HEALTH IMPACTS OF CLIMATE CHANGE

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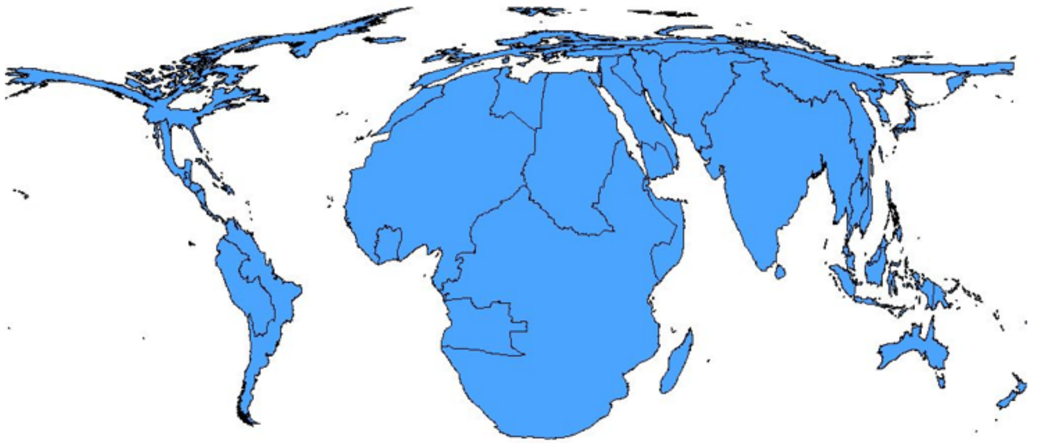
Effects of CC on health are inequally distributed

Greenhouse gaz emissions
(cumulative data up to 2000)



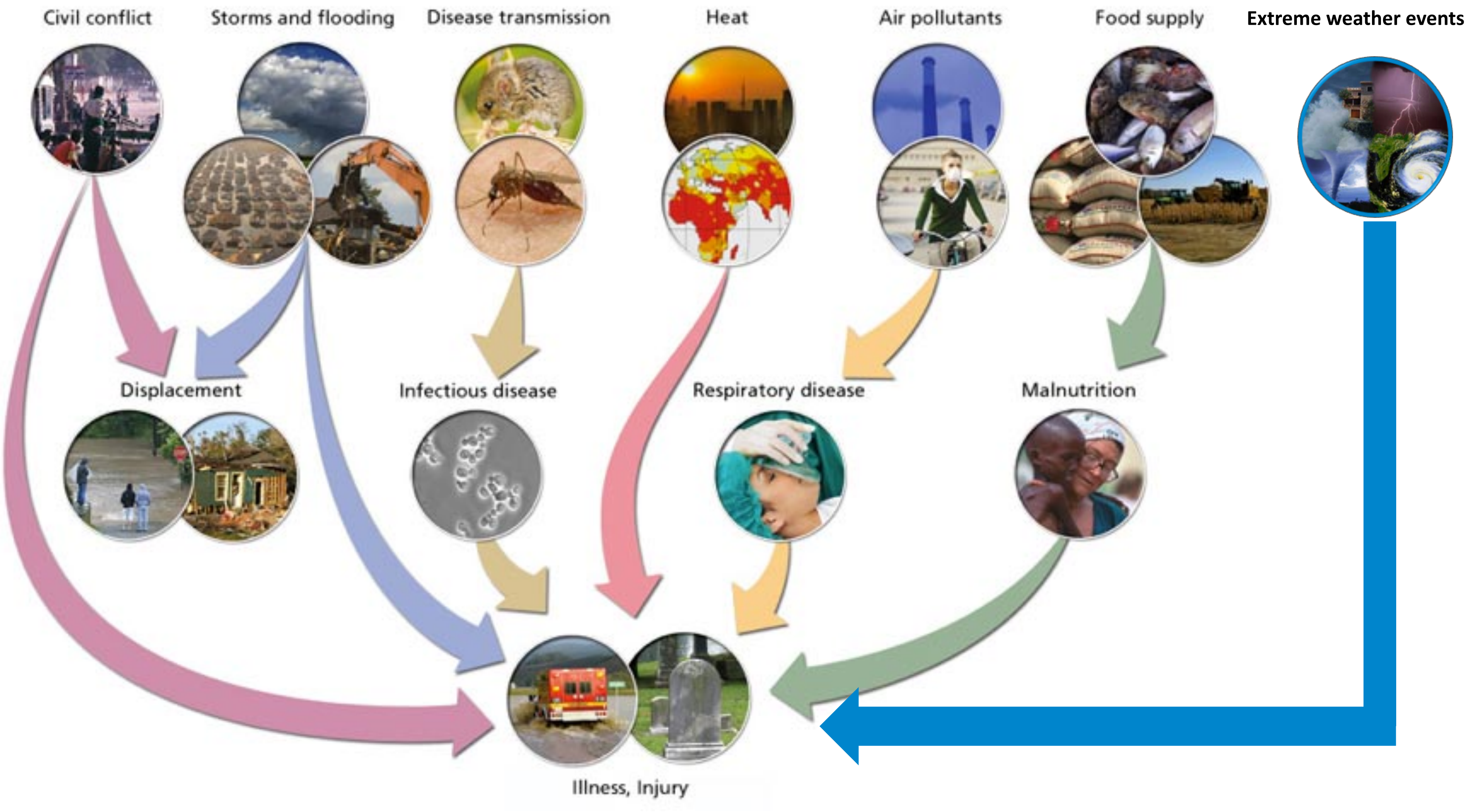
Attributable death to climate change

WHO, 2000

Map projections from Patz et al, 2007; WHO, 2009.

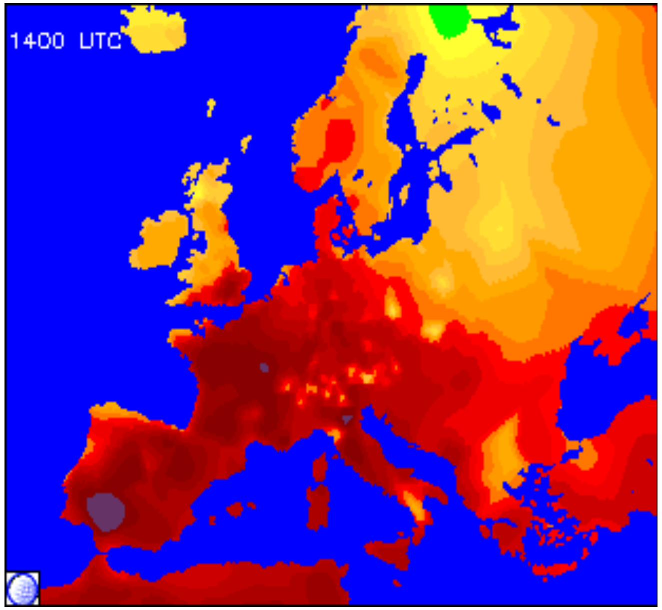
Estimated annual deaths due to climate change from:
malnutrition (~80K), diarrhoea (~50K), malaria (~20K), flooding (~3K)

Impacts on health



France, August 2003

~15000 deaths (~70,000 in Europe) Robine et al 2007



Temperature distribution across Europe on 10 August 2003 at 1500hrs

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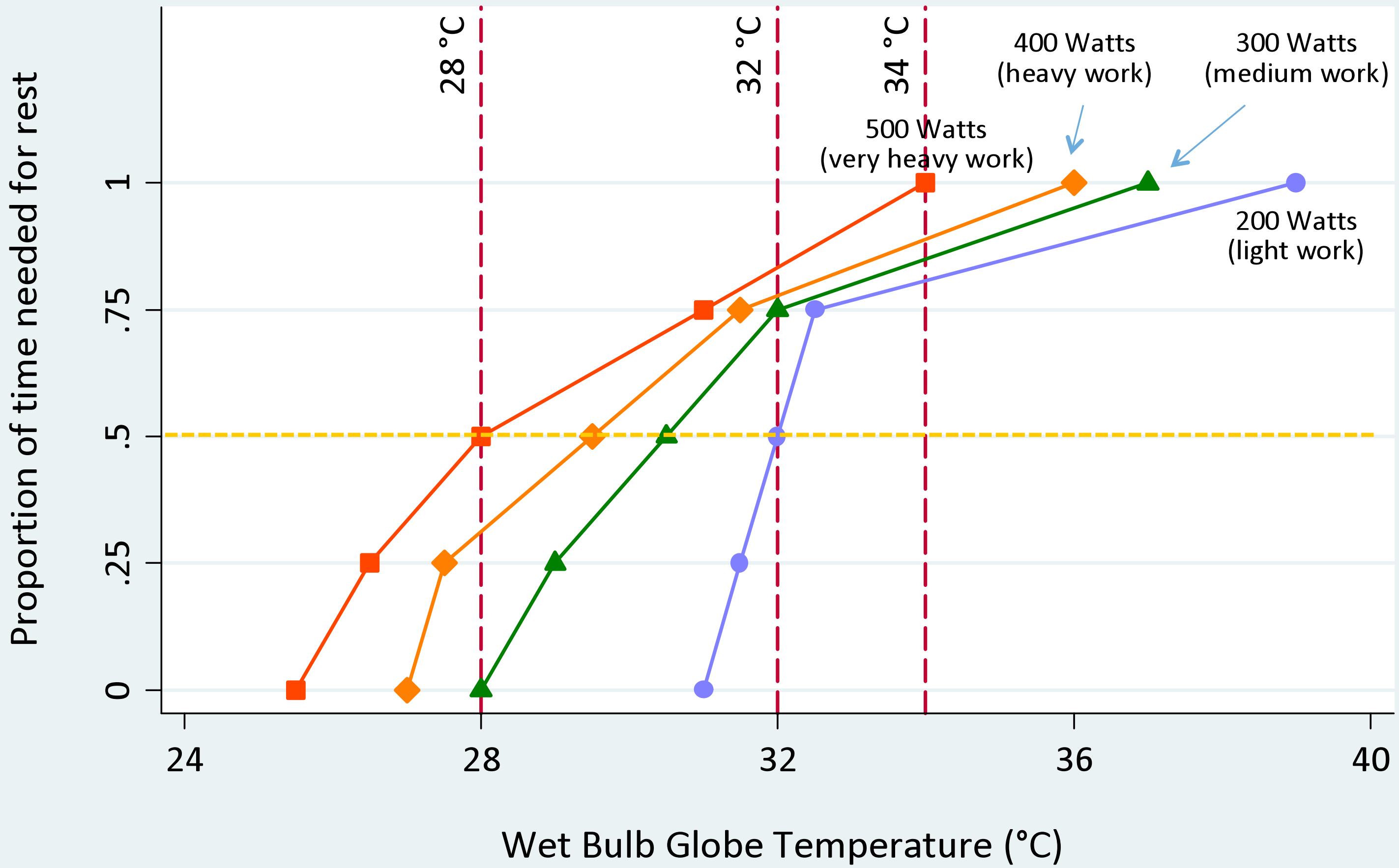
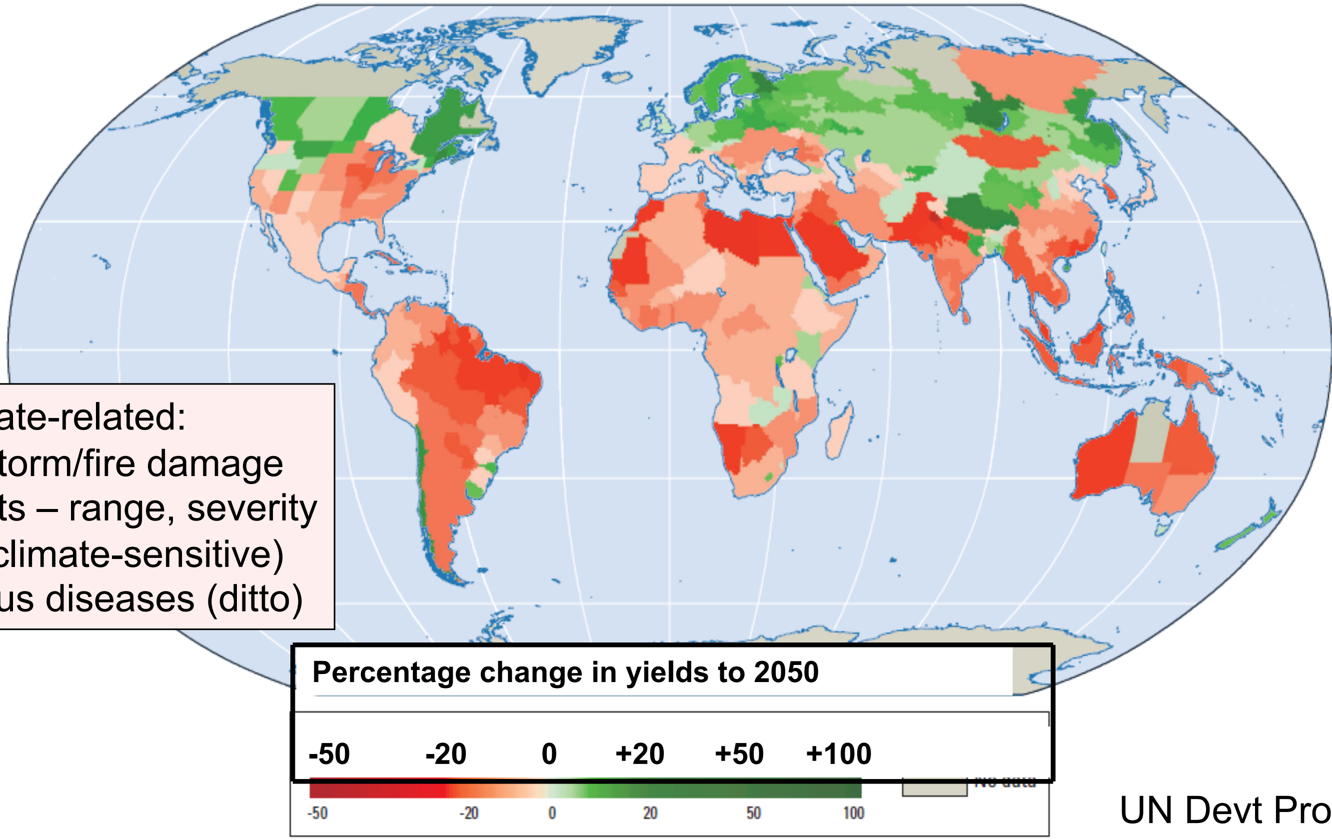
Possible work intensity as a function of temperature

Source: Kjellstrom T et al, Global Health Action 2009. DOI: 10.3402/gha.v2i0.2047



CLIMATE CHANGE: Poor Countries Projected to Fare Worst MODELLED CHANGES IN CEREAL GRAIN YIELDS, TO 2050



Plus climate-related:

- Flood/storm/fire damage
- Droughts – range, severity
- Pests (climate-sensitive)
- Infectious diseases (ditto)

UN Devt Prog, 2009

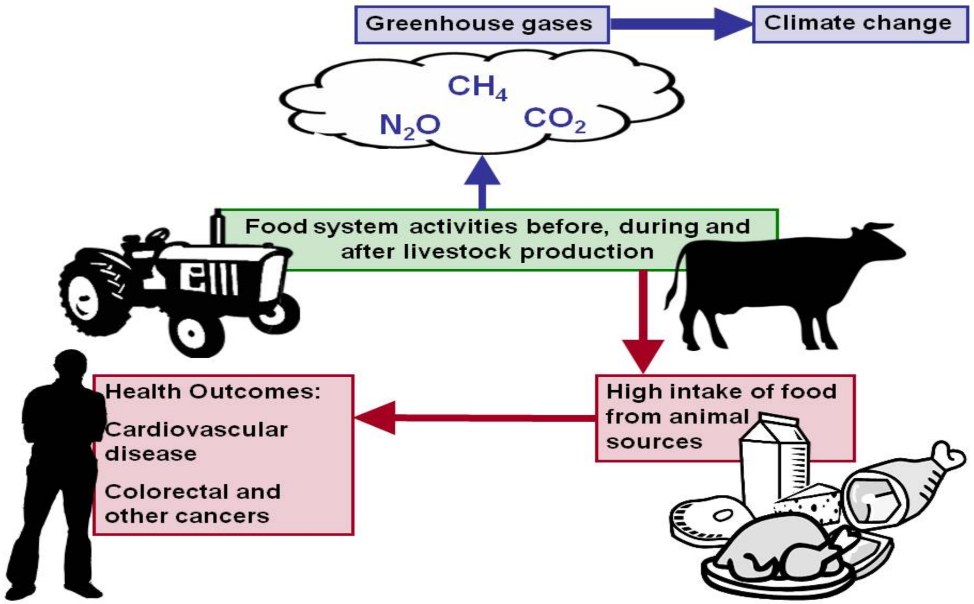
Effects on malnutrition

Increased numbers of stunted children

Lloyd S, Kovats RS, Chalabi Z (2011)

Region	Millions of additional children with stunting in 2050 due to climate change	
	NCAR climate scenario	CSIRO climate scenario
South Asia	7	6
Sub-Saharan Africa	9	9

Food and Agriculture Sector



- 80% of total emissions in sector from livestock production
- Reducing animal source saturated fat by 30 % and replacing it with polyunsaturates could reduce heart disease deaths by ~ 15% (~ 18,000 premature deaths) in the UK

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New technologies for clean energy

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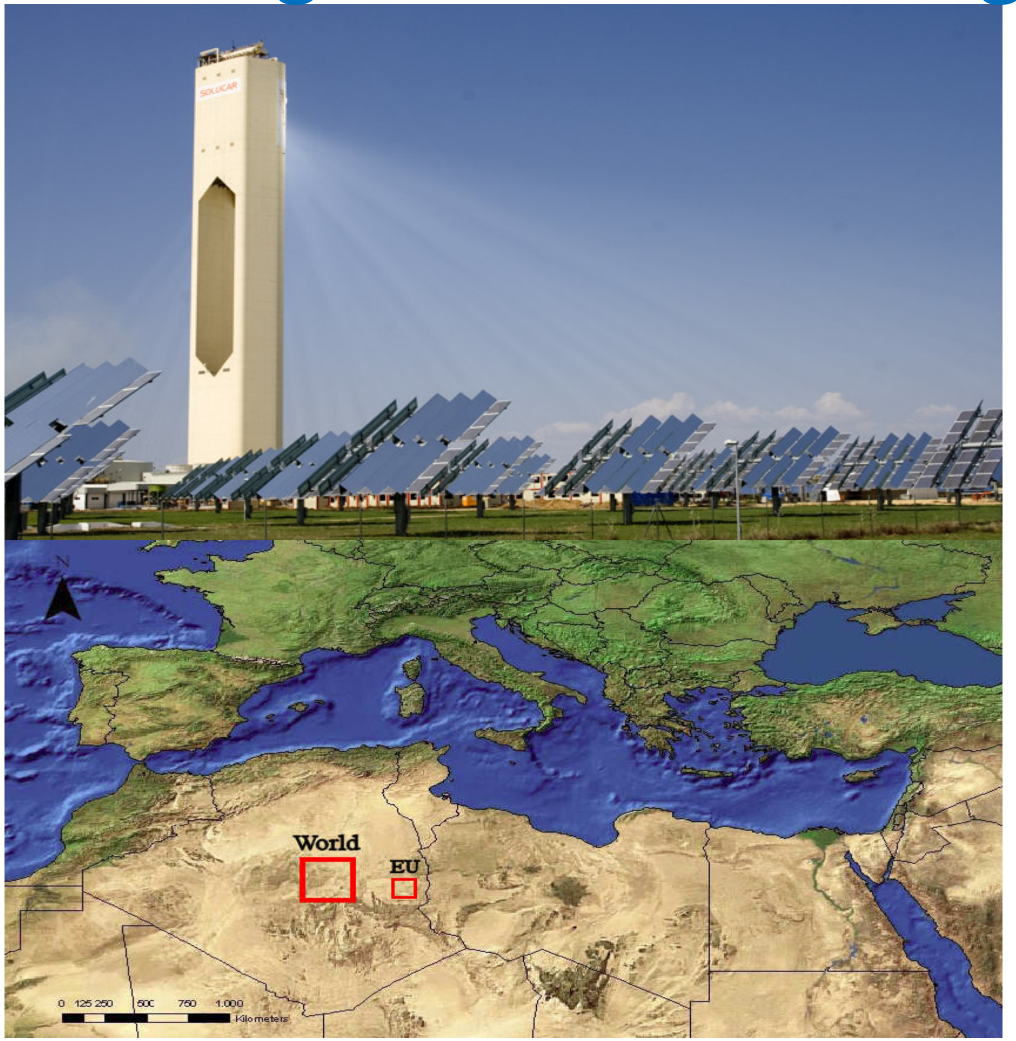

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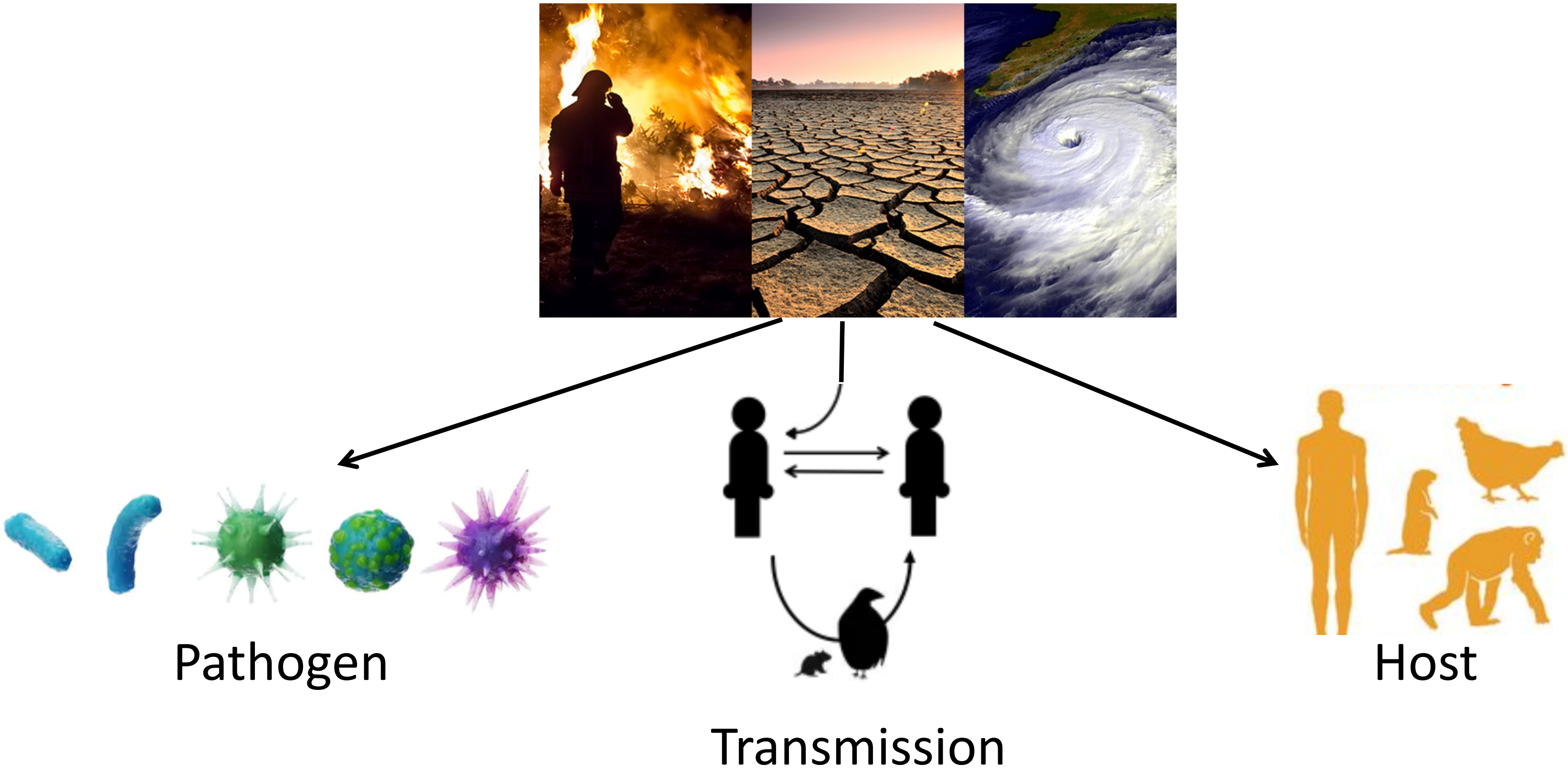
Climate Change and Infectious Diseases



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Climate Change and Transmission routes

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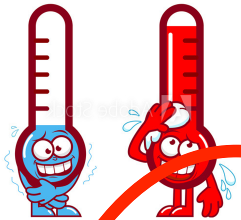
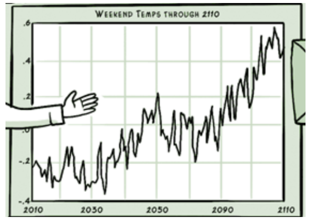
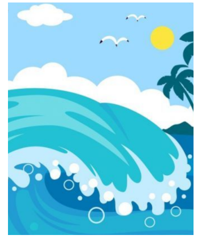
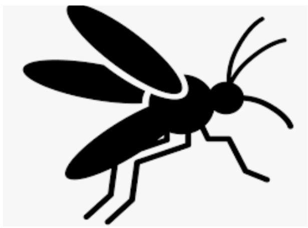
Temperature *Precipitations* Humidity *Extreme Events* Climate variability *Ocean*









Insect-borne

Fecal-oral

Airborne

Zoonoses

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Precipitations and diarrheal diseases

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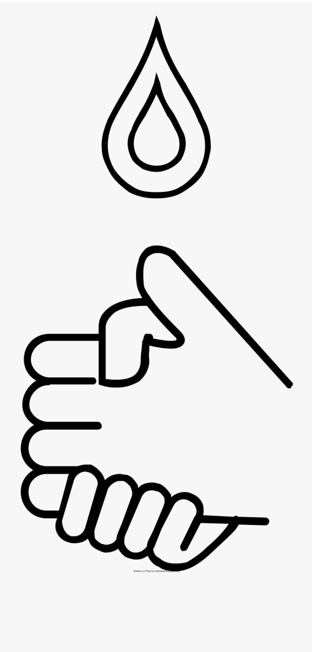
- Global overview of 36 published reports from LMICs from 1954-2000 (Lloyd, Kovats, Armstrong. Climate Res 2007)



- 4% (1-7%) increase in diarrhoea incidence in children aged <5 per 10 mm /month decrease in rainfall
- Reduced effect of hand washing where rainfall is low?

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Climate variability and Infectious Diseases

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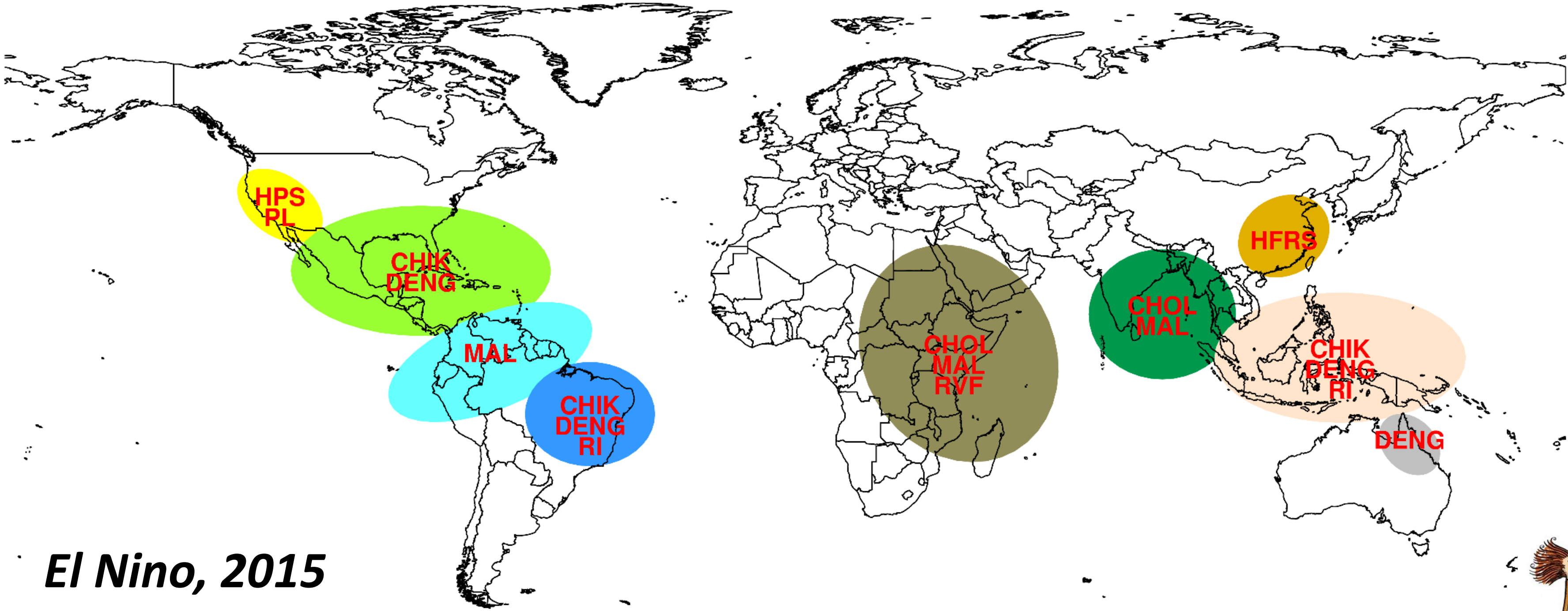
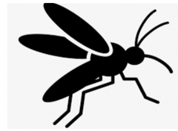
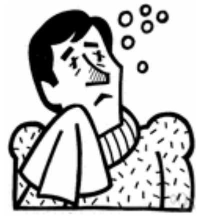
Hotspots of Potential Elevated Risk for Disease Outbreaks: 2014-2015







El Nino, 2015

CHIK Chikungunya
CHOL Cholera
DENG Dengue Fever

HFRS Hemorrhagic Fever with Renal Syndrome
HPS Hantavirus Pulmonary Syndrome
MAL Malaria

PL Plague
RI Respiratory Illness
RVF Rift Valley Fever

Chretien, 2015

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La Niña and Influenza

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PNAS PNAS

The El Niño–Southern Oscillation (ENSO)–pandemic Influenza connection: Coincident or causal?

Jeffrey Shaman[a,1] and Marc Lipsitch[b]

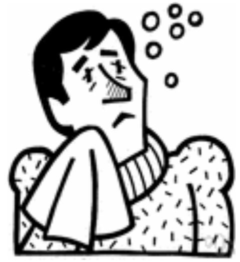
[a]Department of Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, NY 10032; and [b]Center for Communicable Disease Dynamics, Harvard School of Public Health, Harvard University, Boston, MA 02115

Edited by Rita R. Colwell, University of Maryland, College Park, MD, and approved September 19, 2011 (received for review May 26, 2011)

We find that the four most recent human influenza pandemics (1918, 1957, 1968, and 2009), all of which were first identified in boreal spring or summer, were preceded by La Niña conditions in the equatorial Pacific. Changes in the phase of the El Niño–Southern Oscillation have been shown to alter the migration, stopover time, fitness, and interspec… affect their … La Niña condi… some parts o… through simu… the generatio… to test this h… prevalence in…

Niño 3.4 region (5°S–5°N, 170°–120°W) as our measures of ENSO (13). These ENSO SST anomaly values were calculated for the fall and winter seasons preceding each pandemic emergence, and the mean of these four values was also determined to create a pandemic year average.

All four pandemics were preceded by below normal SSTs in the



European Journal of Epidemiology **19**: 1055–1059, 2004.

Association of influenza epidemics with global climate variability

Cécile Viboud[1,2], Khashayar Pakdaman[1], Pierre-Yves Boëlle[1], Mark L. Wilson[3], Monica F. Myers[4], Alain-Jacques Valleron[1] & Antoine Flahault[1,2]

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La Niña and Influenza

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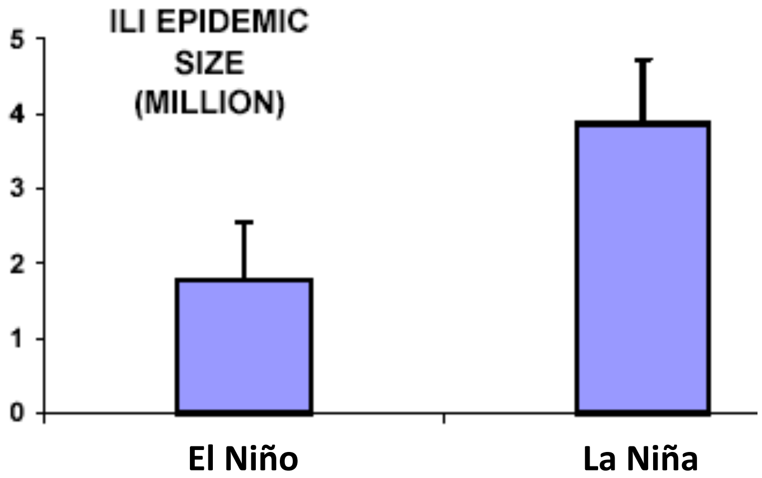
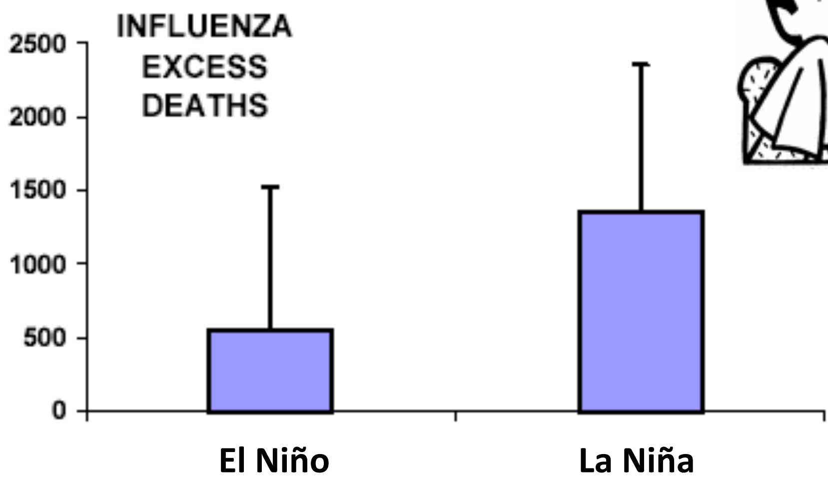


P=0.001



P=0.017

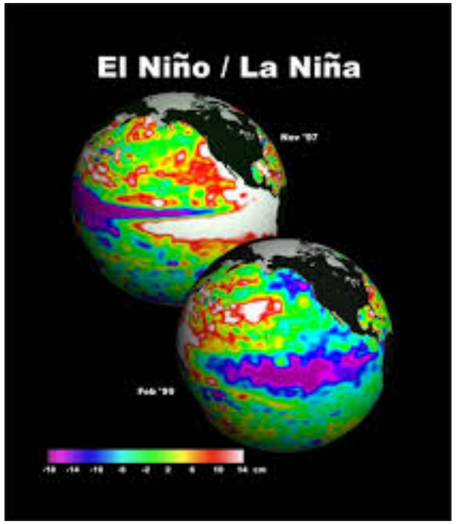
67% of variability of the size of epidemics
is explained by subtypes of prevailing viruses and climate indicator (ENSO)

Flahault et al. Int C Series, 2004

NATURE CLIMATE CHANGE | LETTER

Increasing frequency of extreme El Niño events due to greenhouse warming

Wenju Cai, Simon Borlace, Matthieu Lengaigne, Peter van Rensch, Mat Collins, Gabriel Vecchi, Axel Timmermann, Agus Santoso, Michael J. McPhaden, Lixin Wu, Matthew H. England, Guojian Wang, Eric Guilyardi & Fei-Fei Jin



PNAS

Historical change of El Niño properties sheds light on future changes of extreme El Niño

Bin Wang[a,b,1], Xiao Luo[a], Young-Min Yang[a,b], Weiyi Sun[c,d,e], Mark A. Cane[f], Wenju Cai[g,h], Sang-Wook Yeh[i], and Jian Liu[c,d,e]

[a]Department of Atmospheric Sciences and International Pacific Research Center, University of Hawaii, Honolulu, HI 96822; Nanjing University of Information Science and Technology, 210044 Nanjing, China; [c]Key Laboratory for Virtual Geograph Education, Nanjing Normal University, 210023 Nanjing, China; [d]State Key Laboratory Cultivation Base of Geographical Er Province, Nanjing Normal University, 210023 Nanjing, China; [e]Jiangsu Center for Collaborative Innovation in Geographica Development and Application, School of Geography Science, Nanjing Normal University, 210023 Nanjing, China; [f]Departm Sciences, Lamont–Doherty Earth Observatory of Columbia University, Palisades, NY 10964; [g]Institute for Advanced Ocean Laboratory for Marine Science and Technology, 266003 Qingdao, China; [h]Centre for Southern Hemisphere Oceans Research Hobart 7004, Australia; and [i]Department of Marine Science and Convergent Technology, Hanyang University, 15588 Ans

Edited by Brian John Hoskins, Imperial College London, London, United Kingdom, and approved September 19, 2019 (re

SCIENCE ADVANCES | RESEARCH ARTICLE

CLIMATOLOGY

Weakening Atlantic Niño–Pacific connection under greenhouse warming

Fan Jia[1], Wenju Cai[2,3]*, Lixin Wu[2]*, Bolan Gan[2], Guojian Wang[2,3], Fred Kucharski[4], Ping Chang[5], Noel Keenlyside[6,7]

Sea surface temperature variability in the equatorial eastern Atlantic, which is referred to as an Atlantic Niño (Niña) at its warm (cold) phase and peaks in boreal summer, dominates the interannual variability in the equatorial Atlantic. By strengthening of the Walker circulation, an Atlantic Niño favors a Pacific La Niña, which matures in boreal winter, providing a precursory memory for El Niño–Southern Oscillation (ENSO) predictability. How this Atlantic impact responds to greenhouse warming is unclear. Here, we show that greenhouse warming leads to a weakened influence from the Atlantic Niño/Niña on the Pacific ENSO. In response to anomalous equatorial Atlantic heating, ascending over the equatorial Atlantic is weaker due to an increased tropospheric stability in the mean climate, resulting in a weaker impact on the Pacific Ocean. Thus, as greenhouse warming continues, Pacific ENSO is projected to be less affected by the Atlantic Niño/Niña and more challenging to predict.

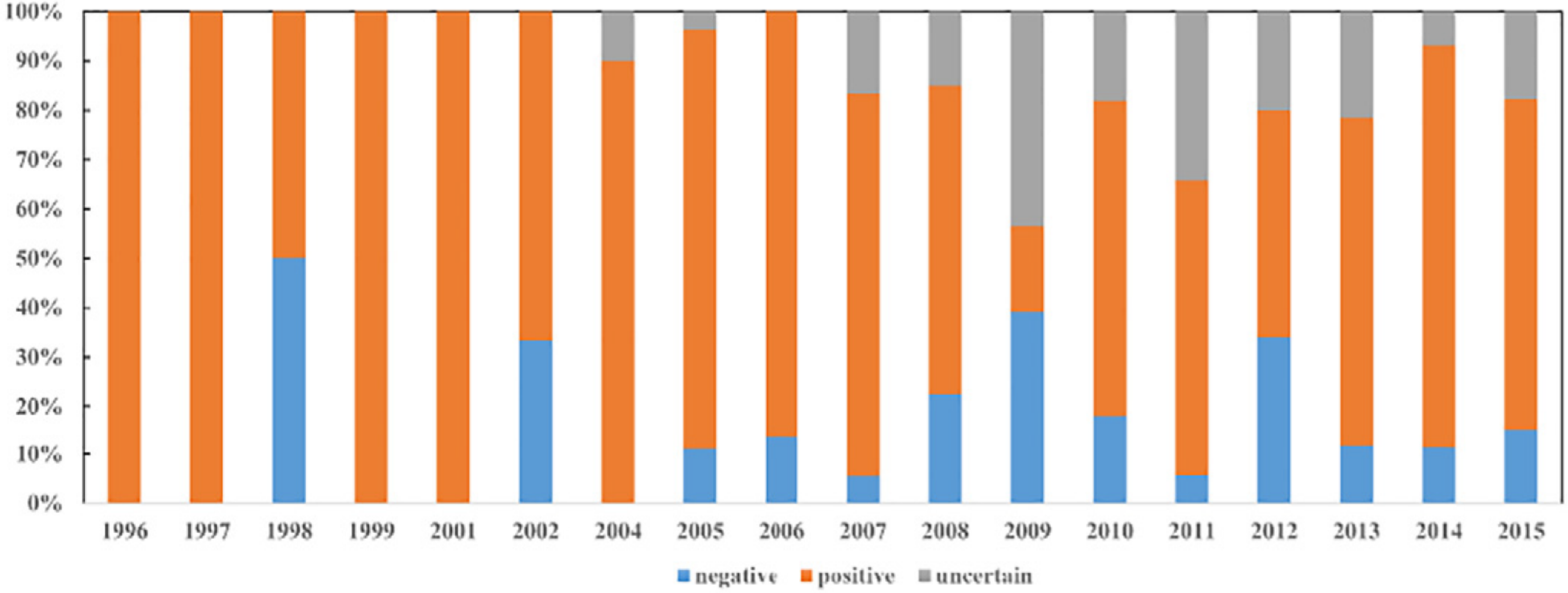
Increased frequency of extreme La Niña events under greenhouse warming

Wenju Cai, Guojian Wang, Agus Santoso, Michael J. McPhaden, Lixin Wu, Fei-Fei Jin, Axel Timmermann, Mat Collins, Gabriel Vecchi, Matthieu Lengaigne, Matthew H. England, Dietmar Dommenget, Ken Takahashi & Eric Guilyardi

Affiliations | Contributions | Corresponding author

Nature Climate Change **5**, 132–137 (2015) | doi:10.1038/nclimate2492
Received 29 July 2014 | Accepted 02 December 2014 | Published online 26 January 2015

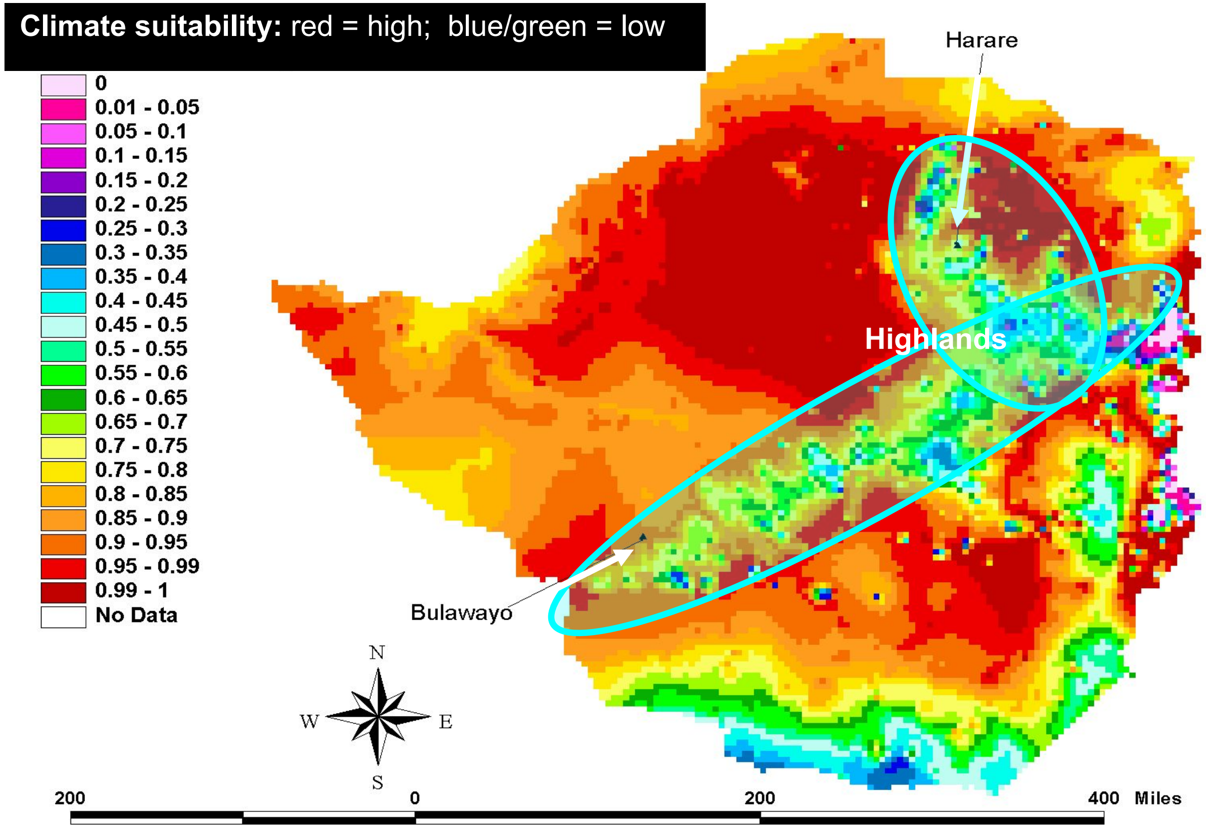
Literature trends: towards controversies



(Source Liang, 2017)

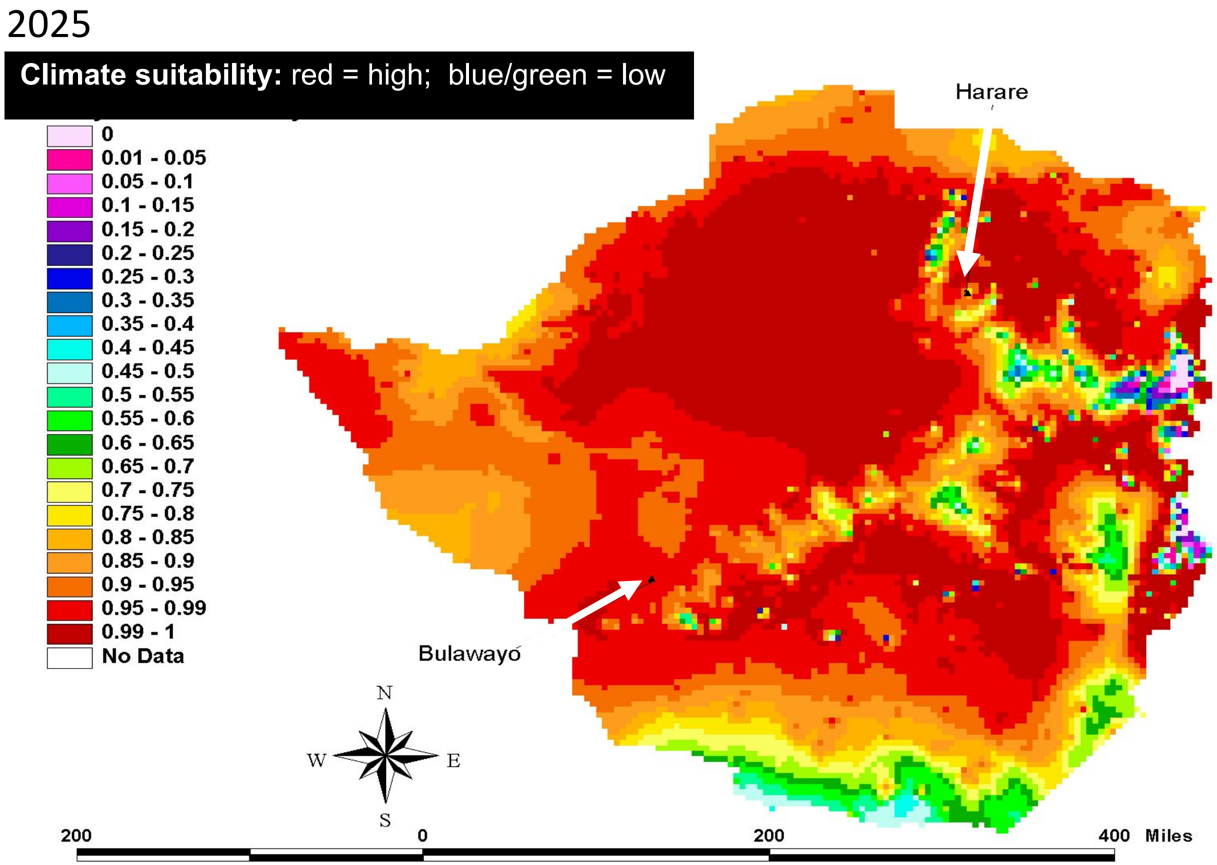
In 2000, Highlands were free from malaria in Zimbabwe

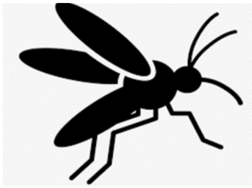
Baseline 2000



Source: Ebi et al., 2005

In 2025, Highlands will no more be malaria-free in Zimbabwe





Source: Ebi et al., 2005

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Yes, but: In the meantime, malaria is dramatically declining…

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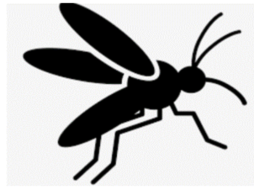
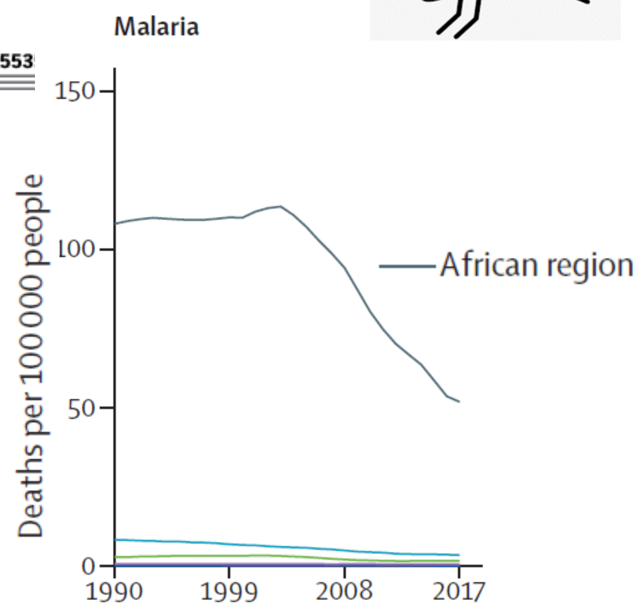


ARTICLE

doi:10.1038/nature1553

The effect of malaria control on *Plasmodium falciparum* in Africa between 2000 and 2015

S. Bhatt[1]*, D. J. Weiss[1]*, E. Cameron[1]*, D. Bisanzio[1], B. Mappin[1], U. Dalrymple[1], K. E. Battle[1], C. L. Moyes[1], A. Henry[1], P. A. Eckhoff[2], E. A. Wenger[2], O. Briët[3,4], M. A. Penny[3,4], T. A. Smith[3,4], A. Bennett[5], J. Yukich[6], T. P. Eisele[6], J. T. Griffin[7], C. A. Fergus[8], M. Lynch[8], F. Lindgren[9], J. M. Cohen[10], C. L. J. Murray[11], D. L. Smith[1,11,12,13], S. I. Hay[11,13,14], R. E. Cibulskis[8] & P. W. Gething[1]



Source: Lancet Countdown., 2019

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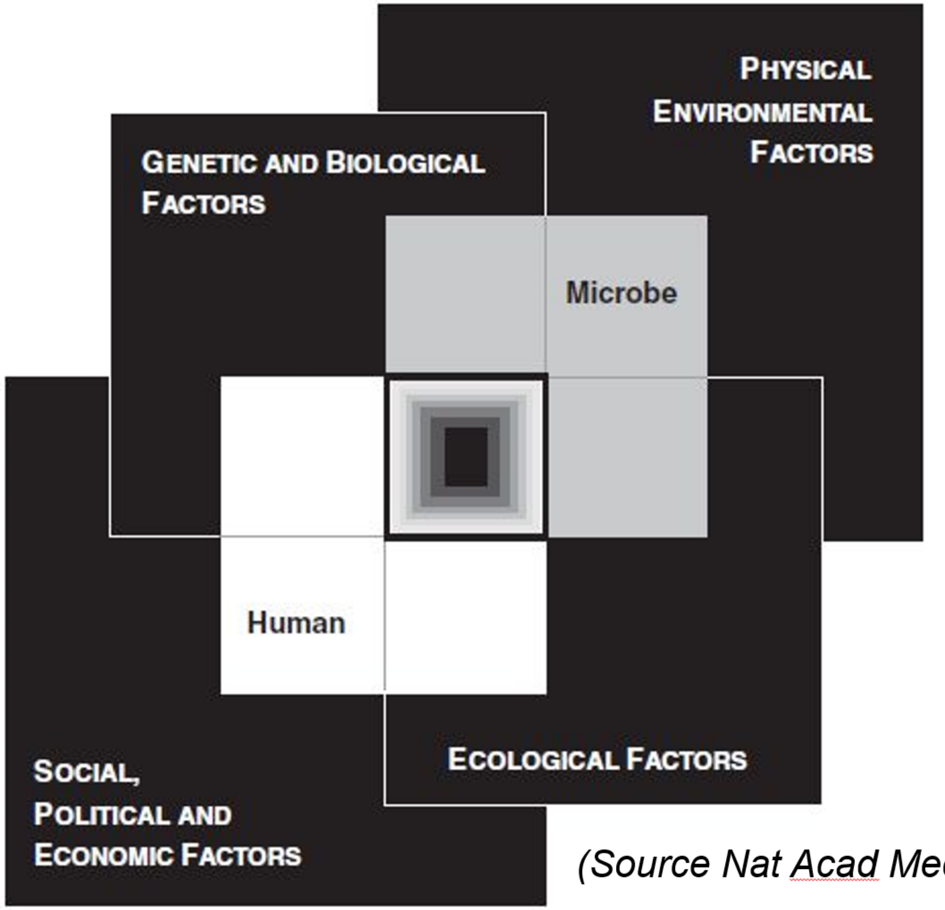
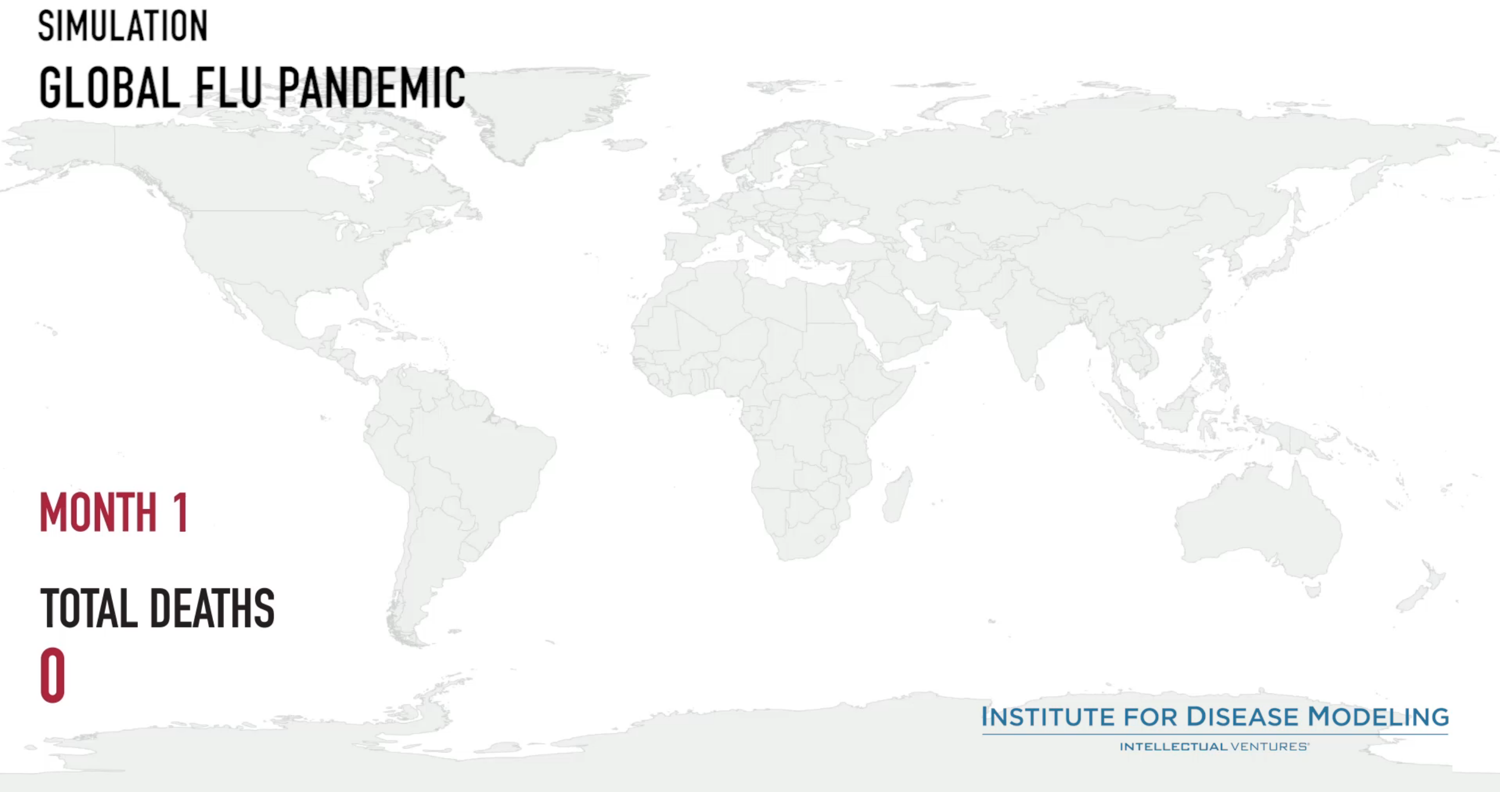
Emerging infectious diseases: Climate is one factor among others



(Source Nat Acad Med, 2003)

We are confronted with an unprecedented pandemic risk



Simulation of a modern-day global influenza pandemic (*N Engl J Med*, 2018)