Environment and Health

Integrative Approach

Emmanuel ROUX

Colloque HYBAM, Manaus
19-21/11/2007
Societal Issues

Public health

1.5 to 2.7 M of deaths / year
Third cause of mortality of children under 5 years old

[Sipe & Dale 2003, OMS 2003]
Societal Issues

Public health

1.5 to 2.7 M of deaths / year
Third cause of mortality of children under 5 years old

[Ministério da Saúde 2006]

Brazilian amazonia

Number of cases

[Ministério da Saúde 2006]
Public health

1.5 to 2.7 M of deaths / year
Third cause of mortality of children under 5 years old

[Sipe & Dale 2003, OMS 2003]

[Sí: 0.01%
D: 1.22%
G: 4.90%
A: 93.65%
B: 0.24%]

Ministério da Saúde 2006

Brazilian amazonia

Guyane

[DSDS, Cire Antilles-Guyane, InVS 2006]
Societal Issues

Public health

1.5 to 2.7 M of deaths / year
Third cause of mortality of children under 5 years old

[Brazilian amazonia]

[Ministério da Saúde 2006]

Guyane

Rivers

Backcountry

Littoral

[Ministério da Saúde 2006]
Societal Issues

Public health
1.5 to 2.7 M of deaths / year
Third cause of mortality of children under 5 years old

Development
- 70% of the GDP / inhabitant
- Development slowed down by 1.3% / year

[Noel 2003]

Guyane

Brazilian amazonia

[Ministério da Saúde 2006]

[DSDS, Cire Antilles-Guyane, InVS 2006]
Objectives and Stakes

Objectives

1. Describing interactions between
   - environmental,
   - biological,
   - socio-medical,
   - socio-demographic factors

   that control the emergence and the dynamics of the epidemics
## Objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1         | Describing *interactions between*  
- environmental,  
- biological,  
- socio-medical,  
- socio-demographic factors  
that control the *emergence* and the *dynamics of the epidemics* |
| 2         | Integrating the *spatial and temporal dimensions* of the environmental parameters into the epidemiological studies of malaria |
Objectives and Stakes

Objectives

1. Describing interactions between environmental, biological, socio-medical, socio-demographic factors that control the emergence and the dynamics of the epidemics.

2. Integrating the spatial and temporal dimensions of the environmental parameters into the epidemiological studies of malaria.

Stakes

Better understanding the emergence and transmission modes → Decision support (public health, land settlement)
Scientific Issues

- Human (host)
  - Bite (transmission)

- Mosquito (vector)
  - Bite
  - Plasmodium

- Plasmodium

- 7 à 35 j
- 8 à 30 j
Scientific Issues

Human (host)

Mosquito (vector)

Bite (transmission)

Laying every 2-3 d

8 à 30 / 7 à 35

Plasmodium

after 3 d

7 to 21 d
Scientific Issues

Mosquito (vector)

Bite (transmission)

Human (host)

Laying every 2-3 d

Transmission

8 to 30 j

7 to 35 d

Temporal resolution

Spatial resolution

10 km

km

100 m

10 m

m

day

week

month

year

Ponctual studies
Scientific Issues

Bite (transmission) Mosquito (vector) Laying every 3 d after 3 d 7 to 21 d 7 to 35 d 21 to 30 d 8 à 30 j P l a s m o d i u m 7 to 21 d 7 to 35 d P l a s m o d i u m B i t e (transmission) Human (host)

Spatial resolution
- day
- week
- month
- year
- Ponctual studies

Temporal resolution
- 10 km
- km
- 100 m
- 10 m
- m

Spatial resolution
- 10 km
- km
- 100 m
- 10 m
- m

Temporal resolution
- day
- week
- month
- year
- Ponctual studies

Remote sensing
- Ecology
- Climatology
- Geography
- Genetics
- Entomology
- Ecology
- Climatology
- Geography
- Genetics
- Entomology

Epidemiology
- Pharmacology
- Medicine
- Parasotology
- Biology
- Genetics
- Entomology
- Ecology
- Climatology
- Geography
- Remote sensing
Scientific Issues

Mosquito (vector) → Human (host) → Mosquito (vector)

Bite (transmission) → Laying eggs every 2-3 d

Temporal resolution:
- day
- week
- month
- year
- Punctual studies

Spatial resolution:
- m
- 10 m
- 100 m
- km
- 10 km

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Temporal resolution:
- day
- week
- month
- year
- Punctual studies

Epidemiology
Pharmacology
Medicine
Parasitology
Biology
Genetics
Entomology
Ecology
Climatology
Geography
Remote sensing
Scientific Issues

- **Mosquito (vector)**
  - Bite (transmission)
  - Laying eggs every 2-3 days after 7-21 days
  - Time from 7 to 35 days

- **Human (host)**
  - Blood feeds

**Spatial resolution**
- m
- 10 m
- 100 m
- km
- 10 km

**Temporal resolution**
- day
- week
- month
- year
- Punctual studies

**Epidemiology**
- Pharmacology
- Medicine
- Parasitology
- Biology
- Genetics
- Entomology
- Ecology
- Climatolgy
- Geography
- Remote sensing

- Hay 1998
- Gurgel 2006
- Omumbo 2002
- Masuoka 2003
- Claborn 2002
- Gurgel 2006
- Masuoka 2003
- Claborn 2002
Remote Sensing

- Temporal resolution
- Very High Resolution

Multispectral

VHR

day  week  month  year  Punctual studies
Remote Sensing

- Temporal resolution
- Very High Resolution
- Altimetry
Remote Sensing

- Temporal resolution
- Very High Resolution
- Altimetry
- Complementarity of the information
Satellite Radar Altimetry and Malaria

CAROEBE
6000 inhab.
IPA = 50-100‰/an
Flooded forest

Relative water stage (m)

2003 2004 2005 2006
0 0 0 0
2 2 2 2
4 4 4 4
6 6 6 6
8 8 8 8
10 10 10 10
12 12 12 12
14 14 14 14
16 16 16 16
18 18 18 18
Satellite Radar Altimetry and Malaria

CAROEBE
6000 inhab.
IPA = 50-100‰/an
Flooded forest
2 km

Relative water stage (m)

Entrances PID, malaria

[Ministério da Saúde]
Integrative Approach - Data

- Satellite based
- In Situ
- Epidemiological
- Entomological
- Sociologic
- Public Policies related
Integrative Approach - Data

Satellite based
- Vegetation index, water quality, altimetry, relief

In Situ
- Pluviometry, quality, discharges

Epidemiological
- Incidence, population features

Entomological
- Species, density, vectors’ aggressiveness

Sociologic
- Social practices

Public Policies related
- Public health, land settlement
Integrative Approach - Methodology

- Multiple Correspondence Analysis
- Machine Learning
- Data Mining

... Taking into account time and space ...
Plan
Objectives

Identifying environmental, demographical, genetic factors that explain the emergence and transmission of the infectious diseases in humid tropical environment
Objectives

Identifying environmental, demographical, genetic factors that explain the emergence and transmission of the infectious diseases in humid tropical environment

Diseases

Malaria, Dengue, Buruli ulcer disease (Mycobacterium ulcerans infection)
**Objectives**

Identifying environmental, demographical, genetic factors that explain the emergence and transmission of the infectious diseases in humid tropical environment

<table>
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<th>Diseases</th>
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<td>Malaria, Dengue, Buruli ulcer disease (Mycobacterium ulcerans infection)</td>
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<th>Methods</th>
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<tbody>
<tr>
<td>Remote sensing (SEAS Guyane → SPOT 2,4,5, and ENVISAT)</td>
</tr>
<tr>
<td>Experimental ponds (artificial breeding places)</td>
</tr>
<tr>
<td>Epidemiological and entomological data</td>
</tr>
<tr>
<td>Vectors and pathogenic agents genetics</td>
</tr>
</tbody>
</table>
PLUPH : Poor Land Use, Poor Health

Marc LUCOTTE (Institute of Environmental Sciences, Québec University, Montréal)

2 health issues

- Hg
- Chagas disease
2 health issues

- Hg
- Chagas disease

Objectives

- Hg and Chagas disease: similarities, synergies and antagonisms
- Describing links between landscape, social practices, housing, diet, land use and health
2 health issues

- Hg
- Chagas disease

Objectives

- Hg and Chagas disease: similarities, synergies and antagonisms
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Methods

- 3 pilot communities
  - Riparian, relatively old
  - Recent near a road
  - Native

- Experimental parcels (pilot planting)
- Social networks
"Environment and Health" Group
Chemists, geo-chemists, geologists, mineralogists, ecologist
pharmacologist (UR152), remote sensing
→ Transverse research axis
http://www.lmtg.obs-mip.fr/user/sante
Environment and Health at OMP

New Team Associated with IRD (PHIESAM)

"Saude e Meio Ambiente" (Dr Wanderli Pedro Tadei)

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IRD S140 ESPACE
Projects Environment/Remote sensing and health (EREMIBA, PLUPH, ...)

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(Re)emergent infectious diseases constitute a major public health issue (malaria, dengue, Chagas disease, buruli ulcer, ...)

→ Understanding, monitoring, predicting and generating alerts
In Brief

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- **Environmental factors** are playing a key role
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  - Understanding, monitoring, predicting and generating alerts
- **Environmental factors** are playing a key role
- **Remote sensing** can help characterizing environment in space and time
  - New sensors **High spatial and temporal resolutions**
  - **Altimetry** ...


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Remote sensing alone is not sufficient

→ Entomological, socio-medical, socio-demographical, ... data/knowledge
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  - data/knowledge

- Methods to **jointly analyse temporal, spatialized, heterogeneous data** have to by applied, adapted, developed
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Transdisciplinary projects, research groups and networks are emerging