

Using the community of pathogens to infer inter-specific host epidemiological interactions at the wildlife/domestic interface

**A tool for exploring and anticipating emerging disease processes in their hot spots**

Caron A., Morand S., de Garine-Wichatitsky M.

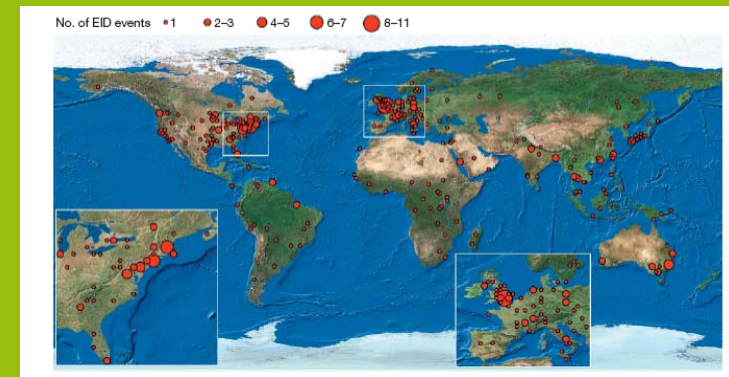


10th AHEAD meeting, 23<sup>rd</sup>-26<sup>th</sup> of February 2010, Hazyview, South Africa



## Global trends in EID

Global richness map of the geographic origins of EID events from 1940 to 2004



(Jones et al., 2008)

## At the wildlife/domestic Interface

- 70% of emerging diseases with a link with wildlife
- Sanitary issue where wildlife & domestic systems are in interaction
- Protected areas often in remote places in contact with poor-livelihood domestic systems with little sanitary surveillance & control
- Spill-over processes between host populations or species

→ Hot spots of Emergence in tropical and sub-tropical ecosystems

## Describe and anticipate the emergence at this interface

- Needs expertise from:
  - Epidemiology (classical, risk analysis, molecular epidemiology, etc.)
  - Ecology (evolutionary biology, community ecology, landscape ecology, etc.)
  - Social sciences
- Already multidisciplinary work exists



**Infectious Disease Ecology:**  
Effects of Ecosystems on Disease and of Disease on Ecosystems  
Ostfeld R.S. et al. (2008)



**Evolution of Infectious Disease**  
Ewald, P.W. (1994)



**Conservation Medicine:**  
Integrating Ecology, Medicine, and Conservation  
Aguirre A.A. et al. (2002)



**Wildlife and Emerging Zoonotic Diseases**  
Childs J.E. et al. (2007)



**Disease Ecology:**  
Community structure and pathogen dynamics  
Collinge S.K. (2006)

## Host & Pathogen framework

- **Host approach: *A priori***

- Movements of hosts
- Contacts of hosts

⇒ Determine the potential for pathogen transmission

- **Pathogen approach: *A posteriori***

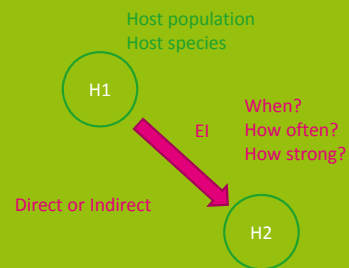
- Observed pathogens in hosts
- Shared pathogens

⇒ Pathways used by pathogens between host populations

## Epidemiological Interactions

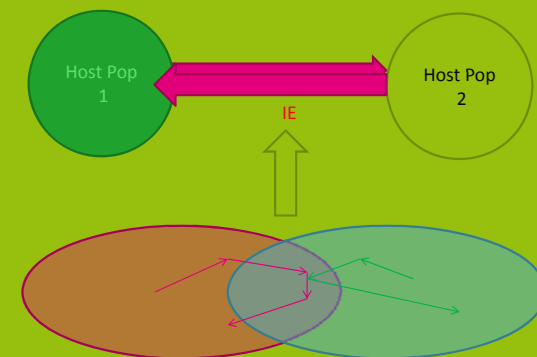
- EI = Any ecological interaction between 2 hosts which results in the transmission of one or more pathogens

- Defined by:
  - Intensity
  - Direction
  - Frequency



Host Approach

## Principle



Host Approach

## 1. Els in avian systems

Complex system of wild and domestic avian populations

- What are the epidemiological interaction between compartments?
- How can they be characterised?

Caron, A., Gaidet N., de Garine-Wichatitsky, M., Morand, S., Cameron, E. Evolutionary Biology, Community Ecology and Avian Influenza Research. Infections, Genetics & Evolution, 9: 298-303.

Host Approach

## 1. Els in avian systems

Counting of bird communities every 2 months for 2 years in wild and domestic compartments

- Targeted protocol on specific species in order to validate the bridge species assumptions

Ostrich Farm	Novemb er Peak	Mars Peak	Representative Species
Hirundidae	38,30%	0,00%	Barn swallow (99%)
Estrilidae	15,90%	9,30%	Bronze mannikin (60%)
Ploceidae	11,20%	57,50%	Red-billed quelea (80%)
Columbidae	0,00%	5,80%	Cape Turtle Dove (76%)
<b>Total</b>	<b>65,40%</b>	<b>72,60%</b>	

Caron, A., de Garine-Wichatitsky, M., Gaidet, N., Chiweshe, N., Cumming, G. S. Estimating dynamic risk factors for pathogen transmission using community-level bird census data. *Submitted to Ecology & Society*

Host Approach

## 2. Els in ungulate systems

Complex system of wild and domestic ungulate populations

- GPS Collaring at the wildlife domestic interface
- Precise quantification of Els at the individual level

Pathogen Approach

## Principle

## Pathogen Approach

## Type of epidemiological data

- Antibody detection → past and presence
- Pathogen detection → presence
- Incidence data
- Molecular data → gene and/or strain type

## Pathogen Approach

## Community of pathogens

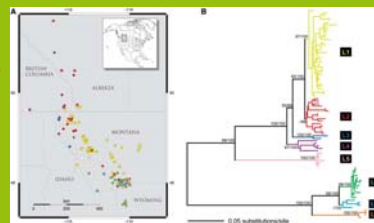
- The more pathogens screened for the stronger the prediction of EI
- High variability in pathogen transmission mode – direct, indirect, vector-borne
- Sanitary Identity Card – SIC
- Presence-absence
- Need to control for phylogeny

→ Information on *Intensity* of EIs

## Pathogen Approach

## Using molecular tools

- Poss, 2002 in Cons Med
  - "suggest that retroviral genomes can be used as proxy genetic markers of hosts and provide (...) information about historical host movement and dynamics as do host genes »
- *A Virus Reveals Population Structure and Recent Demographic History of Its Carnivore Host*, Biek et al., Science, 2006

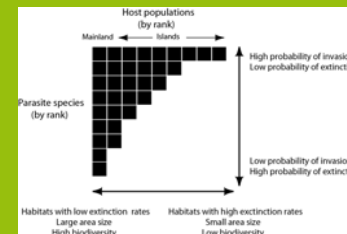


→ Information on  
- *Intensity*  
- *Direction* of EIs

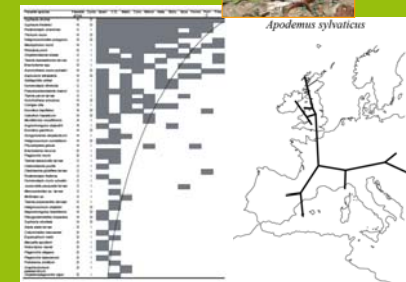
## Pathogen Approach

## Quantifying EIs

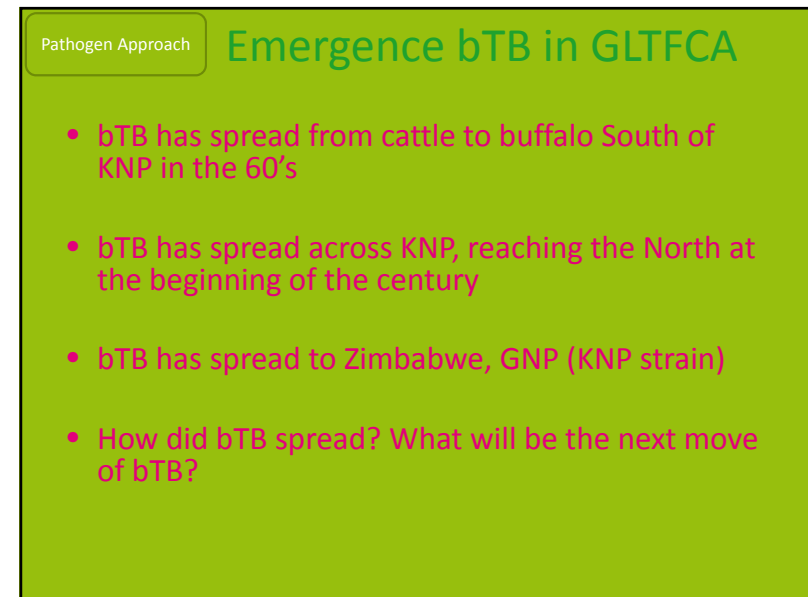
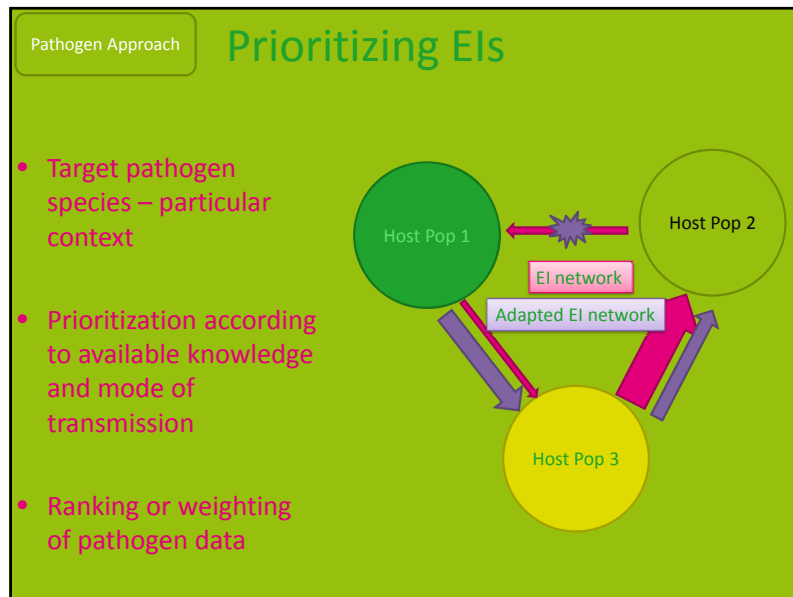
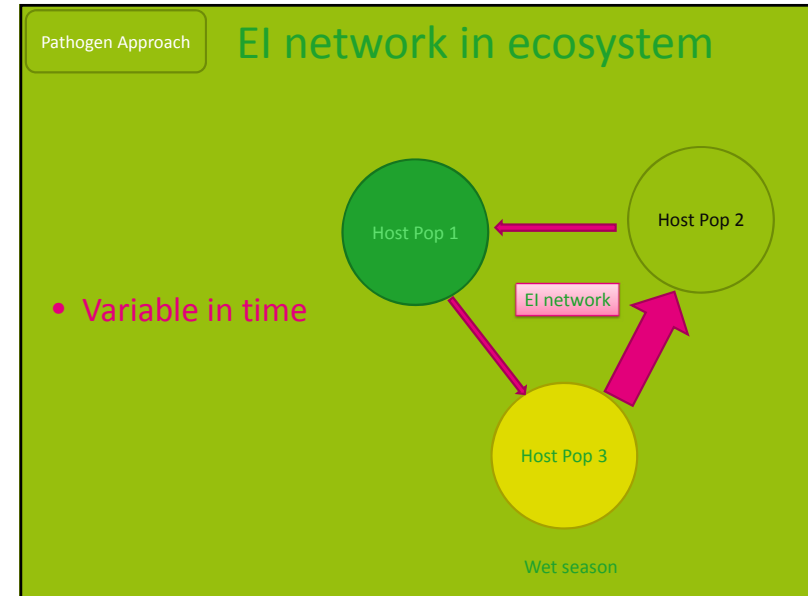
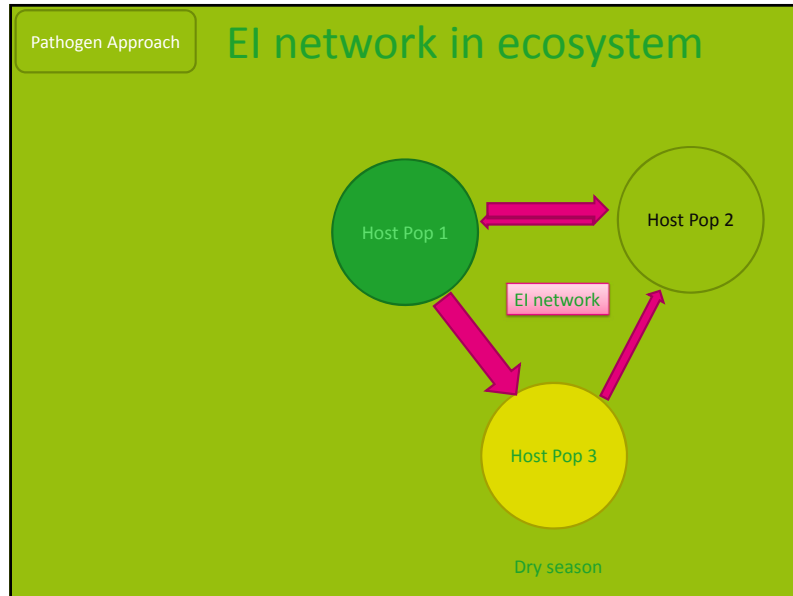
- Presence/absence – Prevalence – Molecular data
- Nested pattern analysis

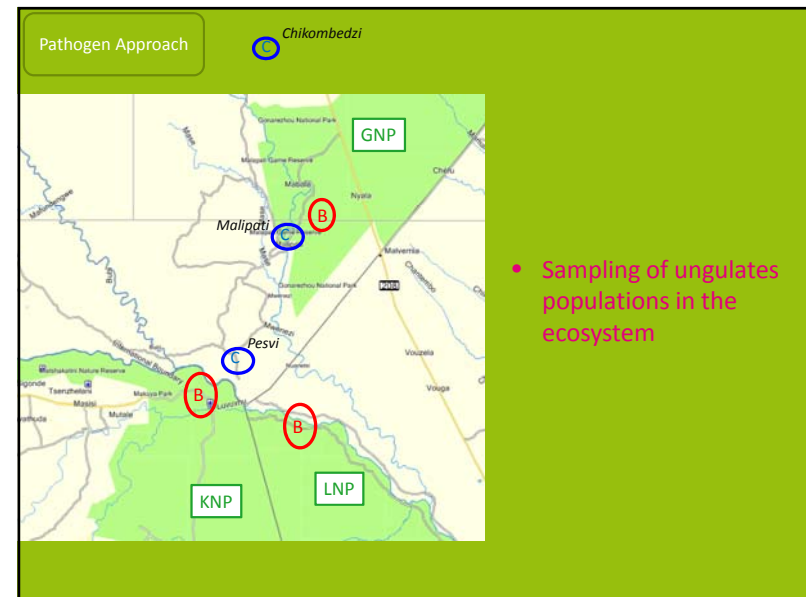
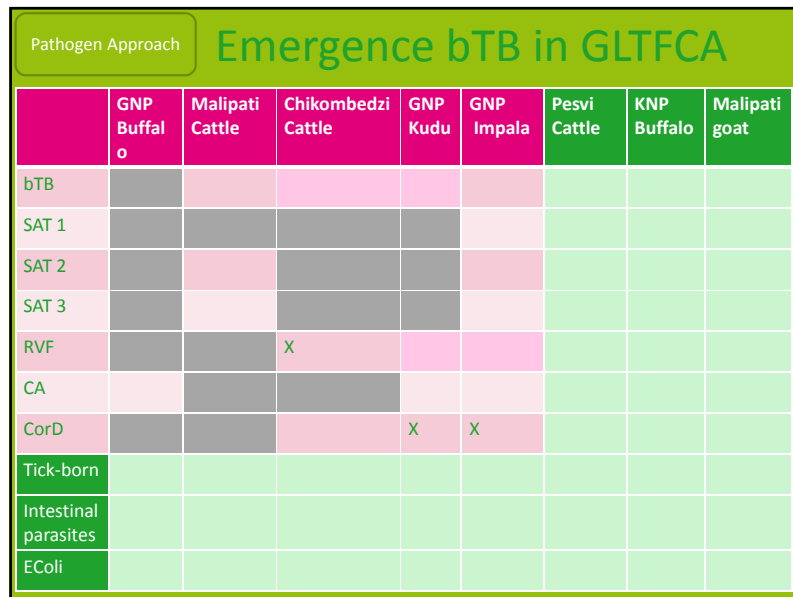
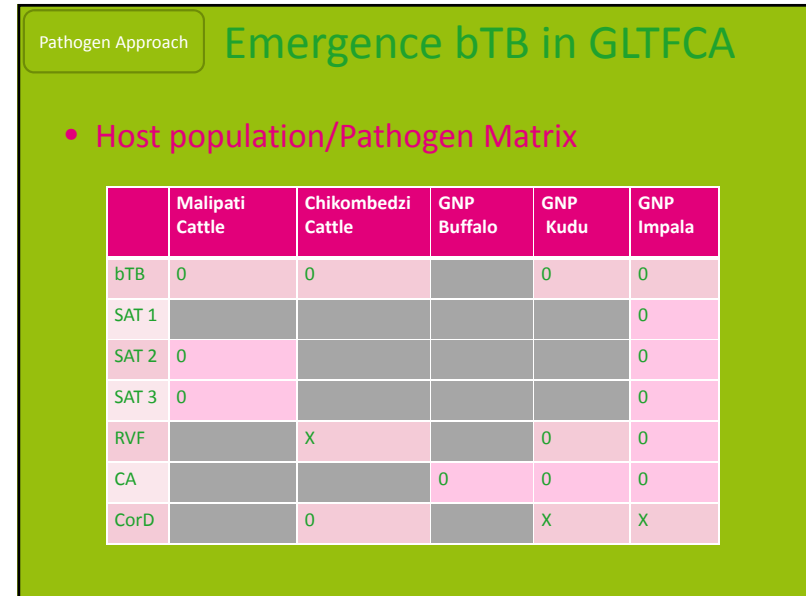
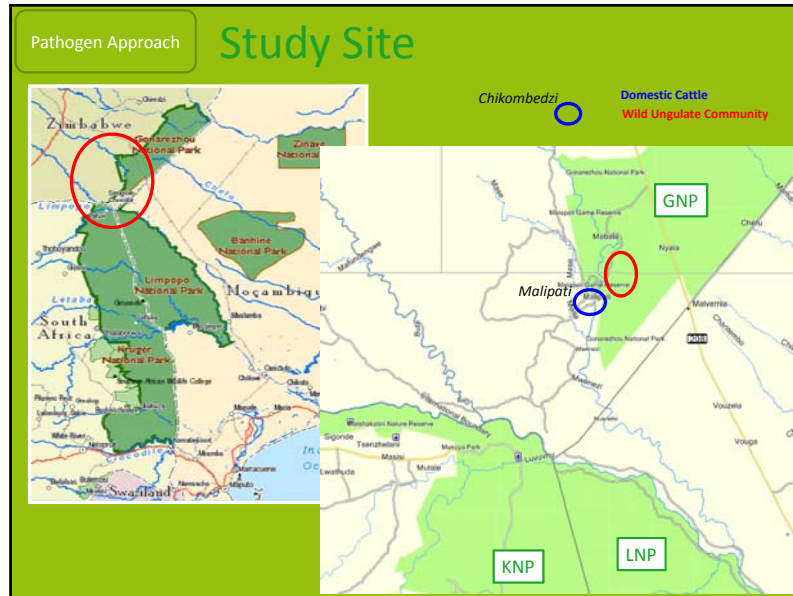


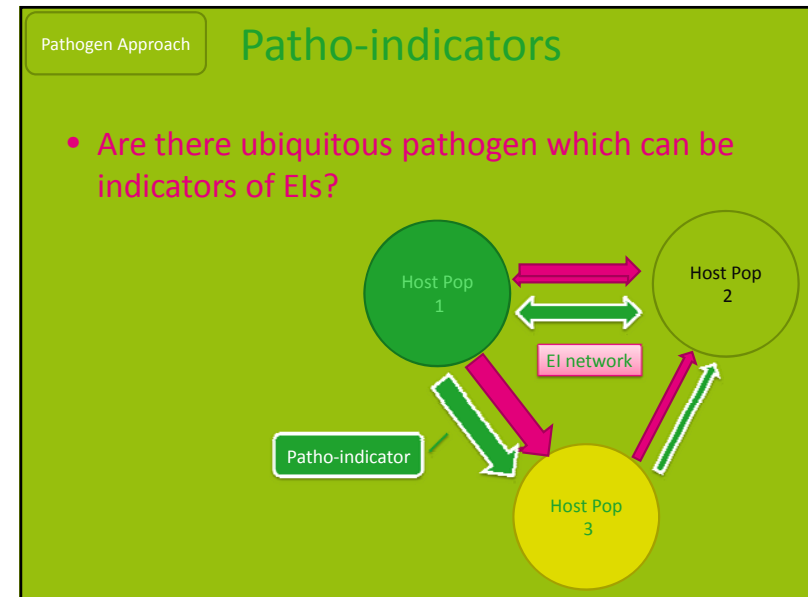
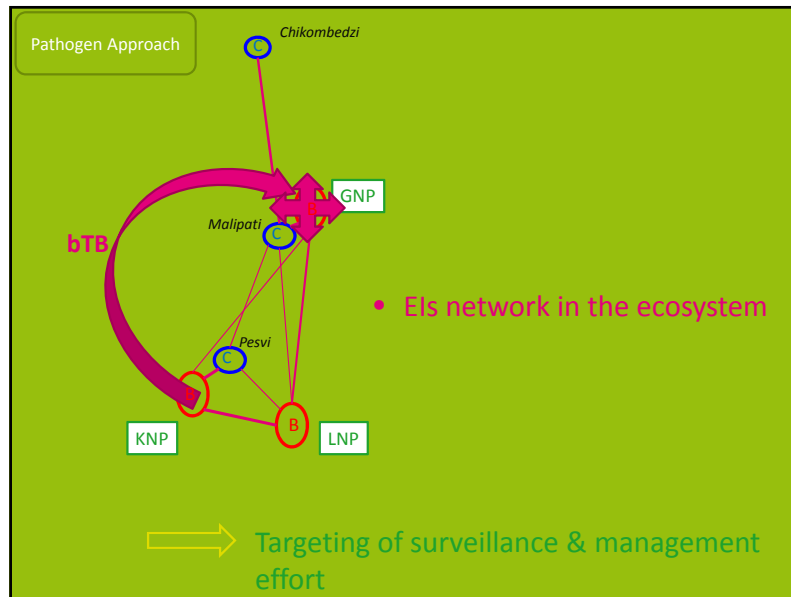
*Apodemus sylvaticus*



Gouy de Bellocq, 2003







Pathogen Approach

## Patho-indicators: E. Coli

- Community of E. Coli strains
- In between Gorillas, Human, Livestock
- The closer the gorillas pops live to the human pops the larger the E. Coli community they share
- Farmers shared more E. Coli strains with their cattle than with their neighbours

Figure 2. Dendrogram of genetic relatedness among 23 major clades of *Escherichia coli* from humans, domestic animals, and primates in 4 locations in and near Kibale National Park, western Uganda, derived from Rep-PCR genotypes. Major clades were identified from the full tree of 791 isolates by using the "cluster cutoff method" available in the computer program BioNumerics.

Goldberg et al. 2008, Rwego et al., 2008

Pathogen Approach

## Conclusion

- Adapted to EIDs processes in their hotspots: use available data; resource-limited situation
- Can be used in combination with Host approach
- « Epidemiological Interaction » concept can provide a tool for working on epidemiological processes using a multipathogen approach.
- Requires multidisciplinary work because of the complexity of the processes and systems at stake
- Need to develop the quantification of the concept
- Applied approach → to better focus surveillance and management



## Acknowledgement

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- EU – PARSEL project
- FMD CORUS project

