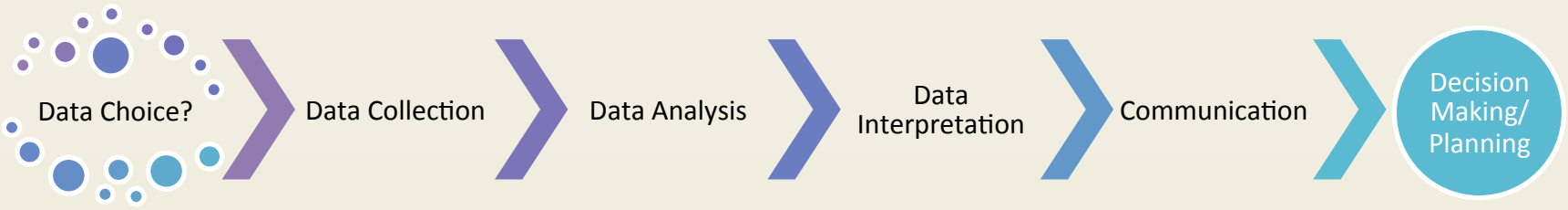
From data to decision-making – and back again



Madeleine C. Thomson,

Senior Research Scientist

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Objectives

- Provide an overview of basic concepts that connect data to decision-making
- Explore how this understanding can help create evidence for policy and practice
- Learn how these perspectives have been developed in the context of disease prevention and control.

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Data

even when its raining data …

… there is an information drought

Data

- The word data is the plural of Latin datum, past participle of dare, "to give", hence "something given". Thus in general, data consists of propositions that reflect reality.

- A large class of propositions are ***measurements*** or observations of a variable. Such propositions may comprise numbers, words, or images.

Data requirements

- To inform decision-making data must be (at the level specific to the decision):

- *Accurate; Timely; Current; Relevant; Complete; Interpretable; Consistent representation; Accessible; Traceable; Easy to use….*

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Information

- Information is the result of processing, manipulating and organizing data in a way that adds to the knowledge of the user. *It includes the context in which data is taken.*

- The word information can refer to both "facts" in themselves and the transmission of the “facts”(e.g. information system).

Assumption

"better use of information can improve decision making"

While there is research evidence to support this view there is an increasing understanding that there are limitations.....

Mainly because decisions are made by people.

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So – information alone is not enough

Global Development Professionals Network
Promoting understanding, dialogue and debate among global development professionals

Beyond access: Turning information into knowledge and power

Access to information as part of development strategy is becoming more important, but is information alone enough? Join the debate, Thursday 14 March at 1pm GMT

Anna Scott
Guardian Professional, Tuesday 12 March 2013 07.57 EDT

Jump to comments (245)

How do we ensure that information access is turned into knowledge, and knowledge to power? Photograph: Dan Chung

Article history

Global development professionals network
Live Q&As

Technology

Global development
Development data

Books
Libraries

Why access to information needs to be central to the debate on poverty

Knowledge

- "what is known". There is no single definition of knowledge on which scholars agree.
- Knowledge acquisition involves complex cognitive processes: perception, learning, communication, association, and reasoning.
- Knowledge is a function not only of truth but also of belief

Knowledge doesn't exist until people are involved.

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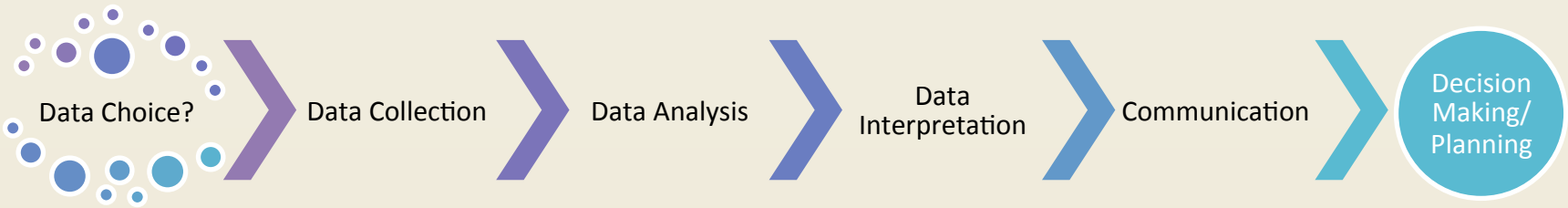
From Data to Decision-making

This requires a systemic process for using data to enhance decision-making, bringing together a vast array of tools to extract value from data and focus efforts on what will add real value to the decision-makers sphere of influence.



Prediction

- Ultimately all decision-making is about the future.

- Therefore if we are to use data to predict climate sensitive health outcomes we need to build models that provides predictive support to health decision-makers to more effectively manage risk and enable change

Models

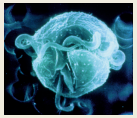
- Since models are by necessity a simplified version of the real-world predictions based on models are always uncertain.
- Understanding how uncertain and what factors determine the uncertainty (and whether uncertainty can be reduced) is essential
- Predictions must necessarily be constantly revised in the light of new experience as the future unfolds.

Laws underpinning predictions

To be able to make predictions it is necessary that we know certain laws:-

- **Exact** – stated in terms of the differential equations of physics and chemistry) – mathematical modeling
- **Statistical** – frequency distributions arising from the very general law of large numbers – statistical modeling
- **Empirical laws** – guided by practical experience and not theory

Climate and infectious disease

Diseases	Inter-annual variability	Sensitivity to climate	Climate variables	
Influenza	* * * * *	* *	(<T)	
Meningitis	* * * *	* * *	>T,<H (>R)	
Leishmaniasis	* *	* * *	(>T,>R)	
Loa loa	*	* * *	>R (<T)	
Cholera	* * * * *	* * * * *	(>T)	
Malaria	* * * * *	* * * * *	(>R,T,H)	
Dengue	* * * *	* * *	(>R,T,H)	

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Getting Evidence into Policy and Practice

Nutley S, Davies HTO. Making a reality of evidence-based practice: Some lessons from the diffusion of innovations
Public Money & Management 2000;20(4):35-42.

Four key requirements:

1) agreement as to the nature of evidence

- impact of climate on outcomes
- impact of climate information on outcome
- cost-effectiveness of the use of climate information relative to other interventions

Four key requirements cont'd:

2) a strategic approach to the creation of evidence, together with the development of a cumulative knowledge base.

3) effective dissemination of knowledge; together with development of effective means of access to knowledge.

4) initiatives to increase the uptake of evidence in both policy and practice.

What are our objectives?

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

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Improve understanding of disease transmission mechanisms: Malaria

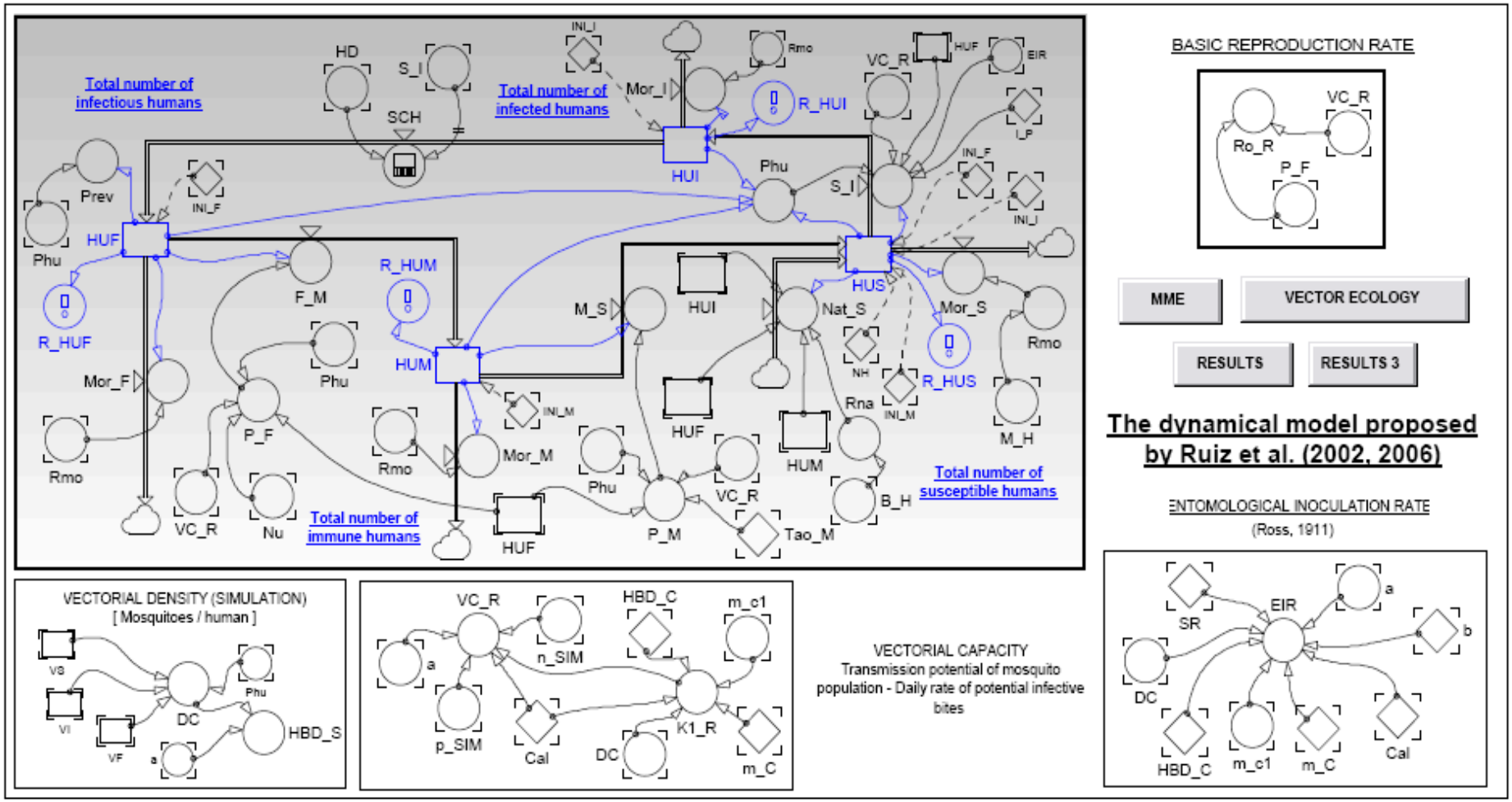


Figure 1.13. Stock-flow model of the human host component of the mathematical tool proposed by Ruiz *et al.* (2006)

But models are limited….

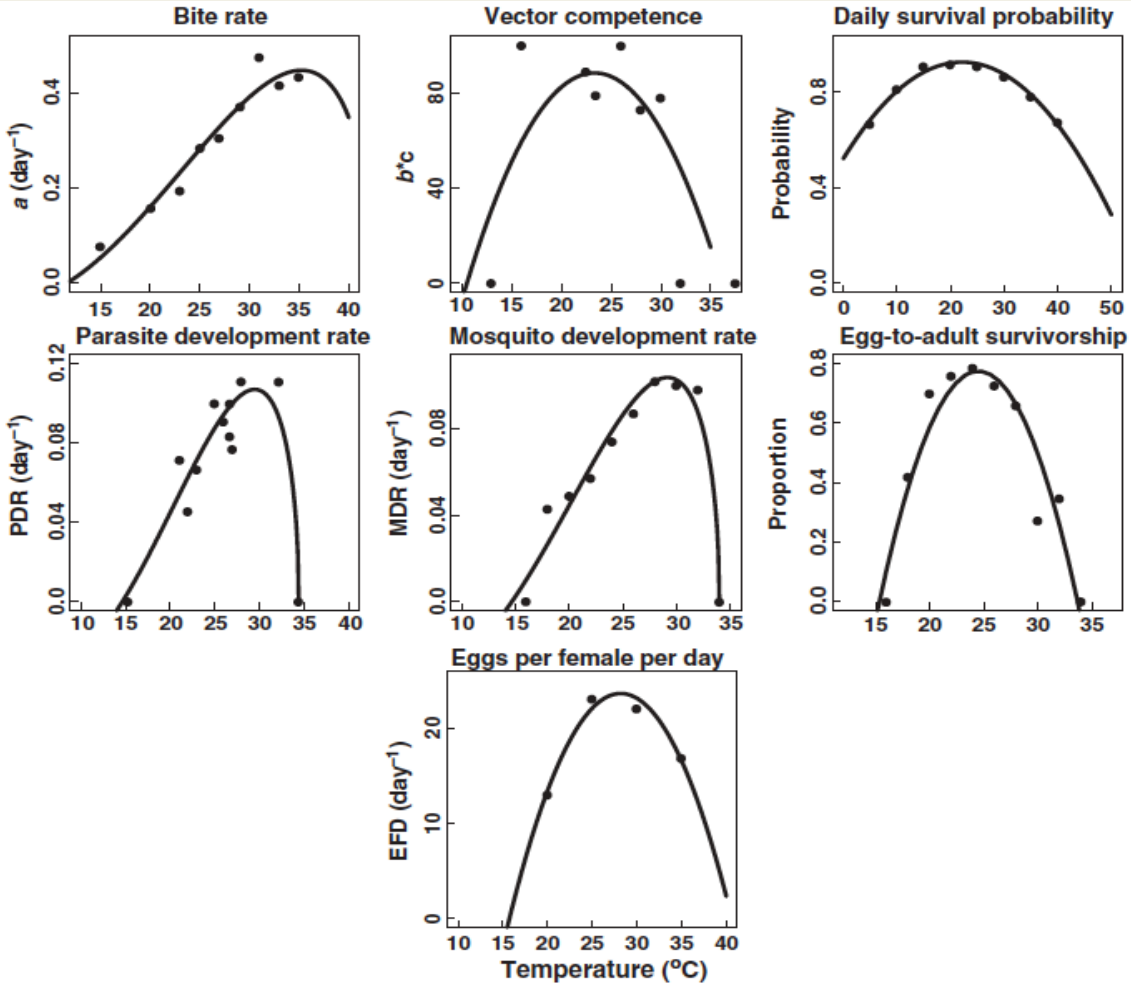
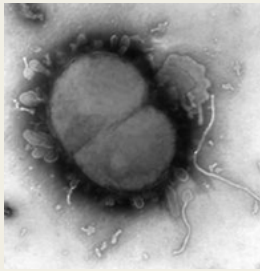
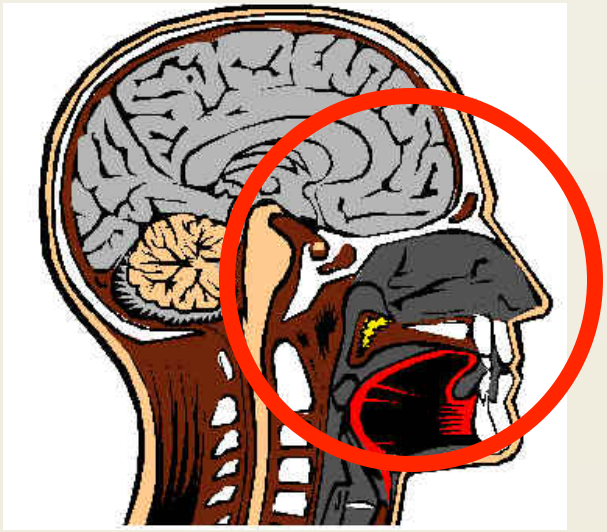


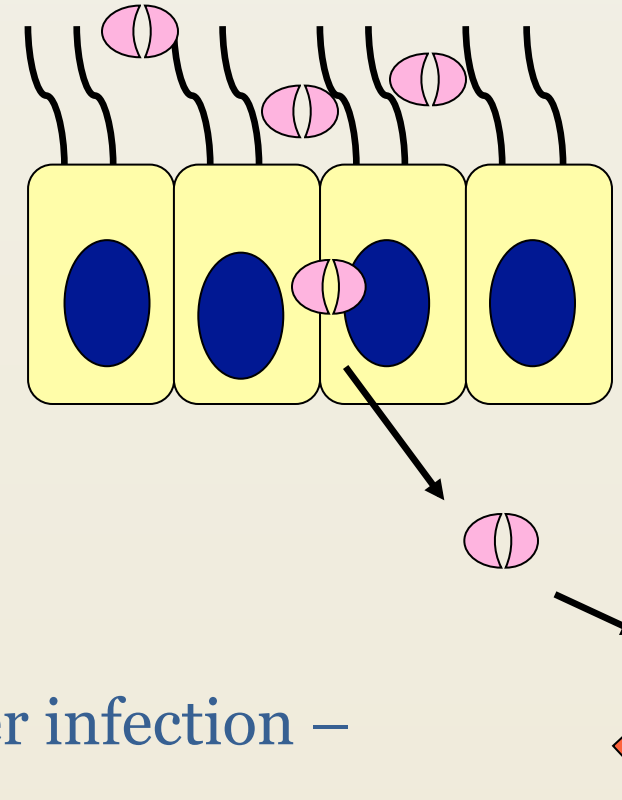
Figure 1 Thermal performance curves for all mosquito and parasite life-history traits that together determine R_0. Note that the temperature ranges (x-axes) differ for different traits. Data sources, parameter descriptions and fit functions are listed in Table 2. The original mortality data are shown in Fig. S2.

Understanding of disease transmission mechanism: Meningitis



Meningococci





Integrity of mucosal membrane lining the nose and throat

Blood stream

Integrity lost through:

- microbial damage from other infection – e.g. flu?
- physical damage from low absolute humidity and dust?

Courtesy Brian Greenwood

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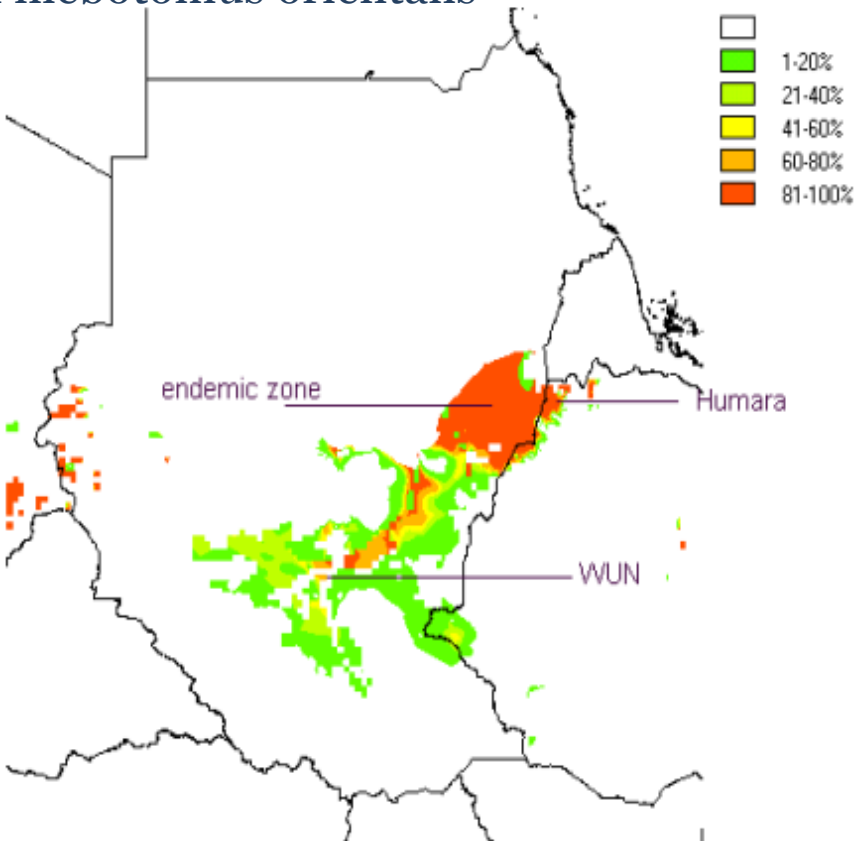
Estimate populations at risk (risk mapping)

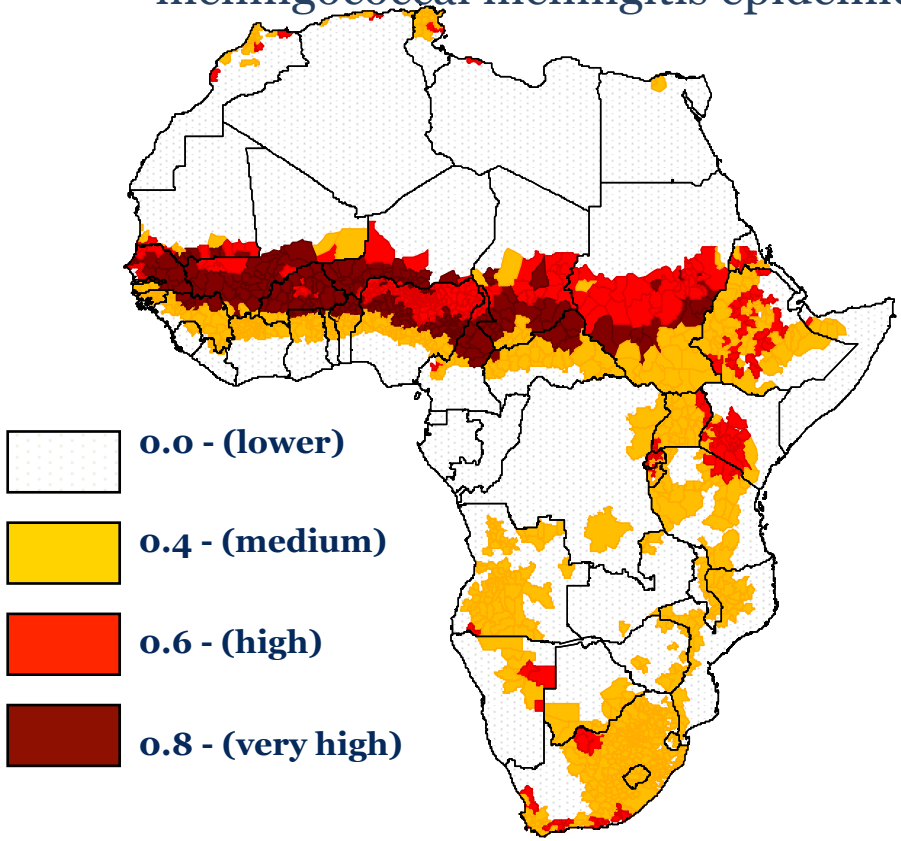
Kala azar –Sudan

Presence/absence of
Phlebotomus orientalis



Meningitis Belt

Presence/absence of recorded
meningococcal meningitis epidemics



Prevalence survey data

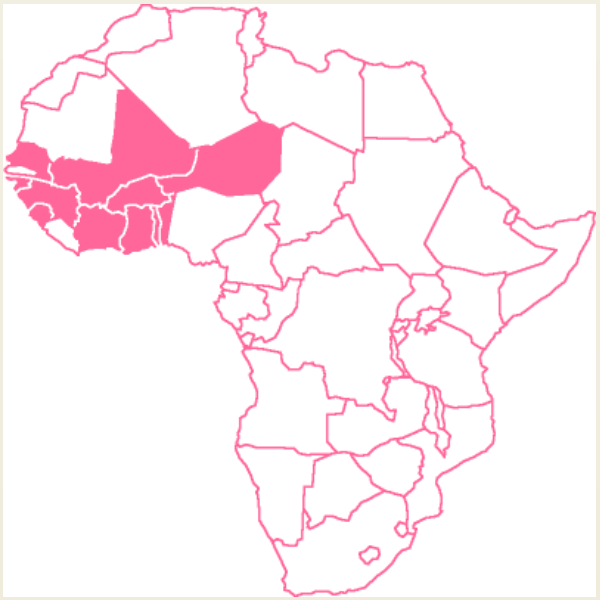
Criteria which should always be assessed:

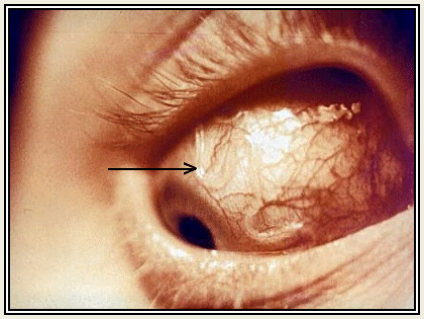
- Was the target population specified?
- Which sampling method was employed?
- Is the survey based on a random sample or a whole population?
- Was the sample size adequate?
- Was the response rate adequate?
- Was information given on non-responders?
- Was a valid and repeatable disease definition given?
- Have reasonable efforts been made to reduce observer bias?

Onchocerciasis Control Programme is being extended to the rest of Africa

OCP

Vector Control





APOC

Drug Control - ivermectin

Drug control has already broken down in some areas where ecological conditions favour the occurrence of *Loa loa*

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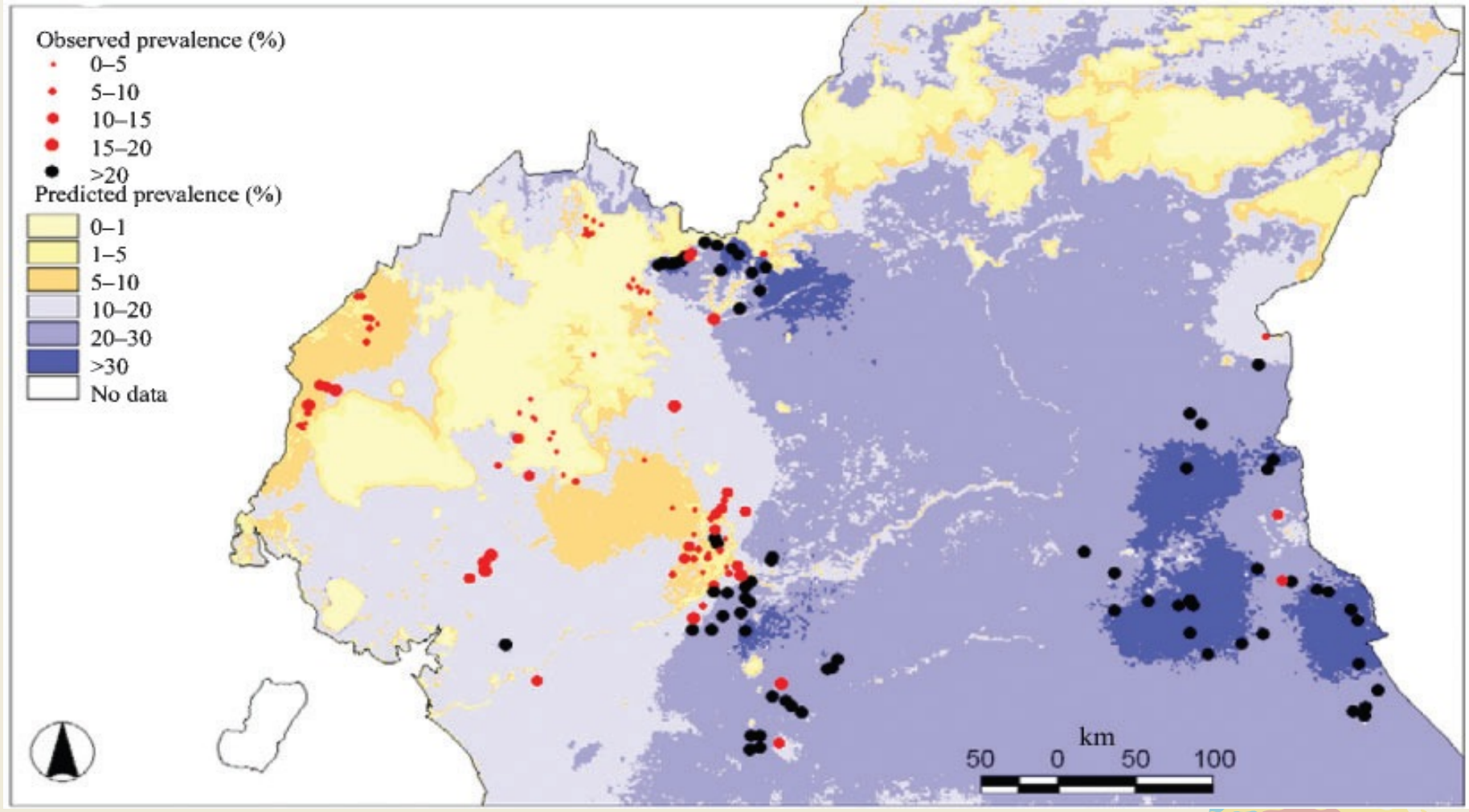
Modeling risk of *Loa loa* infection in Cameroon

Point estimates of the prevalence of Loa loa microfilaraemia, over-laid with the prevalences observed in field studies.



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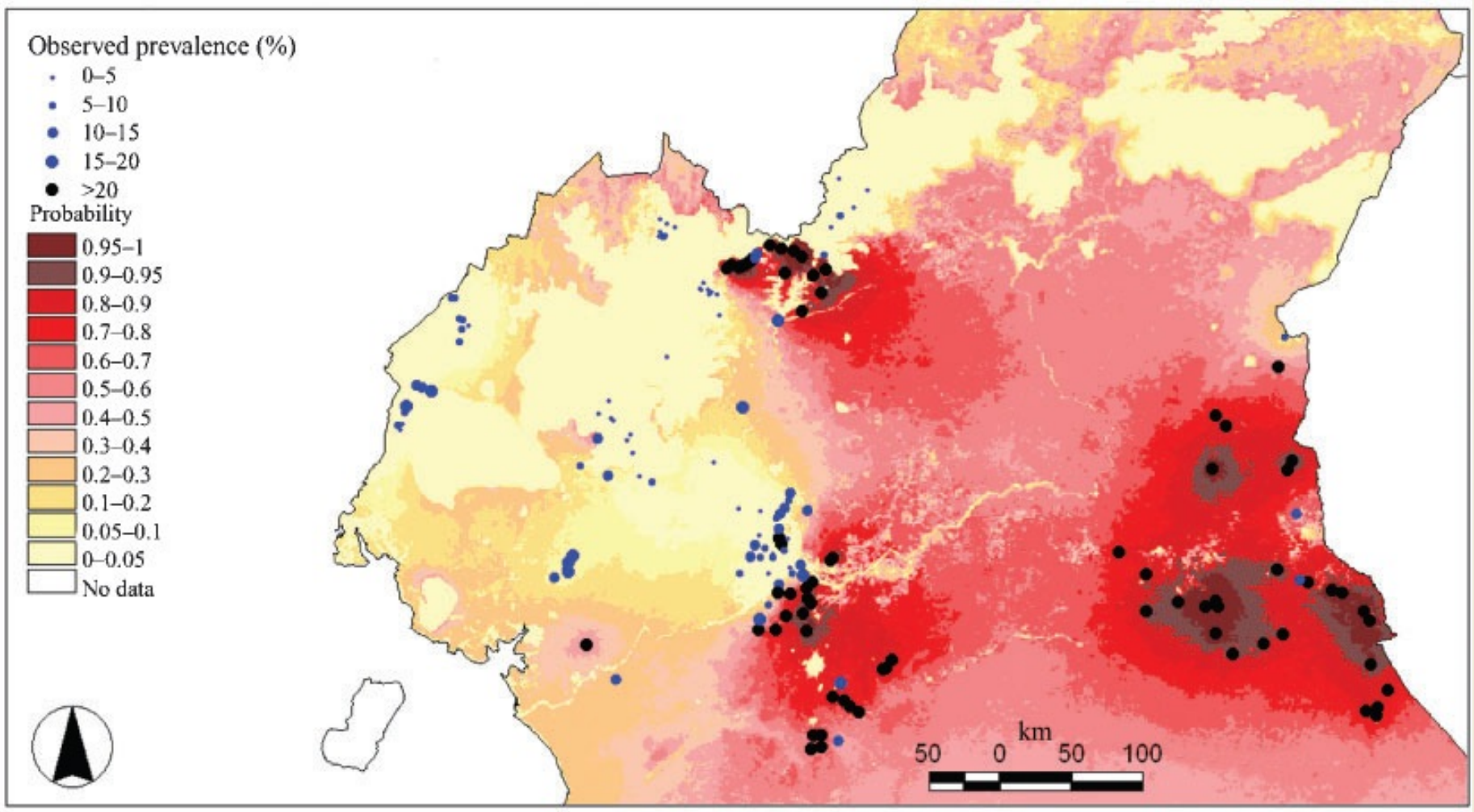
Modeling risk of *Loa loa* infection in Cameroon

A probability contour map, indicating the probability that the prevalence of Loa loa microfilaraemia in each area exceeds 20%, over-laid with the prevalences observed in field studies.



Diggle, P.J., et al., (2007) Spatial modeling and prediction of Loa loa risk: decision making under uncertainty. *Annals of Tropical Medicine and Parasitology* 101 (6): 499-509

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Routine surveillance data

- Data sources:
  - Notifiable disease -specific reporting systems
  - National Health Management Information System
  - Integrated Disease Surveillance and Response System

- Requirements:
  - Consistent reporting units with known populations
  - Clearly defined and useful indicators
  - Reasonable completeness
  - Consistent time periods, preferably at least monthly

Routine surveillance data

Can assist in:

- Monitoring trends
- Clarifying and measuring seasonality
- Prioritizing areas for intervention
- Defining and quantifying epidemics
- Evaluating control measures

Routine surveillance data – use it or lose it?

- The spatial (point, administrative boundary) and temporal (daily, weekly, monthly) structure of health surveillance data along with its national coverage make it theoretically ideal for use in the development of climate and health models.
- However the data is often shunned because of poor quality of records.
- Improvements of the routine surveillance system and a stronger Health Information System are needed.

Indicators and triangulation

Core indicators – population based

- Incidence of total malaria cases (clinical plus confirmed)
  - *Because diagnostics not available everywhere at all times*
  - *Because availability of diagnostics has increased greatly – i.e. total malaria may be more consistent over time*
- Incidence of confirmed malaria (RDT or slide) cases, by species
  - *Because not all clinically diagnosed malaria is really malaria*
  - *Different species may have different trends*
- Incidence of malaria admissions
  - *Measures severe malaria*
  - *Assesses success of early treatment*

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Triangulation

If similar trends observed from several indicators and several data sources, we have more confidence that trends are real

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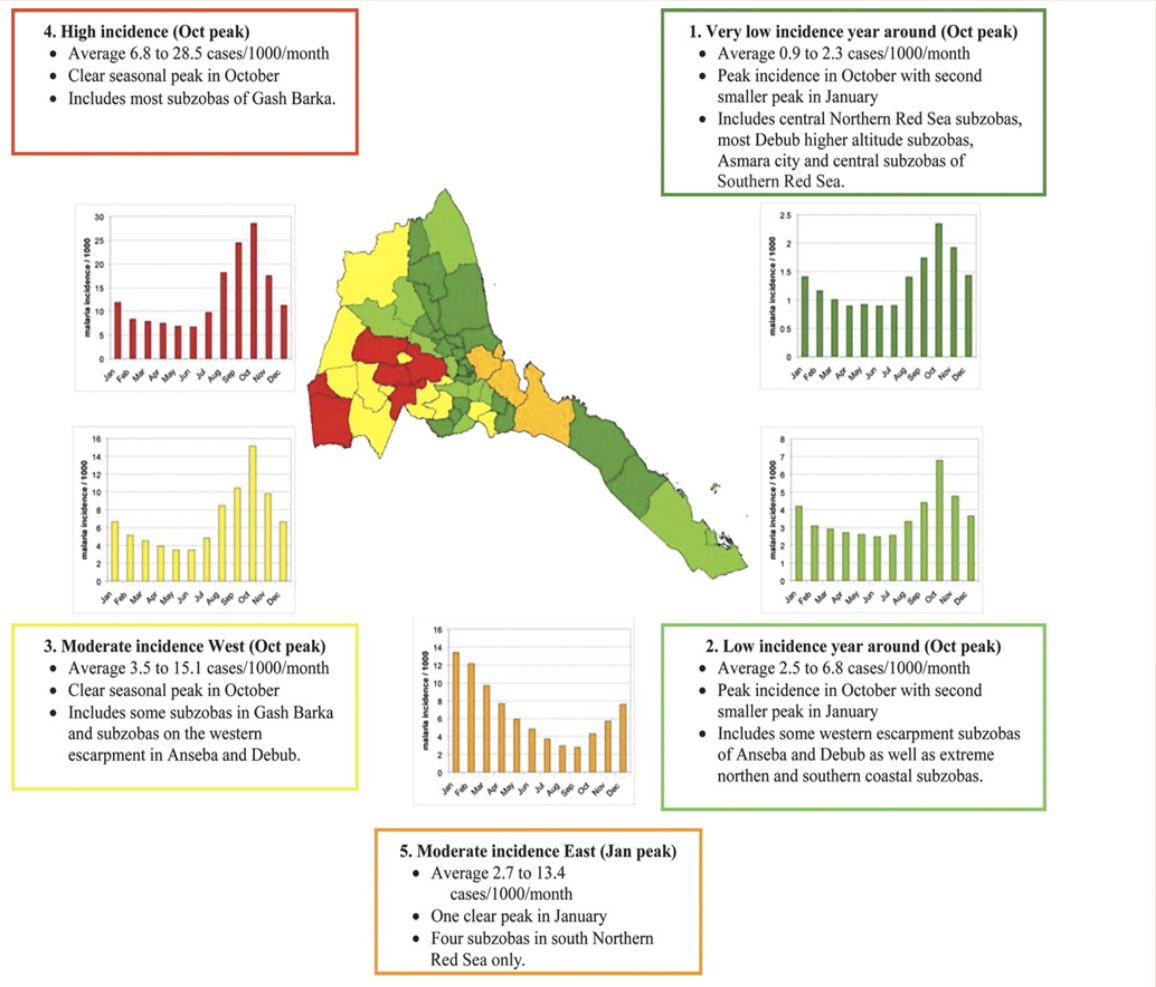
Estimate seasonality of disease and timing of interventions



Using NHIS malaria data in Eritirea to map the seasonality and intensity of malaria

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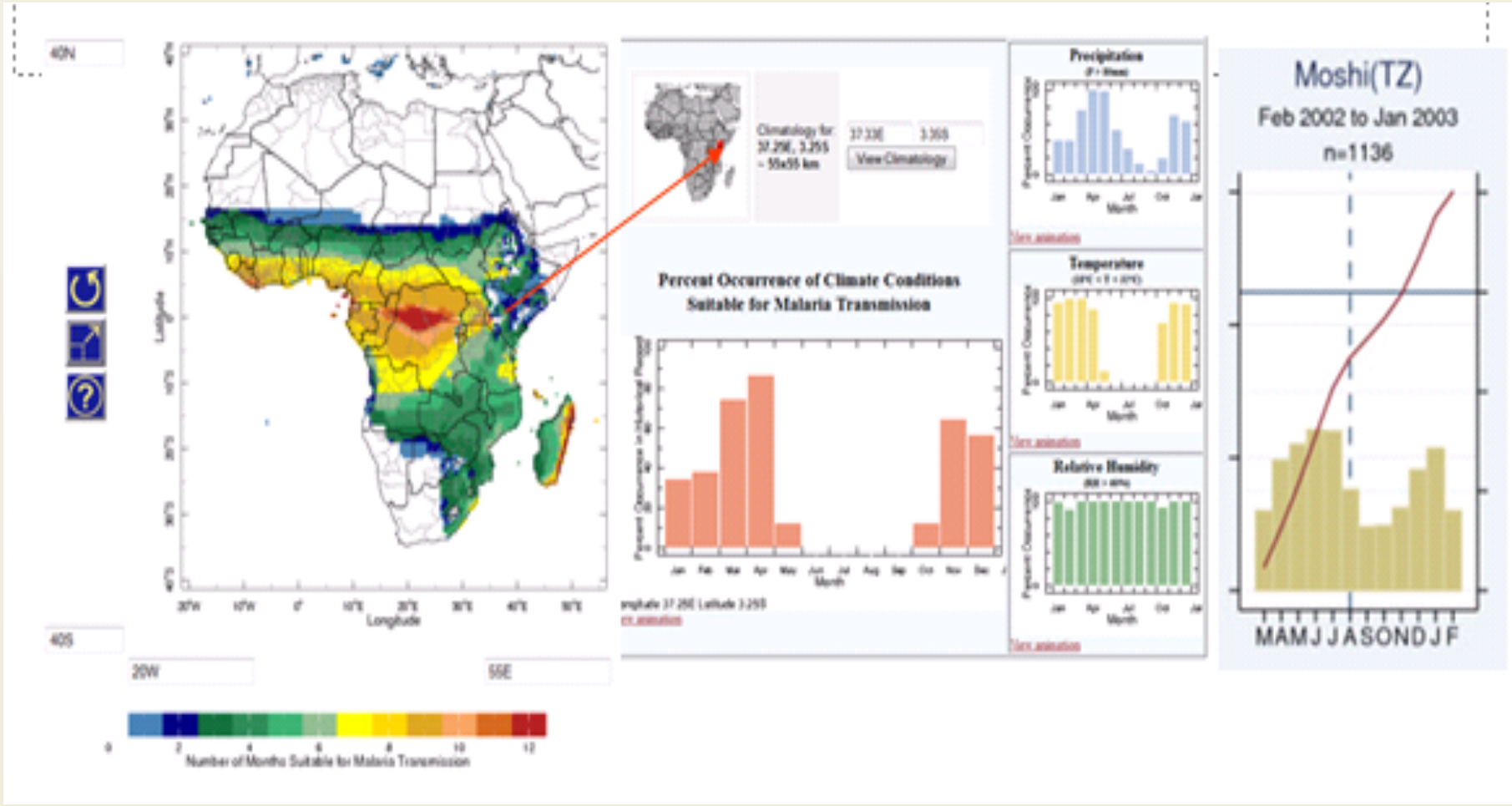
Why is climate data unique?

- The following characteristics of climate make it potentially ideal as an additional layer of information for the health sector for application in malaria vulnerability assessments, surveillance and forecasting:
- - its climatology, seasonality, diurnal rhythm and potential predictability at multiple time scales (weather, seasonal, decadal and climate change).

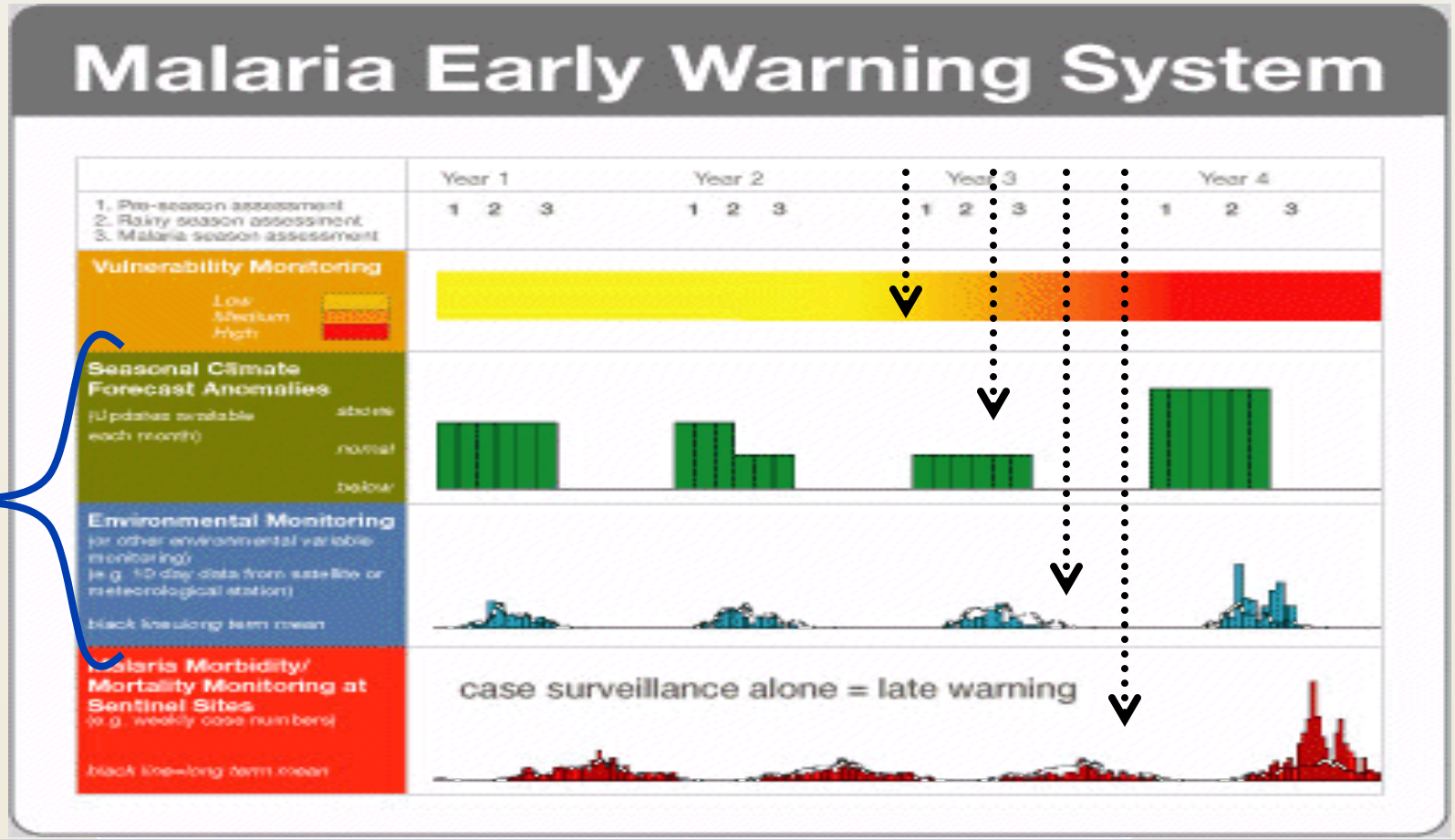
Climate suitability for malaria transmission (CSMT)



Demand for integrated early warning systems …

Climate

Env-Info



Factors which increase vulnerability to malaria epidemics

There are many factors that increase the vulnerability of a population to malaria epidemics and increase the severity of disease outcome should a malaria epidemic occur. Examples include:

- Co-infection with other diseases
- Resistance to therapeutic drugs and insecticides
- Drought, food insecurity and associated population movements between areas of differing endemicity
- Economic losses – reducing household capacity to manage illness

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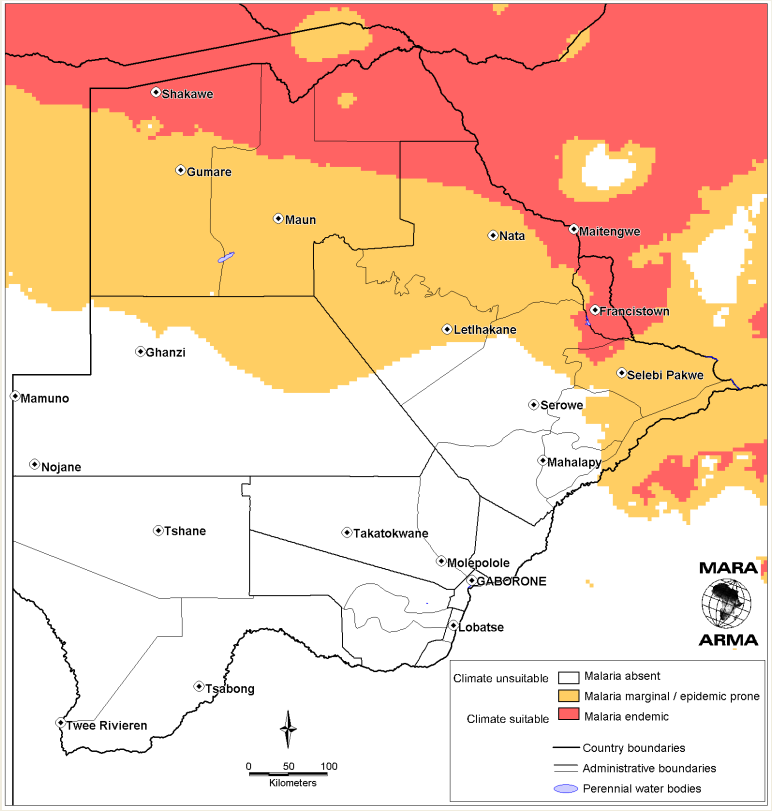
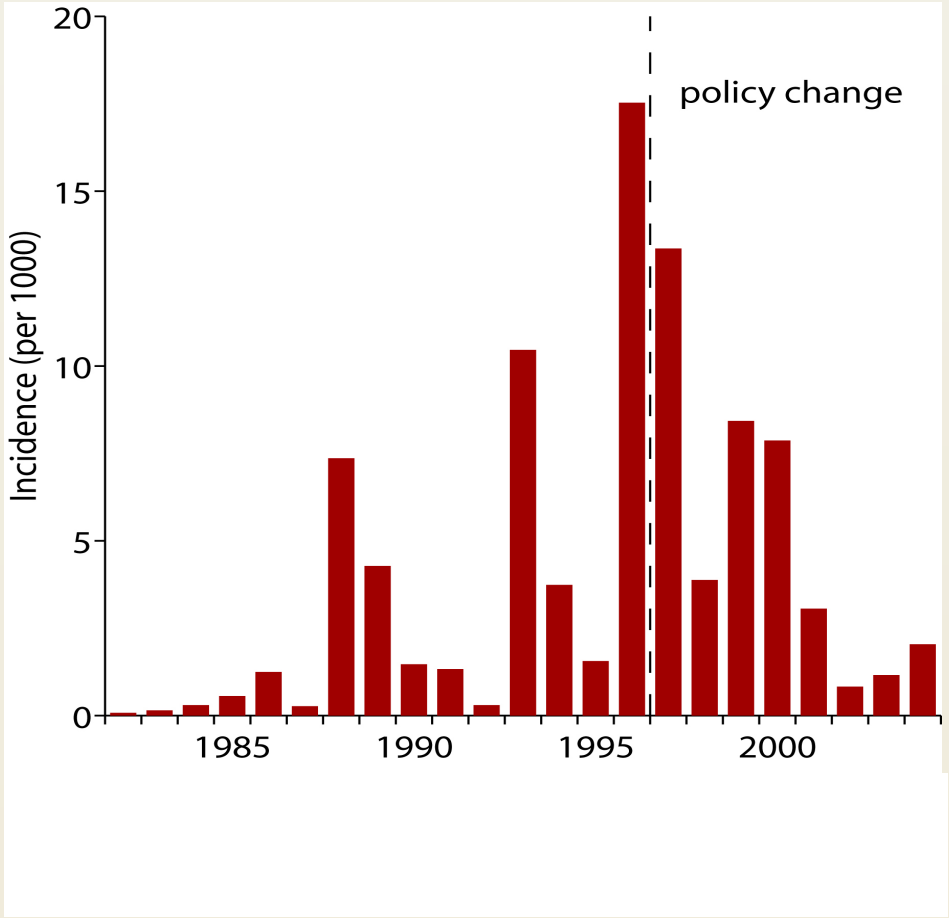
Malaria Early Warning in Botswana





>20 Years good surveillance

Laboratory confirmed

Good coverage as quality service widely used

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Case surveillance

Example in Botswana .. Of a number of indicators (WHO 2004) the NMCP uses case thresholds defined for three levels of alert …

OKAVANGO SUB-DISTRICT

ACTION 1: When district notification reaches/exceeds 600 unconfirmed cases/week

DEPLOY EXTRA MANPOWER AS PER NATIONAL PLAN

- Request 4 nurses from ULGS by telephone/fax
- Collect the 4 nurses from districts directed by ULGS
- Erect tents where needed
- Catchment areas to deploy volunteers in hard-to-reach areas
- Print bi-weekly newsletter to inform community about epidemic

ACTION 2: When district notification reaches/exceeds 800 unconfirmed cases/week

DEPLOY MOBILE TEAMS PER DISTRICT PLAN

a) Each team to be up of a Nurse or FEW, a vehicle and a driver
b) Deploy teams as follows:

TEAM AND DEPLOYMENT AREA	VEHICLE Reg No
Team A: Qangwa area	Council
Team B: Habu/ Tubu / Nxaunxau area	Council
Team C: Chukumuchu / Tsodilo / Nxaunxau area	Council
Team D: Shakawe clinic (vehicle and driver only)	DHT vehicle
Team E: Gani / Xaudum area	Gani HP vehicle
Team F: Mogotho / Tobera / Kaputura / Ngarange area	Mogotho HP vehicle
Team G: Seronga to Gudigwa area	Gudigwa HP vehicle
Team H: Seronga to Jao Flats	Boat

c) Deploy MO at Shakawe and 2 more nurses as per National Manpower contingency plan

ACTION 3: When district notification reaches/exceeds 3000 unconfirmed cases/week

DECLARE DISTRICT DISASTER

a) Call for more outside help (manpower, vehicles, tents, etc)
b) Convent some mobile stops to static treatment centres
c) Station nurses at the static treatment centres
d) Station GDA to assist nurse eg cooking for patients on observation
e) Erect tents with beds and mattresses (6 – 10 beds/tents) at selected centres
f) Station vehicles at selected centres
g) Deploy MO or FNP at Seronga
h) Station officer from MOH to co-ordinate epidemic control with DHSCC

Threshold 1 - 600 unconfirmed cases/week >>> Action Plan 1.

Threshold 2 - 1000 unconfirmed cases/week >>> Action Plan 2.

Threshold 3 - 3000 unconfirmed cases/week >>> Action Plan 3.

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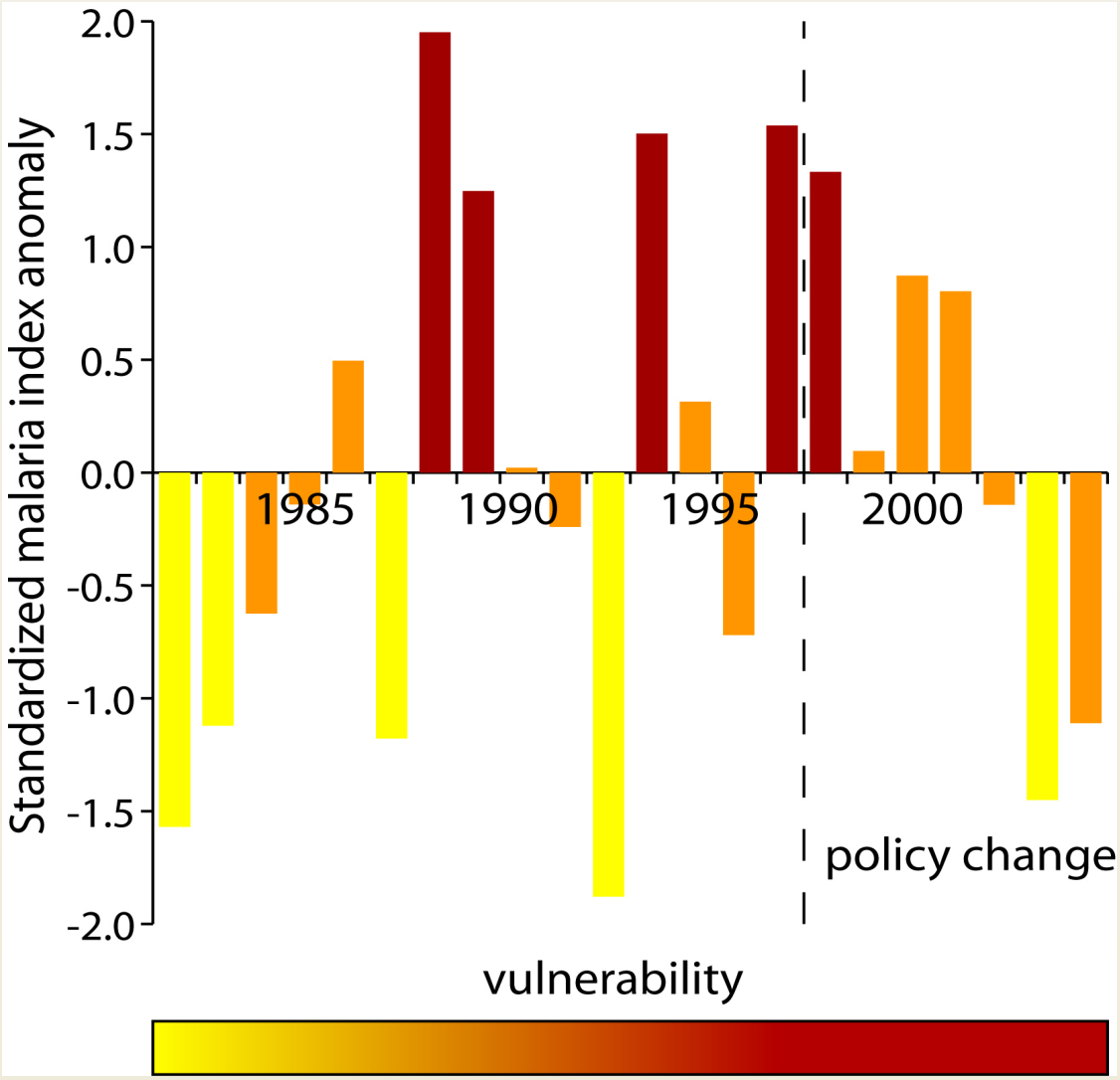
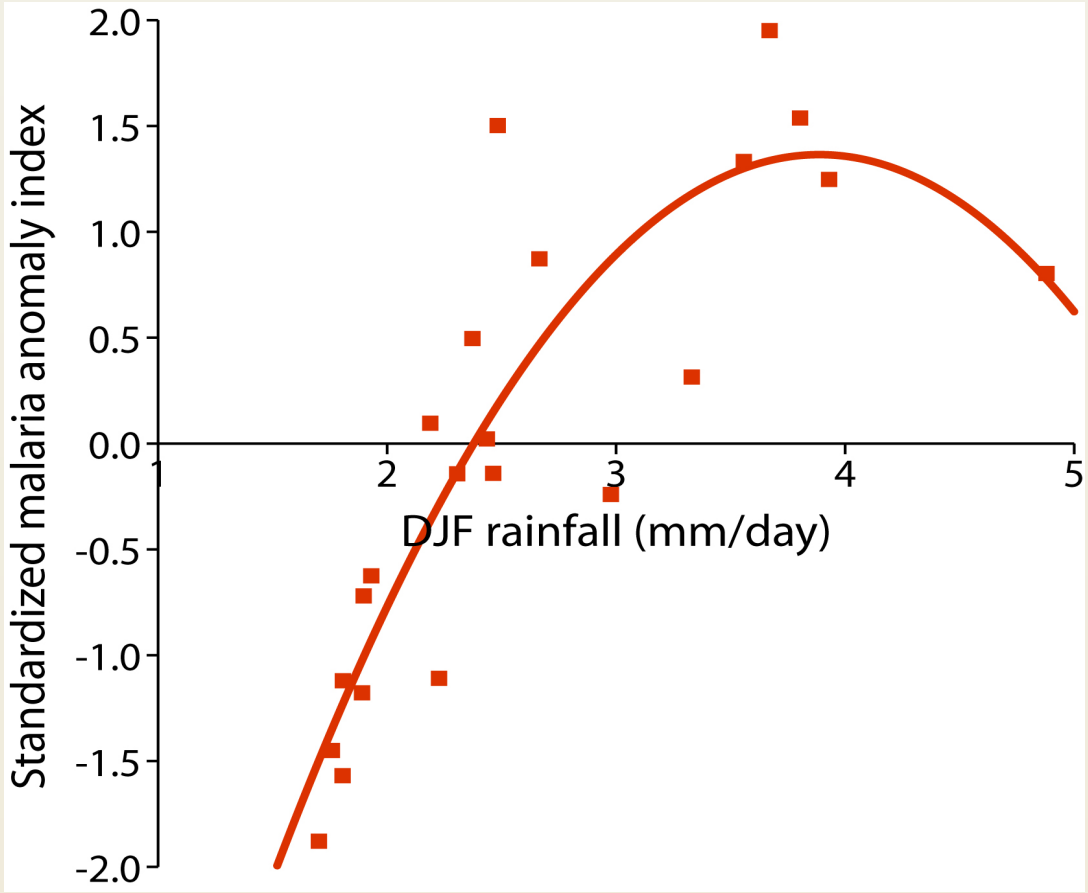
High and low years are defined by the upper and lower quartiles (after detrending and log transformation.

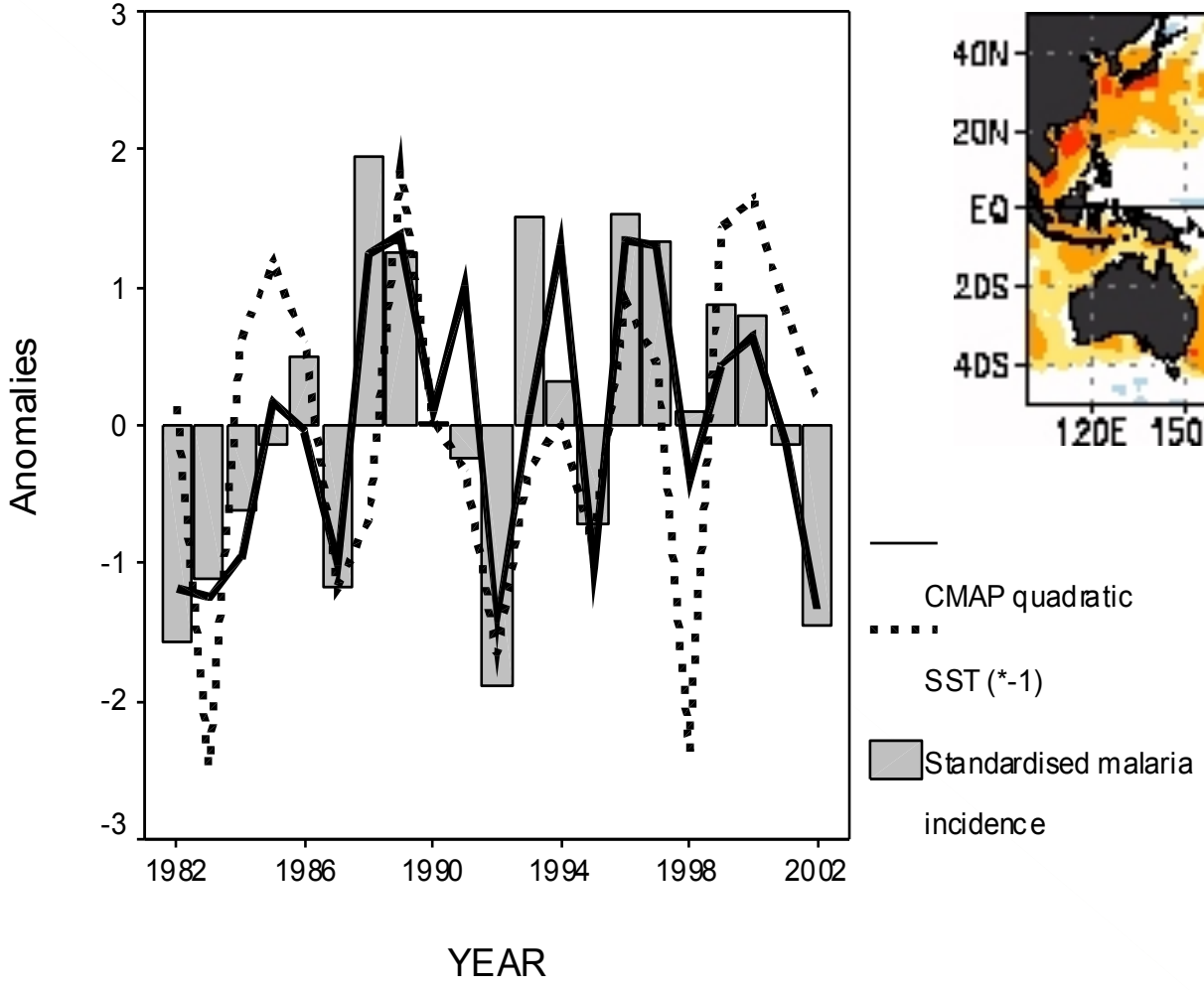


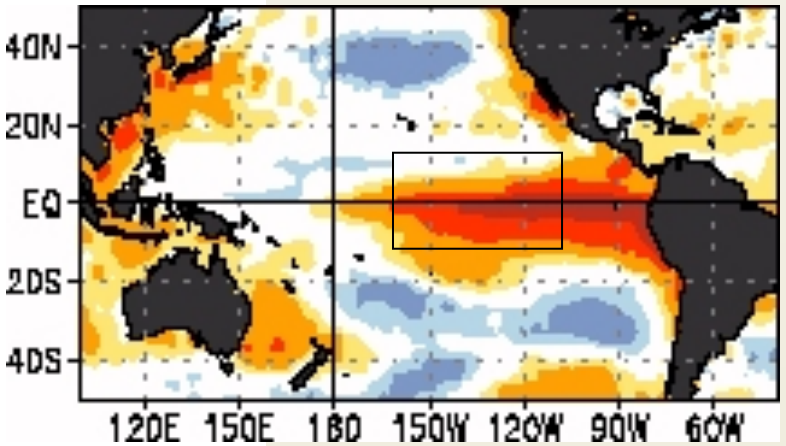
Climate and Environmental monitoring

Malaria incidence in Botswana (Feb, Mar, Apr) is strongly related to rainfall variability during the peak rainfall season December – February.



Malaria in Botswana varies from year to year according to the climate and the temperature of the sea in the Nino 3.4 region.

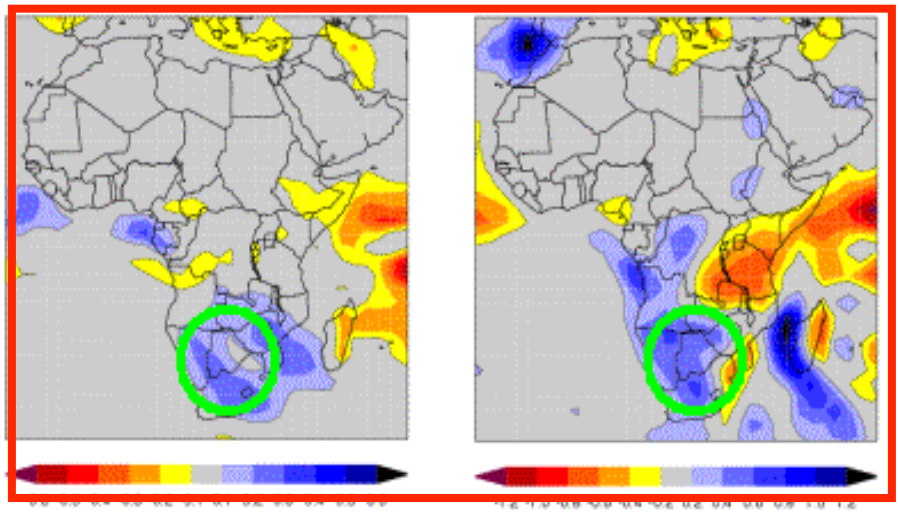




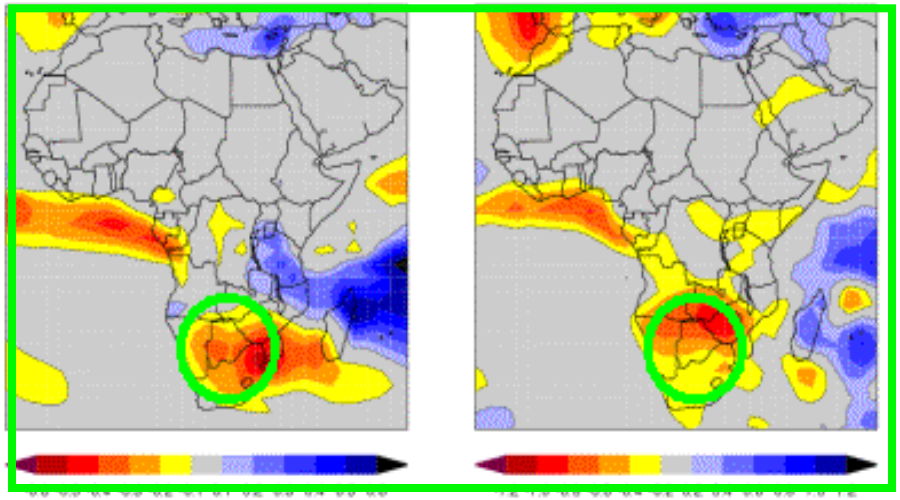
Climate forecasts
5 month warning

Satellite rainfall
2 months warning

WET

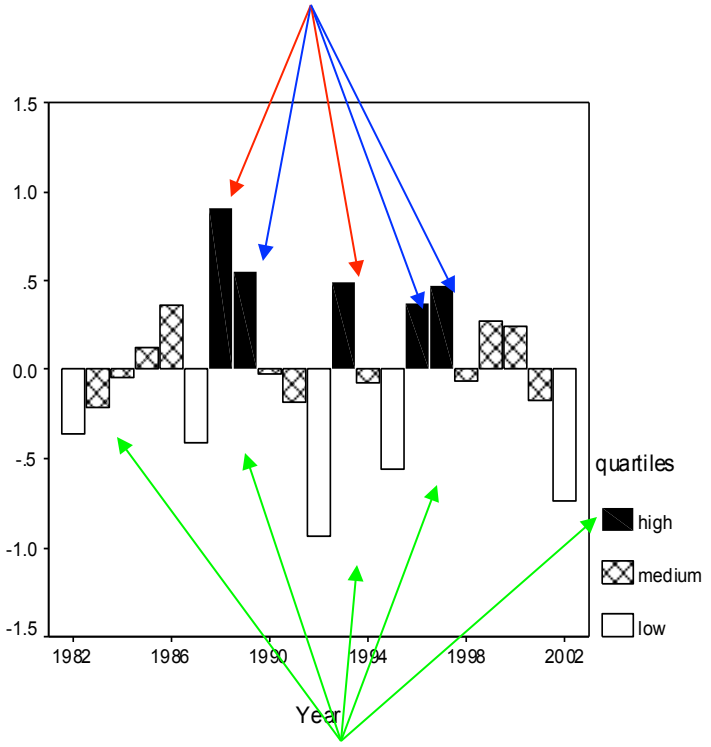


DRY



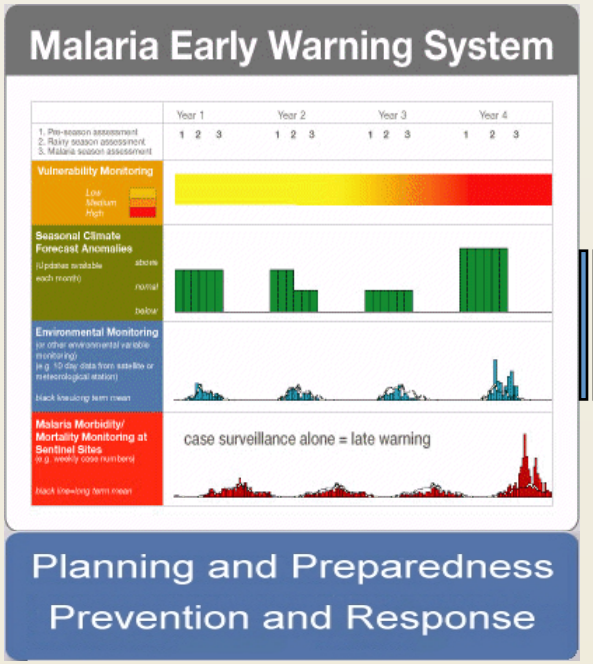
Botswana 1982-2002

5 high malaria anomalies



5 low malaria anomalies

RBM: Southern African Regional MEWS activities



Malaria Surveillance, Forecasting, Preparedness and Response in Southern Africa

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Cross-Border Activities

Vulnerability Monitoring

There are many factors that increase the vulnerability of a population to malaria epidemics (Bates, Fenton, et al., 2004a; Bates, Fenton, et al., 2004b) and increase the severity of disease outcome, should a malaria epidemic occur.

Drug Resistance

Population Movements

Co-infection with Other Diseases

For example HIV/AIDS

Drought and Food Security

Risk Mapping

Risk Areas for Malaria Epidemic

For example:
Eco-epidemiological Stratification Map for Madagascar

For example:
Composite Stratification Map for Zimbabwe, 2002

Post-Season Assessment

Annual national and regional consultation and planning conference
Monitoring scaling up and delivery

Sentinel Case Surveillance

It is of paramount importance to develop good health information and sentinel site surveillance systems. The process of developing malaria early warning systems strengthens integrated health systems surveillance. It is in itself dependent on good epidemiological data for testing and validating the relationship between the component parts.

Diagnosis and Sentinel Site Surveillance

Weekly Surveillance Data

2004 Malaria Cases — Threshold value

Improved Case Management

Malaria Early Warning System

case surveillance alone = late warning

Seasonal Climate Forecast

In recent years there have been significant scientific advances in our ability to predict climate on the seasonal timescale (Goddard, Mason, et al., 2001). The skill associated with these predictions varies from region to region, but is generally higher within the tropics. Updates are available each month.

Rainfall Forecast for December 2004 – February 2005

Southern Africa Regional Epidemic Outlook Forum

Collaboration

WMO — National Meteorological Services — SAMC — National Malaria Control Programmes — SADC Drought Monitoring Center — WHO

What does the seasonal climate forecast mean for malaria transmission?
Will the coming rainy season be wetter or drier than the last?
Will this rainy season be as wet as during the last epidemic?

Distribution of Forecast

Countries → Provinces → Districts

Environmental Monitoring

Environmental variables pertinent to malaria transmission are rainfall, temperatures, humidity, and flooding. Two sources of such information are periodic summaries available through the internet from SADC DMC, FEWS-NET, or IRI websites, or directly from national meteorological services.

Weather Monitoring

10-day Rainfall Estimates

Vector Monitoring, EIR

Flood Monitoring

Prevention and Community Education

Timely Procurement and Distrbution of Medicine

Preparedness

Protection

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WHO (2004). Malaria epidemics: forecasting, prevention, early warning and control - From policy to practice. Geneva, World Health Organization: 59.

The Earth Institute at Columbia University

The European Centre for Medium-Range Weather Forecasts
METEO FRANCE
Met Office
USAID

Temperature and Malaria trends in the East African highlands

A - Has malaria increased?

B - Has Temperature increased?

C - If A and B are both positive is are increases in A are related to increases in B?

D - If B is positive is this related to global warming?

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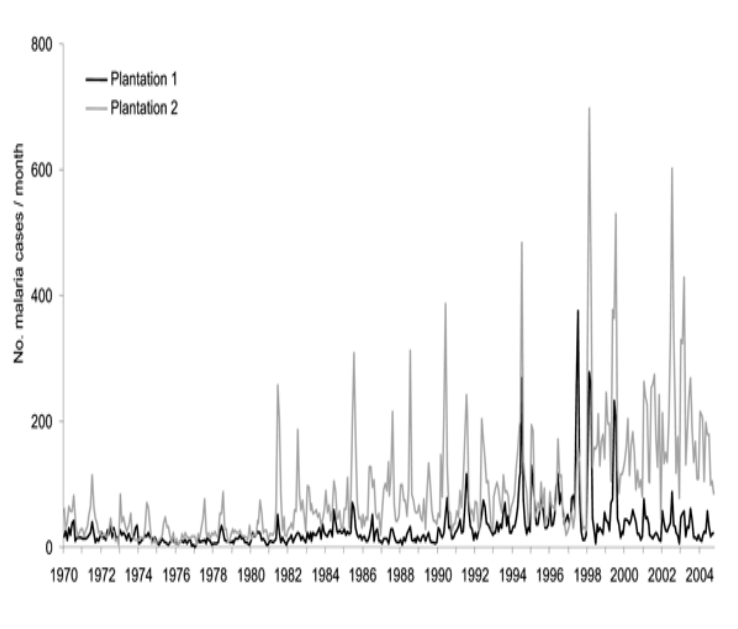
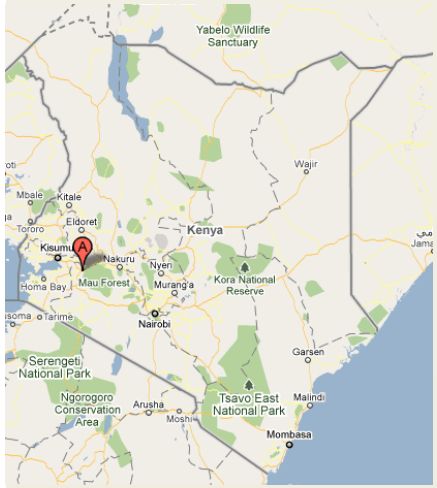
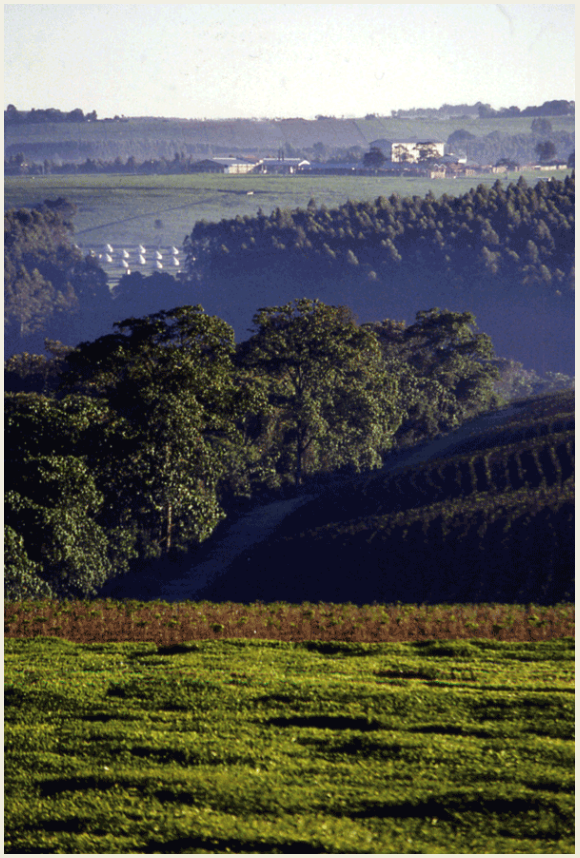
A. Has malaria increased in the East African Highlands







Monthly malaria cases at Kericho Unilever Tea Kenya Ltd Hospital.

'Analyses of malaria time-series at such sites have shown that malaria incidence has increased **in the absence of co-varying changes in climate'**.

Hay et al., (2002).

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B. Has Temperature increased in the East African highlands?

Reiter, (2008)

"Whatever the cause, the history of multiple epidemics in the earlier part of the century, including many at higher altitudes, makes it unnecessary to infer climate change as a contributory factor. **Moreover, a set of well-maintained meteorological records shows no significant change in temperature over recent decades**].

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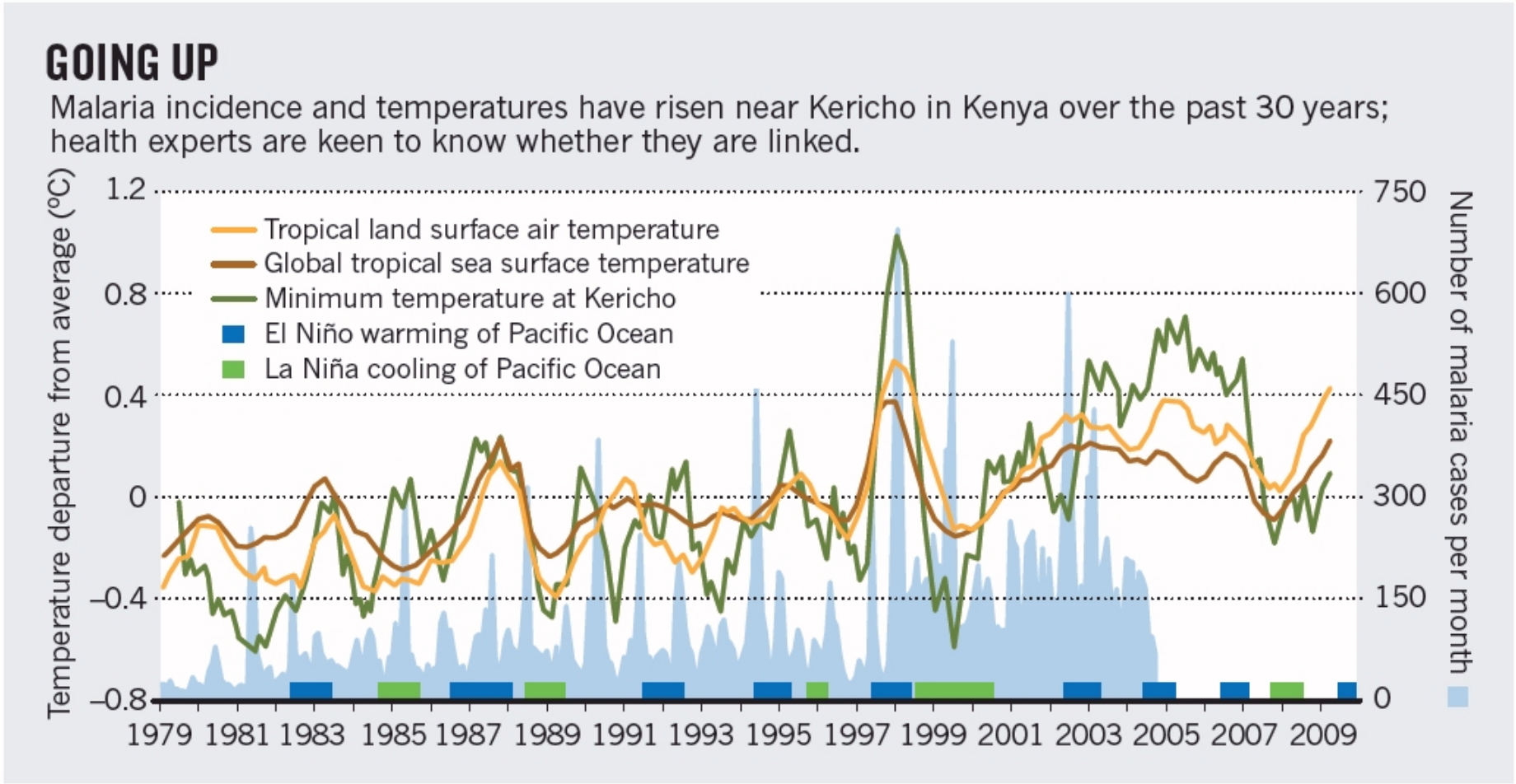
If B is positive is this due to global warming?



Thomson, M.C. Connor, S.J., Zebiak, S.E. Jancloes, M., and Mihretie, A (2011) Africa needs climate data to fight disease. Nature, 471 440-442 (24th March 2011)

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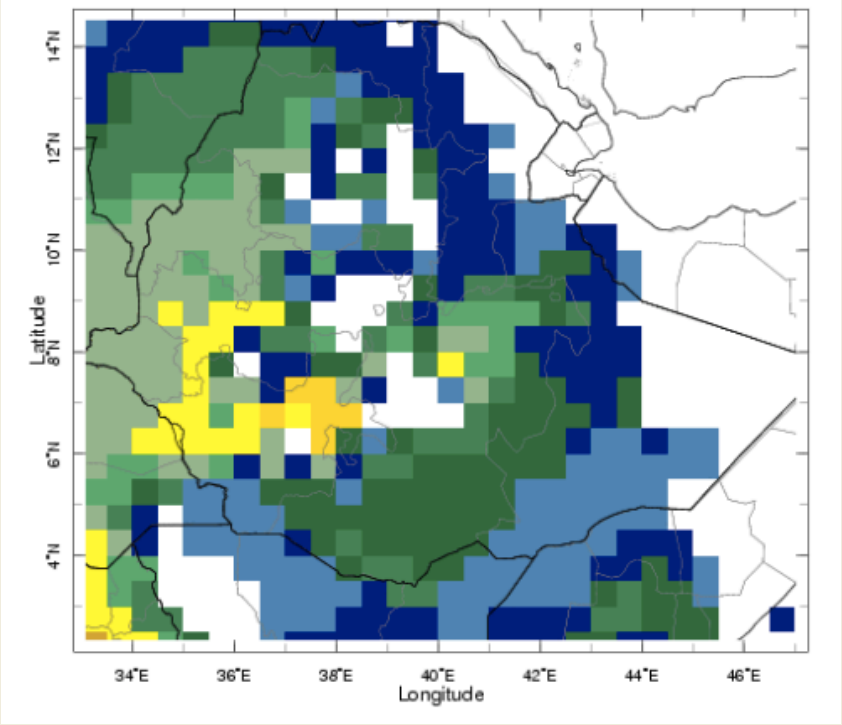
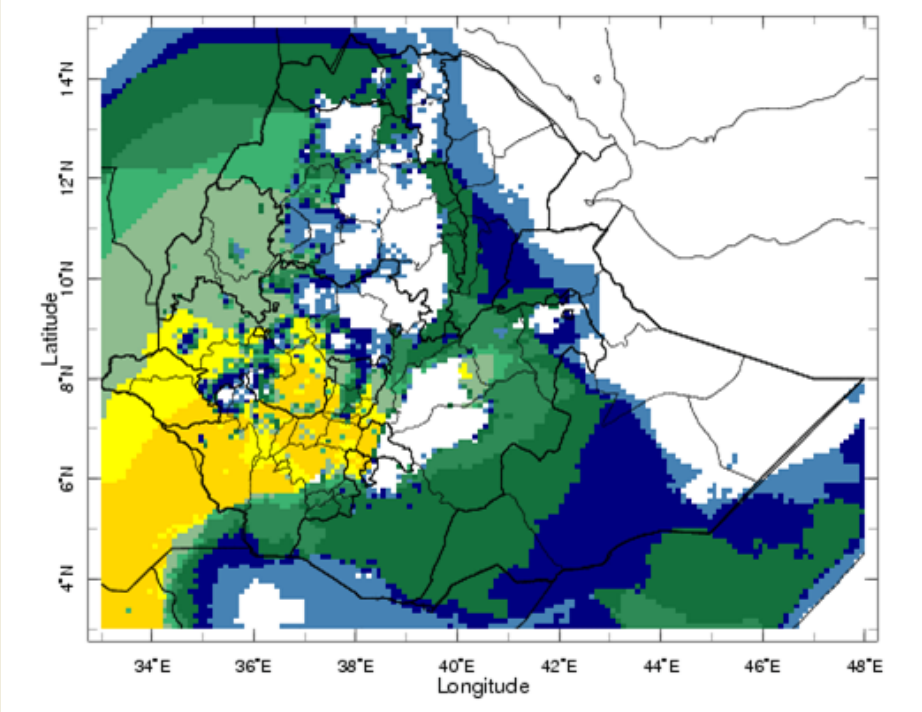
gure 5 – NMA's improved website, designed by IRI and developed by a local ompany, is designed in such a way that the user can find information easily. presents existing and new products from simple station history to more ophisticated maps. It also makes locating and ordering data sets easier. The ector-specific Map Rooms on the right facilitate the use of climate information.

Climate suitability for malaria transmission (CSMT)



Created using interpolated station data (UEA Gridded Data, 0.5 deg lat/lon res)



Created using blended national station data and satellite data (10 km res)

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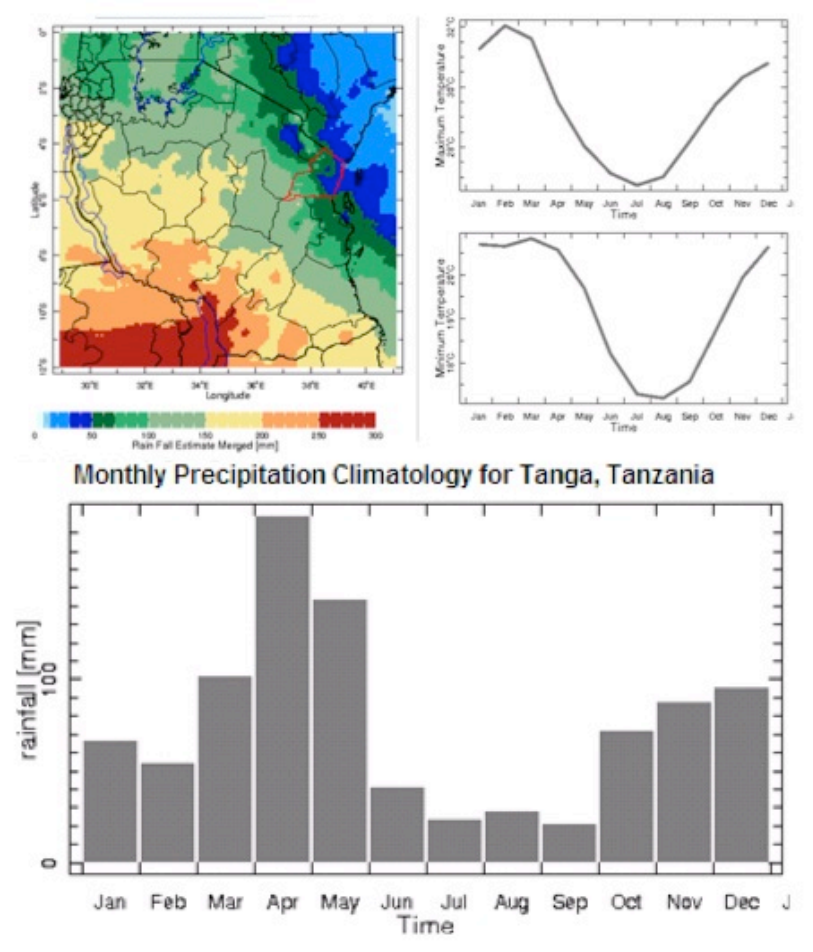
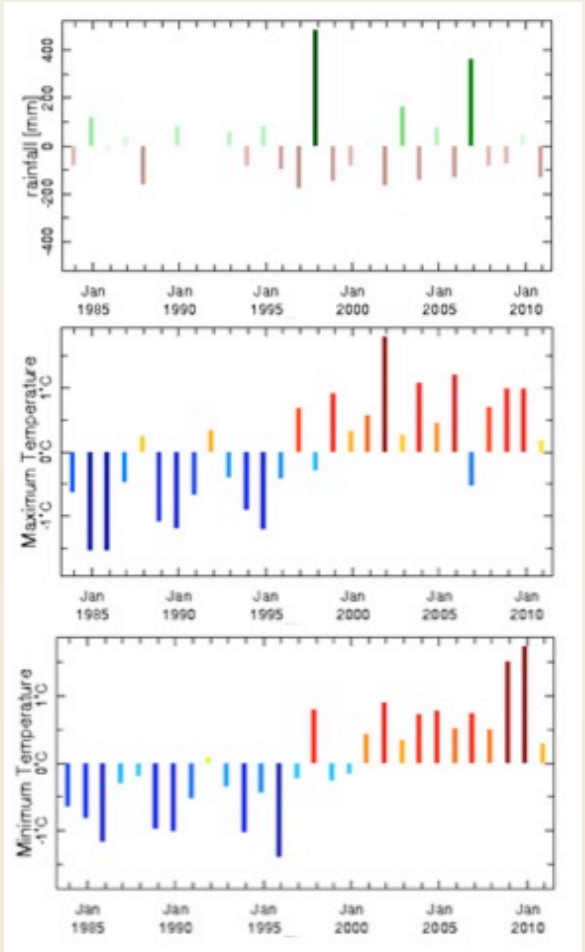
ENACTS (rainfall and Temperature Tanzania





Climatology
Seasonality

Trends

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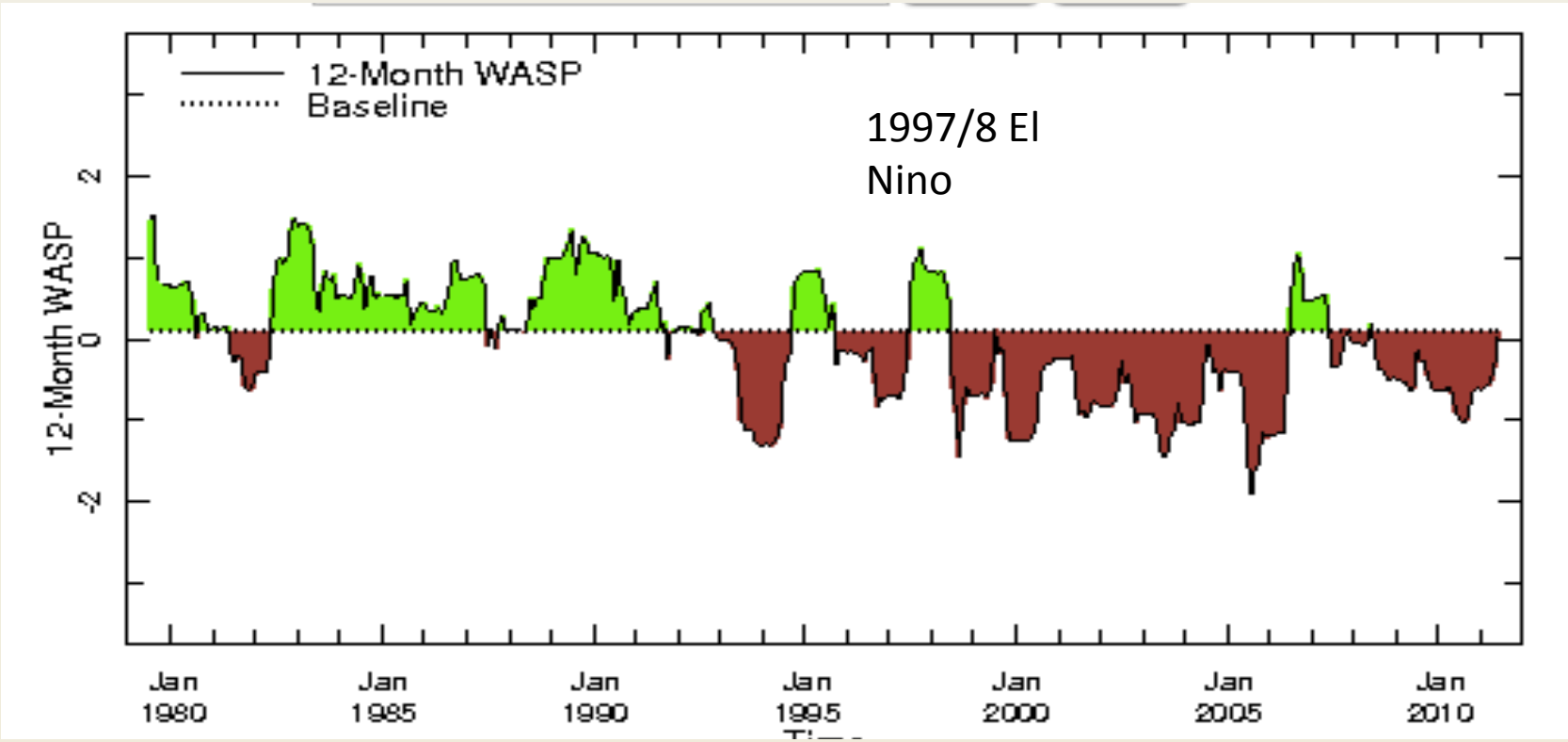
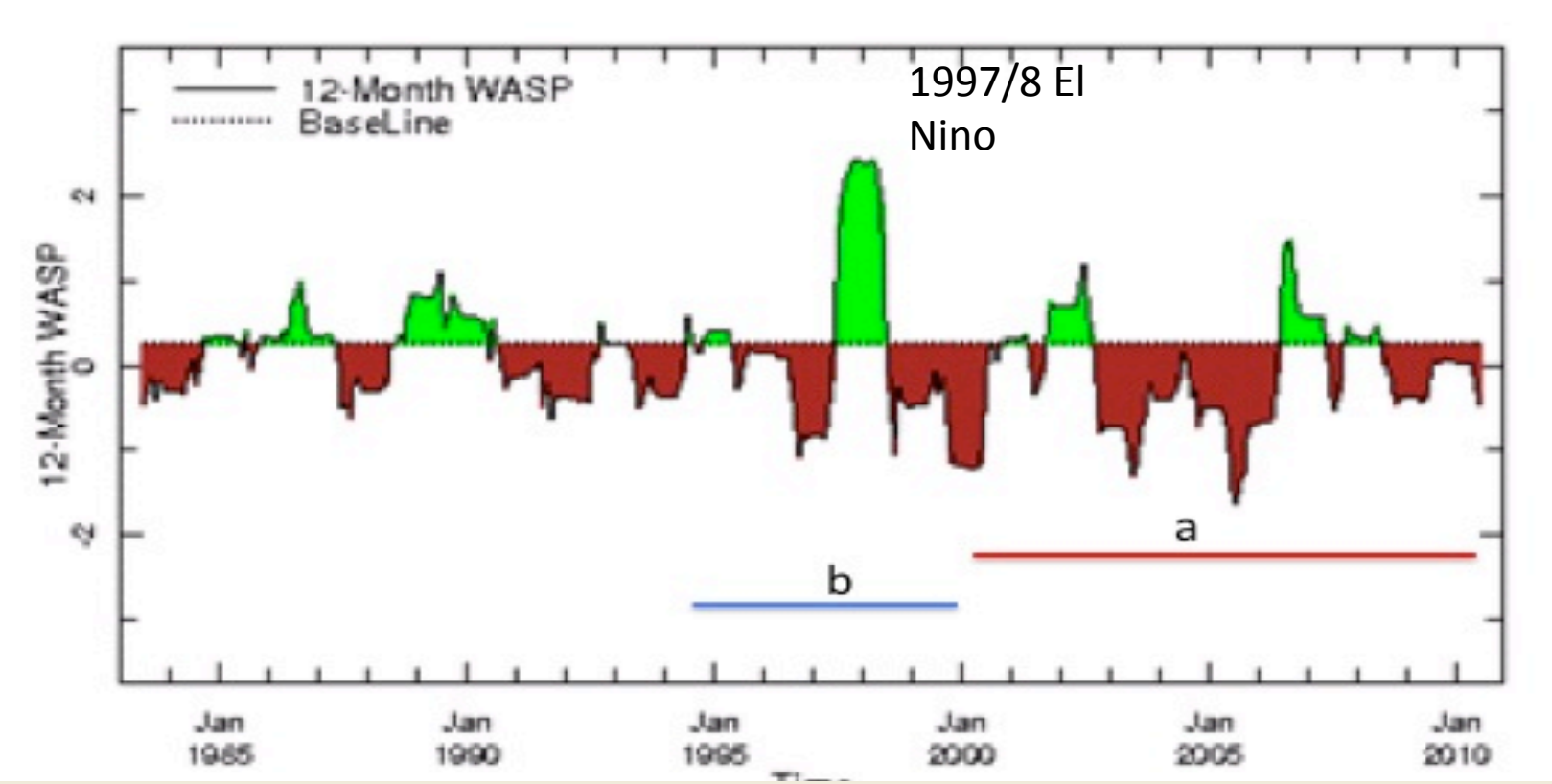
Compare Tanzania CMAP (crude) WASP Analysis for Presidents Malaria Initiative



Tanzania WASP Analysis for PMI



The role of the decision-making in making decisions

- We need to investigate the role of the decision maker in making decisions.
- Causal models are not the only requirements for effective prediction - there must also be a willingness to use the information and the models.
- The process from data collection to dissemination should engender decision making

Decisions may vary depending on:

- Availability and perceived reliability of the data
- Certainty of outcomes associated with different options
- Experience / expertise of decision maker
- Decision making environment
- Personality of the decision maker(s).
- The cognitive biases that influence the decisions in a given situation.
- Incentives/Dis-incentives (decision v. Act of God)

Conclusions

- There is research evidence that use of information can improve decision making.
- Much of the research has focused on a rational approach to decision making.
- However people don't necessarily take a rational approach to making decisions.
- The degree to which data and information reflect fact or truth the greater the potential for informed decision-making .
- We need to understand how individuals make decisions

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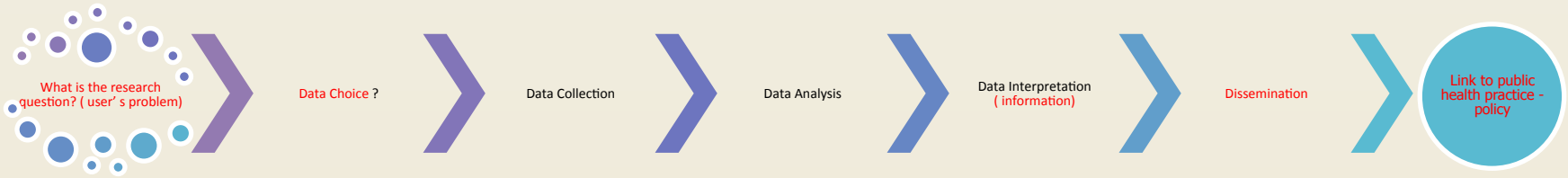
Conclusions

To improve decision making through the use of data and information the models established at each point in the prcoess (from the collection of data to the mental model of the decision-maker_ should be as closely aligned to the entity about which the decision is being made as possible.



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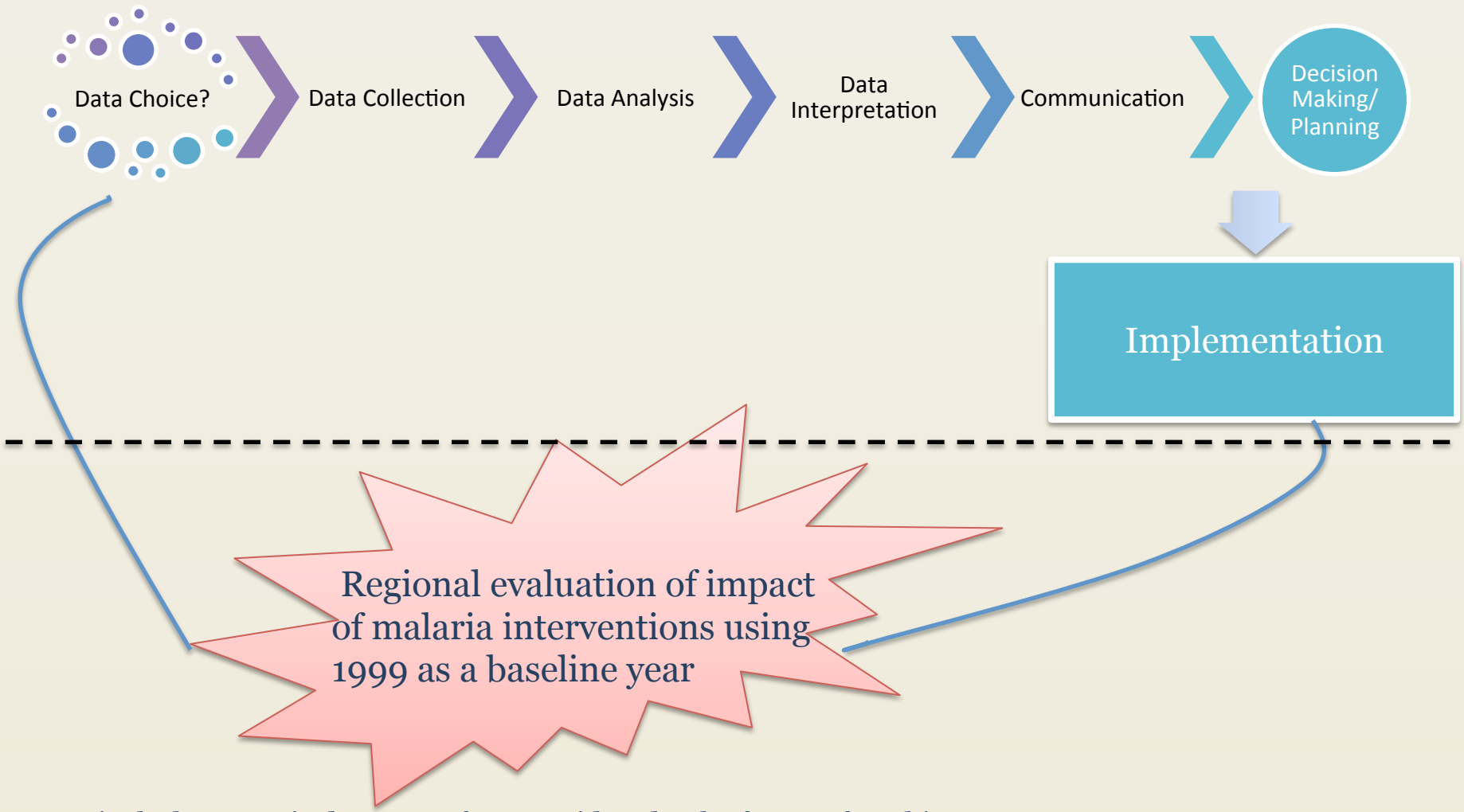
Multiple models inform each stage in the process



Data, particularly numeric data, are often considered to be fact. In fact this discussion demonstrates that the data at the decision-making state is a product of a number of subjective models. In order for decisions to be improved care must be taken to ensure that there is alignment of the models so that they model at the decision stage is as close as possible to representing the entity about which the decision is being made

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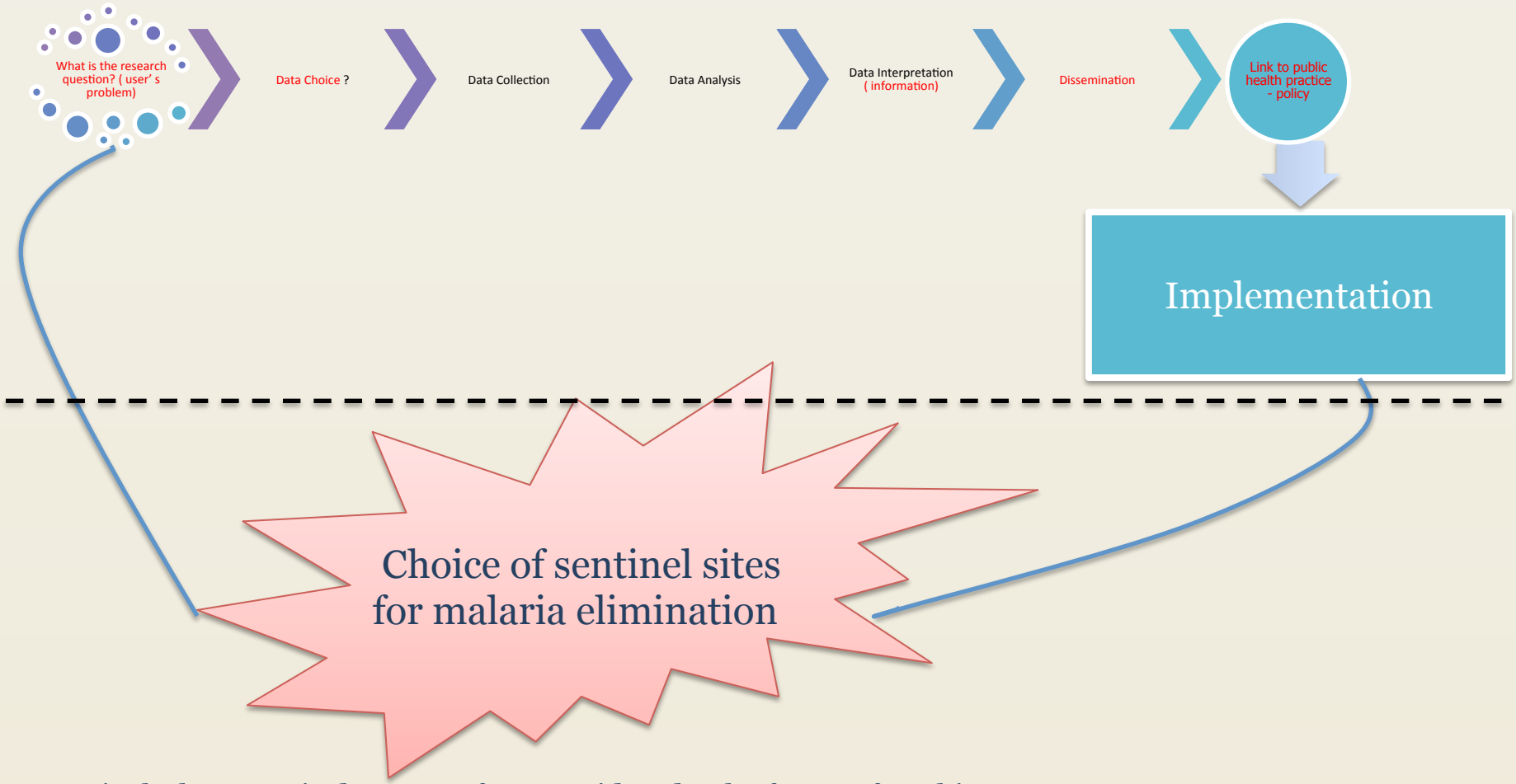
Multiple models inform each stage in the process



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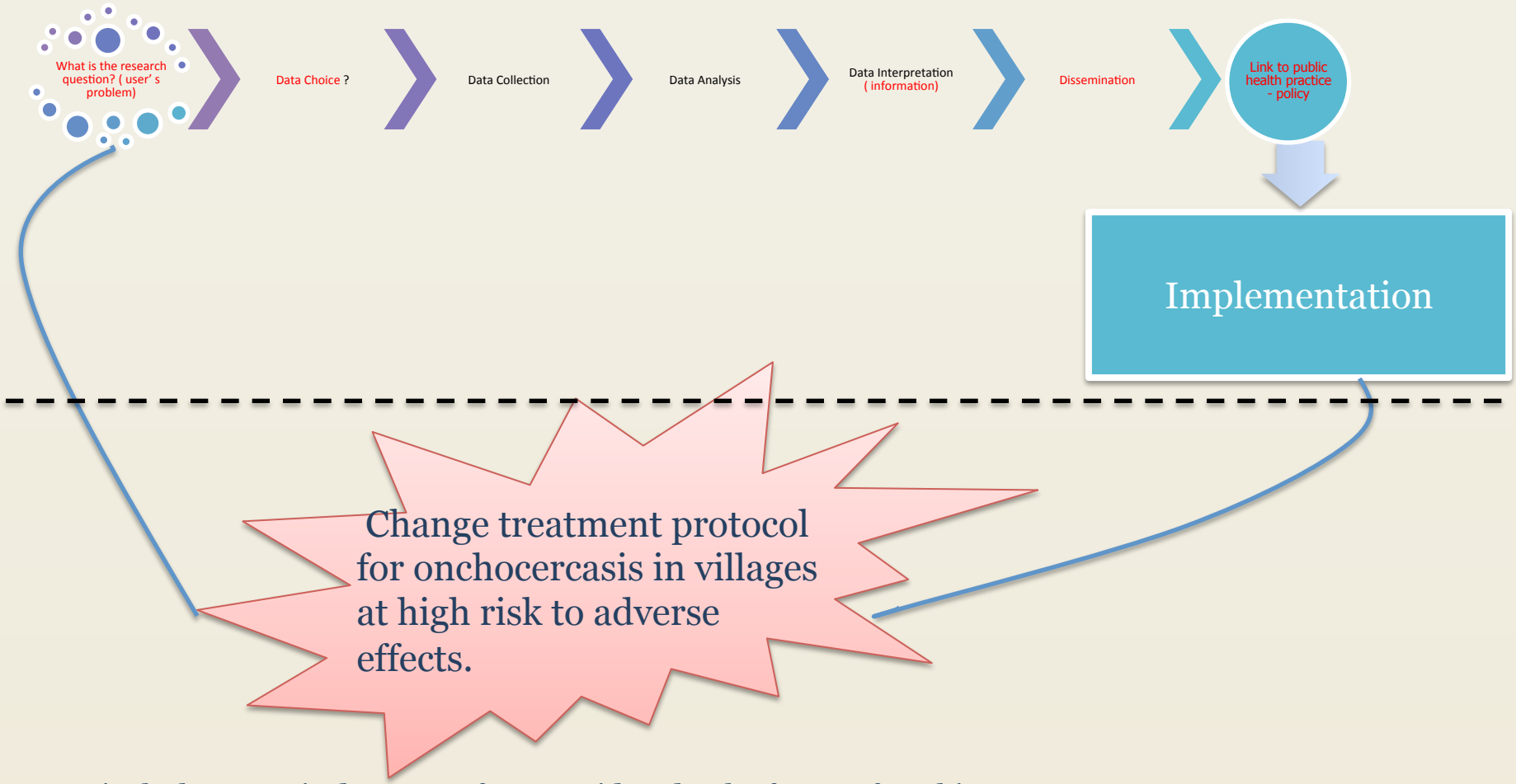

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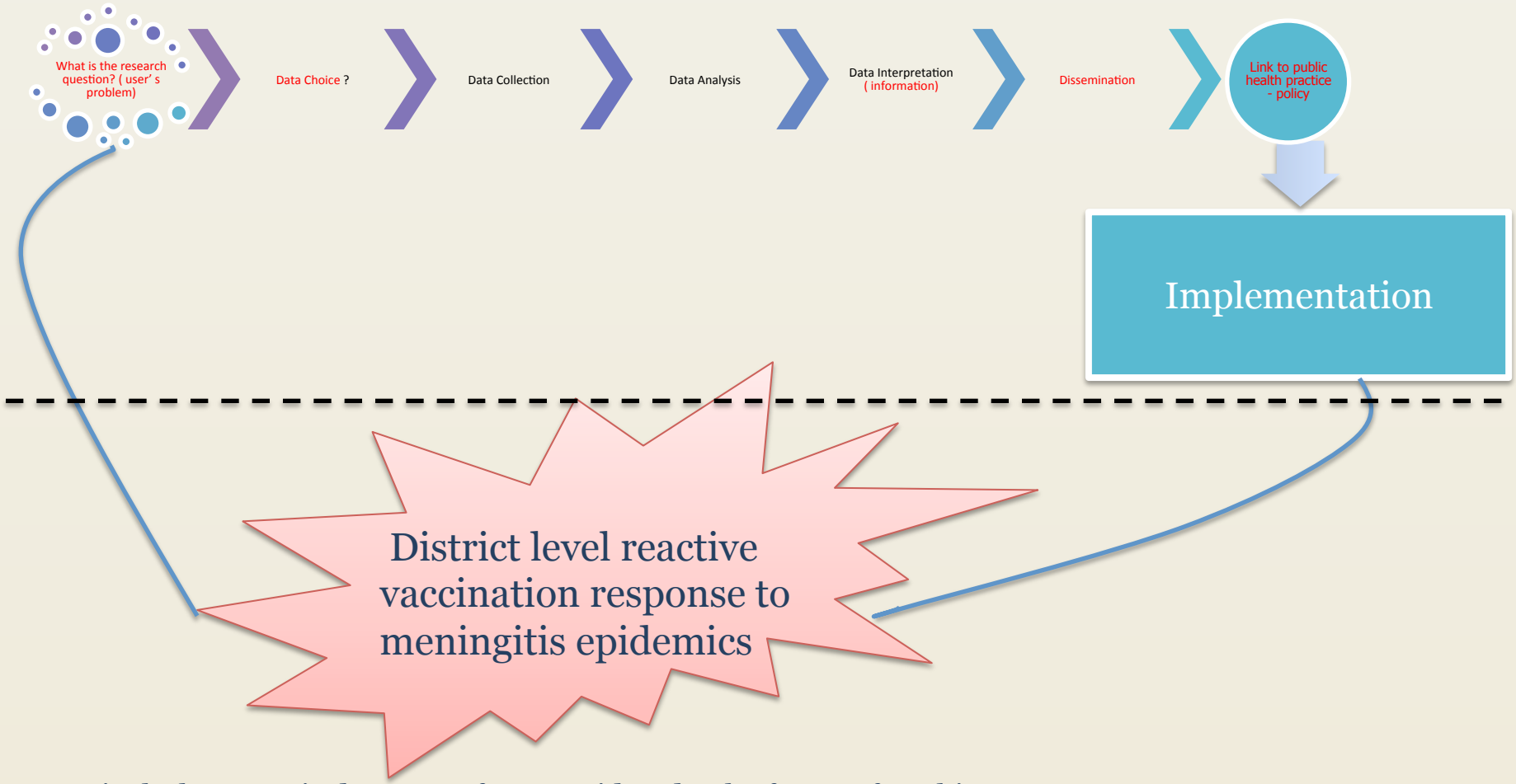

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