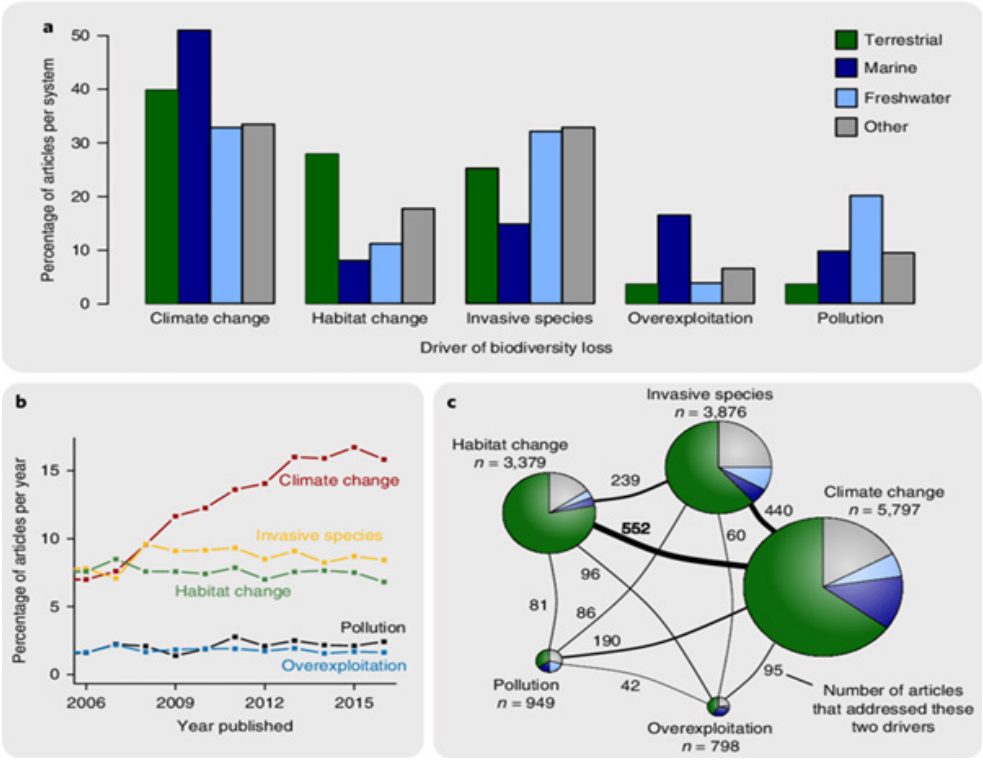

Fig. 1: Drivers of Biodiversity loss
(**Source:** Mazor *et al.,* 2018)

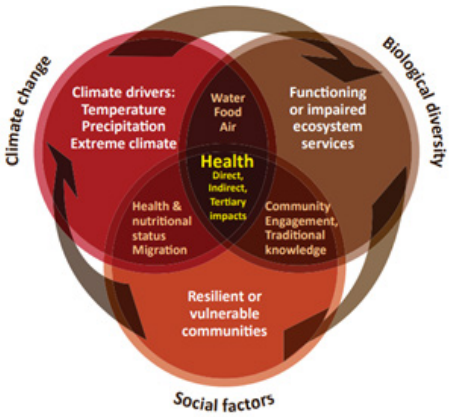

Fig. 2: Interrelation between Climate change, biological diversity and social factors on Human health (Source: Romanelli *et al.,* 2015).

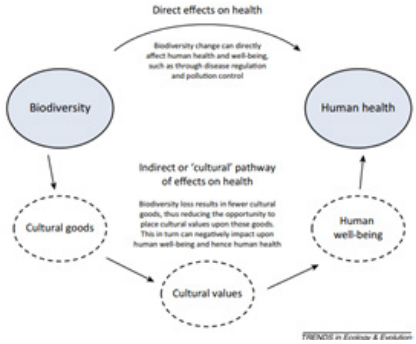

Fig. 3: Direct and Indirect impact of biodiversity (Source: Clark *et al.,* 2014b)

flu, and the revision of the International Health Regulations (Romanelli *et al*., 2015). Several studies covering a wide range of taxa, including plants, have shown that such disease emergence is primarily due to host shifts of pre-existing disease agents, usually driven by anthropogenic factors, such as globalized trade and increased human-wildlife contact rates(Cunningham *et al.,* 2012). In addition, it can affect the transmission of infectious diseases to humans, particularly vector-borne diseases such as malaria and Lyme disease (Pongsiri and Roman, 2007). The growing importance of livestock on the planet, while threatening biodiversity, is also increasingly putting human and animal health at risk (Morand, 2020)biodiversity loss and livestock expansion are increasing globally, and examining patterns that link them is important for both public health and conservation. This study is a first attempt to analysis globally these patterns using General additive modelling and Structural equation modelling. A positive association between the number of infectious and parasitic diseases recorded in humans and the total number of animal species between nations was observed. A similar positive association between the number of outbreaks of human infectious diseases, corrected for the number of surveys, and the number of threatened animal species, corrected for the number of animal species, suggests that outbreaks of human infectious diseases are linked with threatened biodiversity. Results of the analyses over the longest period of the dataset (2000–2019.

Climate change and variability have irreversible impacts on the global environment by altering hydrological systems and freshwater supplies, advancing land degradation and loss

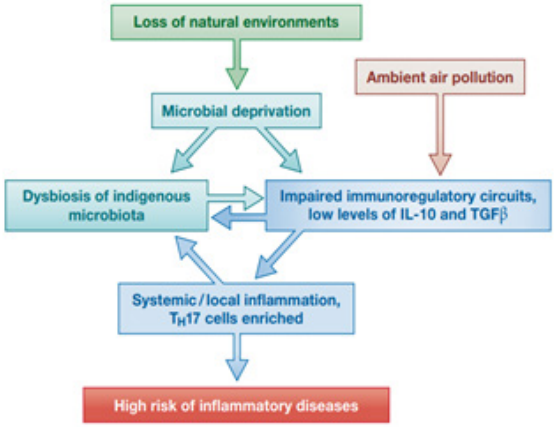

Fig. 4: Causes of inflammatory diseases (Source: "Natural Immunity," 2011a)

of biodiversity, and debilitating food production systems and ecosystem services, thus affecting health outcomes (WHO 2005). These factors are closely interrelated, like deforestation, industrial agriculture and centralized livestock production systems further accelerate climate change and biodiversity loss, thus contributing to potential risks to food security, nutrition, and other aspects of health, livelihoods and well-being (World Health Organization & Convention on Biological Diversity, 2015). The Fig. 2 below shows the interrelation between all the factors.

The constant increase in the human population and the increase in the demand of the food grain is increasing the use of land for agriculture, this in return is contributing to the loss of land that has a rich biodiversity. The extreme climate change triggered by population explosion is the one of the main causes of the spread of infectious diseases. Multiple factors determine the incidence of climate-sensitive infectious diseases such as malaria, dengue fever, Lyme disease, West Nile virus, and diarrheal diseases. Environmental factors such as land use and climate change–related impacts on ecosystems can create, increase, or decrease suitable habitats for vectors, possibly leading to the geographic spread or contraction of associated diseases (Ebi & Hess, 2020)and it will continue to do so. Average temperatures, precipitation amounts, and other variables such as humidity levels are all rising. In addition, weather variability is increasing, causing, for example, a greater number of heat waves, many of which are more intense and last longer, and more floods and droughts. These changes are collectively increasing the number of injuries, illnesses, and deaths from a wide range of climate-sensitive health outcomes. Future health risks will be determined not just by the hazards created by a changing climate but also by the sensitivity of individuals and communities exposed to these hazards and the capacity of health systems to prepare for and effectively manage the attendant risks. These risks include deaths and injuries from extreme events (for example, heat waves, storms, and floods.

The global encroachment by humans into natural habitats drives habitat loss and fragmentation, leading to declines in species richness, which can endanger human livelihoods. Evidence of habitat fragmentation leading to infectious disease emergence has been reported for Ebola virus disease (EVD). Human population density strongly correlates with the risk of emergence of all major classes of emerging infectious diseases (Wilkinson *et al.,* 2018). 75% of emerging human pathogens are zoonotical, meaning they have an animal origin. A comprehensive literature review identifies 1415 species of infectious organisms known to be pathogenic to humans, including 217 viruses and prions, 538 bacteria and rickettsia, 307 fungi, 66 protozoa and 287 helminths. Out of these, 868 (61%) are zoonotical, that is, they can be transmitted between humans and animals, and 175 pathogenic species are associated with diseases considered to be 'emerging' (Taylor *et al.,* 2001).

The wider risks to human health have been brought into sharp focus by the COVID-19 pandemic. COVID-19 is a 'zoonotical' disease, meaning that it originated in non-human animals and passed over to humans. It is the latest in a series of emerging infectious diseases (EIDs) to have reached epidemic or pandemic levels over recent decades; the majority of these EIDs have come from wild or farmed animals(Benton *et al.,* 2021), which is an indirect effect of the biodiversity loss. Biodiversity change can directly affect human health through the regulation of the emergence and transmission of diseases or pollution control. Fig. 3 depicts that biodiversity change can also indirectly impact human health via cultural pathways; biodiversity loss affects the provision of cultural goods, which reduces our opportunity to realise the cultural value placed upon those goods and, consequently, negatively impacts human well-being and, therefore, health (Clark *et al.,* 2014a).

Along with the relationship between biodiversity loss and zoonotical diseases, there has been also an observation between the inflammatory diseases as a result of biodiversity loss. In a study by von Hertzen, *et al.* (2011), they proposed a hypothesis that—biodiversity loss leads to immune dysfunction and disease—has numerous societal and public health implications that are increasingly apparent in the developed world and will have a major impact on developing countries in the near future ("Natural Immunity," 2011b). The Fig. 4 below illustrates the causes of inflammatory diseases:

Conclusion

Climate change and biodiversity loss are one of the major environmental concerns faced by humanity. Biodiversity is important for the well-being and survival of the human race. The loss of biodiversity due to the increased human interference in the ecosystem is increasing day by day and the loss is irreversible, and it threatens every species present on the earth. The loss of biodiversity is linked to climate change, epidemics and other major environmental issues.

Human health and diseases are determined by complex factors. The health threats from the human-animal-ecosystem and zoonotical diseases are increasing. In some recent research, it is found that some taxa are more likely to be zoonotical hosts and these animals are increasing rapidly in human-dominated landscapes. In the less disturbed areas, the risk of the spread of zoonotical diseases is less likely. Due to the loss of biodiversity the interaction between animals and humans is increasing and thus the risk of human exposure to new and established zoonotical pathogens are also increasing.

There is an urgent need to combat the current health crisis in the world, many kinds of research are taking place for the same

but along with that, we can also look into the ways to minimize the loss of biodiversity by spreading awareness among the general public and taking measures at a large scale. According to the World Health Organization, the adverse health effects brought by the loss of biodiversity far exceed the dangers of climate change to human health. Many studies state that protecting and maintaining biodiversity is much simpler and advisable than restoring it. Assessing the impact of the loss, some damaged ecosystems might never return to their original state. Thus, the best way to prevent the biodiversity loss is the conservation of the biological diversity. The conservation refers to the protection, prevention, management and/or the restoration of wildlife and natural resources.

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