

Biodiversité et pandémies : quels liens ?

Serge Morand

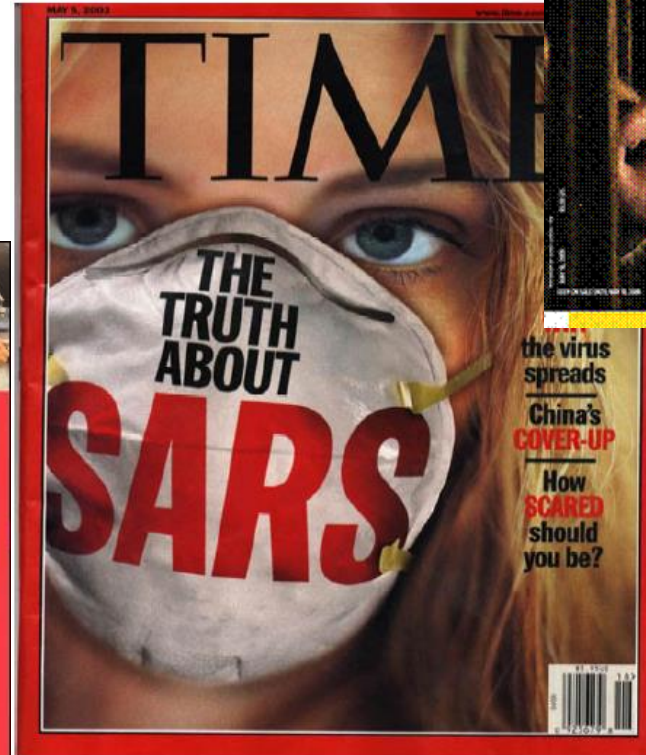
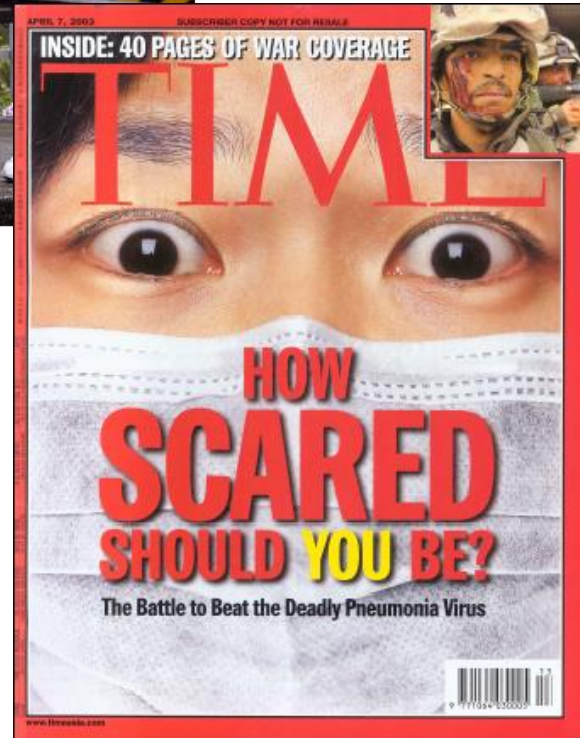
serge.morand@umontpellier.fr



before 2020, I started with ...



2016



12 January 2020

News / Wuhan Coronavirus

17 January 2020 - Imperial College London

Estimating the potential total number of novel Coronavirus (2019-nCoV) cases in Wuhan City, China

Estimation 1,723 cases of 2019-nCoV at Wuhan
(95% CI: 427 – 4,471)

China locking down cities with 18 million to stop virus

23 January 2020, by Ken M



Une personne est conduite à l'hôpital de Wuhan où des patients atteints d'une pneumonie inconnue sont traités, le 18 janvier 2020. STR / AFP



Matère
à débattre • décider

Emergence of infectious diseases

Risks and issues for society

Serge Morand, Muriel Figuié, eds.



éditions
Quæ

Une épidémie d'épidémies

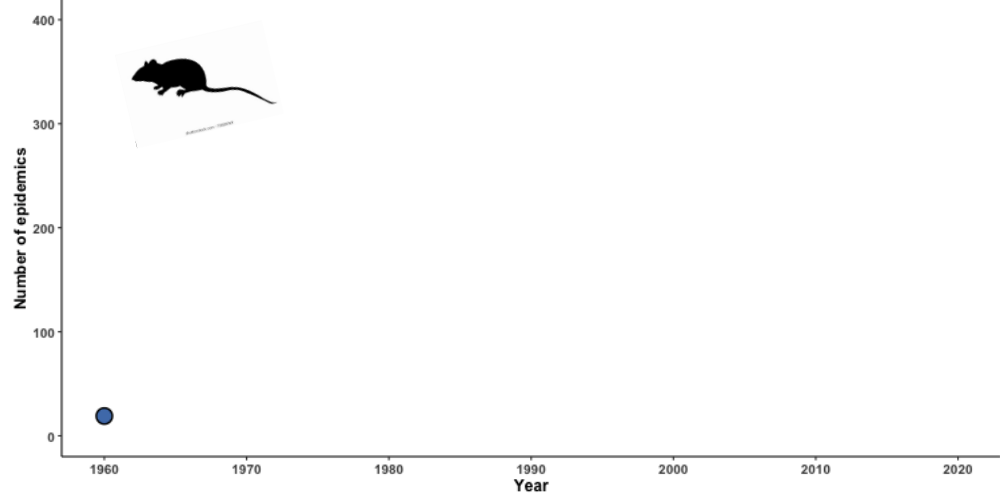
An increasing number of outbreaks



Humans

Outbreaks of zoonotic diseases

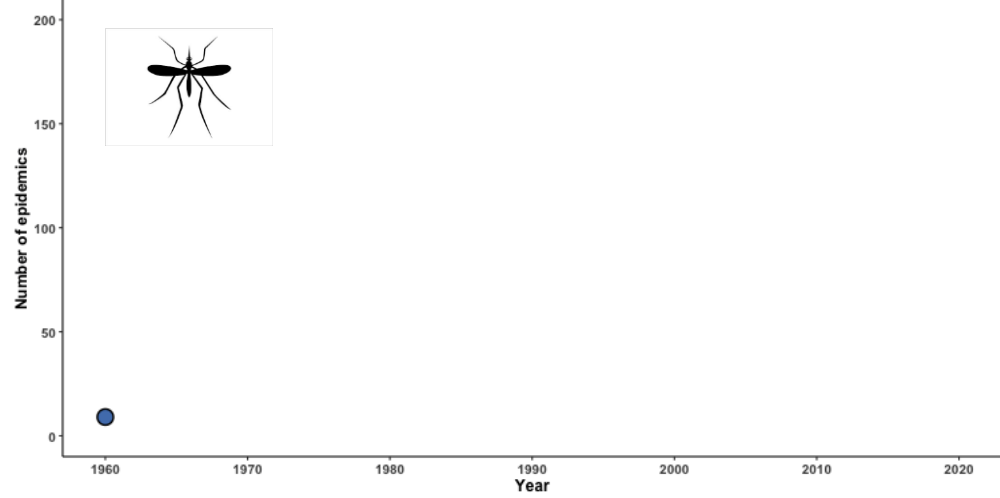
1960-2019



Data source: GIDEON

Outbreaks of vector-borne diseases

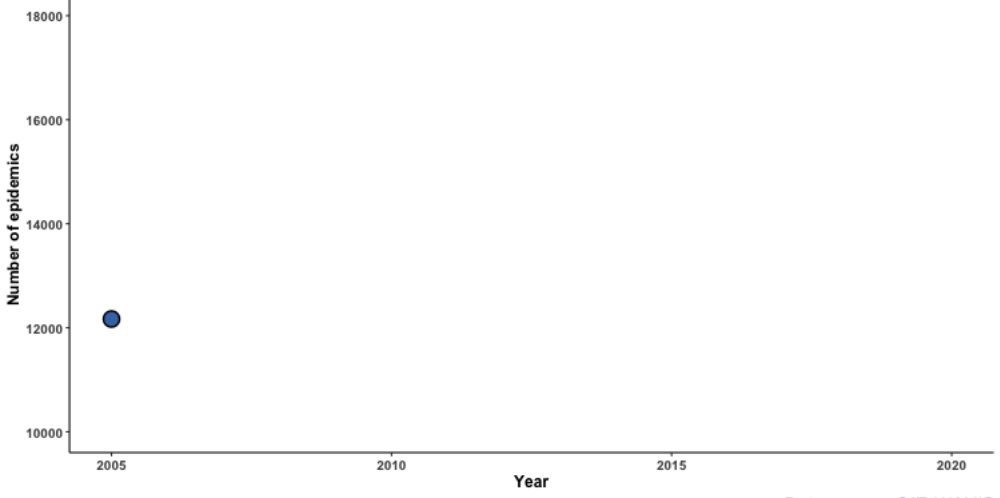
1960-2019



Data source: GIDEON

Outbreaks of livestock - poultry diseases

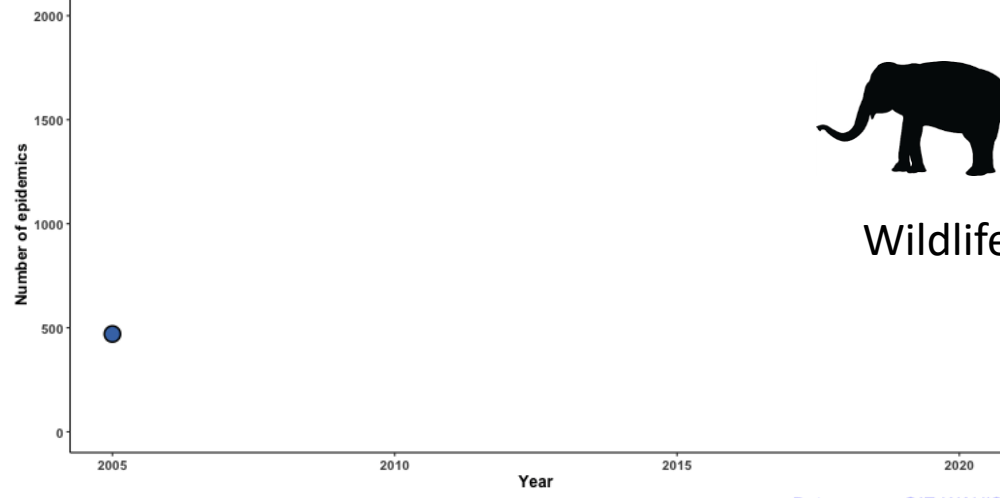
2005-2019



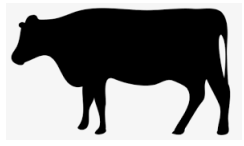
Data source: OIE-WAHIS

Outbreaks of wildlife diseases

2005-2019



Data source: OIE-WAHIS



Livestock



Wildlife



Increase of fungal diseases in plants and animals



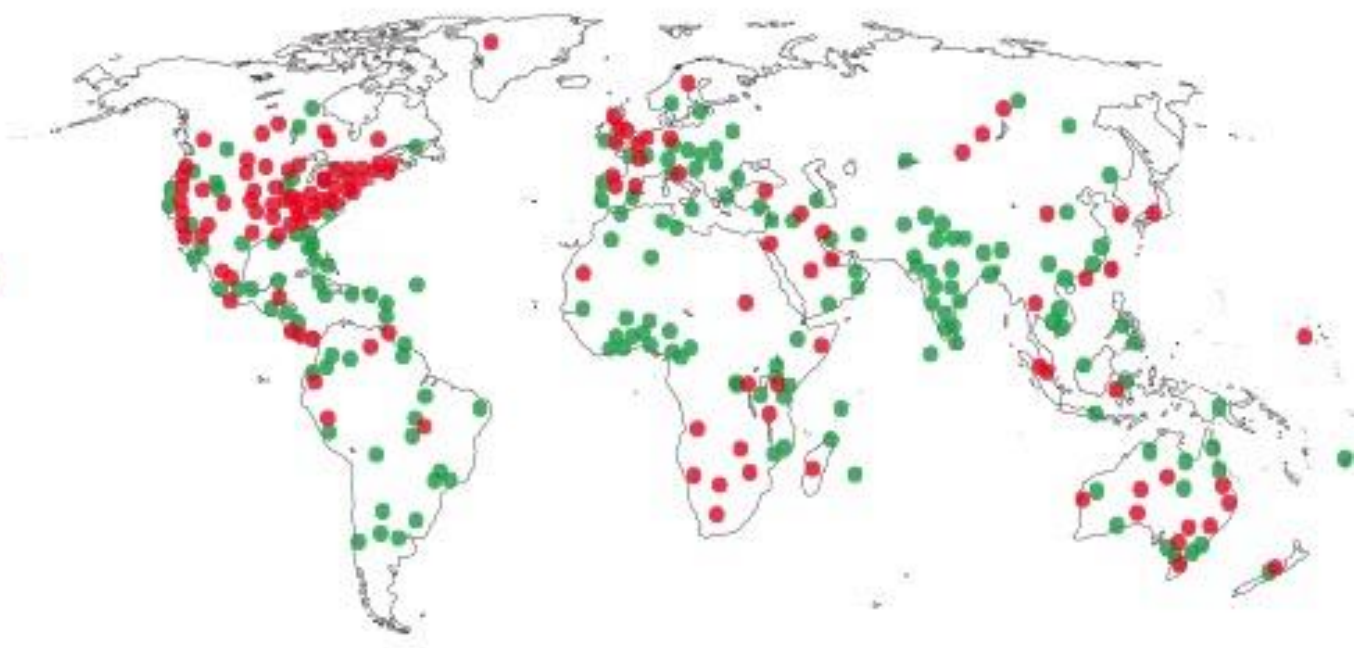
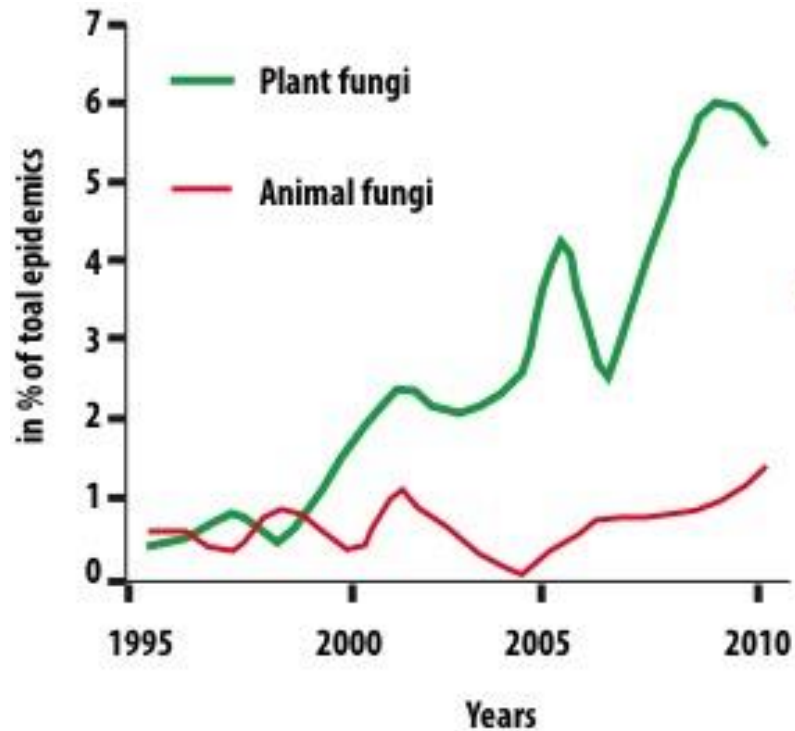
Bat white-nose syndrome

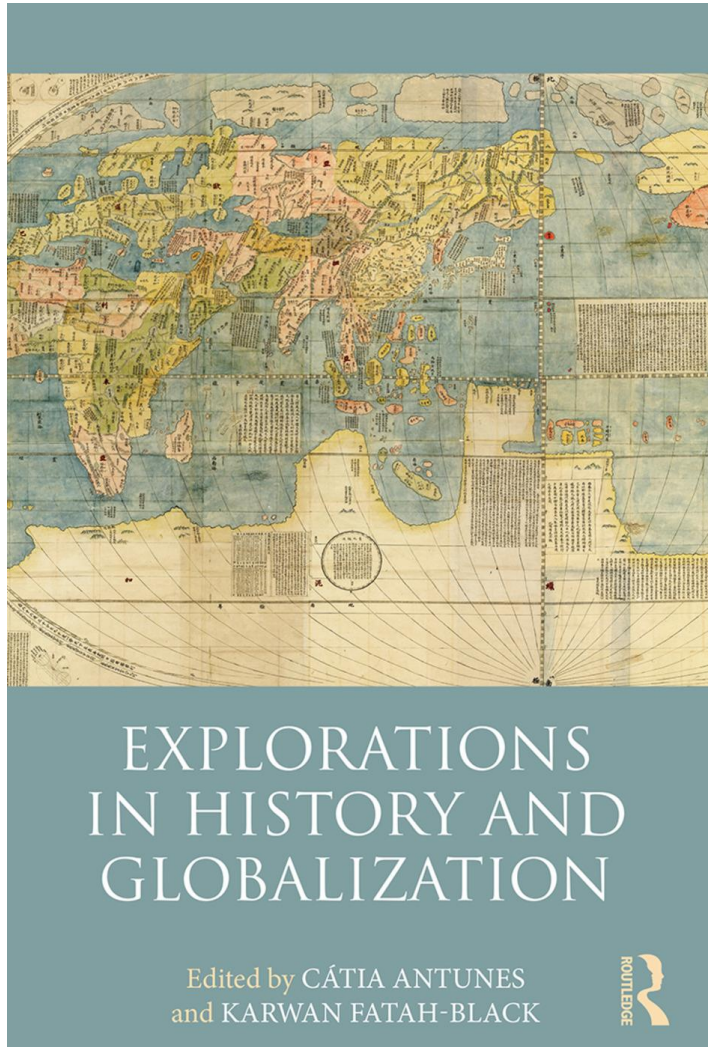


Amphibian chytrid



Plant fungal diseases





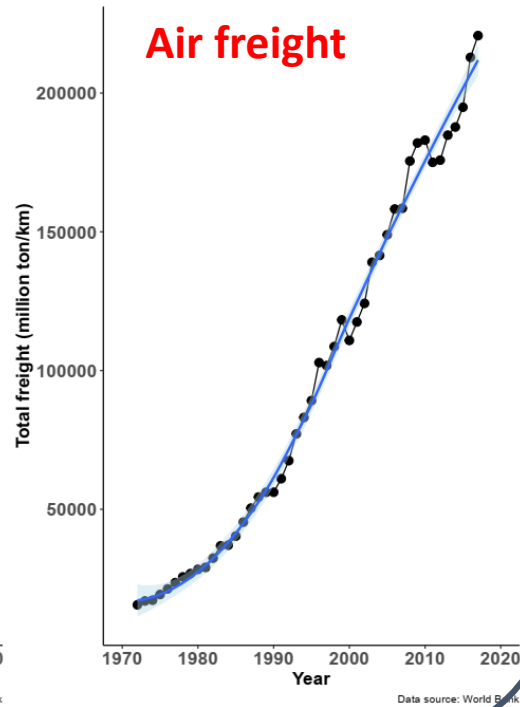
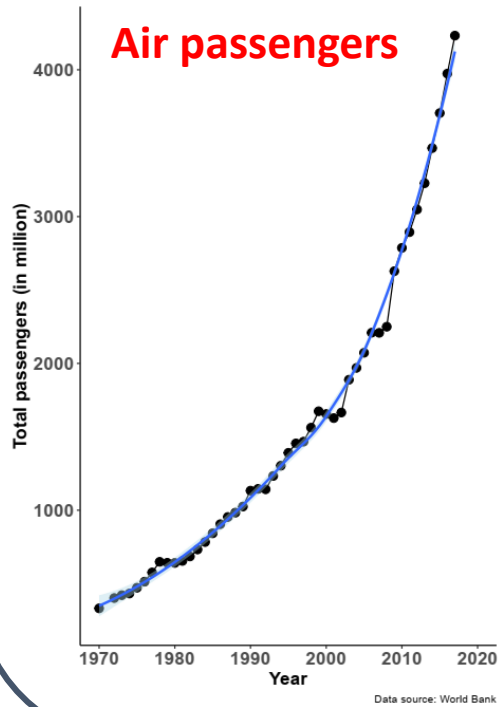
Une planète globalisée

Global trade and travels



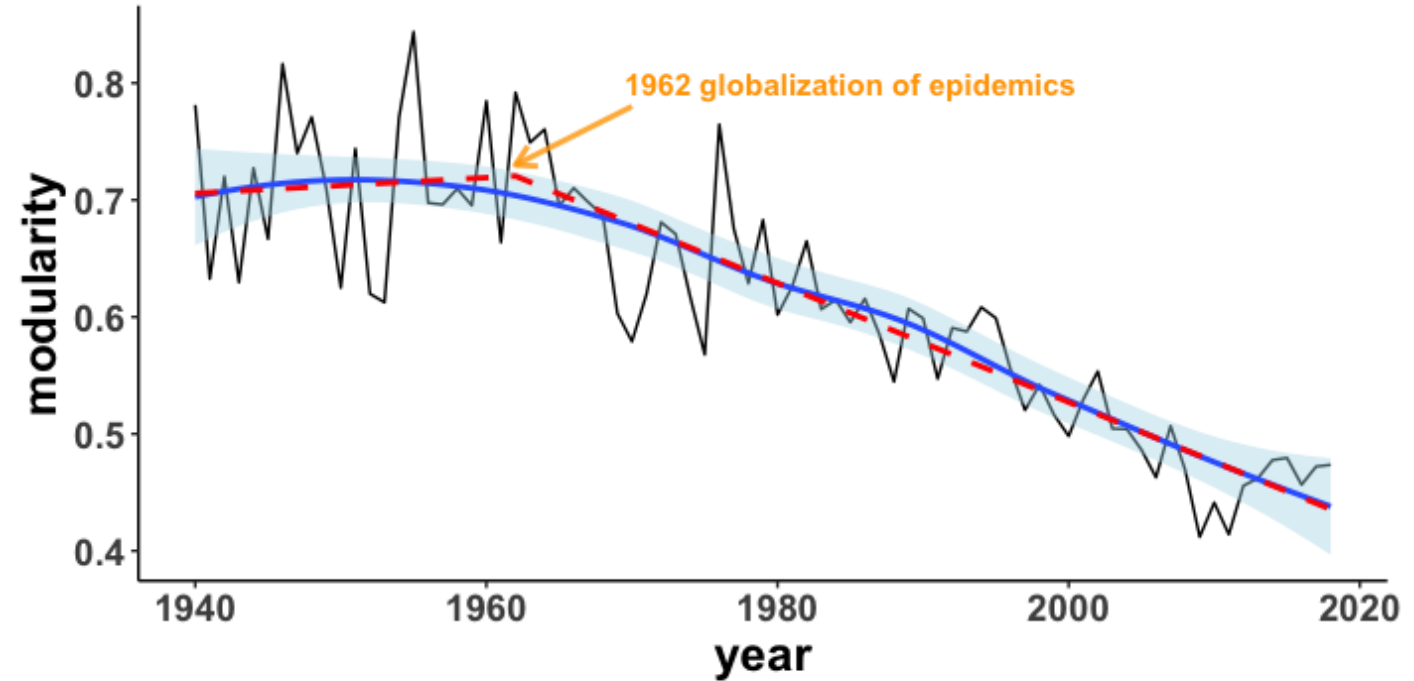
Globalization of epidemics

1,300 % increase 1970-2016



World

Global patterns of outbreaks of infectious diseases



Climate Change and Global Health

Edited by Colin D. Butler



***Un dérèglement
climatique***

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

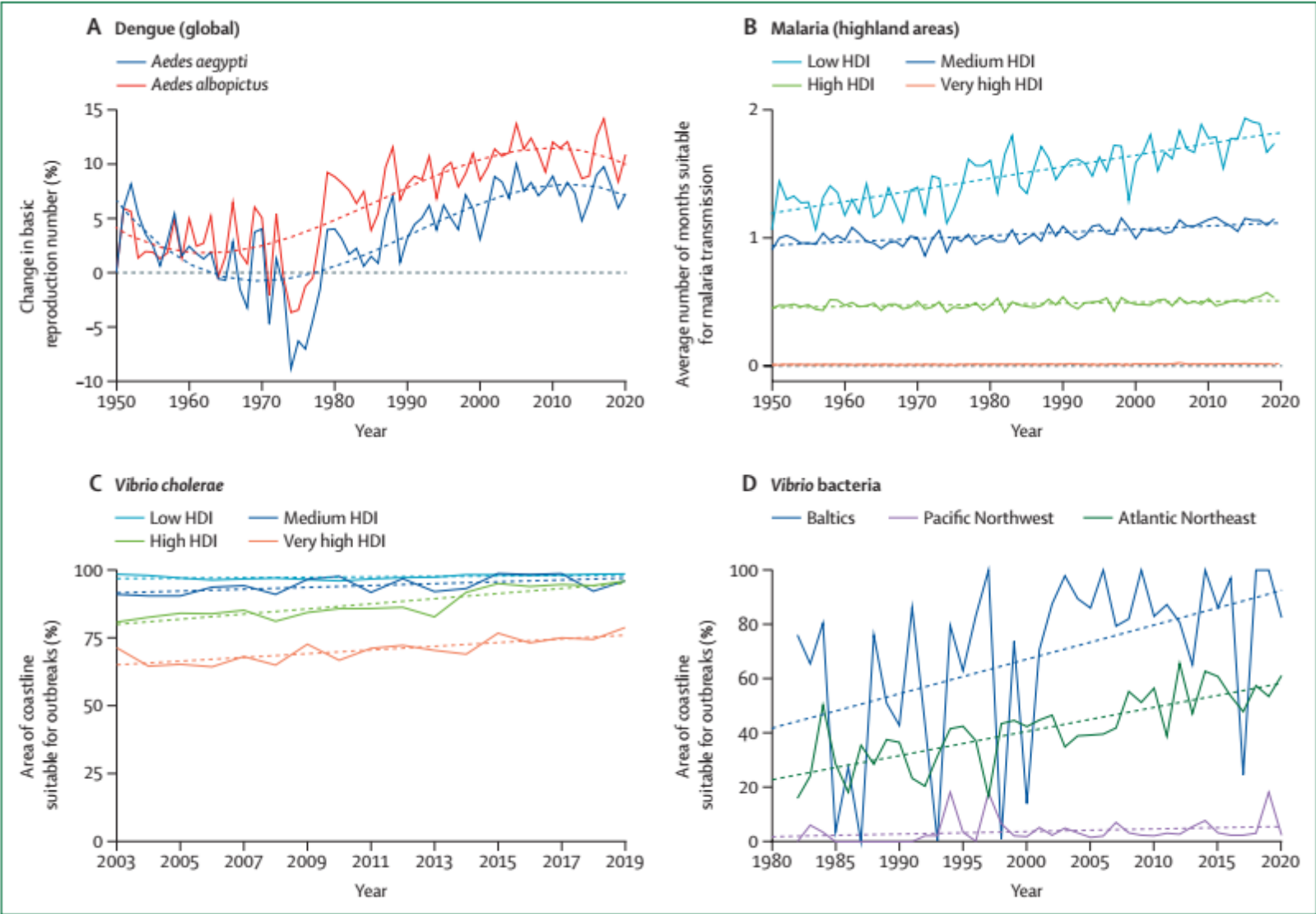


Figure 8: Change in climate suitability for infectious diseases



Epidemiology for
Field Veterinarians
An Introduction

Evan Sergeant and Nigel Perkins

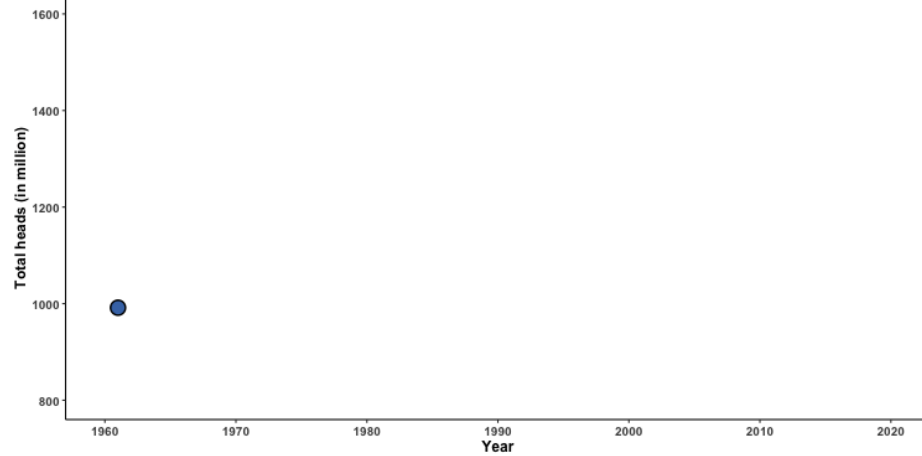


Un élevage en croissance

Livestock and poultry increase



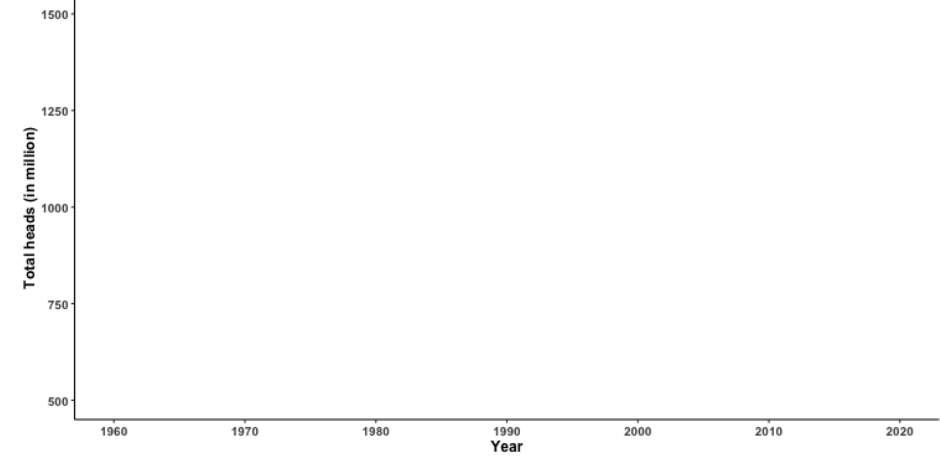
Total heads of cattle (in million)
1960-2020



Data source: FAO



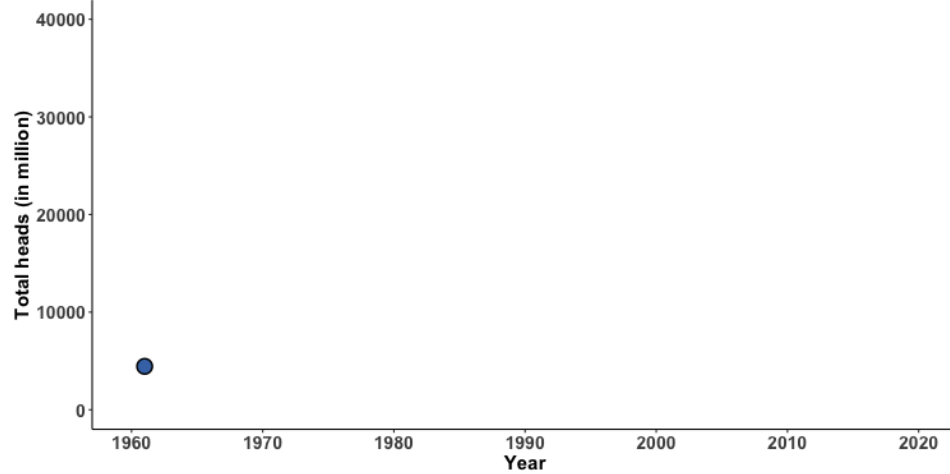
Total heads of pigs (in million)
1960-2020



Data source: FAO



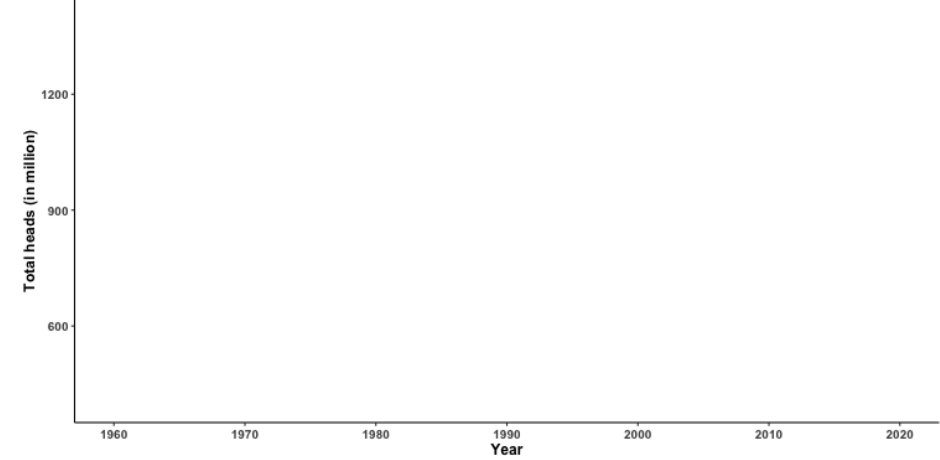
Total heads of chickens (in million)
1960-2020



Data source: FAO

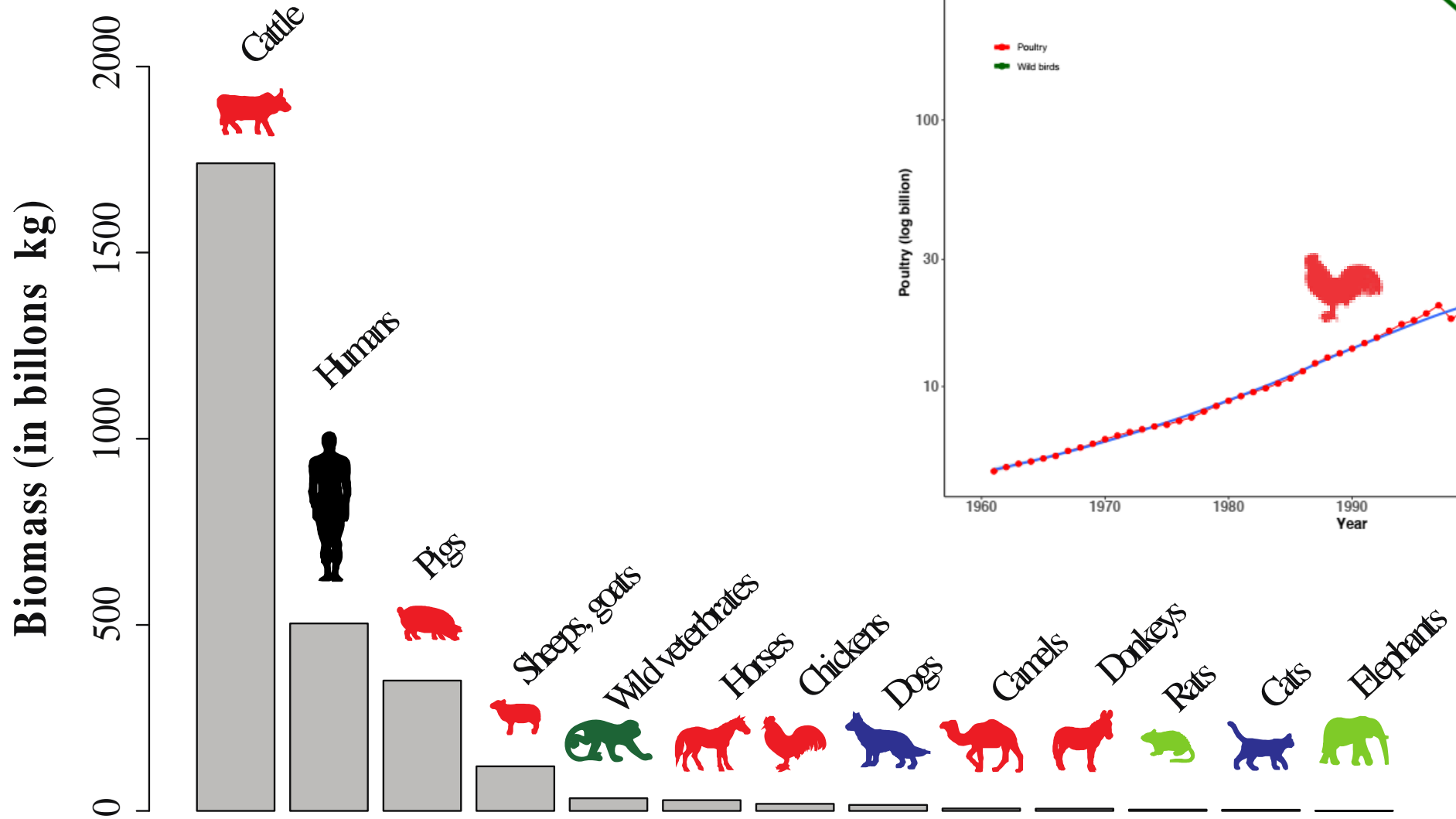


Total heads of goats (in million)
1960-2020

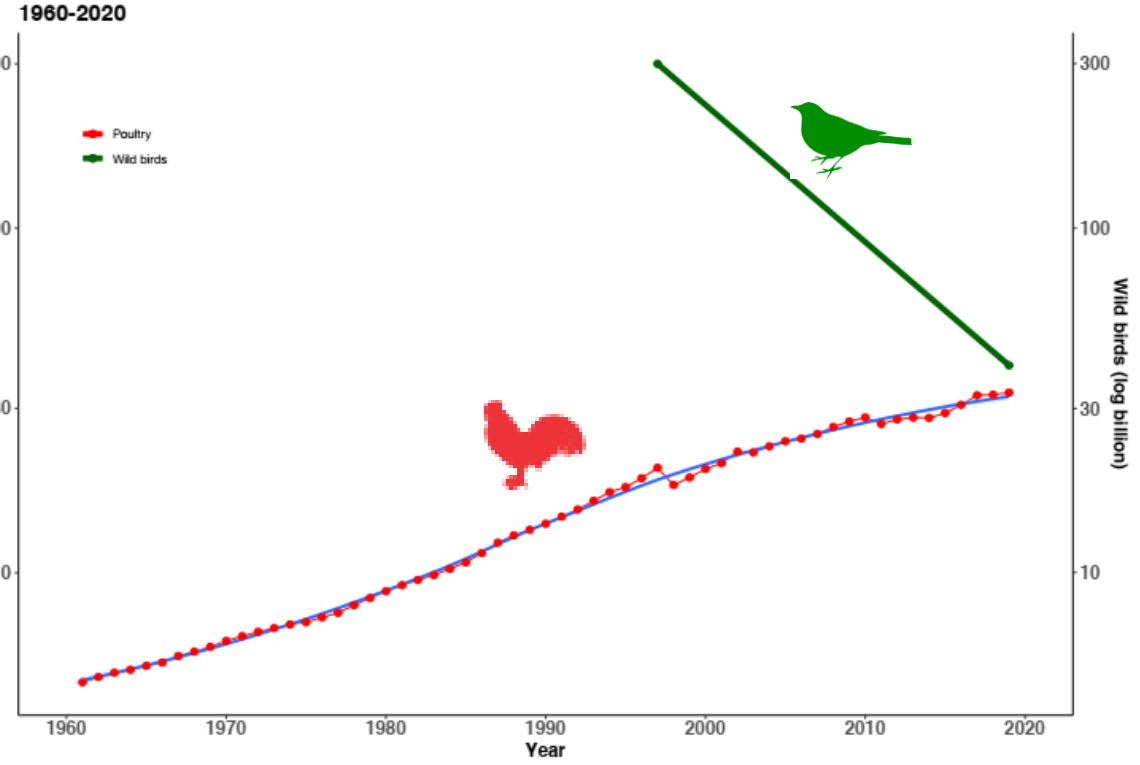


Data source: FAO

A planet dominated by livestock and poultry



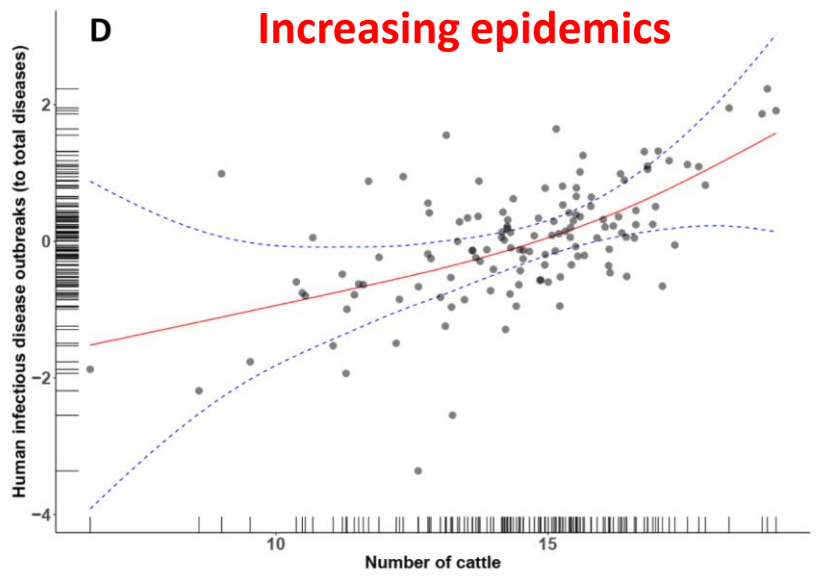
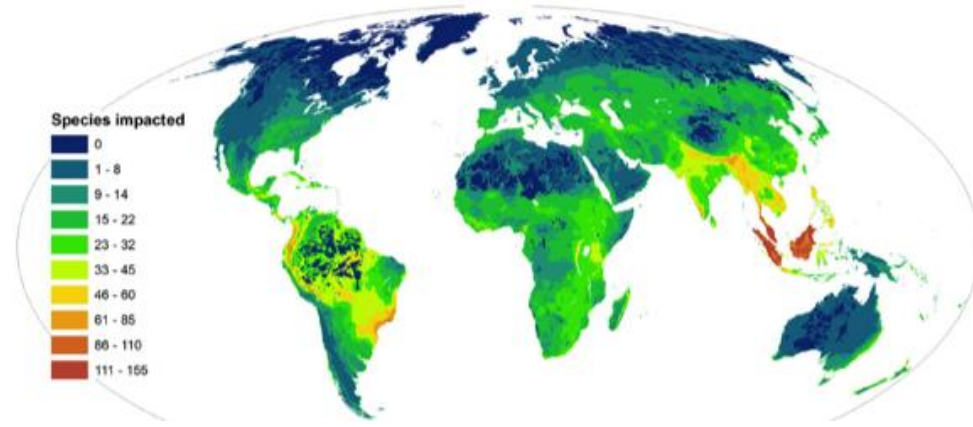
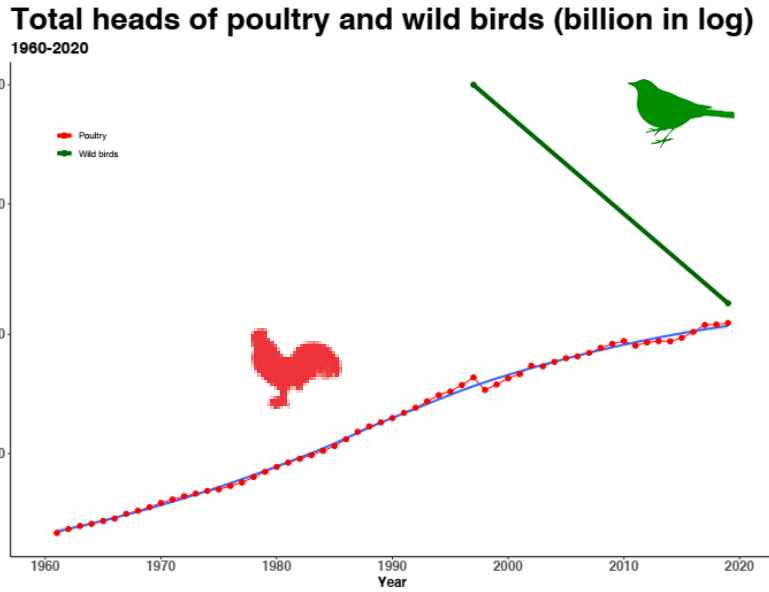
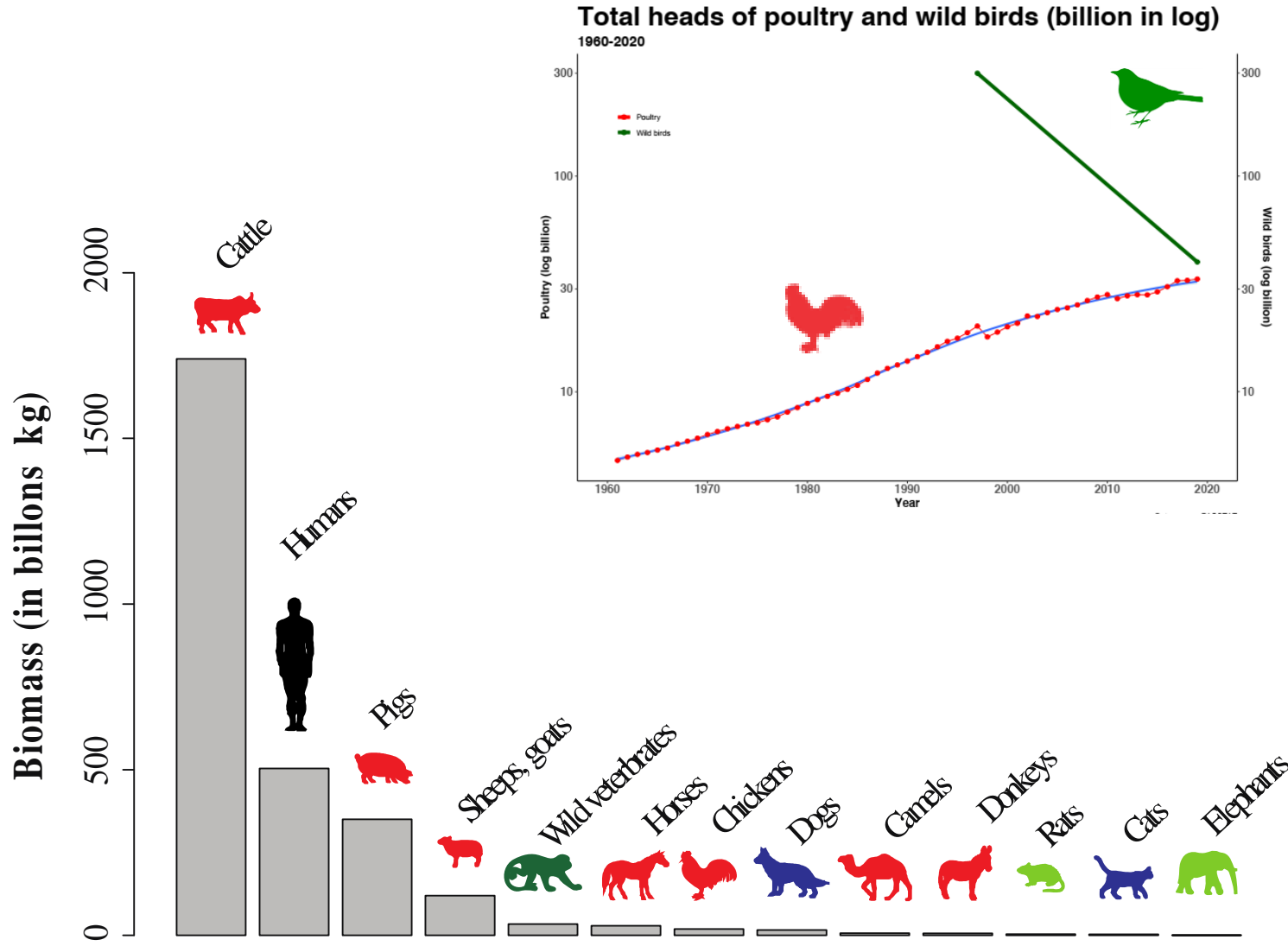
Total heads of poultry and wild birds (billion in log)



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


A planet dominated by livestock and poultry

Increasing biodiversity loss



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

=> Livestock and poultry health







SPREAD – IMPACT – TRENDS

WORLD LIVESTOCK DISEASE ATLAS

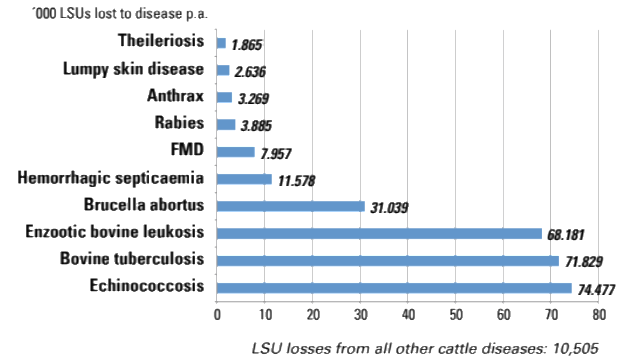
A Quantitative Analysis of Global Animal Health Data (2006-2009)

November 2011

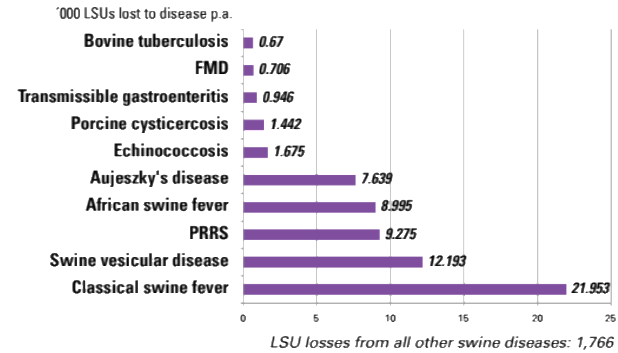
TOP 10 DISEASES CATTLE

2006-2009



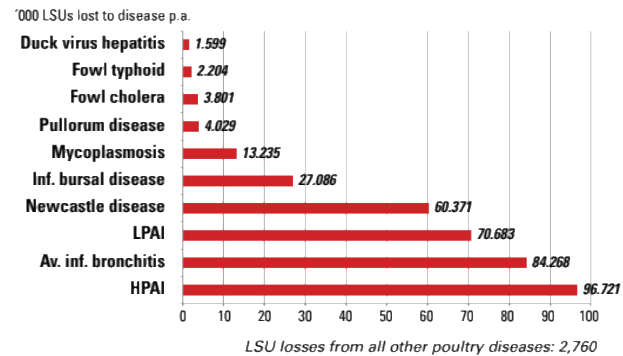
TOP 10 DISEASES SWINE

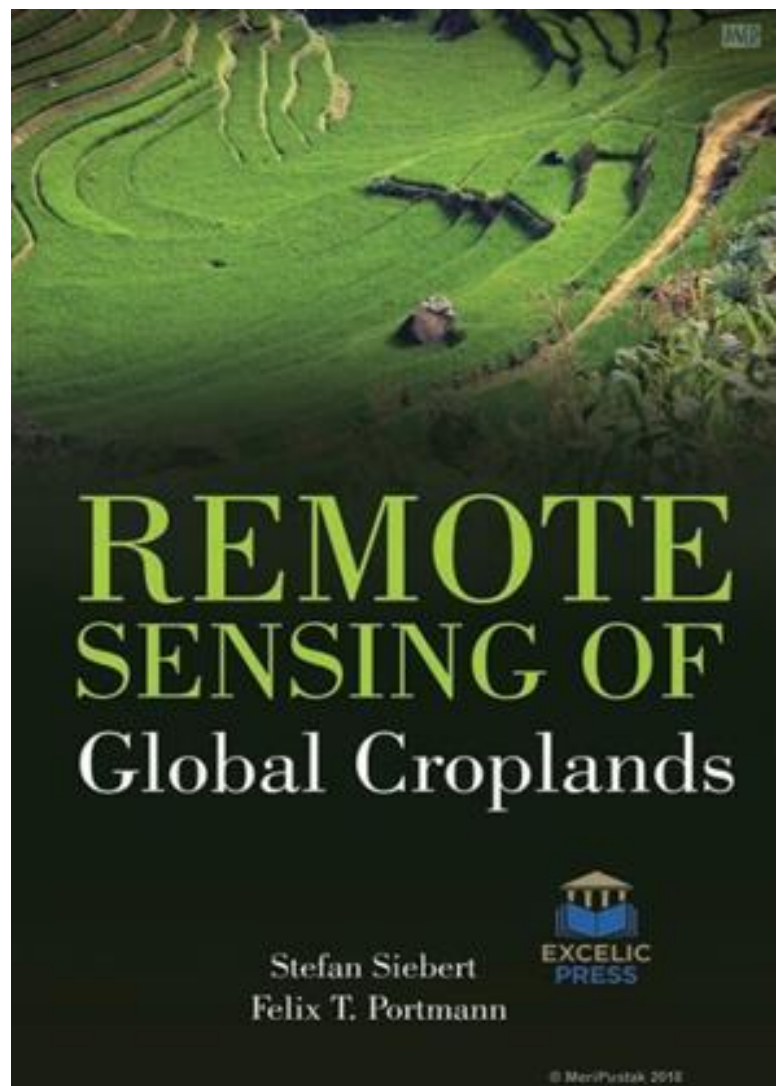
2006-2009



TOP 10 DISEASES POULTRY

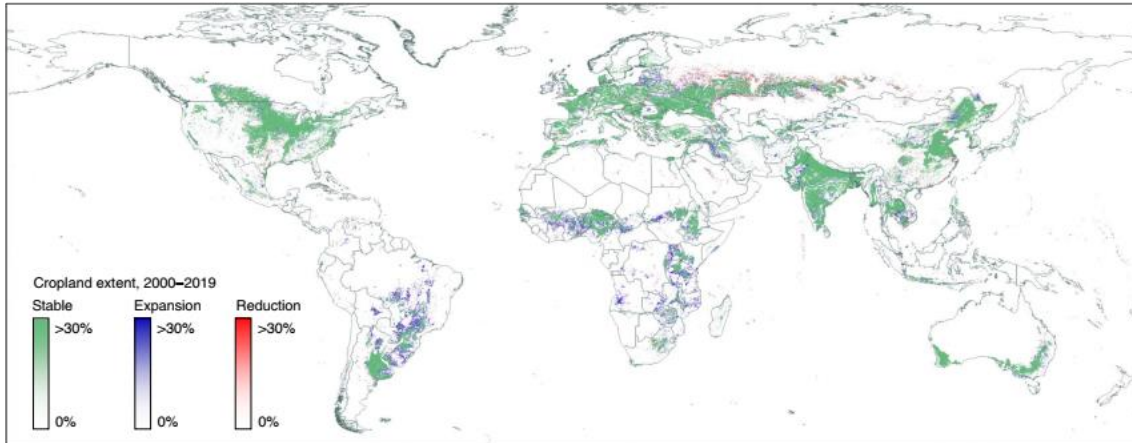
2006-2009





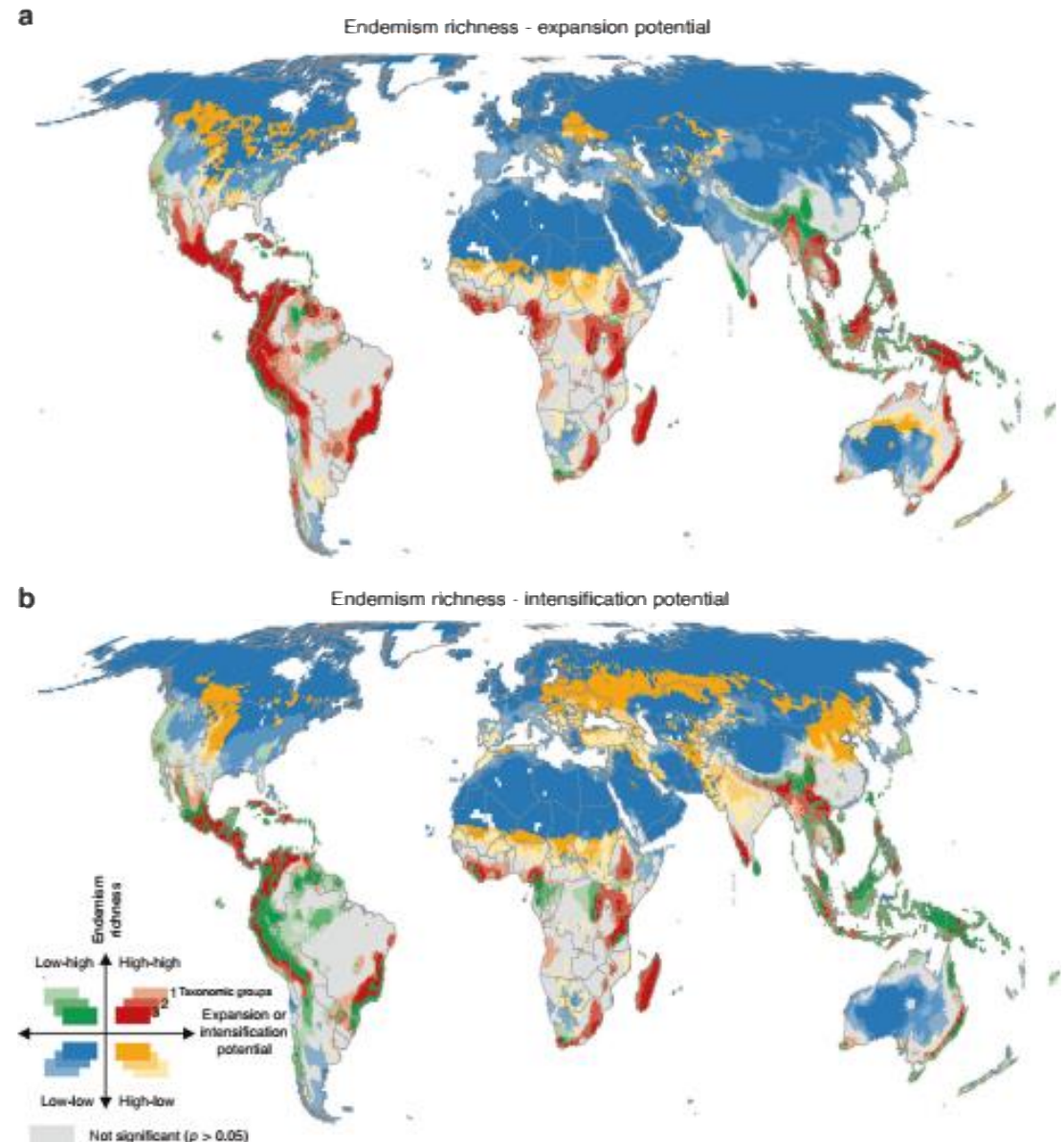
Expansion de l'agriculture

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



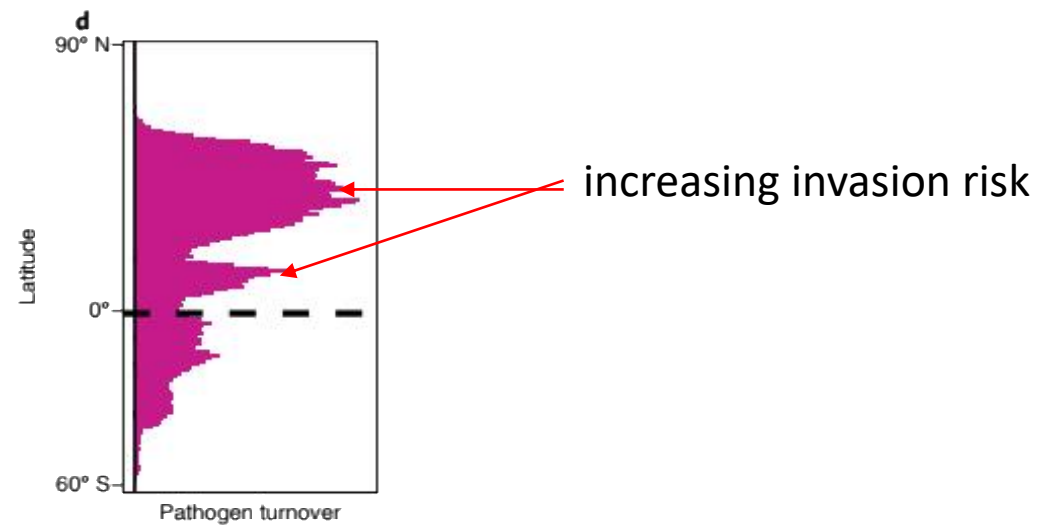
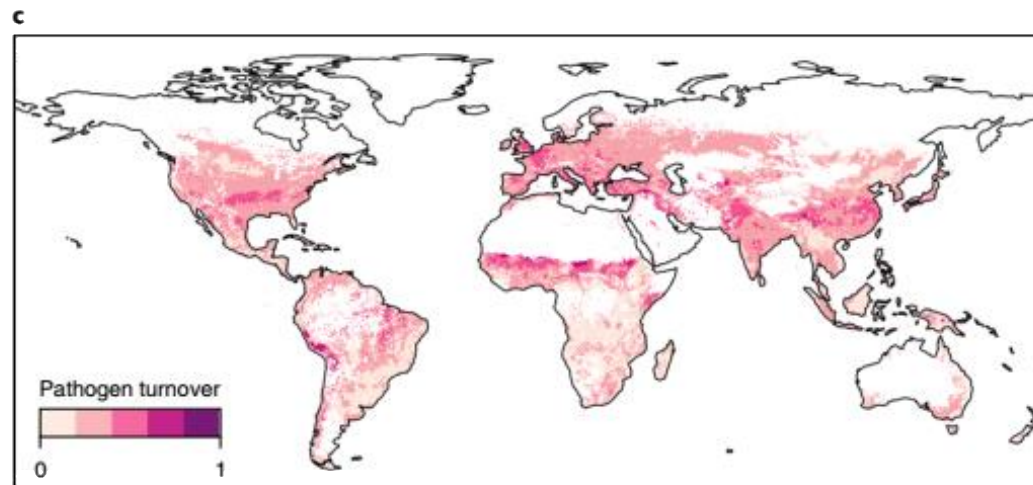
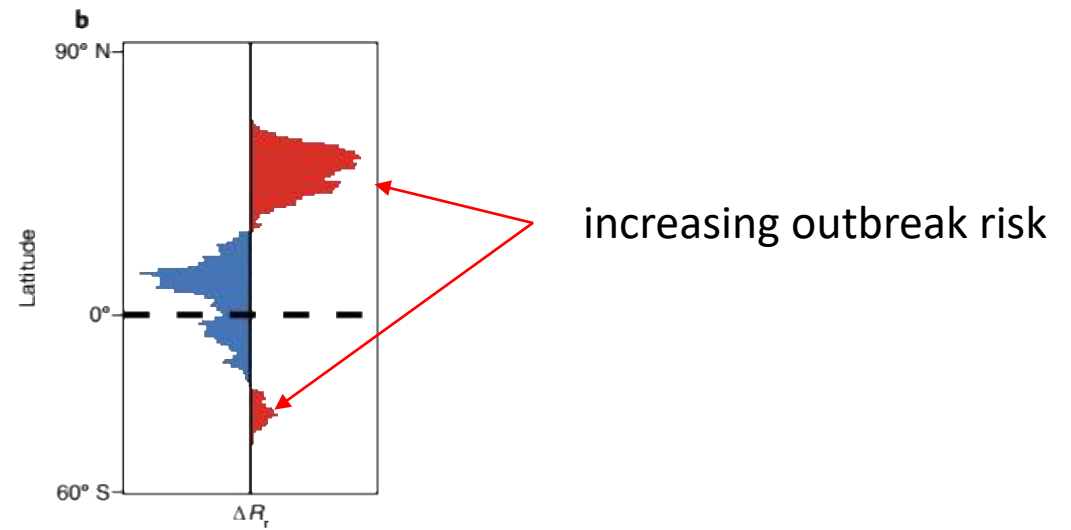
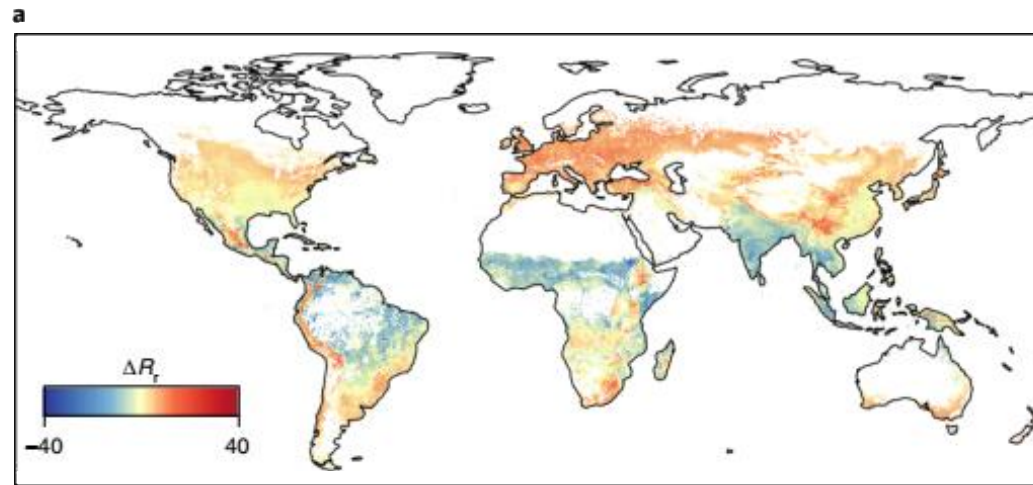
<https://doi.org/10.1038/s43016-021-00429-z>

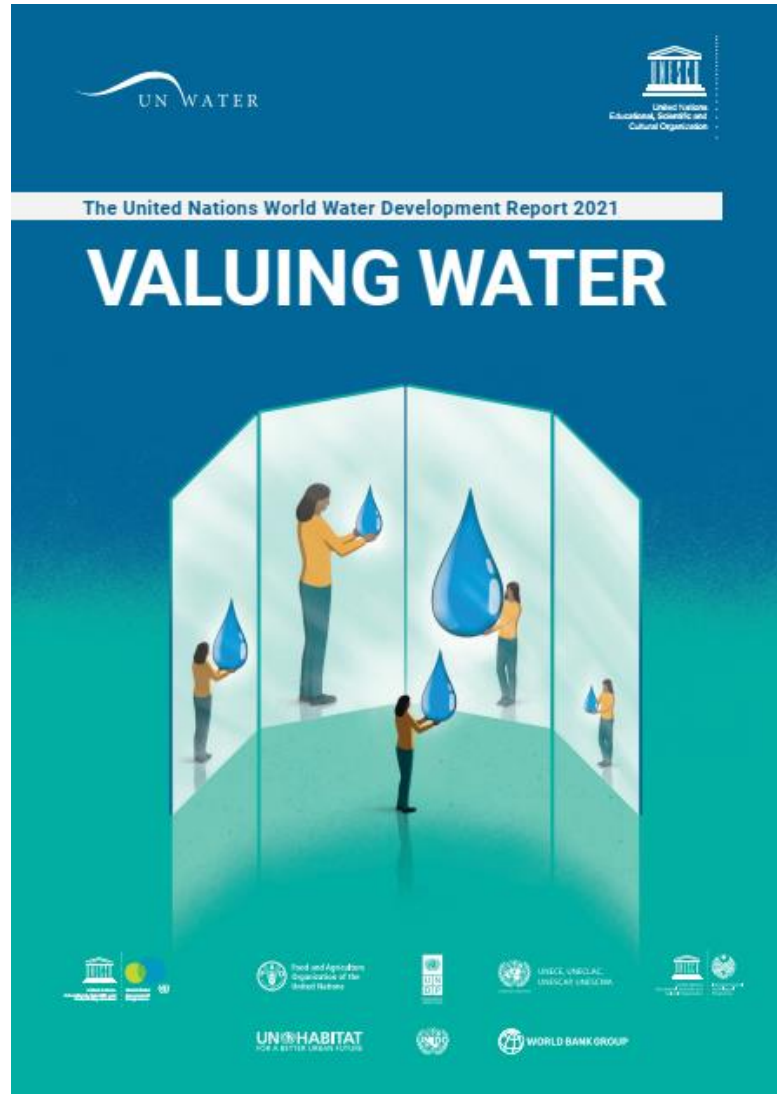
Impact of cropland (a) extension and (b) intensification on biodiversity



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

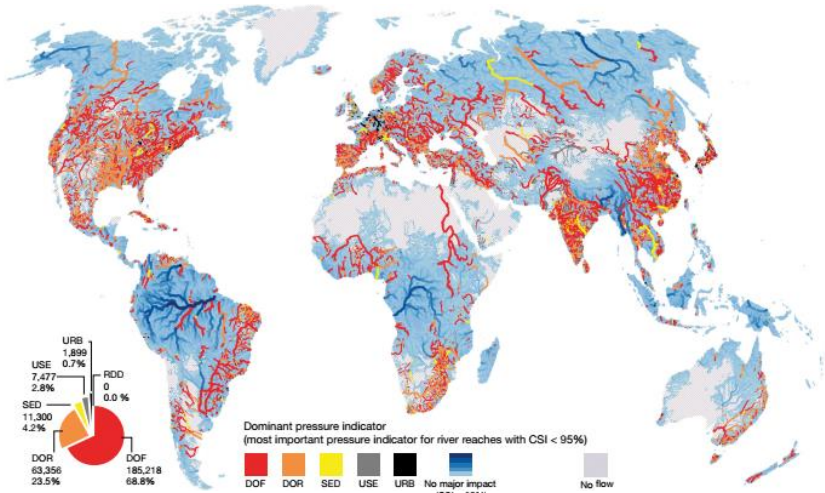
Cropland expansion and climate change may exacerbate plant pathogen infection risks





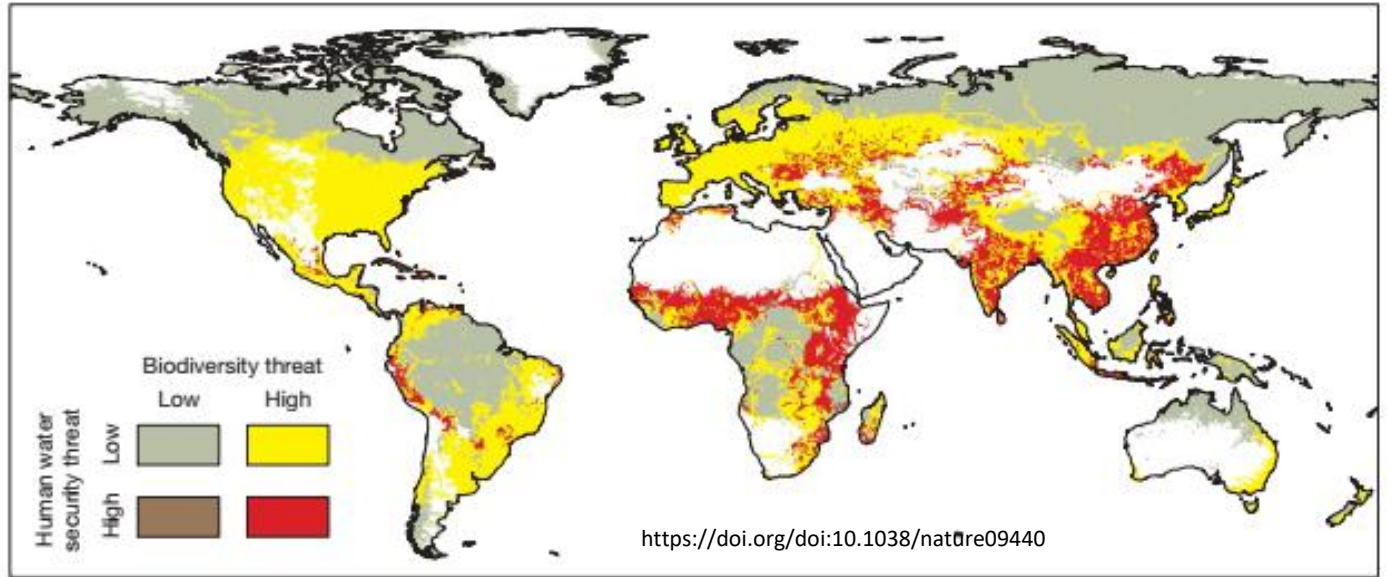
***Augmentation des impacts
sur les eaux continentales,
accroissement des
barrages ...***

Only 37 per cent of rivers longer than 1,000 kilometres remain free-flowing over their entire length and 23 per cent flow uninterrupted to the ocean



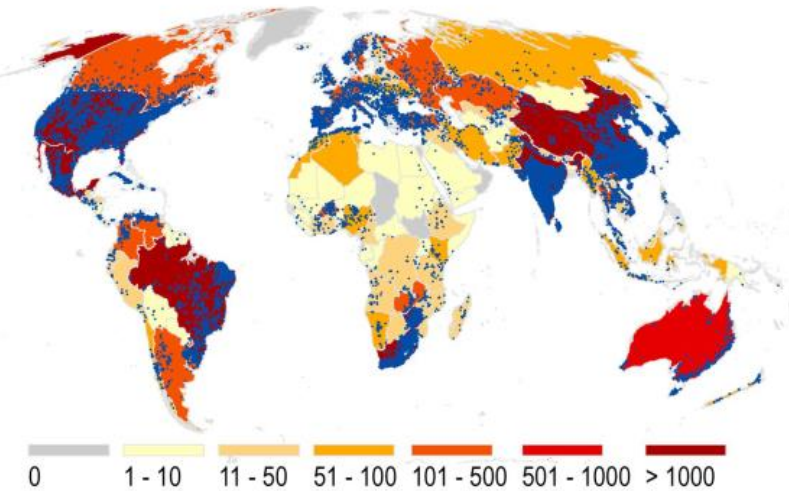
<https://doi.org/10.1038/s41586-019-1111-9>

80% of the world's population is exposed to high levels of threat to water security, and habitats associated with 65% of continental discharge classified as threatened



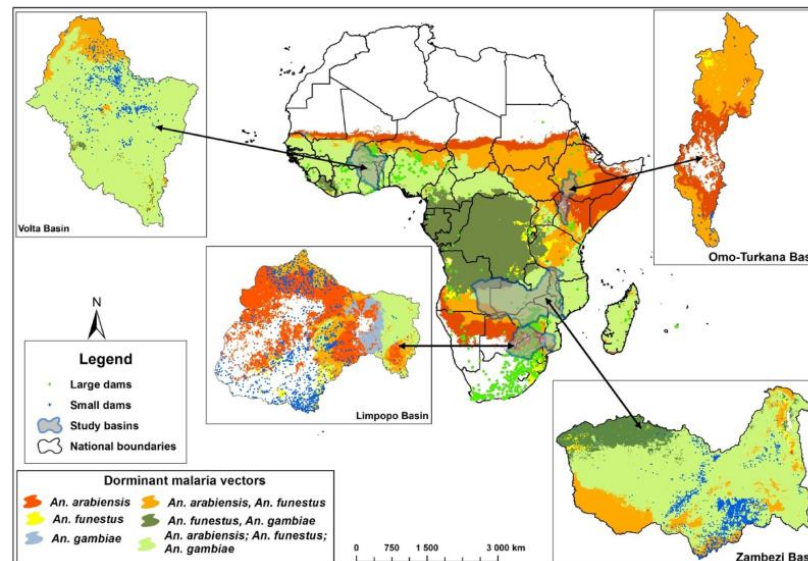
<https://doi.org/doi:10.1038/nature09440>

Number of dams per country (38,000 georeferenced dams)

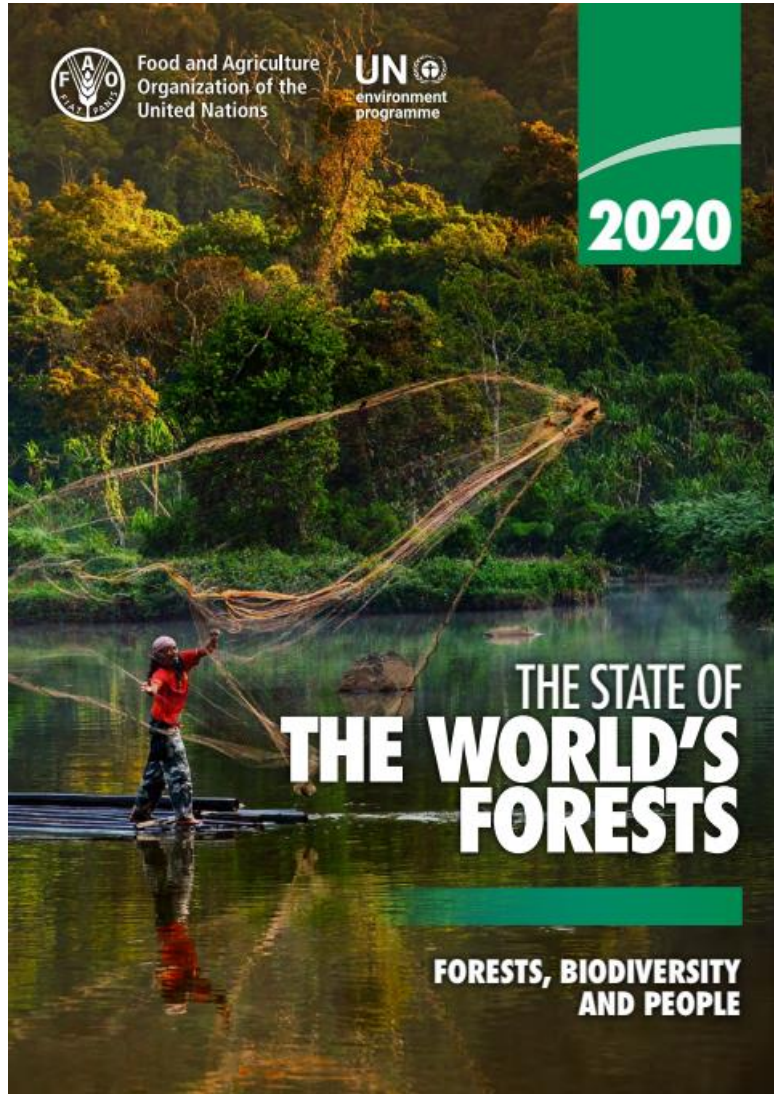


<https://doi.org/10.1038/s41597-020-0362-5>

Evidence on the effect of dams on malaria transmission is mounting. African dams have been shown to cause at least 1.1 million malaria cases each year

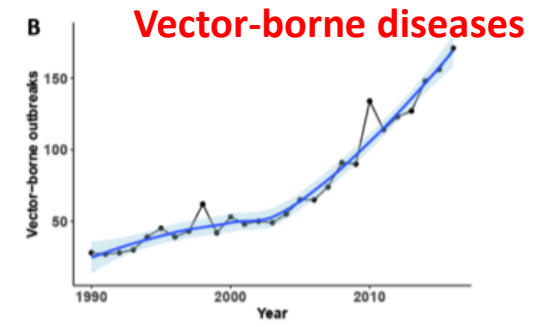
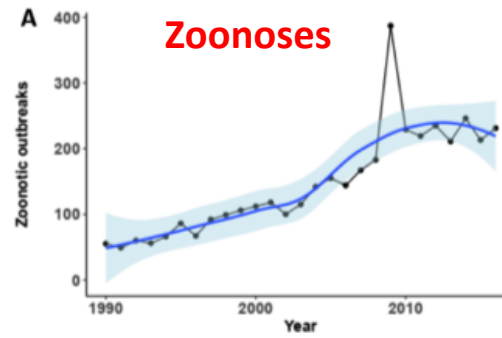


<https://doi.org/10.1038/s41598-021-92924-3>



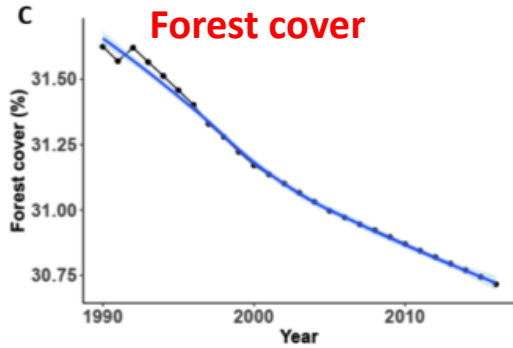
Déforestation et plantations commerciales

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



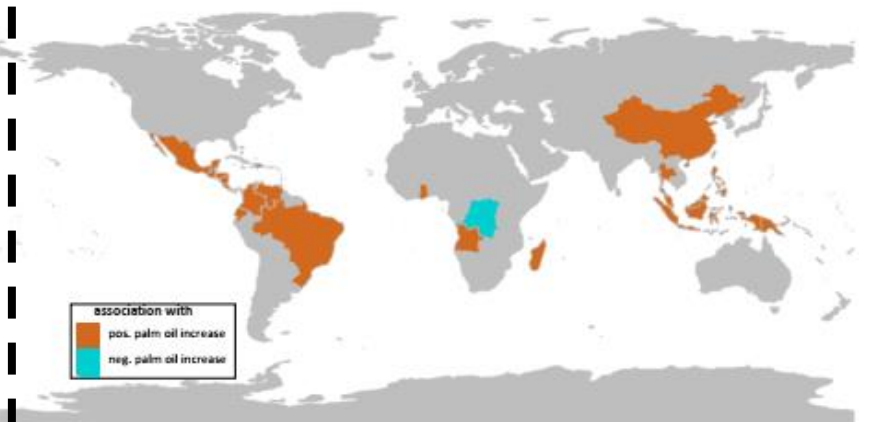
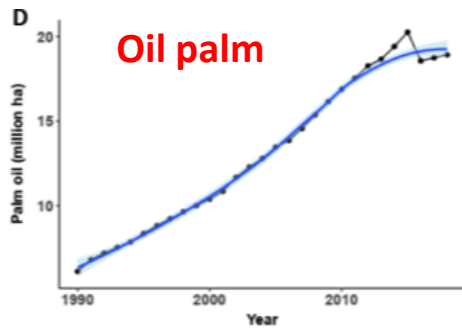
A Outbreaks of zoonotic diseases

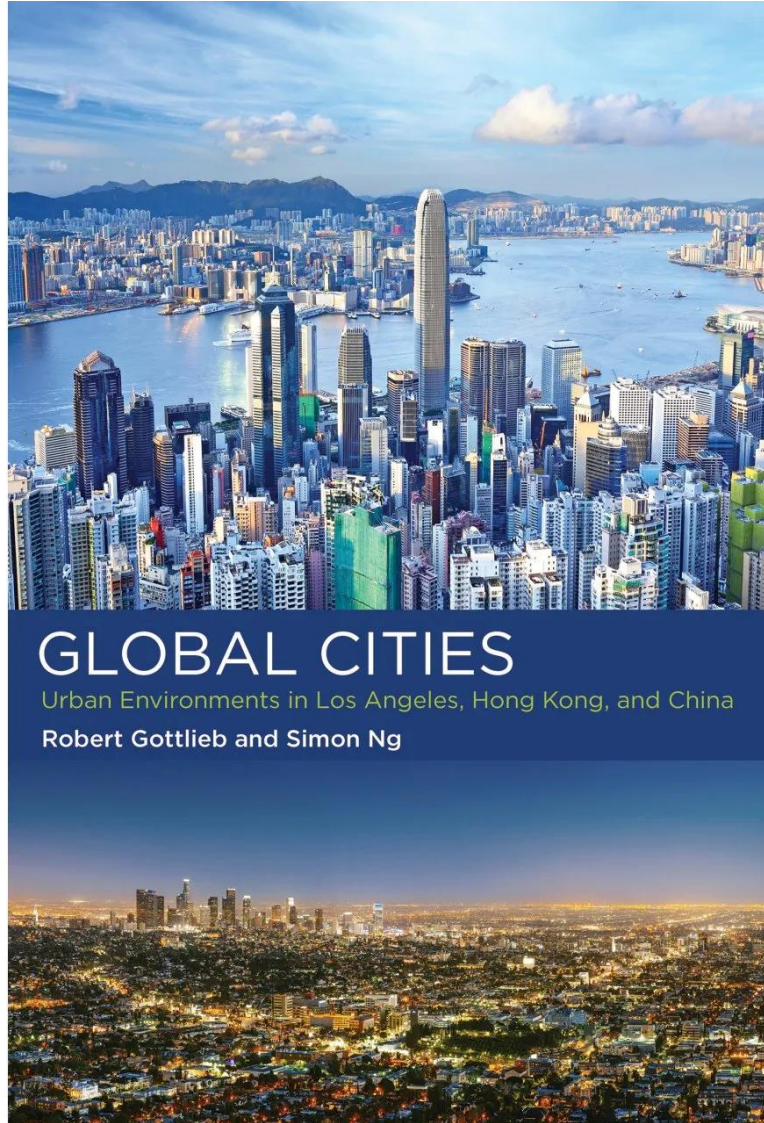
B Outbreaks of vector-borne diseases



C Outbreaks of zoonotic diseases

D Outbreaks of vector-borne diseases



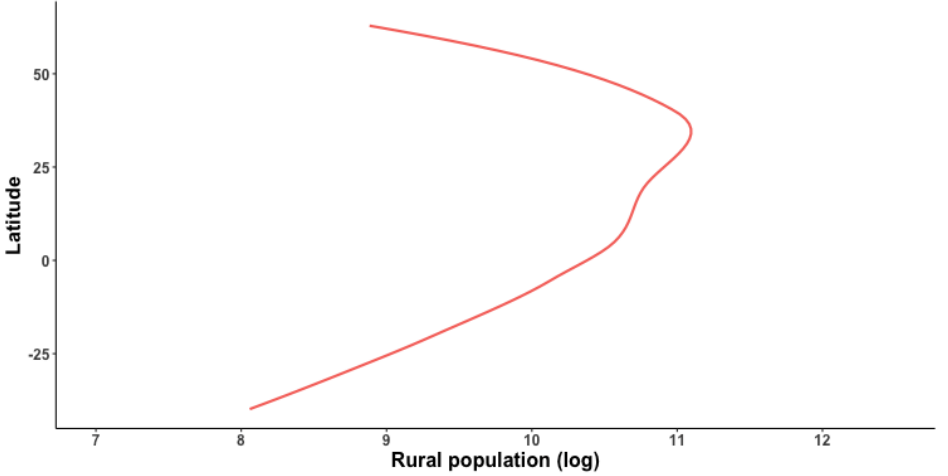


Une planète de plus en plus urbaine

A more urban dominated planet (intertropical region)

Latitudinal change in rural population

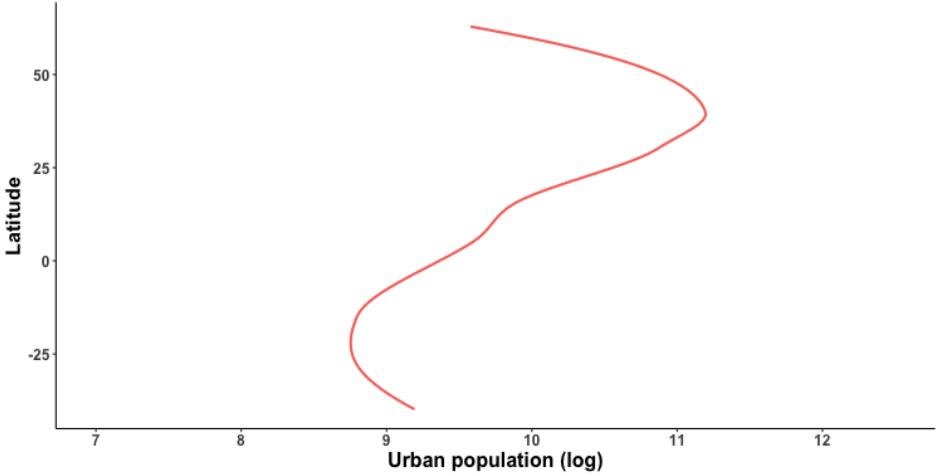
1960-2050



UN

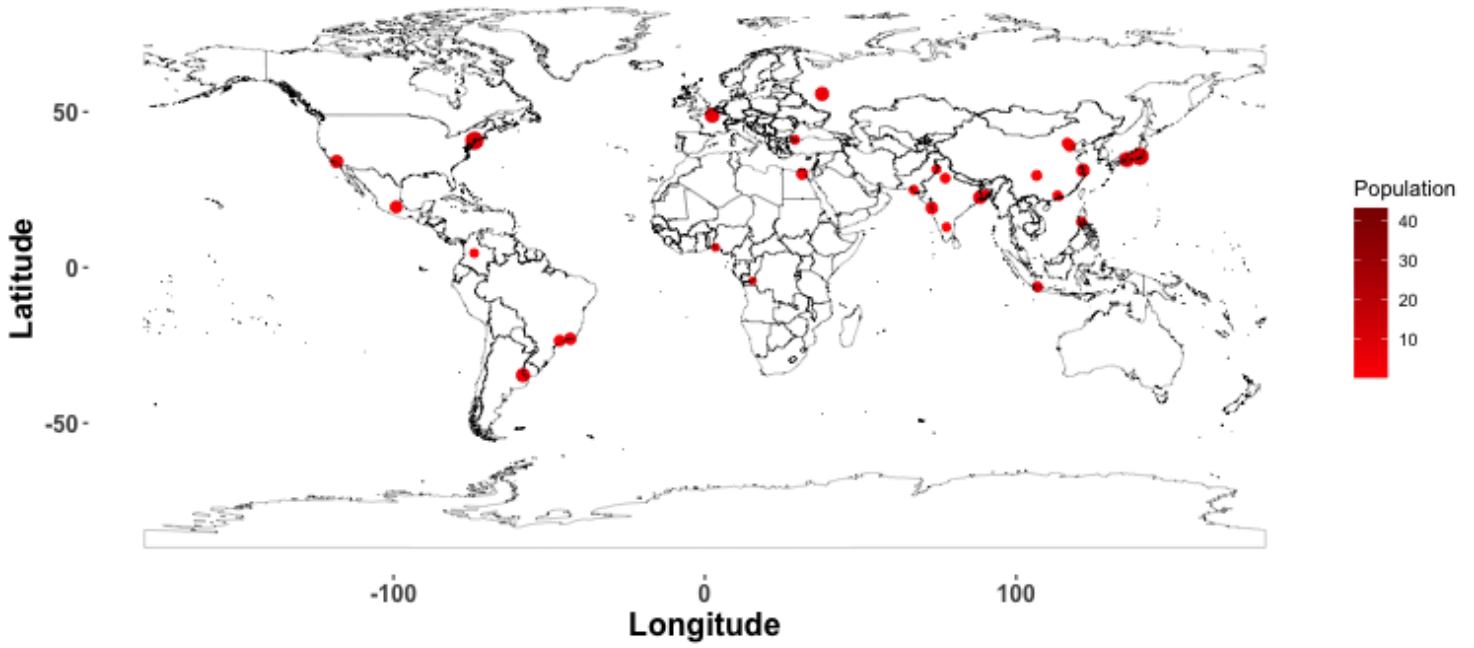
Latitudinal change in urban population

1960-2050



UN

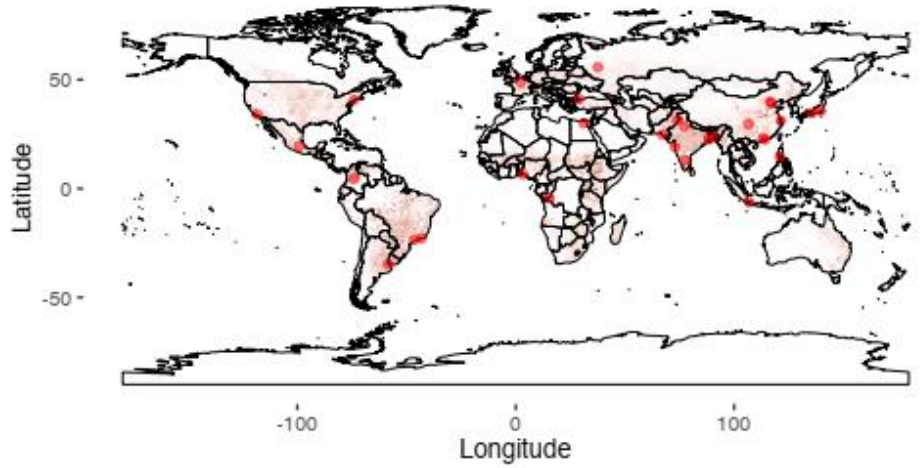
1950



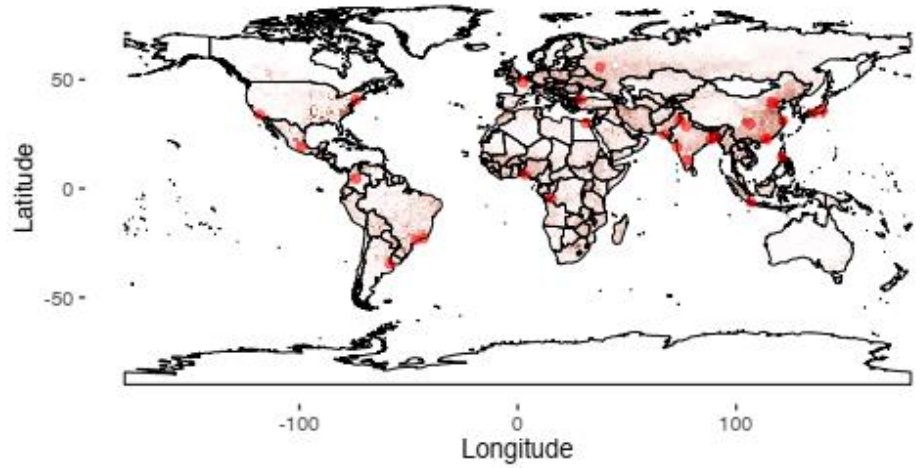
Data source: UN

Big cities, in high wildlife and livestock – poultry areas

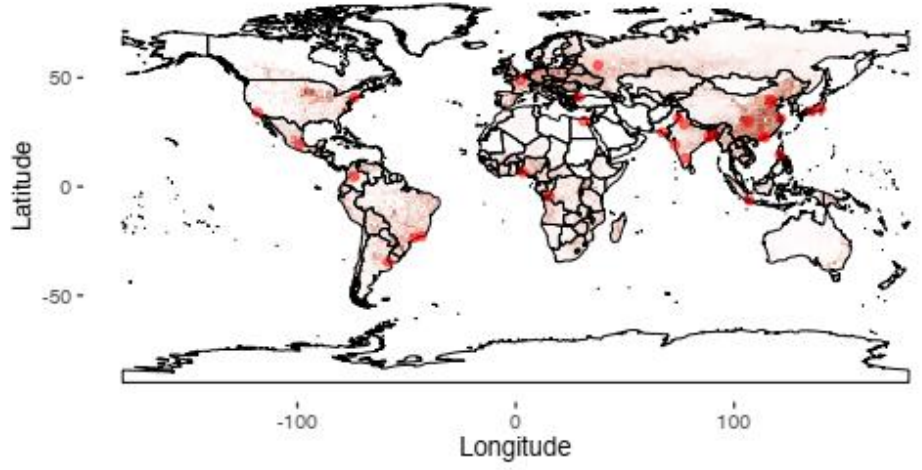
Density of cattle population



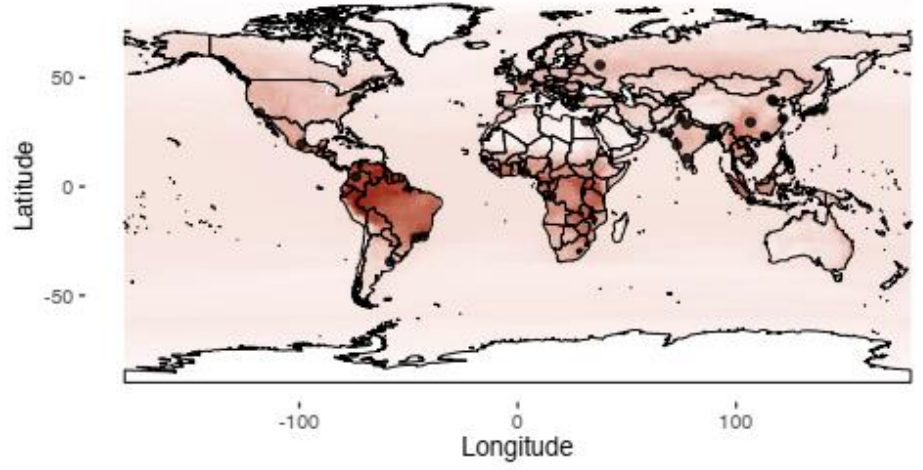
Density of chicken population



Density of pig population



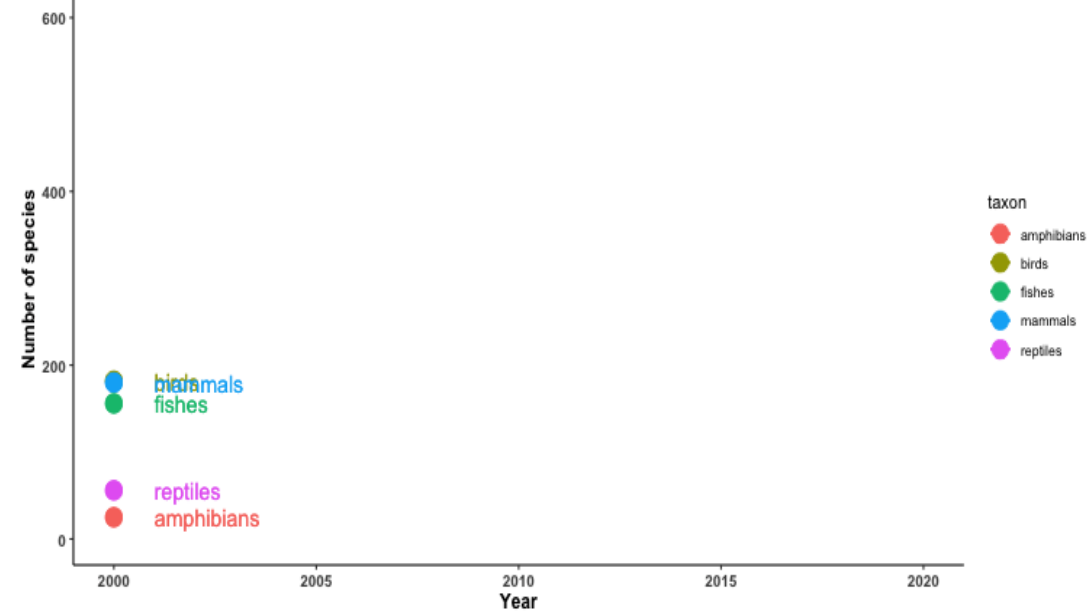
Mammal species richness



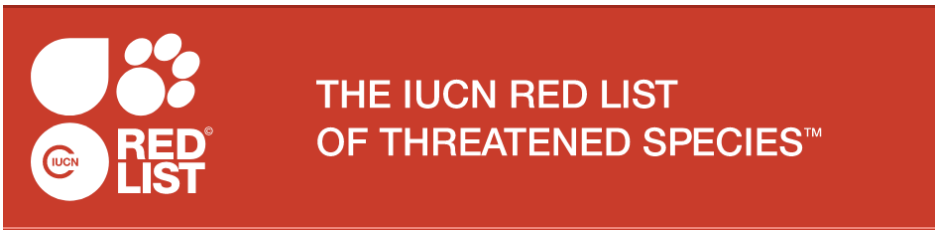


Une biodiversité en crise

IUCN number of critically endangered species 2000-2020



Data source: IUCN



Living Planet Index

Biodiversity is declining at different rates in different places

The global LPI does not give us the entire picture – there are differences in abundance trends between regions, with the largest declines in tropical areas.

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

scale of regions and sub-regions, rather than a global approach, also allows for a more focused way of monitoring progress towards targets developed under the Convention on Biological Diversity,

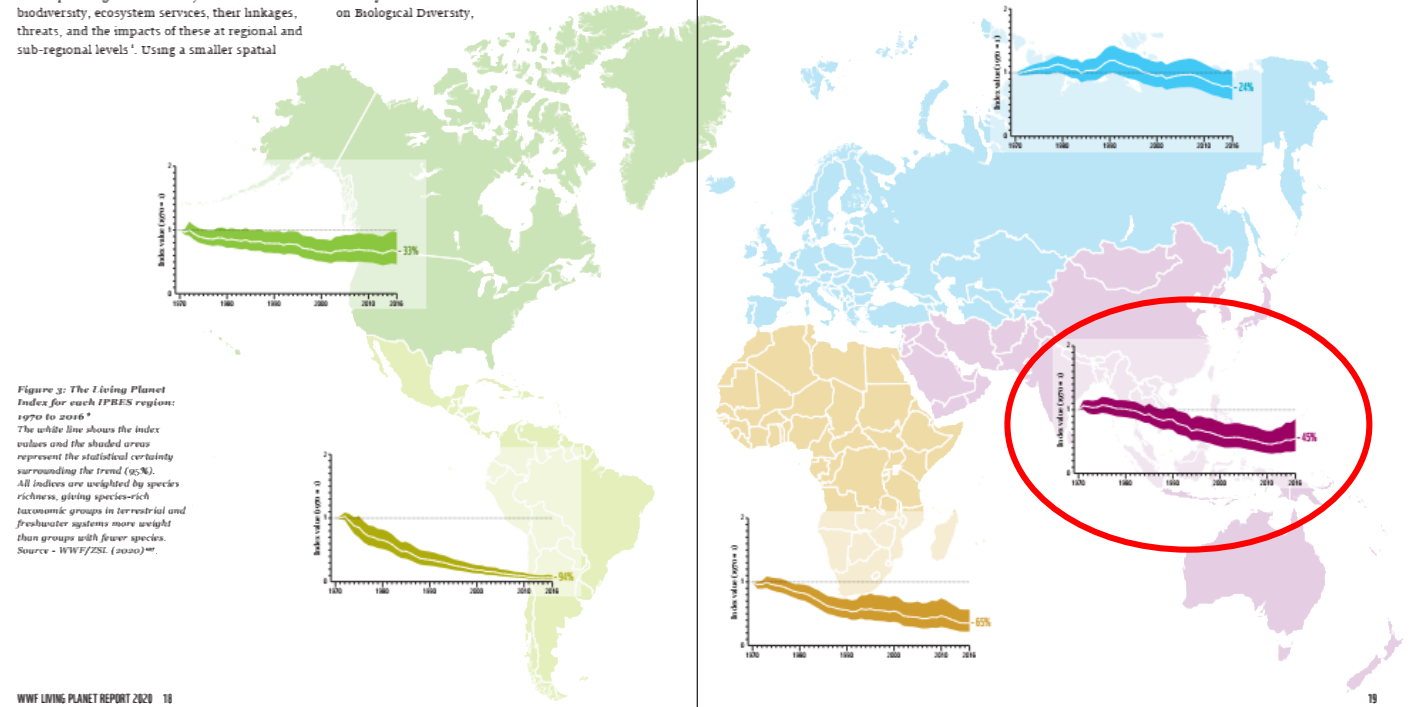
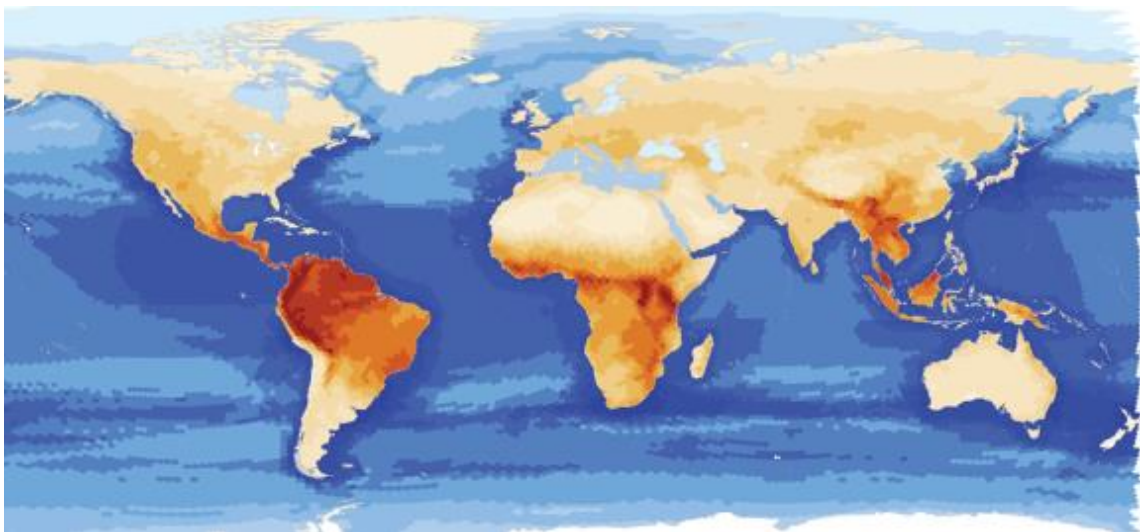


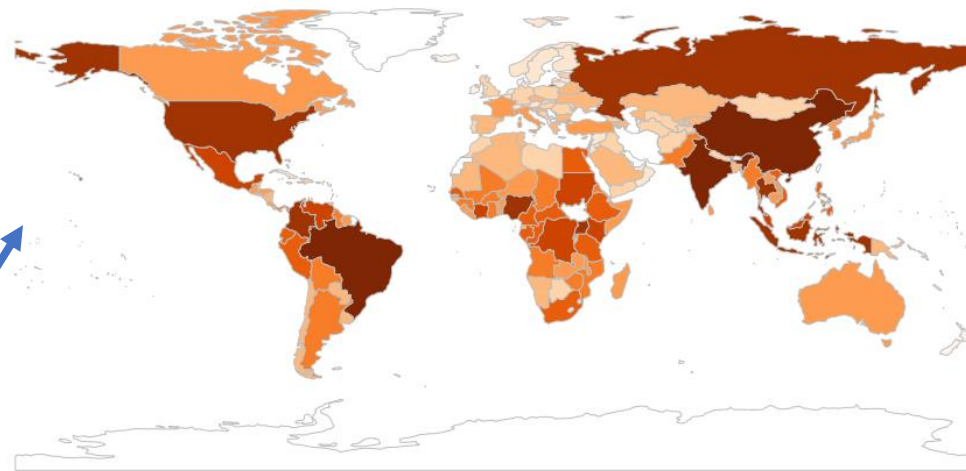
Figure 3: The Living Planet Index for each IPBES region: 1970 to 2016¹. The white line shows the index values and the shaded areas represent the statistical certainty surrounding the trend (95%). All indices are weighted by species richness, giving species-rich taxonomic groups in terrestrial and freshwater systems more weight than groups with fewer species. Source - WWF/ZSL (2020)¹⁰.

including the Aichi Biodiversity Targets, Sustainable Development Goals, and National Biodiversity Strategies and Action Plans. In 2020, in order to align with IPBES, regional Living Planet indices have been divided slightly differently to previous years. Following the regional classifications in Figure 3, all terrestrial and freshwater populations within a country were assigned to an IPBES region. In the case of 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.

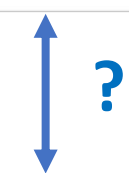
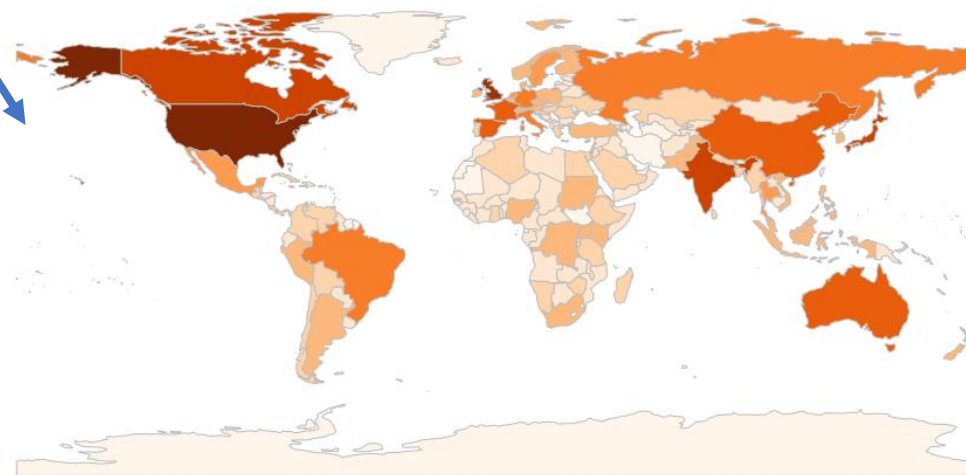
**Biodiversity
(Mammal species richness)**



Known infectious diseases (endemicity)



Outbreaks of infectious diseases

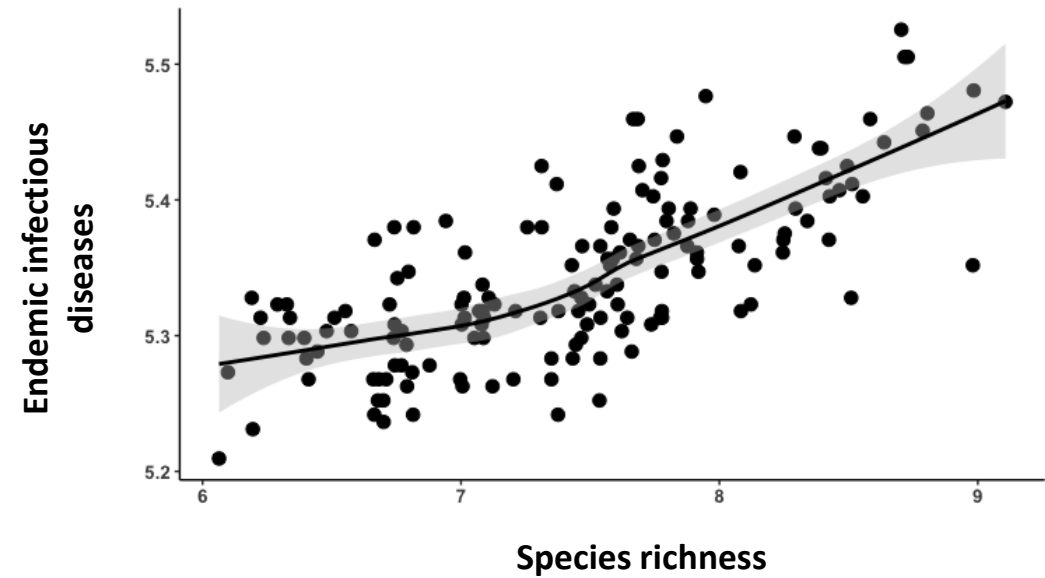
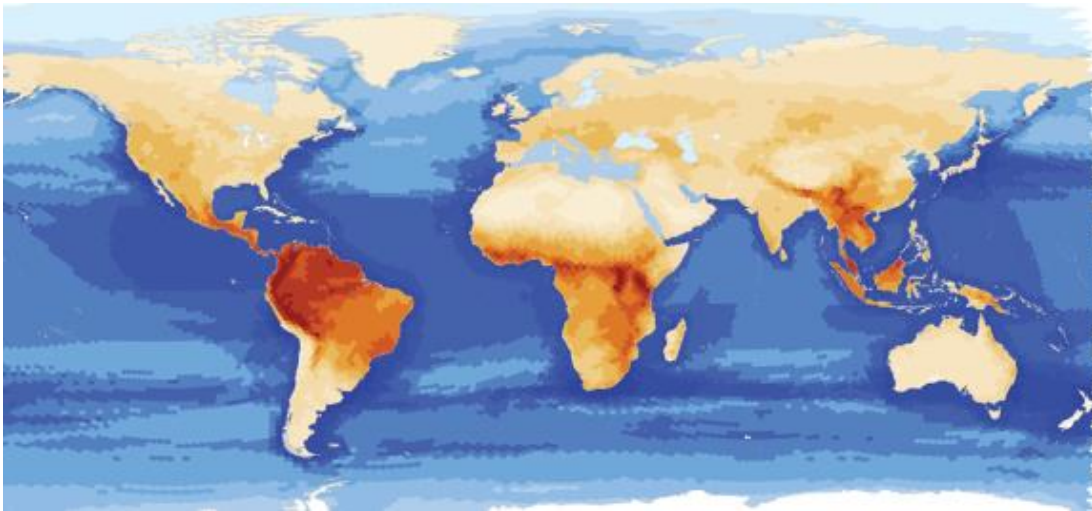


A positive biodiversity – disease richness

High biodiversity



High endemicity of infectious diseases

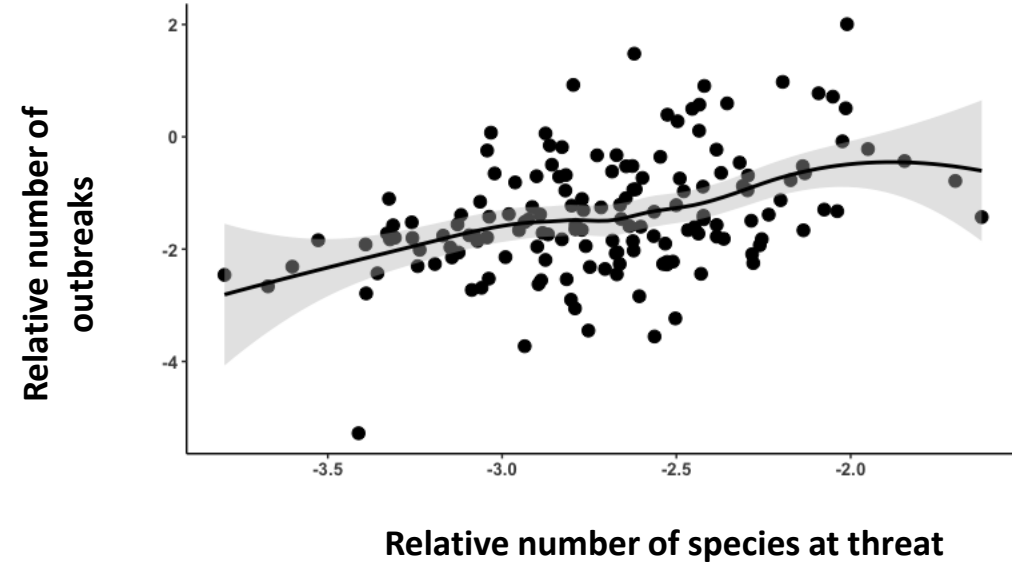
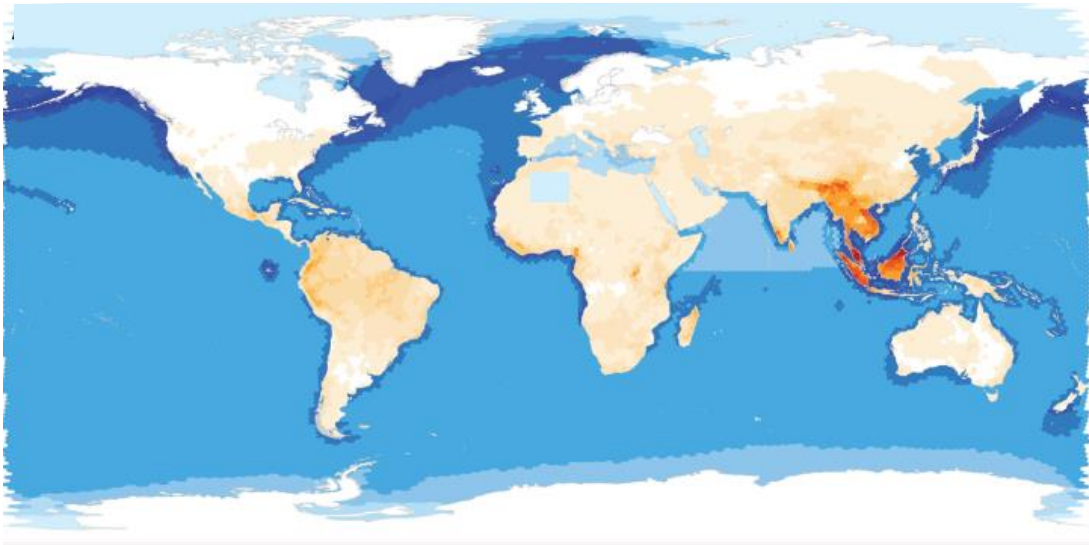


A negative biodiversity – disease transmission

High biodiversity at threat



Higher number of outbreaks!



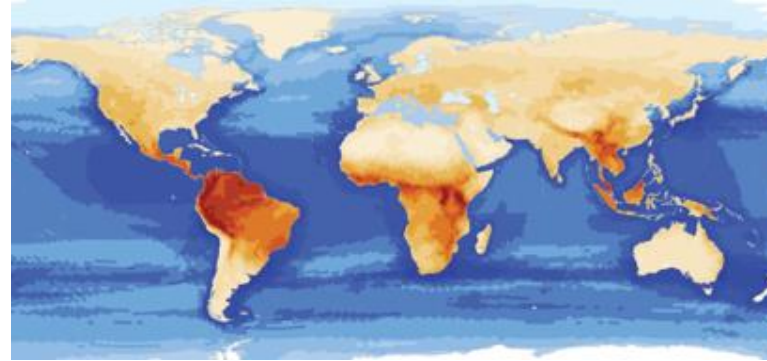


LES ZONNOSES CES MALADIES QUI NOUS LIENT AUX ANIMAUX

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

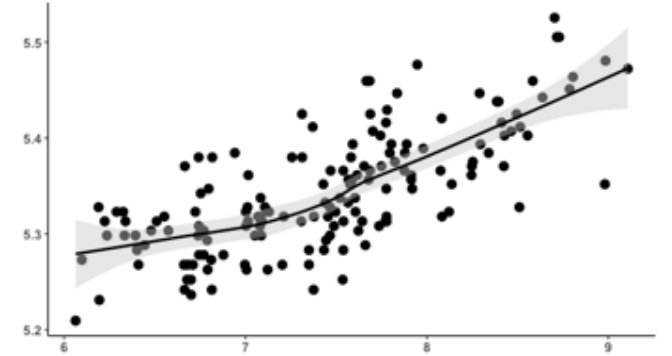
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High biodiversity



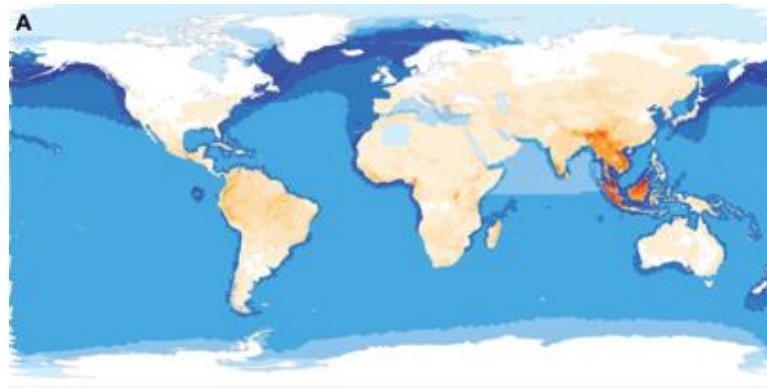
High endemicity of infectious diseases

Endemic infectious
diseases



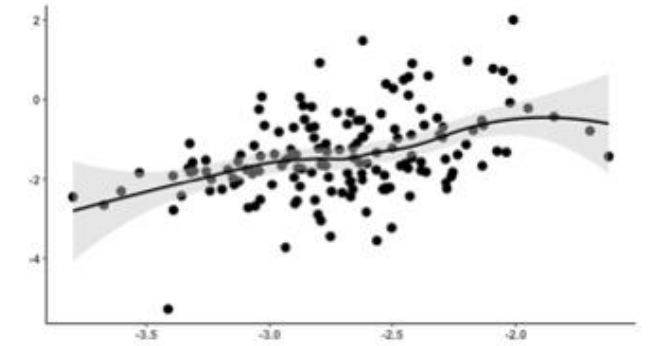
Species richness

High biodiversity at threat



Higher number of outbreaks!

Relative number of
outbreaks



Relative number of species at threat



FAUNE SAUVAGE,
BIODIVERSITÉ ET SANTÉ,
QUELS DÉFIS ?

SERGE MORAND, FRANÇOIS MOUTOU,
CÉLINE RICHOMME, COORD.

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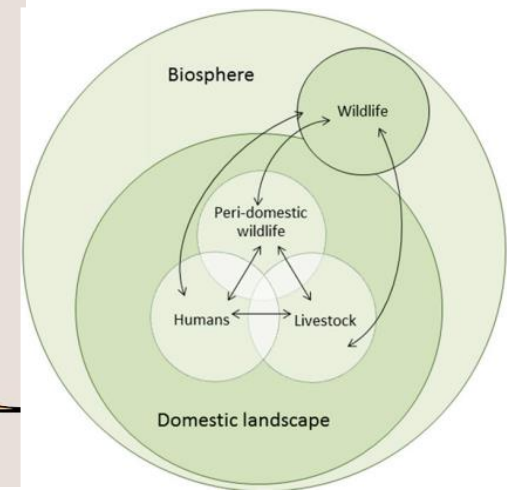
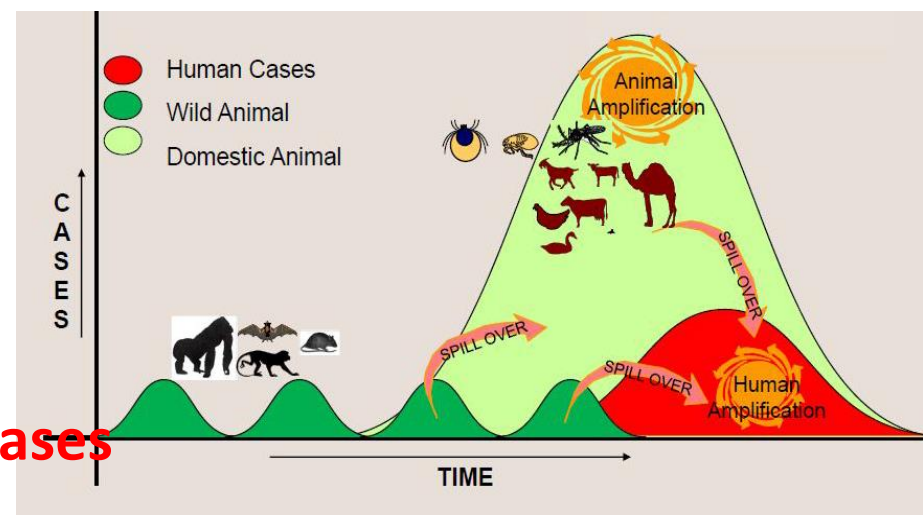
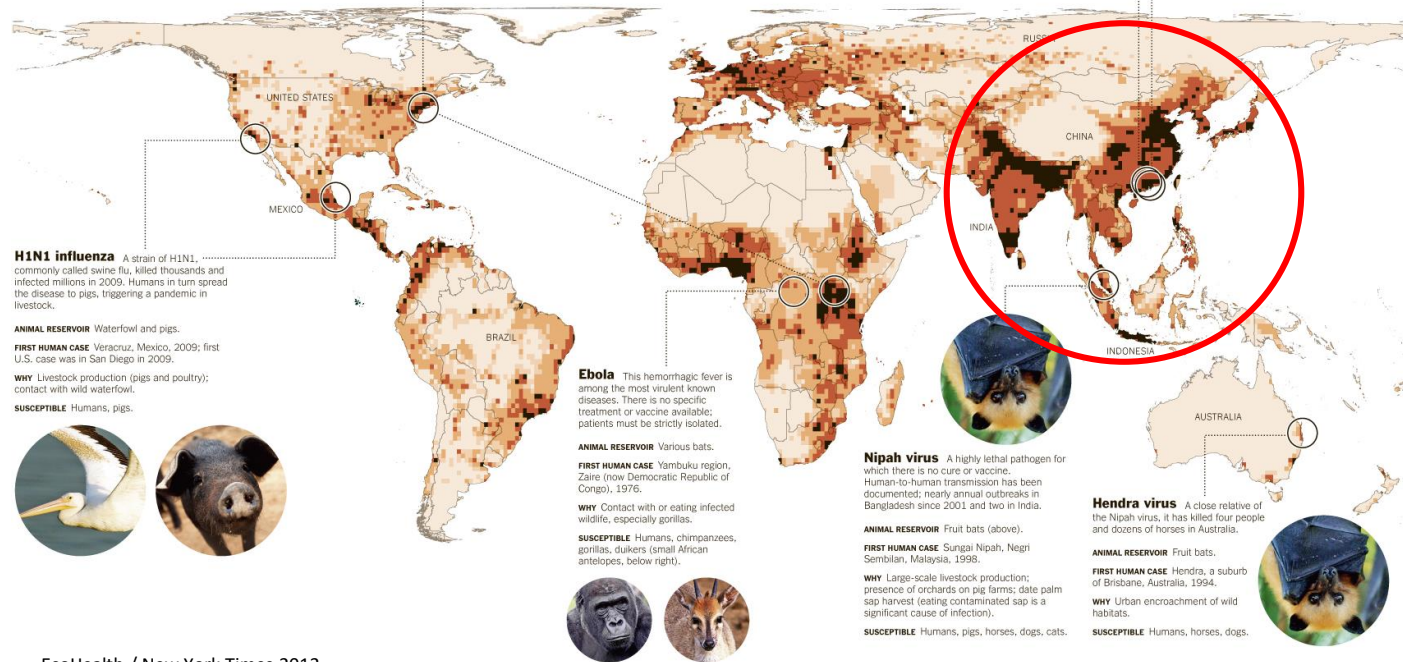
***Transmission aux
interfaces environnement
– faune sauvage –
domestique - humains***

Hot spots of emerging zoonotic diseases

Hot Spots for Emerging Diseases

Map shows an analysis of the future likelihood of infectious diseases originating in wildlife that have the potential to infect humans.

KEY: GREATER RISK
Factors in the analysis included population density, proximity to and variety of wildlife, and climate.



Animal origins of human coronaviruses.

Genetically diverse coronaviruses	Natural host	Intermediate host	Human host
		?	HCov-NL63
			HCov-229E
			HCov-OC43
		?	HCov-HKU1
			SARS-CoV
			MERS-CoV
			SADS-CoV

Legend for arrows:
 - Blue arrow: Spillover to intermediate hosts
 - Orange arrow: Mild infection
 - Red arrow: Severe infection

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

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



SARS-CoV-2 in animals used for fur farming

GLEWS+
Risk assessment



20 January 2021



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,†}

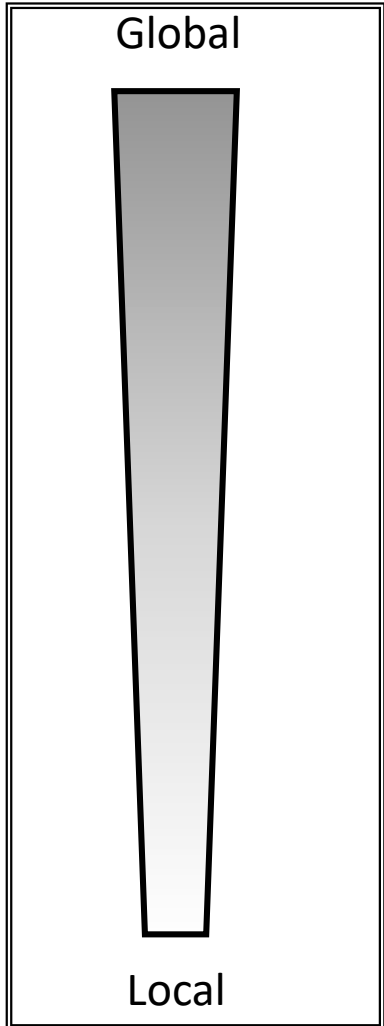
Article

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

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

Scaling and connection effects

Global change



Globalization



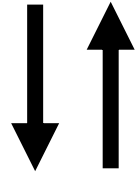
Increasing trade

Land conversion



Biodiversity loss
Deforestation
Agriculture intensification
Livestock expansion
Plantation expansion

mobility



Urbanization



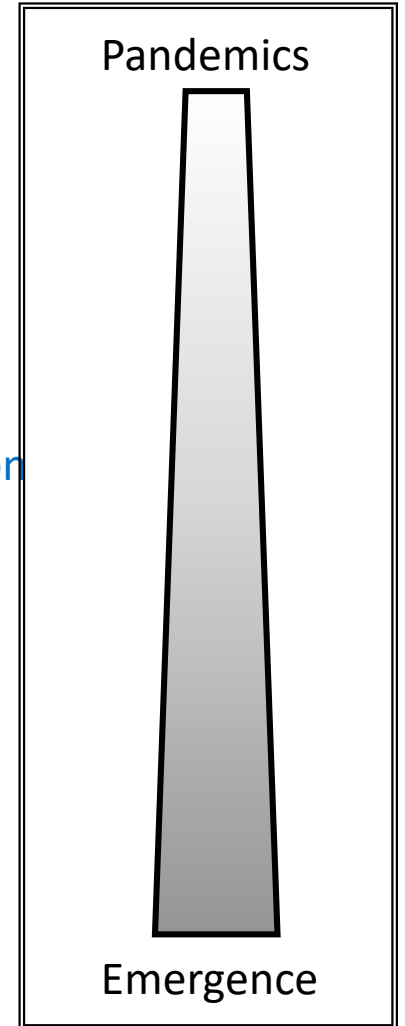
Infrastructure development



Roads
Dams
Mining

mobility

Infectious diseases



Sortir des crises

One Health en pratiques

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



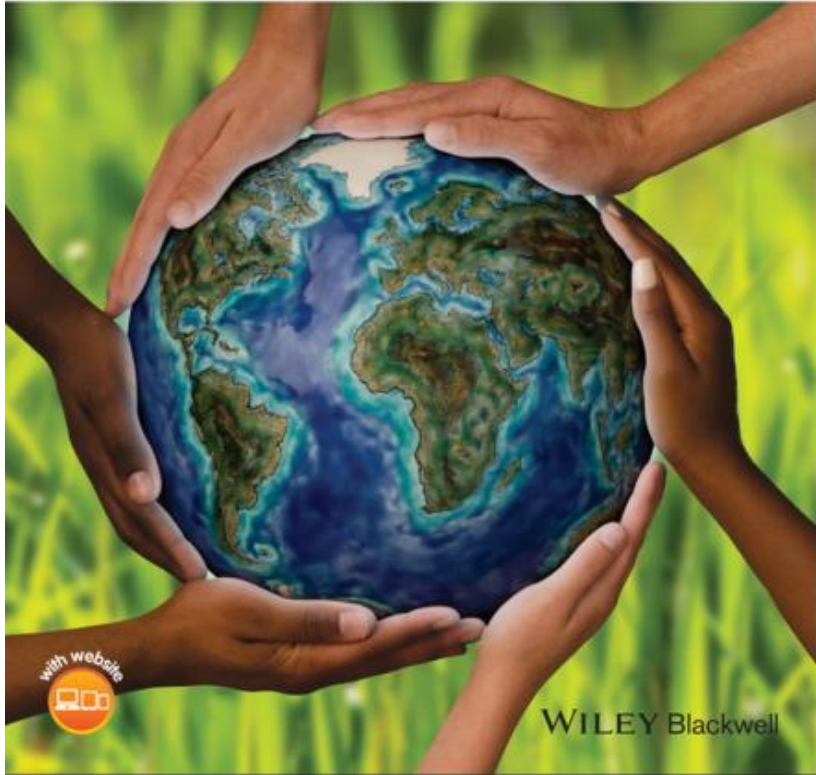
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One Health pour sortir des crises

Introduction to One Health

An Interdisciplinary Approach to Planetary Health

Sharon L. Deem • Kelly E. Lane-deGraaf • Elizabeth A. Rayhel



Insight and Innovation in International Development

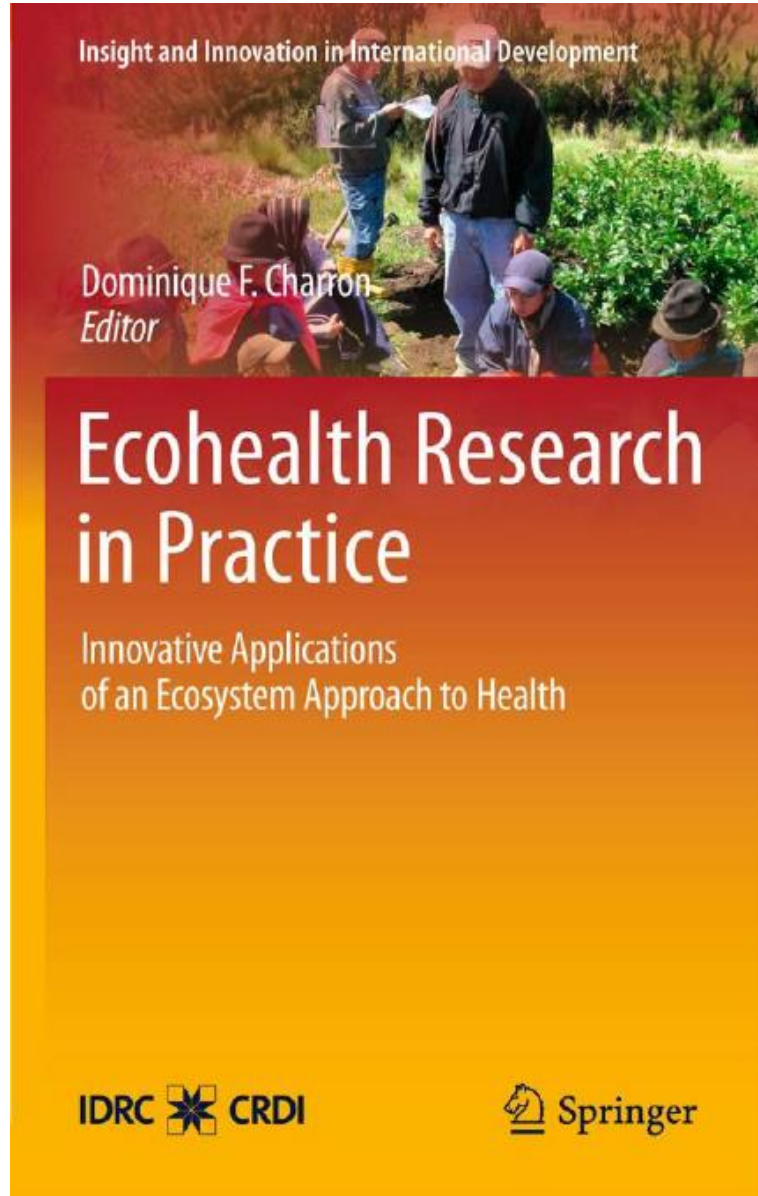
Dominique F. Charron
Editor

Ecohealth Research in Practice

Innovative Applications
of an Ecosystem Approach to Health

IDRC  CRDI

 Springer



Planetary Health

Protecting Nature to
Protect Ourselves

edited by Samuel Myers
and Howard Frumkin



One Health High Level Expert Panel (OHHLEP)

*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***

Co-chairs



Wanda Markotter

Professor, Centre for Viral Zoonoses, University of Pretoria, South Africa

[Learn more >](#)



Thomas Mettenleiter

President of the Friedrich-Loeffler-Institut, Federal Research Institute for Animal Health, Germany

[Learn more >](#)



Food and Agriculture Organization of the United Nations



WORLD ORGANISATION FOR ANIMAL HEALTH



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World Health Organization

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Deputy Head, Russian Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing, Russian Federation



Lei Zhou >
Chief of Branch for Emerging Infectious Disease, China CDC, People's Republic of China



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

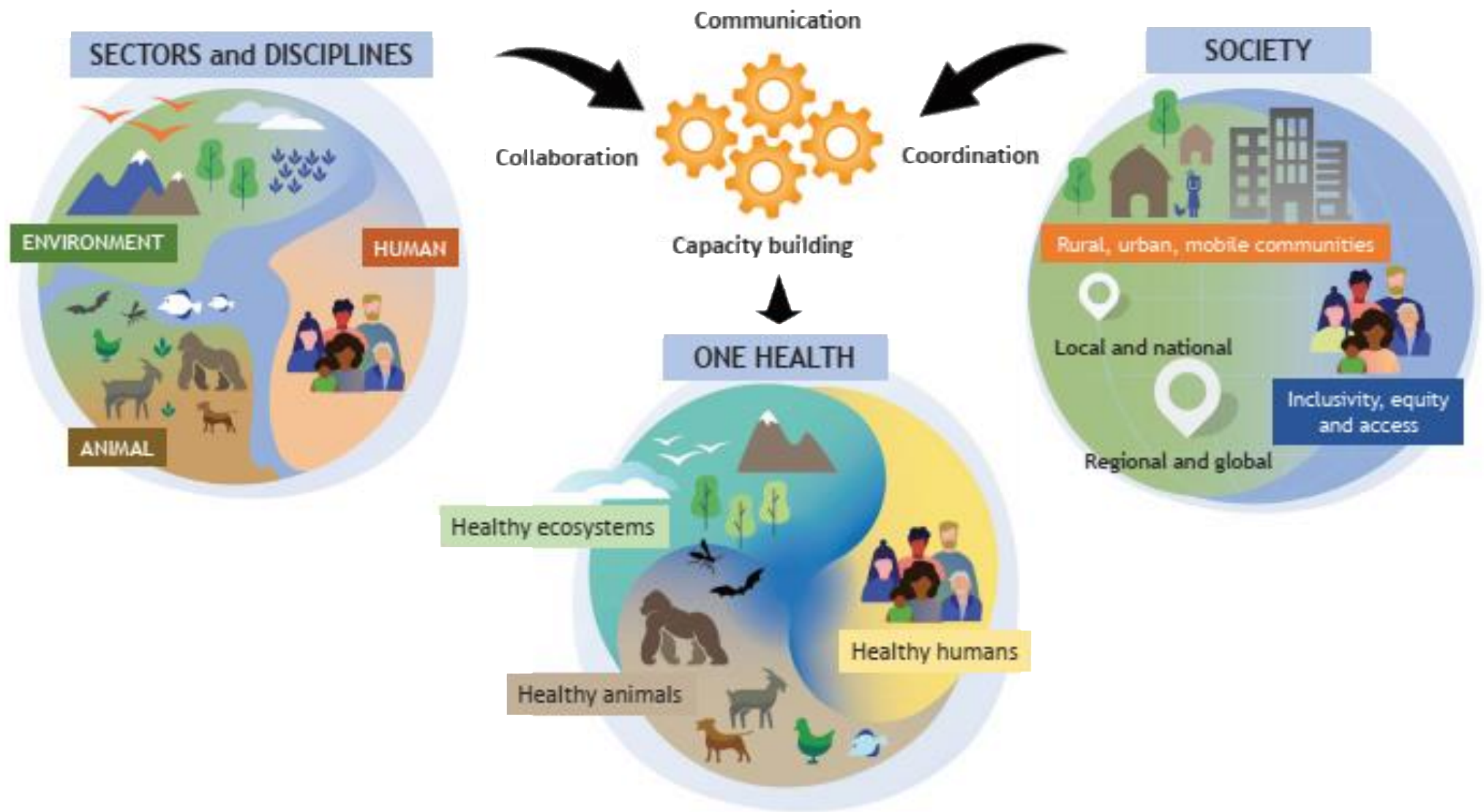
December 1st 2021

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.

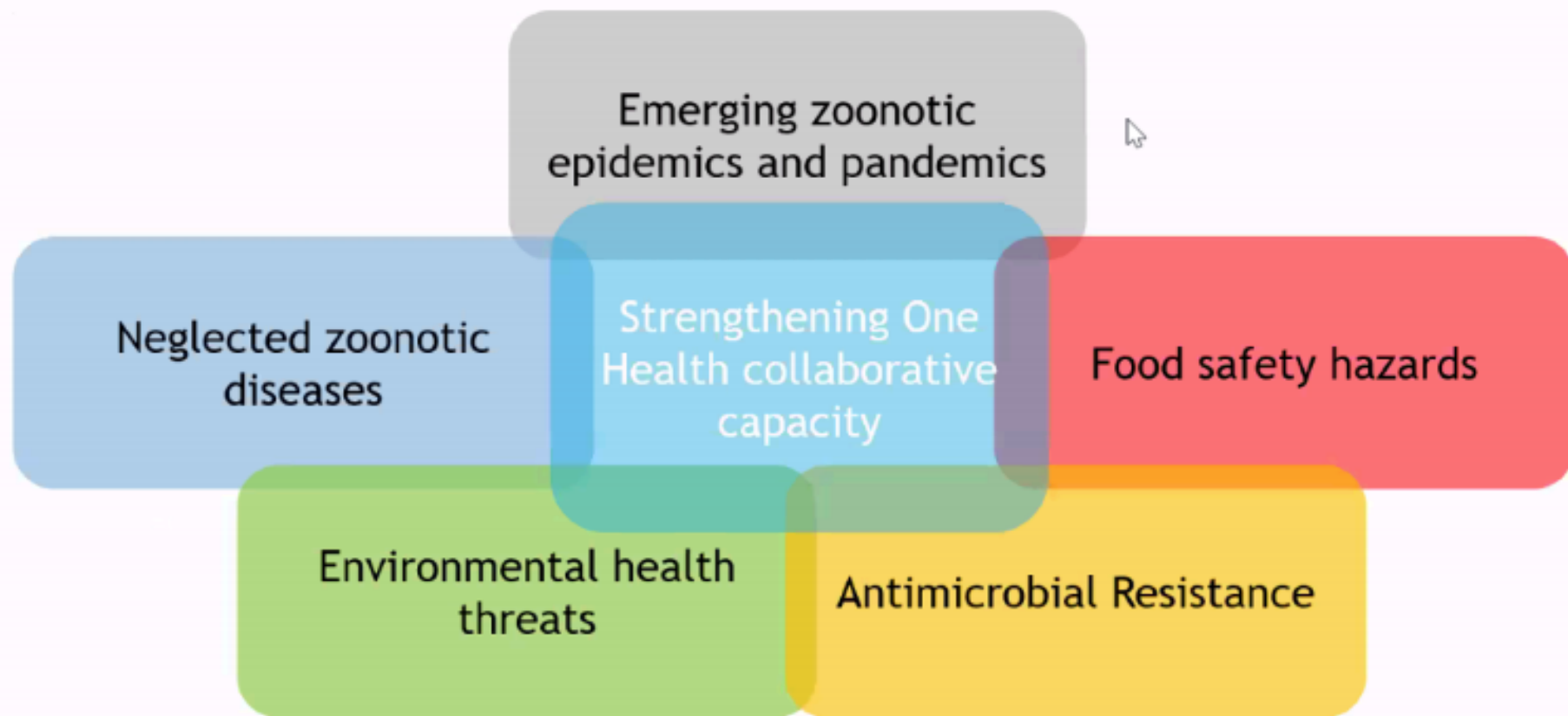


Global Plan of Action for One Health (2022-2026)

Towards a more comprehensive One Health approach to global health threats
at the human-animal-environment interface

Tripartite (FAO/OIE/WHO) and UNEP

Action Tracks



Merci

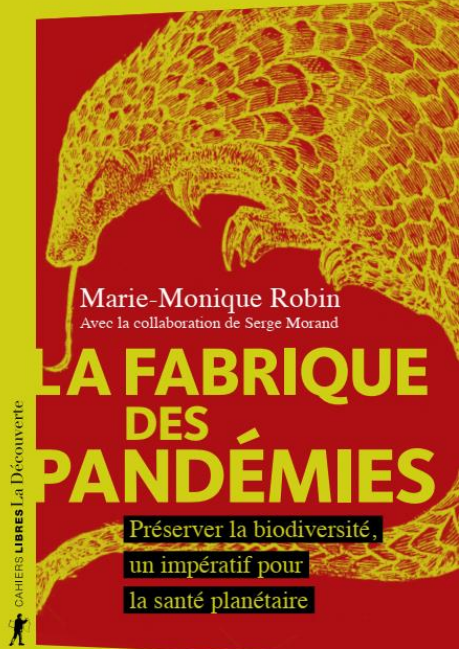


SERGE MORAND

L'homme, la faune sauvage et la peste



fayard



CAHIERS LIBRES La Découverte