Dynamic drivers of disease emergence in Africa: From hypothetical frameworks to the field

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espa ecosystem services for poverty alleviation

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What to talk about today?

1. Disease drivers
2. Ecosystem services
3. Proposed frameworks
4. Dynamic drivers of disease in Africa- case studies
5. Discussion

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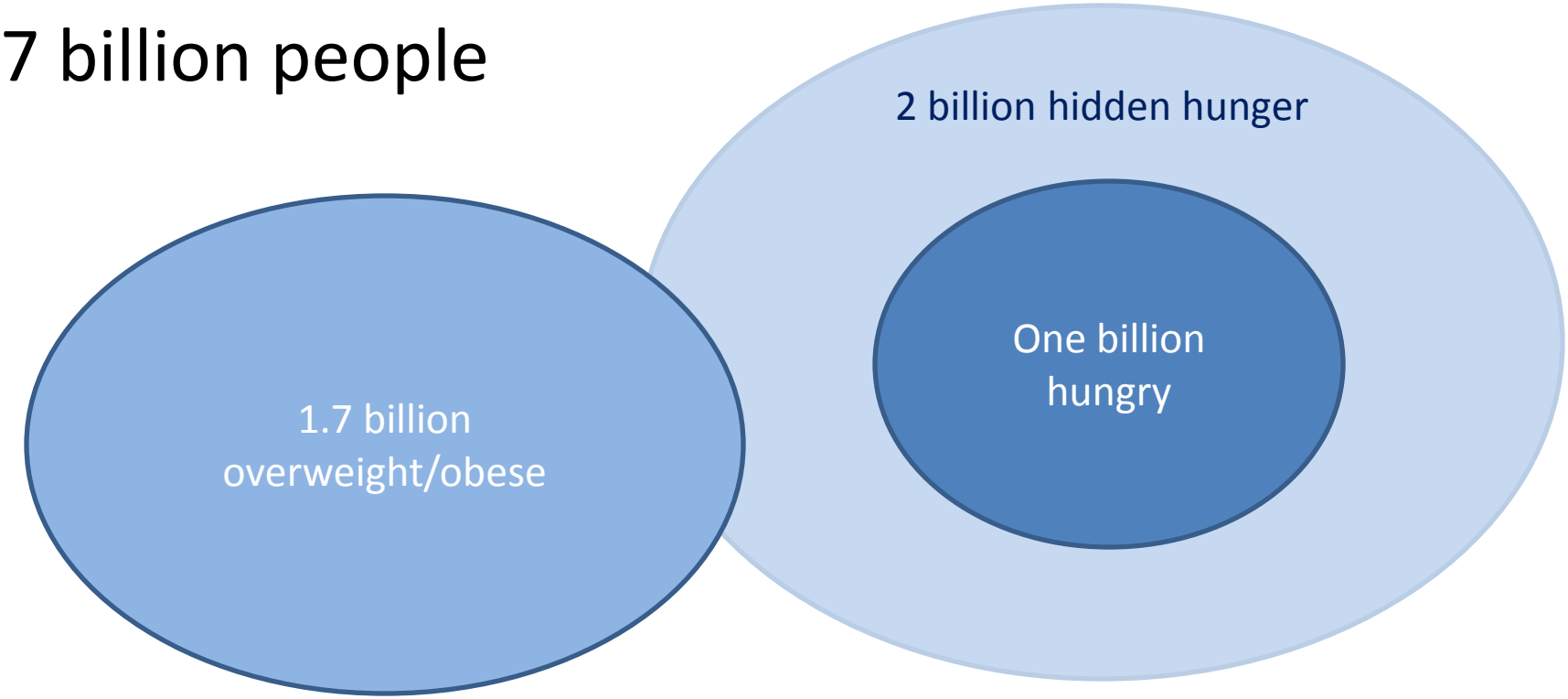
The world today

- Humans are affecting every part of this planet
  - Directly or indirectly

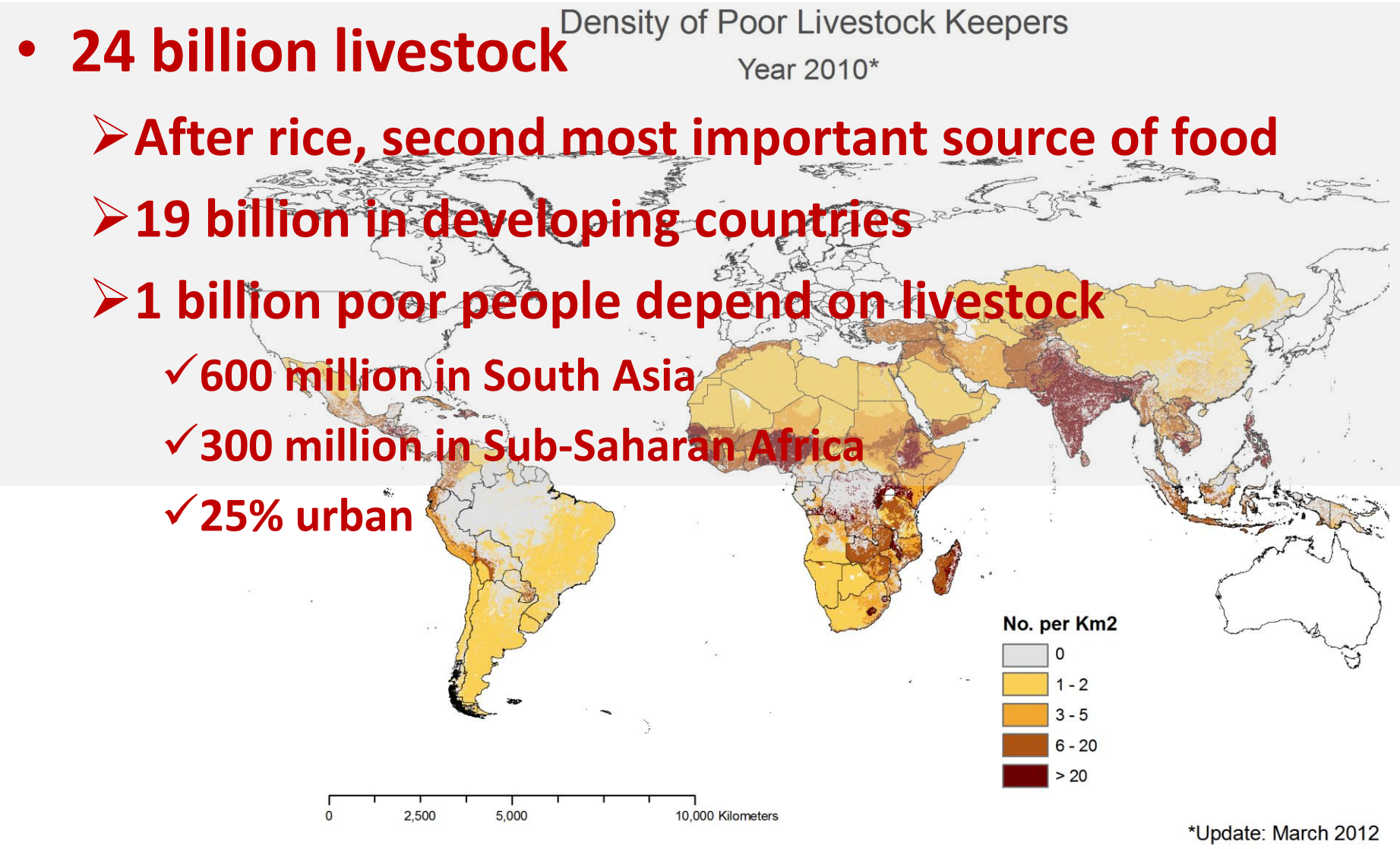
The world today

7 billion people



Livestock is important

- **24 billion livestock**
  - ➢ **After rice, second most important source of food**
  - ➢ **19 billion in developing countries**
  - ➢ **1 billion poor people depend on livestock**
    - ✓ **600 million in South Asia**
    - ✓ **300 million in Sub-Saharan Africa**
    - ✓ **25% urban**



Infectious diseases- historically important

- In 1918-1920 Spanish flu:
  - 50- 100 million humans
- Late 19th century Rinderpest:
  - Death of 2/3 of Maasai population in Tanzania and Kenya
- Early 19th century Potato blight:
  - 25% of Irish population starved or migrated

- 1967: "…war against infectious diseases has been won“
  - US Surgeon General William H. Steward

US Surgeon General William H. Steward was wrong

Infectious diseases as a cause of death has been decreasing

- But not everywhere, and not constant
- Increases due to HIV, drug resistance

In 2011 55 million died

- ❑18 million from infection
- ❑7 million deaths in under fives (2/3 infectious)

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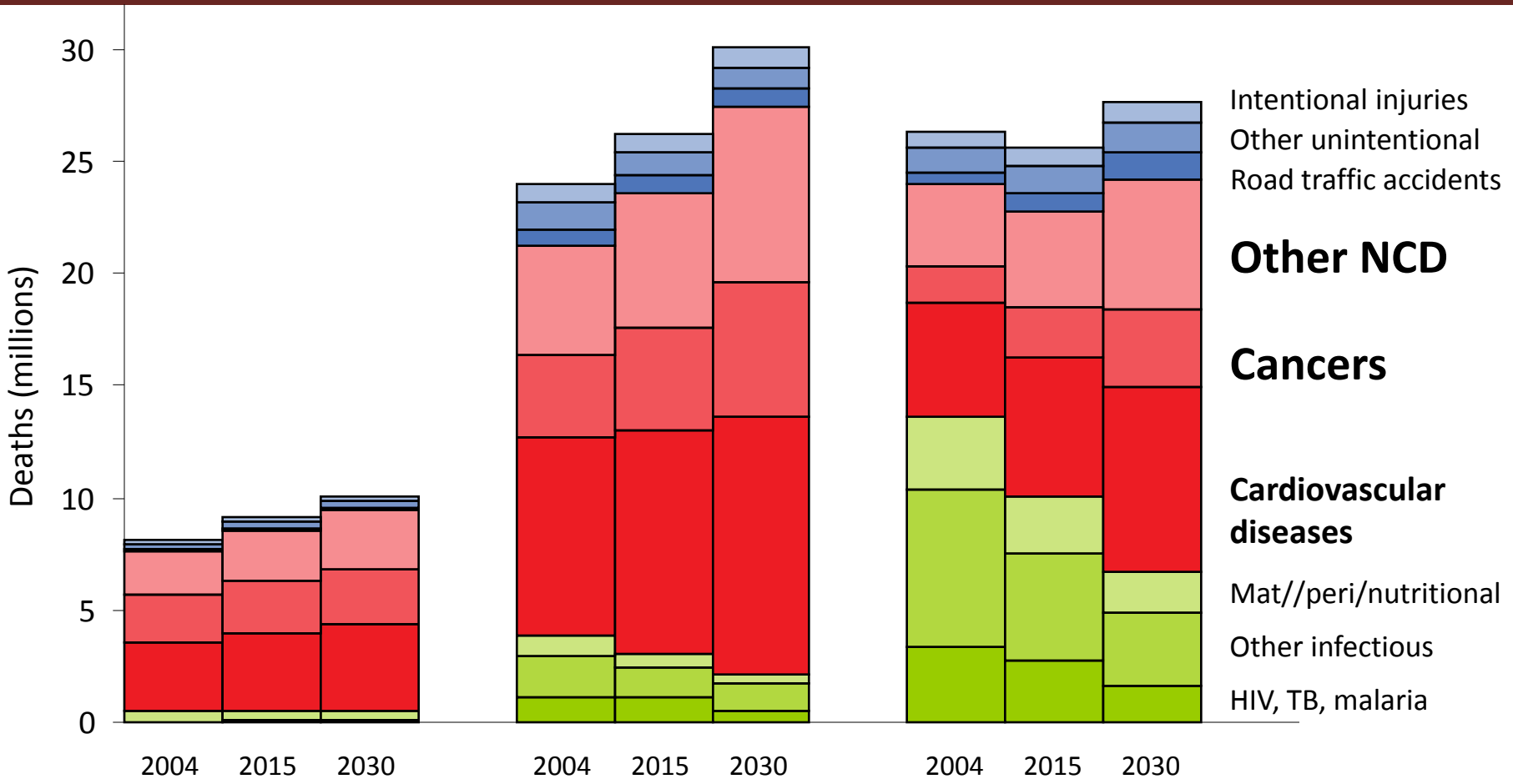
Mortality: global projection, 2004-2030

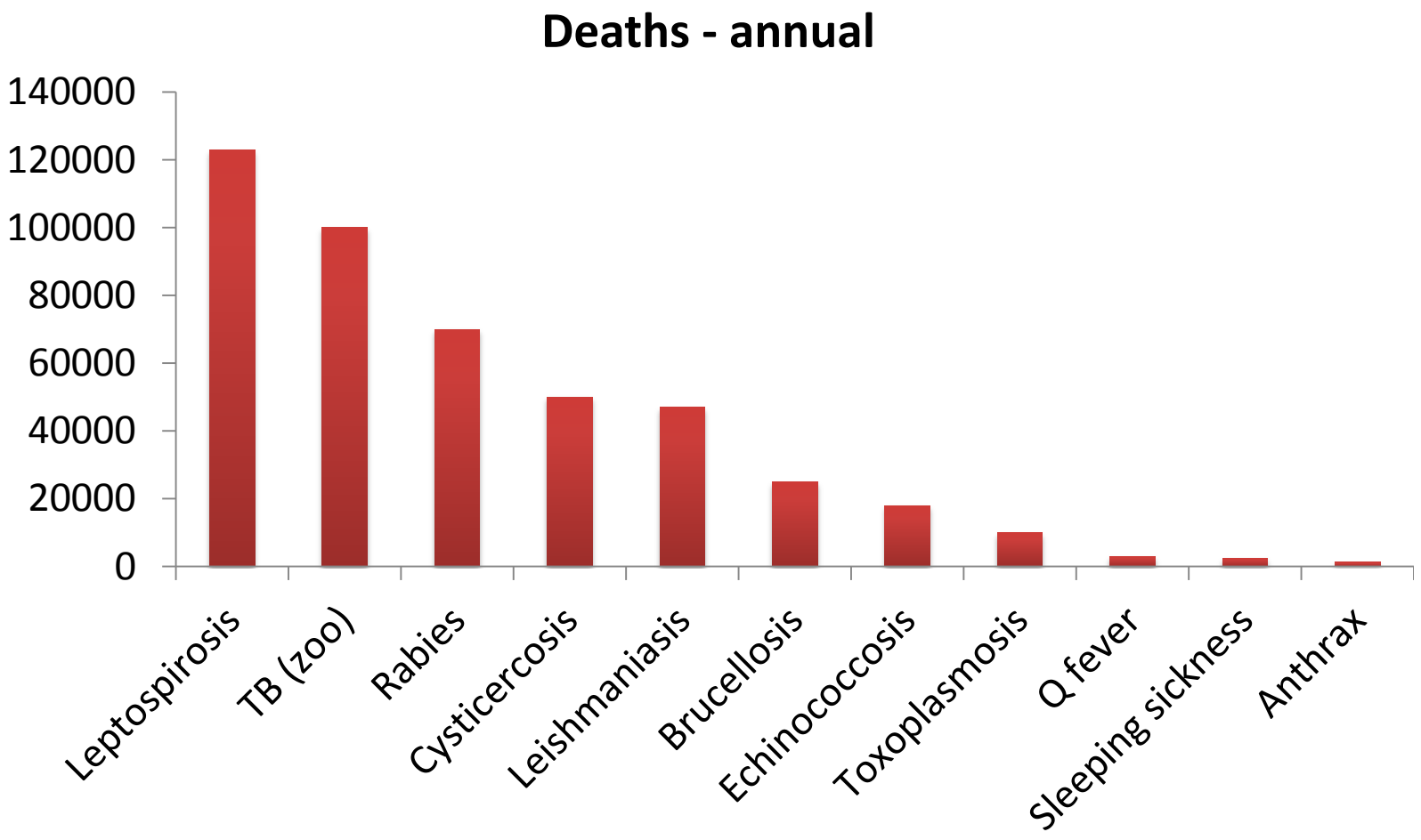


Top Zoonoses (multiple burdens)

- Assessed 56 zoonoses from 6 listings: responsible 2.7 billion cases, 2.5 million deaths
- Top 13 responsible for 2.2 billion illnesses and most deaths
  - Wildlife interface
  - 9 have a major impact on livestock- affect 1 out of 7
  - All 13 amenable to on-farm intervention

  World bank (2010) estimates for last century :
  - direct costs of zoonotic outbreaks >20 billion USD
  - indirect costs 200 billion USD

Zoonoses


Deaths - annual
140000
120000
100000
80000
60000
40000
20000
0
Leptospirosis
TB (zoo)
Rabies
Cysticercosis
Leishmaniasis
Brucellosis
Echinococcosis
Toxoplasmosis
Q fever
Sleeping sickness
Anthrax

Animal health today

5 billion livestock die each year (~20%)

Annual mortality of African livestock
(About half due to preventable or curable diseases)

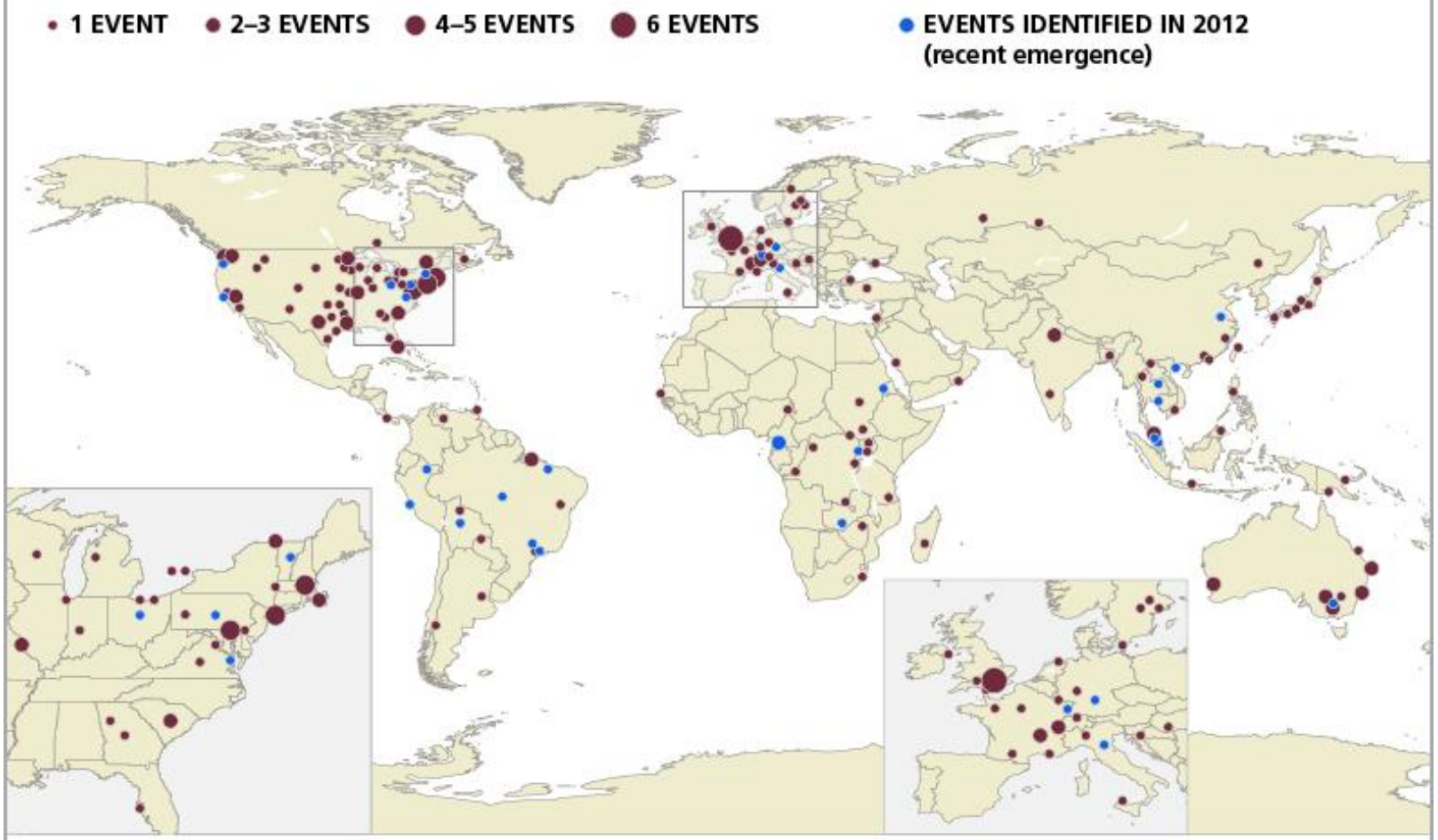
	Young	Adult
Cattle	22%	6%
Shoat	28%	11%
Poultry	70%	30%

Otte & Chilonda, IAEA

Emerging Zoonotic Disease Events, 1940–2012

Potential Hotspots in US, Western Europe, Brazil, Southeast Asia

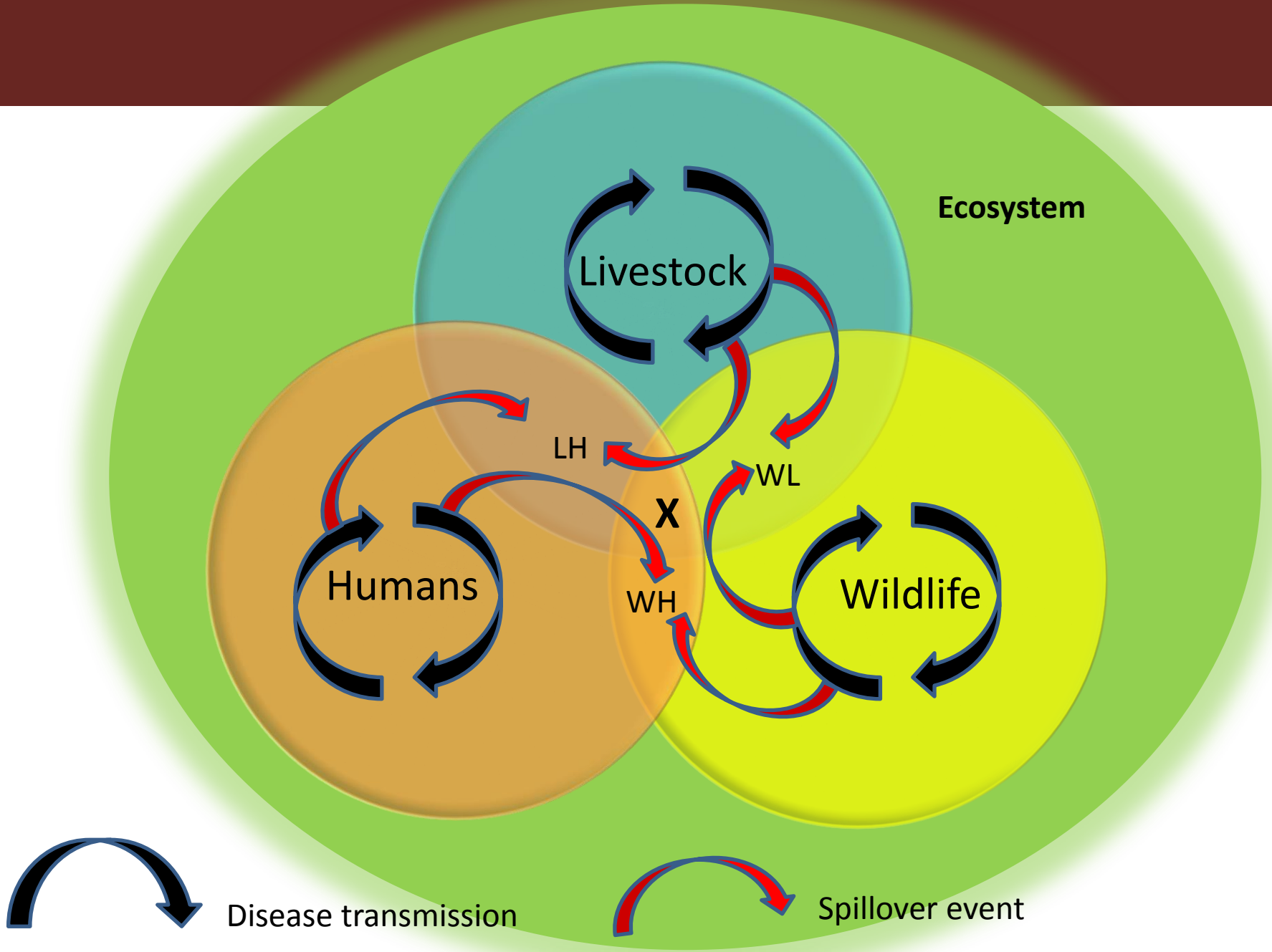
Most emerging human diseases come from animals. This map locates zoonotic events over the past 72 years, with recent events (identified by an ILRI-led study in 2012) in blue. Like earlier analyses, the study shows western Europe and western USA are hotspots; recent events, however, show an increasingly higher representation of developing countries.



Map by IOZ, published in an ILRI report to DFID: *Mapping of Poverty and Likely Zoonoses Hotspots*, 2012.

Disease emergence?

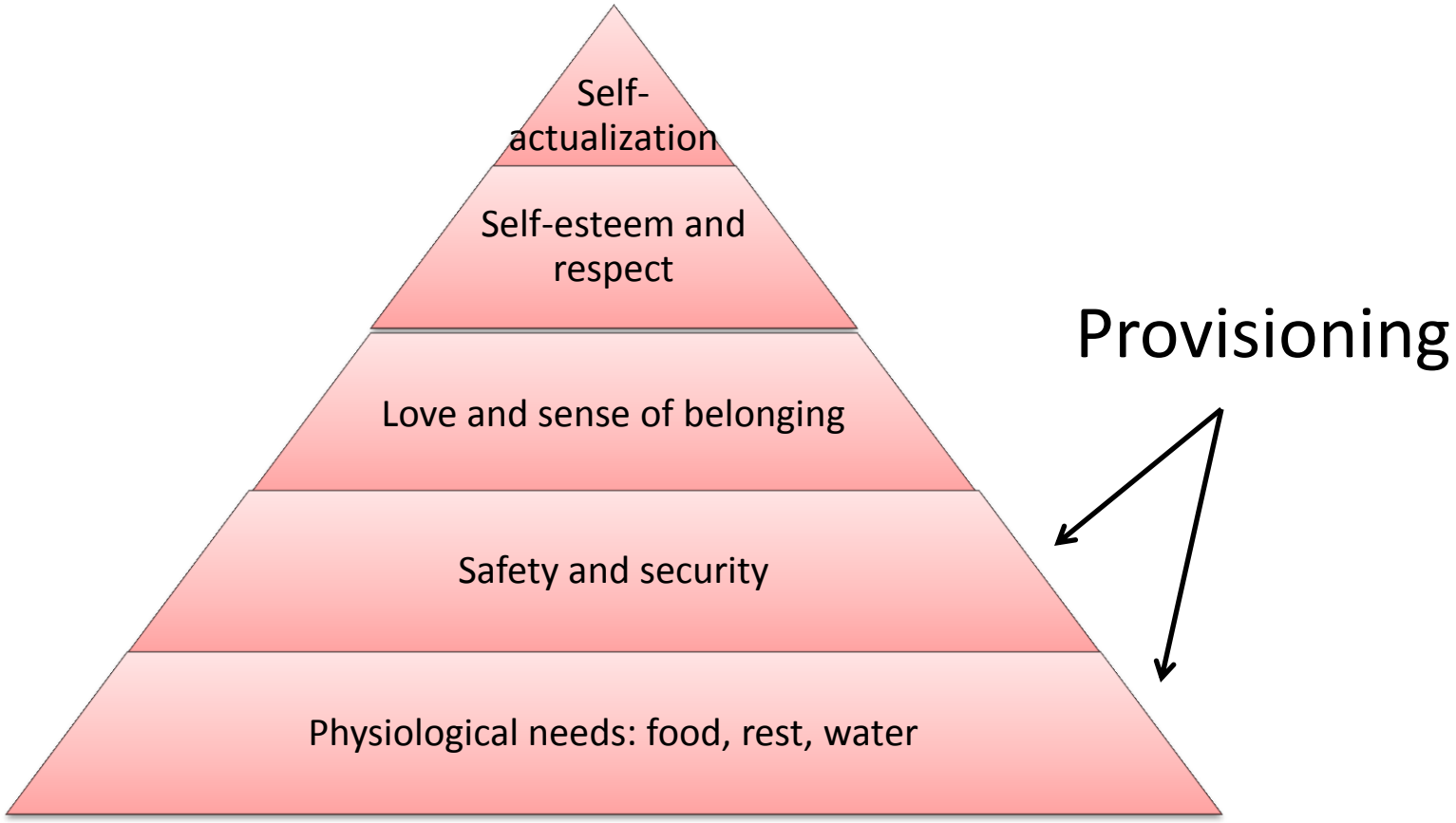
- Definition:
  - a disease which incidence in humans have been increasing
  - a disease which has a tendency to spread geographically, cause an increased incidence or infect a new species or new populations
  - a disease spreading within any host population
- Which diseases?
  - EID twice as likely to be zoonotic than non-zoonotic (zoonotic viruses and protozoa had highest proportion)
  - Quick mutations
- Where?
  - rapid intensification, increasing interactions between animals, humans and ecosystems, often rapidly changing habits and practices


Ecosystem
Livestock
LH
WL
X
Humans
WH
Wildlife
Disease transmission
Spillover event

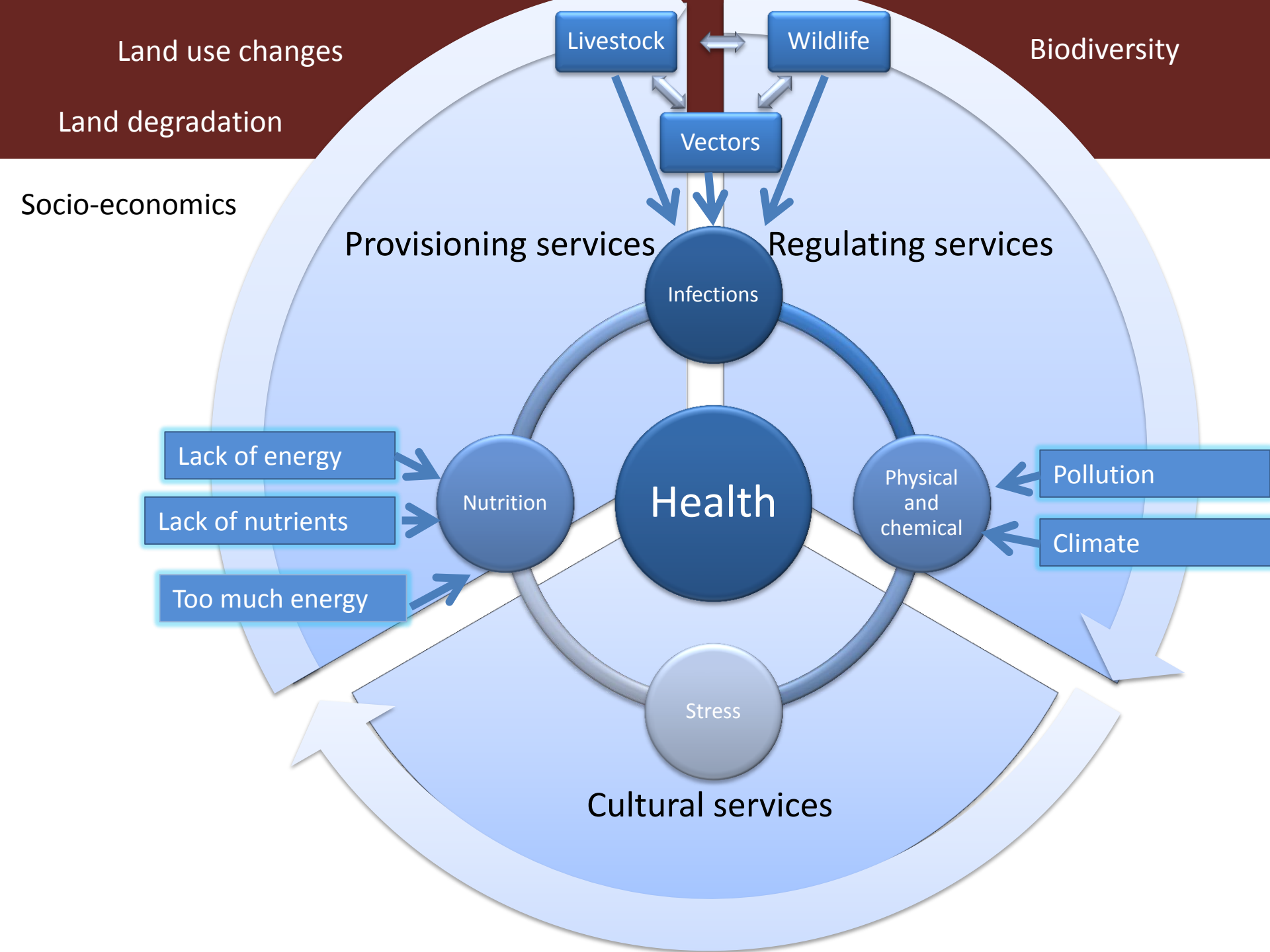
Type of wildlife-livestock-human interface	Level of Biodiversity	Characteristics of Livestock Population	Connectedness between populations	Main interface	Examples of zoonotic disease with altered dynamics
'Pristine' ecosystem with human incursion to harvest wildlife and other resources	High	No livestock	Very low, small populations and limited contact	Ignorable WL interface, large WH interface	Ebola HIV SARS Nipah virus in Bangladesh and India
Ecotones and fragmentation of natural ecosystems - farming edges, human incursion to harvest natural resources	High but decreasing	Few livestock, multiple species, mostly extensive systems	Increasing contact between people, livestock and wild animals	WH and WL interface dominating, increasing LH	Kyasanur Forest disease Bat rabies *E. coli* interspecies transmission in Uganda Nipah virus in Malaysia
Evolving landscape - rapid intensification of agriculture and livestock, alongside extensive and backyard farming	Low, but increasing peri-domestic wildlife	Many, both intensive and genetically homogenous, as well as extensive and genetically diverse	High contacts between intensive and extensive livestock, people and peri-domestic wildlife. Less with endangered wildlife.	Patchwise large LH interface, decreasing WH and WL	Avian influenza Japanese encephalitis virus in Asia
Managed landscape - islands of intensive farming, highly regulated. Farm land converted to recreational and conservancy	Low, but increased number of certain peri-domestic wildlife species	Many, mainly intensive, genetically homogeneous, biosecure	Fewer contacts between livestock and people; increasing contacts with wildlife.	Small but increasing WL and WH, decreasing LH	Bat-associated viruses in Australia WNV in USA Lyme disease in USA
Urban landscape- high densities of humans, with peri-urban intense farming and urban lower intense farming, close to people. Habitat fragmentation of wildlife	Low	High value animals , mainly small ruminants or pigs, and poultry in the urban centres	High densities yield high connectedness	Patchwise increasing LH and WH, especially poor areas	Plague outbreaks Leptospirosis Dog rabies

Ecosystem services – and disease emergence

Ecosystem service	Importance	Effect of decrease
Provisioning	Economics, livelihoods	Increased poverty
Regulating	Health, environment	Increased disease
Cultural	Well-being, recreation	Increased stress?
Supporting	Basis for the other services	Increase in all above

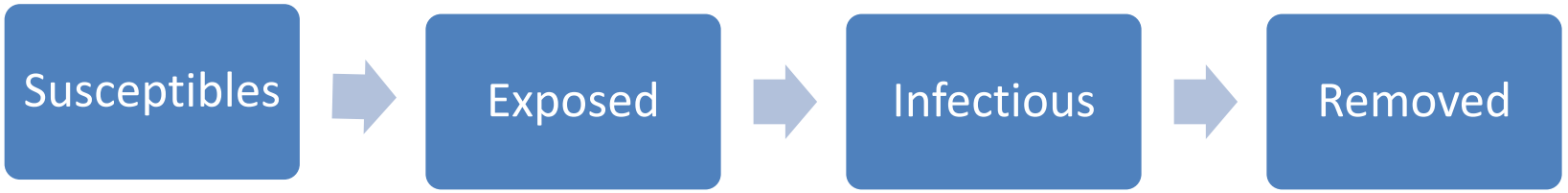


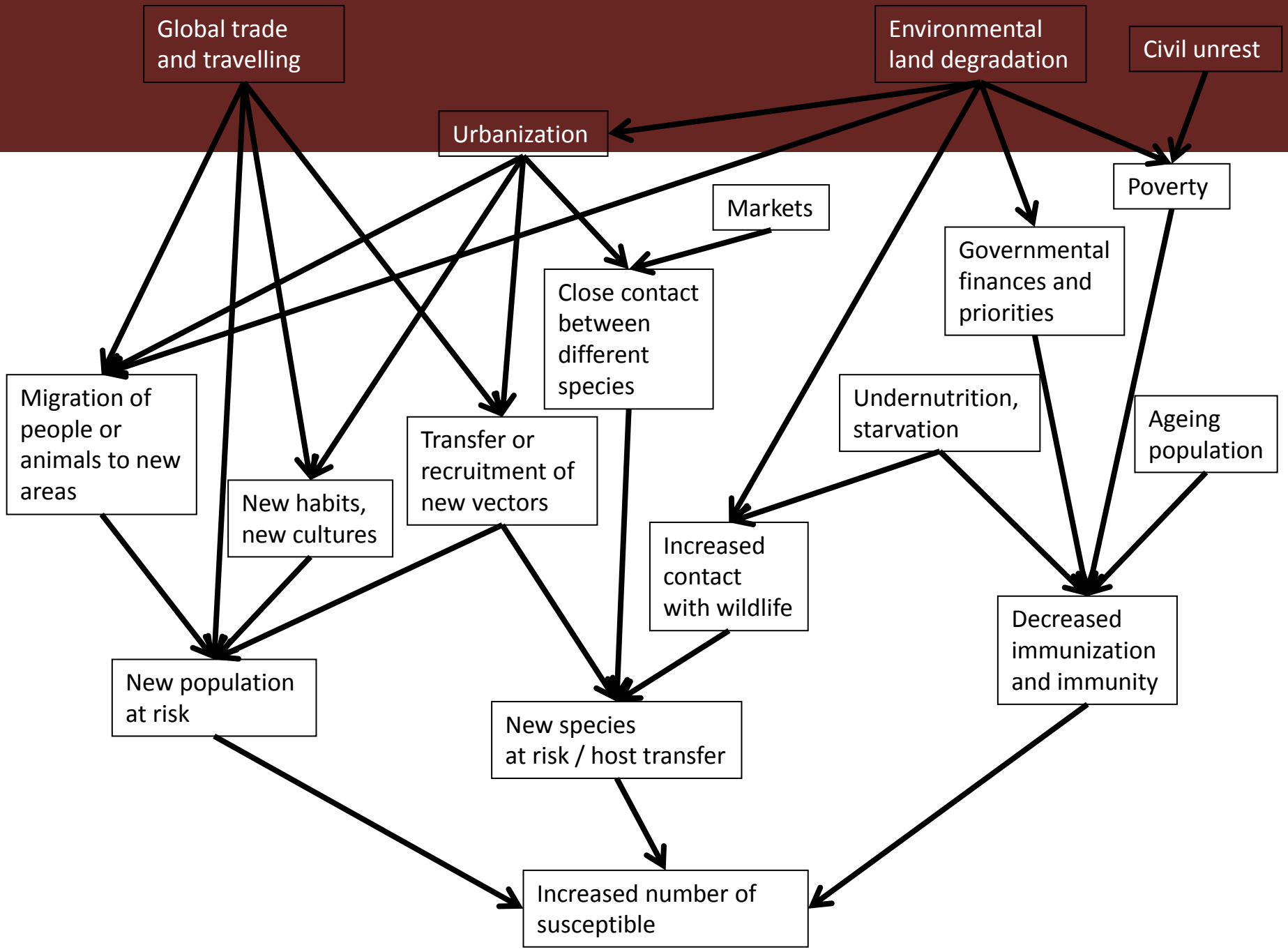
Hierarchy of needs according to Maslow.

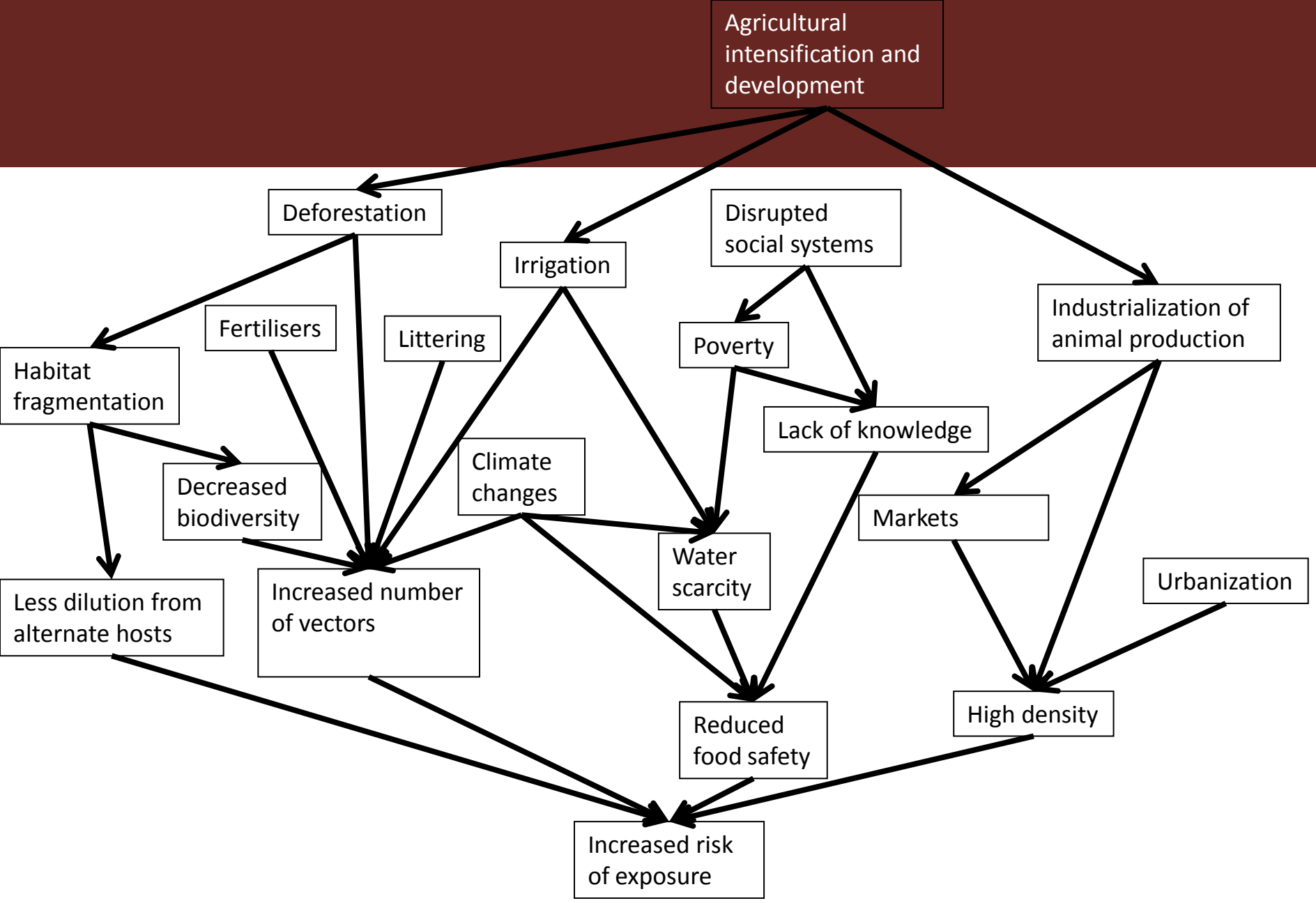

Land use changes
Land degradation
Socio-economics
Livestock
Wildlife
Biodiversity
Vectors
Provisioning services
Regulating services
Infections
Lack of energy
Lack of nutrients
Too much energy
Nutrition
Health
Physical and chemical
Pollution
Climate
Stress
Cultural services

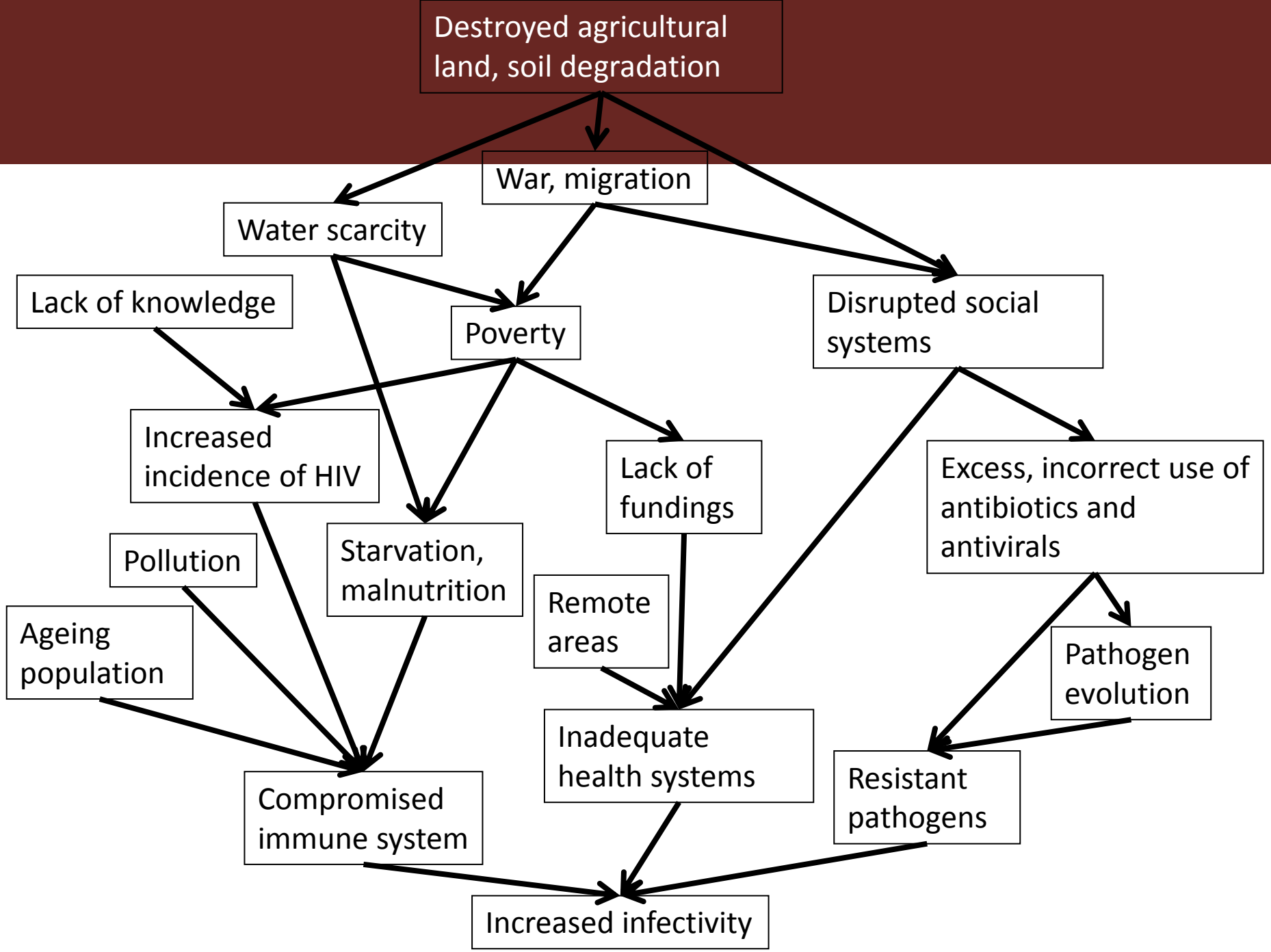
Basic epidemiological principles

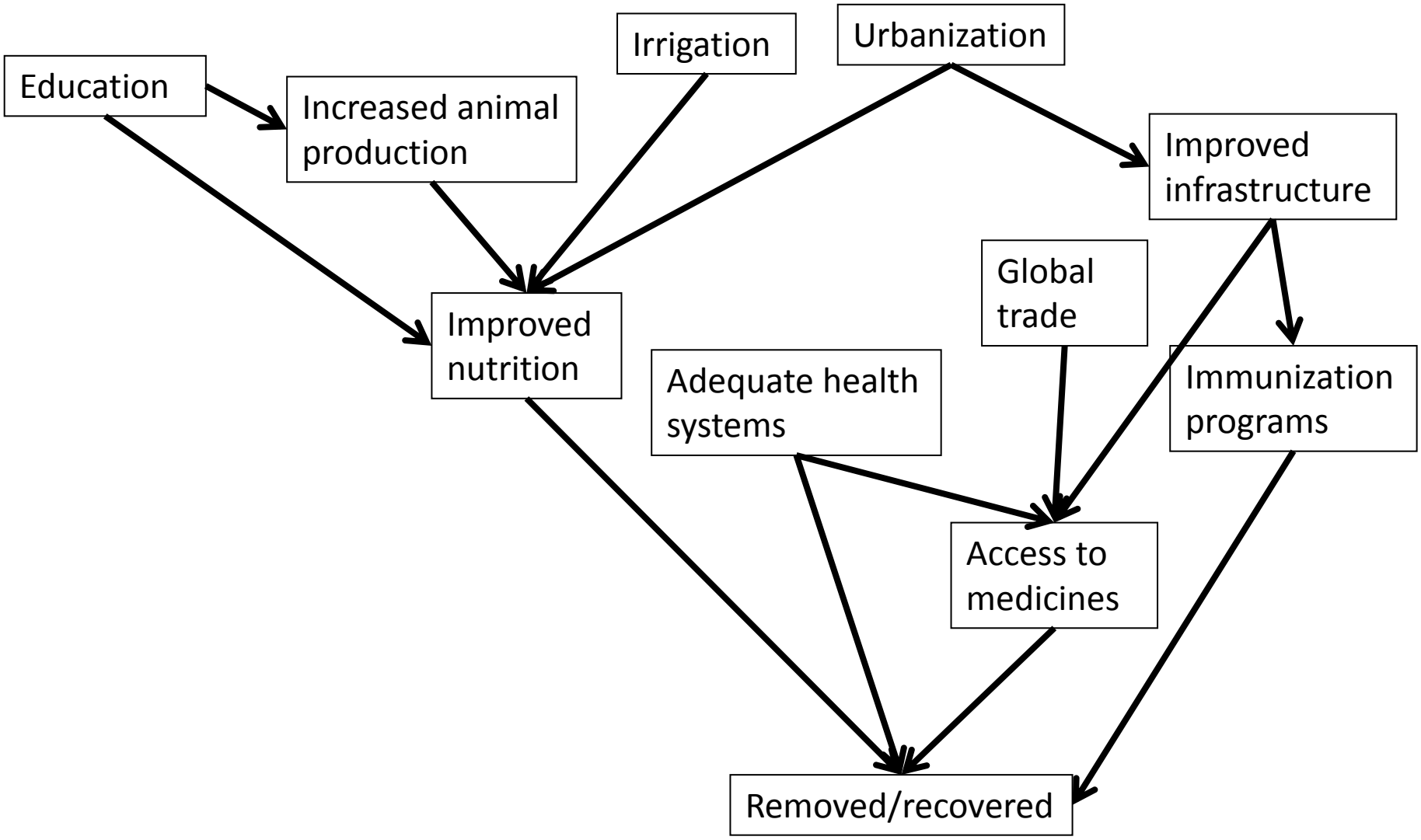
- For an outbreak to occur: $R_0 > 1$
- SIR model

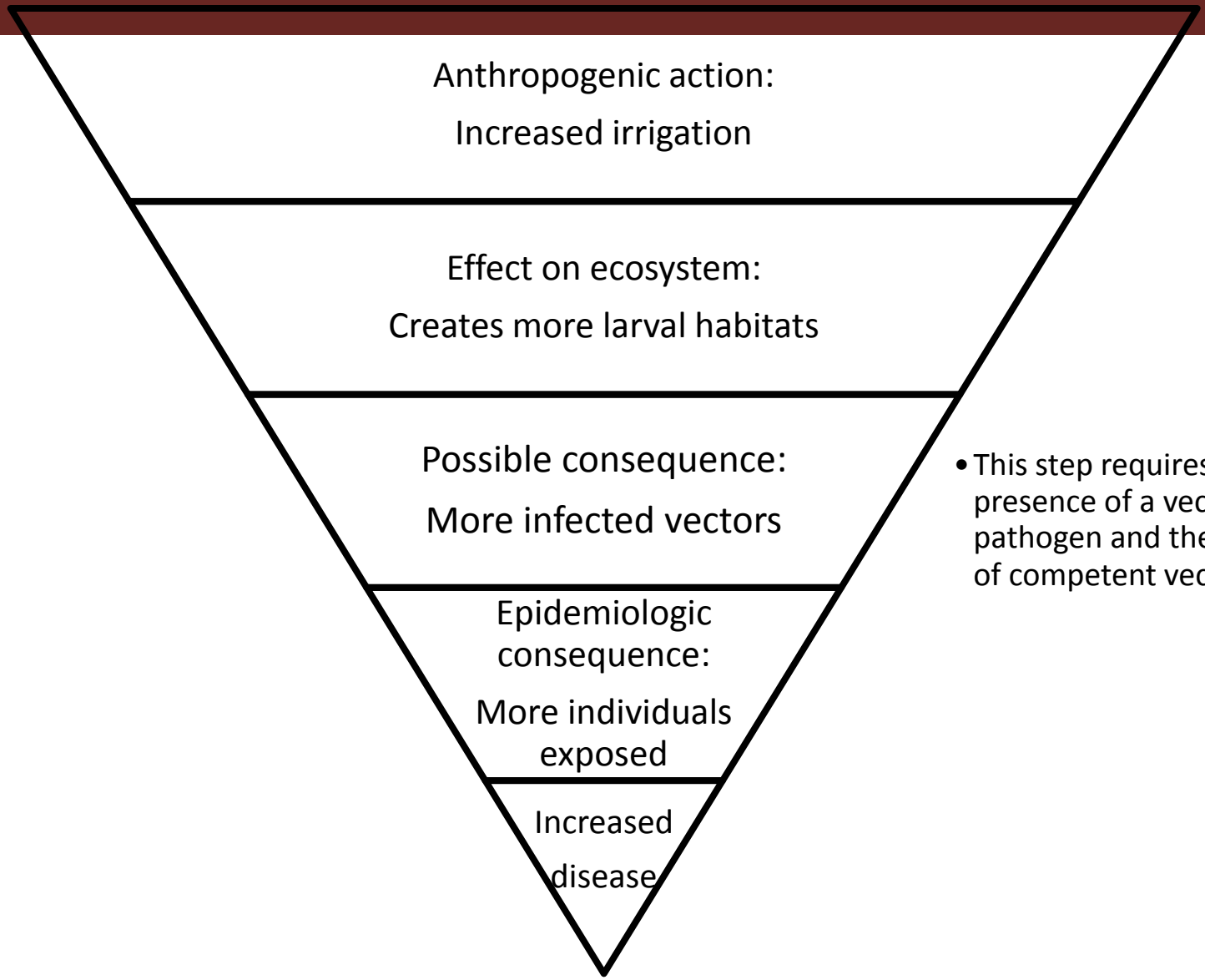



Global trade and travelling
Environmental land degradation
Civil unrest
Urbanization
Poverty
Markets
Governmental finances and priorities
Close contact between different species
Migration of people or animals to new areas
Undernutrition, starvation
Ageing population
Transfer or recruitment of new vectors
New habits, new cultures
Increased contact with wildlife
Decreased immunization and immunity
New population at risk
New species at risk / host transfer
Increased number of susceptible


Agricultural intensification and development
Deforestation
Irrigation
Disrupted social systems
Industrialization of animal production
Fertilisers
Littering
Poverty
Habitat fragmentation
Lack of knowledge
Climate changes
Decreased biodiversity
Markets
Water scarcity
Urbanization
Less dilution from alternate hosts
Increased number of vectors
Reduced food safety
High density
Increased risk of exposure

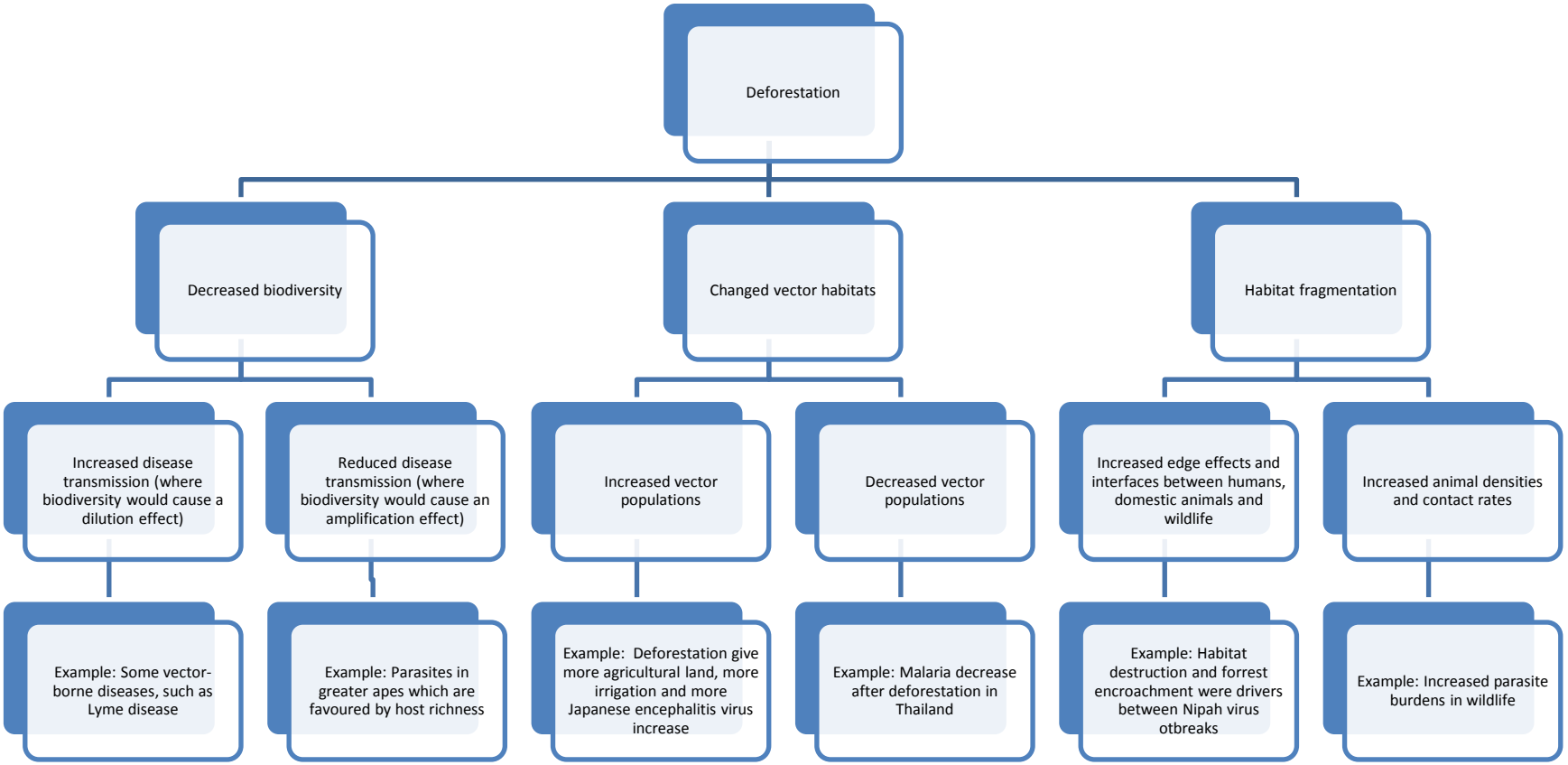

Destroyed agricultural land, soil degradation
War, migration
Water scarcity
Lack of knowledge
Poverty
Disrupted social systems
Increased incidence of HIV
Lack of fundings
Excess, incorrect use of antibiotics and antivirals
Pollution
Starvation, malnutrition
Remote areas
Ageing population
Pathogen evolution
Inadequate health systems
Resistant pathogens
Compromised immune system
Increased infectivity


Education
Increased animal production
Irrigation
Urbanization
Improved infrastructure
Improved nutrition
Global trade
Adequate health systems
Immunization programs
Access to medicines
Removed/recovered

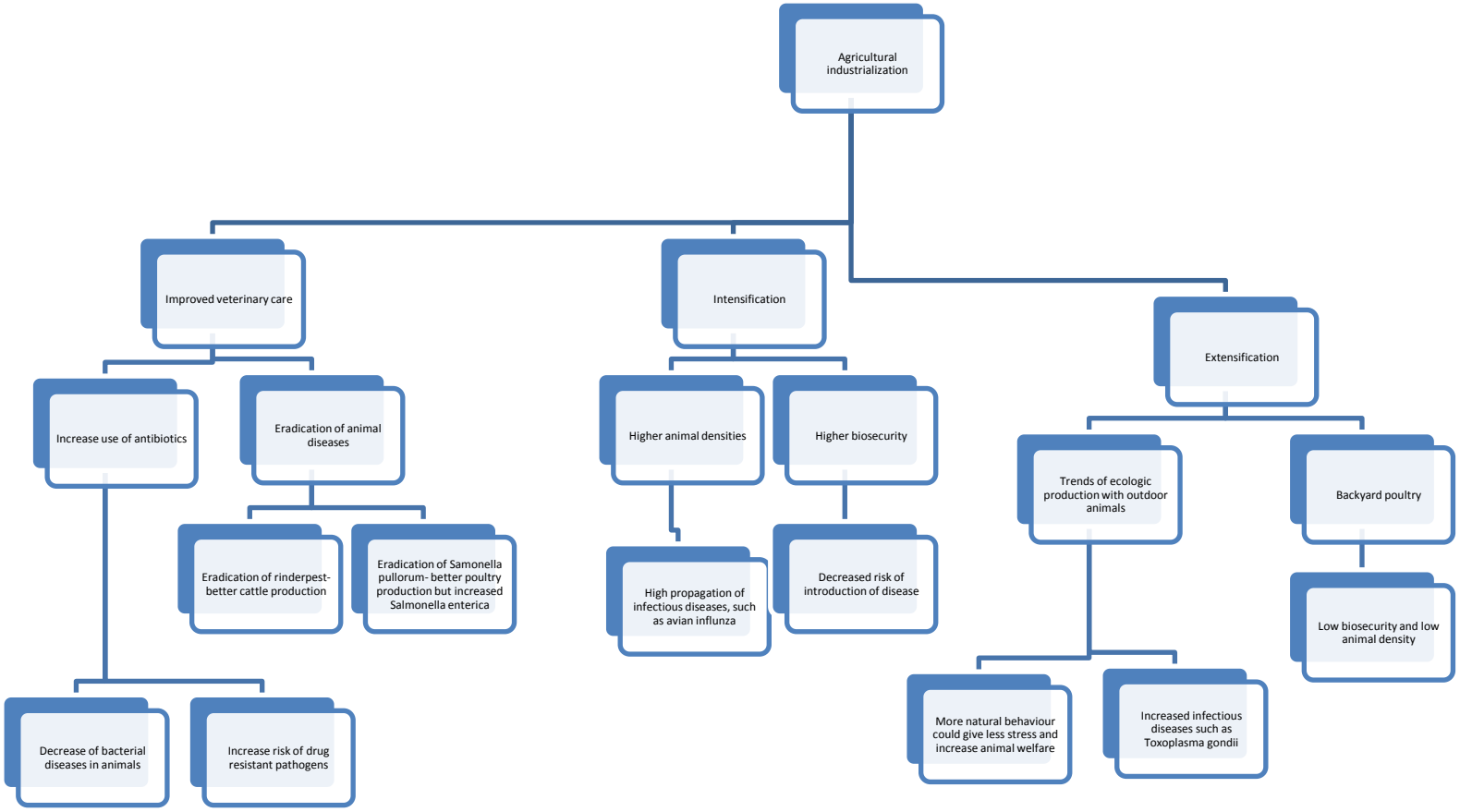


- This step requires the presence of a vector-borne pathogen and the presence of competent vectors

One action- multiple results



One action- multiple results



Dynamic drivers of disease in Africa

How does changes in land use and anthropogenic

changes affect diseases?

And how do we study it?

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Case study: Zambia/ Zimbabwe

- Trypanosomiasis/tse-tse
- Land use changes
  - Protected area
  - Area where livestock has been increasing
  - Former large-scale farms with low biodiversity

Case study: Ghana

- Henipa virus/ bats
- Urban –rural migration
- Livelihoods, poverty, ecology and the association with disease
  - How do humans interact with bats and what perceptions do they have of the risks
  - Protected/sacred area
  - Urban area

Case study: Sierra Leone

- Lassa fever/ multimammate rats
- Land use changes and rodent ecology
  - Urban-rural
  - Irrigation and precipitation
  - Human-rat interaction and risk perceptions

Case study: Kenya

- Rift valley fever/ mosquitoes
- Land use changes
  - Protected area vs irrigated area
  - Pastoralist areas

Case study: Kenya

- Rift valley fever/ mosquitoes
- Land use changes
  - Protected area vs irrigated area
  - Pastoralist areas

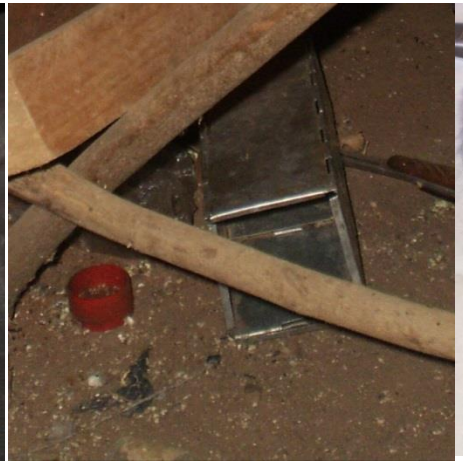
Case study: Kenya

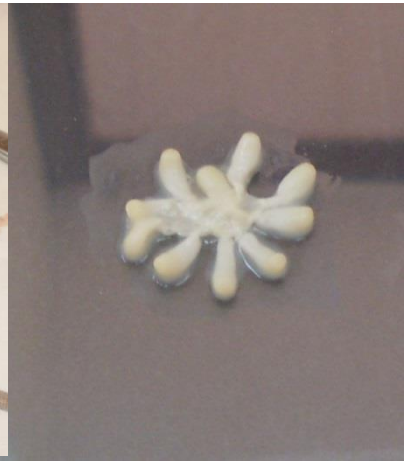
- Making changes in a highly diverse landscape
- Increased number of scavengers
- Increased numbers of mosquitoes



Case study: Kenya

- Participatory rural appraisals indicated a concern about rodents



Case study: Kenya

- What to study:
  - Can we trust hospital data?
  - Screen all febrile patients
  - Too many differentials: Malaria, RVF, Dengue, YF, Brucella, Leptospira, Chikungunya, CCHF

Case study: Kenya

- Who to study:
  - Humans and livestock
  - Mosquitoes
  - Rodents
  - Ticks?
  - Baboons?

Cross-cutting issues

- Participatory rural appraisals
- The economic burden of disease
- The association between poverty and zoonoses- the vicious circle
- Climate change and predictive modelling

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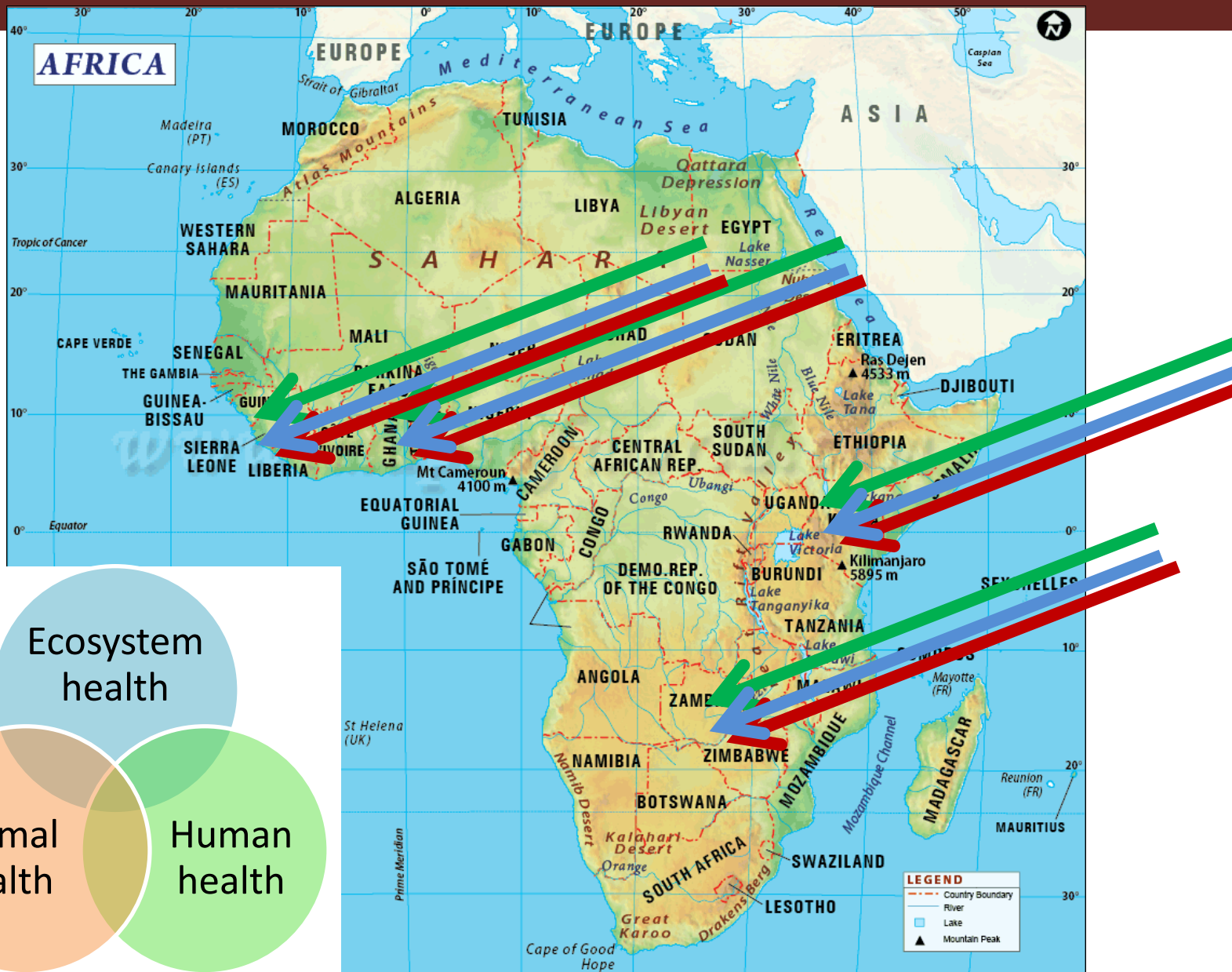
The perfect model?



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Far from perfect

Elephants or mosquitoes ?

Assets or knowledge?

Food or animal contact?

- Assessing biodiversity
- Assessing poverty
- Assessing human- animal interactions
- Assessing impact

Compared to everything else?

- Finding mitigations

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Not the end….
….but the beginning

Open to questions

Open to discussion

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Agriculture Associated Diseases

http://aghealth.wordpress.com/

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