Steering Committee 23-24 January 2018 – Phnom Penh

WP climate change impacts on dengue and leptospirosis dynamics

Benjamin SULTAN et Vincent HERBRETEAU

ECOMORE II

AFD

Institut Pasteur

international network Institut Pasteur

Institut de Recherche pour le Développement FRANCE

French National Research Institute for Sustainable Development

WP CLIMATE

Leptospirosis seasonality, driven by rainfall and floods

Picardeau, PlosNTD 2015, Mwachui et al. PlosNTD 2015: “Floods and heavy seasonal rainfall in tropical countries are the main risk factors of leptospirosis.”

PLOS NEGLECTED TROPICAL DISEASES

EXPERT COMMENTARY

Leptospirosis: Updating the Global Picture of an Emerging Neglected Disease

Mathieu Picardeau*

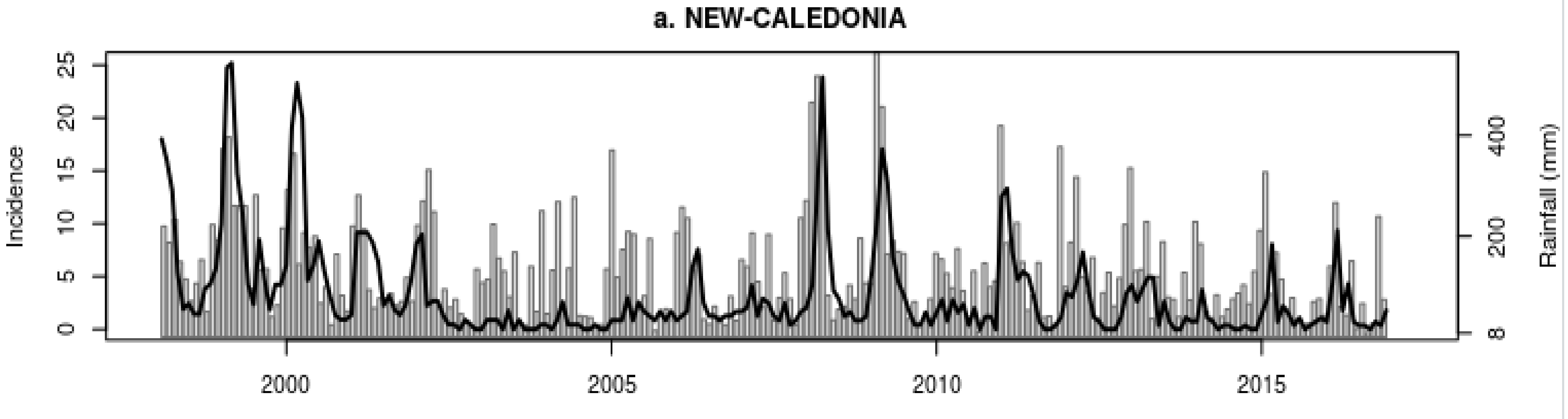
Unité de Biologie des Spirochètes, Institut Pasteur, Paris, France

Picture: Herbreteau V.

Leptospirosis seasonality, driven by rainfall and floods

Climate modelling of leptospirosis in tropical islands

➔*Joséphine Larrieu, Morgan Mangeas, Christophe Menkes, Margot Bador, Cyrille Goarant*

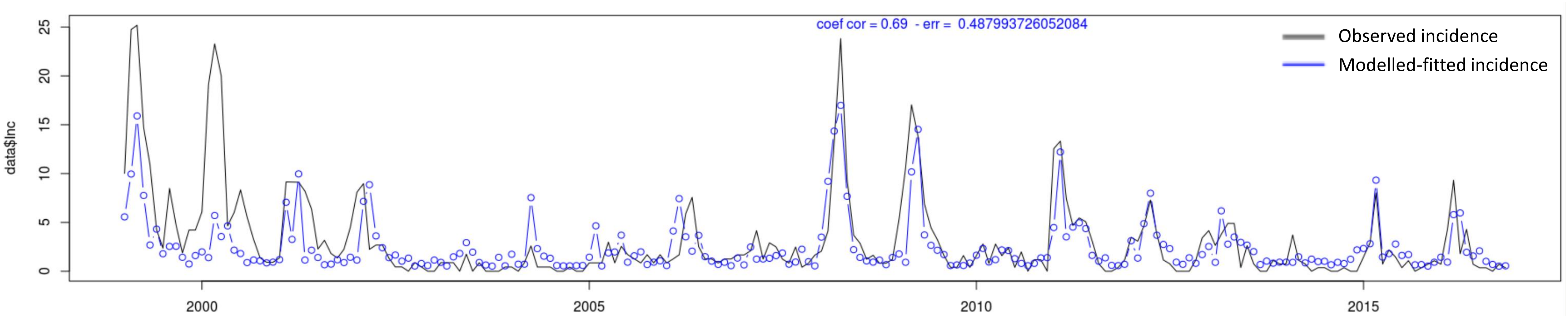


Monthly reported incidence of leptospirosis (solid line) and cumulated satellite rainfall (mm) averaged over New-Caledonia, from 1998 to 2017

Leptospirosis seasonality, driven by rainfall and floods

Climate modelling of leptospirosis in tropical islands

➔*Joséphine Larrieu, Morgan Mangeas, Christophe Menkes, Margot Bador, Cyrille Goarant*

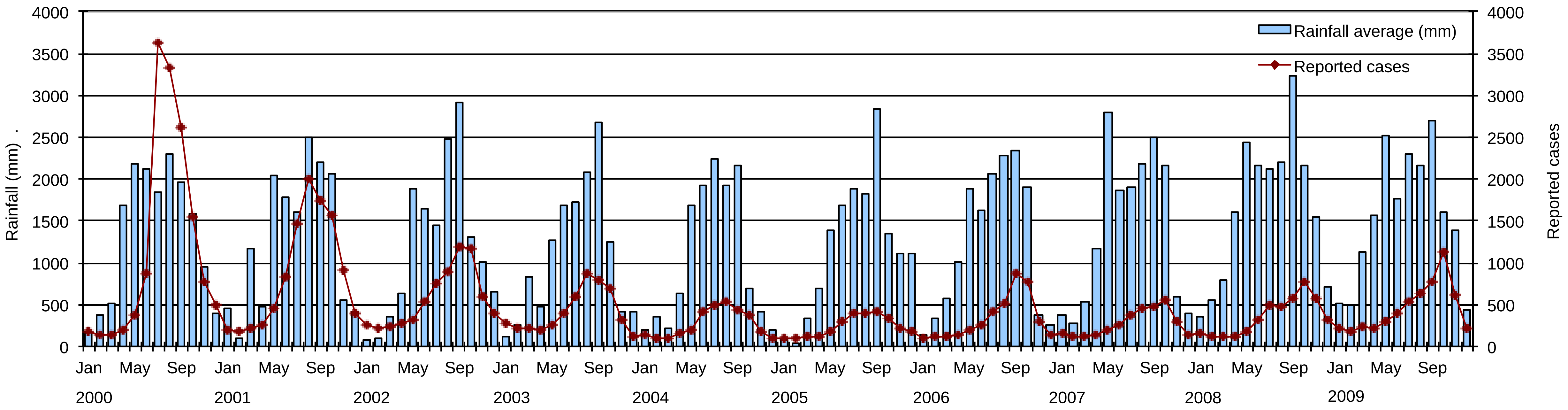


Incidence predicted with r10mm (lag -1 month) & TNm (lag -4 months)

-> SVM (Support Vector Machine)

Leptospirosis seasonality, driven by rainfall and floods

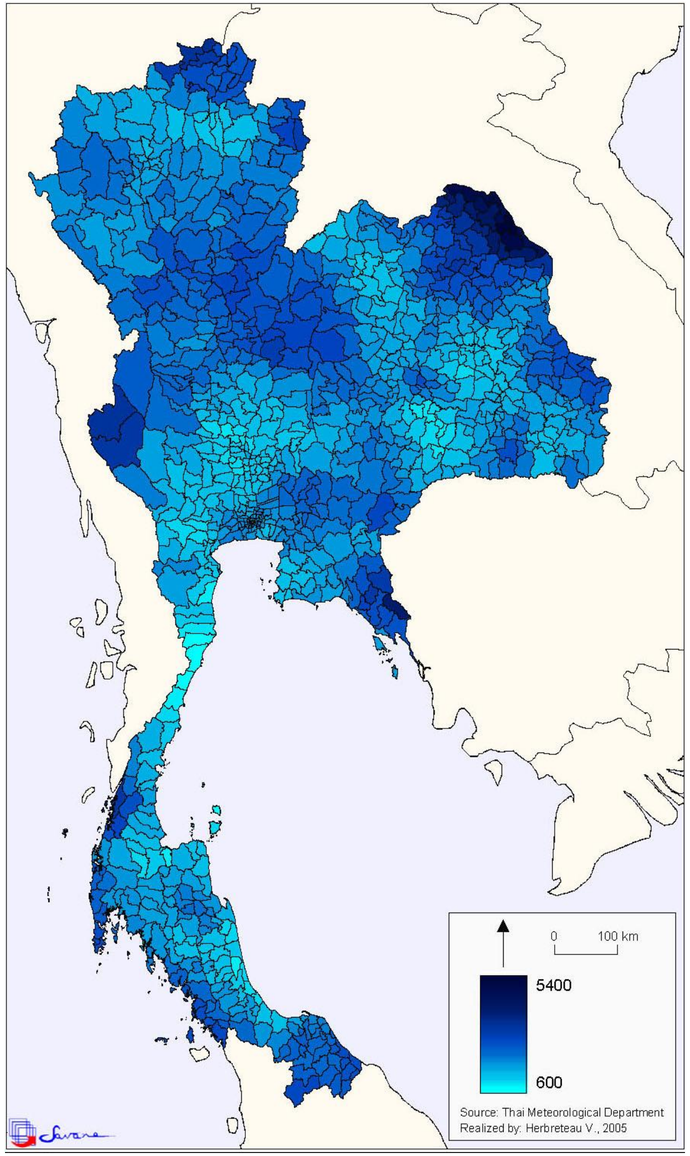
Spatial analysis of leptospirosis reported cases in Thailand



Monthly reported cases of leptospirosis (solid line) and average rainfall average over Thailand, from 2000 to 2009

(Source: Ministry of Public Health, Thai Meteorological Department 2011)

Leptospirosis seasonality, driven by rainfall and floods



Spatial analysis of leptospirosis reported cases in Thailand

➔ 1,250 meteorological stations

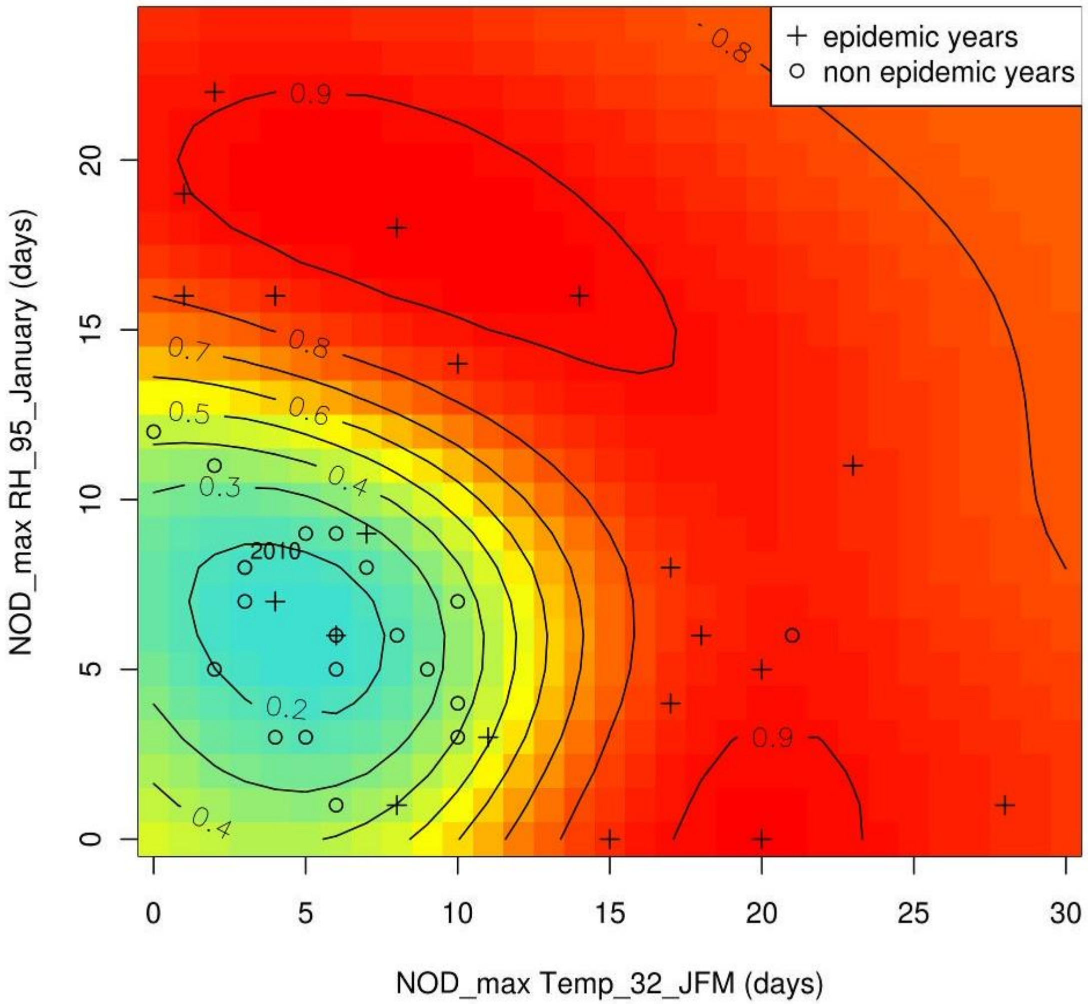
Correlations between monthly leptospirosis incidence and average rainfall:

➔ *Best correlations with rainfall average of the previous month*

Cumulated incidence during the 65 months	> 200	> 300	> 500
Number of districts	88	51	22
Correlation coefficient			
average	0.36	0.35	0.35
standard deviation	0.13	0.12	0.1
minimum	0.06	0.07	0.16
maximum	0.70	0.62	0.62
% of significant coeff	81.82	84.31	90.91

Dengue epidemics, driven by meteorological conditions

Climate modeling of Dengue in New Caledonia



SVM explicative modeling in New Caledonia:

80% of the epidemics from 1971 to 2010 are explained by climate but non-linear effects:

-> best explicative meteorological variables :

- the number of days with maximal temperature exceeding 32°C during January–February–March
- the number of days with maximal relative humidity exceeding 95% during January

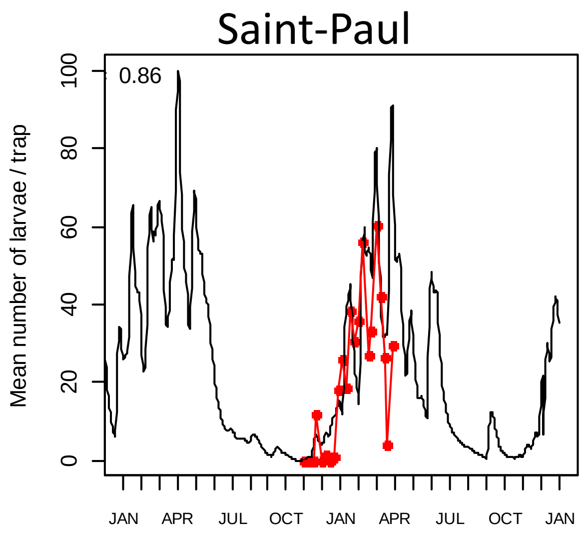
OPEN ACCESS Freely available online
PLoS NEGLECTED TROPICAL DISEASES

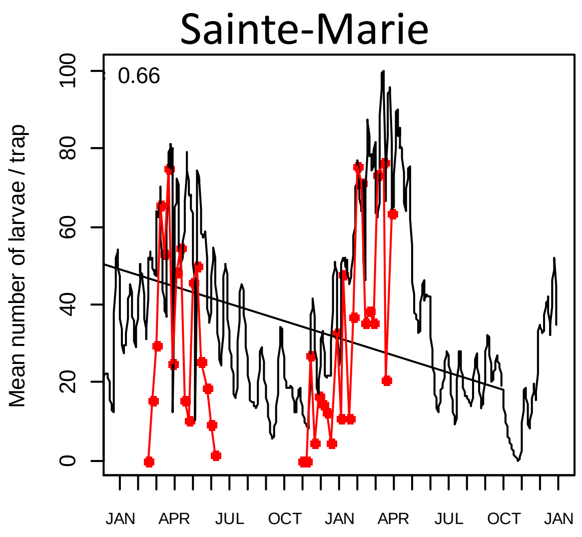
Climate-Based Models for Understanding and Forecasting Dengue Epidemics

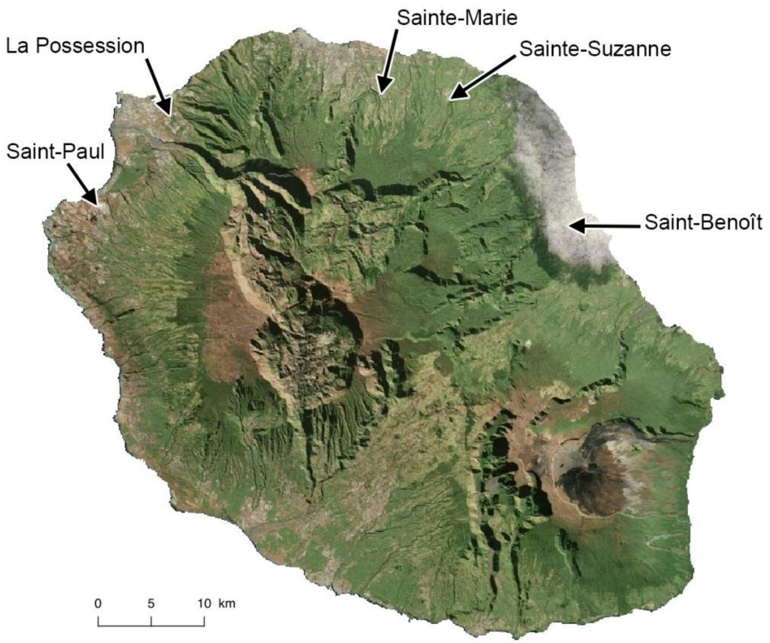
Elodie Descloux[1,2]*, Morgan Mangeas[3], Christophe Eugène Menkes[4], Matthieu Lengaigne[5], Anne Leroy[6], Temaui Tehei[6], Laurent Guillaumot[7], Magali Teurlai[3], Ann-Claire Gourinat[8], Justus Benzler[9], Anne Pfannstiel[10], Jean-Paul Grangeon[10], Nicolas Degallier[5], Xavier De Lamballerie[1]

Vector dynamics, driven by meteorological conditions

AlboRun Project: a tool to predict the dynamics of *Aedes albopictus* in Reunion Island



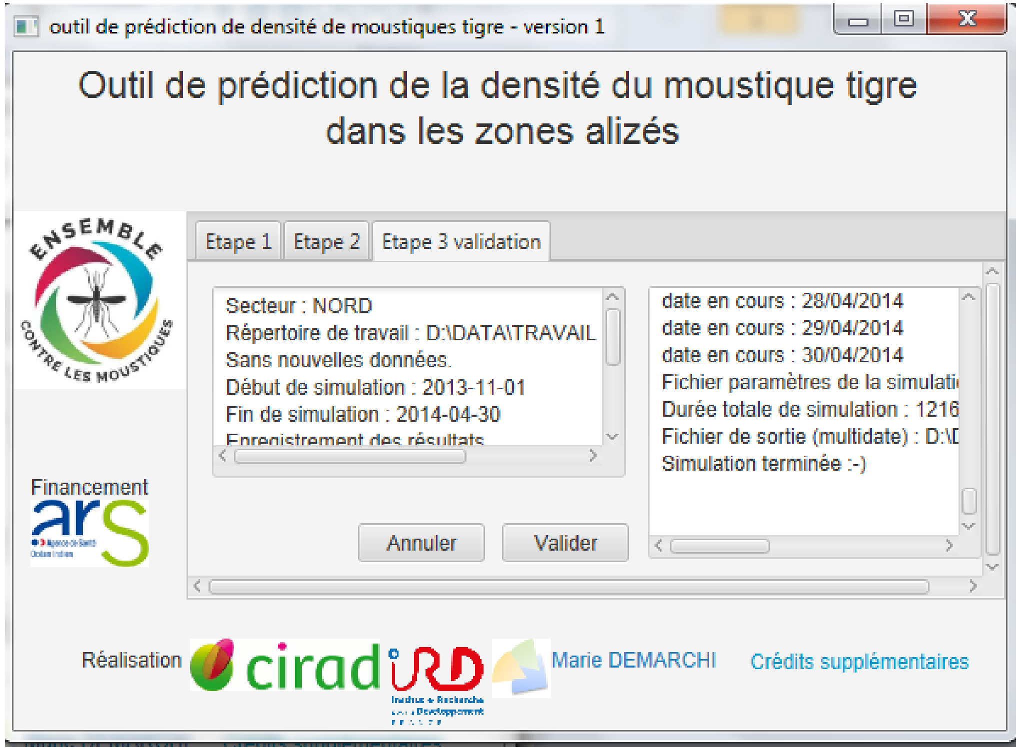


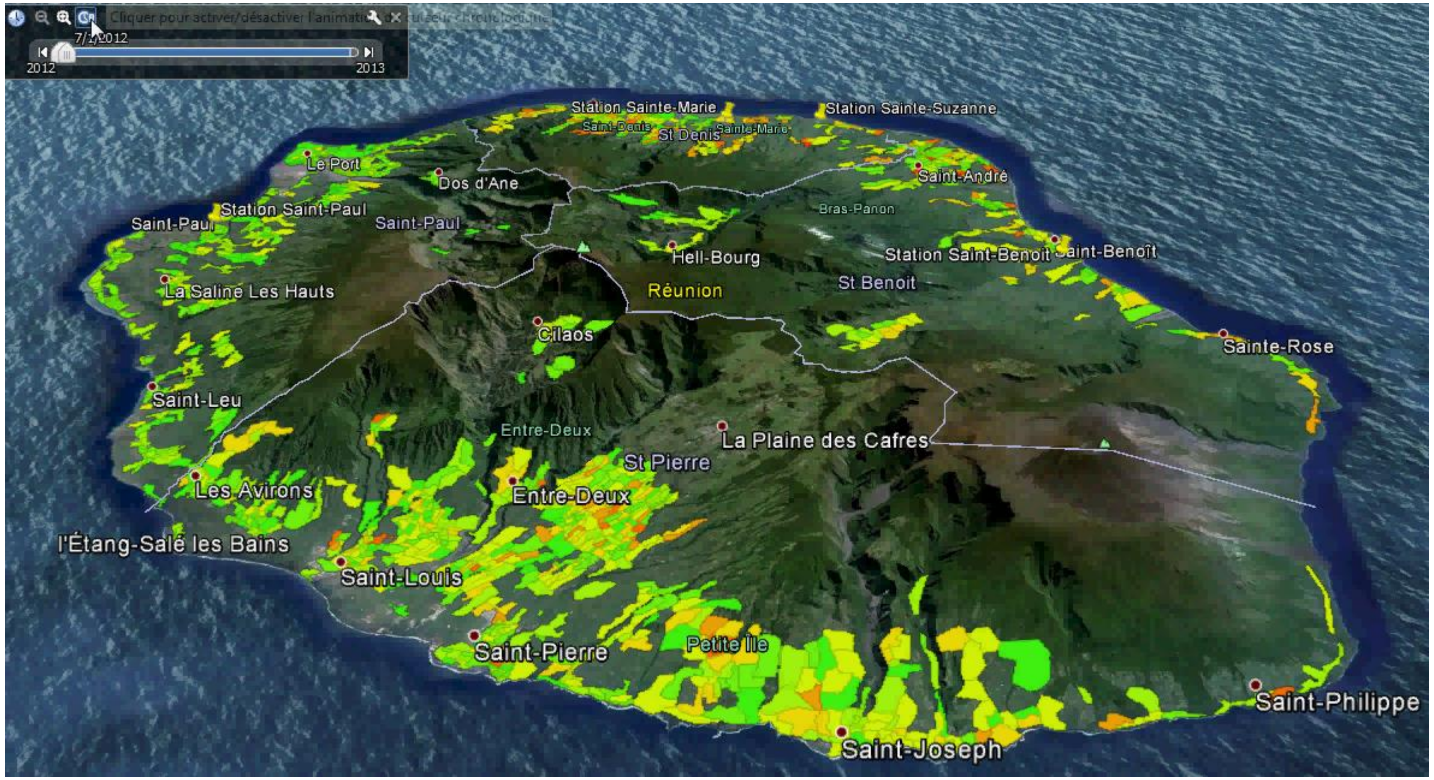


Marie DEMARCHI

Vector dynamics, driven by meteorological conditions

AlboRun Project: a tool to predict the dynamics of *Aedes albopictus* in Reunion Island





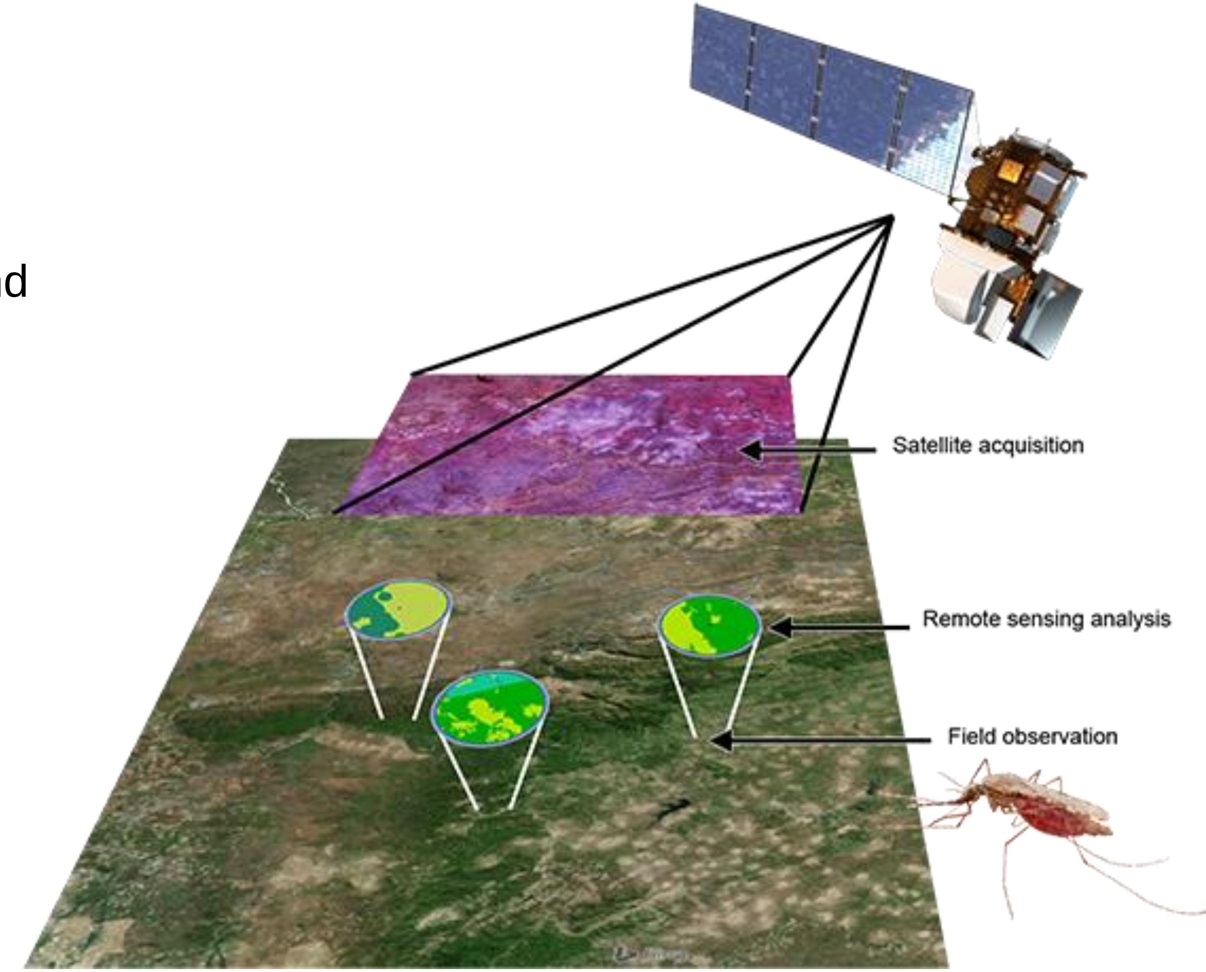
Search for environmental indicators of health observations

- Study of the ecology of reservoirs and vectors of diseases

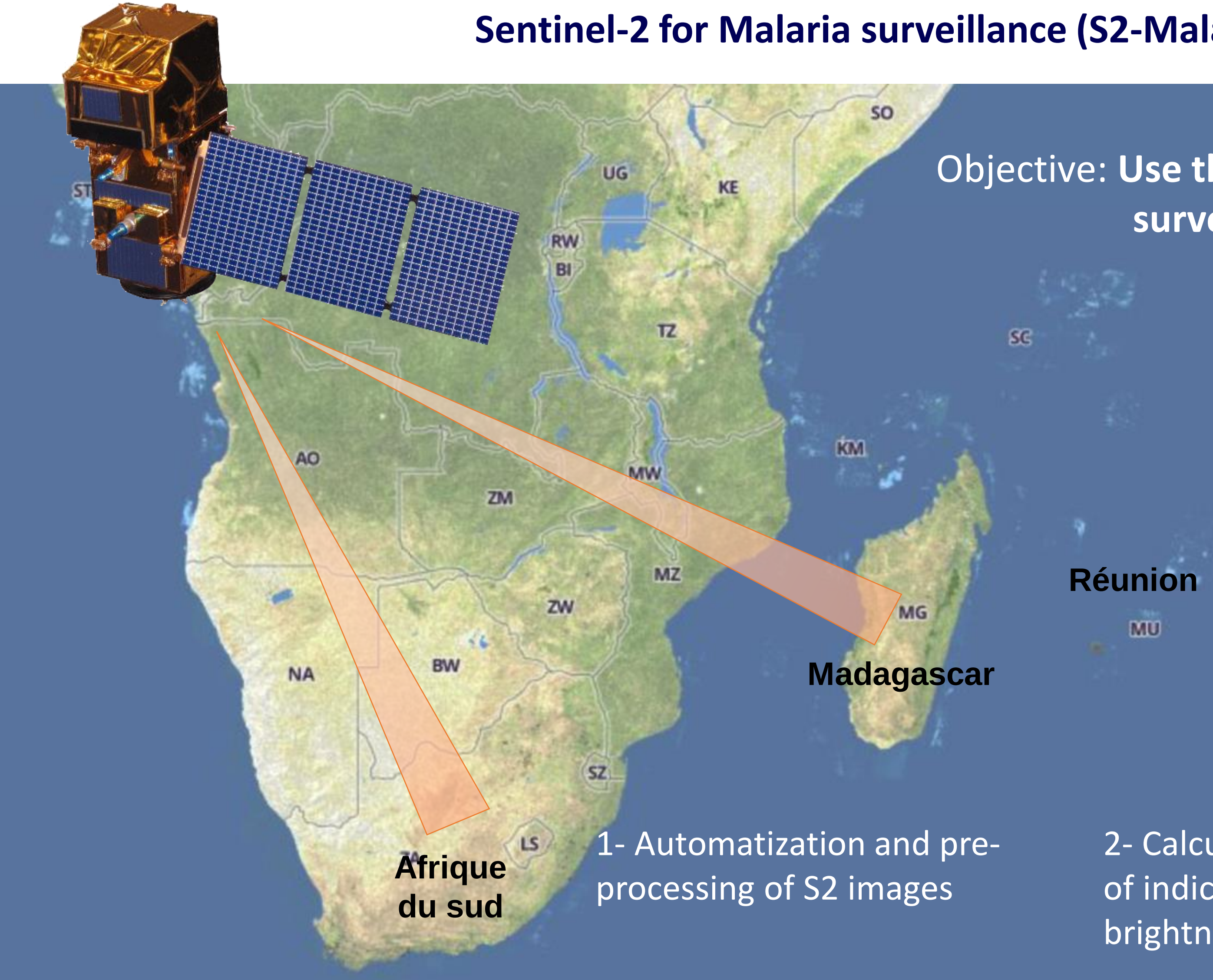
  ➔ Health ecology

- Study of the spatial structure of biotopes
  - Example of the fragmentation of natural habitats and the impact on health

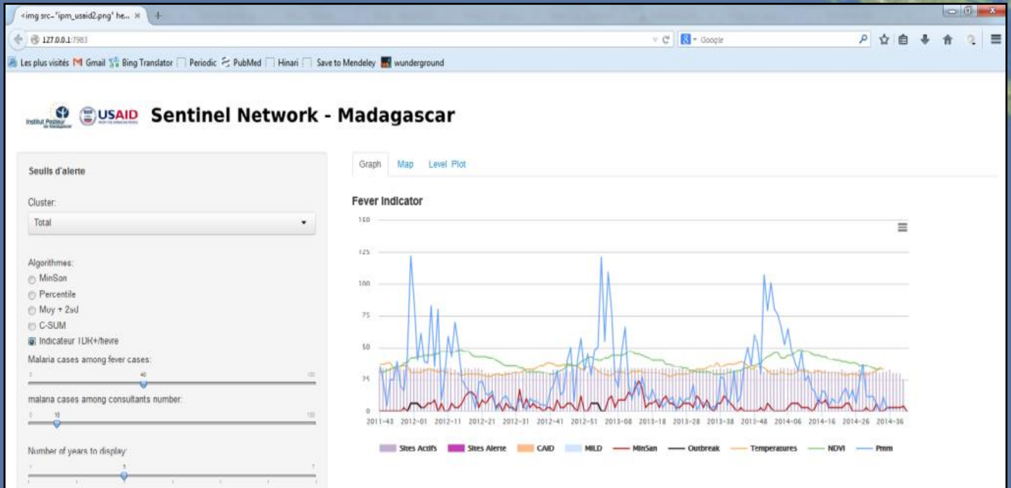
- Study of the vulnerability of human populations to a health risk
  - Example of the inequalities in accessing health services,
  - Example of the proximity to a vector of disease.



Sentinel-2 for Malaria surveillance (S2-Malaria) – Projet TOSCA 2017-2019



Objective: **Use the information provided by Sentinel-2 for the surveillance of malaria**



Malaria Early Warning System, Florian Girond, Patrice Piolat et al. – IP Madagascar

1- Automatization and pre-processing of S2 images

2- Calculation of time series of indices (vegetation, brightness, etc.)

3- Calculation of malaria indicators and integration in a surveillance system

-> Develop reusable tools for epidemiological surveillance

Funding

cnes – De l'espace pour la Terre

Partners

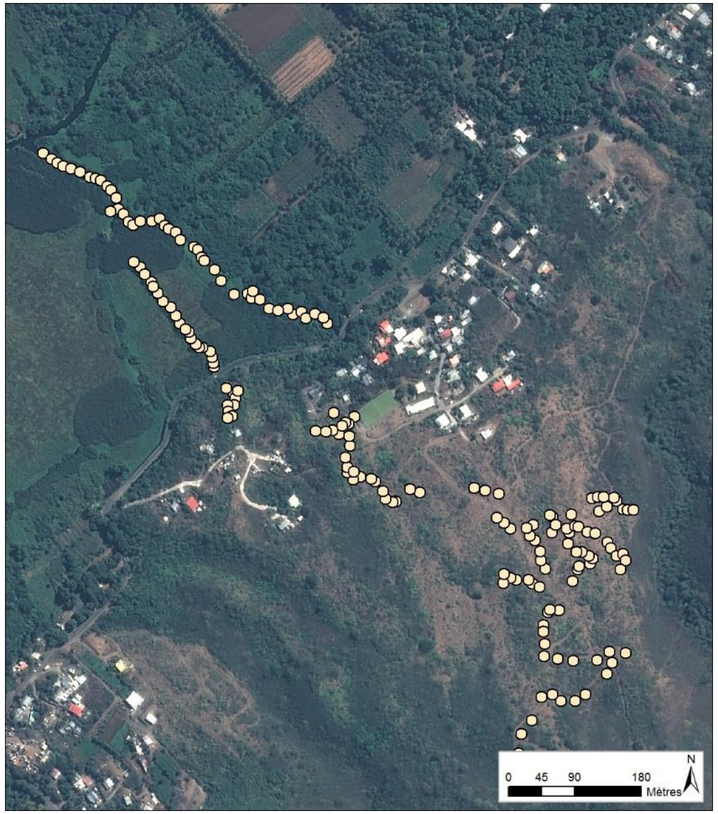
Espace Dev
Institut Pasteur de Madagascar
Universiteit van Pretoria / University of Pretoria / Yunibesithi ya Pretoria
sansa – South African National Space Agency
SEASTIM

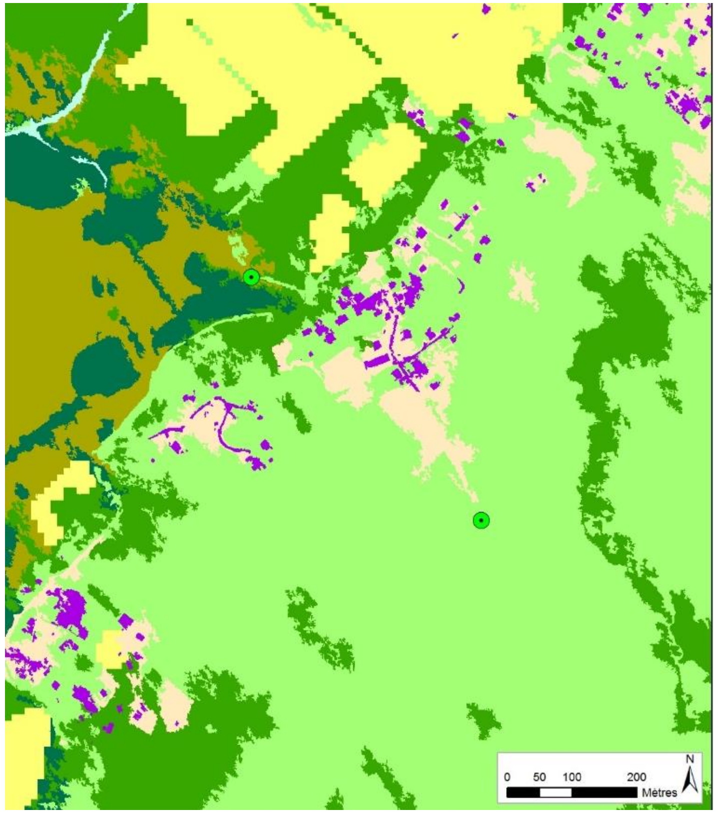
Search for environmental indicators of health observations

Leptospirosis investigation in Reunion and Seychelles

LeptOI project 2012-2015 (Coord. CRVOI / FEDER POCT)

Rodent trapping and leptospirosis investigation by CRVOI and Ministry of Health of Seychelles





Search for environmental indicators of health observations

Leptospirosis investigation in Reunion and Seychelles

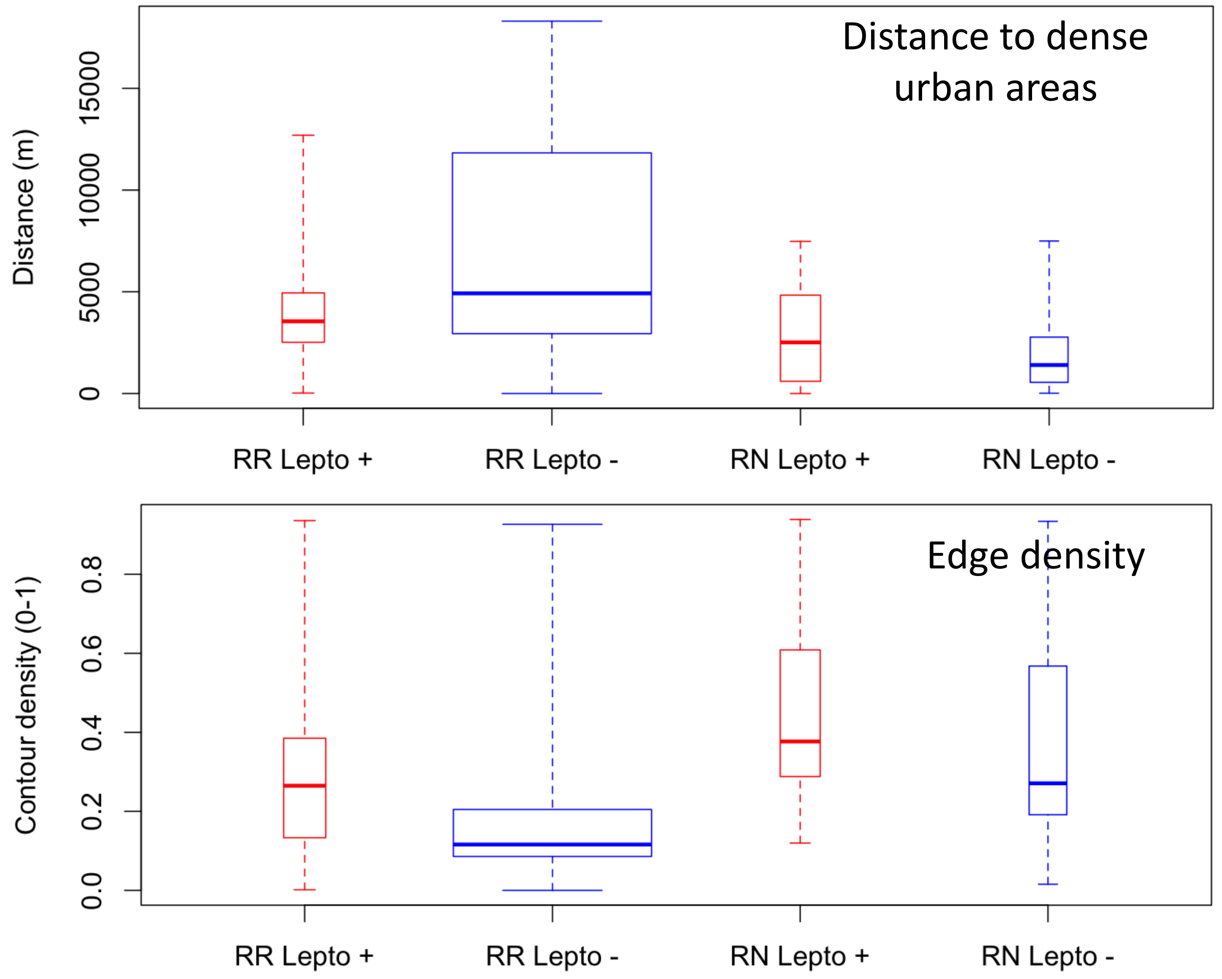
LeptOI project 2012-2015 (Coord. CRVOI / FEDER POCT)

Seychelles:

- *Rattus rattus* are observed further to Dense Urban areas

- Positive *R. rattus are closer whereas negative R. norvegicus are further*

- Positive animals are characterized by a more fragmented landscape (/ edge density)



Search for environmental indicators of health observations

Leptospirosis investigation in Reunion and Seychelles

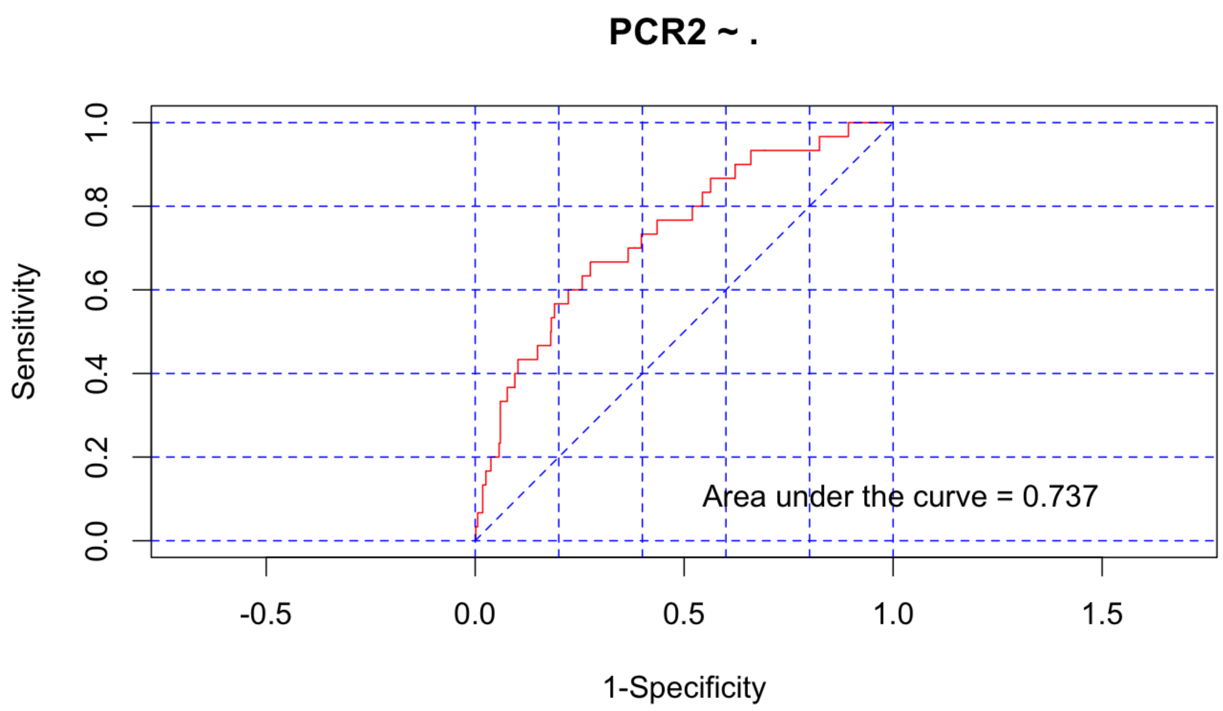
LeptOI project 2012-2015 (Coord. CRVOI / FEDER POCT)

-> Generalized linear model

-> For *Rattus rattus*

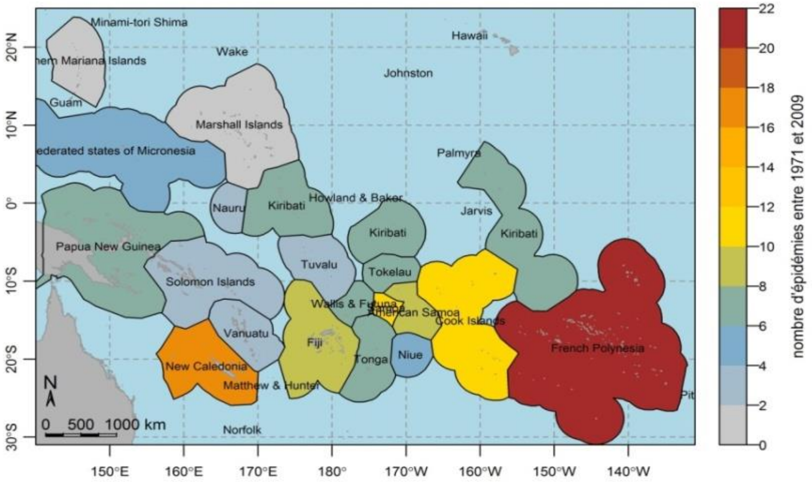
	p value
Rainfall_cumul	< 0.0675
Distance to urban areas	< 0.03 *
Distance to agricultural areas	0.09
Edge_Density(100)	0.23

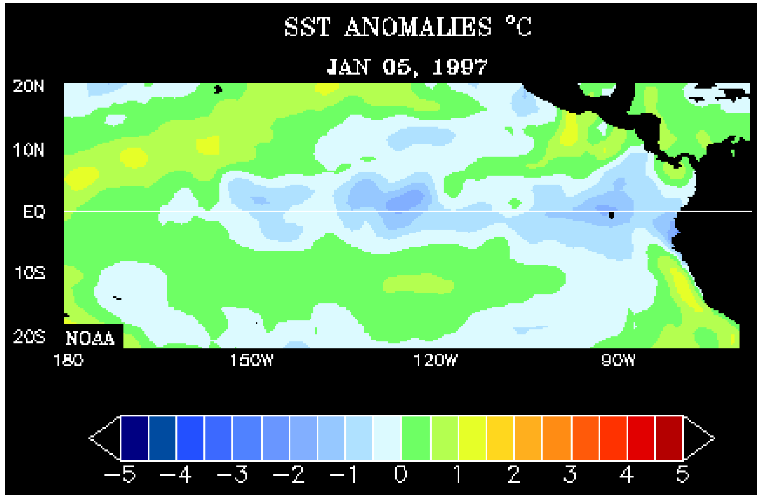
Glm (formula = Lepto_PCR ~ Rainfall_cumul + Distance to urban areas + Distance to agricultural areas + Edge_Density(100)

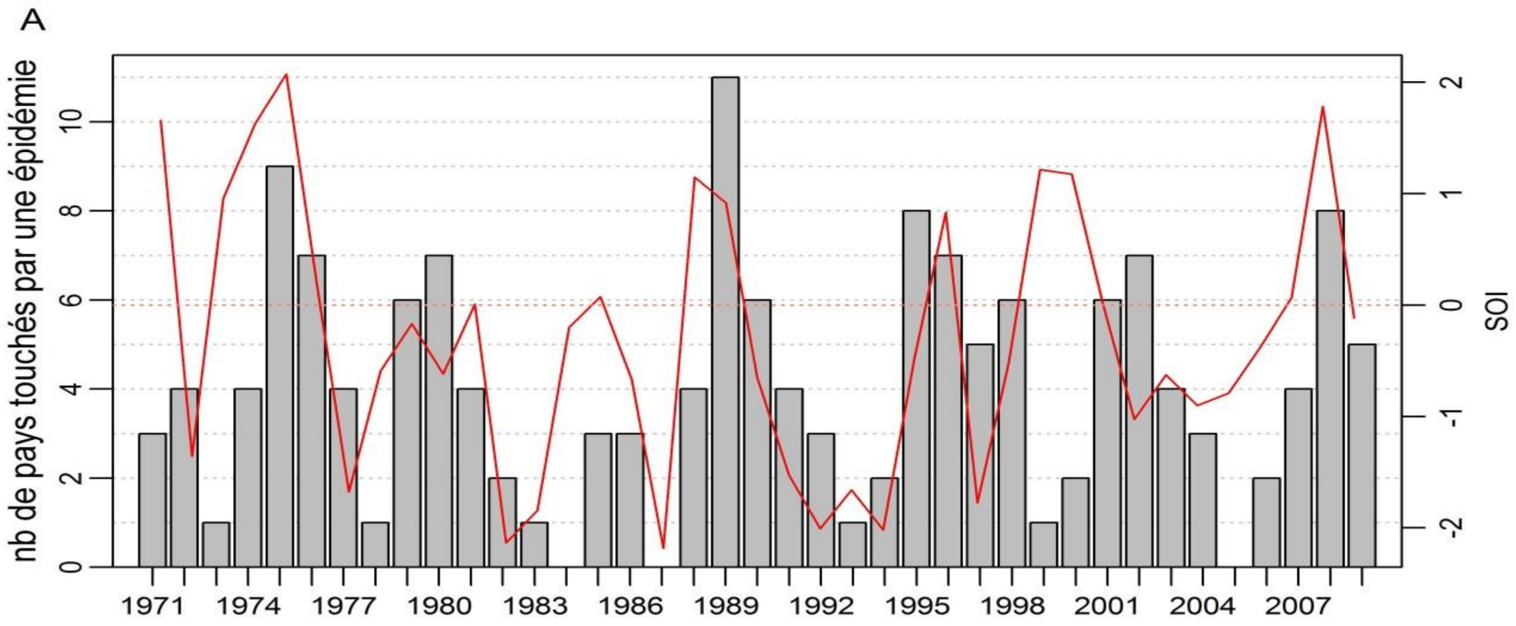


Dengue epidemics, also associated to climate anomalies at a regional scale

Impact of climate anomalies on Dengue in the Pacific

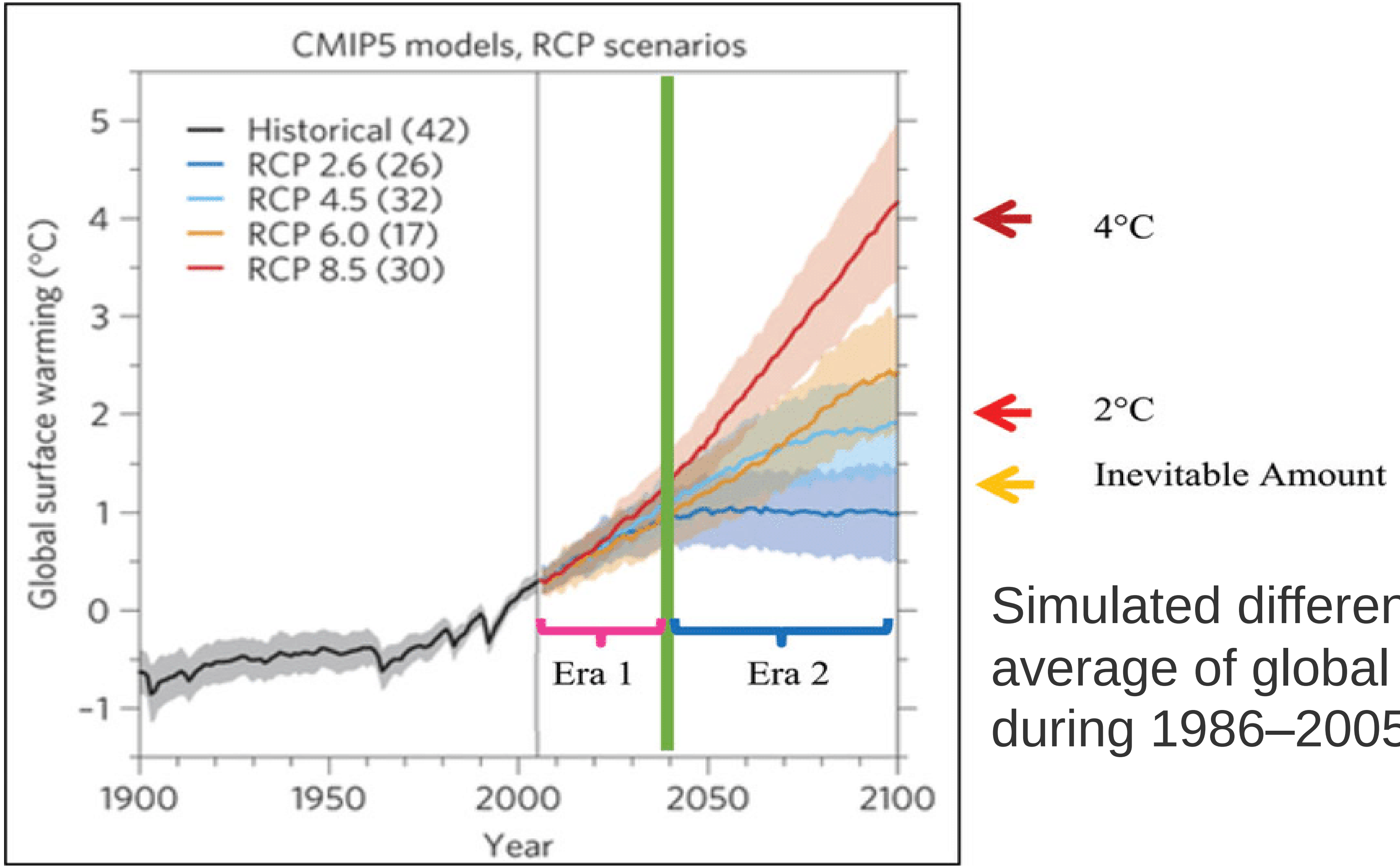






➔ Correlation with ENSO

Climate has changed and more drastic changes are expected

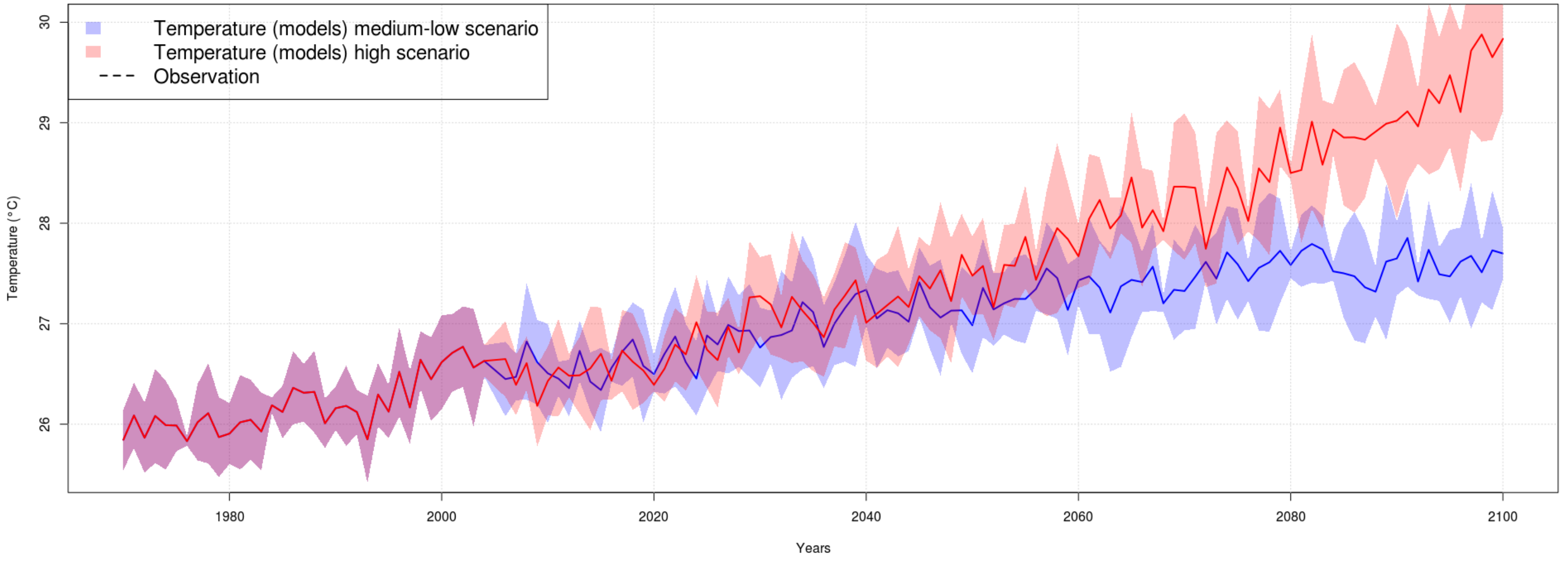


Simulated differences from the average of global temperatures during 1986–2005

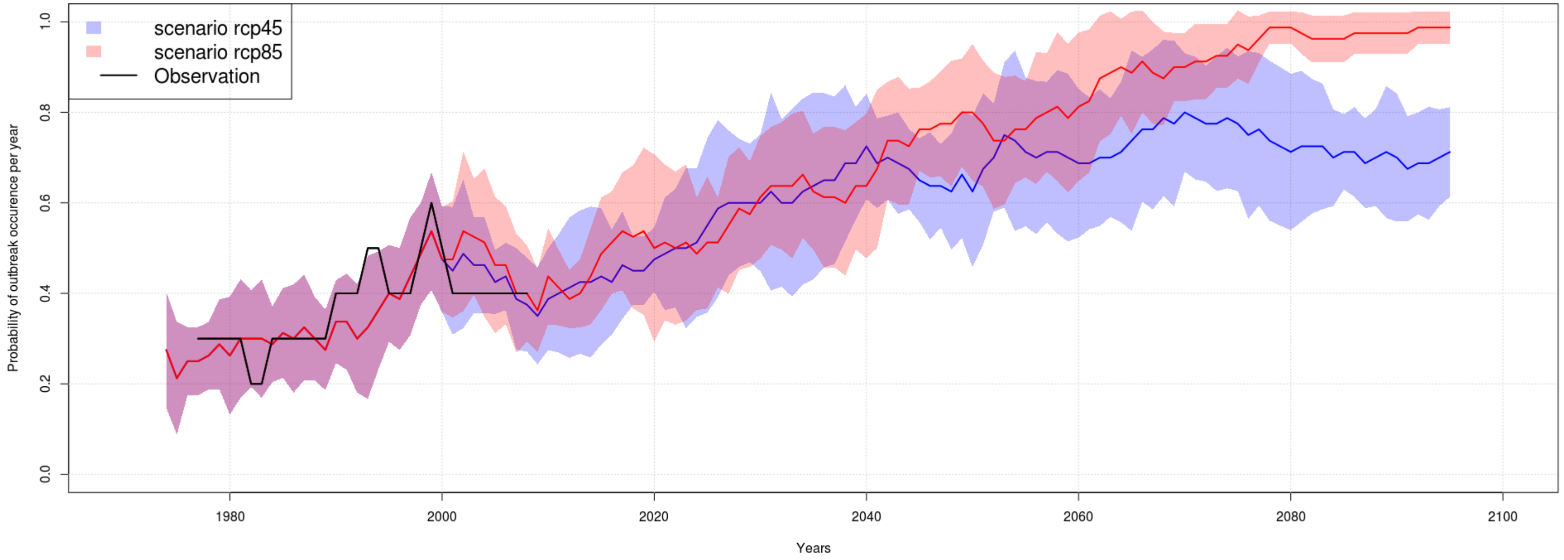
Source: IPCC, McCarl [2015] from Knutti and Sedí aček [2013])

A negative impact of climate change already found in other regions

Observed and simulated temperature evolution

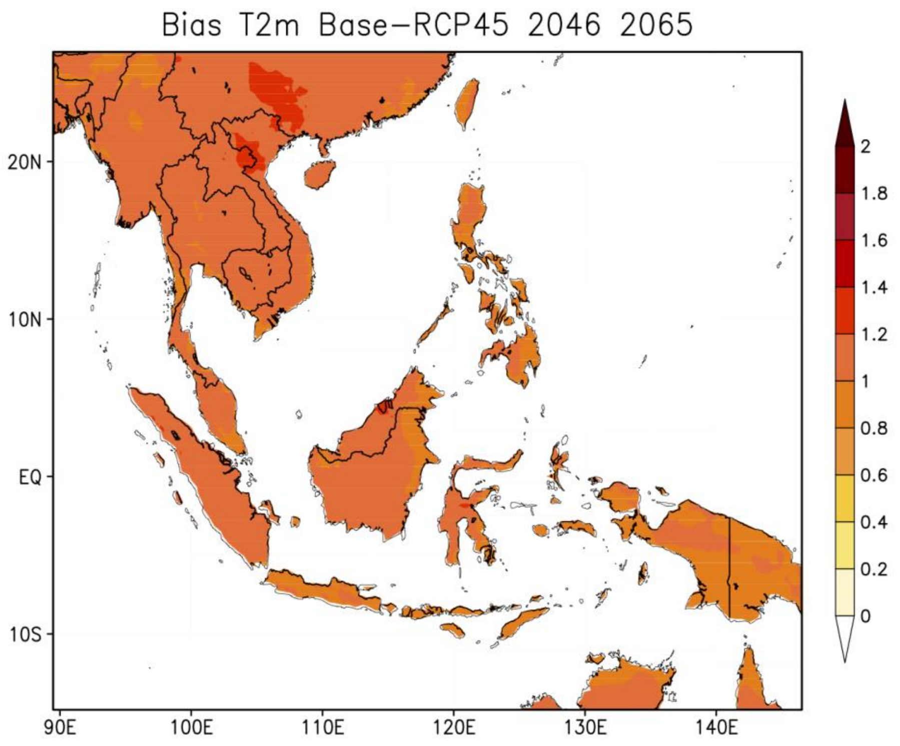


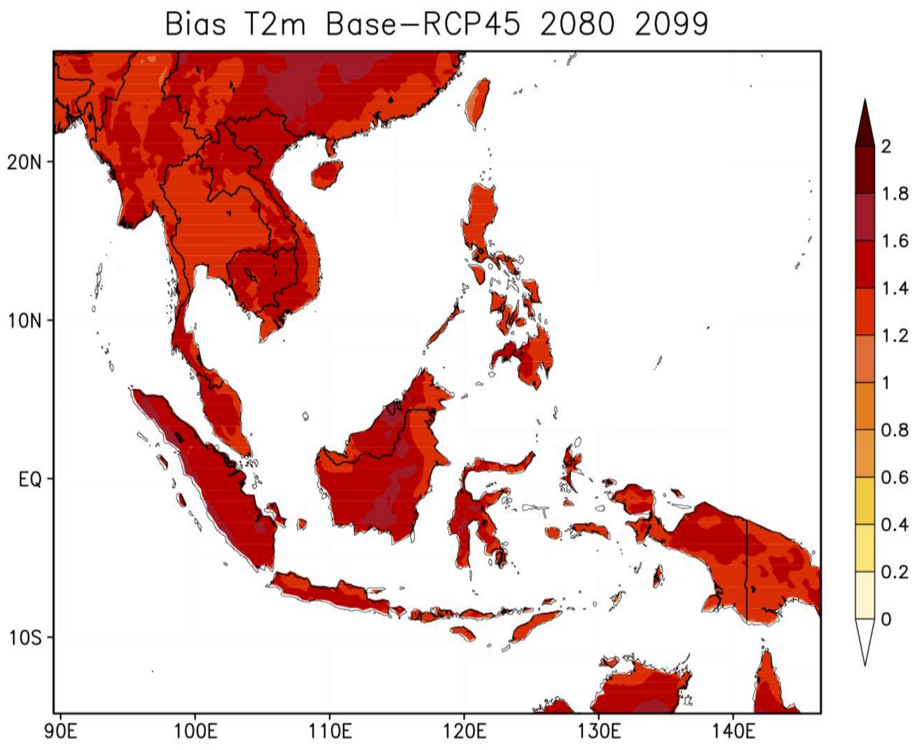
Probability of dengue outbreak occurence



What about climate change in South East Asia?

RegCM-CNRM5: Future – Baseline





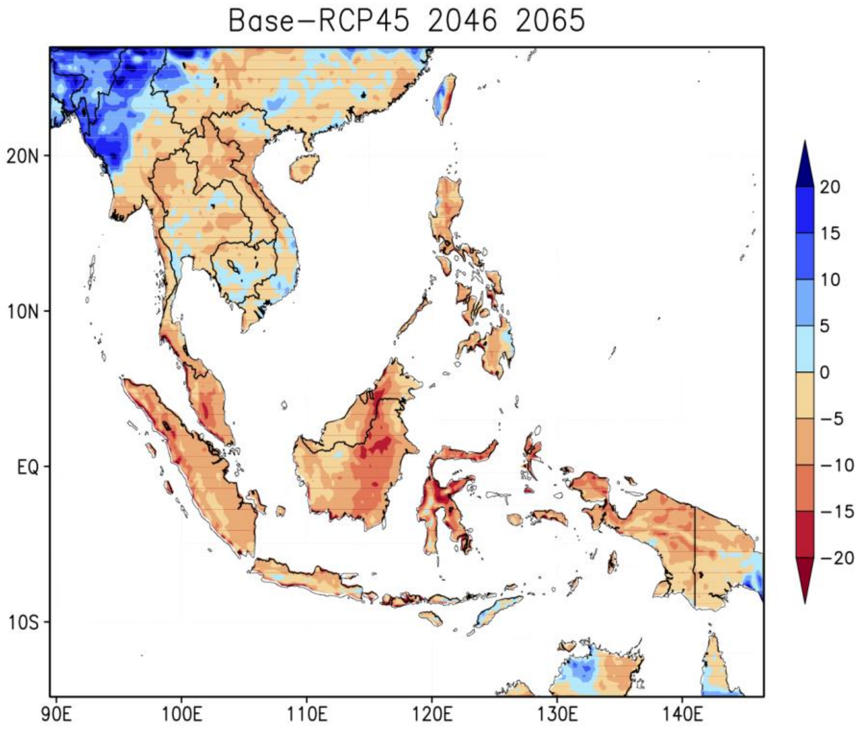
[2046-2065] – [1986-2005]

[2080-2099] – [1986-2005]

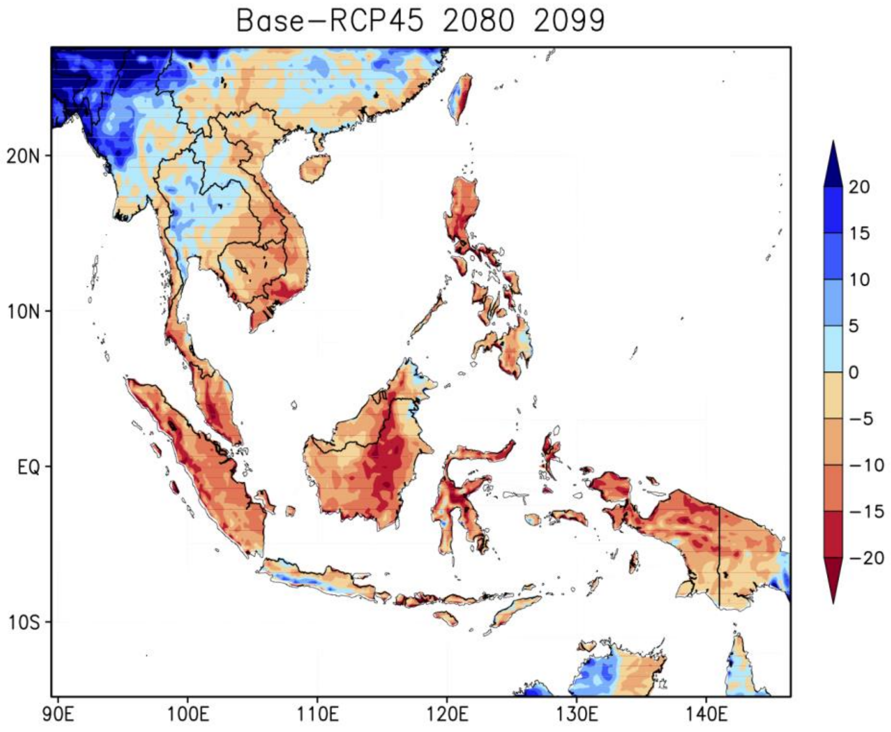
Source: Courtesy of T. Ngo-Duc, VNU Hanoi University of Science

What about climate change in South East Asia?

RegCM-CNRM5: Future – Baseline (%)



[2046-2065] – [1986-2005]



[2080-2099] – [1986-2005]

Source: Courtesy of T. Ngo-Duc, VNU Hanoi University of Science

The ECOMORE II WP Climate

- Primary objective of the WP

Detect climate change impacts on dengue and leptospirosis

- Relevance at the both Regional and National level

All South East Asia with some targeted sites in ECOMORE II countries

- Experts who have participated in the design of the study

An interdisciplinary team of experts:

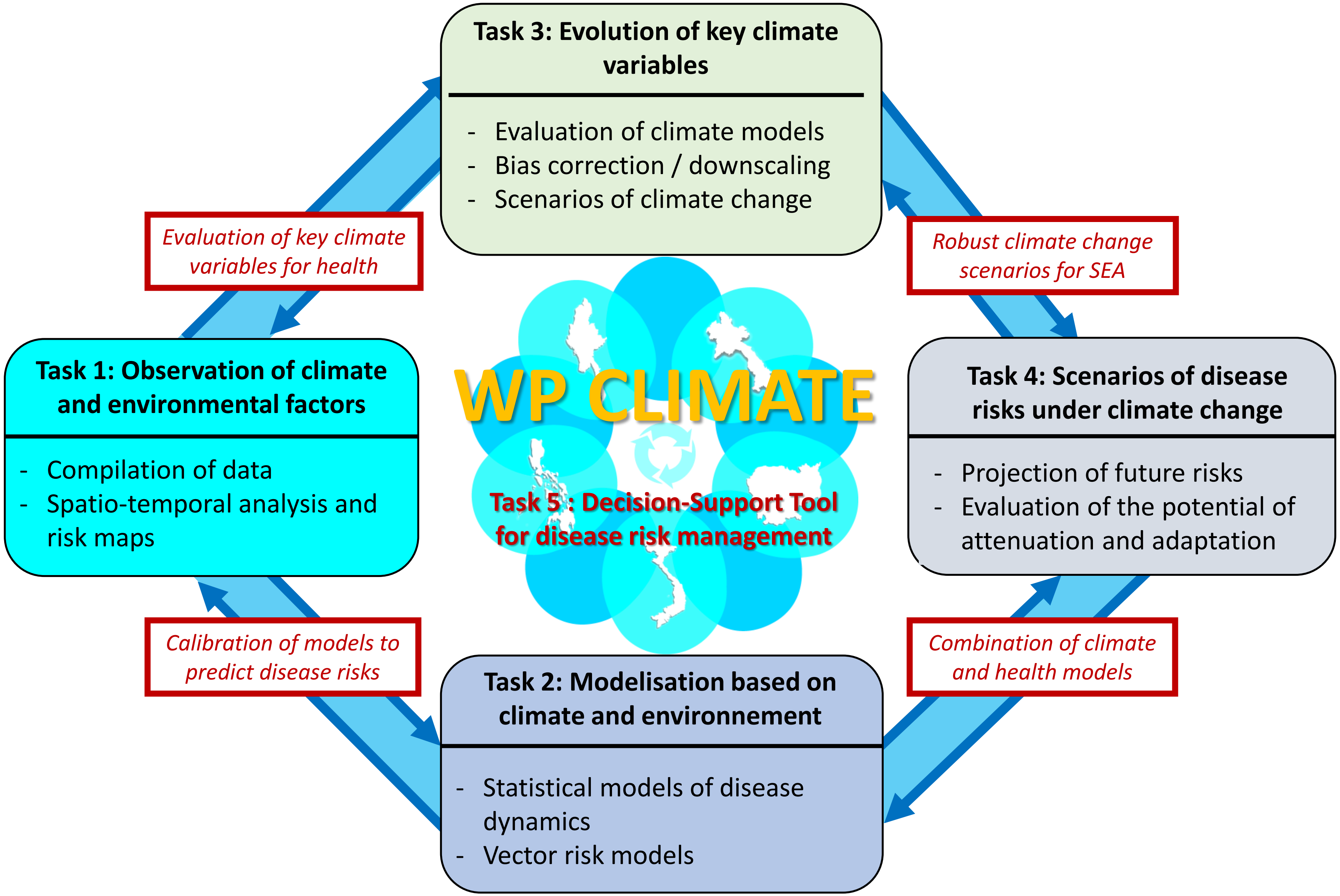
- ***Climate and Environment:*** *B Sultan (IRD), V Herbreteau (IRD) C Menkes (IRD), T Ngo-Duc (VNU Hanoi University of Science)*
- ***Epidemy and vector modelling:*** *M Mangeas (IRD), A Tran (CIRAD), C Goarant (IP), M Souris (IRD)*
- ***Decision support tools:*** *J-P Boulanger (ECOCLIMASOL)*

Institut de Recherche pour le Développement FRANCE

cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

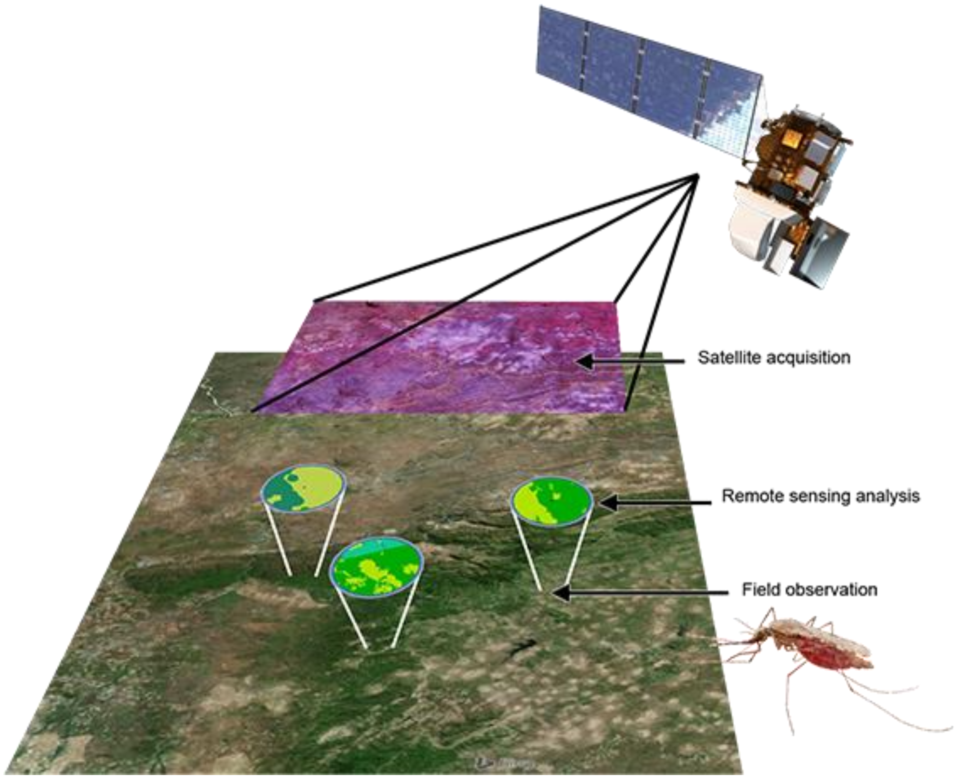
ECOCLIMASOL CLIMATE RISK MANAGEMENT SOLUTIONS

Institut Pasteur


Task 3: Evolution of key climate variables
- Evaluation of climate models
- Bias correction / downscaling
- Scenarios of climate change
Evaluation of key climate variables for health
Robust climate change scenarios for SEA
Task 1: Observation of climate and environmental factors
- Compilation of data
- Spatio-temporal analysis and risk maps
WP CLIMATE
Task 5 : Decision-Support Tool for disease risk management
Task 4: Scenarios of disease risks under climate change
- Projection of future risks
- Evaluation of the potential of attenuation and adaptation
Calibration of models to predict disease risks
Combination of climate and health models
Task 2: Modelisation based on climate and environnement
- Statistical models of disease dynamics
- Vector risk models

Task #1: Identification of key climate and environmental factors for disease dynamics (outbreaks /emergence) and spatio-temporal variability of vectors

- Compilation of existing meteorological / disease / entomological data to produce a regional database.
- Collection of additional regional data (climate reanalyses, satellite imagery using MODIS, Sentinel)
- Application of comparative analyses across WP, meta-analyses of WP results and specific statistical analyses to identify the role of climate on disease dynamics.

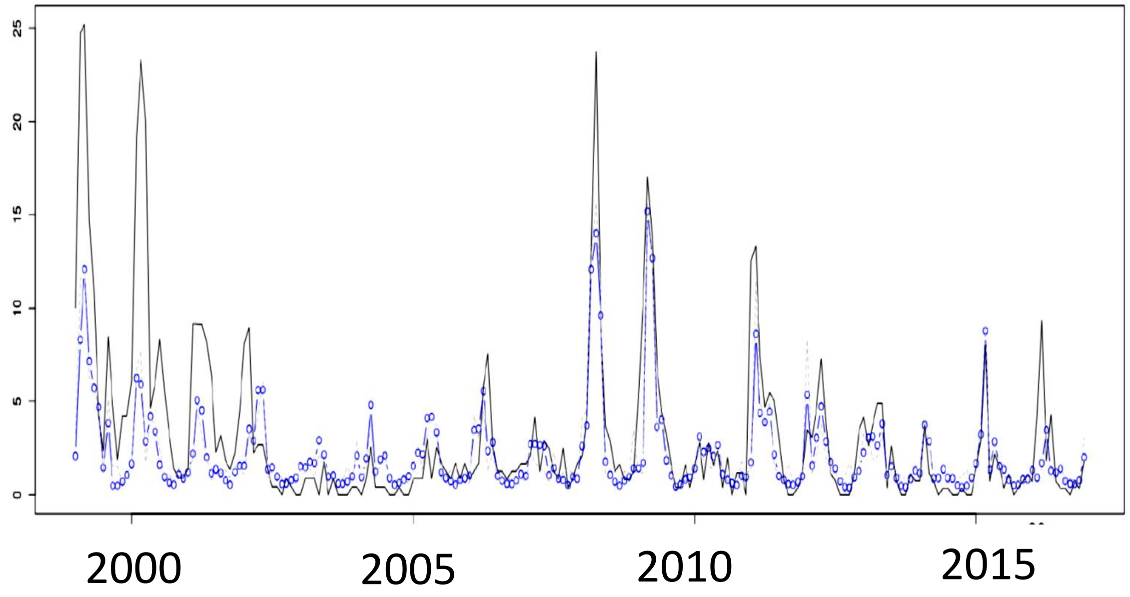


Outputs: Identification of key climate factors, provision of regional present risk maps of disease based on environmental and climate data

Task #2: Modelisation of the disease and vector risk based on climate and environmental factors

- Development of a statistical model to predict disease dynamics based on individual WPs and task 1 data.
- Development of a vector risk model combining statistical and dynamical population dynamics
- Calibration / validation of the models and evaluation of the skill across WPs under different climate conditions
- Training and capacity building on the different models

Predicted incidence of leptospirosis based on satellite rainfall (1-month lag) in New Caledonia

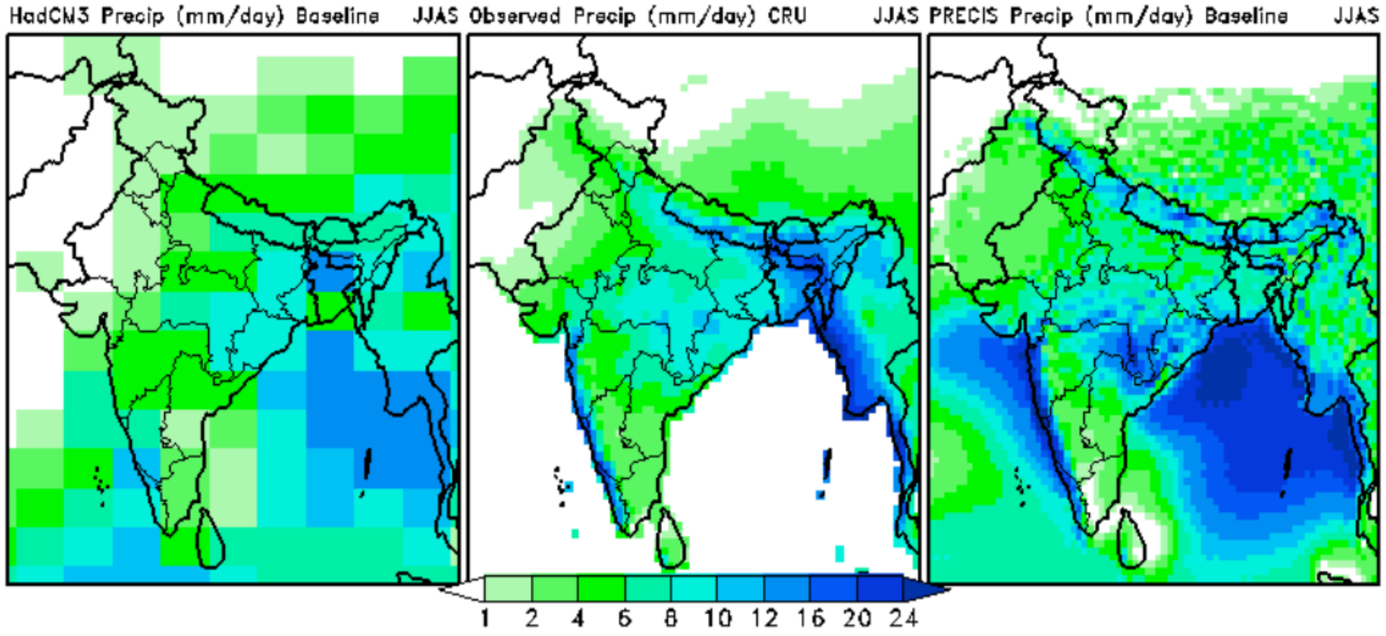


Outputs: Design of models able to predict risk of leptospirosis and dengue disease and vector density based on climate variations

Task #3: Analysis of climate change scenarios and future evolution of key climate factors for disease dynamics

- Analysis of performance of climate model outputs in regards to key relevant climate factors for public health (from task 1)
- Improvement of the skill / resolution of the models with bias correction and downscaling
- Analysis of evolution of key climate factors for disease dynamics under different climate warming scenarios

- Picture

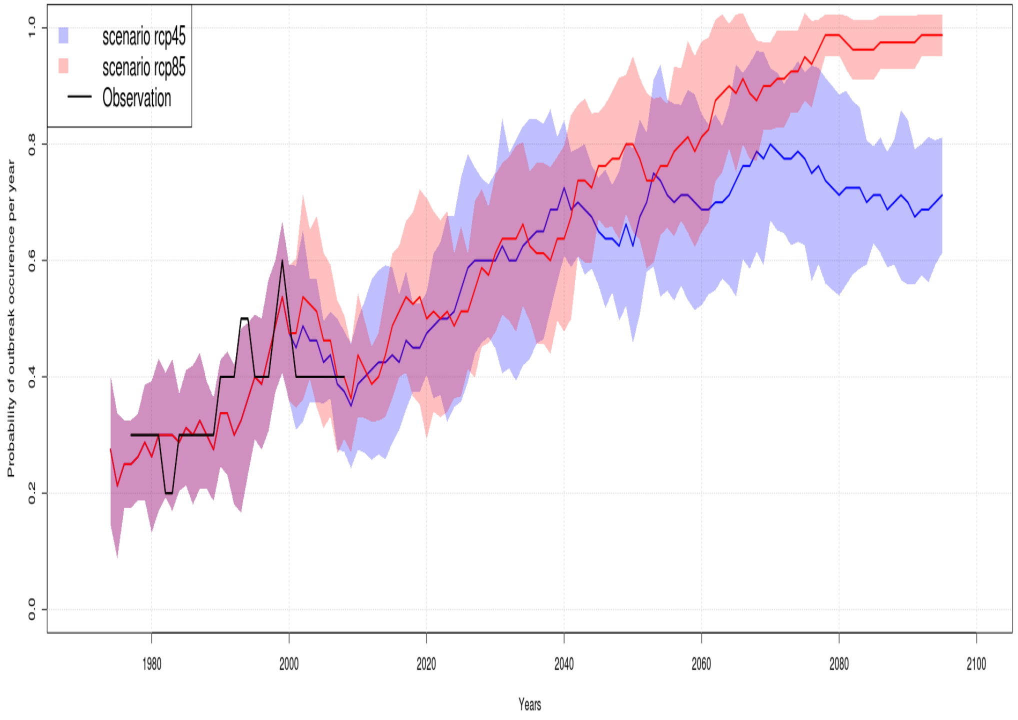


Outputs: Identification of future scenarios of key climate factors involved in leptospirosis, dengue outbreaks and vector risk

Task #4: Analysis of scenarios of climate change impacts on disease dynamics and attenuation / adaptation potential

- Application of climate change scenarios to the disease risk model from task 2 to identify the evolution of the risk of disease
- Analysis of the differences in the simulated risks between climate change conditions derived from different concentration pathways to evaluate the benefits of attenuation for health in the region
- Assessment of the benefits of different disease control technique developed in the WP to reduce the impacts of climate change on the risk of disease

- Picture



Outputs: Production of future risk maps of leptospirosis and dengue dynamics under climate change, evaluation of attenuation and adaptation potential

Task #5: Decision Support Tool for disease risk management

- Design an interactive open-public platform, where each user will be able to visualize and interact with maps of climate change scenarios and impacts in terms of dengue and leptospirosis of the entire region of the ECOMORE2 Project.
- Highlight regions of major risk under climate change in order to guide public health policies. Researchers and decision-makers could use such information in their strategy making, as well as for teachers and professors for dissemination purpose

- Picture

Outputs: Design of a perennial Web-based platform to visualize current and future disease and vector risks

Acknowledgements

Thank you for your attentation