Ecologie de la santé : pour des approches intégrées ?

Serge Morand

CICML
CENTRE D'INFECTIOLOGIE CHRISTOPHE MÉRIEUX DU LAOS

cnrs
dépasser les frontières

cirad

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

Gauthier-Clerc M, Thomas F, eds
Ecologie de la Santé et Biodiversité
De Boeck, 2010

Morand S, Pipien G, eds
Notre Santé et la biodiversité
Buchet Chastel, 2013

Morand S, Moutou D, Richomme C, eds
Faune sauvage, biodiversité et santé, quels défis ?
Quae, 2014

Notre santé dépend-elle de la biodiversité ?

VetAgro Sup

humanité et biodiversité
ENSEMBLE PROTÉGEONS LE VIVANT

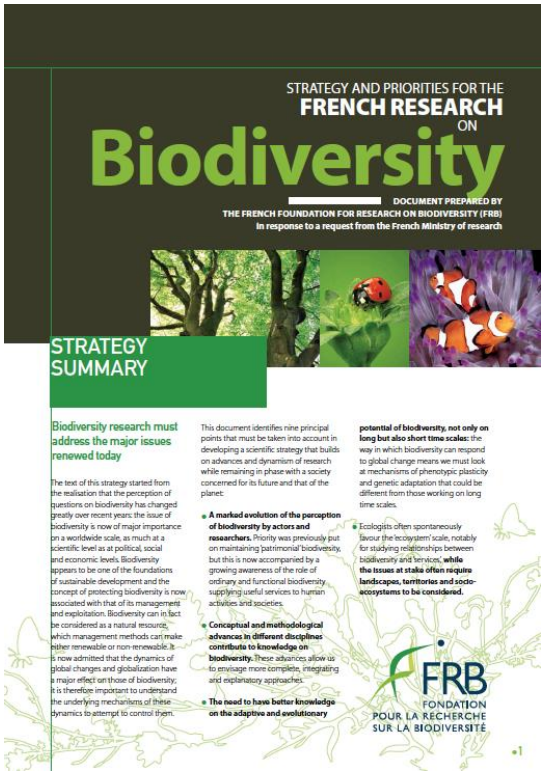
web

Colloque Santé - Biodiversité

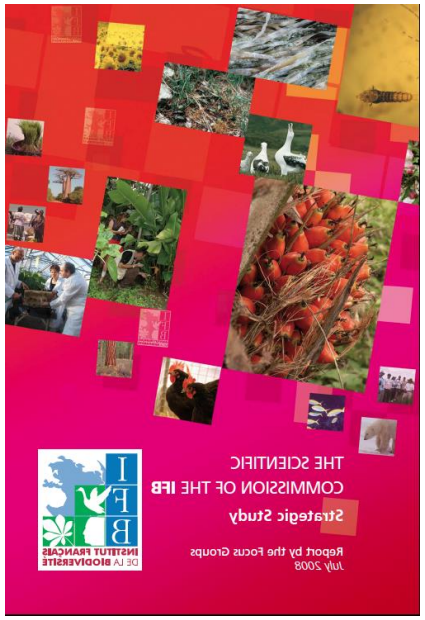
27&28 octobre 2014

VetAgro Sup

Campus vétérinaire de Lyon (Marcy L'Etoile)



2008. Strategic report,
group “biodiversity and health”



2009; Strategy and priorities
For the French research on biodiversity

2011. Report on CC and biodiversity in France
(Forest Ecosystems)

Ecosystems and Human Well-being

Biodiversity Synthesis

MILLENNIUM ECOSYSTEM ASSESSMENT

Living Beyond Our Means




Natural Assets and Human Well-being

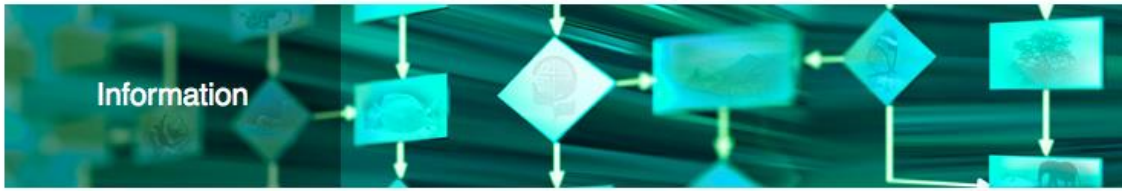
Statement from the Board

MILLENNIUM ECOSYSTEM ASSESSMENT

Convention on Biological Diversity

Se

The Convention | Cartagena Protocol | Nagoya Protocol | Programmes



- News & Communications
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- Statements
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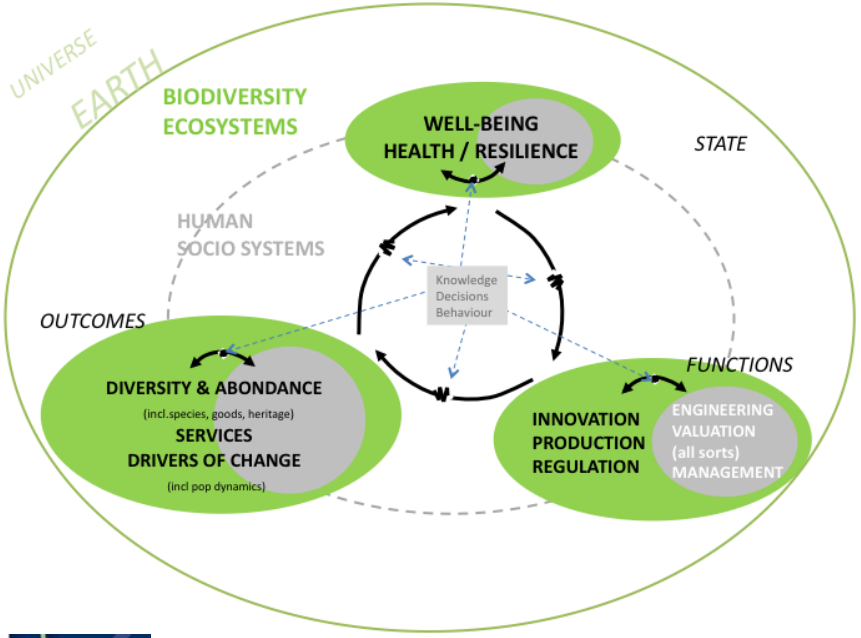
- News Headlines on Biodiversity

> Information > SBSTTA Recommendation

Back to SBSTTA Recommendations

SBSTTA 18 Recommendation XVIII/14

XVIII/14. Health and biodiversity



http://www.ipbes.net/

One Health and EcoHealth: the same wine in different bottles?

François ROGER, Aurélie BINOT, Kawandra CAKON, Véronique CHEVALIER, Muriel FASUR, Nicolas GAGET, Michel de GARINE-WICHATITSKY, Serge MORAND, Miguel PEDRONO, Annelise TRAN, Marie-Noël de VISCHER

Cirad-AGIRs, Cirad-BIOS, CIRD-CIRH - Antananarivo, Bangkok, Nouméa, Montpellier

Please read with no moderation!

Although "One Health" and "EcoHealth" are both holistic approaches to health, their development has been driven by different scientific concerns and cultures

Local Grape Variety...
Link territories through various local « community-based » actions with a multitude of actors

EcoHealth

Is defined more as an ecosystem approach to health, focusing on environmental and socioeconomic issues and initially designed by disease ecologists working in the field of biodiversity conservation.

Yet both approaches are informed by the conviction that health concerns must be addressed at the interface of human, animal, natural and social environments

Both are trying to integrate scientific disciplines in multi-disciplinary and cross-disciplinary approaches

Both aim to mitigate risks threatening ecosystems and public health, including veterinary public health

Both struggle to properly define the boundaries of their concepts

If their points of origin differ, the simultaneous success of both ideas is timely and not purely by chance: they are responding to a growing and common perception of the complexity of public health and conservation issues

Global Grape Variety...
Strategic plans to reduce infectious diseases risks at the human-animal ecosystems interface

One Health

Appears to be mainly concerned with biomedical questions and is historically more health science-driven.
The field of "One Health" is evolving on a large scale and at official levels.

In our view, the convergence, even the fusion, of the two concepts should be seriously considered and would be mutually beneficial.

Such a move would deter the creation of new divisions among medical doctors, veterinarians, ecologists and conservationists, while facilitating the incorporation of social sciences.

In so doing, a single paradigm that can be adapted to different socio-ecosystems and different operational levels could be defined to achieve greater efficiency in "biosphere health" management.

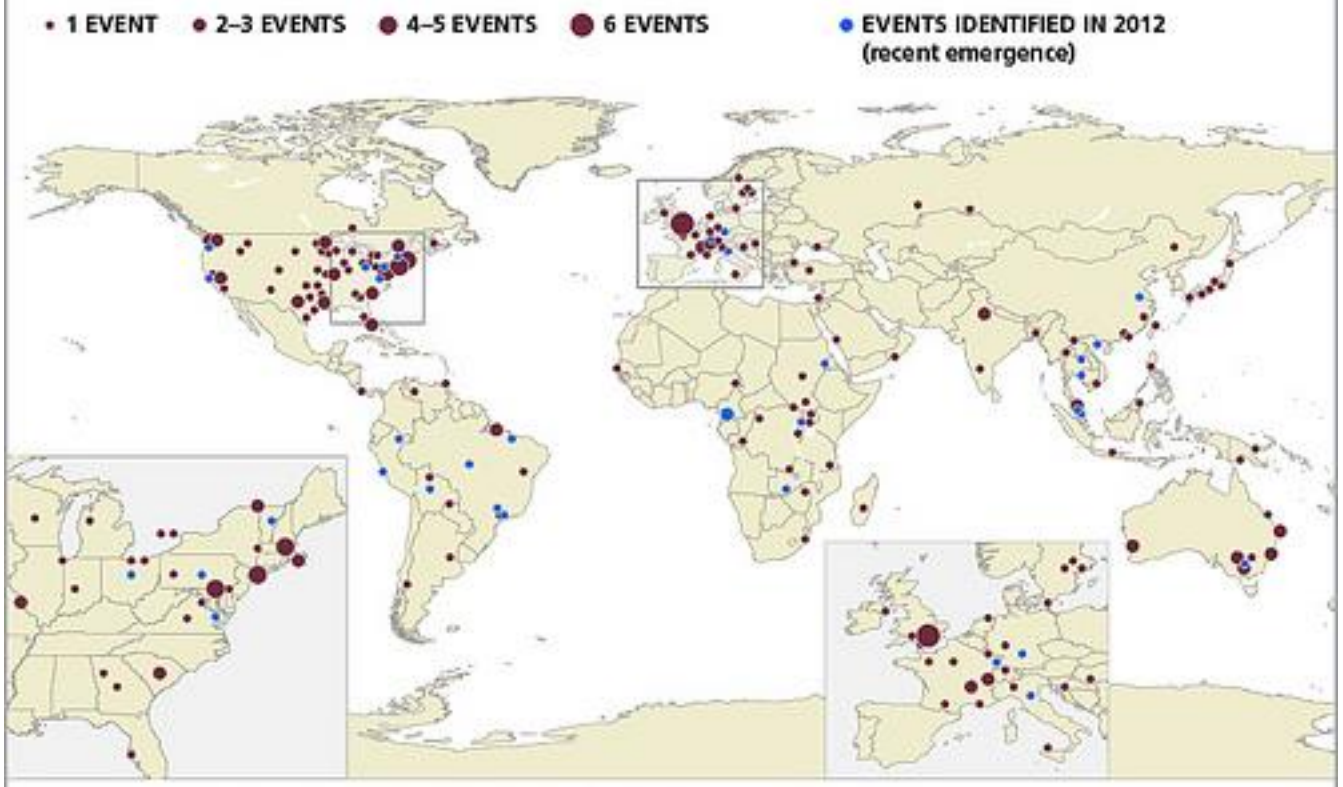
Field Implementation of EcoHealth & One Health Activities by Cirad Teams
Sustainable socio-ecological systems benifiting from Human-Nature healthy interfaces are our common goal.

Importance du Global

Emerging Zoonotic Disease Events, 1940–2012

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

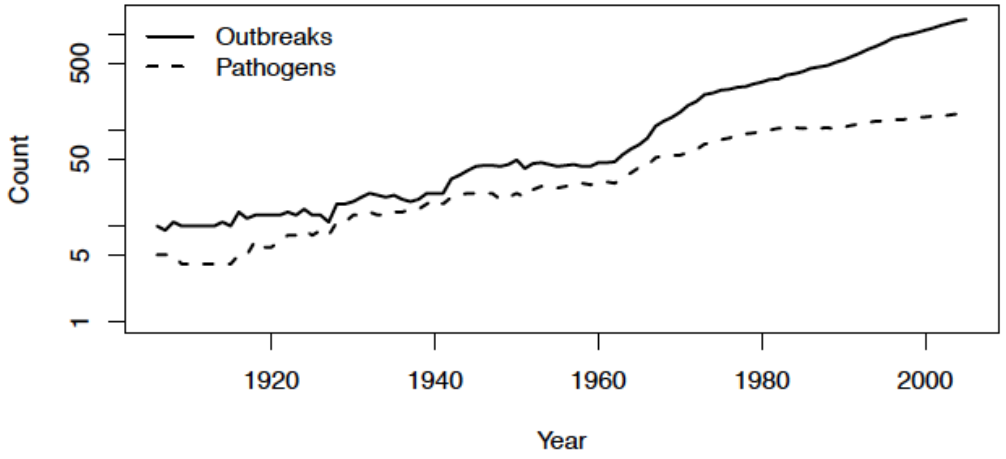
Most emerging human diseases come from animals. This map locates zoonotic events over the past 72 years, with recent events (identified by an ILRI-led study in 2012) in blue. Like earlier analyses, the study shows western Europe and western USA are hotspots; recent events, however, show an increasingly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



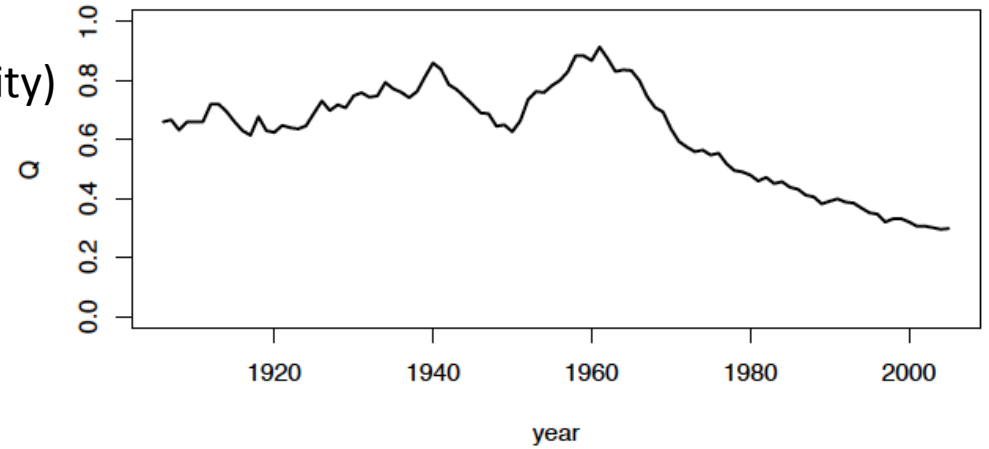
Map by IOZ, published in an ILRI report to DFID: *Mapping of Poverty and Likely Zoonoses Hotspots*, 2012.

Ongoing worldwide homogeneization of human pathogens

Increase of outbreaks

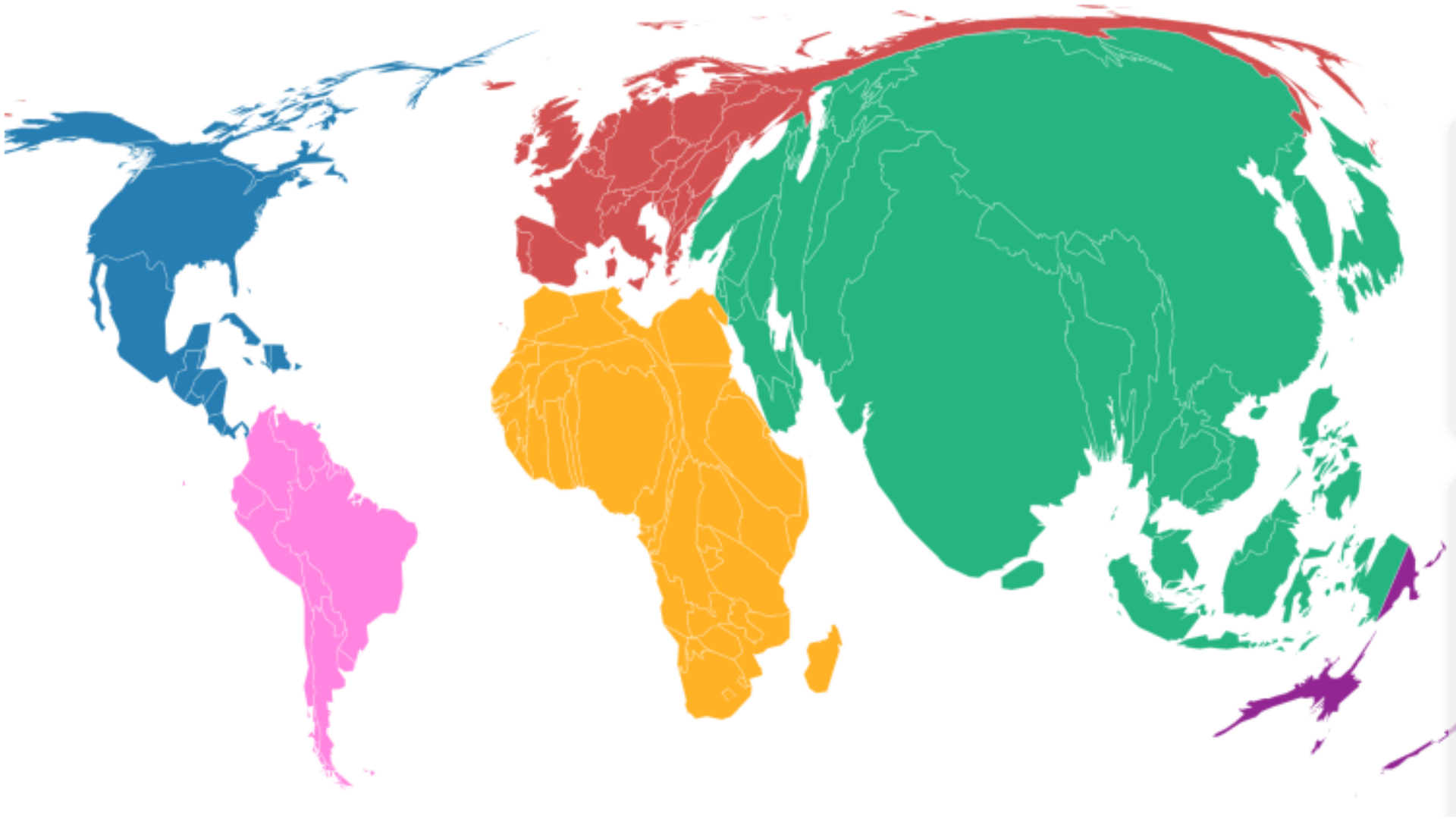


Homogeneization
(pathogen-country modularity)



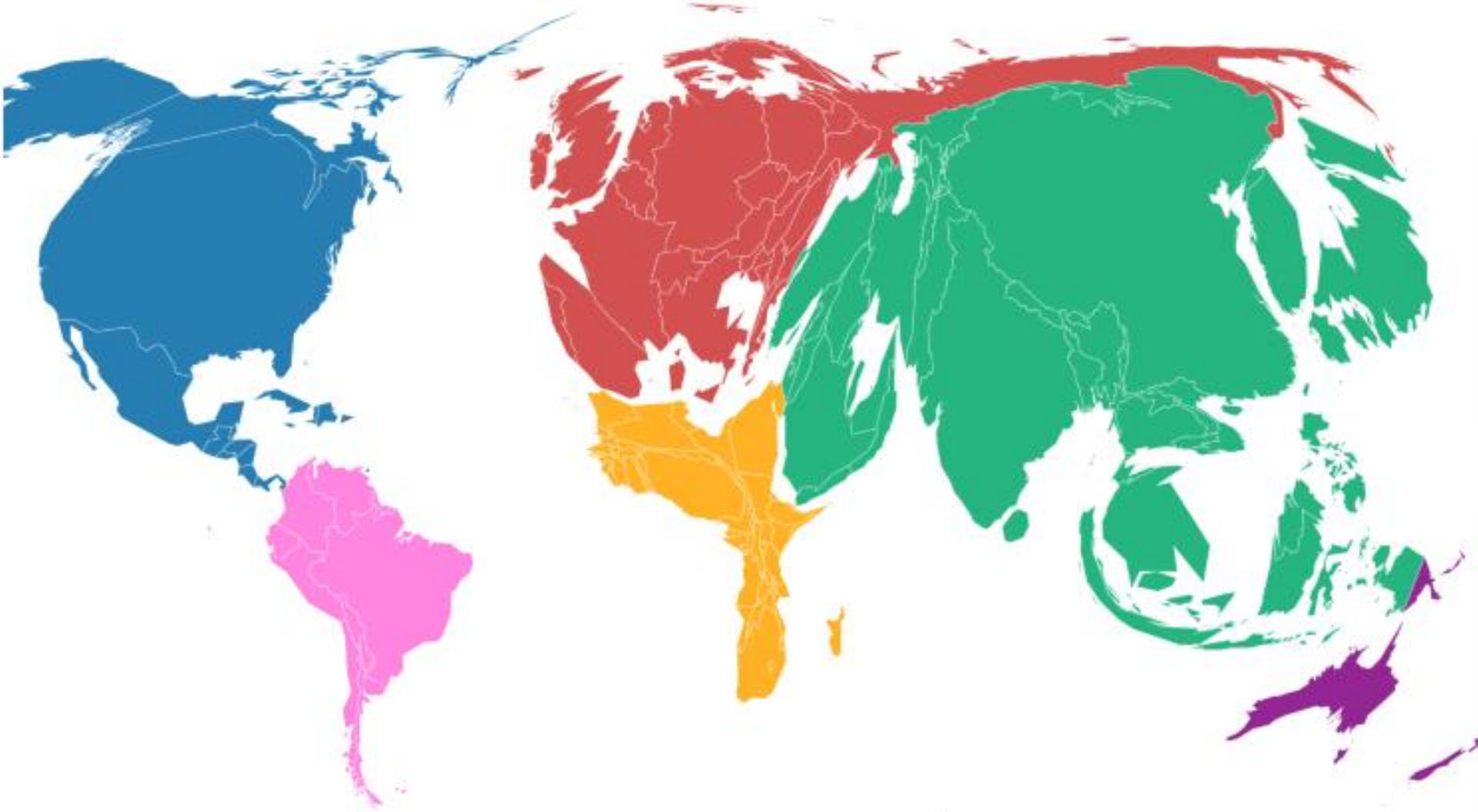
(Poisot, Nunn & Morand, sub)

People

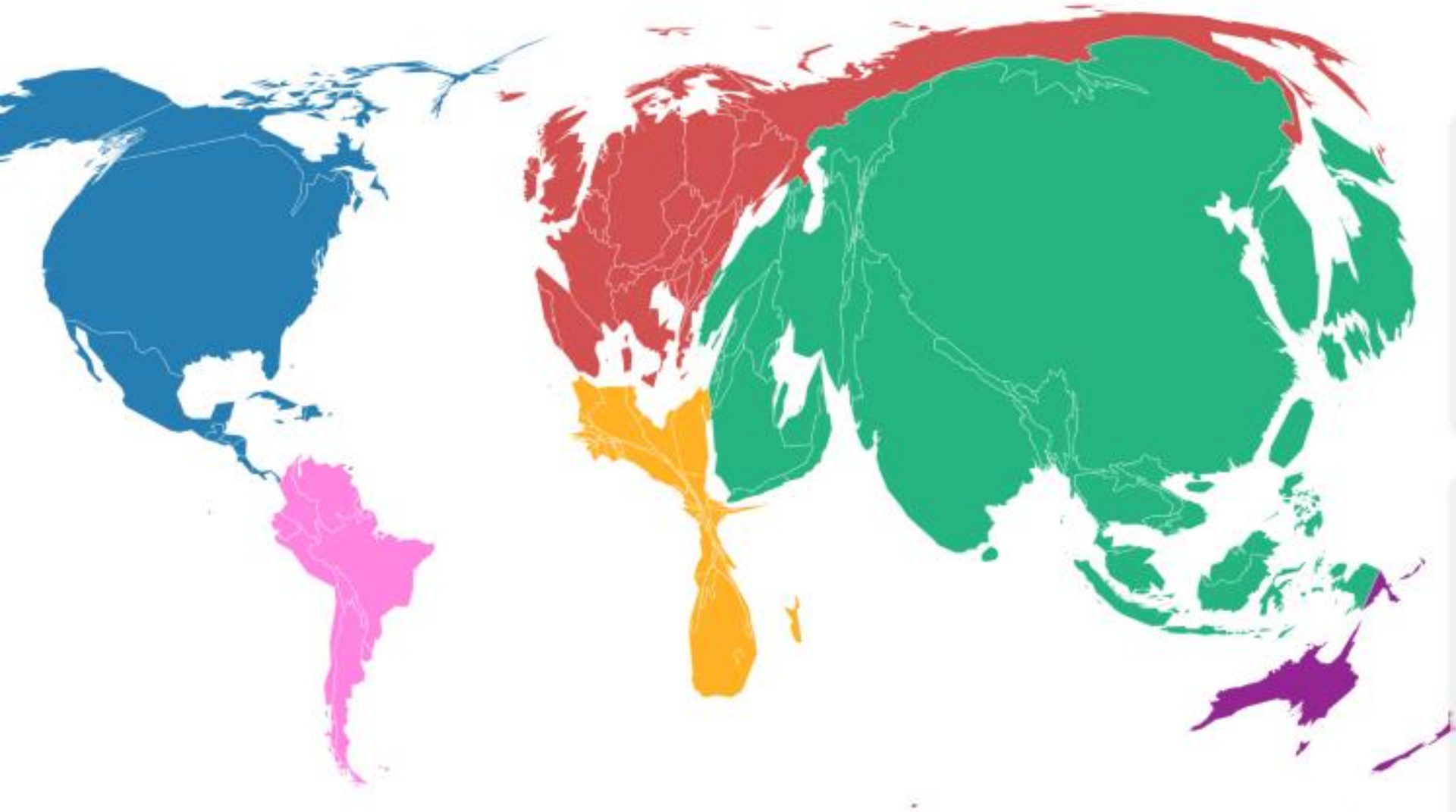


The Guardian

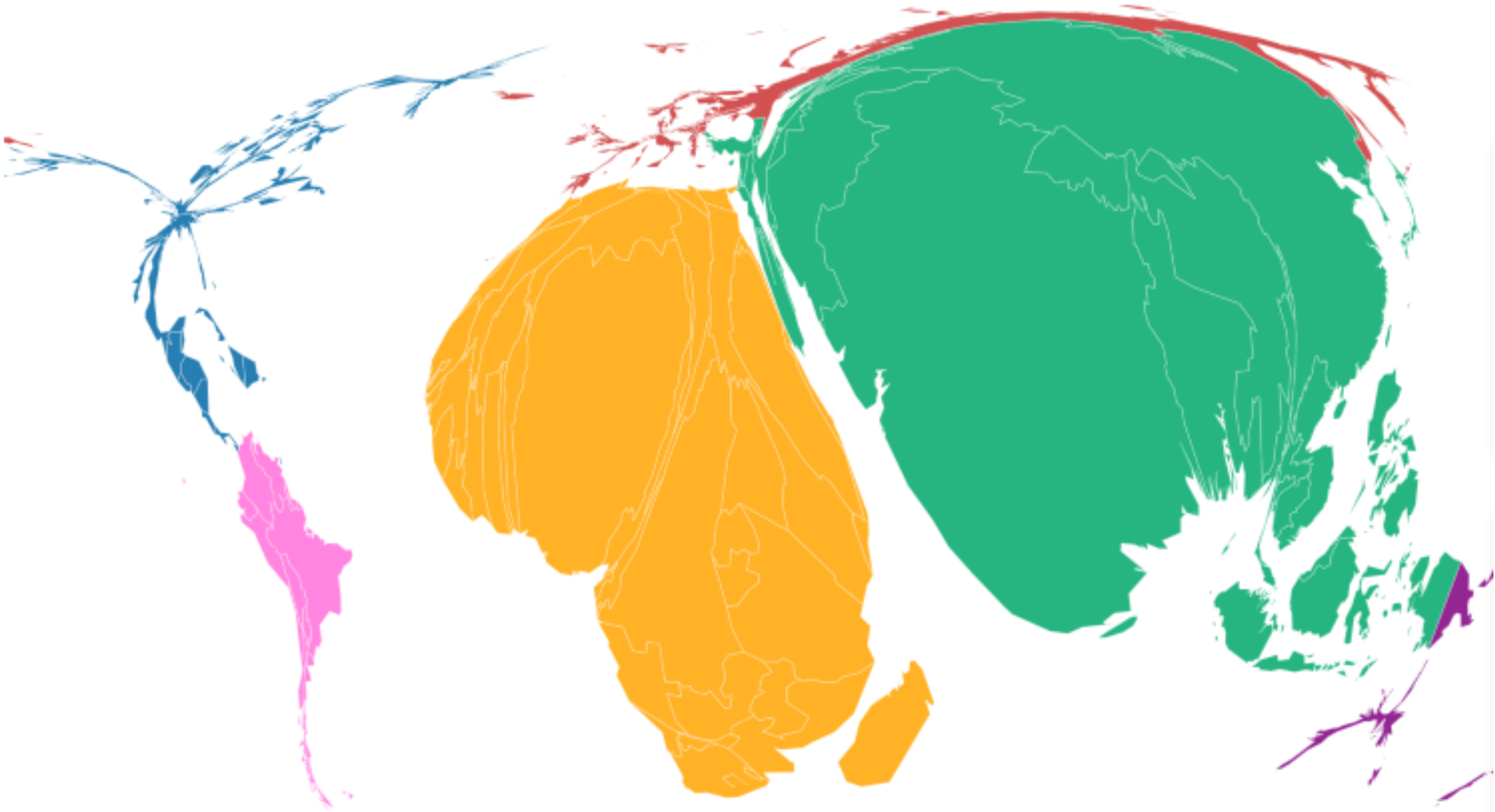
Wealth



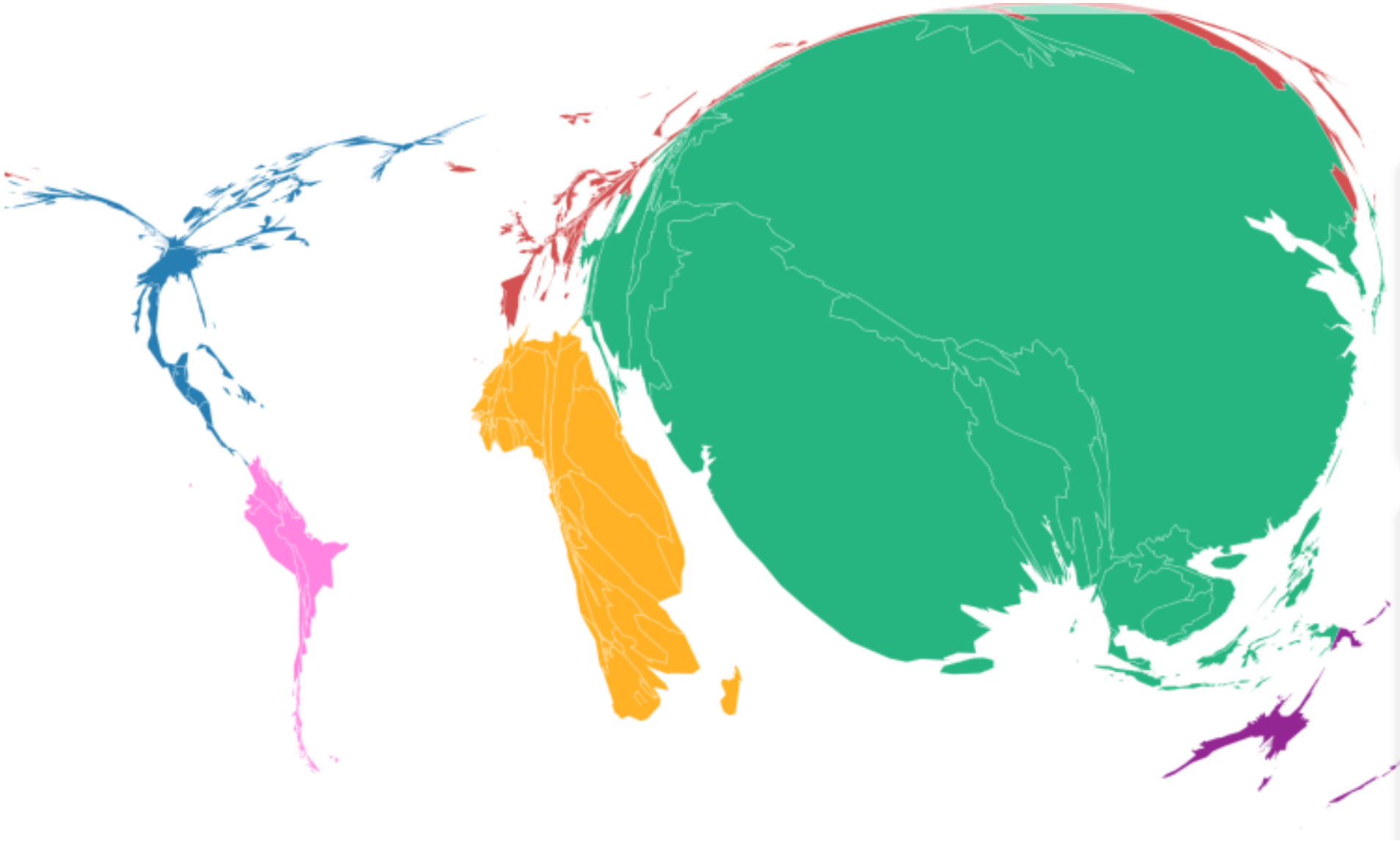
CO2 Emissions



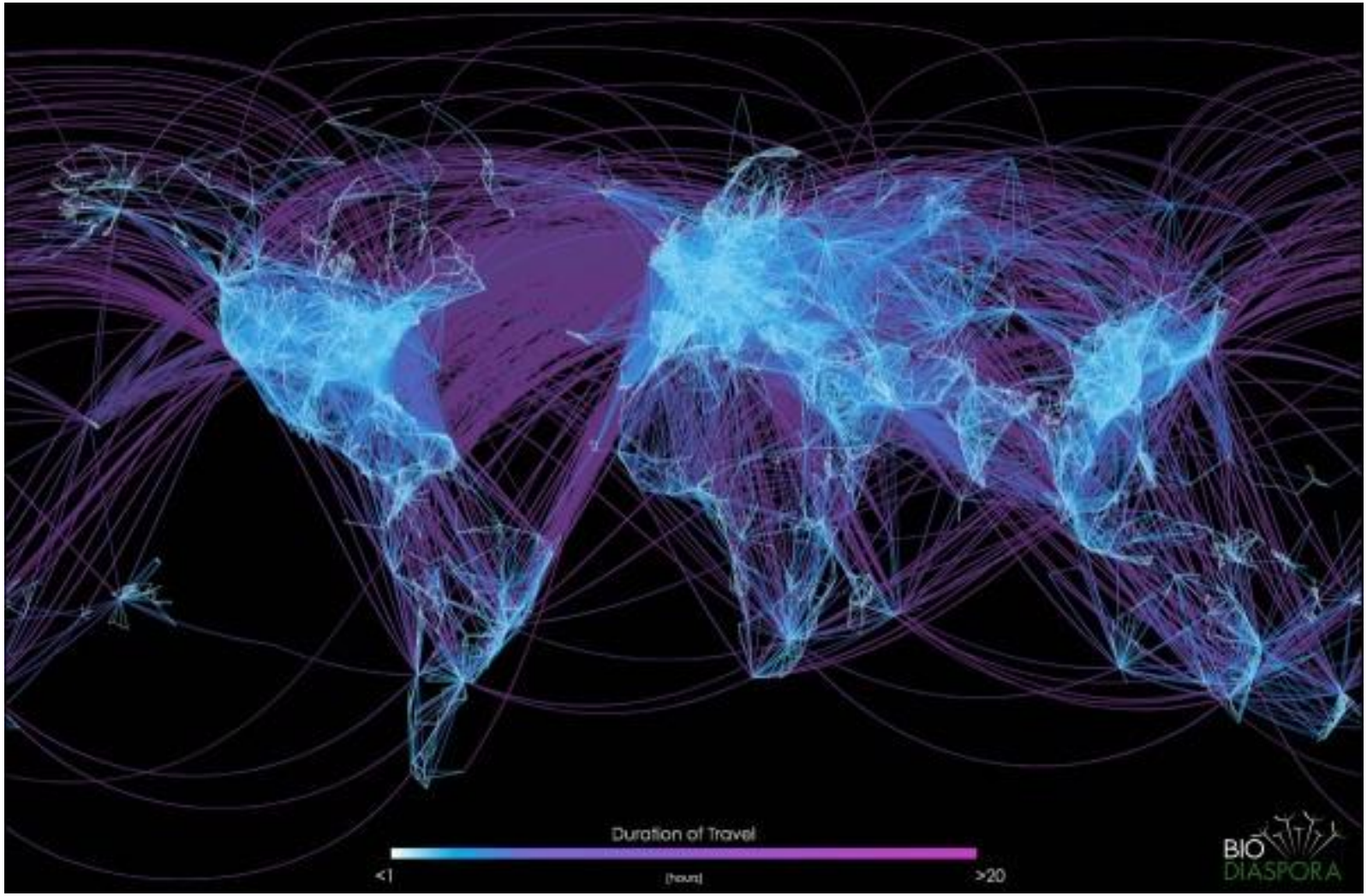
Poverty



People at risk



World flight travels



Climate change

Climate change: the impact on the epidemiology and control of animal diseases
Scientific and Technical Review 27(2), 2008
(de la Rocque, Morand & Hendrickx, eds)

The ecology of climate change and infectious diseases

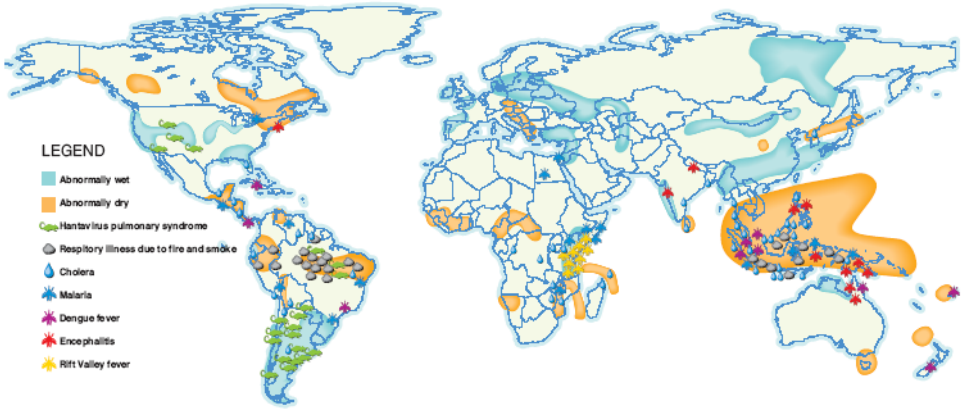
Kevin D. Lafferty[1]

1- There is **little evidence** that climate change has already favored infectious diseases.
2- Recent models predict range shifts in disease distributions, with **little net increase in area.**
3- Variability and **extreme events** matter
4-Many factors can affect infectious disease, and some may overshadow the effects of climate.

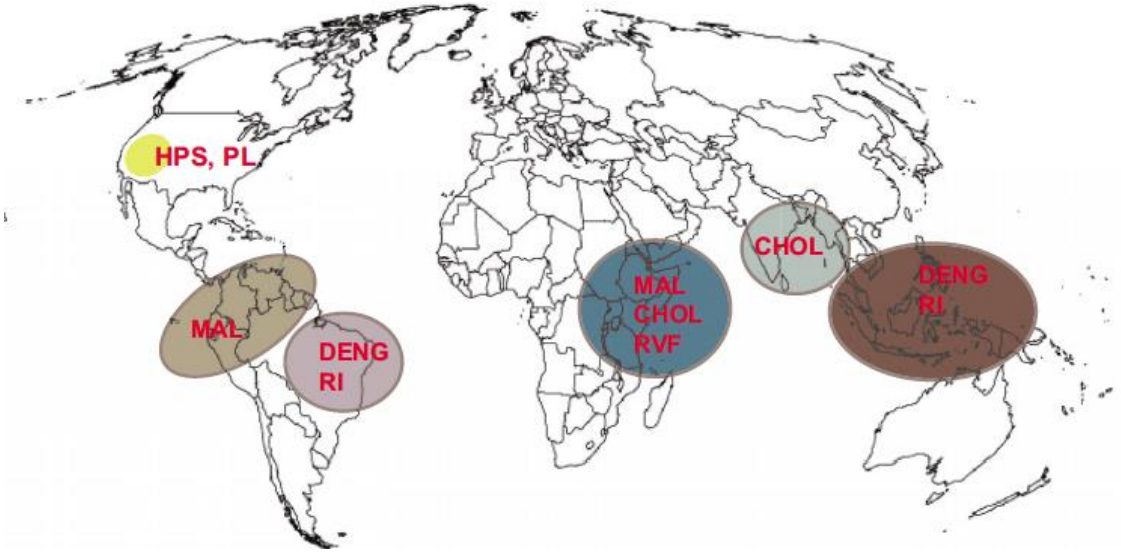
Climate variability

Extreme events, major El Niño, and epidemic outbreaks in 1997-1998

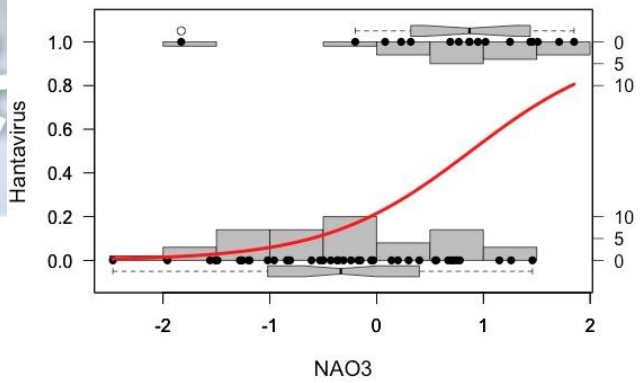
(Bryan Christie/Scientific American 2000)



El Niño and epidemic outbreaks in 2006-2007 (Anyamba et al. 2006)



SCIENTIFIC REPORTS



OPEN

SUBJECT AREAS:
BACTERIAL INFECTION

Climate variability and outbreaks of infectious diseases in Europe

Serge Morand[1,2], Katharine A. Owers[1], Agnes Waret-Szkuta[2], K. Marie McIntyre[3] & Matthew Baylis[3]

OPEN ACCESS Freely available online

PLoS NEGLECTED TROPICAL DISEASES

Climate Teleconnections and Recent Patterns of Human and Animal Disease Outbreaks

Assaf Anyamba[1]*, Kenneth J. Linthicum[2], Jennifer L. Small[1], Kathrine M. Collins[1], Cc
Edwin W. Pak[1], Seth C. Britch[2], James Ronald Eastman[3], Jorge E. Pinzon[1], Kevin L. F

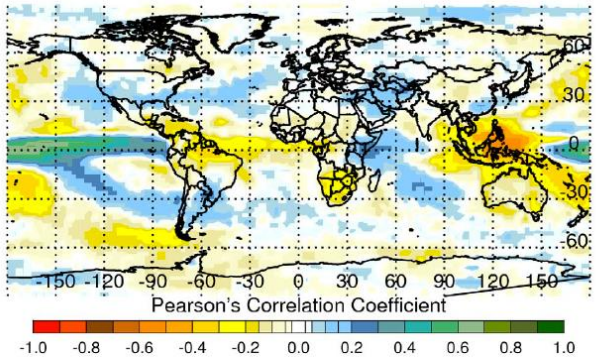


Figure 1. Summary correlation map between monthly NINO3.4 SST and rainfall anomalies, 1979–2008. Correlation of sea surface temperatures and rainfall anomalies illustrate ENSO teleconnection patterns. There is a tendency for above (below) normal rainfall during *El Niño* (*La Niña*) events over East Africa (Southern Africa, Southeast Asia). Similar differential anomaly patterns were observed for other regions, especially within the global tropics. These extremes (above or below) in rainfall influence regional ecology and consequently dynamics of mosquito disease vector populations and patterns of mosquito-borne disease outbreaks.
doi:10.1371/journal.pntd.0001465.g001

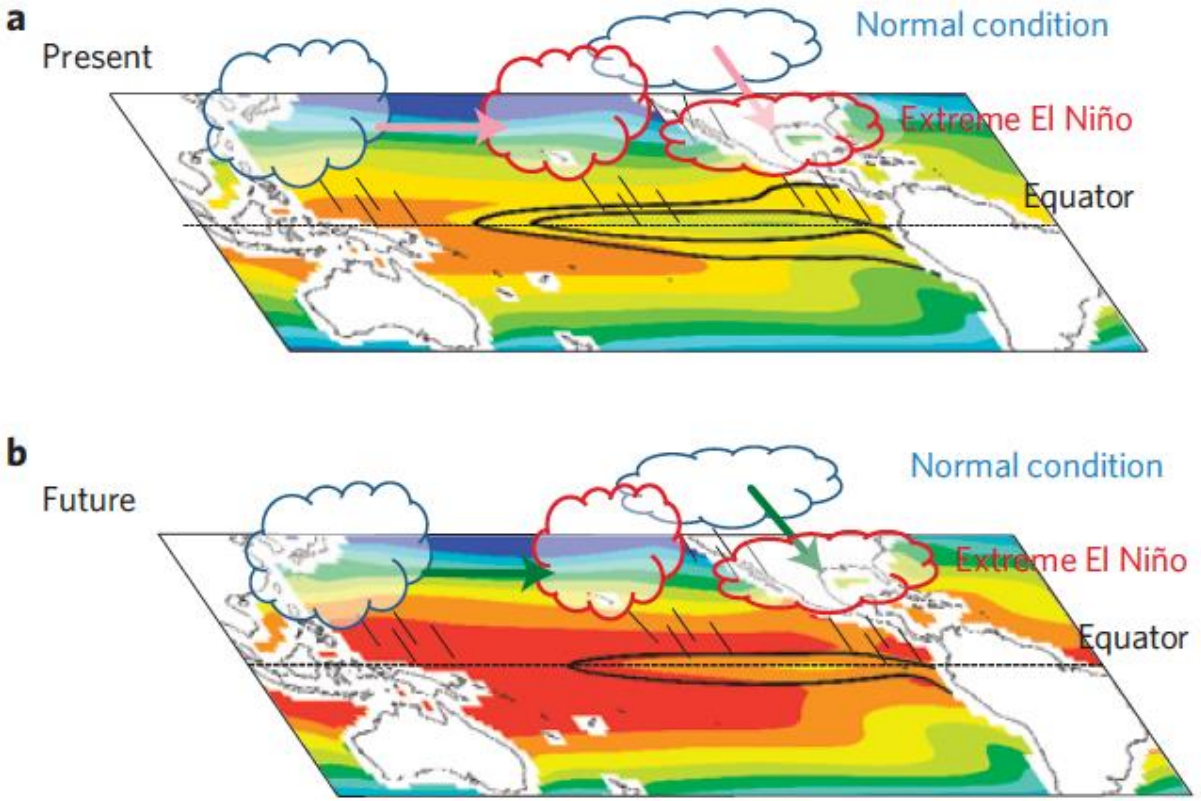
nature climate change

LETTERS

PUBLISHED ONLINE: 19 JANUARY 2014 | DOI: 10.1038/NCLIMATE2100

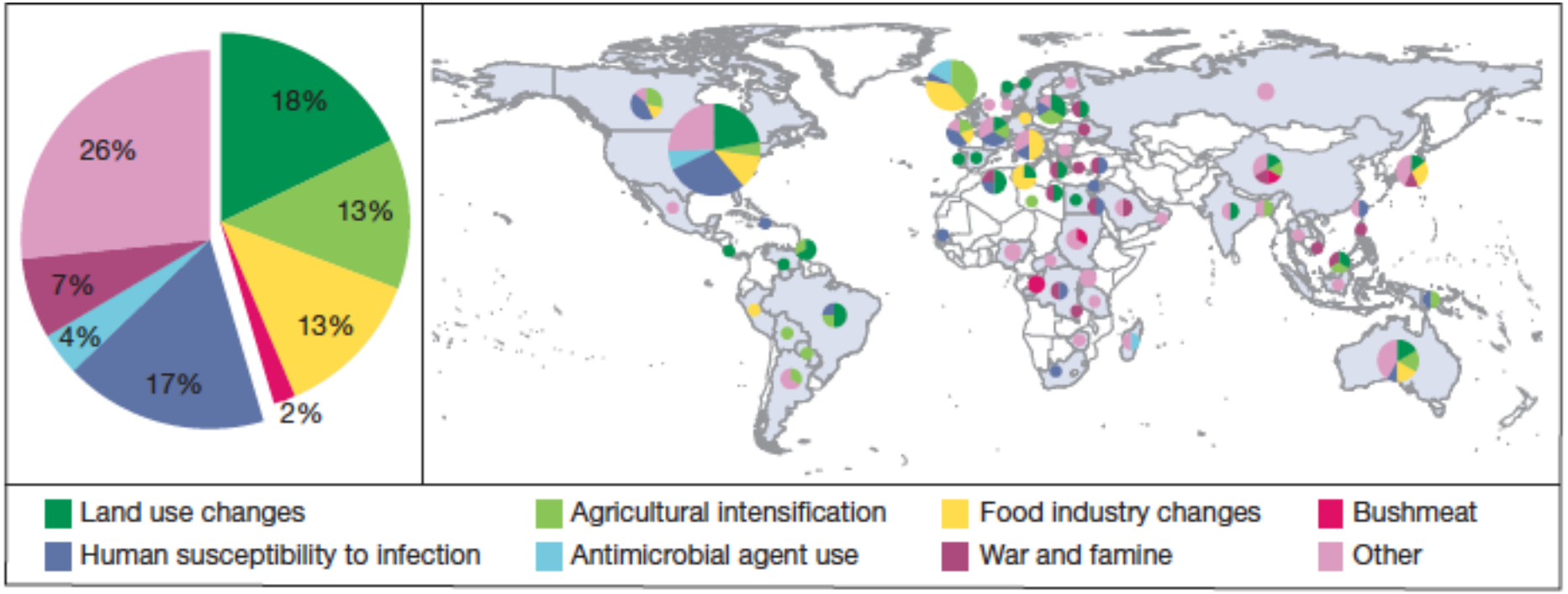
Increasing frequency of extreme El Niño events due to greenhouse warming

Wenju Cai[1,2*], Simon Borlace[1], Matthieu Lengaigne[3], Peter van Rensch[1], Mat Collins[4], Gabriel Vecchi[5], Axel Timmermann[6], Agus Santoso[7], Michael J. McPhaden[8], Lixin Wu[2], Matthew H. England[7], Guojian Wang[1,2], Eric Guilyardi[3,9] and Fei-Fei Jin[10]



Impacts of biodiversity on the emergence and transmission of infectious diseases

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



⇒ Environmental changes (biodiversity, land use)

⇒ Antimicrobial agents

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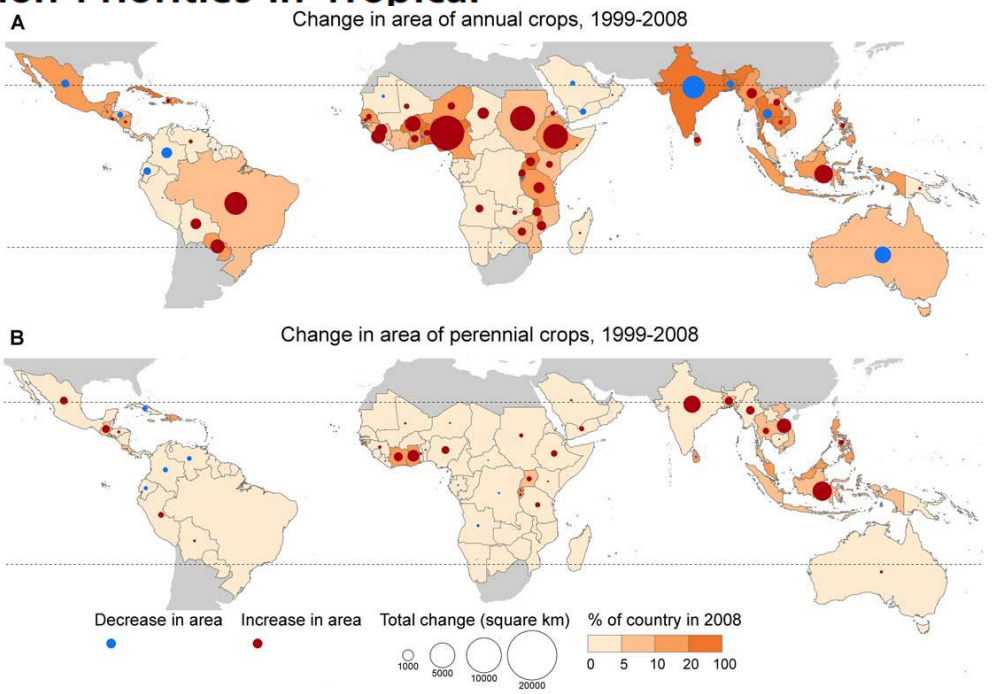
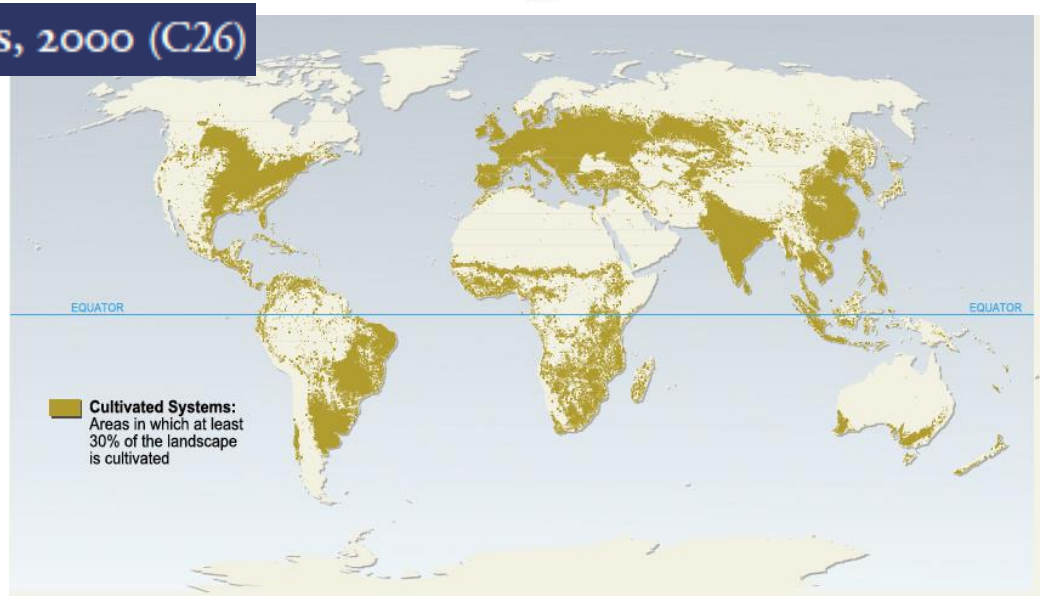
PLOS | ONE

Crop Expansion and Conservation Priorities in Tropical Countries

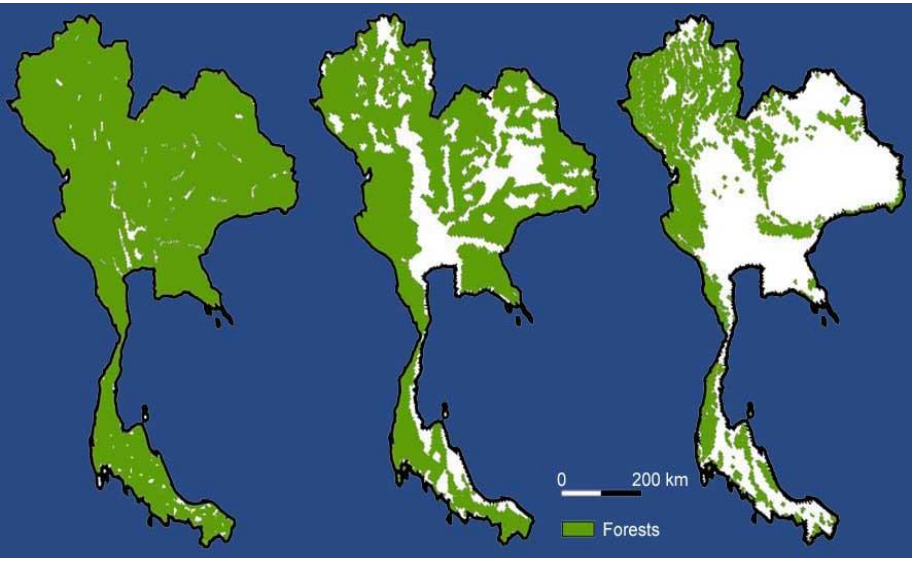
Ben Phalan[1]*, Monika Bertzky[2], Stuart H. M. Butchart[3], P
Alison J. Stattersfield[3], Andrew Balmford[1]



Extent of Cultivated Systems, 2000 (C26)



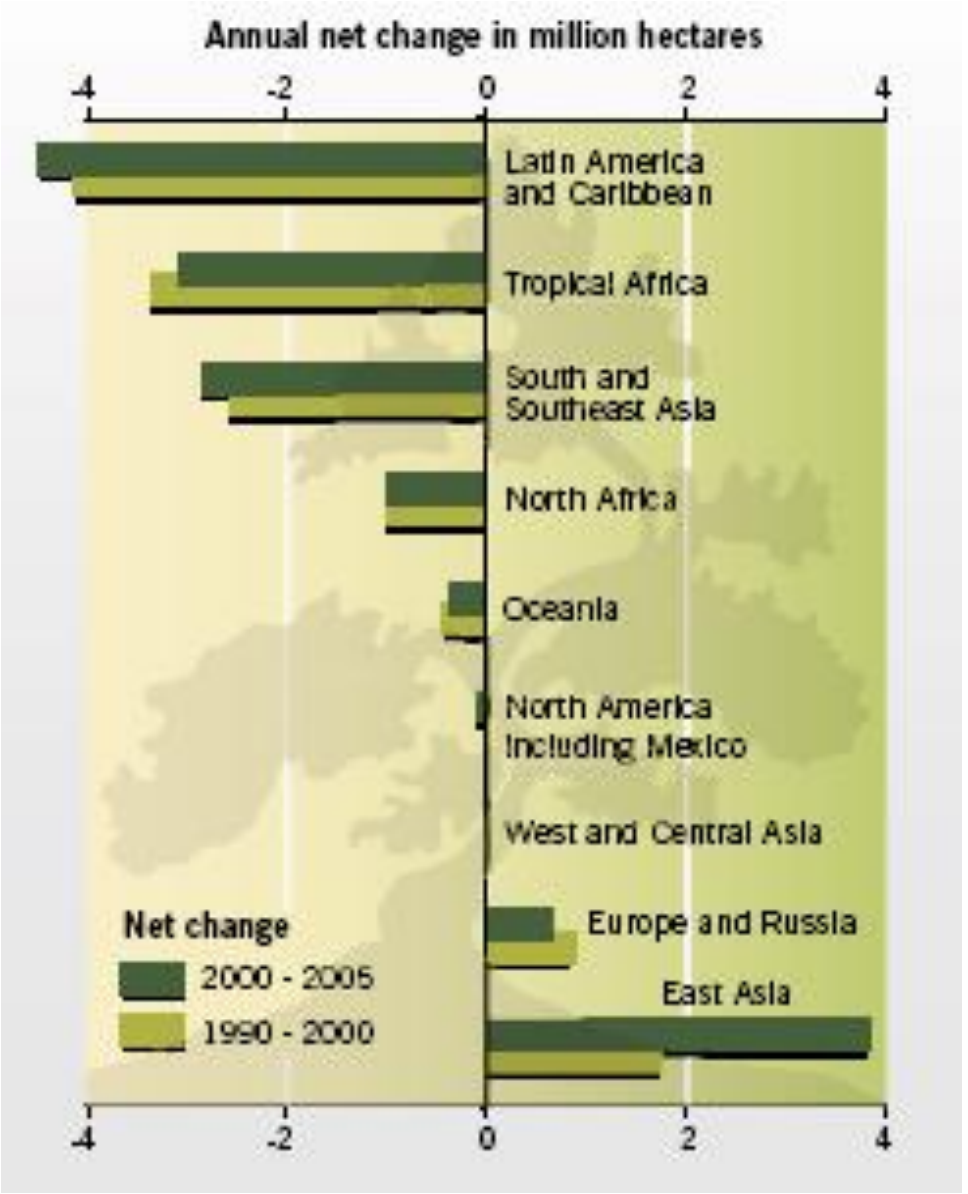
Changes in land use



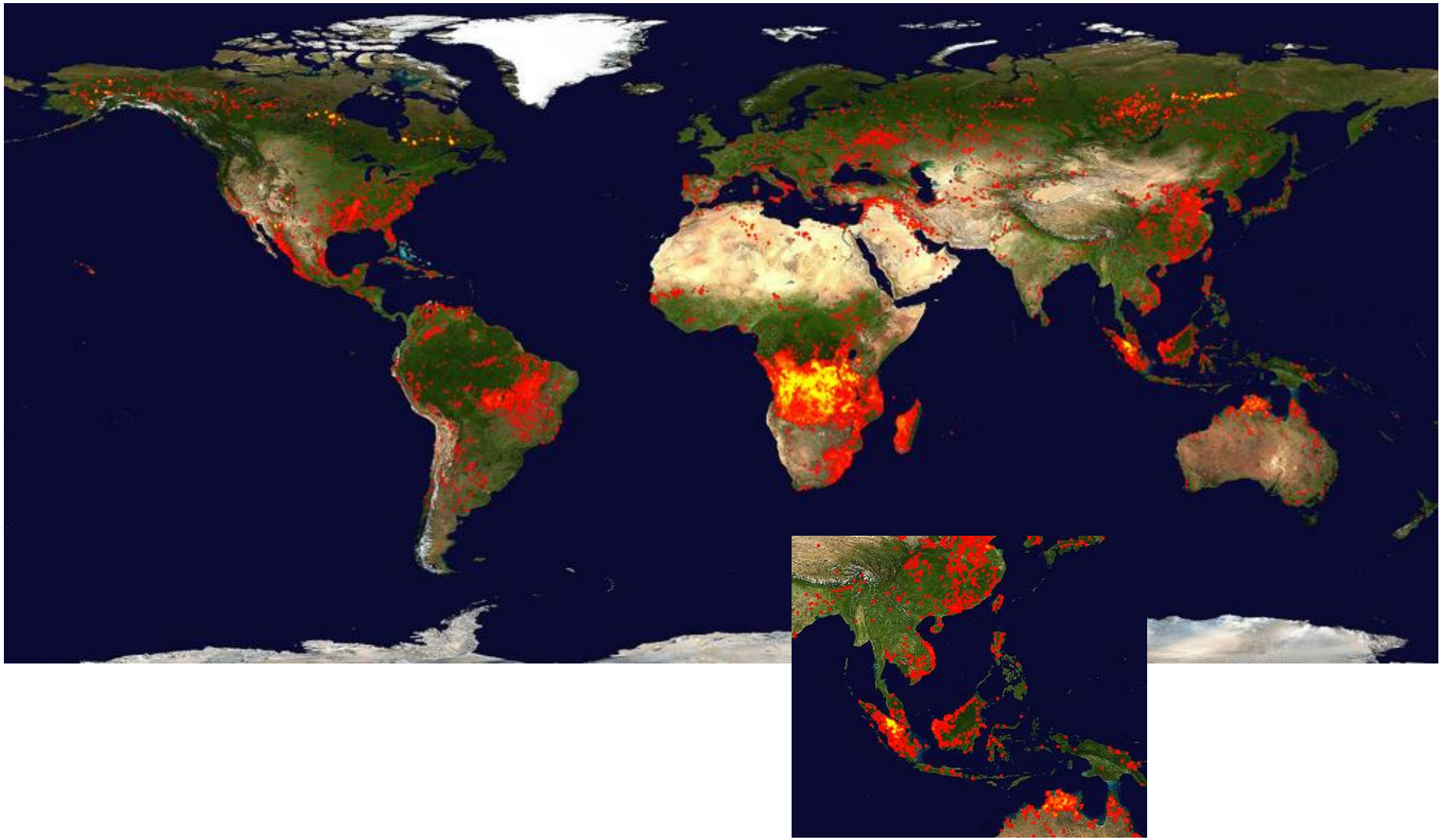
1840 (estimated)

1950

1990

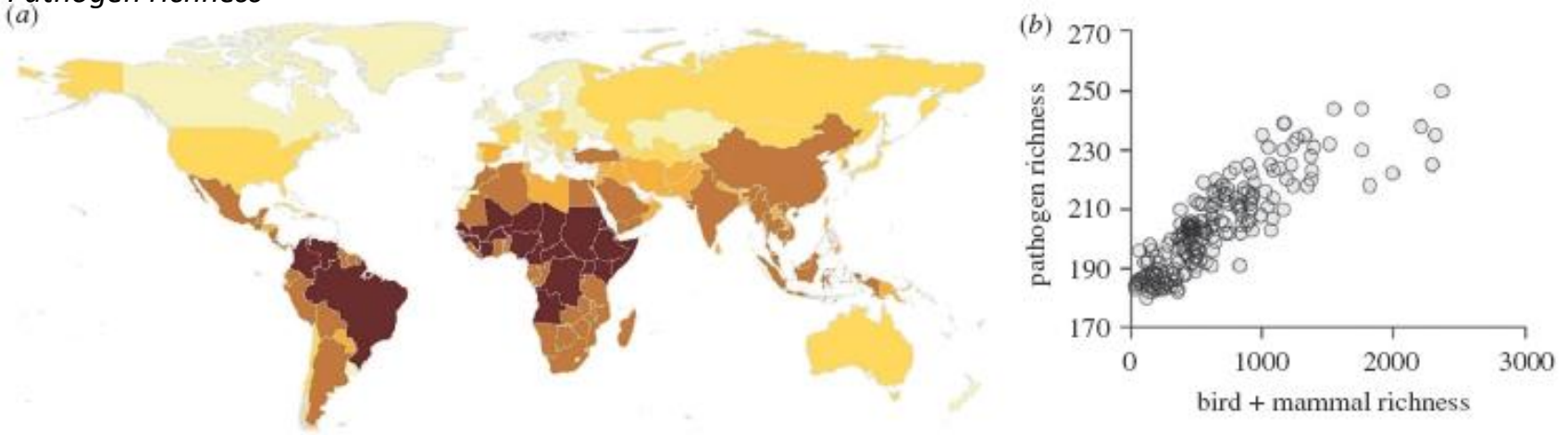


Fire maps

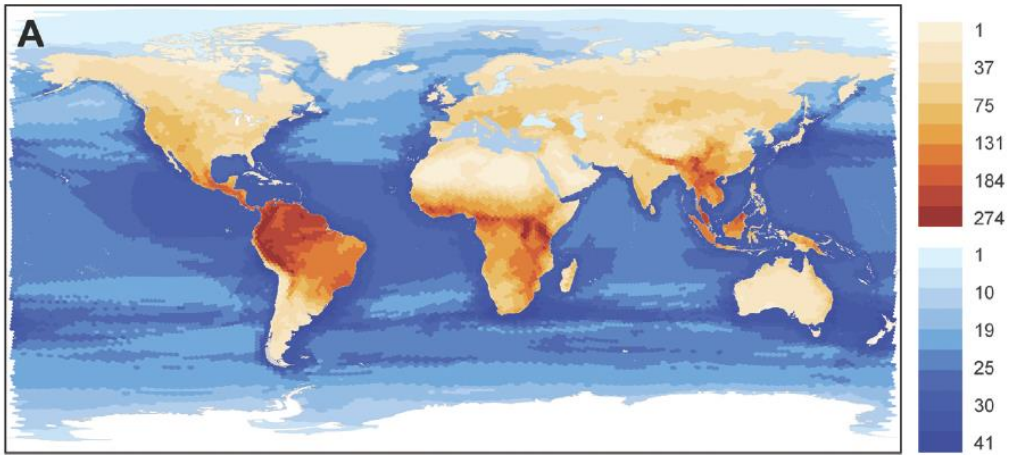


The biogeographic distribution of pathogens

Pathogen richness



Mammal species richness

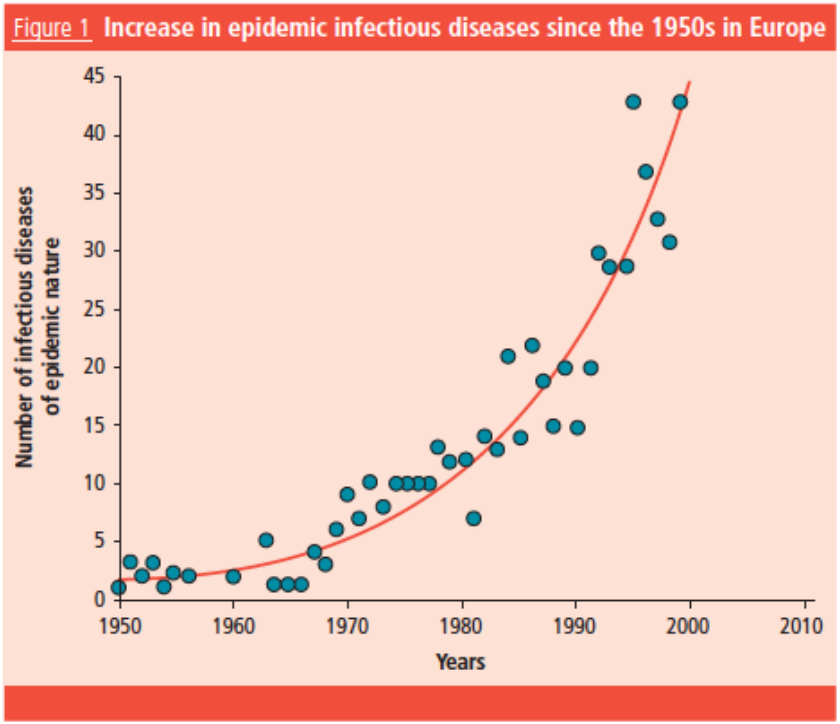


The diversity of Mammals and birds is linked with the diversity of human infectious diseases (Dunn et 2010)

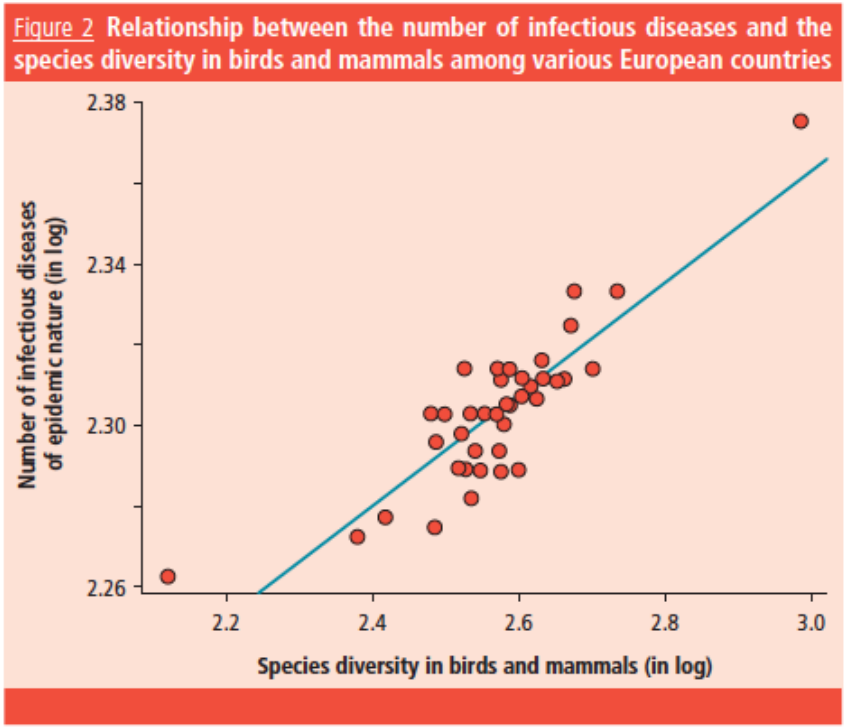
Schipper et al. 2009. Nature

Determinants of human infectious diseases in Europe

Increase of ID outbreaks



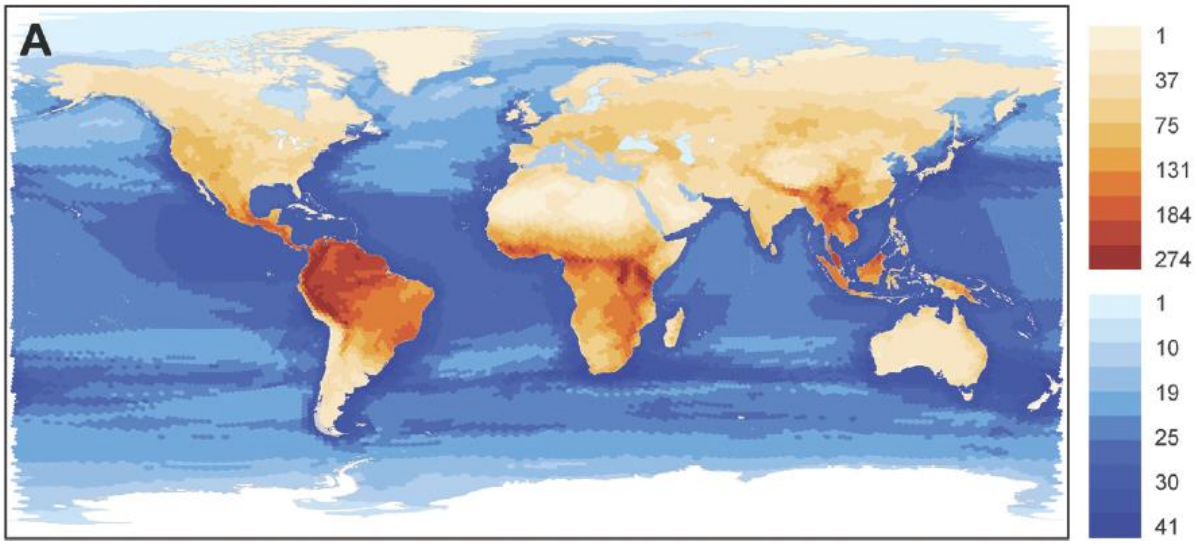
Human ID richness is correlated to biodiversity



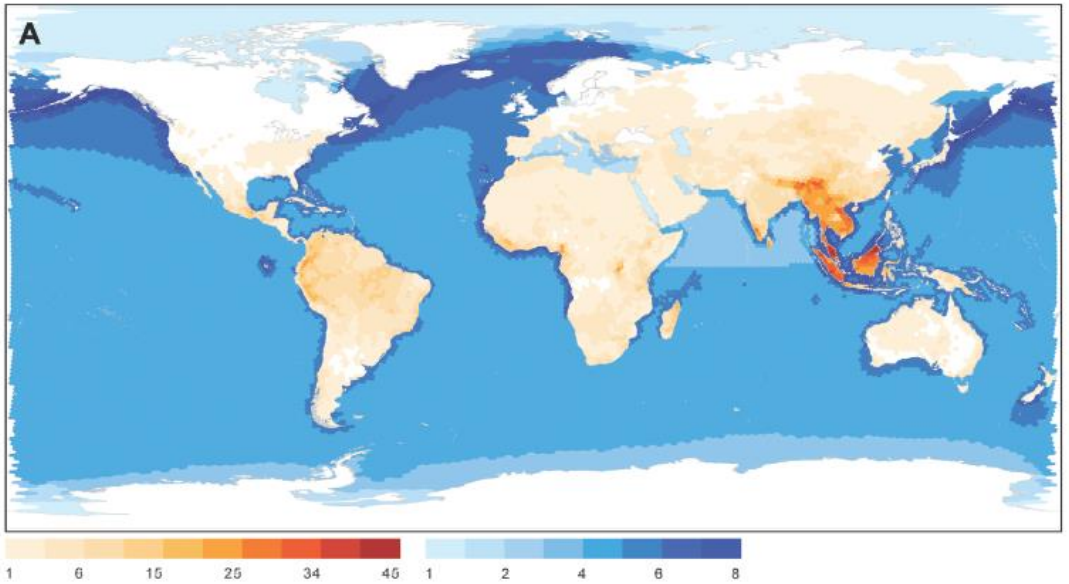
(Morand & Waret-Szkuta, 2012)

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

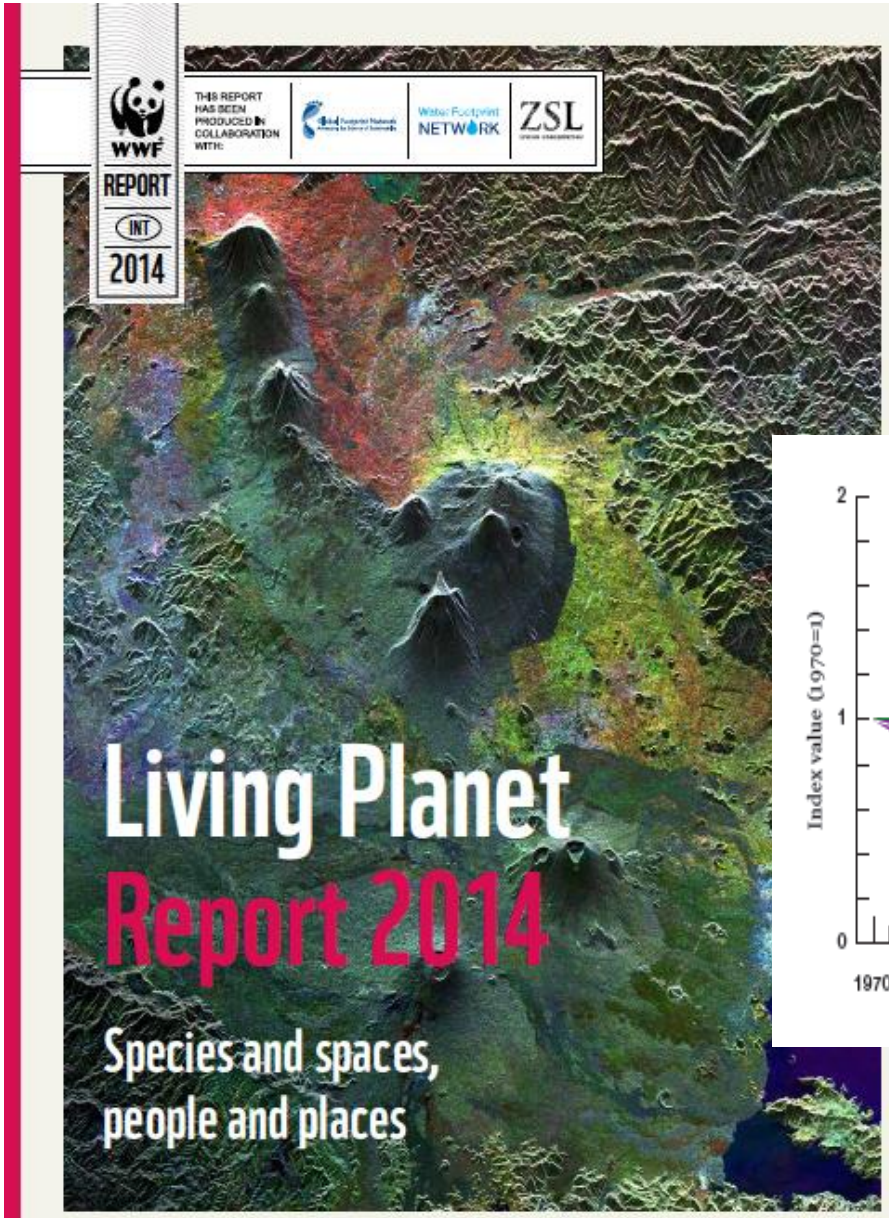
Species richness



Species at threat



Schipper et al. 2009. Nature



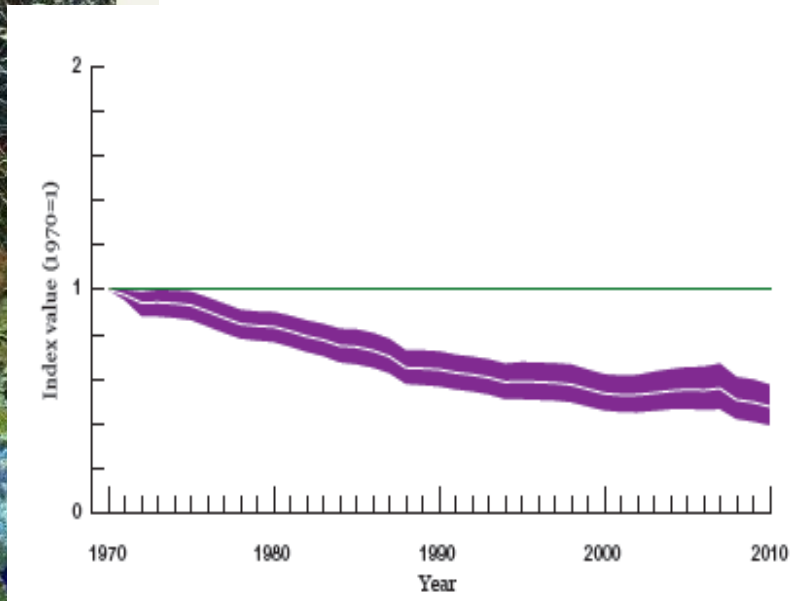


Figure 5: Global Living Planet Index shows a decline of 52 per cent between 1970 and 2010 (WWF, ZSL, 2014).

La différence entre un pessimiste et un optimiste…

La différence entre un pessimiste et un optimiste…

Le pessimiste : “*Cela ne peut être pire …*”

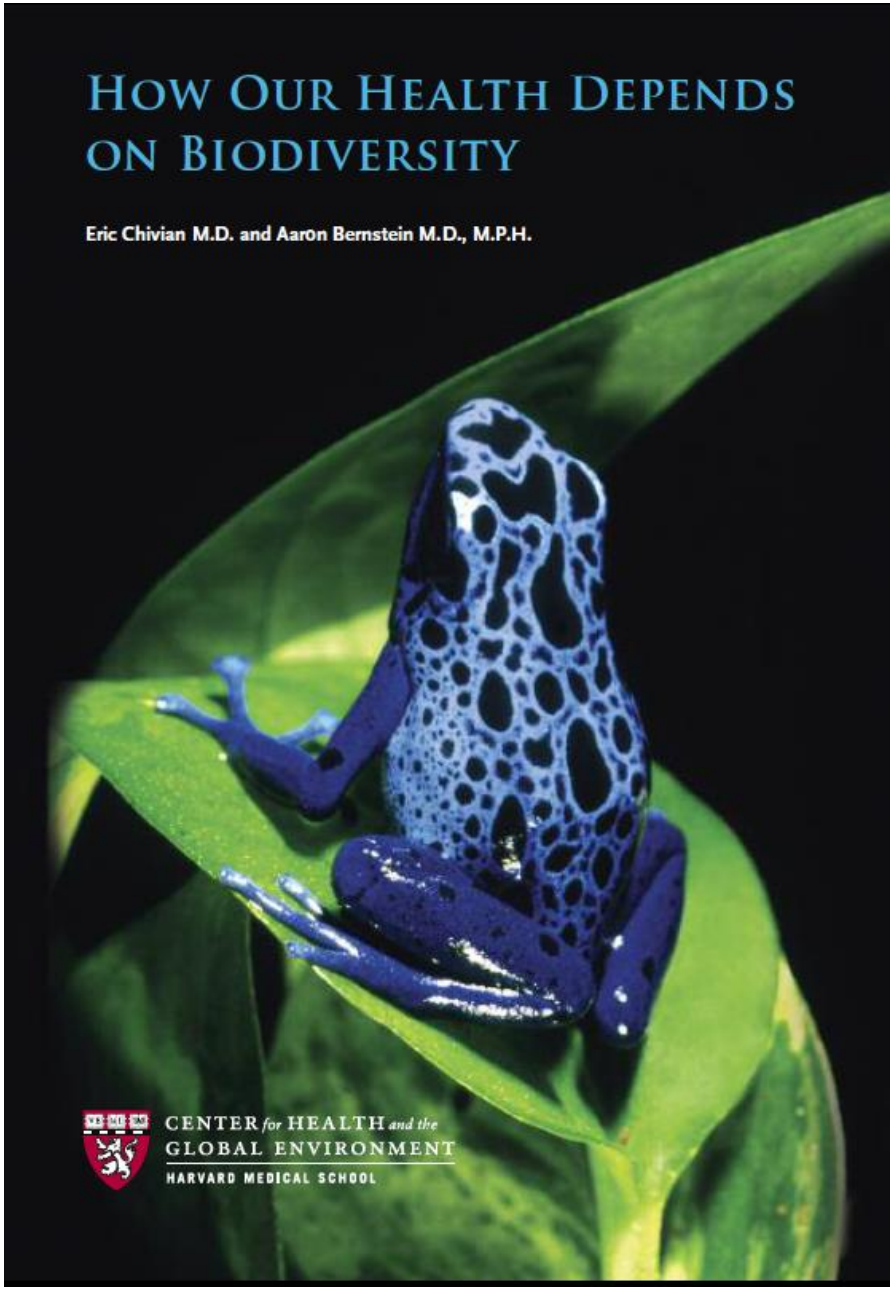
La différence entre un pessimiste et un optimiste…

Le pessimiste : “*Cela ne peut être pire …*”

L’optimiste: “*Mais si, mais si …*”

Représentations

Biodiversity as seen by ecologists …



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 t

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

Olaf Hajek

By JIM ROBBINS
Published: July 14, 2012 | 114 Comments

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3 September 2013 Last updated at 01:01 GMT

Share

Mammals harbour 'at least 320,000 new viruses'

By Rebecca Morelle
Science reporter, BBC World Service

There could be at least 320,000 viruses awaiting discovery that are circulating in animals, a study suggests.

Researchers say that identifying these viral diseases, especially those that can spread to humans, could help to prevent future pandemics.

The team estimates that this could cost more than £4bn ($6bn), but says this is a fraction of the cost of dealing with a major pandemic.

The flying fox is one of many mammals that carry viruses that spread to humans

M Planète

PLANÈTE Climat Énergies Ressources naturelles Biodiversité Population Agriculture & A

Le virus Ebola « hors de contrôle » en Afrique de l'Ouest

Le Monde.fr avec AFP | 30.07.2014 à 12h59 • Mis à jour le 31.07.2014 à 09h56

Abonnez-vous à partir de 1 € Réagir Classer Partager

Recommander Partager 6 930 personnes le recommandent. Inscription pour voir ce que vos amis recommandent.

Brucellose: vers un abattage total à Bargy

ACTUALITE > FLASH ACTU Par lefigaro.fr avec AFP | Mis à jour le 30/09/2014 à 11:44 | Publié le 30/09/2014 à 11:43

L'AUTEUR
SUR LE MÊME SUJET

Le préfet de la Haute-Savoie va saisir le conseil national de protection de la nature (CNPN) d'une demande d'abattage total des 300 bouquetins du massif du Bargy, atteints de brucellose.

Brucellose du bouquetin : l'abattage total n'assainira pas le massif du Bargy

Par Morgane Kergoat
Voir tous ses articles

Publié le 30-09-2014 à 18h10
Mis à jour le 01-10-2014 à 11h21

Les politiques veulent éradiquer le troupeau pour supprimer la maladie. Mais les scientifiques contestent cette mesure qui favoriserait au contraire la propagation de la brucellose.

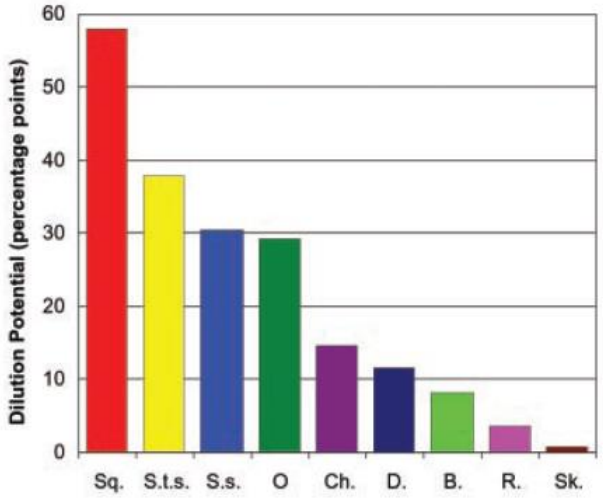
Au lieu d'endiguer l'épidémie de brucellose, l'abattage massif des bouquetins du Bargy pourrait au contraire précipiter sa diffusion aux troupeaux voisins. ©JEAN-PAUL CHATAGNON /

Controverses scientifiques

After some promising results and bright ideas…..

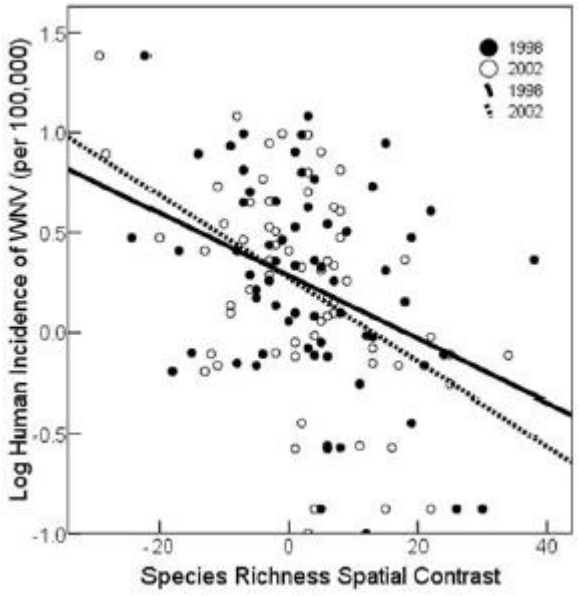
The ecology of infectious disease: Effects of host diversity and community composition on Lyme disease risk

Kathleen LoGiudice*†‡, Richard S. Ostfeld*, Kenneth A. Schmidt*§, and Felicia Keesing*¶



Increased Avian Diversity Is Associated with Lower Incidence of Human West Nile Infection: Observation of the Dilution Effect

John P. Swaddle[1,2]*, Stavros E. Calos[2]



… criticism, refutation and…. pessimism ...

Pangloss revisited: a critique of the dilution effect and the biodiversity-buffers-disease paradigm

S. E. RANDOLPH[1]* *and* A. D. M. DOBSON[1,2]

A meta-analysis suggesting that the relationship between biodiversity and risk of zoonotic pathogen transmission is idiosyncratic

Daniel J. Salkeld,[1,2]* Kerry A. Padgett[2] and James Holland Jones[1]

Biodiversity loss and its impact on humanity

Bradley J. Cardinale[1], J. Emmett Duffy[2], Andrew Gonzalez[3], David U. Hooper[4], Charles Perrings[5], Patrick Venail[1], Anita Narwani[1], Georgina M. Mace[6], David Tilman[7], David A. Wardle[8], Ann P. Kinzig[5], Gretchen C. Daily[9], Michel Loreau[10], James B. Grace[11], Anne Larigauderie[12], Diane S. Srivastava[13] & Shahid Naeem[14]

Table 1 | Balance of evidence linking biodiversity to ecosystem services

Category of service	Measure of service provision	SPU	Diversity level	Source	Study type	*N*	Relationship	
							Predicted	Actual
Regulating								
Biocontrol	Abundance of herbivorous pests (bottom-up effect of plant diversity)	Plants	Species	DS*	Obs	40	↗	↗
		Plants	Species	DS†	Exp	100	↗	↗
		Plants	Species	DS‡	Exp	287	↘	↗↘
		Plants	Species	DS§	Exp	100	↗	0
	Abundance of herbivorous pests (top-down effect of natural enemy diversity)	Natural enemies	Species/trait	DS*	Obs	18	↗	↗
		Natural enemies	Species	DS†	Exp/Obs	266	↗	↗
		Natural enemies	Species	DS‡	Exp	38	↘	↗↘
	Resistance to plant invasion	Plants	Species	DS	Exp	120	↘	↗
	Disease prevalence (on plants)	Plants	Species	DS	Exp	107	↗	↗
	Disease prevalence (on animals)	Multiple	Species	DS	Exp/Obs	45	↘	↗↘

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PLOS | ONE

Conservation Efforts May Increase Malaria Burden in the Brazilian Amazon

Denis Valle[1]*, James Clark[2]

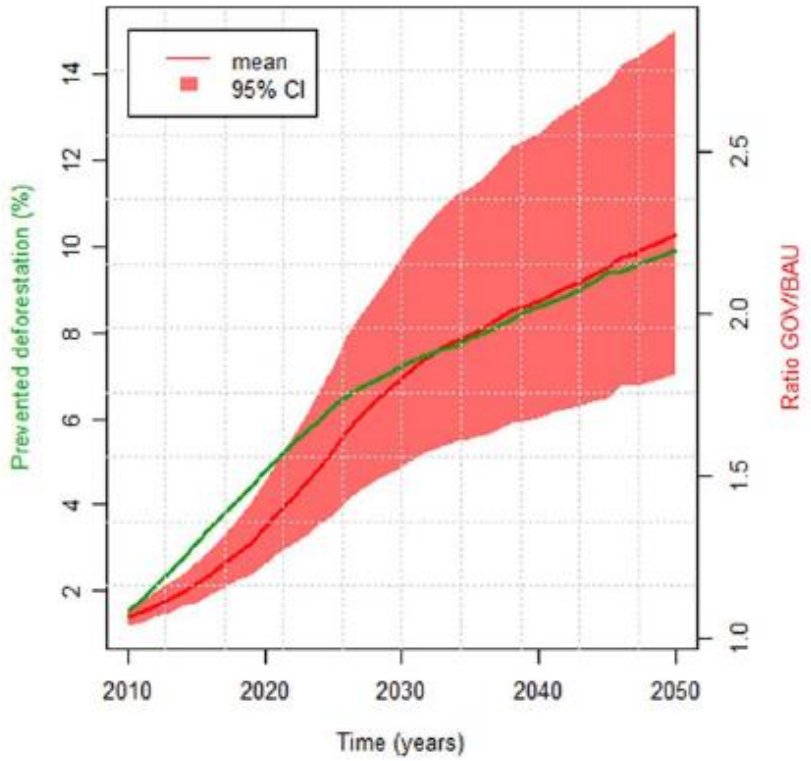


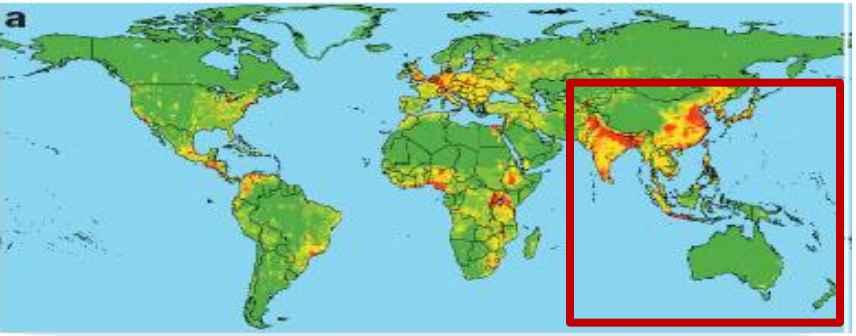
Figure 4. Malaria incidence increase at urban health posts in the governance scenario is predicted to be a direct consequence of prevented deforestation. We depict the relationship between future prevented deforestation under the governance scenario (green line), and the ratio of the expected malaria incidence for each year and city under the governance (GOV) and business-as-usual (BAU) future LULC scenarios (red line) (i.e., $E(C_{iy}^{GOV})/E(C_{iy}^{BAU})$), averaged across all cities. The red polygon represents the 95% credible interval of the average ratio$E(C_{iy}^{GOV})/E(C_{iy}^{BAU})$.

It's a myth that protection against disease is a strong and general service of biodiversity conservation: Response to Ostfeld and Keesing

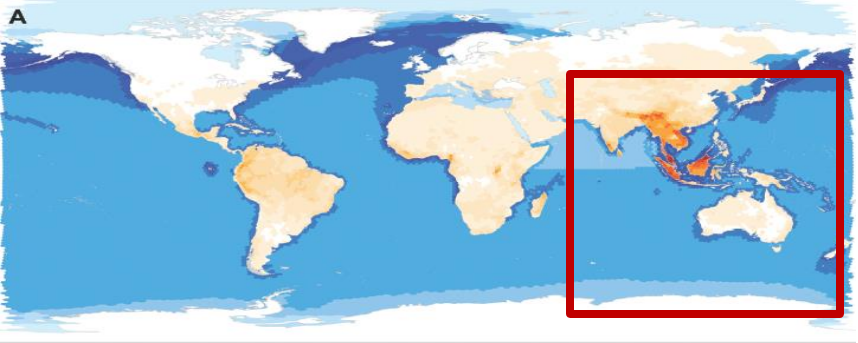
Kevin D. Lafferty[1] and Chelsea L. Wood[2]

Trends in Ecology & Evolution September 2013, Vol. 28, No. 9

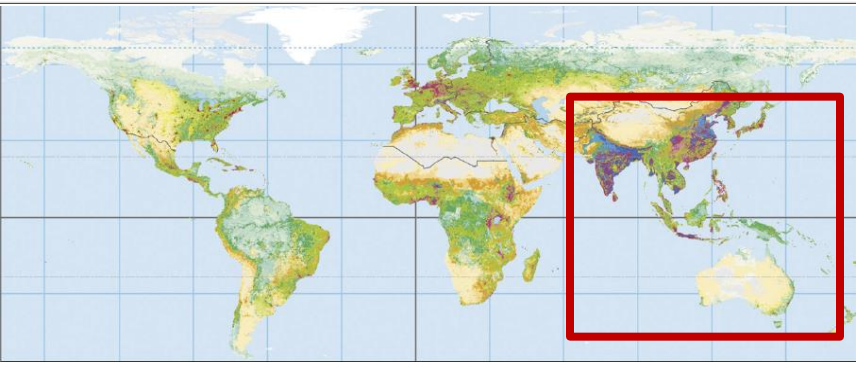
From Global to Local



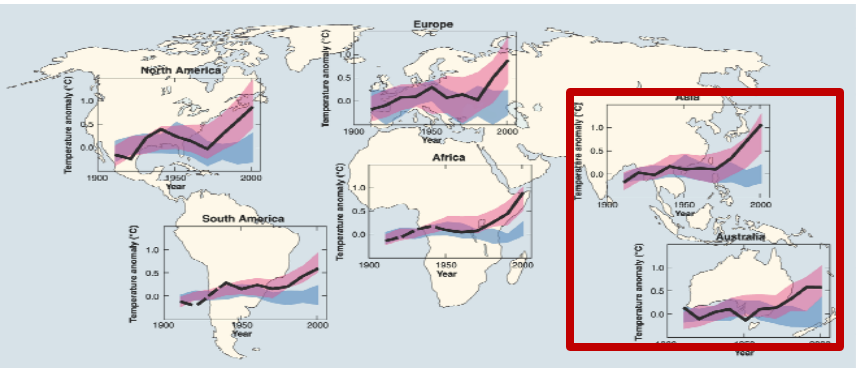
Hotspot for potential (re)-emergences



An ongoing biodiversity and bio-cultural diversity losses

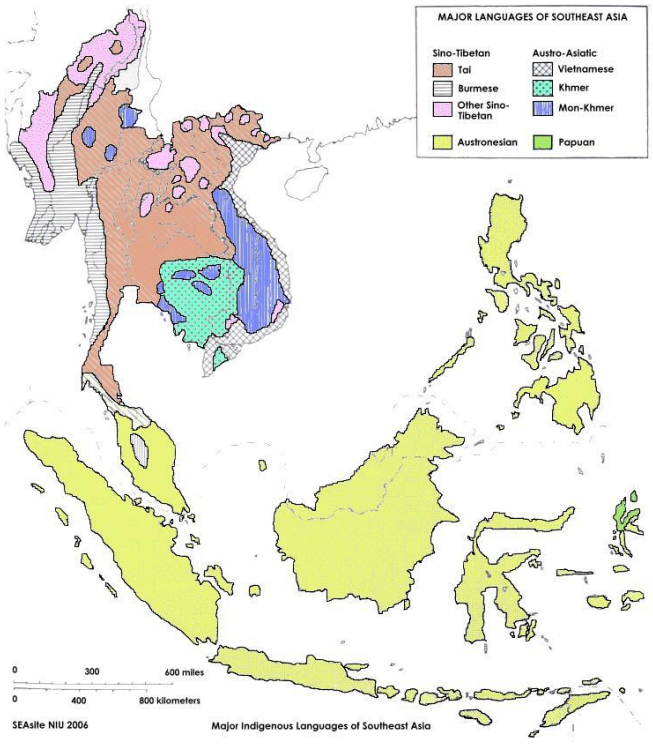


A high variability in human-dominated ecosystems

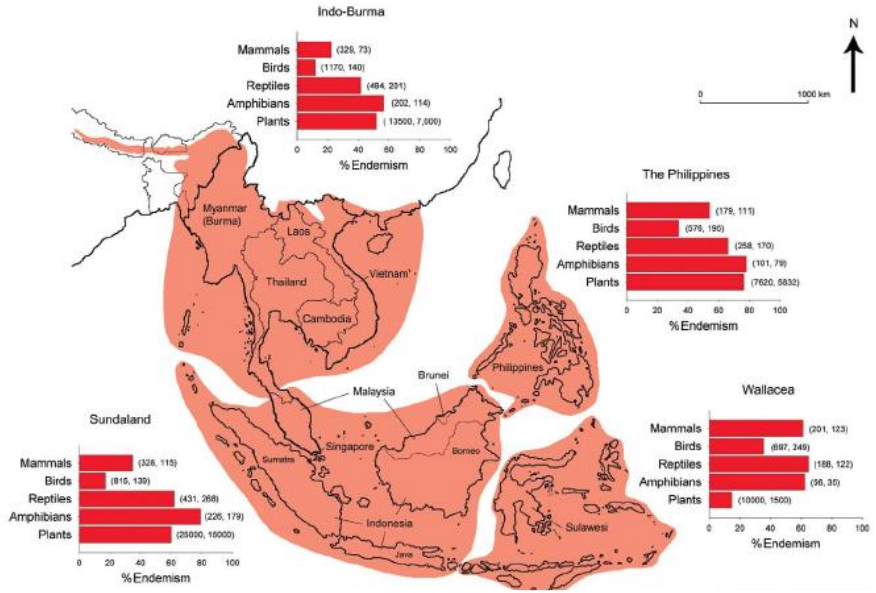


A potential high impact of the climate change

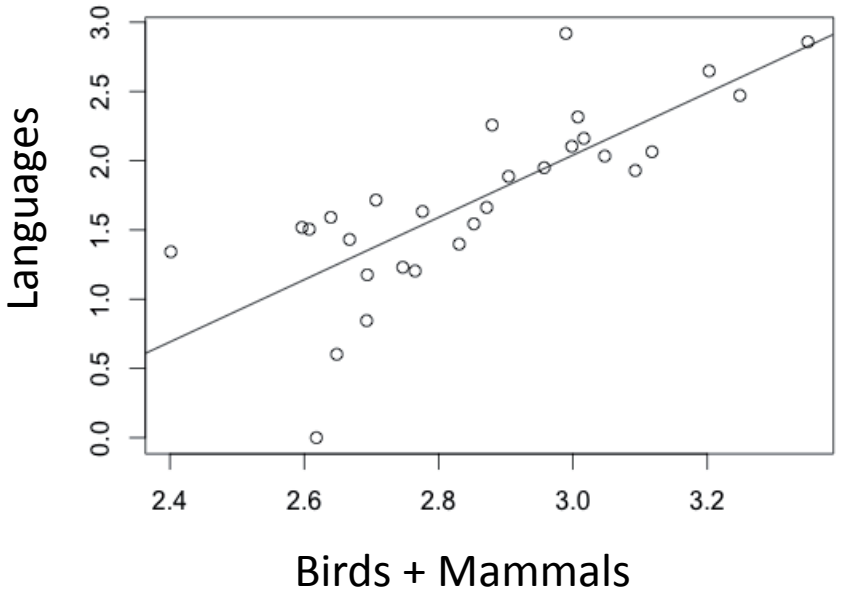
Diversity of languages in Southeast Asia



Species diversity and endemism



High languages' diversity ⇔ high biodiversity



2004

Southeast Asian biodiversity: an impending disaster

Navjot S. Sodhi[1], Lian Pin Koh[1,2], Barry W. Brook[3] and Peter K.L. Ng[1]

2013

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

David S. Wilcove[1], Xingli Giam[1,2*], David P. Edwards[3*], Brendan Fisher[4], and Lian Pin Koh[5]

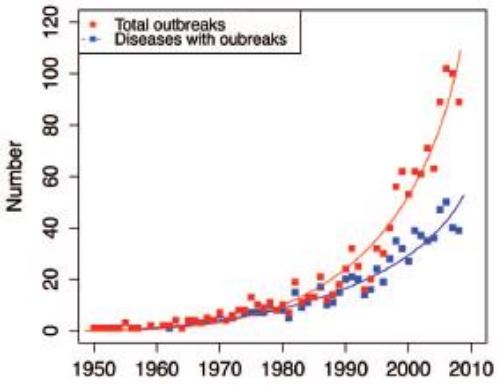
OPEN ACCESS Freely available online

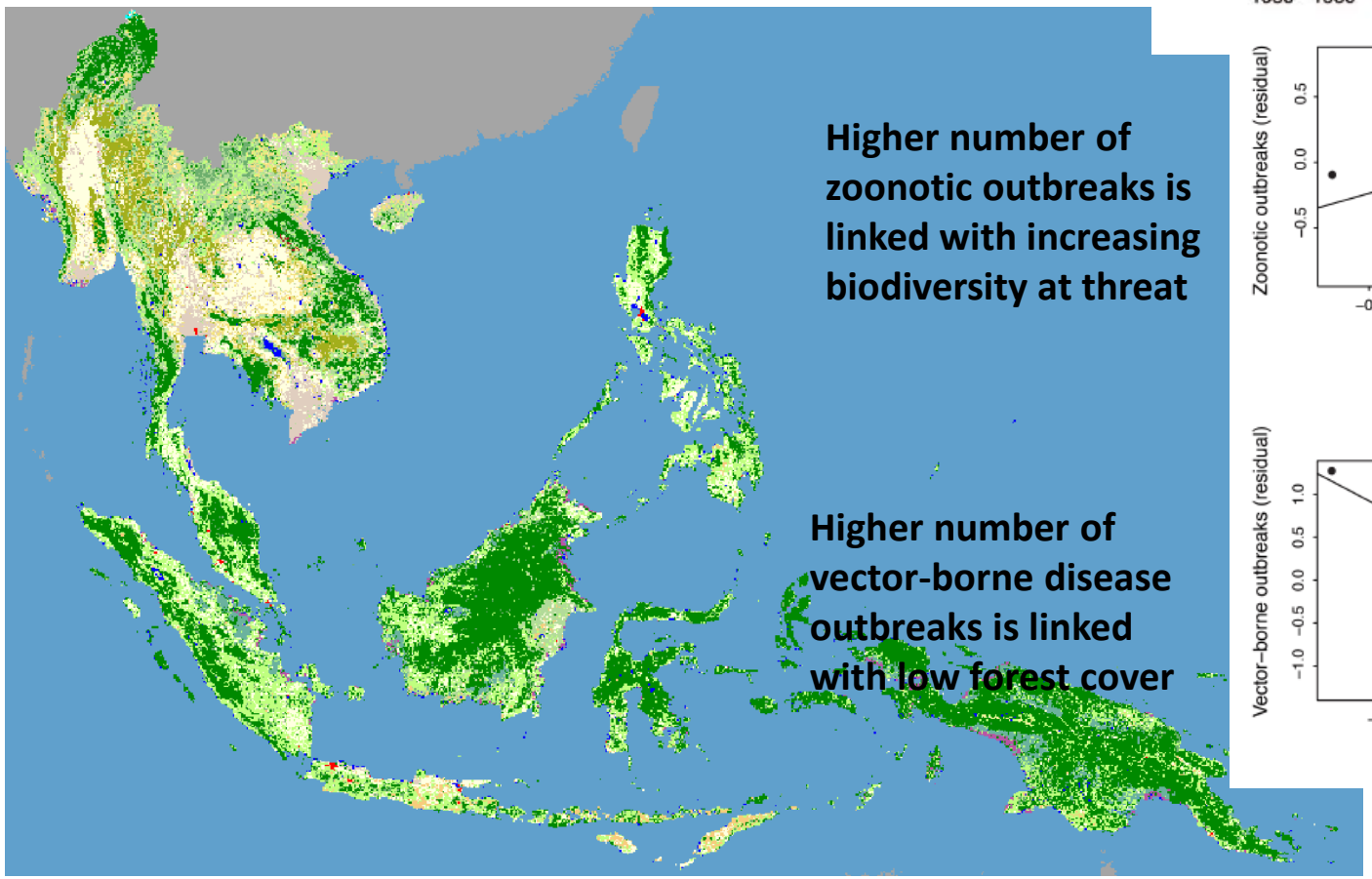
PLOS ONE

Infectious Diseases and Their Outbreaks in Asia-Pacific: Biodiversity and Its Regulation Loss Matter

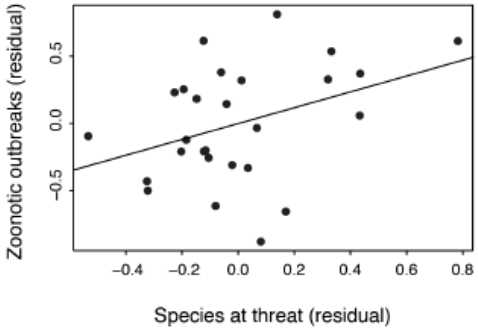
Serge Morand[1,2,3]*, Sathaporn Jittapalapong[4,5], Yupin Suputtamongkol[6], Mohd Tajuddin Abdullah[7], Tan Boon Huan[8]

An increasing number of outbreak events

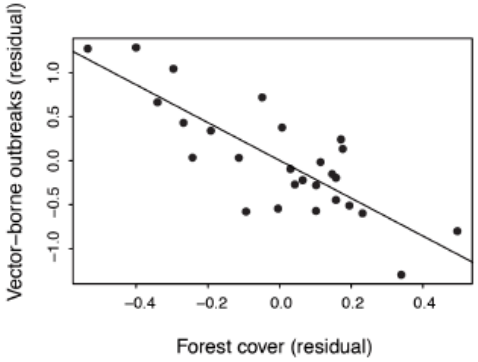




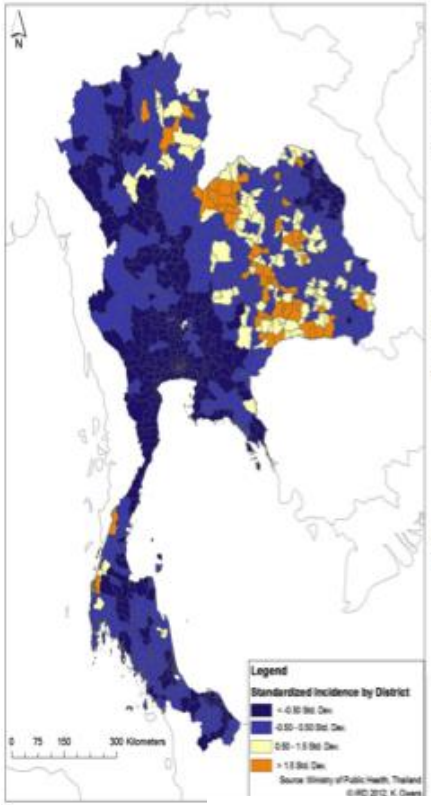
Higher number of zoonotic outbreaks is linked with increasing biodiversity at threat

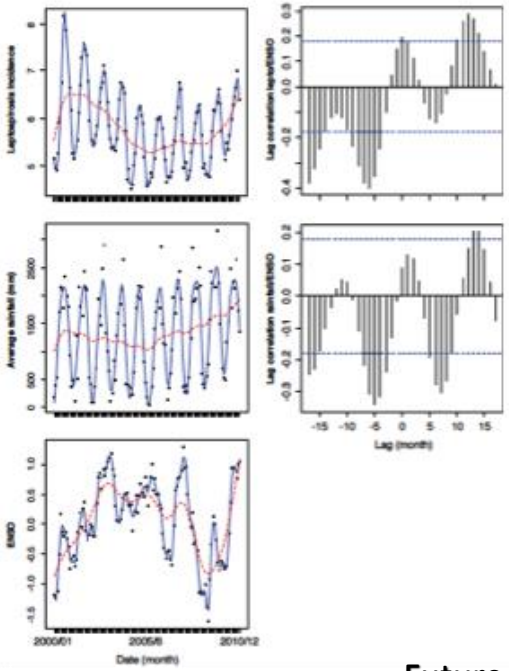


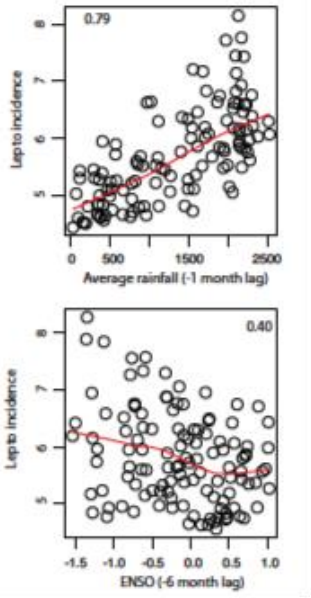
Higher number of vector-borne disease outbreaks is linked with low forest cover

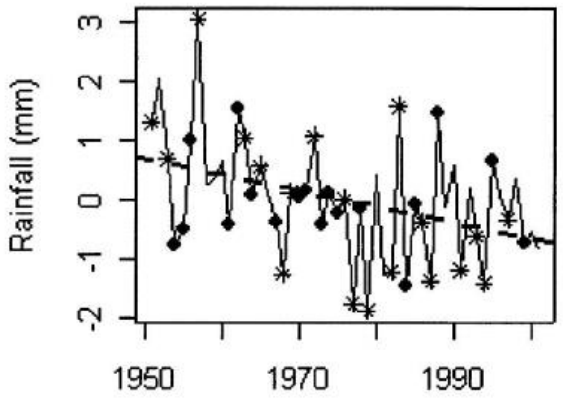


Climate variavbility leptospirosis incidence (2000-2010) in Thailand









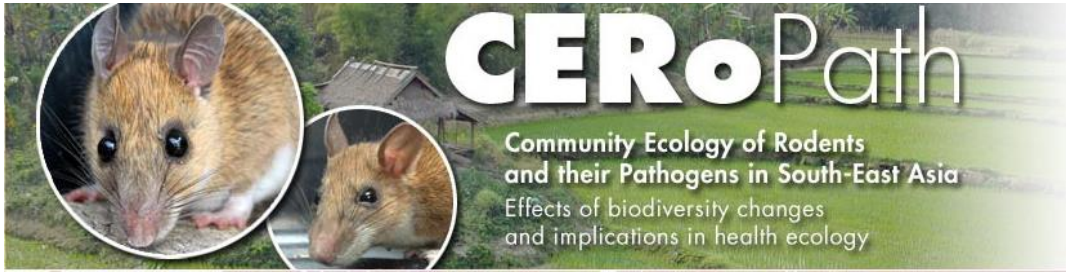
Future of the Monsoon

Dryer:

- Less rainfall amounts
- Shorter monsoon season

More tightly linked to ENSO

- More dry years
- More humid years
- Less « normal » years



Rodents and **rodent-borne diseases** :

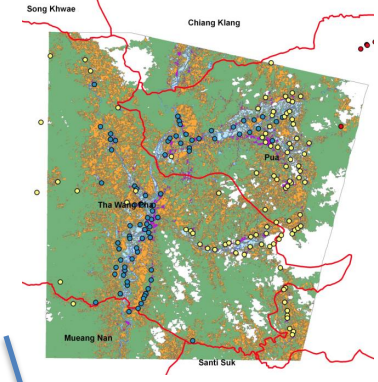
- Biodiversity changes
- Rodent-borne diseases
- Agricultural pests
- Local perception: hunting, health, environment

Project CERoPath 2008-2012
- Tools, database
- Trainings
- Research network in SE Asia

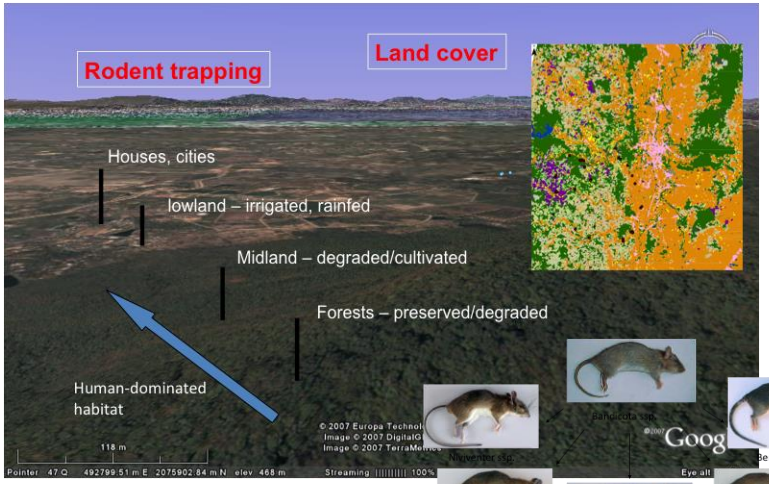
Project BiodivHealthSEA 2012-2015

See more at www.ceropath.org

www.biodivhealthsea.org



Human cases



> 4, 000 individuals

22 species of *Rattini*

Prions

Viruses
Hantaviruses,
LCMV
Arenaviruses
Cowpox

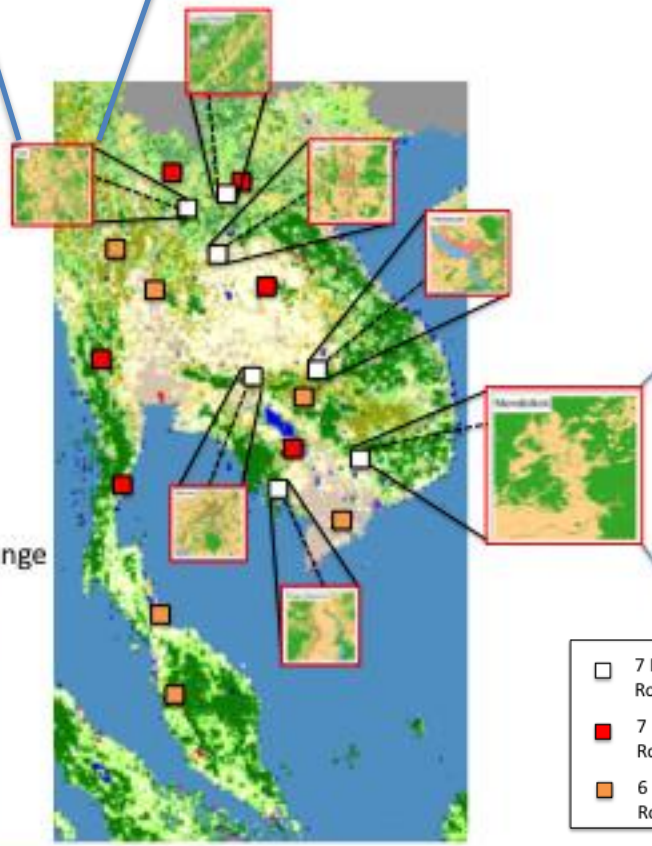
Bacteria
Leptospira
Orientia
Bartonella

Protists
Trypanosoma
Cryptosporidium
Toxoplasma
Babesia

Helminths
(30 species)

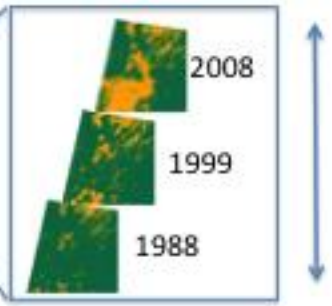
Arthropods
Fleas
lice,
mites
ticks

RoBo diseases



Spatial change

Temporal change

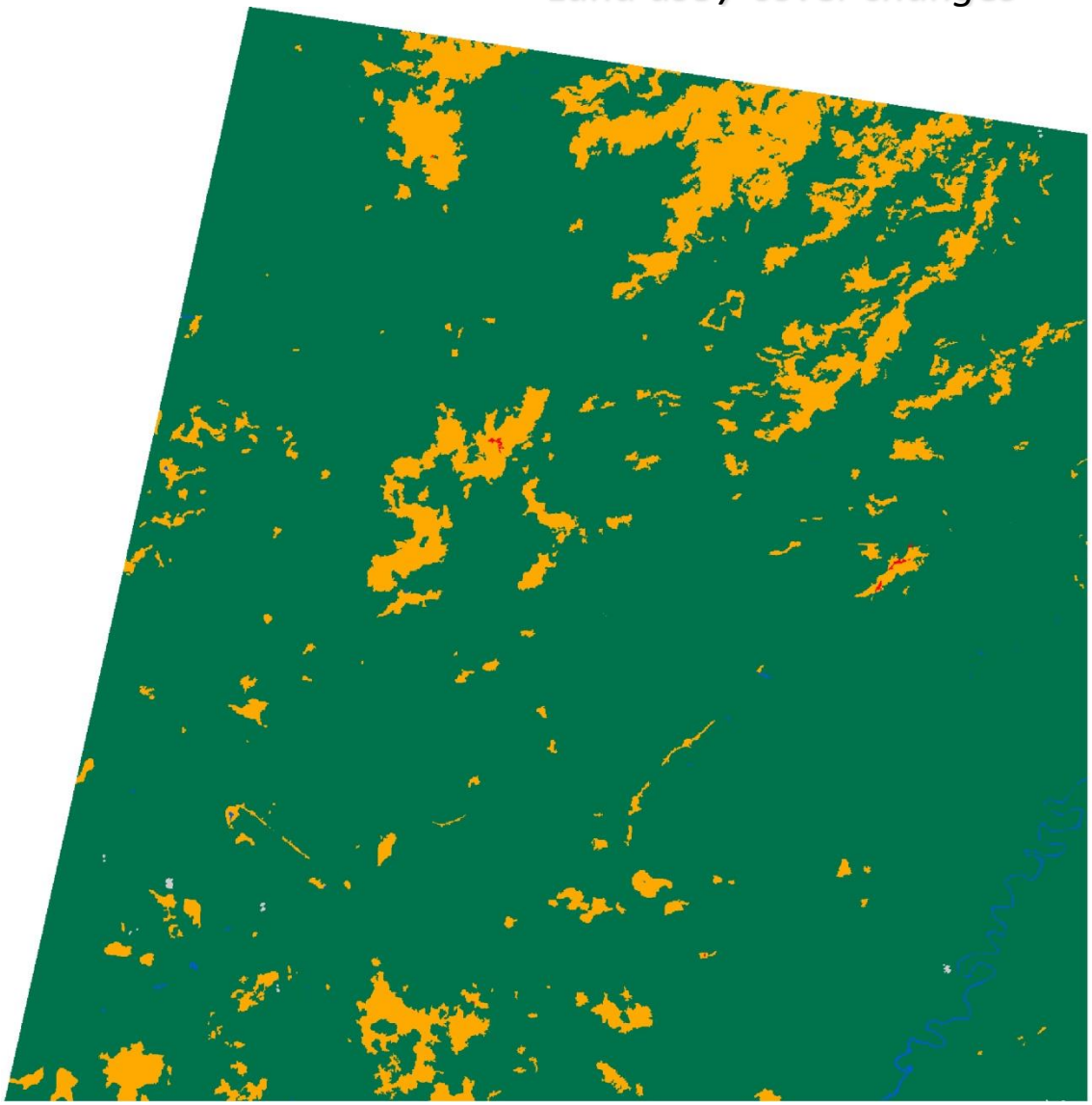


7 HR Land covers developed
Rodents & RoBo acquired

7 HR Land covers in development
Rodents & RoBo acquired

6 HR Land covers to develop
Rodents & RoBo acquired in early 2014

Land use / cover changes



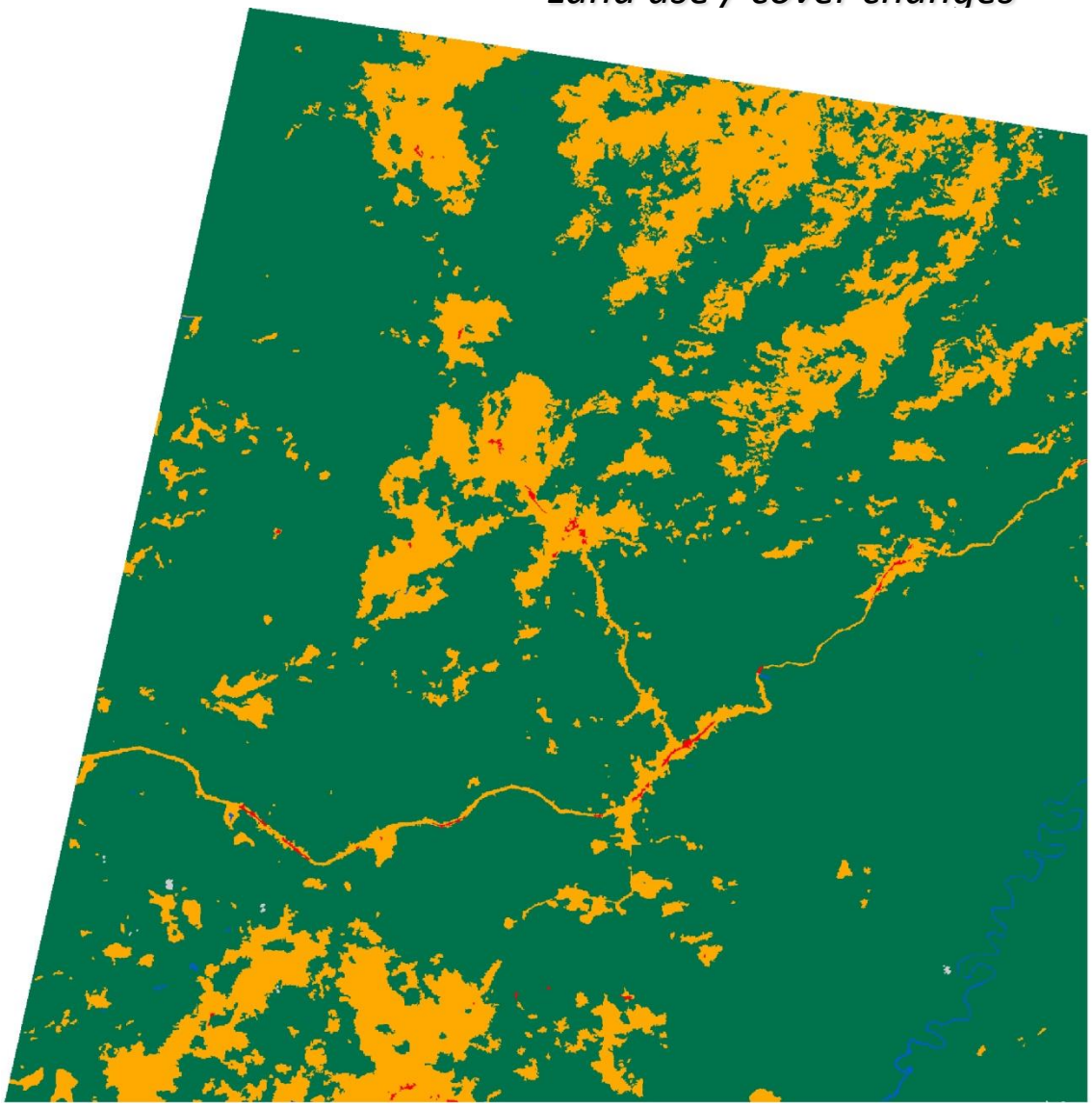
Land use / land cover classification in Mondolkiri province, in 1988

Agricultural areas
Clouds and shadows
Forested areas
Built-up
Water

N

0 2,5 5 10 Km

Land use / cover changes



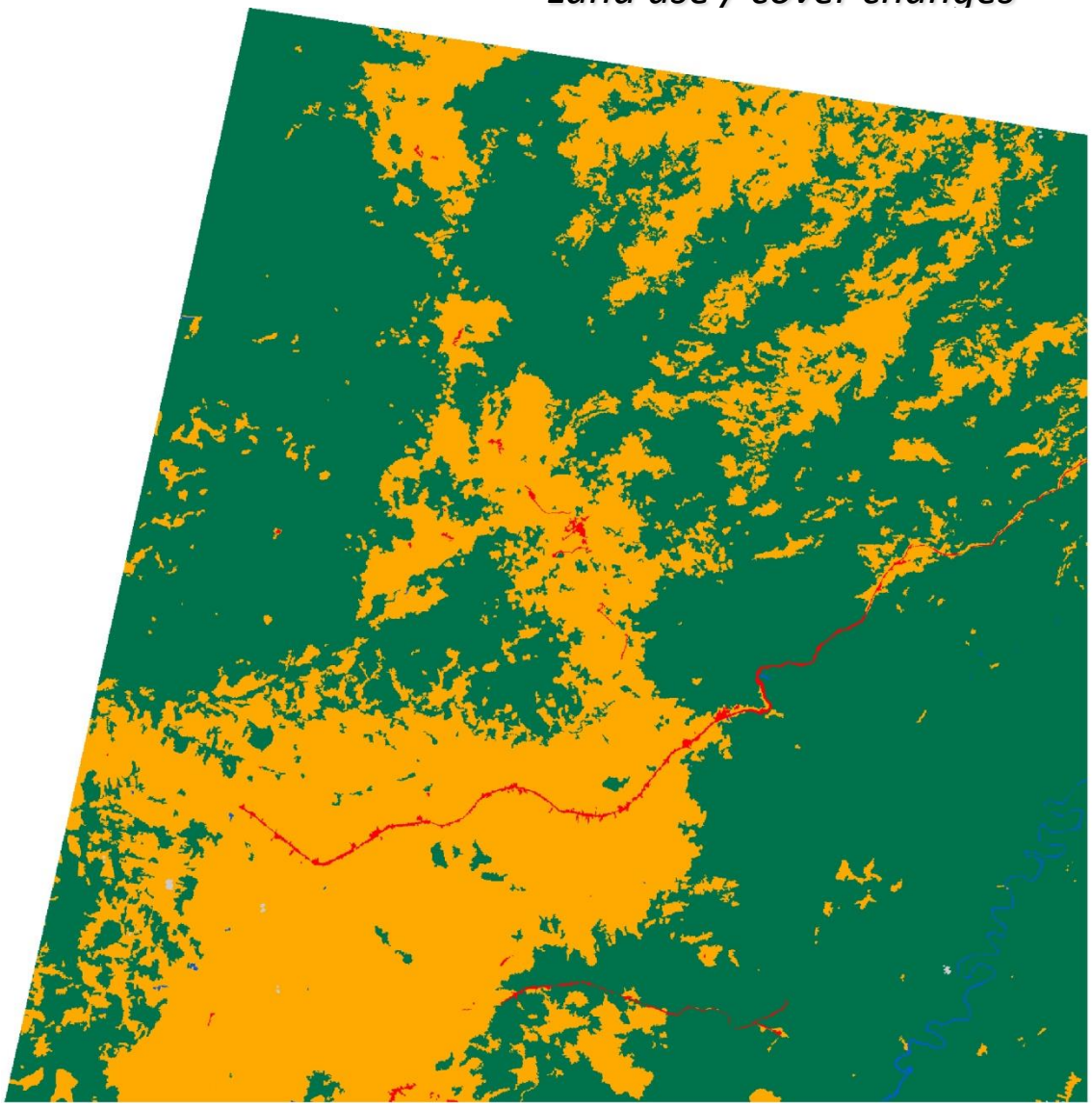
Land use / land cover classification in Mondolkiri province, in 1998

Agricultural areas
Clouds and shadows
Forested areas
Built-up
Water

N

0 2,5 5 10 Km

Land use / cover changes



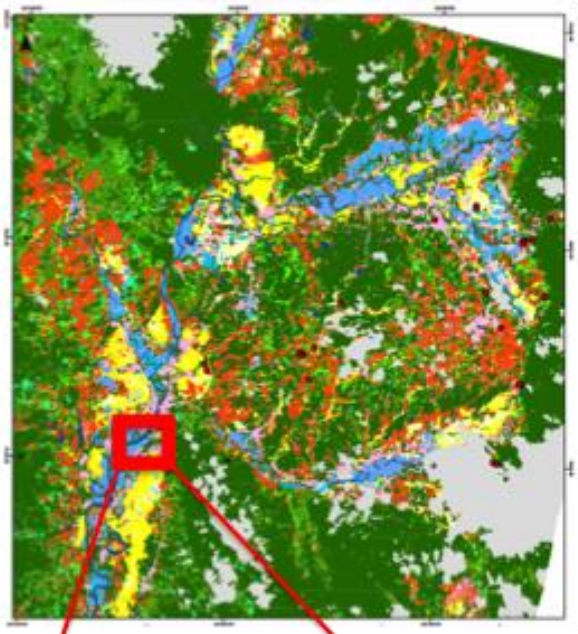
Land use / land cover classification in Mondolkiri province, in 2008

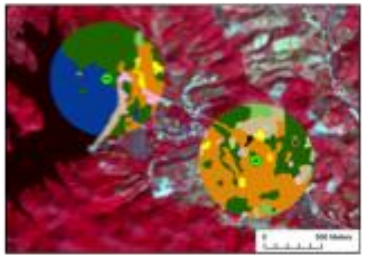
Agricultural areas
Clouds and shadows
Forested areas
Built-up
Water

N

0 2,5 5 10 Km

Habitat Modelling

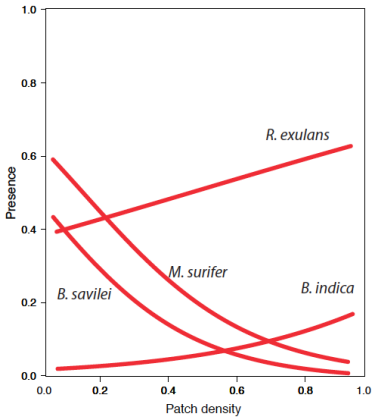


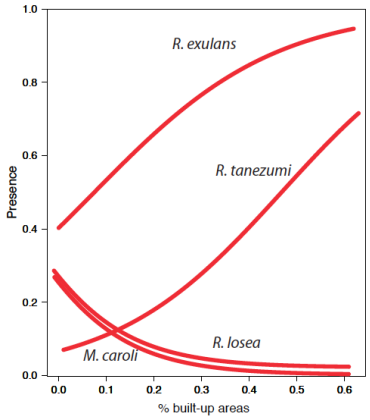


Shortest distance

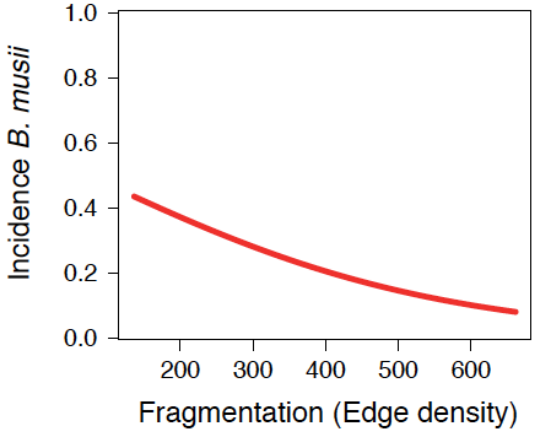
Buffer analysis

Rodent habitat use

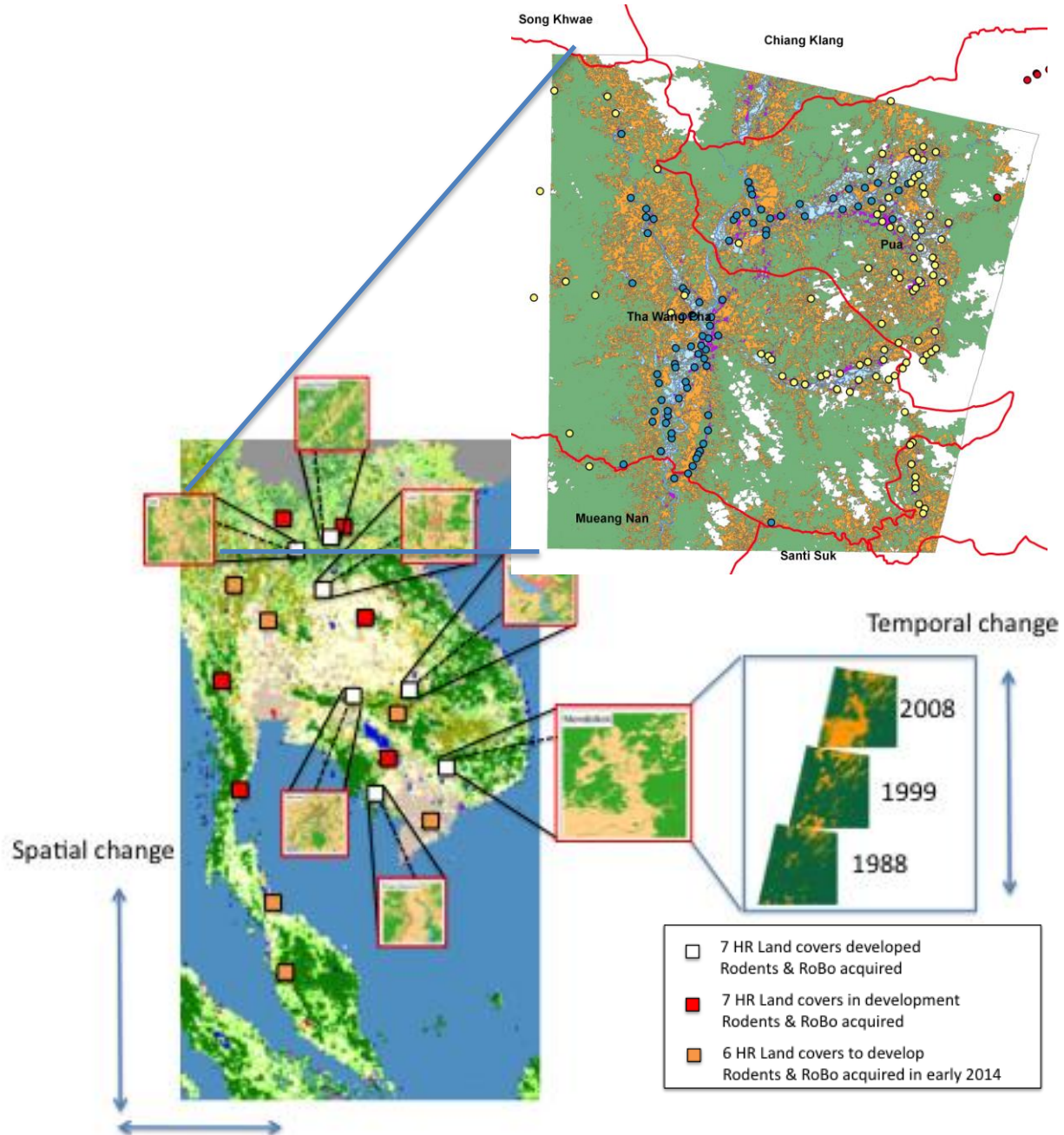




RoBo disease



Linking human cases, land uses and rodent reservoirs



200 villages
Tha Wang Pha, Pua (Nan)

Leptopsirosis

Scrub typhus

One Health/Ecohealth studies

Ban Huay Muang

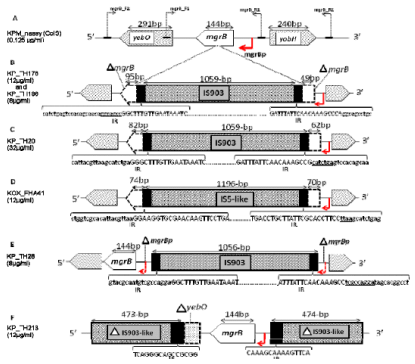
Laksip

- Human diseases (stool investigation)
- Livestock
-Rodents (rodent-borne diseases)
- Interviews
- Antibiotics resistance

Social representation and knowledge

Worldwide emergence of colistin resistance in *Klebsiella pneumoniae* from healthy humans and patients in Lao PDR, Thailand, Israel, Nigeria, and France due to inactivation of the PhoP/PhoQ *mgrB* regulator : a molecular and epidemiological study

Abiola Olumuyiwa Olaitan[1†], Seydina M Diene[1†], Marie Kempf[2], Meryem Berrazeg[1], Sofiane Bakour[1], Sushim Gupta[1], Boupha Thongmalayvong[3], Kongsap Akkhavong[3], Silaphet Somphavong[4], Phimpha Paboriboune[4], Kittipong Chaisiri[5], Chalit Komalamisra[5], Olawale Olufemi Adelowo[6], Obasola Ezekiel Fagade[6], Omowumi Abosede Banjo[6], Adeyeye James Oke[7], Amos Adler[8], Marc Victor Assous[9], Serge Morand[10], Didier Raoult[1], and Jean-Marc Rolain[1]*



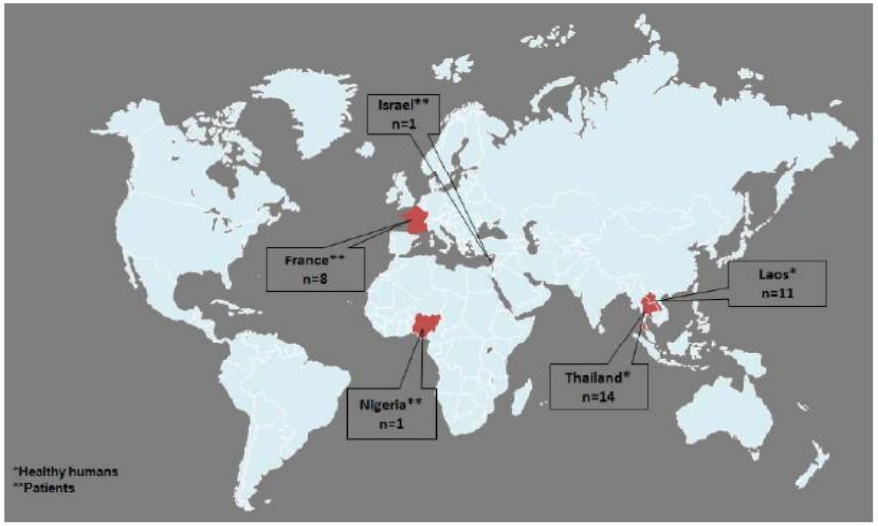
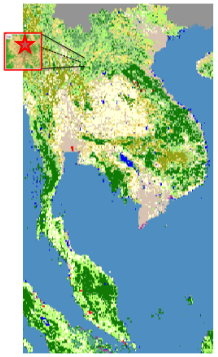


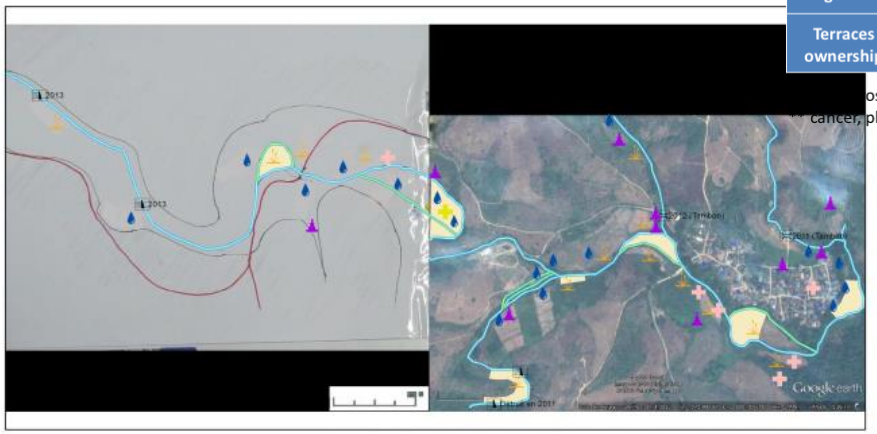
Figure 4: Distribution of the isolated colistin resistant *K. pneumoniae* and *K.oxytoca* in healthy humans and patients

Laos				Thailand			
Isolate	Col (µg/ml)	ST	*mgrB*	Isolate	Col (µg/ml)	ST	*mgrB*
KP_LH102	8	87	Intact	KP_TH20	32	1313	IS[1]
KP_LH12	32	507	Stop	KP_TH224	4	1314	Intact
KP_LH131	32	1319	Stop	KP_TH28	8	1311	IS[2]
KP_LH140	16	483	Intact	KP_TH196	8	477	IS[1]
KP_LH17	12	37	Intact	KP_TH54	16	1312	Intact
KP_LH61	24	491	Sub	KP_TH68	64	37	Intact
KP_LH70	12	2	Intact	KP_TH205	64	37	Intact
KP_LH74	12	491	Sub	KP_TH34	24	1320	Intact
KP_LH92	12	39	Intact	KP_TH166	2	661	Intact
KP_LH94	16	39	Intact	KP_TH176	12	477	IS[1]
KP_LH375	12	1315	Intact	KP_TH21	12	1308	Intact
				KP_TH213	12	37	IS[3]
				KP_TH114	8	1321	Intact
				KP_TH164	6	873	Intact

Participatory cartography

Water and health risks





carte participative: lien entre inondations et santé (exemple de la Leptospirose)

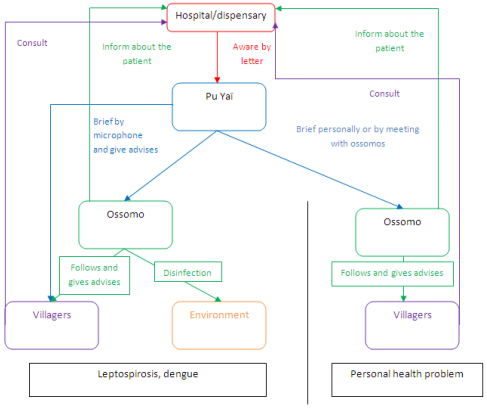
Local perceptions of risks associated to water :

Variation in the population	Conditions	Risks			
		Pathogens in water	Flooding in village	Flooding in terraces	Chemicals in water
Age	< 18 years old	–			
	> 18 years old	**Health ***			
Location of the house in village	Near the river		**Livelihood**		**Health****
	Upper		–		
Terraces ownership	Positive			**Livelihood**	
	Negative			–	

osis, skin disorder, worms
cancer, physical condition

Health care schemes choosed by villagers

Behavior schemes modeling contacts (villagers and health specialists)

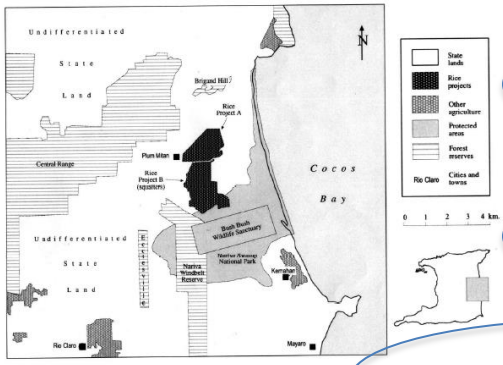


(Della Rosa, 2013)

Perspectives

Data integration
Knowledge representation

Administrative boundaries



Socio economics

Regulation rules

Land covers

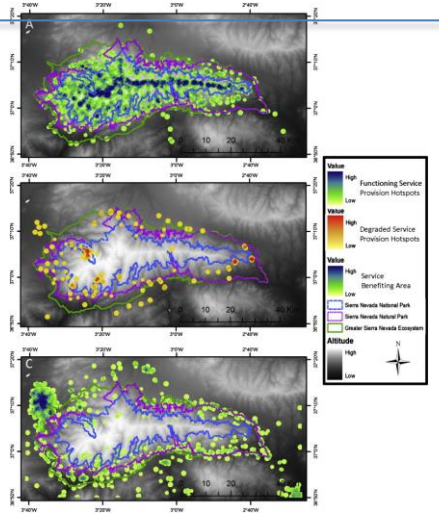
Diseases cases

Epidemiological maps

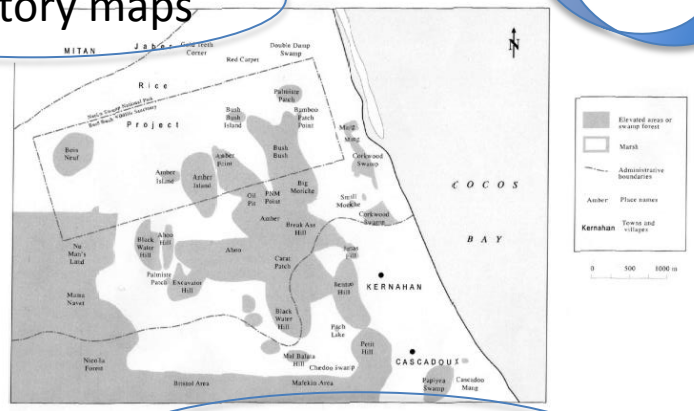
Landscape genetics

Conceptual maps

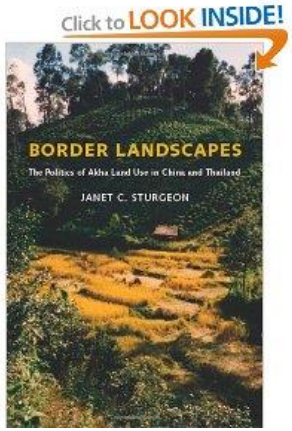
Mapping ecosystem services



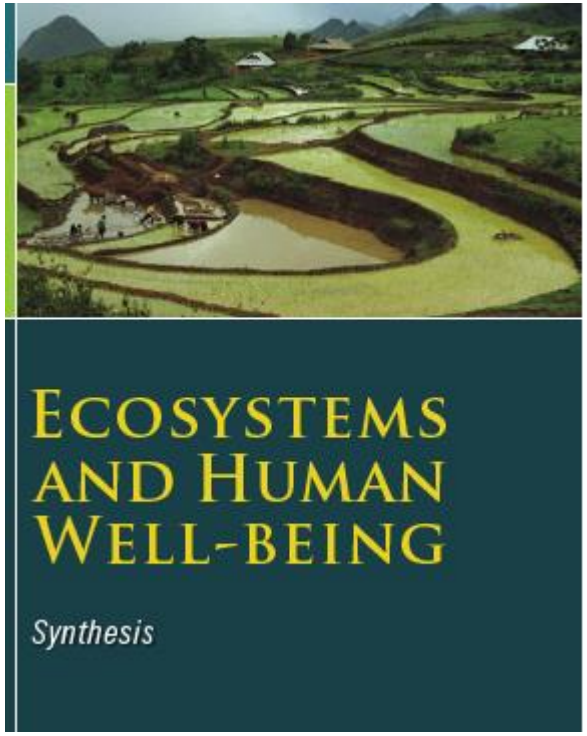
Participatory maps

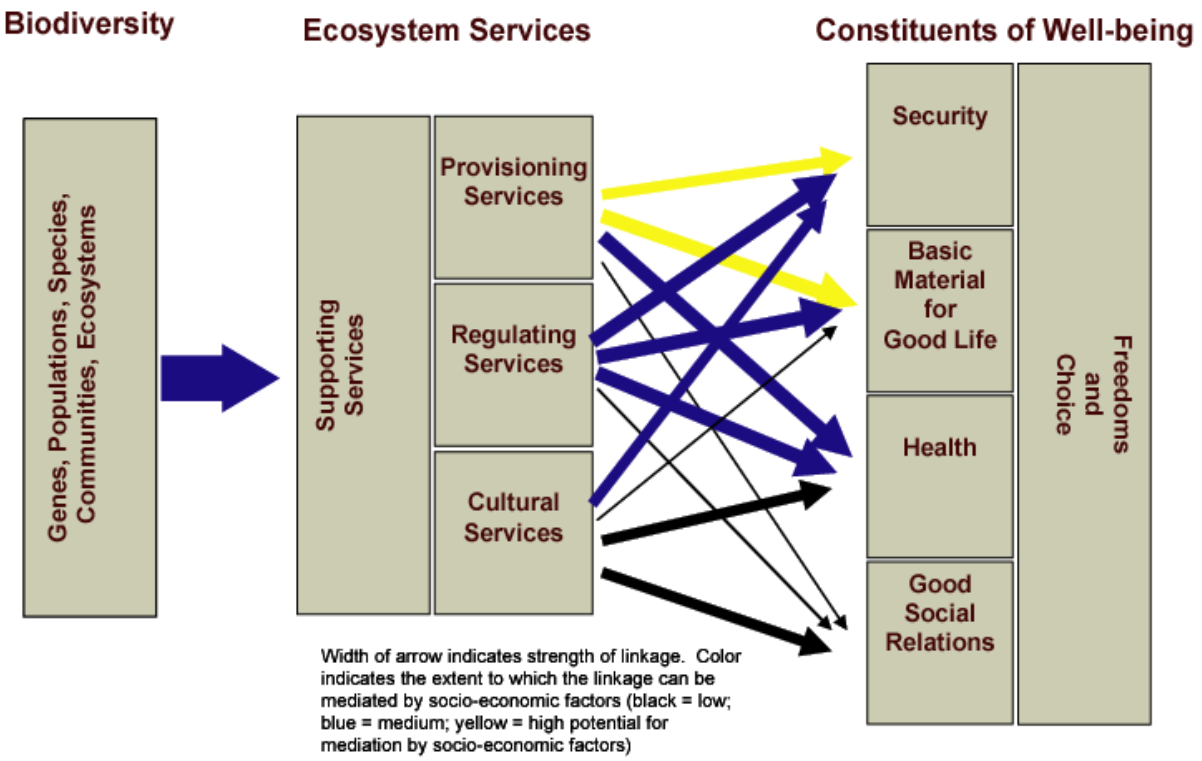


Historical maps



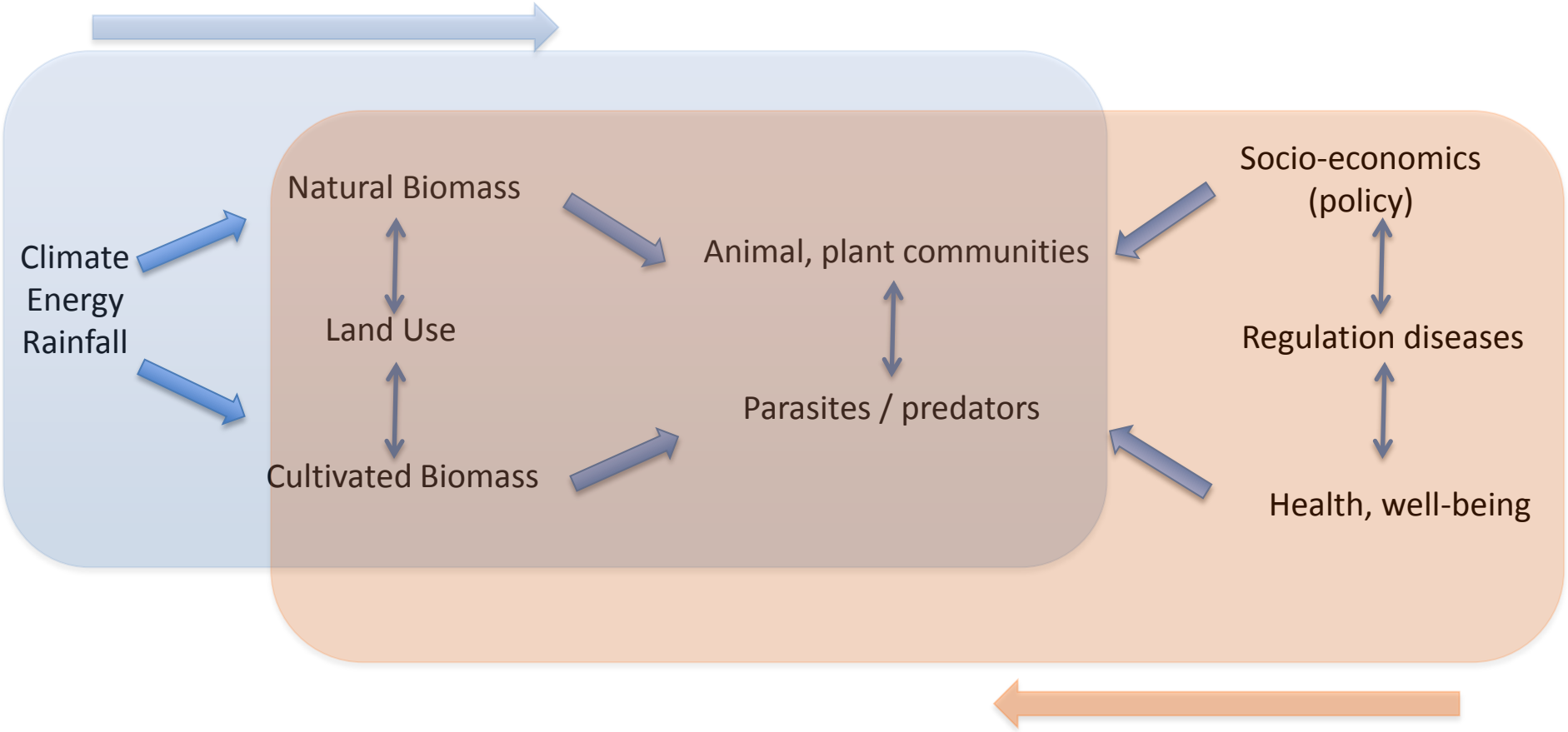
Millenium Ecosystem Assessment (MA): ecosystem services



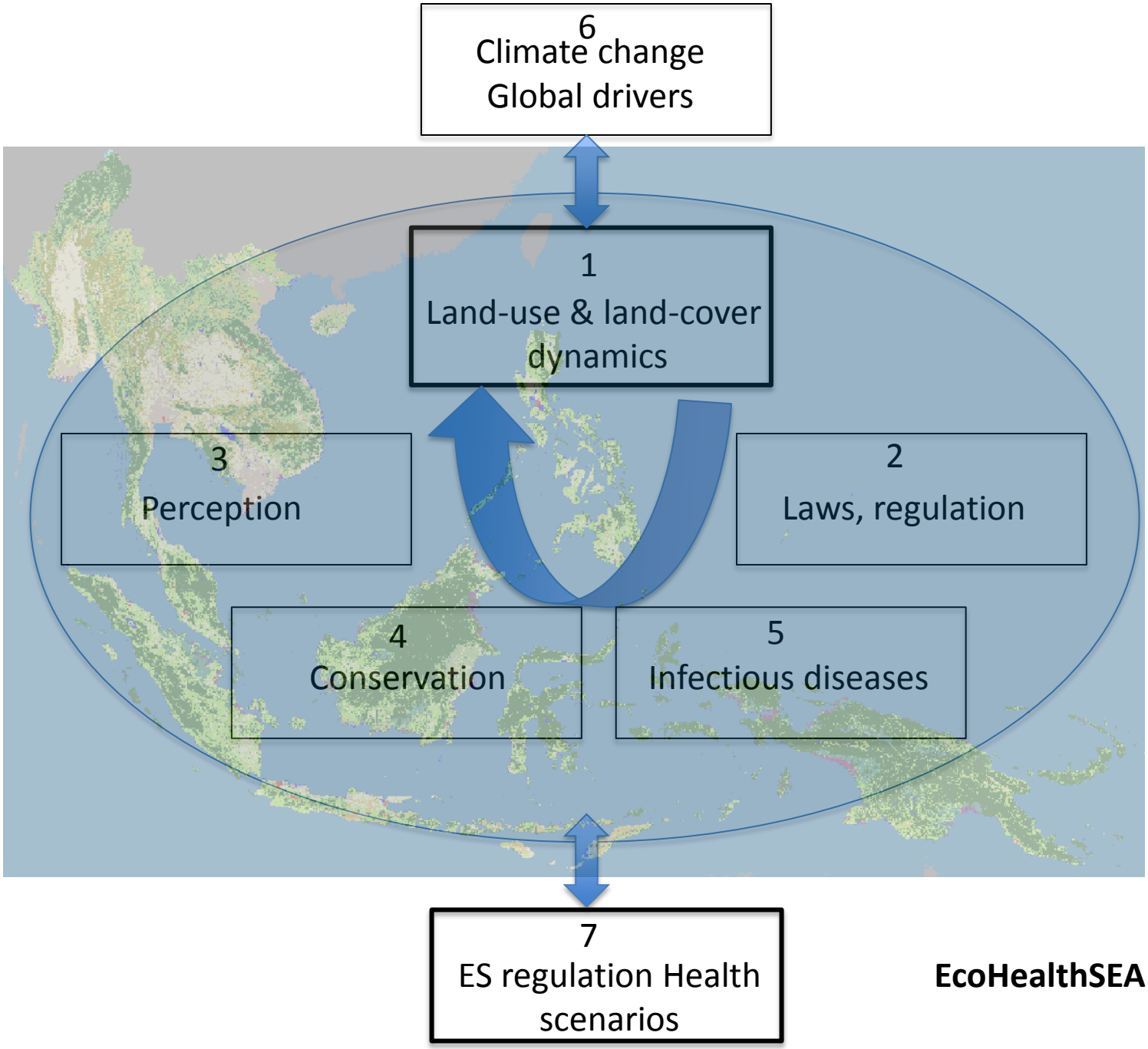


- 60% of ecosystems are degraded
- source of conflicts
- reduction of poverty implies a sustainable use of ecosystems

Functions of Ecosystems



Ecosystem services



EcoHealthSEA

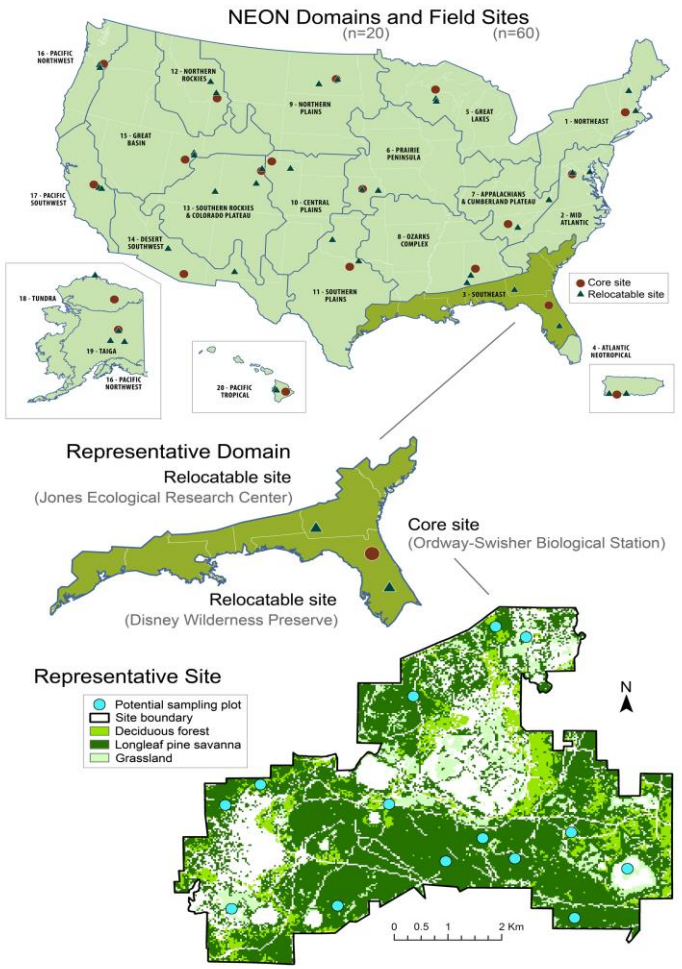
A dream

Need for long-term monitoring (in Asia):

Such as NEON in USA

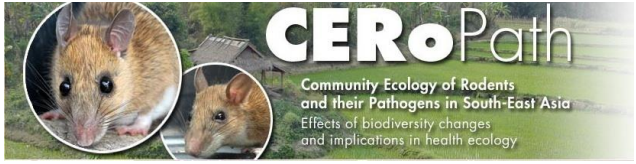
(National Ecological Observatory Network)

Vector and Pathogen Sampling Designs for the National Ecological Observatory Network



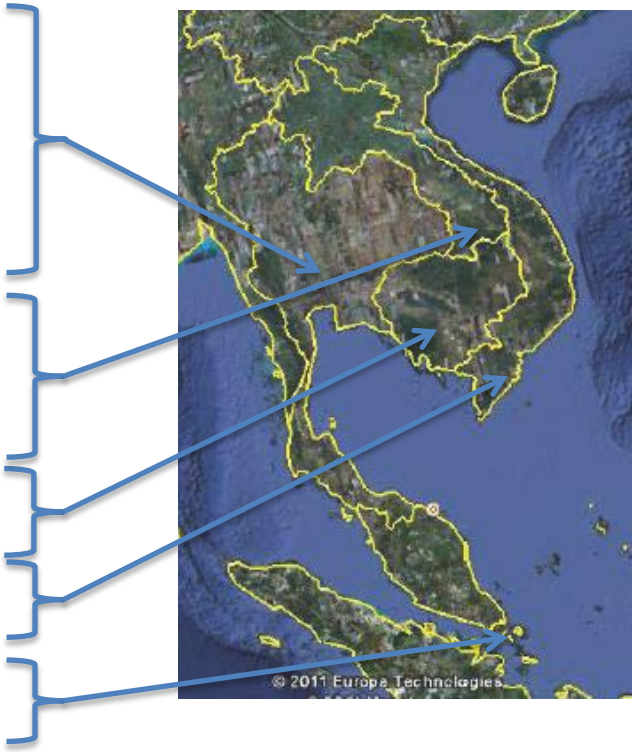
(Springer et al., subm *Ecosphere*)

Biodiv HealthSEA .org



- **French teams**
  - CNRS-IRD-ISEM — PathoDivSEA (AFD-CNRS) — GDRI-CNRS?
  - CIRAD-AGIRs — GREASE-CIRAD (network) => CommAccross (FP7-EU)
  - INRA-CBGP — PathoID-INRA (metaprogram)
  - IRD-BIOMECO — PPR SELTA-IRD (network)
  - IRD-CIRAD-InterTryp — Platform BioZoonoSEA
  - Institut Pasteur Cambodia

- **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 Army), Bangkok
  - NAFRI, Agricuture & Forestry, Vientiane
  - National Institute of Health, Vientiane
  - Centre Christophe Mérieux, Vientiane
  - University of Health Sciences, Phnom Penh
  - OUCRU, Ho Chi Minh City
  - National University of Singapore



Phnom-Penh

17-18 November

1. Biodiversity and infectious diseases
2. Antibiotic resistance
3. Pollutants and the trophic web
4. Ecosystem services, conservation and health
5. “One Health” and biodiversity
6. Laws and ethics for biodiversity and health

Merci !