

# Chapter 21

## Global Environmental Change and Emerging Infectious Diseases: Macrolevel Drivers and Policy Responses

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### **ABSTRACT**

*The prediction of emerging infectious diseases (EIDs) and the avoidance of their tremendous social and economic costs is contingent on the identification of their most likely drivers. It is argued that the drivers of global environmental change (and climate change as both a driver and an impact) are often the drivers of EIDs; and that the two overlap to such a strong degree that targeting these drivers is sound epidemiological policy. Several drivers overlap with the leading causes of biodiversity loss, providing opportunities for health and biodiversity sectors to generate synergies at local and global levels. This chapter provides a primer on EID ecology, reviews underlying drivers and mechanisms that facilitate pathogen spillover and spread, provides suggested policy and practice-based actions toward the prevention of EIDs in the context of environmental change, and identifies knowledge gaps for the purpose of further research.*

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## **INTRODUCTION**

Recent outbreaks of emerging infectious diseases (EIDs) often seem to appear without warning, severely exacerbating public health burdens and spreading across regions (Heymann & Dar, 2014). Since 1940 the rate of infectious disease emergence events has risen, even after controlling for reporting bias, spiking in the 1980's with the human immunodeficiency virus (HIV) pandemic leading to acquired immunodeficiency syndrome (AIDS), which resulted in between 30 and 42 million deaths and untold costs in treatment (Jones et al., 2008; Nakagawa et al., 2015; Schwartlander et al., 2011; UNAIDS, 2013). More recently, as of February 2016, over 11,300 deaths had been recorded due to the West Africa Ebola outbreak that began in December 2013 (Baize et al., 2014; World Health Organization, 2016).

In this chapter we elaborate on the thesis that human modification of the environment serves as an underlying driver in EID risk: in particular, the processes associated with global environmental change cannot be neglected in outbreak investigations to identify disease origin and contribute to the development of effective policy responses. Most environmental degradation, such as deforestation or the contamination of water supplies, is most immediately apparent at the local level; yet broader-scale (macro) impacts also exist and influence local dynamics which both contribute to and are affected by global environmental change (World Health Organization and Convention on Biological Diversity, 2015). Impacts include changes in species abundance and pathogen prevalence, novel exposure to pathogens through increased or new types of exposure, selection pressures for rapid pathogen evolution, enablers for the spread of disease, and ultimately, the potential for increased associated human health burden. To fully grasp these dynamics and connections, a solid understanding of links between human, animal, and ecosystem health in a changing global environmental landscape is required- a concept described as One Health.

This chapter will begin by elaborating on this theme by introducing the concept of EIDs and pathogens, explicating some of their immense human and environmental costs, and then focusing on the drivers and impacts of global environmental change that are considered most pertinent to emerging disease risks. The chapter also proposes solutions to more effectively combat the direct and indirect causes of environmental change, thus lowering EID risk on a global scale. Finally, it puts forth suggestions for future research to enable more effective policy development.

## **BACKGROUND: A PRIMER ON PATHOGENS**

We can examine infectious disease emergence on both micro- and macro-levels. On a microscopic (or single pathogen) level, emergence events may have complex mechanisms, prompting various theories about different factors that may lead to disease emergence and spread and their relation to changes in biodiversity or species composition in an ecosystem (Keesing, Holt, & Ostfeld, 2006; Randolph & Dobson, 2012). While microlevel analyses and their interactions with macrolevel processes are useful, the thematic focus of this chapter is on the macrolevel, where emergence is driven by the many anthropogenic impacts that are altering ecological dynamics on a large scale, leading to global environmental change. For example, land conversion for agricultural uses and livestock production and other anthropogenic activities have increased or led to new types of human or domestic animal contact with wildlife, thereby facilitating pathogen “spillover” to humans (Jones et al., 2008; Karesh et al., 2012). At the same time, the rapid expansion in trade and travel in recent decades also establishes new pathways for the spread of dangerous pathogens, including through the introduction of invasive species and the climatic and

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