A Regional and Global Perspective on Pathogens at the Animal-Human-Environmental Interface

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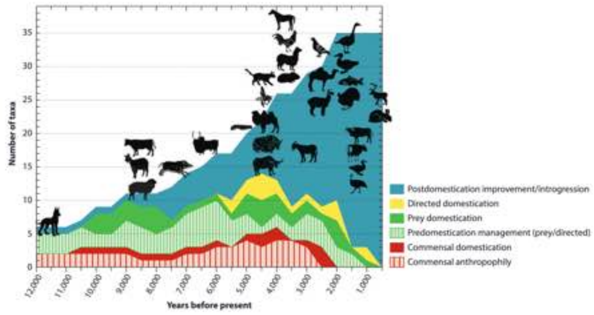
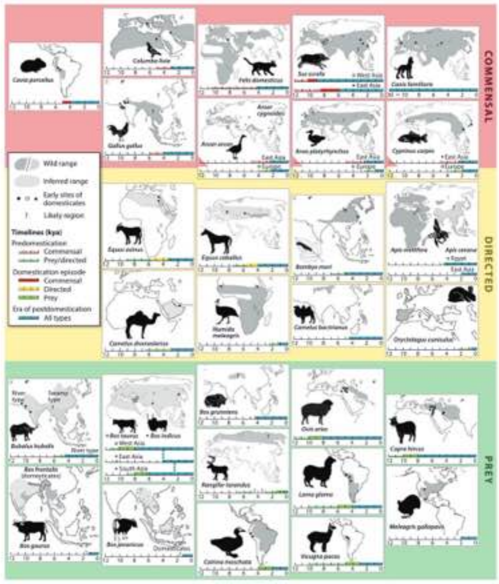
1

Human-Animal Relationship

- Domestication started 12k years ago
- Global phenomenon
- Commensal, direct and prey pathway

Larson and Fuller. 2014. Annu. Rev. Evol. Syst.





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Human-Animal Relationship
https://www.borchelhof.de
https://www.foodnavigator.com
https://herz-fuer-tiere.de
https://www.marienhof-puten.de
https://www.tierschutzbund.de
https://www.bz-berlin.de
https://www.landwirt-masterclass.com
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Human-Animal Relationship
https://www.dlg.org
https://www.borchelhof.de
https://www.foodnavigator.com
https://herz-fuer-tiere.de
Common ground: close contact
https://www.marienhof-puten.de
https://www.tierschutzbund.de
https://www.bz-berlin.de
https://www.landwirt-masterclass.com
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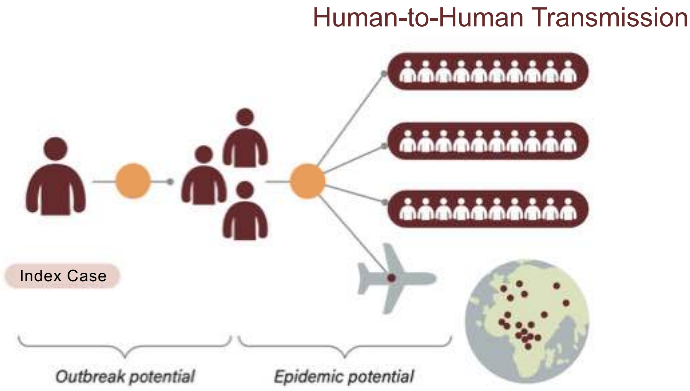
From One Medicine to One Health

Rudolf Virchow (1855)

“Infectionen durch contagiöse Thiergifte - Zoonosen”

5

From One Medicine to One Health



Africa CDC. 2020. modified

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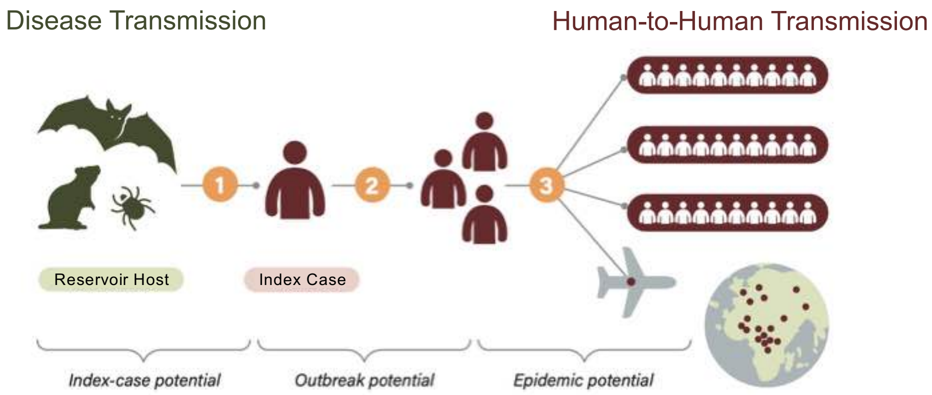
From One Medicine to One Health



Africa CDC. 2020. modified

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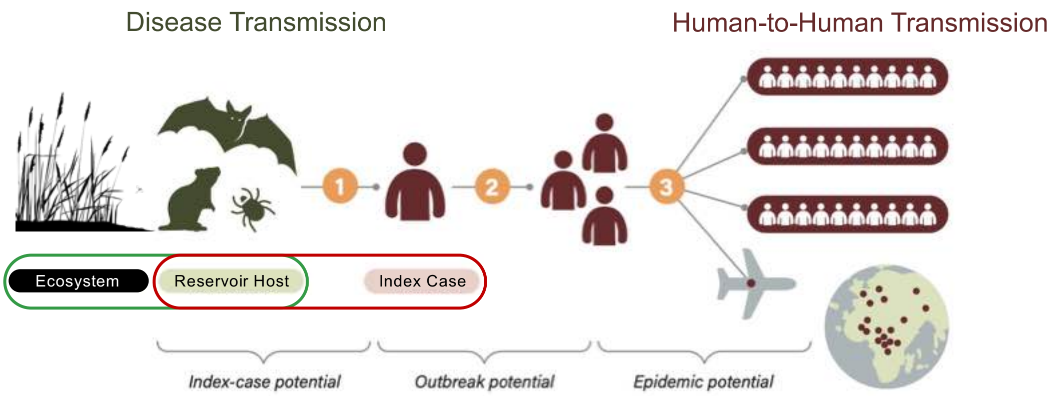
From One Medicine to One Health



Africa CDC. 2020. modified

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One Health High-Level Expert Panel (OHHLEP)

Definition of One Health

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

OHHLEP. 2022. PLoS Pathogens

Co-chairs: OHHLEP II

OHHLEP I

Thomas C. Mettenleiter | Wanda Markotter | Carlos Goncalo des Neves

Food and Agriculture Organization of the United Nations | World Organisation for Animal Health | UN environment programme | World Health Organization

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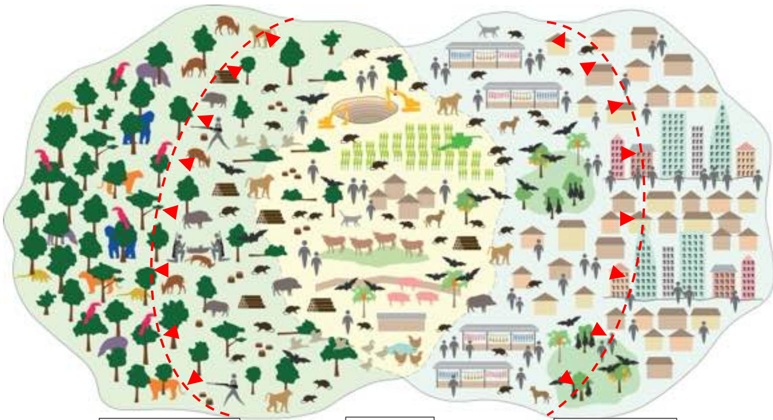
The Human-Animal-Environmental Interface



Pristine Forest
- Penetration of intact ecosystems
- Biodiversity loss and habitat destruction

Ecotone
- Human activities incl. livestock farming (interface)
- Sylvatic pathogens are no longer controlled by environmental stochasticity

(Peri-)Urban
- Wild animals enter urban areas in search for resources
- Exposure of wildlife to urban diseases

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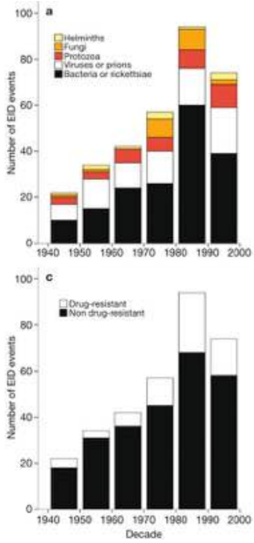
Wegner, G. et al. 2022. Eclinicalmedicine (mod.)

10

Emerging Infectious Diseases

- EIDs have increased at more than four times the rate of prior decades



Jones et al. 2008. Nature

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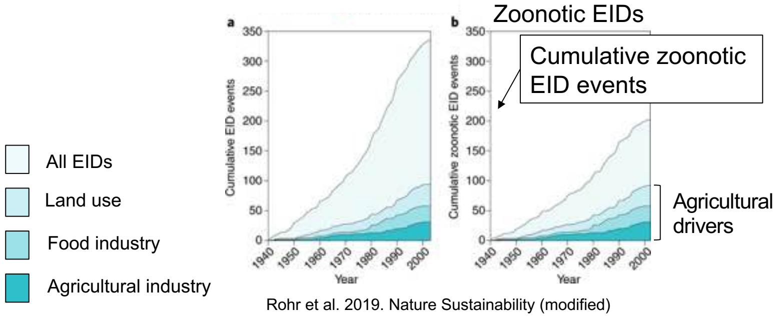
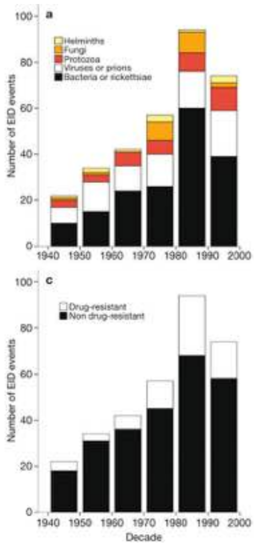
Emerging Infectious Diseases

- EIDs have increased at more than four times the rate of prior decades
- Since 1940, an estimated 50% of zoonotic disease emergence has been associated with agriculture



Rohr et al. 2019. Nature Sustainability (modified)



Jones et al. 2008. Nature

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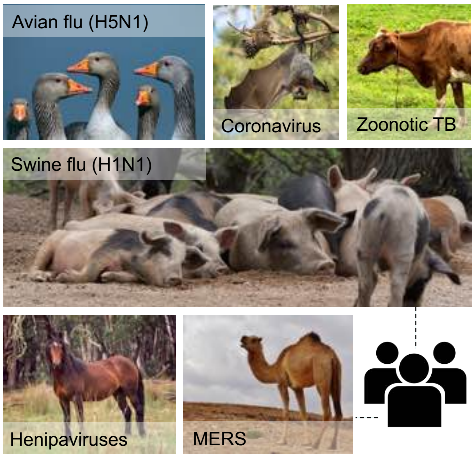
Major Human Diseases of Animal Origin



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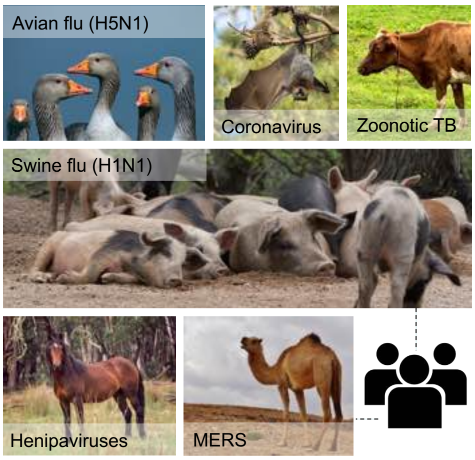
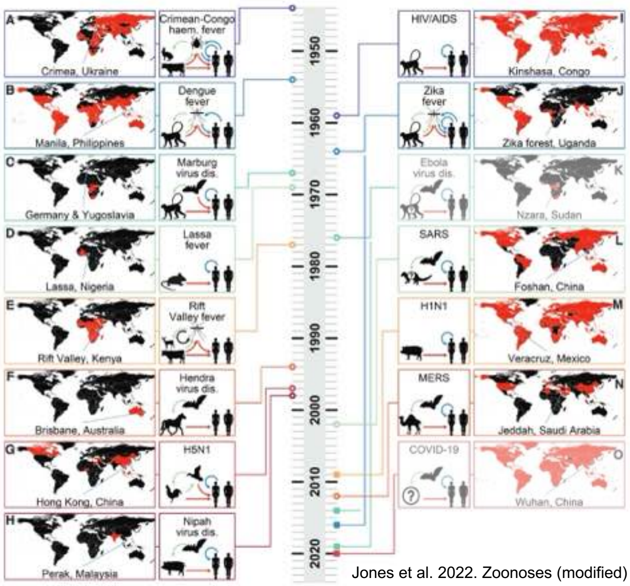
Major Human Diseases of Animal Origin





Jones et al. 2022. Zoonoses (modified)

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Disease Ecology

- Wildlife is a source for pathogens with epidemic potential
- Livestock is contributing relatively more to zoonotic spillovers than wildlife
- Spillovers can also have positive effects

Data: Greenspoon et al. 2023. PNAS

https://phys.org

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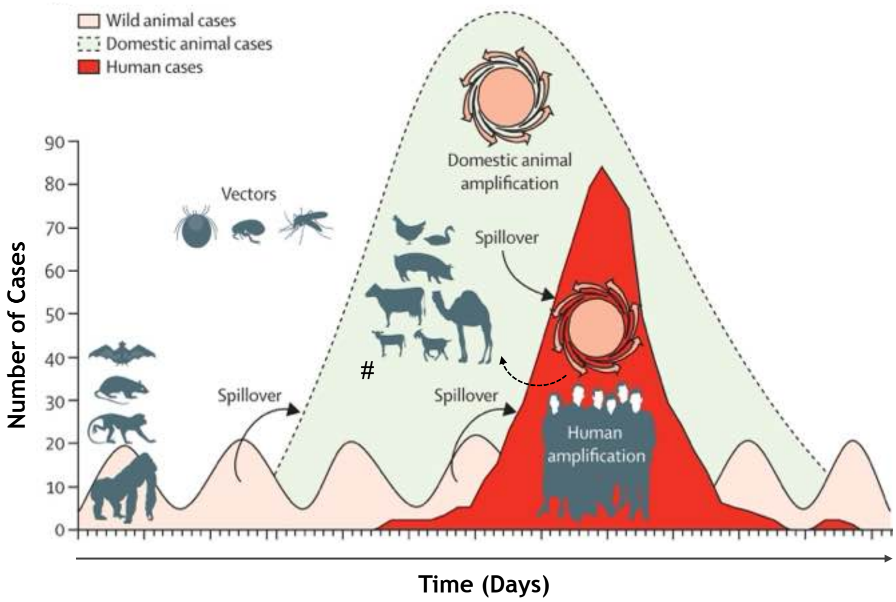
Farmed Animals are Central to One Health

#Bridging host



Karesh, W. B. et al. 2012. Lancet (modified)

16

Amplificatory and Incubator

Science REPORTS

Cite as: B. B. Oude Munnink *et al.*, *Science* 10.1126/science.abe5901 (2020).

Transmission of SARS-CoV-2 on mink farms between humans and mink and back to humans

Bas B. Oude Munnink[1]*, Reina S. Sikkema[1], David F. Nieuwenhuijse[1], Robert Jan Molenaar[2], Emmanuelle Munger[1], Richard Molenkamp[1], Arco van der Spek[3], Paulien Tolsma[4], Ariene Rietveld[5], Miranda Brouwer[5], Noortje Bouwmeester-Vincken[6], Frank Harders[7], Renate Hakze-van der Honing[7], Marjolein C. A. Wegdam-Blans[8], Ruth J. Bouwstra[2], Corine GeurtsvanKessel[1], Annemiek A. van der Eijk[1], Francisca C. Velkers[9], Lidwien A. M. Smit[10], Arjan Stegeman[9], Wim H. M. van der Poel[7], Marion P. G. Koopmans[1]

[1]Erasmus MC, Department of Viroscience, WHO collaborating centre for arbovirus and viral hemorrhagic fever Reference and Research, Rotterdam, Netherlands. [2]Royal GD, Deventer, Netherlands. [3]Netherlands Food and Consumer Product Safety Authority (NVWA), Utrecht, Netherlands. [4]Municipal health Services GGD Brabant-Zuidoost, Eindhoven, Netherlands. [5]Municipal health Services GGD Hart voor Brabant, 's-Hertogenbosch, Netherlands. [6]Municipal health Services GGD Limburg-Noord, Venlo, Netherlands. [7]Wageningen Bioveterinary Research, Lelystad, Netherlands. [8]Stichting PAMM, Veldhoven, Netherlands. [9]Farm Animal Health, Utrecht University, Utrecht, Netherlands. [10]Institute for Risk Assessment Sciences (IRAS), Utrecht University, Utrecht, Netherlands.

***Corresponding author: Email: b.oudemunnink@erasmusmc.nl**

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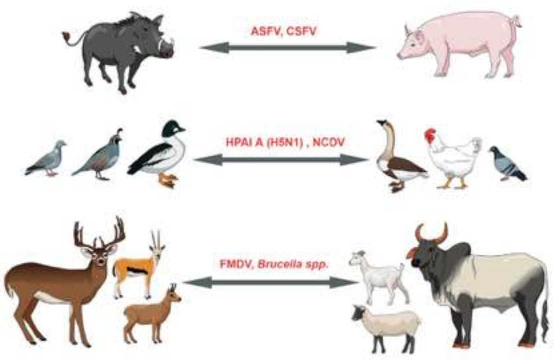
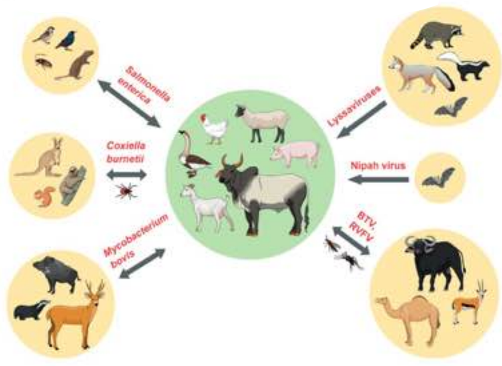
The Wild Side of Livestock (and Human) Health

Pathogens transmitted between closely related species



Opportunistic pathogens in multi-genera systems



Jori, F. et al. 2022. Animal Frontiers

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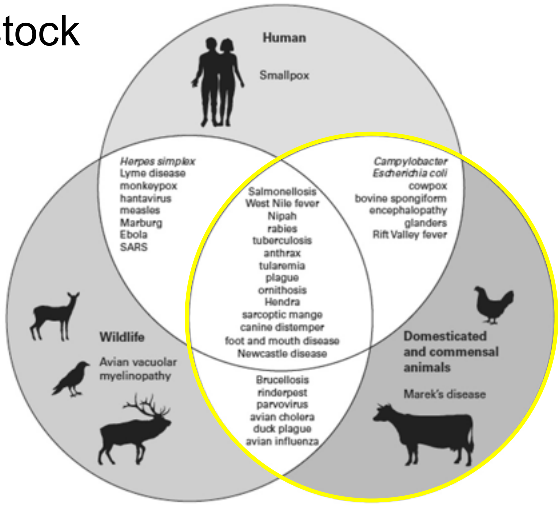
Zoonotic Livestock Diseases I



Examples of linkage between important infectious diseases of wildlife, domestic animals, and humans

mod. Friend, M. (2006). Biowarfare, Bioterrorism, and Animal Diseases as Weapons. Circular 1285.

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Zoonotic Livestock Diseases II

Table 2
Overview of micro-organisms reported in selected publications. The columns depict; the micro-or... ...ease; excretion site of the micro-organism to uptake site, transmission pathway; mode of transmission of the micro-organism, num...

Micro-organism	Animal involved
Antibiotic-resistant *Escherichia coli*	Pigs
Avian influenza	Chickens, layer hens, broilers, turkeys, wild birds
Avian Metapneumo virus	Turkeys
Blastocystis	Pigs
Brucella spp.	Sheep, goats, "farm animals"[a]
Campylobacter spp.	Cattle, dairy cattle, chickens, pigs
Chlamydophila psittacosi	Poultry, chickens, turkeys
Coxiella burnetii	Goats, sheep, cattle, poultry, "farm animals"[a]
Cryptosporidium parvum	Cattle, sheep, buffalo
Extended-Spectrum-β-lactamase producing *Enterobacteriaceae*	Poultry
Hepatitis E virus	Pigs, cats, chickens, deer, goats, horses, sheep
Leptospira spp.	"Farm animals"[a]
Methicillin-resistant *Staphylococcus aureus*	Pigs, veal calves, poultry, cattle, broilers, sheep, horses dogs, cats, rodents
Orf virus	Sheep, goats
Swine influenza	Pigs
Trichophyton verrucosum	Cattle
Verotoxin-producing *Escherichia coli* O157	Cattle, goats, pony, dog
Not applicable/all zoonotic infections	"Farm animals"[a]

[a] Livestock animals not specified, or all possible livestock animals studied.
[b] All transmissions possible, not specified in publications.
[c] All transmission pathways possible, not specified in publications.

...4–47,57–61,77,78,80,82–84,86] ...0,41,48,54,55,99,100,120] ...42,43,51,64–74,96,97] ...3]

Klous et al. 2016. One Health

- **Antibiotic-resistant *Escherichia coli***
- Avian influenza
- Avian metapneumo virus
- Blastocystis
- *Brucella* spp.
- *Campylobacter* spp.
- *Chlamydophila psittacosis*
- *Coxiella burnetiid*
- *Cryptosporidium parvum*
- **ESBL producing Enterobacteriaceae**
- **Hepatitis E virus**
- *Leptospira* ssp.
- **Methicillin-resistant *Staphylococcus aureus***
- Orf virus
- Swine influenza
- ***Trichophyton verrucosum***
- **Verotoxin-producing *E. coli* O157**

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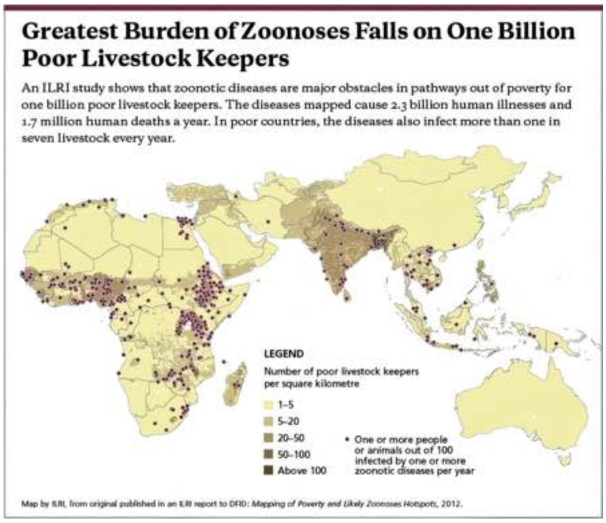
Emerging Infectious Diseases

- The **pandemic risk** from zoonotic livestock diseases must be seen in a global context

ILRI study shows that zoonotic diseases in livestock cause **2.3 billion human illnesses** and **1.7 million deaths/year**.⟶



Gilbert. 2012. Nature

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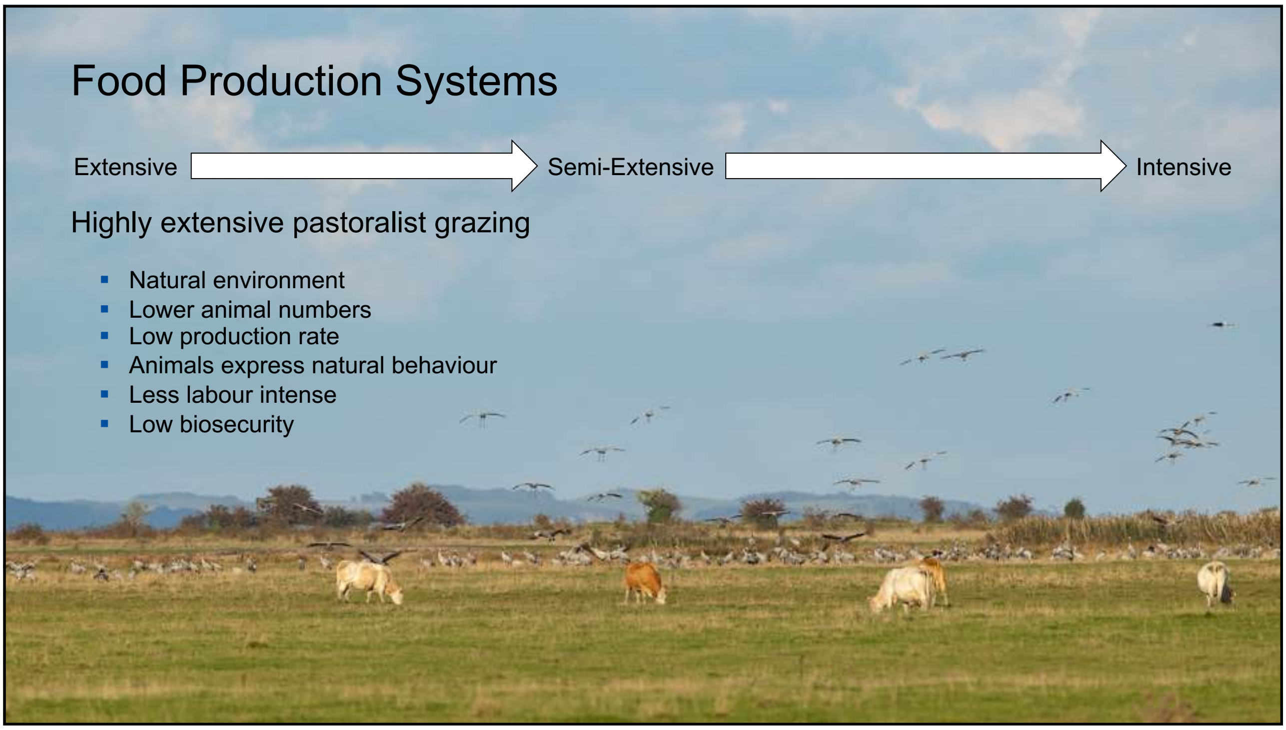

Food Production Systems

Extensive ⟶ Semi-Extensive ⟶ Intensive

Highly extensive pastoralist grazing

- Natural environment
- Lower animal numbers
- Low production rate
- Animals express natural behaviour
- Less labour intense
- Low biosecurity

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Integrated Poultry & Fish Farming

Integrated Livestock Farming System

INTEGRATED POULTRY & FISH FARMING

June 11, 2019 · Dr. Rajesh Singh · Comments(3)

INTEGRATED CHICKEN & FISH FARMING (AQUACULTURE)

By – Ritesh kumar Pandey, जागो, किसान, जागो।

pashudhanpraharee.com/

(…) Chicken raising for meat (broilers) or eggs (layers) can be integrated with fish culture to reduce costs on fertilizers and feeds in fish culture and maximize benefits. Chicken can be raised over or adjacent to the ponds and the poultry excreta recycled to fertilize the fishponds. Raising chickens over the pond has certain advantages: it maximizes the use of space; saves labour in transporting manure to the ponds and the poultry house is more hygienic. No significant differences have been observed on the chickens' growth or egg laying when they are raised over the ponds or on land. In case of the former, the pond embankment could still be utilized for raising vegetables. (…)

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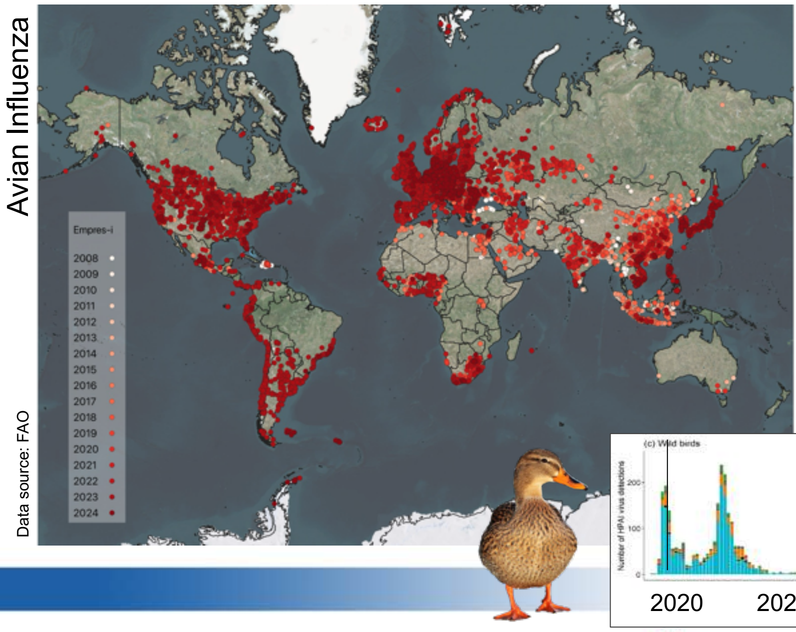
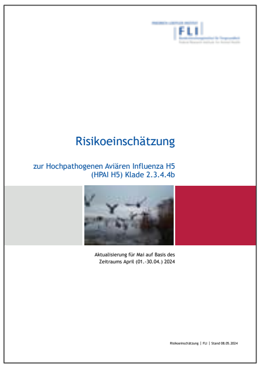
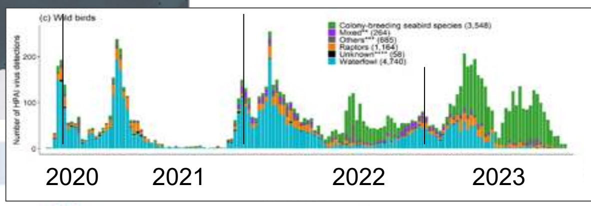
Ecology is Key to Understand (HP)AI



https://www.fli.de/



Avian influenza overview June–September 2023. *EFSA J.* **21**, e08328 (2023). (mod.)



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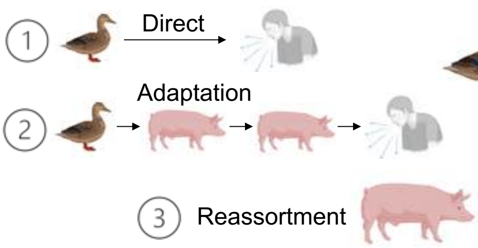
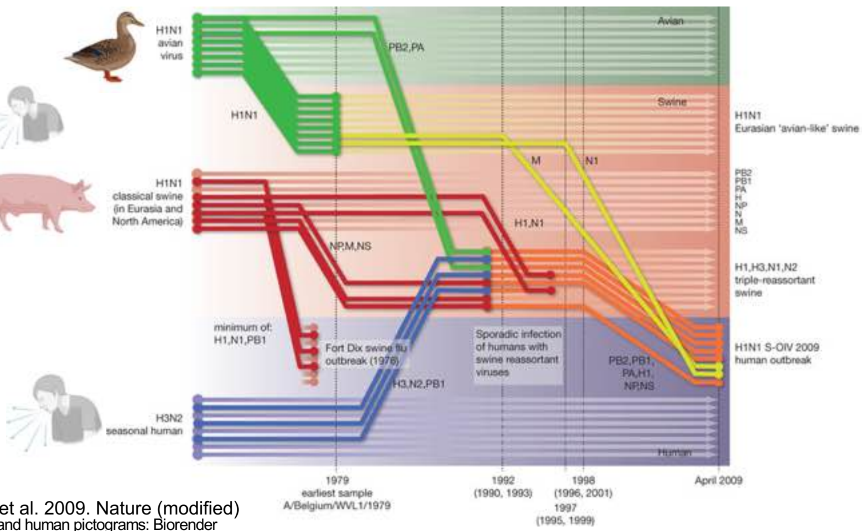
The HPAI Pandemic Potential



- Antigenic shift & drift

  Reconstruction of the sequence of reassortment events leading up to the emergence of S-OIV (H5N1).



Smith et al. 2009. Nature (modified)
Animal and human pictograms: Biorender

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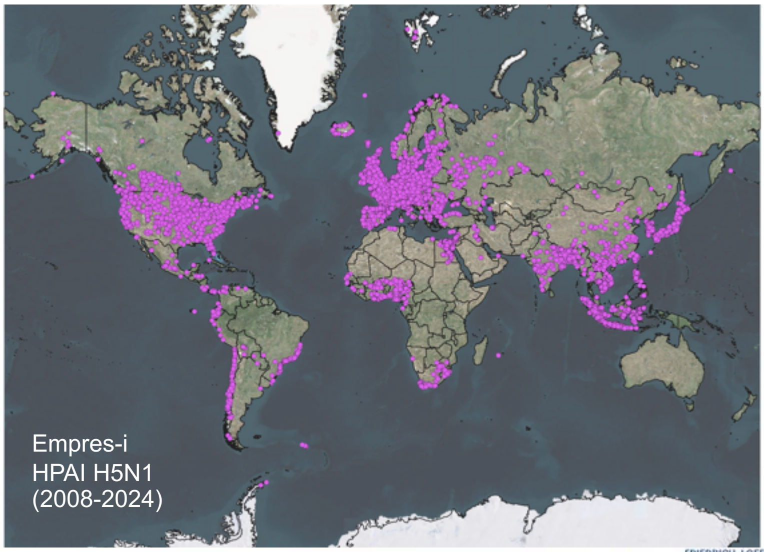
Ecology is Key to Understand (HP)AI

Avian Influenza



Data source: FAO

The Guardien, 21.03.2023

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Mass Mortality of Marine Mammals Associated to HPAI (H5N1) in South America

Gamarra-Toledo et al. 2023. bioRxiv

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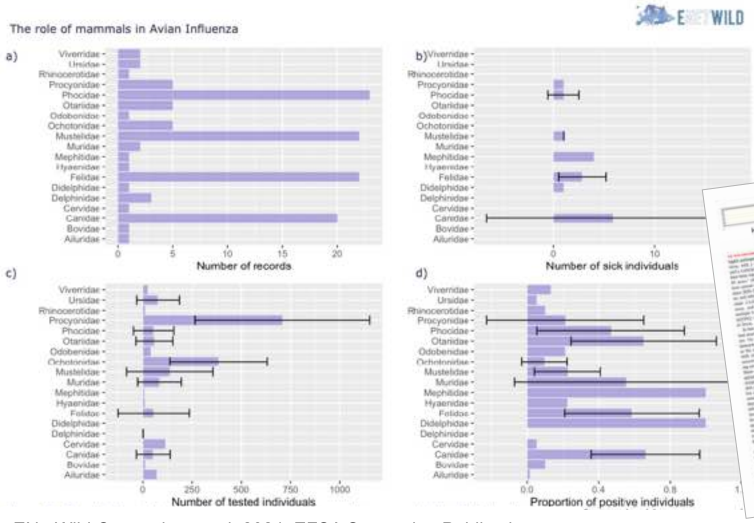
The Role of Mammals in Avian Influenza: a Review



ENetWild Consortium et al. 2024. EFSA Supporting Publication

Uyeki. 2024. NEJM

Reardon. 2024. Nature

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HPAI – The Ecological Disaster Is Near

Northern Gannet breeding colony in Scotland, UK

FAO Scientific Task Force on AI in Wild Birds, Statement – July 2023

In 2023 HPAI reached Antarctica

https://www.bas.ac.uk/media-post/penguins-test-positive-for-avian-flu-on-south-georgia/

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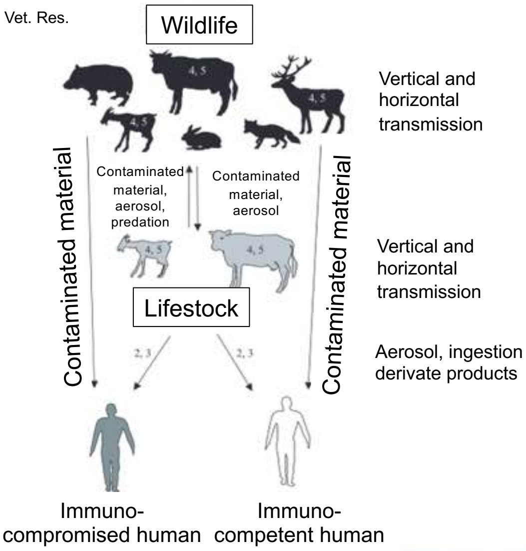
Zoonotic Tuberculosis

Biet et al. 2005. Vet. Res.



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Zoonotic Tuberculosis

Example I: South-Central Spain

Significant risk factors for zoonotic TB

- Extensive production system
- High number of fenced big game estates ≤2km near to farm (reservoir system)
- High number of open game estates in vicinity
- Large farm size (spatial overlap with reservoir systems)
- High number of hunted deer (proxy for deer density)


Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Farm-level risk factors for the occurrence, new infection or persistence of tuberculosis in cattle herds from South-Central Spain

B. Martínez-López[a,b,c,*], J.A. Barasona[b], C. Gortázar[b], V. Rodríguez-Prieto[c], J.M. Sánchez-Vizcaíno[c], J. Vicente[b]

Multispecies reservoir system →

Picture: Seano et al. 2020. Pathogens

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Food Production Systems

- Complex systems within a greater ecological landscape

- Environmental impacts **before** and **after the farm gate** have **an indirect impact** on zoonotic disease emergency

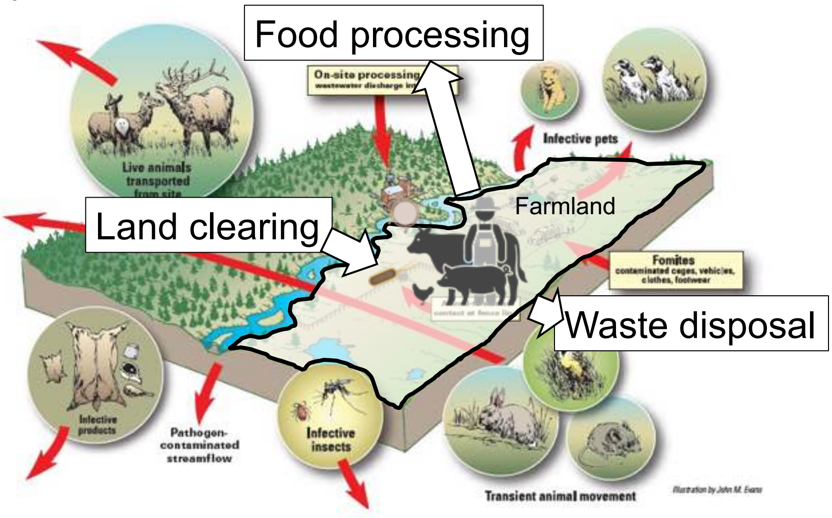

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Illustration by J.M. Evans, modified with BioRender.com

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Intensive Animal Management Strategies

Evidence of zoonotic disease emergence

Elevated risks

- Indoor production and confinement
- Genetic homogenisation
- Subtherapeutic and growth-promoting antibiotic use
- Long-distance transportation
- Physiological stress from crowding, confinement, and conflict (e.g., gestation crates, veal crates, and battery cages)
- Temporary/seasonal and transient human labour
- Concentrated animal waste

Hayek. 2022. Science Advances (Review)

Commercial poultry farming, Ghana

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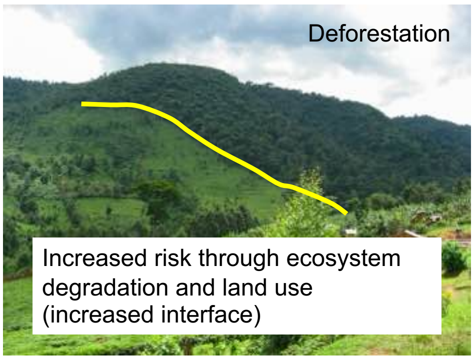
Intensive Animal Management Strategies



Bwindi Impenetrable Forest, Uganda

Evidence of reduced land and resource needs

Neutral or reduced risks

- Improving veterinary care and reducing mortality
- Improving animal husbandry management (e.g., lower reproductive age)
- Integrating crop and livestock production

In ruminants:

- Optimizing grazing densities
- Improving forage quality
- Amending and restoring degraded pastures

Hayek. 2022. Science Advances (Review)

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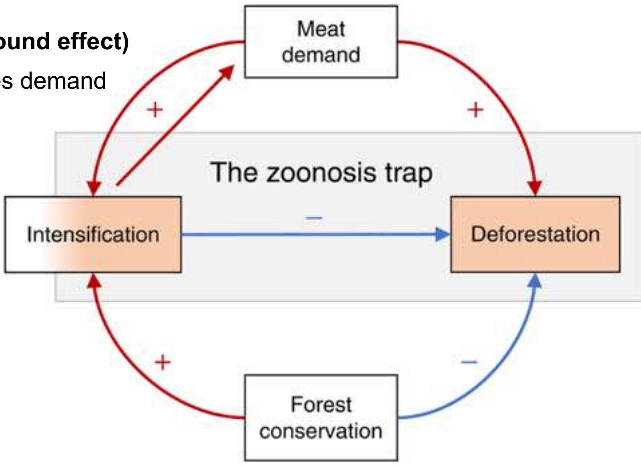
Intensive Animal Management Strategies

Jevon's paradox (rebound effect)

- Intensification creates demand

(lower costs beget more consumption & production)



Hayek. 2022. Science Advances (Review)

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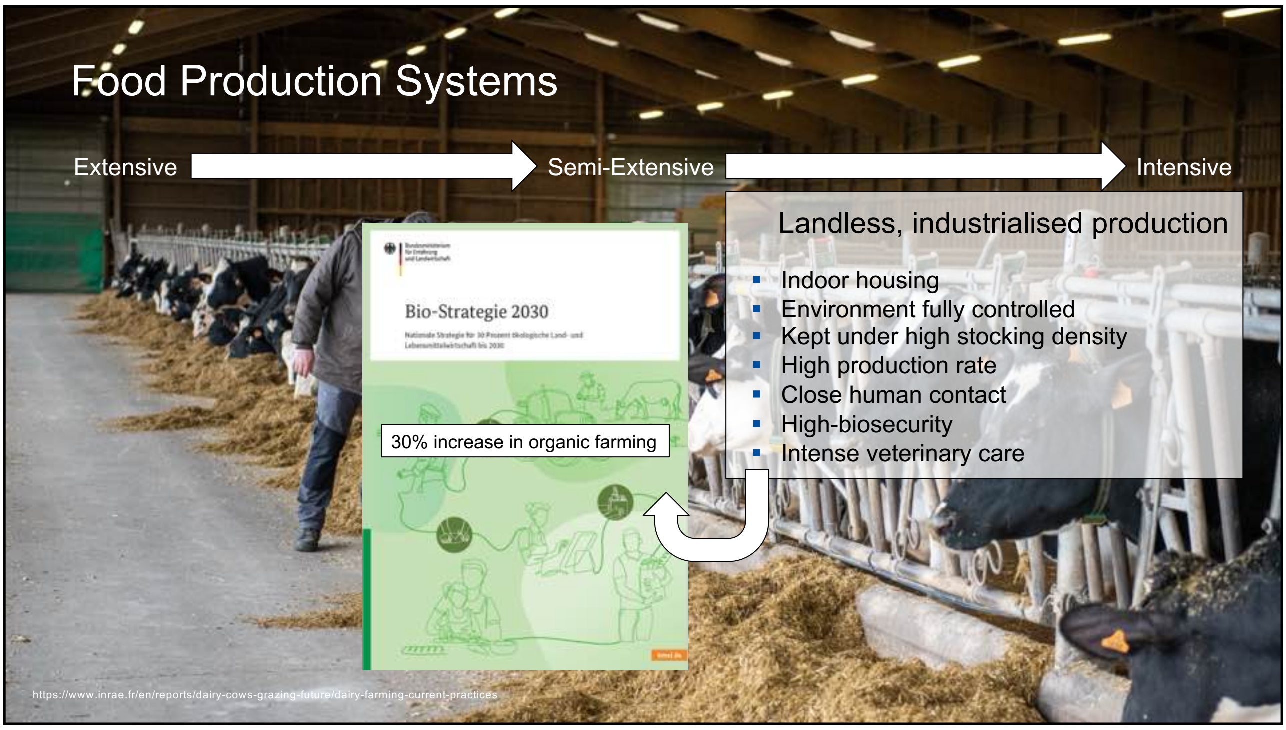

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Low Biosecurity and Organic Farming – What to expect when we enlarge the interface?

Photos: Klaus Depner

Characteristic aspects of organic farming

- Outdoor rearing (→ increased contact with wildlife)
- Limited use of curative and preventive conventional medicine (→ increased susceptibility)
- Organic feed (→ risk of contamination)
- Incorporation of biological cycles within the farm (→ risk of recirculating infectious diseases)
- Increased land use

Kijlstra, A. & Eijck, I. A. J. M. 2006. J Life Sci

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i0.wp.com

- Dangerous interaction of two or more diseases in a population
- Leads to worse health outcomes

Classical examples in human health

- Flu and bacterial infection
- HIV & tuberculosis
- Syphilis & HIV

Under the One Health approach we should also include non-zoonotic diseases!

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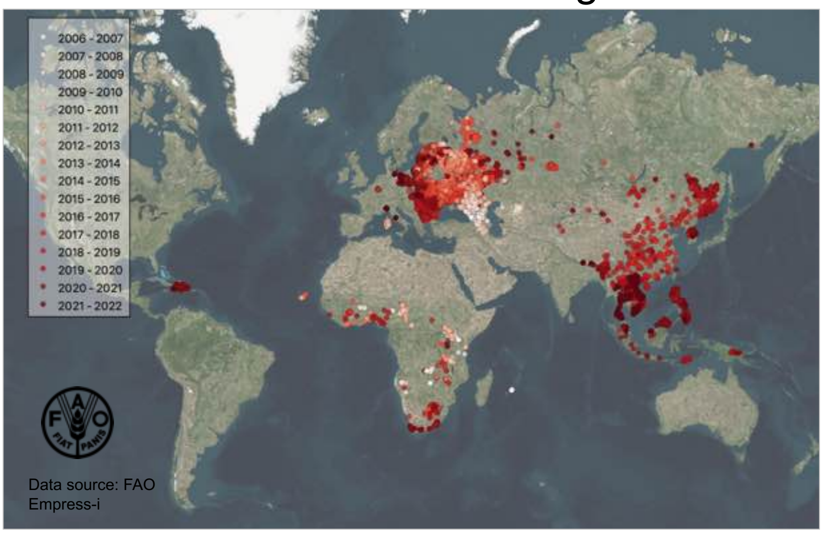
African Swine Fever – The Forgotten 'Pandemic'



e.g. Viet Nam (2019)


NewScientist

A quarter of all pigs have died this year due to African swine fever

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Food-and-Mouth Disease

https://www.theguardian.com

More than six million pigs, cattle and sheep were slaughtered across 10,000 UK farms in the 2001 outbreak. Photograph: Murdo Macloed/the Guardian

Thompson et al. 2002. Rev. sci. tech. Off. int. Epiz.

Table VII
Sectoral economic effect of foot and mouth disease in the United Kingdom, 2001-2005
(£ million)

Sector	National	Rural	Urban
Agriculture/food chain	**–3,125**		
– compensated by Government	2,585		
– direct effect	–525	–525	
Tourism (range)			
– direct effect (range)	**–2,700 to –3,205**	–1,685 to –2,030	–1,015 to –1,175
Estimated indirect effect (not allocated to sectors)			
Arising from losses to:			
– agriculture	–85		
– tourism	–1,835 to –2,180		

* This table shows the losses arising from foot and mouth disease. There are some sectors of the economy that will have benefited from tourist expenditure which has been displaced; these are not shown here (see text)

https://www.freepik.com

Disease control and prevention + Add to myFT

Foot-and-mouth outbreak in Germany forces meat and dairy export ban

Non-EU countries announce curbs after outbreak of viral disease in eastern state

The German government says the outbreak has originated in water buffalo on a farm in the eastern state of Brandenburg © Odd Andersen/AFP/Getty Images

Serotype-O confirmed

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The Socio-ecological and Economical Context

- Farmers are globally aware of livestock diseases
- After reporting an outbreak and subsequent depopulation
  - Only global North gets financial compensation for depopulation
- Consequences
  - Lack of reporting
  - Market sale of sick animals and products (further spread of disease)
  - Increases risk behaviour (e.g., bushmeat consumption)
  - No access to health care

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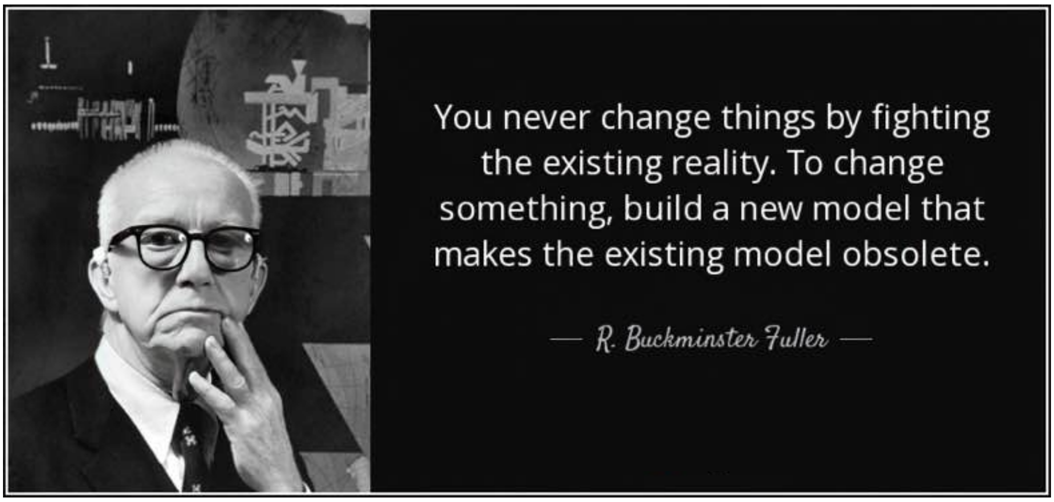
One Health as a New Model



AZ Quotes

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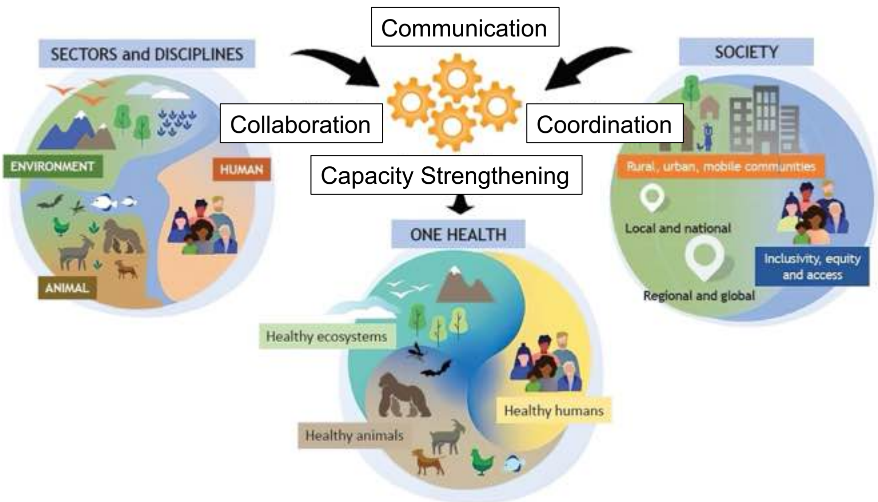
The Four Cs of One Health



OHHLEP (2021)

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Communication

Authenticity and credibility

One Health is an ethical dilemma: Respect for all and harm for none?

- Conflicting interests
  - not always possible to act in the best interests of all
- Generally anthropocentric viewpoint
- How do we reach all levels of society?

https://www.zeit.de/2014/21/tierversuche-versuchstiere-maeuse-ratten

https://www.sueddeutsche.de/bayern/bayern-vogelgrippe-bse-tierseuchen-1.6000365?reduced=true

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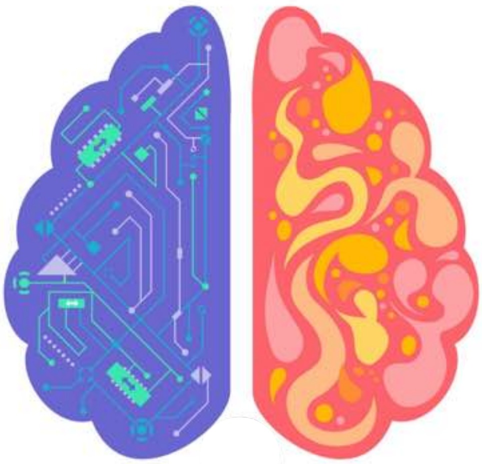
Collaboration

- One Health does not mean everyone, or every institution is doing everything
  - We need specialists and generalists in all sectors
- Reversing conservative systems from competitive to collaborative
- Appreciation of the different research disciplines and depths
- Respectful and ethically correct
- Listen to the needs of your partner
  - Context specific



https://ruinunes.com/wp-content/uploads/2022/06/3.png

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Tools to foster intersectoral collaboration

International Health Regulations (IHR)-Public Veterinary Service (PVS) National Bridging Workshop (NBW)

- Brings together stakeholders from the animal health and human health services within a given country

SEEG

Impressions of the pilot rabies NB workshops (Ghana and Bali):



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Coordination

One Health Lighthouse Projects

- Local, regional and global showcase projects that demonstrate the positive effect of One Health
- Not only in the academic world
- Innovative thinking (out of the box)
- The motivation to change something (crossing borders)

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Institute of International Animal Health/One Health [est. 2020]
Mandate and Mission

§27 (8) Tiergesundheitsgesetz (German Animal Health Law)

- Reinforcing German commitment and visibility in infectious disease prevention abroad
- Capacity strengthening and technical support for international partners

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Capacity Strengthening

The inequity in One Health

- Many countries in the tropics are committed to the One Health thinking (*more than countries in the Northern Hemisphere*)
- Uneven distribution of resources
  - ❖ Imbalance of the health system
- Cross-sectoral collaboration only possible when all partners have basic equipment and training

Livestock Health 'Data Hub', Zanzibar 2022

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Capacity Strengthening

In addition to our world-wide flexible support

- Establishment of two field presences (Africa and Asia)
- Equal partnership (involving all FLI institutes)
- Basic and applied sciences
- Sustainable training and education (Training-of-trainers, ToT)
- Local relevant – globally significant
- **One Health (Animal – Human – Environment)**

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Zanzibar

Livestock type	Number of livestock
Cattle	166,047
Goat	55,575
Sheep	2,769
Pig	0
Poultry	2,903,221

Total numbers of livestock by type in Zanzibar, created from Zanzibar household budget survey 2019-20, Y. Hikita (2023)

Area – 2,461 km²

Population – 1.5 Mio (2012)

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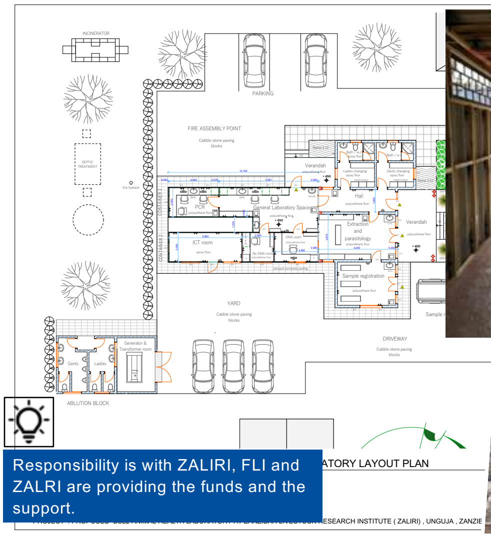
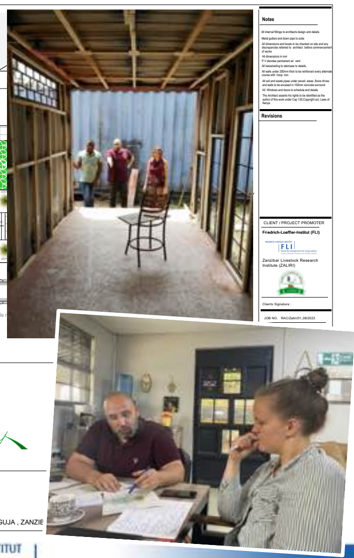
Zanzibar Animal Health Center



Responsibility is with ZALIRI, FLI and ZALRI are providing the funds and the support.



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1st FLI-Field School

“Healthy Livestock - Healthy People” 27.11.-01.12.2023

- Highly recognised by the Revolutionary Government of Zanzibar (Preseident of Zanzibar)
- Opening speech by Hon. Shamata Shaame Khamis (Minister, Ministry of Agriculture, Irrigation, Natural Resource and Livestock)
- Training-of-Trainer (ToT) approach

Learning objective

- Recognizing sick animals
- Herd health
- Case definitions
- Differential diagnoses
- Knowledge of correct and high quality sampling
- Overview of livestock diagnostics
- Interpretation of the results

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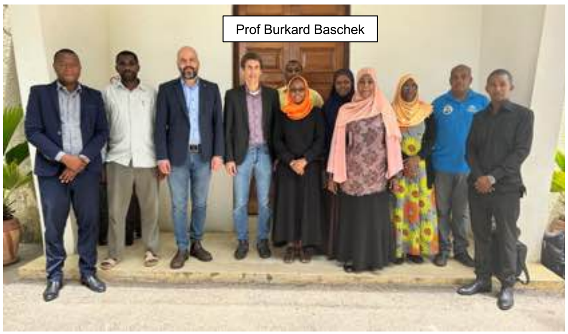
Step-wise Growth Of The One Health Family On Zanzibar

High-Level Meetings – High Support



Zanzibar Ministry of Tourism and Heritage (Director Level)

Zanzibar Ministry of Blue Economy and Fisheries (Principal Secretary Level)

One Health – One Ocean
Zanzibar Ocean Museum

Deutsches Meeresmuseum Stralsund

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What We Can Learn From The Global South?

- National One Health Strategic Plans
- Transforming traditional systems into intersectoral transdisciplinary workspaces
- Information about emerging and re-emerging pathogens
- Data needed to evaluate the One Health approach

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European Union and One Health

2024. Scientific Opinion '**One Health Governance in the European Union**' by the Group of Chief Scientific Advisors

2023. European Parliament's report '**COVID-19 pandemic: lessons learned and recommendations for the future**'

2022: EU Global Health Strategy '**Better Health for All in a Changing World**'

2020: **EU Biodiversity Strategy to 2030** 'Bringing nature back into our lives'

One Health EJP

Horizon Europe 2021-2027

One Health Projects

jpiamr

EU Partnership on OH AMR

EU's Global One Health Initiative Collaboration

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EU Human Zoonoses Data for 2022 and 2023

efsa EUROPEAN FOOD SAFETY AUTHORITY

ebay.com/itm/303652004630

TABLE 3 Number of confirmed human cases and notification rates (per 100,000 population) in 2023, including the absolute and relative (%) difference as compared with 2022, by zoonosis, EU.

Zoonosis	Cases (N) 2023	Cases (N) Absolute difference (compared with 2022)	Notification rates (N of confirmed cases per 100,000 population) 2023	Notification rates Absolute difference (compared with 2022)	Notification rates Relative difference (%) (compared with 2022)
Campylobacteriosis	148,181	8956	45.7	1.9	+4.3
Salmonellosis	77,486	12,008	18.0	2.6	+16.9
STEC infections	10,217	2186	3.1	0.70	+30.0
Yersiniosis	8738	809	2.4	0.29	+13.5
Listeriosis	2952	174	0.66	0.04	+5.8
Tularaemia	1185	561	0.27	0.13	+89.3
Echinococcosis	929	190	0.21	0.02	+8.4
Q fever	805	86	0.19	0.02	+11.5
West Nile virus infection[a]	713	−403	0.16	−0.09	−37.2
Brucellosis	259	33	0.06	0.01	+14.1
Tuberculosis caused by *M. bovis, M. caprae*	138	−9	0.04	−0.002	−6.1
Trichinellosis	76	37	0.02	0.01	+94.0
Rabies[b]	1	1	–	–	–

[a]For West Nile virus infection, the total number of locally acquired infection cases was used (includes probable and confirmed cases).
[b]In 2023 one case was reported by France, probably infected in Morocco.

EFSA. The European Union One Health 2023 zoonoses report. *EFSA J.* 2024.

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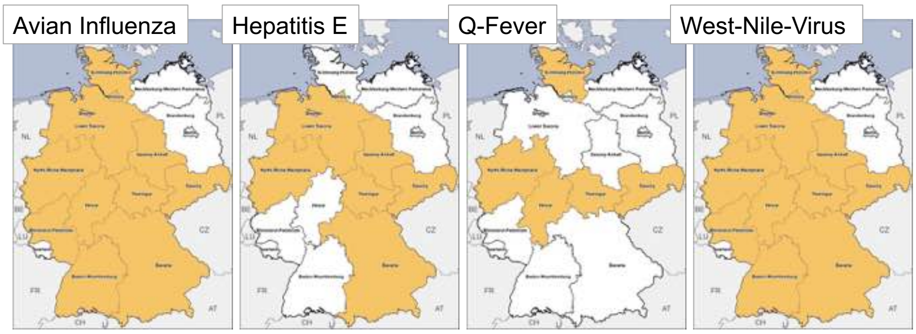
One Health for Surveillance

Setting up a coordinated surveillance under the One Health approach (OH4Surveillance) in Europe

Avian Influenza | Hepatitis E | Q-Fever | West-Nile-Virus



Funded by the European Union

EU4H Project Grant

efsa

One Health SubGroup

- Harmonized at international level
- Standardized procedures
- Widening of the scope

C. Staubach C. Sauter-Louis

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Integrated Wildlife Disease Surveillance In Europe

efsa

ENETWILD-2

Integrated wildlife disease surveillance that combines data from disease surveillance, and the monitoring of wild populations and the biotic components of the ecosystem (adapted from Cardoso 2022).

- E*Net*Wild-*2* Consortium

External Scientific Report

The role of mammals in Avian Influenza: a review

ENETWILD Consortium[1], Occhibove Flavia, Knauf Sascha, Sauter-Louis Carola, Staubach Christoph, Allendorf Valerie, Anton Alina, Barron Sophia, Bergmann Hannes, Bröjer Caroline, Buzan Elena, Cerny Jiri, Denzin Nicolai, Gethöffer Friederike, Globig Anja, Gethmann Jörn, Gonzálvez Moisés, García-Bocanegra Ignacio, Harder Timm, Jori Ferran, Keuling Oliver, Neimanis Aleksija, Neumann Heise Joaquin, Pastori Ilaria, Parreira Perin Patricia, Rijks Jolianne, Schulz Katja, Trogu Tiziana, Plis Kamila, Vada Rachele, Vercher Gauthier, Wischnewski Natalie, Zanet Stefania, Ferroglio Ezio

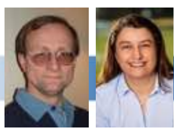
External Scientific Report

APPROVED: 8 March 2024
doi:10.2903/sp.efsa.2024.EN-8965

Modelling wild boar abundance at high resolution

ENETWILD-consortium[1], Simon Croft, José A Blanco-Aguiar, Pelayo Acevedo, Sonia Illanas, Joaquín Vicente, Daniel A Warren, Graham C Smith

C. Staubach C. Sauter-Louis



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BEPREP

Funded by the European Union

2022 -2027

Identification of Best Practice for Biodiversity Recovery and Public Health Interventions to Prevent Future Epidemics and Pandemics

- Nature restoration targeting biodiversity recovery - isolated or in combination with public health interventions - has been identified as a major disease risk mitigation tool.

- ❖ Spatially and temporally replicated field studies and experiments
- ❖ 12 case study areas in Europe and the tropics

→ Identify causal mechanisms of infection dynamics and generate knowledge how to interrupt infection pathways.

BE PREP

R. Ulrich

A. Anton

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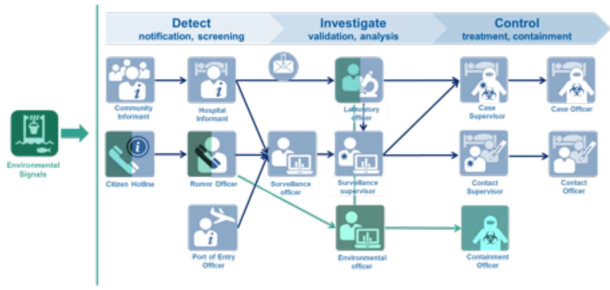
Surveillance, Outbreak Response Management and Analysis System

SORMAS goes One Health

Water-based Outbreak Prediction in Peri-Urban Africa
(IITG-HZI joint project)

KCCR



Curtesy to J. Dörrbecker and the SORMAS Team (HZI)

09/2021 Kumasi, Ghana

HZI HELMHOLTZ Zentrum für Infektionsforschung

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Water Sources

Kumasi, Ghana

- 2 L surface water/site per week
- 7 weeks sampling

Knauf et al. in prep.

- Antibiotic-resistant Enterobacteriaceae resistant to third-generation cephalosporins (ESBL-producers)
- High-risk clonal *Escherichia coli* lineages that are usually multi-drug resistant and highly virulent for humans and animals

Eger et al. 2024. JAC-Antimicrob Restist

UNIVERSITÄT GREIFSWALD Wissen lockt. Seit 1456

KCCR

HZI HELMHOLTZ Zentrum für Infektionsforschung

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Quadripartite's One Health Joint Plan of Action

Action track 1: Enhancing One Health capacities to strengthen health systems
Action track 2: Reducing the risks from emerging and re-emerging zoonotic epidemics and pandemics
Action track 3: Controlling and eliminating zoonotic, neglected tropical and vector-born diseases
Action track 4: Strengthening the assessment, management and communication of food safety risks
Action track 5: Curbing the silent pandemic of Antimicrobial Resistance (AMR)
Action track 6: Integrating the environment into One Health

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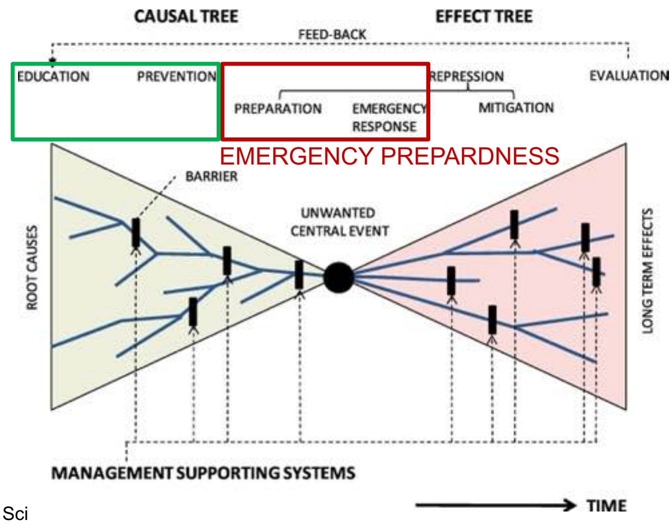
Root Causes And Long-Term Effects



Bow-tie model and the safety hierarchy

Lindout, P. et al. 2017. Safety Sci

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The COVID19 aftermath

Guardian graphic. Source: Dobson et al, Science 2020

ITEM	VALUES (2020 $)
Expenditures on preventive measures	
Annual funding for monitoring wildlife trade (CITES+)	$250–$750 M
Annual cost of programs to reduce spillovers	$120–$340 M
Annual cost of programs for early detection and control	$217–$279 M
Annual cost of programs to reduce spillover via livestock	$476–$852 M
Annual cost of reducing deforestation by half	$1.53–$9.59 B
Annual cost of ending wild meat trade in China	$19.4 B
TOTAL GROSS PREVENTION COSTS (*C*)	**$22.0–$31.2 B**
Ancillary benefit of prevention	
Social cost of carbon	$36.5/tonne
Annual CO_2 emissions reduced from 50% less deforestation	118 Mt
Ancillary benefits from reduction in CO_2 emissions	$4.31 B
TOTAL PREVENTION COSTS NET OF CARBON BENEFITS (*C*)	**$17.7–$26.9 B**
Damages from COVID-19	
Lost GDP in world from COVID-19	$5.6 T
Value of a statistical life (*V*) adjusted for COVID-19 mortality structure	$5.34 M or $10.0 M
Total COVID-19 world mortality (Q_0) forecast by 28 July 2020. 50th percentile with 95% error bounds	590,643 [473,209, 1,019,078]
Value of deaths in world from COVID-19 = $Q_0 \times V$	
Lowest ($5.34 M × 2.5th percentile mortality forecast)	$2.5 T
Middle ($10 M × 50th percentile mortality forecast)	$5.9 T
Highest ($10 M × 97.5th percentile mortality forecast)	$10.2 T
TOTAL DISEASE DAMAGES (*D*):	
Lowest ($5.34 M × 2.5th percentile mortality forecast)	**$8.1 T**
Middle ($10 M × 50th percentile mortality forecast)	**$11.5 T**
Highest ($10 M × 97.5th percentile mortality forecast)	**$15.8 T**

Dobson et al. 2020. Science

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Conclusion

- There is no magic in One Health
- Lead by example
- On the local, regional and global level
- Animal, human AND environment
- Don't allow One Health to become a 'new' silo
- Be committed to 'Good Scientific Practice'
- One Health is politically supported (the momentum is now)

"If you want to go quick, go alone.
If you want to go far, go together."

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Never Stop Exploring.
One Health – For Good and For All.
FLI.

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JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

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