Dynamic drivers of disease emergence in Africa

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espa ecosystem services for poverty alleviation

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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

- Socio-economic
- Costs of disease

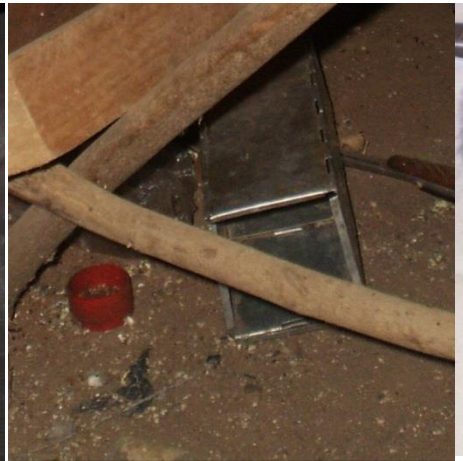
Case study: Kenya

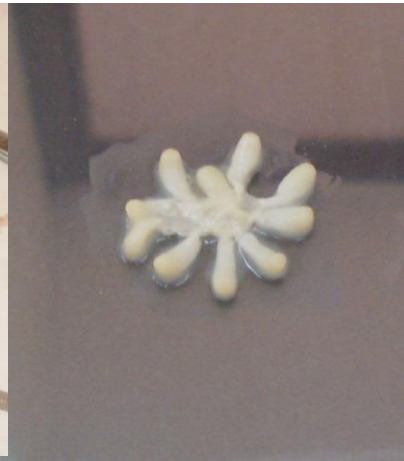
- Making changes in a highly diverse landscape
- Increased number of scavengers
- Increased numbers of mosquitoes



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?

Salome Bukachi **Institute of Anthropology, Gender and African Studies, University of Nairobi, and** **John Muriuki, Damaris Mwololo and Purity Kiunga, College of Agriculture and Veterinary Sciences, University of Nairobi**	**Ian Njeru and Joan Karanja** **Disease Surveillance and Response, Ministry of Health, and** **Salome Wanyoike** **Department of Veterinary Services, Ministry of Agriculture, Livestock and Fisheries**	**Rosemary Sang and Joel Lutomiah, Kenya Medical Research Institute**	**Mohamed Said, Enoch Ontiri, Johanna Lindahl, Shem Kifugo, Fredrick Tom Otieno, Deborah Mbotha and Bernard Bett** **International Livestock Research Institute**

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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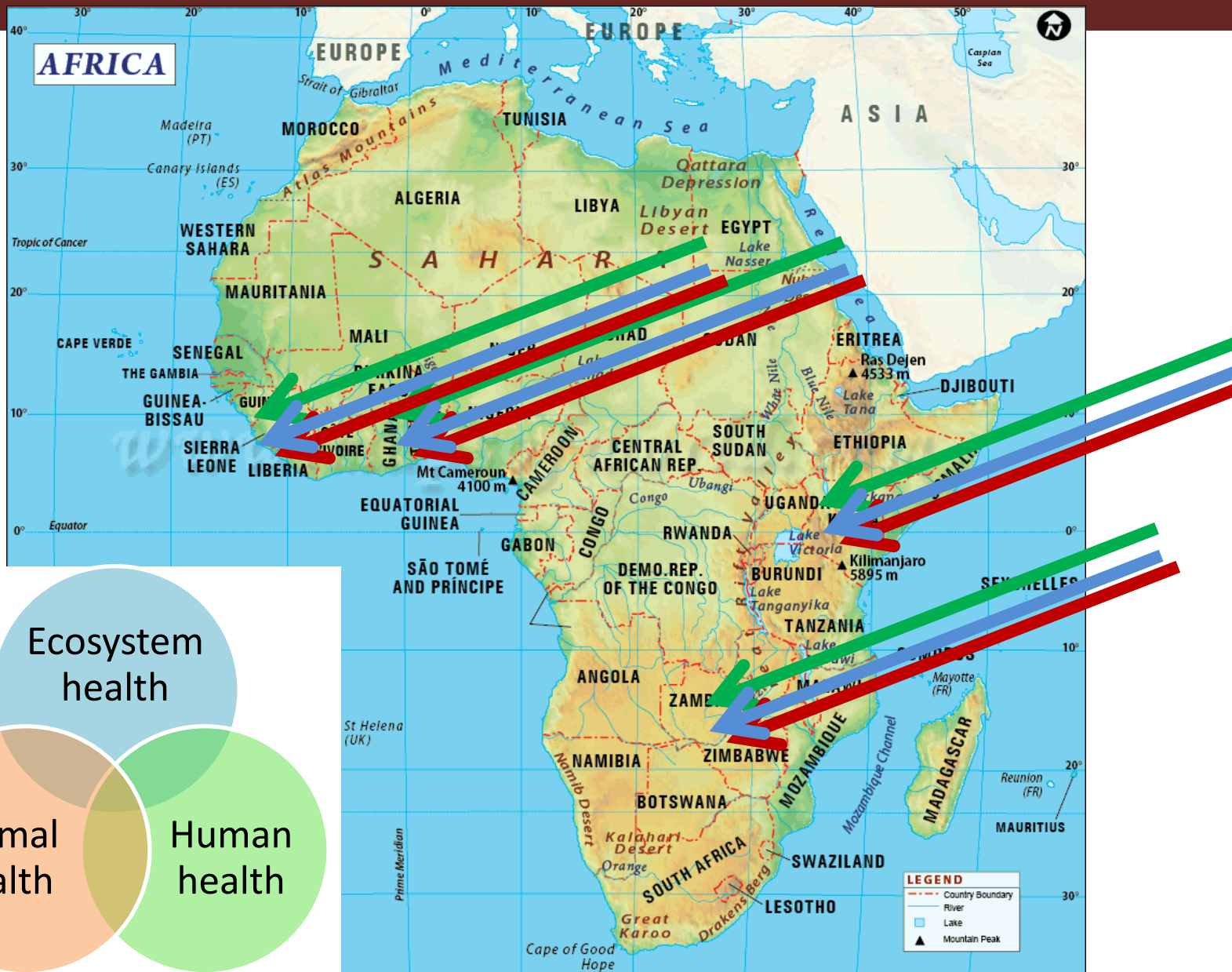
The perfect model?



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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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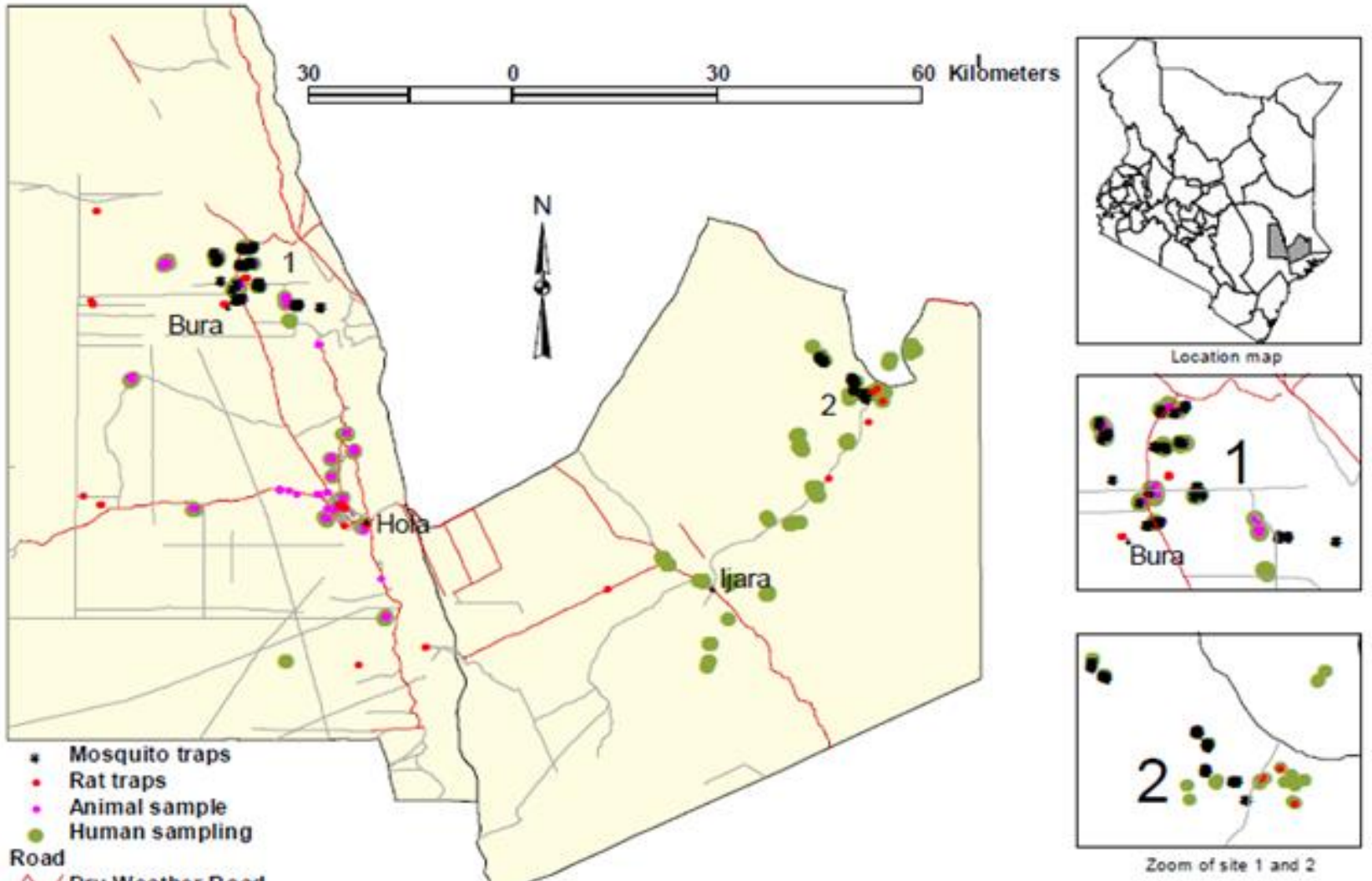
Sampling so far



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Human diseases listed

1. Malaria
2. Bilharzia, or schistosomiasis
3. Typhoid
4. Diabetes
5. Cancer
6. Chicken pox
7. HIV/AIDS
8. Tuberculosis
9. Brucellosis

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1. CBPP
2. Trypanosomiasis
3. CCPP
4. FMD
5. Helminthosis
6. Mange
7. Orf
8. RVF
9. Anthrax
10. Heart water
11. Orchitis
12. Black water
13. Lumpy skin disease
14. Rinderpest
15. Ticks

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Serological survey

- 2,848 animals (599 (21%) cattle, 1383 (49%) goats and 867 (30%) sheep) sampled in Bura and Hola.
- 1,092 human samples collected.
- Blood samples are being collected from patients who visit local hospitals in Bura, Hola, Ijara and Sangailu health centres with current or history of fever over the last 14 days

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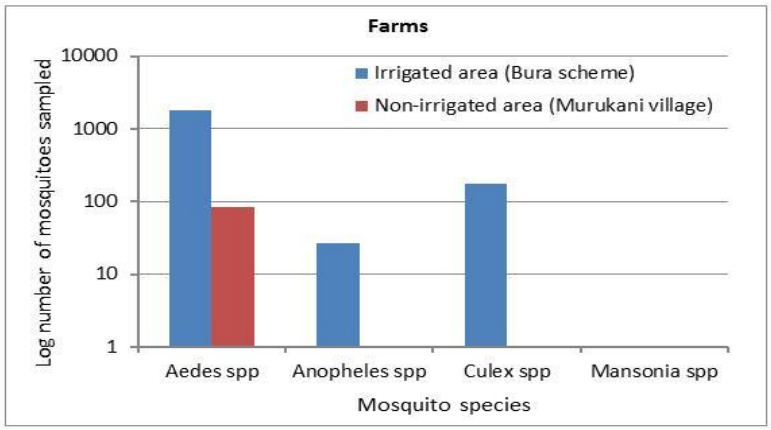
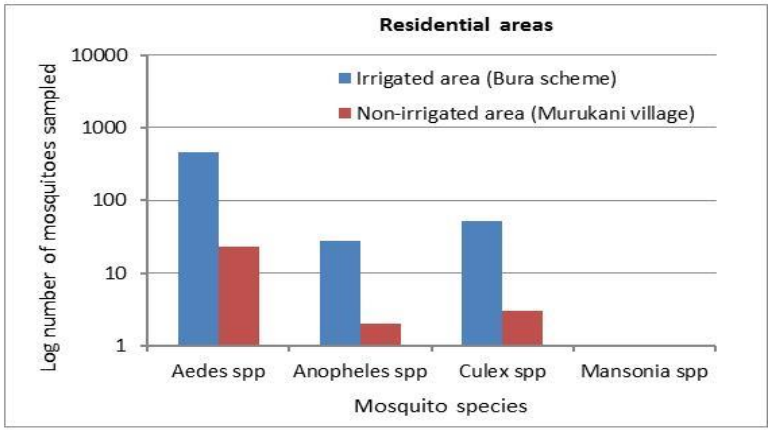
Entomological survey

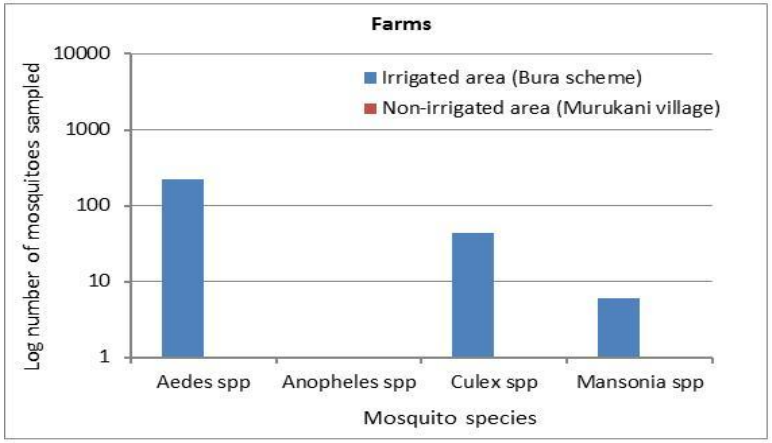
Sampling of adult mosquitoes was done using CDC light traps baited with carbon dioxide

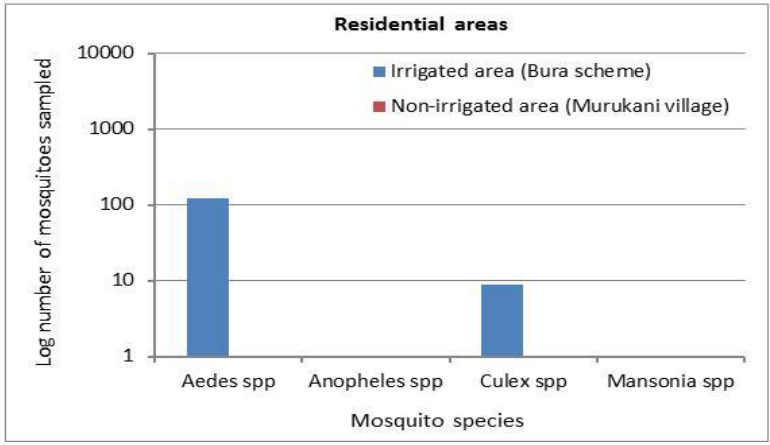
(a) Results from surveys done when irrigation was active





(b) Results from surveys done at the inactive phase of irrigation





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- Densities of the primary RVF vectors are significantly higher in irrigation fields than in the residential areas; (ii)
- Proportion of the primary RVF vectors in Murukani village, one of the non-irrigated areas, is higher during active irrigation phase compared to non-irrigation phase
- No adults or larvae were trapped or collected in Sangailu, the control site in Ijara, during the period

Mosquitoes reared from larvae

Sampling site/Village	Breeding habitat	Species	Number of mosquitoes identified
National Irrigation Board[1]	Unit drain	Aedes mcintoshi	55
National Irrigation Board[1]	Unit feeder	Aedes mcintoshi	105
Village 1	Unit feeder	Culex univittatus	5
Village 1	Unit feeder	Culex pipiens	8
Village 1	Unit feeder	Anopheles gambiae	4
Village 1	Unit feeder	Culex vansomereni	8
Village 2	Unit drain	Culex univittatus	31
Village 2	Unit drain	Uranotaenia spp.	9
Village 7	Block feeder	Culex univittatus	58
Village 7	Block feeder	Culex pipiens	1
Total			284

Table 1: Types and number of mosquitoes reared from larvae collected from various irrigation canals in Bura irrigation scheme
[1]National irrigation board demonstration fields

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Rodent collection

Rodent collection

Activities planned for the next quarter:

- Complete the screening of serum and blood samples from livestock and people
- Commence analyses of samples collected from rats (and a few from bats)
- Finalize sampling that is on-going in the health centers and commence laboratory analysis of the samples collected
- Carry out repeat entomological surveys and commence laboratory analysis of mosquito samples for blood meal sources and infection patterns
- Start a longitudinal entomological and serological survey


LAIKIPIA WEST
LAIKIPIA NORTH
LAIKIPIA EAST
Density people per km²
13
48
58
Urban centres with population of more

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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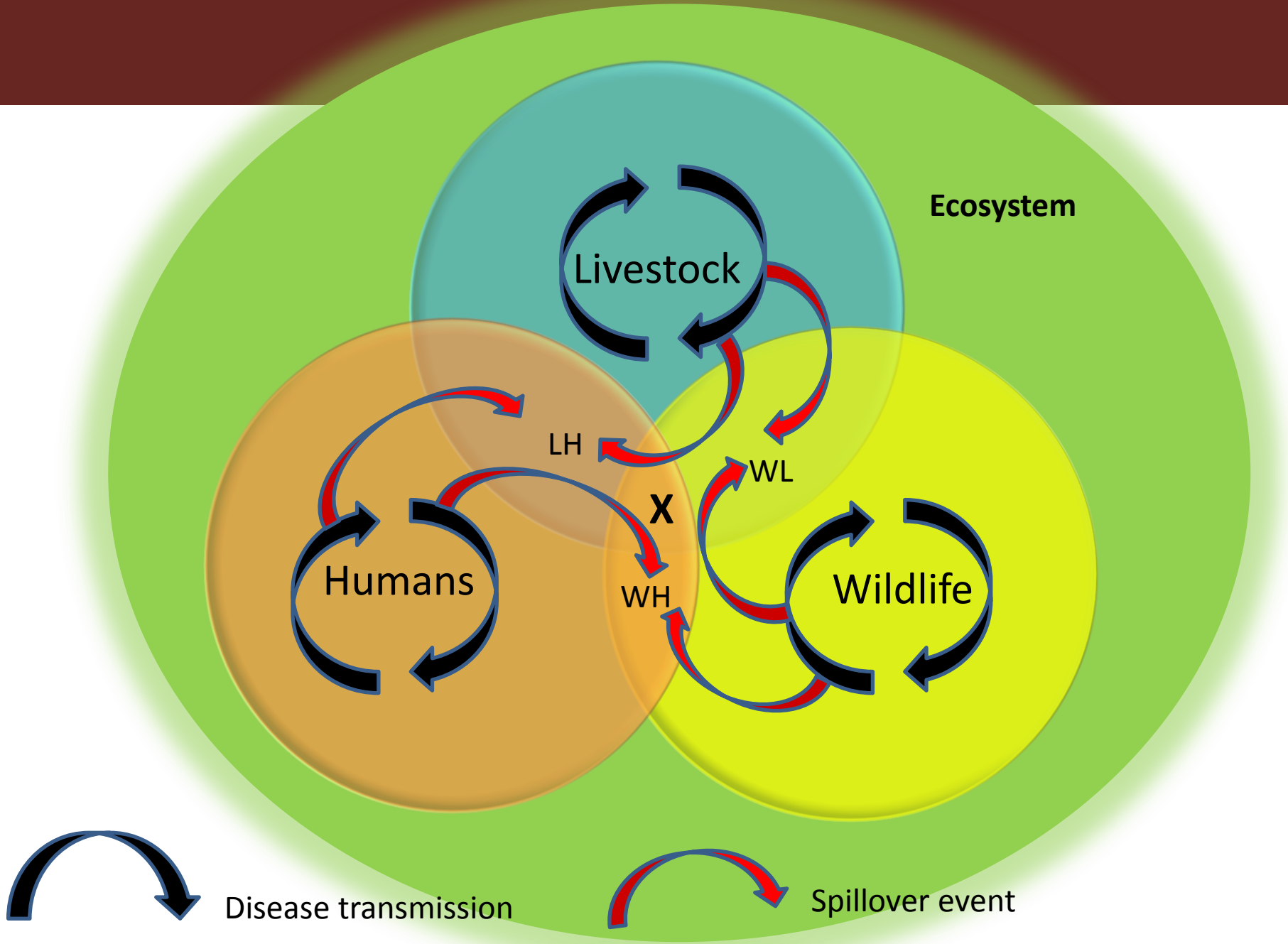
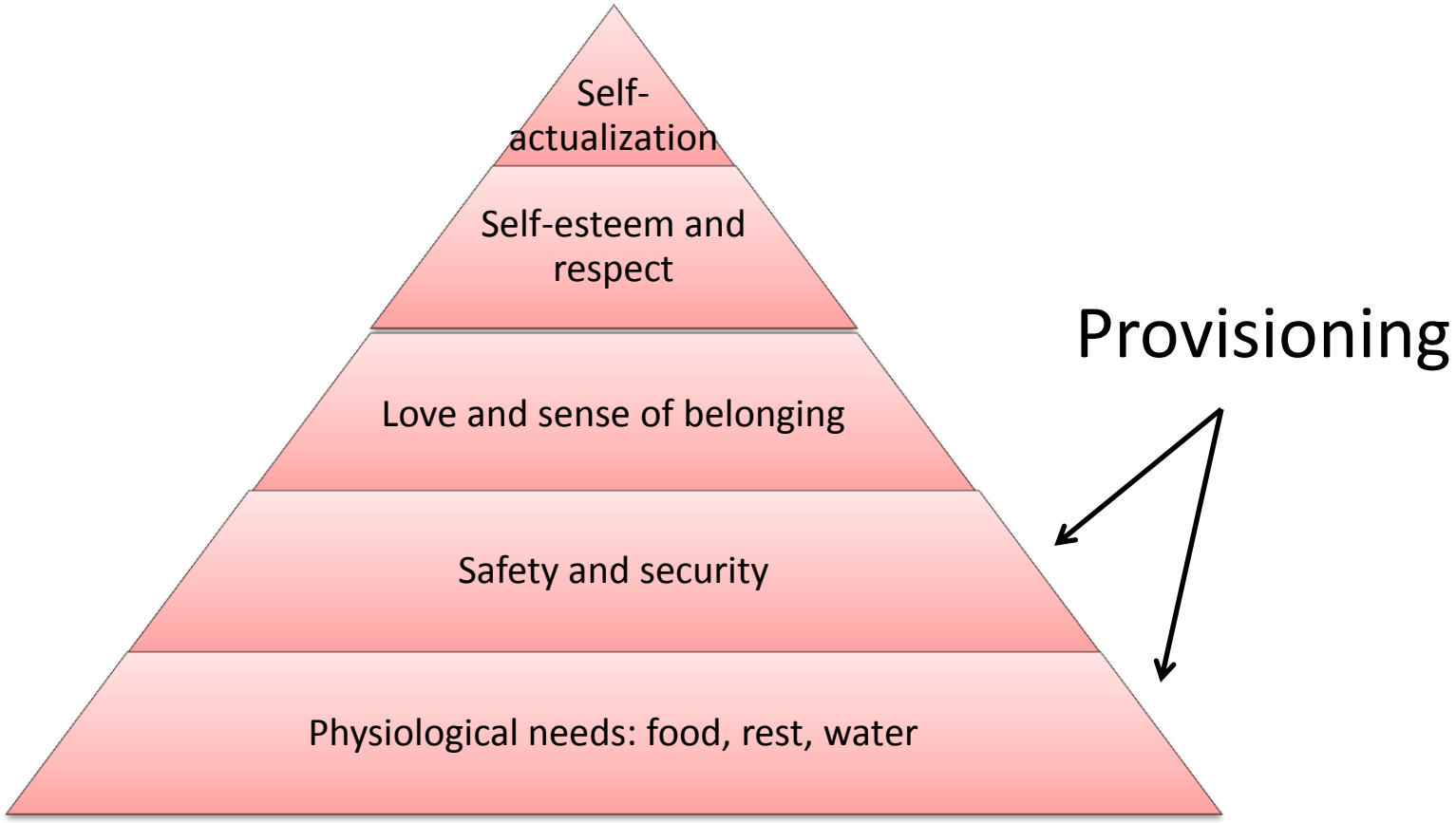

Ecosystem
Livestock
LH
WL
X
Humans
WH
Wildlife
Disease transmission
Spillover event

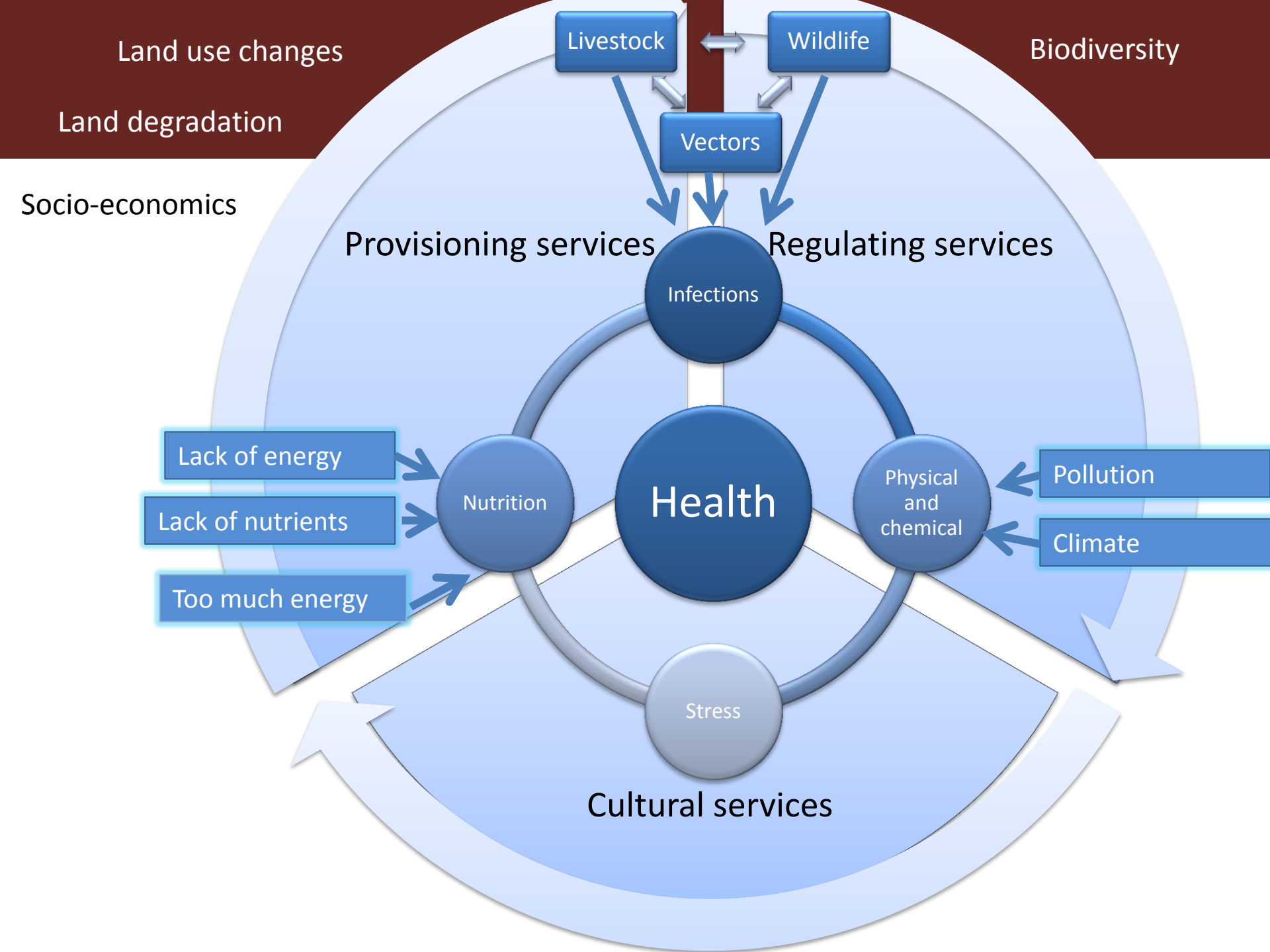
Type of wildlife-livestock-human interface	Level of Biodiversity	Characteristics of Livestock Population	Connectedness between populations	Main interface	Examples of zoonotic disease with altered dynamics
'Pristine' ecosystem with human incursion to harvest wildlife and other resources	High	No livestock	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

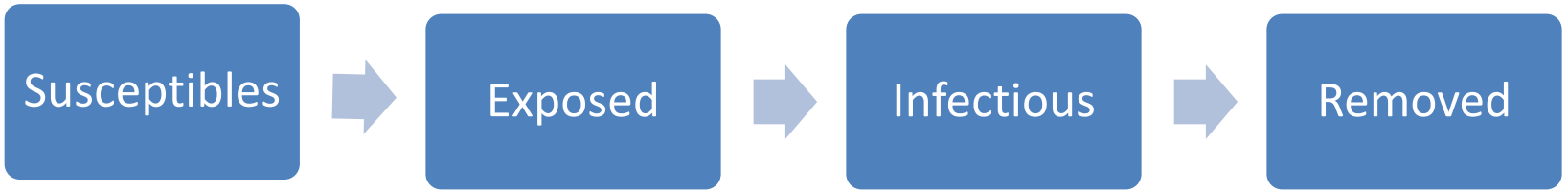


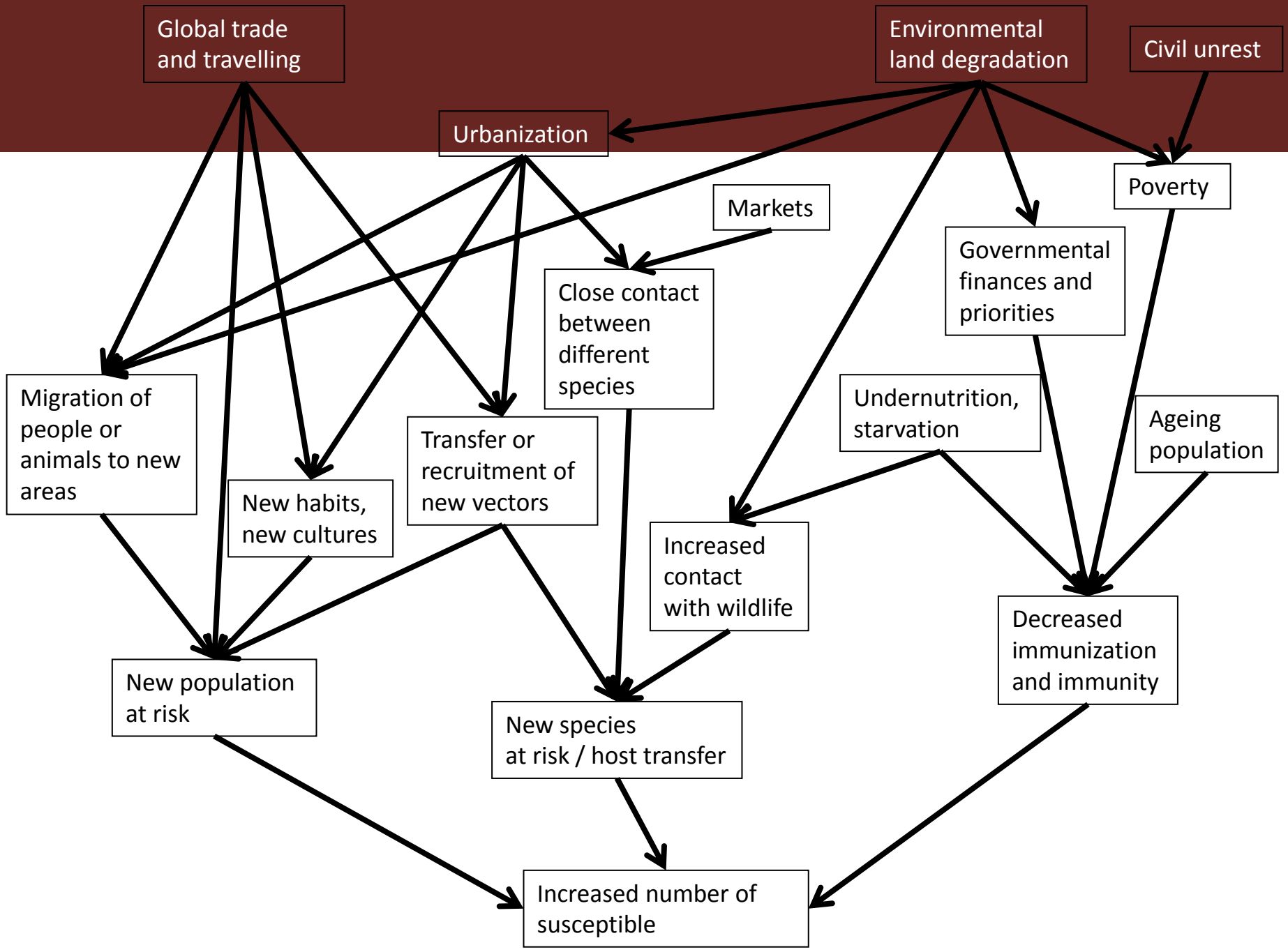
Hierarchy of needs according to Maslow.

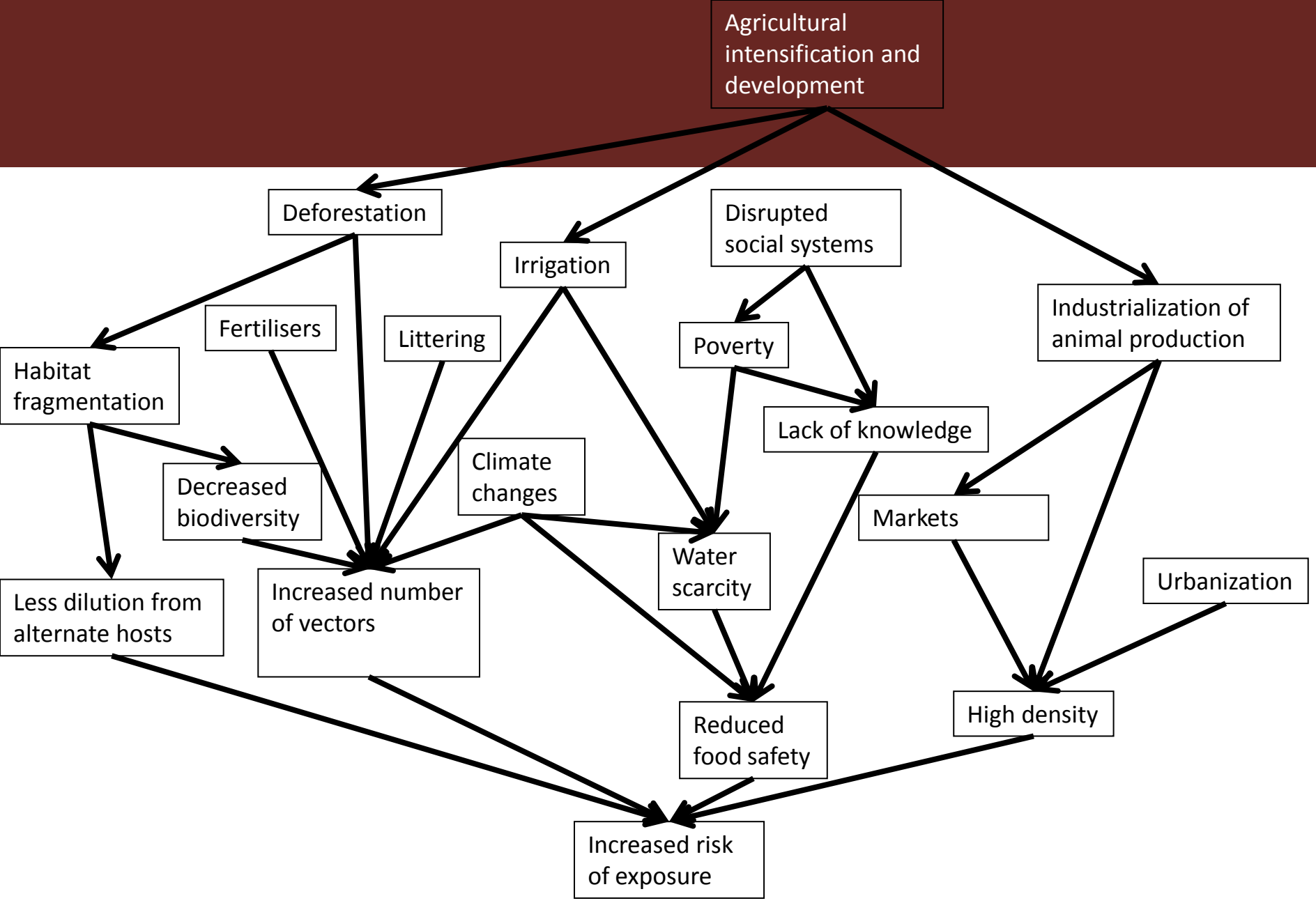

Land use changes
Land degradation
Socio-economics
Livestock
Wildlife
Biodiversity
Vectors
Provisioning services
Regulating services
Infections
Lack of energy
Lack of nutrients
Too much energy
Nutrition
Health
Physical and chemical
Pollution
Climate
Stress
Cultural services

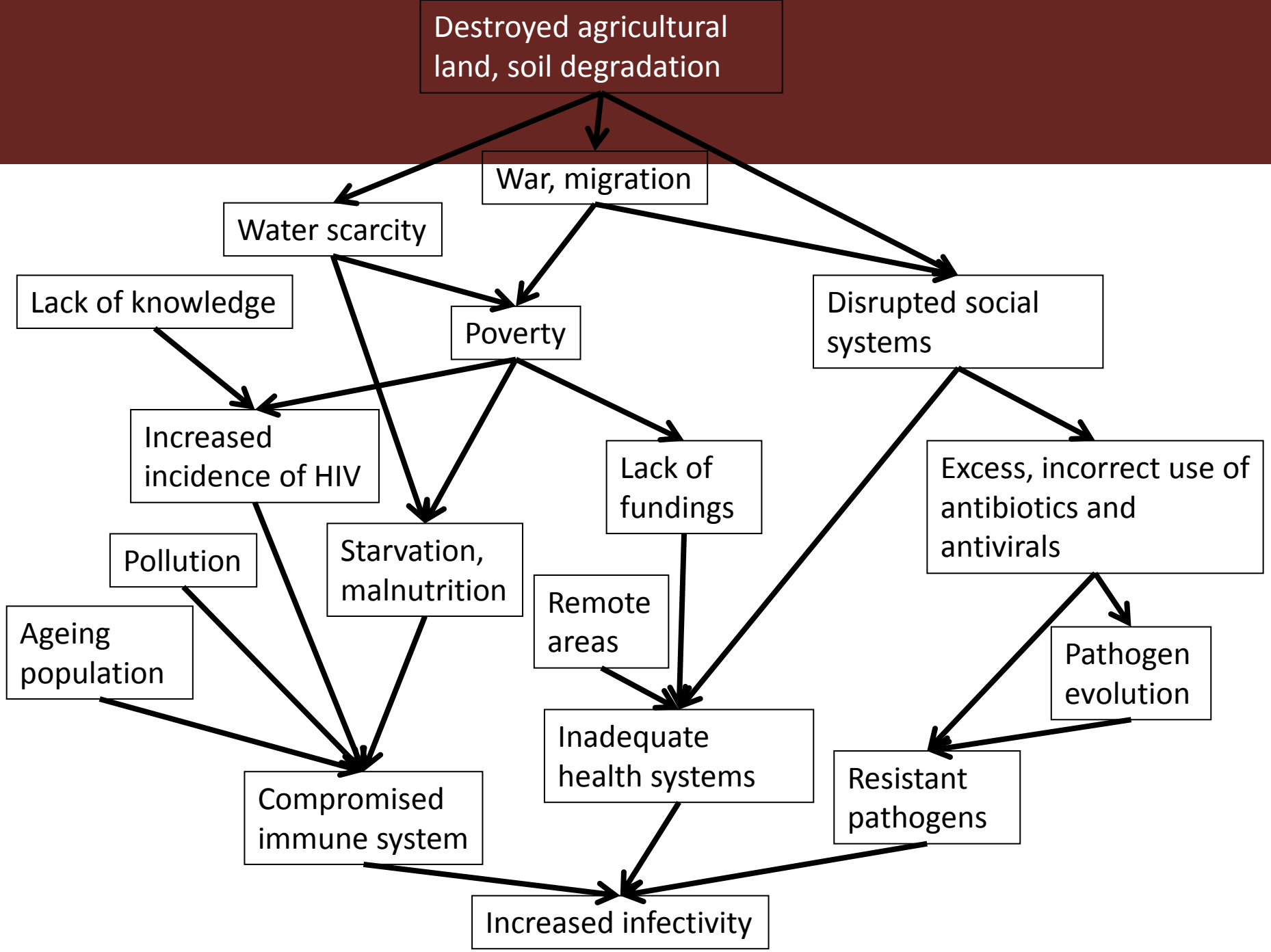
Basic epidemiological principles

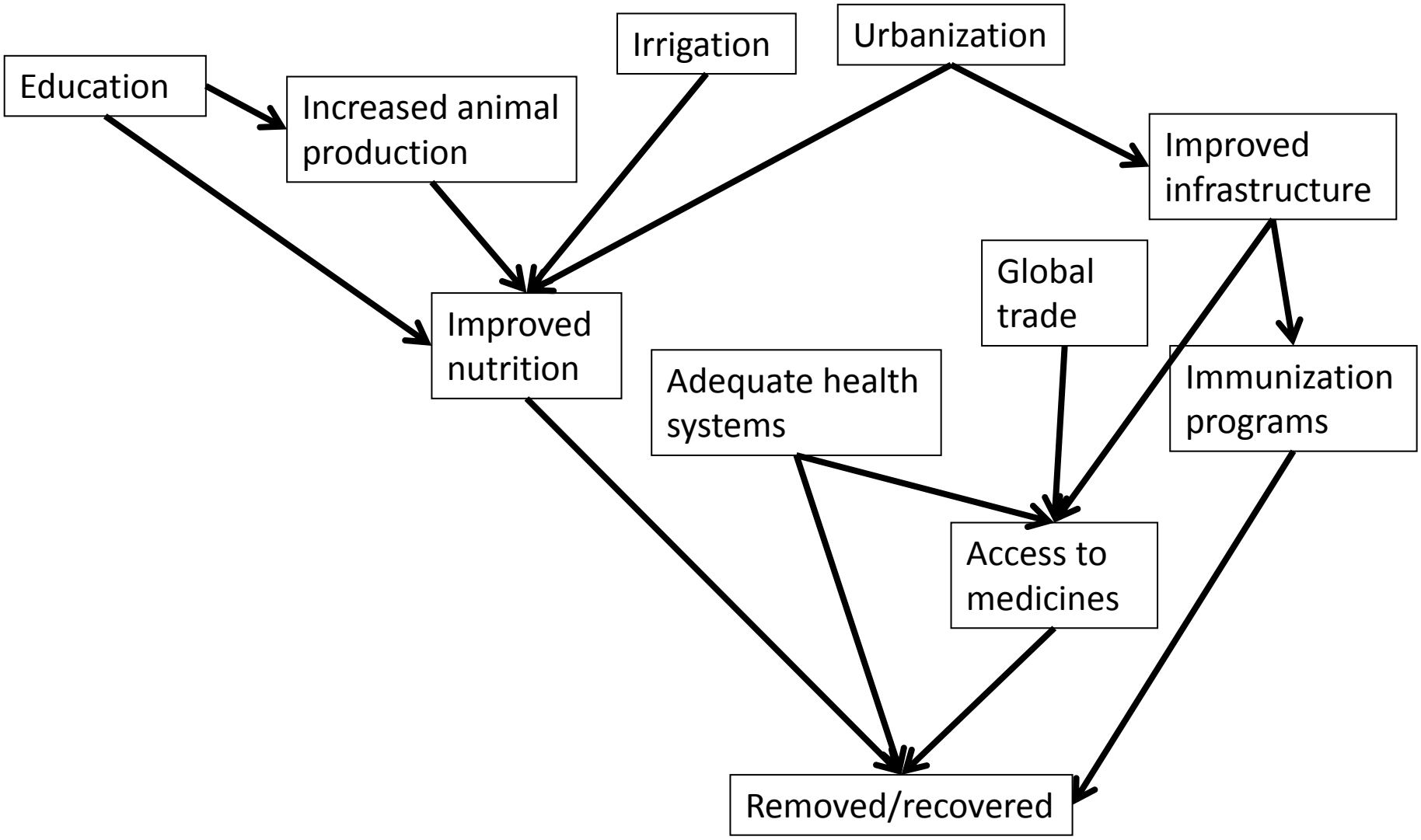
- For an outbreak to occur: $R_0 > 1$
- SIR model

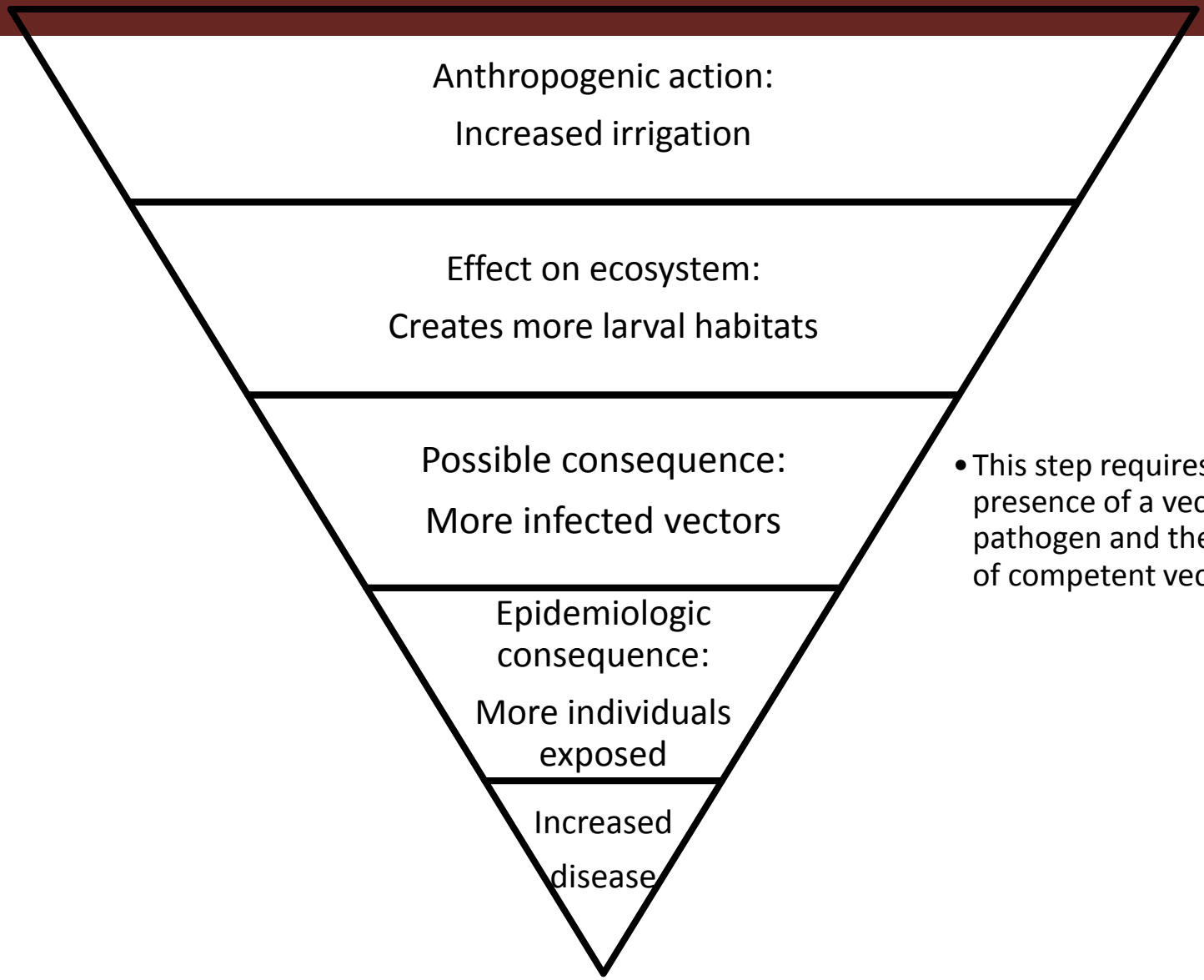



Global trade and travelling
Environmental land degradation
Civil unrest
Urbanization
Poverty
Markets
Governmental finances and priorities
Close contact between different species
Migration of people or animals to new areas
Undernutrition, starvation
Ageing population
Transfer or recruitment of new vectors
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

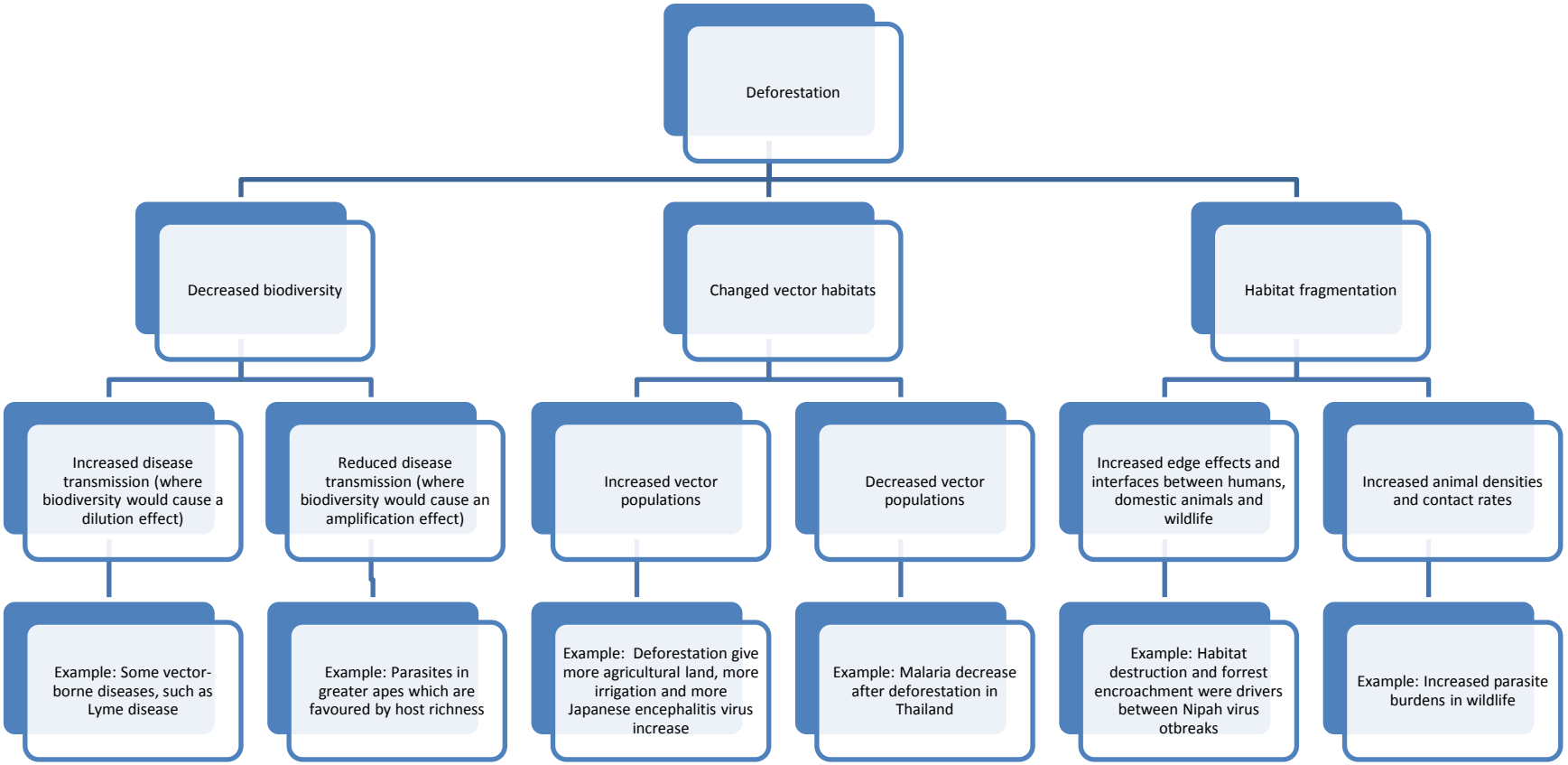

Destroyed agricultural land, soil degradation
War, migration
Water scarcity
Lack of knowledge
Poverty
Disrupted social systems
Increased incidence of HIV
Lack of fundings
Excess, incorrect use of antibiotics and antivirals
Pollution
Starvation, malnutrition
Remote areas
Ageing population
Pathogen evolution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