CLIMATE-SMART Agriculture 2015

Global Science Conference

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Le Corum, Montpellier France

What impact of climate change on animal health?

R. Lancelot

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UMR CIRAD-INRA "Contrôle des maladies animales exotiques et émergentes"

Montpellier, 17th March 2015

Outline

1. Vectors and vector-borne infections as models of the effect of climate change on health
2. How climate change can affect animal (and human) health?
   - Direct effects
   - Indirect effects
3. How can we quantify changes?
   - Climate changes & meteorological events
   - Vector & health data
4. Requirements and perspectives for assessing impacts of climate change on health

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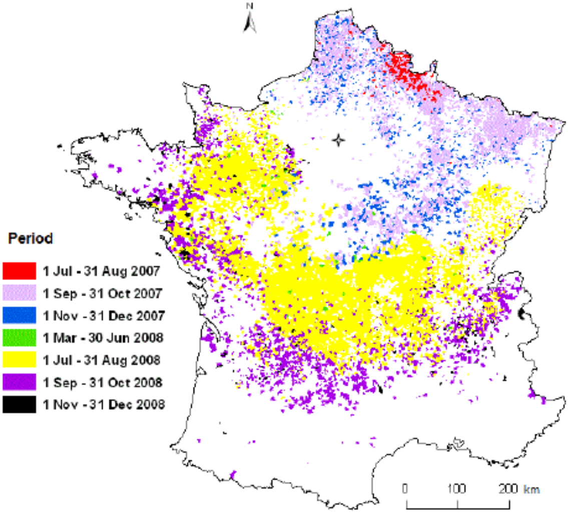
Why bothering?

French municipalities with at least one clinical case of bluetongue reported in 2007-2008 ($n = 10,994$) (Pioz et al., 2011)



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Vectors & vector-borne infections

- Hematophagous arthropods: insects, ticks

Tiger mosquito *Aedes albopictus*

Dengue, chikungunya…

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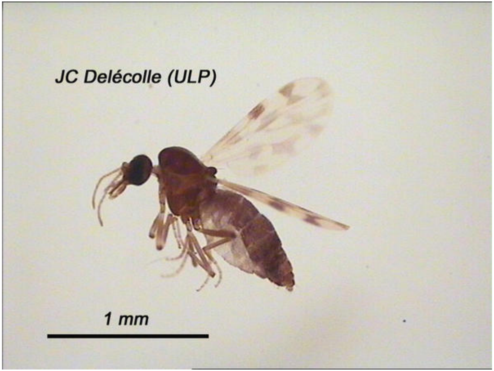
- Extrinsic cycle: pathogen multiplication within the vector

Culicoides imicola



Bluetongue, Schmallenberg…

Vectors & vector-borne infections

- Hematophagous arthropods: insects, ticks
- Get infected through blood meal on an infected host
- Extrinsic cycle: pathogen multiplication within the vector
- Pathogen transmission during the next blood meal

Tick *Ixodes ricinus*

Lyme borreliosis, tick-borne encephalitis...

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R_0: basic reproduction number

- Epidemic risk: if $R_0 > 1$, epidemics may occur
- R_0 for malaria: *Plasmodium* parasite transmitted to humans by *Anopheles* mosquitoes

$$\begin{cases} R_0 = C \times b \times \dfrac{1}{r} \\ C = \dfrac{m \times a^2 \times p^n}{-\log(p)} \end{cases}$$

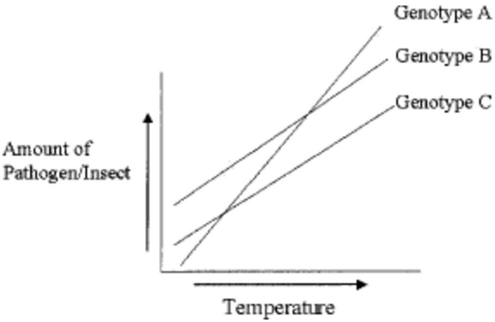
where

- C: vectorial capacity of the vector population
  - m: vectors / hosts ratio
  - a: number of hosts bitten mosquito^{-1} day^{-1} (aggressivity)
  - p: daily survival rate for mosquitoes
  - n: length of extrinsic cycle (days)
- b: vector competence, i.e. proportion of infecting bites
- r: host recovery rate (day^{-1})

Possible effects of climate changes on R_0

- Minor effects
  - Vector competence b: possibly influenced by temperature

Hypothetic interactions between genetic factors and temperature (Tabachnick, 2003)



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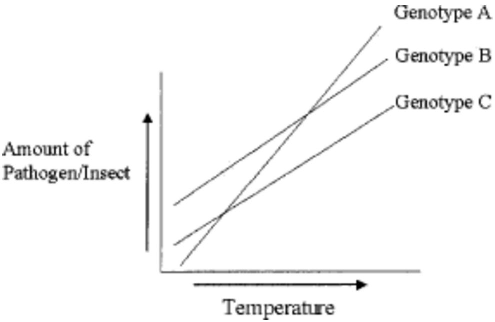

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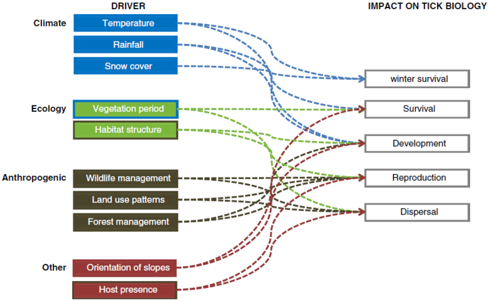
- Large expected effects
  - Vectors / hosts ratio: abundance of vectors (and hosts)

Drivers of *Ixodes ricinus* abundance (Medlock et al., 2013)



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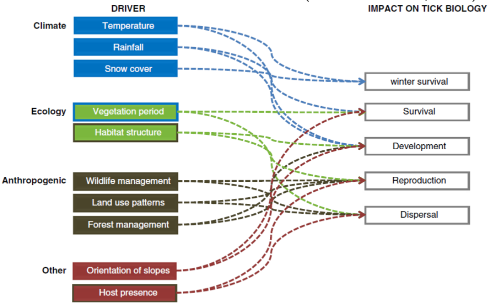

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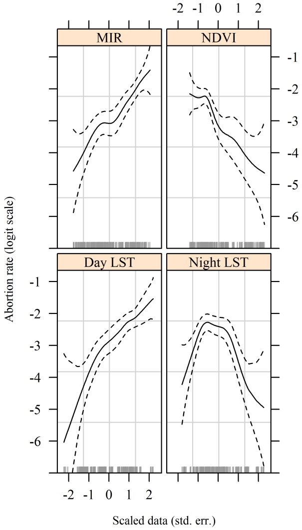
  - Aggressivity a, survival p: temperature and RH

Abortion rate in a tsetse population, Senegal (Bouyer *et al.*, unpubl.)



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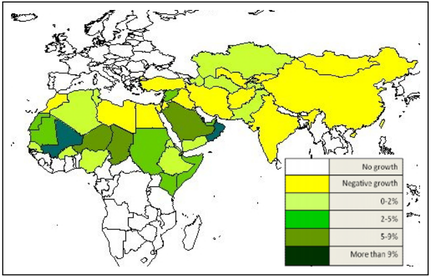
Indirect effect of climate changes on health

- Changes in livestock production systems: less cattle, more small ruminants and camels (Seo and Mendelsohn, 2008)

Observed changes in camel populations (Faye et al., 2012)



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- "Desertification" → rural exodus → larger cities → Increasing demand on red meat in large cities → intensification of livestock trade

Sheep and goats trade from Somaliland to Saudi Arabia

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- Changes in livestock production systems: less cattle, more small ruminants and camels (Seo and Mendelsohn, 2008)
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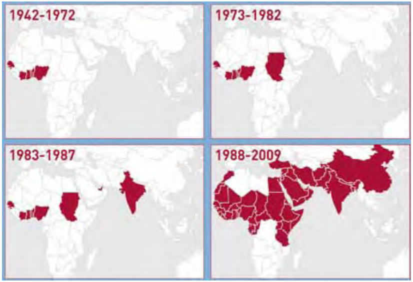
- Increased risk of transboundary diseases like FMD or PPR

Known emergence of PPR 1942-2009



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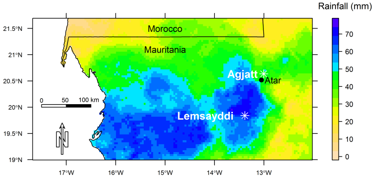
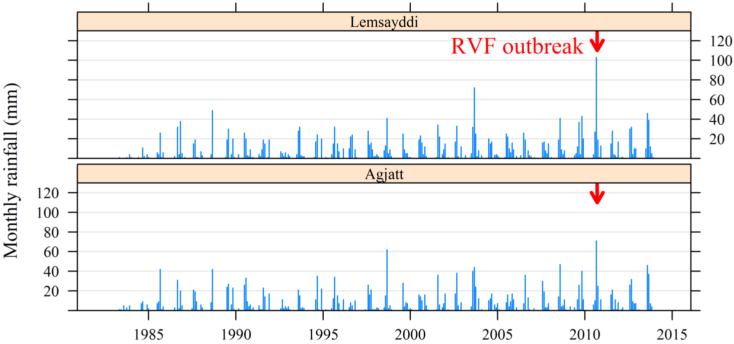
Environmental data

We need data with:

- a global coverage, a moderate spatial resolution and a high temporal resolution to model seasonal & annual changes
- long time series to detect & model pluri-annual changes

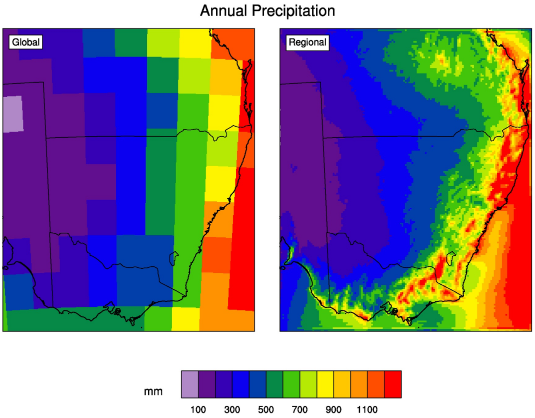
Rift Valley fever outbreak in northern Mauritania, 2010 (El Mamy et al., 2014) - Rainfall: TAMSAT dataset



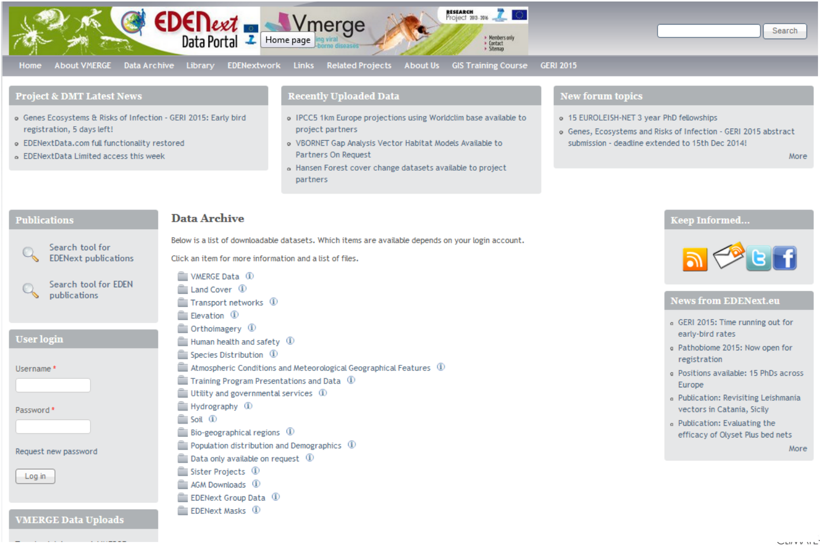


Datasets for possible future climates

- IPCC (data distribution center): coarse data provided by the GCM: 300 km resolution
- European ENSEMBLES datasets: finer data provided by RCMs: 25 km resolution



A nice resource: `http://www.edenextdata.com`



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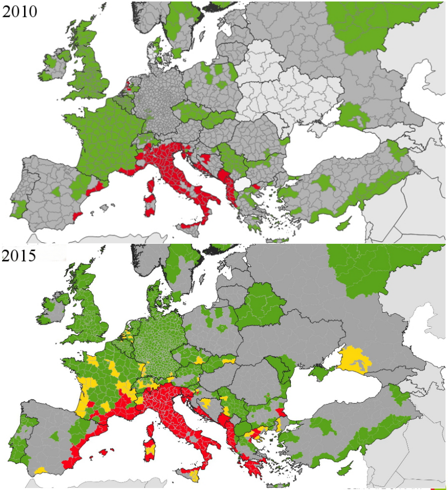
- Africa: a few good datasets: tsetse flies, mosquitoes (malaria, RVF), some tick species
- Caribbean region: tick *Amblyomma variegatum*
- Europe: mosquitoes (*Aedes albpictus*), ticks (*Ixodes ricinus*), biting midges (*Culicoides imicola*), sandflies: coordinated field studies spanning over 15 years: EDEN / EDENext / Vbornet / Vectornet

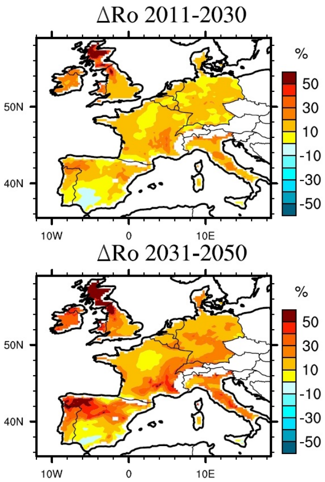


Back to *Culicoides* and bluetongue

R_0 for BTV transmission by *Culicoides* biting midges Obsoletus group) with 2 different host species - cattle and sheep - playing different epidemiological roles (Guis et al., 2012):

$$R_0 \propto \frac{b\beta a^2}{\mu} \frac{\nu}{\mu + \nu} \left(\frac{m\phi^2}{r_c + d_c} + \frac{m(1-\phi)^2}{r_s + d_s} \right)$$

Future R_0 for bluetongue in Europe according to climatic scenarios



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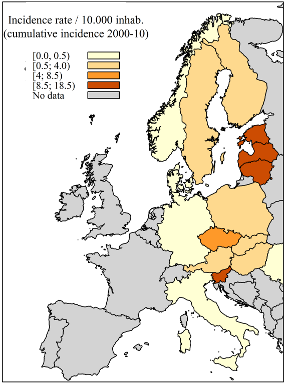
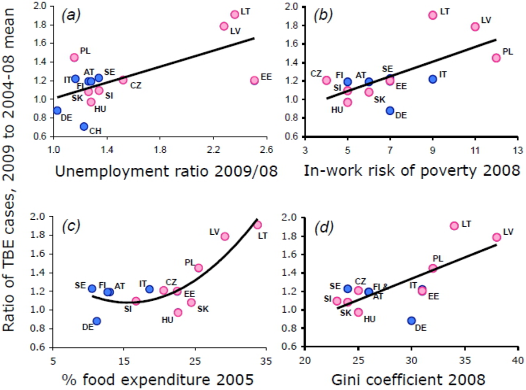
- **Involve stakeholders** (farmers, vets, labs…) for a better appropriation of results: important for sustainability
- Adopt a **multi-disciplinary approach with social sciences and economics**, as from the start of the projects, for at least cost-benefits assessment, and perception studies with respect to diseases and control strategies.

Other changes: tick-borne encephalitis in central and northern Europe



Source: ECDC / Eurostat



Godfrey and Randolph (2011)

Welcome to GERI-2015
Heraklion, 21-23 April 2015

EDEN EDENext

GERI 2015

21-22-23 April 2015 • Heraklion, Crete, Greece

SEVENTH FRAMEWORK PROGRAMME

Genes, Ecosystems and Risk of Infection

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