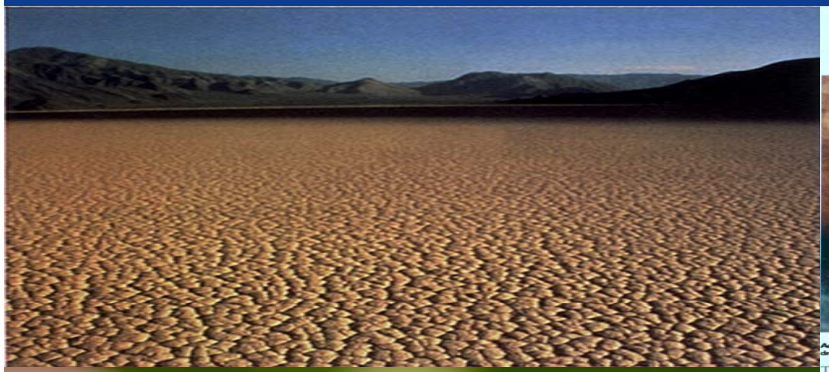
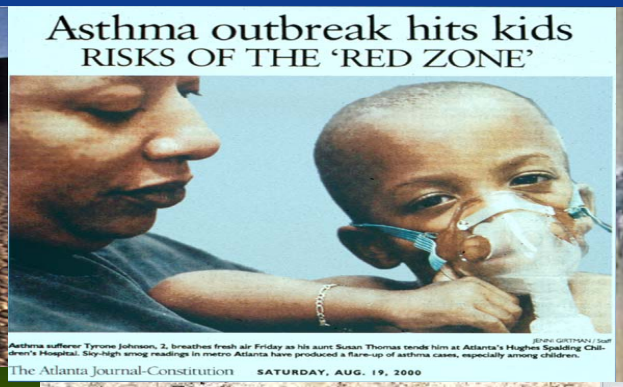
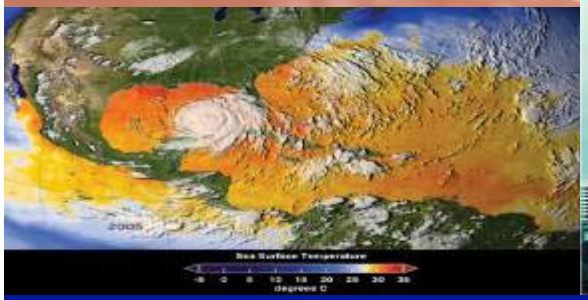
Climate Change and Human Health

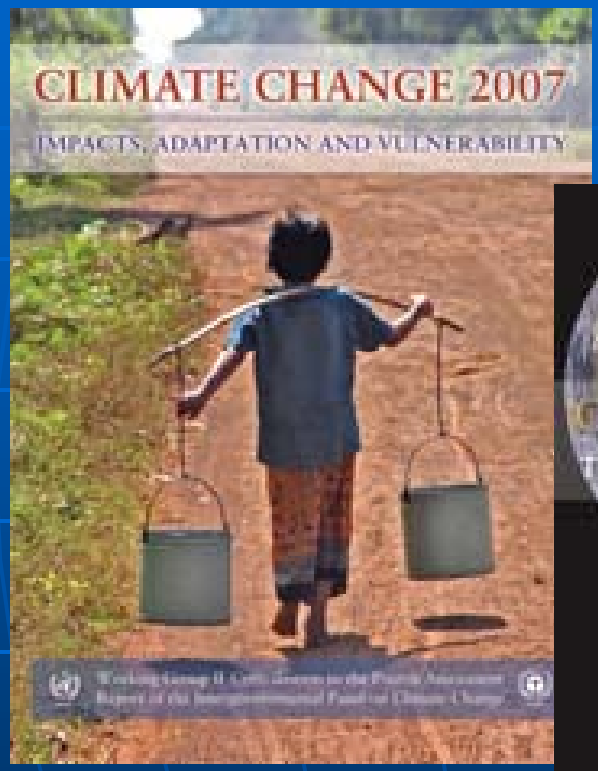
George Luber, PhD

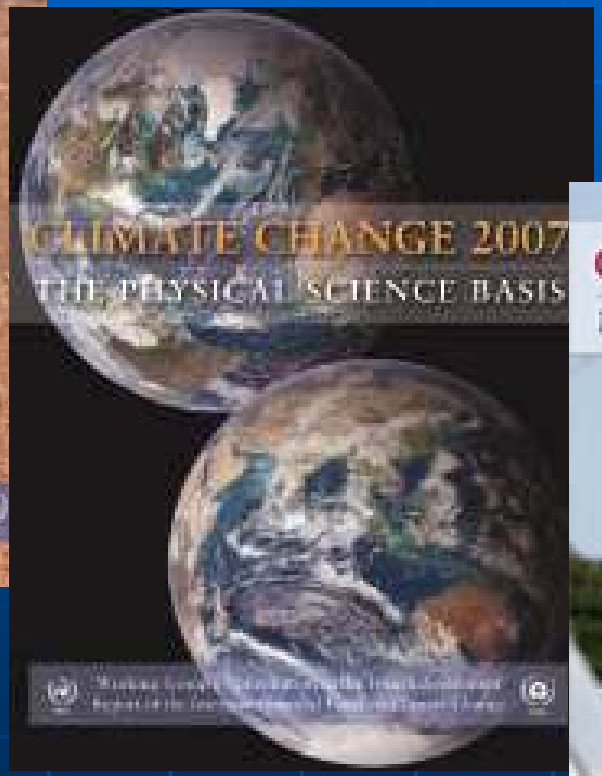


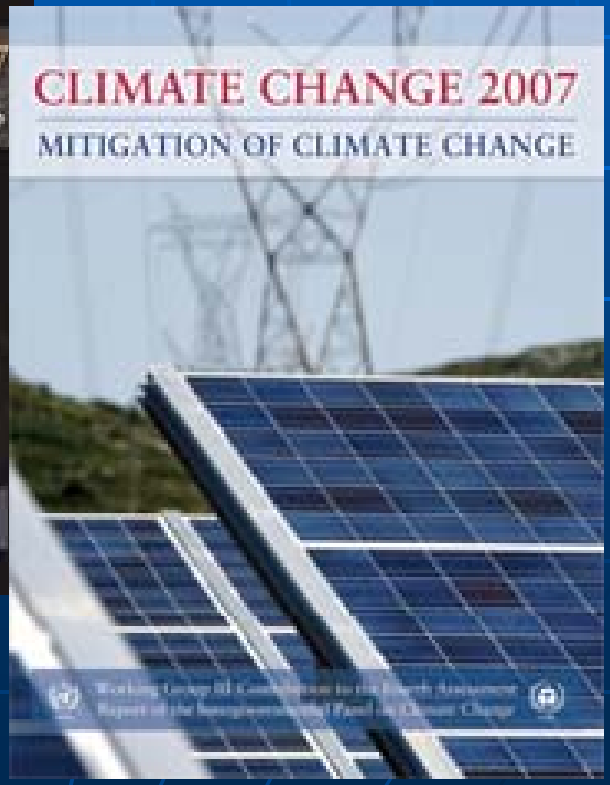




Intergovernmental Panel on Climate Change (IPCC) 2007 Landmark Reports



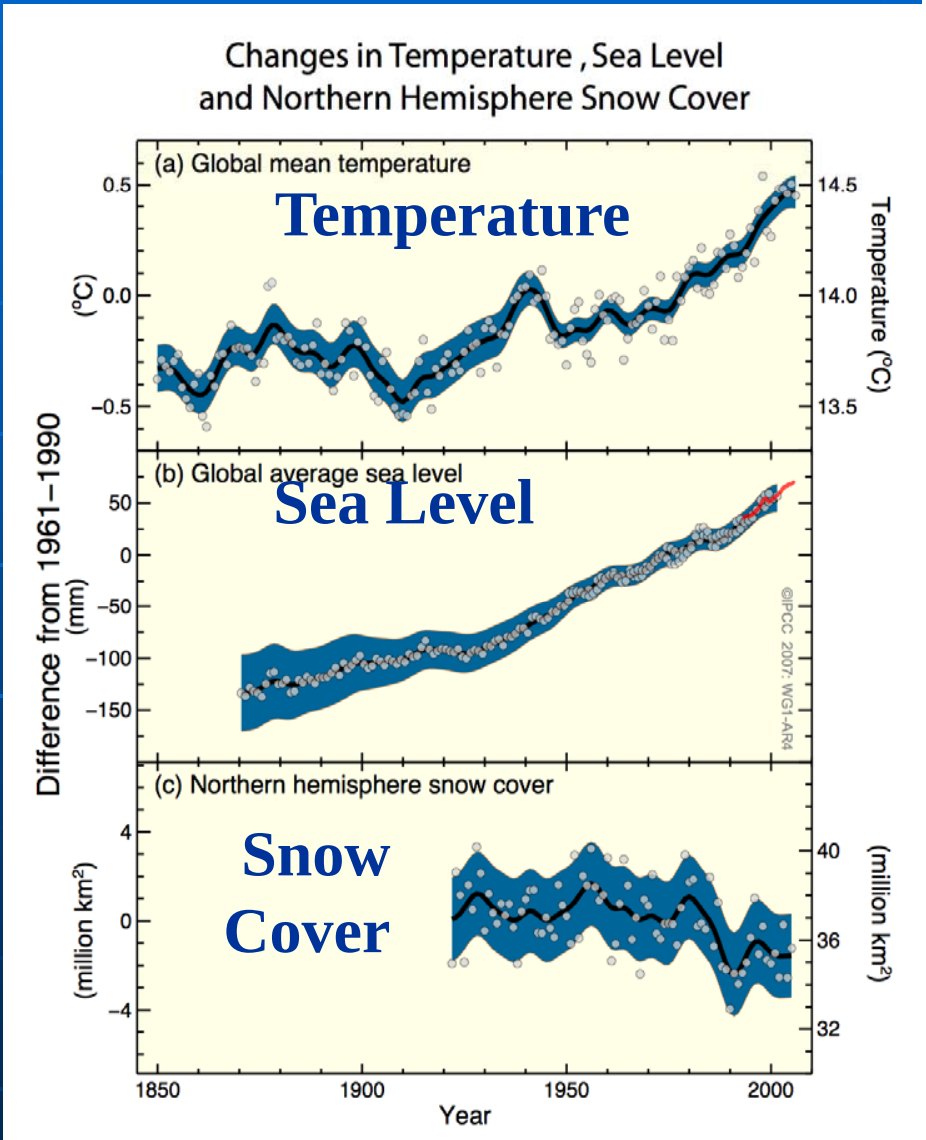




Climate Change is Happening Now

- Warming is unequivocal; most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases.
- Physical and biological systems on all continents and oceans already affected by climate changes.
- Already committed to more warming (next few decades); choices about emissions affect the longer term more and more.

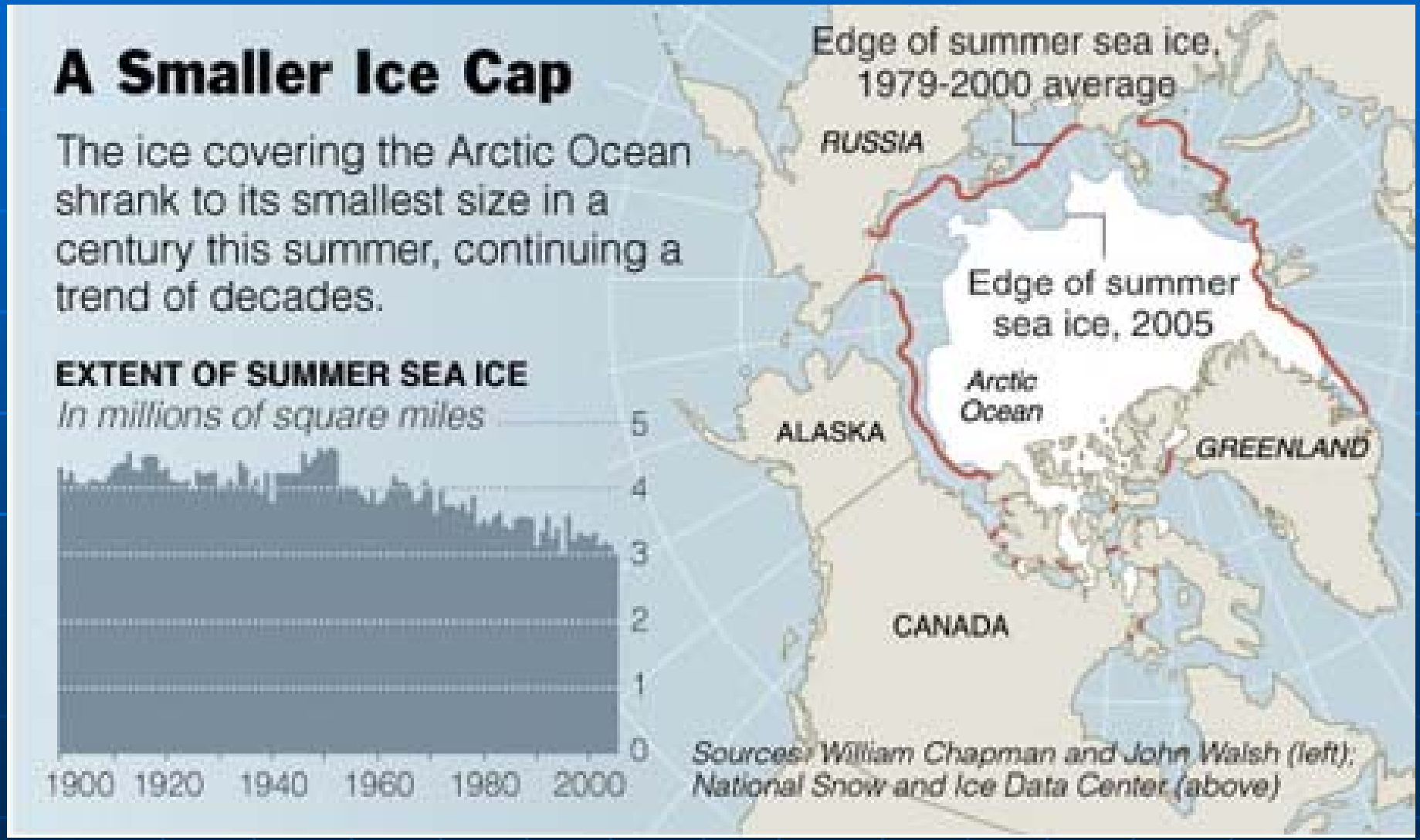
(IPCC2007)



Worldwide Effects of Global Warming

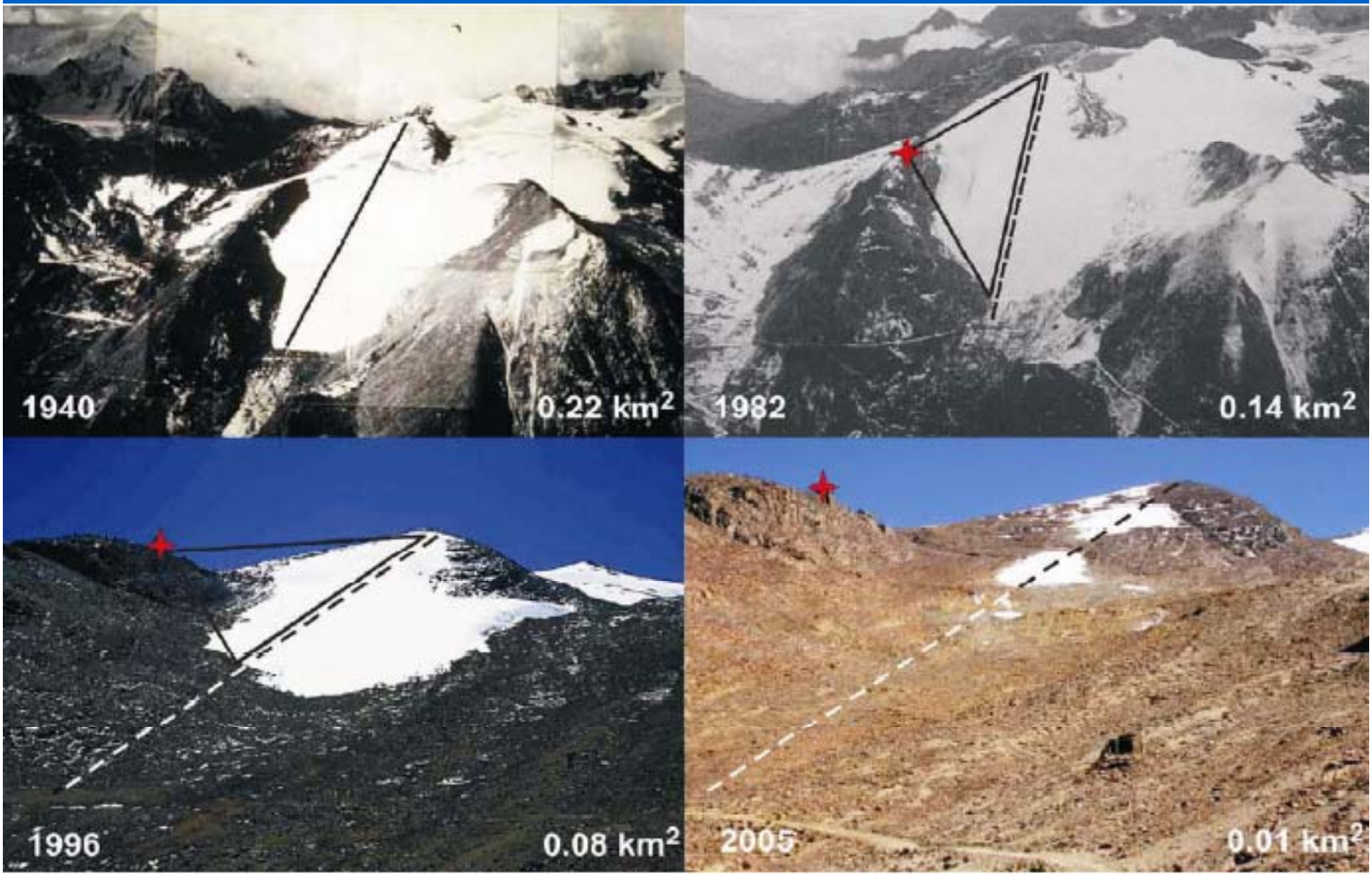
- Evidence of global destabilization of natural systems:
  - Ice cap & glacier melting
  - Early arrival of Spring
  - Oceans warming
  - Rising sea levels
  - Extreme weather patterns
  - Coral reef disintegration

Polar ice cap shrinkage, 1979-2005



New York Times, 29 September 2005, p 1

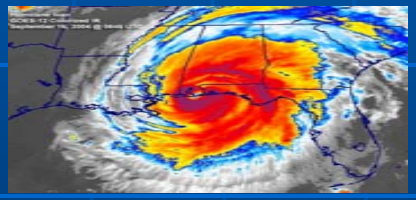
Chacaltaya Glacier, Bolivia (1940 – 2005)



Some Projections of Future Changes in Climate (IPCC 2007)

- Very likely that heat waves, will become more intense and frequent. [> 90% probability]

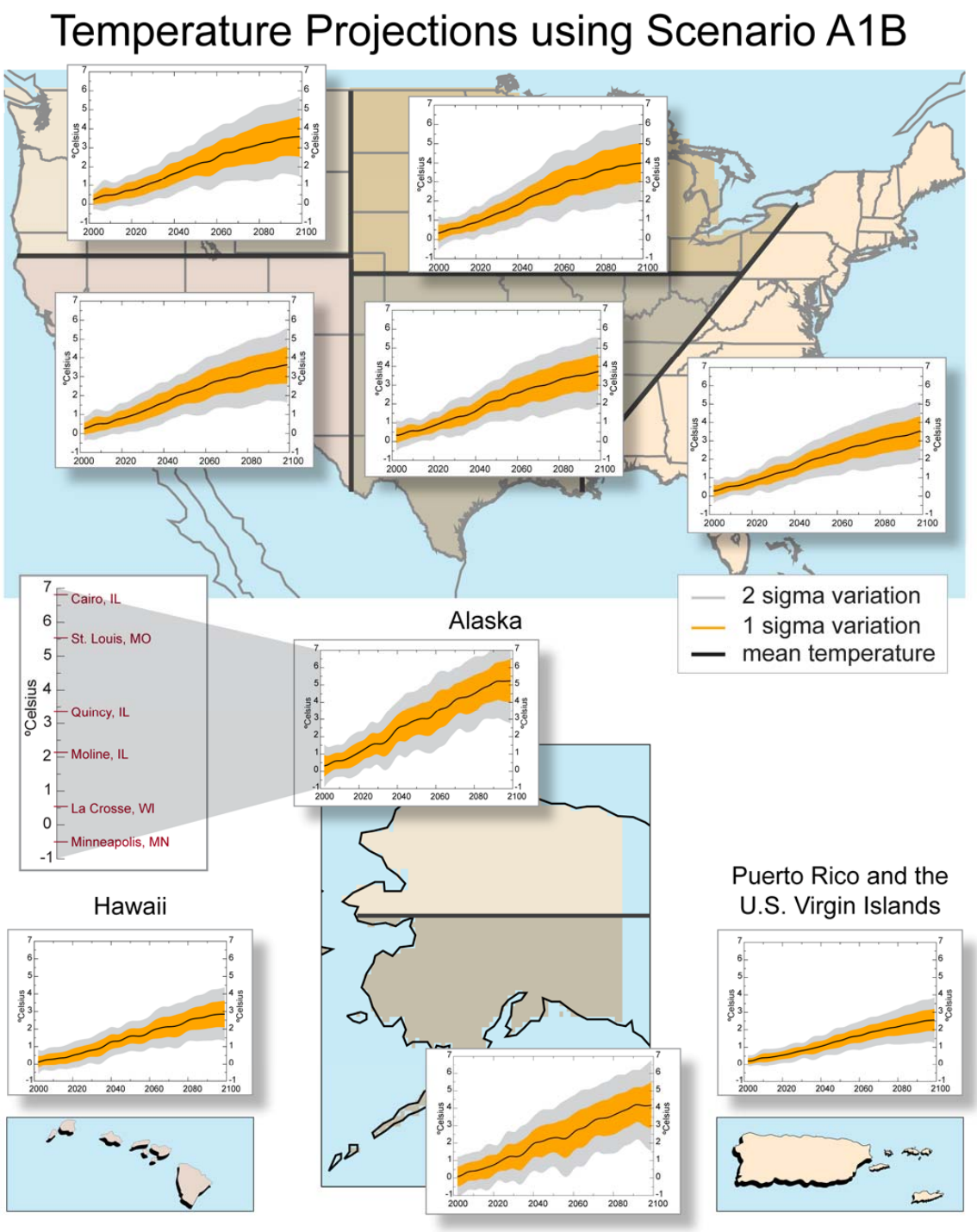
- Very likely that heavy precipitation events will become more frequent. [> 90% probability]



- Likely that tropical cyclones will become more intense, with larger peak wind speeds and more heavy rainfall [> 66% probability]

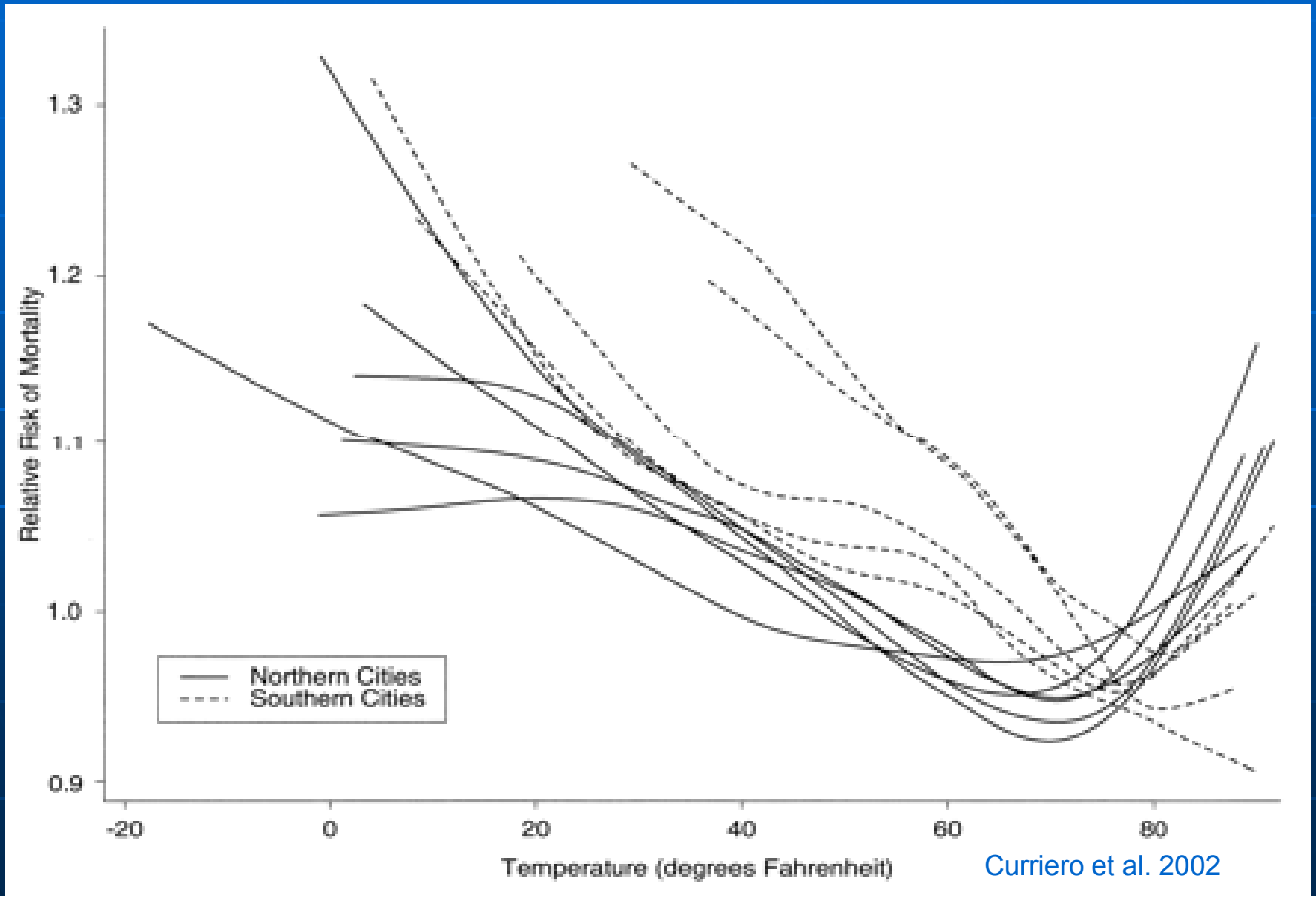
- Likely increase in areas affected by drought. [> 66% probability]

- Likely increase in incidence of extremely high sea level [> 66% probability]

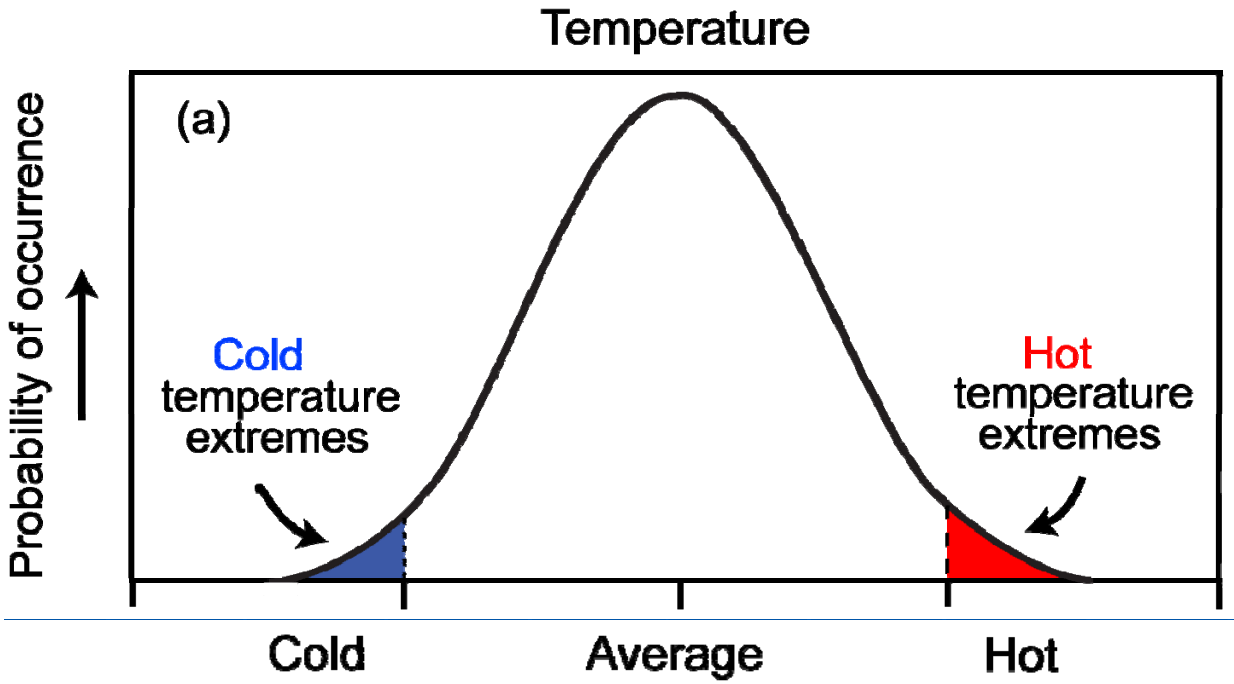


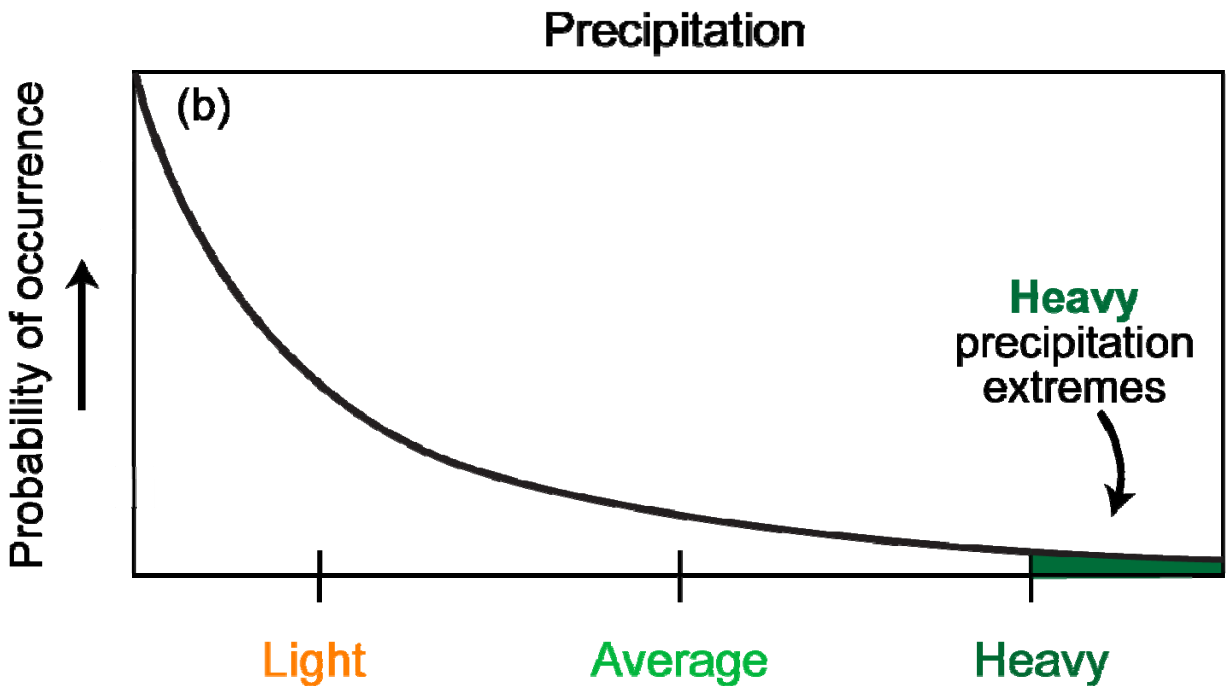
Warming in the US is projected to vary by region

Temperature-mortality relation for 11 US cities, 1973–1994



Curriero et al. 2002



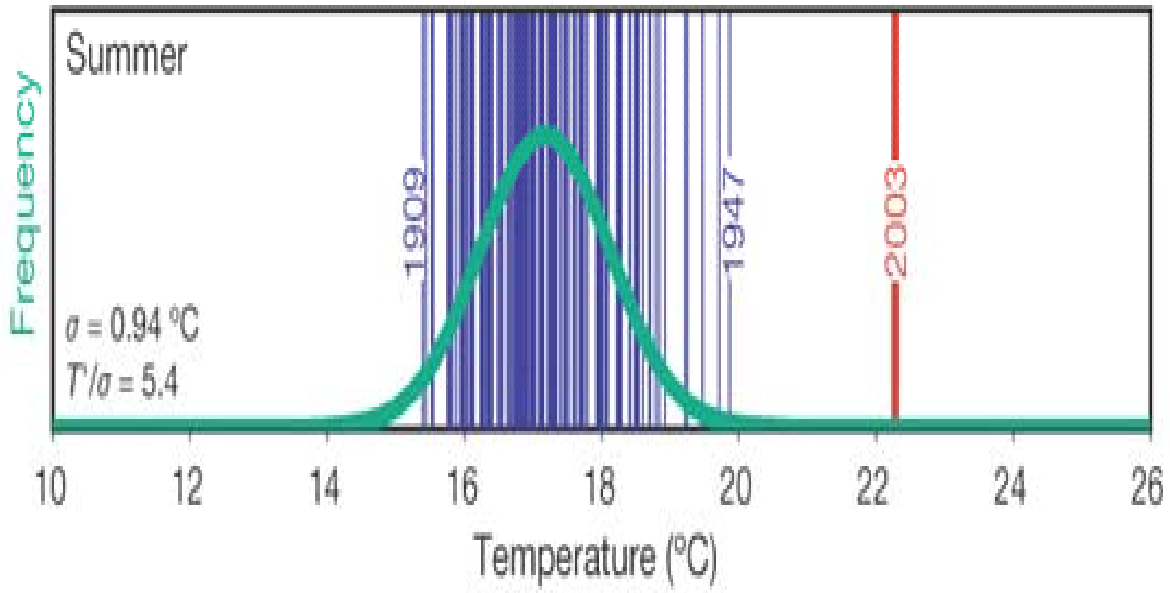


Extremes impact people more than mean

Peterson *et al.*, 2007b

Some occurrences will be well beyond historical experience

European heat wave of 2003



from Schär et al., 2004

CONFIRMED MORTALITY

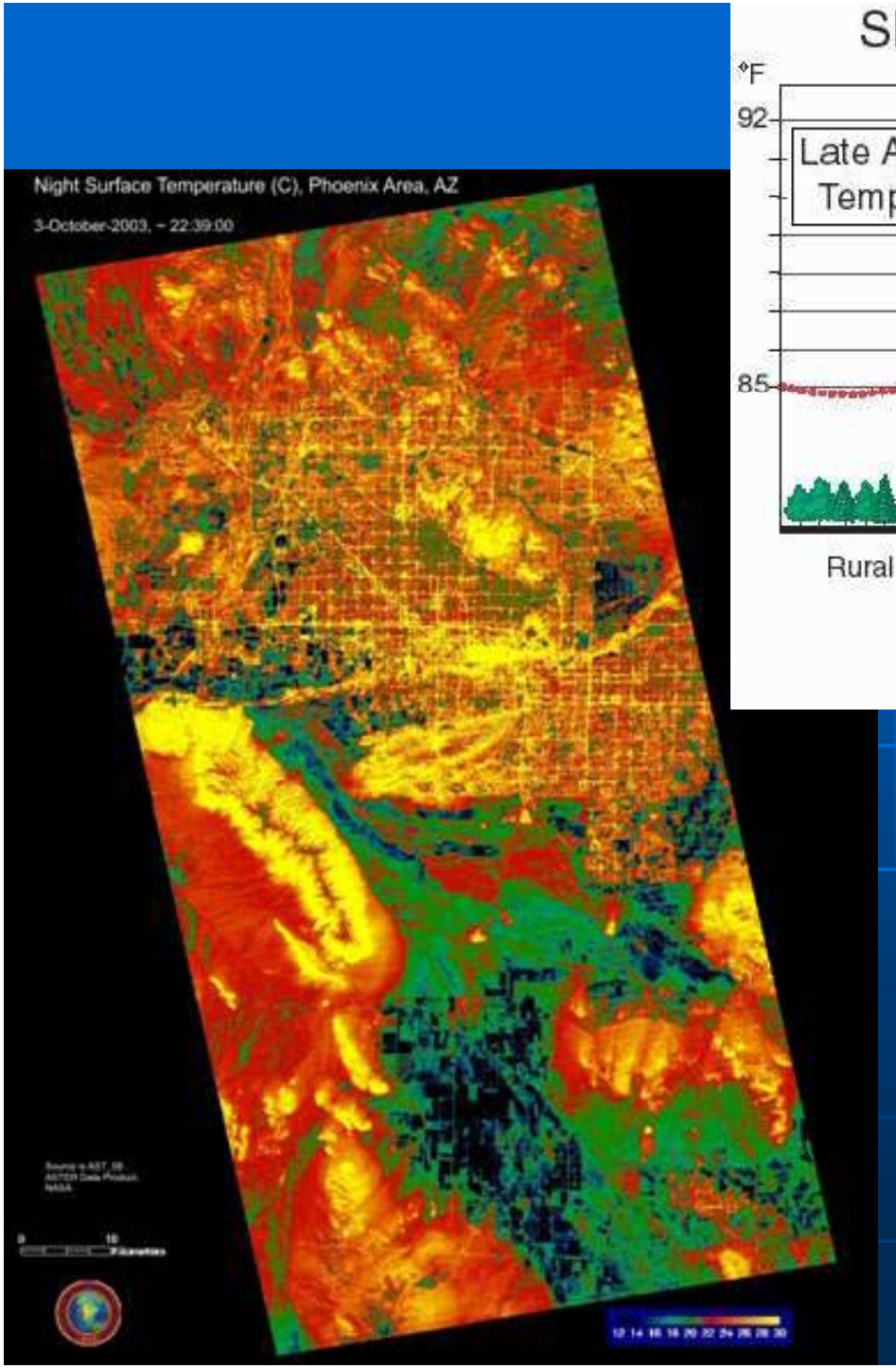
UK	2,091
Italy	3,134
France	14,802
Portugal	1,854
Spain	4,151
Switzerland	975
Netherlands	1,400-2,200
Germany	1,410
TOTAL	29,817-30,617

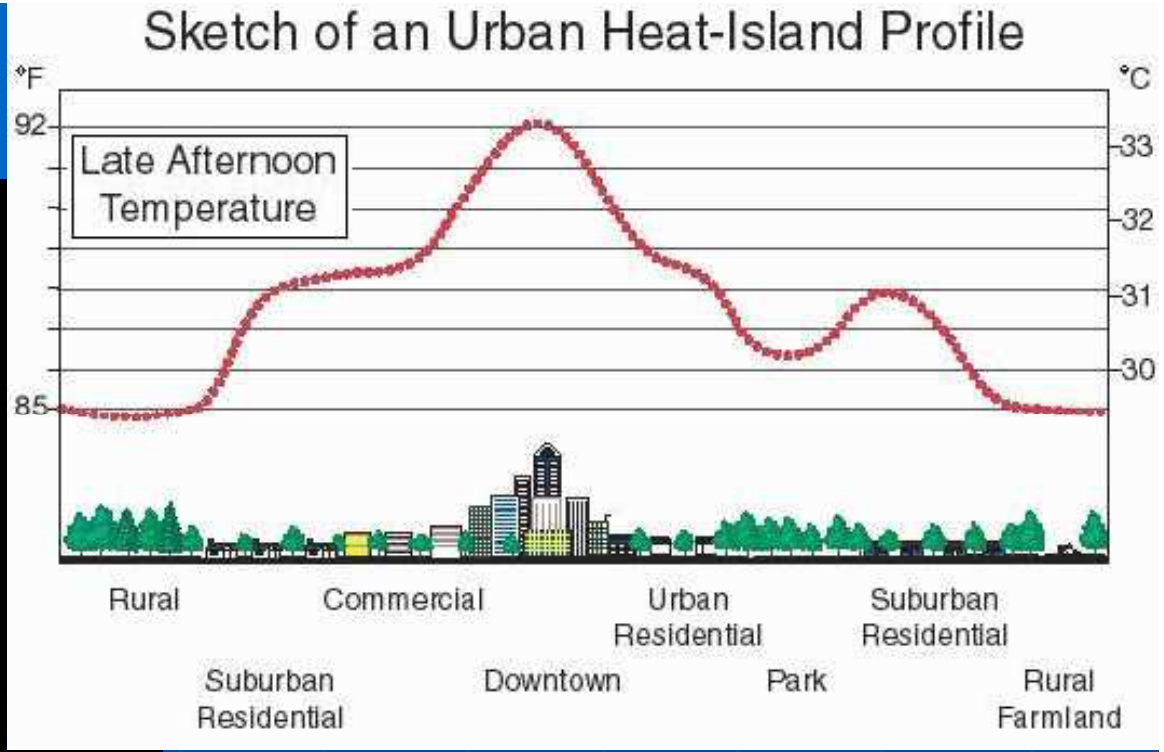
Haines et al. Climate change and human health: Impacts, vulnerability and public health. *Public Health* 2006;120:585-96.

Climate Change and Urban "Built" Environments

- Cities and climate are coevolving to place more populations at risk:
- Increase in vulnerable populations:
  - Today, more than half of the world's population lives in cities, up from 30% in 1950.
  - By 2100 there will be 100 million more people > 65 years old (relative to 2000) (Ebi et al. 2006).
- Intensification of exposures: Urban heat islands

CDC
Environmental Health





Urban Heat Island can add 7° – 12° F

Thermal Satellite Image of Phoenix, AZ Night Surface Temperature

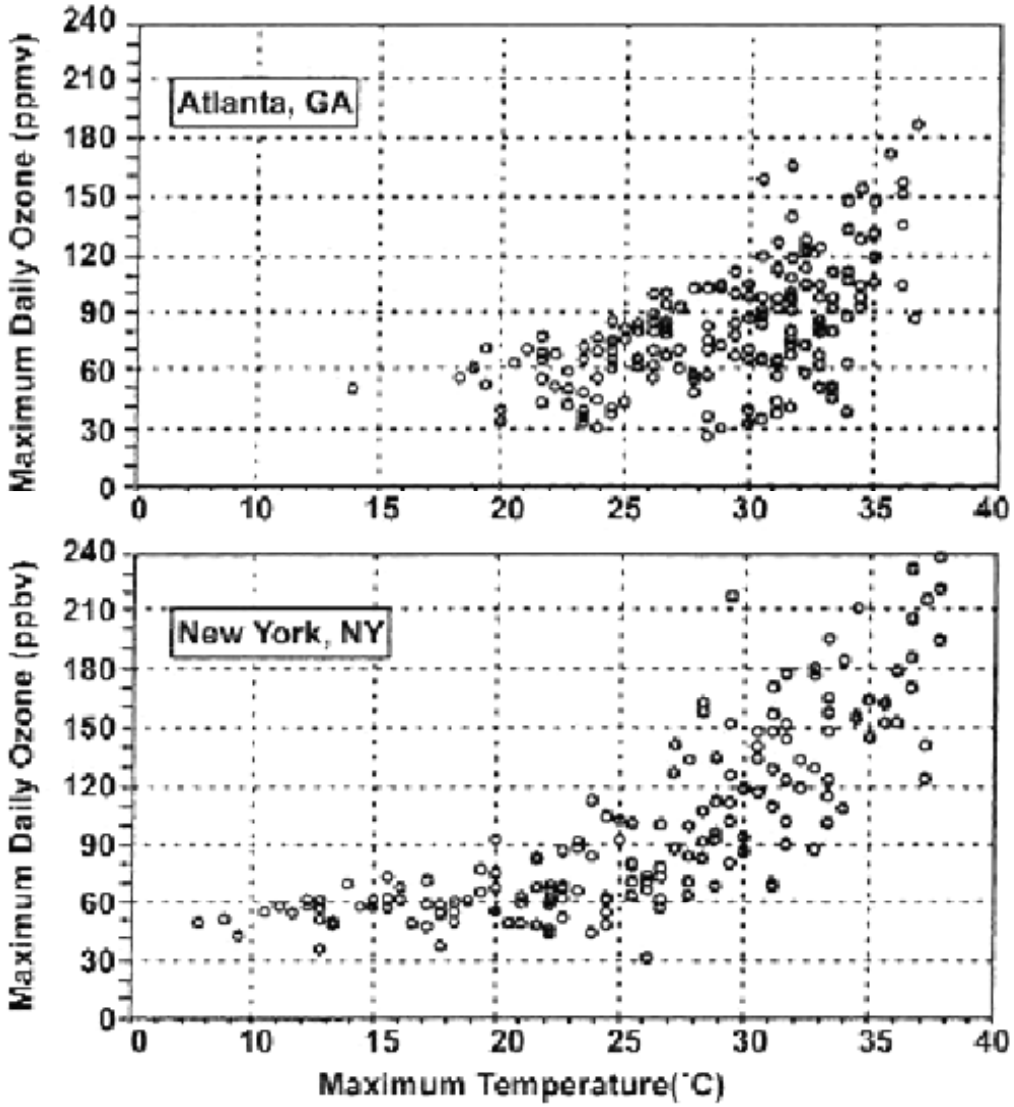
CDC
Environmental Health

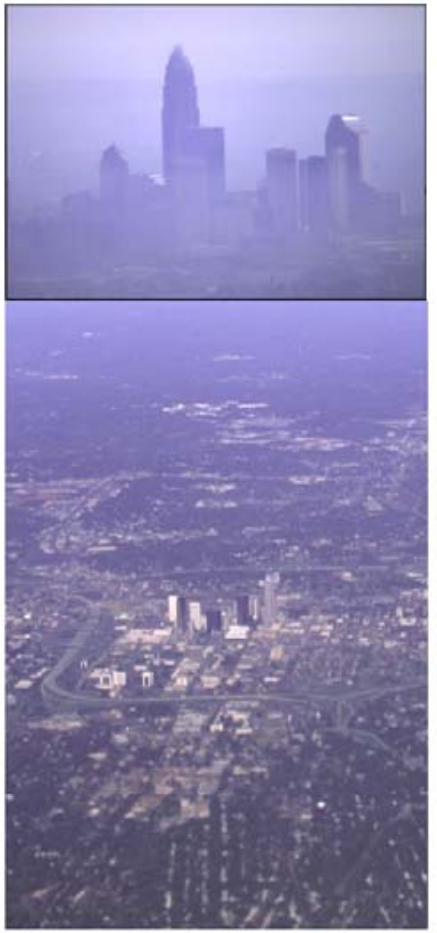
Heat Island Impacts on Air Pollution

Maximum Daily Ozone Concentrations vs. Maximum Daily Temperature

Atlanta

New York

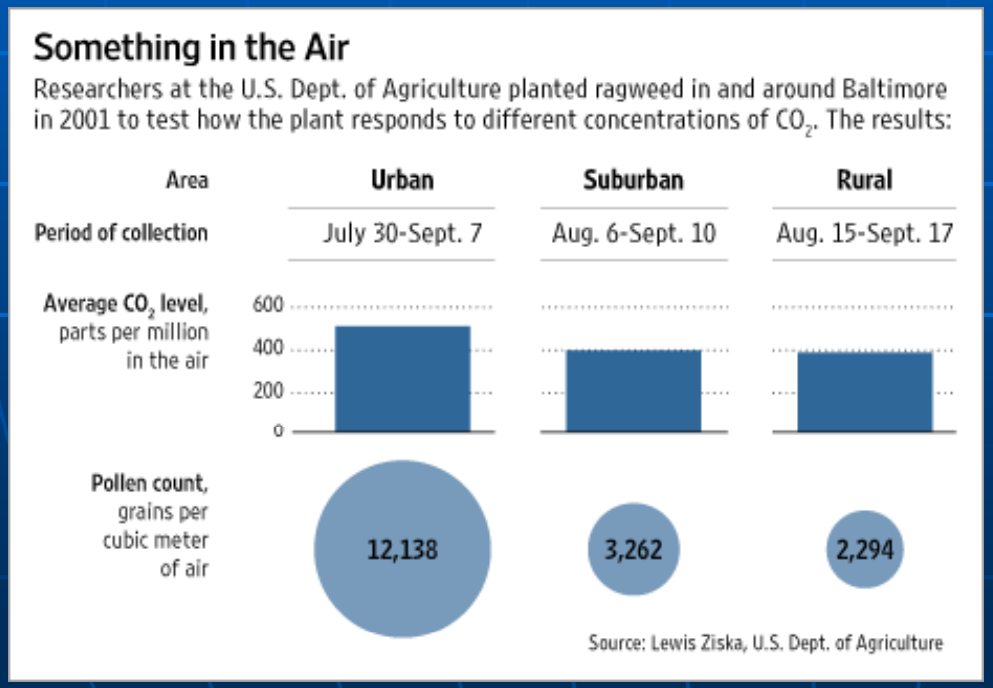




Atlanta

Heat Island and CO_2 Dome impact on Urban Aeroallergens

- Ragweed
- ↑ CO_2 and temperature → ↑ pollen counts, longer growing season



Source: Ziska et al., *J Allerg Clin Immunol* 2003;111:290-95;
Graphic: *Wall Street Journal*, 3 May 2007.

Poison Ivy

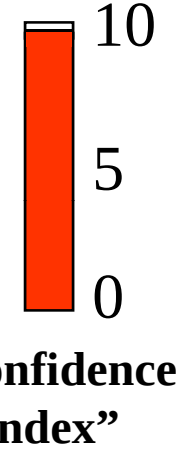
- *Toxicodendron radicans*
- ↑ CO_2 leads to
  - ↑ photosynthesis
  - ↑ water use efficiency
  - ↑ growth
  - ↑ biomass
  - More allergenic urushiol
- Greater CO_2 stimulation than most other woody species

Source: Mohan et al. *PNAS* 2006;103:9086-89.

Climate projections:
Heavy Precipitation

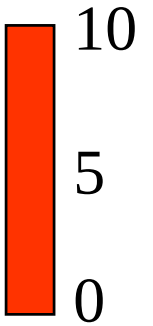
Facts from Climate Models and Theory

- Increasing levels of greenhouse gases warm the climate and lead to increases in ***very heavy*** precipitation events



"Confidence Index"

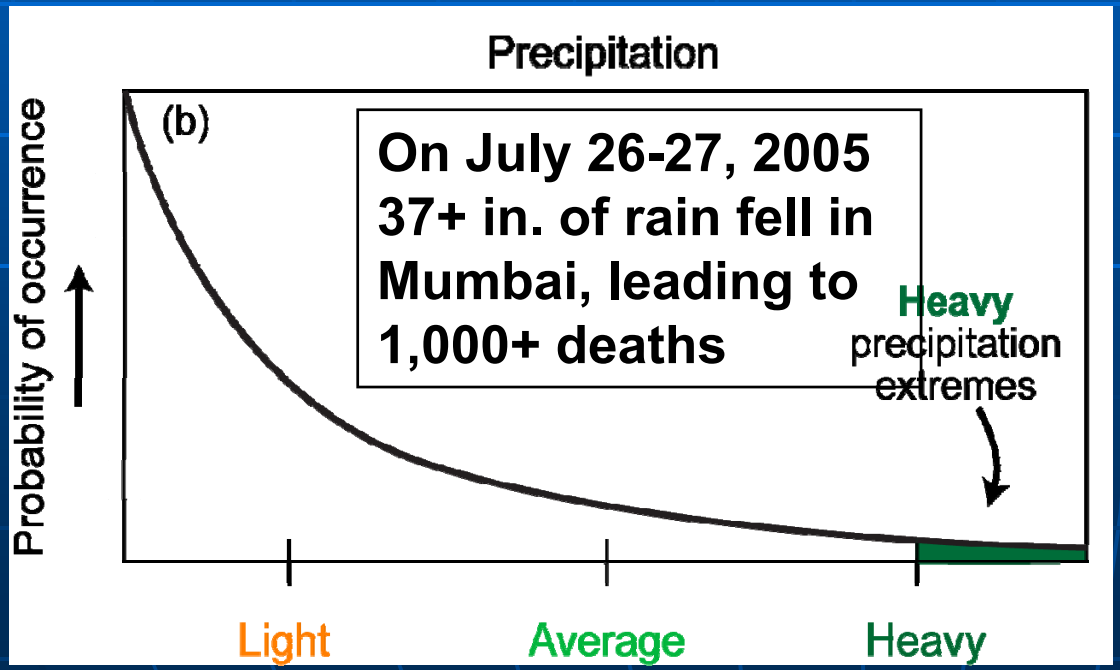
Why: Increasing air temperatures result in a greater amount of water vapor in the air



"Confidence Index"

Extreme Precipitation Events

- ↑ frequency of more intense rainfall → ↑ severe floods, landslides, and debris and mud flows.



Sources: Cruz et al., 2007;
Image: Peterson et al., 2007b; news.bbc.co.uk

Extreme Precipitation and Waterborne Disease Outbreaks in the US: 1948 -1994

- **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 correlated with heavy precip in the month of outbreak; groundwater-related outbreaks lagged 2 months following extreme precipitation.

Curriero, Patz, et al, 2001.

Hydrologic Extremes and Water-borne Disease:

Milwaukee 1993

Cryptosporidiosis epidemic

405,000 cases, 54 deaths

Preceded by heaviest rainfall in 50 years (Curriero et al., 2001)

$31.7 million in medical costs
$64.6 million in lost productivity
(Corso et al., 2003).

Direct Effects of Hydrologic Extremes

↑ drier climates → forest fires and smoke

<u>Vulnerable Populations</u>:

- Young Children
- Elderly
- Pregnant Women
- People with Preexisting Respiratory and Cardiac Diseases

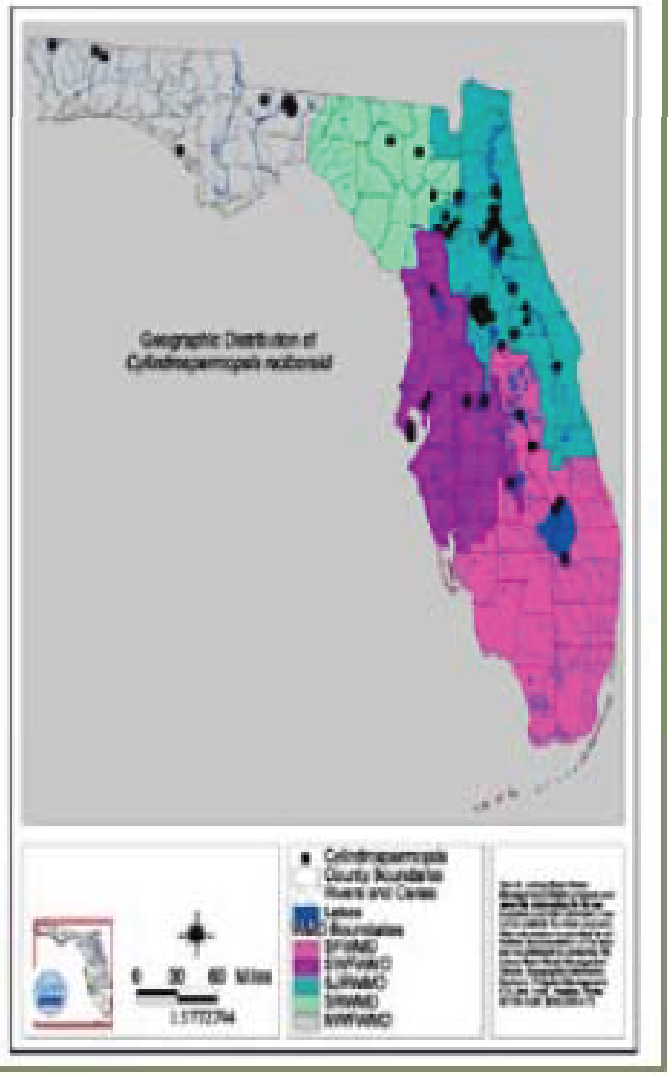
Source: Ziska et al., *J Allerg Clin Immunol* 2003;111:290-95; Graphic: www.abcnews.net/au

Harmful Algal Blooms (Red-tides)

Enhanced by:

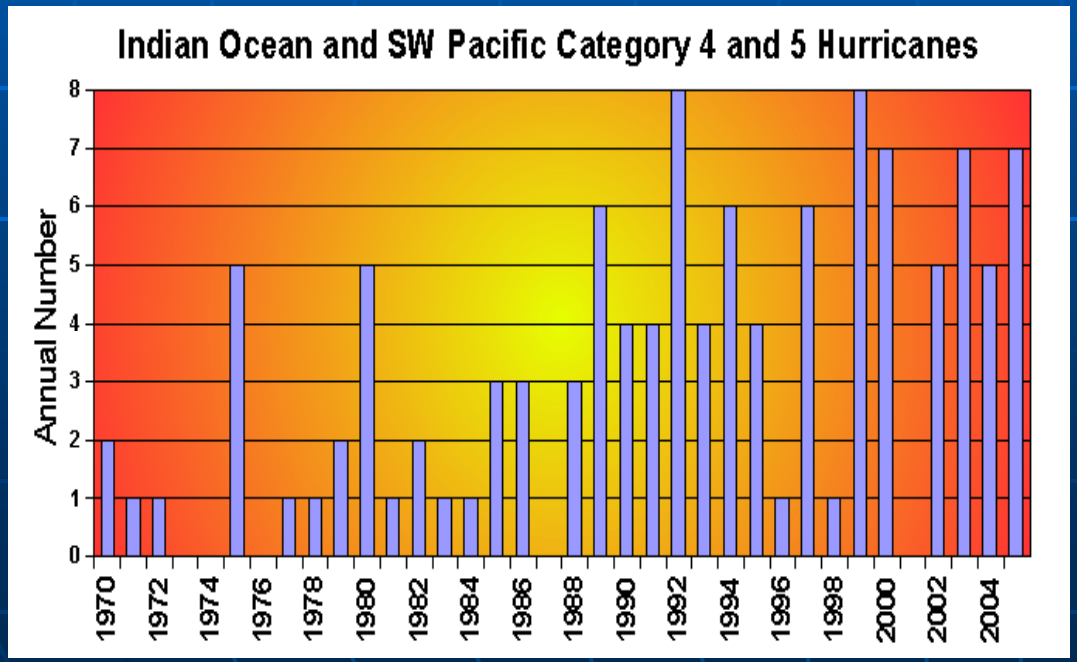
- **Increased water temps**
- **nutrient runoff**

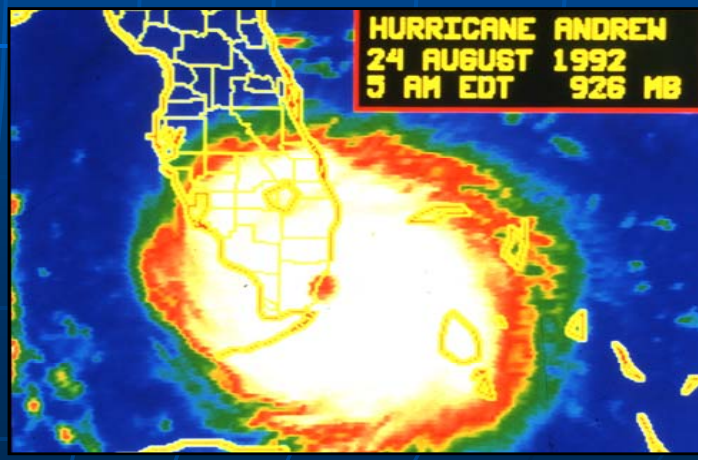
Figure 2. Distribution of the CyanoHAB, *Cylindrospermopsis raciborskii,* in Florida (Williams 2001, Fristachi et al. 2007). *C. raciborskii,* which produces potent hepatotoxins (Table 2), was originally found only in tropical areas but has recently spread to cooler regions.



Tropical Cyclones

- ↑ sea-surface temperatures → ↑ tropical cyclone intensity and ↑ the height of storm surges





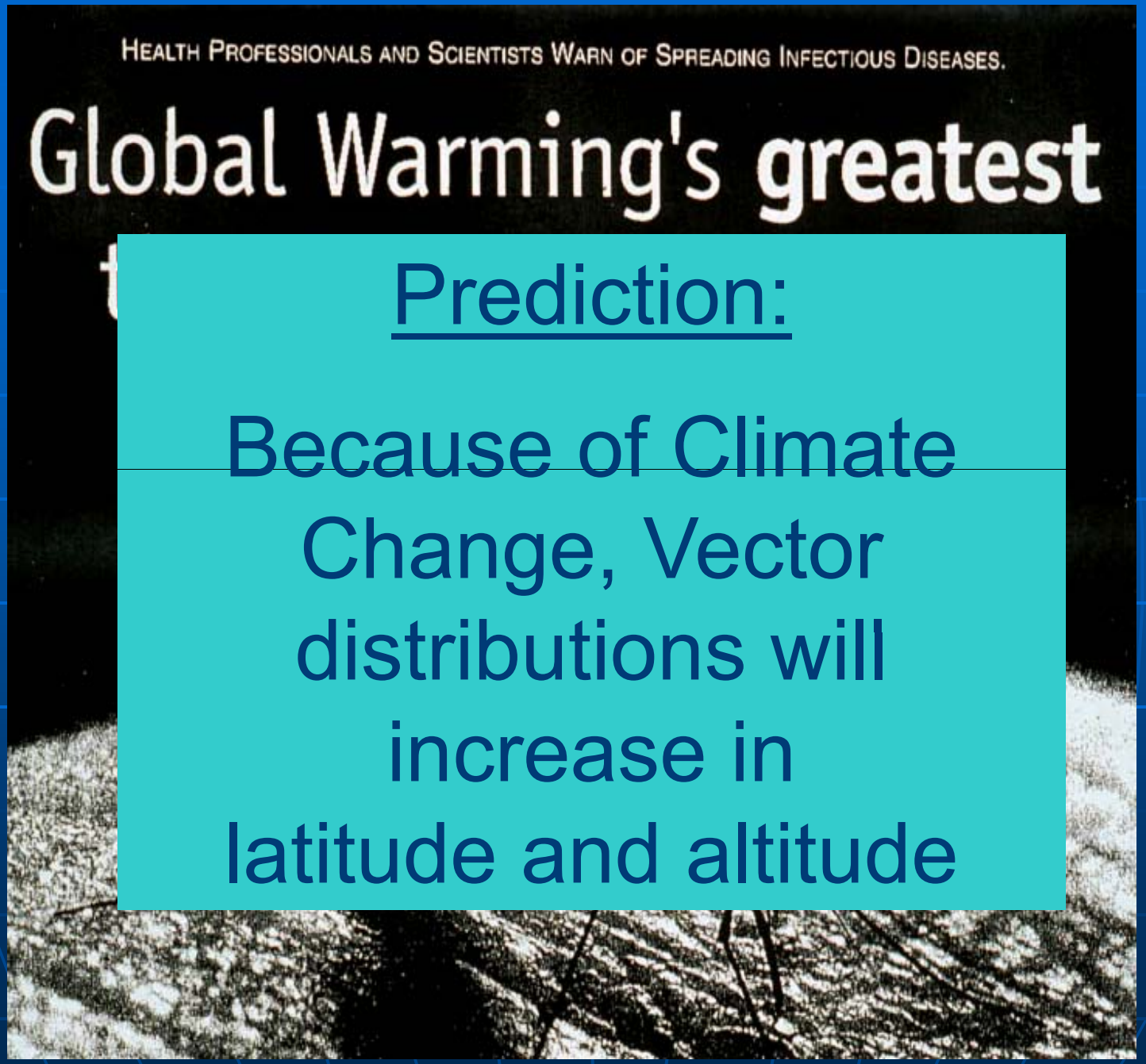
Sources: Ali, 1999; Images: NOAA.gov; www.weatherunderground.com

Secondary Effects of Hydrologic Extremes

- Droughts encourage:
  - Aphids
  - Locusts
  - Whiteflies
  - Aspergillus flavus (aflatoxin)
- Floods encourage:
  - Mold
  - Fungi
  - Nematodes



Sources: Rosenzweig et al., 2001; Images: entemology.ucdavis.edu



Prediction:

Because of Climate Change, Vector distributions will increase in latitude and altitude

Deadly dengue fever surging in Mexico

Mosquito-control teams dispatched to springtime tourist areas

Associated Press
Updated: 4:57 p.m. ET March 30, 2007

The deadly hemorrhagic form of dengue fever is increasing drastically in Mexico, and experts predict a surge throughout Latin America fueled by climate change, migration and faltering mosquito eradication efforts.

Overall dengue cases have increased by more than 600 percent in Mexico since 2001, and worried officials are sending special teams to tourist resorts to spray pesticides and remove garbage and standing water where mosquitoes breed ahead of the peak Easter Week vacation season.

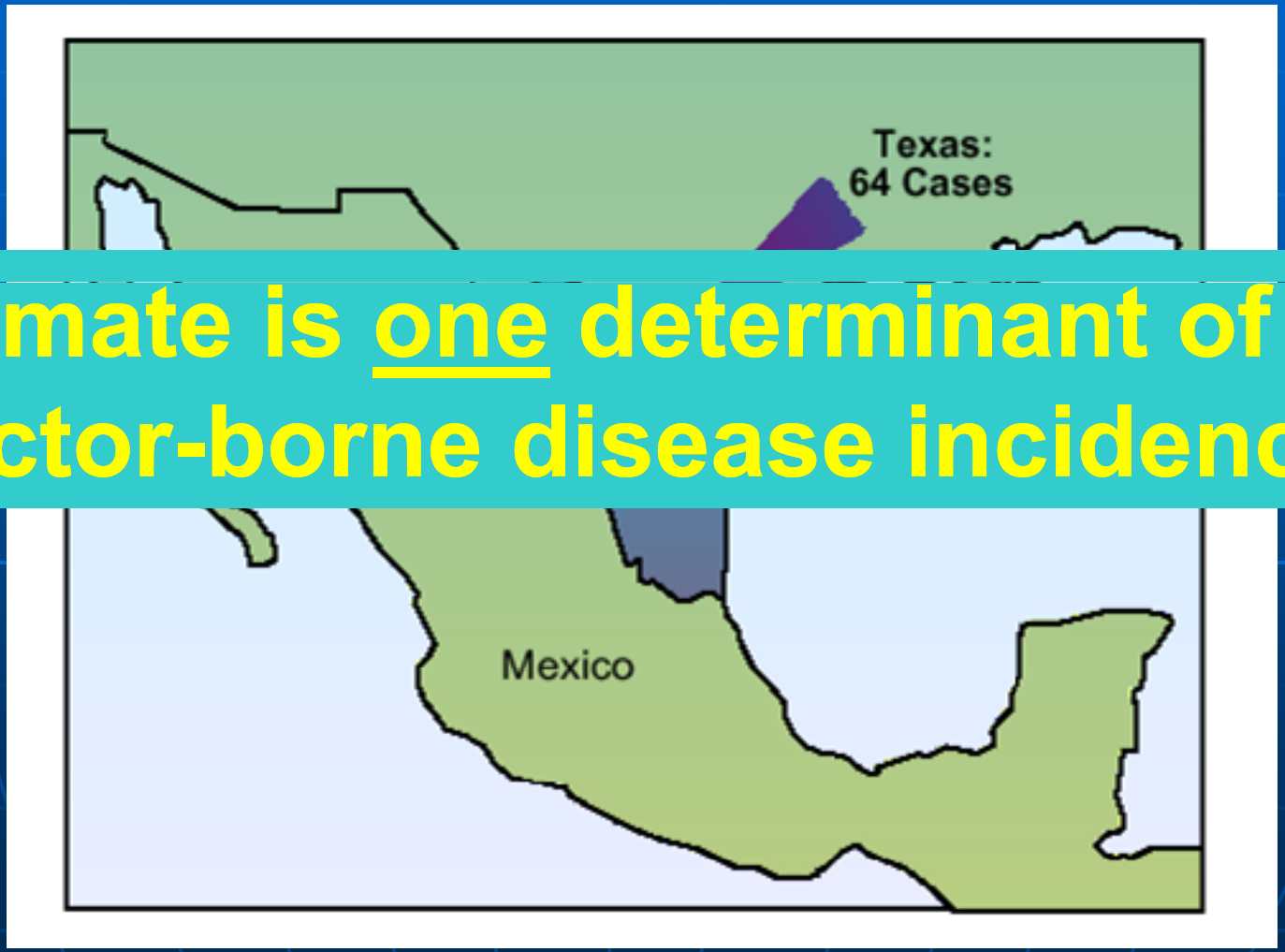
Israel Leal / AP

A anti-dengue brigade, belonging to the municipal health department mark a home after checking for standing water or other areas where mosquitoes breed in the resort city of Cancun, Mexico.

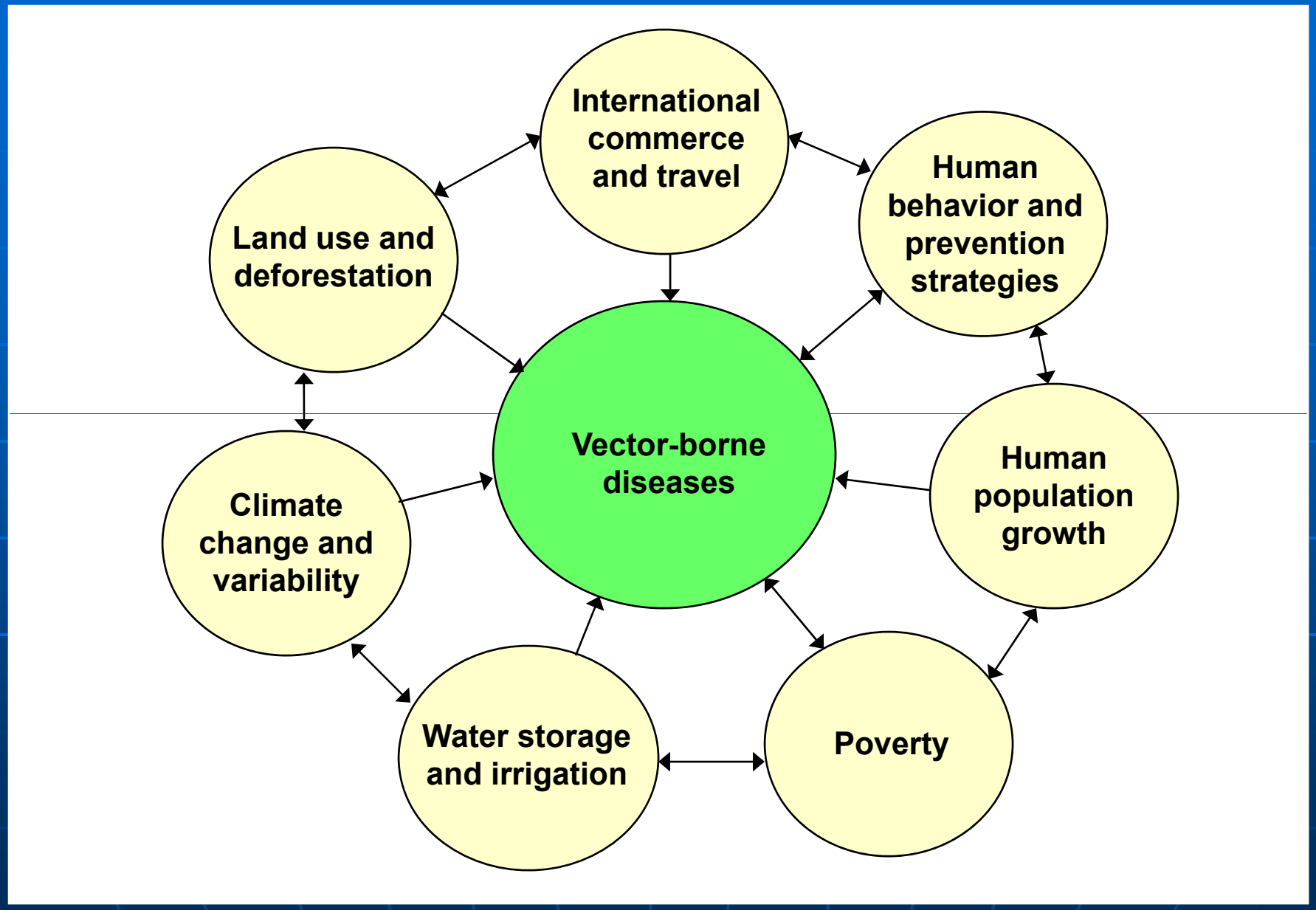
The Intergovernmental Panel on Climate Change, made up of the world's leading climate scientists, predicted in March that global warming and climate change would cause an upsurge in dengue. In Mexico, officials say longer rainy seasons already are leading to more cases.

"It used to be seasonal, in the hottest, wettest months, and now in some regions we are seeing it practically all year," said Joel Navarrete, an epidemiologist with the Mexican Social Security Institute.

Reported Cases of Dengue 1980-1999

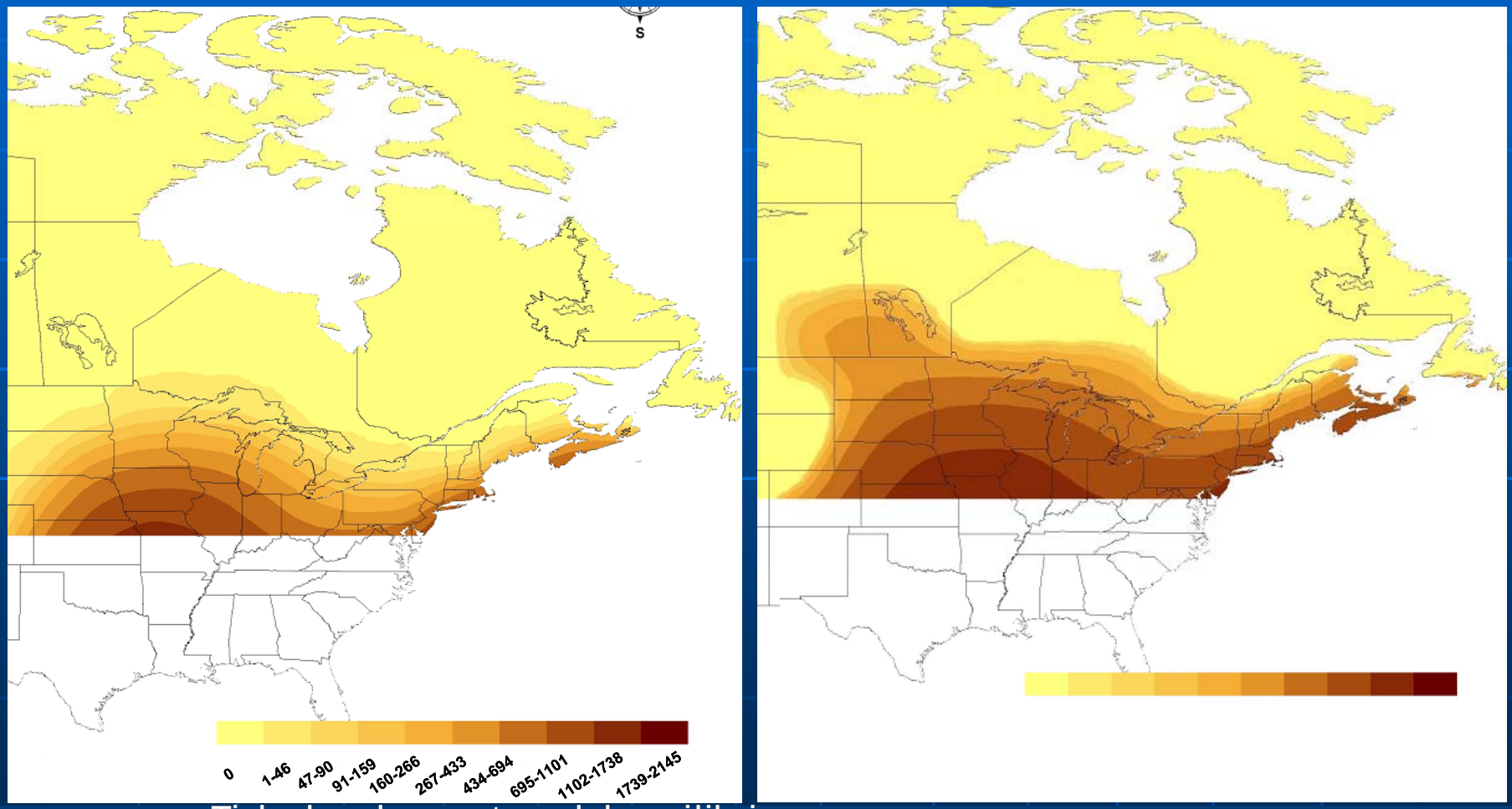


Climate is <u>one</u> determinant of vector-borne disease incidence



Modified from Sutherst R.W. Clin Micribiol Rev 2004;17:136-73

Distribution of Lyme Disease, 1991-2000 and 2020



Tick abundance at model equilibrium

Ogden et al. Int. J. Parasitol. 2005, 2006

Potential Health Effects of Climate Change

Climate Change:

- **Temperature rise**
- **Sea level rise**
- **Hydrologic extremes**

HEAT	→	Heat stress, cardiovascular failure
SEVERE WEATHER	→	Injuries, fatalities
AIR POLLUTION	→	Asthma, cardiovascular disease
ALLERGIES	→	Respiratory allergies, poison ivy
VECTOR-BORNE DISEASES	→	Malaria, dengue, encephalitis, hantavirus, Rift Valley fever
WATER-BORNE DISEASES	→	Cholera, cryptosporidiosis, campylobacter, leptospirosis
WATER AND FOOD SUPPLY	→	Malnutrition, diarrhea, harmful algal blooms
MENTAL HEALTH	→	Anxiety, despair, depression, post-traumatic stress
ENVIRONMENTAL REFUGEES	→	Forced migration, civil conflict

Adapted from J. Patz

Other Considerations

- There will be significant regional variation in the effects of climate change
- There will be significant variation in the demographic groups effected by climate change

Now the bad news…

- Despite existing breadth of organizations and sectors with initiatives on climate change
- Despite the likelihood of anticipated health effects of climate change

Public health effects of climate change remain largely unaddressed

CDC
Environmental Health

TOWARD A PUBLIC HEALTH FRAMEWORK FOR ADDRESSING CLIMATE CHANGE

Guiding principles, both practical and ethical:

- Public Health Prevention Framework
- Co-Benefits and synergies
- Environmental Justice
- Complexity/Ecosystems thinking

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A PUBLIC HEALTH FRAMEWORK FOR ADDRESSING CLIMATE CHANGE

Guiding principles:

Public Health Prevention Framework:

- Primary prevention: aims to prevent the onset of injury or illness
  - Corresponds with *mitigation*—efforts to slow, stabilize, or reverse climate change by reducing greenhouse gas emissions.
- Secondary and Tertiary Prevention: aims to diagnose disease early in order to control its advance and reduce the resulting morbidity
  - Corresponds with *adaptation*—efforts to anticipate and prepare for the effects of climate change, and thereby to reduce the associated health burden.

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Public Health role in Primary prevention (mitigation)

Mitigation efforts will largely occur in sectors other than health, however public health can:

- Reduce GHG emissions in our own operations (health care settings)
- Assess health implications of various mitigation strategies
- Educate the public and policymakers on health benefits of mitigation approaches.

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Public Health role in Secondary Prevention (Adaptation)

Correspond closely to conventional public health practices.

These can include:

- Track and monitor disease (surveillance)
- Enhance emergency response capacity
- “Weatherize” communities

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A PUBLIC HEALTH FRAMEWORK FOR ADDRESSING CLIMATE CHANGE

Guiding principles:

Co-benefits and synergies

- Efforts to mitigate or adapt to the effects of climate change frequently yield other health benefits, both direct and indirect.

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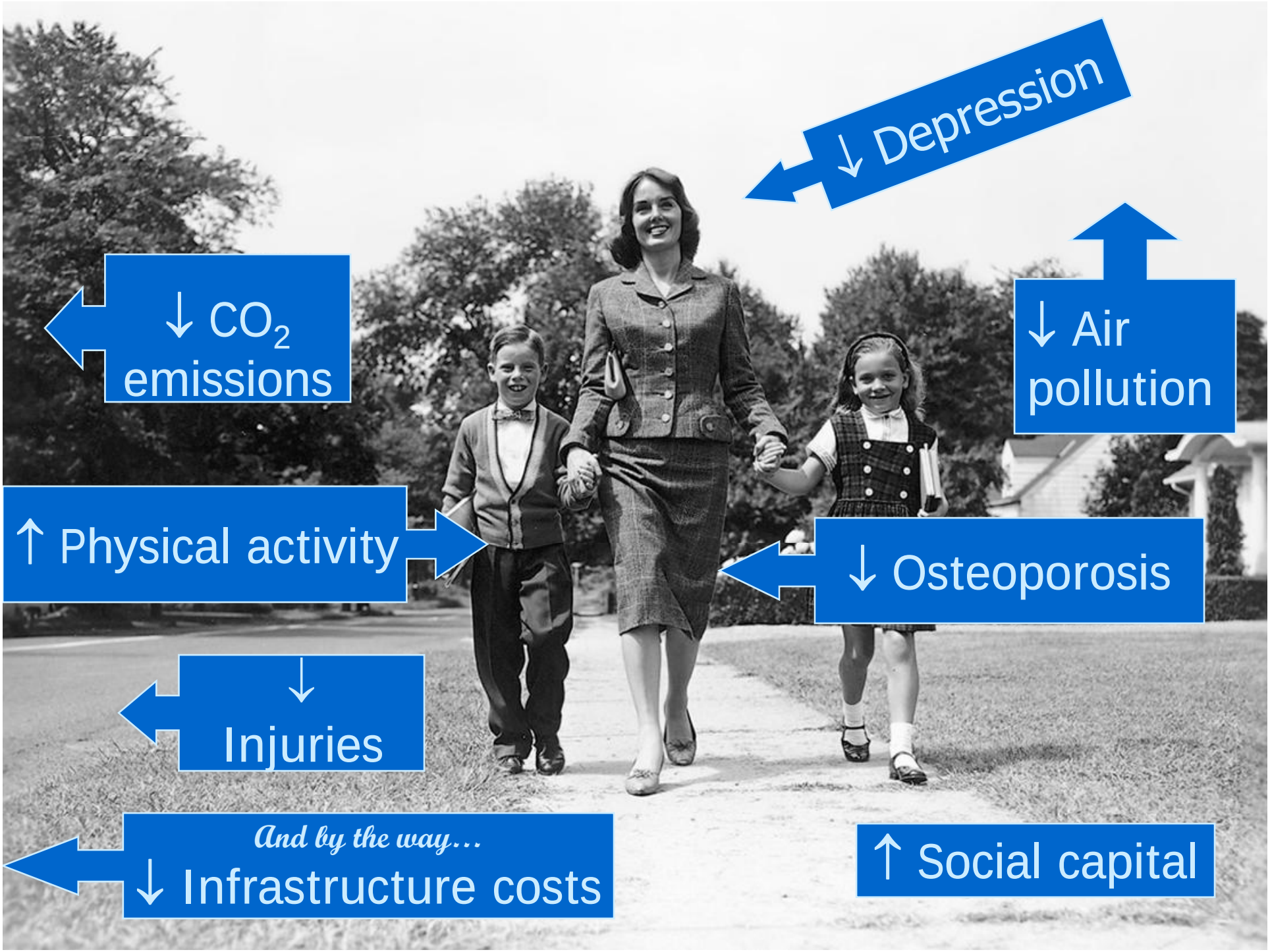
↓ Depression
↓ CO_2 emissions
↓ Air pollution
↑ Physical activity
↓ Osteoporosis
↓ Injuries
And by the way…
↓ Infrastructure costs
↑ Social capital

Health & Climate Change Adaptation Synergies

Heat wave plans using "buddy systems"	↑ social capital, ↑ community resiliency
↓ vehicular travel	↓ car crashes, ↓ air pollution
↑ fuel efficiency	↓ air pollution
Locally grown food	↓ pesticide loading, ↓ fuel
Energy-efficient buildings	↓ operating costs
Alternative energy sources	Business opportunities

A PUBLIC HEALTH FRAMEWORK FOR ADDRESSING CLIMATE CHANGE

Guiding principles:

Environmental Justice

Climate change will disproportionately threaten certain populations, especially poor people and members of ethnic and racial minority groups

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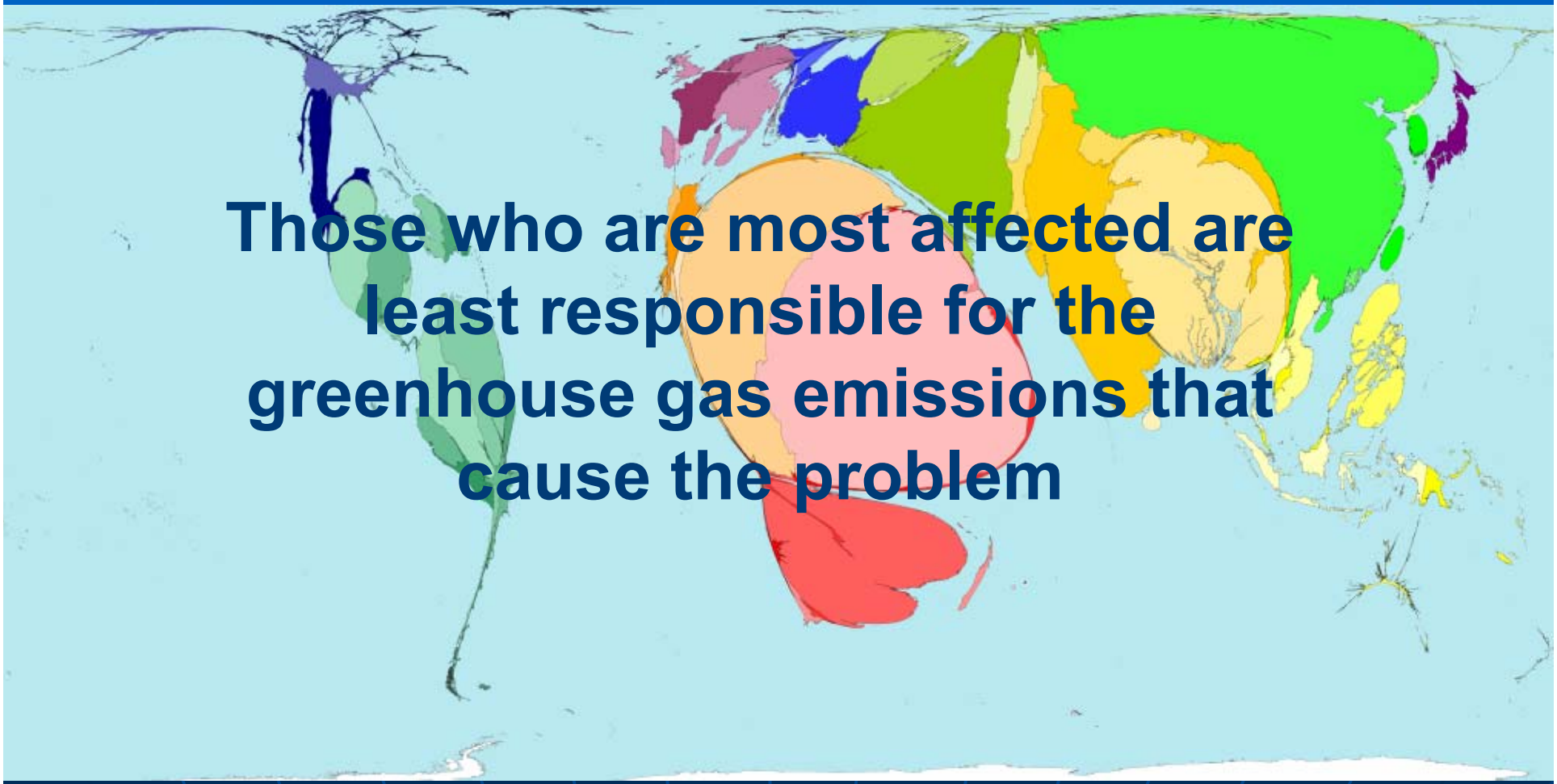
Carbon Emissions 2000

The United States emits one quarter of the worlds gases that cause global warming.

Worldmapper.com

Persons killed by disasters: 1975 - 2004

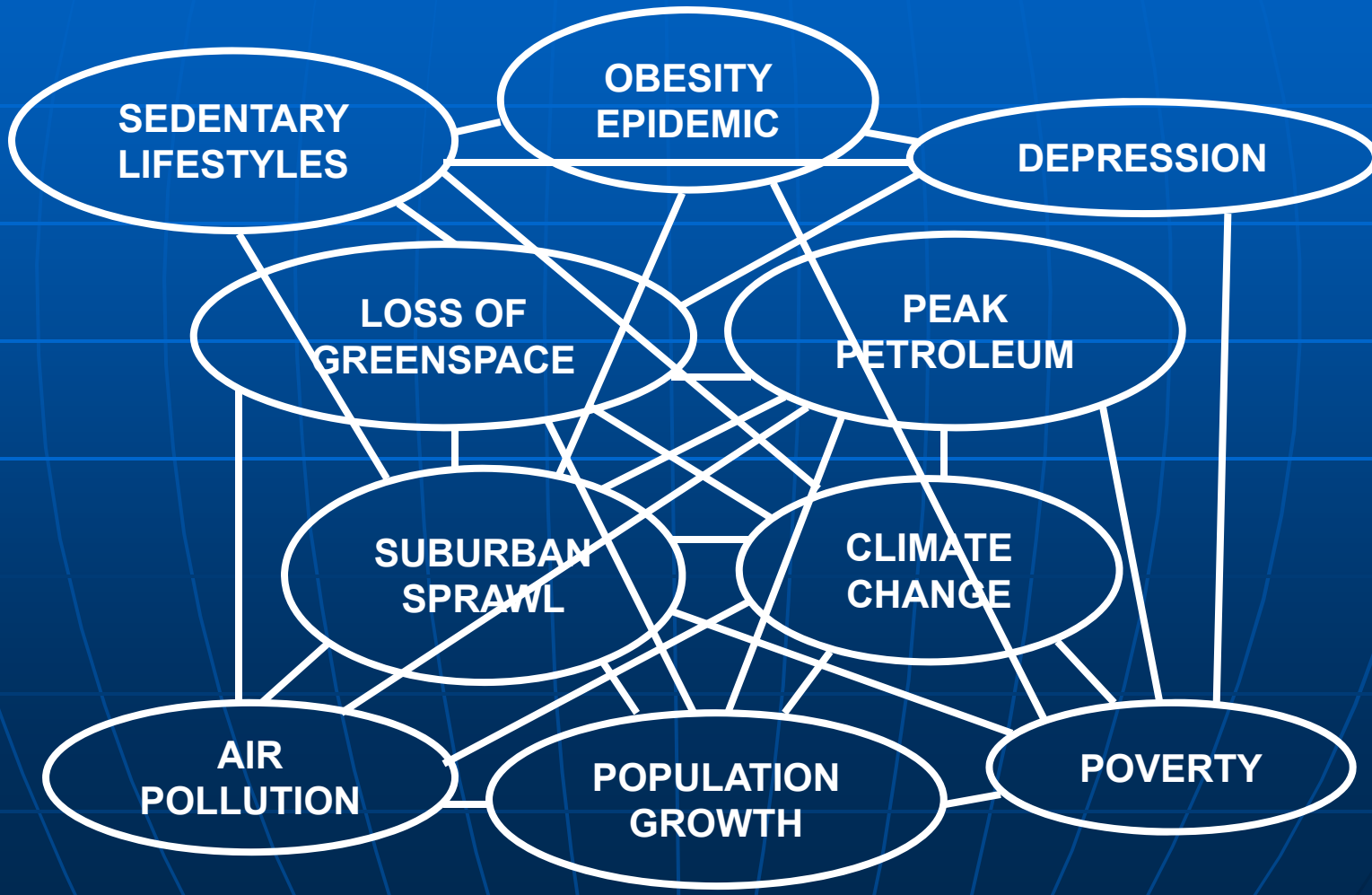


Low-income people typically lack insurance to replace possessions lost in storms. Only 25 percent of renters have renters insurance.

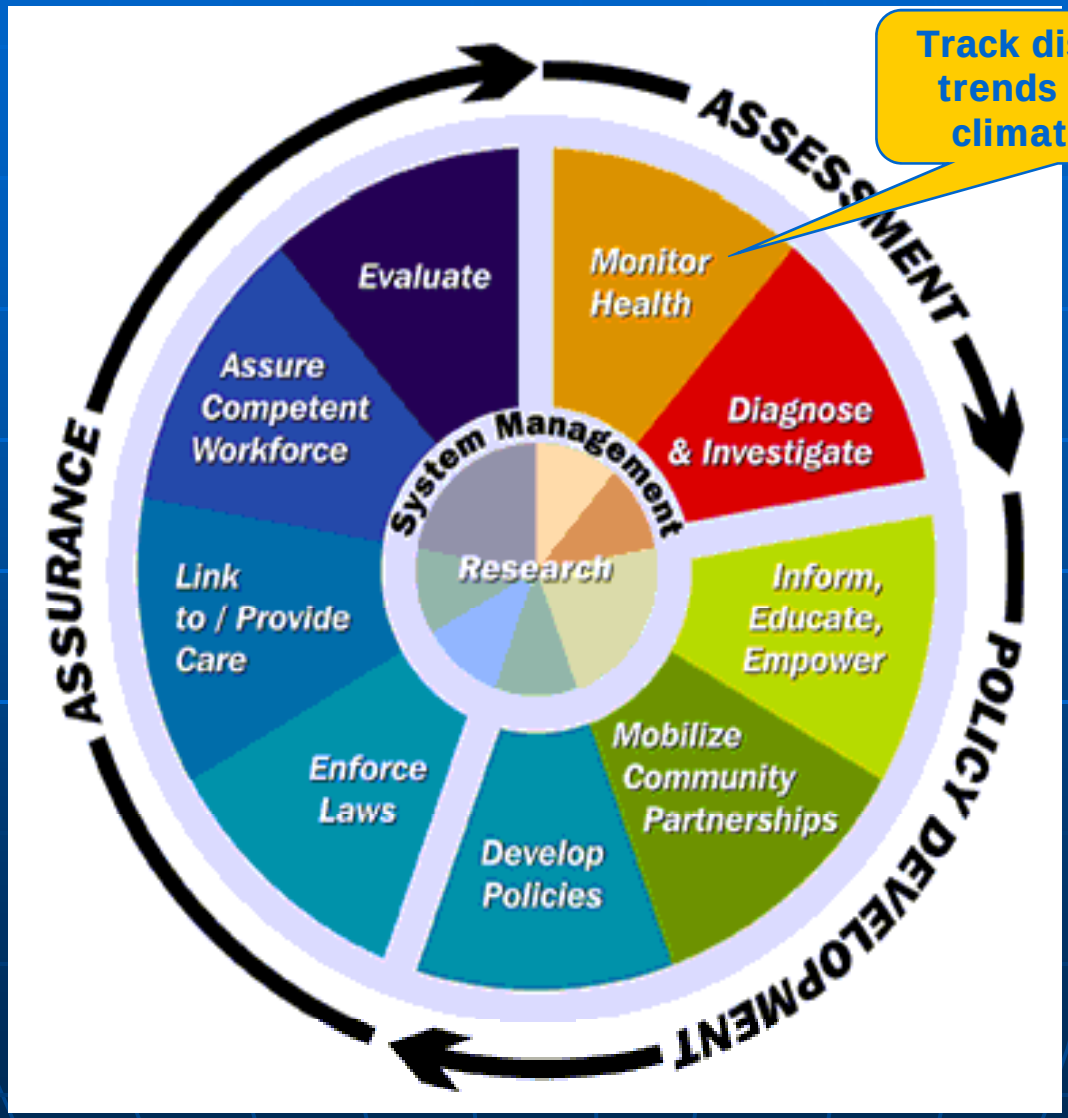
A PUBLIC HEALTH FRAMEWORK FOR ADDRESSING CLIMATE CHANGE

Guiding principles:

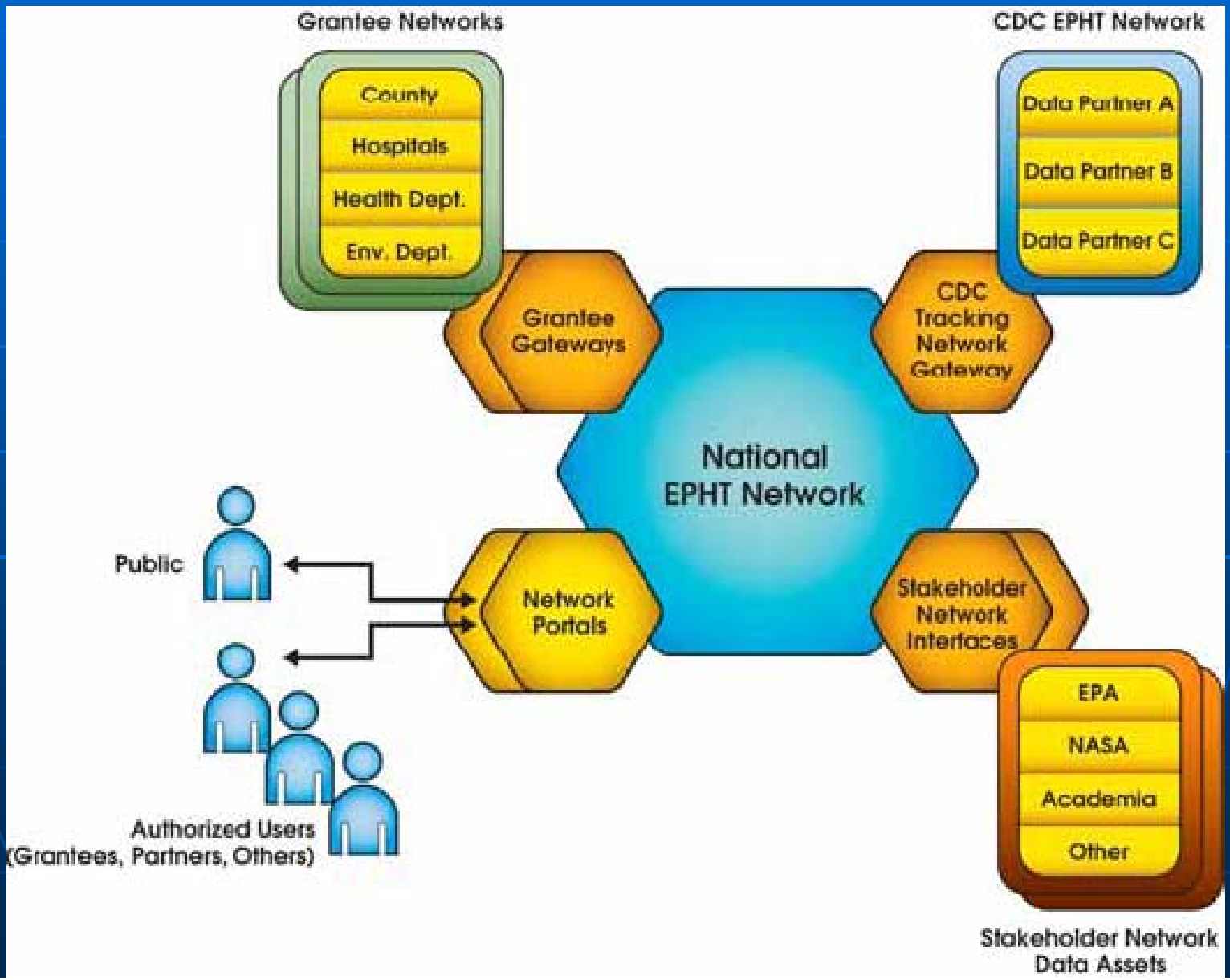
Complexity and Ecosystems thinking



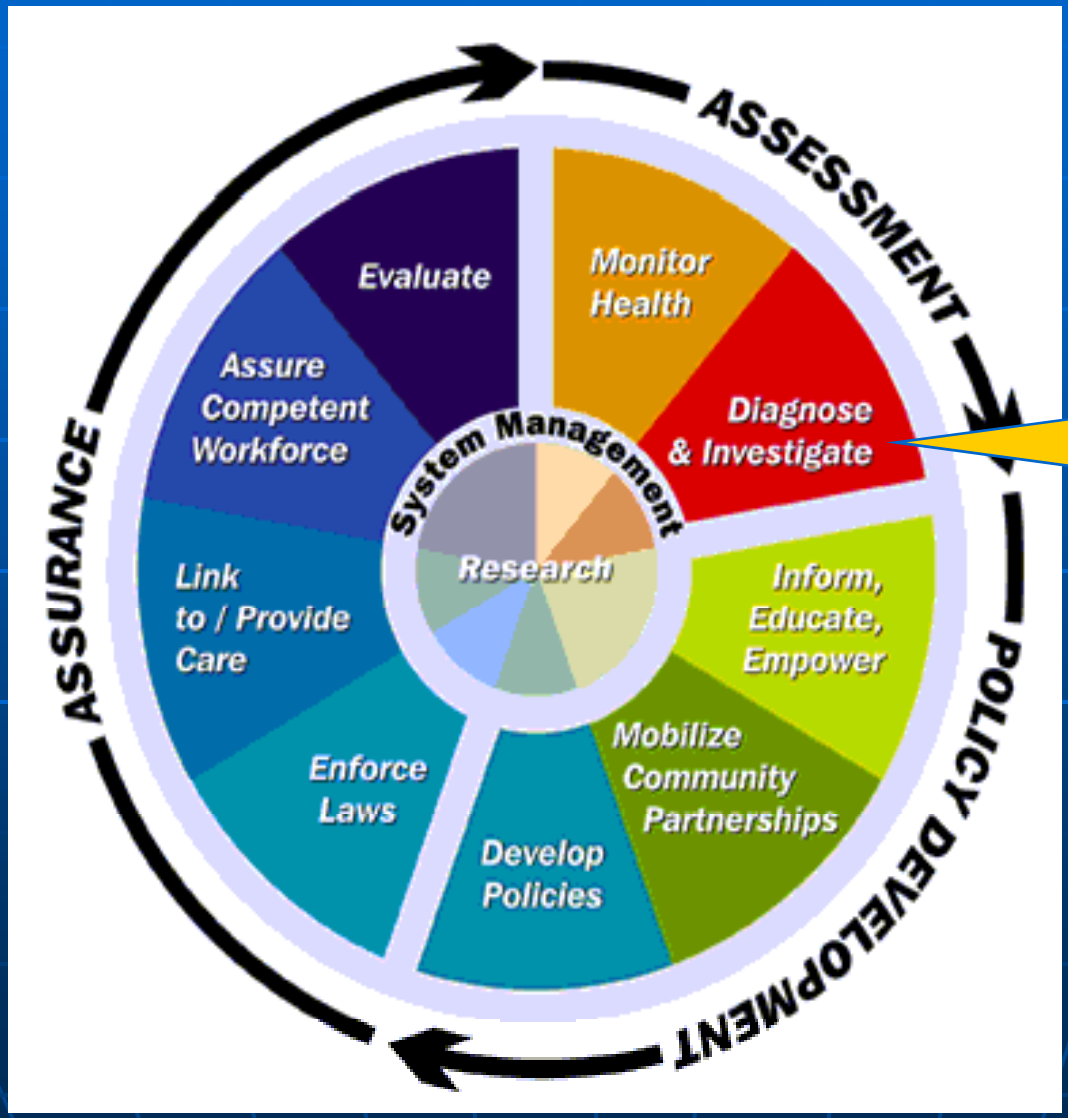
Adaptation strategies for health



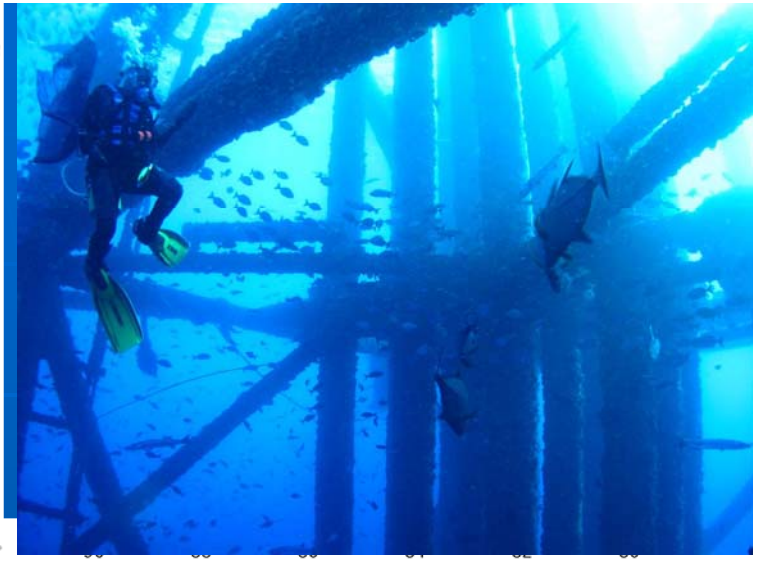
CDC's National Environmental Public Health Tracking Program



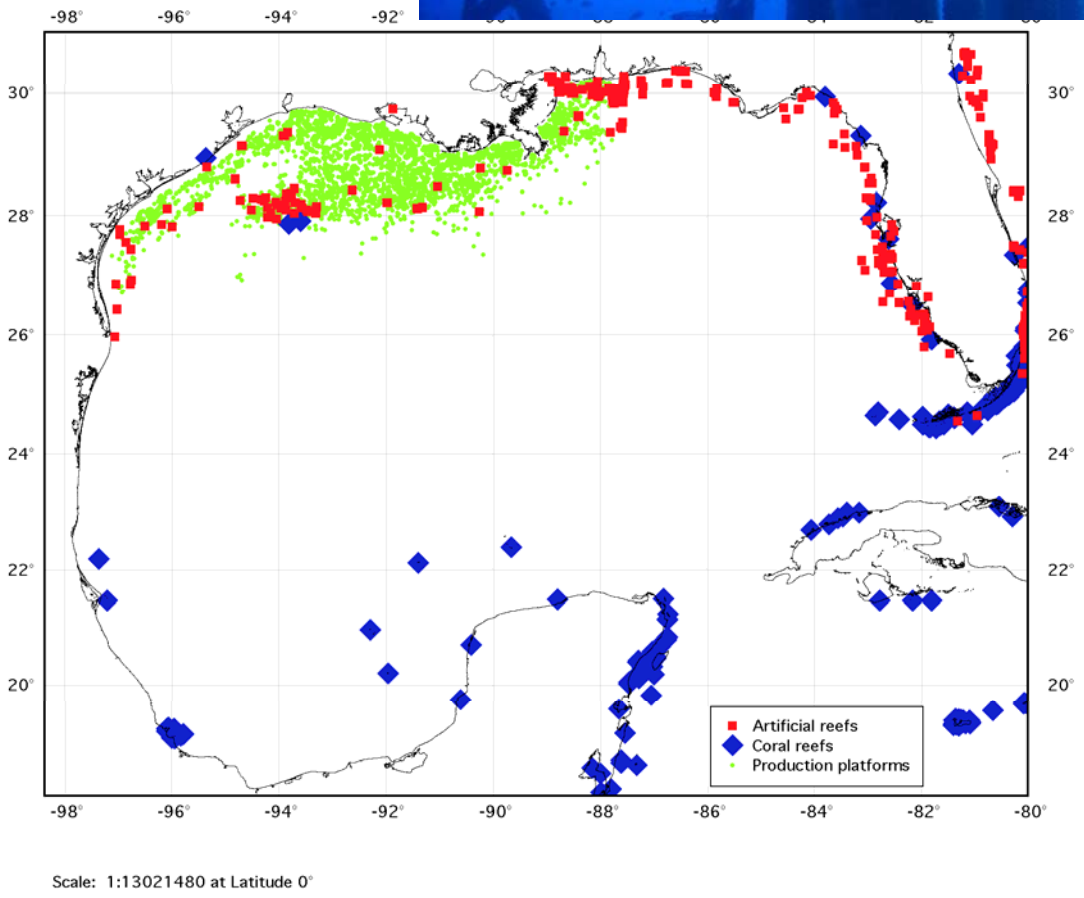
Adaptation strategies for health



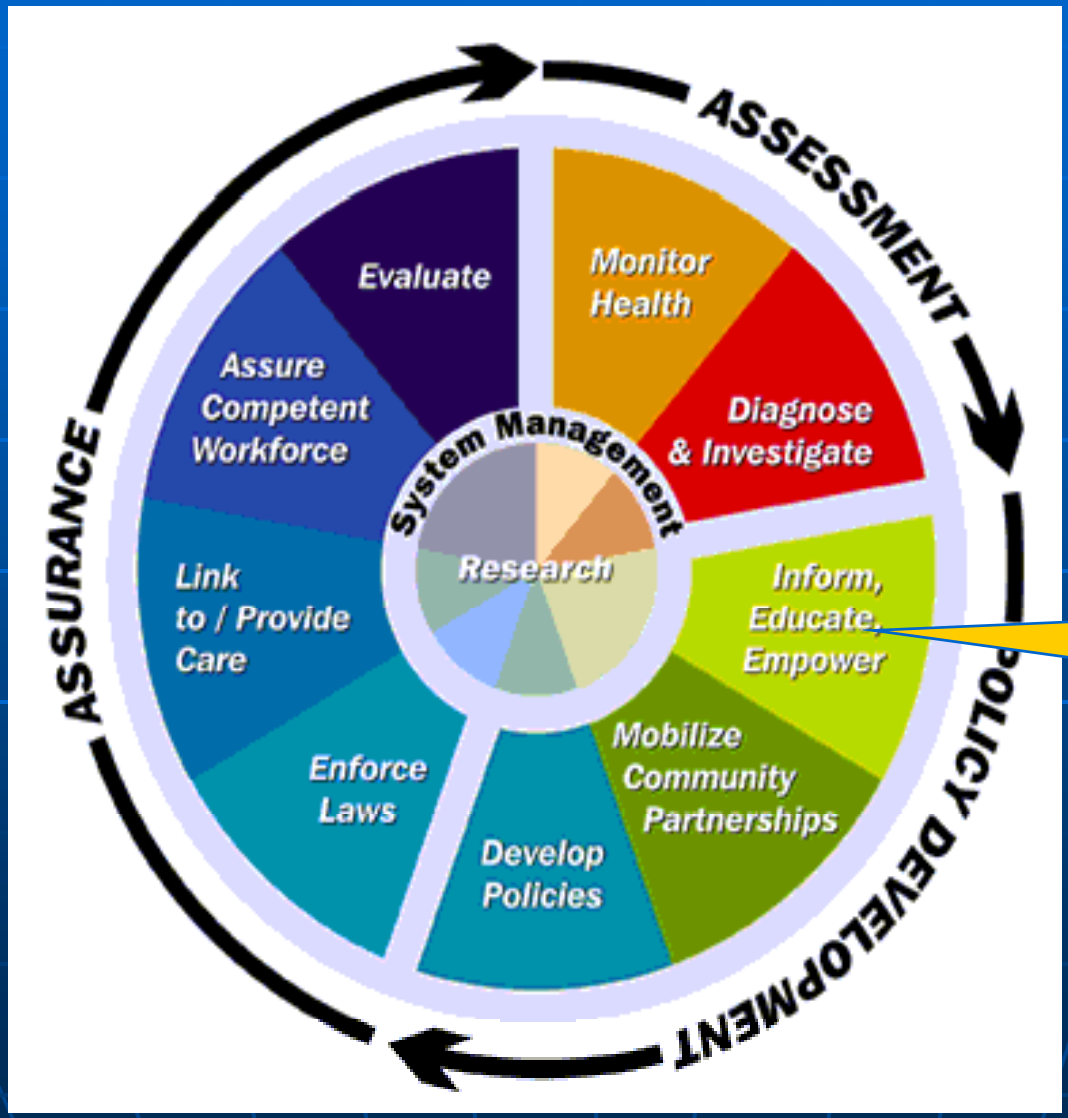
Investigate infectious water-, food-, and vector-borne disease outbreaks



Ciguatera Fish Poisoning on Texas Coast Oil Rigs



Adaptation strategies for health



Communicate effectively on climate change

washingtonpost.com

Climate Change Scenarios Scare, and Motivate, Kids

By Darragh Johnson
Washington Post Staff Writer
Monday, April 16, 2007; Page A01

The boy has drawn, in his third-grade class, a global warming timeline that is his equivalent of the mushroom cloud.

"That's the Earth now," the 9-year-old says, pointing to a dark shape at the bottom. "And then," he says, tracing the progressively lighter stripes across the page, "it's just starting to fade away."

BBC NEWS

Last Updated: Tuesday November 14 2006 11:15 GMT

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Climate change is kids' top fear

How we're damaging the environment is more of a worry to you than getting a girl or boyfriend, says a survey.

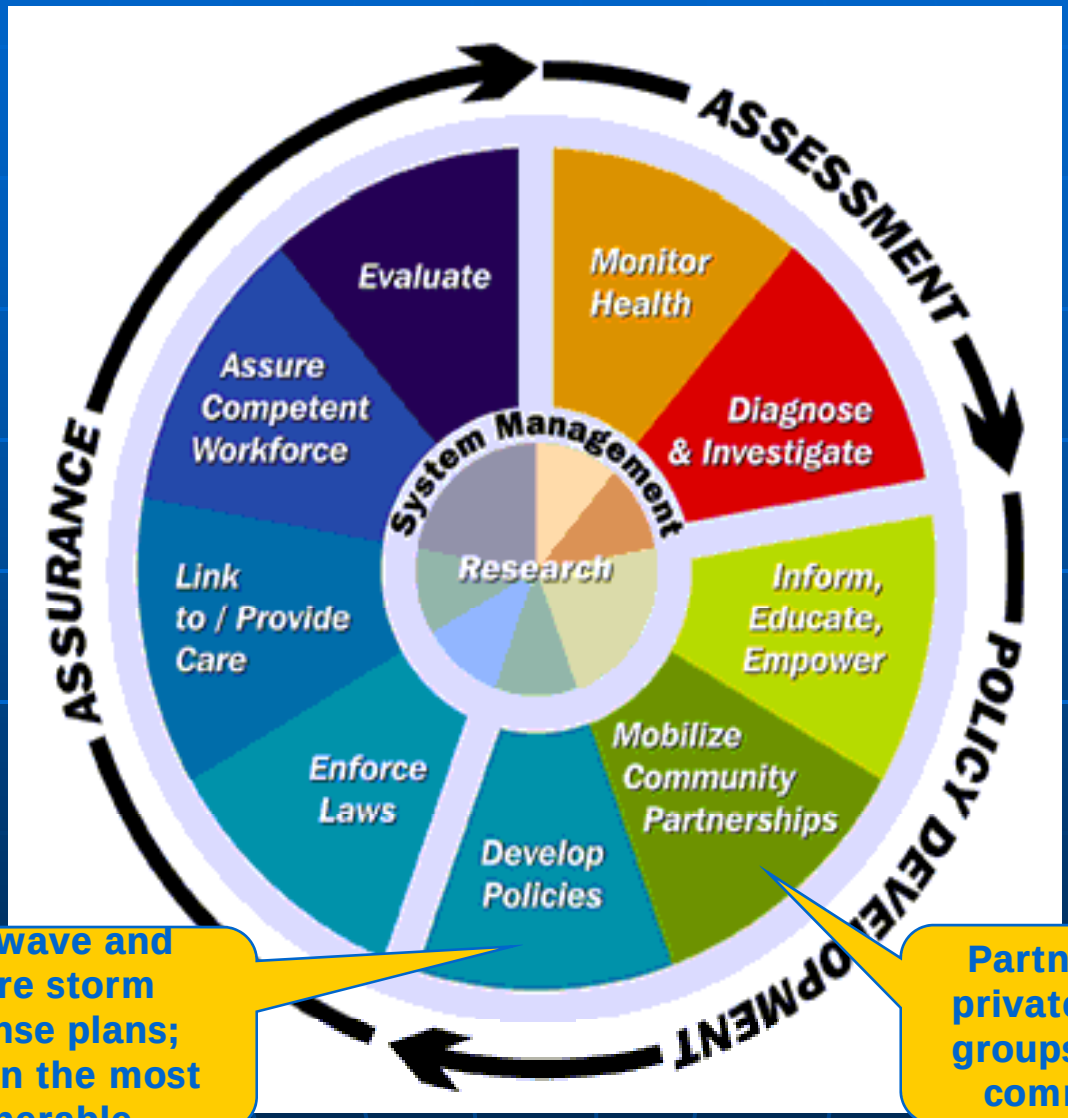
The results showed three quarters of 11 to 14-year-olds worry about climate change, compared to 41% who are worried about going out with someone.

And it looks like you lot aren't just all talk - 63% turn off the lights when you leave a room, 82% of you recycle, and 75% say we should recycle more.

The survey quizzed 1,554 kids on their views on the

Image courtesy of Jonathan Patz.

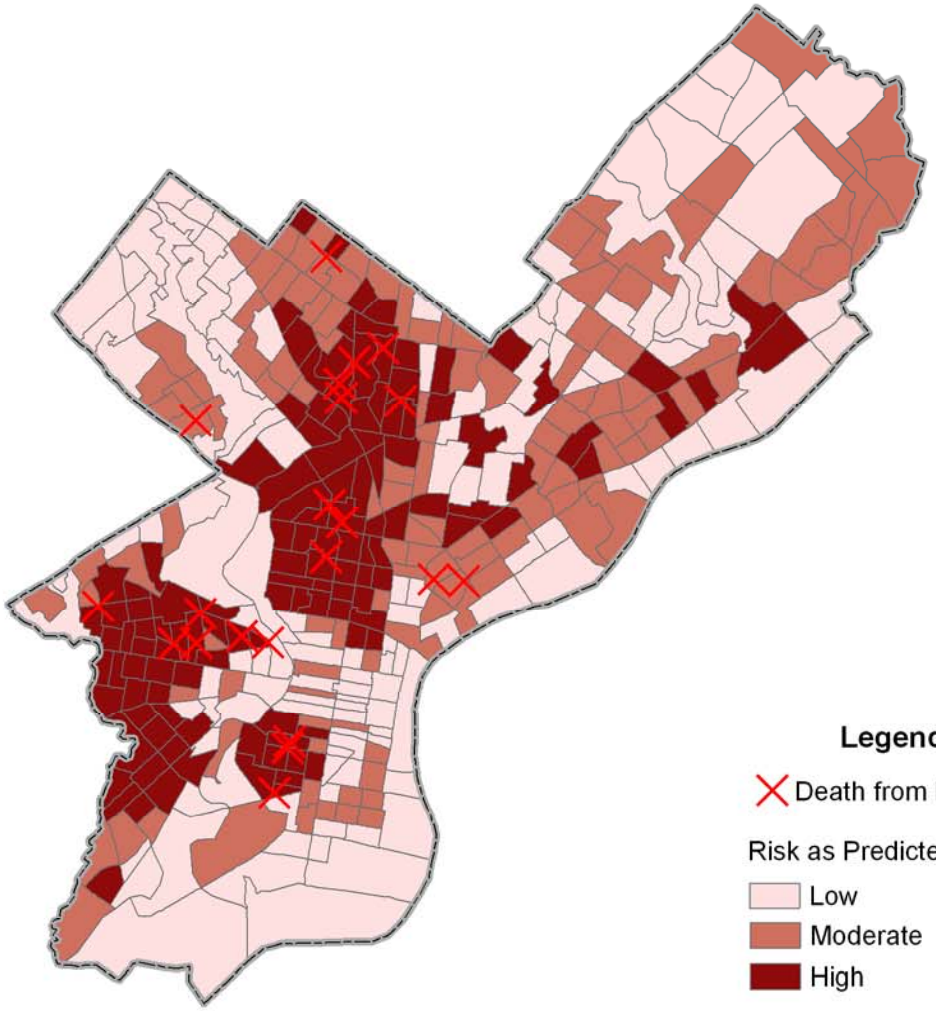
Adaptation strategies for health



Heat wave and severe storm response plans; focus on the most vulnerable

Partnerships with private sector, civic groups, NGOs, faith community, etc.

Risk for Hyperthermia: Thermal & Census Model



Legend

Death from Hyperthermia (Primary Cause)

Risk as Predicted from Neural Network

- Low
- Moderate
- High

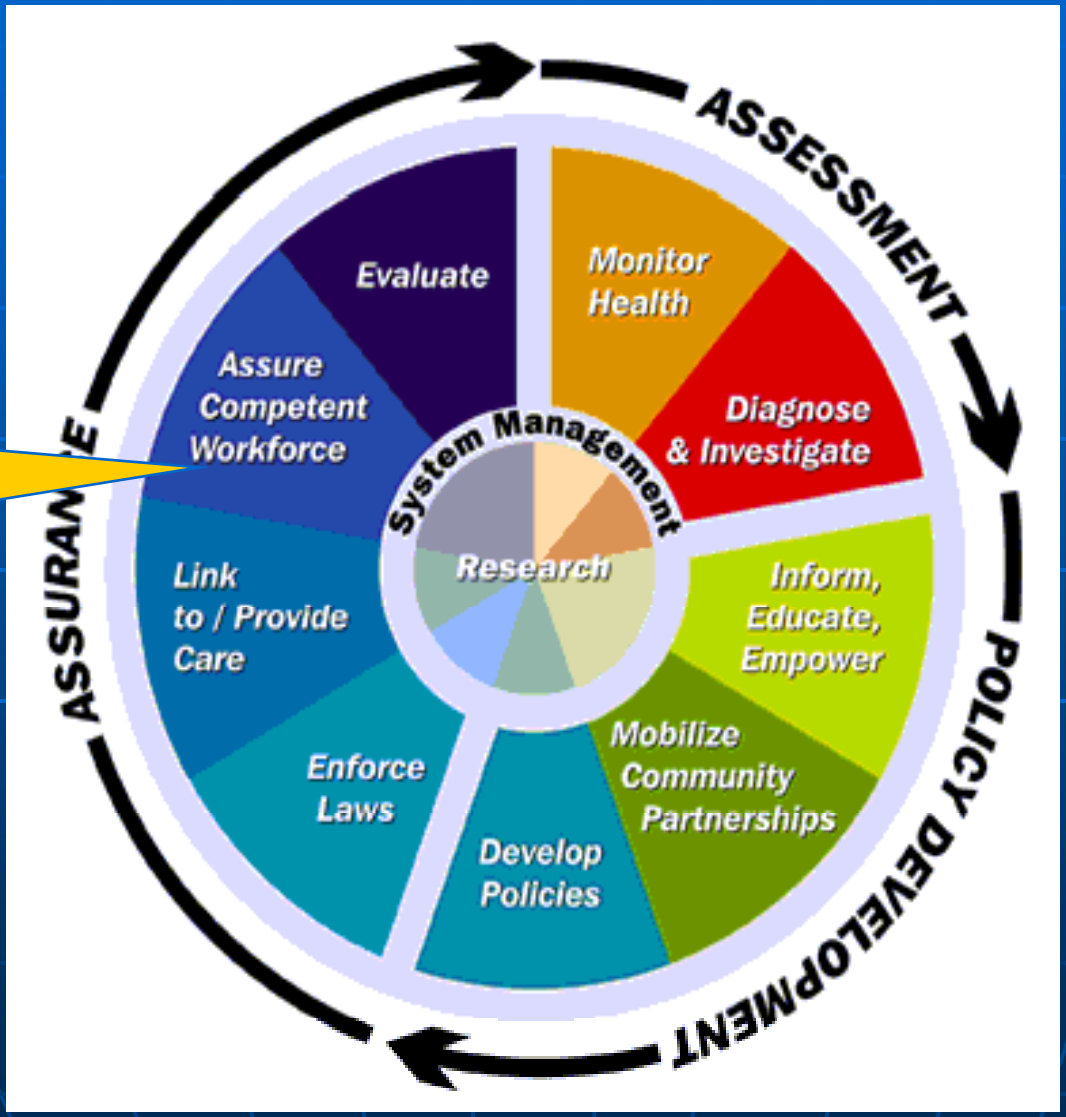
N W E S

0 2.5 5 10 Kilometers

Death Locations are in Assigned Census Tracts but are Randomly Offset to Protect Privacy

Adaptation strategies for health

Public health workforce prepared to respond



Priority health actions for climate change

Promote workforce development by ensuring the training of a new generation of competent, experienced public health staff to respond to the health threats posed by climate change.

TEPHINET

Training Programs in Epidemiology and Public Health Interventions NETwork

Strategies for Climate Change

- Develop region and city-specific strategies
  - Focus on vulnerable populations in urban areas
- Enhanced surveillance integrating environmental and health data
  - Climate change indicators?
- Identify Co-Benefits

Conclusions

- Climate change is now a mainstream issue
- Climate change must also be framed as a public health issue
- Opportunity costs of not taking action are high

CDC
Environmental Health

Thank You

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