Disease Emergence from Global Climate & Land Use Change

• Institute for Children's Environmental Health

• Seattle Biotech Legacy Foundation

*** Town Hall, Seattle March 9, 2006 ***

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Nelson Institute for Environmental Studies &
Dept Population Health Sciences
University of Wisconsin – Madison

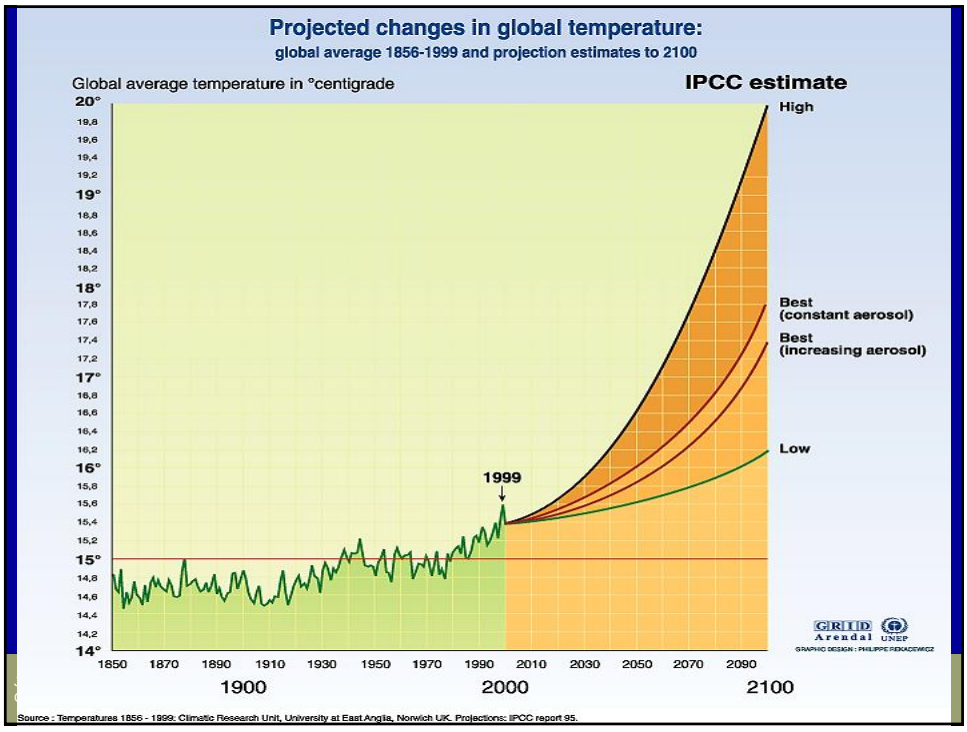
Conclusions

1. Many widespread & serious **diseases are highly sensitive to climate** (even to slight warming)

2. Landcover/**habitat change can exacerbate** health effects of climate change (or act independently)

3. ETHICAL Challenge: The countries or **populations least responsible** for causing global warming **are the most vulnerable** to adverse health and societal impacts


The Greenhouse Effect
Greenhouse gases and clouds keep the Earth's surface 33°C warmer than it would otherwise be.
Atmosphere
Source: IPCC (1994)
EPA


Projected changes in global temperature:
global average 1856-1999 and projection estimates to 2100
Global average temperature in °centigrade
IPCC estimate
High
Best (constant aerosol)
Best (increasing aerosol)
Low
1999
20°
19°
18°
17°
16°
15°
14°
1850 1870 1890 1910 1930 1950 1970 1990 2010 2030 2050 2070 2090
1900
2000
2100
GRID Arendal UNEP
Source : Temperatures 1856 - 1999: Climatic Research Unit, University at East Anglia, Norwich UK. Projections: IPCC report 95.

Today's temperature is well above any temperature in the last 1000 years.

Based on tree rings, corals, and ice cores.

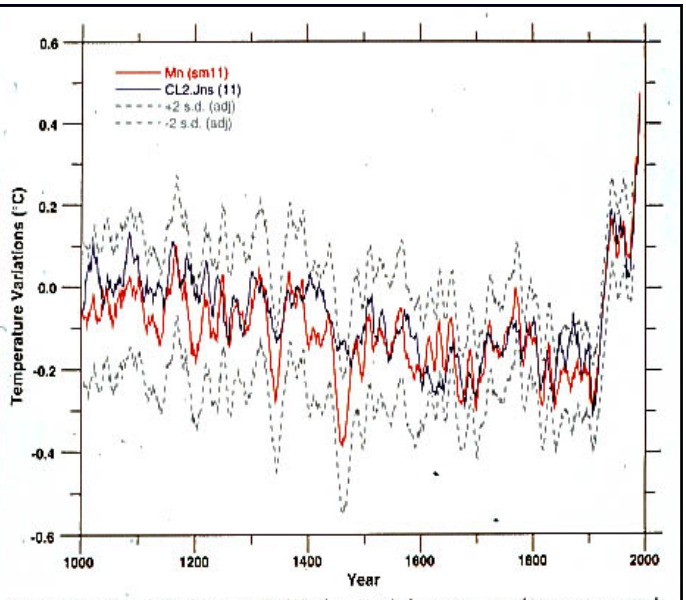
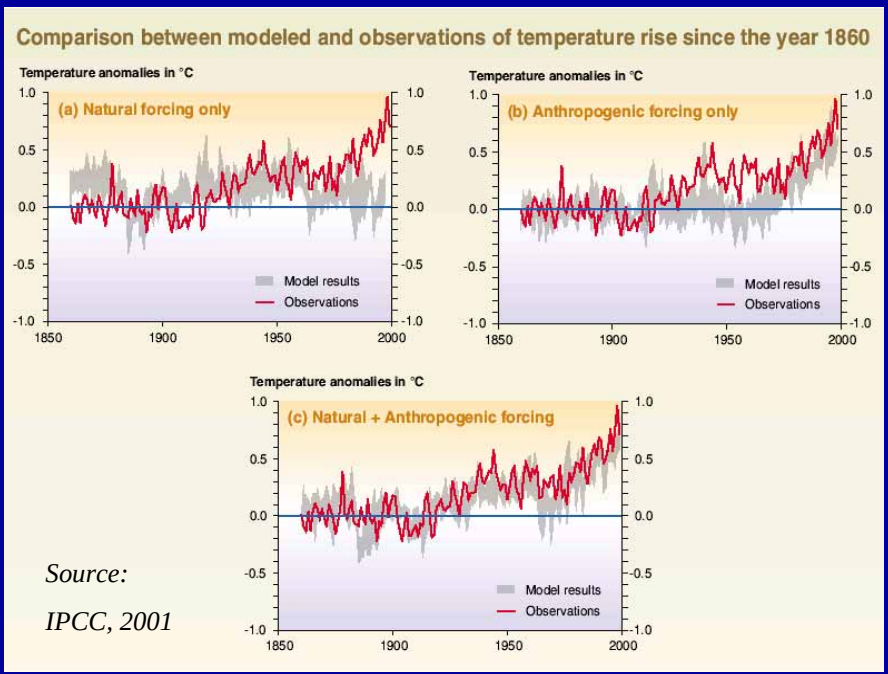


Fig. 1. Comparison of decadally smoothed Northern Hemisphere mean annual temperature records for the past millennium (1000–1993), based on reconstructions of Mann *et al.* (Mn) (*11*) and CL (*12*). The latter record has been spliced into the 11-point smoothed instrumental record (*16*) in the interval in which they overlap. CL2 refers to a new splice that gives a slightly better fit than the original (*12*). The autocorrelation of the raw Mann *et al.* time series has been used to adjust (adj) the standard deviation units for the reduction in variance on decadal scales.



Source:

IPCC, 2001

IPCC Third Assessment Report Conclusions (cont.)

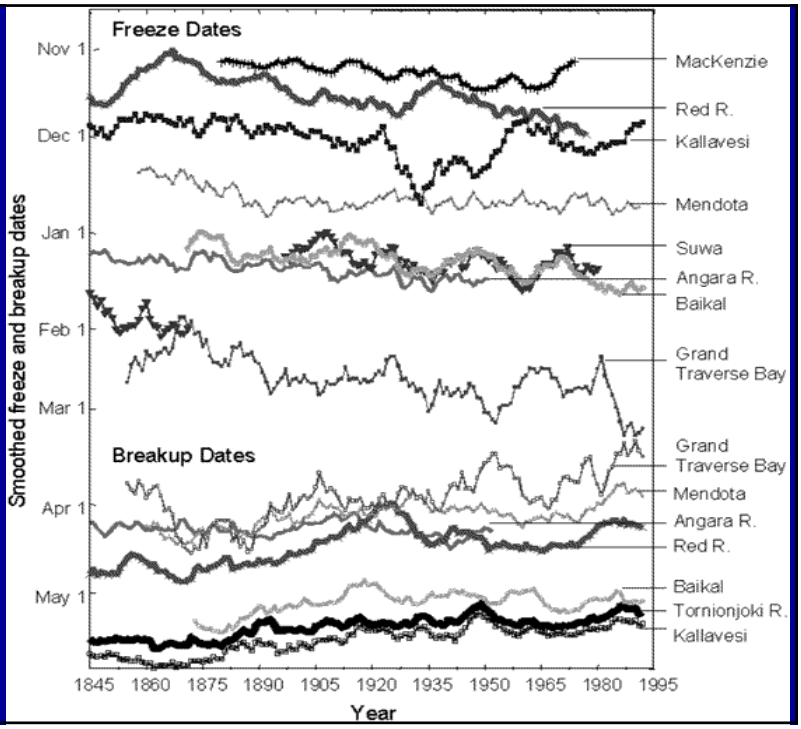
- **"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities"**
- **Human influences will continue to change atmospheric composition throughout the 21st century**
- **Global average temperature and sea level are projected to rise under all IPCC SRES scenarios**
  - Global surface temps. increase **~3°C** (or 5°F) by 2100
  - Global mean sea level rises by **~ 45 cm** by 2100

" Warming Trend Revealed in Global, Long-term Ice Breakup Study."

North Temperate Lakes LTER site have amassed lake and river ice **freeze dates or breakup dates** spanning the Northern Hemisphere that show a **150-year warming trend**, and "represents one of the largest and longest records of observable climate data ever assembled."

From:

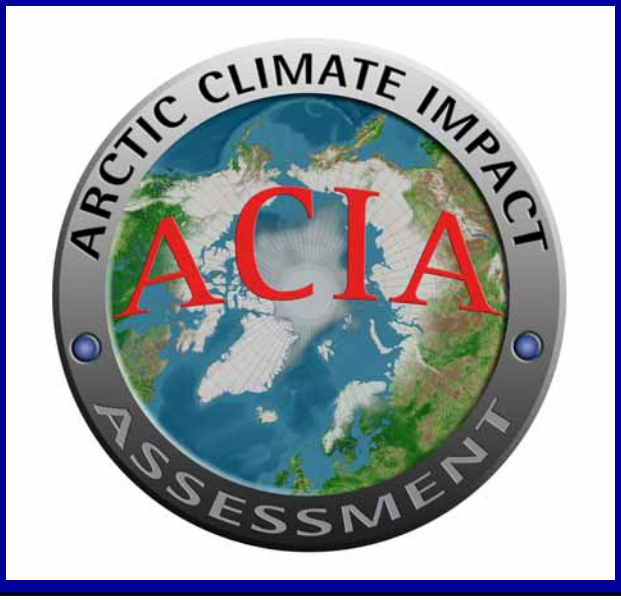
Magnuson, et al. 2000)



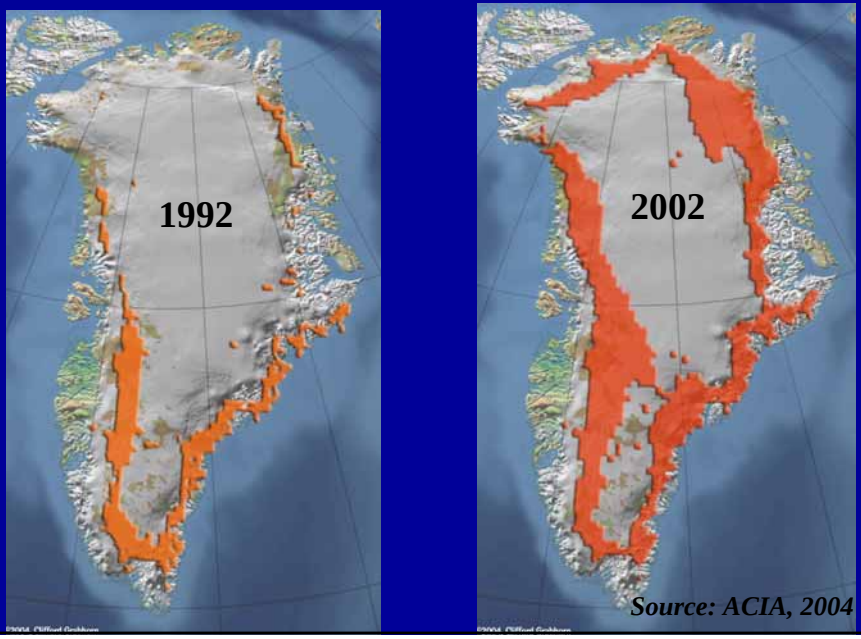
Since 1853, there has been a 25 percent decrease in the amount of time Lake Mendota remains frozen over during the winter.

(John Magnuson et al., Science 2000)

Surprised by bad news, Nov. 2004…



Extent of Greenland Ice Sheet Melt

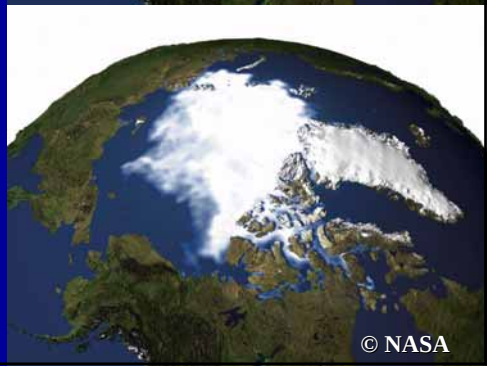


Source: ACIA, 2004

Observed Sea Ice

September, 1979

September, 2003



Composite satellite reconstruction
© NASA

Source: ACIA, 2004

Last week's issue of Time Magazine

"How it threatens your health"

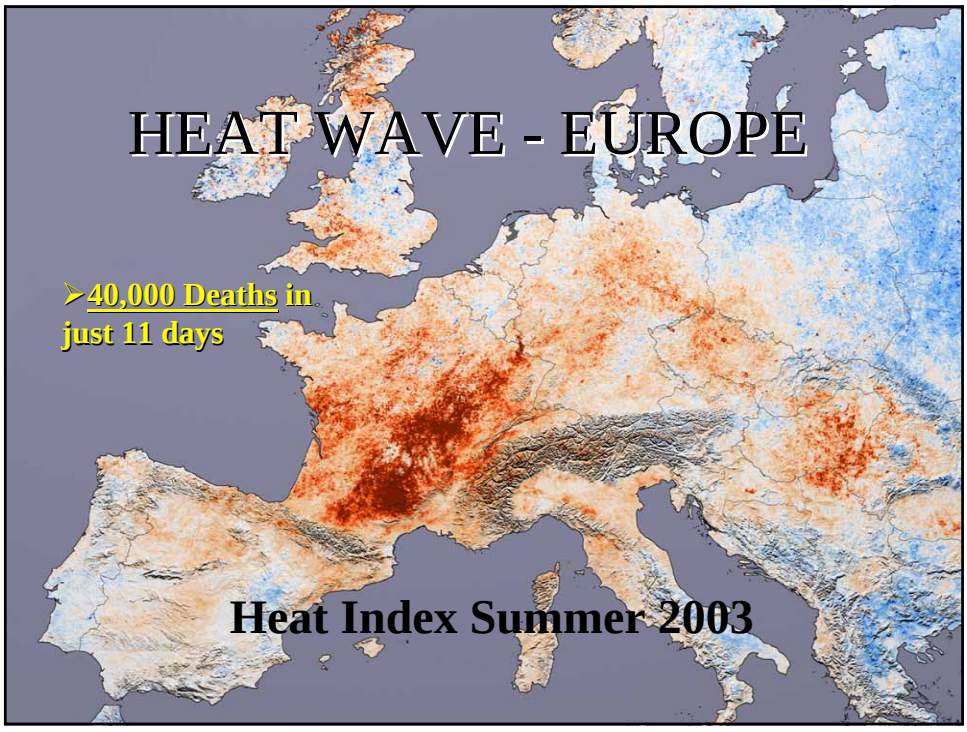
HEALTH EFFECTS OF CLIMATE CHANGE

CLIMATE CHANGE

Temperature Rise [1]
Sea level Rise [2]
Hydrologic Extremes

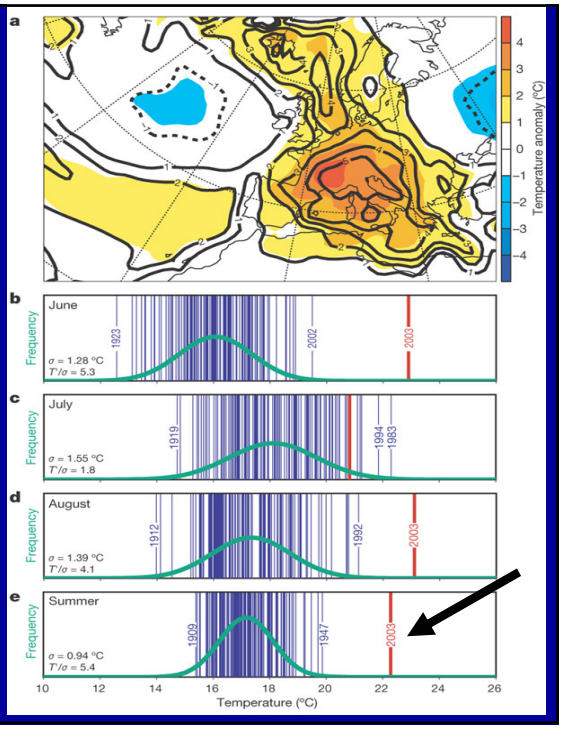
[1] **3°C** by yr. 2100
[2] **40 cm** " "
IPCC estimates

Urban Heat Island Effect	Heat Stress Cardiorespiratory failure
Air Pollution	Respiratory diseases, e.g., COPD & Asthma
Vector-borne Diseases	Malaria Dengue Encephalitis Hantavirus Rift Valley Fever
Water-borne Diseases	Cholera Cyclospora Cryptosporidiosis Campylobacter Leptospirosis
Water resources & food supply	Malnutrition Diarrhea Toxic Red Tides
Environmental Refugees	Forced Migration Overcrowding Infectious diseases Human Conflicts



Schar et al (2004)

showed that the summer of 2003 was certainly an extreme climate event.



"THE WHEEZY CITY"

↓

"SWELTERING IN CHICAGO"

(as in, "Sleepless in Seattle")

Relationship between temperature and ground-level ozone

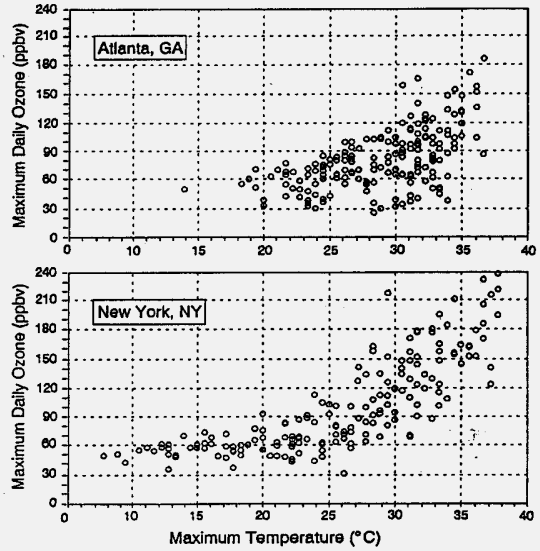


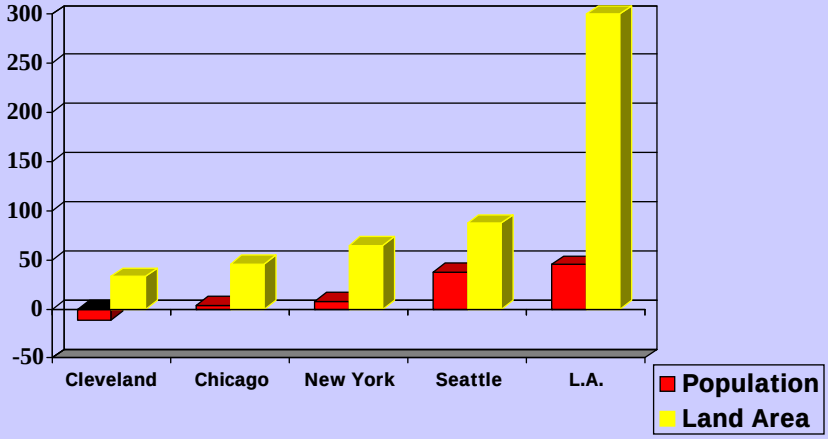
Figure 5-3. Maximum daily ozone concentrations in Atlanta, GA, and New York, NY, versus maximum daily temperature, May-October, 1988-1990

Source: (USEPA 1996a)

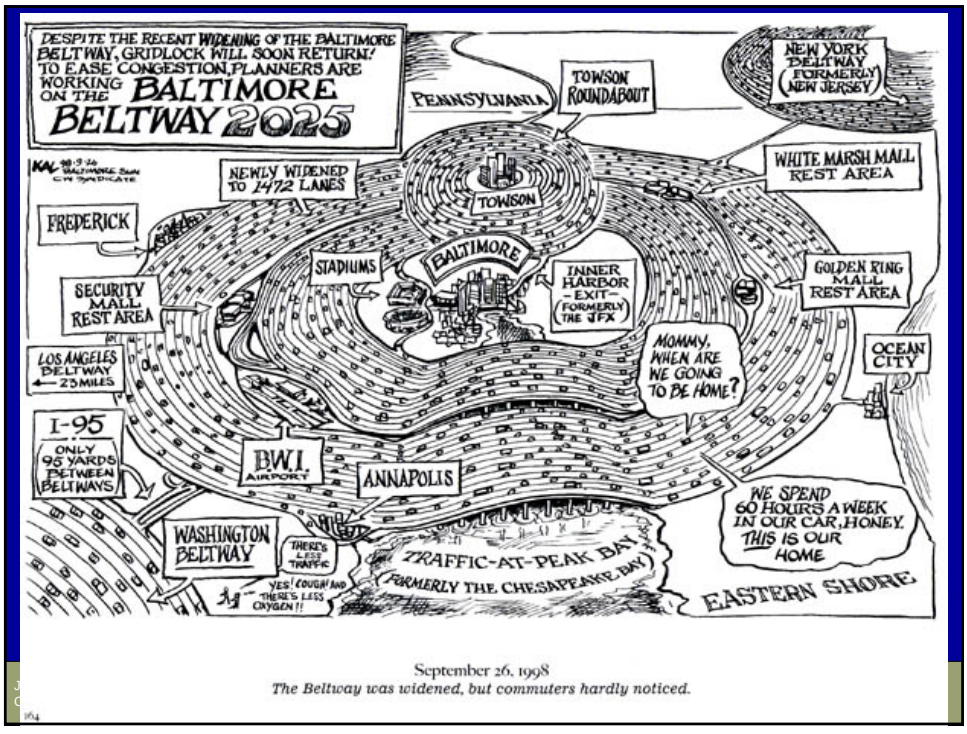
CLIMATE & LAND USE SYNERGY

…or local determinants of vulnerability

Changes in population and developed land area, selected metropolitan areas, 1970-1990.



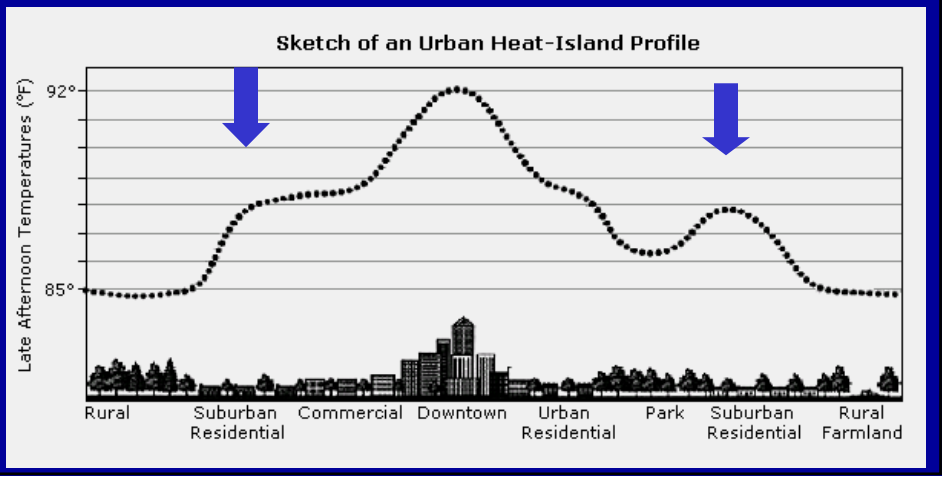
Source: Benfield et al., *Once There Were Greenfields*, NRDC and STPP, 1999.



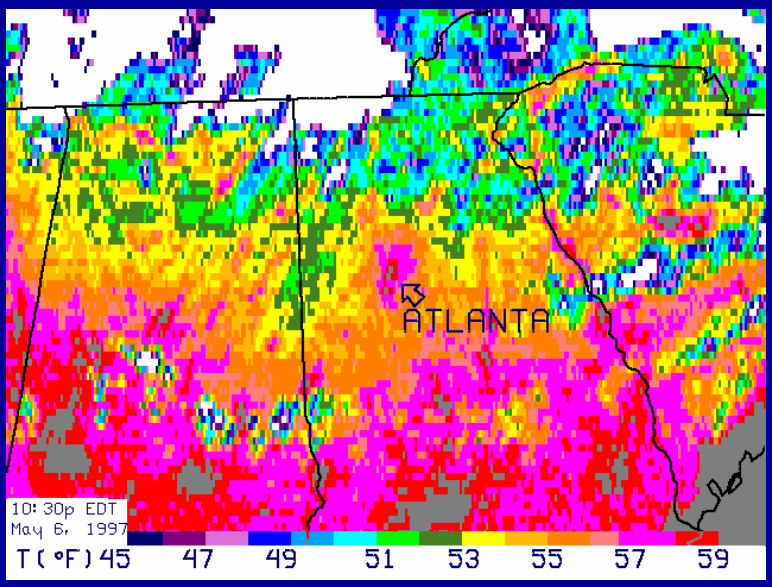
September 26, 1998
The Beltway was widened, but commuters hardly noticed.

The Heat Island

Dark surfaces such as asphalt roads or rooftops can reach temperatures 30-40°C higher than surrounding air

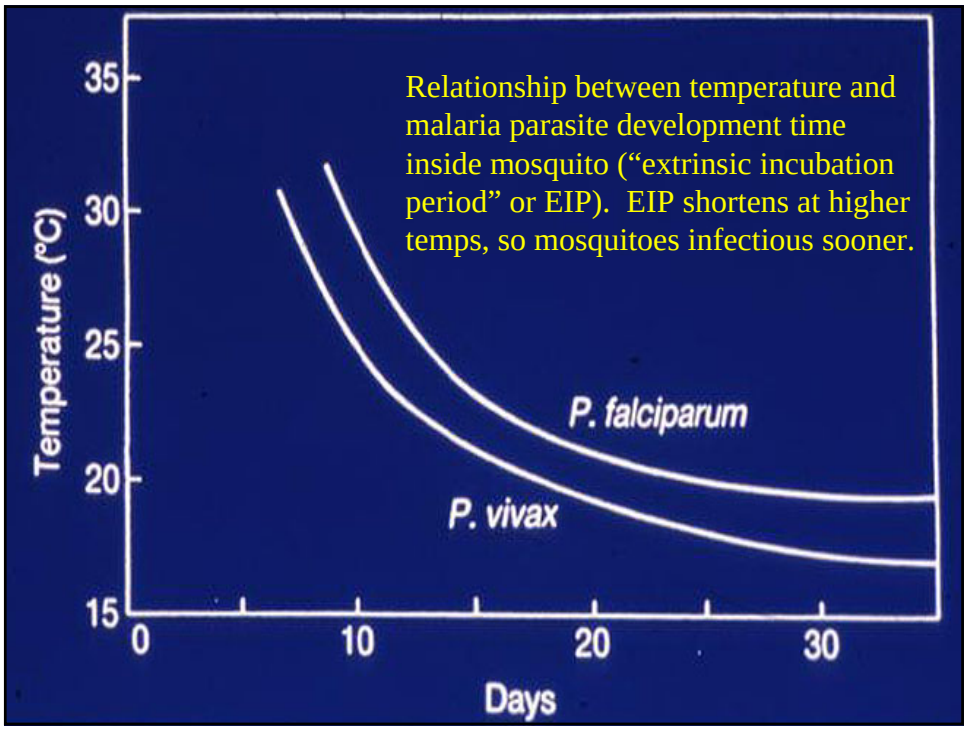


Atlanta's Heat Island



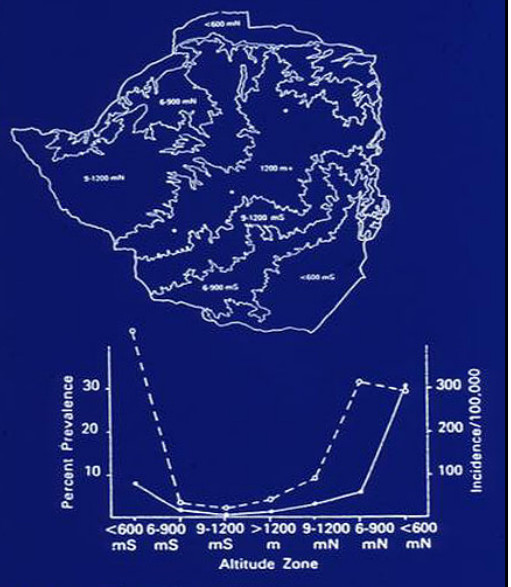
Source: NASA Marshall Space Flight Center


Health Professionals and Scientists Warn of Spreading Infectious Diseases.
Global Warming's greatest threat may also be the smallest.


Relationship between temperature and malaria parasite development time inside mosquito ("extrinsic incubation period" or EIP). EIP shortens at higher temps, so mosquitoes infectious sooner.
Temperature (°C)
35
30
25
20
15
0
10
20
30
Days
P. falciparum
P. vivax

Relationship between malaria and altitude, Zimbabwe.

Altitude a good surrogate for temperature: the average temperature decrease with height = **6°C per 1000 meters**

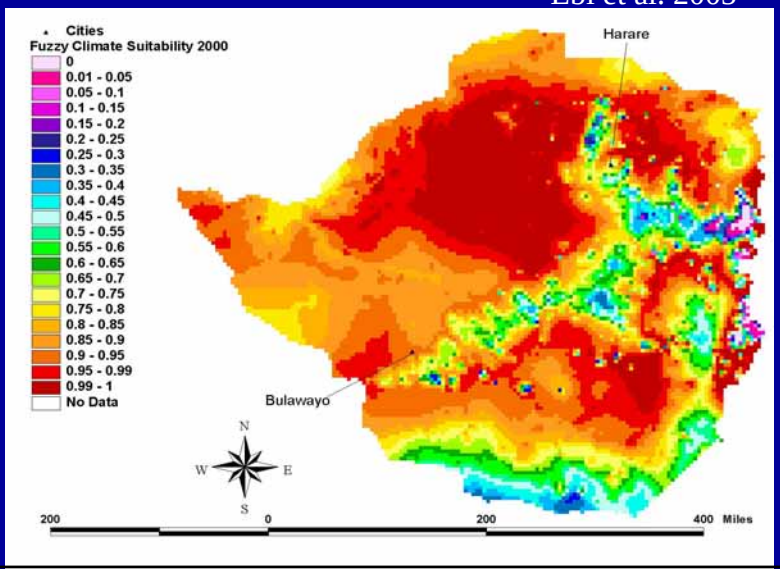


Average annual prevalence and incidence/100,000 population of malaria by altitude zone for the years 1969-1981 and 1972-1981, respectively (Taylor & Mutambu, *Trans. Royal Soc.Trop. Med. & Hyg.*, 1986; 80: 12-19).

Source: Taylor and Mutambu, 1986

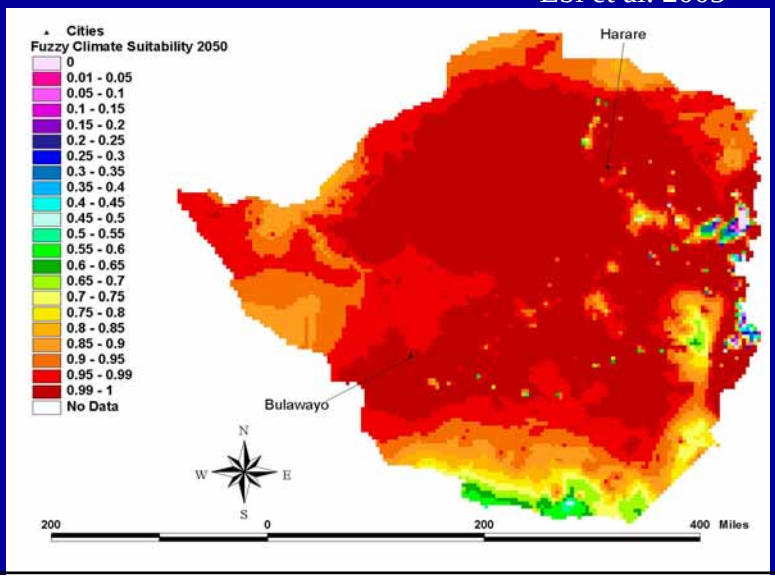
Baseline *2000* 2025 2050 2075 2100

Ebi et al. 2005



Baseline 2000 2025 *2050* 2075 2100

Ebi et al. 2005



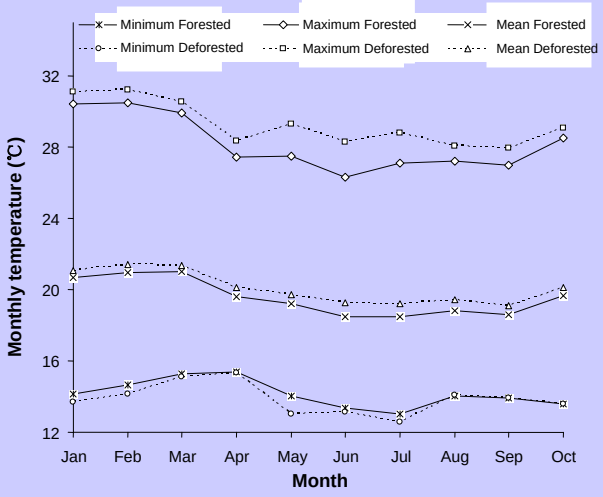


Fig. 1

West Nile Virus Transmission Cycle in Old World

Mosquito vectors
Culex species

VIRUS

Dead - end Hosts

VIRUS

VIRUS

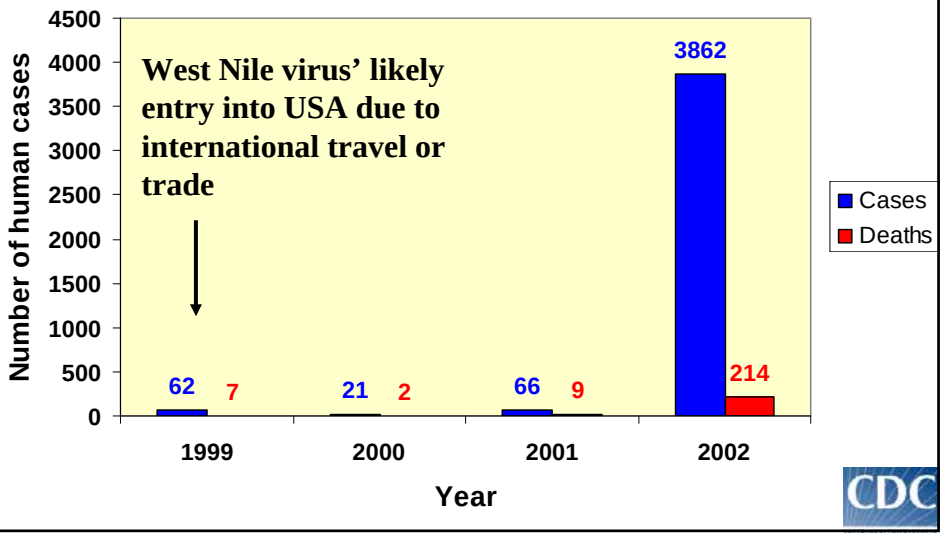
Avian reservoirs

USGS, National Wildlife Health Center

Dissemination of WNV by migratory birds?

USGS, National Wildlife Health Center

2002: West Nile's Year of Reckoning



Temperature Deviations 2002 vs. 2003: Chicago

April 2002 →	+2.1 F	+0.5 F	← April 2003
May	*-3.5*	*-2.5*	May
June	+2.7	*-2.7*	June
July	+3.8	*-1.0*	July
August	+1.4	+1.9	August
Sept	+3.5	*-0.4*	Sept
Deviations	+ 10	- 4.2	

Summer 2002 optimal for *Culex* mosquitoes

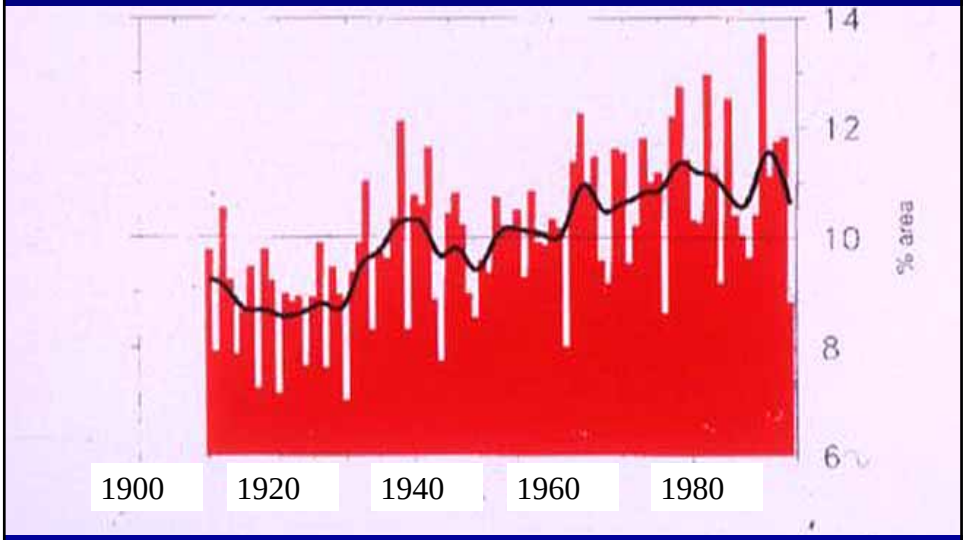
Note Temperature differences 2002 vs. 2003

Source: CDC

Climate change:

It's not just about warming.

Proportion of the USA affected by much above normal annual precipitation from extreme events (>2 inches/day)



Source: Karl et al. 1996

USA: Combined sewer overflows (CSOs)

Courtesy: K. Schwab

1.2 trillion gal. of sewage & stormwater a year discharged during combined sewer overflows – would keep Niagara Falls roaring for 18 days

JOHNS HOPKINS UNIVERSITY
CWH
Center for Water and Health

Results

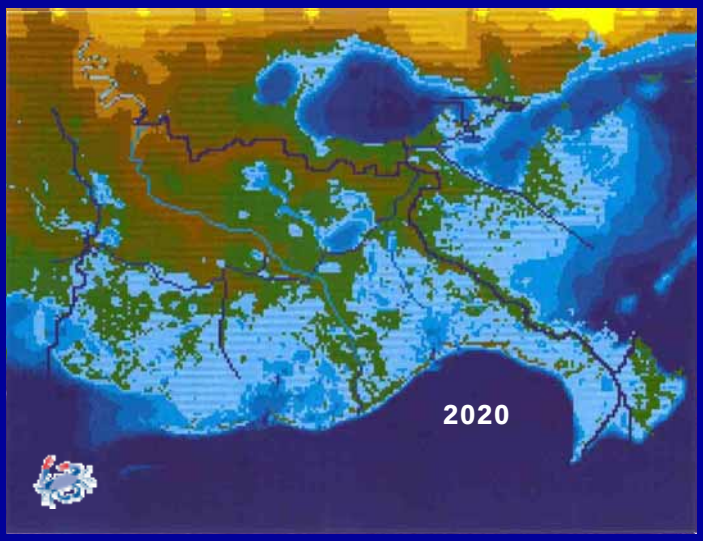
- **67% of waterborne disease outbreaks were preceded by precipitation above the 80th percentile** (across a 50 yr. climate record), $p < 0.001$
- **51% of outbreaks were preceded by precipitation above the 90th percentile,** $p < 0.002$
- Surface water-related outbreaks had strongest correlation with extreme precipitation in the month of outbreak; groundwater-related outbreaks lagged 2 months following extreme precipitation.

Curriero, Patz*, Rose, Lele, 2001.

ETHICS

OF CLIMATE CHANGE & HEALTH

wetland loss in the Mississippi delta (1839 to 2020)



Barataria-Terrebonne Estuary Program

Comparing average consumption: USA, Canada, India, and World -1991

- Ecological Footprint (ha/person)
  - **USA = 5.1**
  - **Canada = 4.3**
  - **India = 0.4**
  - **World = 1.8**

Source: Wackernagel & Rees. *Our Ecological Footprint* 1996.

The Tragedy of the Commons

"Picture a village with a grassy common at its center. Each villager has a right to graze one or more cows on the common. **It is in the private interest of each villager to graze as many cows as possible on this common land, because the cost is shared by all the villagers**, while he/she alone gets the milk from his cows. **As each villager acts in his private interest, there are soon so many cows that the grass on the common is destroyed.** And therein lies the tragedy. **The only workable solution to the short-sightedness of each individual is to set up some form of governance to regulate the use of the common."**

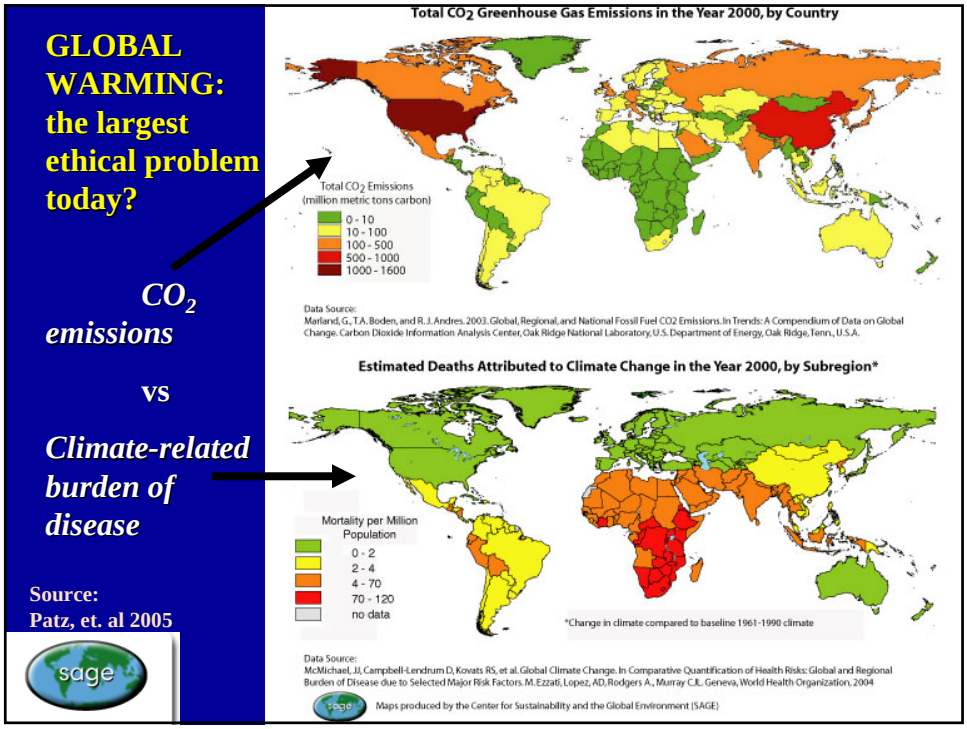
GLOBAL WARMING: the largest ethical problem today?

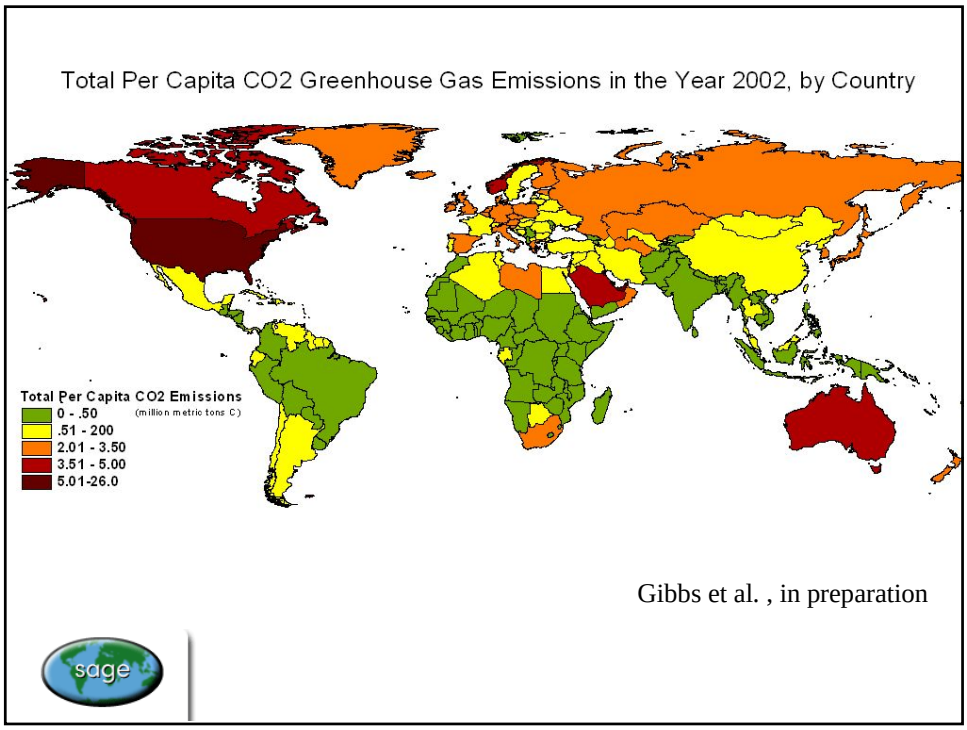
CO_2 emissions

vs

Climate-related burden of disease

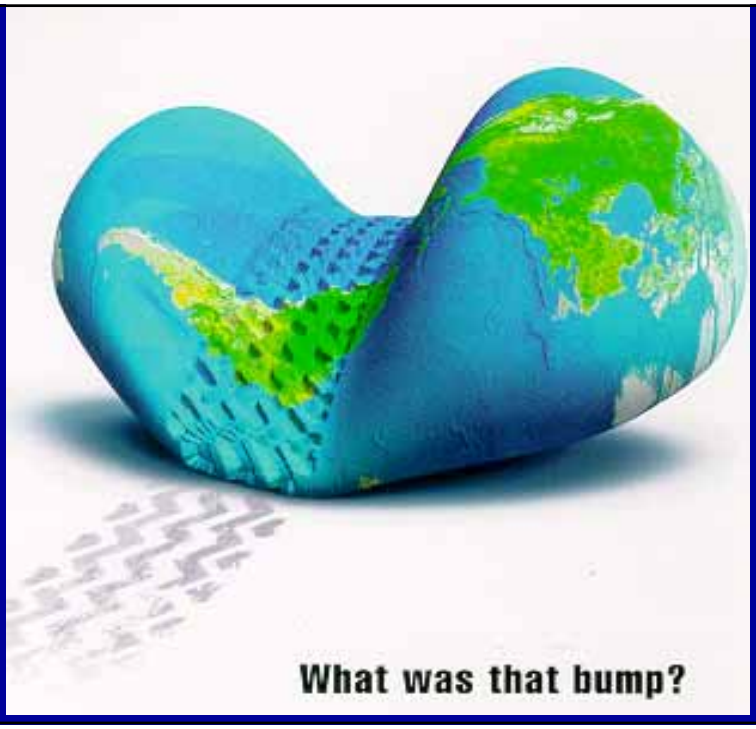
Source:
Patz, et. al 2005





Gibbs et al. , in preparation


HEY, YOU UP AT THE FRONT!
STOP BREEDING!
Developing countries
USA
Canada
EU
©Steve Bell 1994
481·18·8·94


What was that bump?

Wealth & Health: CLEAN AIR ACT

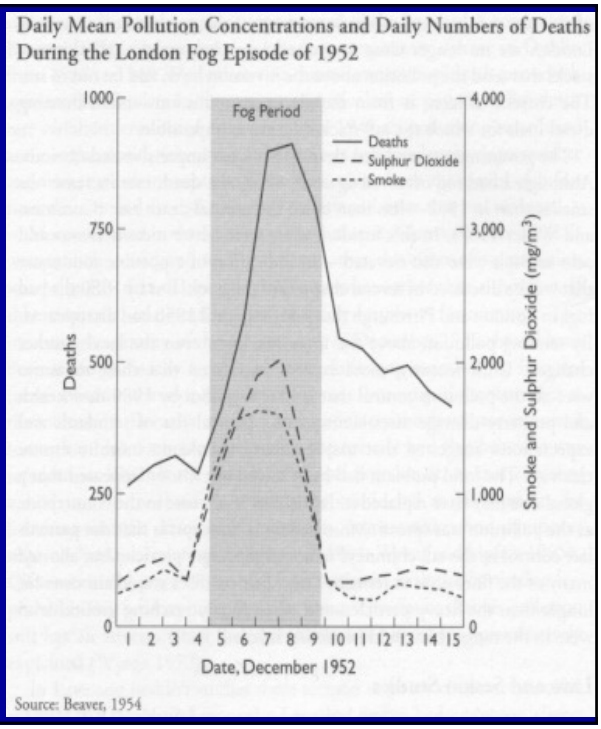
QUESTION: Since health and wealth are so closely tied, could switching from cheap fossils fuels 'harm' people?

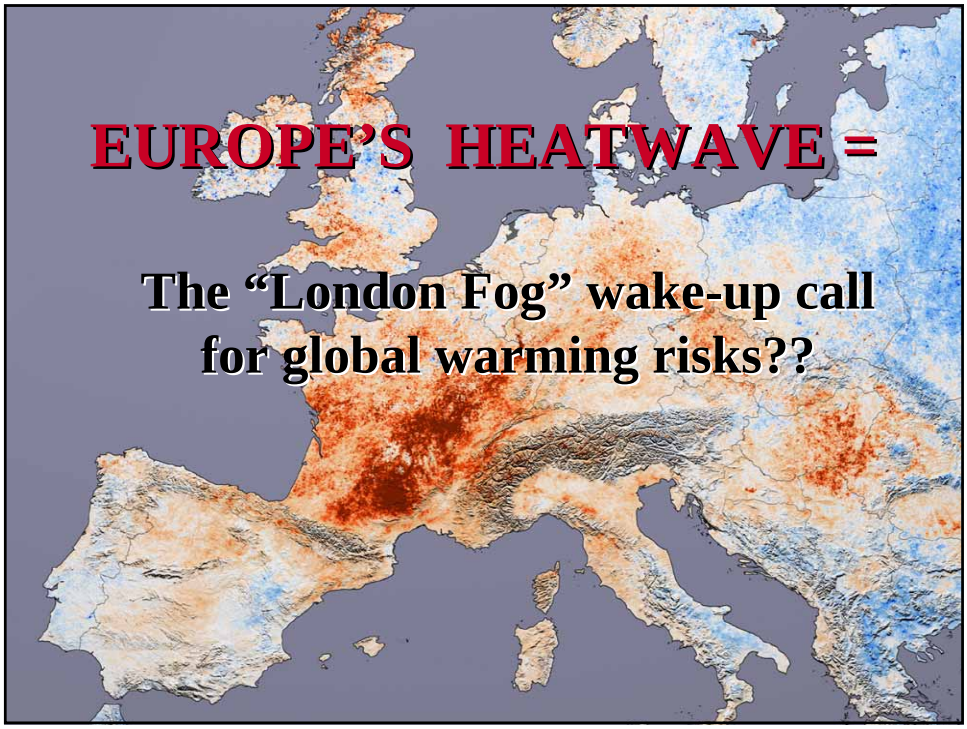
- **US Clean Air Act, Benefit/Cost assessment mandated by Congress found …**
- **$22 trillion economic benefit (health & economy) versus $ 0.523 trillion ($523 billion) direct costs**
- **Benefit/cost ratio = 42:1 (range 10-95)**

Source: US EPA 812 Report

The London Fog of 1952:

when we really woke up about air pollution as a hazardous problem





'Co-Benefits' of GHG Reduction

Fossil Fuels are source of GHGs and local air pollutants

- **Deaths from Air Pollution ranked within top 10 causes of disability**
- **460,000/yr avoidable deaths due to PM air pollution** (WHO, 1997)
- **3/4 of the world's 24 megacities are in developing countries; GHG mitigation --> major 'co-benefits'** (Cifuentes et al 2001)

sage

Wealth & Health: RENEWABLE ENERGY

QUESTION: Since health and wealth are so closely tied, could switching from cheap fossils fuels 'harm' people?

- **Alternative Energy Sources (e.g. Wind & Biofuels) are already price-competitive with fossil fuels**
- **Consumer price of fossil fuel energy does not include health cost of pollution & environmental degradation (from oil spills to climate change) – let alone hidden government subsidies for roads, etc.**
- **Oil supply will eventually run out - Do we want to keep building our economy on this single energy source?**

sage

GREEN ROOFS

responds to:

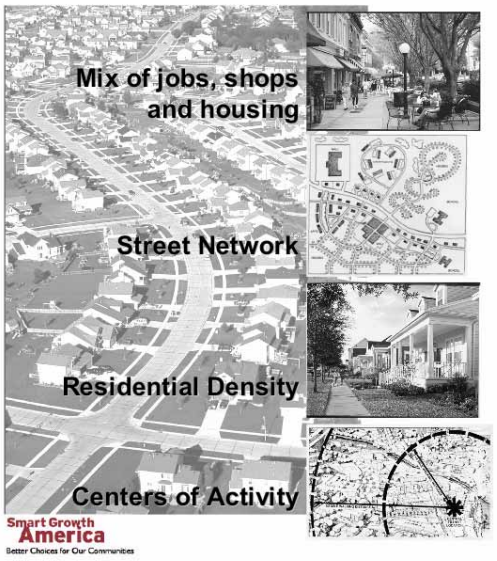
- **stormwater runoff**
- **urban heat island effect**
- **regional warming due to global climate change**

SOURCE: Colin Cheney Director | Earth Pledge Green Roofs Initiative

Seattle Mayor Greg Nickels initiated the "US Mayors' Climate Protection Agreement" leading mayors across the US to reduce greenhouse gas emissions

MEASURING SPRAWL AND ITS IMPACT

Reid Ewing, Rutgers University, Rolf Pendall, Cornell University, Don Chen, Smart Growth America



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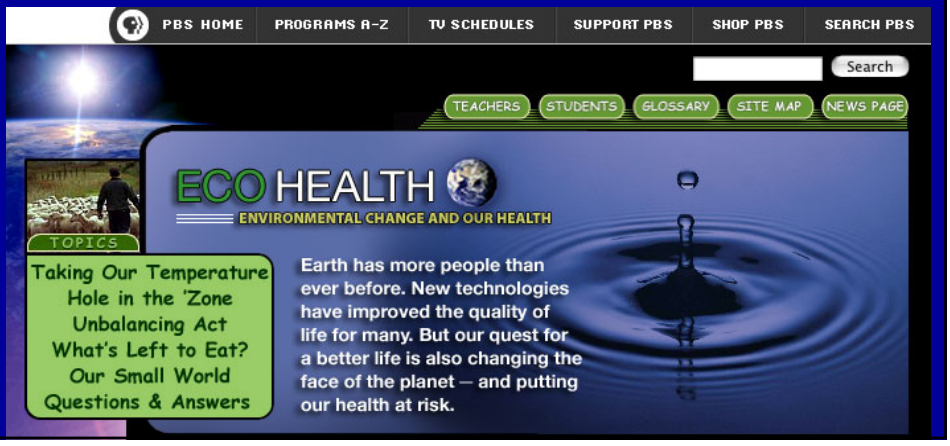
3. ETHICAL Challenge: The countries or **populations least responsible** for causing global warming **are the most vulnerable** to adverse health and societal impacts

New journal addressing global ecological change and human and wildlife health, and ecosystem sustainability

Information for middleschool teachers, students, and the general public

ECOHEALTH101.ORG



October 7-10, 2006
Madison, WI, USA

EcoHealthONE

The First Biennial Meeting of the International EcoHealth Association

- The 1st Biennial Conference of the International EcoHealth Association: Forging Collaboration Between Health and Ecology
- Meeting Theme: Promoting Global Health - Sustaining Natural Resources
- Registration is now open and we are now accepting abstracts for oral presentations.
- Conference Website: www.ecohealth.net/Conference/site/

October 7-10, 2006
Madison, WI

Thank you and see you there!

patz@wisc.edu

EcoHealth ONE Oct. 7-10, 2006
Madison, Wisconsin

THEME: *"Promoting Global Health-Sustaining Natural Resources"*

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

THANK YOU &

Visit the website

http://www.ecohealth.net