Introduction to Module 1 (Infectious Diseases)

Future trends in infectious diseases

BSc Global Health

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Imperial College London

Table 5. Changes in Rankings for 15 Leading Causes of DALYs, 2002 and 2030 (Baseline Scenario)

Category	Disease or Injury	2002 Rank	2030 Ranks	Change in Rank
Within top 15	Perinatal conditions	1	5	−4
	Lower respiratory infections	2	8	−6
	HIV/AIDS	3	1	+2
	Unipolar depressive disorders	4	2	+2
	Diarrhoeal diseases	5	12	−7
	Ischaemic heart disease	6	3	+3
	Cerebrovascular disease	7	6	+1
	Road traffic accidents	8	4	+4
	Malaria	9	15	−6
	Tuberculosis	10	25	−15
	COPD	11	7	+4
	Congenital anomalies	12	20	−8
	Hearing loss, adult onset	13	9	+4
	Cataracts	14	10	+4
	Violence	15	13	+2
Outside top 15	Self-inflicted injuries	17	14	+3
	Diabetes mellitus	20	11	+9

Source : PLoS Med 2006

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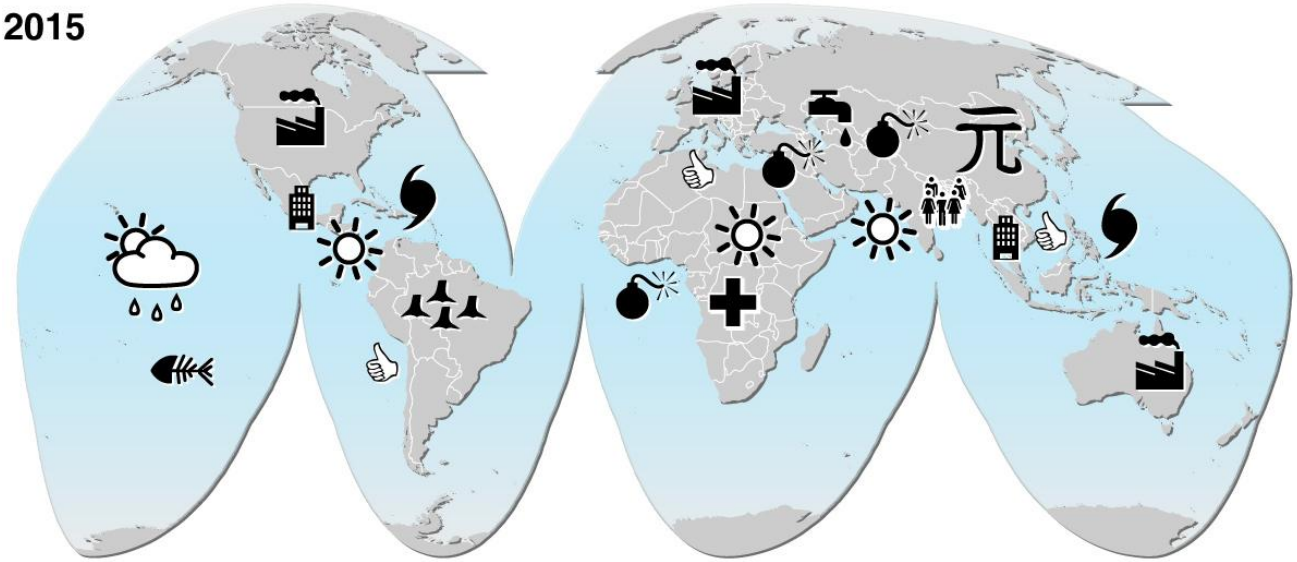
Which factors will influence infectious diseases?

Forecast / World 2015



Water governance disputes

Urban problems

Good progress on the MDGs

Overfished seas

Economic progress

Hurricane warning!

HIV/AIDS

Industrial pollution

Conflicts and tension

Loss of biodiversity

Overpopulation

Rising temperatures

The overall outlook for the upcoming period is overall fairly gloomy, with occasional bright spots. It is still not too late, though, to do something about it.

The forecast for Latin America and the Caribbean, as well as North Africa and large parts of Asia is generally good. Current trends indicate that these regions are on track to achieving the Millennium Development Goals. However, these and other regions will feel the increasing effects of climate change, such as rising temperatures and increased occurrence of extreme events (like hurricanes).

Increased urban populations will lead to new problems, primarily in Southeast Asia and Latin America, while destruction of ecosystems happen everywhere, like the deforestation in the Amazon or overfishing of all seas.

In Sub-Saharan Africa, HIV continues to be a problem. Achieving the Millennium Development Goals will be further complicated by climate change and conflicts.

The potential for conflicts and tension will affect the conditions in Central Asia and Western Asia, particularly in the area of water resources.

The economy will continue to grow and become stronger. China and Southeast Asia will emerge as new major players in the international market.

The developed countries will continue to pollute and abuse the global environment, but trends indicate that measures are being taken to reduce pollution and help the rest of the world.

Population forecast 2015:

World	7.22 billion	+12%
India	1.26 billion	+14%
China	1.39 billion	+5.8%
Bolivia	10.9 million	+18%
Zambia	47.9 million	+1%
Australia	22 million	+10%

Life expectancy at birth 2015:

Laos	59 years	+8.3%
USA	78 years	+1.6%
Kyrgyzstan	71 years	+4.1%
Gabon	61 years	+7.6%
Peru	73 years	+3.9%
Mozambique	39 years	+3.1%

Data sources: United Nations Common Database, through http://globalis.gvu.unu.edu

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Some factors that will influence infectious diseases

Climate change
- water, migration, vectors

Urbanization

Conflict

Finance, poverty and inequality

Medical advances
- vaccines, drugs and diagnostics

Climate change and infectious diseases

There is a consensus that climate change will alter the nature of infectious diseases seen globally

There is little consensus on what the overall impact will be either in local terms or global terms

Causal evidence is hard to establish

Dimensions of Climate change

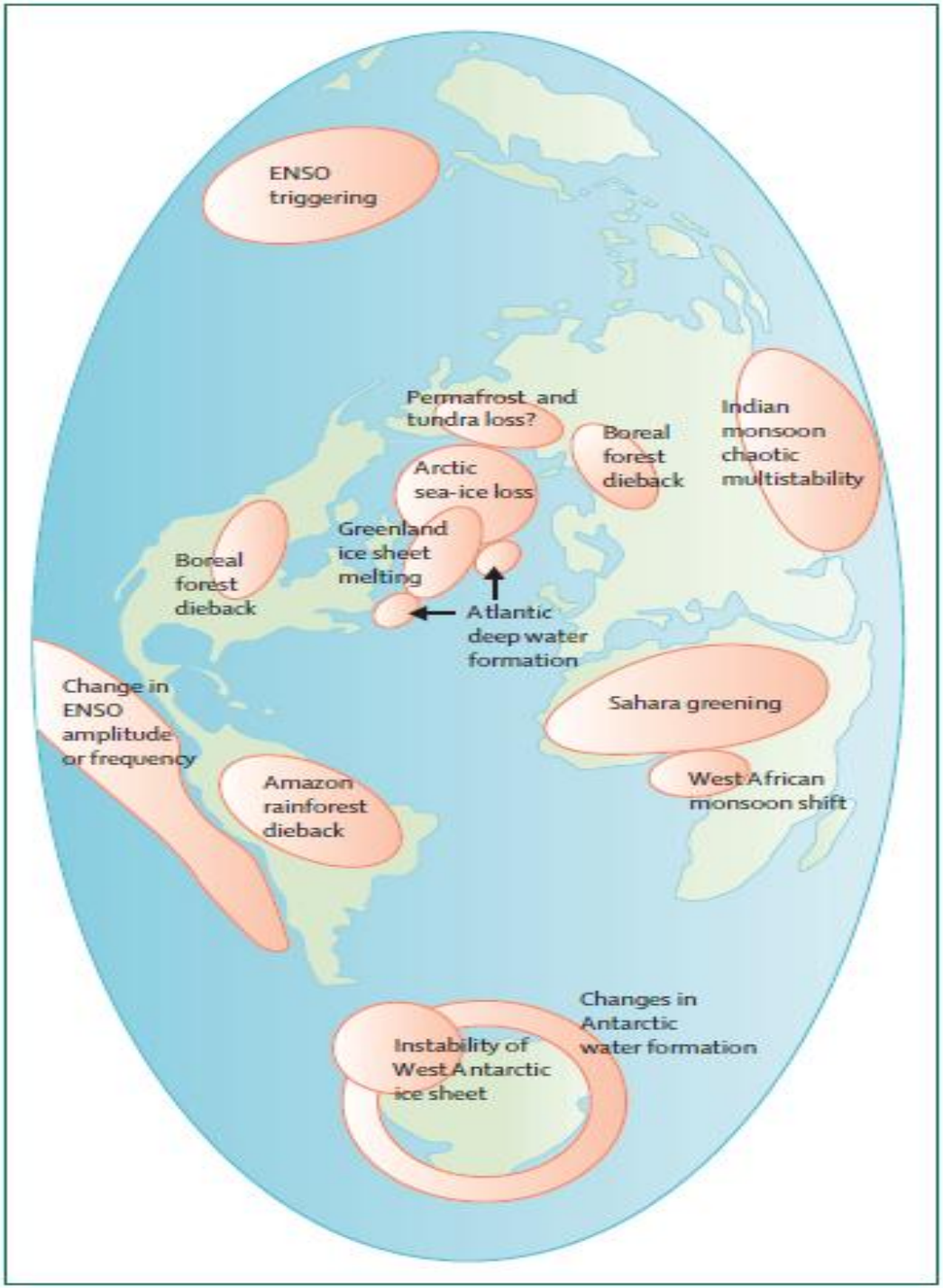
Trends in increasing global temperatures with estimates Over the next century of increases from 2-4 degrees

Increases seen in rising minimum temps rather than average or maximum temps

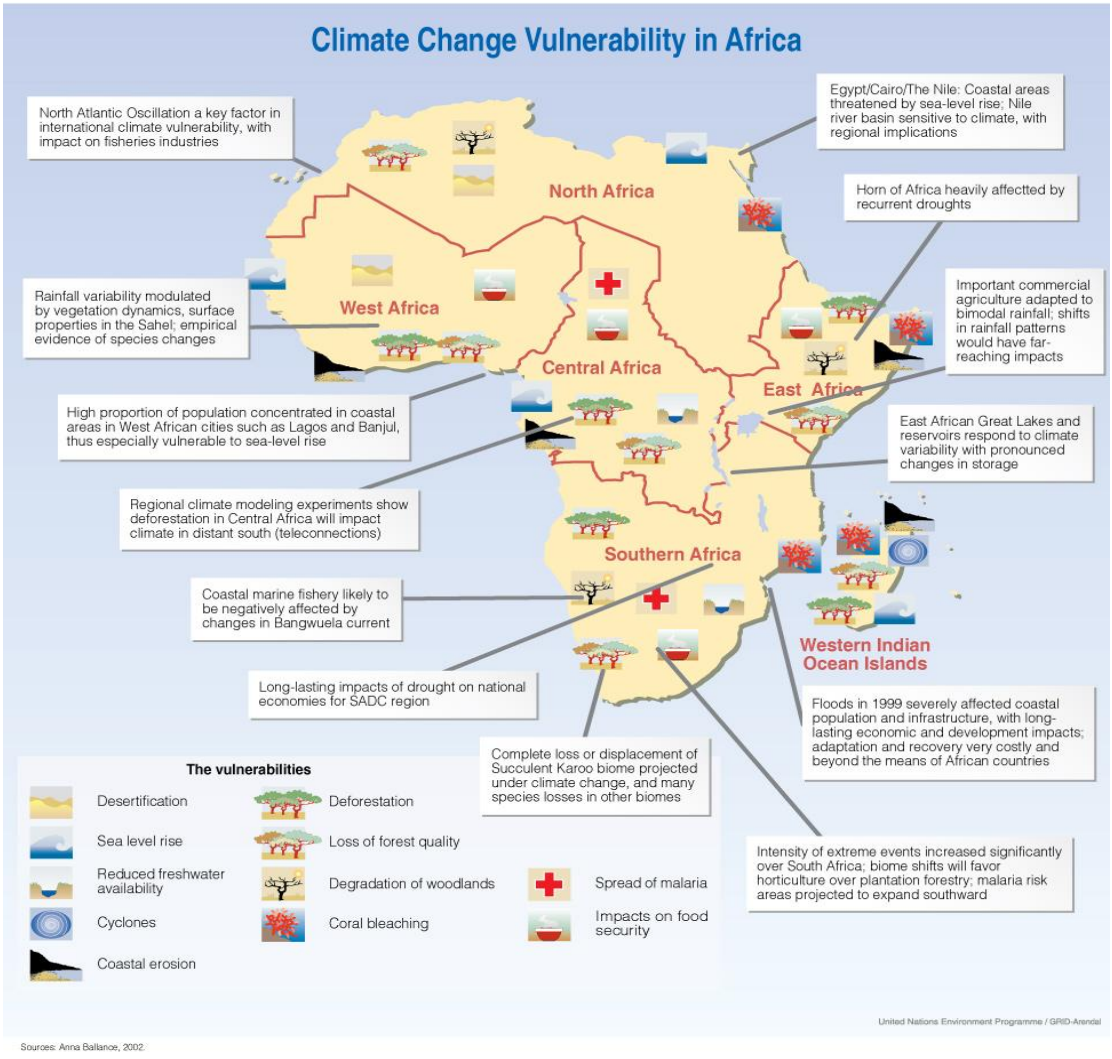
Warming of higher latitude regions

Extreme weather events of greater frequency and severity but unevenly distributed

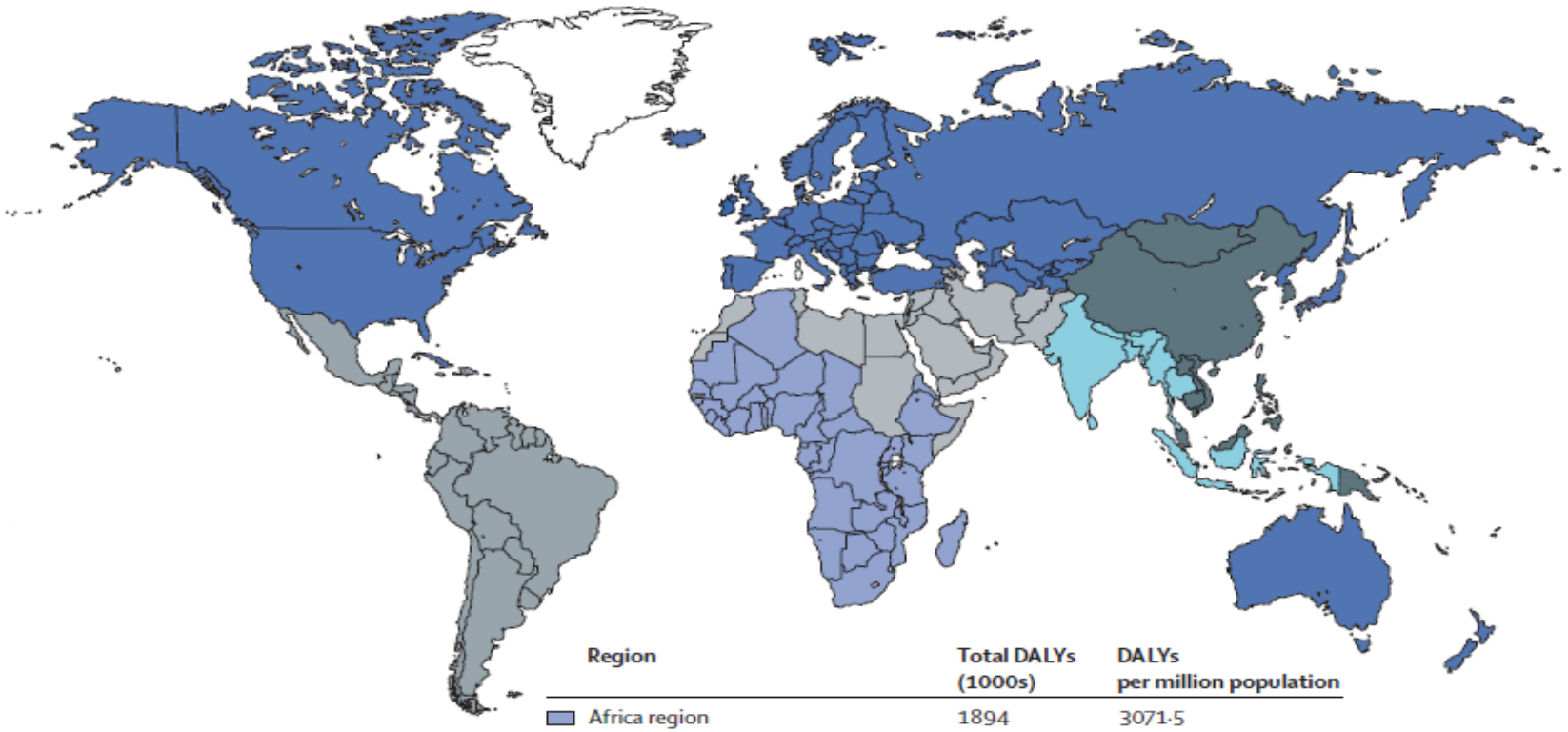
Global weather systems and potential stress points



Impact of climate change in Africa



Impact of climate change on DALYs



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Southeast Asia region	2572	1703·5
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Developed countries†	8	8·9
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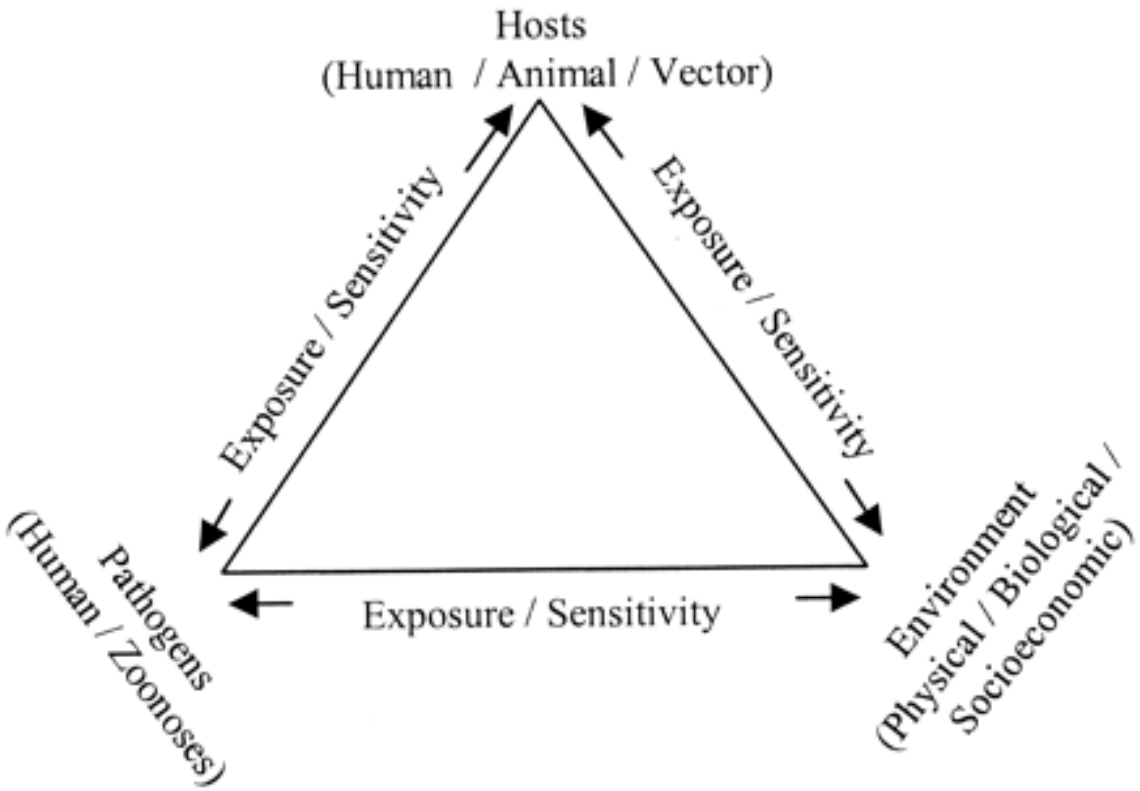
*Without developed countries. †And Cuba.

Climate change and vector borne disease



Sutherst, Clin Microbiol Rev 2004 17:136

Local warming and vectors

Increased pathogen replication and growth within mosquitos (e.g. WNV, dengue, malaria, tick-borne encephalitis)

Insect/vector density increases in new environments, for example, higher altitudes

However, some parasites will survive less well if Minimum temperatures rise

The rise of dengue fever

The last 50 years have seen substantial rises in cases of Dengue fever

Much of this increase is in SE Asia, driven by factors including Increased urbanisation and increased population growth/density

The disease is often asymptomatic or mild, particularly in childhood, but far more severe on reinfection

Case fatality can be as high as 10% in DHFS

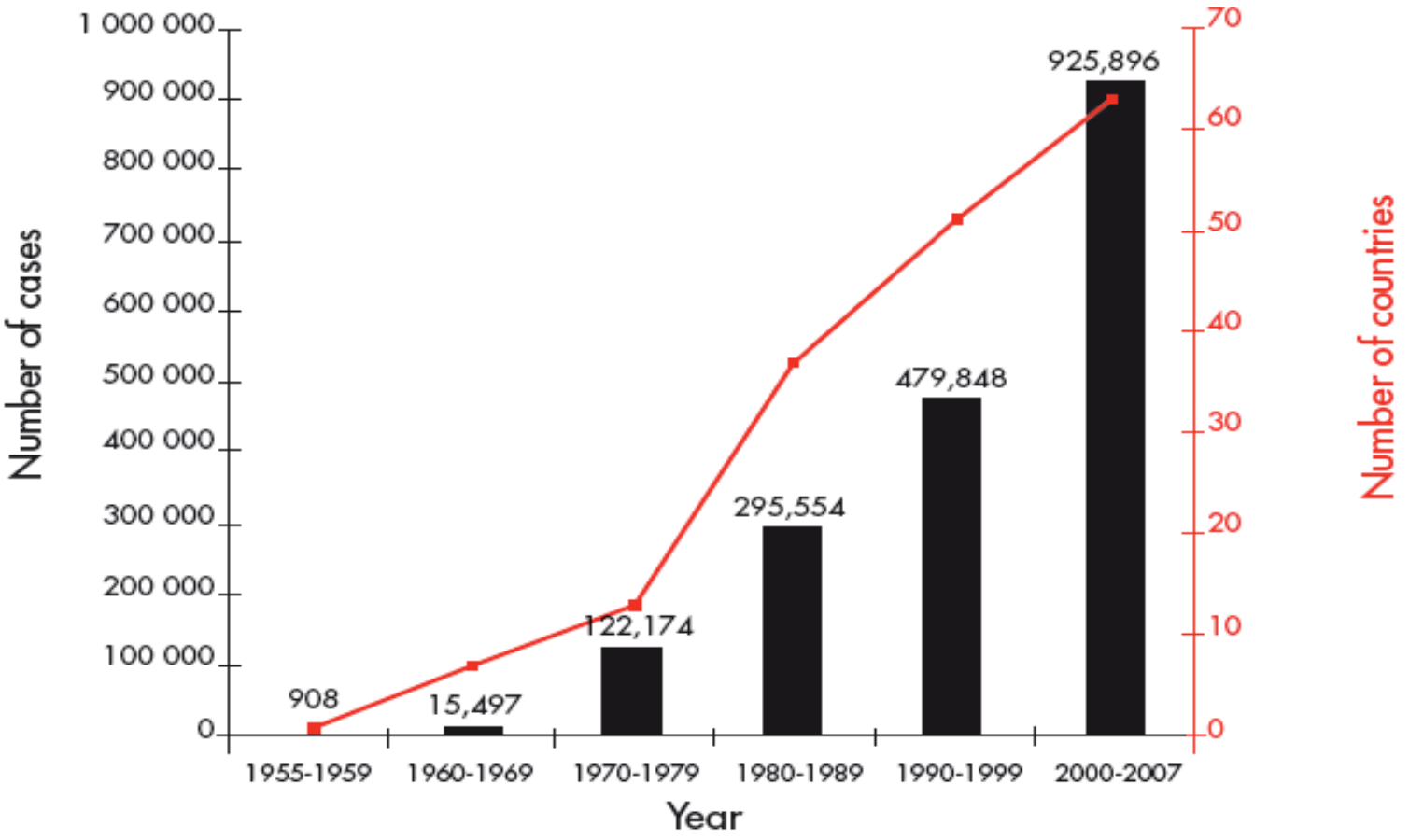
The rise of dengue fever

Vector for transmission is aedes mosquitoes (usually aegypti)

Association between rainfall, temperature and humidity and incidence of dengue fever

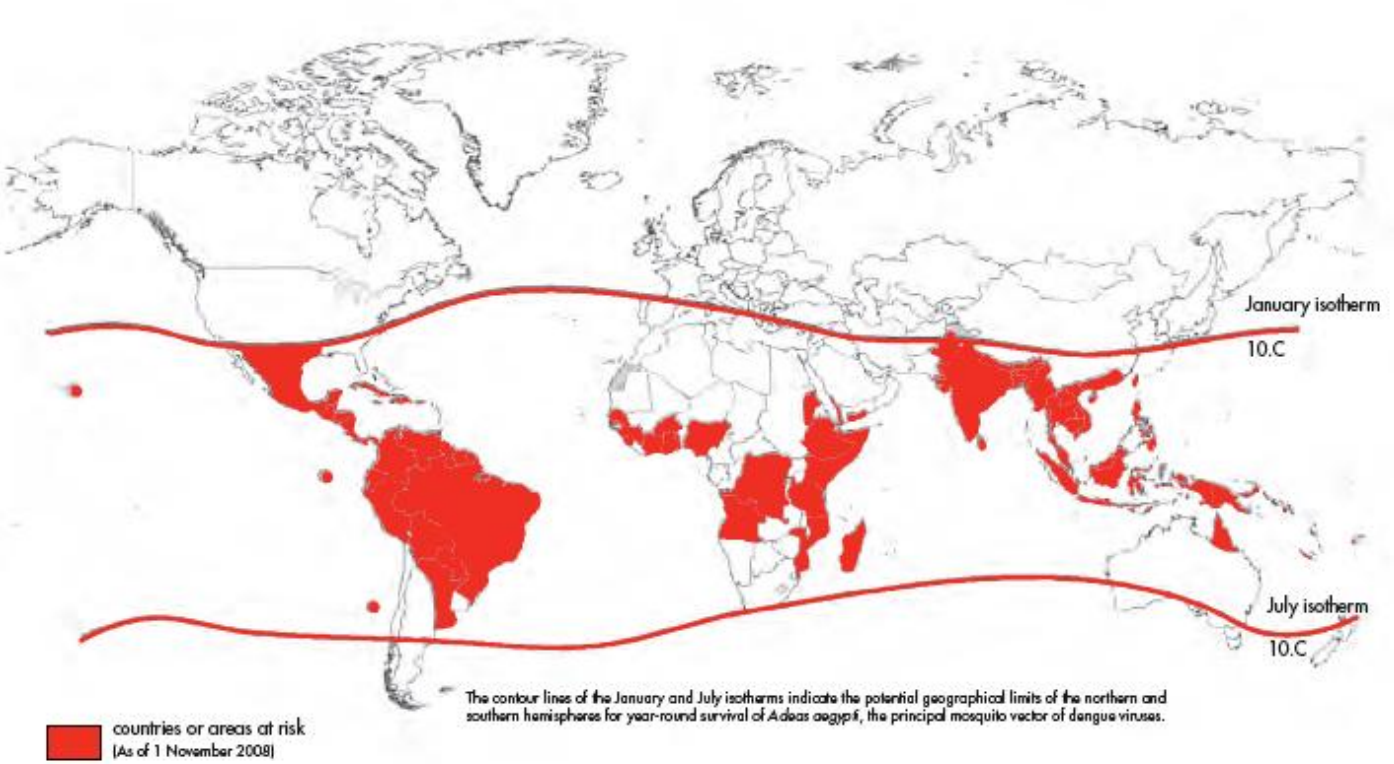
Effects primarily mediated through effect on aedes population

The rise of dengue fever



Source WHO 2008

The rise of dengue fever: risk of transmission

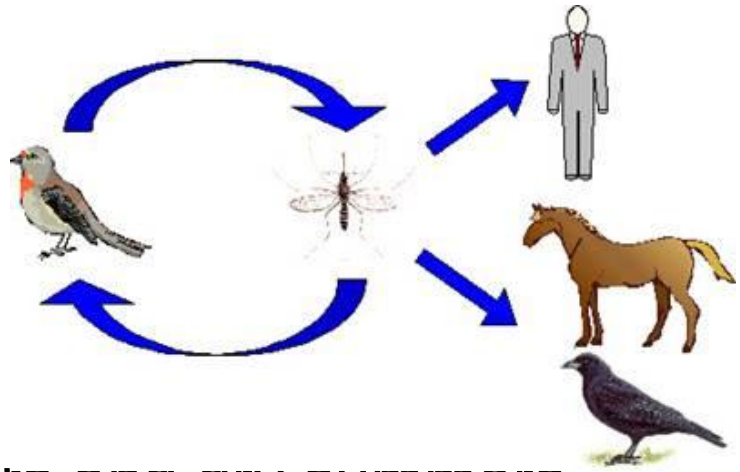


Source WHO 2008

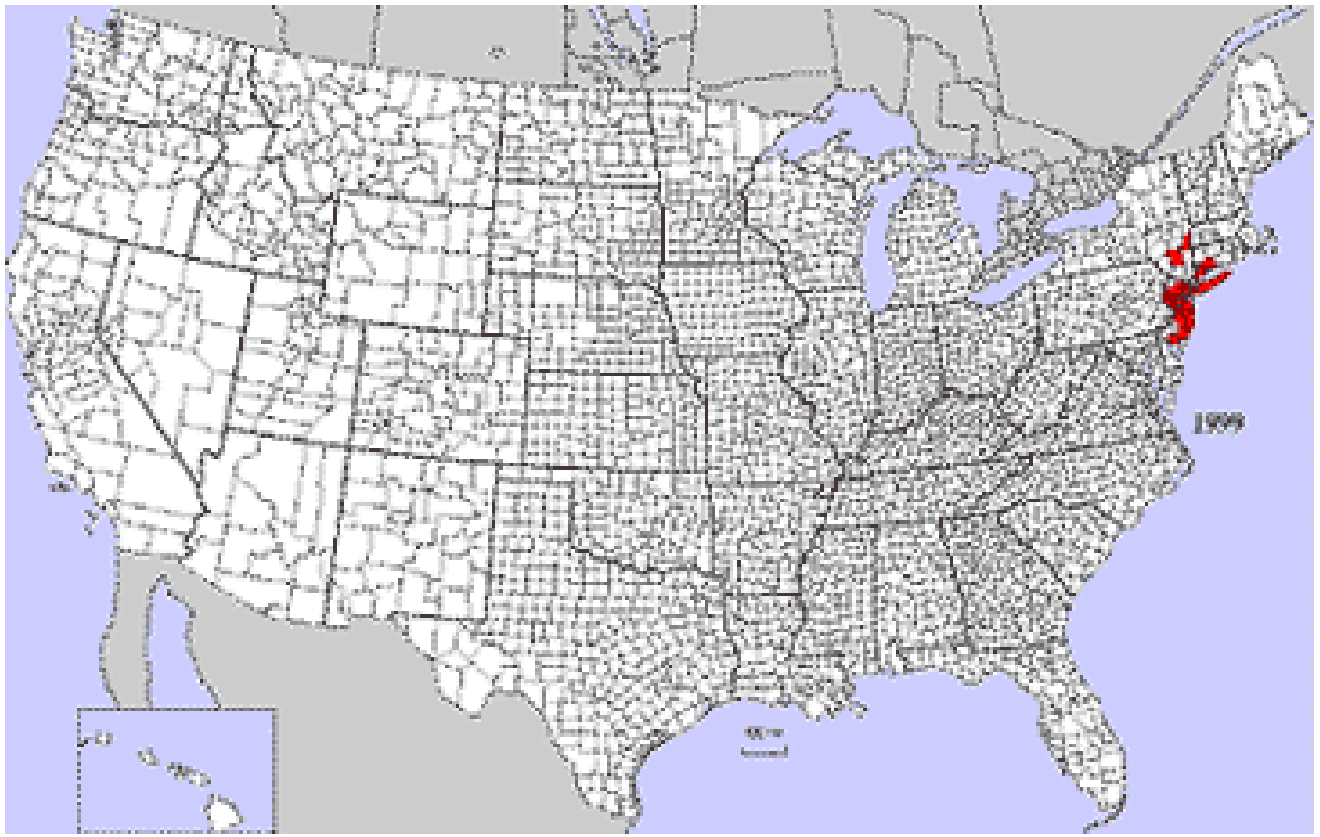
The rise of WNV infection

- **Incubation period** 2 – 15 days (usually 2-6 d)
- **Asymptomatic** (80%)
- **Moderate infection** (19%)
  - fever, flu-like illness, rash, generalised lymphadenopathy
- **Severe infection** (1%)
  - Meningoencephalitis (more likely in age > 50), polio-like illness, other neurological abnormalities (movement disorders etc)
  - CSF shows moderate lymphocytic pleocytosis, moderate raised protein, normal glucose
  - Some deaths

Climate change and WNV



- Warm winters and dry summers
- Favours breeding of city dwelling mosquitoes
- Mosquito predators decline with drought
- Birds congregate around reduced water sites
- Birds and mosquitoes mix



www.cdc.gov/ncidod/dvbid/westnile/

Tick borne diseases

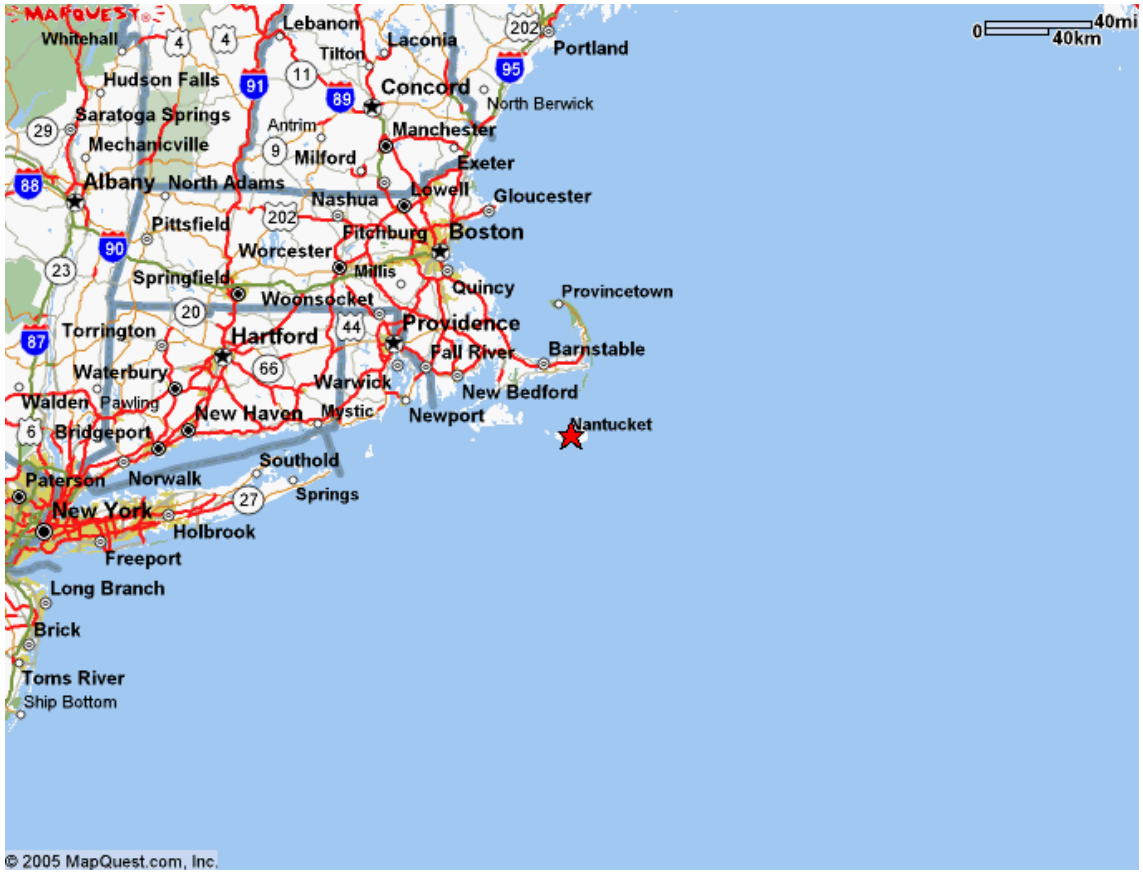
Changes in exposure might be relevant (increased outdoor leisure activity, travel)

Globally more likely to be increase in diseases such as Lyme, for example increases in the Ukraine have been recognised

Lyme disease

- Borrelia carried by two ticks commonly found deer-tick
- Active year round, particularly if mild winter.
- More cases of Lyme are caused by nymph stages of tick which are most active in June and summer

Area	Incidence
Nantucket	850/100,000
Mass	23.7/100,000
US	8.2/100,000



Source: Mapquest.com

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150-170 cases Lyme each year in Nantucket

Human population 10,000-50,000, Deer population 2,600

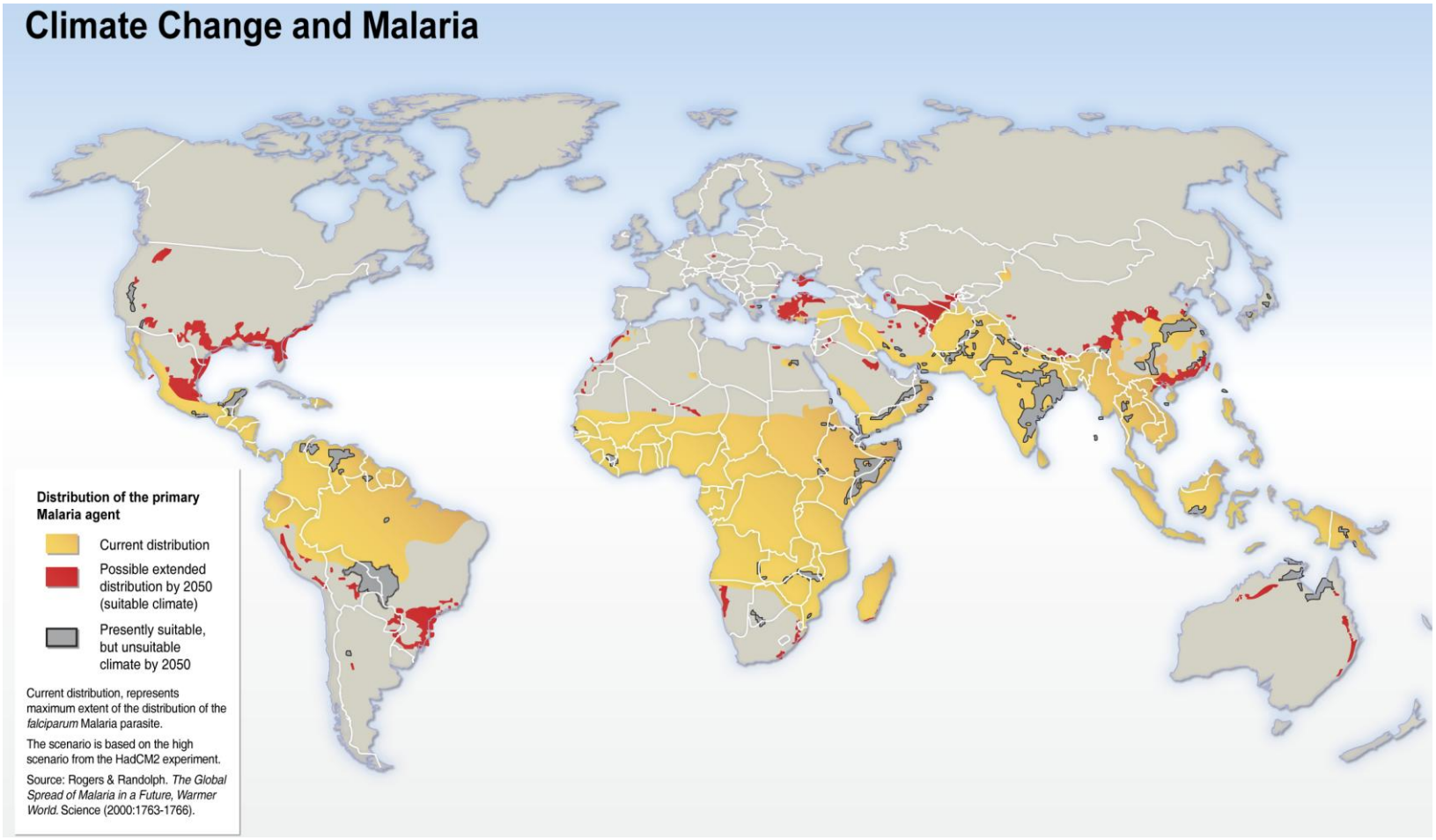
Photo: HPA

Other strong associations with tick-borne disease

The rise of TBE (tick borne encephalitis in central Europe)

Climate change and malaria

Climate Change and Malaria



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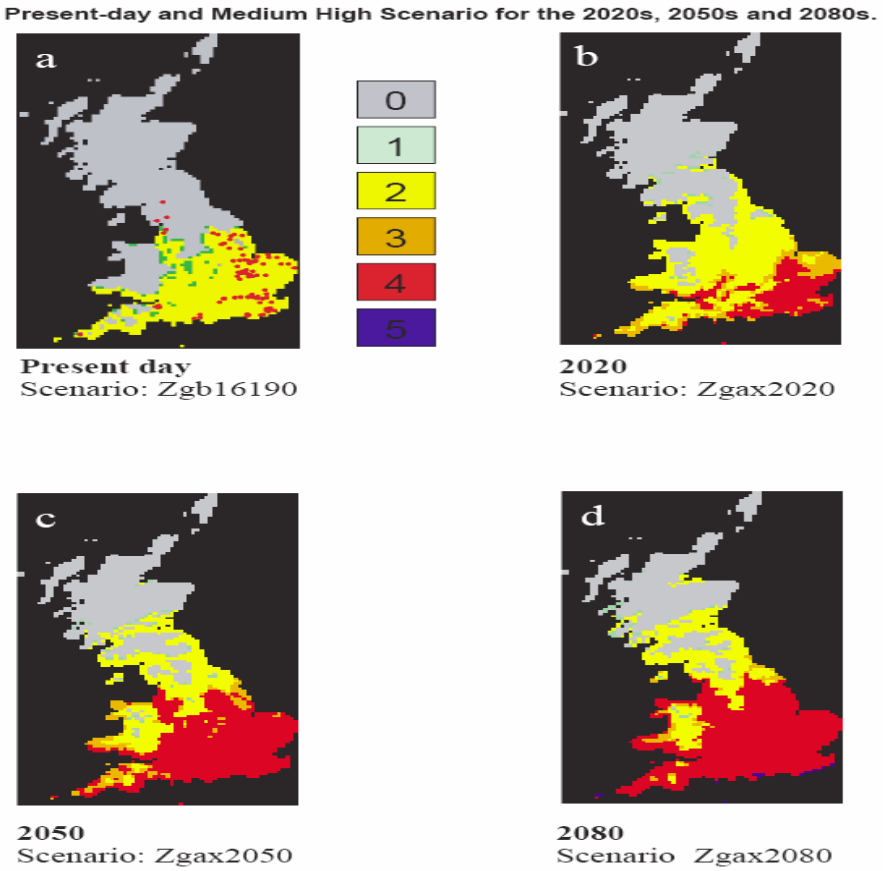
Malarial transmission in UK



Source HPA. No months during which vivax could be spread in the UK

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UK health and climate change

Source: Health Effects of Climate Change in the UK 2008 (HPA)

Concludes:

- UK climate changing
- Increase 2.5 –3 degrees by end century
- Periods of cold weather less common
- More extreme events (flood, drought)

Infectious disease – food borne disease
- water borne disease
- vector borne disease

Infectious Diseases with the evidence for a link with climate change

- Malaria
- Meningococcal disease
- Dengue
- Leishmaniasis

- West Nile fever
- Ross River fever
- Murray valley fever
- Japanese & St Louis encephalitis
- Yellow fever
- Rift valley fever
- Cholera

Source: WHO

Climate change and diarrhoeal disease

Climate change and diarrhoeal disease

Factors potentially associated with diarrhoeal disease

- Weather; short terms trends in temperature and rainfall

Methods: time-series analysis; weather exposure and outcome usually at one location

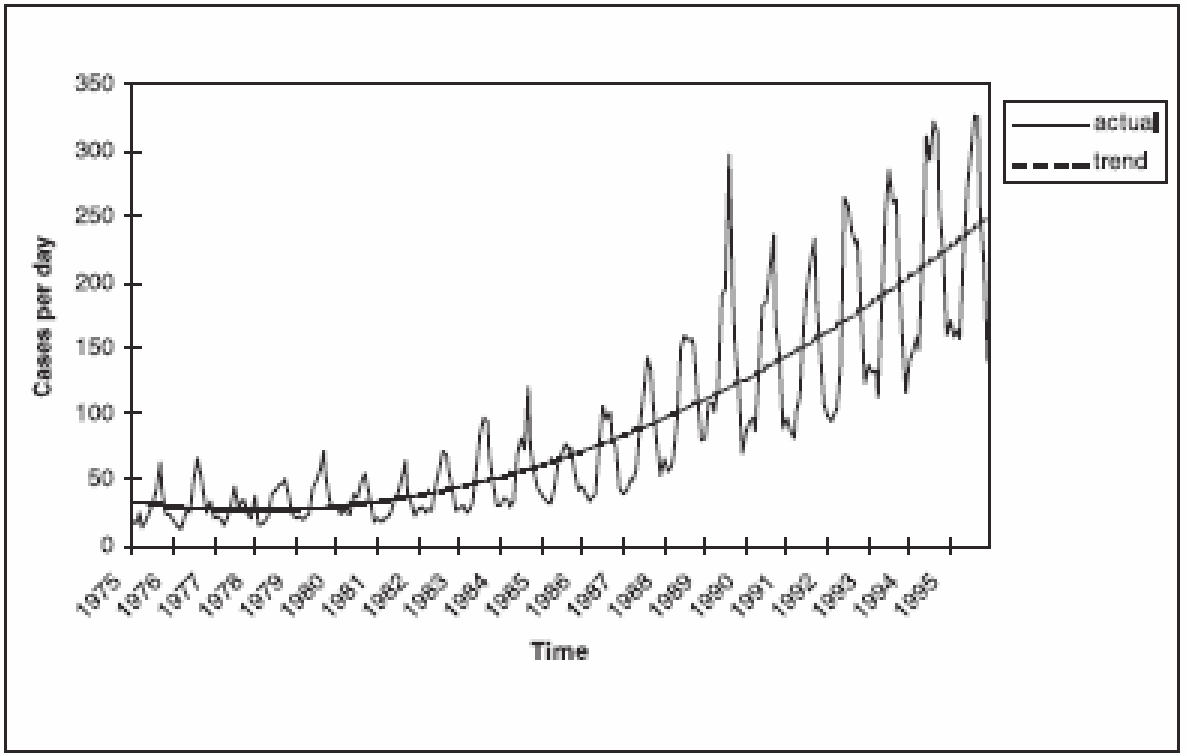
Use: early warning systems

- Climate; longer terms trends in climate

Methods: cross-sectional analysis,use of mean values over longer time periods; multilocational

Use: Infrastructure planning

Notified food poisoning per day 1975-1995



Source: HPA Climate Change and Health 2001

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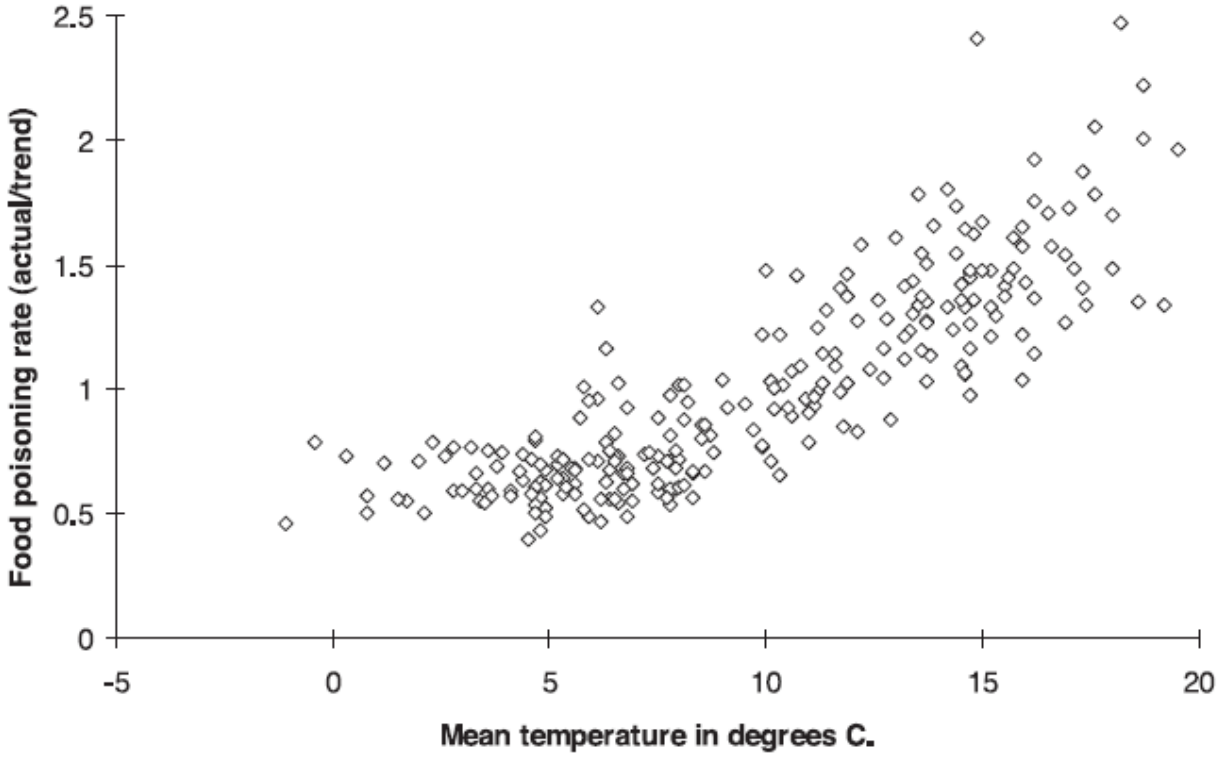
Food poisoning notification and mean temperature previous month



Source: HPA 2001

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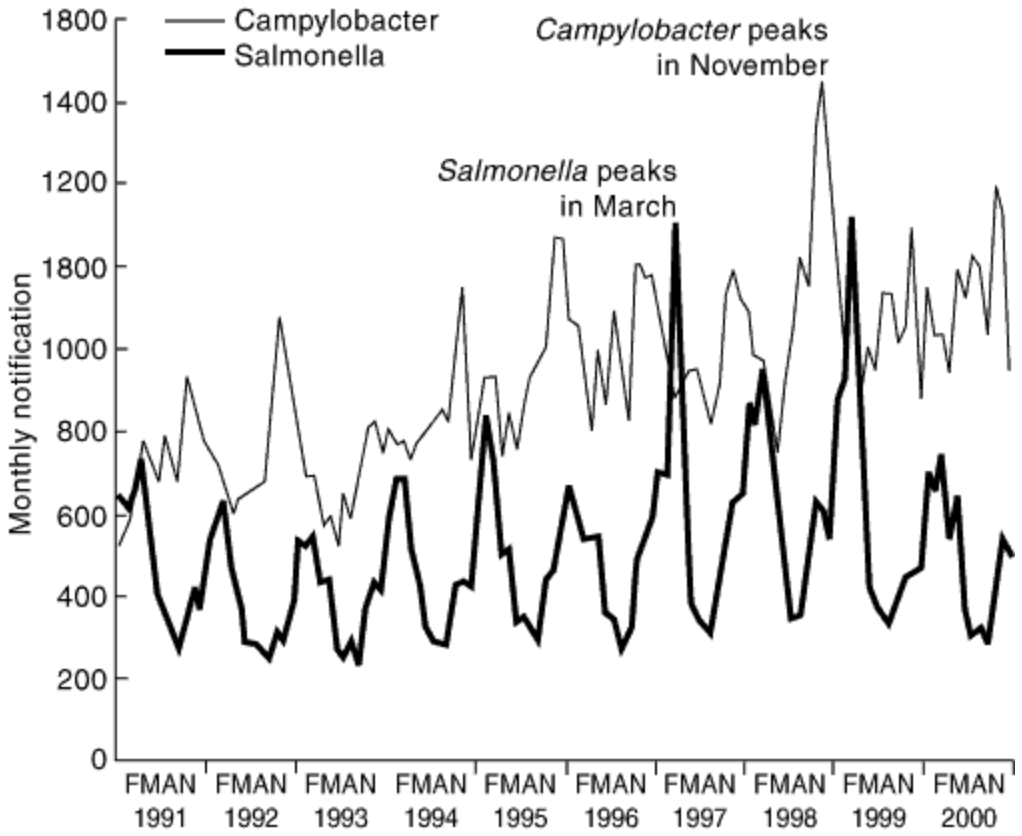

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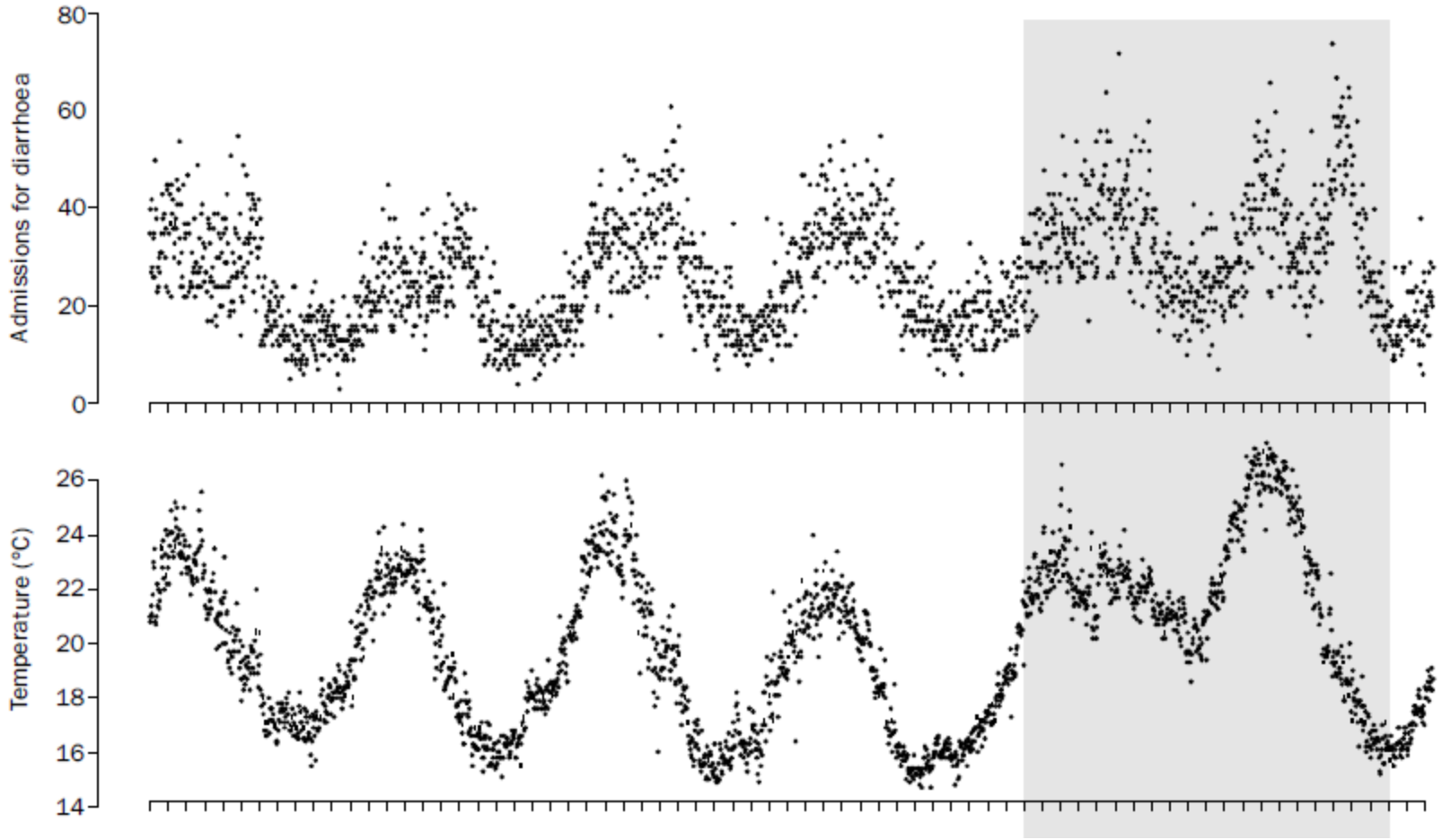
Source : HPA

Short term association (El Nino, Peru)



Checkley Lancet 2000

Climate change and severe weather events

Extreme weather events

Climate change likely to increase the frequency of Extreme weather events

In particular, flooding can lead to important effects on infectious diseases

Can reduce incidence of some infections; e.g. vector borne disease may reduce in short term as washed away (though may rise later)

Source: WHO factsheet

Extreme weather events

Flooding can lead to increase in ID, but not commonly

When effects are seen, may be consequence of population displacement

- notable examples
    - Sudan (1980) diarrhoeal disease
    - Mozambique (2000) diarrhoeal disease
    - Bengal (1998) cholera

Flood water can contaminate water supplies

Source: WHO factsheet

Extreme weather events: flooding

Water-borne disease can be more common (direct contact with polluted water)

- dermatitis
- conjunctivitis
- wound infections

But with epidemic potential

- leptospirosis
- number of examples of outbreaks, possibly due to increase in rat populations

Source: WHO factsheet

Extreme weather events: flooding

Flooding will often lead to temporary reduction in vector populations

Typically 6-8 weeks later, vectors will return and may be a rise in malaria

El Nino rains associated with increase in dengue fever and malaria in Americas

Rise in WNV associated with heavy rains in Europe

Source: WHO factsheet

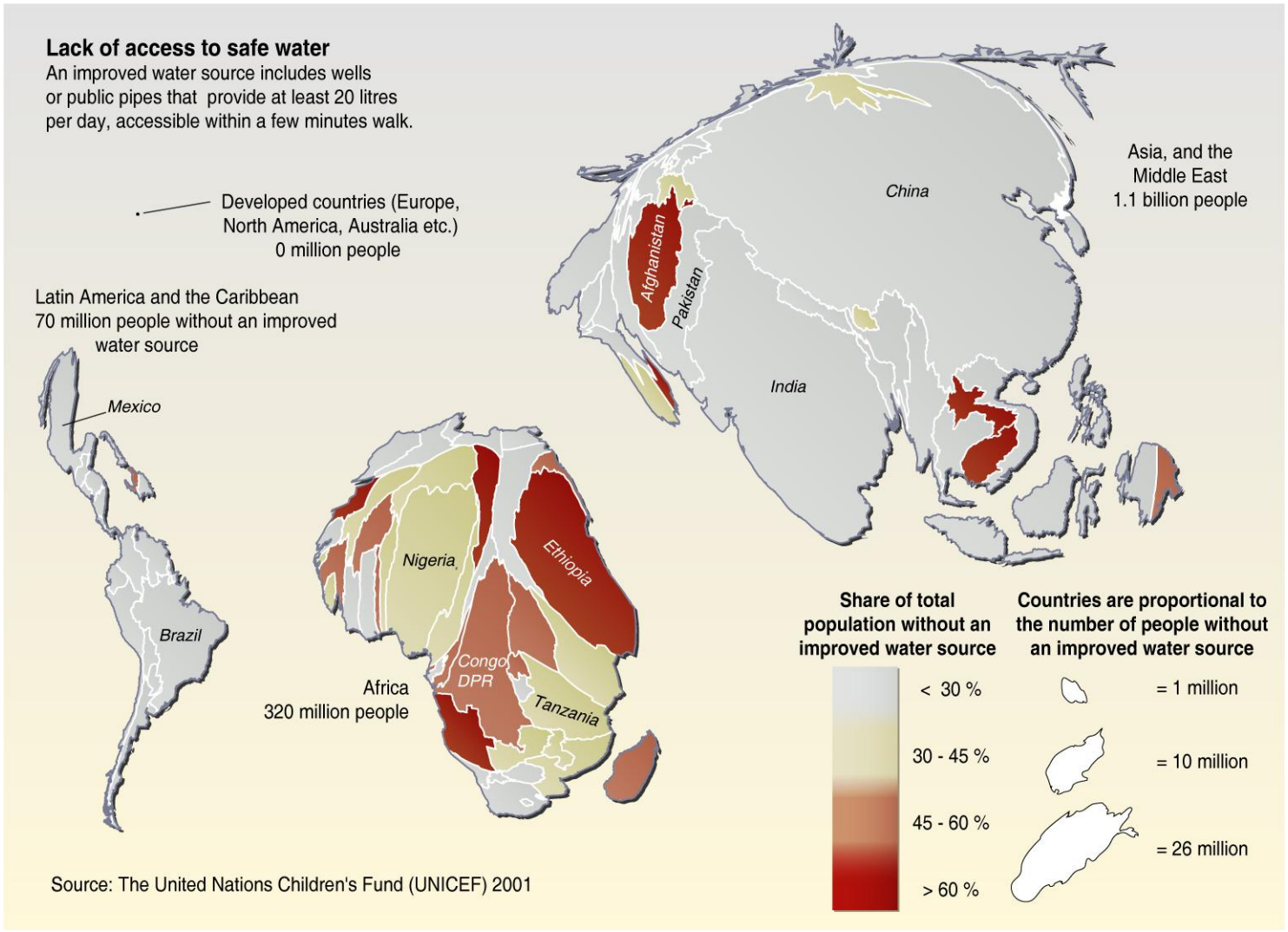
Extreme weather events: flooding

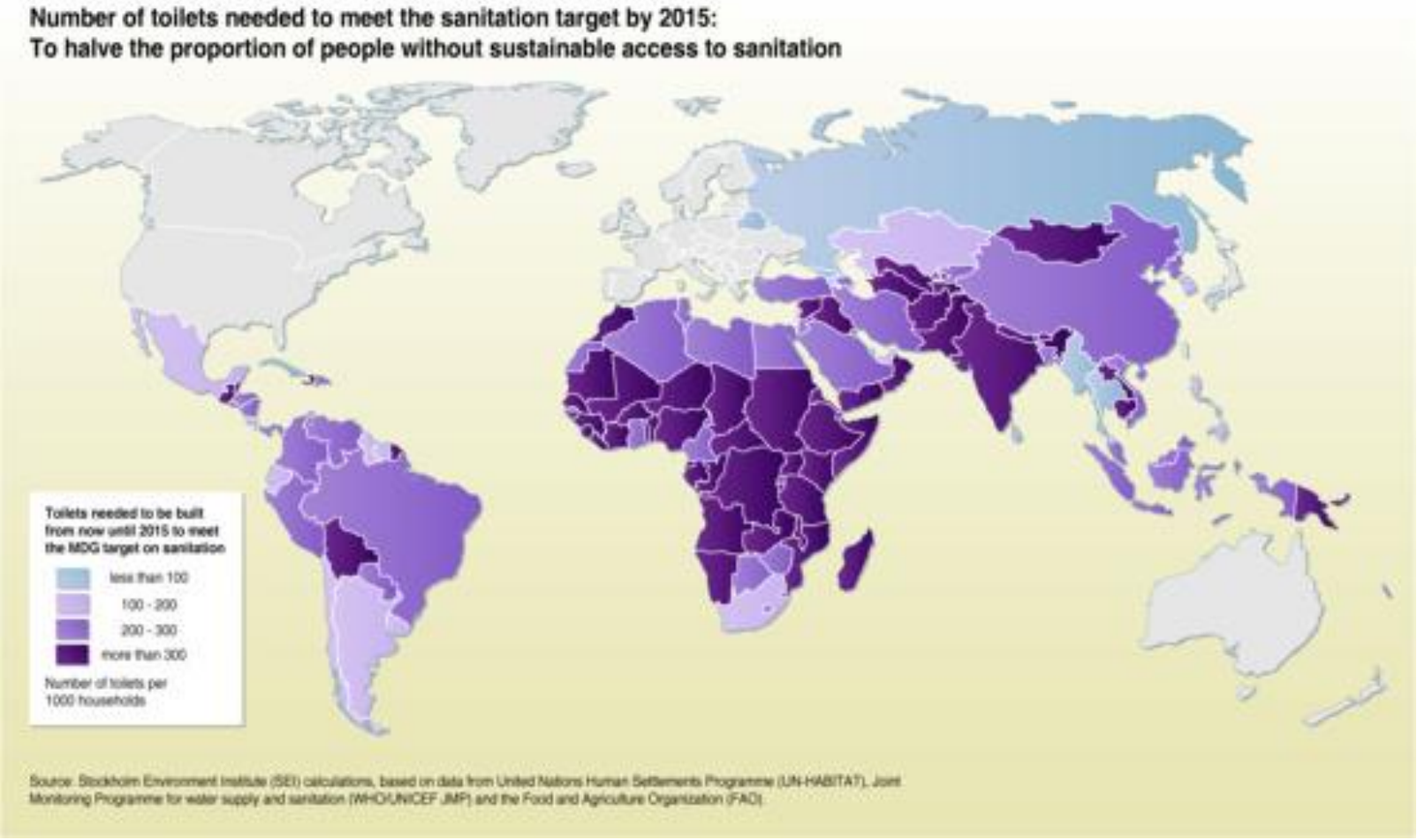
Other aspects of flooding in short term may be important but unlikely to contribute to long term disease trends

- Blood borne virus transmission
- Injuries, trauma
- TB

Source: WHO factsheet

Water, Sanitation


Lack of access to safe water
An improved water source includes wells or public pipes that provide at least 20 litres per day, accessible within a few minutes walk.
Developed countries (Europe, North America, Australia etc.)
0 million people
Latin America and the Caribbean
70 million people without an improved water source
Mexico
Brazil
Africa
320 million people
Nigeria
Ethiopia
Congo DPR
Tanzania
Asia, and the Middle East
1.1 billion people
China
India
Afghanistan
Pakistan
Share of total population without an improved water source
< 30 %
30 - 45 %
45 - 60 %
> 60 %
Countries are proportional to the number of people without an improved water source
= 1 million
= 10 million
= 26 million
Source: The United Nations Children's Fund (UNICEF) 2001


Number of toilets needed to meet the sanitation target by 2015:
To halve the proportion of people without sustainable access to sanitation
Toilets needed to be built from now until 2015 to meet the MDG target on sanitation
less than 100
100 - 200
200 - 300
more than 300
Number of toilets per 1000 households
Source: Stockholm Environment Institute (SEI) calculations, based on data from United Nations Human Settlements Programme (UN-HABITAT), Joint Monitoring Programme for water supply and sanitation (WHO/UNICEF JMP) and the Food and Agriculture Organization (FAO)

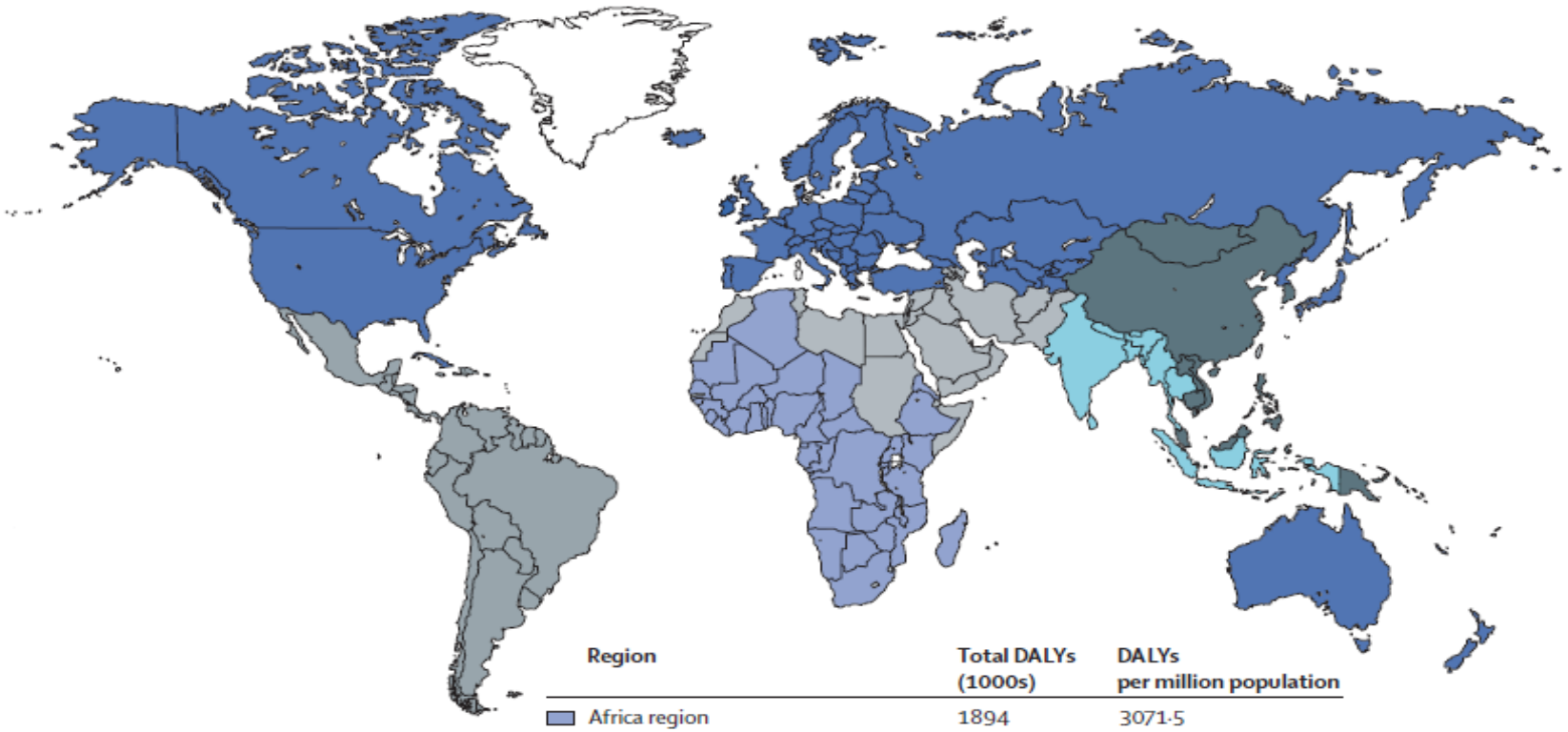
Poverty, inequality

Overall there is very little consensus on where climate change will lead us in regard to infectious diseases

Some diseases will likely increase and others decrease

However, many commentators argue that the impact of climate through ID will be outweighed by changes in economic development, migration, urbanization and medicine

Poverty and inequality



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Global Urbanization and Infectious Diseases

Urbanization : what is it and where is it happening?

Urbanization is a heterogenous process across the world

No agreed definitions exist. Different approaches include

- administrative definition (i.e. in the capital)
- size or density of population
- definition of economic activity

Nonetheless it is widely accepted that there is a global trend towards urbanisation, with the great changes occuring in developing world settings

Urbanization : what is it and where is it happening?

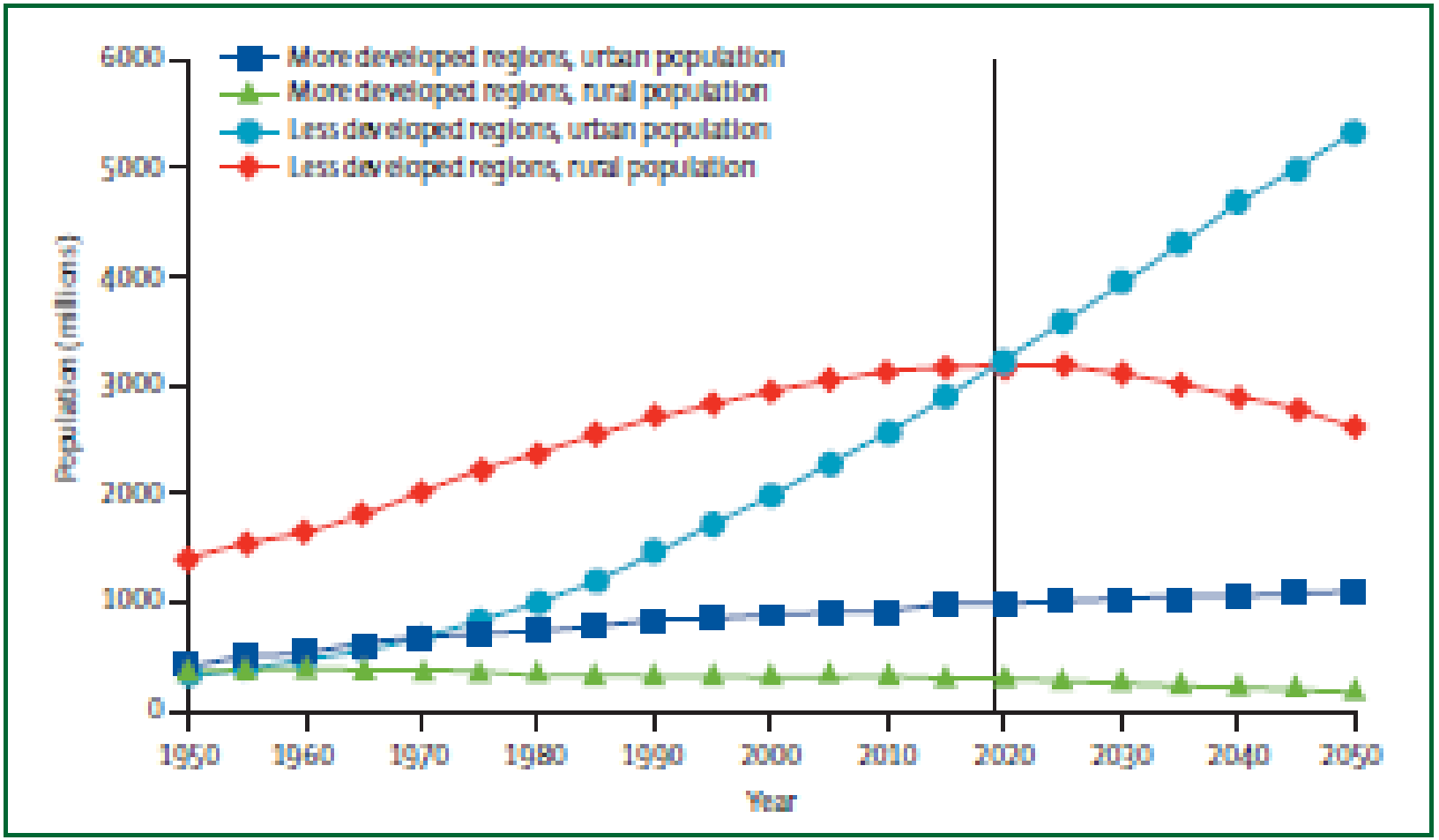
Estimated increase in worlds urban population from 3.3 billion to 6.3 billion in 2050

In developed countries, urban populations are the majority and are likely to grow slowly

Evolution of global mega-cities

In developing nations there will be a transition in the next 20 years when the majority of individuals will live in urban environment

Urbanization : what is it and where is it happening?



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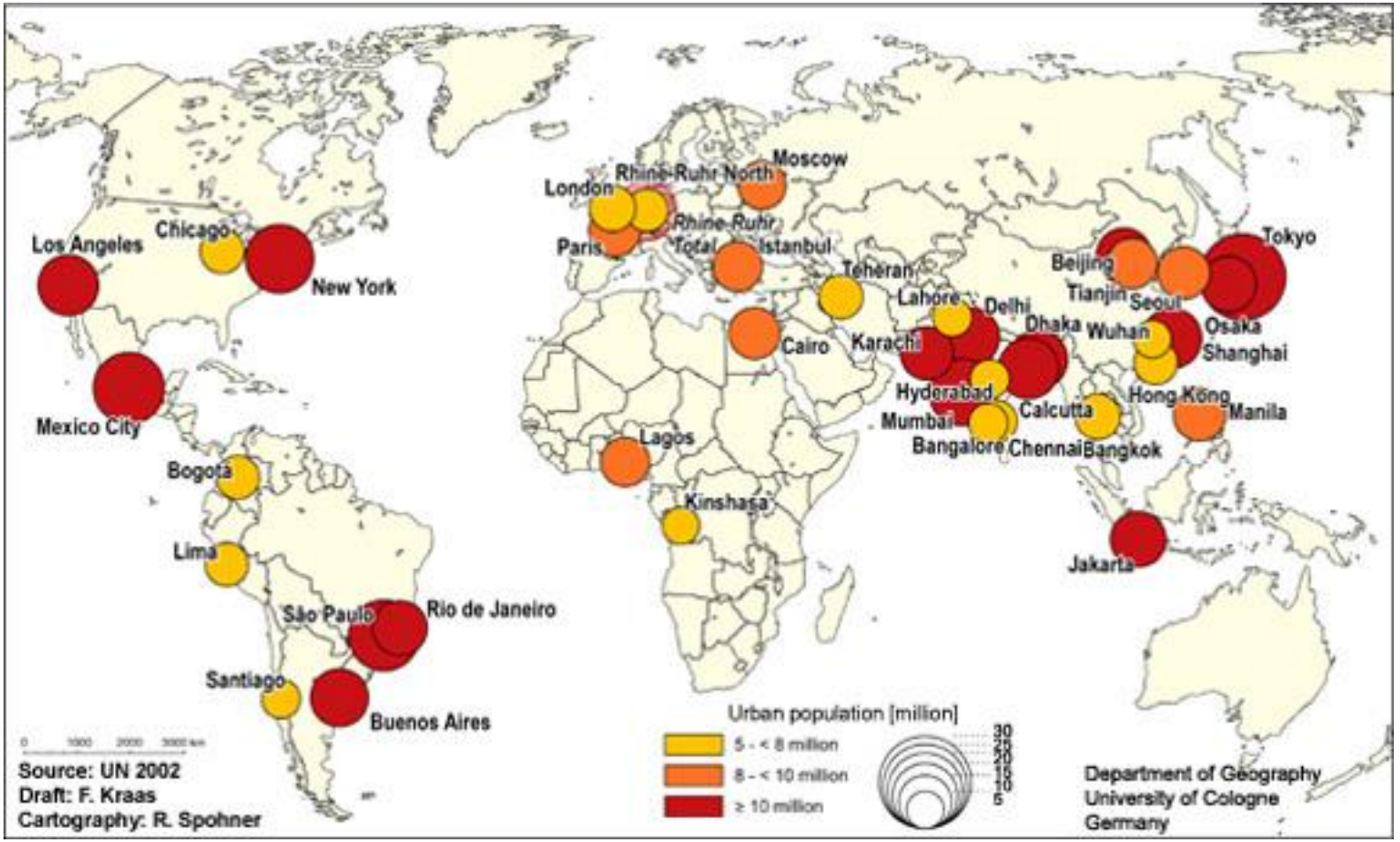
Source UN:2008

Urbanization : Growth of cities



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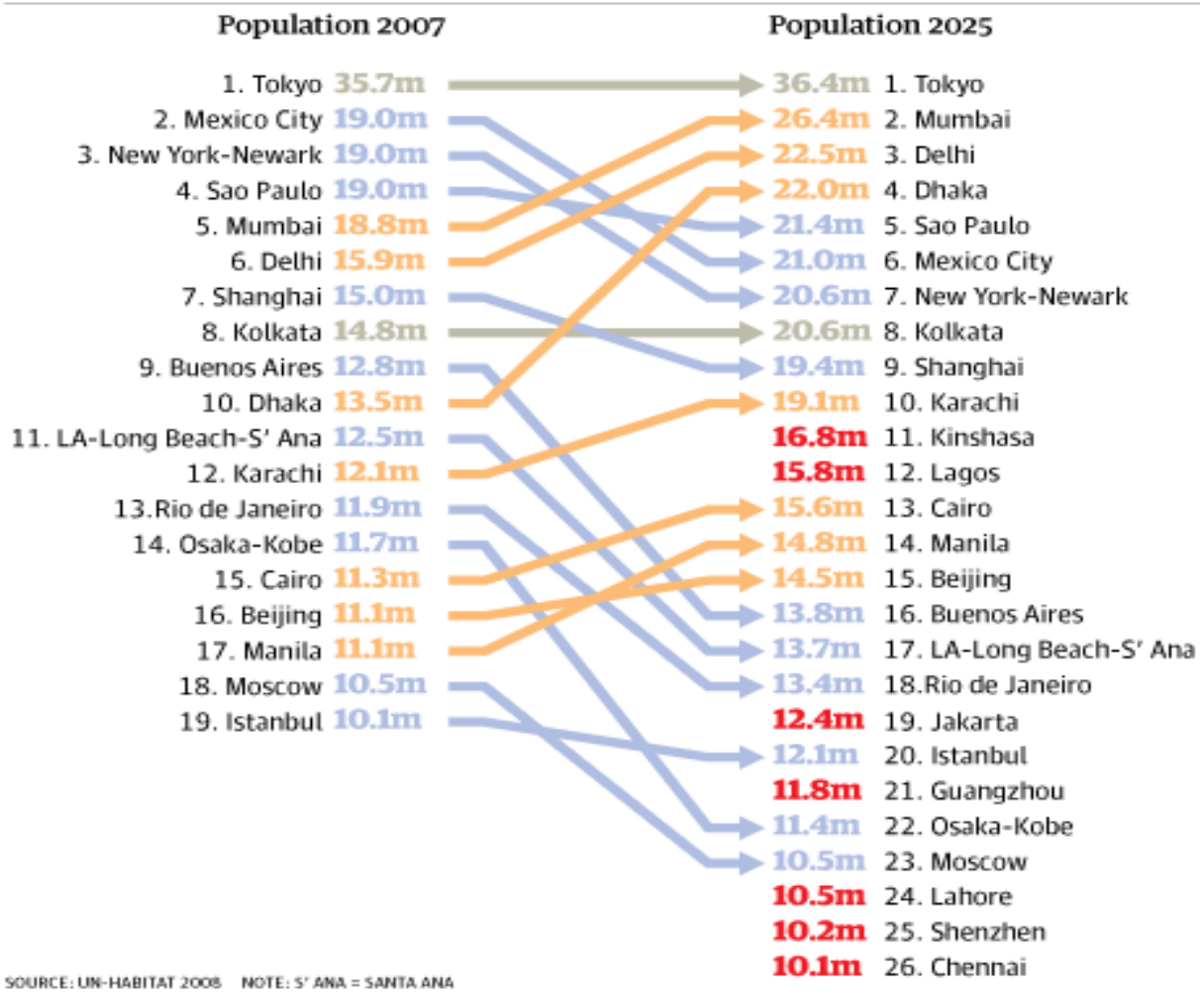
Source UN:2002

Urbanization : Growth of cities



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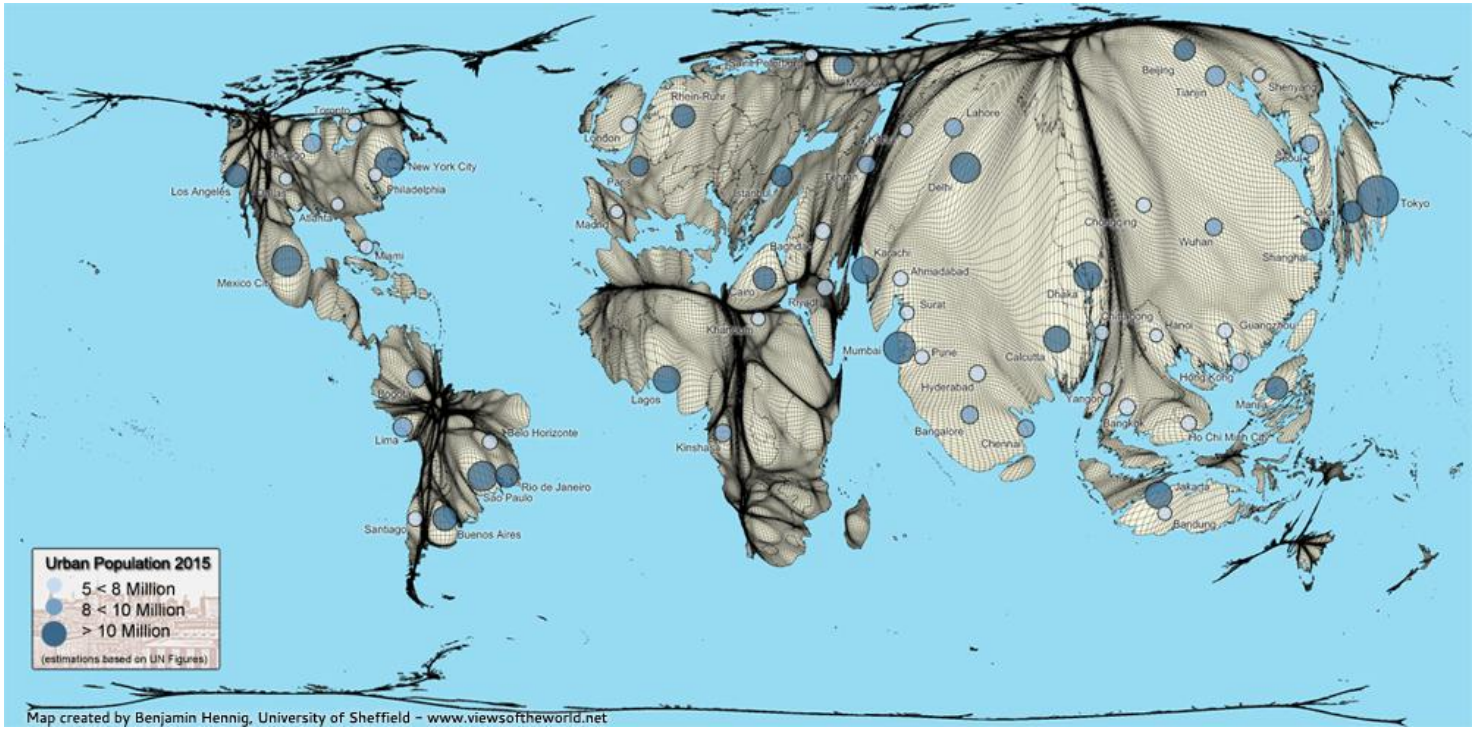
Source UN Habitat 2008

Urbanization : Growth of cities



Drivers to urbanisation

In most low income countries urban expansion is due to natural population growth

However, there can also be significant rural to urban migration

Reason for migration varies (economic, conflict, etc)

Consequences of urbanisation

In well resourced economies one of the consequences of urbanisation has been the rise of morbidity and mortality due to non-communicable diseases

However, in developing countries urban environments may be more suitable to transmission of infectious diseases

ID in urban areas

However, urban environments can reduce transmission of some infectious diseases

New diseases can emerge in urban settings

Emerging diseases can spread rapidly in urban settings

Diseases previously seen in rural areas can adapt to urban ones

Urban populations are often migratory and linked via travel patterns to many parts of the world

Housing quality and informal settlements

Informal settlements are therefore a far greater challenge to urban health in developing countries and in turn can create conditions for spread of ID

In 2001 it was estimated that nearly 1 billion individuals lived in shanty towns, a number that is estimated to double by 2030

Informal settlements

Kibera, Nairobi

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The urban home environment

Housing quality may be very variable, substantial amounts of slum dwelling

Dirt floors can harbour parasites and lead to poor sanitation

Some evidence that programmes to replace dirt floors can reduce incidence of diarrhoeal and parasitic diseases

Urbanisation and increased ID transmission

Increased population density can lead to increase transmission of disease particularly

- Airborne/respiratory infectious diseases
  - flu, TB, measles, SARS

- Food/water borne infectious diseases
  - diarrhoeal disease, cholera, etc

The urban physical environment

In many large urban populations, access to clean water and adequate sanitation is limited (for example in Lagos 9% individuals have access to piped water)

Can create the condition for diarrhoeal disease

- outbreaks of cholera, etc

Can lead to high levels of parasitic infection including STH

Poor sanitation increases rodent population

- outbreaks of leptospirosis, plague (Yersinia pestis)

Large quantities of solid waste

- pollution, mosquitos (aedes)

Urbanisation of an infectious diseases : mosquitoes

Many species of mosquitoes have adapted to urban environments and can breed in stagnant water (often inside old tyres, tins, plastic containers)

Mosquitoes act as a vector for infections including dengue, leishmaniasis, yellow fever, chikungunya.

The urban environment and leishmaniasis

Populations can expand into areas where disease is endemic or vectors can adapt to environments where transmission is more likely

Population movements can move in to urban areas creating environment for transmission

Brazilian study found visceral leishmaniasis 6x higher in households without regular refuse collection compared to those that did (Costa et al, 2005)

Great rises documented in many South American cities, Kabul, Khartoum (IDPs)

Social inequality and health in the urban setting

Social inequality and health in the urban setting

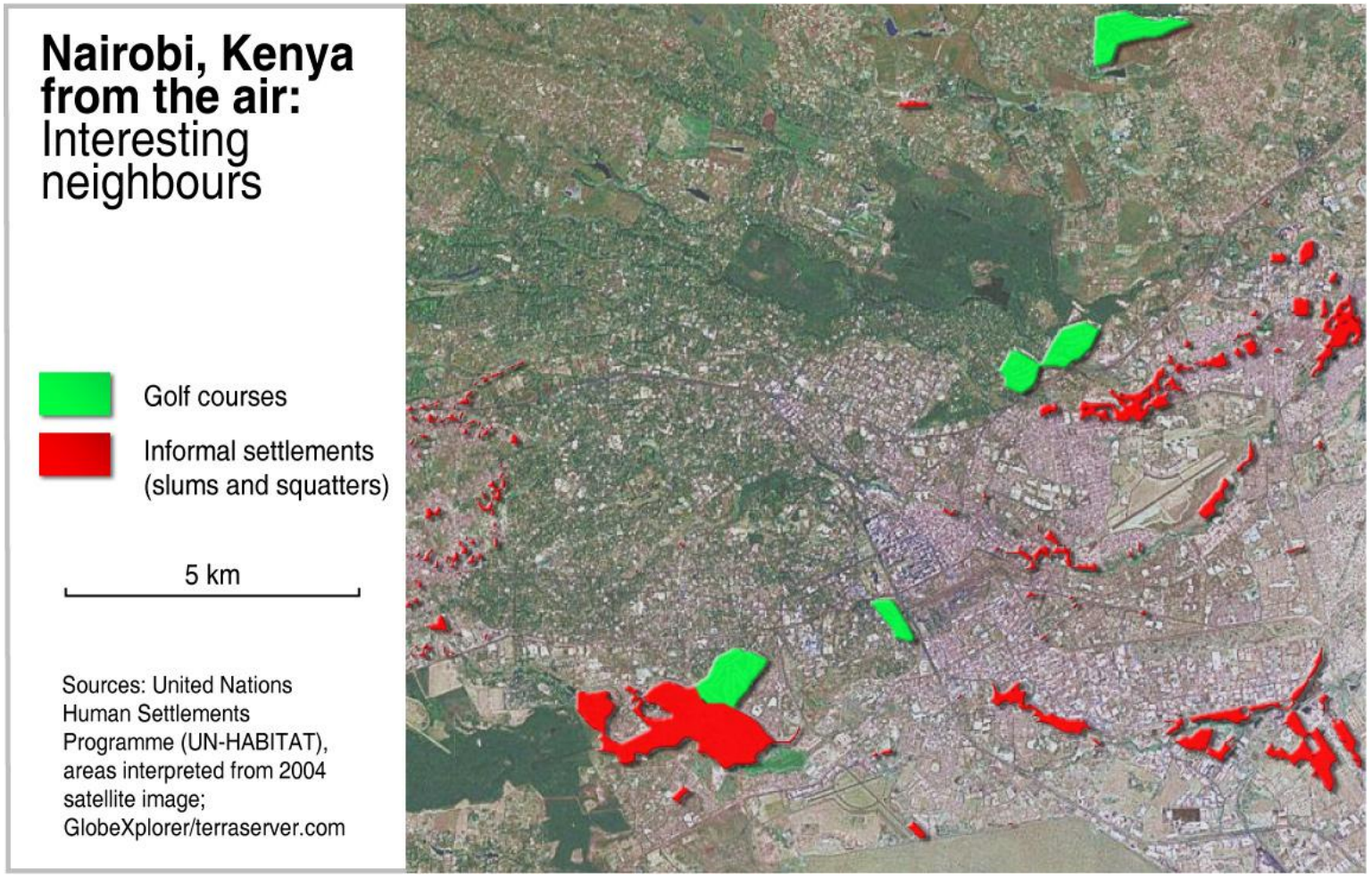
Urban centres can bring significant improvements to health through increased employment and higher salaried work

Overall , health status is often better in urban rather than rural communities

Levels of education are usually higher and this is associated with Increased rates of breast-feeding, immunization, simple hygiene

However, often also great inequalities within cities

Social inequality and health in the urban setting



Urbanisation may lead to reduced disease transmission

Air and water pollution can hinder vector proliferation

Anopheles mosquitoes are less common and less likely to be infected with Plasmodium species

International travel and respiratory viruses

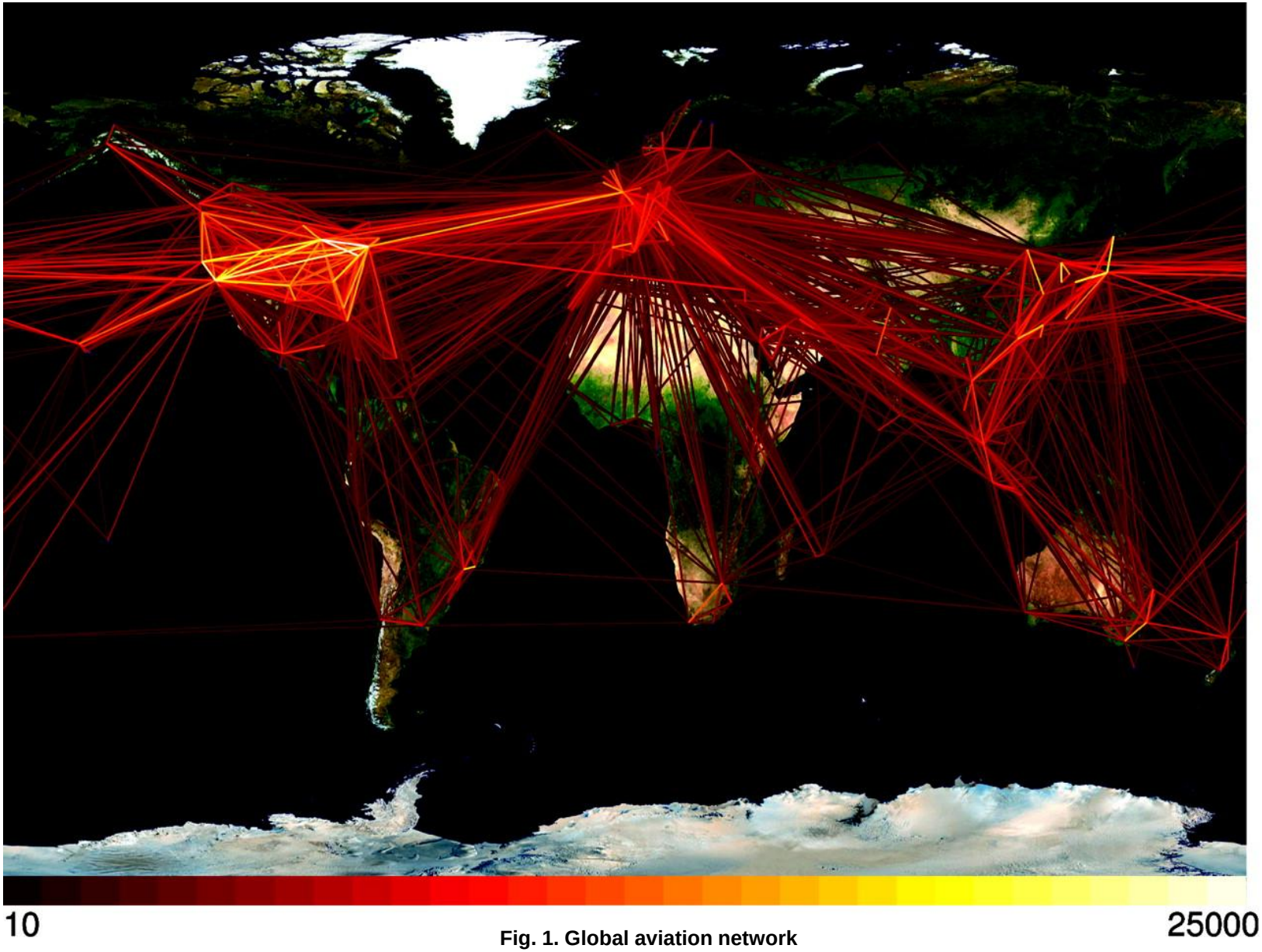


Fig. 1. Global aviation network
Hufnagel, L. et al. (2004) Proc. Natl. Acad. Sci. USA 101, 15124-15129

2007 International air traffic

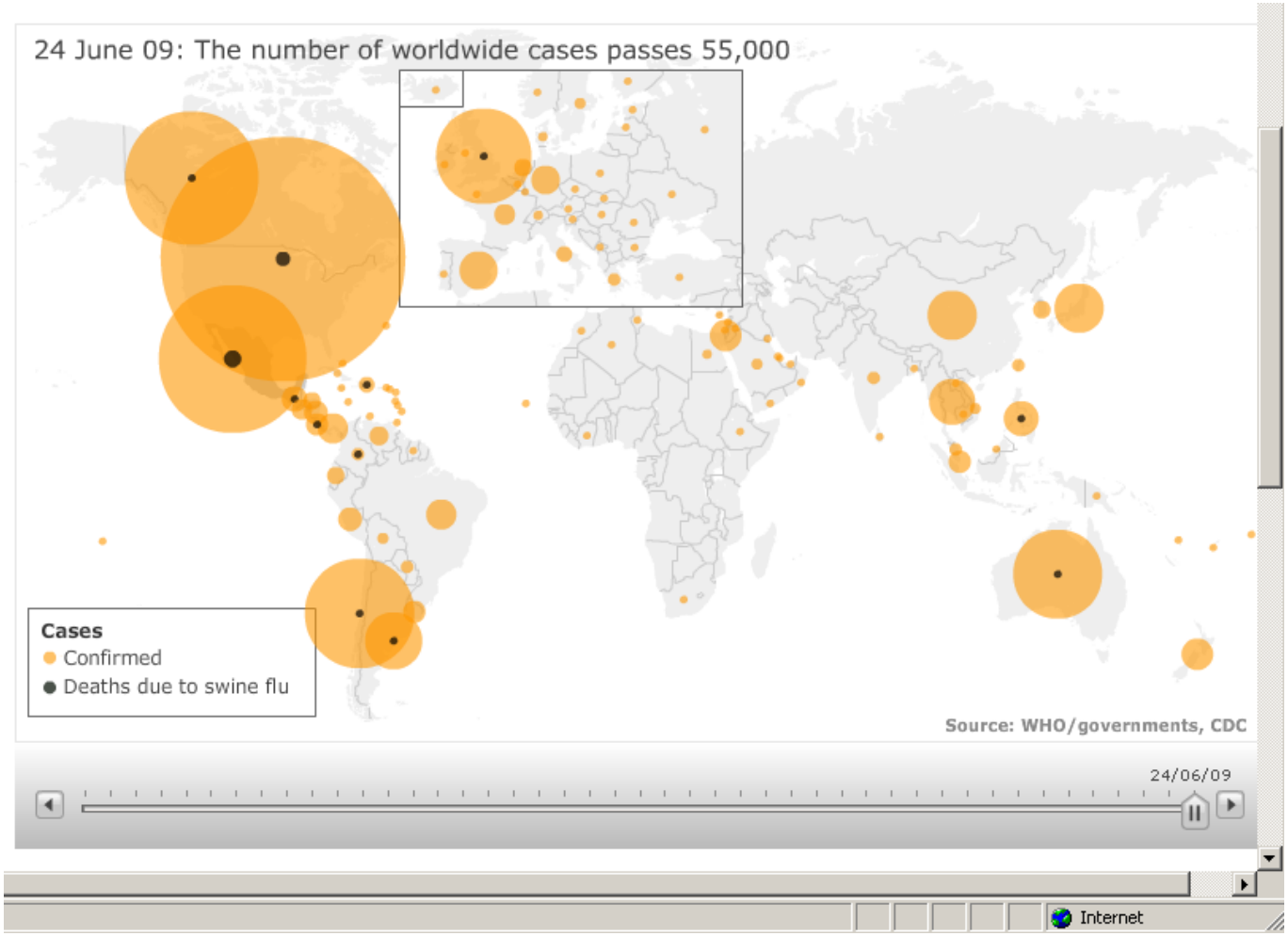
Rank	Airport	Passengers/yr
1	London Heathrow	62,099,530
2	Charles De Gaulle Paris	54,901,564
3	Schipol Amsterdam	47,677,570
4	Frankfurt	47,087,699
5	Hong Kong	46,281,000
6	Singapore Changi	35,221,203
7	Narita, Tokyo	34,289,064
8	Dubai International	33,481,257
9	Suvarnabhumi, Bangkok	31,632,716
10	London Gatwick	31,139,166

Source: Airports Council International 2007

MATT

Christopher Robin and Pooh decided to have Piglet put down

Swine Flu



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SARS: 2003

Image: Donald Low, University of Toronto

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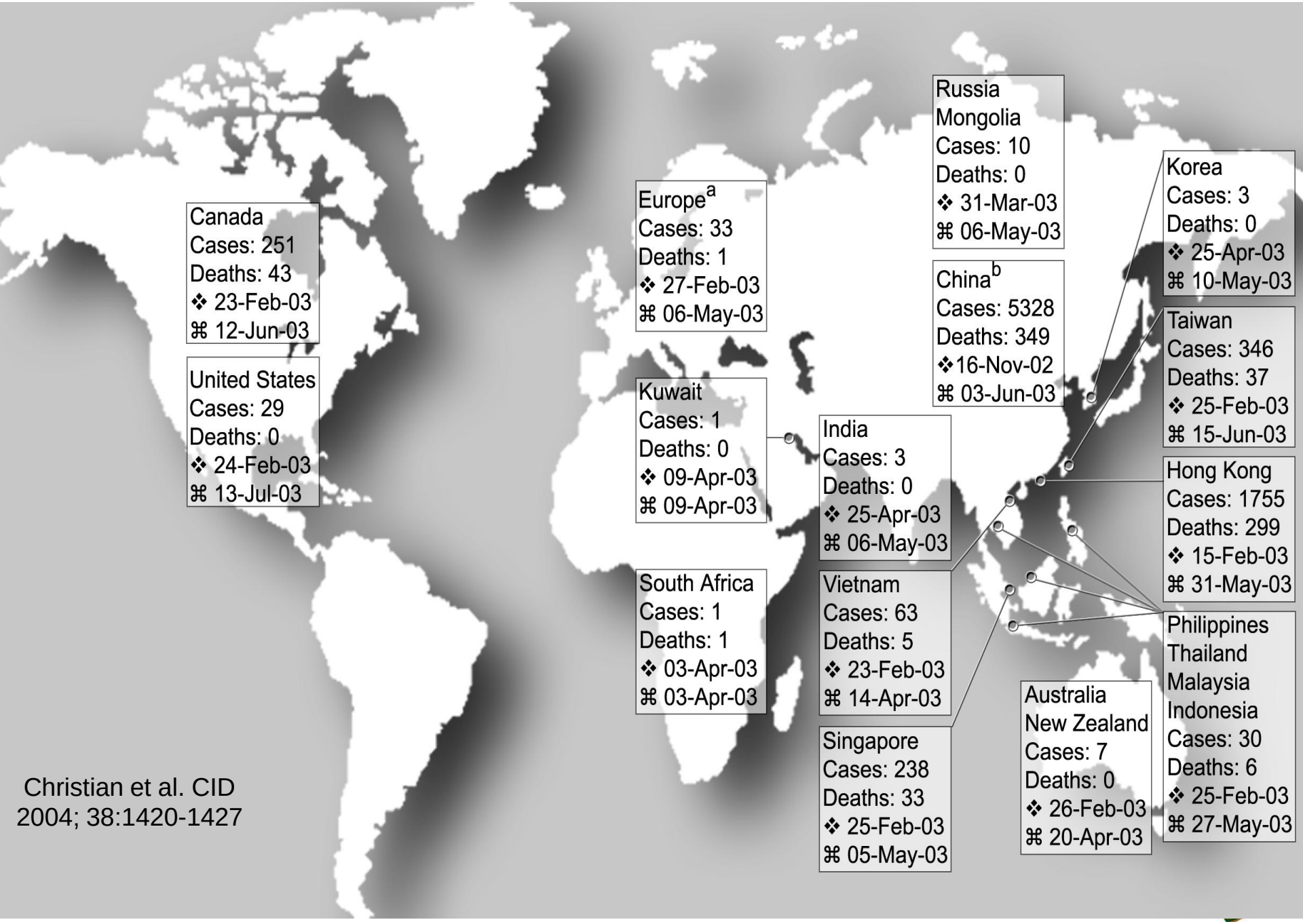


Christian et al. CID
2004; 38:1420-1427

Christian et al. CID 2004; 38:1420-1427

International Migration

Migration and susceptibility to disease

Migrants to urban areas can be vulnerable to infections due to imported susceptibility rather than imported infection

Greenaway et al (AIM, 2007) study of immigrants to Canada
Over 36% of participants were susceptible to M,M or R

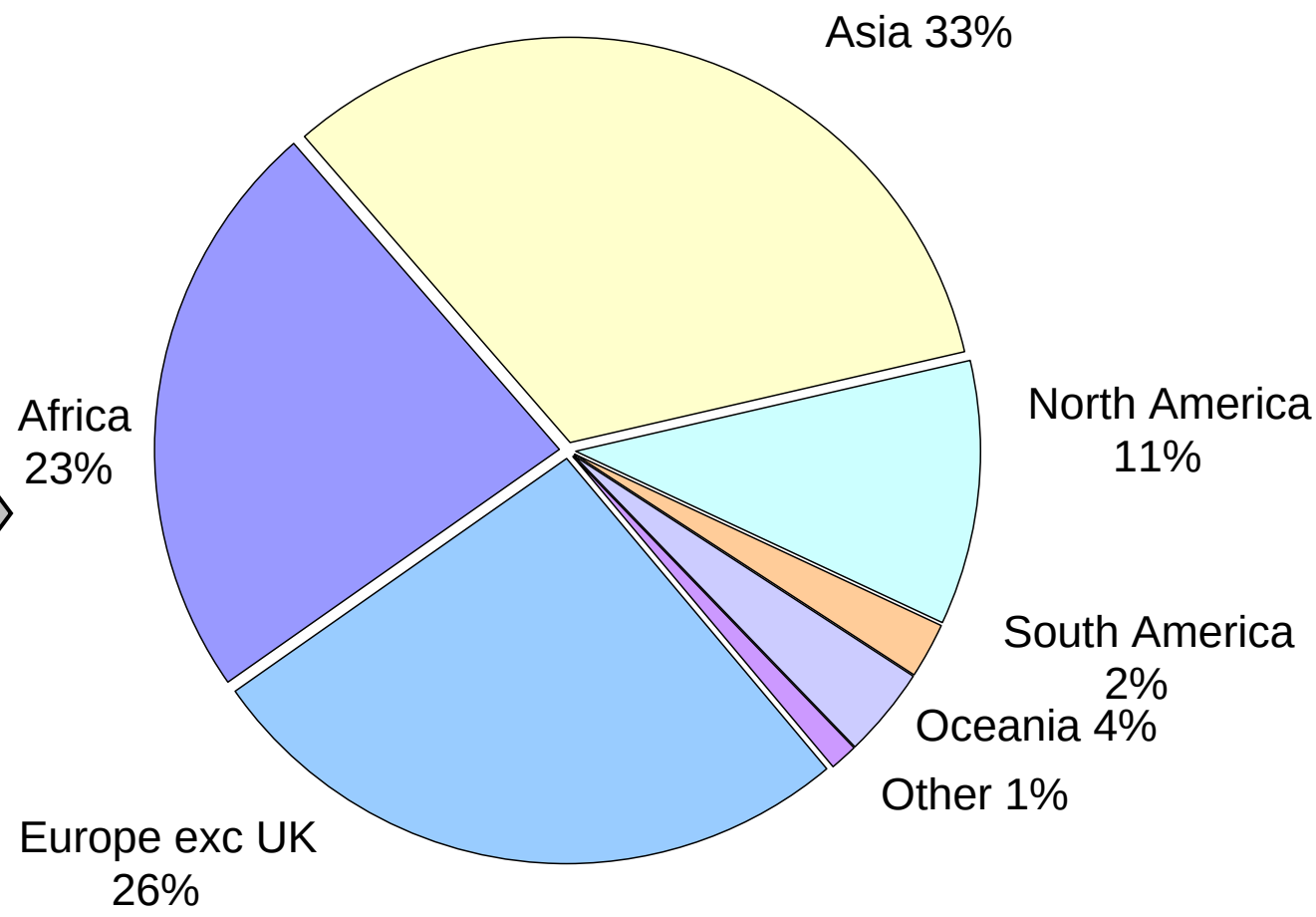
In London we see significant numbers of cases of measles in Individuals from Eastern Europe (Poland, former Soviet States)

In less well developed settings, immunity might be acquired through childhood illness rather than vaccination

Londoners born outside UK by region of birth

27% of Londoners were born outside UK

(~ 2 million



Source: 2001 Census, ST102

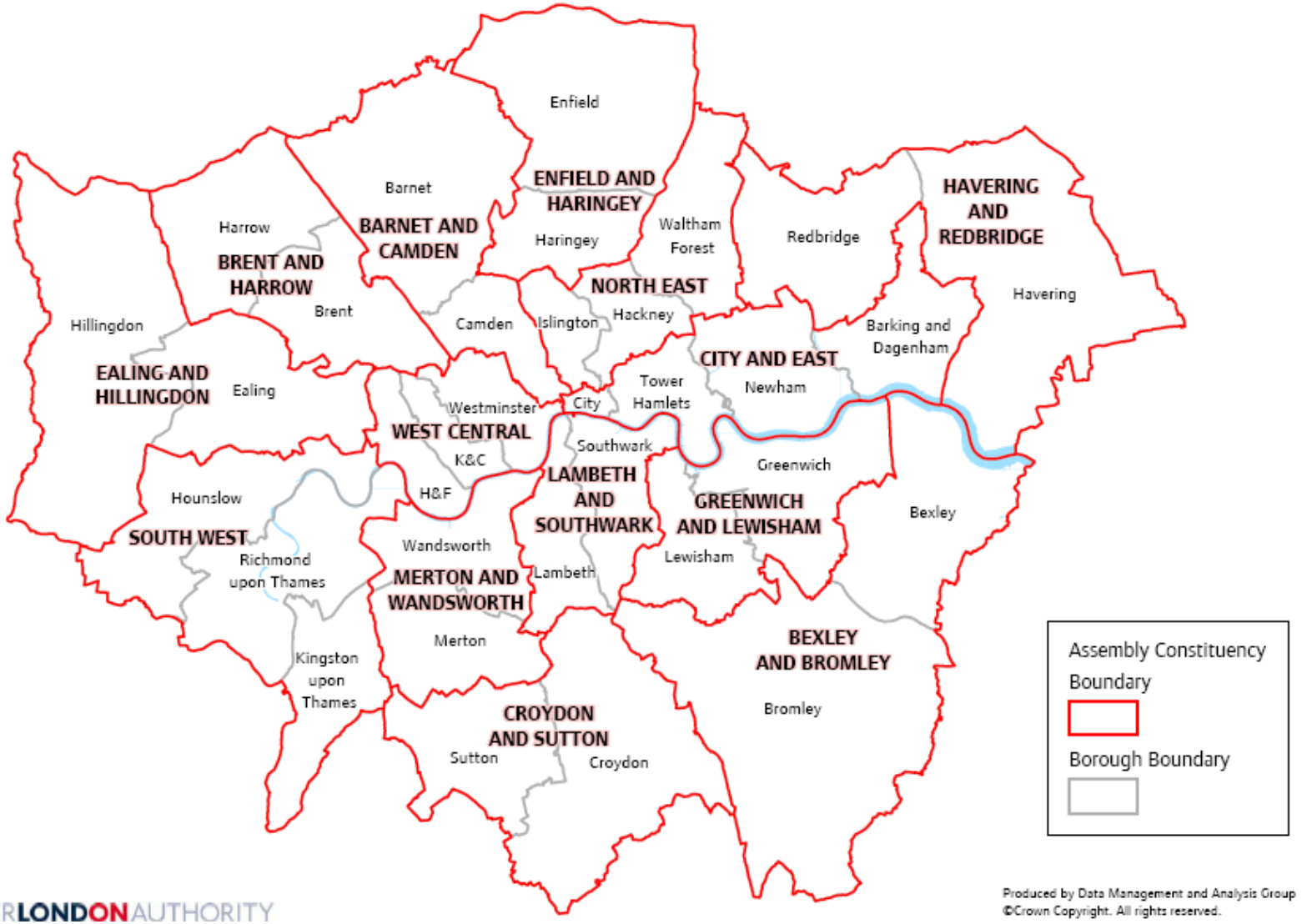
Survey in ICHT ID service

111 respondents (83% return) at Hammersmith Hospital

53 (47.7%) overseas born v 33% from local data
14 (26.4%) <10 years in UK
39 (73.6%) > 10 years in UK

Asia	(30%)
Africa	(21%)
EU	(20%)
Caribbean	(10%)
Middle East	(8%)
South America	(4%)
Oceania	(4%)
North America	(3%)

Source: (2007) BMC Health Serv Res



Source: DMAG Briefing 2008-2009

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West Central Demographics

	West Central		Greater London	
	2006	2026	2006	2026
Total	**551,500**	**608,500**	**7,461,400**	**8,265,200**
White	414,000	443,300	5,036,200	5,031,400
Black Caribbean	18,000	15,800	362,000	403,600
Black African	21,400	22,000	449,900	598,800
Black Other	13,300	15,000	192,900	255,700
Indian	14,400	18,700	491,100	621,500
Pakistani	5,300	6,300	170,100	238,400
Bangladeshi	7,900	7,800	178,500	248,200
Other Asian	15,800	19,400	229,500	304,700
Chinese	11,100	15,700	98,100	143,100
Other	30,500	44,500	253,100	419,800

9.4%

10%

Source: DMAG Briefing 2008-2009

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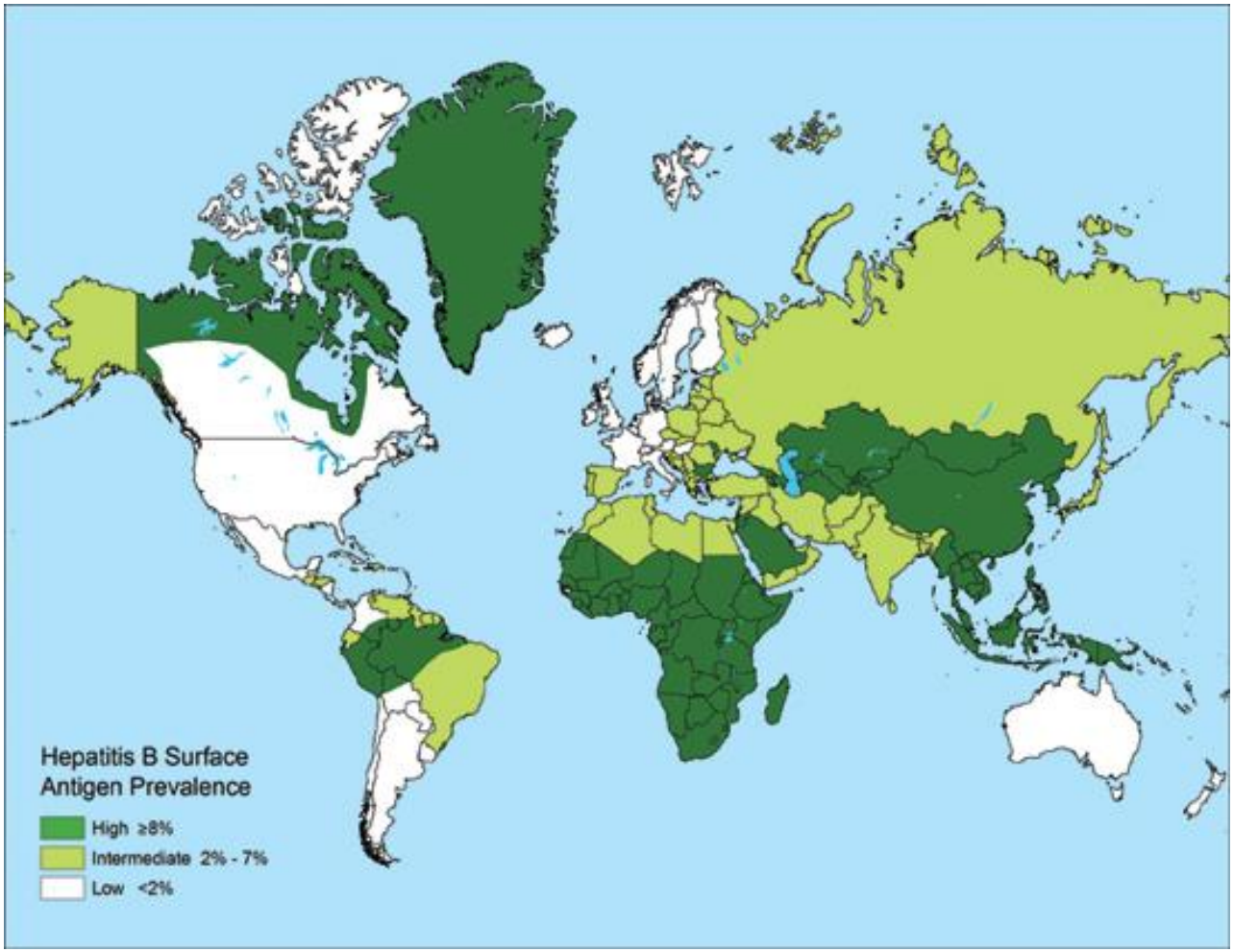
International migration and asymptomatic infectious diseases



Source: CDC

Also ….

TB
HIV
HCV
HTLV
…

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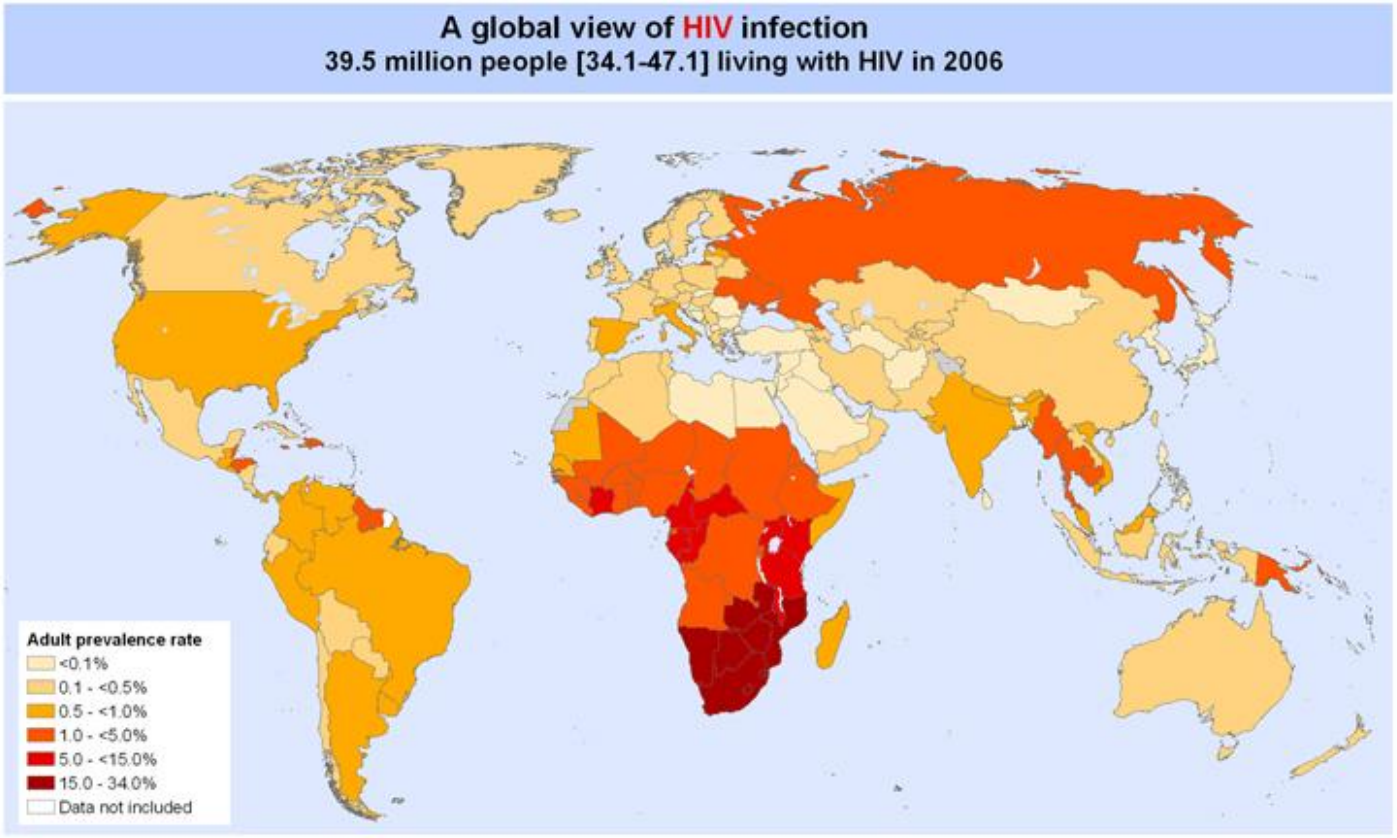
HIV



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Thank you