



Biodiversity and Health

Serge Morand

serge.morand@umontpellier.fr

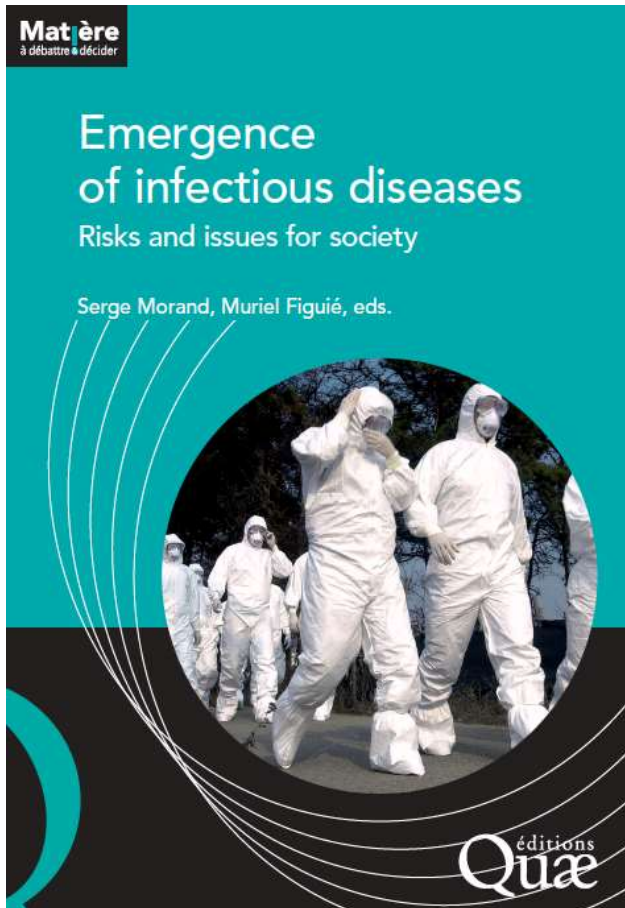


มหาวิทยาลัยเกษตรศาสตร์
KASETSART UNIVERSITY



MAHIDOL UNIVERSITY *Wisdom of the Land*
Faculty of Tropical Medicine



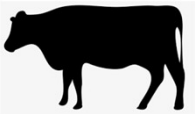
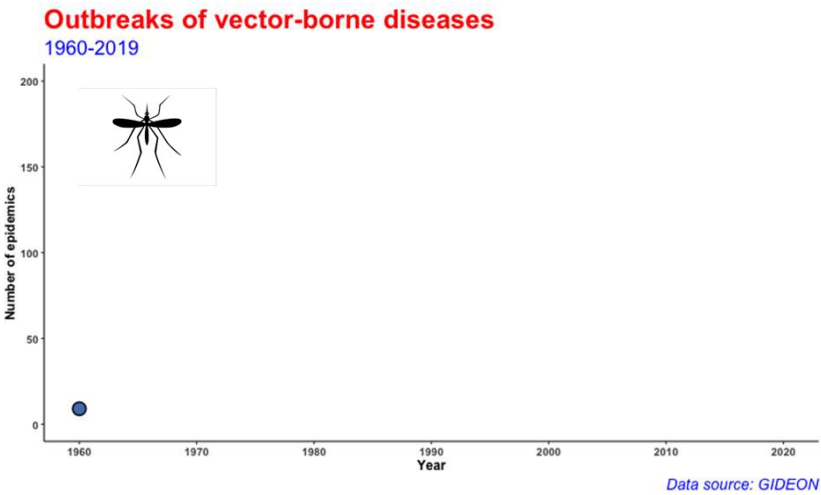
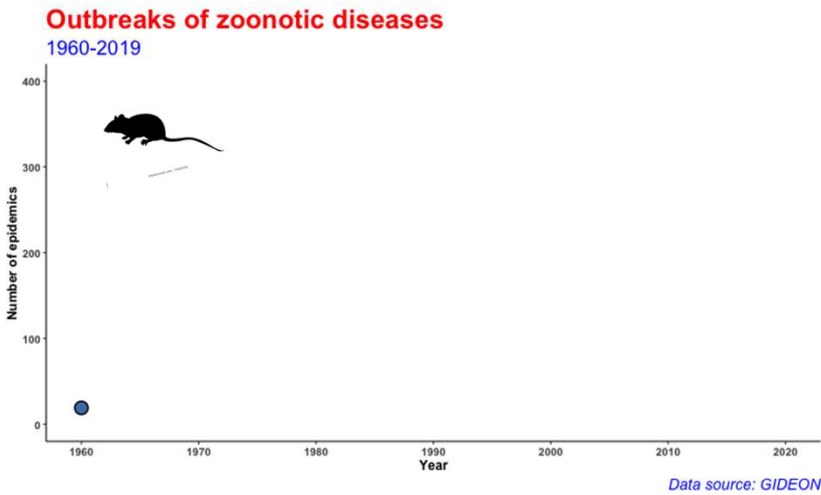


The great acceleration of epidemics

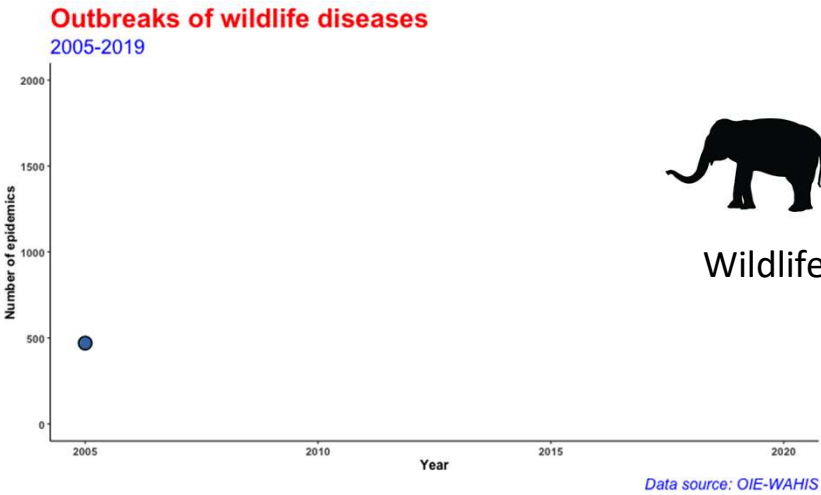
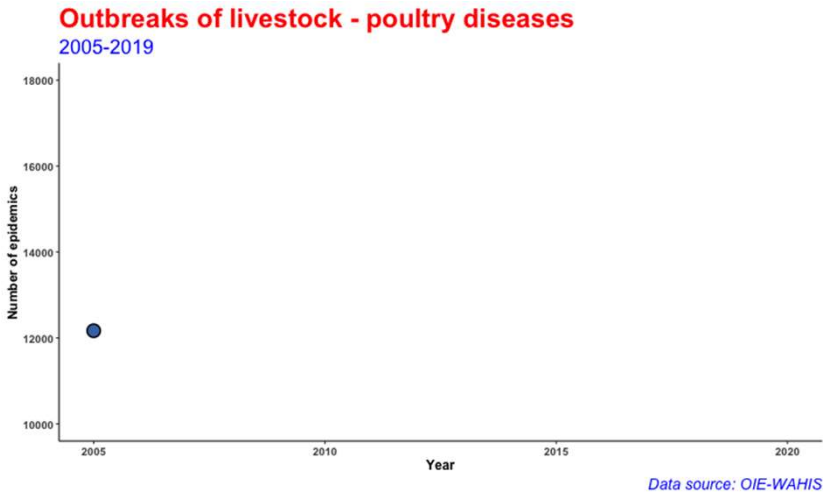
Une augmentation des épidémies



Humans



Livestock

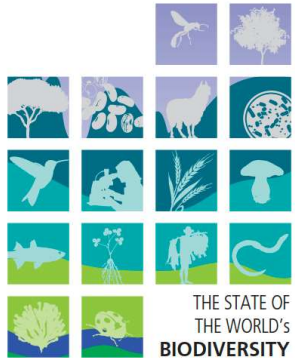


Wildlife



Food and Agriculture
Organization of the
United Nations

COMMISSION ON
GENETIC RESOURCES
FOR FOOD AND
AGRICULTURE



THE STATE OF
THE WORLD'S
BIODIVERSITY
FOR FOOD AND AGRICULTURE

FAO COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE
ASSESSMENTS - 2010

Increase of fungal diseases in plants and animals



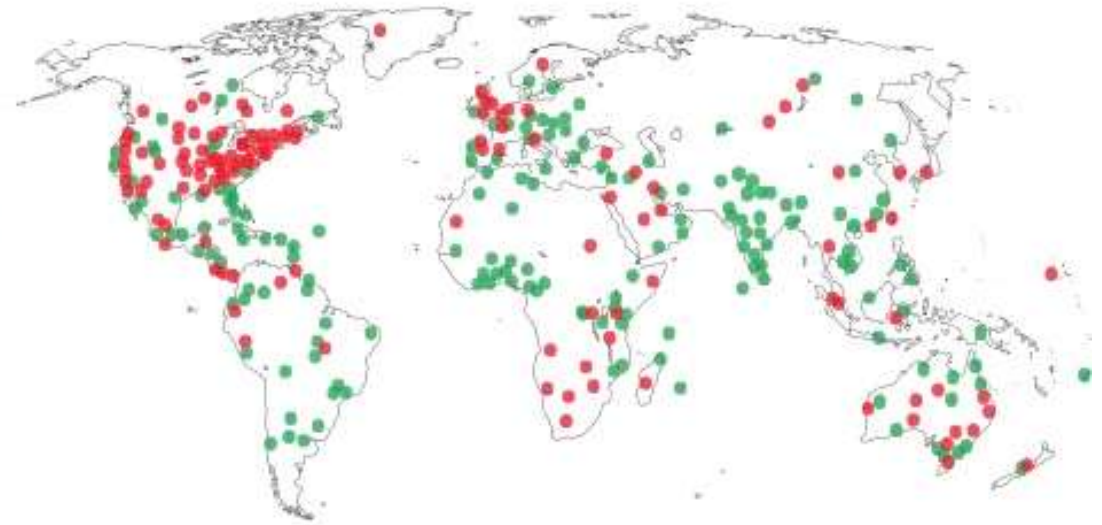
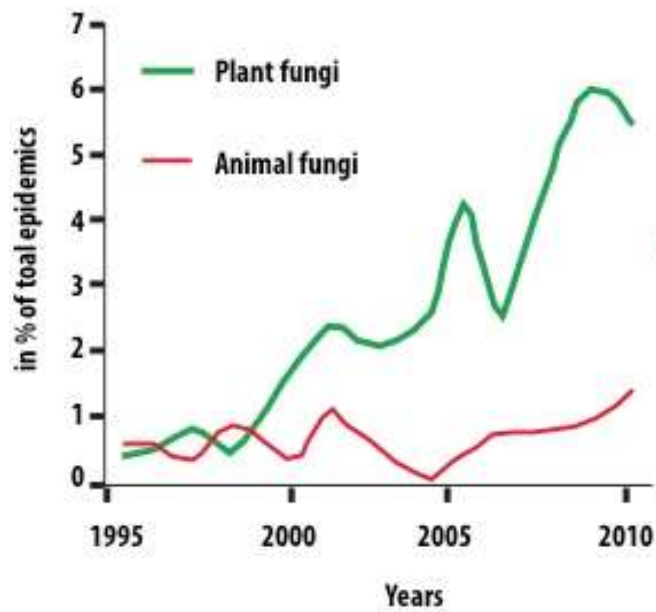
Bat white-nose syndrome



Amphibian chytrid



Plant fungal diseases



Climate Change and Global Health

Edited by Colin D. Butler



Climate change

The 2021 report of the *Lancet* Countdown on health and climate change: code red for a healthy future

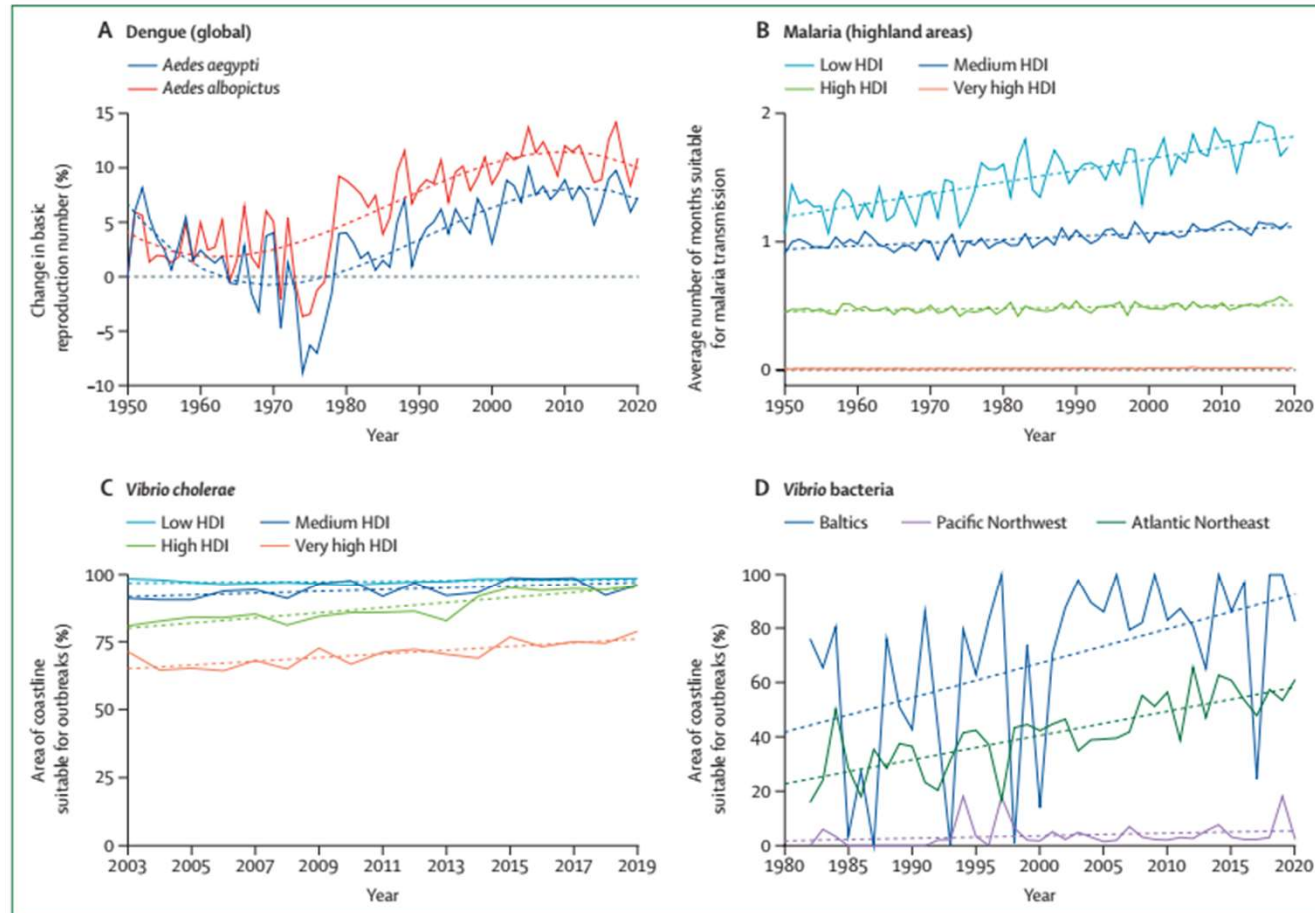
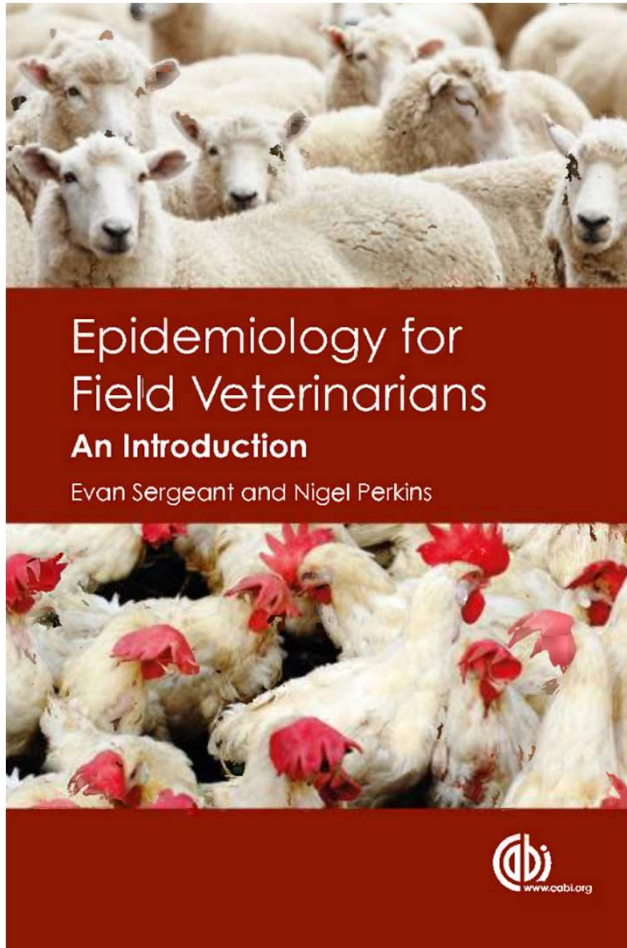
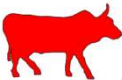


Figure 8: Change in climate suitability for infectious diseases

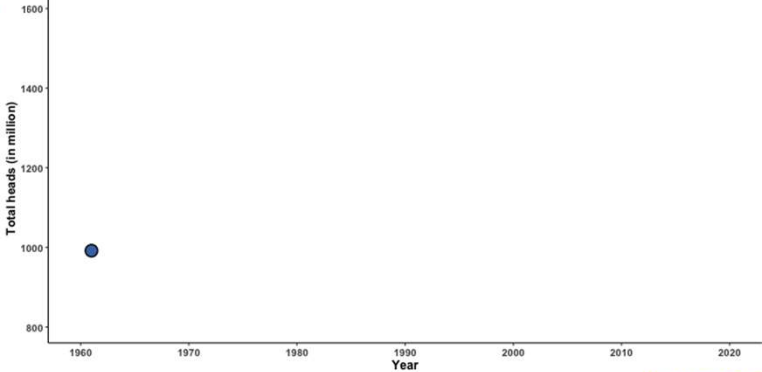


Livestock expansion

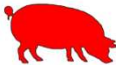
Livestock and poultry increase



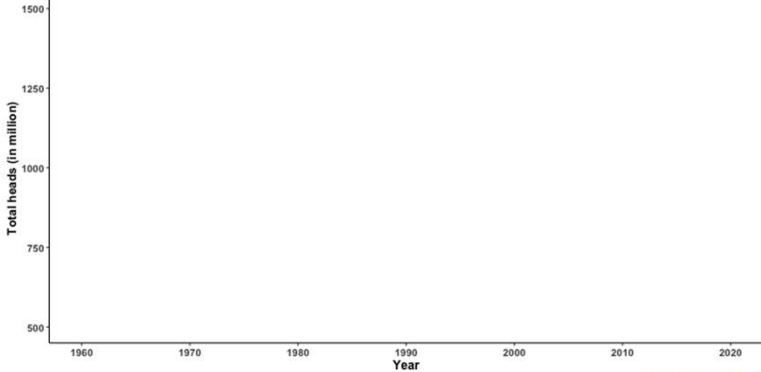
Total heads of cattle (in million)
1960-2020



Data source: FAO



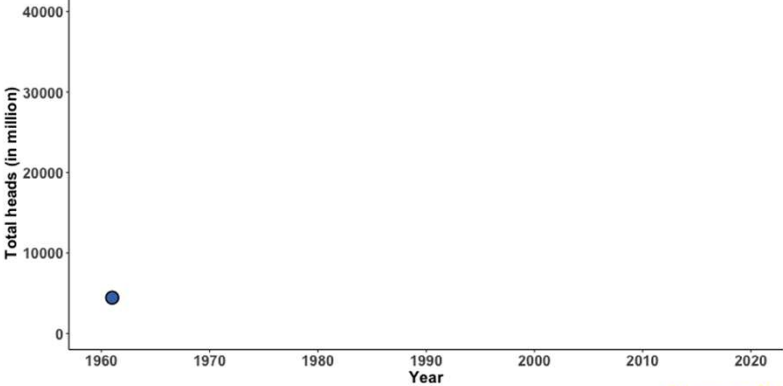
Total heads of pigs (in million)
1960-2020



Data source: FAO



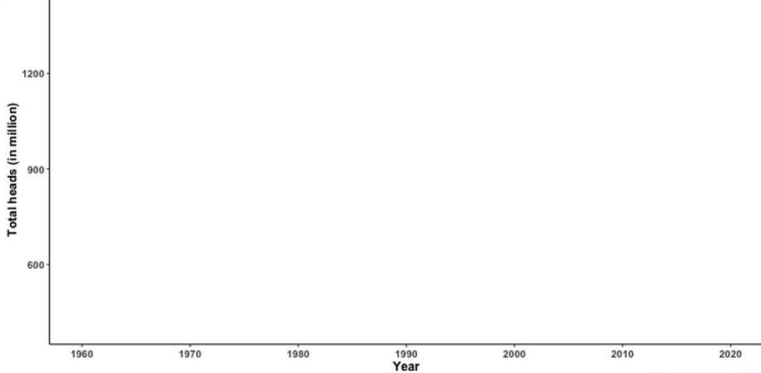
Total heads of chickens (in million)
1960-2020



Data source: FAO

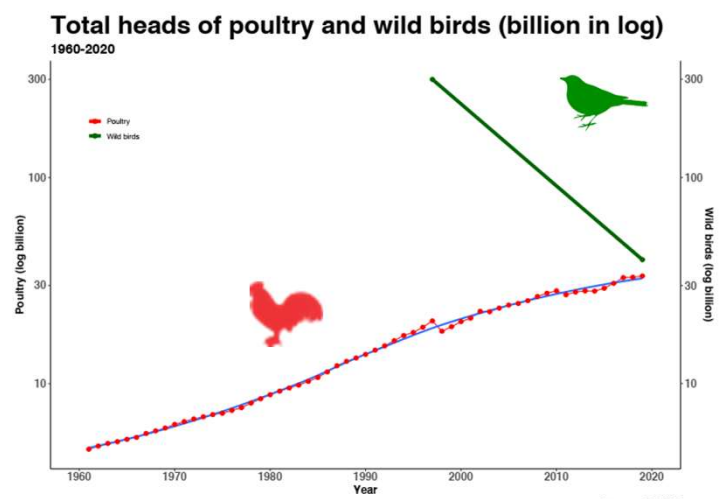
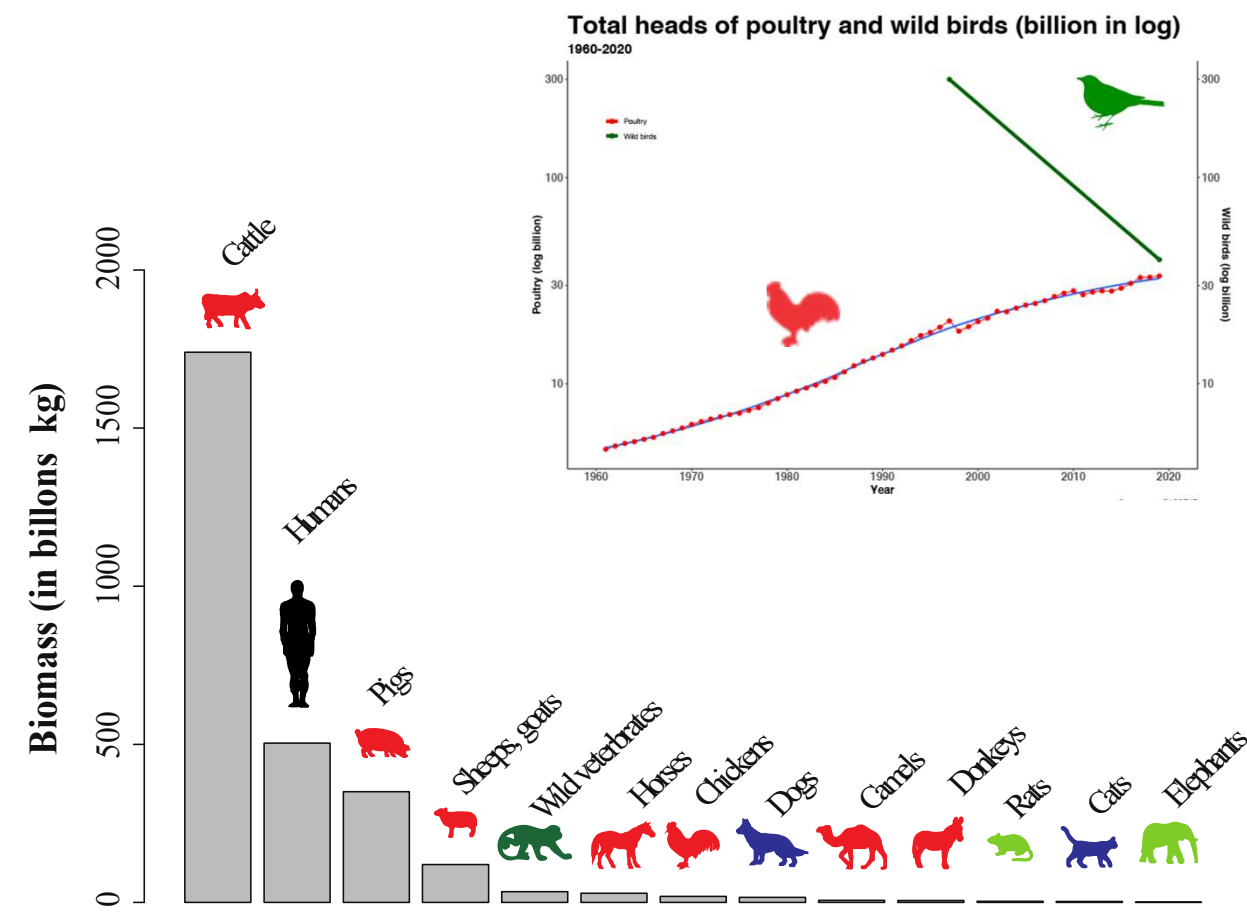


Total heads of goats (in million)
1960-2020

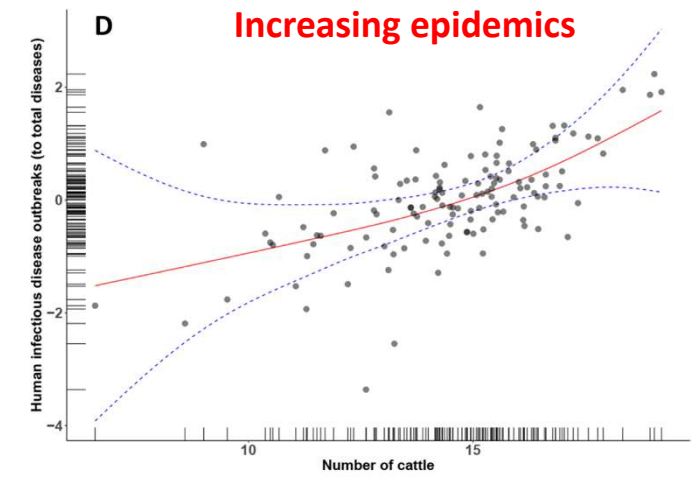
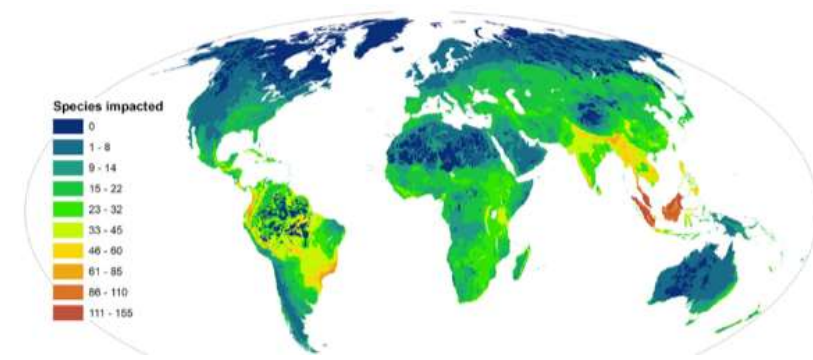


Data source: FAO

A planet dominated by livestock and poultry

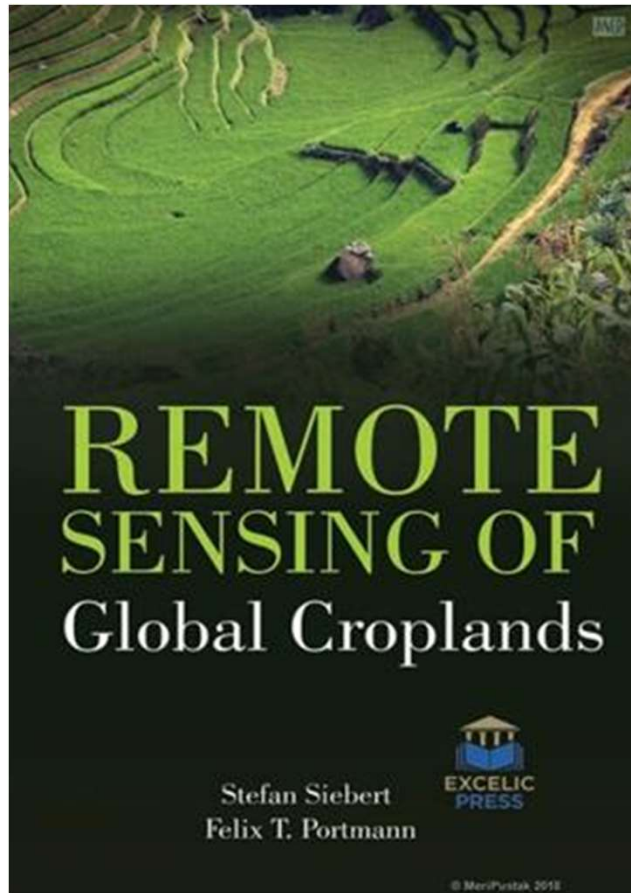


Increasing biodiversity loss



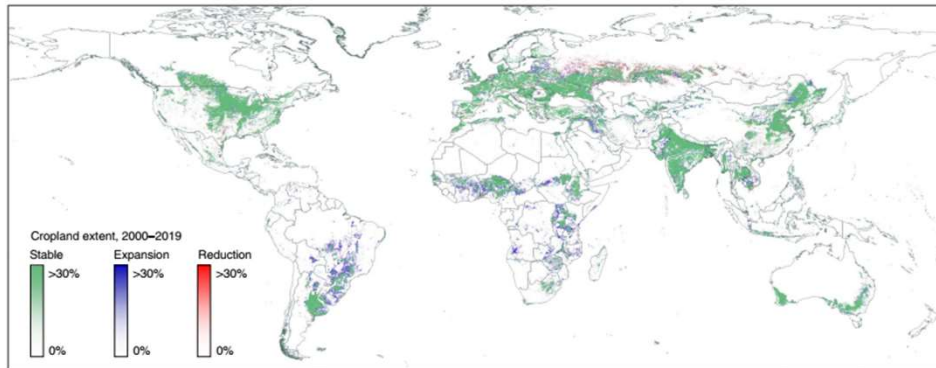
Increasing epidemics

(Morand & Lajaunie, 2017; données de Vaclav Smill, 2002)



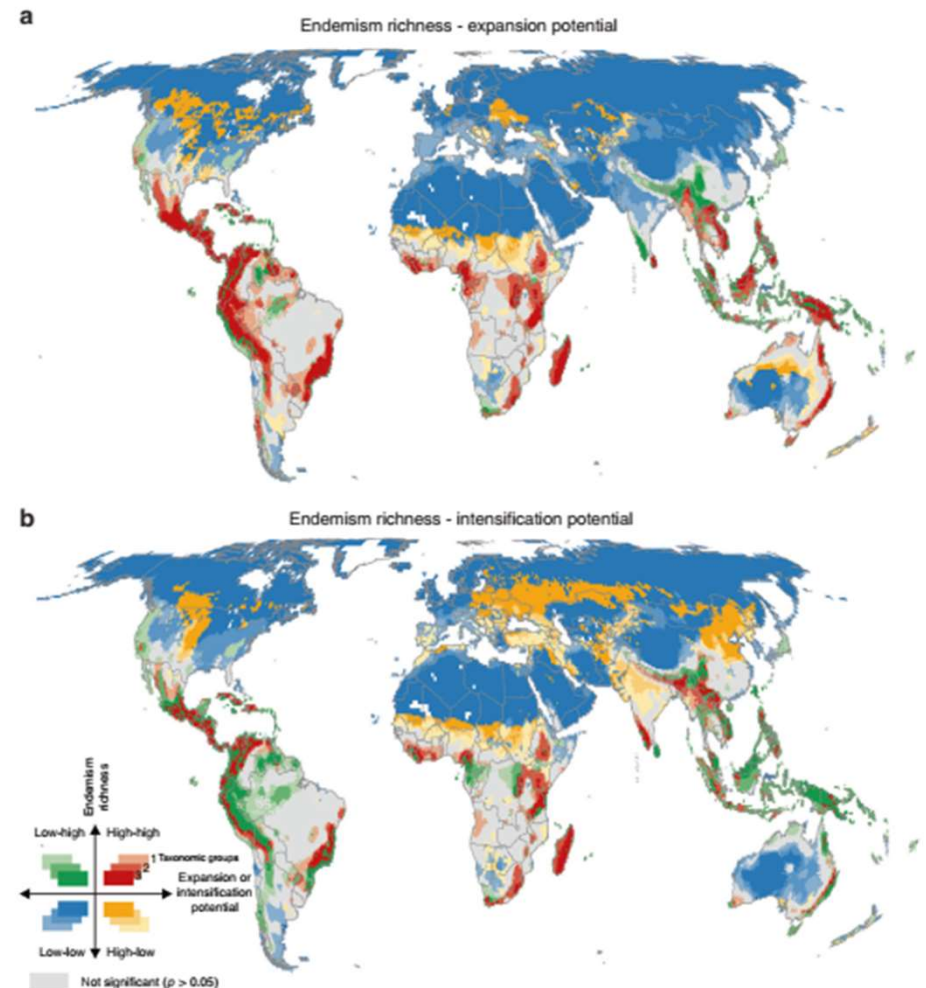
Agriculture expansion

From 2003 to 2019, cropland area increased by 9% (primarily due to agricultural expansion in Africa and South America)



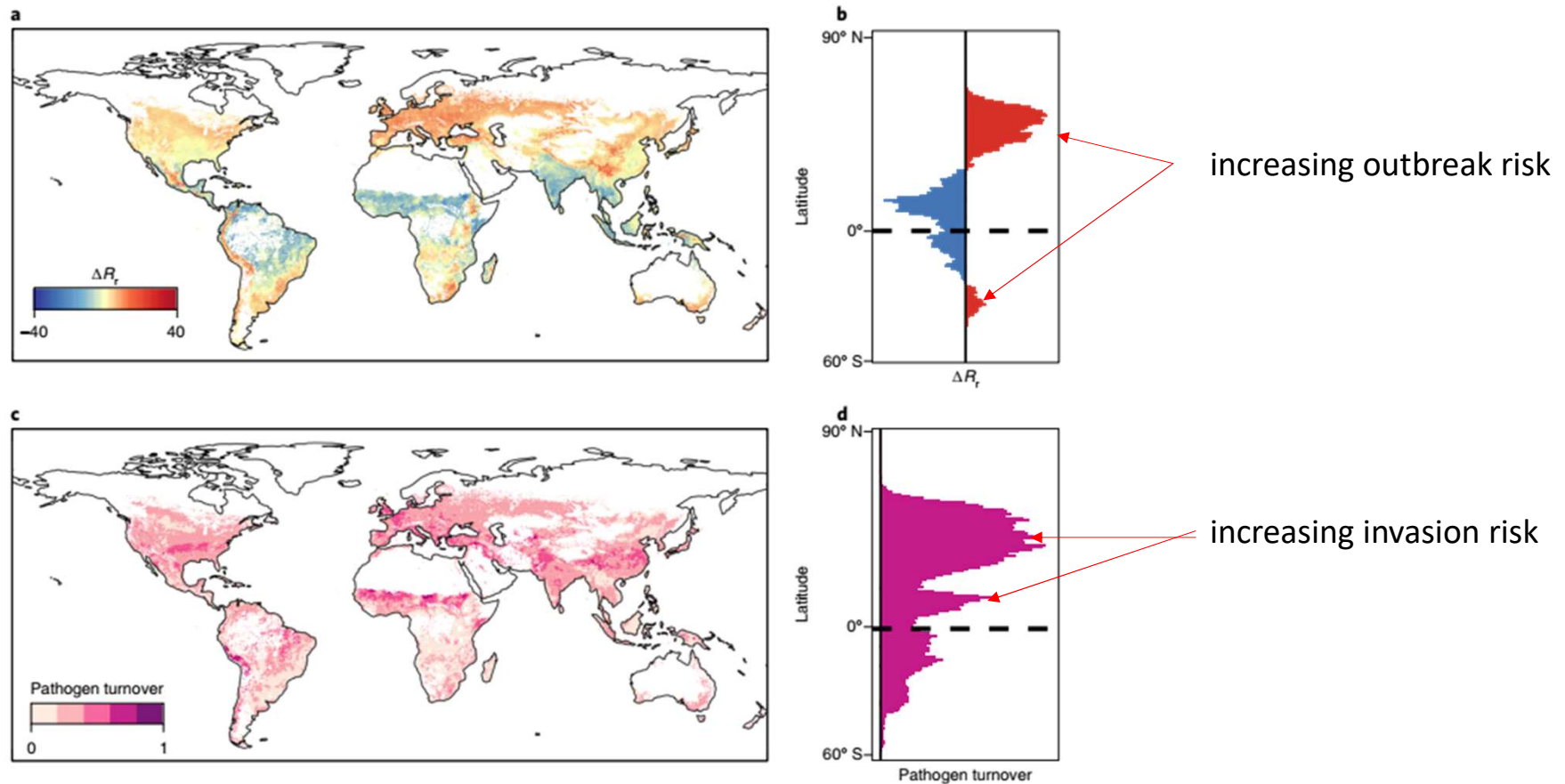
<https://doi.org/10.1038/s43016-021-00429-z>

Impact of cropland (a) extension and (b) intensification on biodiversity



<https://doi.org/10.1038/s41467-019-10775-z>

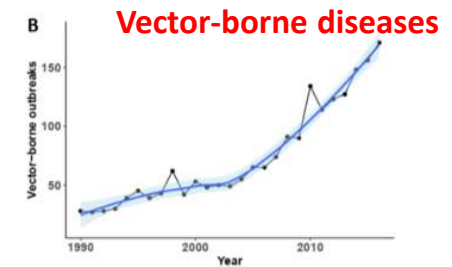
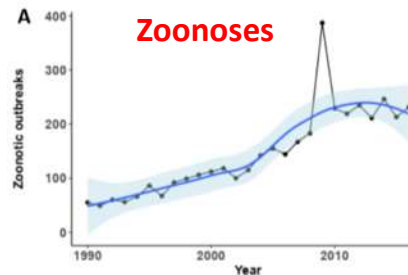
Cropland expansion and climate change may exacerbate plant pathogen infection risks





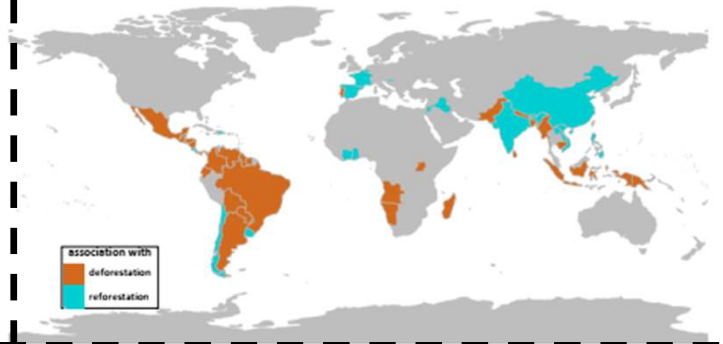
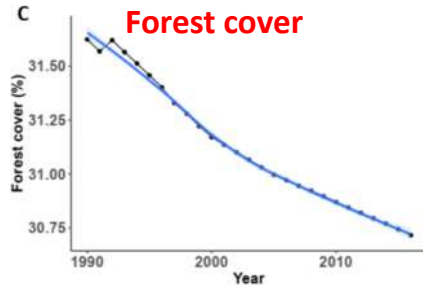
Forest loss and plantation expansion

Outbreaks of Vector-Borne and Zoonotic Diseases Are Associated With Changes in Forest Cover and Oil Palm Expansion at Global Scale



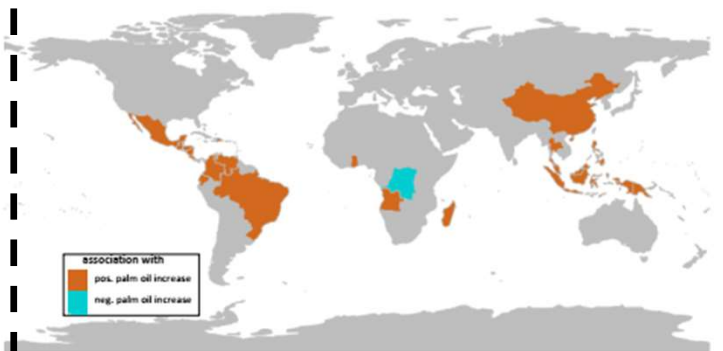
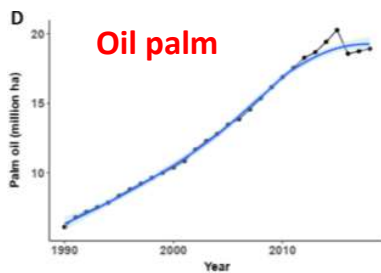
A Outbreaks of zoonotic diseases

B Outbreaks of vector-borne diseases



C Outbreaks of zoonotic diseases

D Outbreaks of vector-borne diseases



(Morand & Lajaunie 2021)



Increasing biodiversity loss



The scatter plot displays the number of species for five animal groups over a 21-year period. The y-axis represents the 'Number of species' from 0 to 600, and the x-axis represents the 'Year' from 2000 to 2020. The data points are clustered at the beginning of the timeline, with most groups showing a slight increase in species count over time. Birds and mammals have the highest species counts, while reptiles and amphibians have the lowest.

Year	birds	mammals	fishes	reptiles	amphibians
2000	180	180	150	100	100
2001	185	185	155	105	105
2002	190	190	160	110	110
2003	195	195	165	115	115
2004	200	200	170	120	120
2005	205	205	175	125	125
2006	210	210	180	130	130
2007	215	215	185	135	135
2008	220	220	190	140	140
2009	225	225	195	145	145
2010	230	230	200	150	150
2011	235	235	205	155	155
2012	240	240	210	160	160
2013	245	245	215	165	165
2014	250	250	220	170	170
2015	255	255	225	175	175
2016	260	260	230	180	180
2017	265	265	235	185	185
2018	270	270	240	190	190
2019	275	275	245	195	195
2020	280	280	250	200	200

taxon

- amphibians
- birds
- fishes
- mammals
- reptiles

Biodiversity is declining at different rates in different places

In 2019, the landmark IPBES global assessment on the state of biodiversity divided the world into different geographic regions (Figure 3) in order to complete regular and timely assessments of biodiversity, ecosystem services, their linkages, threats, and the impacts of these at regional and sub-regional levels¹. Using a smaller spatial

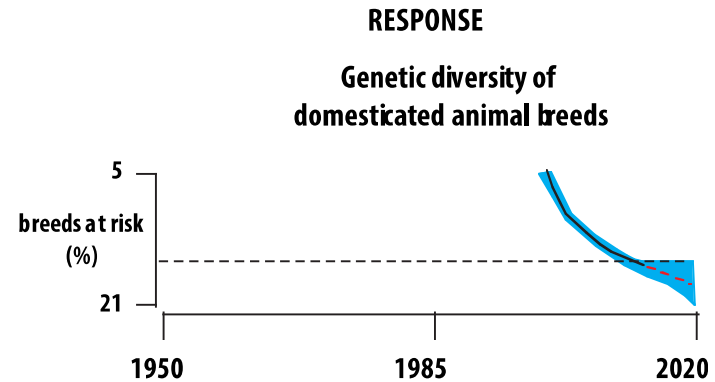
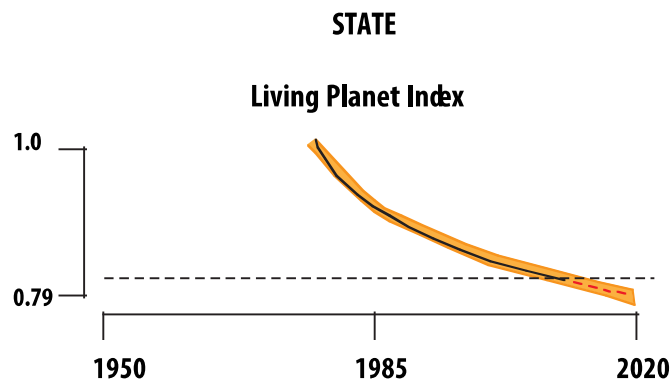
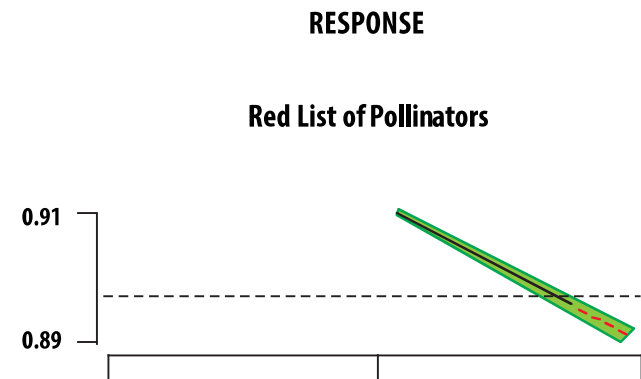
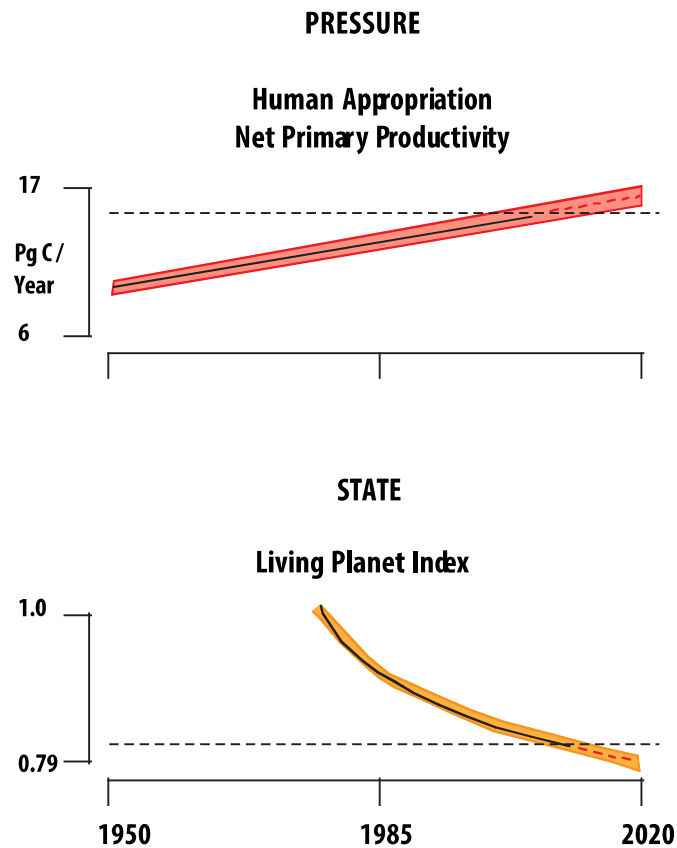
Figure 3: The Living Planet Index for each IPBES region: 1970 to 2016^a. The white line shows the index values and the shaded areas represent the statistical certainty surrounding the trend (95%). All indices are weighted by species richness, giving species-rich taxonomic groups in terrestrial and freshwater systems more weight than groups with fewer species. Source: WWF/ZSL (2020)¹⁰⁰.

WWF LIVING PLANET REPORT 2020 18

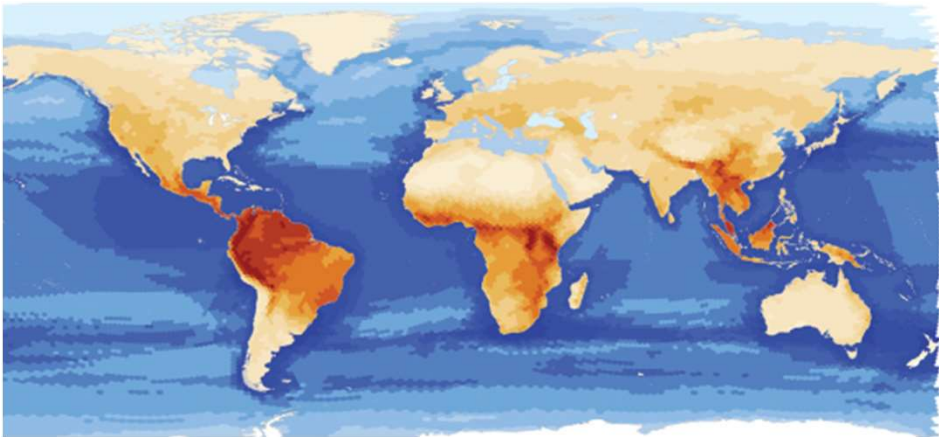
the Americas, this region was further subdivided in two: North America, and Latin America and the Caribbean (Mesoamerica, the Caribbean and South America combined). Trends for each species group are weighted according to how many species are found in each IPBES region. Threats to populations in each region are shown on page 21, and detail behind the trends can be found in the technical supplement.

Sad news from the Anthropocene

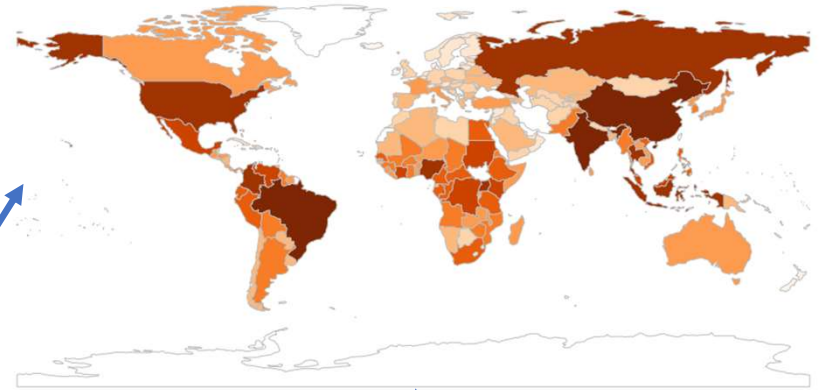
Increasing human appropriation on biological productivity is leading to a major biodiversity crisis



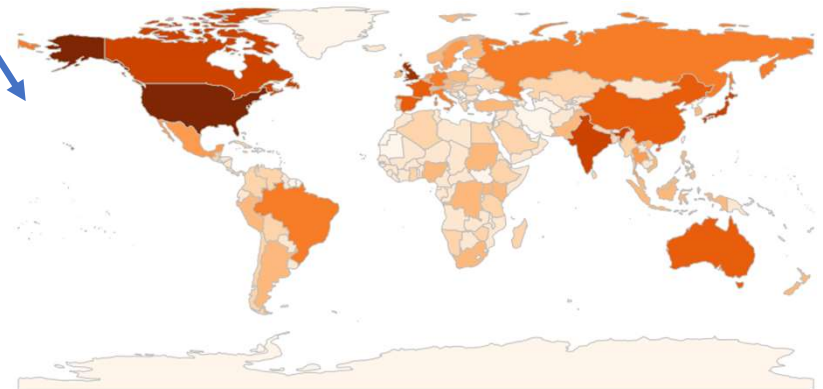
Biodiversity
(Mammal species richness)



Known infectious diseases (endemicity)



Outbreaks of infectious diseases



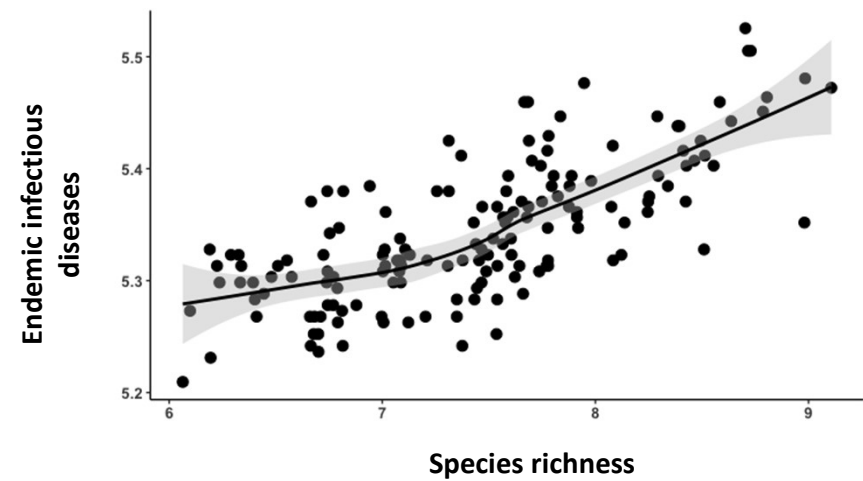
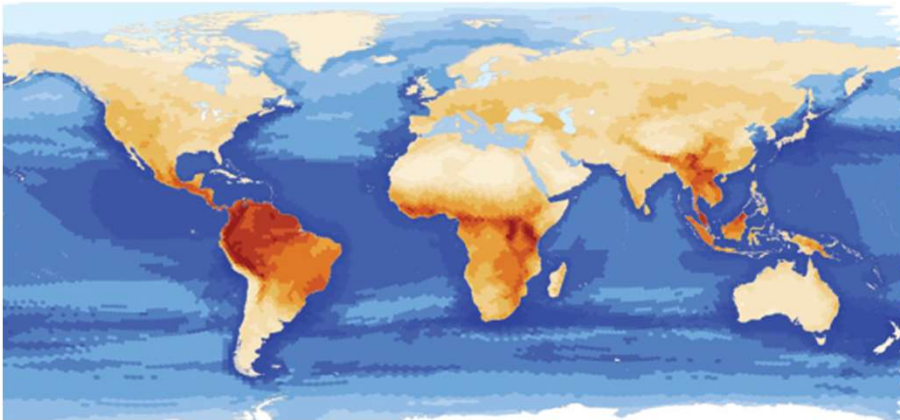
(Schipper et al. Science 2008)

A positive biodiversity – disease richness

High biodiversity



High endemicity of infectious diseases

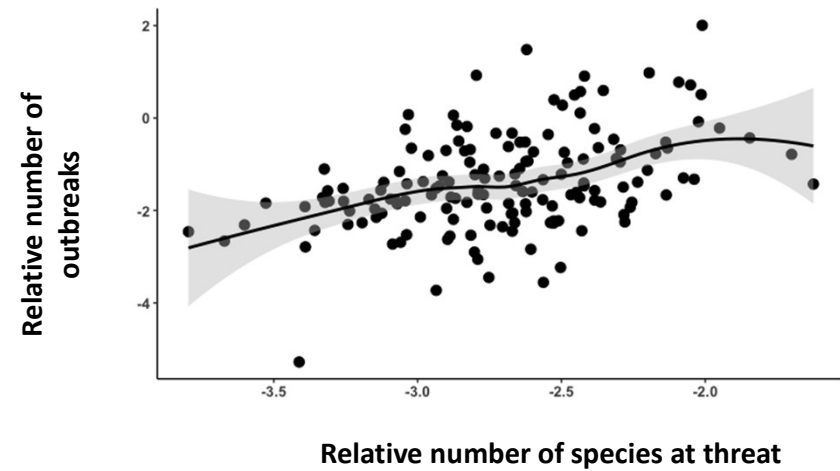
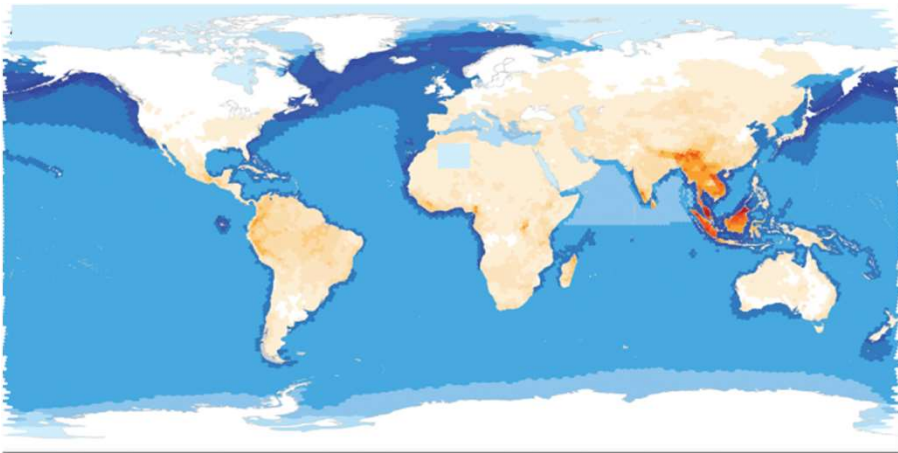


A negative biodiversity – disease transmission

High biodiversity at threat



Higher number of outbreaks!



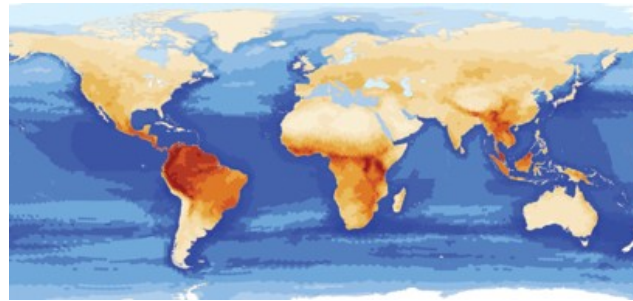


LES ZOONOSES CES MALADIES QUI NOUS LIENT AUX ANIMAUX

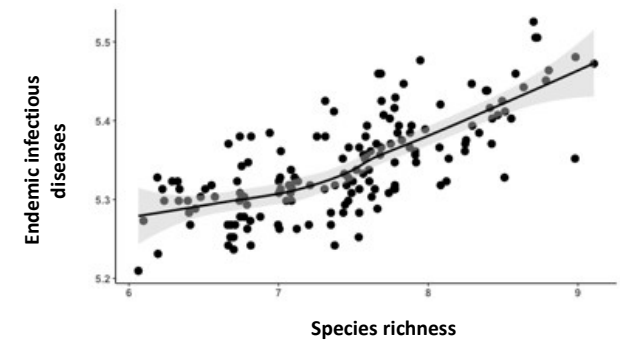
GWENAËL VOURC'H, FRANÇOIS MOUTOU,
SERGE MORAND, ELSA JOURDAIN

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Quæ

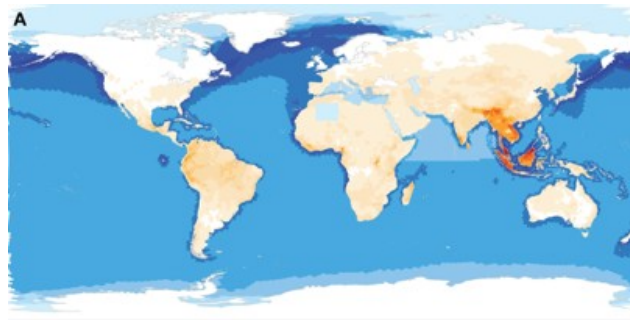
High biodiversity



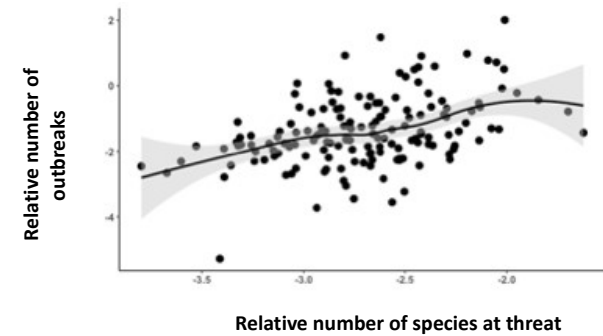
High endemicity of infectious diseases



High biodiversity at threat



Higher number of outbreaks!





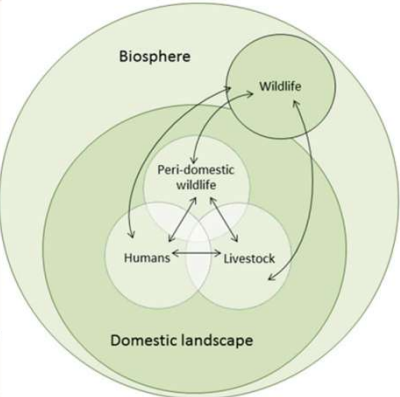
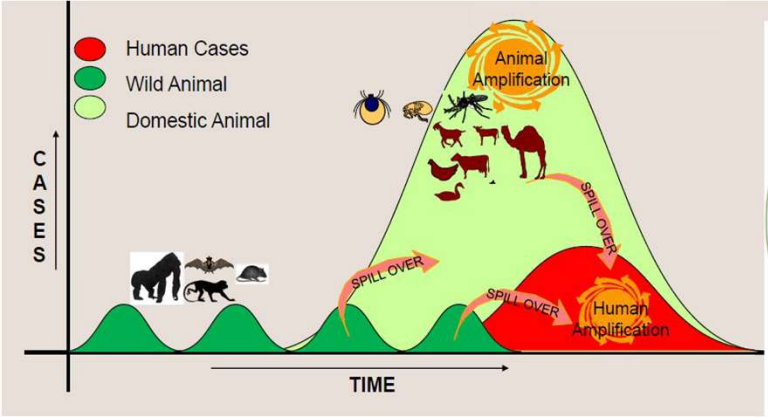
Transmission at the interface

The fabric of pandemics

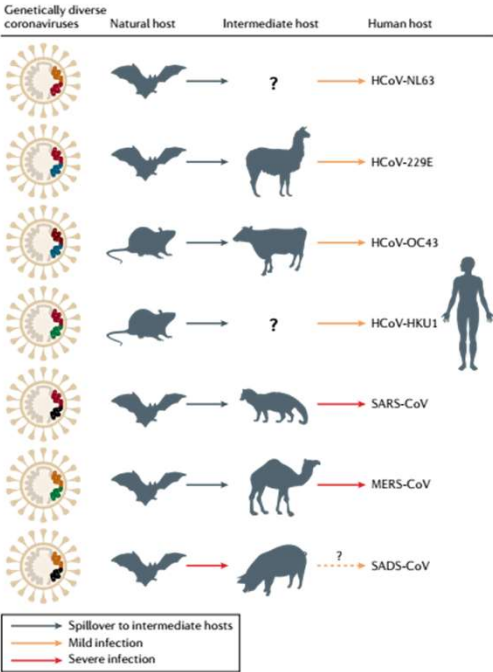
Hot Spots for Emerging Diseases



EcoHealth / New York Times 2012



Animal origins of human coronaviruses.



Susceptibility of White-Tailed Deer (*Odocoileus virginianus*) to SARS-CoV-2

① Mitchell V. Palmer,^a ② Mathias Martins,^b Shollie Falkenberg,^c Alexandra Buckley,^d Leonardo C. Caserta,^b Patrick K. Mitchell,^b ③ Eric D. Cassmann,^d Alicia Rollins,^b Nancy C. Zyllich,^b Randall W. Renshaw,^b Cassandra Guarino,^b Bettina Wagner,^b Kelly Lager,^d ④ Diego G. Diel^b



SARS-CoV-2 in animals used for fur farming

GLEWS+
Risk assessment



20 January 2021

GLEWS+ TRIPARTITE RISK ASSESSMENT FOR EMERGING THREATS AT THE ANIMAL, HUMAN, ECOSYSTEM INTERFACE
*GLEWS+ is the Joint FAO-OIE-WHO Global Early Warning System for health threats and emerging risks at the human-animal-ecosystems interface



Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE

Confirmation of COVID-19 in Deer in Ohio



CORONAVIRUS

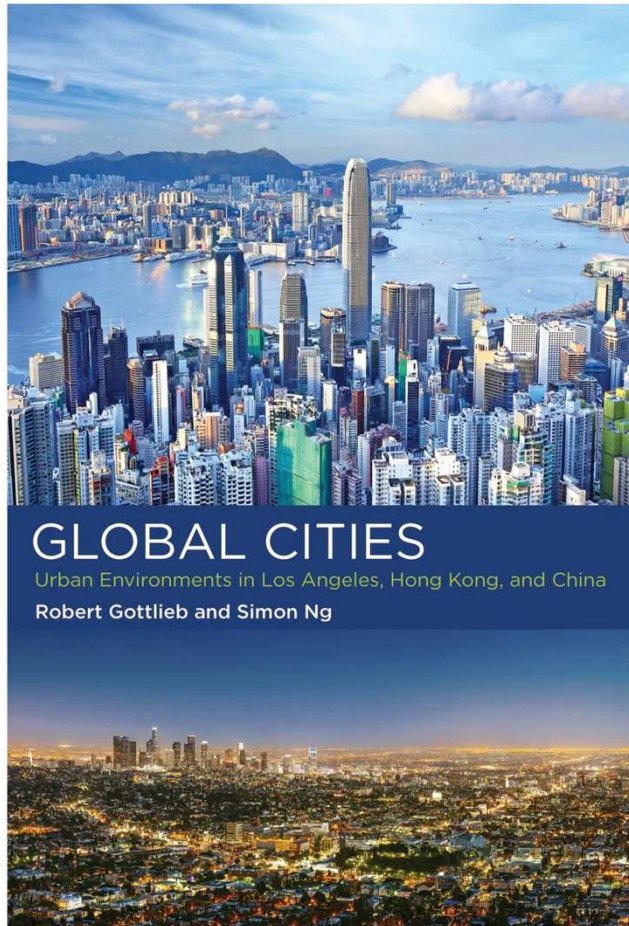
Susceptibility of ferrets, cats, dogs, and other domesticated animals to SARS-coronavirus 2

Jianzhong Shi^{1,*}, Zhiyuan Wen^{1,*}, Gongxun Zhong^{1,*}, Huanliang Yang^{1,*}, Chong Wang^{1,*}, Baoying Huang^{2,*}, Renqiang Liu¹, Xijun He³, Lei Shuai¹, Ziruo Sun¹, Yubo Zhao¹, Peipei Liu², Libin Liang¹, Pengfei Cui¹, Jinliang Wang¹, Xianfeng Zhang³, Yuntao Guan³, Wenjie Tan², Guizhen Wu^{2,†}, Hualan Chen^{1,†}, Zhigao Bu^{1,3,†}

Article

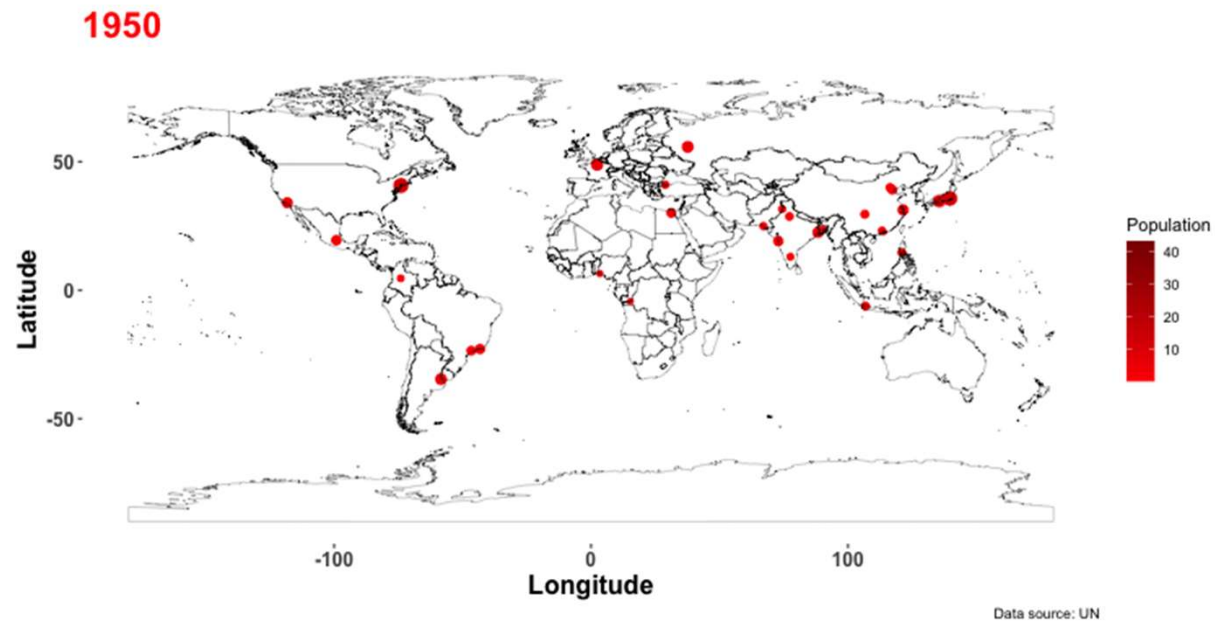
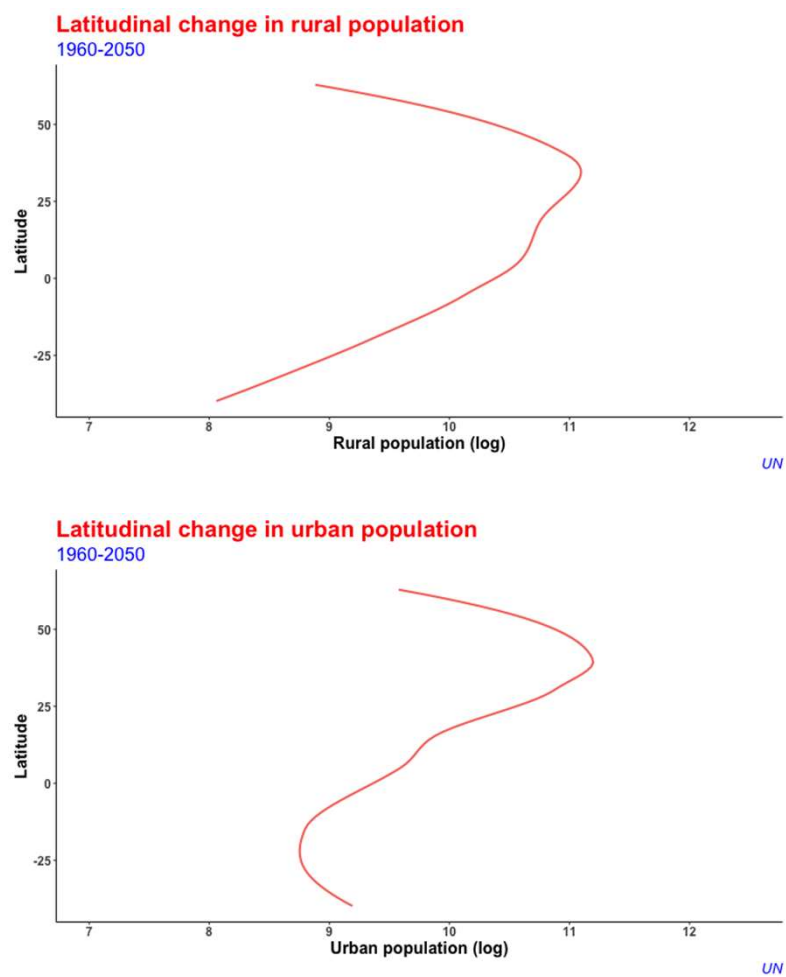
First Description of SARS-CoV-2 Infection in Two Feral American Mink (*Neovison vison*) Caught in the Wild

Jordi Aguiló-Gisbert^{1,†} ②, Miguel Padilla-Blanco^{2,†}, Victor Lizana^{1,3} ②, Elisa Maiques⁴, Marta Muñoz-Baquero¹, Eva Chillida-Martínez¹, Jesús Cardells^{1,3,*} and Consuelo Rubio-Guerri^{2,*}



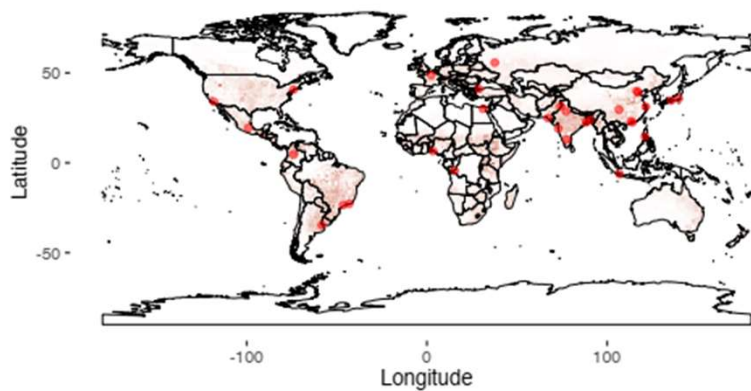
An urban-dominated planet

A more urban-dominated planet (intertropical region)

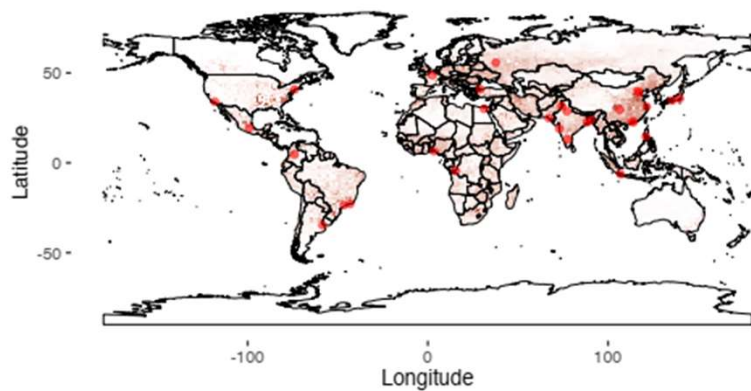


Big cities, in high wildlife and livestock – poultry areas

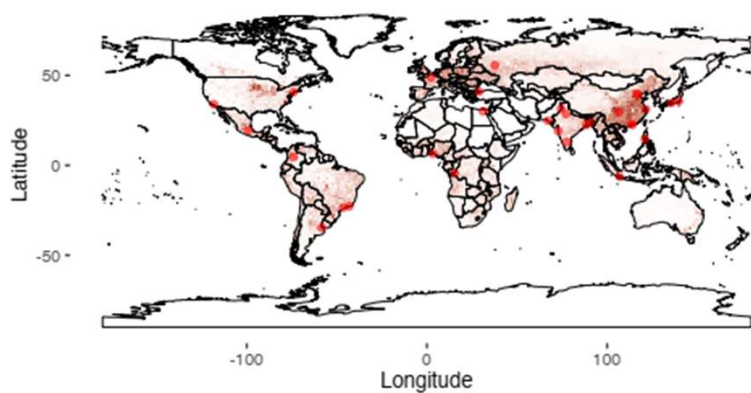
Density of cattle population



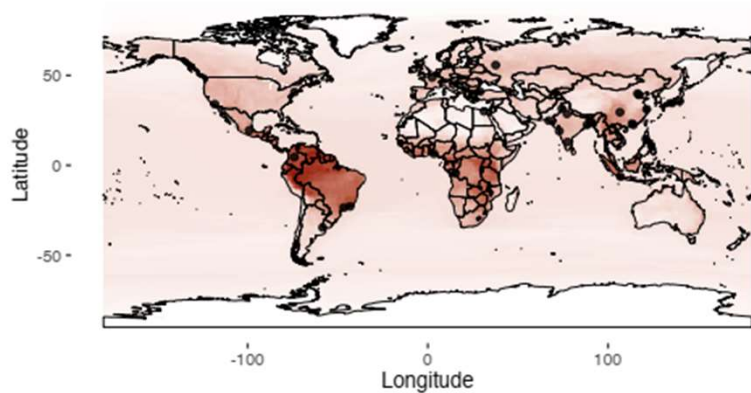
Density of chicken population

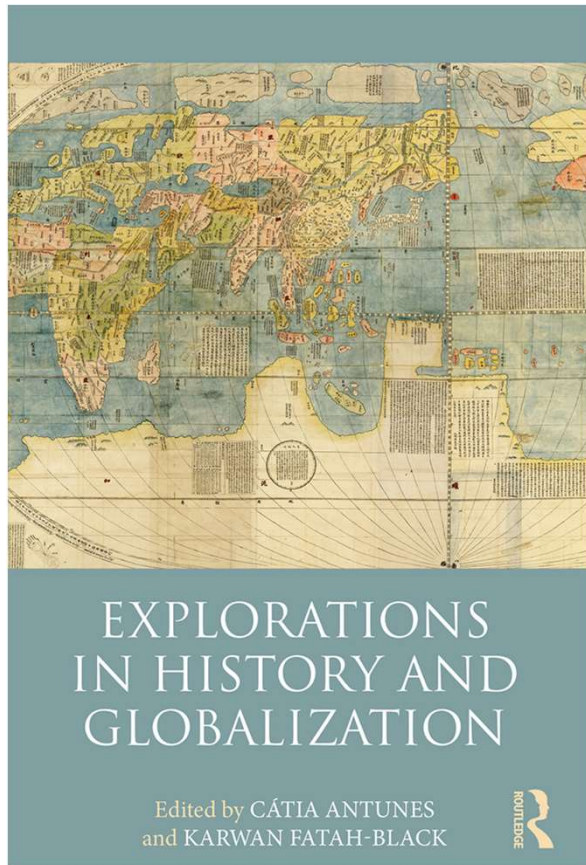


Density of pig population



Mammal species richness





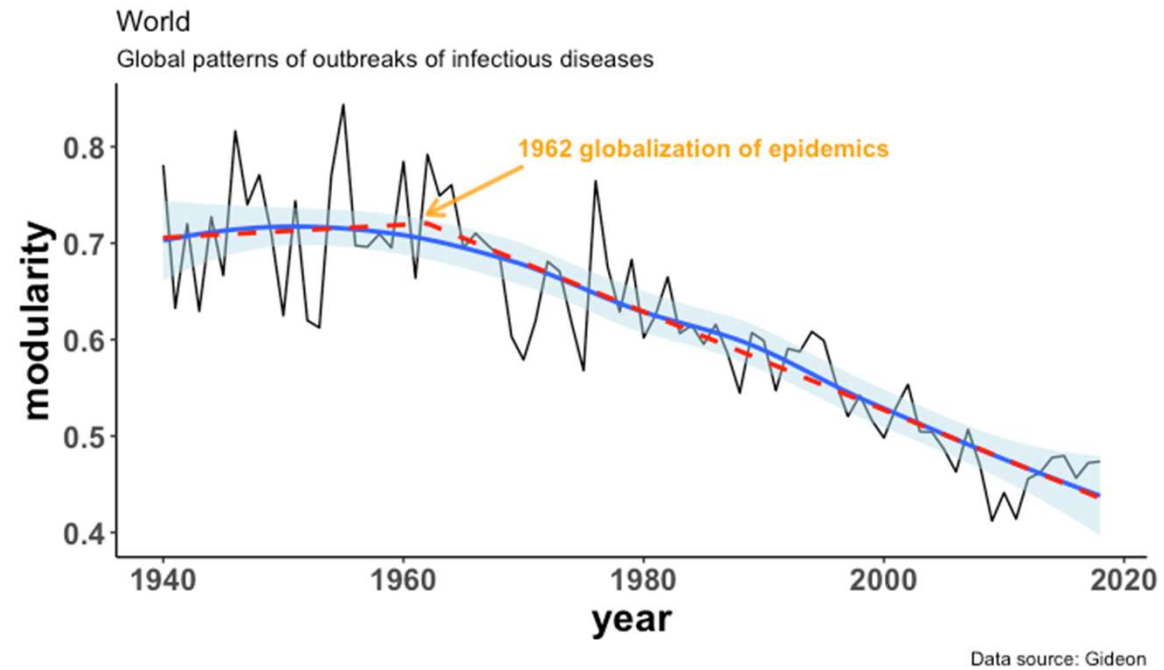
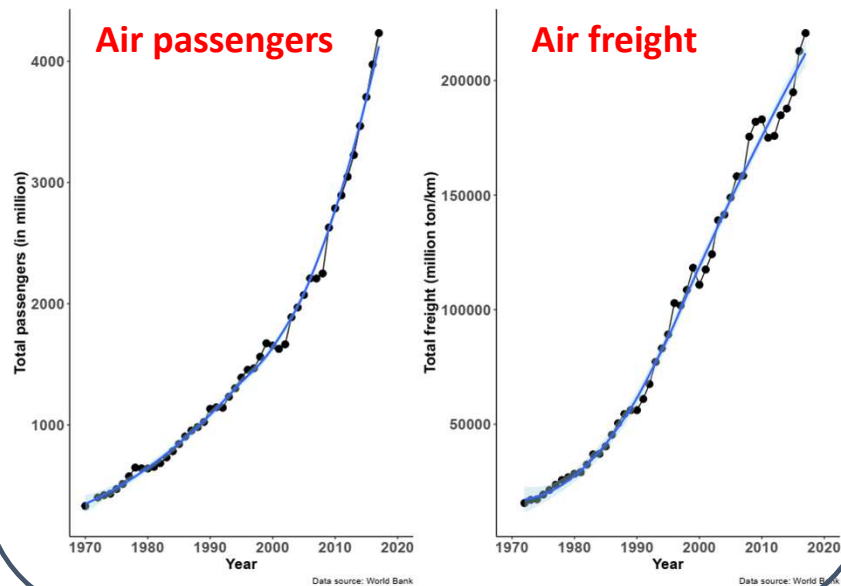
A globalized planet

Global trade and travels



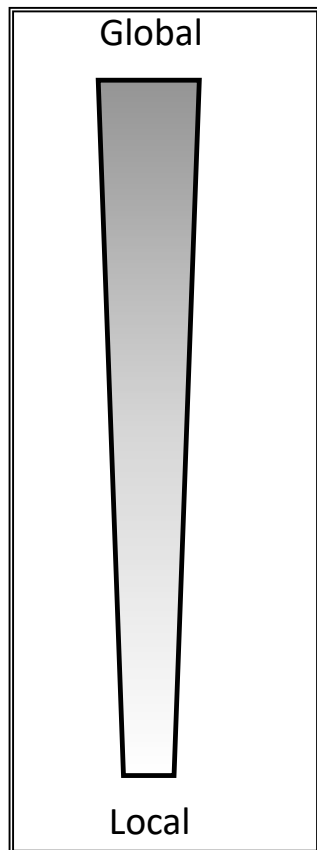
Globalization of epidemics

1,300 % increase 1970-2016



Scaling and connection effects

Global change

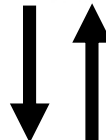


Globalization



Increasing trade

mobility



Urbanization



Land conversion



Biodiversity loss
Deforestation
Agriculture intensification
Livestock expansion
Plantation expansion

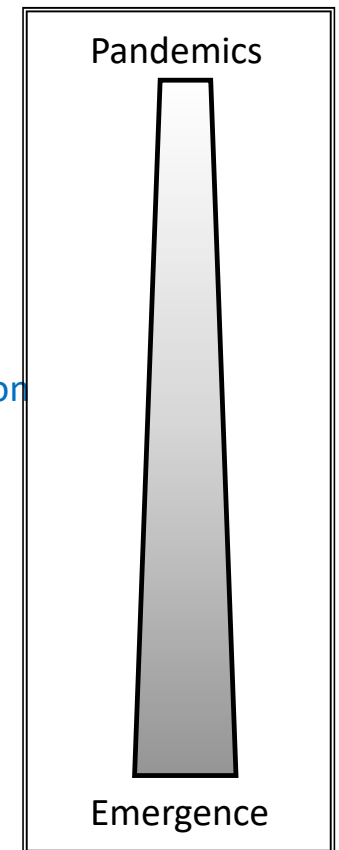
Infrastructure development

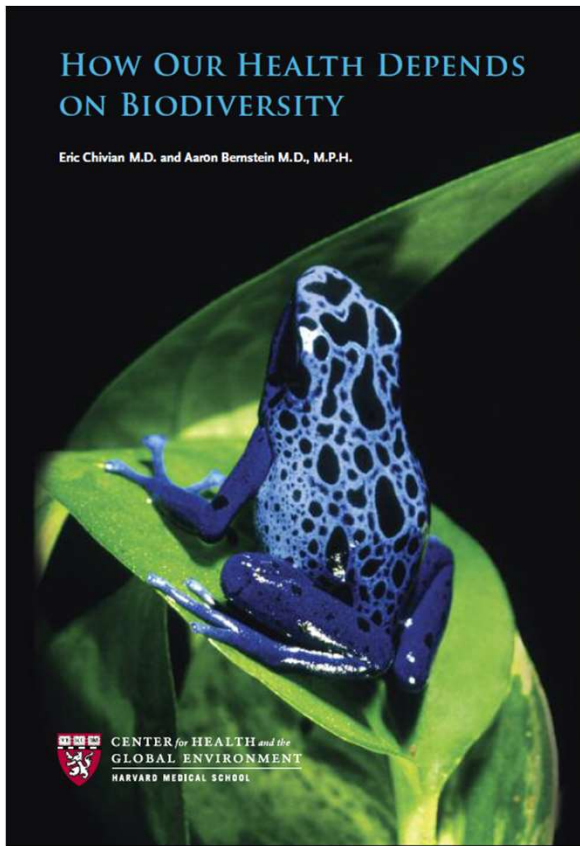


Roads
Dams
Mining

mobility

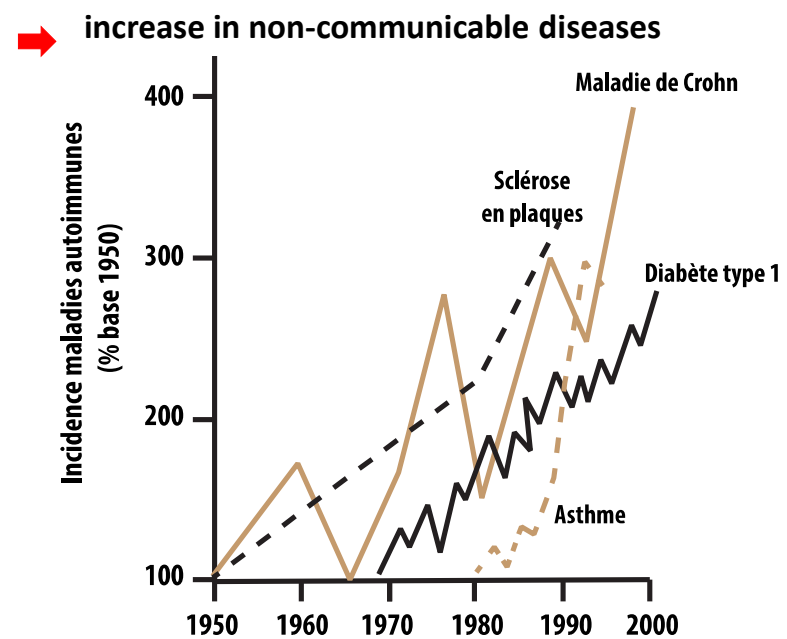
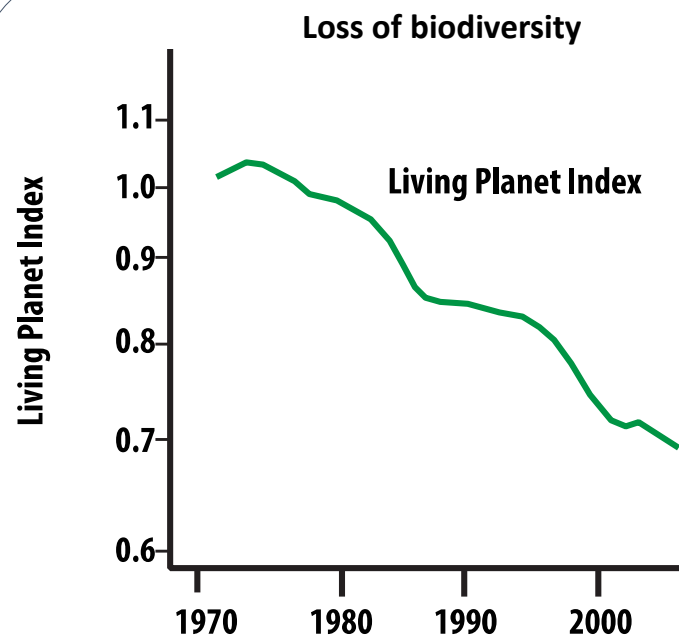
Infectious diseases





The great increase of non communicable diseases

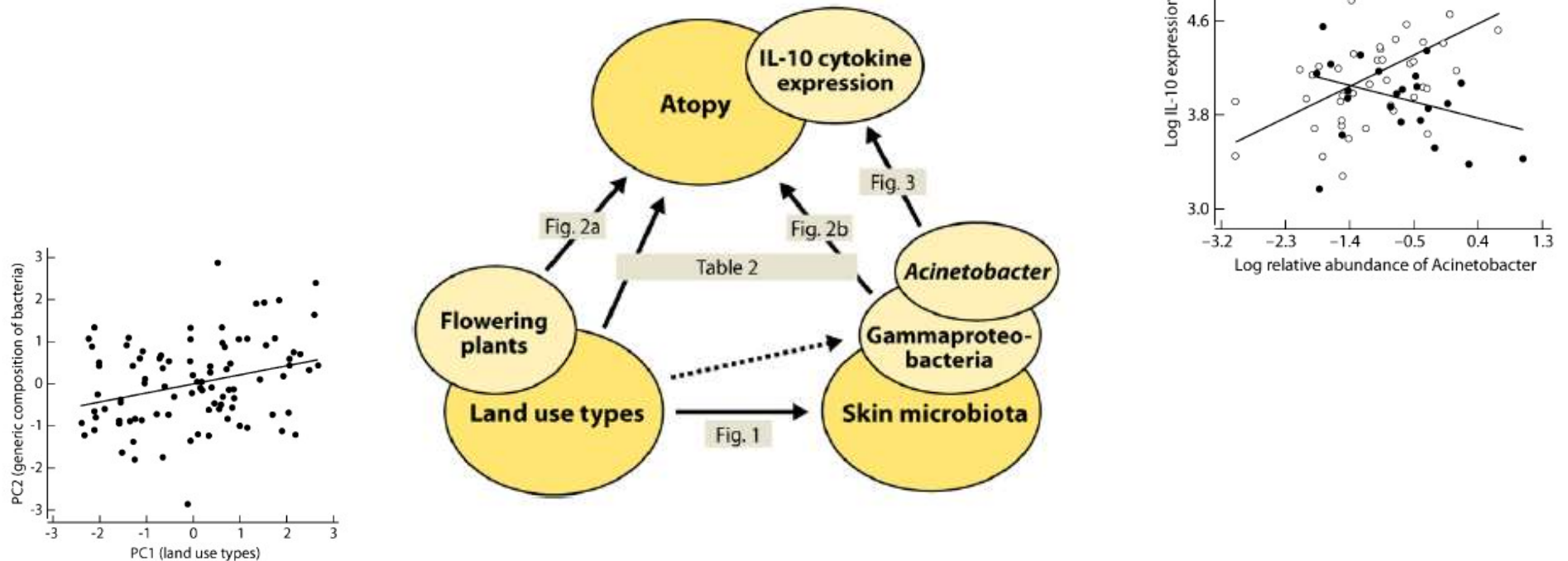
Biodiversity loss and non-communicable diseases



Environmental biodiversity, human microbiota, and allergy are interrelated

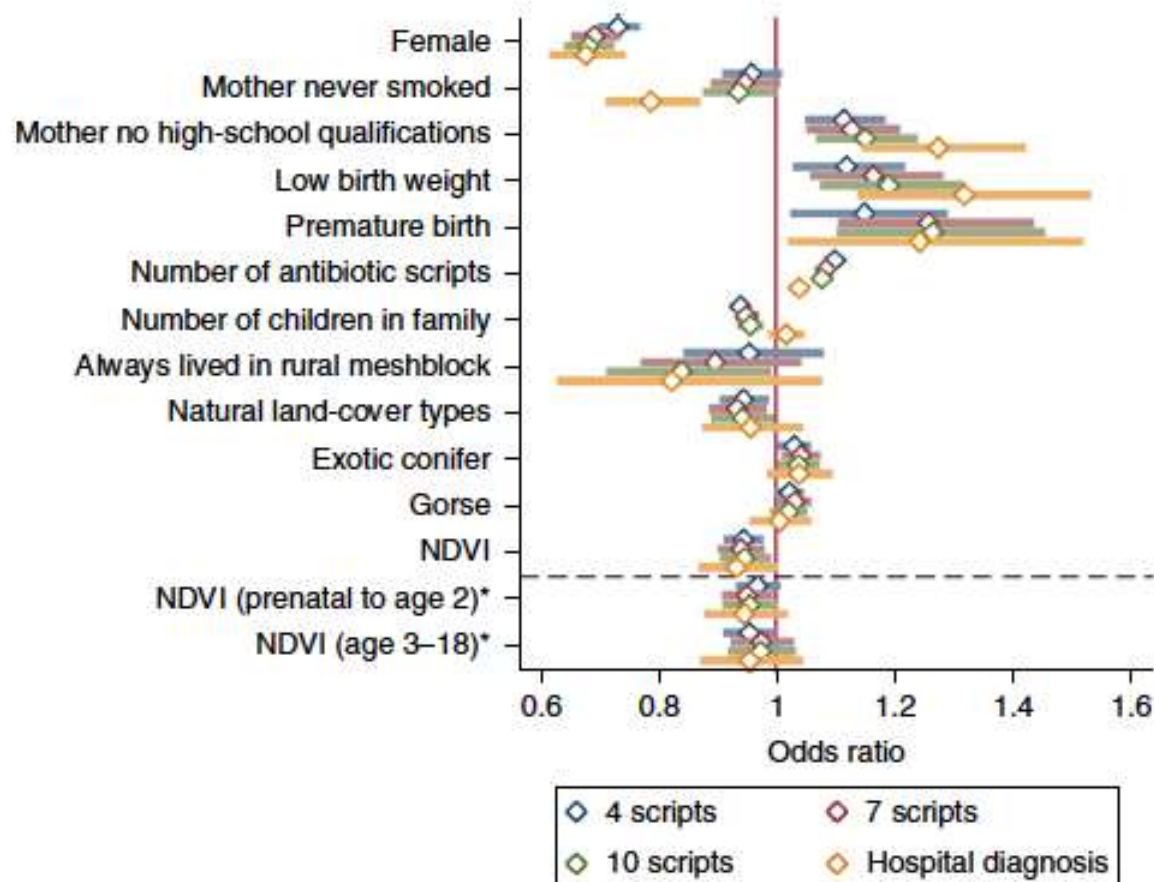
2012

Ilkka Hanski^{a,1}, Leena von Hertzen^b, Nanna Fyhrquist^c, Kaisa Koskinen^d, Kaisa Torppa^a, Tiina Laatikainen^e, Piia Karisola^c, Petri Auvinen^d, Lars Paulin^d, Mika J. Mäkelä^b, Erkki Vartiainen^e, Timo U. Kosunen^f, Harri Alenius^c, and Tari Haahtela^{a,b,1}



Vegetation diversity protects against childhood asthma: results from a large New Zealand birth cohort

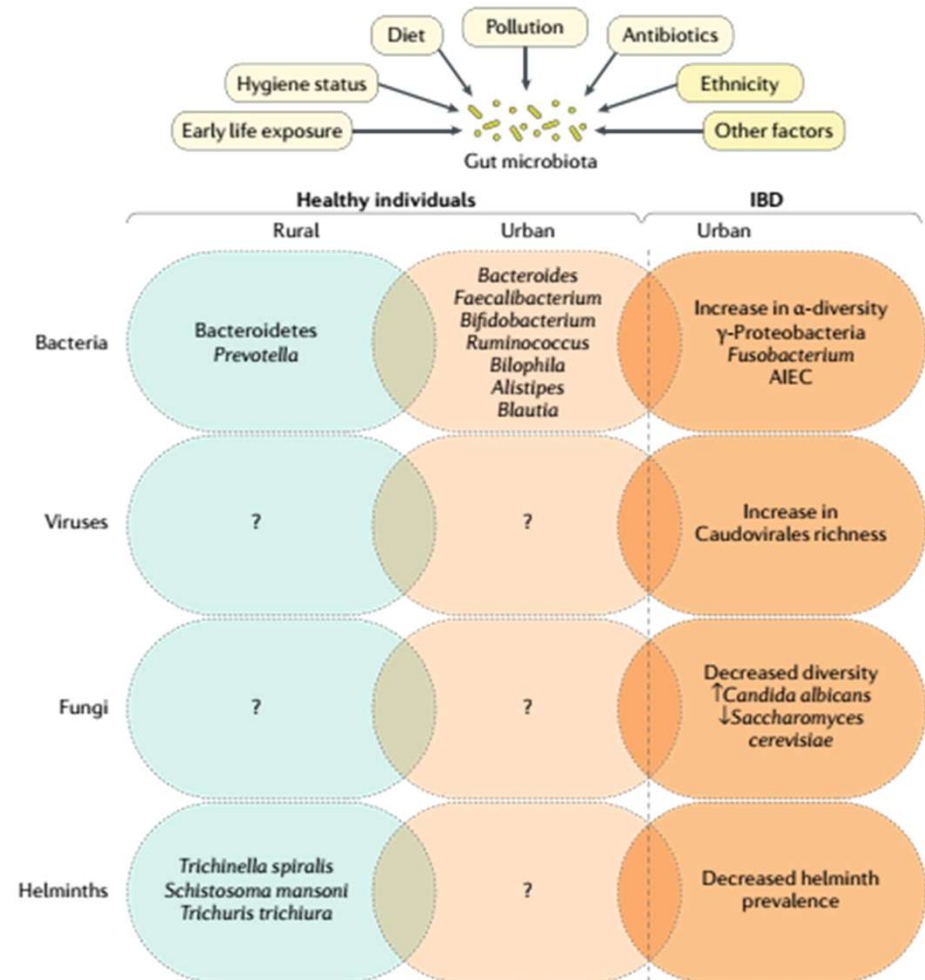
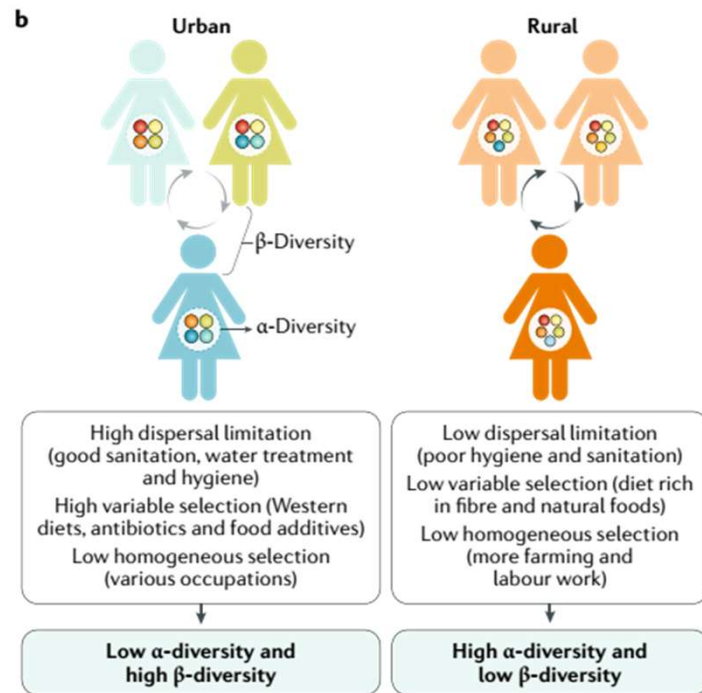
Geoffrey H. Donovan



Nature Plant, 2018

Urbanization and the gut microbiota in health and inflammatory bowel disease

Tao Zuo, Michael A. Kamm, Jean-Frédéric Colombel and Siew C. Ng



Sortir des crises

One Health en pratiques

Sous la direction de
Sébastien Gardon, Amandine Gautier,
Gwenola Le Naour et Serge Morand



éditions
Quæ

Getting out of the crises

Tripartite and UNEP support OHHLEP's definition of "One Health"

*In November 2020 at the Paris Peace Forum
FAO, OIE, UNEP and WHO create a multidisciplinary
One Health High-Level Expert Panel (OHHLEP)
with the support of **France** and **Germany***

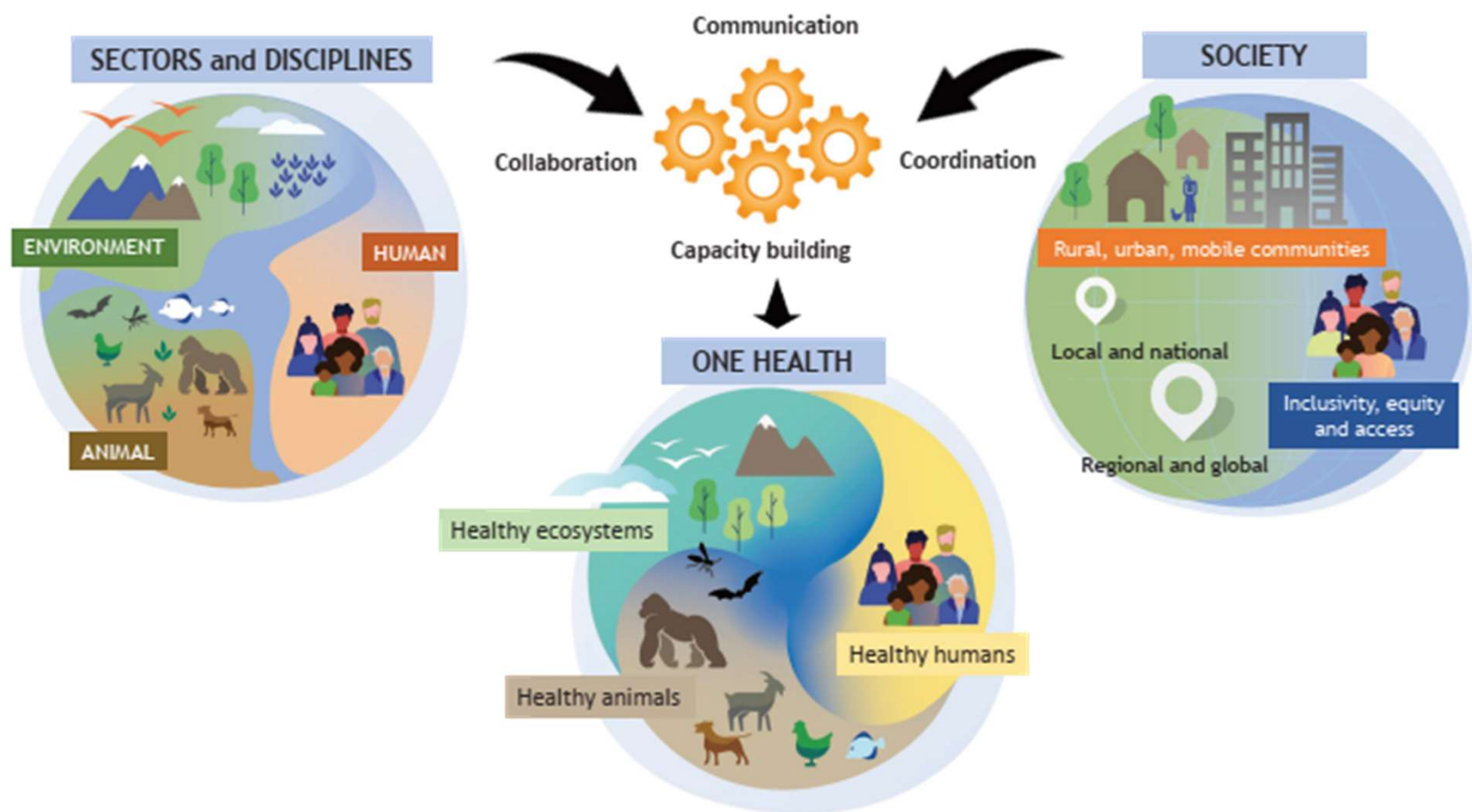
Joint Tripartite (FAO, OIE, WHO) and UNEP
Statement

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems.

It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent.

The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development.

December 1st 2021



Nexus assessment

Thematic assessment of the interlinkages among biodiversity, water, food and health

The IPBES Plenary, at IPBES 7 (April/May 2019, Paris), adopted a new work programme (2019-2030; available [here](#)), following up on the first IPBES work programme 2014-2018.

This new work programme includes a **thematic assessment of the interlinkages among biodiversity, water, food and health (nexus assessment)**, which will examine the interlinkages among the sustainable development goals related to **food** and **water** security, **health** for all, protecting **biodiversity** on land and in the oceans and combating **climate change**.



Chapter 5.3: Options for delivering sustainable approaches to health

- Solutions that involve other sectors – water, biodiversity, food, etc. – One Health, healthy planet
- Human health-related contributions from biodiversity
- Equity in accessibility to health-related benefits
- Linkages between biodiversity and disease prevention (zoonoses) and their drivers (land-use change, climate change, consumption, etc.)
- Covid-response options and the nexus





Bridging the gap between policy and knowledge
on Biodiversity in Europe

Call for experts on Biodiversity and Pandemics

Topic of evidence needs/request: Building on existing relevant work on research agendas and knowledge gap analysis, identifying interdisciplinary research [and action] priorities that contribute to a strategic research agenda on Biodiversity and pandemics addressing the critical interlinkages between relevant sectors needed to make future actions more effective.

Description: Eclipse is inviting applications from different fields of expertise to join an Expert Working Group (EWG – Read the [EWG's guidance note](#) to learn more). This [request](#) was originally put forward by the [European Commission's Directorate-General for Research and Innovation \(EC-DG R&I\)](#) and is now also followed by a cross-sectoral consortium of requesters, including the EC Directorates-General [Agriculture and Rural Development \(AGRI\)](#), [Health Emergency Preparedness and Response Authority \(HERA\)](#), [Environment \(ENV\)](#), and key relevant stakeholders such as [PREZODE \(Preventing Zoonotic Disease Emergence\)](#), [One Health High-Level Expert Panel \(OHHLEP\)](#), [HERA project](#) and [Norwegian Veterinary Institute \(NRI\)](#).

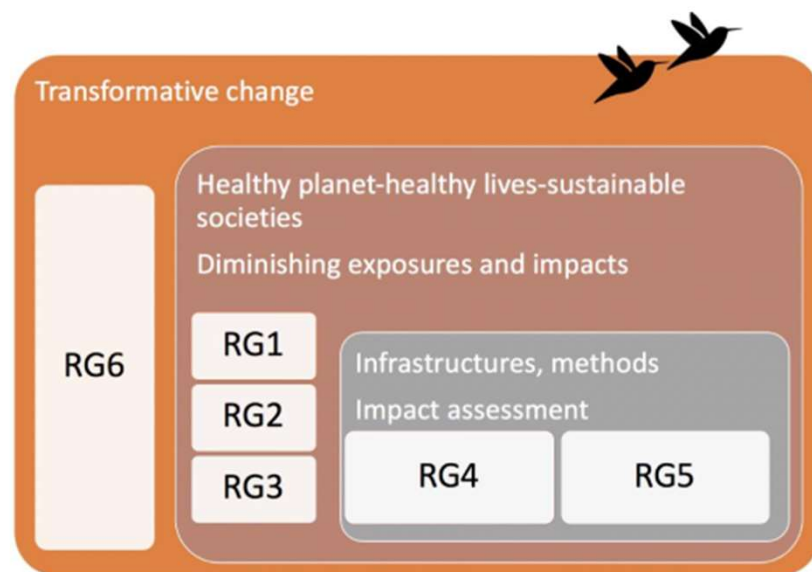


RG6. Support transformational change approaches in environment and health: transformational approaches are required to address the environmental challenges; they are based on interdisciplinarity and include technical, political, economic and ethical components.

RG1. Reduce the effects of climate change and ecological degradation on health: the identified research needs concern the effects of climate change on health, the role of biodiversity loss and the possible impact of the degradation of natural systems.

RG2. Eliminate environmental exposures harmful to health: additional research is required concerning a variety of stressors including chemicals and chemical mixtures, plastics, waste (also in relation to circular economy), water contaminants, different types of radiation and biological agents.

RG3. Promote healthy lives in sustainable and inclusive societies: this research goal covers a large number of critical research needs concerning urban and rural living, air pollution, mobility, sustainable energy consumption, occupational conditions including farming, and ecosystem services for more sustainable and inclusive societies.



RG4. Improve health impact assessment of environmental factors and promote intervention research: this goal covers methodologies in health impact assessment as well as the related social and economic costs and methods for implementation research.

RG5. Develop infrastructures and new technologies for understanding environmental impacts on health: robust infrastructures and tools are critical for the sustainability of research efforts in this field. Such infrastructures include cohorts, exposome, and planetary health monitoring.



PREZODE Initiative (PREventing ZOonotic Disease Emergence)

Officially launched in January 2021 at the **One Planet Summit**

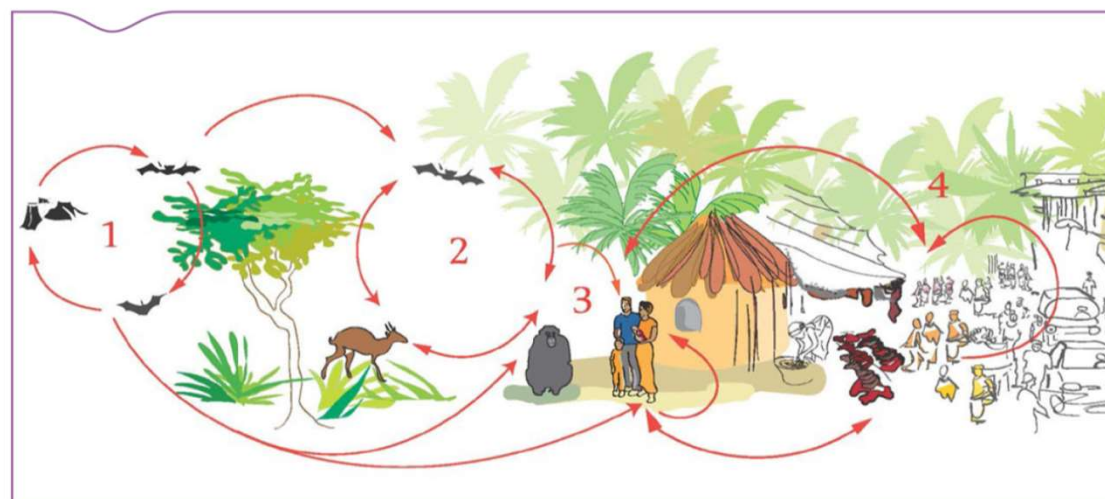
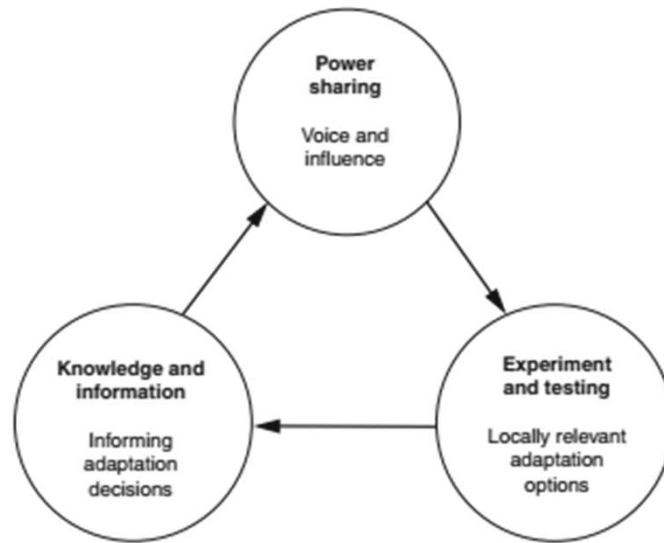
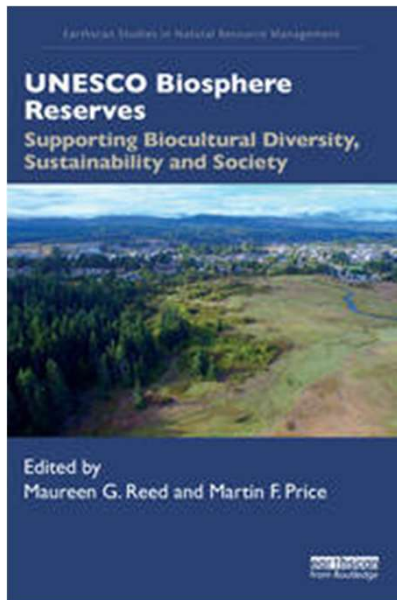


Figure 1. Circulation et transmission des virus Ebola dans un socio-écosystème forestier : (1) chauves-souris (2) espèces sauvages (3) contacts entre l'Homme et la faune sauvage (4) communautés humaines.
 © D. Guard-Lavastre/Cirad, d'après CDC : <http://www.cdc.gov/vhf/ebola/resources/virus-ecology.html>

Succeeding One Health through resilient territories: healthy ecosystems for healthy people



Planning thinking

Learning system

Scenario thinking

Theory of change

PLANNING

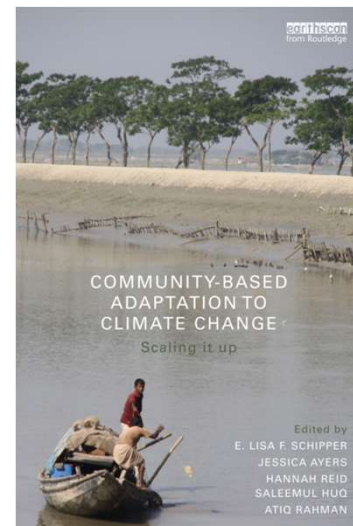
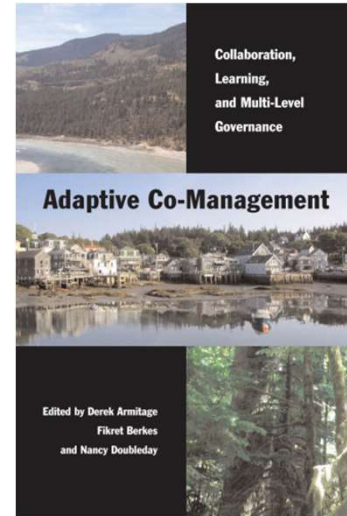
A) Involve all stakeholders in the planning and design process, including users, caregivers and healthcare staff, to ensure their needs and concerns are considered. Multiple perspectives help to maximise the value of the garden¹

B) Identify users' cultural backgrounds, age groups, and extent of their illnesses (e.g. stage of dementia disease) to better design for their needs

C) Consider programming in tandem with the planning, design and development of the garden



Stakeholders of therapeutic gardens



5

One Health and Biodiversity

HANS KEUNE, UNNIKRISHNAN PAYYAPPALLIMANA, SERGE MORAND
AND SIMON R. RÜEGG



Table 5.1 *One Health transformative biodiversity governance potential*

Generic transformative governance challenges	One Health challenges			
	1. Practical implementation of One Health	2. Integration of animal, human, plant and ecosystem health	3. Integrated view on nature-related health risks and benefits	4. Integration of structural societal One Health drivers
A. Integrative	Combining different relevant ecosystem and health issues, sectors, and structural systemic drivers and outcomes			
B. Inclusive	Choosing how to deal with system complexity is inherently normative, which warrants the inclusion of societal deliberation next to scientific analysis			
C. Transdisciplinary	Combining different relevant forms of knowledge, stemming both from different scientific disciplines and different societal perspectives			
D. Adaptive	We cannot wait for perfect understanding or consensus; we need to take One Health to iterative implementation: learning by doing			
E. Anticipatory	Complexity, ongoing normative debate and development of insight need to be incorporated in analytical–deliberative transformative processes			

Thank you



Biodiversity and Health

Serge Morand and Claire Lajaunie

Linking Life, Ecosystems and Societies

ISTE
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