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One health approach to decreasing biodiversity and the problem of emerging zoonotic diseases

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Abstract

In the last half century, decreasing biodiversity caused by anthropogenic factors turned into ecosystem health problem. With the decrease of biodiversity, the degradation of the ecological balance also poses a threat to public health. The damages caused by ecological and anthropogenic factors are the main triggers for the development of Emerging Zoonotic Diseases (EZDs). In this context, persistent EZDs due to multiple factors have reached more dangerous levels in terms of human, animal and environmental health. Increasing land-use changes, intensified agriculture and animal husbandry practices, global climate changes, changes in people's food consumption preferences, intensive migration from rural to urban areas, ecological distortions due to changing trade and tourism mobility are all human-induced dynamics, all of which lead to socioeconomic threats. In recent years, both ecosystem related problems resulting from the decline of biodiversity and the dynamic interactions between human, animal and environment (HAE) have made interdisciplinary cooperation more important than in the past. It has become an inevitable necessity to eliminate the accumulated Anthropocene remains in the last 150 years, to solve the health problems at the HAE-interface and to make the health and well-being of humanity sustainable. These accumulated problems of today can be solved with 'One Health' which is defined as multi-interdisciplinary understanding, joint effort and thought system which is worked on local, national, regional and global-scale in order to obtain the optimum health for humans, animals and our environment. As a result, interdisciplinary cooperation should be prioritized to solve common problems of complex health problems and threats. Therefore, the 'One Health' approach should be functionalized, institutionalized and expanded. Because exponentially growing ecological, anthropogenic disasters increase microbial threats. Therefore, in the 21st century, humanity has no more than 50 years to lose.

Key words: decreased biodiversity, emerging zoonotic diseases, one health, anthropogenic factors

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Biyoçeşitliliğin azalması ve yeniçıkan zoonotik hastalıklar sorununa tek sağlık yaklaşımı

Özet

Son yarım yüzyılda antropojenik faktörlerin sebep olduğu biyoçeşitliliğin azalması, ekosistem sağlığı sorununa dönüşmüştür. Biyoçeşitliliğin azalmasıyla birlikte ekolojik dengenin bozulması halk sağlığı yönünden de tehdit oluşturmaktadır. Ekolojik ve antropojenik faktörlerin neden olduğu zararlar Yeniçıkan Zoonotik Hastalıklar (YZH)'ı hazırlayan başlıca tetikleyicilerdir. Bu bağlamda, çoklu faktörlere bağlı olarak süregelen YZH'lar, insan hayvan ve çevre (İHÇ) sağlığı bakımından geçmişten daha tehlikeli boyutlara ulaşmışlardır. Artan oranda arazi kullanımı değişiklikleri, yoğunlaştırılmış tarım ve hayvancılık uygulamaları, küresel iklim değişiklileri, insanların gıda tüketim tercihlerindeki değişim, kırsaldan kentlere yoğun göçler, değişen ticaret ve turizm hareketliliğine bağlı ekolojik bozulmalar insan kaynaklı dinamikler olup, bunların hepsi sosyoekonomik tehditlere yol açmaktadırlar. Son yıllarda, hem biyoçeşitliliğin azalmasından kaynaklanan ekosistem ile ilgili sorunlar hem de insan hayvan çevre (İHÇ)-arayüzünde süregelen dinamik etkileşimler, geçmişten daha çok disiplinlerarası işbirliğini zorunlu hale getirmiştir. Son 150 yıllık süreçte birikmiş

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Antroposen kalıntılarını ortadan kaldırmak, İHÇ–arayüzündeki sağlık sorunlarını çözüme kavuşturmak ve insanlığın sağlık ve gönencini sürdürülebilir kılmak kaçınılmazdır. Günümüzün birikmiş bu sorunları, "insanlar, hayvanlar ve çevremiz için en uygun sağlık elde etmek amacıyla yerel, ulusal, bölgesel ve küresel ölçekte çalışılan çoklu disiplinlerarası anlayış, ortak çaba ve düşünce sistemi" olarak tanımlanan 'Tek Sağlık' ile çözümlenebilir. Sonuç olarak, devingen özellikteki karmaşık sağlık sorunları ve tehditleri "ortak düşünce ile çözmek" için disiplinlerarası işbirliği öncelenmelidir. Bu yüzden, 'Tek Sağlık' yaklaşımı işlevselleştirilmeli, kurumsallaştırılmalı ve yaygınlaştırılmalıdır. Çünkü katlanarak büyüyen ekolojik, antropojenik felaketler mikrobiyal tehditleri artırmaktadır. Bu yüzden, 21. yüzyılda, insanlığın kaybedecek bir 50 yılı daha kalmamıştır.

Anahtar kelimeler: biyoçeşitliliğin azalması, yeniçıkan zoonotik hastalıklar, tek sağlık, antropojenik faktörler

1. Introduction

Biodiversity or biological diversity is a term that refers to the diversity of all biological systems at the molecular, organism, population, species and ecosystem levels, and includes diversity within and between species [1]. Although it may seem difficult to talk about the existence of a direct link between biodiversity and human health at first [2], studies has gained momentum about urbanization, industrial activities, climate changes, invasive species alone or their combinations that change the natural environment and biodiversity, and thus affect human health [3].

2. Biodiversity, loss of biodiversity and its effects on health

Biodiversity is potentially effective on health through 3 different mechanisms. These are positive / negative effects on physiological and psychological health values, effects on the course of chronic diseases and infectious diseases [2]. Allergy, autoimmune diseases, chronic inflammatory diseases such as inflammatory bowel disease (IBD), the presence of cancer and psychiatric diseases are the main examples of these effects. Biologically diverse environments are reported to be capable of altering and enhancing the endogenous human microbiota, which is essential for the presence of a balanced and functional immune system, and thus affects human health [4-6].

Interacting with forests, urban parks and other semi-natural environments, even for a short time, improves self-confidence, mood and mental perception while reducing stress symptoms and attention deficiencies as well as physical health. Moreover, biodiversity has been suggested to be effective even in prenatal development and in the early stages of life and has a positive effect on the birth weight of infants. It should be noted that plant diversity has direct or indirect effects on reducing air pollution, which can cause allergies, asthma, cardiovascular diseases and premature births [6].

Various scientific studies on the positive effects of interacting with natural environment and biodiversity environments on human health and welfare are summarized in Table 1.

Table 1. Studies on the effects of natural environment / biodiversity on health effects

Relationship between biodiversity / natural environment and human health / welfare level	**References**
Physiological / Psychological / Psychiatric effects	7-11
Chronic disease and immune system effects	12-19
Infectious disease effects	20-23

In addition to the studies in Table 1, Ray and Jakubec (2014) reported in their meta-analysis that the survival of a nature-based life has therapeutic effects in cancer patients[24]. It should also be noted that the ethnobotanical-based drug development strategies still remain valid in the treatment of diseases such as cancer [25, 26]. Further animal modeling and epidemiological studies should be conducted to assess the health effects of biodiversity [6] and new strategies should be developed. On the other hand, the loss and / or reduction of biodiversity caused by various reasons leads to increased infectious disease agents in nature, transmission of pathogens at the HAE-interface, displacement of vectors and loss of our ability to fight infectious diseases [21-23].

Therefore, this review will focus on the increase of infectious disease agents due to loss and/or reduction of Biodiversity and their interactions at the HAE-interface.

3. Emerging zoonotic diseases

The concept of "emerging zoonoses" which entered the literature in the last quarter century; "An emerging zoonosis is a zoonosis that is newly recognized or newly evolved, or that has occurred previously but shows an increase in incidence or expansion in geographical, host or vector range." [27].

In recent years, Emerging Zoonotic Diseases (EZD's), which have caused serious problems in human and animal health, are important both in terms of clinical services and epidemiological features. In addition, EZD's remain one of the most important health problems of the 21st century in terms of livestock economy, biosecurity and Global Health Safety [28).

Especially in the last quarter of the 150-year that is defined as the 'Anthropocene Age', ecological and anthropogenic factors have multiplied, the acceleration of latent potential has increased and threats have become globalized [29]. The degradation of the ecosystem and the increase in globalization due to anthropogenic reasons have accelerated the loss of species and the decrease of biodiversity. It has increased ecosystem degradation that alters infectious disease patterns, accumulation of toxic pollutants and invasion of wild species / pathogens [30].

In many areas of life, EZD's caused by pathogens (Figure 1, Tables 3 and 4) pose a threat with dynamic interactions at the HAE-interface in the last 40-45 years. According to current data [29-35], there are two main causes of these multiple and complex threats namely ecological and anthropogenic factors.

3.1 Ecological and Anthropogenic Factors in Emerging Zoonotic Disease

In recent years, land use, climate change, human movements and animal-commodity transport are important factors that lead to regional and global spread of Re-emerging Disease and/or Emerging Zoonotic Disease [30-34]. As with all infections, it should not be ignored that the occurrence dynamics of EZDs or Re-Emerging Zoonotic Diseases are complex and involve many sectors in the prevention / protection process. In recent years, these have been the focus of increasing interest in infectious diseases, medical and veterinary services, and many other health institutions [35].

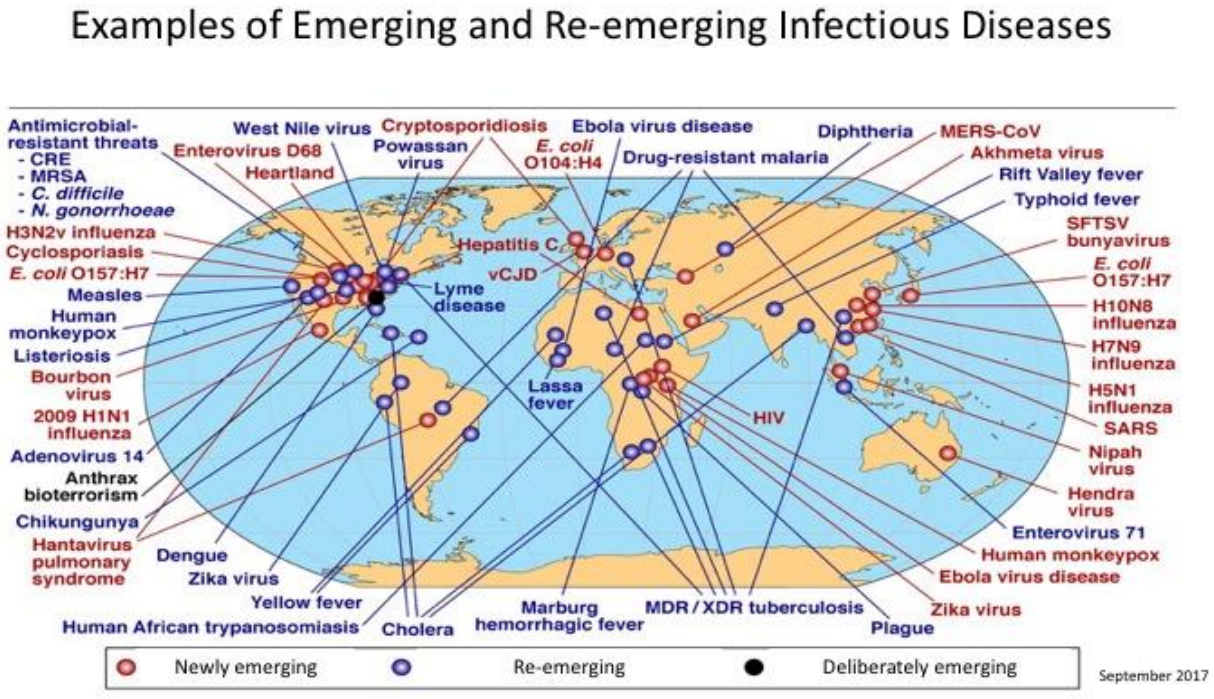

Figure 1. Emerging and Re-emerging Infectious Diseases defined by the world until 2017 (Adapted from Paules, C.I., 2017).

Most of the factors on the map are zoonotic. Red dots and blue dots respectively indicate newly identified, existing and redefined pathogens. Considering that only AIDS exists on the map in the 1980s, the identification of so many pathogens poses a serious threat to public and ecosystem health in the last 37 years. In addition, according to Morand et al. [32] report and Table 2, there is a positive relationship between the decrease of biodiversity and local / regional spread of pathogens and increase of Re-emerging disease. Therefore, as shown in the map in Figure 1 and in

Tables 2 and 3, when the effects of pathogens on human and animal health are reviewed, it is understood that there are many "preparatory factors" in the background of the increase and spread of EZD's [33].

Table 2. Examples of reduced biodiversity and increased transmission of pathogens (Adapted from Morand, S. et al., 2014)

Host species	**Location**	**Pathogens**
Rodents	USA	Hantavirus (*Sin Nombre Virus*)
	Southeast Asia	Hantavirus (*Seoul Virus*)
	Belgium	Hantavirus (*Puumala Virus*)
	USA	*Bartonella spp*.
Rodents and other mammals	USA	*Borrelia burgdorferi* (Lyme disease)
Small mammals	USA	*Anaplasma phagocytophilum*
Birds	USA	West Nile virus (BNV)
	Germany	*Himasthla elongata* (helmint)

Table 3. Some emerging pathogens endemicly located in different parts of the world (Adapted from Kilpatrick A.M., and Randolph S.E. 2012)

Pathogens	**Regions at risk**	**Endemic region**	**Pathways**
Japanase encephalitis virus	America	Asia	Infected livestock
Rift Valley Fever Virus	America, Mediterranean Europe	Africa, Asia	Infected livestock
Chikungunya virus	Europe, America, Australia	Africa, Asia	Infected human
Mayaro virus	Africa, Asia, Europe	South America	Infected human
Zika virus	Europe, America	Africa, Asia	Infected human
Dengue virus	Southern Europe	Southern hemisphere	Infected human
West Nile virus	Central Europe, Turkey	Africa, Asia, Europe, Australia	Migratory birds

3.2 Ecological factors

Decreased biodiversity due to global climate change, land use and deforestation and Vector-borne Diseases (VBDs) due to disruption in the ecosystem are important issues for regional and global health [1, 2, 6, 32-36]. As shown in Figure 2, continuous and dynamic interactions at the IHC-interface in nature are important in terms of environmental changes and pathogen microorganism-host relationships. Meantime, the ongoing dynamism at the IHC-interface is valuable to predict risks arising from zoonoses.

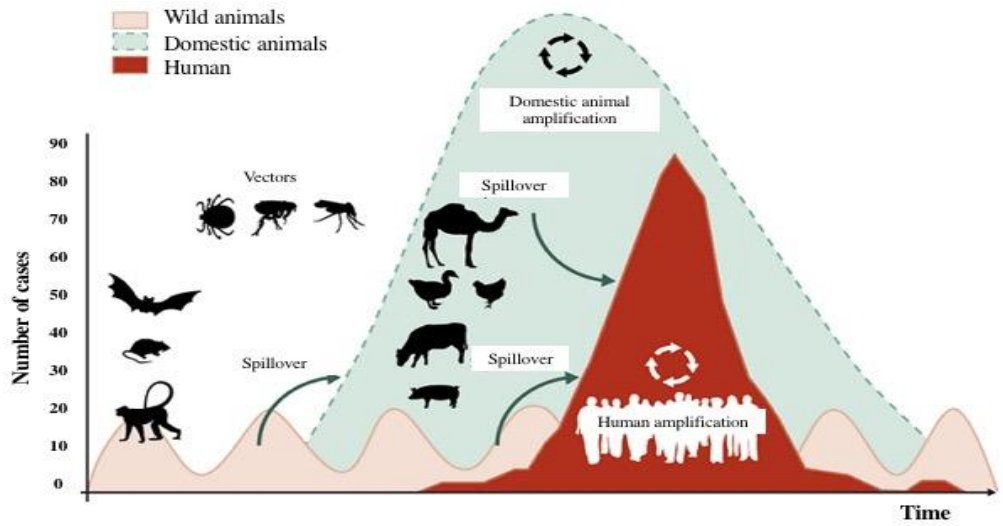

Figure 2. Ecology of emerging infectious and re-emerging infectious diseases (Adapted from Karesh, W.B., 2012)

Considering the relationships between wild animals, domestic animals and humans given in Figure 2; the ongoing dynamics of emerging infectious diseases are highly influenced by ecological factors. The red, pink and green colors in the figure represent respectively the transmission and multiplication of infections in humans, the transmission of a pathogen from wild animals to humans, the ability of the pathogen to contact and the outbreak [37].

These zoonotic risks may vary according to geography and seasons, and the results may depend on factors such as land use, weather, climate or environmental changes. Researches on the dynamics of zoonotic pathogens in wildlife reservoirs can be considered as an early warning system to report the risk of an outbreak in livestock or humans and reduce the number of human disease cases [34, 37]. In this context, characteristics of the host, pathogen and vector are largely influenced by environmental conditions. Interactions and complex health problems in Figure 2 are similar to the close relationship and interaction between human, animal and environmental health in "One Health".

As seen in Figure 3 and Table 3, When Turkey's condition is evaluated by the data, West Nile Virus continues to be a regional problem in the European continent and the Mediterranean coastal countries in recent years. Based on the latest data, the West Nile Virus and *Sindbis virus*, which also spread with migratory birds, maintains the potential for regional risk [34, 36].

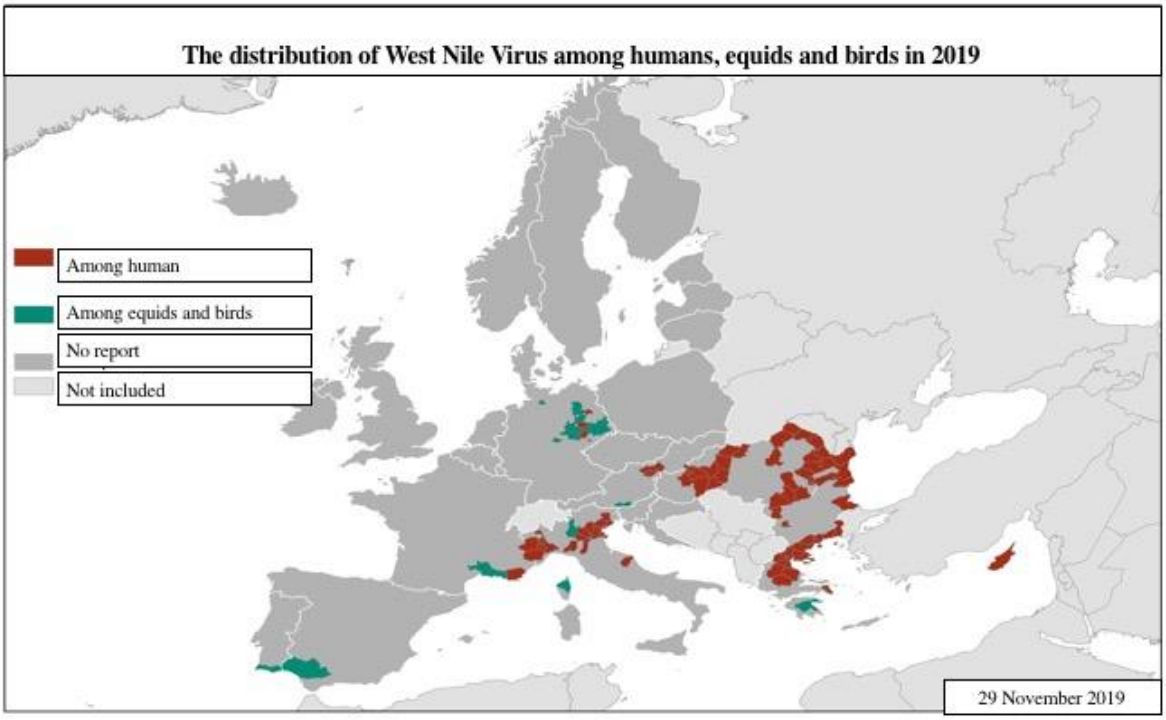

Figure 3. Outbreaks of West Nile virus between humans, equids and / or birds in European Union countries as of November 29, 2019 (Adapted from ECDC, 2019)

3.3. Anthropogenic Factors

Similar to ecological factors, humanity has caused unexpected changes in nature and the HAE-interface in the last half century. Intensified and industrialized agricultural practices, an increasing trend in tourism and travel [38] and anthropogenic factors such as expansion of trade volume, land use changes and rapidly increasing urbanization have led to the emergence of infectious diseases in certain countries or regions [39]. In this context, there is a correct relationship between the density of human population in cities and the spread of infections.

Traveling of 55% of the tourists with the aim of recreation across the continents increases the potential of the global threat of EZD pathogens such as SARS-CoV, MERS-CoV Ebola, Zika virus, and this dynamism makes unpredictable risks permanent and threatens global health safety [38, 40, 41]. A study about zoonoses problem with 'One Health' perspective reported the presence of at least more than 10 EZD pathogens in Turkey [42].

4. Emerging zoonotic diseases and "One Health" approach

Zoonotic outbreaks caused by old zoonotic pathogens (*Bacillus anthracis, Mycobacterium tubeculaosis, Brucella spp.*, *Rabies virus*) and emerging zoonotic pathogens (*Borrelia burgdorferi, Bartonella henseleae, MERS-CoV Ebola virus, Zika virus*) have threatened human health throughout history [33, 37, 39, 41]. The intellectual history of the idea of One Health, which protects public health from these threats, begins in the 1850s [43]. But in the current sense, the emergence of One Health concept coincides with the early years of the 21st century [2002-2004]. "One Health" is a multidisciplinary understanding and a common effort working at local, national, regional and global scale to achieve optimal health for people, animals and our environment [44]. With this comprehensive expression, "One Health" has gained importance as a transdisciplinary thinking system in order to produce solutions to "complex health problems" that arise from multifactorial reasons [40, 41,43]. Instead of the traditional approach to health, it is recommended to functionalize the core competencies of One Health Education in the education processes to place and spread this thinking system, to take advantage of preventive and protective dynamics [45].

4. Conclusions and discussion

In the 21st century we live in, the "paradigm shift" is inevitable in order to solve the health problems related to EZDs and to avoid possible risks, which have accumulated by neglect [46]. In this context, taking into account the EZDs with ecological and anthropogenic factors, One Health does not only mean combating infections that are on the agenda in the 21st century. Based on the prediction of the future, the One Health approach includes health problems [47], Antimicrobial resistance-AMR [48], and AMR combating and surveillance systems [49] caused by global climate changes. Ecosystem health problems resulting from the rapid migration of people from rural to urban areas and distorted urbanization and the degradation / degradation of urban vegetation forced by other anthropogenic factors [reduction of green space, air pollution) affect urban ecology and lead to a decrease in biodiversity [50]. It also includes preventing the problem of anthropogenic factor-based obesity and obesogens, and preventing social threats from endocrine disrupting chemicals [51] and complex non-infectious health problems. Attempts to prevent all these health risks and reduce unforeseen infectious and non-infectious threats are possible through transdisciplinary thinking system, with interdisciplinary cooperation as a priority. This system is a 'One Health' thinking system and approach, which should be should functionalized, institutionalized and expanded and the system has vital importance as air and water. Today, ecological and anthropogenic disasters growing exponentially accelerate the decline of biodiversity and increase microbial threats caused by EZDs and the AMD crisis with climatic disasters. Therefore, in the 21st century, humanity has no more 50 years to lose in the 21st century. All humanity should see the coming hurricane of huge problems. The only way to prevent an impending hurricane is to institutionalize the "One Health" thought ve and transfer it to life immediately.

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