Introduction to climate-health issues

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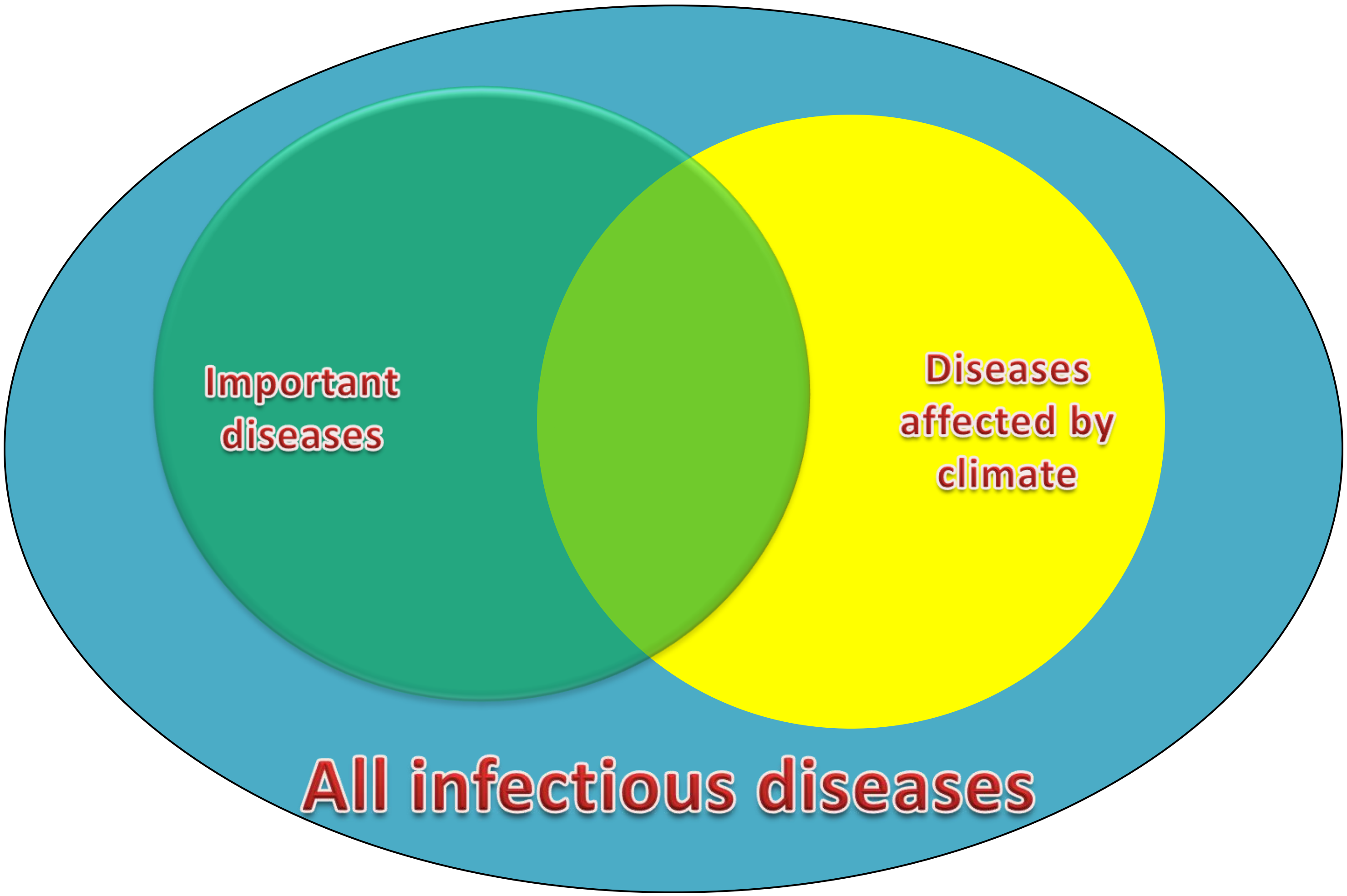
Not all diseases are climate driven



…but many are:

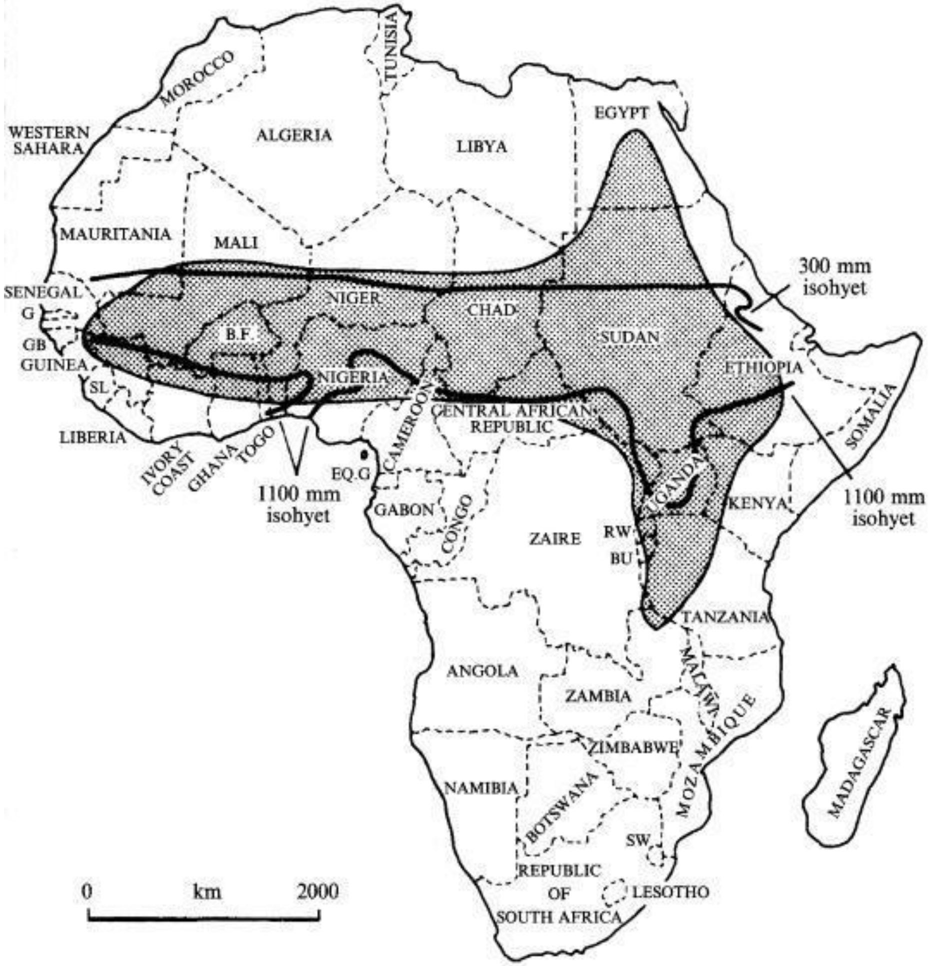
Climate change and health

Climate effect	Climate extremes: heat/cold waves	Climate extremes: floods, storms	Climate extremes: drought
Health effect	More mortality & morbidity	More mortality & morbidity	More mortality & morbidity
Infectious disease effect		More diarrhoeal diseases after floods – cholera, typhoid, cryptosporidiosis	Infectious diseases, exacerbated by effects of malnutrition
Example	Europe 2003 - heat wave killed ~50,000 (older) people in Western Europe	Mozambique 2001 – 447 additional deaths from diarrhoeal disease	Meningococcal meningitis in Africa - distribution & intensity linked to drought. Drought termination can trigger outbreaks of vector-borne disease.

Example: Meningitis research

slide from Michelle Stanton

Cheesbrough, Morse and Green (1995)



- An area of sub-Saharan Africa referred to as the meningitis belt experiences large-scale meningitis epidemics every 7-12 years.
- Meningitis incidence within this area is seasonal, with peaks occurring during the dry season and few cases occurring once the rains begin.
- This relationship between meningitis and the climate, is poorly understood.
- Further, the scales at which the climate influences meningitis is not well-defined.

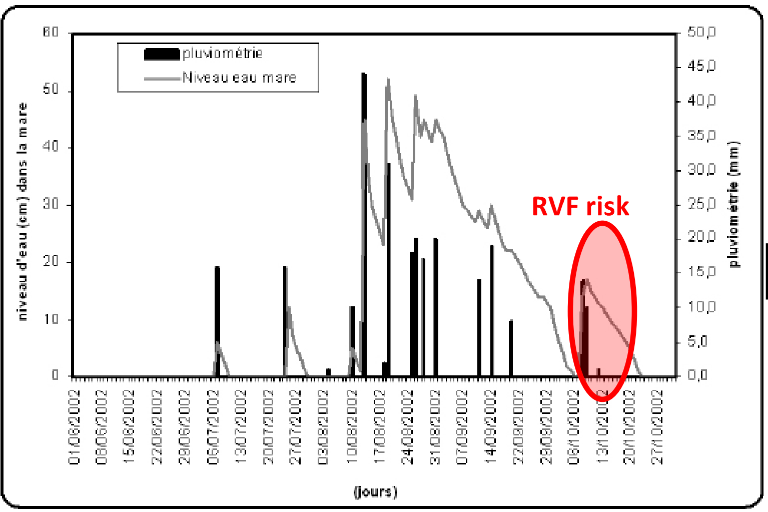
Climate change and health

Climate effect	Food safety	Air quality	Vector-borne diseases
Health effect	More mortality & morbidity	More mortality & morbidity	More mortality & morbidity
Infectious disease effect	Food poisoning – salmonella, shell fish		Distributional & altitudinal shifts of vectors; Rainfall/temperature affect transmission rates More exposure to rodents
Example	Alaska 2004 - shell fish poisoning linked to atypically high temperatures	Indonesia 1997 – forest fires increased mortality from cardiovascular and respiratory diseases	China: 20.7 million more people at risk of schistosomiasis because of higher snail survival

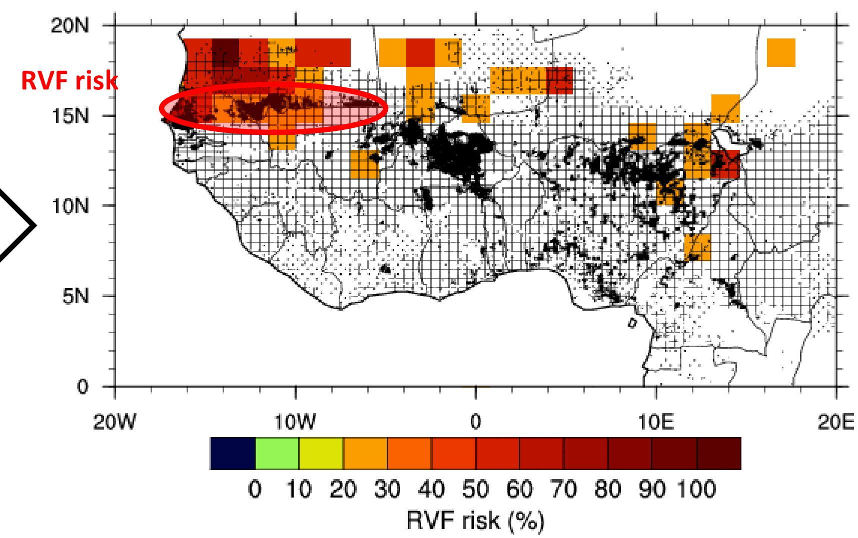
- IPCC Fourth Assessment Report (2007)

Example: RVF & climate

slide from C. Caminade and , J.A. Ndione



Ndione et al, 2008



Dry spell followed by a rainfall peak during the late rainy season (Sep-Oct) over Northern Senegal

 Rehydrating ponds

 mosquitoes hatching + hosts

 high RVF risk

C. Caminade, J.A. Ndione, C.M.F. Kebe, A. E. Jones, S. Danuor, S. Tay, Y.M. Tourre, J.P. Lacaux, J.B. Duchemin, I. Jeanne, A.P. Morse (2011) Mapping Rift Valley Fever and Malaria risk over West Africa using climatic indicators. Atm. Sc. Lett., 12: 96-103, DOI: 10.1002/asl.296

How can climate information improve health outcomes?

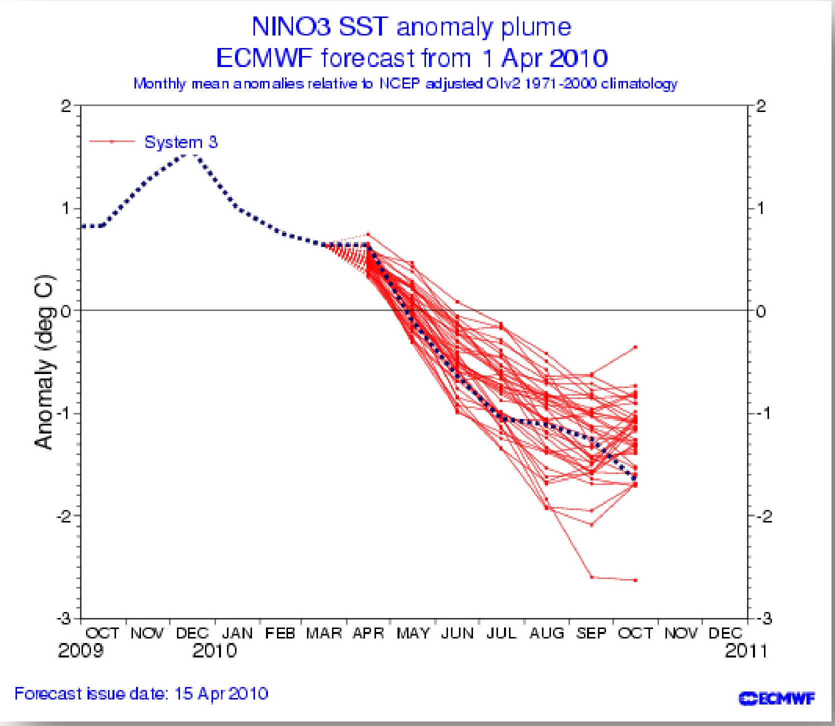
- improve understanding of the mechanisms of climates impact on transmission and disease
- estimate populations at risk (risk mapping)
- estimate seasonality of disease and timing of interventions
- monitor and predict year-to-year variations in incidence (including early warning systems)
- monitor and predict longer term trends (climate change assessments)
- improve assessment of the impact of interventions (by removing climate as a confounder)

After more than a decade research

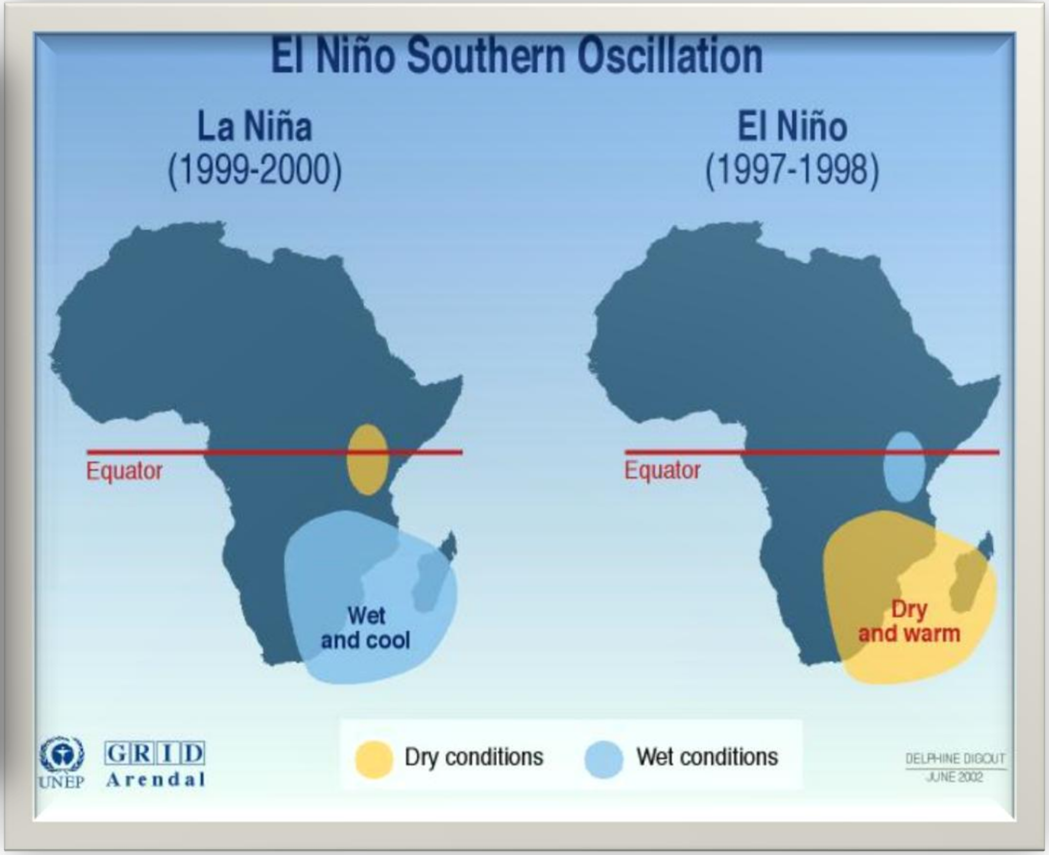
- Improving (and improved access to) monthly to seasonal+ forecast products from leading global centres such as NCEP and ECMWF
- Use of large ensembles of decadal-climate projections from IPCC
- Statistical and dynamical downscaling/bias correction research such as CORDEX to provide information on the local scale
- New EUFP projects examining the integration with sectorial impacts models for agriculture, health, energy, water.

Example: ENSO

ENSO seasonal forecast April 2010



ENSO Climate Relationships



Today and joint CLIVAR session:
lessons on data and model products

How can this climate information be used in health planning? Important example: vector borne disease

Vector borne diseases have clear climate drivers

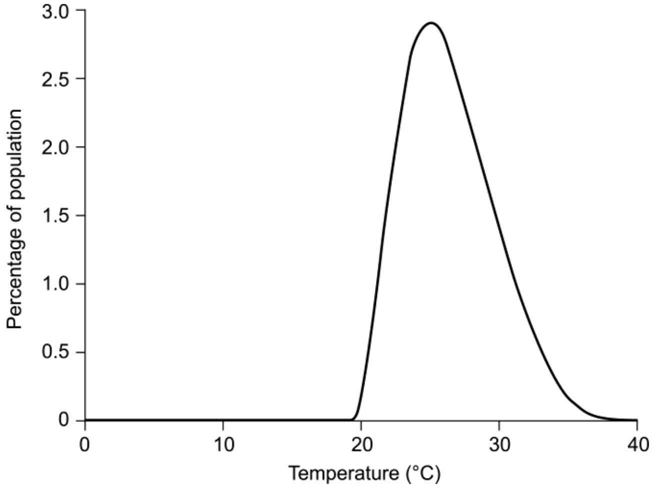
Malaria and Rift Valley Fever:

- Rainfall (vector breeding)
- Temperatures (parasite and vector cycles)
- Relative Humidity (vector mortality)

Quantifying Weather & Climate Impacts QWeCI on health in developing countries

Aim of QWeCI: To examine the potential to produce malaria forecasts and risk projections from monthly to seasonal/decadal timescales

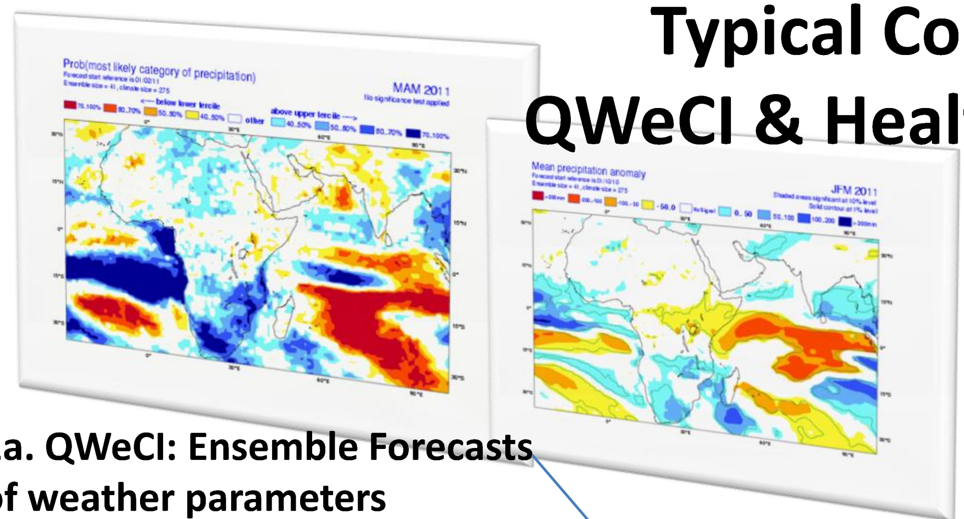
EUFP7 funded project 2010-2014, 13 partners (6 EU, 7 Africa) in **three target regions in Africa:** Senegal, Ghana and Malawi



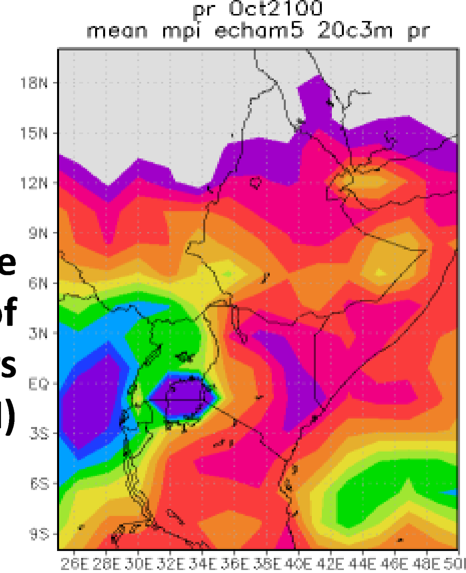
Percentage of mosquito population surviving to infectious stage

Adapted from Jones (2007) in Cui, Parker and Morse (2009)

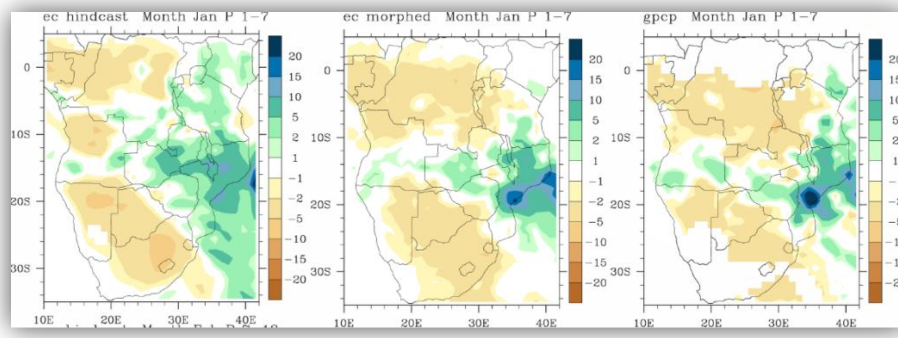
Typical Concepts:
QWeCI & Healthy Futures



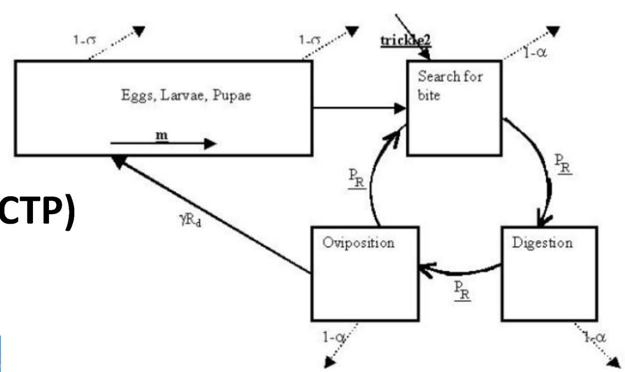
1a. QWeCI: Ensemble Forecasts of weather parameters (T,rain,RH)



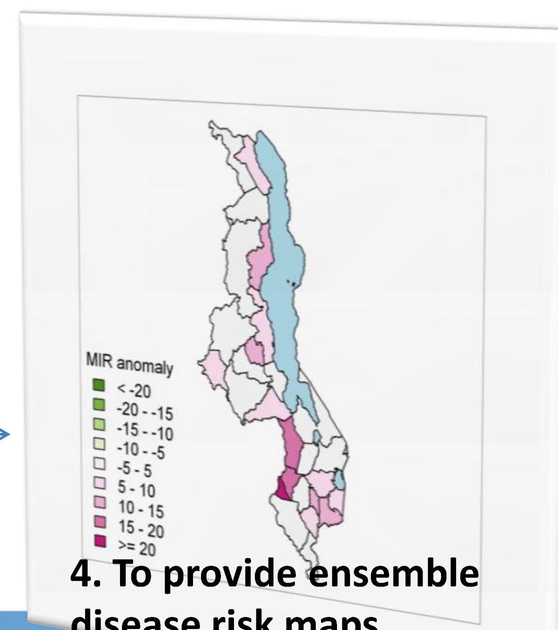
1b. HF climate projection of weather parameters (T,rain,RH)



2. Biases corrected statistically and/or dynamically (CDF and EOF approaches)



3. Fed into statistical (ICTP) and dynamical disease models



4. To provide ensemble disease risk maps

Quantifying Weather and Climate Impacts on health in developing countries

Quantifying Weather & Climate Impacts

QWeCI

on health in developing countries

- Importance of data as the foundation of the research WP1…
- Project meeting next week with a CLIVAR joint session on Wednesday

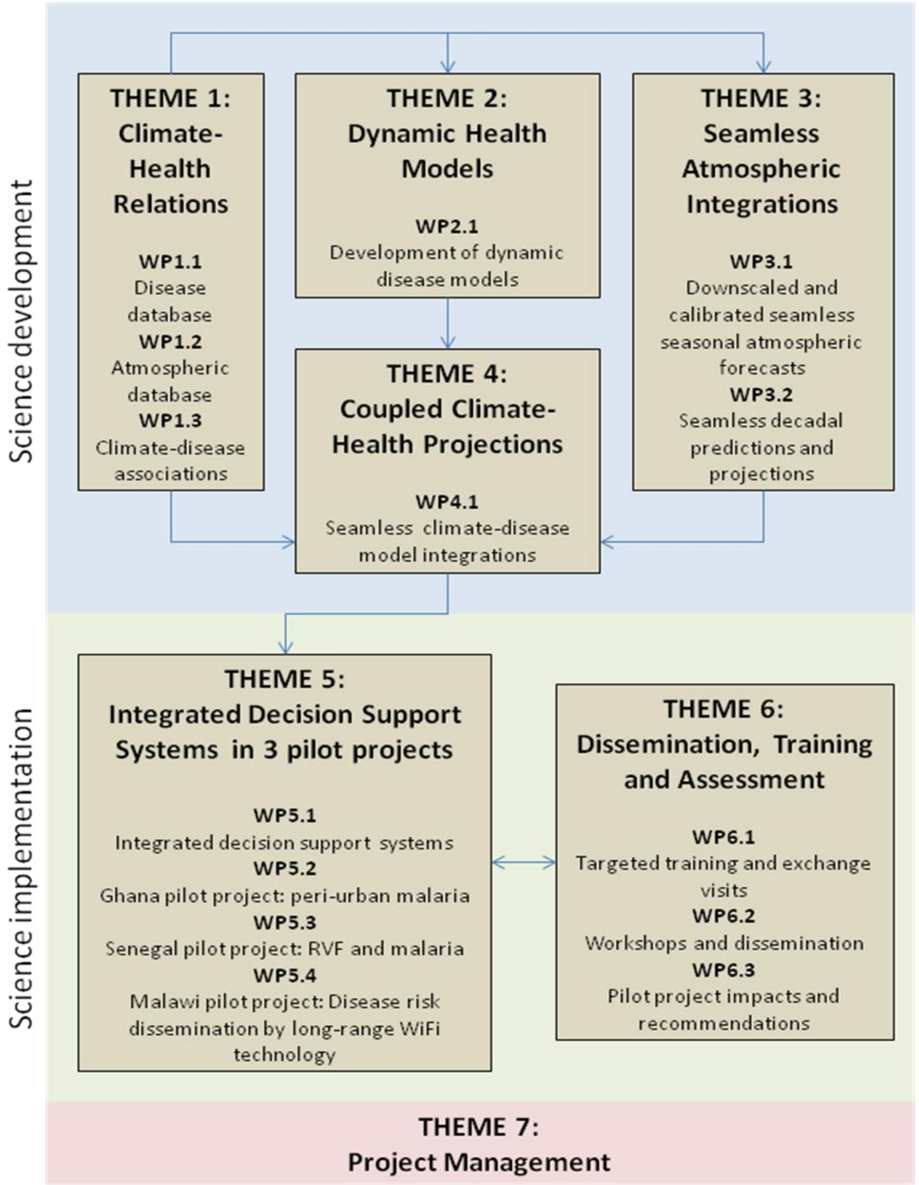


Figure 1: The overall structure of QWeCI

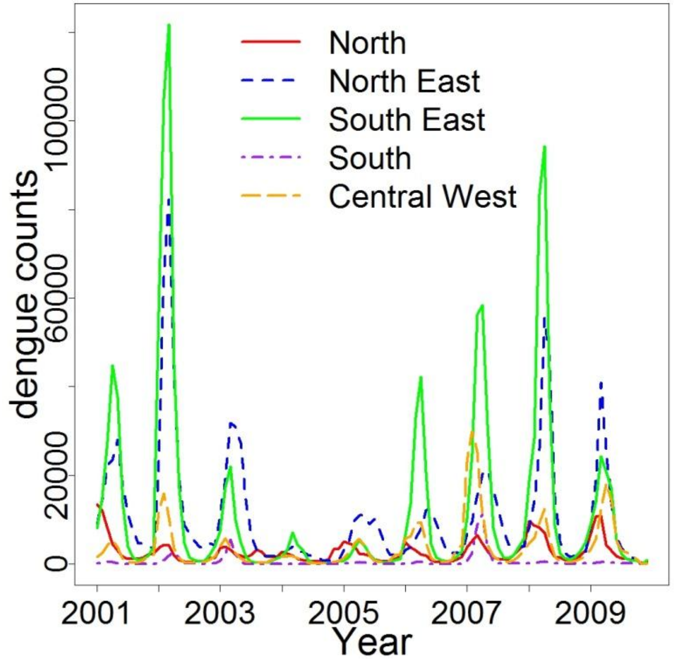
Disease models: statistical and/or dynamical?

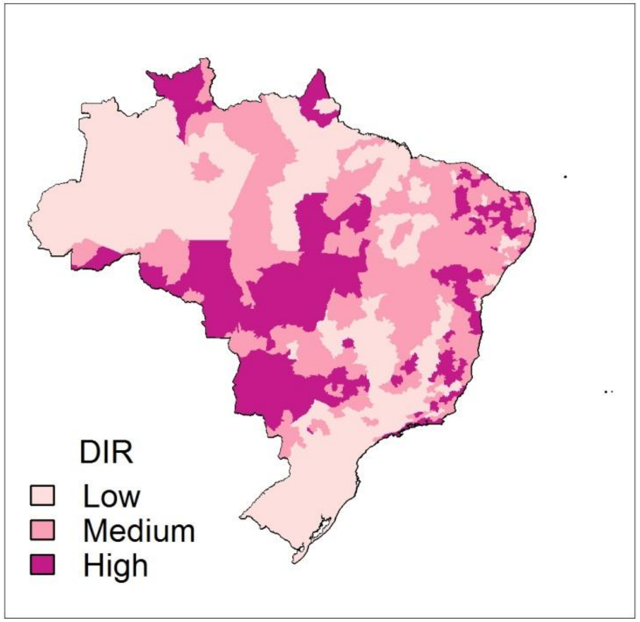
- Statistical Model:
  - Predictands related to predictors using a model developed with training data
  - Relies on good datasets spanning wide parameter space, care to avoid overfitting
  - Difficult (but not impossible) to include sub-seasonal variability
  - Can take confounding factors into account

Example of a state-of-the-art statistical model: Dengue in Brazil

(Lowe et al. 2011)

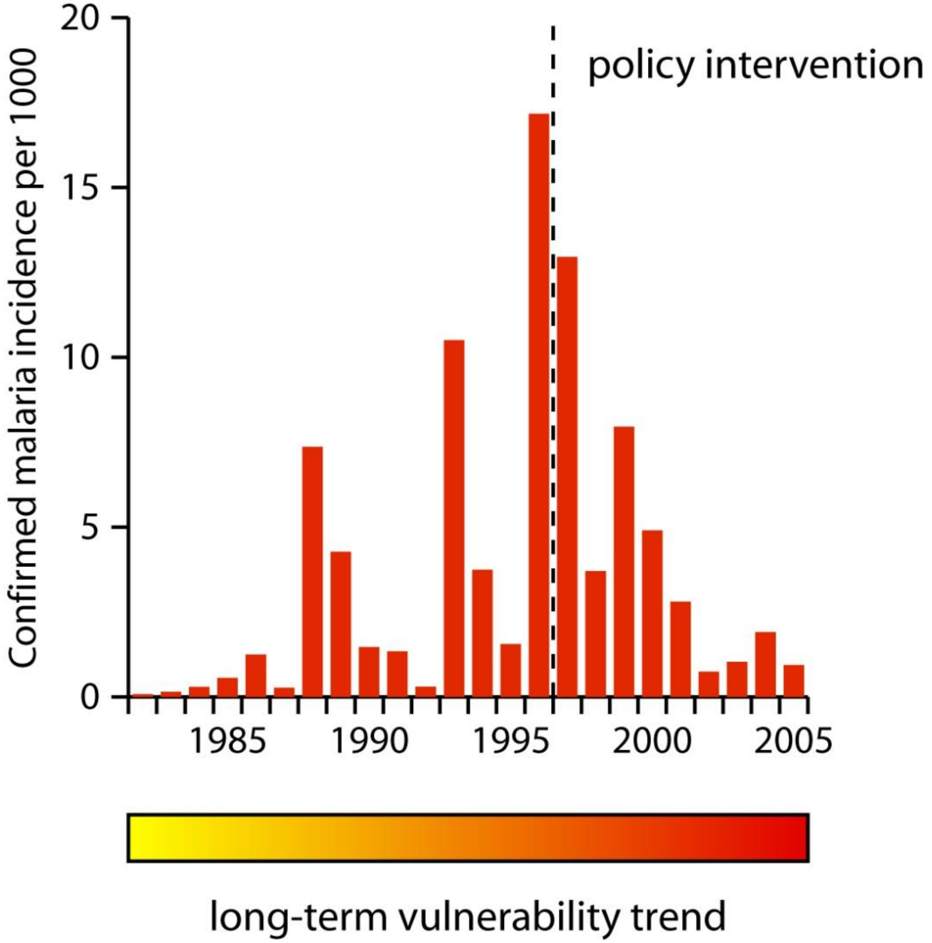
- Sophisticated statistical modelling ideas can contribute to the solution of public health problems
- Used in development of a dengue early warning system for Brazil





Malaria in Botswana

- Trends in malaria incidence may result from trends in climate but mostly indicate changes in vulnerability, e g drug or insecticide resistance, declining control services, etc
- <u>Next week</u>: Practical session to obtain some experience in using statistics and R to investigate a real world climate and health problem



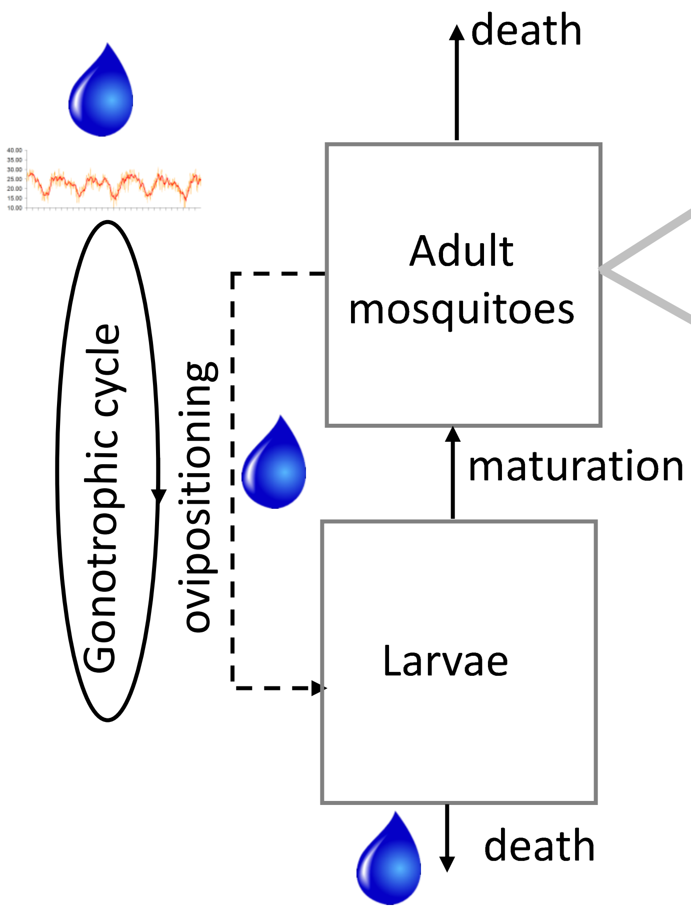
Dynamical models

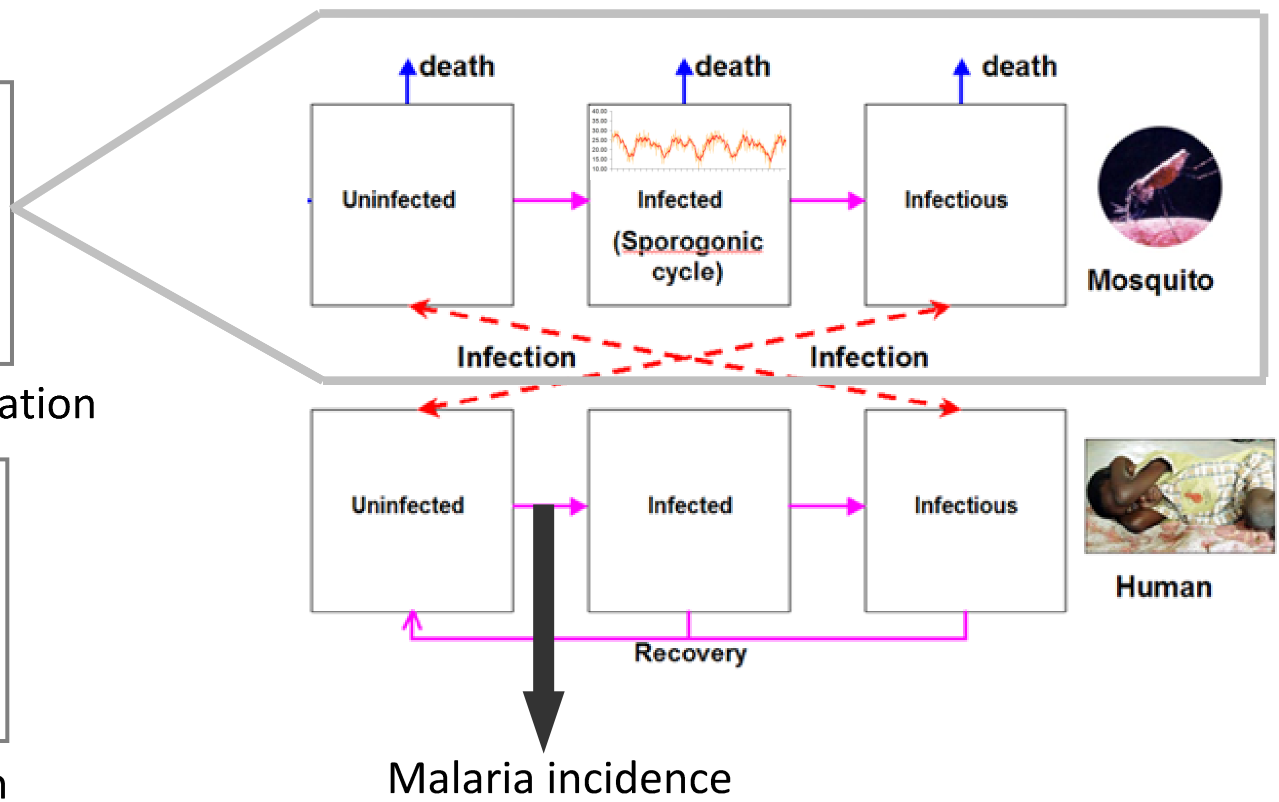
- Directly integrate equations representing the system’s physics
- Example malaria: equations that model the growth rates of larvae, vector, malaria parasite as a function of temperature
- Can incorporate highly nonlinear physics and account for weekly fluctuations in multiple climate variables
- Requires a good knowledge of the system – Often parametrizations rely on a single lab or field study

Liverpool Malaria Model – LMM
classes next week on Tuesday

(Hoshen and Morse, 2004)

Dynamic, process-based model driven by daily temperature and rainfall





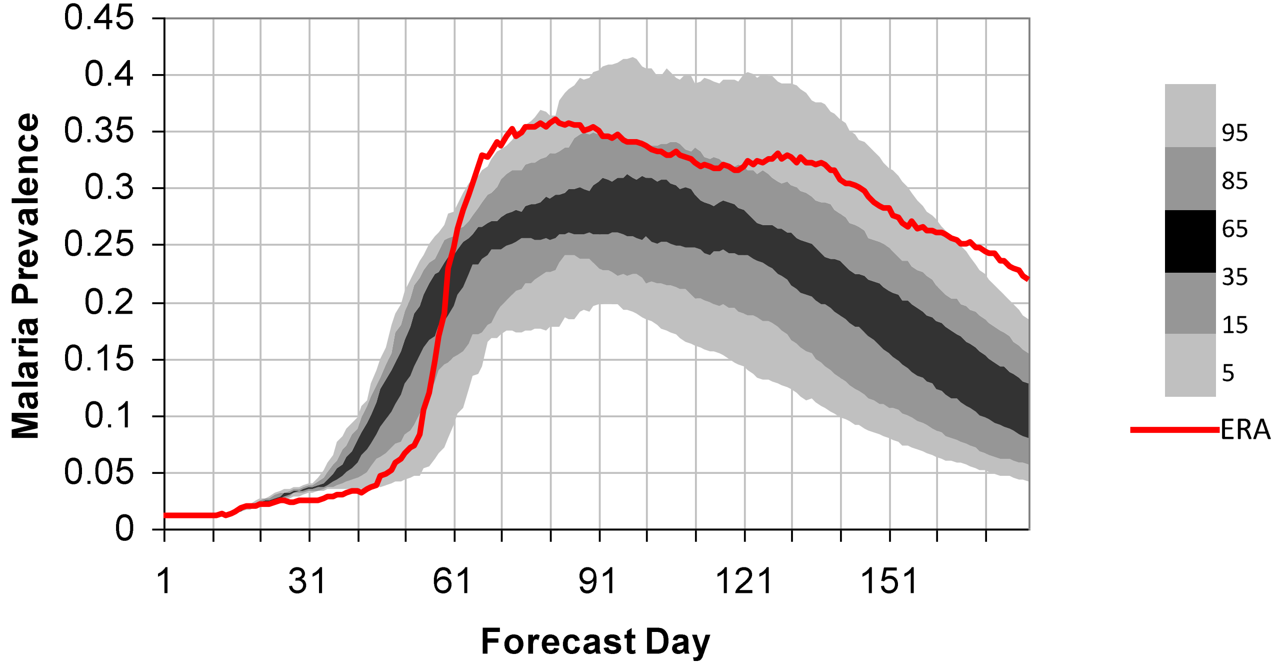
Dynamic mosquito population

Temperature and rainfall-driven

Dynamic malaria transmission

Temperature-driven

Malaria Prediction Plume

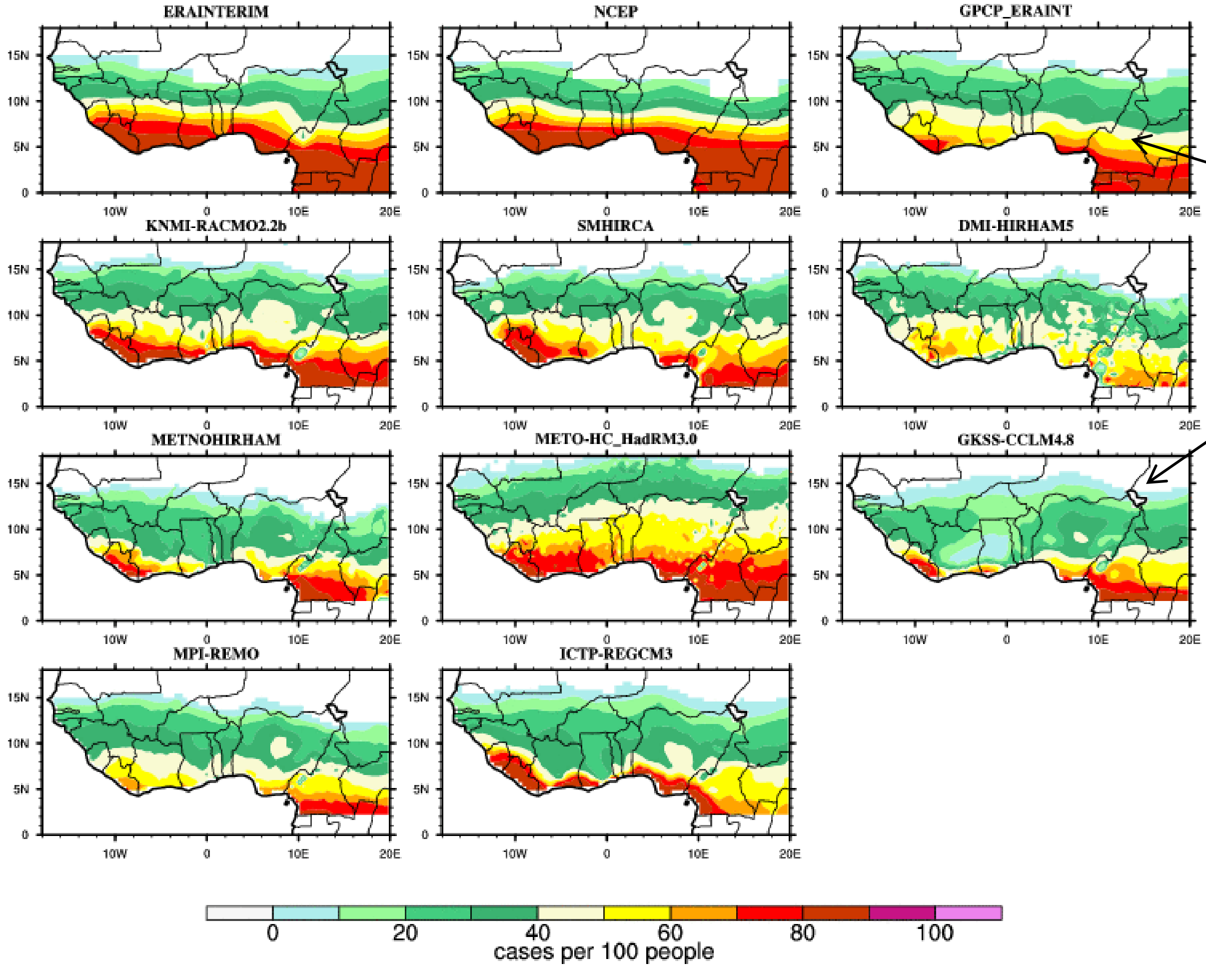


Botswana malaria forecast
for February 1989

LMM (Hoshen and Morse, 2004) driven by DEMETER multi-model 63 members

(ERA-driven model shown in red)

Mean Annual Malaria Modelled Incidence 1990-2007



Mean annual simulated malaria incidence (1990-2007) driven by "Observed datasets" and the ENSEMBLES RCM ensemble

Endemic areas >80%

"Endemic and seasonal" yellow = area between 20-80%

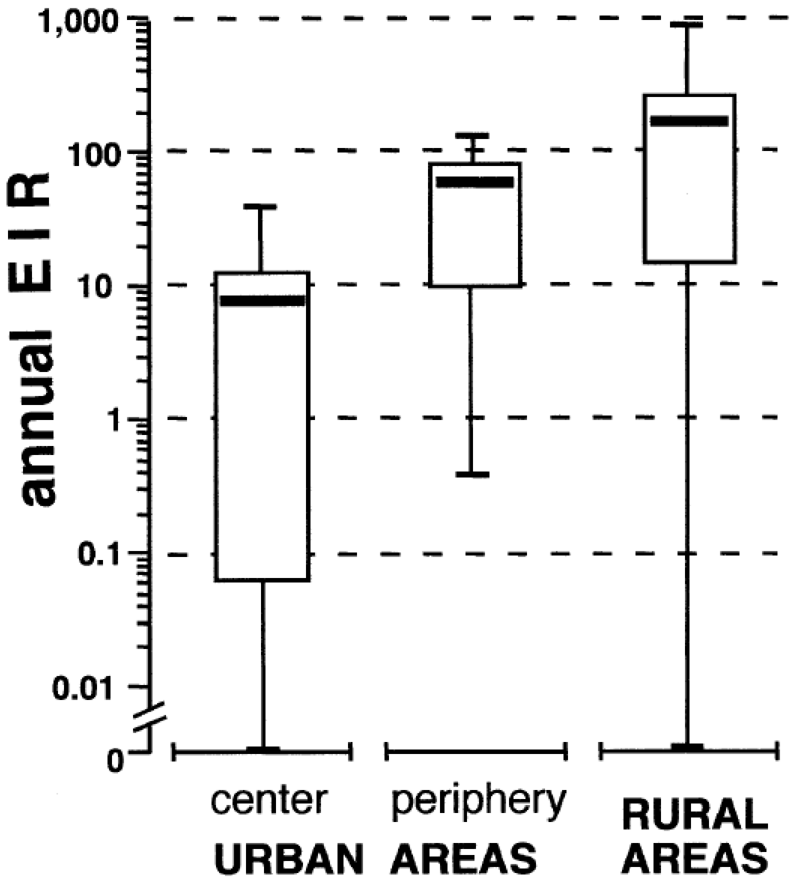
Epidemic Areas (<20%)
-> Northen fringe of the Sahel
-> Strongly connected to climate variability

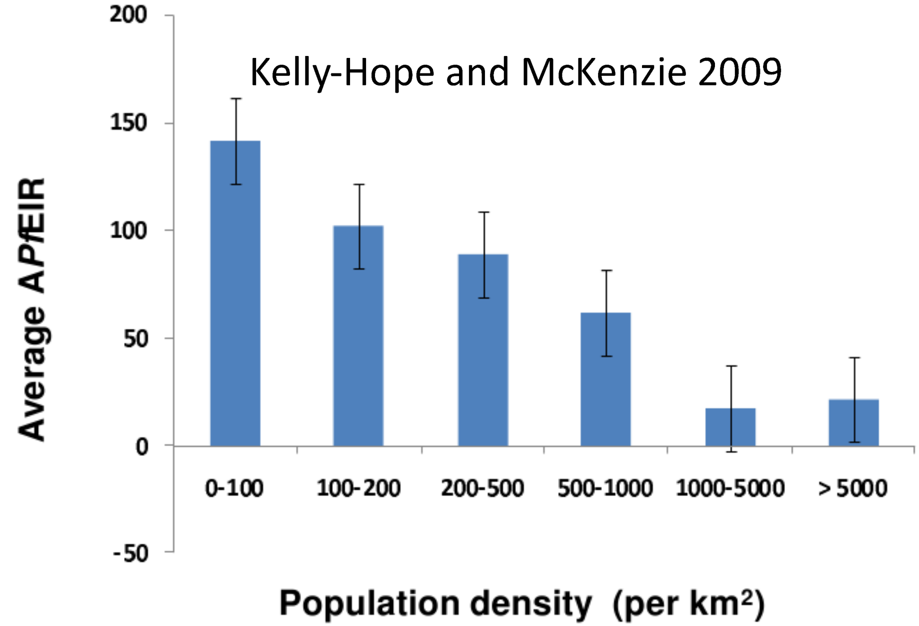
Underestimation of the Northern extension of the malaria incidence belt by LMM

ITCZ extends too far north in the RCM world

Accounting for population: VECTRI

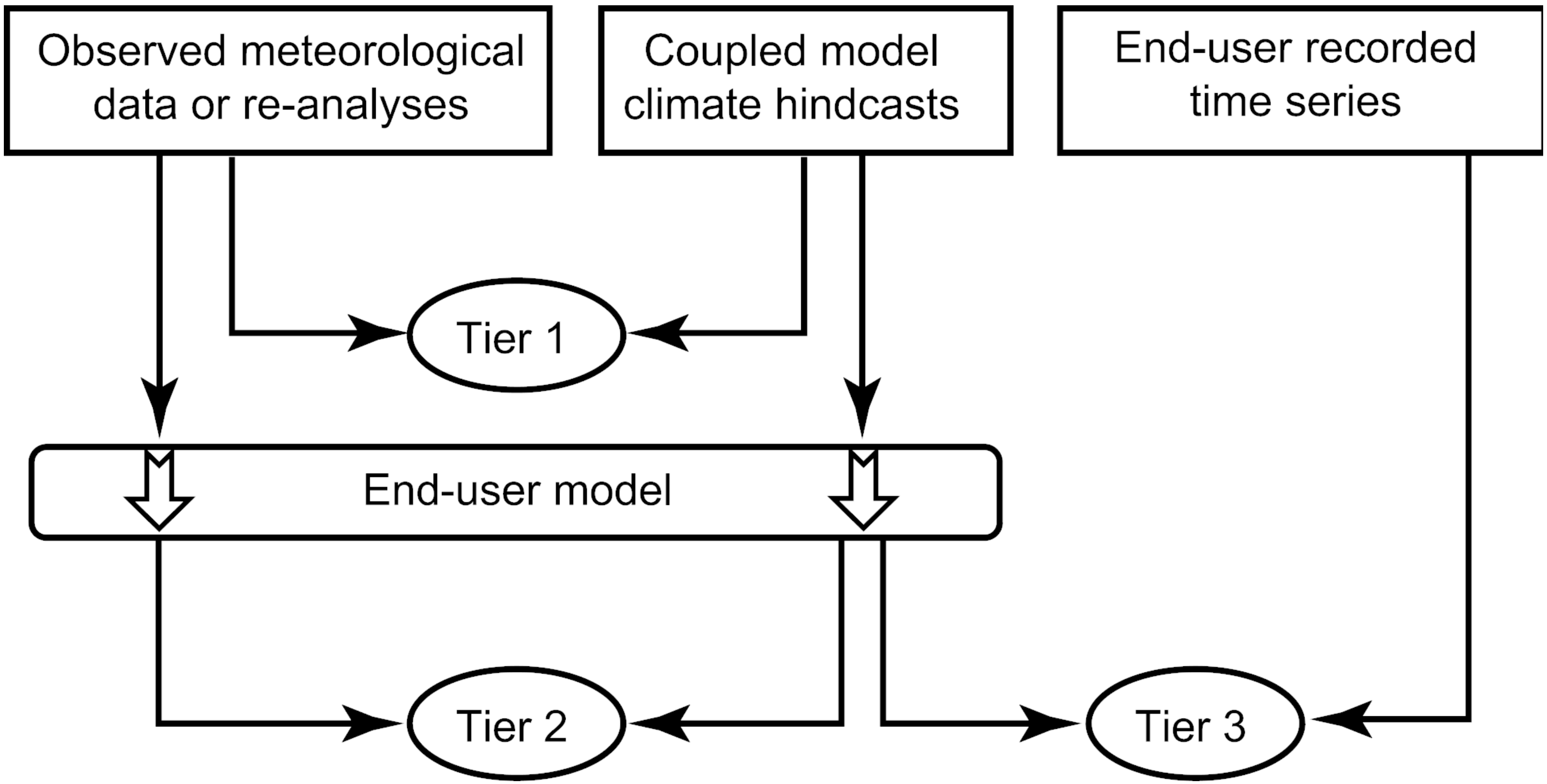
Robert et al. 2003





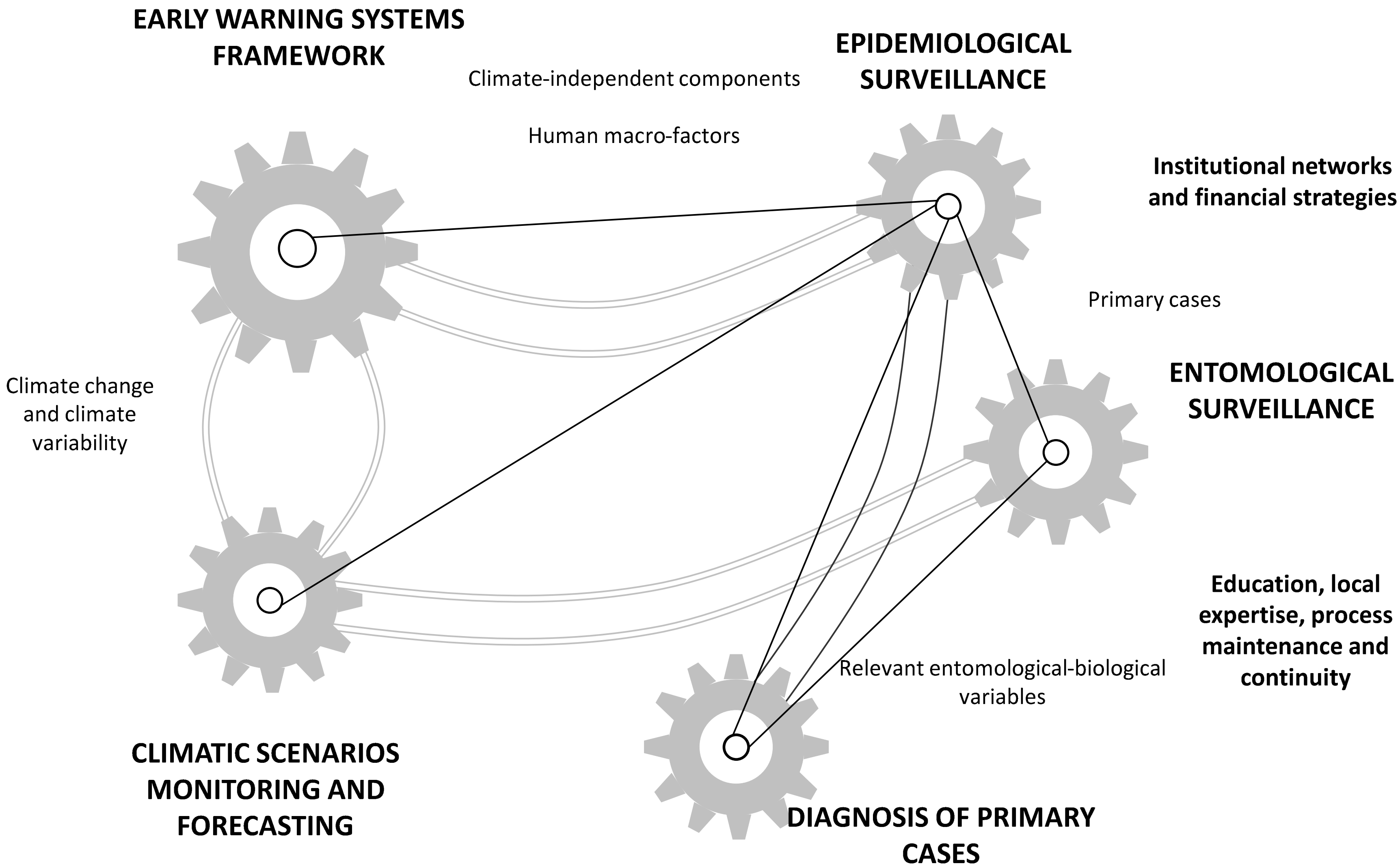
VECTRI: VEctor borne disease Community model of TRIeste.
A new community model under development at ICTP in collaboration with University of Cologne. Similar structure to LMM, but additionally accounting for population density and surface hydrology (so far in a simple way)

Integrated Climate Model Impacts Verification Paradigm



from Morse et al. (2005)
Tellus A 57 (3) 464-475

COLOMBIAN INTEGRATED SURVEILLANCE AND CONTROL SYSTEM
Slide from Daniel Ruiz IRI



Overview of health program in school week 2

- Monday :
  - introduction to QWeCI project
  - Statistical modelling of malaria
  - VECTRI: Dynamical malaria of ICTP
  - Lab classes: statistical model for malaria in Botswana using R
- Tuesday
  - Research results from dynamical Liverpool malaria model LMM
  - Health and climate change
  - Lab classes: Liverpool malaria model LMM