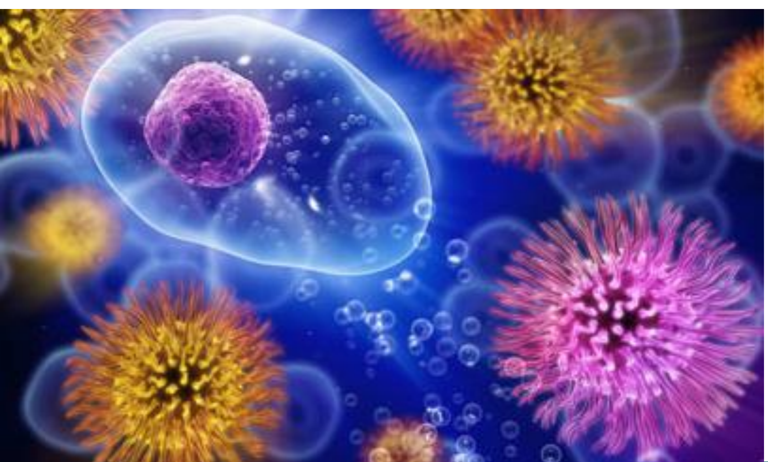
Impact of Climate Change on Infectious Diseases



STEVEN VAN DEN BROUCKE

ECO HEALTH
SYSTEMS APPROACHES

INSTITUTE OF TROPICAL MEDICINE ANTWERP
SVANDENBROUCKE@ITG.BE

Key Messages

- Complex ++++, multifactorial
- The human response to a prediction is very unpredictable
- Micro-organisms and vectors don’t read textbooks, nor scientific publications that tell them how to behave
- Good surveillance is crucial: observe, don’t panic!
- Countries with poorest response capacity -- > biggest victims

The NEW ENGLAND JOURNAL of MEDICINE

REVIEW ARTICLE

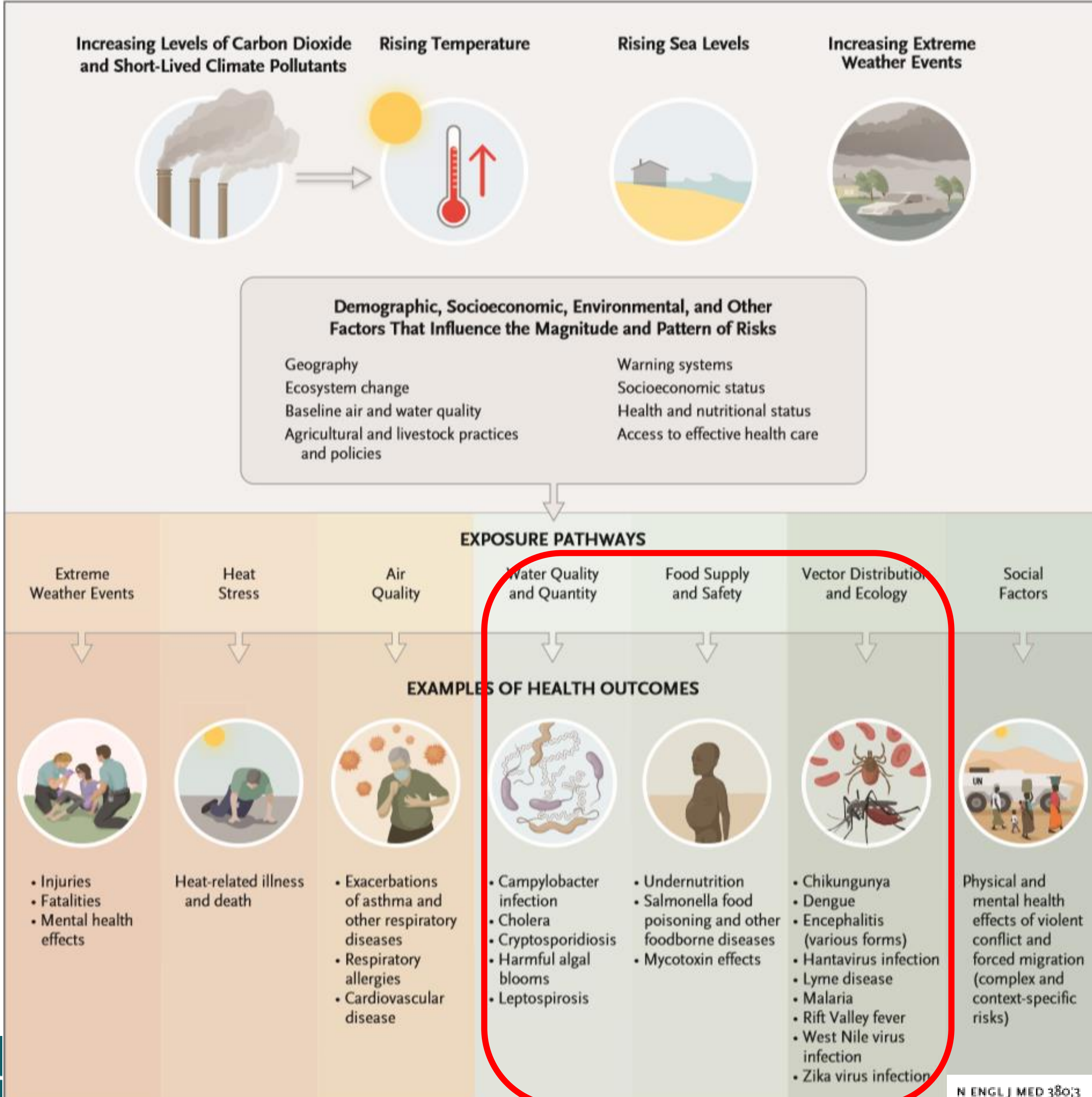
Caren G. Solomon, M.D., M.P.H., *Editor*

The Imperative for Climate Action to Protect Health

Andy Haines, M.D., and Kristie Ebi, M.P.H., Ph.D.

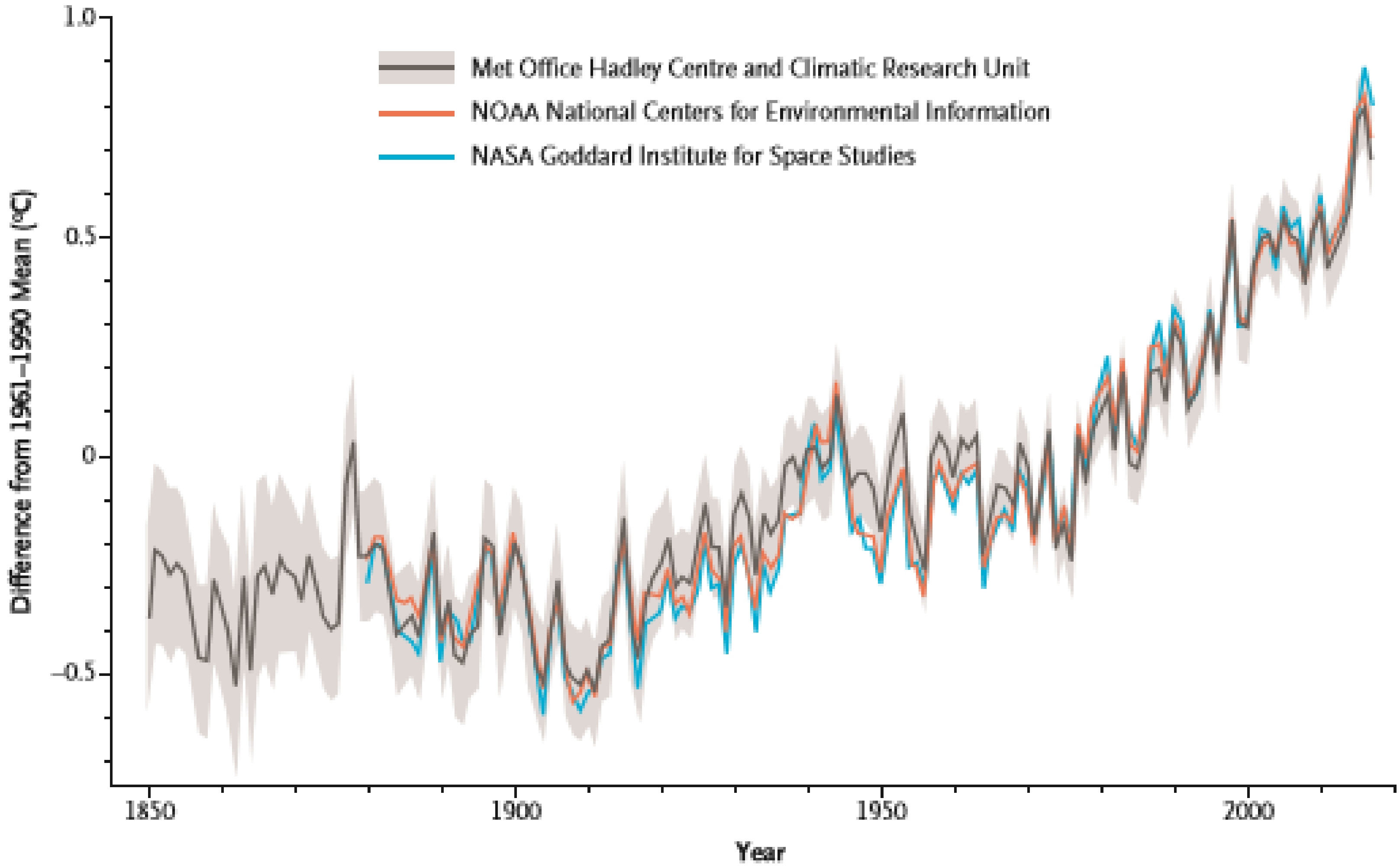
The 2021 report of the *Lancet* Countdown on health and climate change: code red for a healthy future

Marina Romanello, Alice McGushin, Claudia Di Napoli, Paul Drummond, Nick Hughes, Louis Jamart, Harry Kennard, Pete Lampard, Baltazar Solano Rodriguez, Nigel Arnell, Sonja Ayeb-Karlsson, Kristine Belesova, Wenjia Cai, Diarmid Campbell-Lendrum, Stuart Capstick, Jonathan Chambers, Lingzhi Chu, Luisa Ciampi, Carole Dalin, Niheer Dasandi, Shouro Dasgupta, Michael Davies, Paula Dominguez-Salas, Robert Dubrow, Kristie L Ebi, Matthew Eckelman, Paul Ekins, Luis E Escobar, Lucien Georgeson, Delia Grace, Hilary Graham, Samuel H Gunther, Stella Hartinger, Kehan He, Clare Heaviside, Jeremy Hess, Shih-Che Hsu, Slava Jankin, Marcia P Jimenez, Ilan Kelman, Gregor Kiesewetter, Patrick L Kinney, Tord Kjellstrom, Dominic Kniveton, Jason KW Lee, Bruno Lemke, Yang Liu, Zhao Liu, Melissa Lott, Rachel Lowe, Jaime Martinez-Urtaza, Mark Maslin, Lucy McAllister, Celia McMichael, Zhifu Mi, James Milner, Kelton Minor, Nahid Mohajeri, Maziar Moradi-Lakeh, Karyn Morrissey, Simon Munzert, Kris A Murray, Tara Neville, Maria Nilsson, Nick Obradovich, Maquins Odhiambo Sewe, Tadj Oreszczyn, Matthias Otto, Fereidoon Owfi, Olivia Pearman, David Pencheon, Mahnaz Rabbaniha, Elizabeth Robinson, Joacim Rocklöv, Renee N Salas, Jan C Semenza, Jodi Sherman, Liuhua Shi, Marco Springmann, Meisam Tabatabaei, Jonathon Taylor, Joaquin Trinanes, Joy Shumake-Guillemot, Bryan Vu, Fabian Wagner, Paul Wilkinson, Matthew Winning, Marisol Yglesias, Shihui Zhang, Peng Gong, Hugh Montgomery, Anthony Costello, Ian Hamilton



N ENGL J MED 380;3 NEJM.ORG JANUARY 17, 2019

Temperature Evolution



N ENGL J MED 380;3 NEJM.ORG JANUARY 17, 2019

Temperature Projection

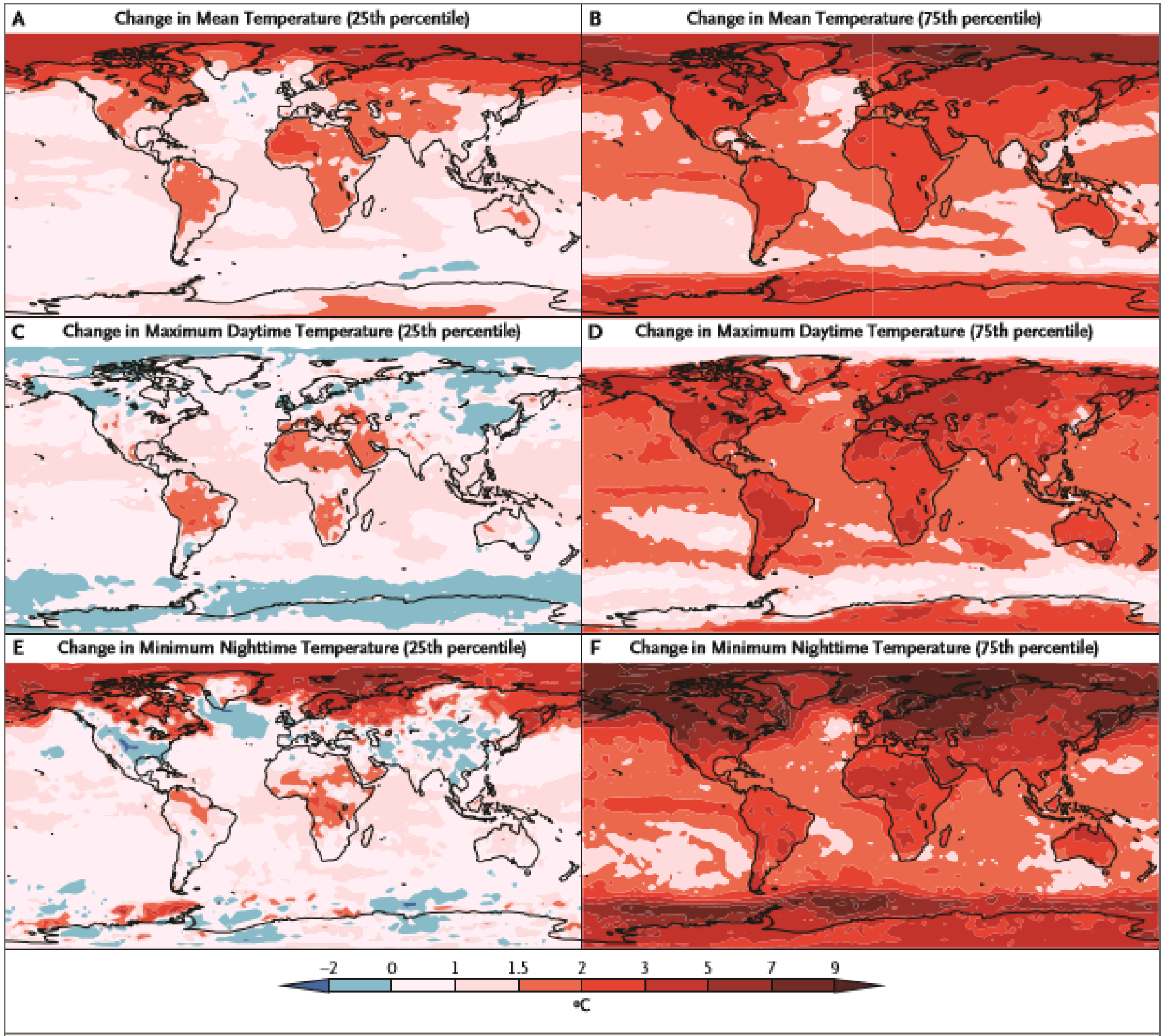
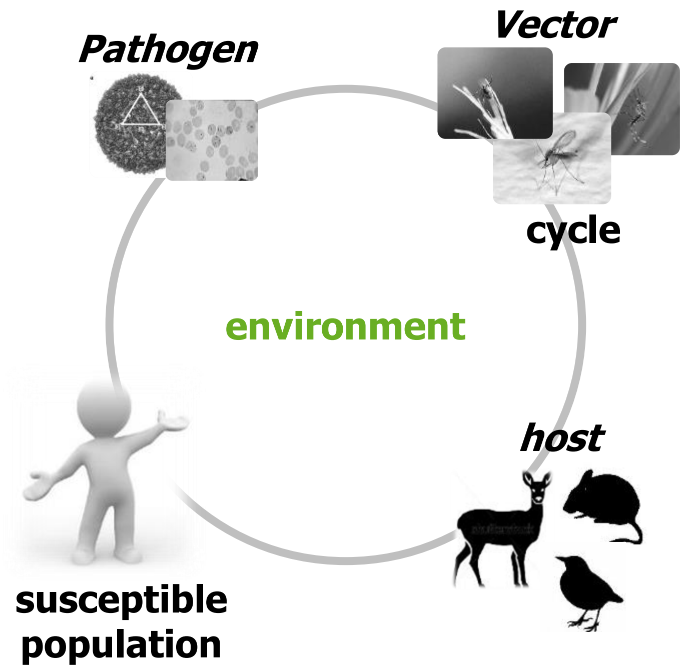


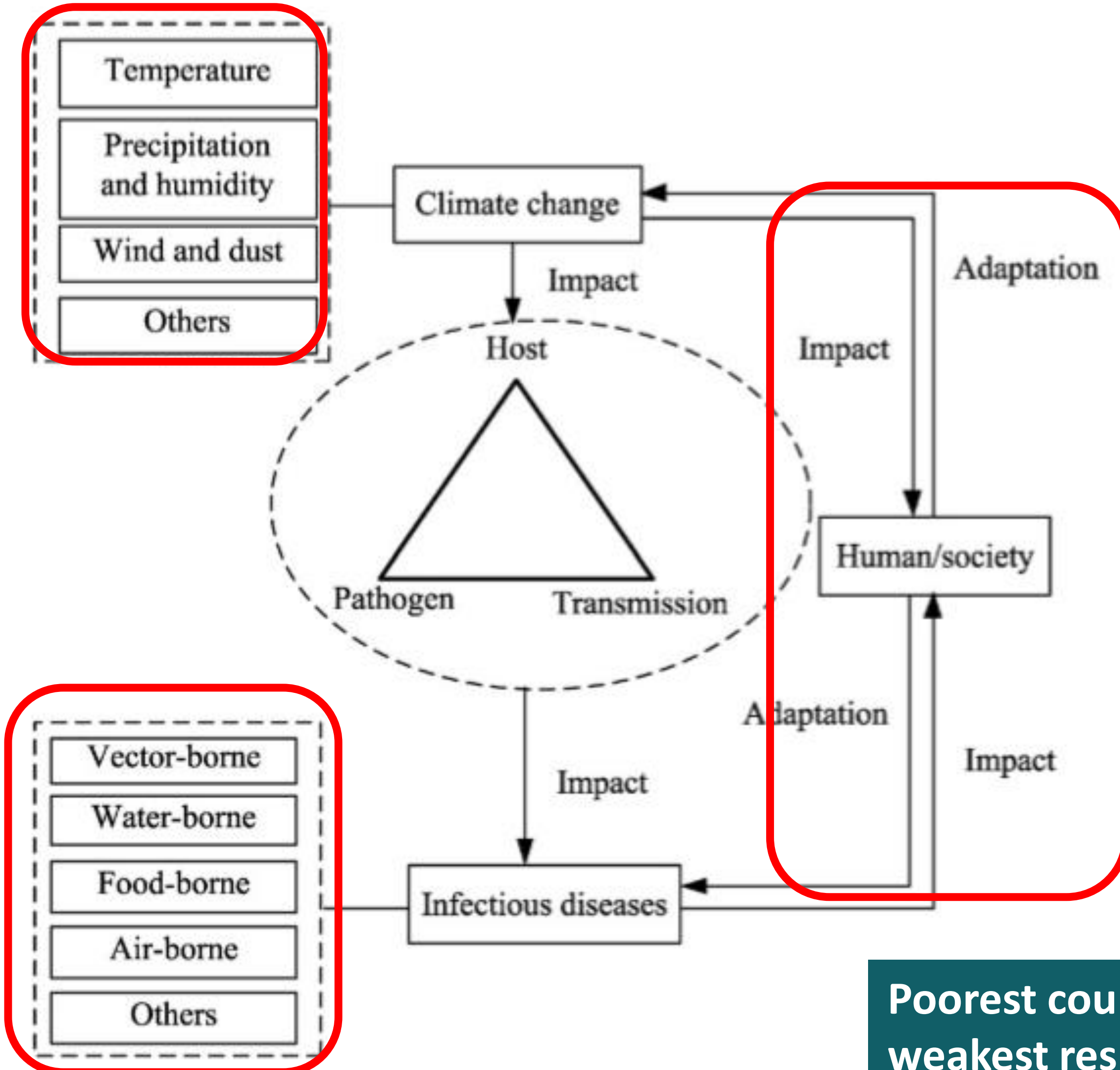
Figure 2. Potential Regional Temperature Changes in a World That Warms to 1.5°C above the Preindustrial Mean Temperature.
At each location in the maps, the 25th percentile and 75th percentile values of the range of possible projected changes in yearly mean, maximum daytime, and minimum nighttime temperatures are shown in a world with a global mean temperature that is 1.5°C warmer than preindustrial times, which could occur within three decades at current rates of warming. Adapted from Seneviratne et al.[13]

N ENGL J MED 380;3 NEJM.ORG JANUARY 17, 2019

Vector-borne diseases



Impact Climate Change on Infectious Diseases



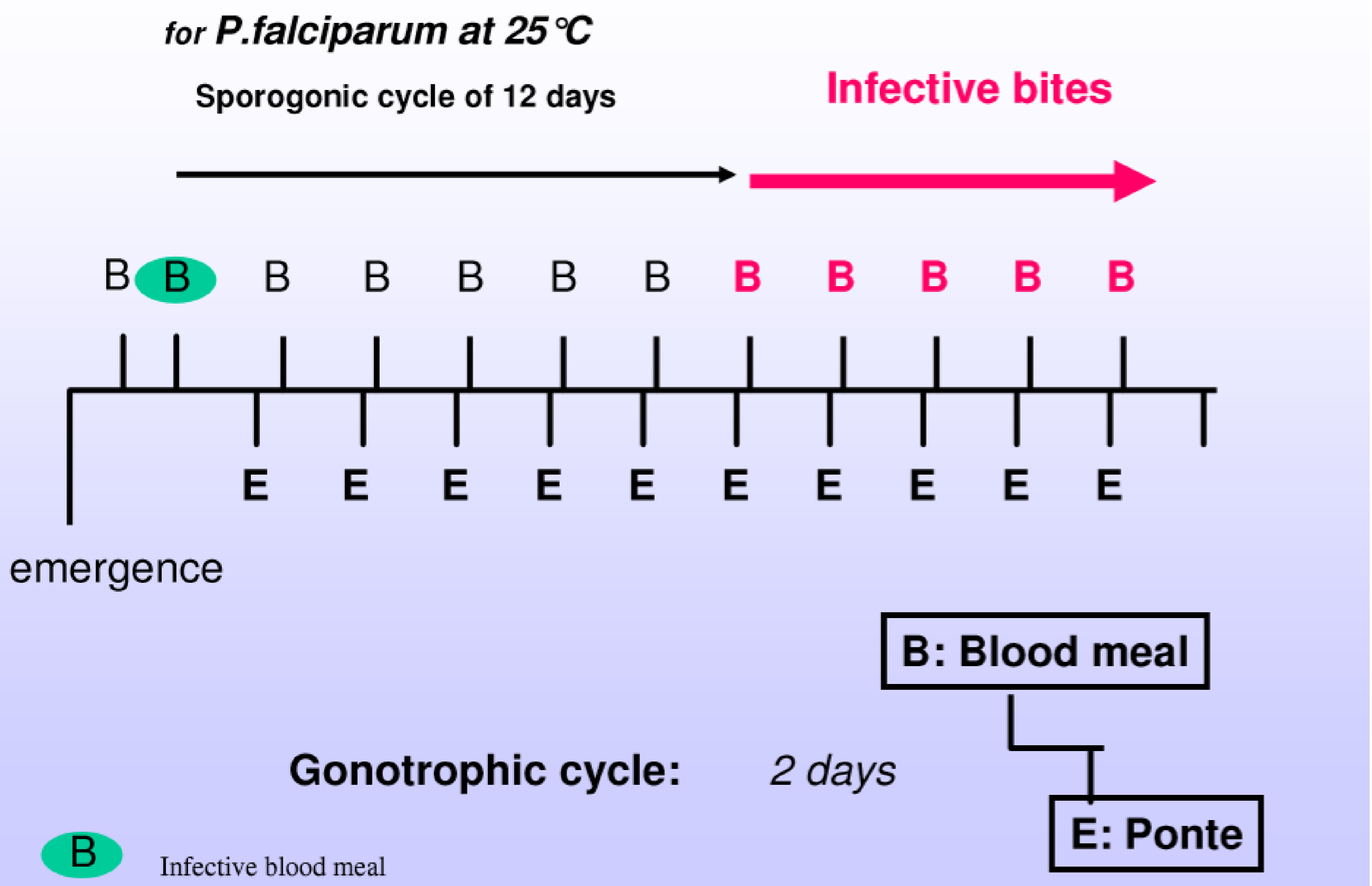
Poorest counties weakest response capacity

X. Wu et al. / Environment International 86 (2016) 14–23

Temperature

- Pathogen
  - **Extrinsic incubation period malaria ↓ : 26 days at 20 °C, 13 days at 25 °C**
  - Salmonella: reproduction rises with temperature (water)
  - Campylobacter: outcompeted by other bacteria when °T rises, UV-light blocks Campylobacter
  - Algal bloom
  - Vibrio spp. ↑
- Vector/host
  - Insects in low-latitude regions -- > mid- or high latitude regions: expansion
  - China: winter temp. rises -- > *Oncomelania* ↑ -- > *Schistosoma japonicum* ↑ -- > distribution to new areas
  - *Aedes aegypti* larvae die when > 34 °C, adult mosquitos die when > 40 °C
  - ***Anopheles* needs T > 16 °C (winterisotherm)**

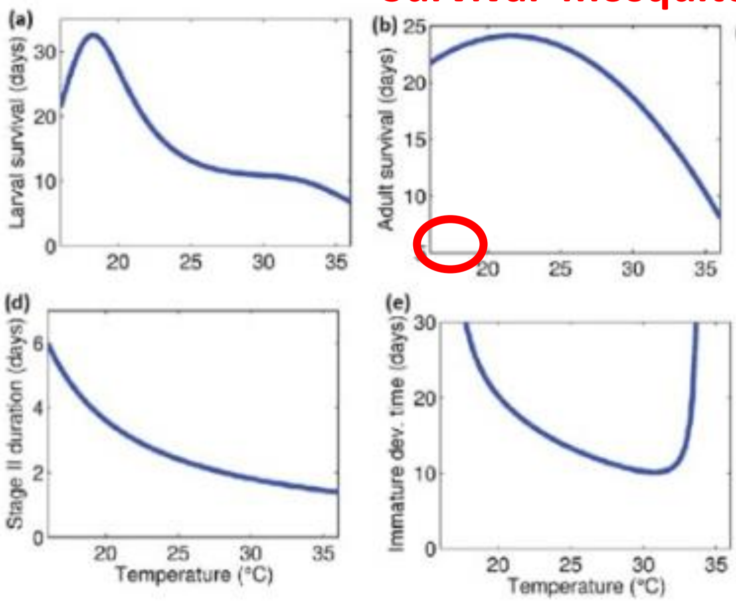
Infective life of a vector



Weather-driven malaria transmission model with gonotrophic and sporogonic cycles

January 2019 · Journal of Biological Dynamics 13(3):1-37

Survival mosquitoes **Sporogonic cycle**

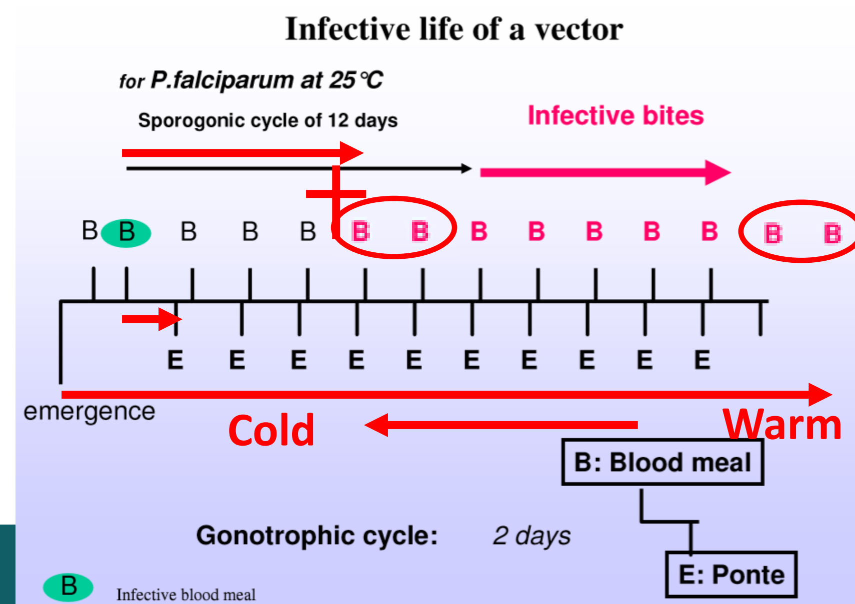


Gonotropic cycle

Figure

Caption

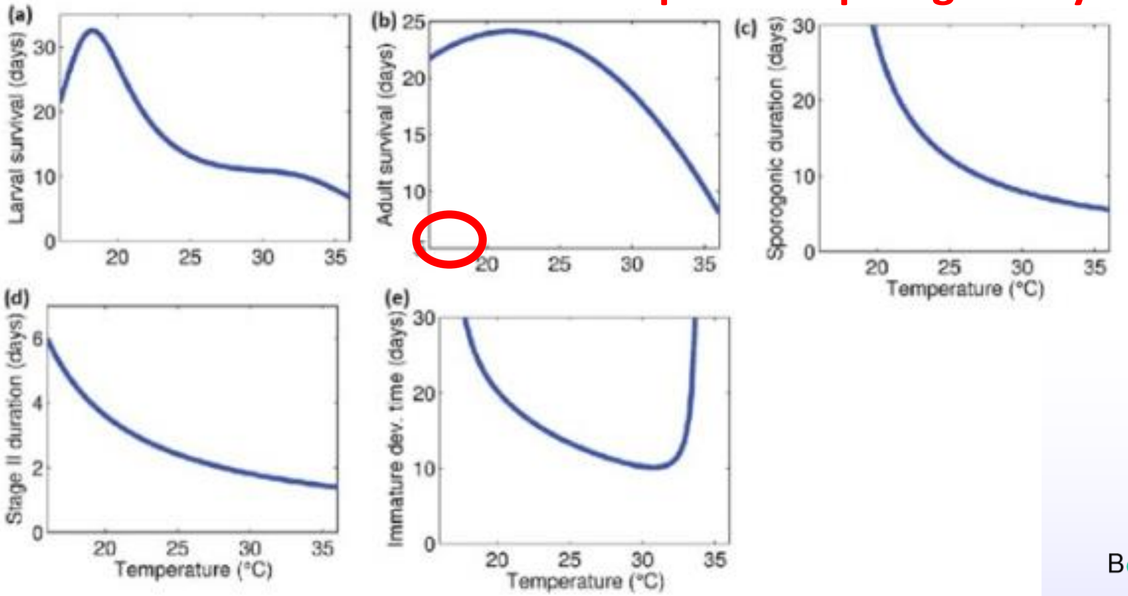
Figure 3. Profile of temperature-dependent parameters of the model {(1)-(3)}: (a) Survival time of larvae, (μ L (T W)) −1 (b) Survival time of adult mosquitoes, (μ M (T W)) −1 (c) Sporogonic cycle duration in adult female mosquitoes, (κ M (T A)) −1 (d) Duration of Stage II of the gonotrophic cycle, (θ Y (T A)) −1 ,



Weather-driven malaria transmission model with gonotrophic and sporogonic cycles

January 2019 · Journal of Biological Dynamics 13(3):1-37

Survival mosquitoes **Sporogonic cycle**

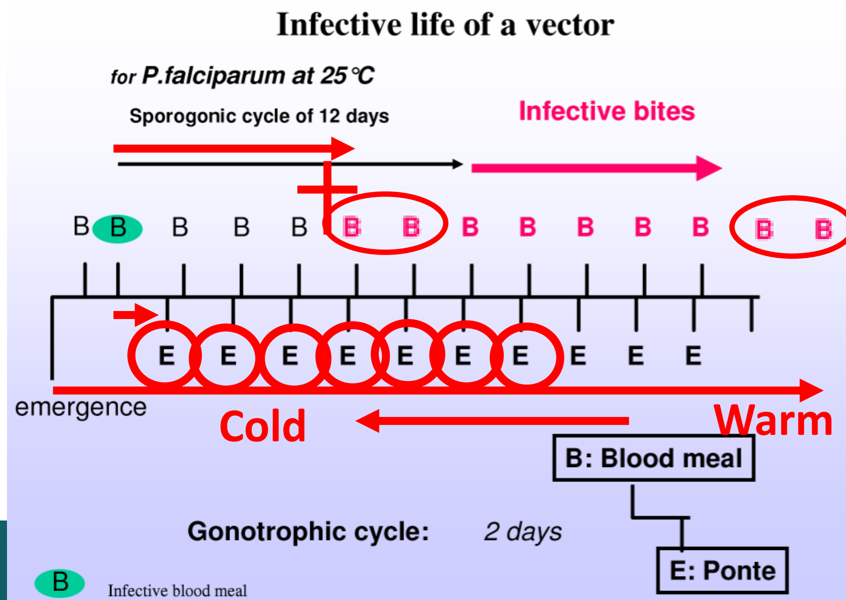


Gonotropic cycle

Figure

Caption

Figure 3. Profile of temperature-dependent parameters of the model {(1)-(3)}: (a) Survival time of larvae, (μ L (T W)) −1 (b) Survival time of adult mosquitoes, (μ M (T W)) −1 (c) Sporogonic cycle duration in adult female mosquitoes, (κ M (T A)) −1 (d) Duration of Stage II of the gonotrophic cycle, (θ Y (T A)) −1 ,



Malaria in Europe

Clinical Microbiology and Infection
Volume 22, Issue 6, June 2016, Pages 487-493

Review

Malaria in Europe: emerging threat or minor nuisance?

E.T. Piperaki [1], G.L. Daikos [2]

Show more

https://doi.org/10.1016/j.cmi.2016.04.023

Get rights and content

Anopheles in Europe today

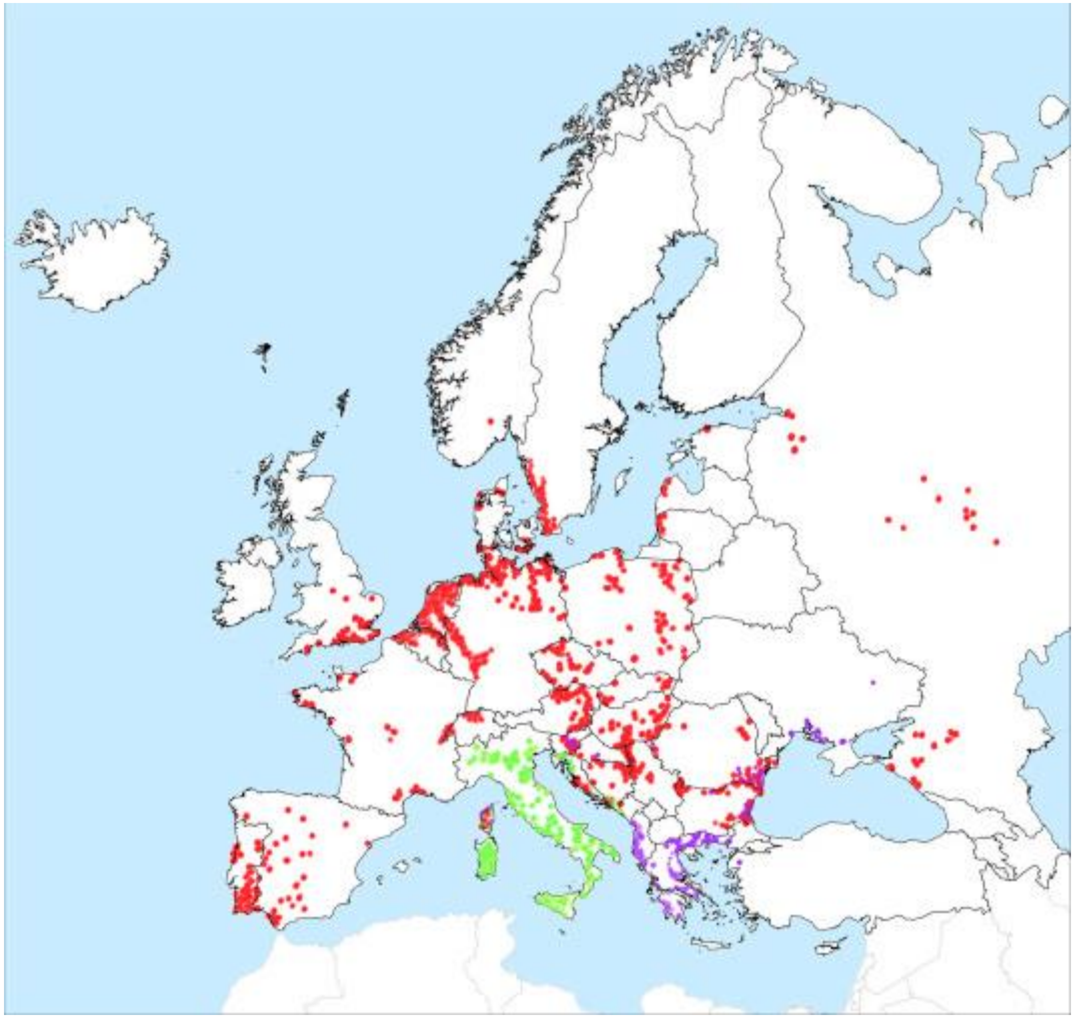
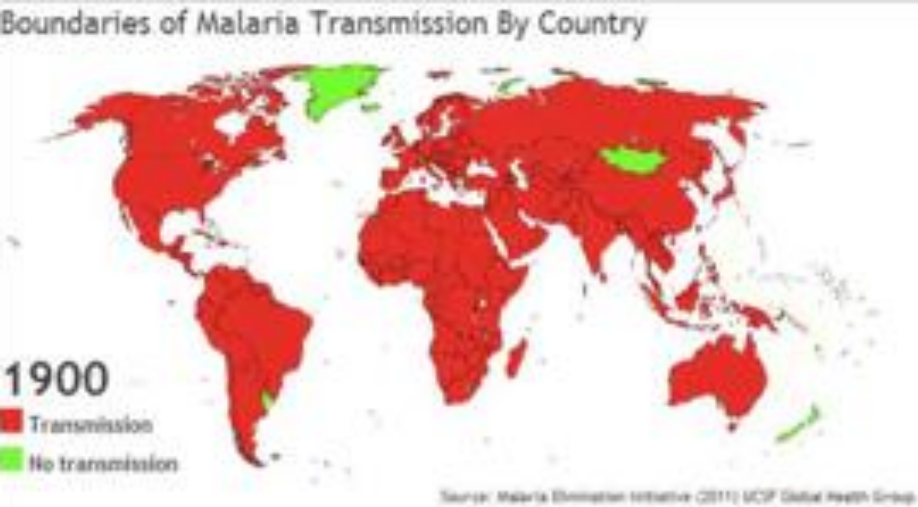
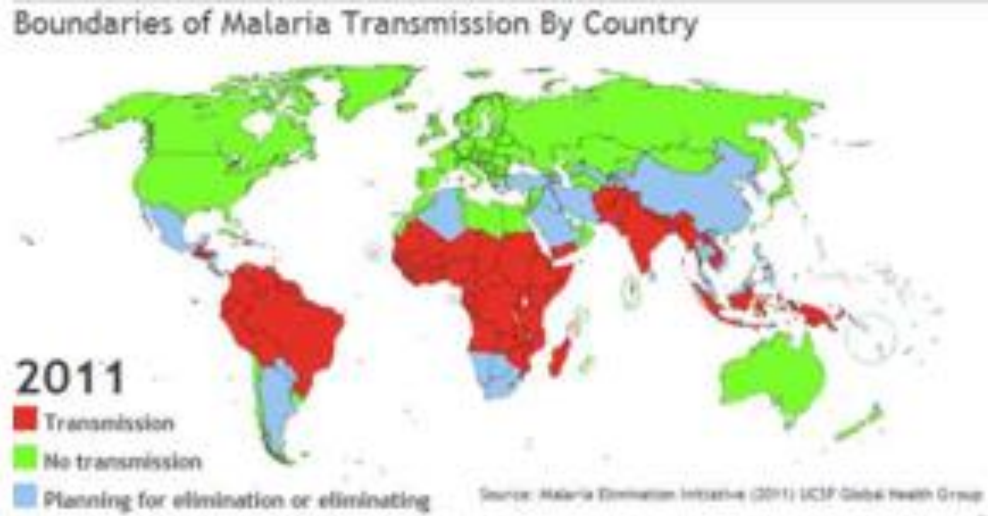


Fig. 1. Geographical distribution of three important malaria vectors: *Anopheles* atroparvus (red), *An. labranchiae* (green) and *An. sacharovi* (purple). Adapted from Kuhn et al. [21].

Clin Microbiol Infect 2016; 22: 487–493

Malaria history





- Dissapearance of malaria?
  - End 19th century: °T drop
  - Swamps eliminated
  - Cattle in separated cowsheds
  - 'Kininistation'
  - DDT
- Remember: Europe has 'eradicated' malaria in the past! So very unlikely it will return

Moeraskoorts, Polderziekte

Outbreak in Greece 2011

- 1974: malaria eradicated
- Sporadic reports autochthonous transmission
- 2009: locally acquired *P. vivax* malaria consistently every year
- 2011: 42 cases
- Migrant workers from Pakistan and Afghanistan: orange harvesting in a region where *Anopheles sacharovi* was present

Clin Microbiol Infect 2016; **22**: 487–493

If pinguins in the Antwerp Zoo stay outside, should they take malaria prophylaxis?

Total number of Plasmodium species?

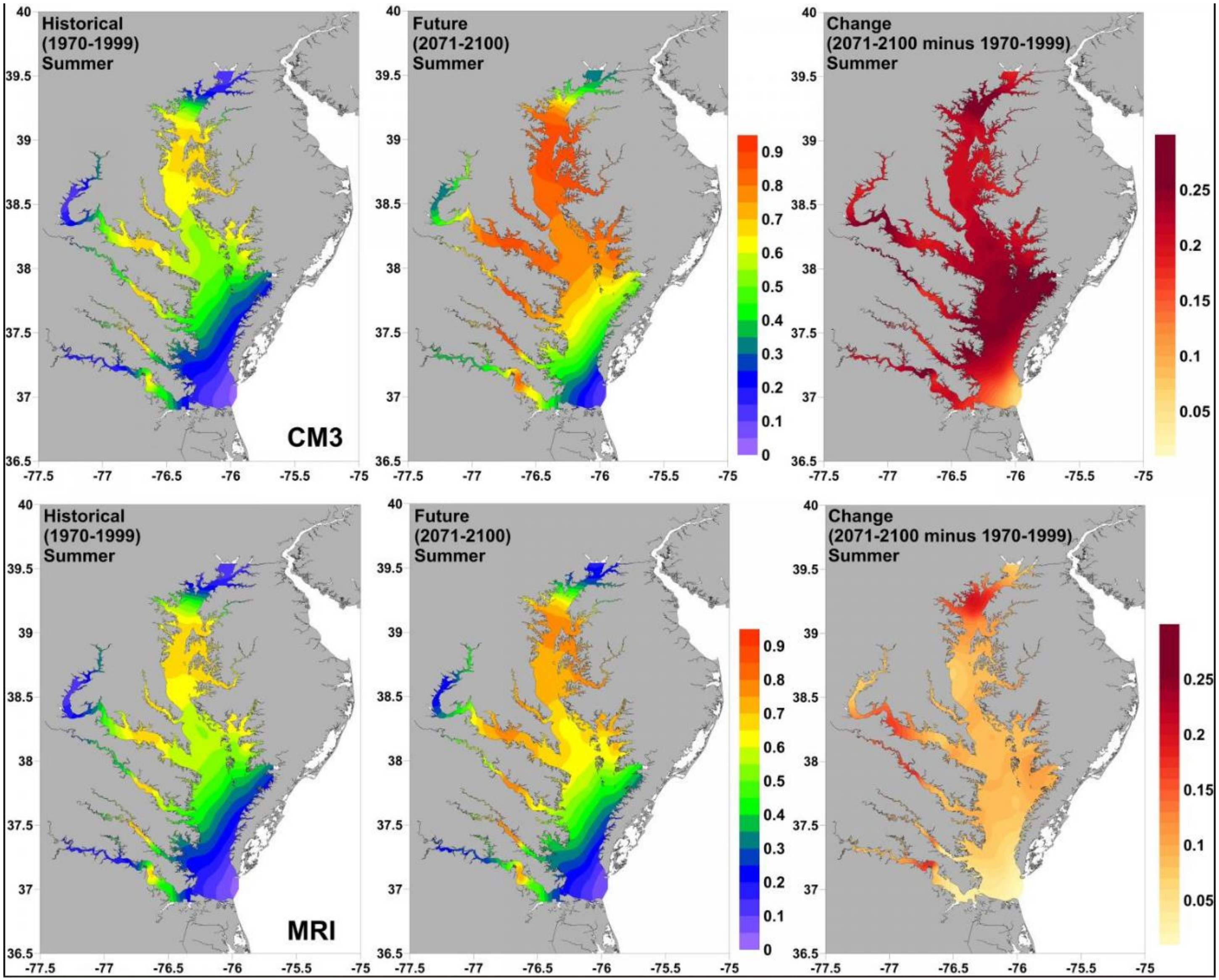
- 172
- Birds, reptiles, mammals (apes, antelopes,…)
- Avian malaria is transmitted by the Culex mosquitoes
- → Penguins in open air should take malaria prophylaxis

CAVE : ANTHROPOCENTRIC POINT OF VIEW!

Temperature

- Pathogen
  - Extrinsic incubation period malaria ↓ : 26 days at 20 °C, 13 days at 25 °C
  - **Salmonella: reproduction rises with temperature (water)**
  - **Campylobacter: outcompeted by other bacteria when °T rises, UV-light blocks Campylobacter**
  - Algal bloom
  - **Vibrio spp. ↑**
- Vector/host
  - Insects in low-latitude regions -- > mid- or high latitude regions: expansion
  - China: winter temp. rises -- > *Oncomelania* ↑ -- > *Schistosoma japonicum* ↑ -- > distribution to new areas
  - *Aedes aegypti* larvae die when > 34 °C, adult mosquitos die when > 40 °C
  - *Anopheles* needs T > 16 °C (winterisotherm)

Warming climate could increase bacterial impacts on Chesapeake Bay shellfish, recreation



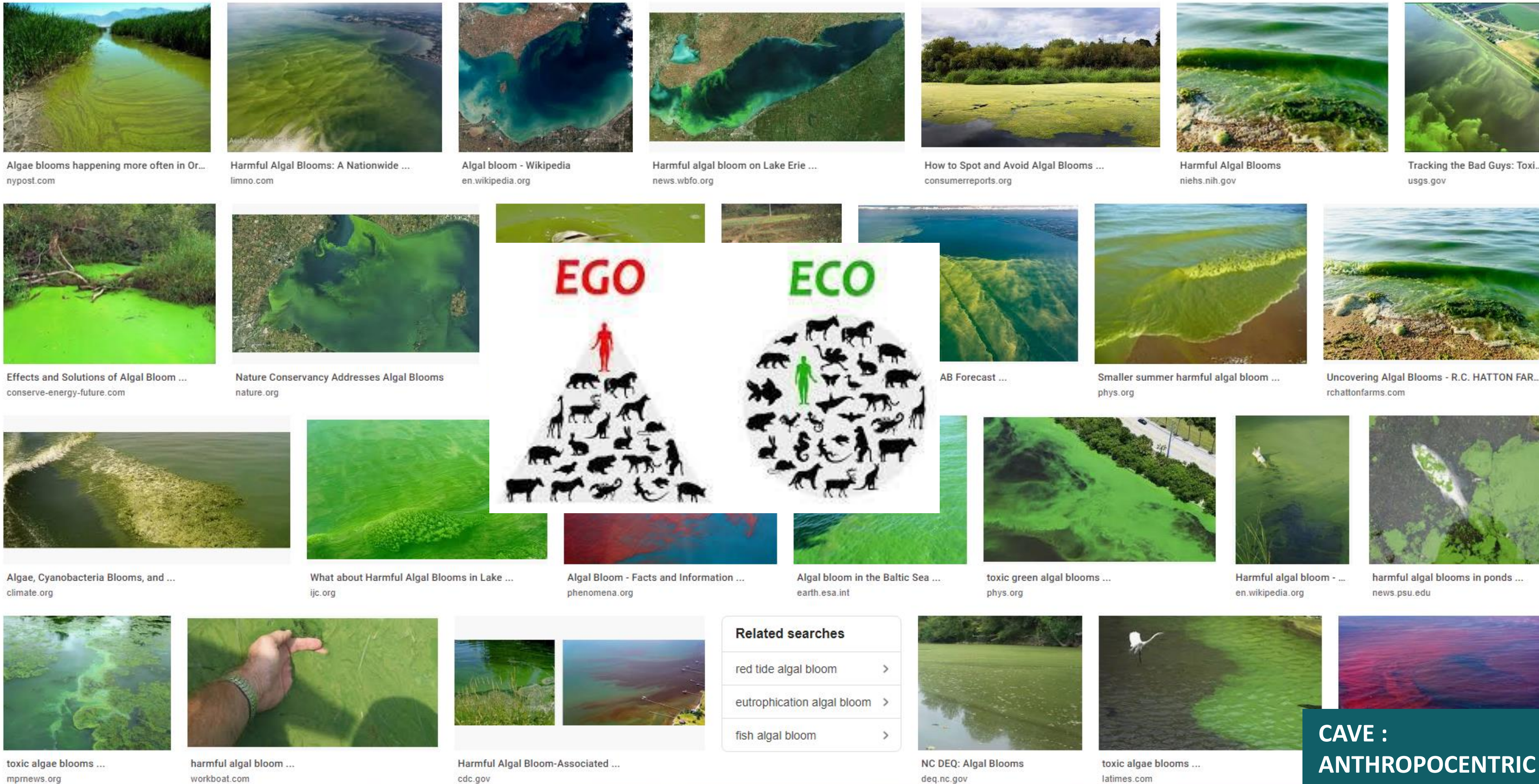
Vibrio vulnificus

— A photo of a Korean man's hand after he was infected with Vibrio vulnificus. ***New England Journal of Medicine***

Temperature

- Pathogen
  - Extrinsic incubation period malaria ↓ : 26 days at 20 °C, 13 days at 25 °C
  - Salmonella: reproduction rises with temperature (water)
  - Campylobacter: outcompeted by other bacteria when °T rises, UV-light blocks Campylobacter
  - **Algal bloom**
  - Vibrio spp. ↑
- Vector/host
  - Insects in low-latitude regions -- > mid- or high latitude regions: expansion
  - China: winter temp. rises -- > *Oncomelania* ↑ -- > *Schistosoma japonicum* ↑ -- > distribution to new areas
  - *Aedes aegypti* larvae die when > 34 °C, adult mosquitos die when > 40 °C
  - *Anopheles* needs T > 16 °C (winterisotherm)

Algae blooms



CAVE : ANTHROPOCENTRIC POINT OF VIEW!

Temperature

- Pathogen
  - Extrinsic incubation period malaria ↓ : 26 days at 20 °C, 13 days at 25 °C
  - Salmonella: reproduction rises with temperature (water)
  - Campylobacter: outcompeted by other bacteria when °T rises, UV-light blocks Campylobacter
  - Algal bloom
  - Vibrio spp. ↑
- Vector/host
  - **Insects in low-latitude regions -- > mid- or high latitude regions: expansion**
  - China: winter temp. rises -- > *Oncomelania* ↑ -- > *Schistosoma japonicum* ↑ -- > distribution to new areas
  - *Aedes aegypti* larvae die when > 34 °C, adult mosquitos die when > 40 °C
  - *Anopheles* needs T > 16 °C (winterisotherm)

Ticks

Medlock *et al. Parasites & Vectors* 2013, **6**:1
http://www.parasitesandvectors.com/content/6/1/1

Parasites & Vectors

REVIEW **Open Access**

Driving forces for changes in geographical distribution of *Ixodes ricinus* ticks in Europe

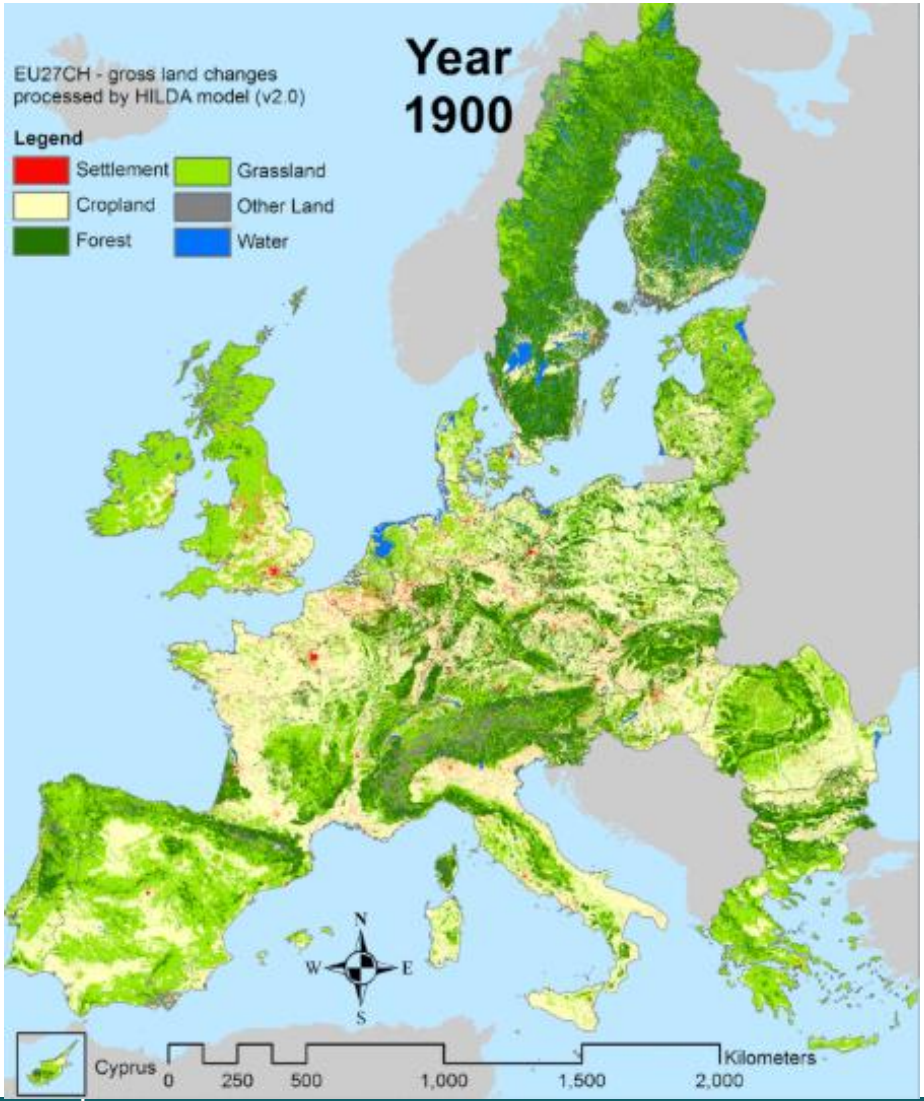
- Northern latitude: moves up
  - Southern latitude: decrease? If humidity decreases -- > less tick survival
- Altitude: higher

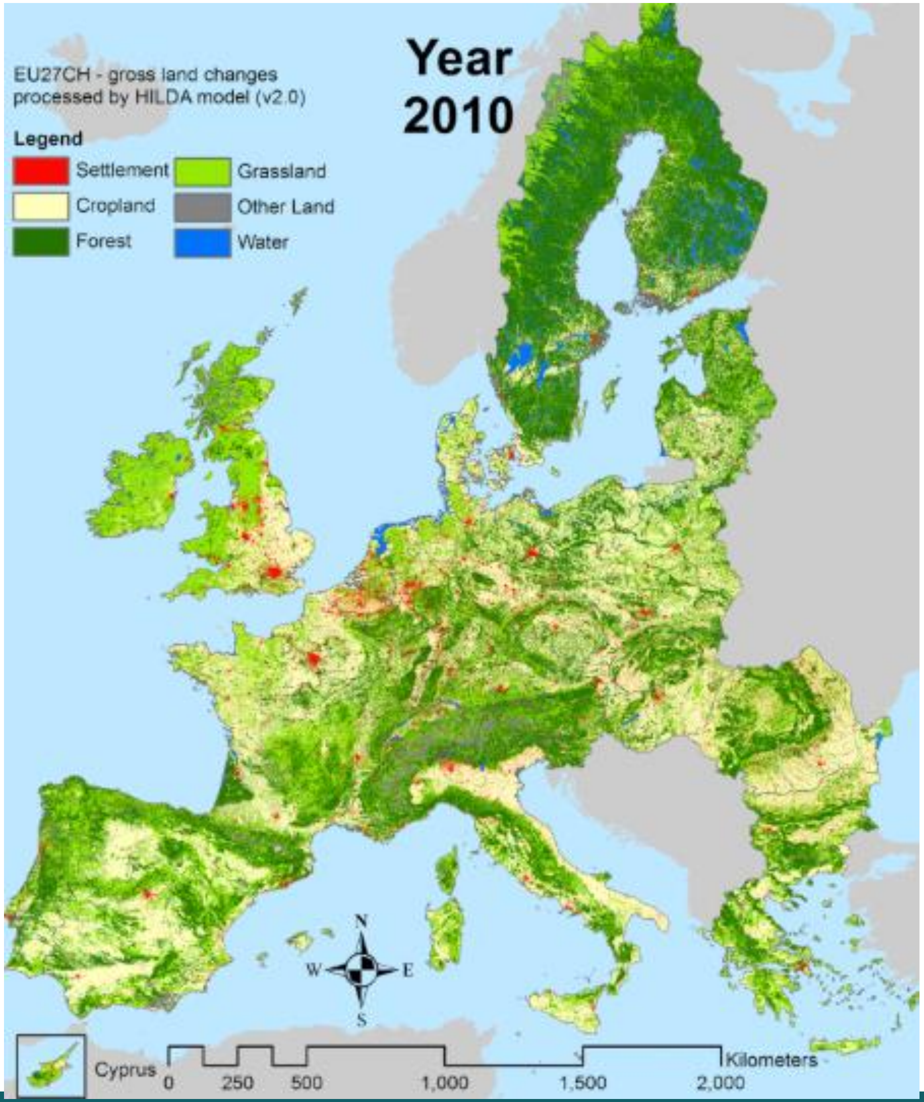
Publication bias; to prove the absence of something = hard ++

- Nymphs and larvae: feed on small rodents and bigger wildlife
- Adult ticks: feed only on big wildlife
- Ticks need +/- 80% humidity

Reforestation in Europe, 1950 – 2002 : +2%

CO2 stimulates vegetation!!!





HTTPS://WWW.WASHINGTONPOST.COM/NEWS/WORLDVIEWS/WP/2014/12/04/WATCH-HOW-EUROPE-IS-GREENER-NOW-THAN-100-YEARS-AGO/

Pathogens transmitted by ticks

- Hard ticks
  - Lyme (Borrelia Burgdorferi/Afzelii, Garinii)
  - Anaplasma
  - Ehrlichia
  - Bartonella
  - Babesia
  - Rickettsia: RMSF, R. conori, Japanese spotted fever,...
  - Tularemia: Francisella tularensis
  - Colorado Tick fever, Powassan virus
  - Hemorragic fevers: Crimean-Congo, Omsk,..
  - FSME (Frühsommer meningo-encephalitis) = TBE

A tularemia lesion on the dorsal skin of the right hand

- Soft ticks
  - TBRL: Tick Born Relapsing Fever (B. duttonii, hermsii,...) = soft tick

Epidemiology

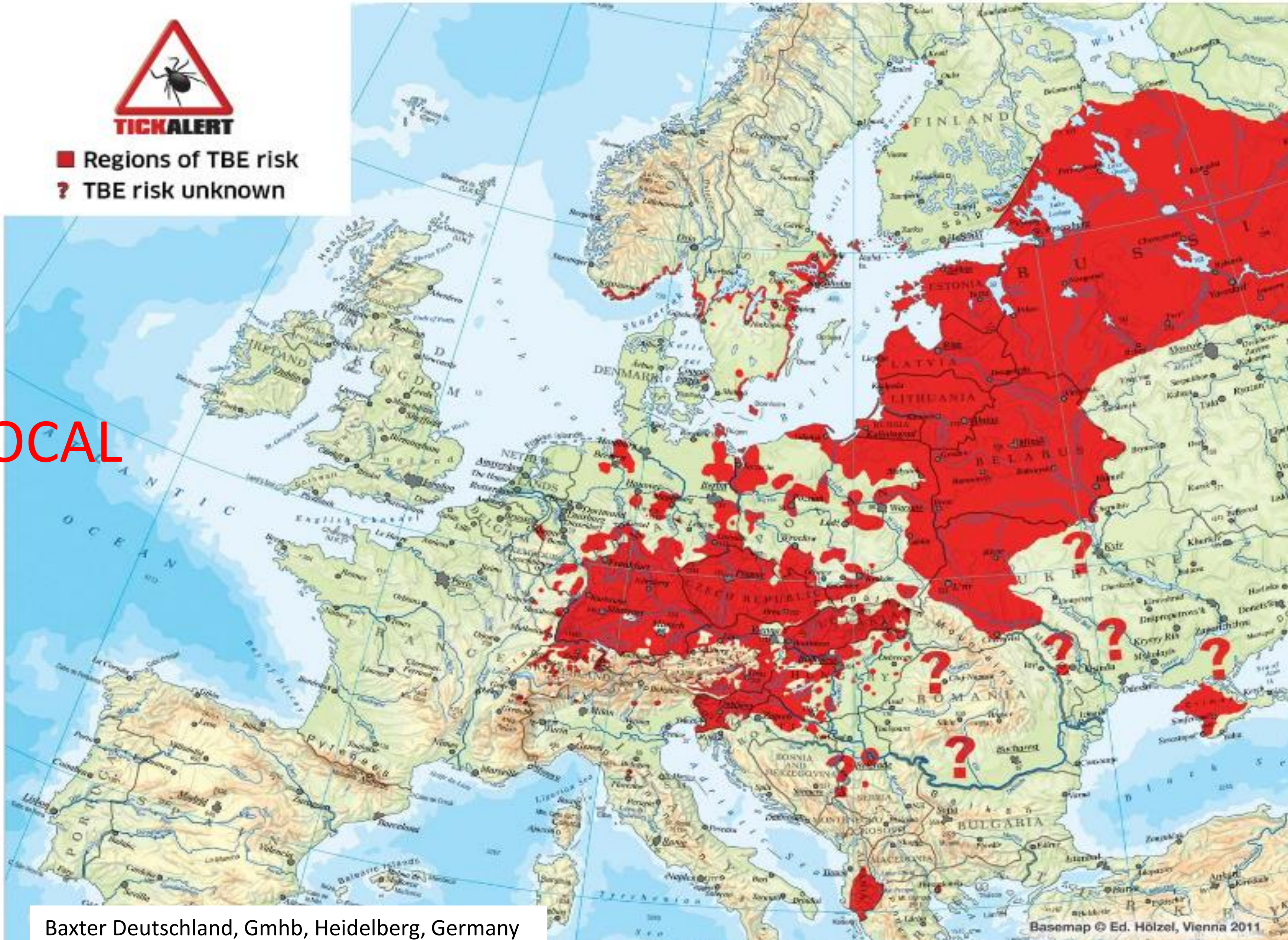
TBE - Tick Borne Encephalitis

(Eastern European Encephalitis, Russian Spring Summer Encephalitis)

TICKALERT

- Regions of TBE risk
- ? TBE risk unknown

FOCAL



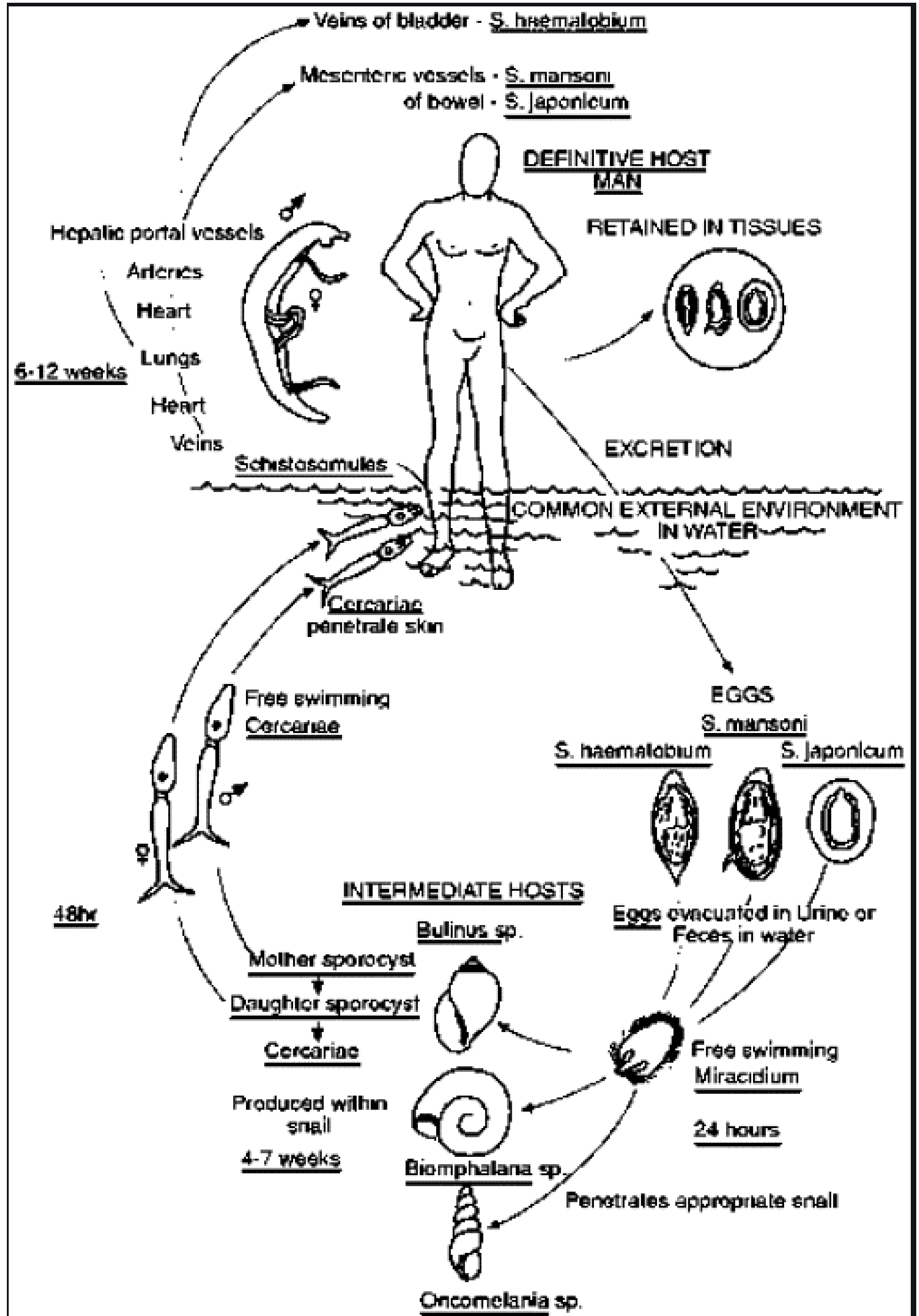
Baxter Deutschland, Gmhb, Heidelberg, Germany

Tick surveillance

Temperature

- Pathogen
  - Extrinsic incubation period malaria ↓ : 26 days at 20 °C, 13 days at 25 °C
  - Salmonella: reproduction rises with temperature (water)
  - Campylobacter: outcompeted by other bacteria when °T rises, UV-light blocks Campylobacter
  - Algal bloom
  - Vibrio spp. ↑
- Vector/host
  - Insects in low-latitude regions -- > mid- or high latitude regions: expansion
  - **China: winter temp. rises -- > *Oncomelania* ↑ -- > *Schistosoma japonicum* ↑ -- > distribution to new areas**
  - *Aedes aegypti* larvae die when > 34 °C, adult mosquitos die when > 40 °C
  - *Anopheles* needs T > 16 °C (winterisotherm)

Oncomelania hupensis



Schistosomiasis

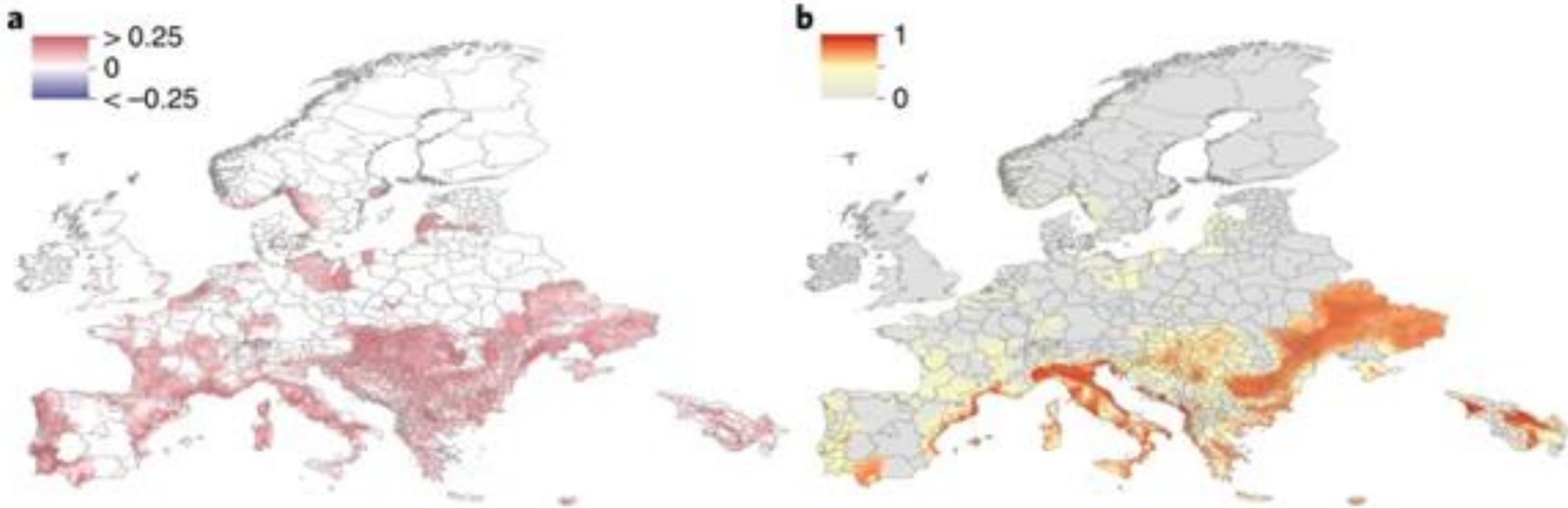
Schistosomiasis, periportal fibrosis

Schistosomiasis, hematuria

Temperature

- Pathogen
  - Extrinsic incubation period malaria ↓ : 26 days at 20 °C, 13 days at 25 °C
  - Salmonella: reproduction rises with temperature (water)
  - Campylobacter: outcompeted by other bacteria when °T rises, UV-light blocks Campylobacter
  - Algal bloom
  - Vibrio spp. ↑
- Vector/host
  - Insects in low-latitude regions -- > mid- or high latitude regions: expansion
  - China: winter temp. rises -- > *Oncomelania* ↑ -- > *Schistosoma japonicum* ↑ -- > distribution to new areas
  - ***Aedes aegypti* larvae die when > 34 °C, adult mosquitos die when > 40 °C**
  - *Anopheles* needs T > 16 °C (winterisotherm)

Fig. 3: Predicted future spread of *Ae. albopictus* in Europe.



a, The expansion (red) and contraction (blue) of *Ae. albopictus* between 2020 and 2050 under the medium climate scenario RCP 6.0, with emissions peaking in 2080. **b**, The predicted distribution of *Ae. albopictus* and predicted habitat suitability for the presence of *Ae. albopictus* in 2050. Pixels with no predicted suitability are in grey.

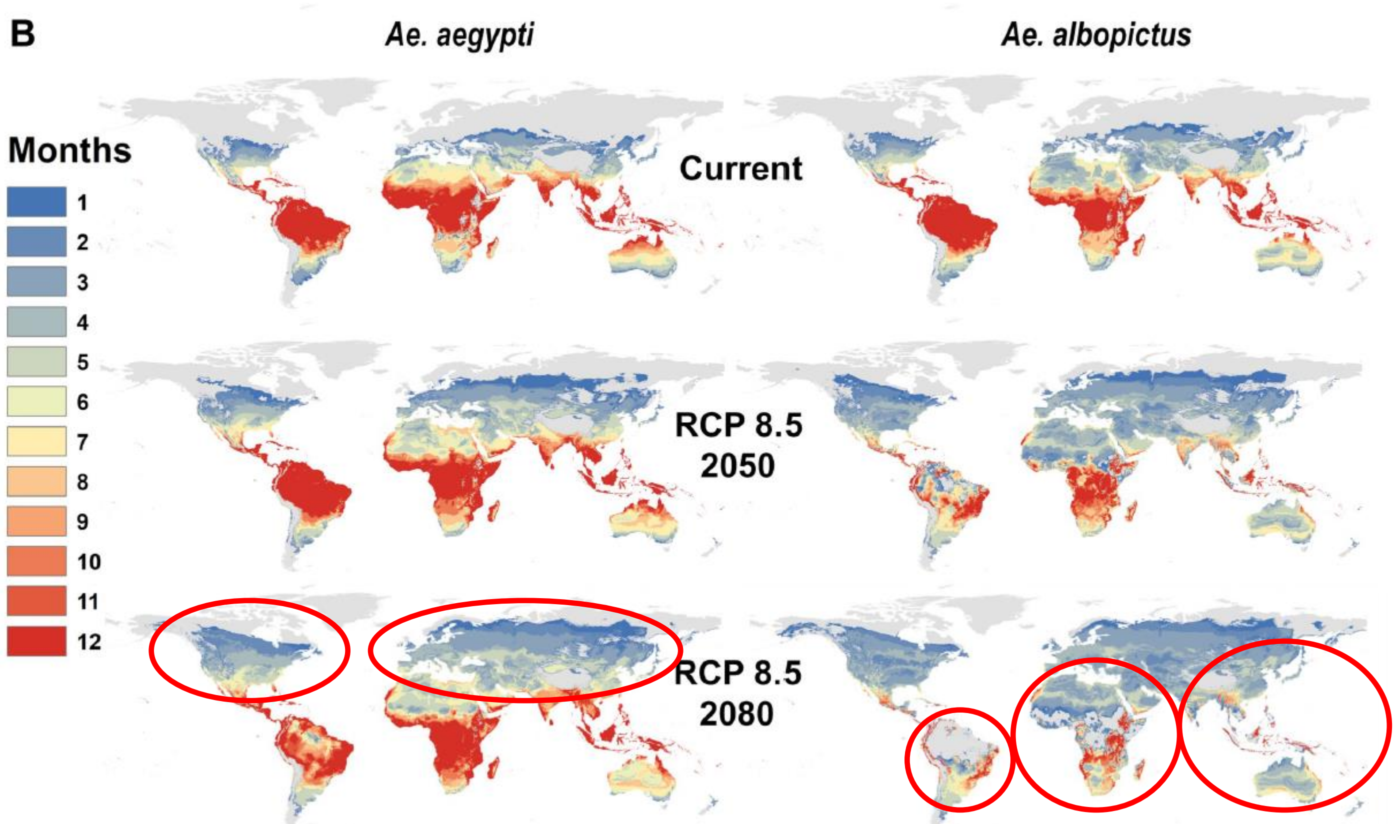
Past and future spread of the arbovirus vectors *Aedes aegypti* and *Aedes albopictus*

Moritz U. G. Kraemer, Robert C. Reiner Jr, […] Nick Golding

Nature Microbiology **4**, 854–863(2019) | Cite this article

Aedes-borne diseases | a model

Mapping future temperature suitability for transmission scenarios for *Aedes aegypti* and *Ae. albopictus (most applicable to dengue)*

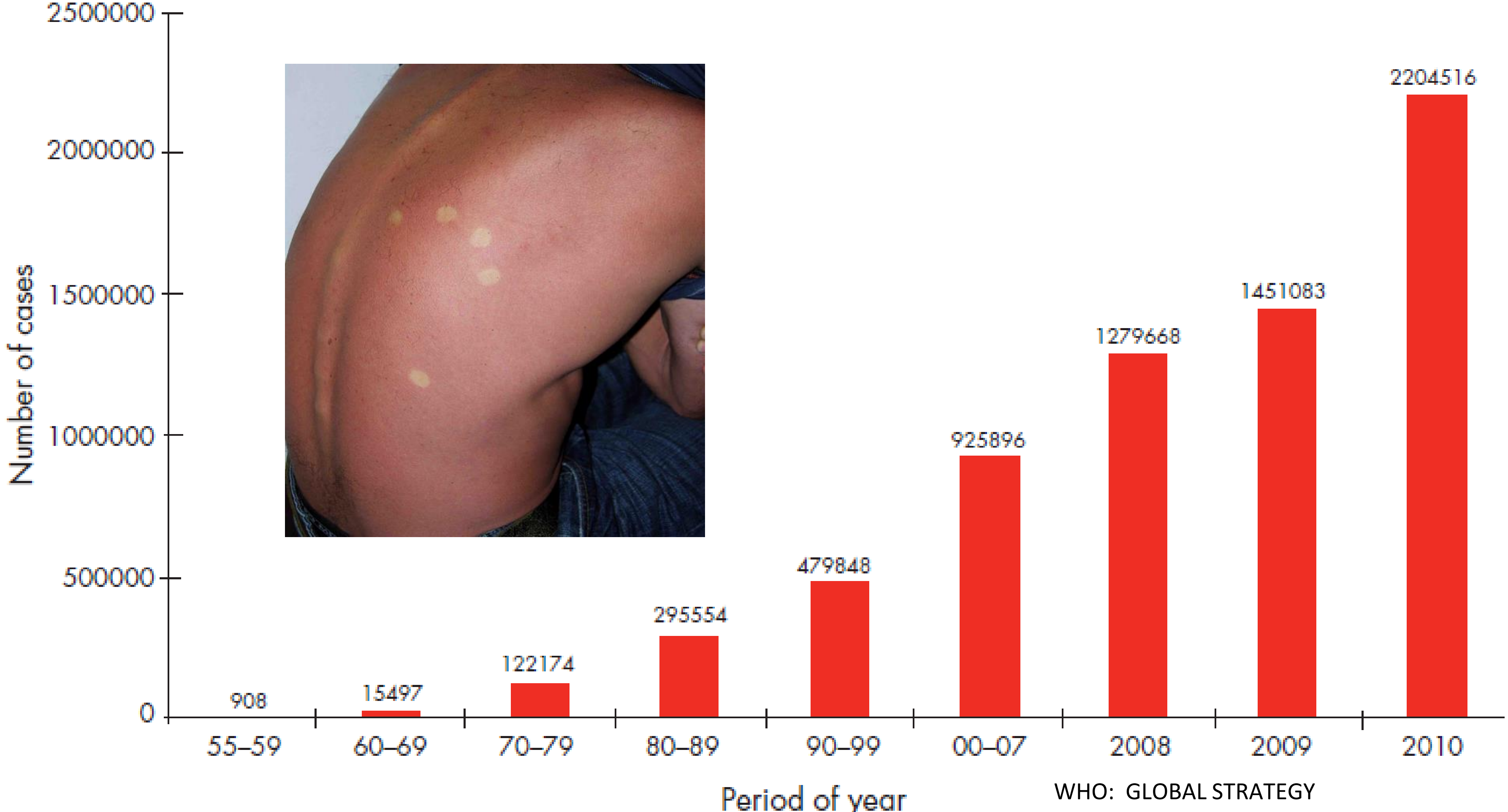


Maps of monthly suitability based on a temperature threshold corresponding to the posterior probability that scaled *R0* > 0 is greater or equal to 97.5%, for transmission by *Ae. aegypti* and *Ae. Albopictus* for predicted mean monthly temperatures under current climate and future scenarios for 2050 and 2080: b. RCP 8.5 in HadGEM2-ES.

Source. Ryan et al. 2019. PLoS Negl Trop Dis 13: e0007213

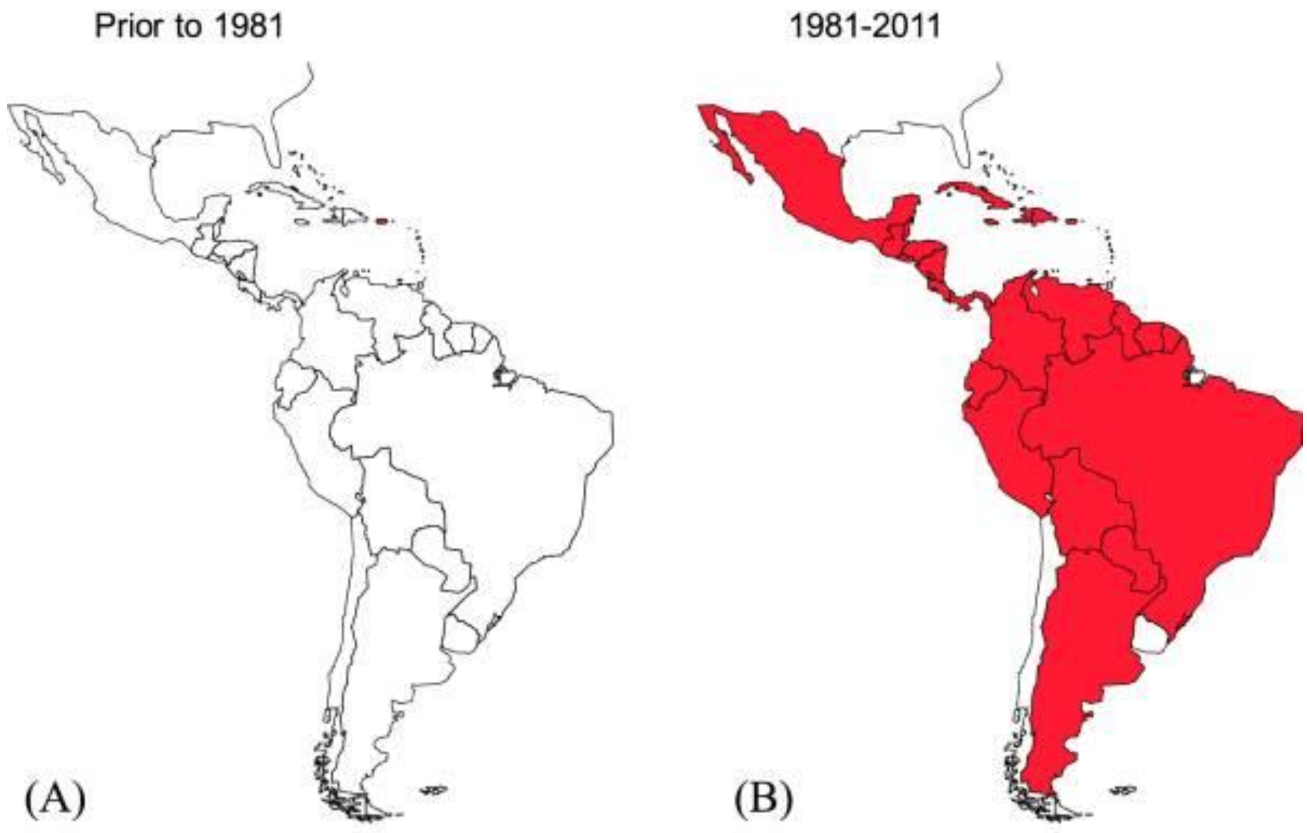
Dengue

Figure 1. Average number of dengue and severe dengue cases reported to WHO annually in 1955–2007 and number of cases reported in recent years, 2008–2010



WHO: GLOBAL STRATEGY
FOR DENGUE PREVENTION AND CONTROL

Spread of Dengue in the Americas



Adapted from Gubler, 1998

Trop Med Health. 2011 Dec; 39(4 Suppl): 3–11.

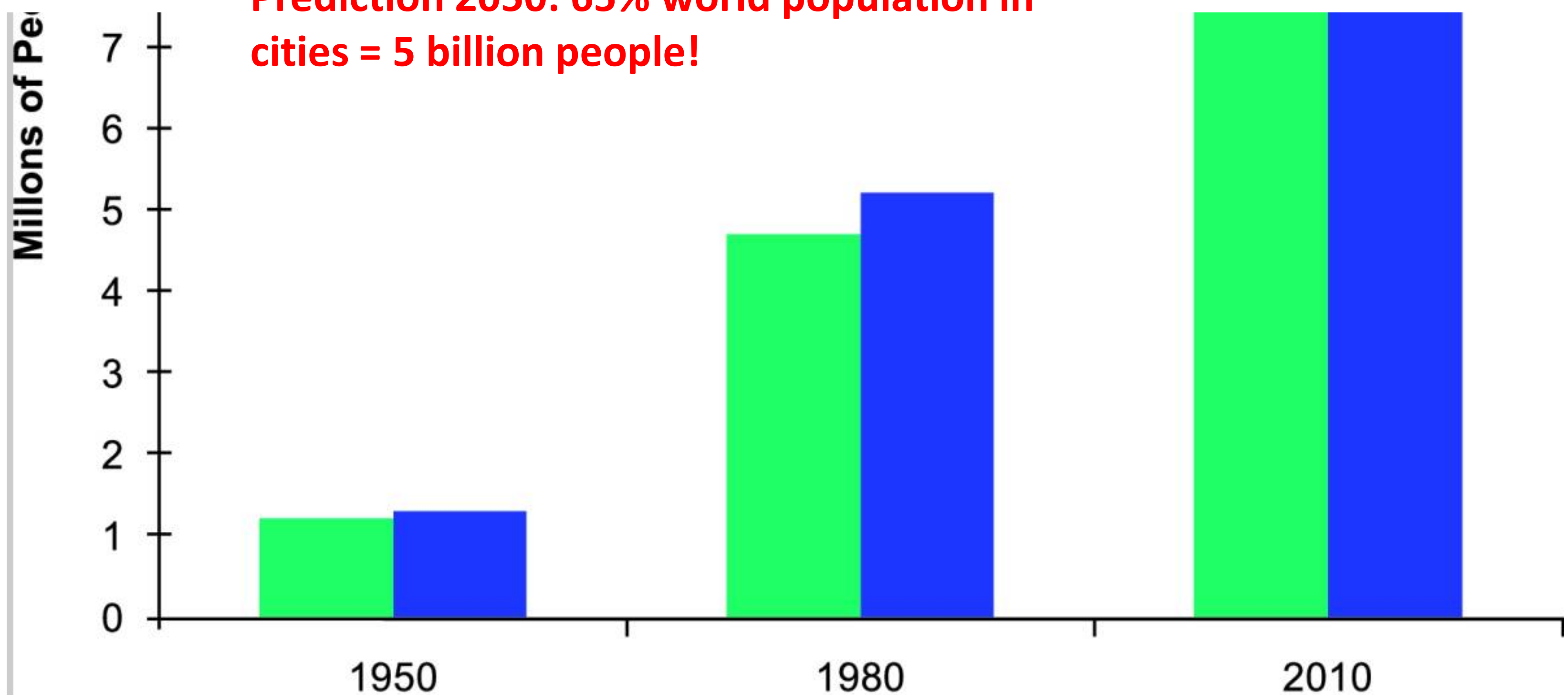
Tropical Medicine and Health
BMC

Trop Med Health. 2011 Dec; 39(4 Suppl): 3–11.
Published online 2011 Aug 25. doi: 10.2149/tmh.2011-S05
PMCID: PMC3317603
PMID: 22500131

Dengue, Urbanization and Globalization: The Unholy Trinity of the 21st Century

Duane J. Gubler

Prediction 2050: 65% world population in cities = 5 billion people!



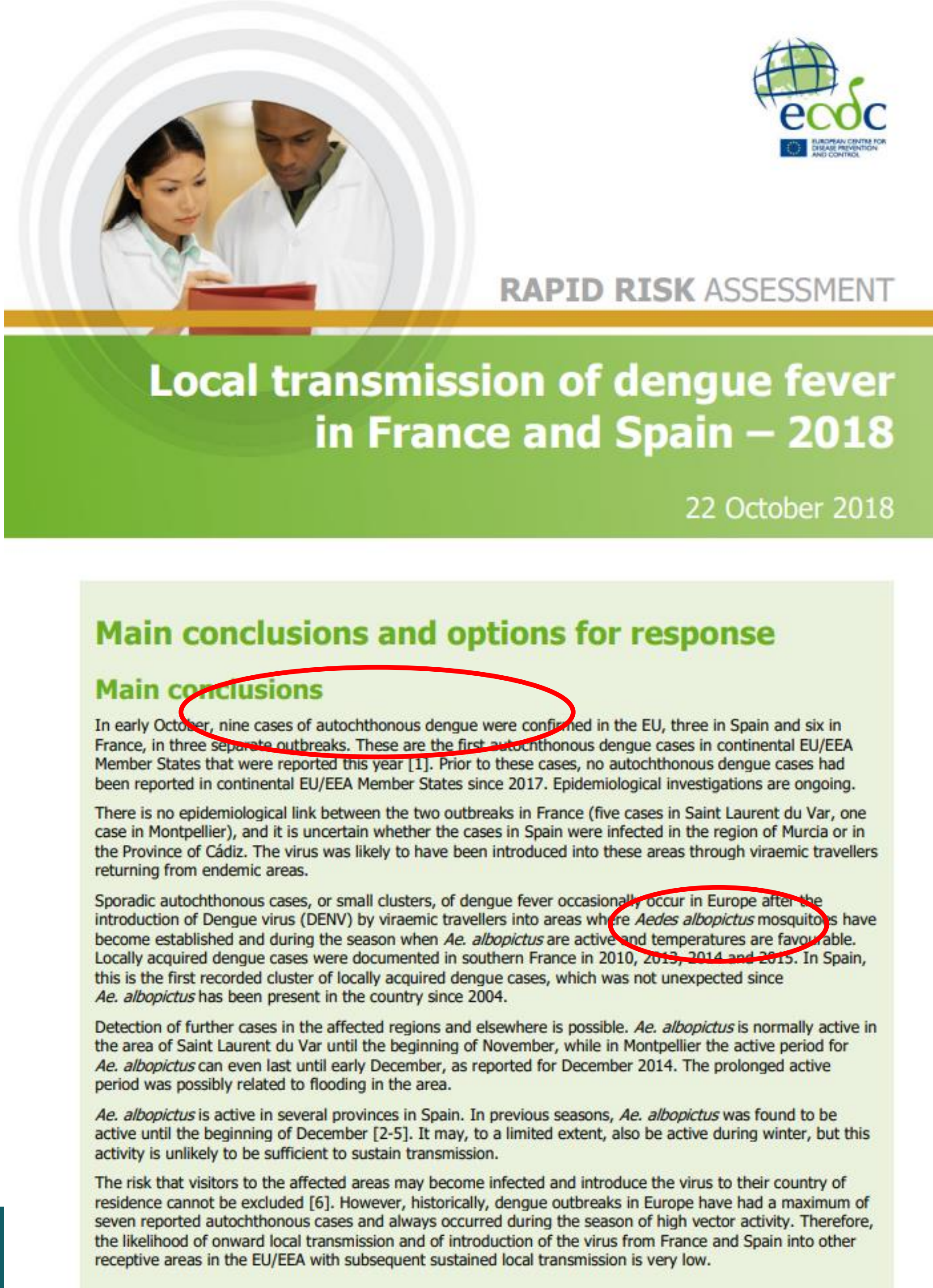
1. Mean population of Dhaka, Bangkok, Jakarta, Manila and Saigon.
2. Mean population of Rio de Janeiro, Sao Paulo, San Juan ,Caracas

Dengue drivers

Major Drivers of the increased Incidence and Geographic Spread of Dengue

- Lack of effective mosquito control
- Changing life styles
- Unplanned urbanization
- Globalization

Trop Med Health. 2011 Dec; 39(4 Suppl): 3–11.


RAPID RISK ASSESSMENT

Local transmission of dengue fever in France and Spain – 2018

22 October 2018

Main conclusions and options for response

Main conclusions

In early October, nine cases of autochthonous dengue were confirmed in the EU, three in Spain and six in France, in three separate outbreaks. These are the first autochthonous dengue cases in continental EU/EEA Member States that were reported this year [1]. Prior to these cases, no autochthonous dengue cases had been reported in continental EU/EEA Member States since 2017. Epidemiological investigations are ongoing.

There is no epidemiological link between the two outbreaks in France (five cases in Saint Laurent du Var, one case in Montpellier), and it is uncertain whether the cases in Spain were infected in the region of Murcia or in the Province of Cádiz. The virus was likely to have been introduced into these areas through viraemic travellers returning from endemic areas.

Sporadic autochthonous cases, or small clusters, of dengue fever occasionally occur in Europe after the introduction of Dengue virus (DENV) by viraemic travellers into areas where *Aedes albopictus* mosquitoes have become established and during the season when *Ae. albopictus* are active and temperatures are favourable. Locally acquired dengue cases were documented in southern France in 2010, 2013, 2014 and 2015. In Spain, this is the first recorded cluster of locally acquired dengue cases, which was not unexpected since *Ae. albopictus* has been present in the country since 2004.

Detection of further cases in the affected regions and elsewhere is possible. *Ae. albopictus* is normally active in the area of Saint Laurent du Var until the beginning of November, while in Montpellier the active period for *Ae. albopictus* can even last until early December, as reported for December 2014. The prolonged active period was possibly related to flooding in the area.

Ae. albopictus is active in several provinces in Spain. In previous seasons, *Ae. albopictus* was found to be active until the beginning of December [2-5]. It may, to a limited extent, also be active during winter, but this activity is unlikely to be sufficient to sustain transmission.

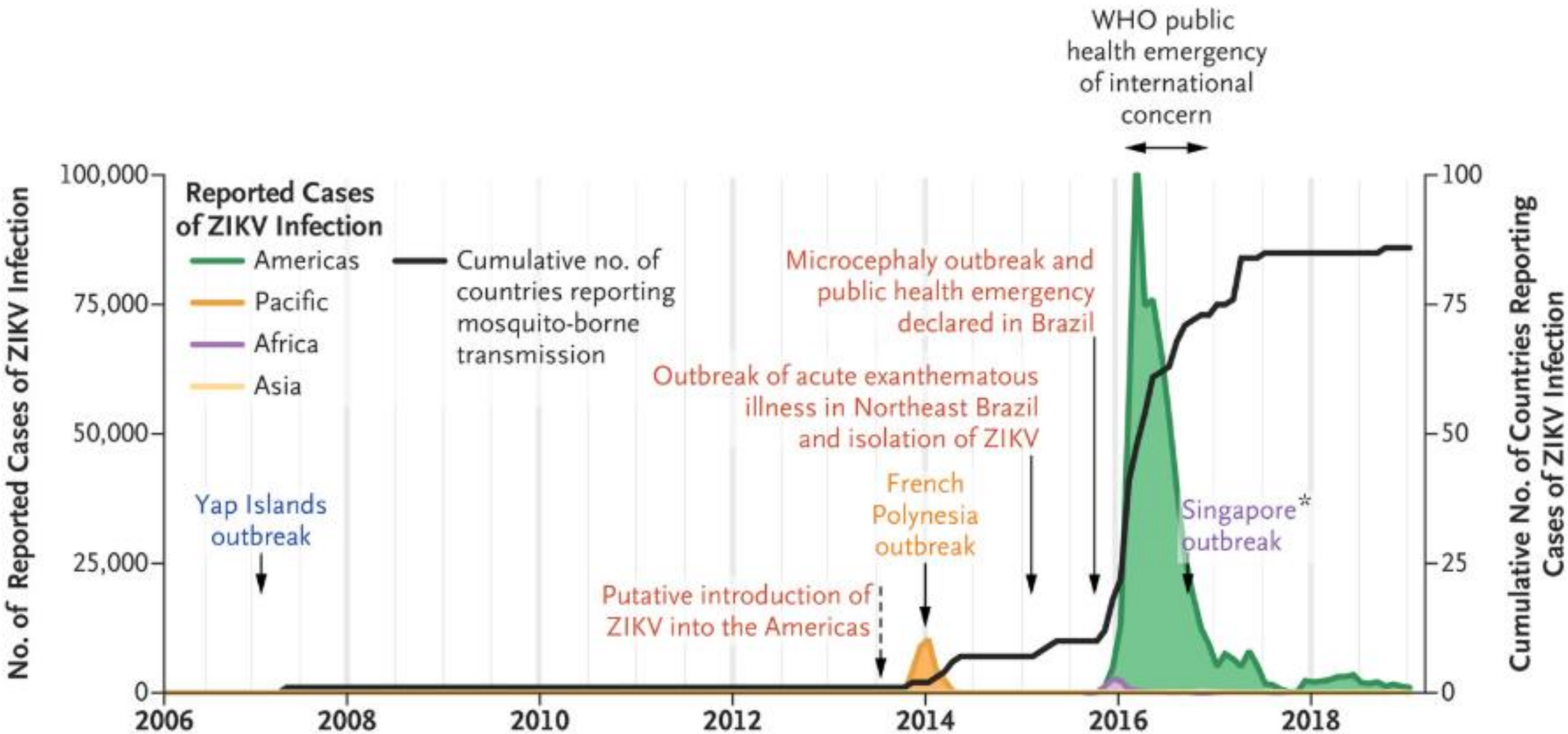
The risk that visitors to the affected areas may become infected and introduce the virus to their country of residence cannot be excluded [6]. However, historically, dengue outbreaks in Europe have had a maximum of seven reported autochthonous cases and always occurred during the season of high vector activity. Therefore, the likelihood of onward local transmission and of introduction of the virus from France and Spain into other receptive areas in the EU/EEA with subsequent sustained local transmission is very low.

- Maideira outbreak 2012-2013 (+/- 3000 cases)
  - *Ae. aegypti* present

Zika

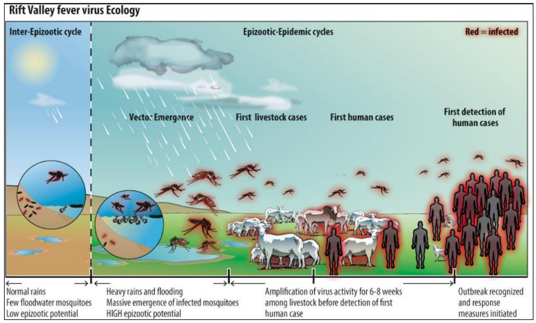
Pathogens don't read textbooks!!!

Cases of ZIKV Infection



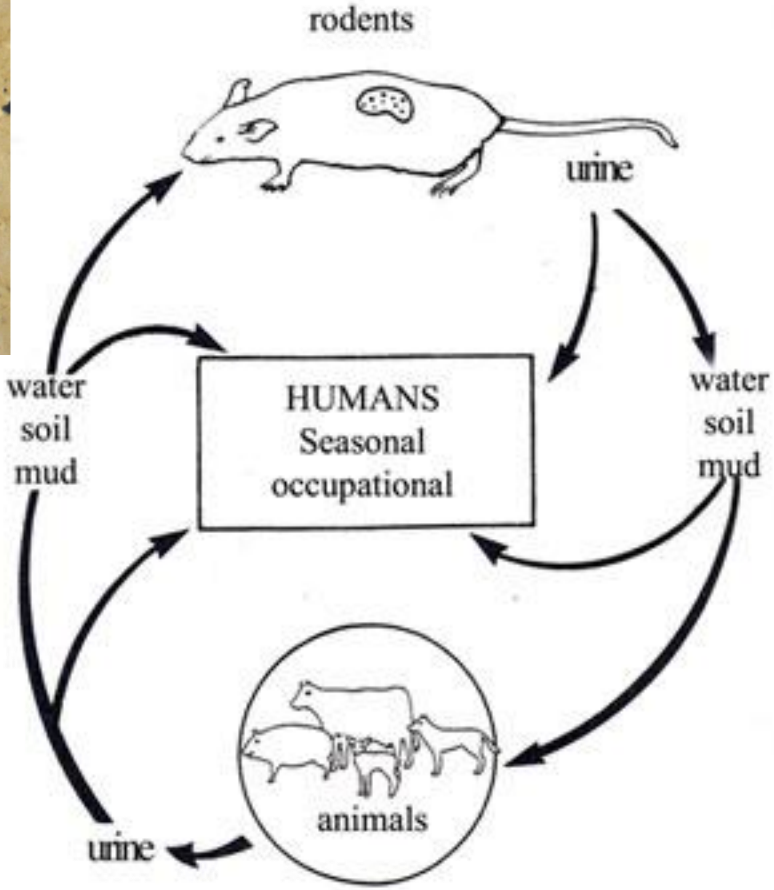
Precipitation

- Fecal pathogens ↑
- But… water scarcity also ↑ diarrhea rates in < 5y: reduced hygiene
- Flooding: *hantavirus* ↑, *leptospirosis* ↑
- After heavy rains -- > Rift-Valley Fever epidemics



Flooding and the Threat of Infectious Disease

Leptospirosis



Fayne et al 1999

Vrees voor massale besmetting rattenziekte na Titan Run

03/10/2015 om 08:15 door werner rommers

Print

+/- 2500 participants

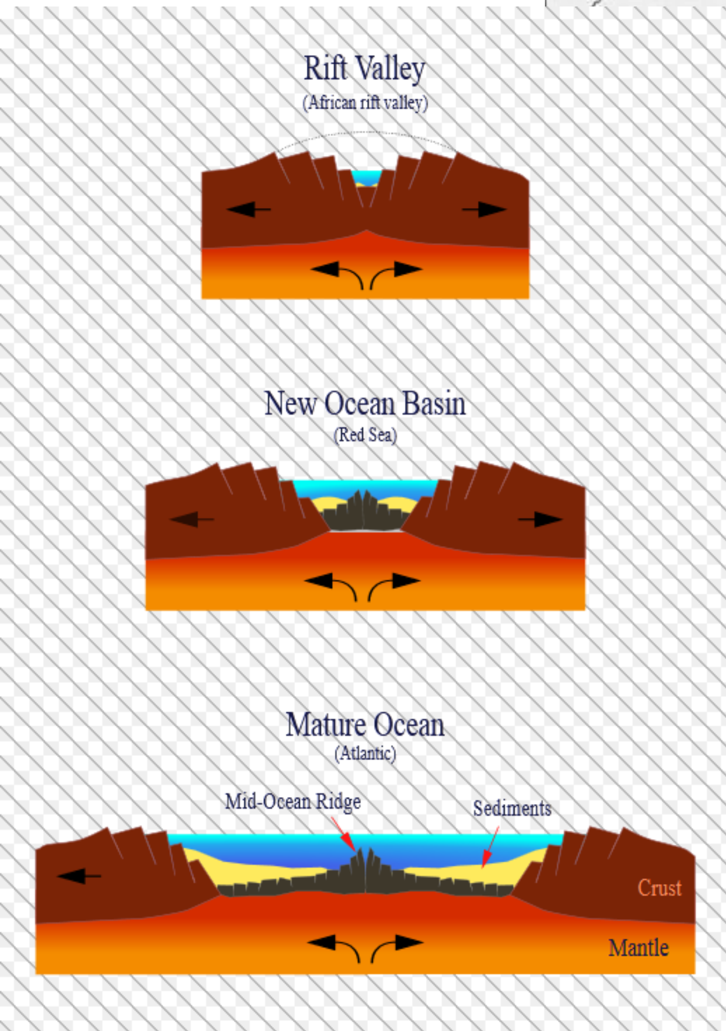
9 seroconversions

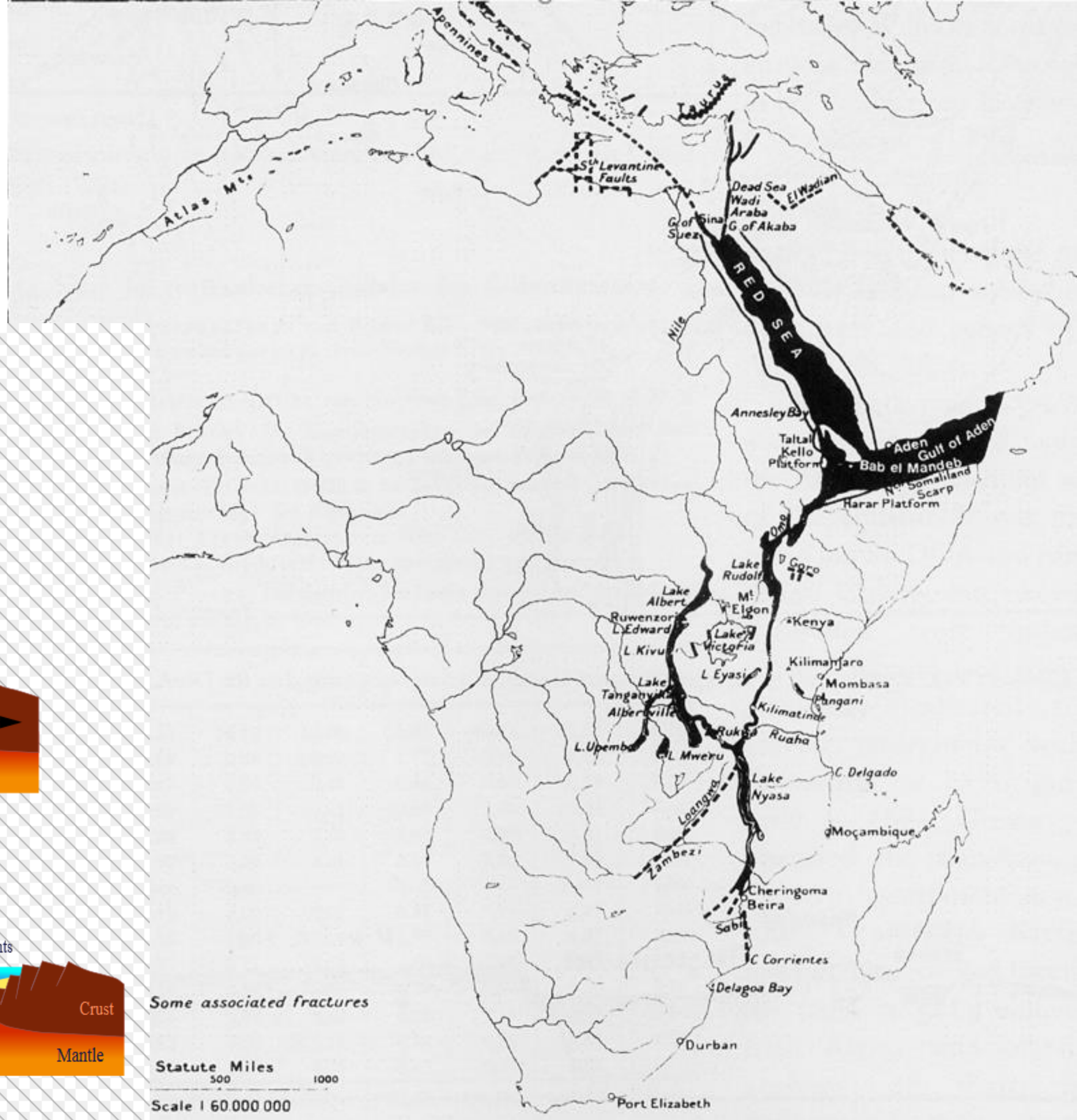
3 symptomatic

1 intensive care

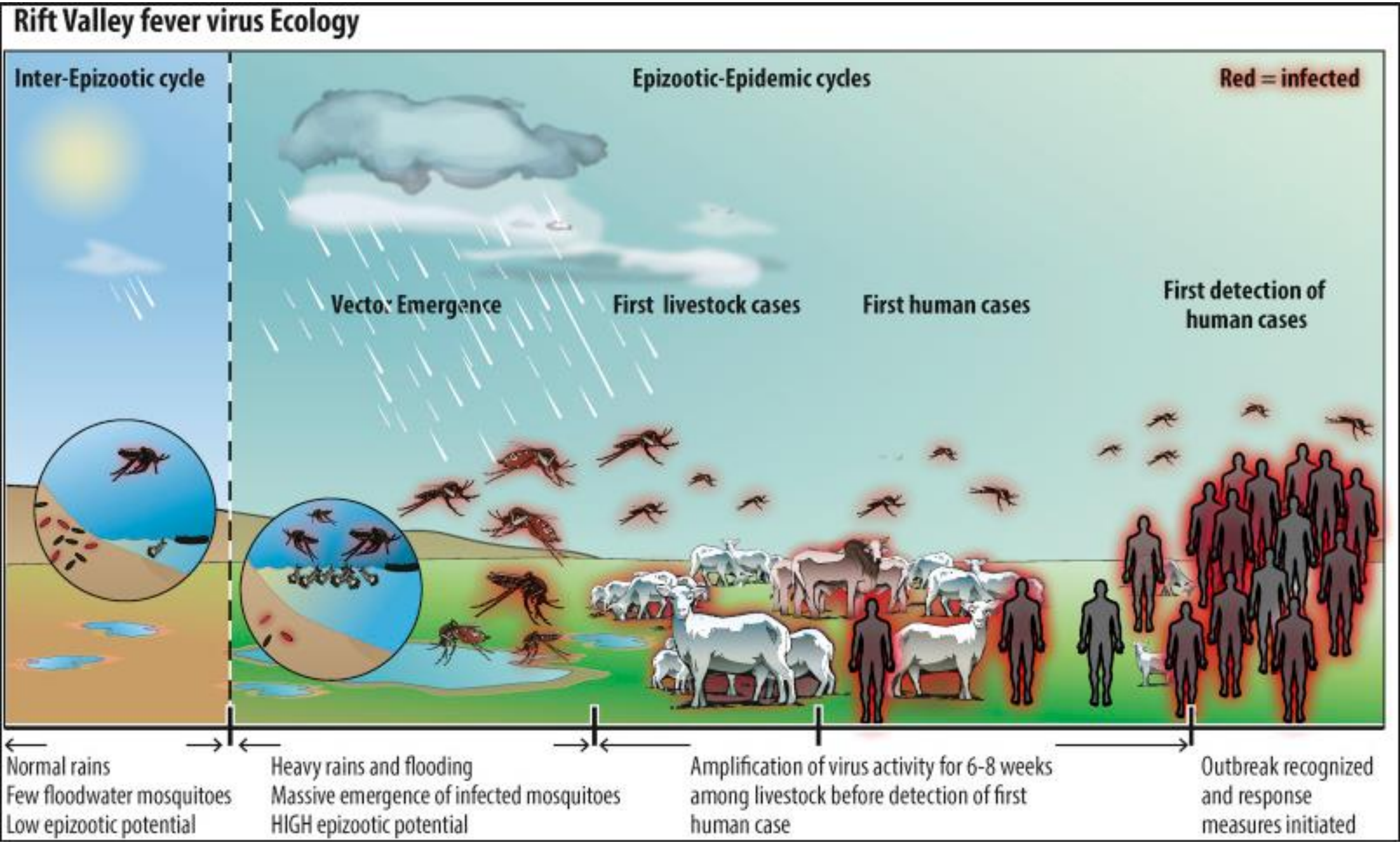
Rift Valley

- Syria → Mozambique


Rift Valley
(African rift valley)
New Ocean Basin
(Red Sea)
Mature Ocean
(Atlantic)
Mid-Ocean Ridge
Sediments
Crust
Mantle


Apennines
Taurus
Atlas Mts
Levantine Faults
Dead Sea
Wadi Araba
G of Akaba
El Wadian
G of Suez
Sinai
Nile
RED SEA
Annesley Bay
Taltal
Kello
Platform
Aden
Gulf of Aden
Bab el Mandeb
Nr Somaliland Scarp
Harar Platform
Omo
Lake Rudolf
Goro
Lake Albert
Mt Elgon
Ruwenzori
L Edward
Lake Victoria
Kenya
L Kivu
L Eyasi
Kilimanjaro
Mombasa
Pangani
Lake Tanganyika
Albertville
Kilimatinde
Rukwa
Ruaha
L Upemba
L Mweru
Lake Nyasa
C Delgado
Loangwa
Moçambique
Zambezi
Cheringoma
Beira
Sabi
C Corrientes
Delagoa Bay
Durban
Port Elizabeth
Some associated fractures
Statute Miles
500
1000
Scale 1 60.000 000

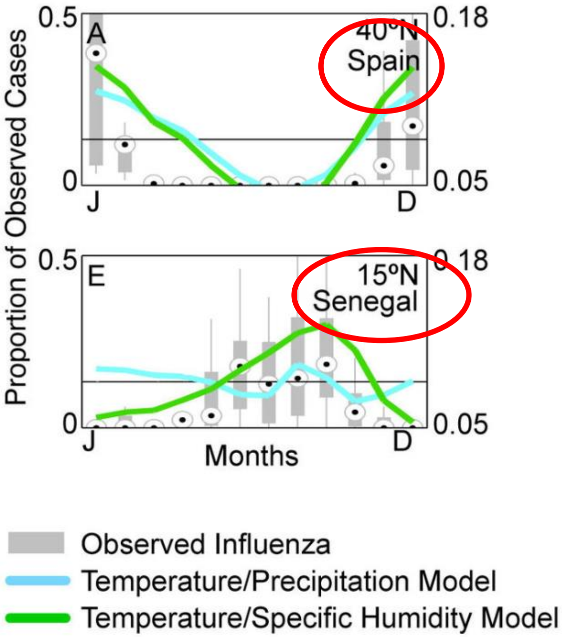
Rift Valley fever



Drought

- ↑ Concentration of water-borne pathogens (Salmonella,…)
- Rotten organic material accumulate in pools: *Culex* ↑ -- > West-Nile Virus ↑

Humidity



Sunshine

- ↑ Concentration of *V. cholera*

Wind

- Asian dust storms: Influenza A ↑ (downwind)
- Transport of pathogens across oceans
- Mosquitoes: reduces biting opportunities, but extend flight distance

Other factors

- Crop failure -- > malnutrition -- > immunity ↓ -- > infections

Extreme weather events

!TIME CORRELATION ≠ CAUSALITY!

Key studies that assess the relationship between extreme weather events and infectious diseases.[a]

Extreme weather events	Disease type	Authors, year	Main findings
El Nino	Vector-borne disease	Epstein (1999)	Increasing outbreaks of emerging diseases were linked to El Nino event.
		Haines and Patz (2004)	Outbreaks and epidemic of malaria were positively connected with El Nino events in many regions.
		…dsay et al. (2000)	Strikingly less malaria were found in the El Nino year than in the preceding year in the Usambara Mountains, Tanzania.
		…s (2000)	Record of hantavirus cardiopulmonary syndrome has been found to be related to El Nino events in the Colorado Plateau.
	Wa…	…	The risk of symptoms associated with diarrhea is twice the previous when exposed to southern California coastal waters during an El Nino winter.
La Nina	V…	…	…ungunya fever epidemic was connected with the drought incurred by La Nina.
		…	…ar produced an epidemic of West Nile fever and Japanese encephalitis.
	V…	…	…ross diarrhea symptom during a La Nina winter.
Quasi-Biennial Oscillation (QBO)	Vecto…	…	…be linked to the incidence of Ross River virus in south-eastern …
Heatwaves	Vector-borne dis…	…	…tbreak of West Nile fever in Israel in 2000.
	Air-borne disease	…	…rbidity and mortality from infectious respiratory …
Drought	Water-borne disease	Epste…	…cially in refugee camps.
	Vector-borne disease	Khasnis and …	…ulmonary syndrome (HPS).
		Wang et al. (201…	…
		Shaman et al. (2002)	…vould increase, during the …
		Chretien et al. (2007)	Th… …h droughts.
Flood	Water-borne disease	MacKenzie et al. (1994)	Flood fa… …s *Cryptosporidium* infection.
		Reacher et al. (2004)	A significant … …ociated with depth of flooding in the town of Lewes …
	Vector-borne disease	Epstein (1999)	Floods in Mozambique le… …yphoid and cholera
		Mackenzie et al. (2000)	Strong rain or flood can lead to … River fever
		Ahern et al. (2005)	After a flood, such diarrheal disease … olera may grow
		Woodruff et al. (1990)	Increases in diarrhea and malaria inciden…s were observed after floods in 1988 in Khartoum, Sudan.
		Nielsen et al. (2002)	There have been reported increases in lymphatic filariasis in different areas.
		Cordova et al. (2000)	There have also been reported increases in arbovirus disease after flood
		Chen (1999)	Hemorrhagic Fever with Renal Syndrome diseases may increase during flooding
		CDC (2000)	HPS diseases may also increase during flooding
		Leal-Castellanos et al. (2003)	Leptospirosis diseases may also increase during flooding in different areas.
Hurricane	Vector-borne disease	Epstein (2000)	Following the hurricane, malaria and dengue fever occurred in Honduras and in Venezuela.
Cyclone	Vector-borne disease	Sanders et al. (1999)	A cyclone tends to increase the incidence of leptospirosis.
	Water/food-borne disease	Shultz et al. (2005)	A cyclone tends to increase the incidence of cholera.

Predictions from the past

Status of Major Vector-borne Diseases and Predicted Sensitivity to Climate Change*

Disease	Populations at Risk, Millions†	Prevalence of Infection, Millions‡	Present Distribution	Possible Change of Distribution as a Result of Climatic Change
Malaria	2100	270	Tropics, subtropics	Highly likely
Lymphatic filariases	900	90.2	Tropics, subtropics	Likely
Onchocerciasis	90	17.8	Africa, Latin America	Likely
Schistosomiasis	600	200	Tropics, subtropics	Very likely
African trypanosomiasis	50	25 000 new cases per year	Tropical Africa	Likely
Leishmaniasis	350	12 million infected + 400 000 new cases per year	Asia, southern Europe, Africa, South America	Not known
Dracunculiasis	63	1	Tropics (Africa, Asia)	Unlikely
Arboviral diseases				
Dengue	...	...	Tropics, subtropics	Very likely
Yellow fever	...	...	Africa, Latin America	Likely
Japanese encephalitis	...	...	East and Southeast Asia	Likely
Other arboviral diseases	...	...	Tropical to temperate zones	Likely

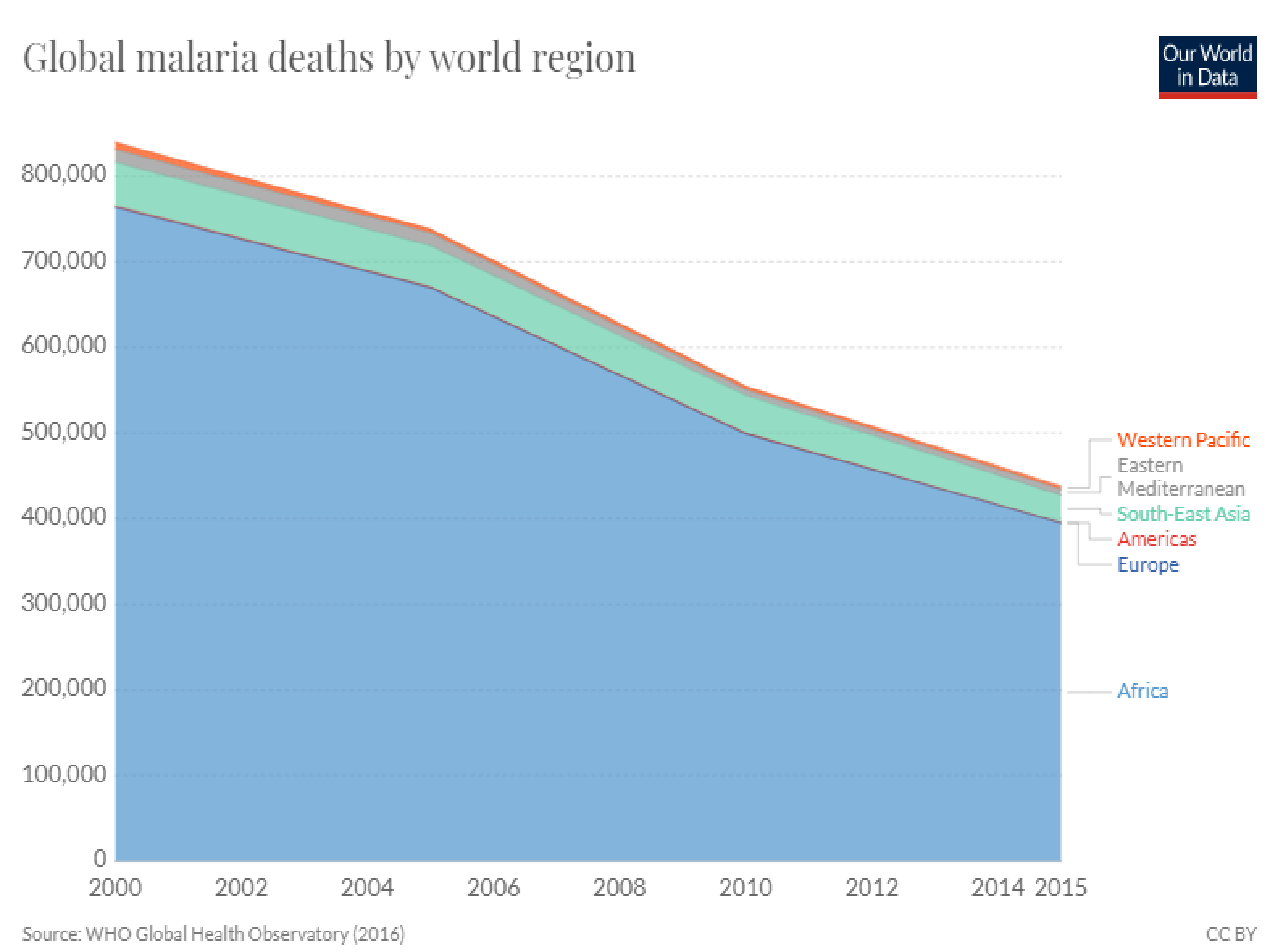
*Data from World Health Organization.[31]
†Based on a world population estimated at 4.8 billion (1989).
‡Ellipses indicate no estimates available.

JAMA, January 17, 1996—Vol 275, No. 3

Prediction

change scenarios,[41,42] risk of malaria epidemics would rise substantially in both tropical and temperate regions. An estimated 1 million additional fatalities per year could be attributed to climate change by the middle of the next century, according to one model.[43]

JAMA, January 17, 1996—Vol 275, No. 3



Global malaria deaths by world region
Our World in Data
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
2000
2002
2004
2006
2008
2010
2012
2014
2015
Western Pacific
Eastern Mediterranean
South-East Asia
Americas
Europe
Africa
Source: WHO Global Health Observatory (2016)
CC BY

Prediction from the past were ALL correct!!

… but for some in the opposite direction!

Status of Major Vector-borne Diseases and Predicted Sensitivity to Climate Change*

Disease	Populations at Risk, Millions†	Prevalence of Infection, Millions‡	Present Distribution	Possible Change of Distribution as a Result of Climatic Change
Malaria	2100	270	Tropics, subtropics	Highly likely
Lymphatic filariases	900	90.2	Tropics, subtropics	Likely
Onchocerciasis	90	17.8	Africa, Latin America	Likely
Schistosomiasis	600	200	Tropics, subtropics	Very likely
African trypanosomiasis	50	25 000 new cases per year	Tropical Africa	Likely
Leishmaniasis	350	12 million infected + 400 000 new cases per year	Asia, southern Europe, Africa, South America	Not known
Dracunculiasis	63	1	Tropics (Africa, Asia)	Unlikely
Arboviral diseases				
Dengue	...	...	Tropics, subtropics	Very likely
Yellow fever	...	...	Africa, Latin America	Likely
Japanese encephalitis	...	...	East and Southeast Asia	Likely
Other arboviral diseases	...	...	Tropical to temperate zones	Likely

*Data from World Health Organization.[31]
†Based on a world population estimated at 4.8 billion (1989).
‡Ellipses indicate no estimates available.

The NEW ENGLAND JOURNAL of MEDICINE

REVIEW ARTICLE

Caren G. Solomon, M.D., M.P.H., *Editor*

The Imperative for Climate Action to Protect Health

Andy Haines, M.D., and Kristie Ebi, M.P.H., Ph.D.

The World Health Organization (WHO) estimated that approximately 250,000 deaths annually between 2030 and 2050 could be due to climate change–related increases in heat exposure in elderly people, as well as increases in diarrheal disease, malaria, dengue, coastal flooding, and childhood stunting.[16] This is a conser-

Cavé : Bias in Media

DE TROPEN IN EUROPA: **DE VERRADERLIJKE STREKEN VAN VIRUSSEN, VLEERMUIZEN, TIJGERMUGGEN EN REUZENTEKEN**

Behalve verzengende hittegolven, een dalend grondwaterpeil en straks misschien een verbod om uw zwembad te vullen of uw tuin te sproeien, heeft de klimaatverandering nog andere, onverwachte gevolgen. Steeds meer muggensoorten en andere insecten die gevaarlijke, zelfs dodelijke tropische ziekten kunnen overbrengen, voelen zich thuis in onze contreien. Slapen wij om malaria, knokkelkoorts en de westnijlziekte af te houden, straks allemaal onder een muskietennet? 'Het is niet uitgesloten dat het ebolavirus een geschikte gastheer vindt bij onze inheemse vleermuizen.' MARC VAN SPRINGEL

Eén van de insecten waar men zich zorgen over maakt, is de tijgermug, die virussen als het dengue-, chikungunya- en zikavirus op de mens kan overbrengen en vanuit het warme zuiden naar noordelijker streken oprukt. Omdat de tijgermug ook al in ons land is waargenomen, werd in 2017 het project Monitoring van Exotische Muggen (MEMO) opgestart, om exotische muggensoorten tijdig op te sporen en te verhinderen dat ze zich hier definitief vestigen. De coördinator is **Wim Van Bortel**, insectendeskundige van het Instituut voor Tropische Geneeskunde in Antwerpen.

WIM VAN BORTEL «Van de tijgermug of *Aedes albopictus* hebben we vorig jaar op vijf plaatsen in ons land zeventig exemplaren gevonden. Onder andere bij een importeur van *lucky bamboo*, een sierbamboe die vooral uit China komt, en in enkele bedrijven die in tweedehands-autobanden handelen. Die banden komen uit de hele wereld en de eitjes van de muggen reizen erin mee. Die vondsten waren niet verrassend: in het verleden hebben we op die plekken ook al tijgermuggen aangetroffen. Nieuw is dat we ze vorig jaar ook gevonden hebben op parkeerterreinen langs de Route du Soleil in Luxemburg. Wellicht zijn de muggen met de auto meegereisd uit Frankrijk of Duitsland, waar ze zich al definitief gevestigd hebben.»

HUMO Waar komt de tijgermug normaal voor?

VAN BORTEL «Ze komt oorspronkelijk uit Azië, maar ze heeft ondertussen de hele wereld veroverd. In 1979 is ze voor het eerst in Europa opgedoken, in Albanië. In de jaren 90 vestigde ze zich in Italië en in 2004 is ze voor het eerst in Frankrijk waargenomen. We zien nu dat ze naar noordelijke streken oprukt.»

HUMO Is dat een gevolg van de klimaatverandering?

VAN BORTEL «Het klimaat speelt zeker een rol. De weersomstandigheden in ons land zijn op dit moment ideaal voor de tijgermug. We hebben nog geen aanwijzingen dat ze hier overwintert, maar dat is in de toekomst zeker niet uitgesloten. Ze kan zich zeer goed aanpassen aan nieuwe situaties. Ze gedijt nu in het Zuid-Europese klimaat en is in het hele mediterrane gebied te vinden.»

HUMO Wordt er nu al iets gedaan om de tijgermug te bestrijden?

VAN BORTEL «Als wij ze ergens aantreffen, melden wij dat aan de overheden en dan moeten zij actie ondernemen.»

HUMO Hoe is de tijgermug te herkennen?

VAN BORTEL «Het is een kleine, zwarte mug met witte strepen op de poten en de rug. Ze wordt soms verward met de inheemse mug, die ook streepjes op de poten heeft, maar die veel groter is.

»Het grote verschil met de mug die wij kennen, is dat de tijgermug overdag actief is. Dat maakt haar extra vervelend.»

HUMO Welke rol speelt het klimaat bij de opmars van soorten als de tijgermug? Hebben ze warmte nodig om te kunnen overleven?

VAN BORTEL «Ze ontwikkelen zich in twee weken van eitje over larve tot mug. Als het warm is, gaat het iets sneller. Ook het virus in de mug zal zich dan sneller vermenigvuldigen. Maar een mug heeft ook water nodig. In een heel droge zomer zoals vorig jaar kunnen er ook minder muggen zijn, omdat er onvoldoende broedplaatsen zijn.»

HUMO De tijgermug is vooral gevaarlijk omdat het virussen aan de mens kan doorgeven.

VAN BORTEL «Ze moet daarvoor wel eerst iemand steken die met het virus besmet is. Voor een overdracht moeten de drager van het virus en de tijgermug zich ook op hetzelfde moment op dezelfde plaats bevinden. Op dit moment is de kans op een infectie zeer klein. Maar als we in de toekomst een grote populatie tijgermuggen zouden krijgen, neemt die kans wel toe.»

HUMO Komen de virussen die de tijgermug kan overbrengen nu al in Europa voor?

VAN BORTEL «Van het chikungunyavirus zijn er al een paar uitbraken geweest. De bekendste zijn die in Italië in 2007 en 2017, omdat toen ook de meeste gevallen werden gerapporteerd. Het ging in 2017 om ongeveer vierhonderd geïnfecteerden, dat is toch een redelijk grote uitbraak. In Frankrijk zijn er ook een paar geweest, maar daar hebben ze die beter kunnen indijken, of vroeger kunnen detecteren.»

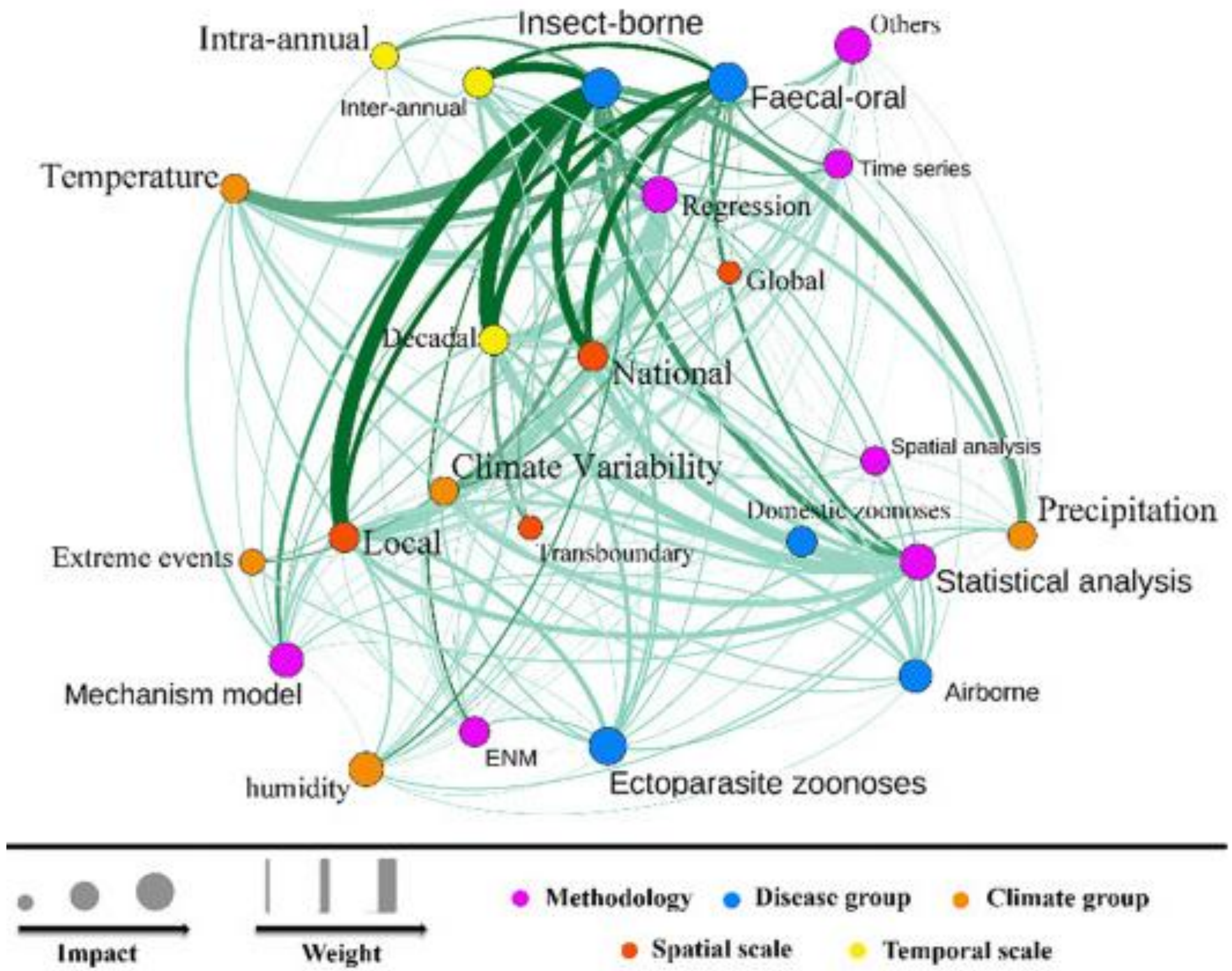
HUMO Wat voor ziekte is chikungunya?

STEVEN VAN DEN BROUCKE (expert tropische ziekten van het Instituut voor Tropische Geneeskunde) «De naam komt uit het Makonde, een taal in Tanzania, en betekent 'kromgebogen mens'. Het verwijst naar één van de belangrijkste symptomen van de ziekte: patiënten krijgen zulke vreselijke gewrichtspijnen dat ze krom beginnen te lopen. Die gewrichtspijnen kunnen weken tot maanden en soms zelfs jaren duren.

»Een specifieke behandeling voor chikungunya is er niet. Je kunt alleen de symptomen bestrijden met pijnstillers, of vocht ▸

'ALS WE NIET SNEL EN ACCURAAT INGRIJPEN, KAN OOK BIJ ONS EEN EPIDEMIE UITBREKEN'

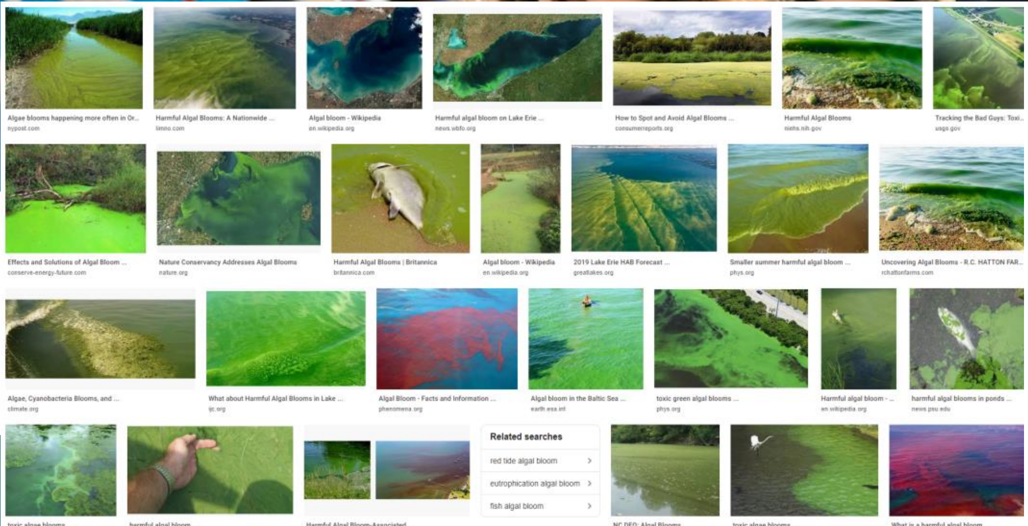
Complex

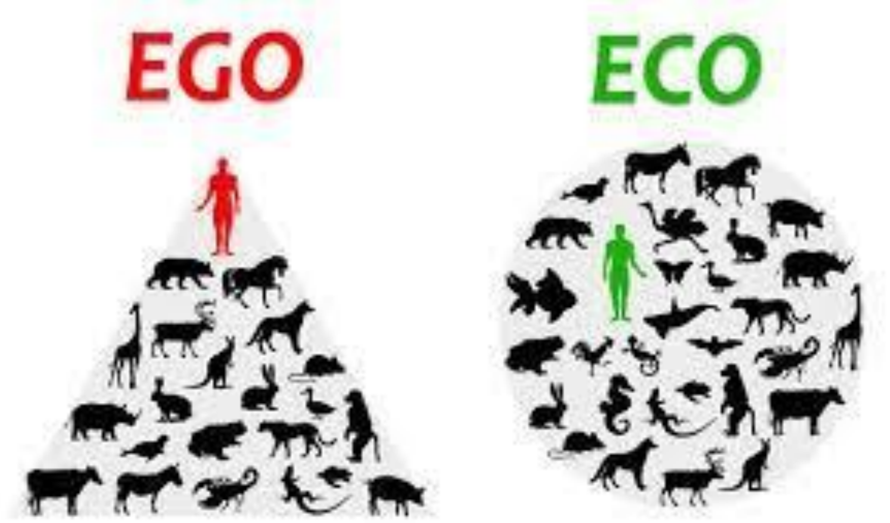


Environment International
Volume 103, June 2017, Pages 99-108

Stop Climate Change now cause we will all die of infectious diseases!!!!

Stop climate Change now but be aware that it is a Complex Multifactorial matter, that the human response to predictions is a priori unpredictable but that the countries with the poorest response capacity will be the biggest victims. That micro-organisms don't always behave as we think they will. That further study and good surveillance is needed and that we should observe, prevent and react but not panic!





Thanks

SVANDENBROUCKE@ITG.BE

INSTITUTE OF TROPICAL MEDICINE ANTWERP

SVANDENBROUCKE@ITG.BE