

# ***Does « One Health » fit the biodiversity research agenda?***

Serge Morand



MAHIDOL UNIVERSITY *Wisdom of the Land*  
Faculty of Tropical Medicine



Biodiversity as seen by ecologists ...

# HOW OUR HEALTH DEPENDS ON BIODIVERSITY

Eric Chivian M.D. and Aaron Bernstein M.D., M.P.H.

 CENTER for HEALTH and the  
GLOBAL ENVIRONMENT  
HARVARD MEDICAL SCHOOL

When bees go extinct...



Humans have to pollinate by hand (south of China)



... and as seen by epidemiologists

# A walk on the wild side—emerging wildlife diseases

*They increasingly threaten human and animal health*



*Pteropus alecto*—the black flying fox—known to



The New York Times

**SundayReview** | The Opinion Pages

WORLD U.S. N.Y./REGION BUSINESS TECHNOLOGY SCIENCE HEALTH SPORTS OPINION

AUTOS

NEWS ANALYSIS

## The Ecology of Disease



Claf Hagek

By JIM ROBBING

Published: July 14, 2012

114 Comments

# A quick journey in the wild side

- Why biodiversity and infectious diseases are linked?
- Threats of biodiversity and infectious diseases
- Investigating some patterns in Southeast Asia: dilution effect, habitat use changes
- Conclusions: “One Health” and biodiversity  
=> Towards “Evolutionary and Anthropological Ecology of Diseases”

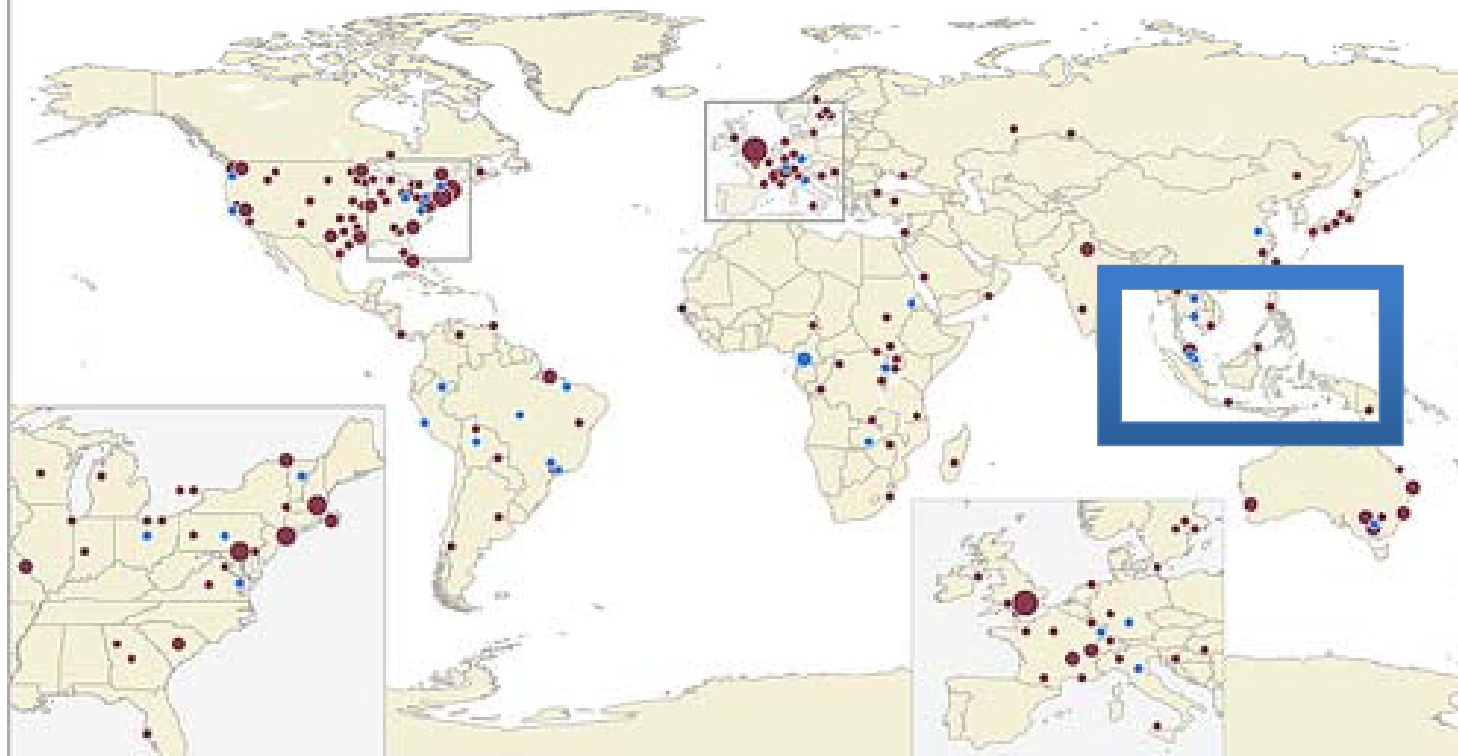
**Biodiversity,  
and the diversity of infectious diseases**

# 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.

- 1 EVENT
- 2-3 EVENTS
- 4-5 EVENTS
- 6 EVENTS
- EVENTS IDENTIFIED IN 2012 (recent emergence)

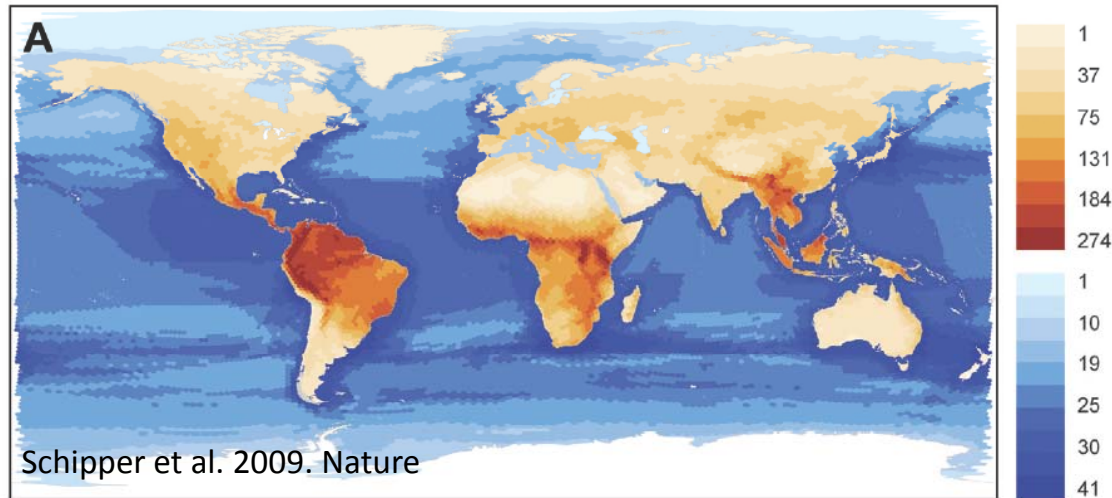


Map by IOZ, published in an ILRI report to DFID: *Mapping of Poverty and Likely Zoonoses Hotspots*, 2012.

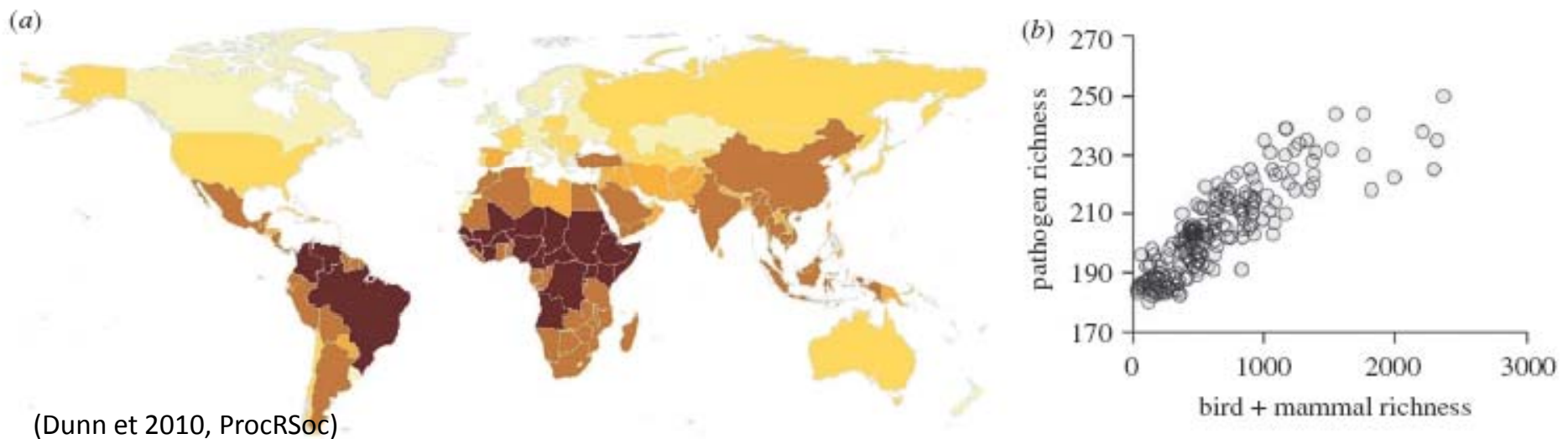


# The diversity of human infectious diseases is linked to the diversity of mammals and birds

## *Mammal species richness*

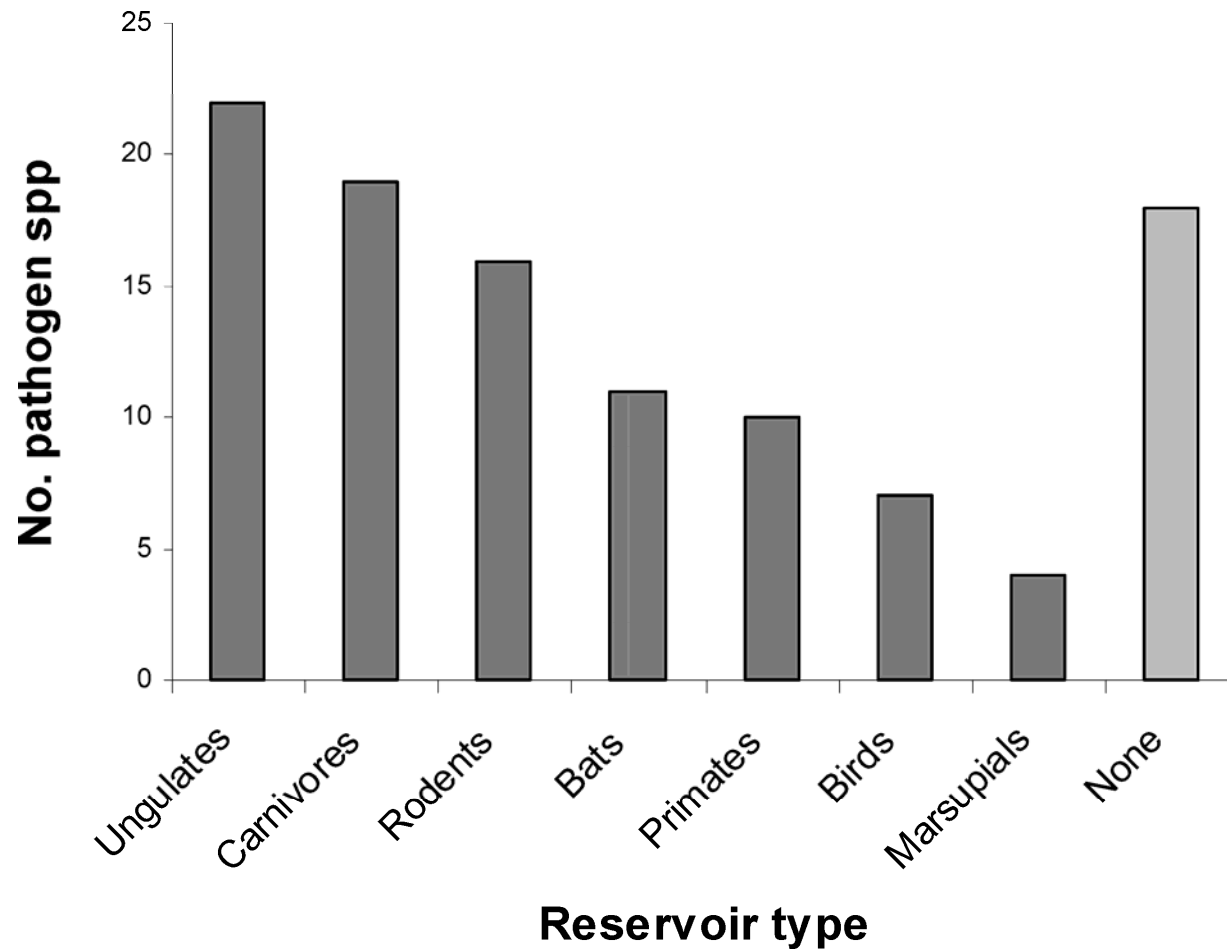


## *Pathogen richness*



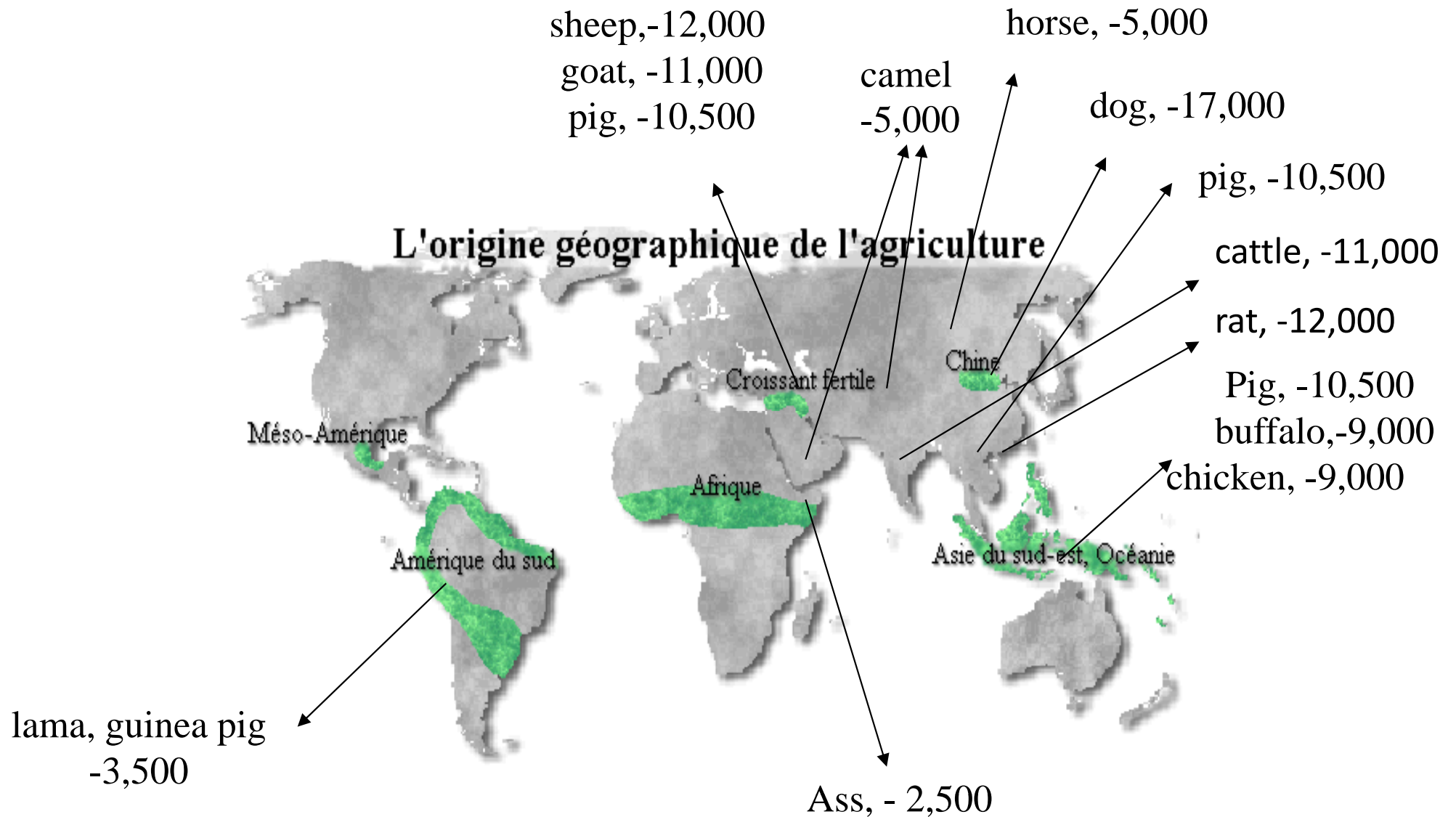
# Ecological Origins of Novel Human Pathogens

Mark Woolhouse and Eleanor Gaunt

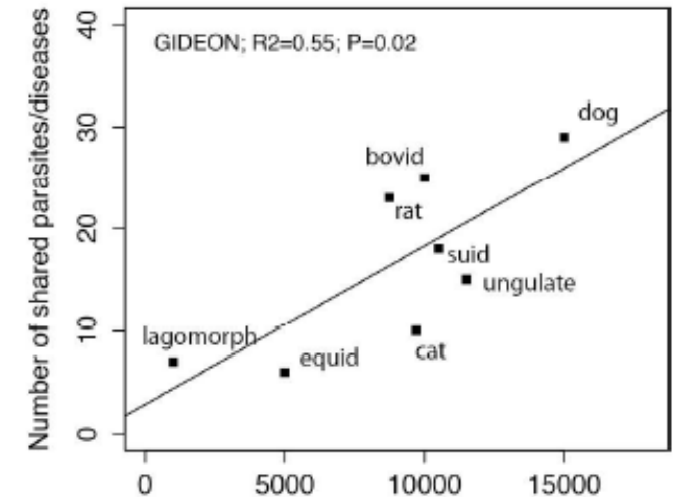
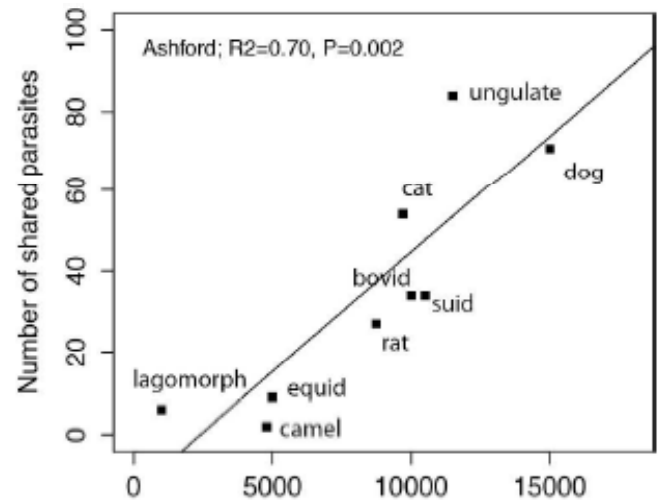
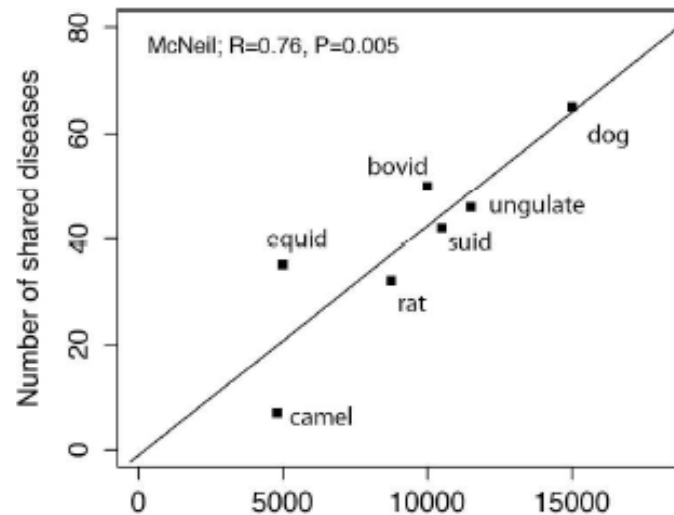


Domestication,  
and the diversity of infectious diseases

# Centres (and time) of animal domestication



# Shared infectious diseases/parasites between domesticated animals and humans: domestication time matters



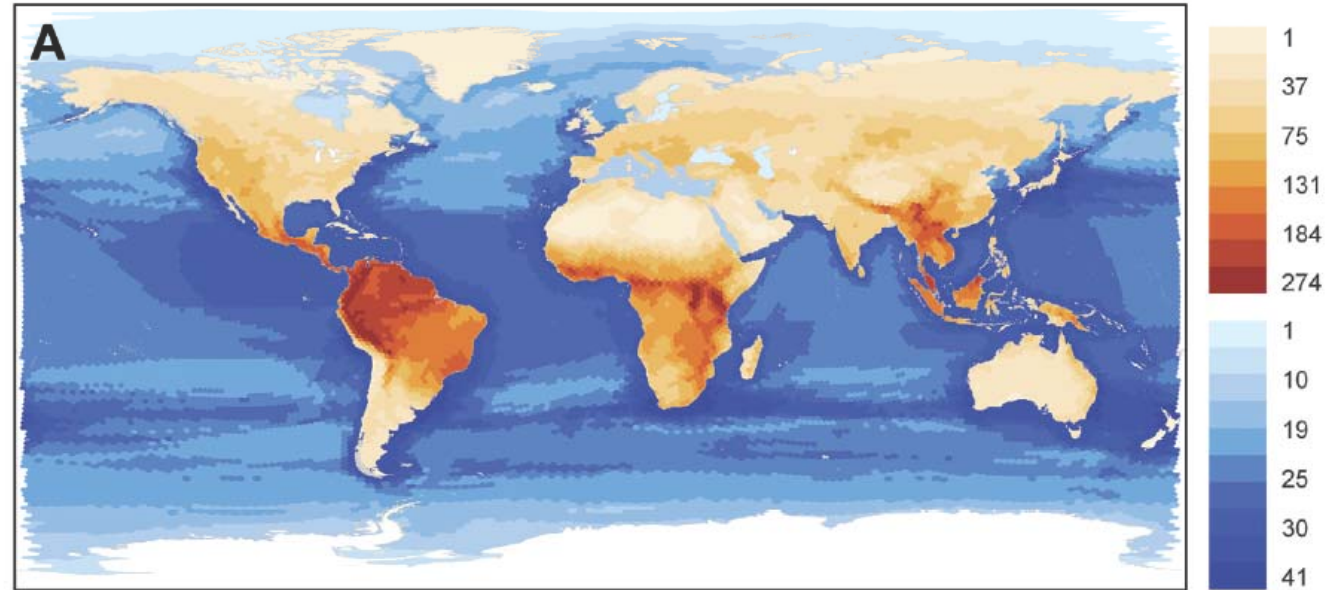
Years since domestication

=> It takes times for an infectious disease to establish

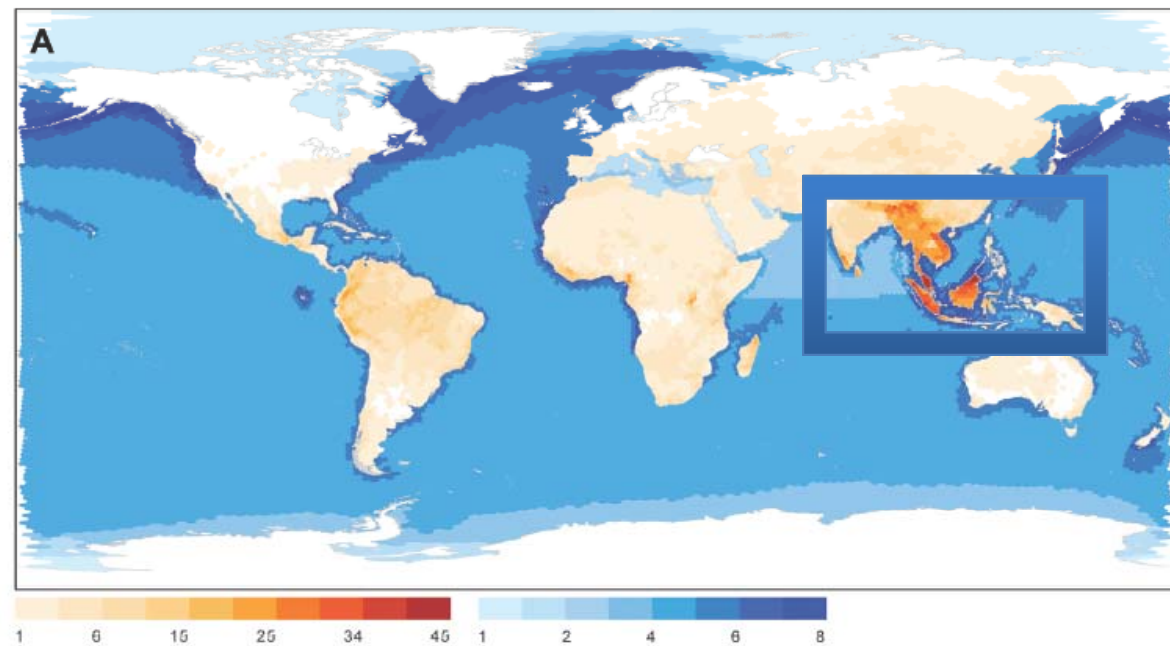
# Threats of biodiversity and infectious diseases

# The Status of the World's Land and Marine Mammals: Diversity, Threat, and Knowledge

Species richness

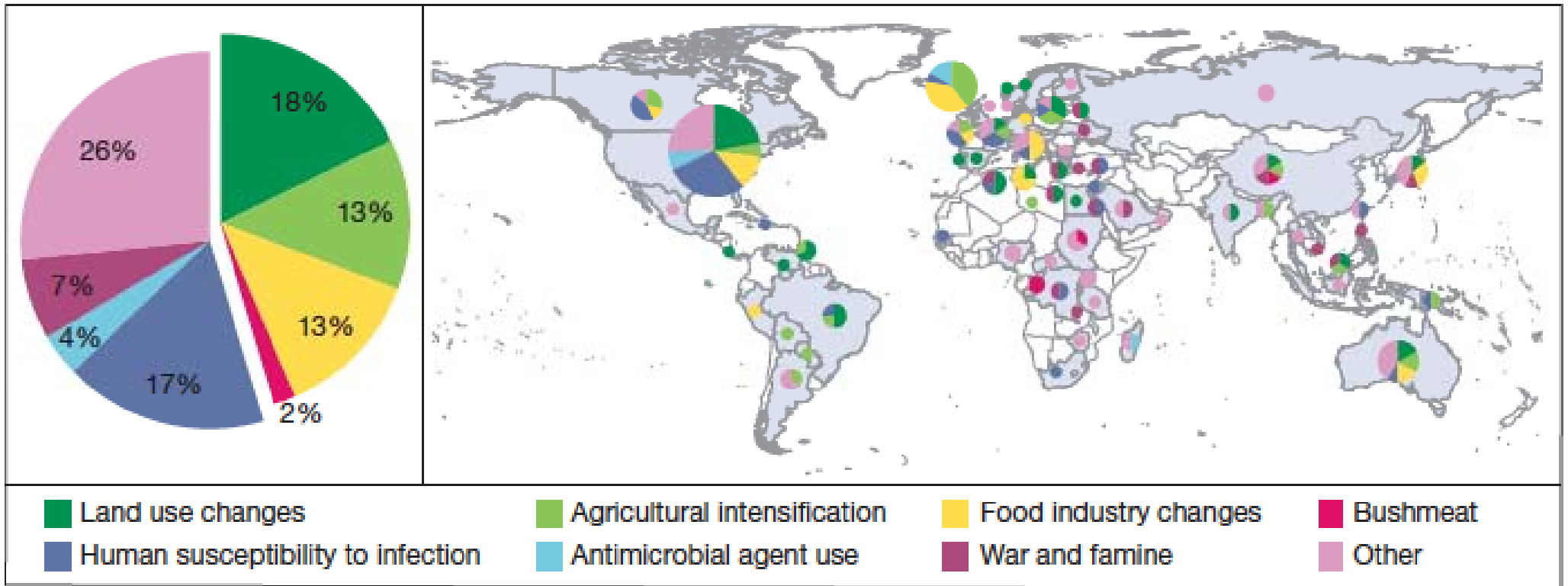


Species at threat



# Impacts of biodiversity on the emergence and transmission of infectious diseases

Felicia Keesing<sup>1</sup>, Lisa K. Belden<sup>2</sup>, Peter Daszak<sup>3</sup>, Andrew Dobson<sup>4</sup>, C. Drew Harvell<sup>5</sup>, Robert D. Holt<sup>6</sup>, Peter Hudson<sup>7</sup>, Anna Jolles<sup>8</sup>, Kate E. Jones<sup>9</sup>, Charles E. Mitchell<sup>10</sup>, Samuel S. Myers<sup>11</sup>, Tiffany Bogich<sup>3</sup> & Richard S. Ostfeld<sup>12</sup>



⇒ Environmental changes (biodiversity, land use)

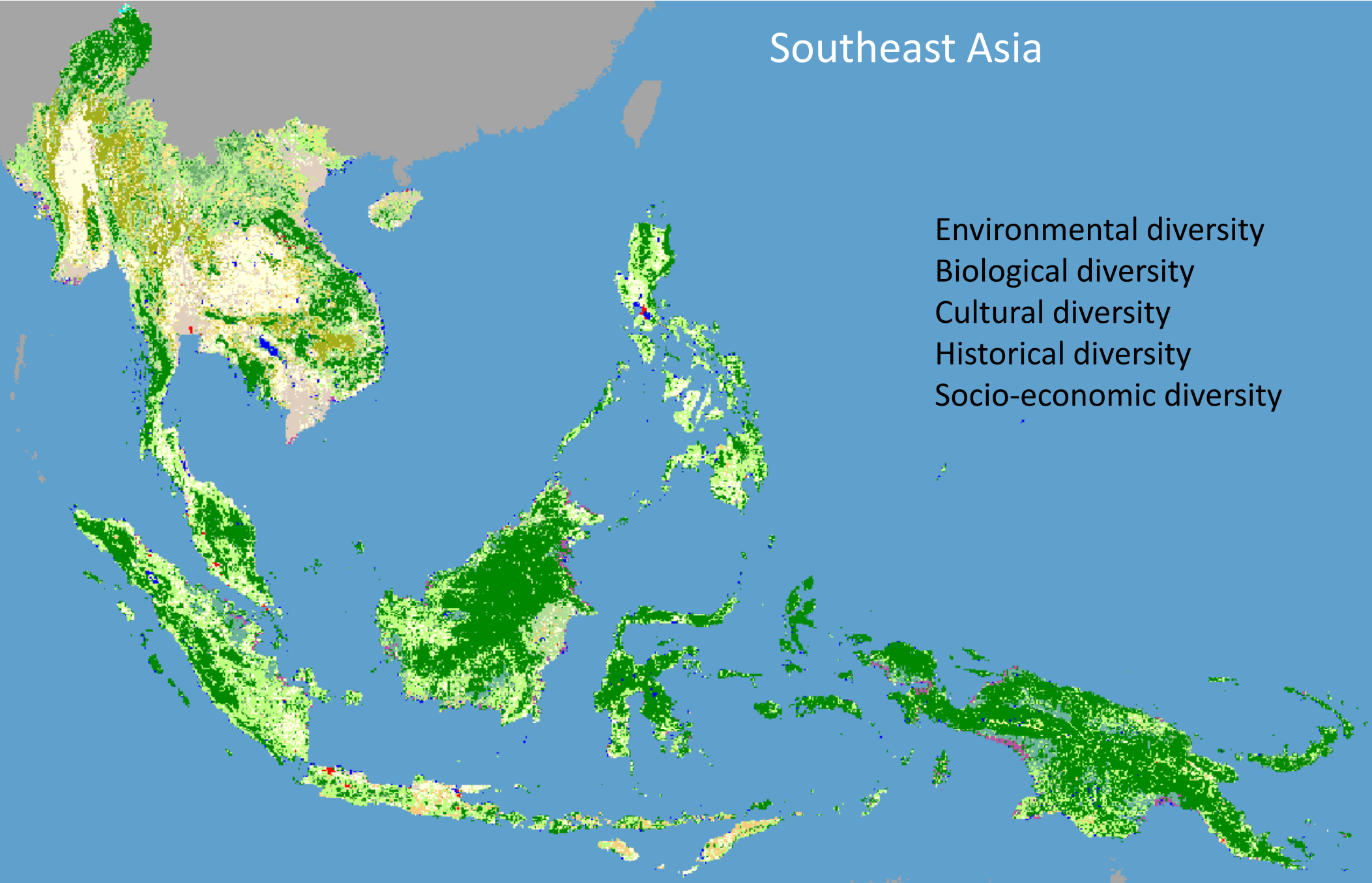
⇒ Antimicrobial agents



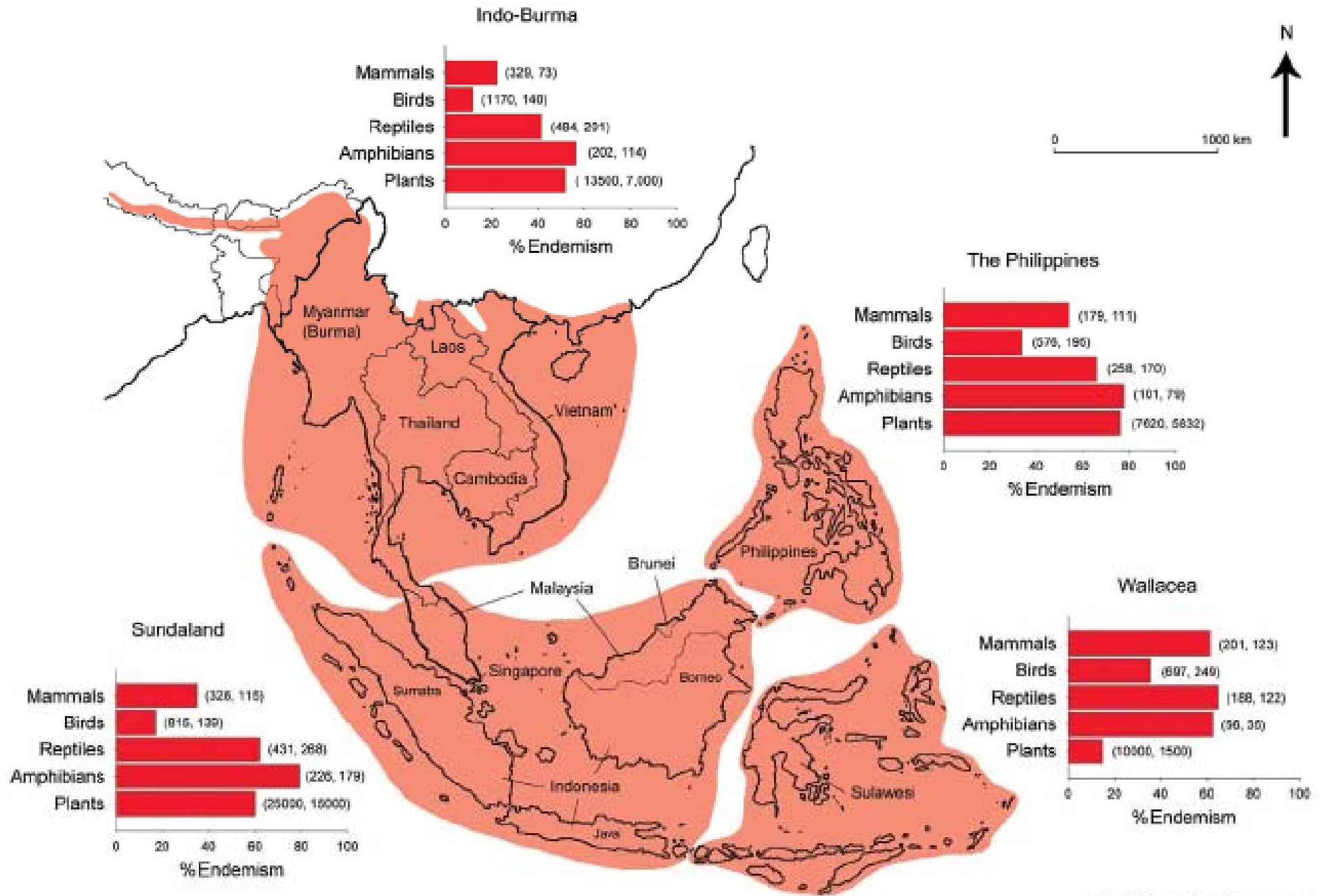
# Biodiversity and infectious diseases in Southeast Asia

# Southeast Asia

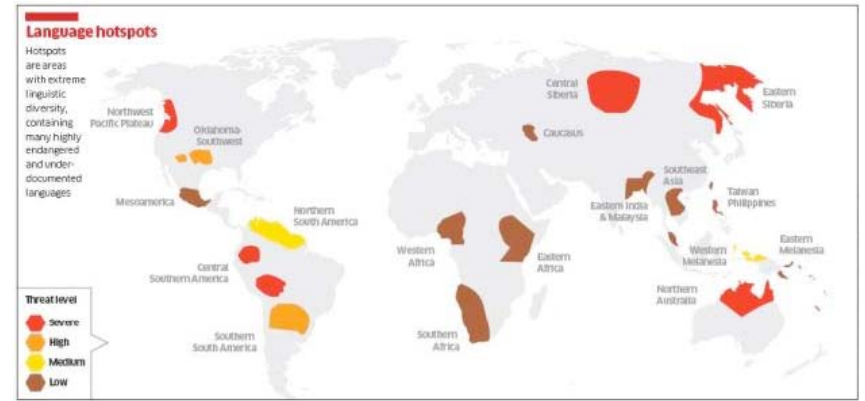
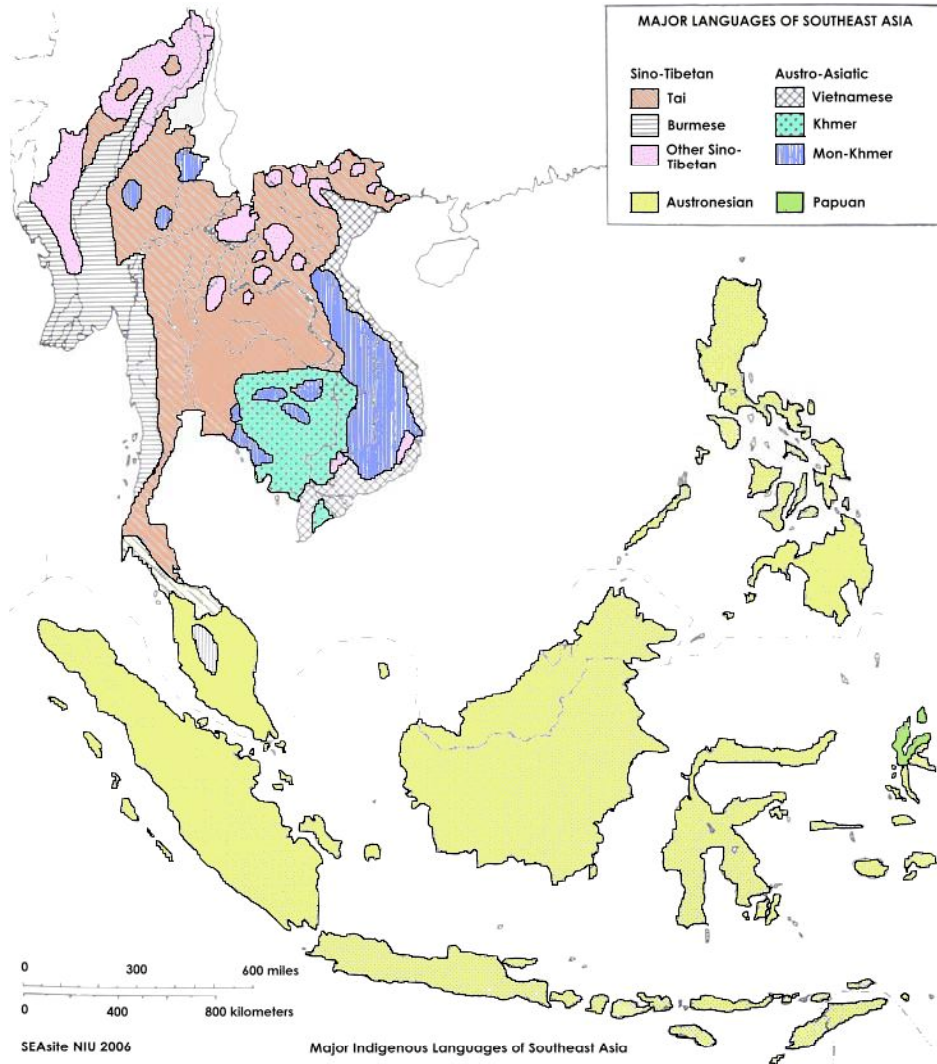
- Environmental diversity
- Biological diversity
- Cultural diversity
- Historical diversity
- Socio-economic diversity



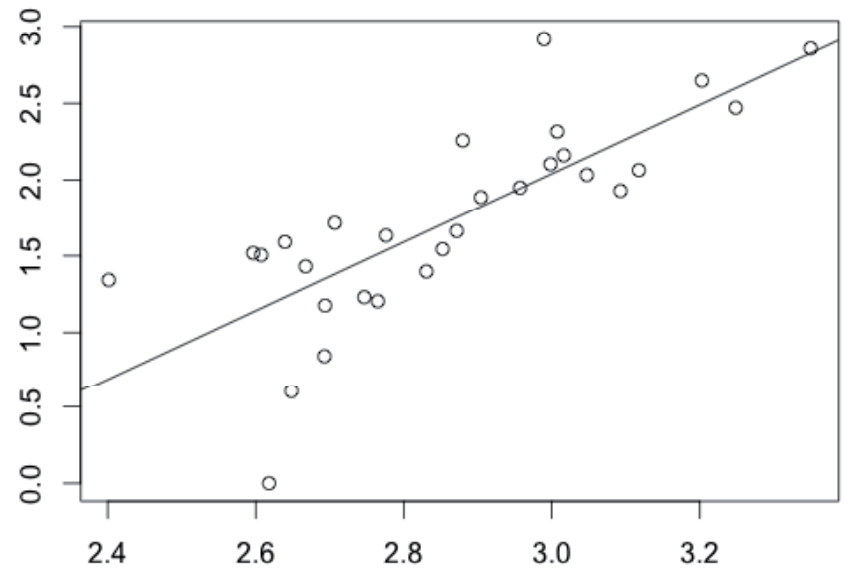
# Species richness and endemism in SEA (Sodhi et al. 2004)



# High languages' diversity is linked with high biodiversity in Southeast Asia



## Languages



Birds + Mammals

# Emerging infectious diseases in southeast Asia: regional challenges to control

Richard J Coker, Benjamin M Hunter, James W Rudge, Marco Liverani, Piya Hanvoravongchai

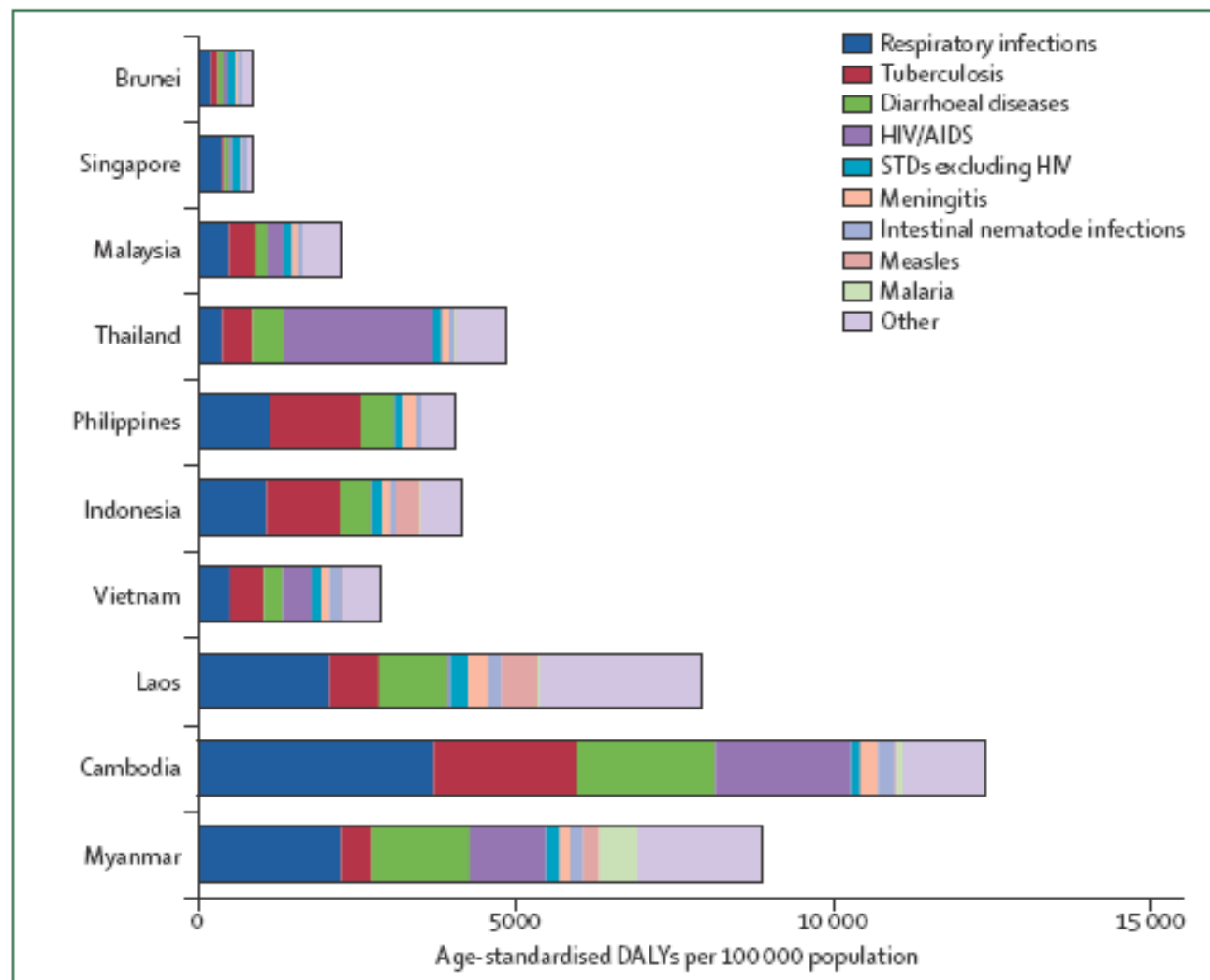
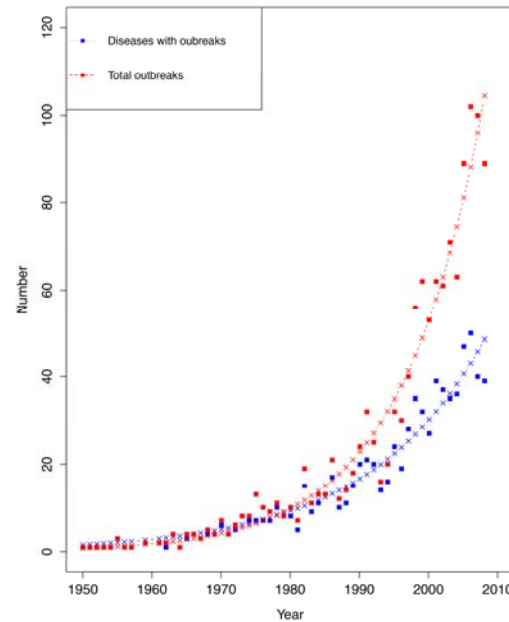


Figure: The burden of communicable disease in southeast Asian countries, 2004

Data are from WHO Global Burden of Disease, 2004 update. <sup>1</sup> DALYs=disability-adjusted life-years. STDs=sexually

# An increasing number of outbreak events in Asia-Pacific!



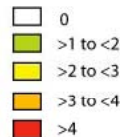
A  
Zoonotic



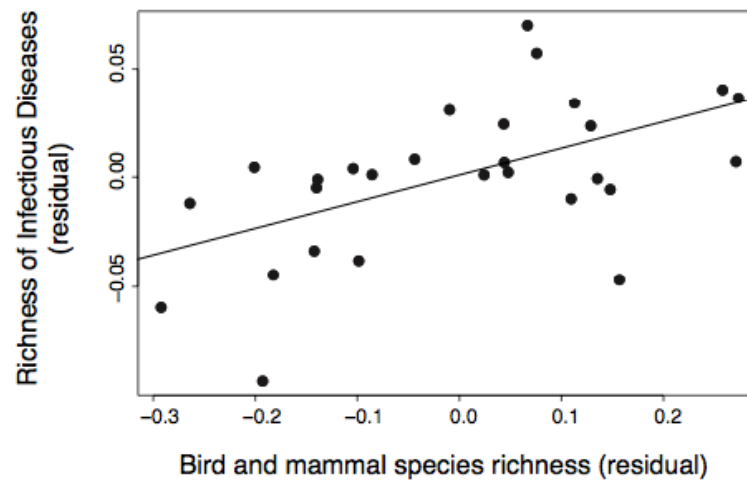
B  
Vector-borne



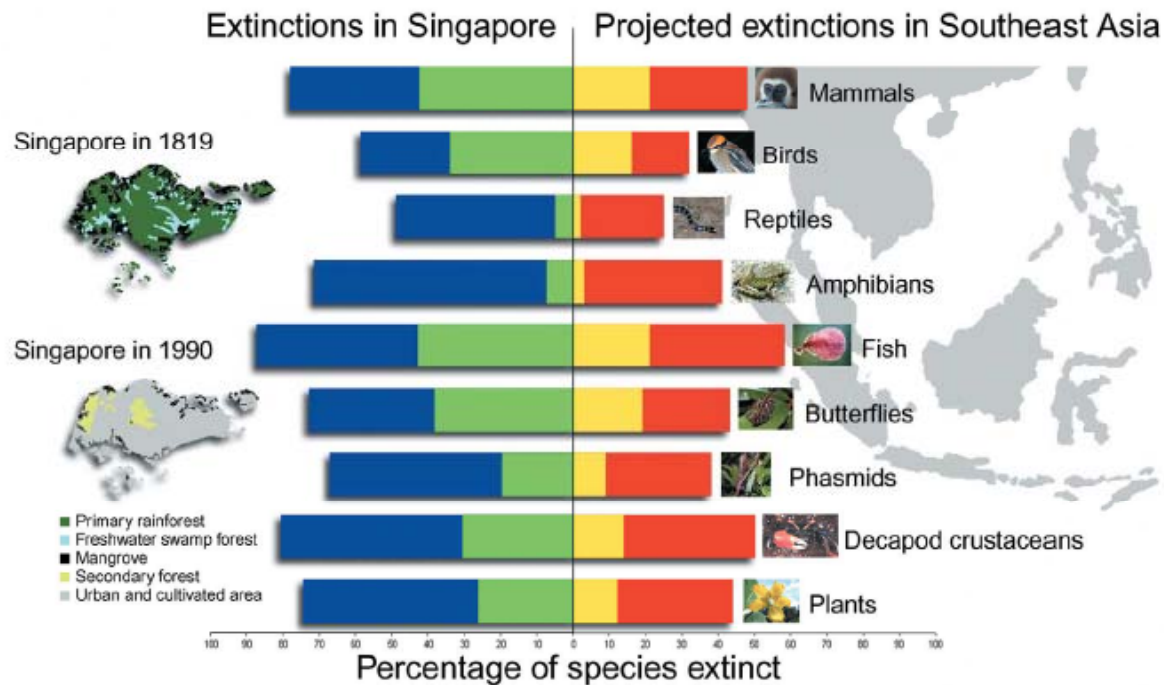
C  
Non zoonotic



# Correlation between ID and biodiversity



(Morand et al. in prep)



## 2004 Southeast Asian biodiversity: an impending disaster

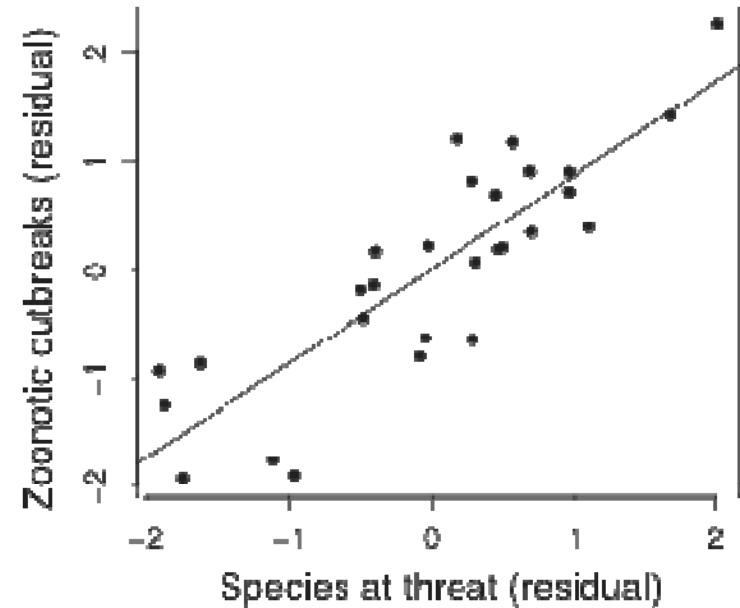
Navjot S. Sodhi<sup>1</sup>, Lian Pin Koh<sup>1,2</sup>, Barry W. Brook<sup>3</sup> and Peter K.L. Ng<sup>1</sup>

## 2013 Navjot's nightmare revisited: logging, agriculture, and biodiversity in Southeast Asia

David S. Wilcove<sup>1</sup>, Xingli Giam<sup>1,2\*</sup>, David P. Edwards<sup>3\*</sup>,  
Brendan Fisher<sup>4</sup>, and Lian Pin Koh<sup>5</sup>

## Southeast Asia: ID outbreaks are related to biodiversity loss

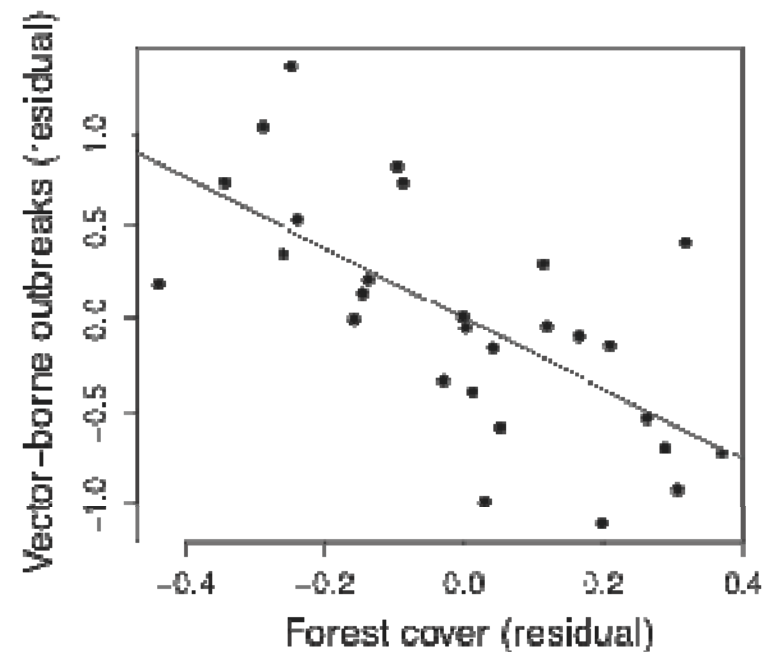
Higher number of zoonotic outbreaks is linked with increasing biodiversity at threat



Higher number of vector-borne disease outbreaks is linked with low forest cover

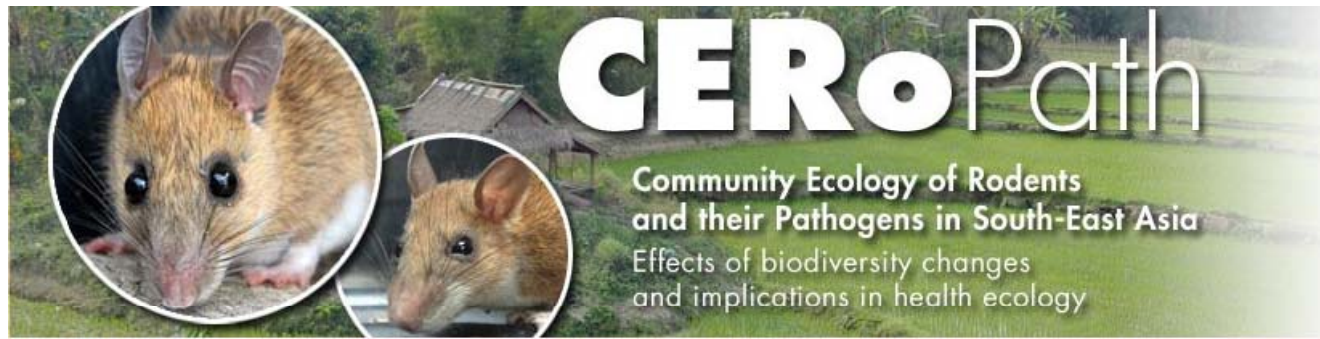


(Morand et al., in subm)





Rodent-borne diseases  
and biodiversity in Southeast Asia



## Rodents and rodent-borne diseases :

- Biodiversity changes
- Rodent-borne diseases
- Agricultural pests
- Local perception: hunting, health, environment



Project CERoPath 2008-2012

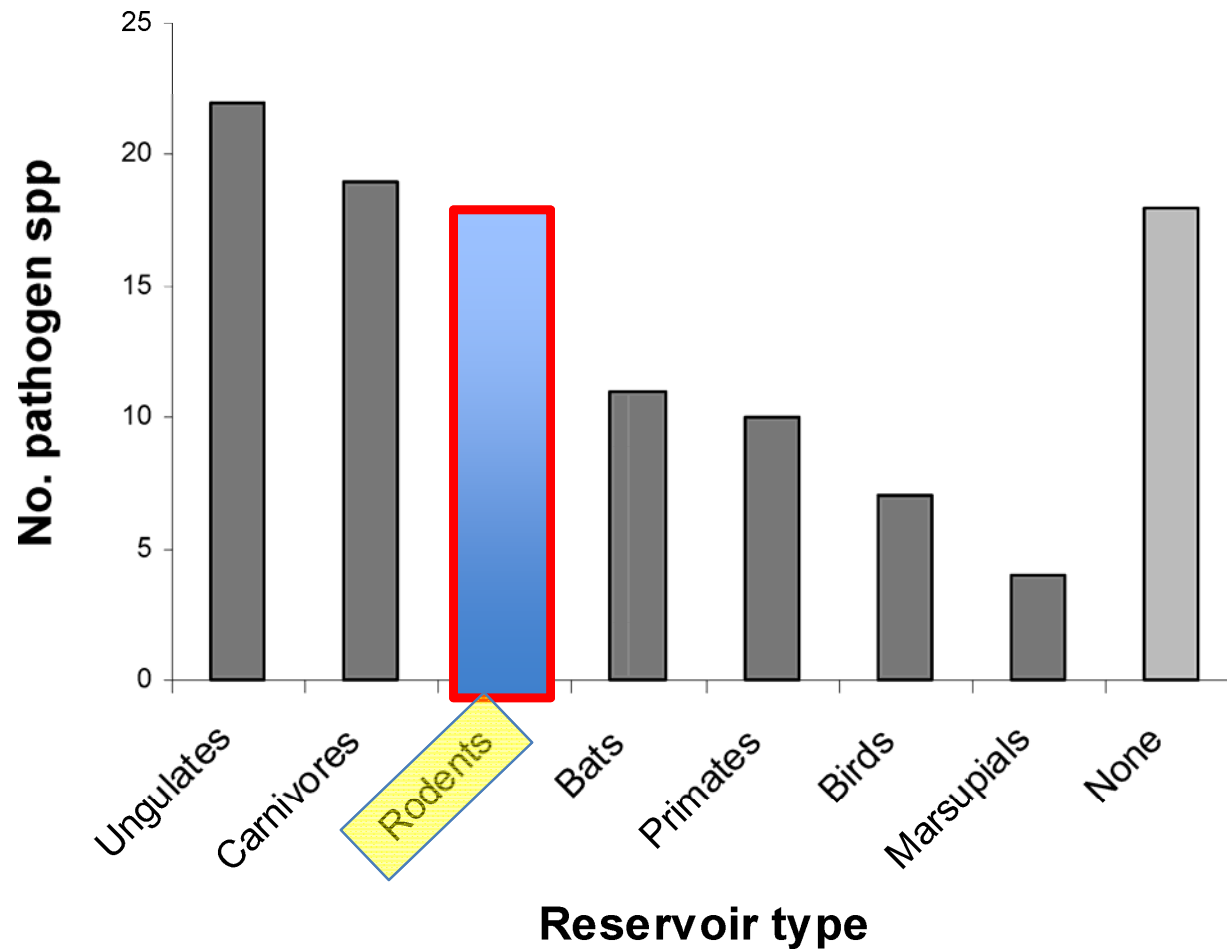
- Tools, database
- Trainings
- Research network in SE Asia

Project BiodivHealthSEA 2012-2015

See more at [www.ceropath.org](http://www.ceropath.org)

# Ecological Origins of Novel Human Pathogens

Mark Woolhouse and Eleanor Gaunt



## Some Rodent-borne (RoBo) diseases

### Viruses

- ✓ Hantaviruses
- ✓ TBE
- ✓ LCM
- ✓ Arenavirus
- ✓ Cowpox
- ✓ Hepatitis E

### Bacteria

- ✓ Plague
- ✓ Leptospirosis
- ✓ Bartonellosis
- ✓ Murine typhus
- ✓ Scrub typhus
- ✓ Rickettsial

### Protozoa

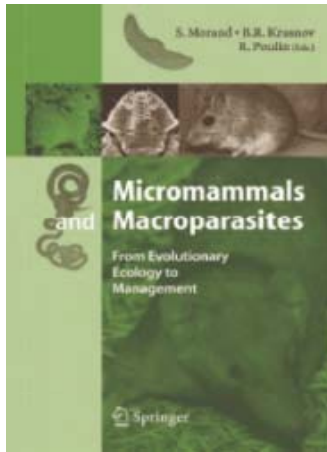
- ✓ Toxoplasmosis
- ✓ Babesiosis
- ✓ Cryptosporidiosis
- ✓ Trypanosomiasis

### Fungi

- ✓ Pneumocystis

### Helminths

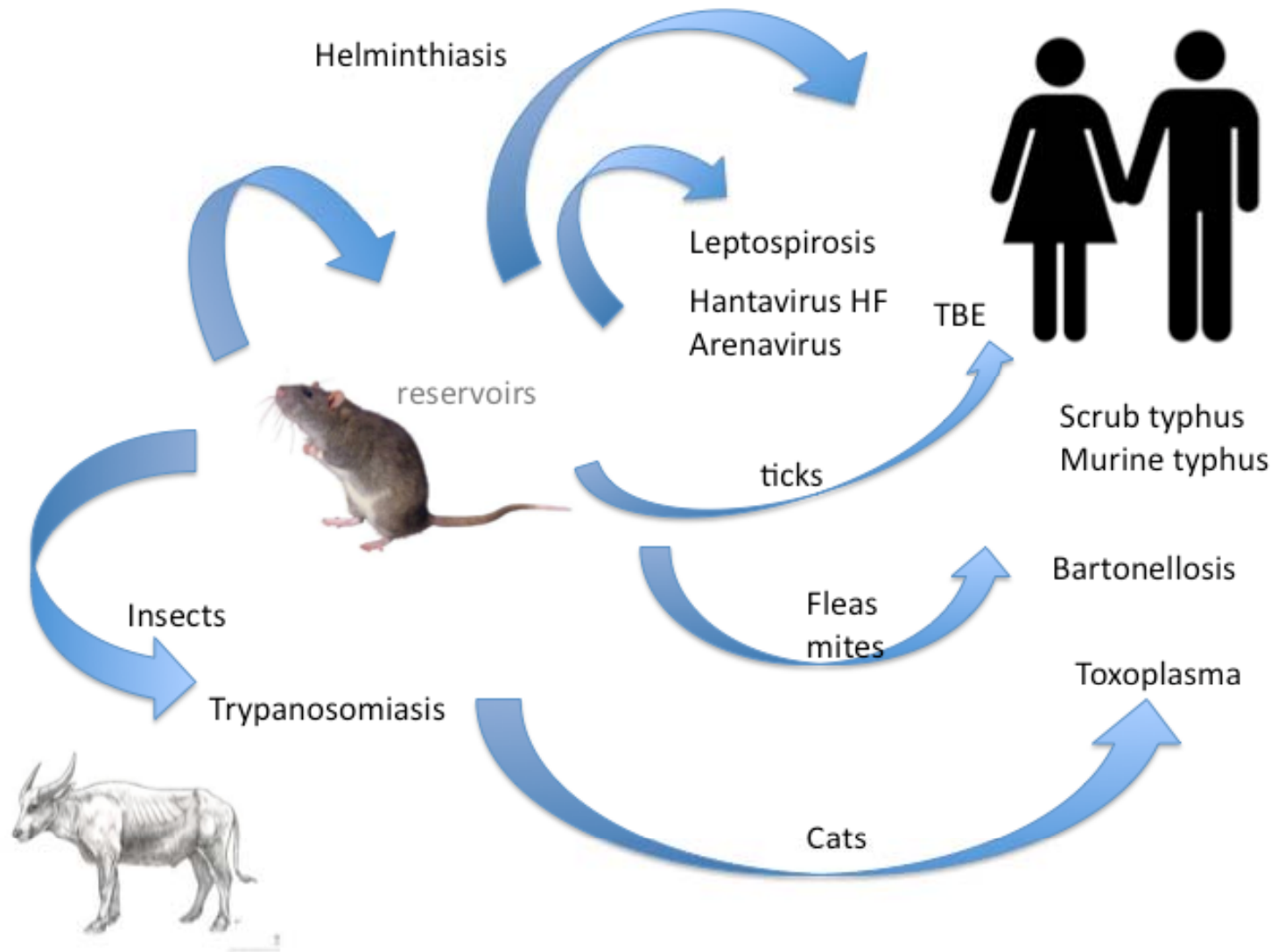
- ✓ Hymenolepis
- ✓ Rodentolepis
- ✓ Trichinosis
- ✓ Toxascariasis
- ✓ Capillariasis



## Micromammals and macroparasites: : from evolutionary ecology to management

Morand S, Krasnov BR, Poulin R 2006  
Springer

Rodents are the most diversified group of mammals





LOCALITY

Dry season

Wet season



Forest

Non irrigated landscape

Irrigated agriculture

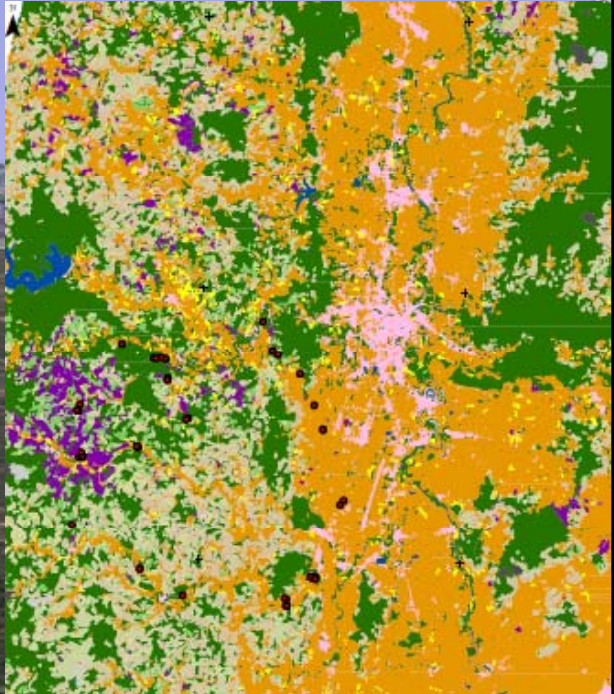
Houses and villages



⇒ 1,200 night traps by site and by season  
+ rodents trapped by hunters + traps in houses

# Rodent trapping

# Land cover



Houses, cities

lowland – irrigated, rainfed

Midland – degraded/cultivated

Forests – preserved/degraded

Anthropization

118 m

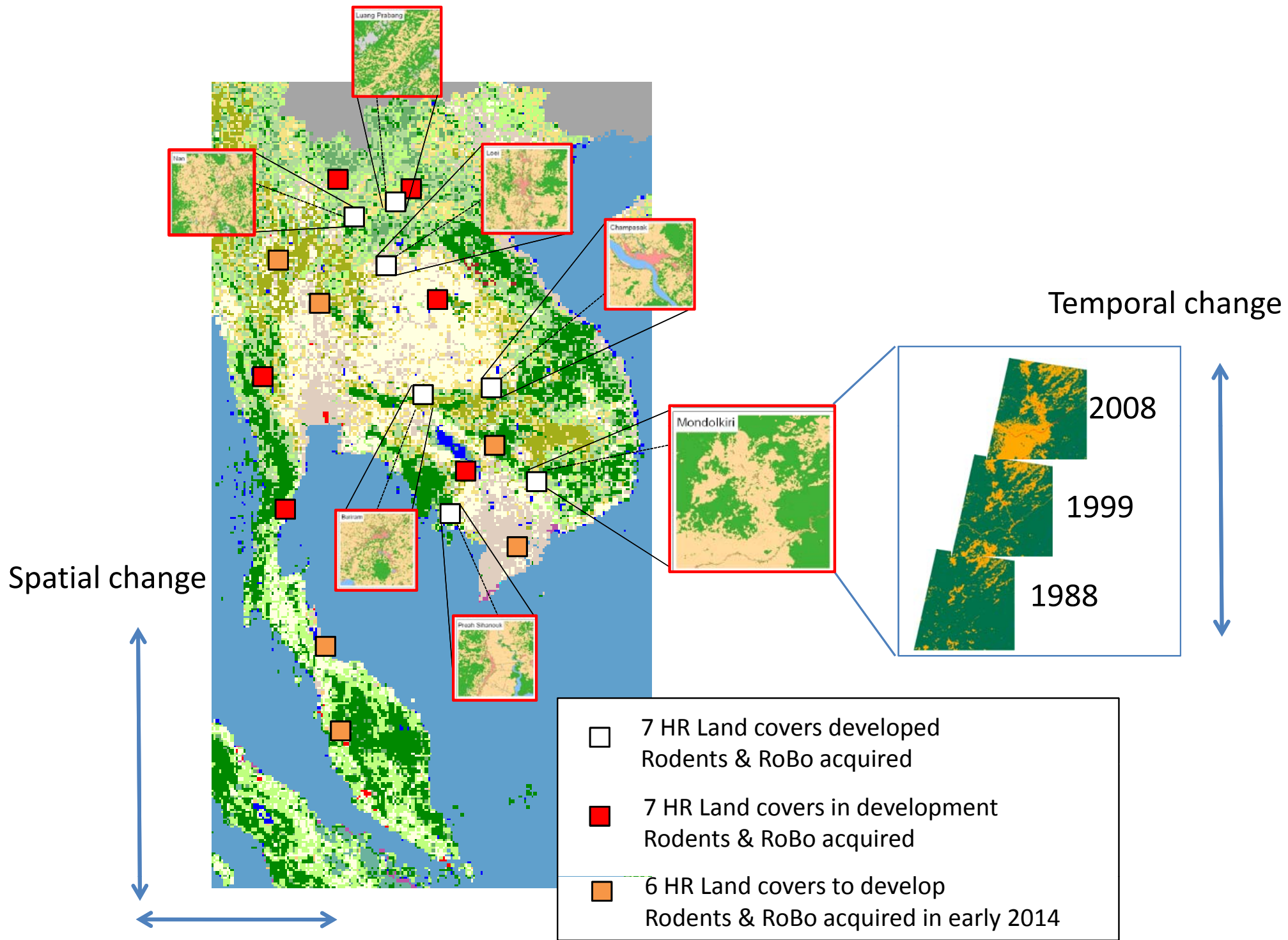
© 2007 Europa Technologies  
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47 Q 492799.51 m E 2075902.84 m N elev 468 m

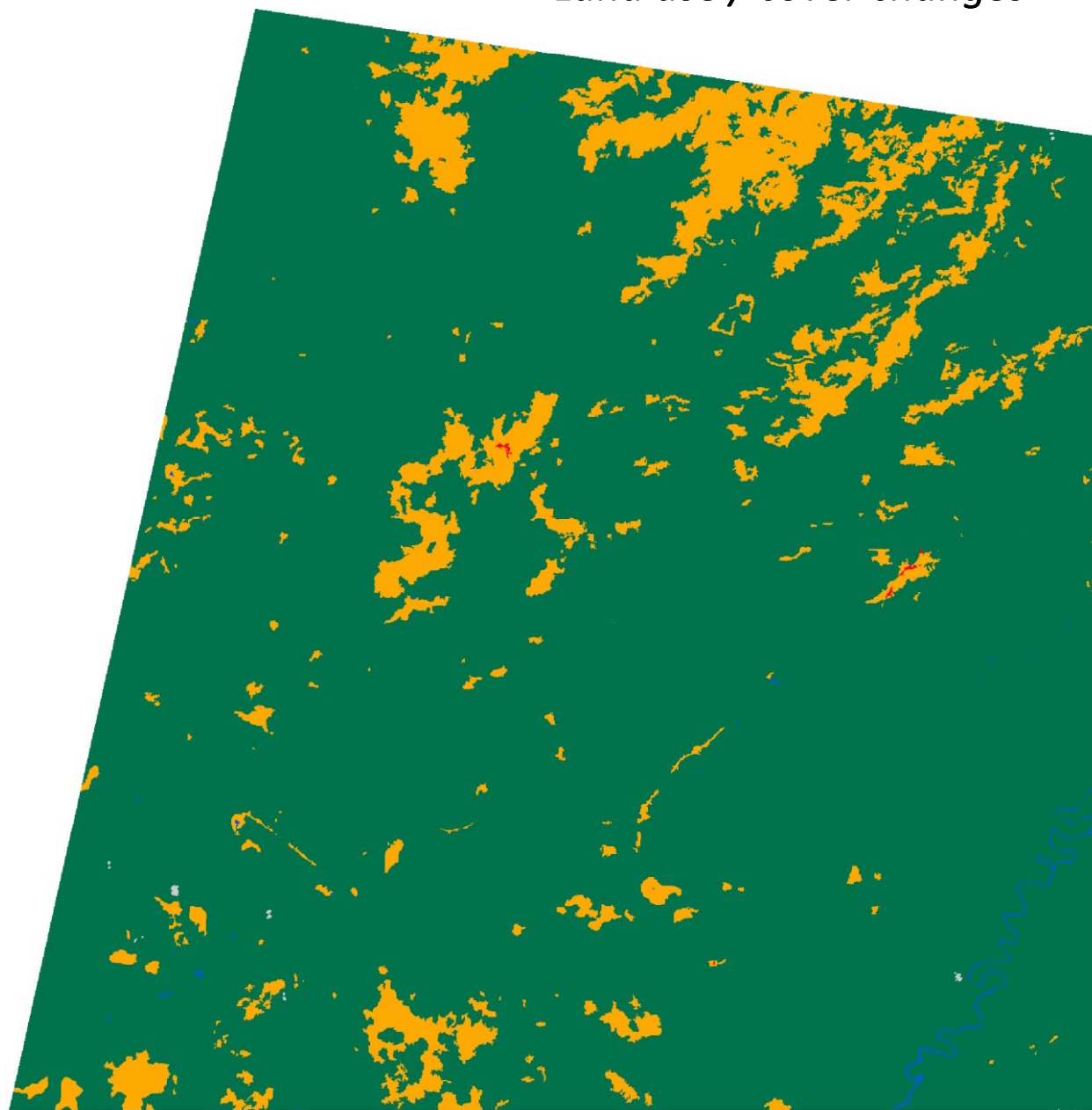
Streaming ||||| 100%

Eye alt

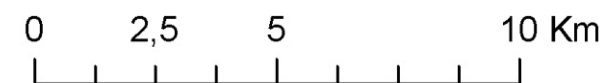
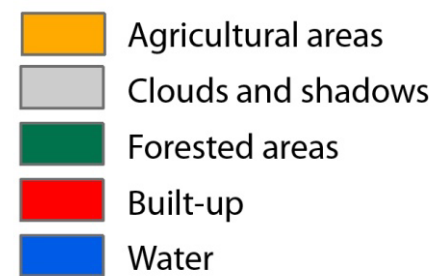




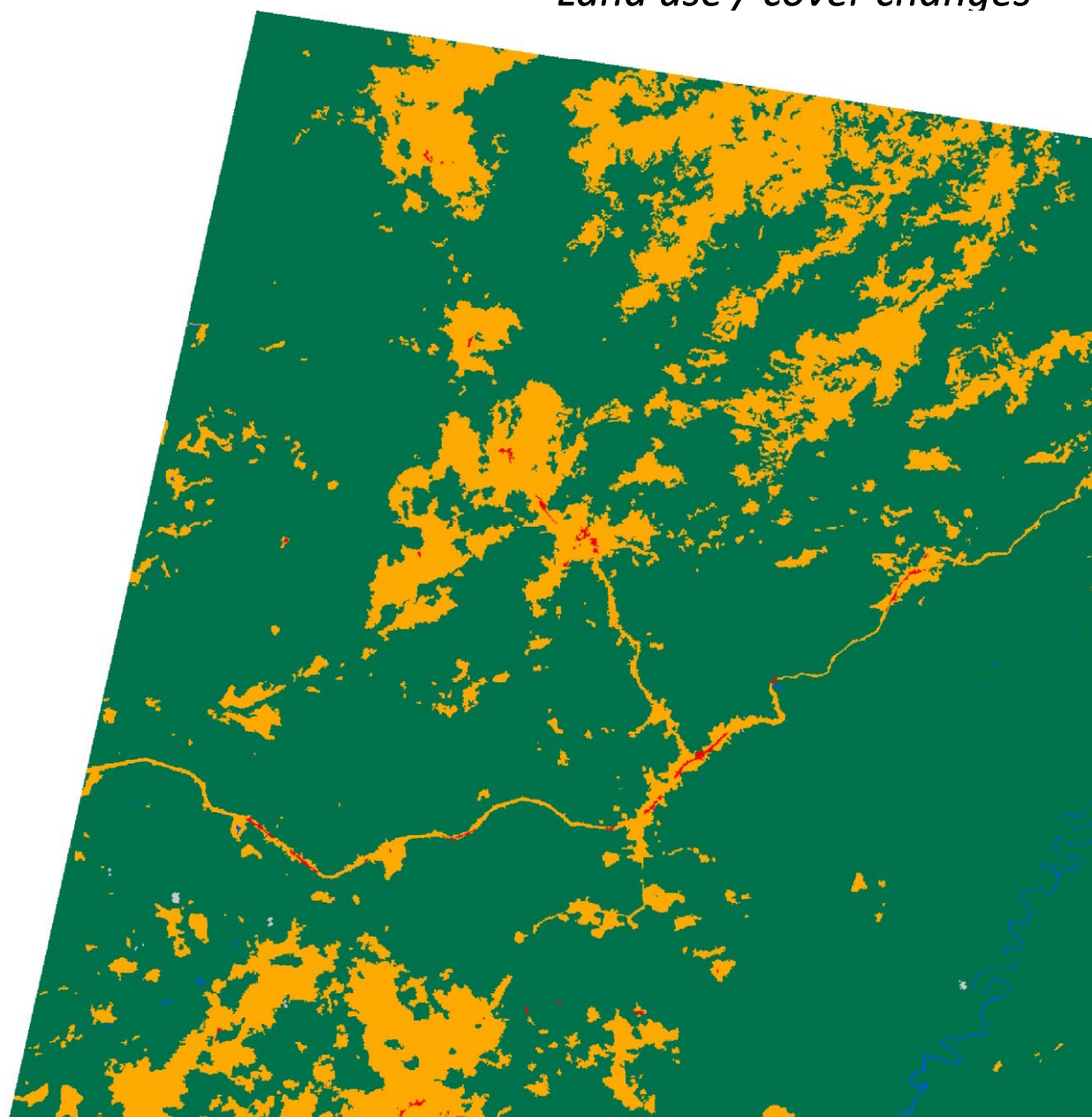
*Land use / cover changes*








Land use / land cover  
classification in  
Mondolkiri province, in  
1988

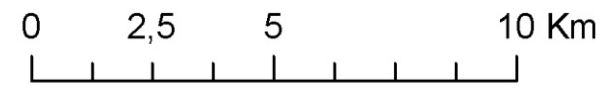


*Land use / cover changes*

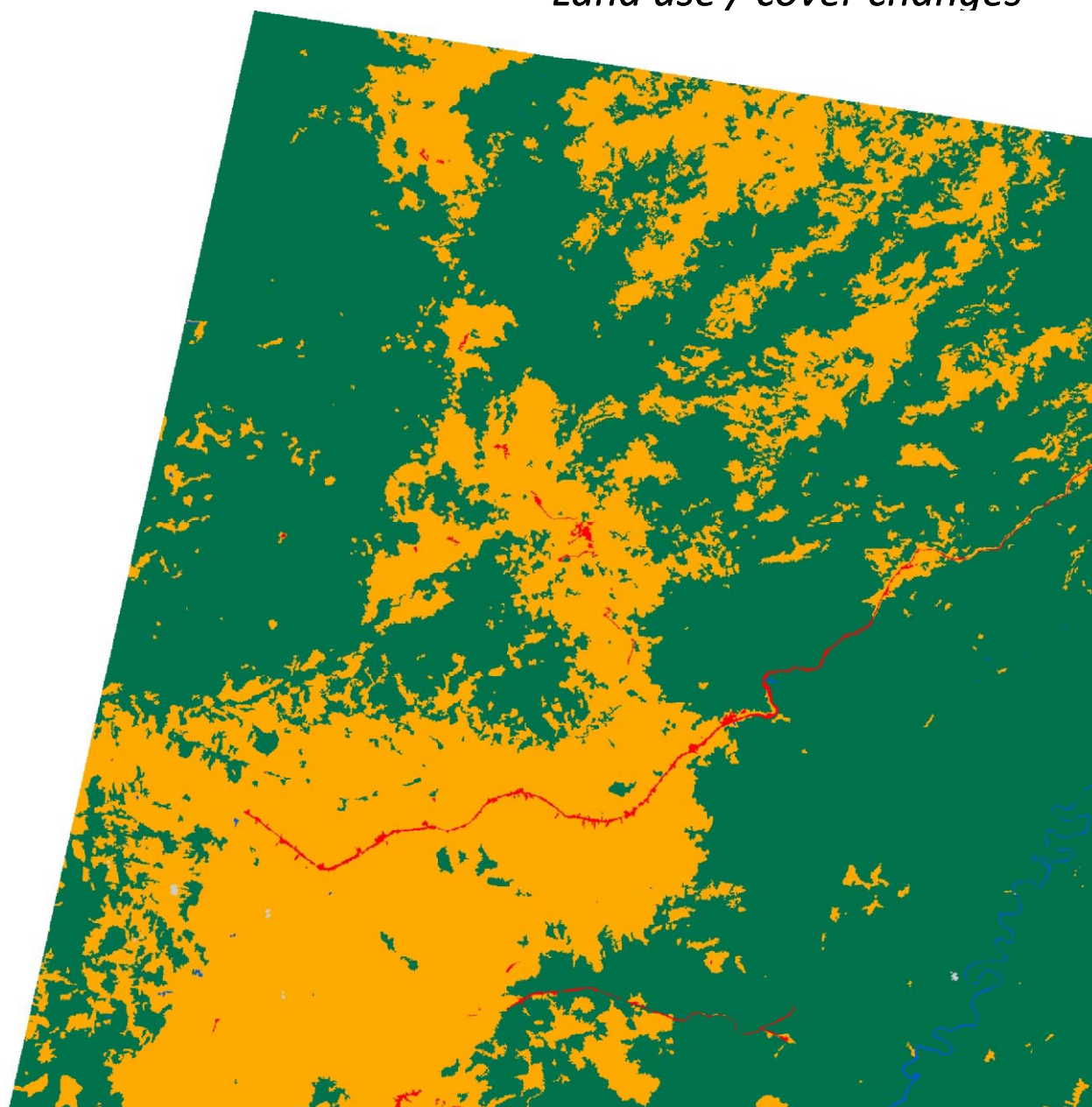


Land use / land cover  
classification in  
Mondolkiri province, in  
1998






-  Agricultural areas
-  Clouds and shadows
-  Forested areas
-  Built-up
-  Water

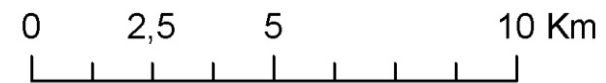


*Land use / cover changes*



Land use / land cover  
classification in  
Mondolkiri province, in  
2008

-  Agricultural areas
-  Clouds and shadows
-  Forested areas
-  Built-up
-  Water



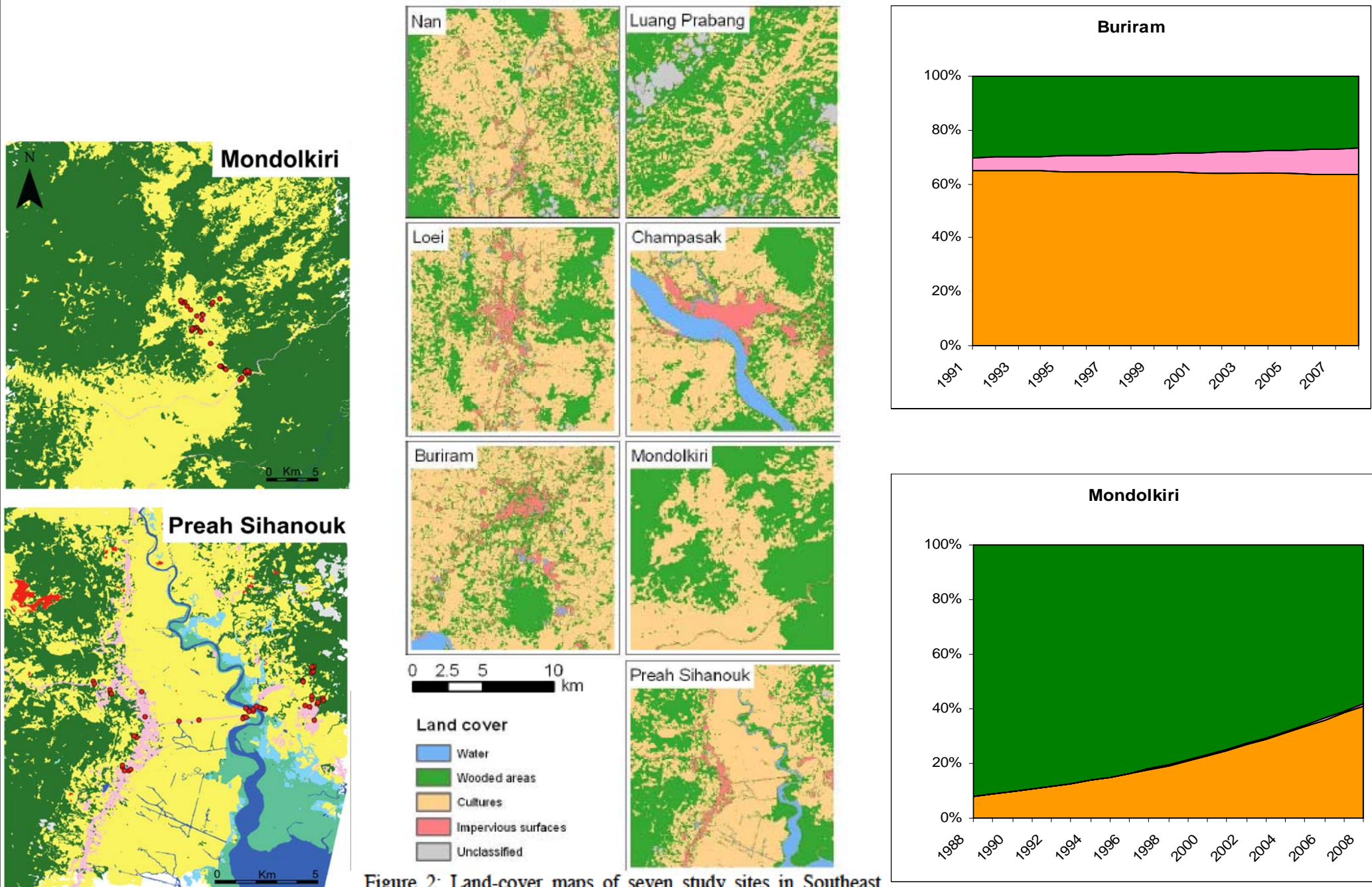
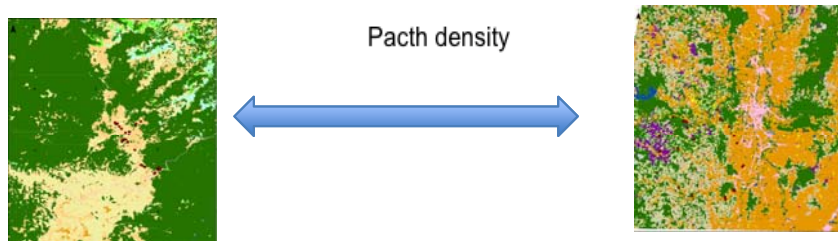
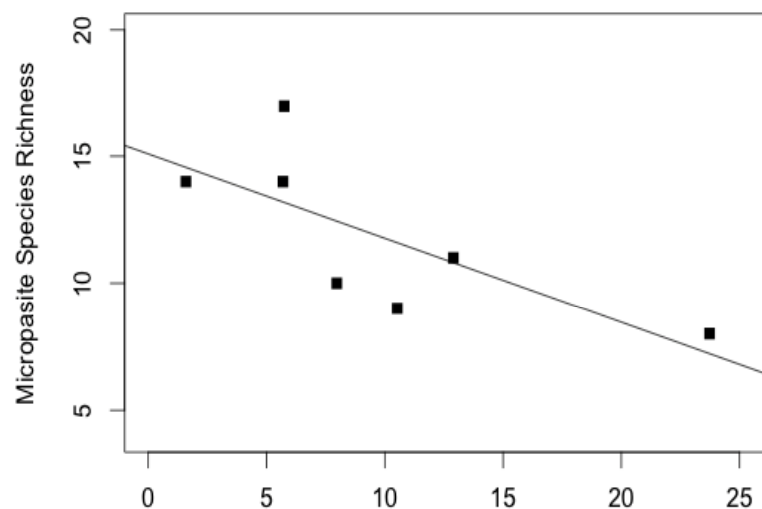


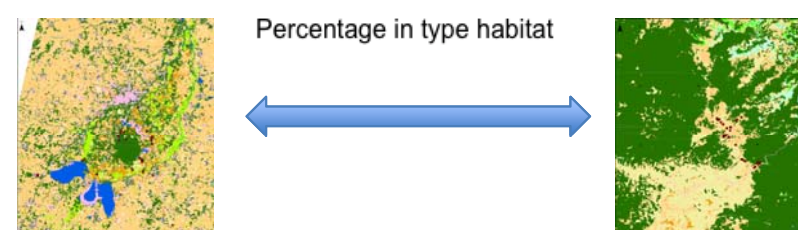
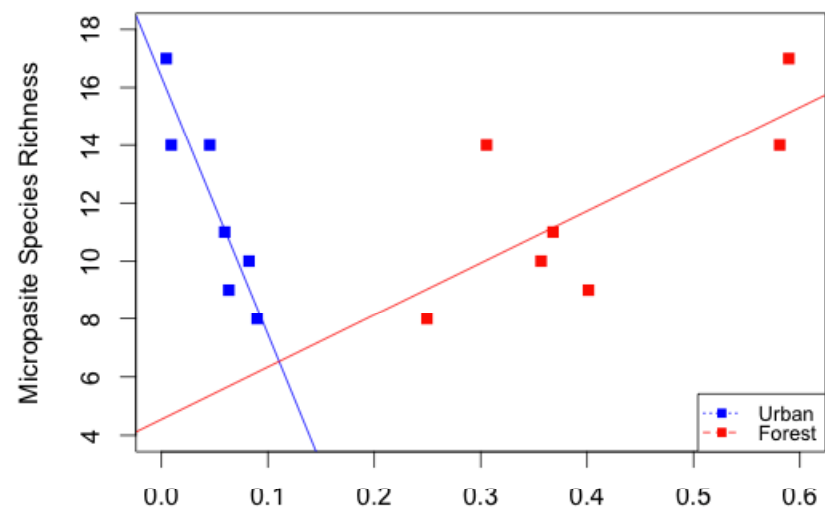
Figure 2: Land-cover maps of seven study sites in Southeast Asia, derived from SPOT imagery by object-oriented classification

# The diversity of rodent-borne diseases decreases with habitat fragmentation

Habitat fragmentation decreases the diversity of rodent-borne diseases



Increased urbanization and decreased forest cover, decrease the diversity of rodent-borne diseases

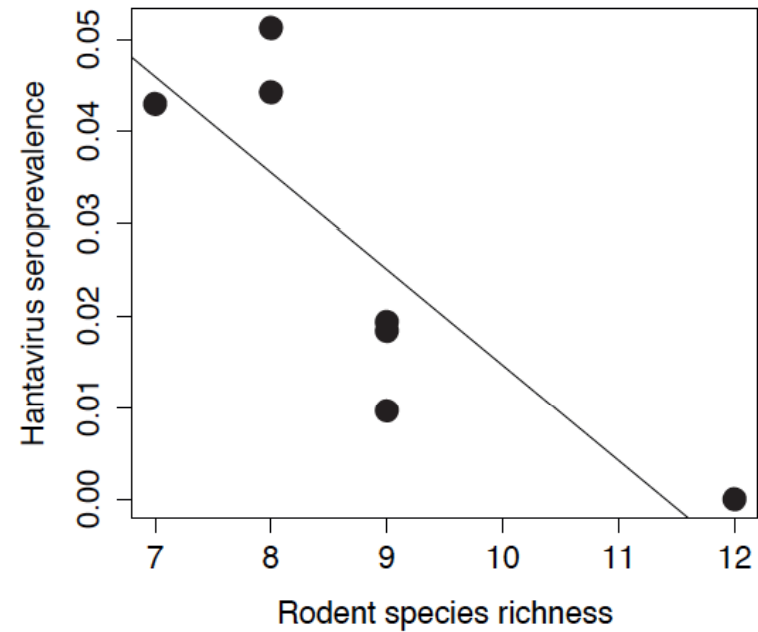


=> Loss of biodiversity is linked with loss of rodent-borne diseases (in the reservoirs)

## Dilution effect: Hantavirus

=> Decreasing biodiversity increased hantavirus prevalence in rodents

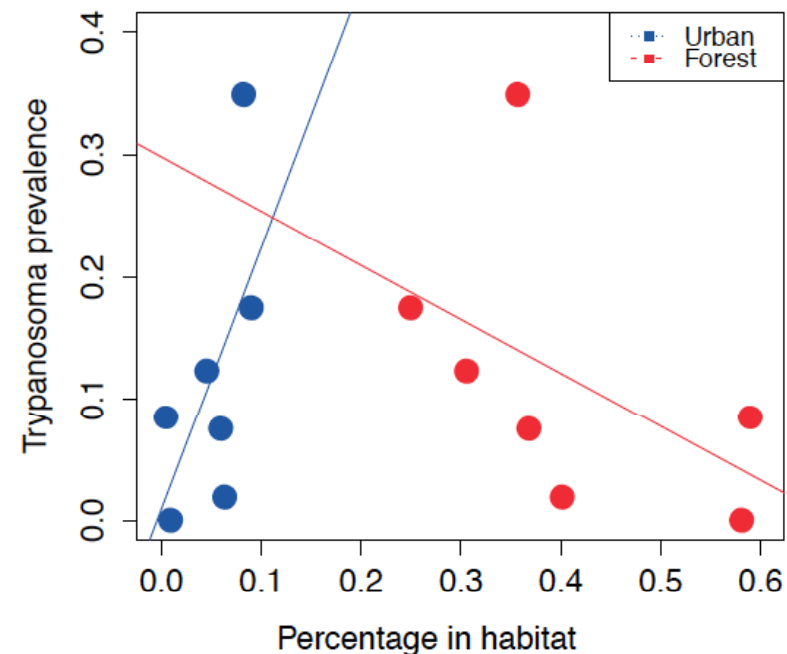
(Blasdell et al., *EcoHealth* 2012)



## Land use changes' effect: Trypanosomes

=> Decreasing forest cover (or increasing urban areas) increased *Trypanosoma* prevalence in rodents

(Pumphon et al., *Infec & Epidem* 2013, in prep)



=> Loss of diversity is linked with the increasing of the remaining rodent-borne diseases

Ongoing works:

Downscaling at the level of the village



(Pauline Della Rossa)

- Human diseases (stool investigation)
- Livestock
- Rodents (rodent-borne diseases)
- antimicrobial resistance (humans and animals)

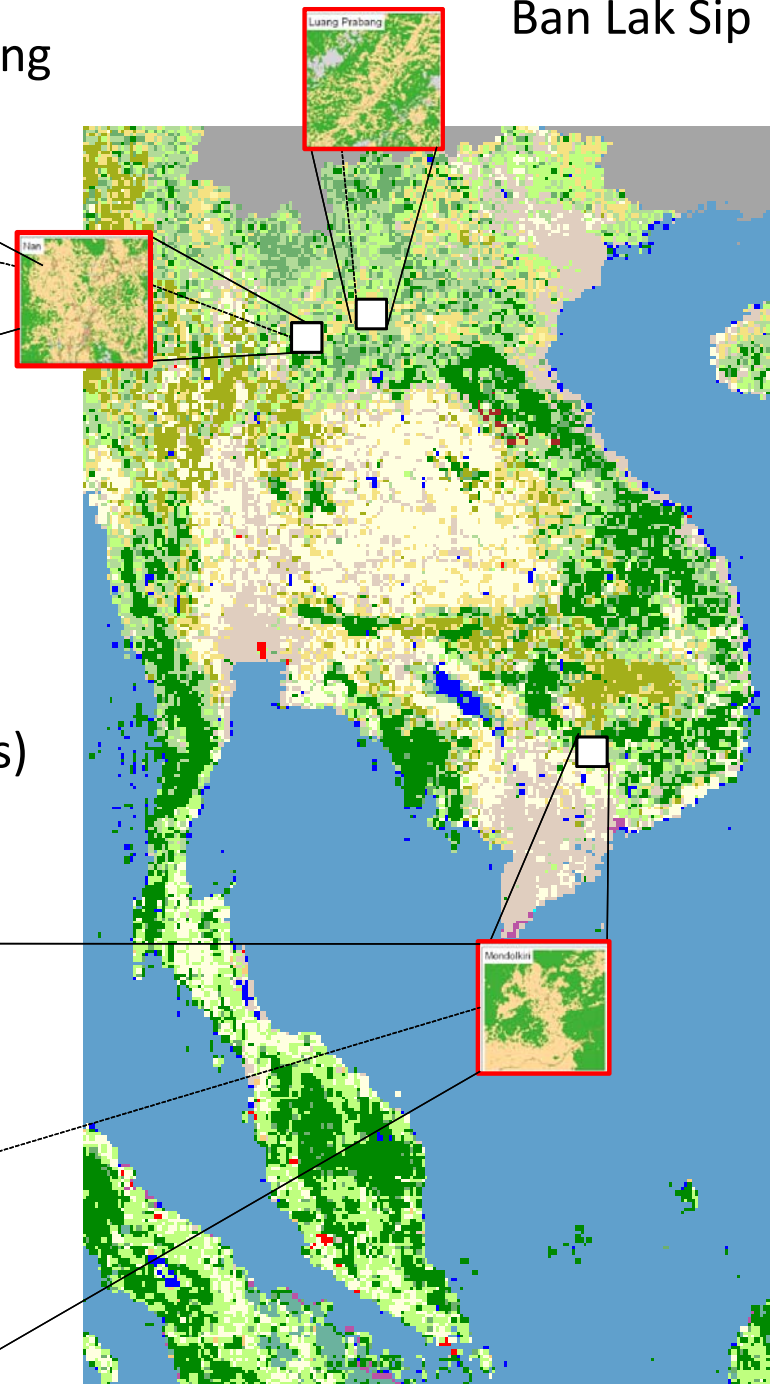
### Social representation and knowledge



(Ludovic Chiffot)

Ban Huay Muang

Ban Lak Sip





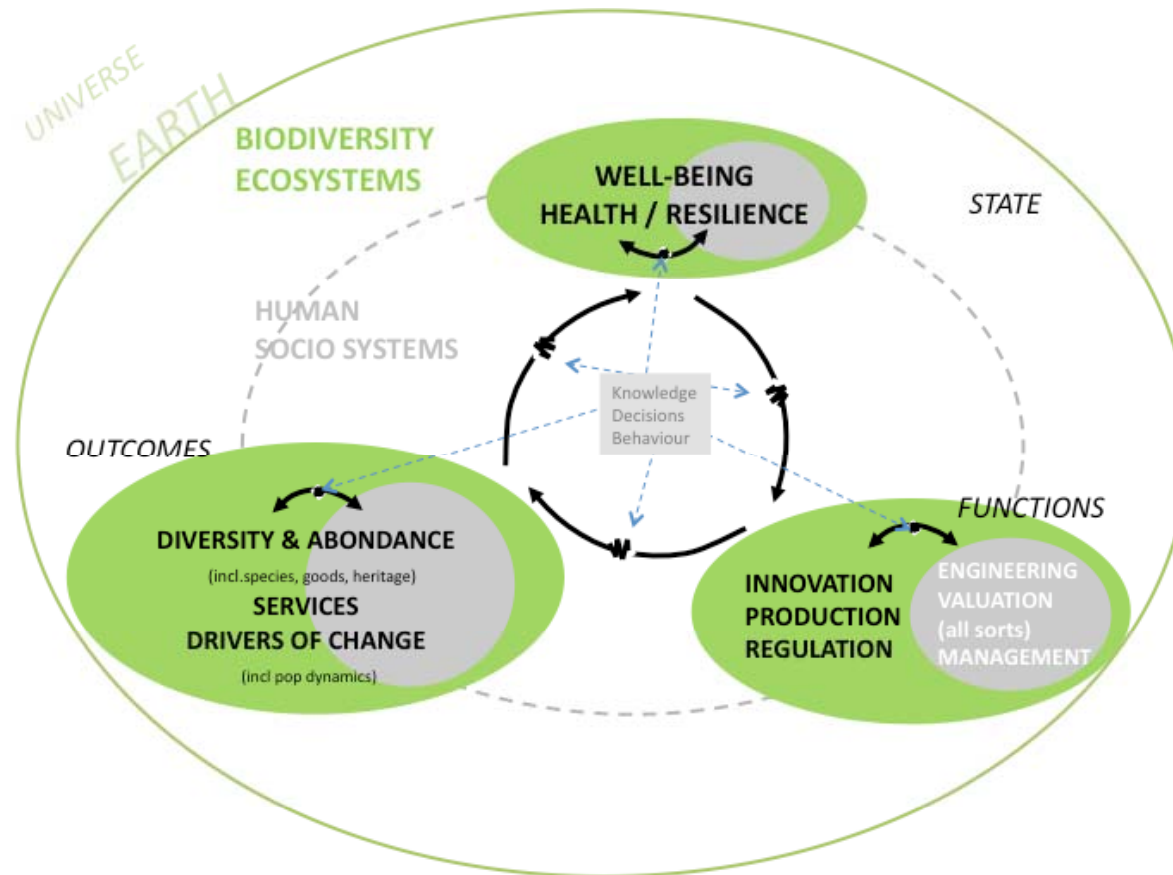
The ongoing actions ...



Intergovernmental Platform on  
Biodiversity & Ecosystem Services



## The agenda for Biodiversity and Health

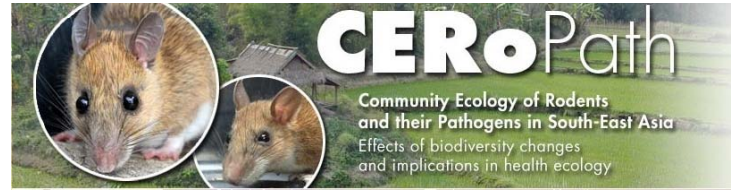


# Conclusion

- High biodiversity means high diversity of infectious diseases!  
⇒ Does it mean high risks?
- Outbreaks and emergence are linked to biodiversity at threat, and land use changes (Regional scale)  
⇒ Local scale?
- Ecosystem services  
=> Is biodiversity a “regulation service” for health?

# “One Health” and biodiversity

- Where are the sciences of biodiversity (ecology, evolution, anthropology)?
- A missing ingredient: The domestic animals
  - ⇒ Transmission ecology: amplifiers / spill-over
  - ⇒ The loss of their genetic diversity and the increase of health problems (the limits of the biosecurity approach)
- For which policy: resilience-based or preparedness-based?



[www.biodivhealthsea.org](http://www.biodivhealthsea.org)

[www.ceropath.org](http://www.ceropath.org)

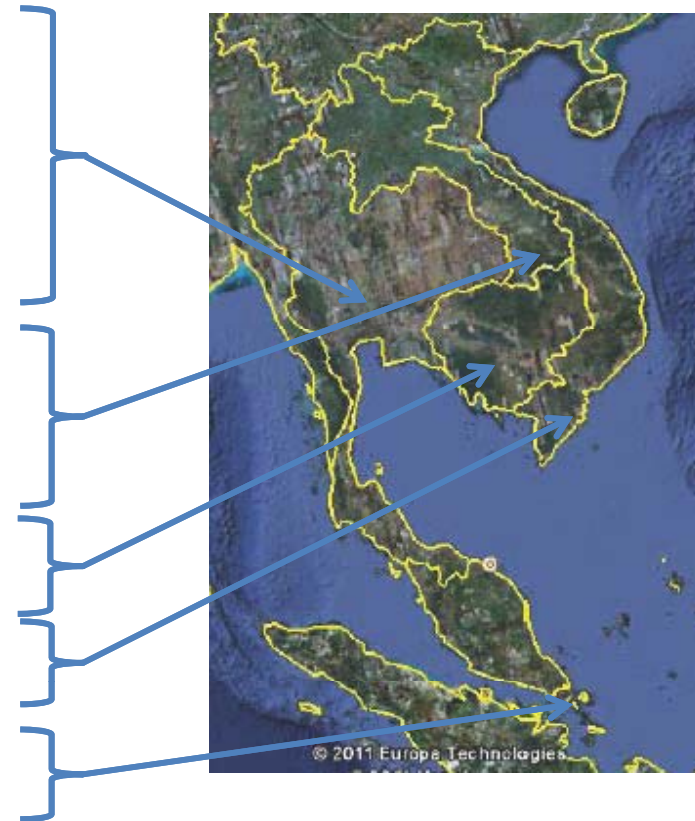


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Faculty of Tropical Medicine



• **Thanks to SE Asian teams**

- Mahidol University, Dpt Medecine, TropMed, Bangkok
- Kasesart University, Dpt Veterinary, Bangkok
- Thammasat University, Dpt Anthropology, Bangkok
- Chulalongkorn University, Dpt Biology Bangkok
- Maha Sarakham University, Dpt Biology, Mahasarakham
- AFRIMS (US AFMC), Bangkok
  
- NAFRI, Agricuture & Forestry, Vientiane
- National Institute of Health, Vientiane
- Centre Christophe Mérieux, Vientiane
  
- Pasteur Institute Cambodia
- University of Health Sciences, Phnom Penh
  
- OUCRU, Ho Chi Minh City
  
- National University of Singapore



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# Many thanks

Yannick Chaval (CBGP-INRA, Rodent barcode tool)

Marie Pagès, Johan Michaux, Alice Latinne (CBGP, Univ Liège) (Rodent phylogeny)

Jean-Marc Rolain, Didier Raoult (Univ Marseille) and Infectiopole Sud (*Bartonella spp*)

Jean-François Cosson (CBGP-INRA) et Michel Picardeau (IP Paris)

Yupin Supputamongkol (Mahidol U) (*Leptospira spp*)

Magali Chabe, Eduardo Dei Cas (IP Lille) (*Pneumocystis spp, Cryptosporidium*)

Philippe Buchy, Kim Blasdel (IP Cambodia) (hantaviruses, rna viruses)

Heikki Henttonen (Finland) (viruses)

Sathaporn Jittapalapong, Marc Desquesnes, (K.U. Thailand, CIRAD) (*Trypanosoma spp*)

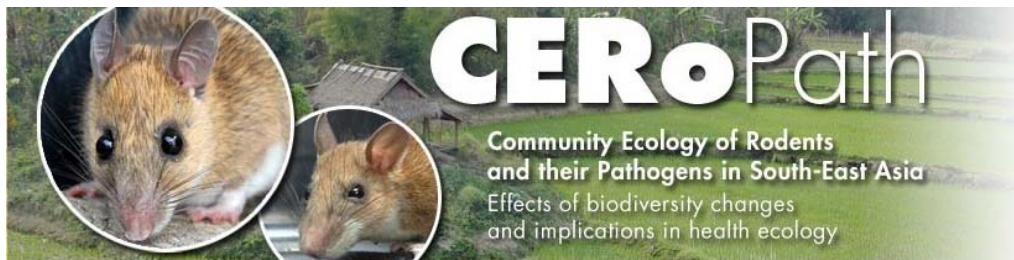
Vincent Herbreteau, Stéphane Dupuy, Annelise Tran (MTD, Espace-Dev, AGIRs)

**PhD Students**      *Shai Pilosof, Ben Gurion U (network analyses)*

*Kittipong Chasiri, Mahidol U (helminths)*

*Tawisa Jiyipong, Kasetsart U (bacteria)*

*Pornpan Pumhom, Kasetsart U (protozoa)*



[www.ceropath.org](http://www.ceropath.org)



Local impacts and perceptions of global changes:  
Health, biodiversity and zoonoses in Southeast Asia

[www.biodivhealthsea.org](http://www.biodivhealthsea.org)



**Khop khun krap!!**



**CERoPath**

Community Ecology of Rodents  
and their Pathogens in South-East Asia  
Effects of biodiversity changes  
and implications in health ecology