

# Impact of Climate Change on Infectious Diseases



GENEESKUNDIGE DAGEN UA, 17-9-2021 STEVEN VAN DEN BROUCKE



#### **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

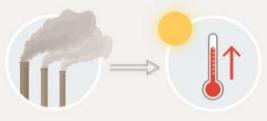
Good surveillance is crucial: observe, don't panic!

#### Increasing Levels of Carbon Dioxide and Short-Lived Climate Pollutants

#### **Rising Temperature**

#### **Rising Sea Levels**

#### Increasing Extreme Weather Events







#### Demographic, Socioeconomic, Environmental, and Other Factors That Influence the Magnitude and Pattern of Risks

Geography
Ecosystem change
Baseline air and water quality
Agricultural and livestock practices
and policies

Warning systems Socioeconomic status Health and nutritional status Access to effective health care

#### **EXPOSURE PATHWAYS**

Extreme Weather Events Heat Stress Air Quality Water Quality and Quantity

Food Supply and Safety Vector Distribution and Ecology Social Factors

#### EXAMPLES OF HEALTH OUTCOMES





- Fatalities
- Mental health effects



Heat-related illness and death



 Exacerbations of asthma and other respiratory diseases

- Respiratory allergies
- Cardiovascular disease



 Campylobacter infection
 Cholera

- Crolera
   Cryptosporidiosis
   Harmful algal
- blooms • Leptospirosis
- 7816777777777



• Undernutrition •

- Salmonella food poisoning and other foodborne diseases
- Mycotoxin effects



Chikungunya

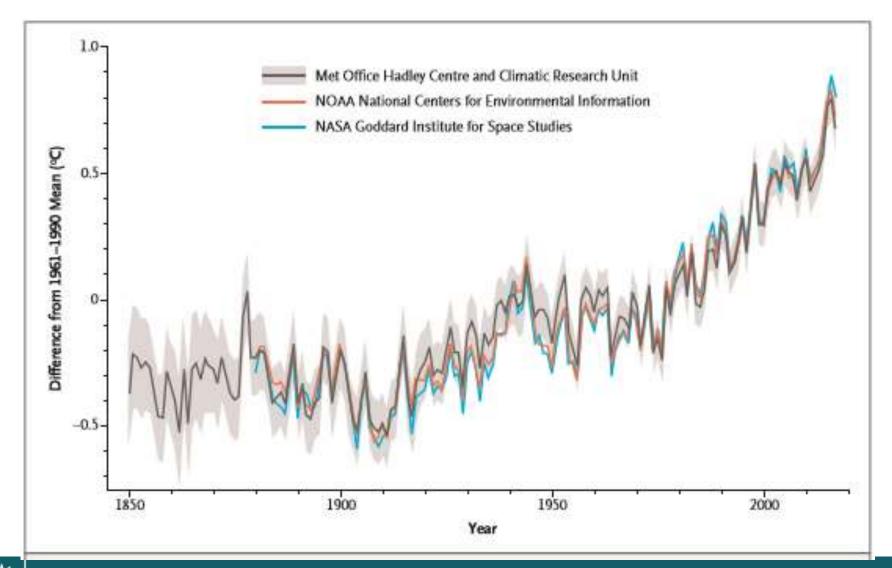
- Dengue
- Encephalitis (various forms)
- · Hantavirus infection
- Lyme disease
  Malaria
  - · Rift Valley fever
  - West Nile virus infection
- Zika virus infection



Physical and mental health effects of violent conflict and forced migration (complex and context-specific risks)



#### **Temperature Evolution**





#### **Temperature Projection**

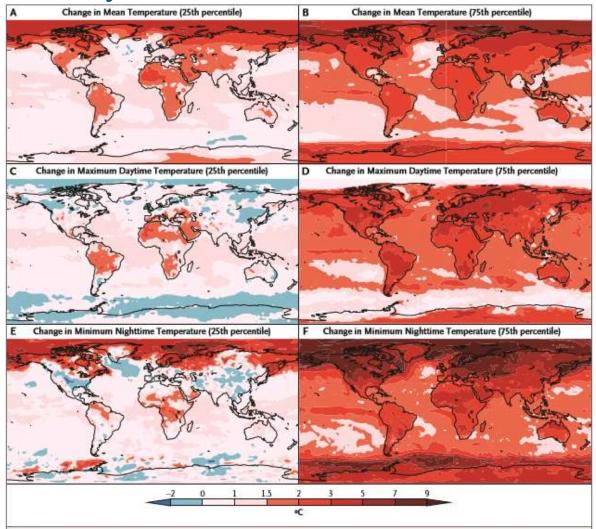
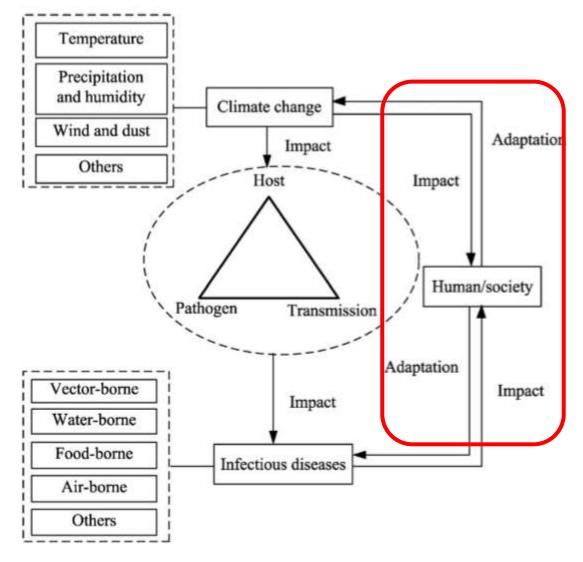


Figure 2. Potential Regional Temperature Changes in a World That Warms to 1.5°C above the Preindustrial Mean Temperature.

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.<sup>13</sup>

## **Impact Climate Change on Infectious Diseases**



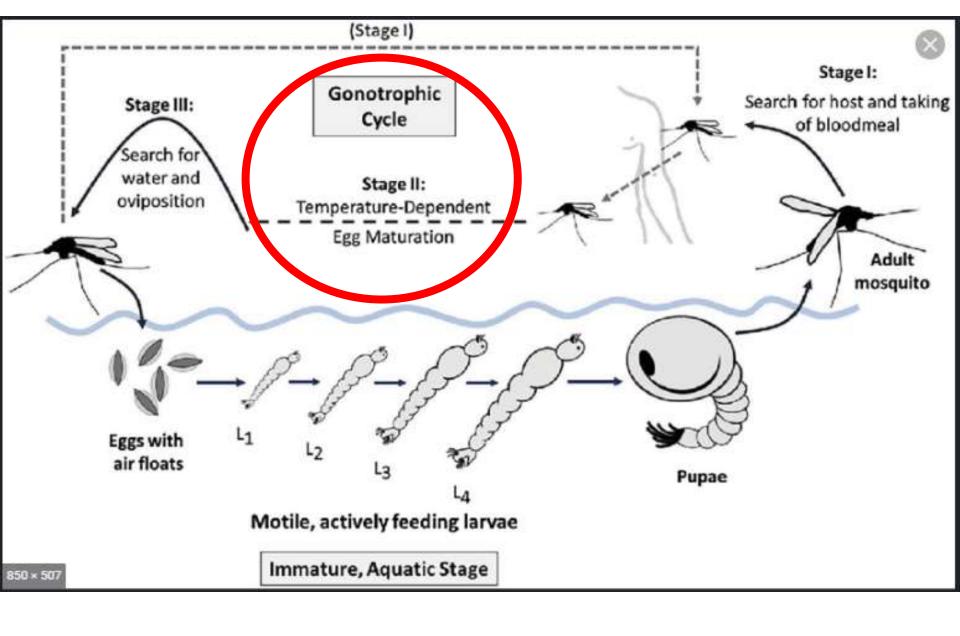
#### **Temperature**

- 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. 个
- Vector/host
  - Insects in low-latitude regions -- > mid- or high latitude regions: expansion
  - China: winter temp. rises -- > Oncomelania  $\uparrow$  -- > Schistosoma japonicum  $\uparrow$  -- > 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

for P.falciparum at 25 ℃ Infective bites Sporogonic cycle of 12 days В В E emergence B: Blood meal Gonotrophic cycle: 2 days E: Ponte Infective blood meal



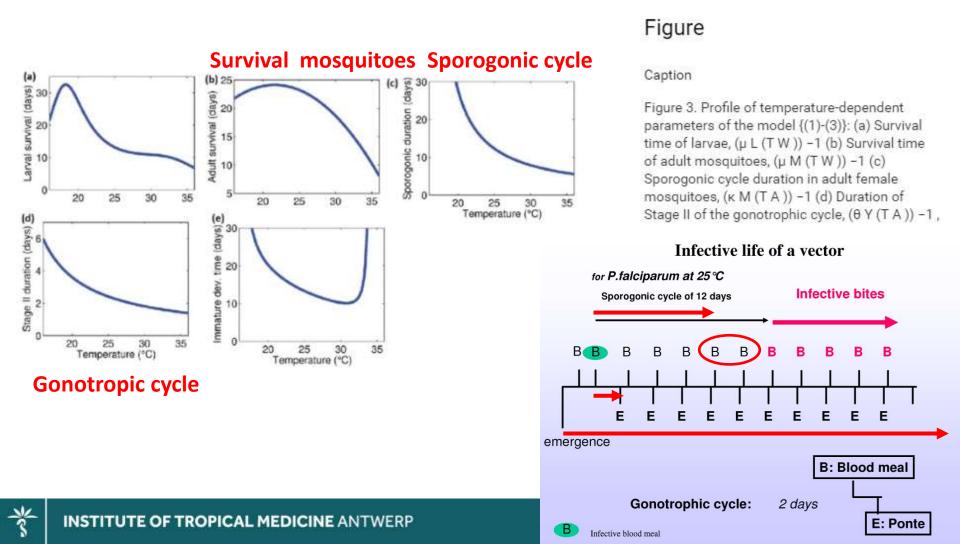




Weather-driven malaria transmission model with gonotrophic and sporogonic cycles

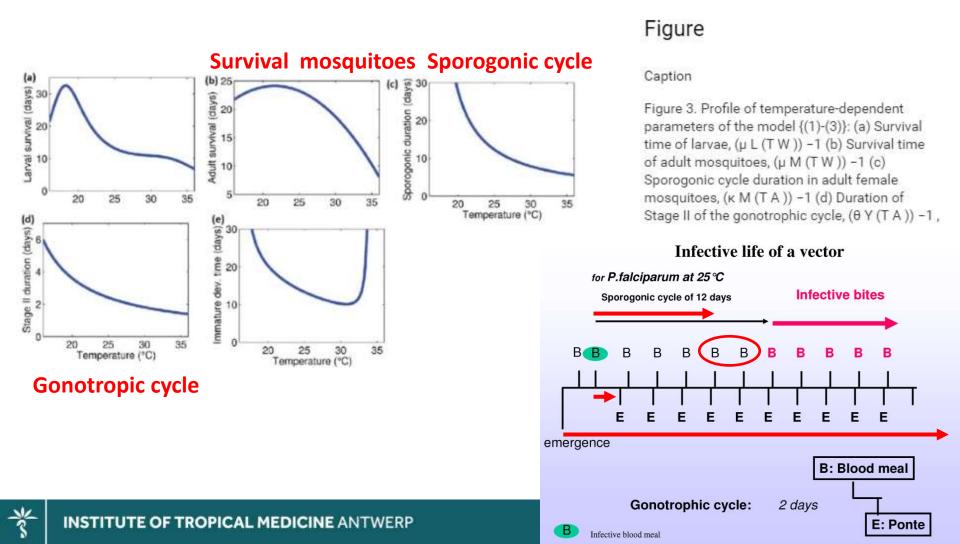
# Weather-driven malaria transmission model with gonotrophic and sporogonic cycles

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



# Weather-driven malaria transmission model with gonotrophic and sporogonic cycles

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

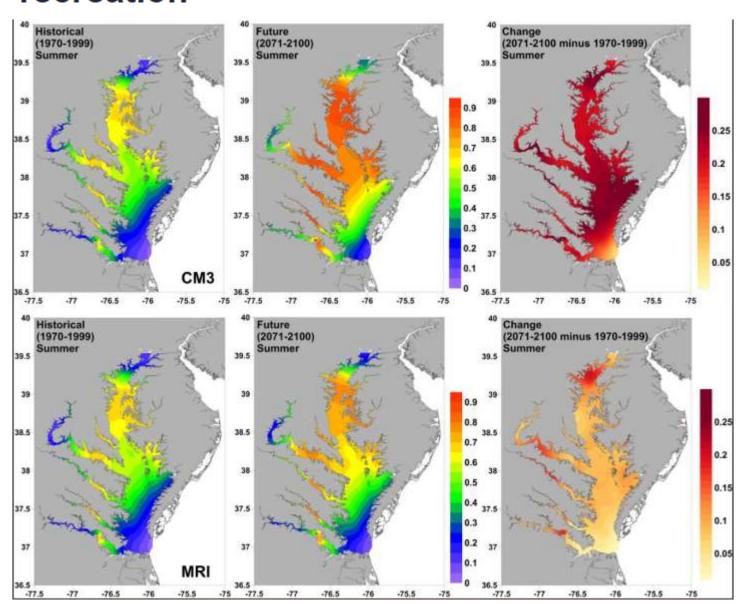


#### **Temperature**

- Pathogen
  - Extrinsic incubation period malaria  $\downarrow$ : 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. 个
- 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



#### **Temperature**

- Pathogen
  - Extrinsic incubation period malaria  $\downarrow$ : 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. 个
- 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



Algae blooms happening more often in Or...
rypost corr



Harmful Algal Blooms: A Nationwide ...



Algal bloom - Wikipedia on wikipedia org



Harmful algal bloom as Lake Erie ... news.wbfi.org



How to Spot and Avoid Algal Blooms ...



Harmful Algal Blooms niets.nit.gov



Tracking the find Guye: Toxi... wags gov



Effects and Solutions of Algai Bloom .... commy-sharpy-falars sees



Nature Conservancy Addresses Algal Blooms seture org



Hamful Algal Blooms | Britannics billarinia core



Algal bloom - Wikipedia en Hikipedia.org



2019 Lake Erie HAB Forecest ... greatlakes.org



Smaller cummer harmful algal bloom ... pkys.org



Uncovering Algal Blooms - R.C. HATTON FAR\_



Algae, Cyanobacteria Blooms, and ...



What about Hamful Algal Blooms in Lake ...



Algal Bloom - Facts and Information ...



Algal bloom in the Baltic Sea ...



toxic green algal blooms ... phys org



Harmful algal bloom - \_ en schoedia arg



harmful algal blooms in ponds ...



toxic algae blooms ...



harmful sigal bloom ...



Humful Algal Bloom-Associated ...



NC DEQ: Algal Blooms deg to pov.



toxic algae blooms .... (above, core



What is a harmful algal bloom ...

#### **Temperature**

- Pathogen
  - Extrinsic incubation period malaria  $\downarrow$ : 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. 个
- Vector/host
  - Insects in low-latitude regions -- > mid- or high latitude regions: expansion
  - China: winter temp. rises -- > Oncomelania  $\uparrow$  -- > Schistosoma japonicum  $\uparrow$  -- > 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



#### REVIEW Open Access

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

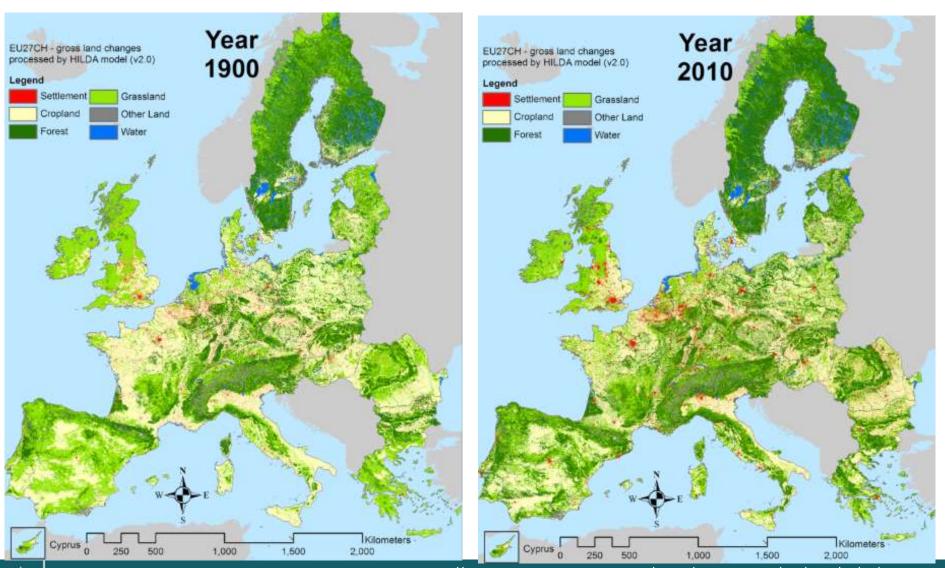
- Northern latitude: moves up
  - Southern latitude: decrease? If humidity decreases -- > less tick survival
- Altitude: higher
- Nymphs and larvae: feed on small rodents and bigger wildlife
- Adult ticks: feed only on big wildlife
- Ticks need +/- 80% humidity





## Reforestation in Europe, 1950 – 2002: +2%

# CO2 stimulates vegetation!!!



### **Tick surveillance**



#### Pathogens transmitted by 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
- TBRL: Tick Born Relapsing Fever (B. duttonii, hermsii,...)





A tularemia lesion on the dorsal skin of the righ

han

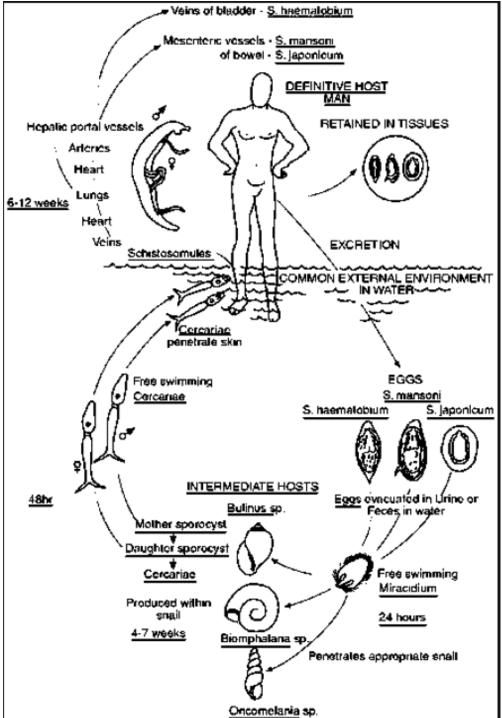
#### **Temperature**

- Pathogen
  - Extrinsic incubation period malaria  $\downarrow$ : 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. 个
- 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**



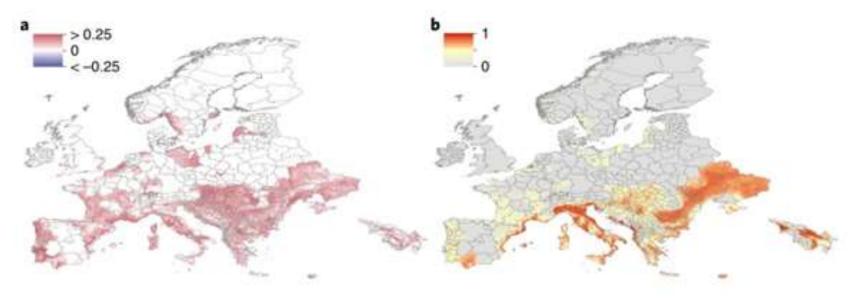


#### **Temperature**

- Pathogen
  - Extrinsic incubation period malaria  $\downarrow$ : 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. 个
- Vector/host
  - Insects in low-latitude regions -- > mid- or high latitude regions: expansion
  - China: winter temp. rises -- > Oncomelania  $\uparrow$  -- > Schistosoma japonicum  $\uparrow$  -- > 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.



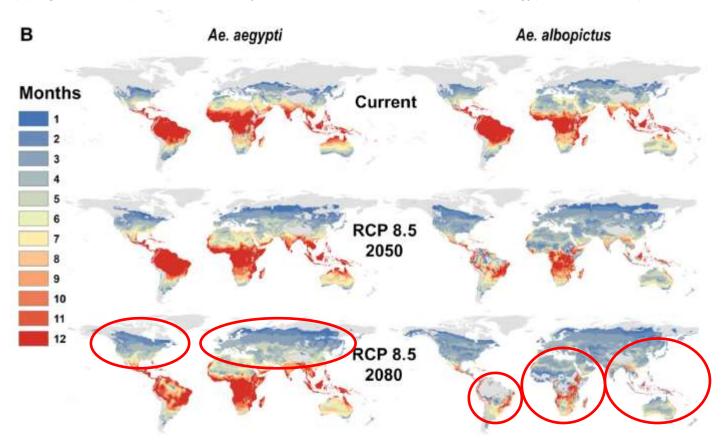
a, The expansion (red) and contraction (blue) of Ae. albopictus between 2020 and 2050 under the medium climate scenario RCP 6.0, with emissions peaking in 2080. b, The predicted distribution of Ae. albopictus and predicted habitat suitability for the presence of Ae. albopictus in 2050. Pixels with no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

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

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

#### Aedes-borne diseases | a model

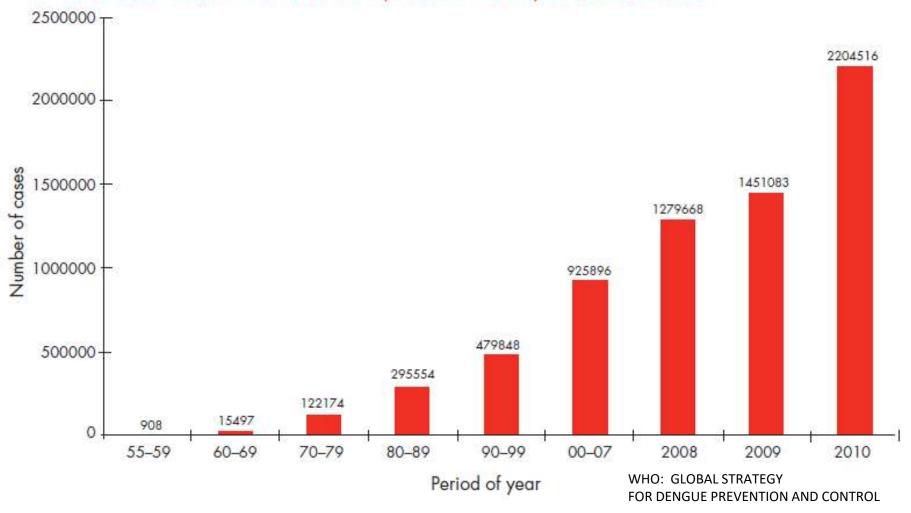
Mapping future temperature suitability for transmission scenarios for Aedes aegypti and Ae. albopictus (most applicable to dengue)



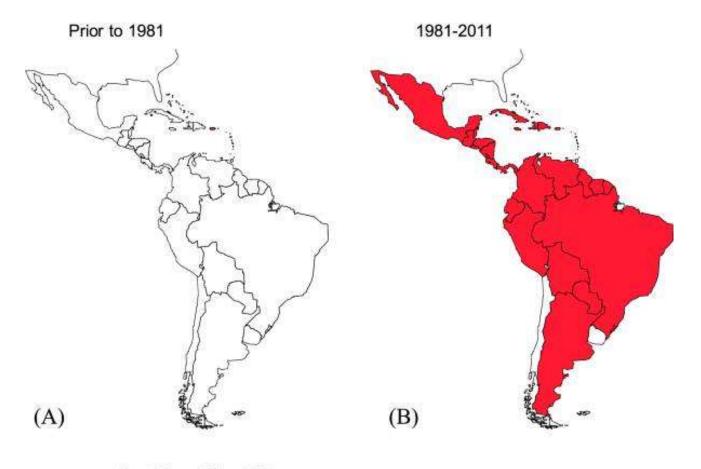
Maps of monthly suitability based on a temperature threshold corresponding to the posterior probability that scaled *R0* > 0 is greater or equal to 97.5%, for transmission by *Ae. aegypti* and *Ae. Albopictus* for predicted mean monthly temperatures under current climate and future scenarios for 2050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

#### **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



## **Spread of Dengue in the Americas**





# Tropical Medicine and Health



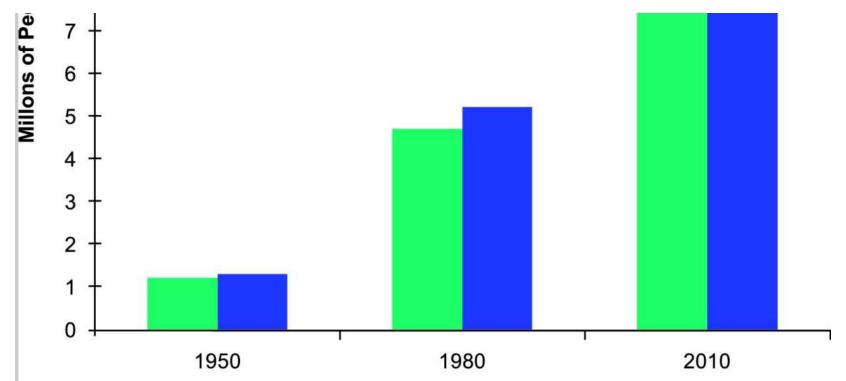
Trop Med Health. 2011 Dec; 39(4 Suppl): 3–11.

Published online 2011 Aug 25. doi: 10.2149/tmh.2011-S05

PMCID: PMC3317603 PMID: 22500131

# Dengue, Urbanization and Globalization: The Unholy Trinity of the 21<sup>st</sup> Century

Duane J. Gubler



- 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



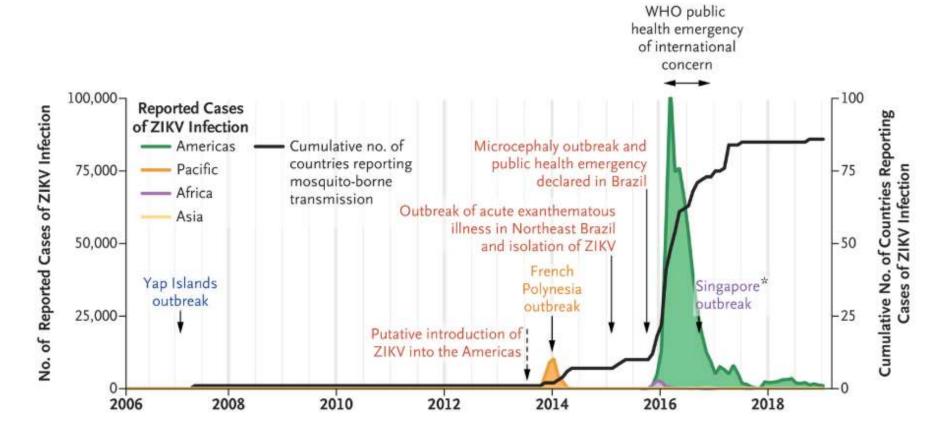






#### Zika

#### Cases of ZIKV Infection



#### **Precipitation**

- Fecal pathogens 个
- But... water scarcity also ↑ diarrhea rates in < 5y: reduced hygiene
- Flooding: hantavirus ↑, leptospirosis ↑

Flooding and the Threat of Infectious Disease



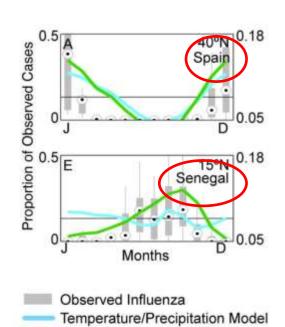
#### **Drought**

- ↑ Concentration of water-borne pathogens (Salmonella,...)
- Rotten organic material accumulate in pools: Culex 个 -- > WNV 个

### **Humidity**

- Cold temperature and relative low humidity: air-borne pathogens like influenza 个
- Anopheles: needs > 60 °C humidity to transmit malaria
- Low humidity: unfavorable for ticks and fleas





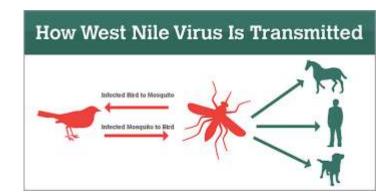
Temperature/Specific Humidity Model

#### **West Nile Virus**

#### Outbreak in USA



- Autums 1999 : sudden mortality in crows and flamingoes in Bronx Zoo,
  New York
- Cases of human encephalitis (67 cases with 7 death)
- How did the virus arrive in the USA?
  - ✓ migrating birds
  - ✓ smuggled birds
  - ✓ lost birds



Followed by a warm winter and summer droughts



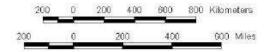


#### West Nile Virus Activity 1999 - 2001

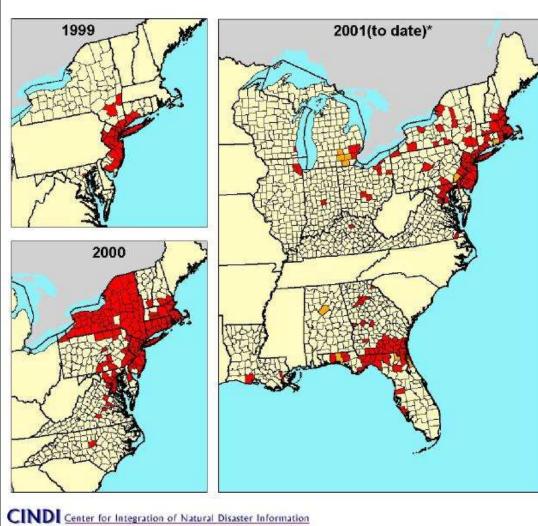
This map shows all counties in the United States that reported West Nile virus activity in 1999 and 2000, as well as current 2001 status. This surveillance includes positive test results from humans, horses, wild birds, sentinel chickens, or mosquitoes.

West Nile Virus Activity Reported to Centers for Disease Control and Prevention and Verified (9/10/01)\*

West Nile Virus Activity Reported by State Agencies (9/7/01)\*

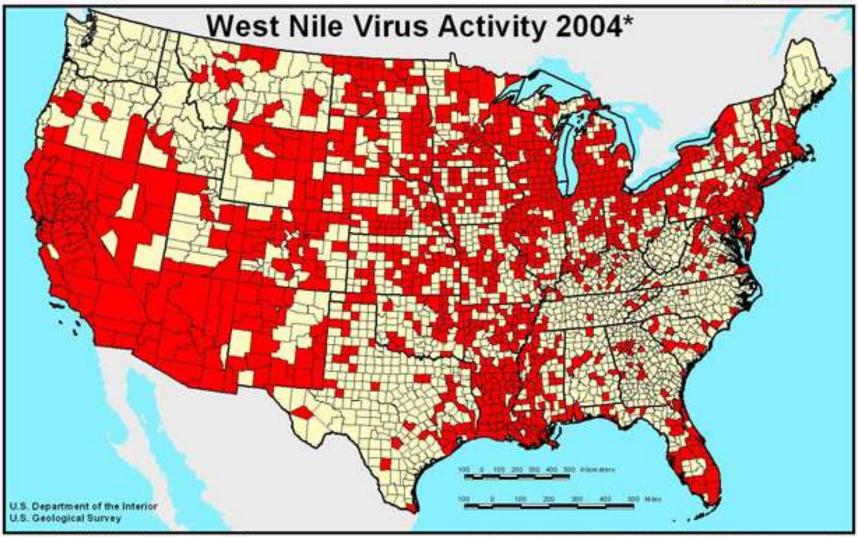


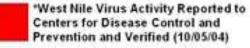
U.S. Department of the Interior U.S. Geological Survey











This map shows all counties in the United States that reported West Nile virus activity in 2004 This surveillance includes positive test results from humans, horses, wild birds, sentinel chickens, or mosquitoes.

#### **Sunshine**

个 Concentration of V. cholera

#### Wind

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

#### Other factors

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

#### **Extreme weather events**

Key studies that assess the relationship between extreme weather events and infectious diseases.<sup>a</sup>

Extreme weather events	Disease type	Authors, year	Main findings
El Nino	Vector-borne disease	Epstein (1999) Haines and Patz (2004)	Increasing outbreaks of emerging diseases were linked to El Nino event.  Outbreaks and epidemic of malaria were positively connected with El Nino events in
		dsay et al. (2000)	many regions.  Strikingly less malaria were found in the El Nino year than in the preceding year in the
		25) et al. (2000)	Usambara Mountains, Tanzania.
		(2000)	Record of hantavirus cardiopulmonary syndrome has been found to be related to El
			Nino events in the Colorado Plateau.
	Wa	VIF -	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	y		ungunya fever epidemic was connected with the drought incurred by La Nina.
			ar produced an epidemic of West Nile fever and Japanese encephalitis.
			cross diarrhea symptom during a La Mina Winter.
Quasi-Biennial Oscillation (QBO)	Vector		be linked to the incidence of Ross River virus in south-eastern
Heatwaves	Vector-borne dise.		threak of West Nile fever in Israel in 2000.
	Air-borne disease	74/10	scially in refugee camps. sulmonary syndrome (HPS).  vould increase, during the
Drought	Water-borne disease	Epste <sub>1</sub> .	ecially in refugee camps.
	Vector-borne disease	Khasnis and	sulmonary syndrome (HPS).
		Wang et al. (2016,	
2007-7-20		Chretien et al. (2007)	h. Ch droughts.
Flood	Water-borne disease	MacKenzie et al. (1994)	Flood Is. S Cryptosporidium infection.
		Reacher et al. (2004)	A significant is. ociated with depth of flooding in
	• • Grant of the order of the control of the contro		the town of Lewes is
	Vector-borne disease	Epstein (1999)	Floods in Mozambique les phoid and cholera
		Mackenzie et al. (2000)	After a fleed such diseases a fleed such din
		Ahern et al. (2005) Woodruff et al. (1990)	After a flood, such diarrheal disease college may grow Increases in diarrhea and malaria incidence were observed after floods in 1988 in
		woodruit et al. (1990)	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.
<i>™</i>	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	
nchocerclasis 90		17.8	17.8 Africa, Latin America		
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		N. 141	Africa, Latin America	Likely	
Japanese encephalitis	4+4	F Y49	East and Southeast Asia	Likely	
Other arbovirsi diseases	- 60	144	Tropical to temperate zones	Likely	

<sup>\*</sup>Data from World Health Organization."



<sup>†</sup>Based on a world population estimated at 4.8 billion (1989).

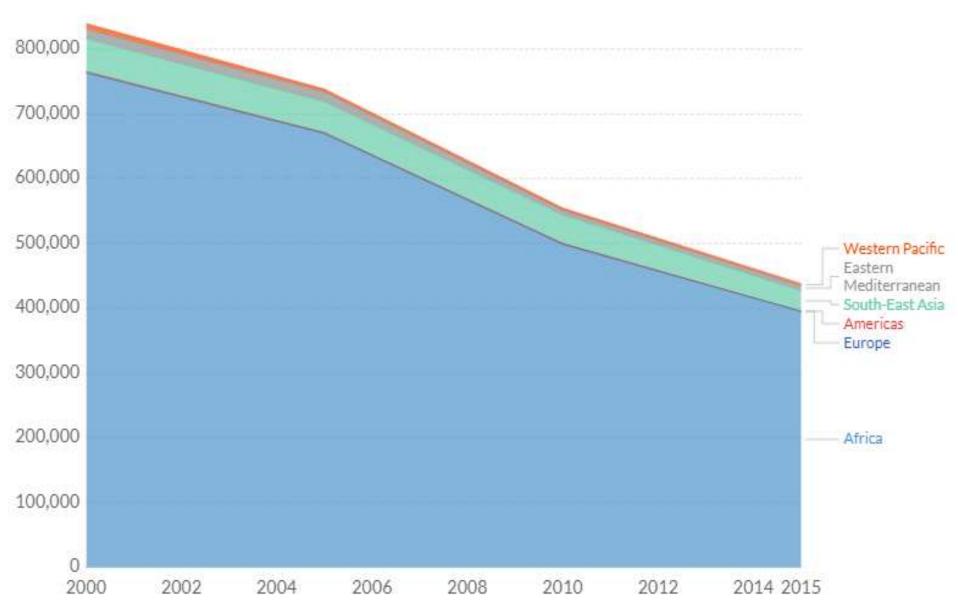
<sup>#</sup>Ellipses indicate no estimates available.

#### **Prediction**



# Global malaria deaths by world region





### **Interactive Map Malaria Incidence**

https://ourworldindata.org/malaria

Status of Major \	Vactor-home	Dispasses and	Predicted	Sensitivity t	o Climate Change*
STATUS OF MURIOR	vecipi-purite	Diagonate di N	T DESCRIPTION	CONTRACTOR OF	C. CHINDOO CHOOLING

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	522	N 144	Africa, Latin America	Likely	
Japanese encephalitis	444	F Y49	East and Southeast Asia	Likely	
Other arboviral diseases	122	144	Tropical to temperate zones	Likely	



<sup>\*</sup>Data from World Health Organization.\*\*
†Based on a world population estimated at 4.8 billion (1989).

<sup>#</sup>Ellipses indicate no estimates available.

#### 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.<sup>16</sup> This is a conser-

#### Cavé: Bias in Media

# BATTY VAN MARKENILE BITTY VAN

#### DE TROPEN IN EUROPA: DE VERRADERLIJKE STREKEN VAN



#### VIRUSSEN, VLEERMUIZEN, TIJGERMUGGEN EN REUZENTEKEN





ên van de insector waar men zich zoe gen over maakt, is de tijgeoraag. die virussen als het dengtie-, elificanguaya-es diavieus op de mens han over orrogen en vanuit het warme naklen naar noordelijker ste ken oprukt. Omdat de tijgermagnek alin one hard is waar genomen, word in 3017 bet project Monitoring van Eastselve Maggen (MEMC) opgestart, on notische maggensourten tijdig op te sporen en te oorhinderen dat av zich hier de finitief vestigen. De coördinator is Wim Van Borlel, insectesdeskundige van het Instituat voor Tropinche Geneedaande

was was correct. Wan de tigerrang of Andreafsquester bebleve we worig jaar op vijf plaatsen in oos land overstig consultation.

in Antwerpen.

grondwaterpeil en straks misschien een verbod om uw zwembad te vullen of uw tain te sproeien, heeft de klimaatverandering nog andere, ouverwachte 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 westnijtziekte af te houden, straks allemaal onder een muskietennet? Het is niet uitgesloten dat het ebolavirus een geschikte gastheer vindt bij onze inheemse vleermuizen.

Behalve verzengende hittegolven, een dalend

gevonden. Omder undere hij een importeur van hedy hondro, een sierhamboe die vooral uit China koon, en in enkele he-

autobanden handelen. Die banden komen uit de hele wereld en de eitjes van de auaggen reisen erin nee. Die wand sten warm niet verrausenik in het verfoden behöret we op die pleikken roti al tjøgermaggen aangetroffen. Nieuw isdat we ze veriej jaar ook geworden behöret op parkretterrierne langs de Stoute du Sodel in Lanzenburg. Welliet, zijn de maggen met de natimogyeried uit Frankrijk of Duckdand, waar ze icht al definitief gevestigt hebben.a staso Waar kord de ligjermag staso Waar kord de ligjermag

WANGATEL, «Že komat userspecenkrijk vit Azië, resur ze haeft undertamen de hale werekt verovert. In topy is ze voorhet erest in Europa oppeleken, in Allunië. In die jamm 100 vertigde ze zich in Halië en in noosin ze voor het overt in Frankrijk, waargenomen. We ziën na dat ze naar noordelijks zerelens op-

isseo is dat een grenig van de klinsastverandering? VAN ROWERL «Flot klimmat speed rober von rot. He weersonstansligheicht in one land zijn op dit zuoment idend voor de tigerman. We hebben nog geen aanwijdengen dat ze hier ontwikkelt, maar dat in in de bedoomst arker niet uitgrobten. Ze kan sich neer geed aanpaster, aan nieuwe-situatien. Ze godijn ni in het Zaid Europe klimmat en is in het hele randiterrater gehiedt it vinden, a saaso Word er na al left.

gedaan om de filgermag te bestrijdes? van soortet, «Als wij se-ergens aanteeffen, meiskes wij dat aan de overheldes en dan moeten zij

actic ondernements state Hote is de Oppermag in horkesteen?

NAM BORTEL «Étet in een kleine, zwarte mag met wilte strepen op de poten en de rug. Ze wordt noms verward met de inheem-

ar mag, die ook streepjes op de peten heeft, maar die wel groter is

of hit grate wounded toot the many die wij kornen, in dat de liger may overdag as the fire. Dat mank thane extra verschend, a nano Walter not spooff that klimsat hij die opmars van noorten sin die liggermag! Heibben ze worde nodig een te karnen overleven? Aan norma, ode ontwikke-

her idels in towe welcers van et ig-over larve tot mag, Ab het waren is, gad het det neellen. Ook het virus in de mig zol nich dan medler versamigend-digen. Maar vers mag heeft ook water molig, for ook het dirige morer zoak vorig jaar krussen er ook minder enzgen zijn, eneeld er enzydskersle broest planten zijn.

ruse De tijgermug is voord gevaarlijk omdat het virusse aan de mens kan doorgeven, war somtet, «Ze meet daarvoor wel eerst iemand steken die met het virus beurset is.

Voir een ouwellacht morten de drager van het virus en de litjeermag nich ook op betoeff de moment op den fille plaats bevinden. Op dit moment in de kann op een inderie zeer klein. Maar als we in de toekorret een grote pequidate tijpermaggen ouden krijen, neem die leans

numo Komen de virussen die de tigermug kan overtrempen nu al in Europa voor?

www.borth. «Van het ehikunganywirms eijner alven paar uitherden gewend. De heidend ete zijn die in Italië in 2007 en 2007, omfalt been ook de meeste gewallen werden gerapportoerd. Het ging in 2007 om ongewer vierhensderd geluifetrenden, dat in och een redelijkt grote uitheask. In Frankrijk zijn er ook een paar geweed, maar daar hebben te die beter kunnen indijken, of vroeger kunnen detectoren.»

Huseo Wat voor giekte is chikumgaryo?

communicative.

INTANE AND SER MEDICACE forport tropics for infektor van.

He Instillant voor Tropische
Generokunde de saam komt di

He Makende voor Tropische
Generokunde de saam komt
di het Makende, om taal in
Tantannia, on beeldere Kronsgebogen neuen. Het voer wijs
maar ein van de belangrijksie vynspinsen van de elektupatikenen kriigen make vruseigke geweichengienen dat se
krons begrinzen te legen. Die
geweichengiene haaren weken het maanzhoven nomm mildi

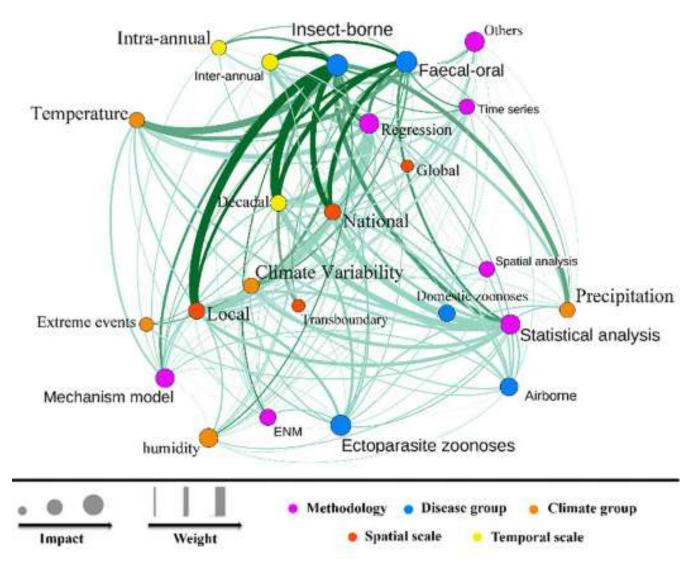
intern duren.

sken specificke behandeling voor chikungunya is er niet. Je kunt alten de symptomen beste jilen met pijantillers, of vocht

## 'ALS WE NIET SNEL EN KAN OOK BIJ ONS EEN

ACCURAAT INGRIJPEN, EPIDEMIE UITBREKEN'

#### **Complex**





#### **Thanks**

