Climate/Health Modeling

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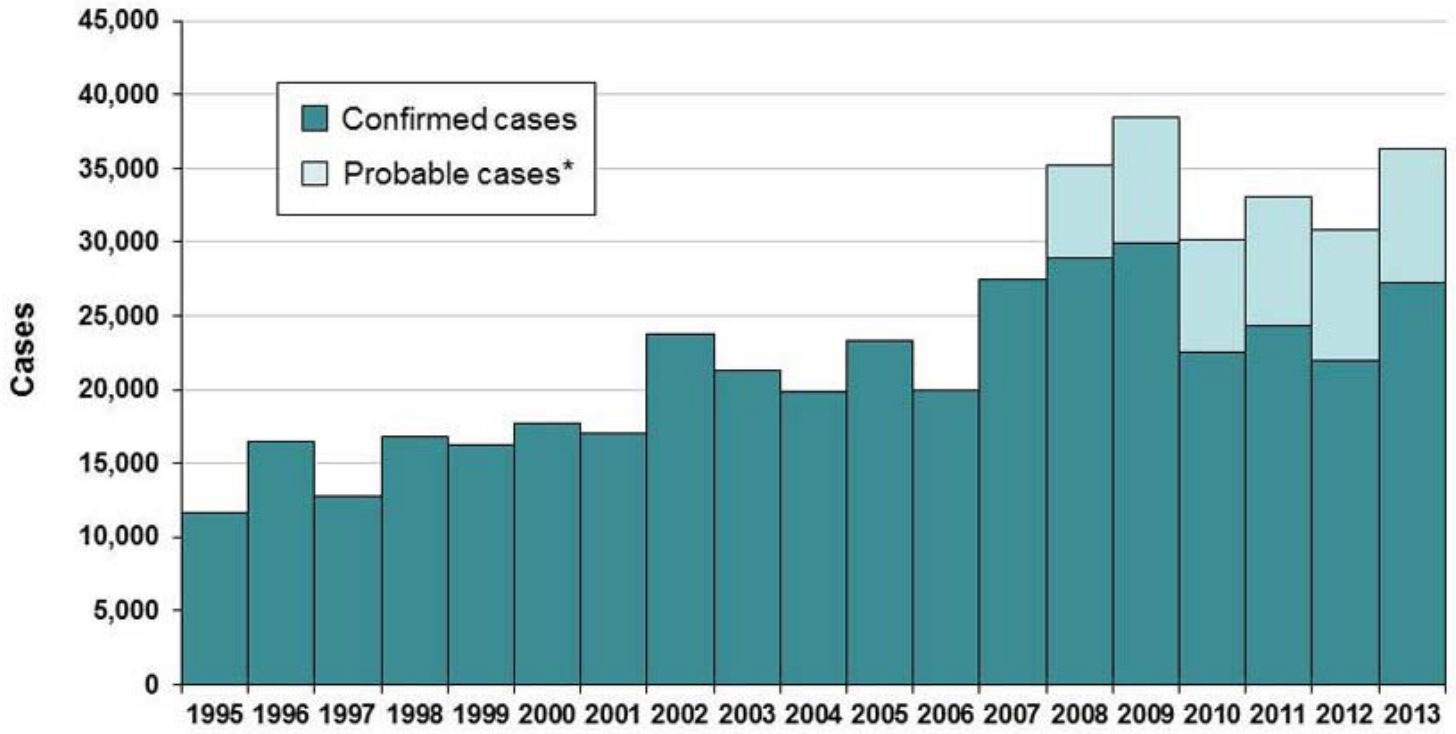
A Guide to the Perplexed (abridged)

- Trends vs. variability
- Targets
- Memory
- MIP?
- Movement

Trends vs. Variability



Lyme Disease

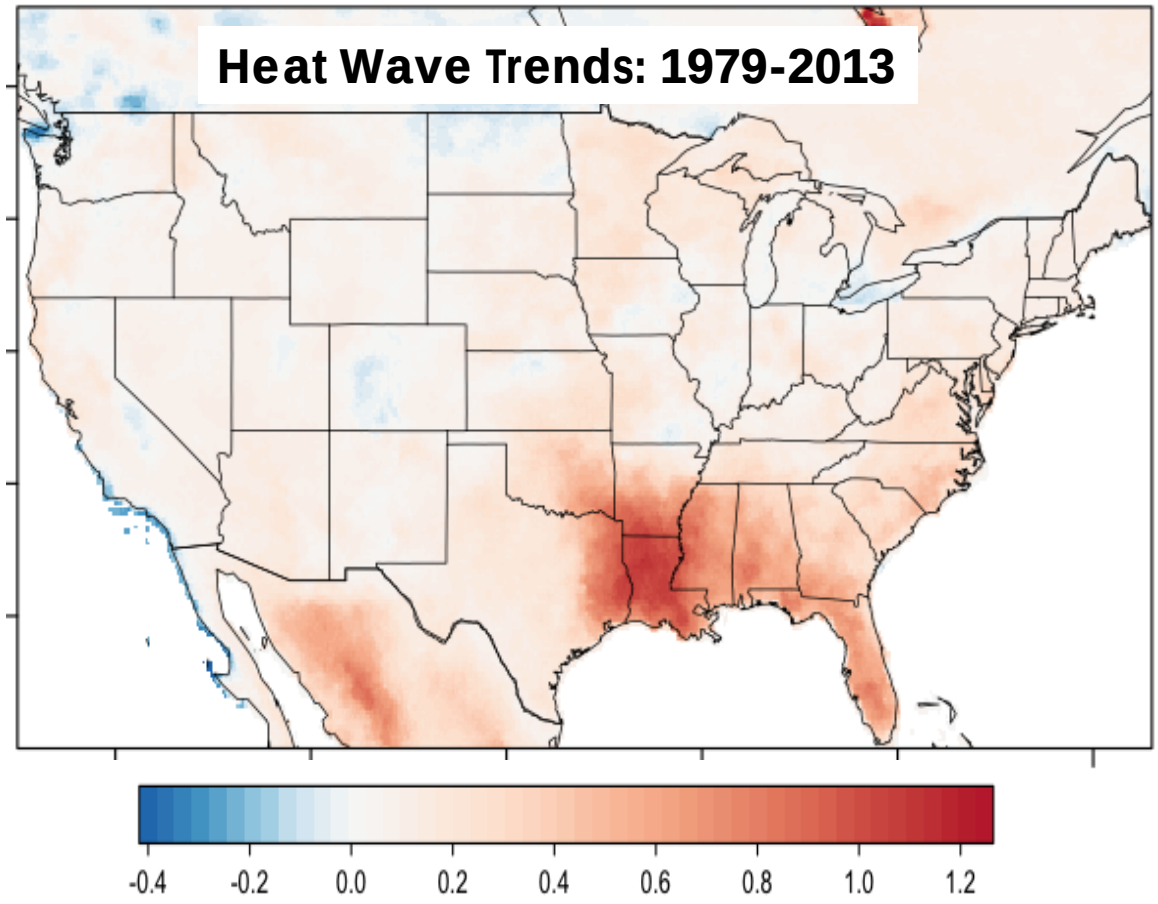
CDC

Trends vs. Variability

Different:

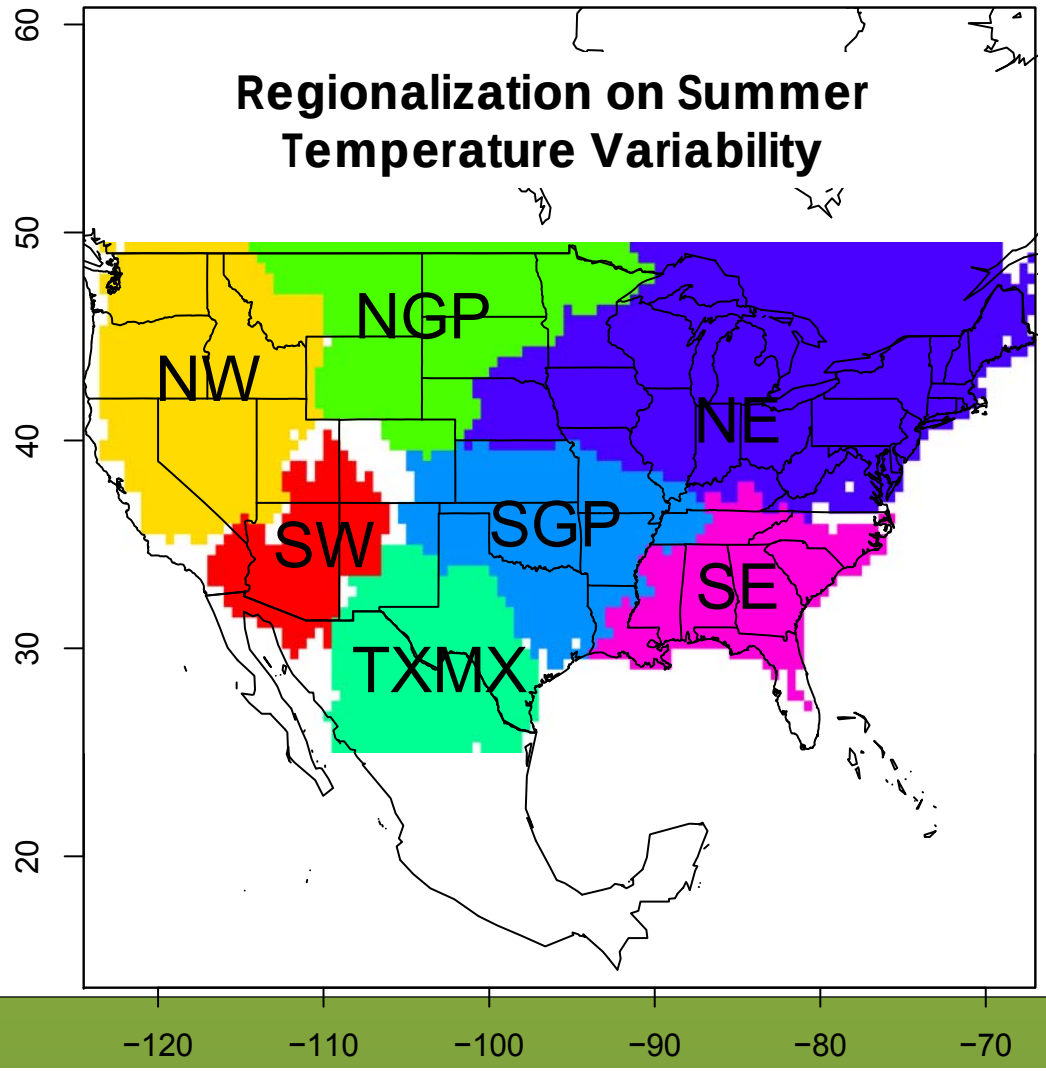
- decisions
- datasets
- modeling approaches
- uncertainties

Trends vs. Variability: Heat waves



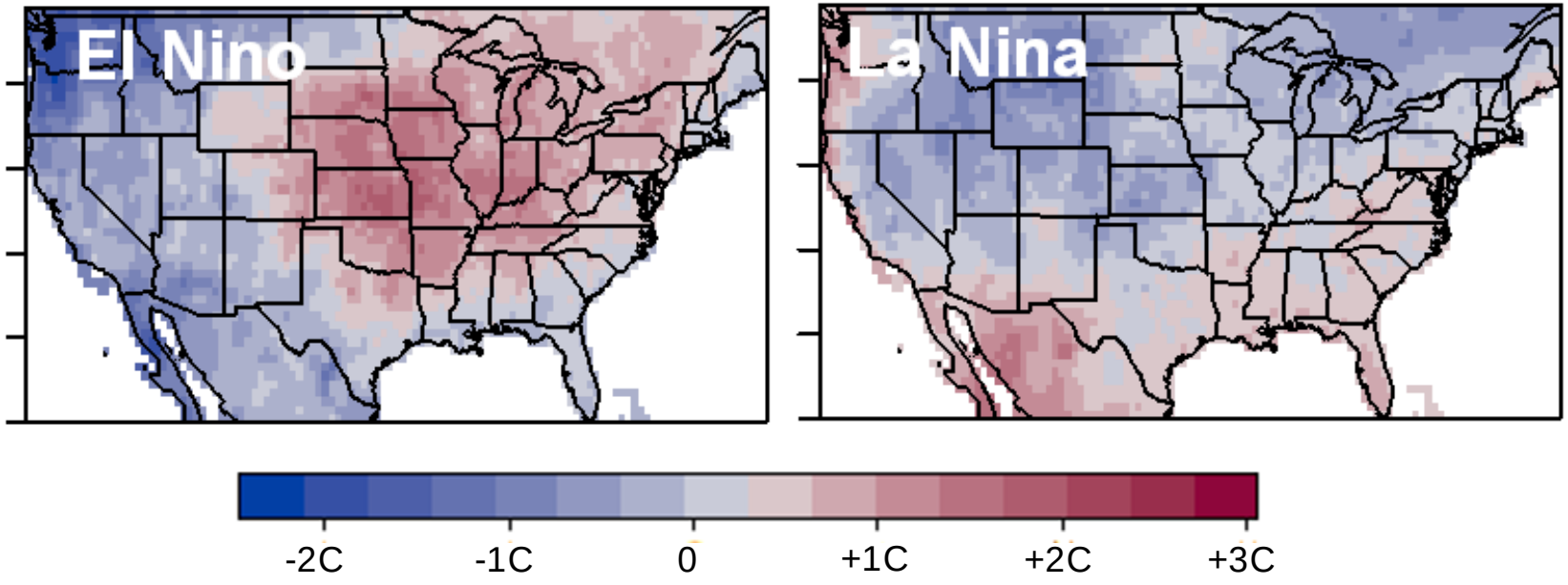
Smith et al. (2014)

Trends vs. **Variability**: Heatwaves

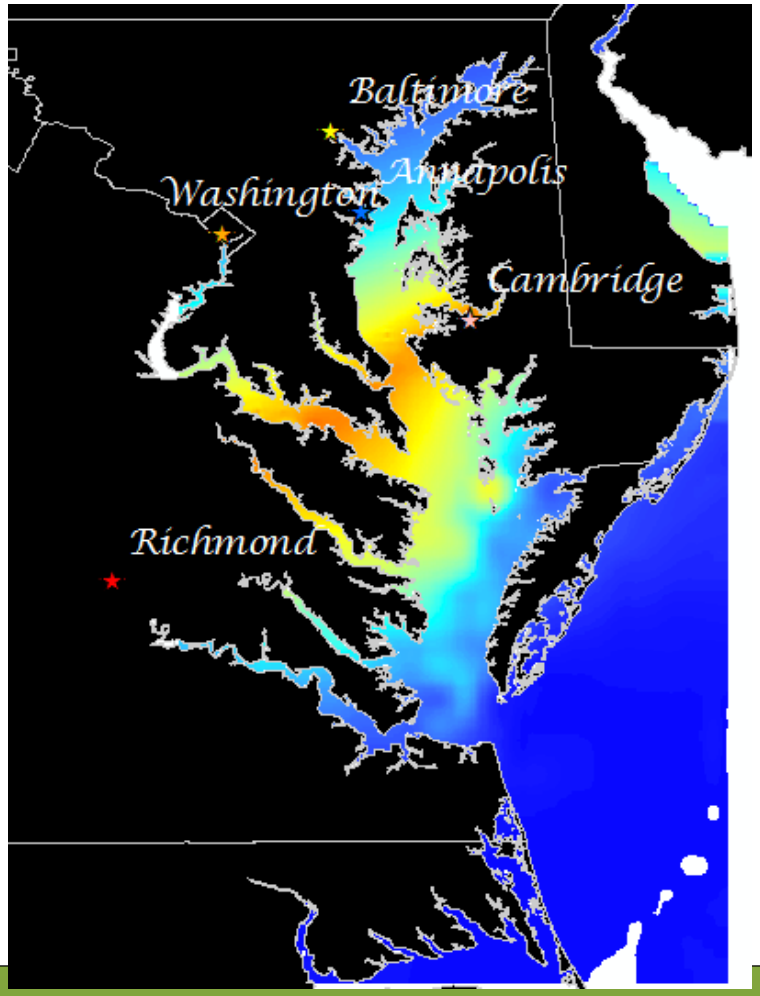


Trends vs. **Variability**: Heat waves

Summertime Temperature Composites



Trends vs. Variability: *Vibrio*

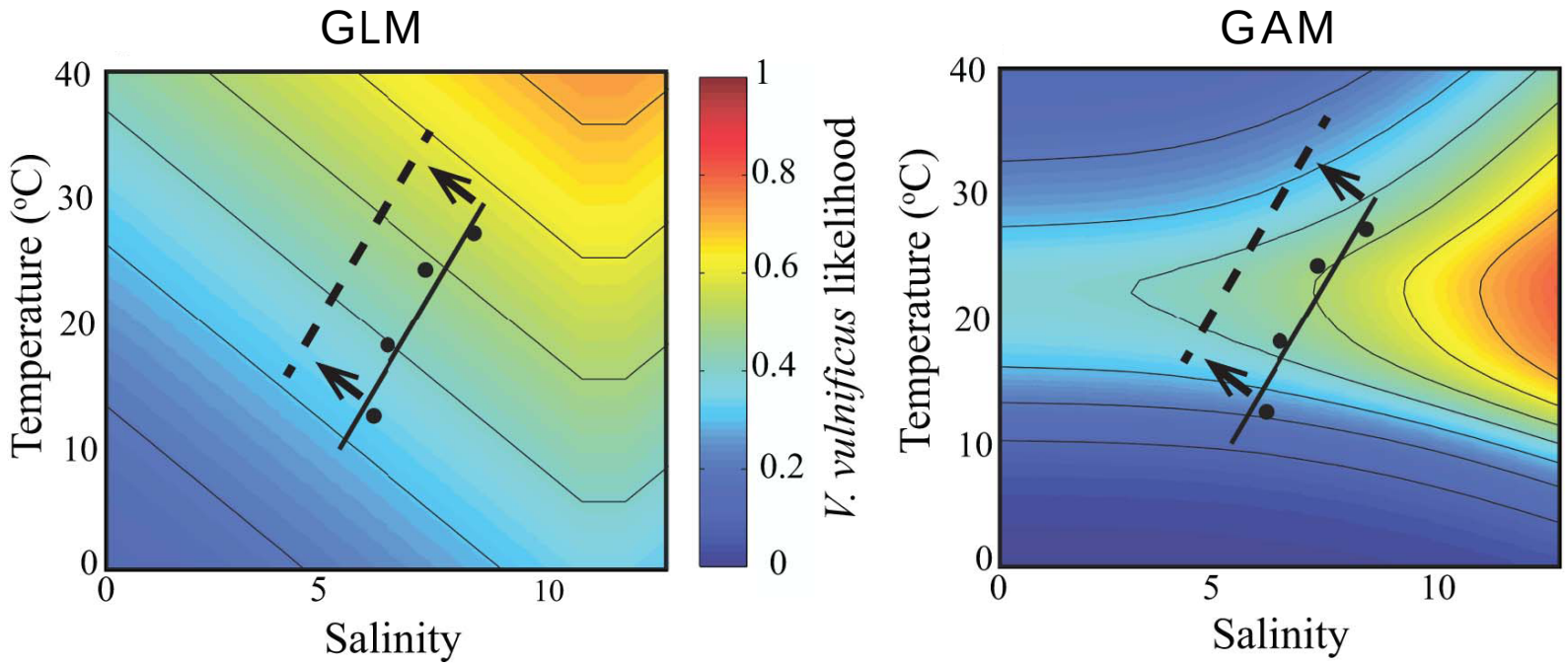


Vibrio vulnificus probability

0.0 0.6

Urquhart et al. (2014)

Trends vs. Variability: *Vibrio*

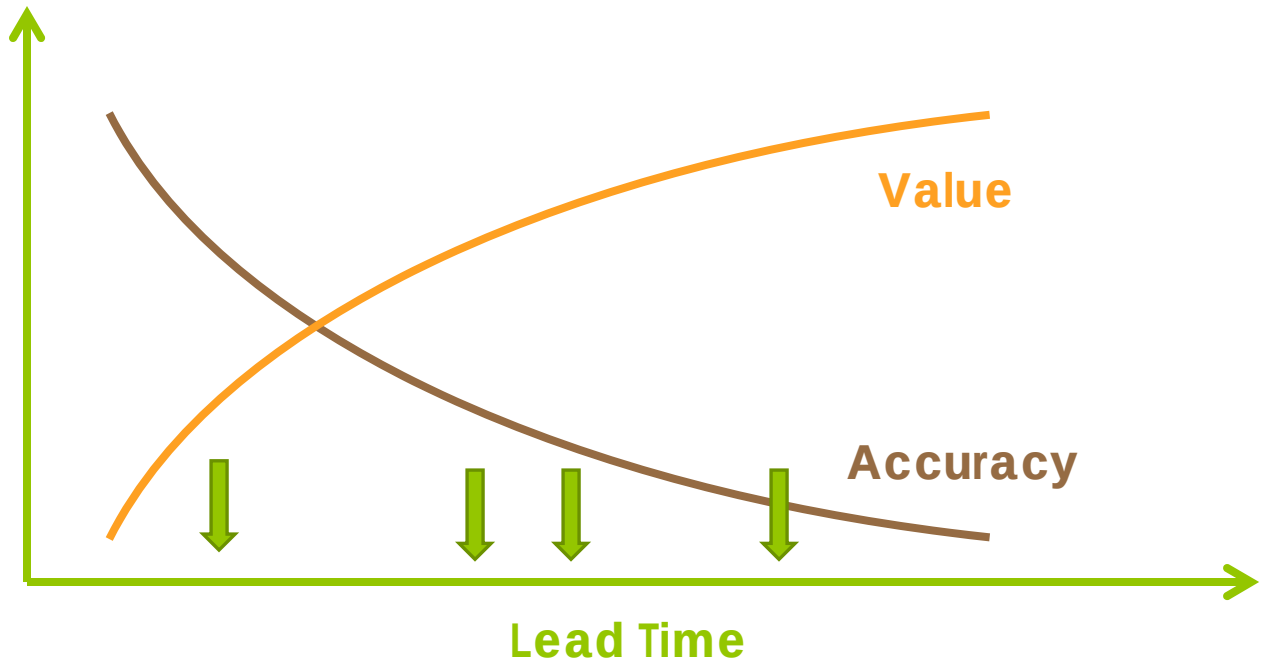


Urquhart et al. (2014)

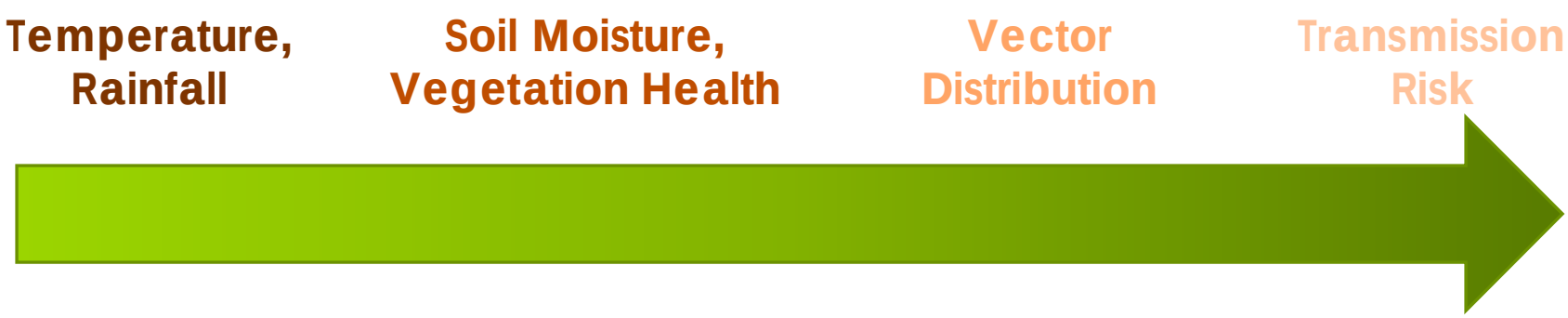
Targets

- Lead time
- Chain of analysis
- Performance metric

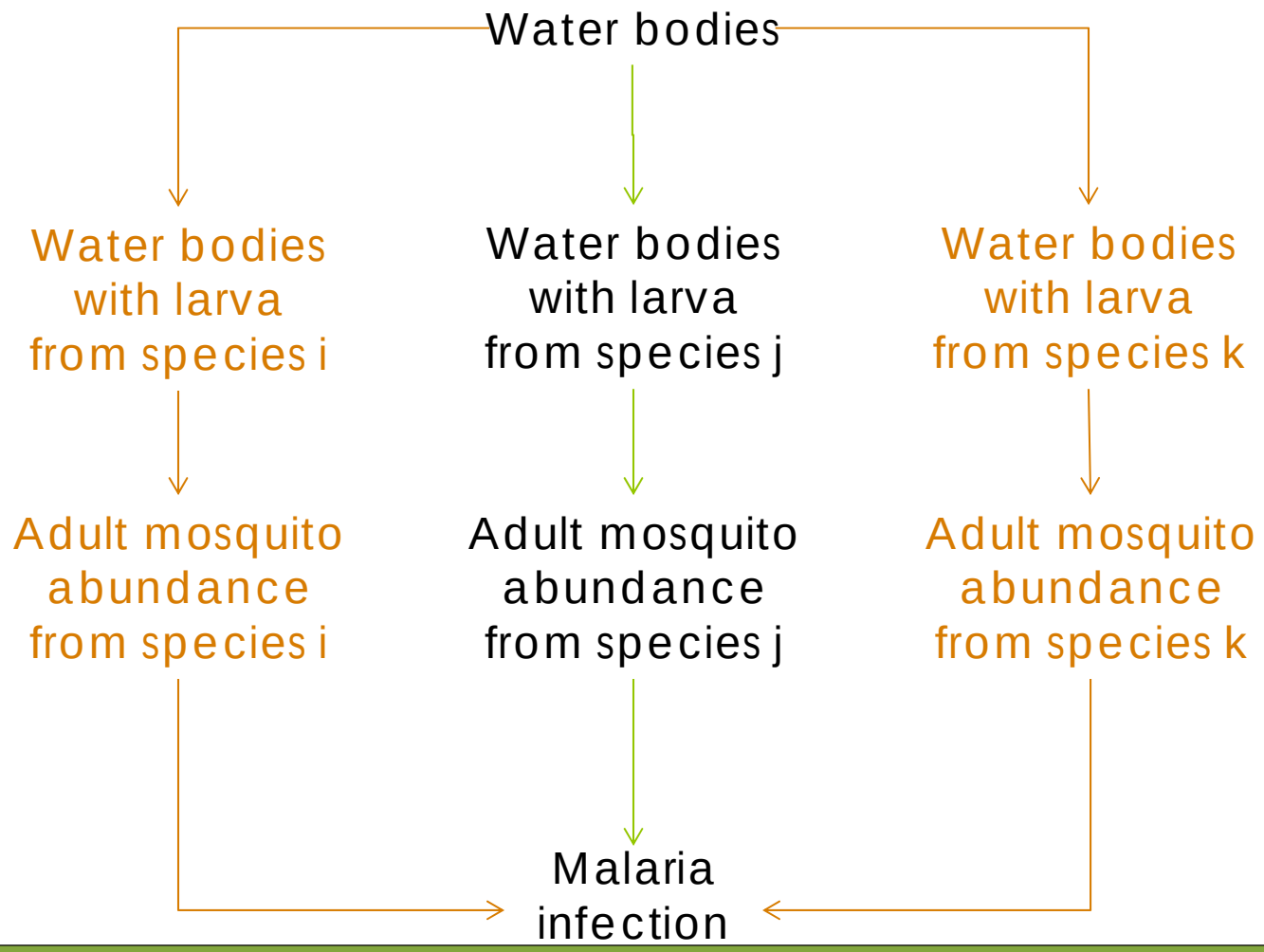
Targets: lead time



Targets: chain of analysis



Example: Hierarchical Bayesian model of Malaria risk



Model 1: water bodies

Model 2: larva

Model 3: adult mosq.

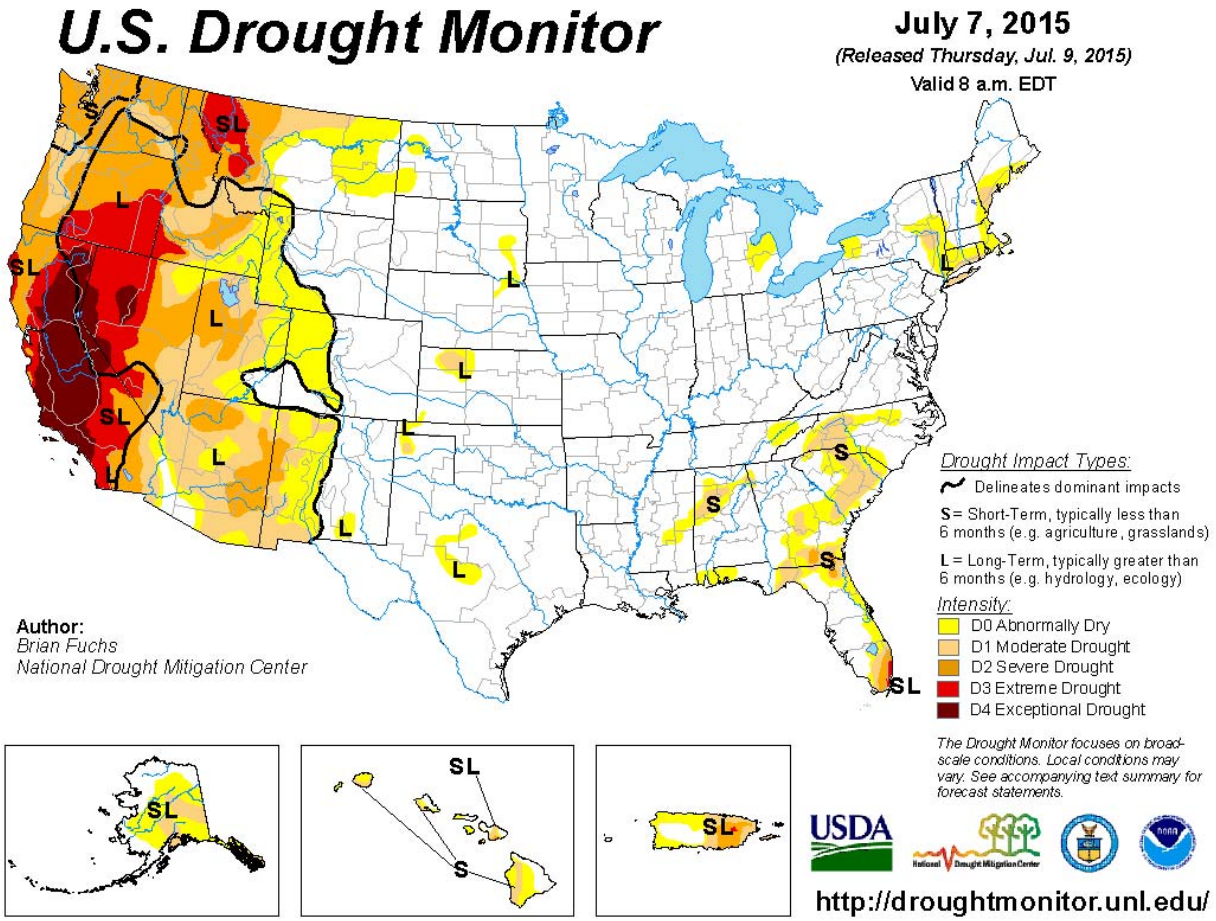
Model 4: infection

Targets: chain of analysis

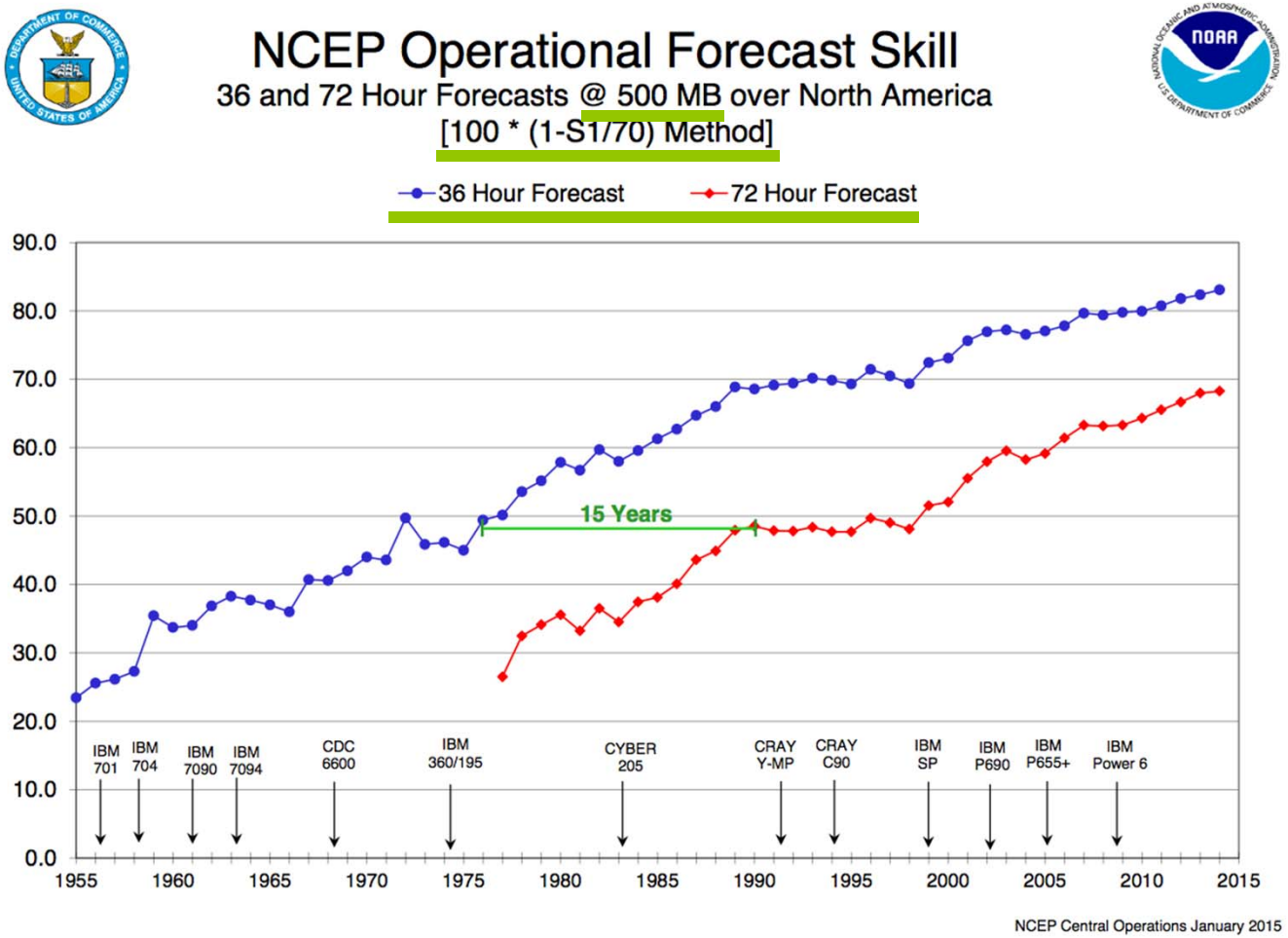
Temperature, Rainfall → **Soil Moisture, Vegetation Health** → **Vector Distribution** → **Transmission Risk**

What suite of information is most useful for health officials?

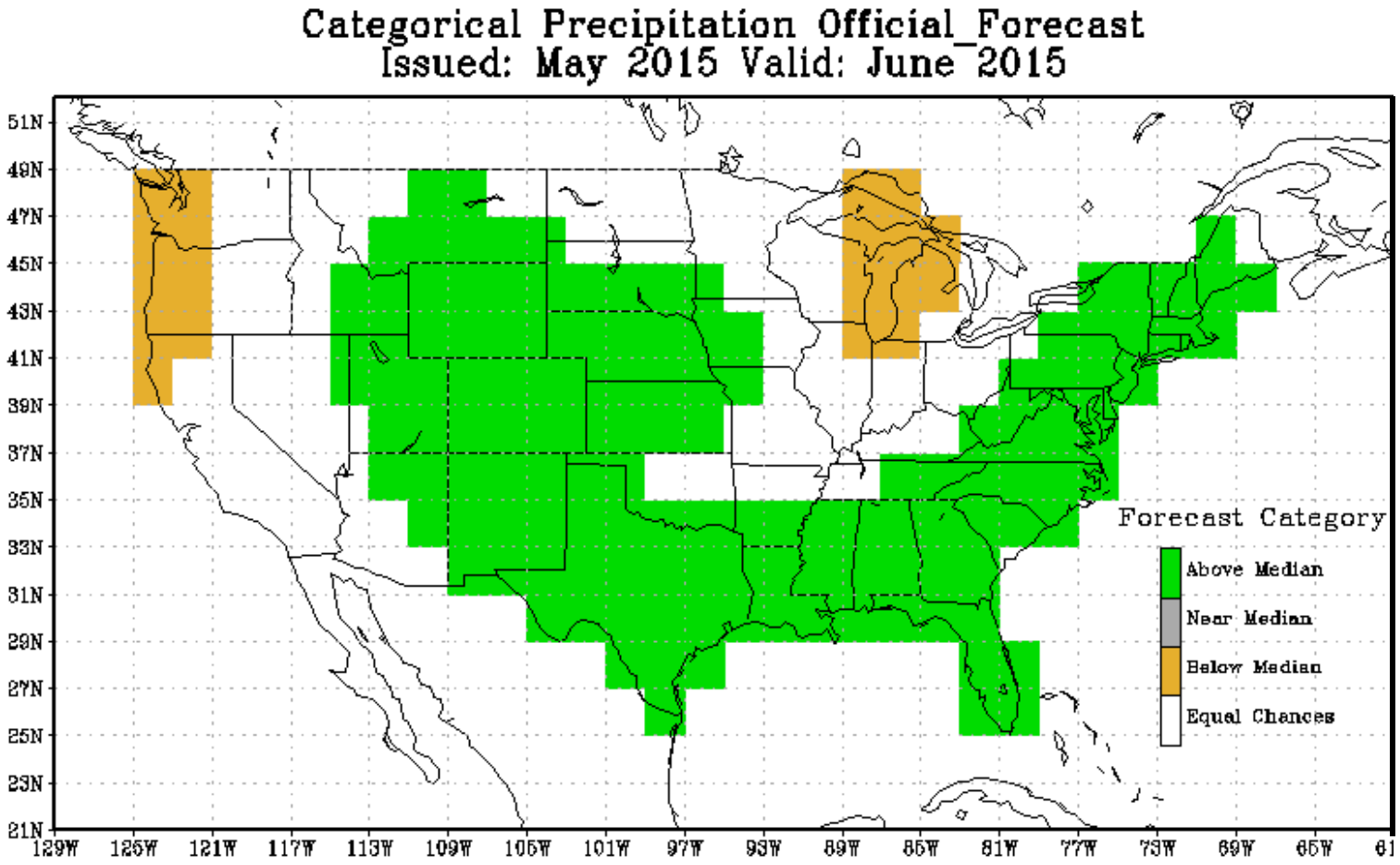
Example: the USDM



Targets: performance metric



Targets: performance metric



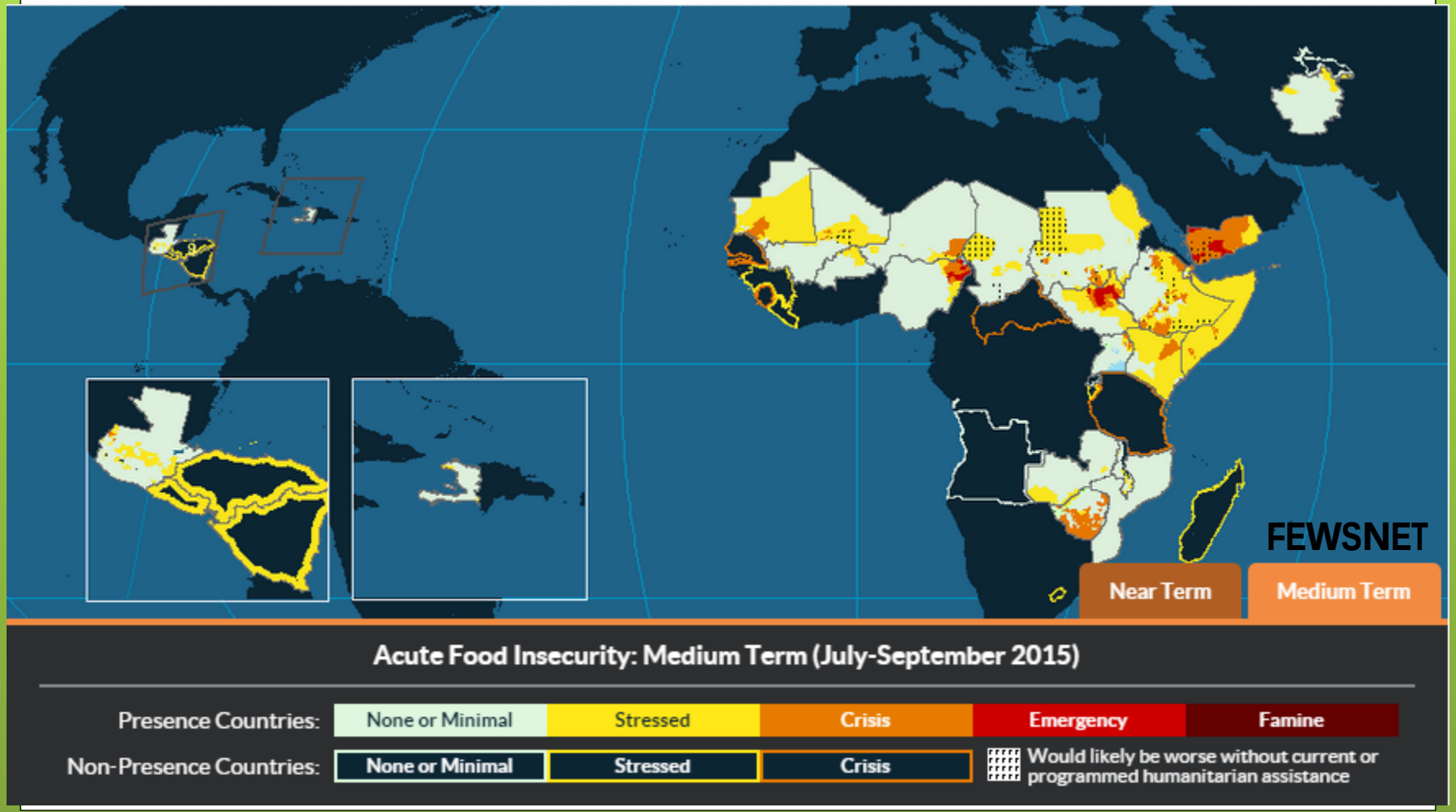
The Persistence of **Memory**

- Seasonal forecasts don't necessarily require climate forecasts

Memory: Infectious Disease

- Murray Valley Encephalitis Virus (MVEV) can be predicted using satellite observations at **2 month lead**
- In our Amazon malaria risk model, satellite rainfall rate is most predictive at **10 week lead**.
- Rift Valley Fever warnings in East Africa make use of satellite observations **integrated over 3 months**.
- For hantavirus, seasonal rainfall anomalies can influence cases **two or more years** later.
- Cholera dynamics have been related to precipitation at lead times **from days to seasons**.

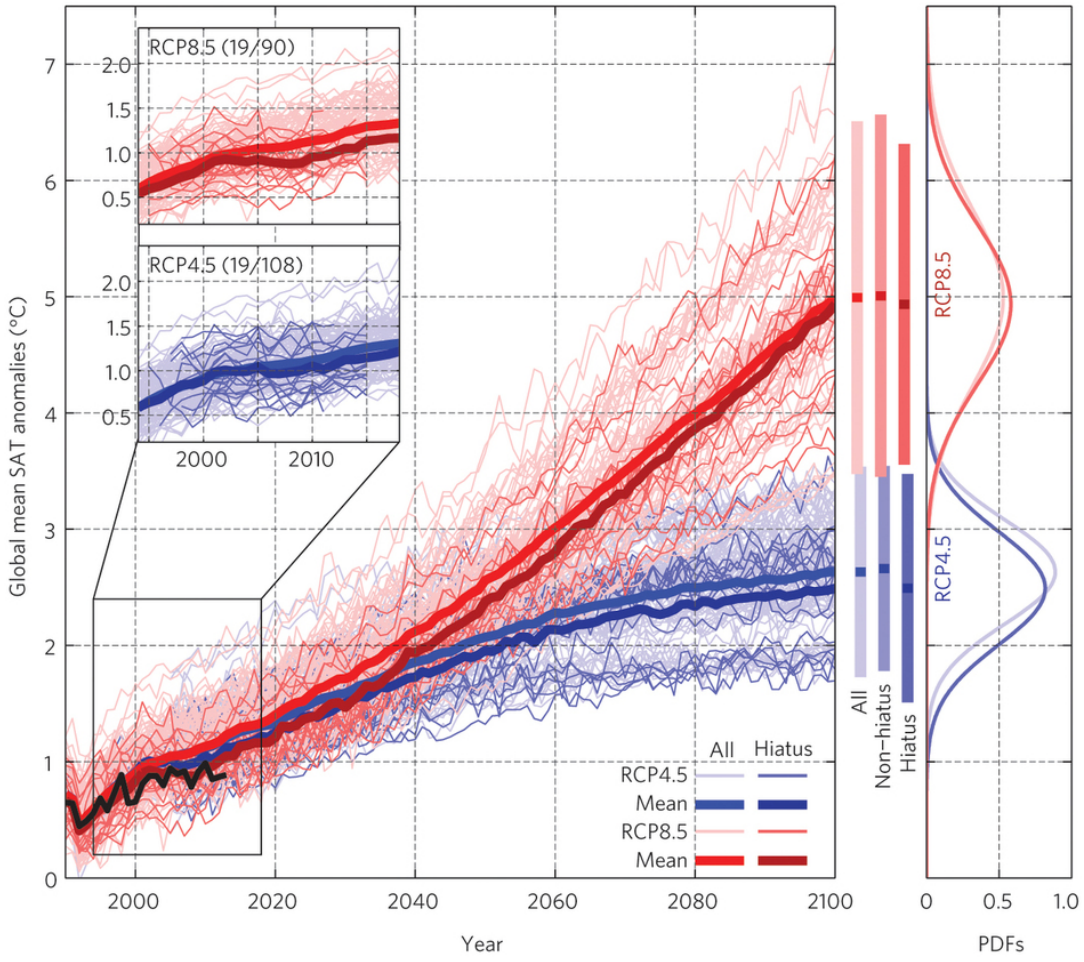
Memory: Food Insecurity



Memory: Food Insecurity

- Current climate observation + past performance [operational]
- Current climate observation + food system models [~operational]
- Large scale dynamical model + statistical regression [experimental]
- Fully dynamical seasonal forecast [experimental]

To **MIP** or not to MIP



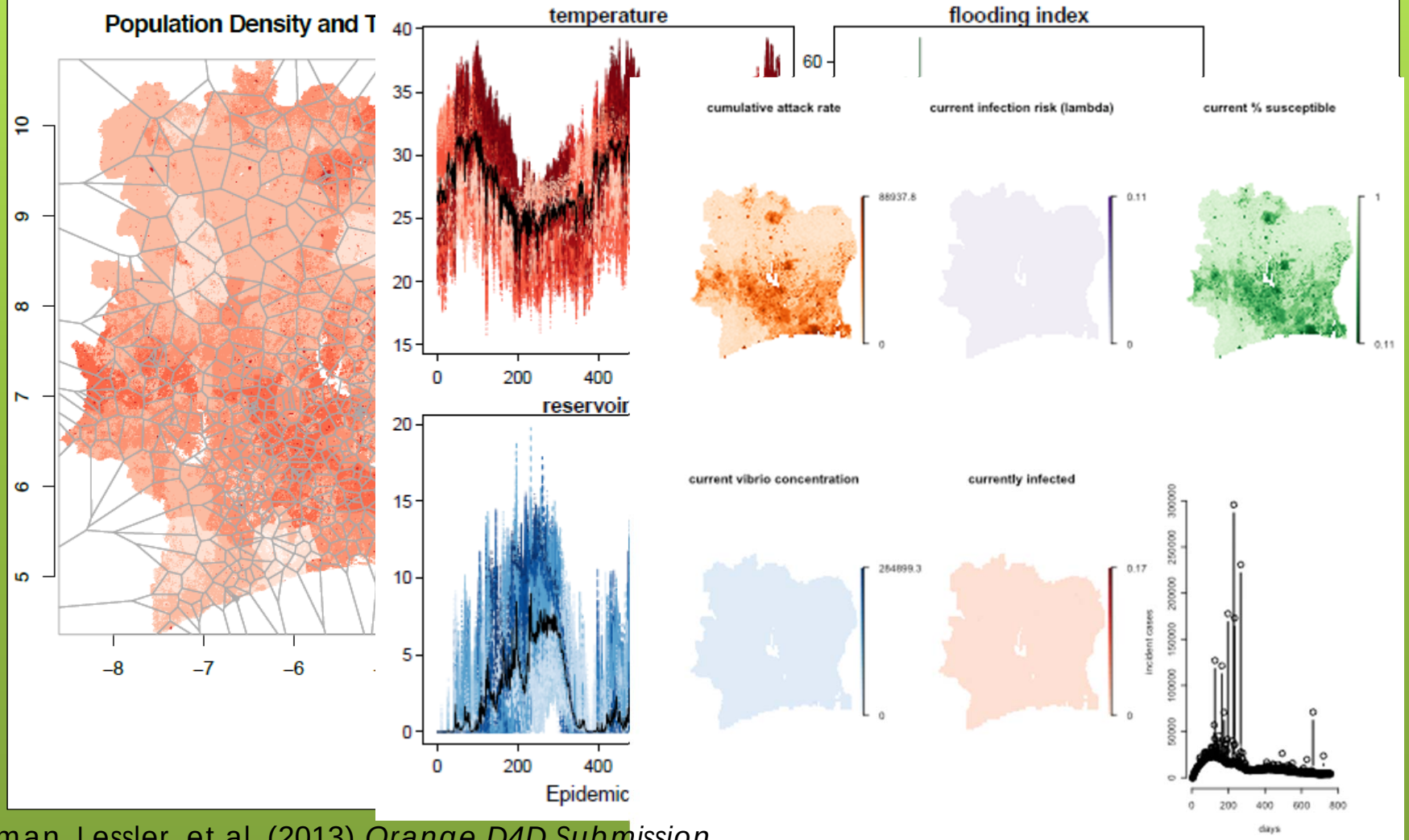
MIP

- MIP vs. model challenges
- What would a VectorMIP look like?
- What are the science questions?

And yet it **moves**

- Vectors are on the move: ecological range is often larger than observed distribution
- People are on the move: travel, settlement, and migration
- Behaviors change (humans, animals, and vectors)

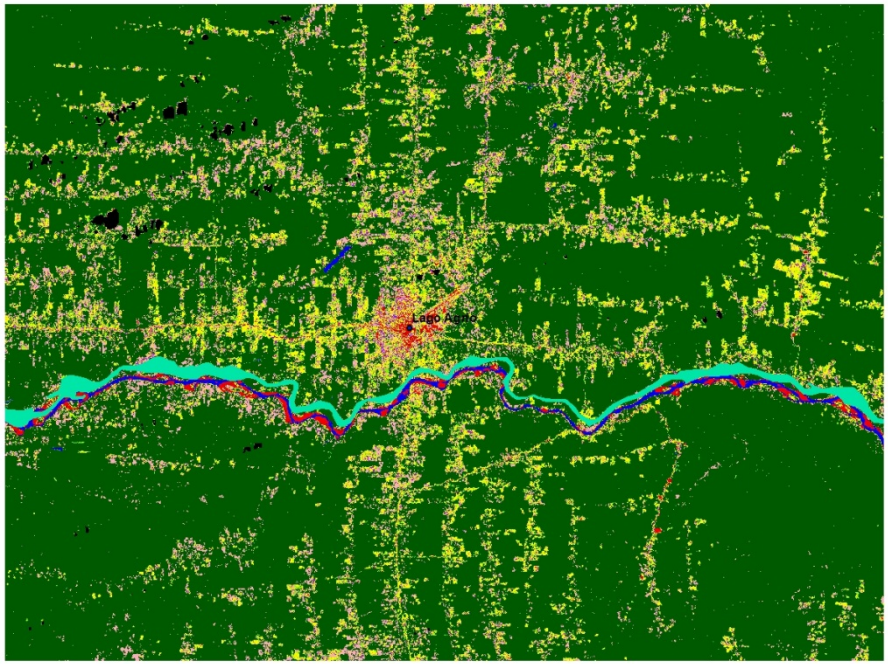
Travel



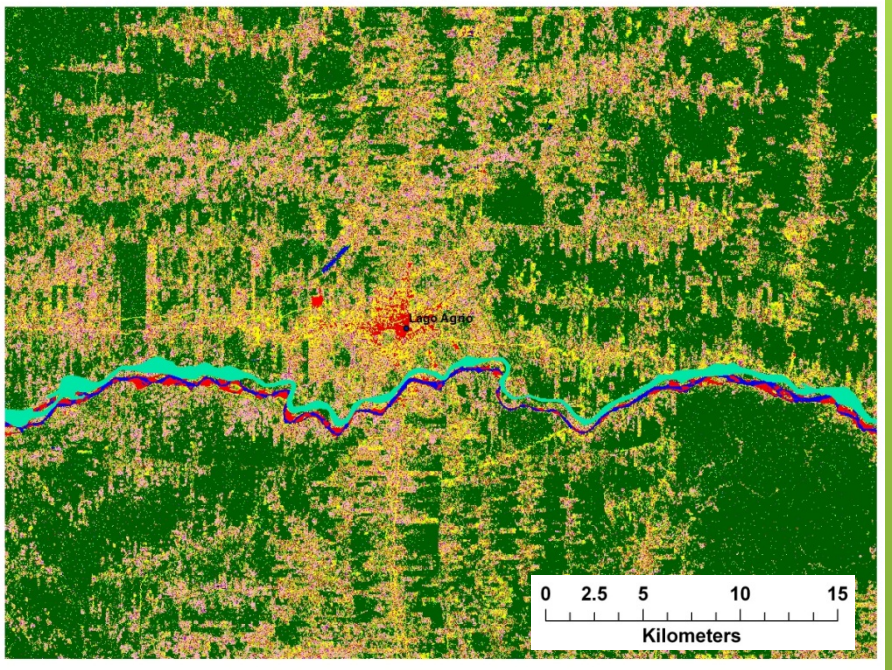
Azman, Lessler, et al. (2013) *Orange D4D Submission*

Settlement & Migration

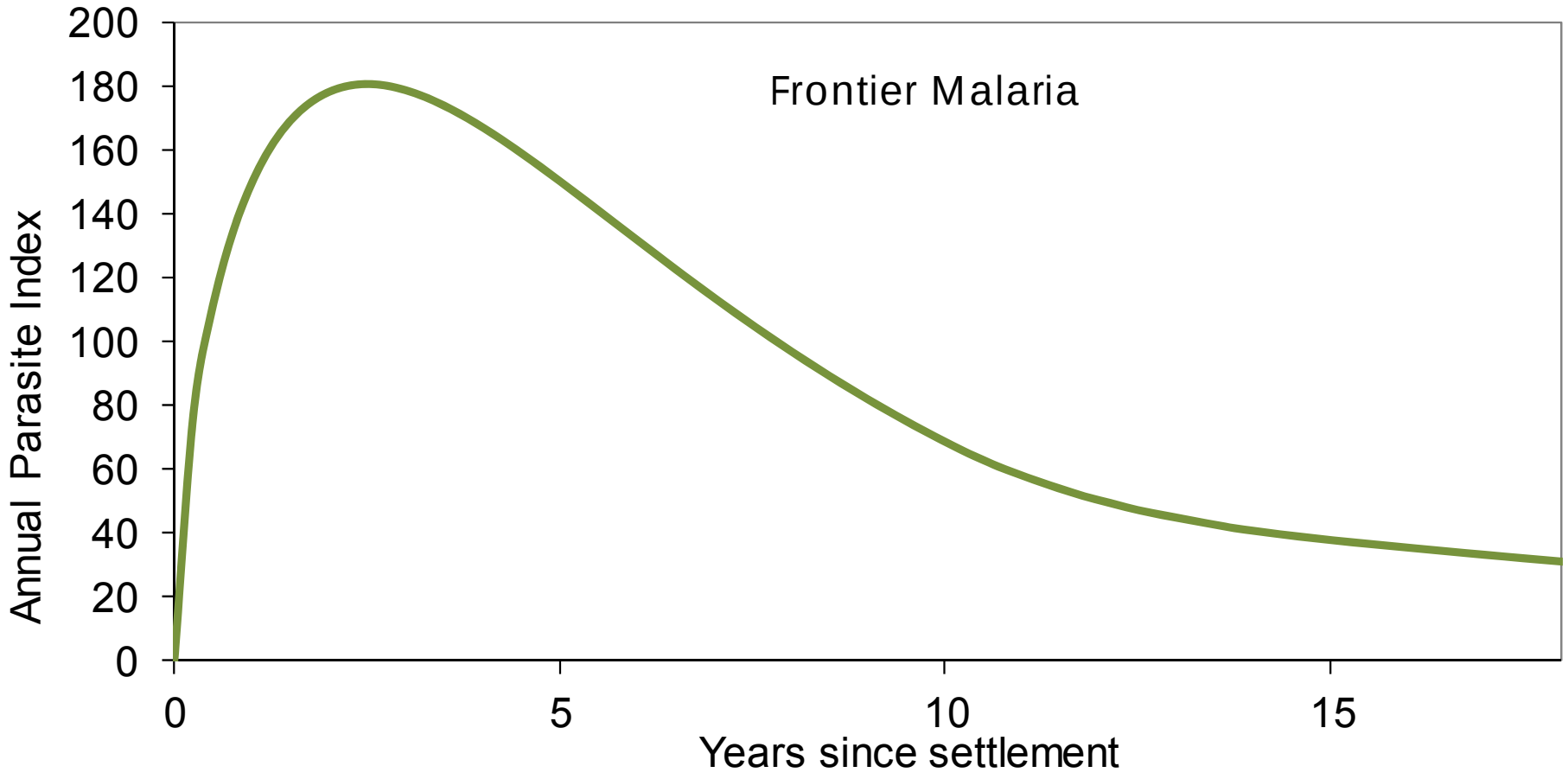
1986



2002

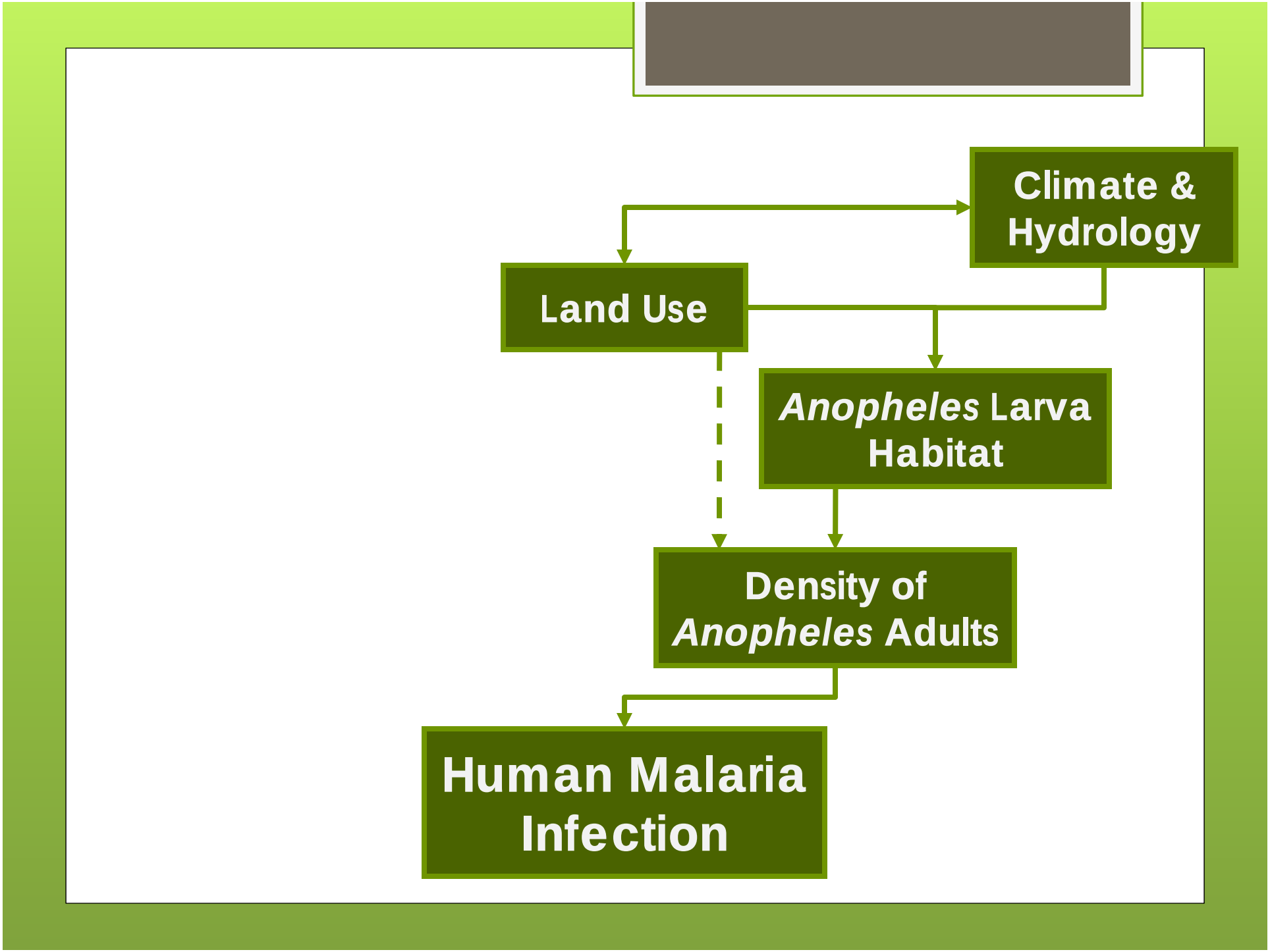


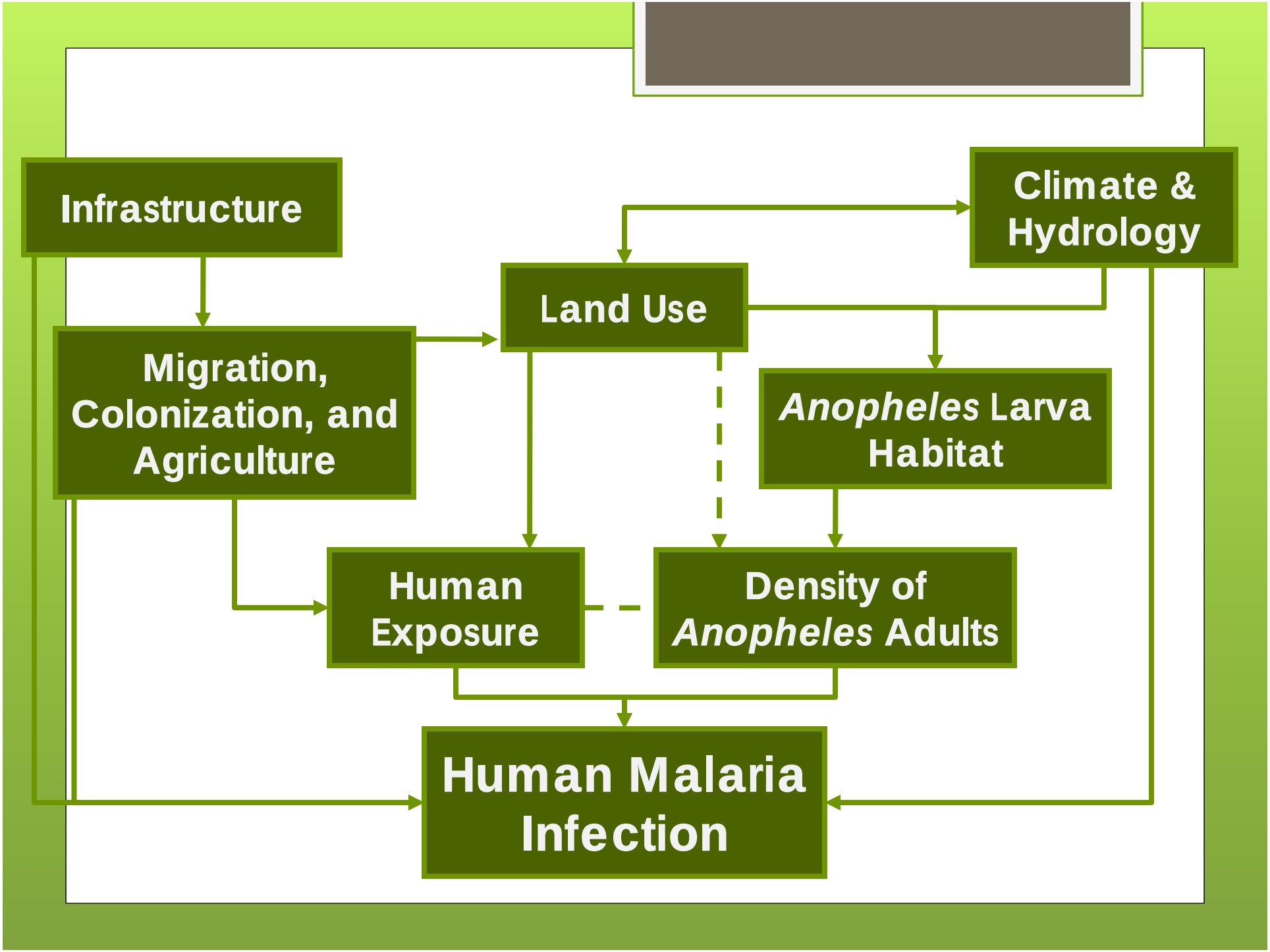
Settlement & Migration



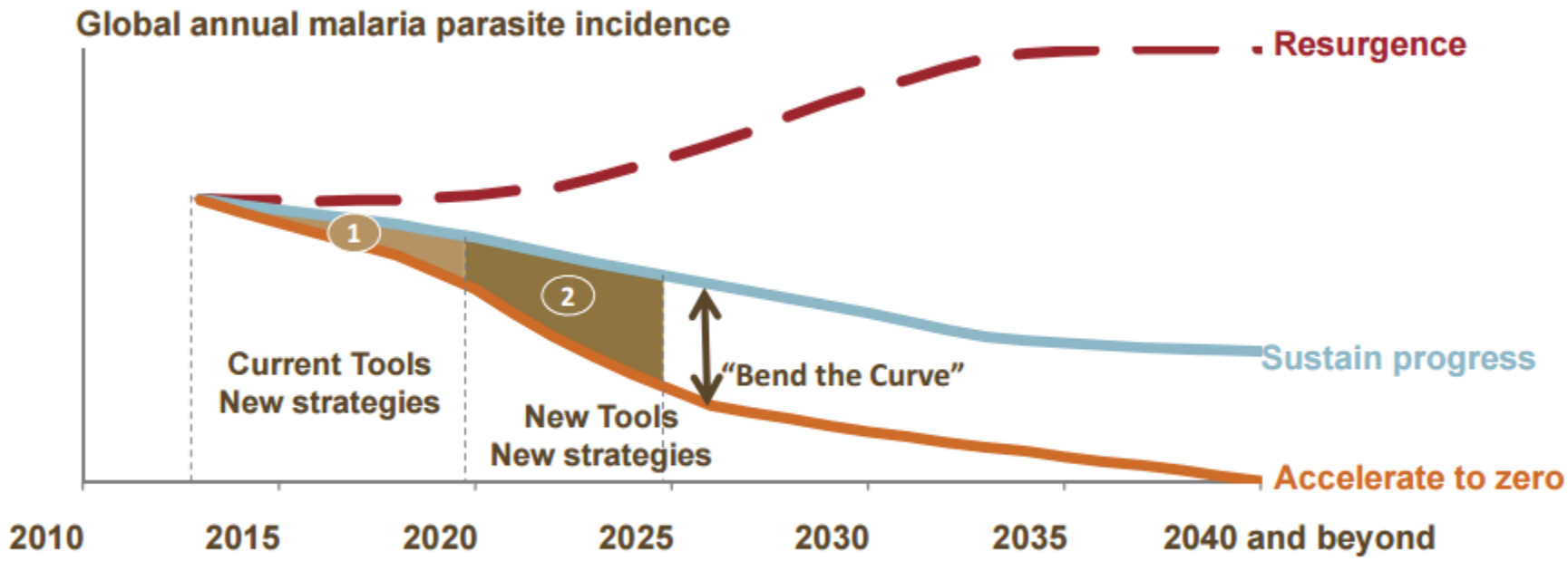
Climate & Hydrology

Human Malaria Infection

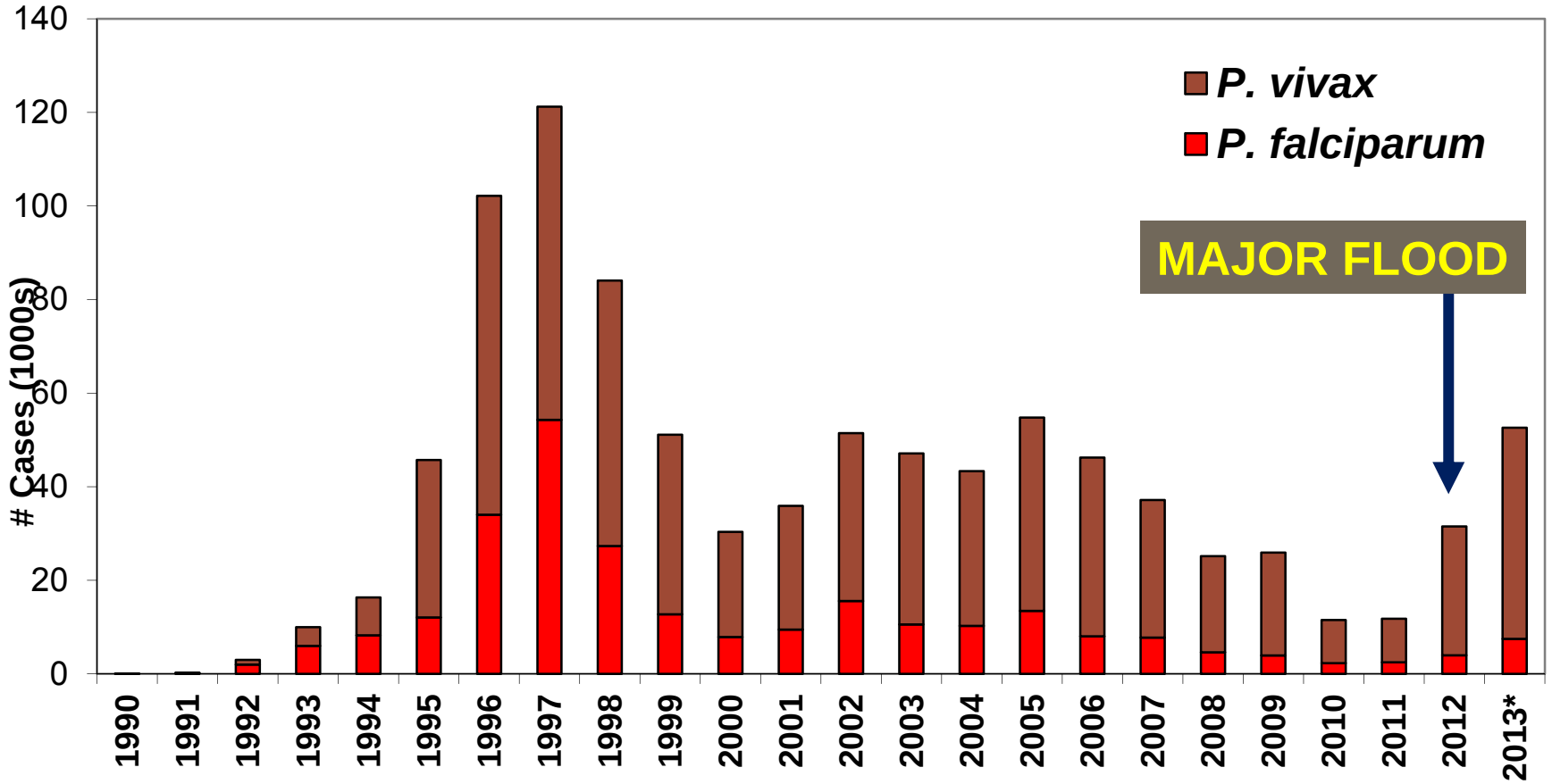

Climate & Hydrology
Land Use
Anopheles Larva Habitat
Density of *Anopheles* Adults
Human Malaria Infection


Infrastructure
Climate & Hydrology
Land Use
Migration, Colonization, and Agriculture
Anopheles Larva Habitat
Human Exposure
Density of *Anopheles* Adults
Human Malaria Infection

Behavioral Change



Reported Malaria, Loreto Province 1990-2013



Highest Deforestation Rate in Peru

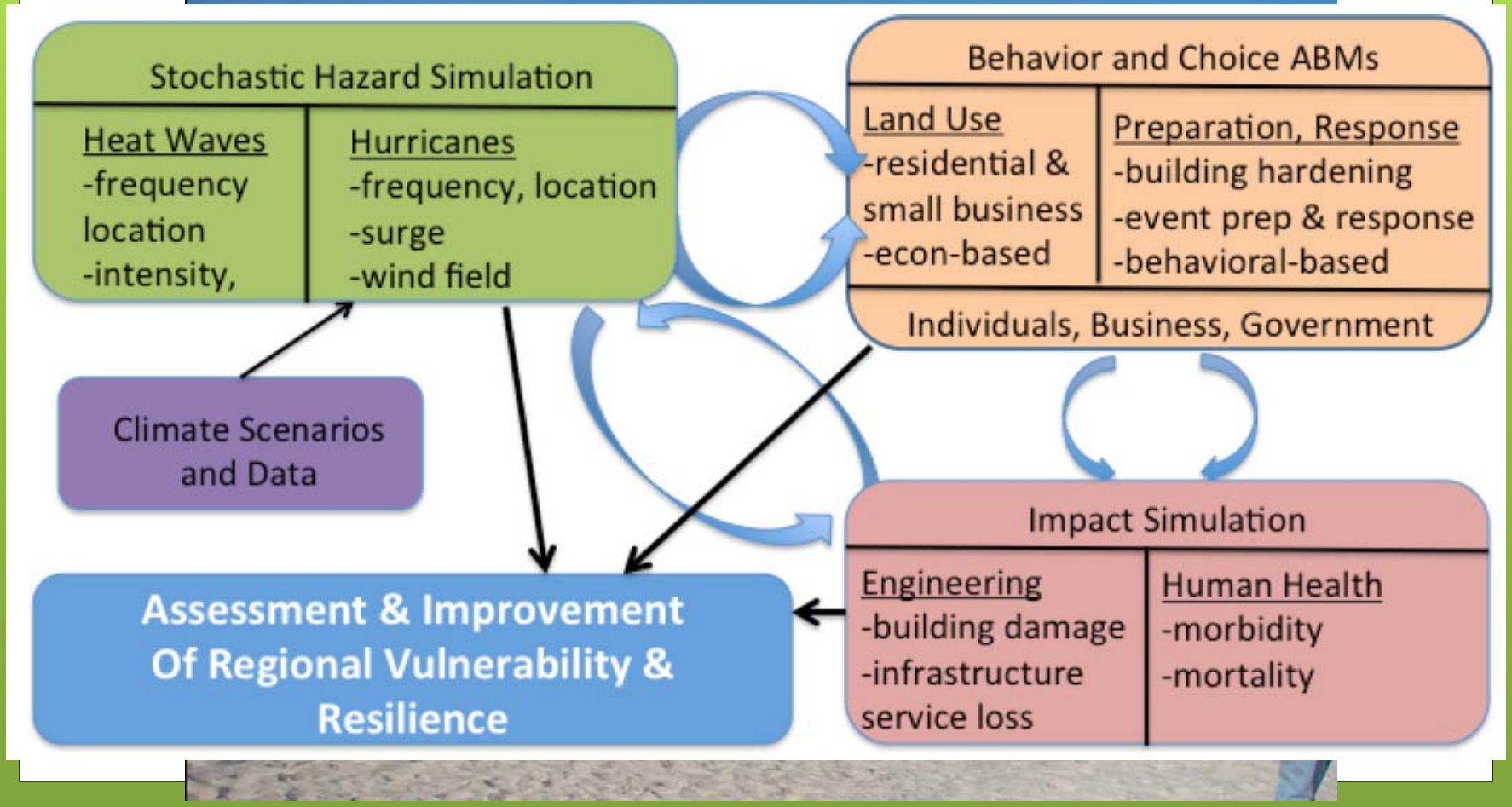
Iquitos-Nauta Road Paving & Fujimori logging concessions

Roll Back Malaria

2nd highest increase in the Amazon to 2006,
Major decline to 2011

Bill Pan, Duke Univ.

Behavioral Change



Seth Guikema, U Mich

A Guide to the Perplexed

- There are opportunities for **projection** and **prediction**, but the opportunities differ
- Actionable information can be found **throughout the analysis chain**
- "Forecast" has **multiple meanings**
- **It can be useful to plan a MIP**, even if we don't pursue it
- **Change matters**, and we can address it

Thank You