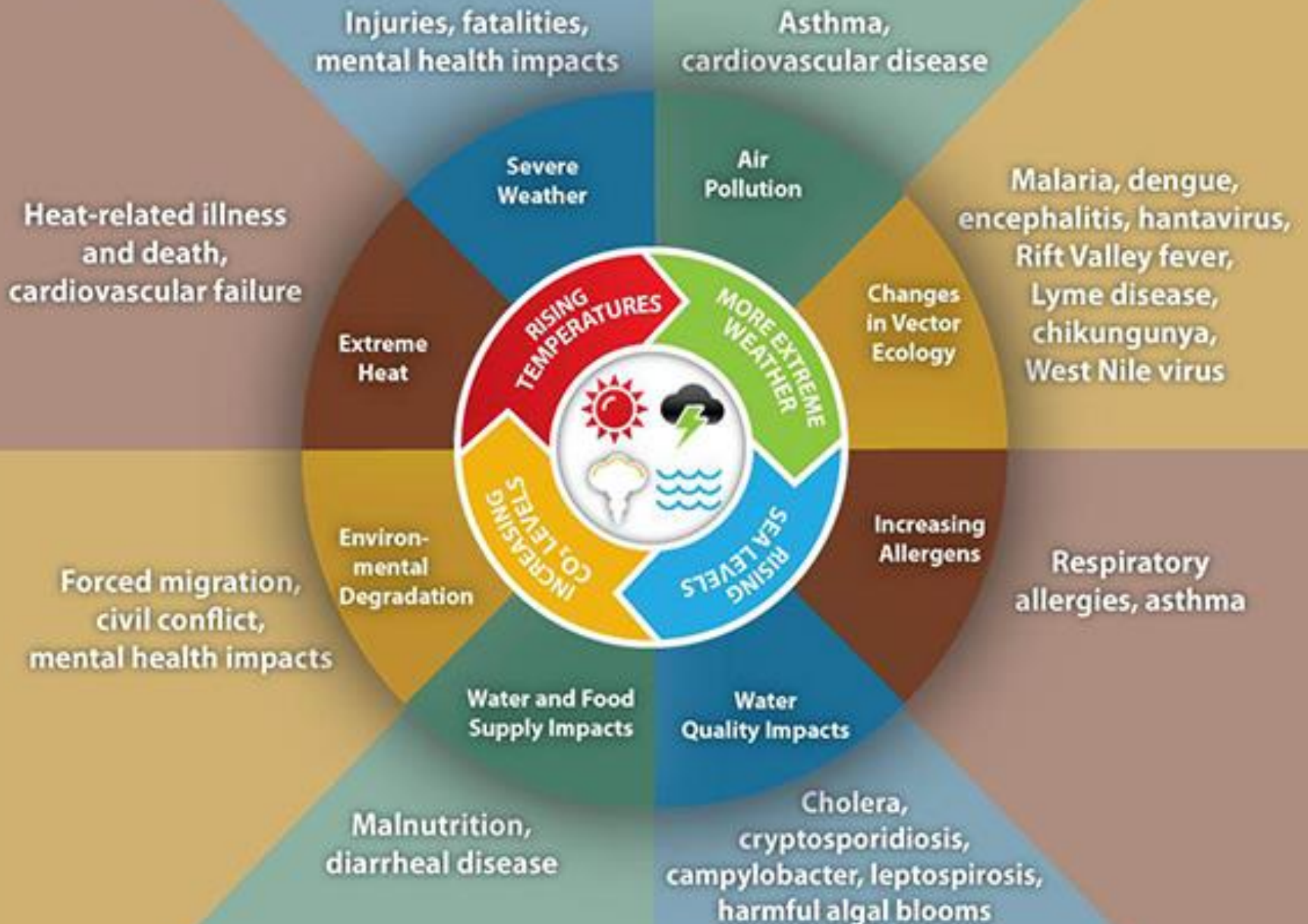


Climate Change and Health:

The Greatest Global Health Threat and Opportunity of the 21st Century

*The Forum for Medical Affairs
AMA Interim Meeting November
17, 2019 San Diego CA*

Impact of Climate Change on Human Health



Heat Waves

130 million vulnerable people exposed to heat waves each year, 1 billion by 2040



CHRIS HOLLINGSWORTH IMAGES NORTH AMERICA/GETTY IMAGES

Heat Related Effects/ Clinical Presentations

- **Mild symptoms** (rash, fatigue)
- **Heat Exhaustion**
 - Thirst/Weakness/Dizzy
 - Cramps/Headache
 - Nausea/Vomiting
 - Profuse diaphoresis/tachycardia

Heat Stroke:

Confusion/Syncope/Coma

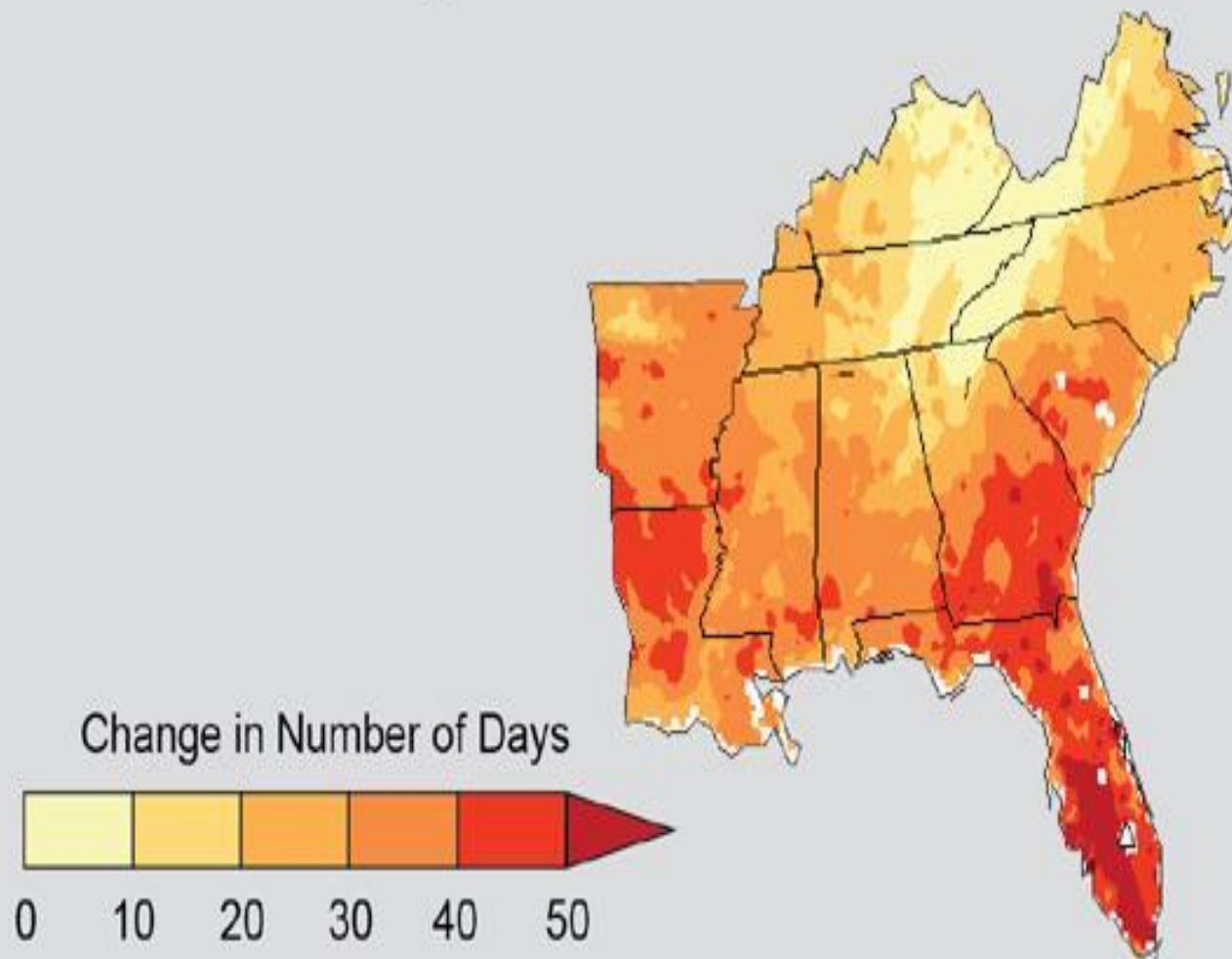
Dry or moist skin

Core temperature > 104 F



Projected Change in Number of Days Over 95°F

Projected Difference from Historical Climate

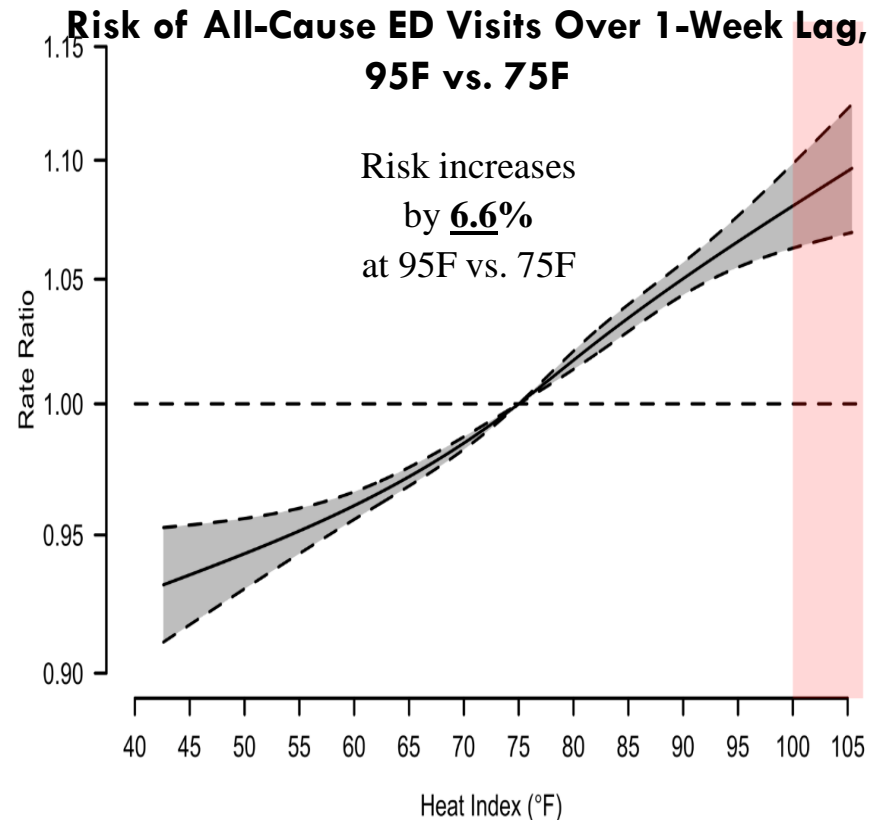


Extreme Heat Research & Policy Change

For a day when the max heat index was 95°F (compared to 75°F):

- All-cause ED visits ↑ 6.6% over the following 7 days
- Heat-related ED visits ↑ 89% over the following 7 days
- Deaths ↑ 5.8% on the same day

Key point: Health effects occur at 'moderate' heat index below the current NWS threshold for a Heat Advisory.

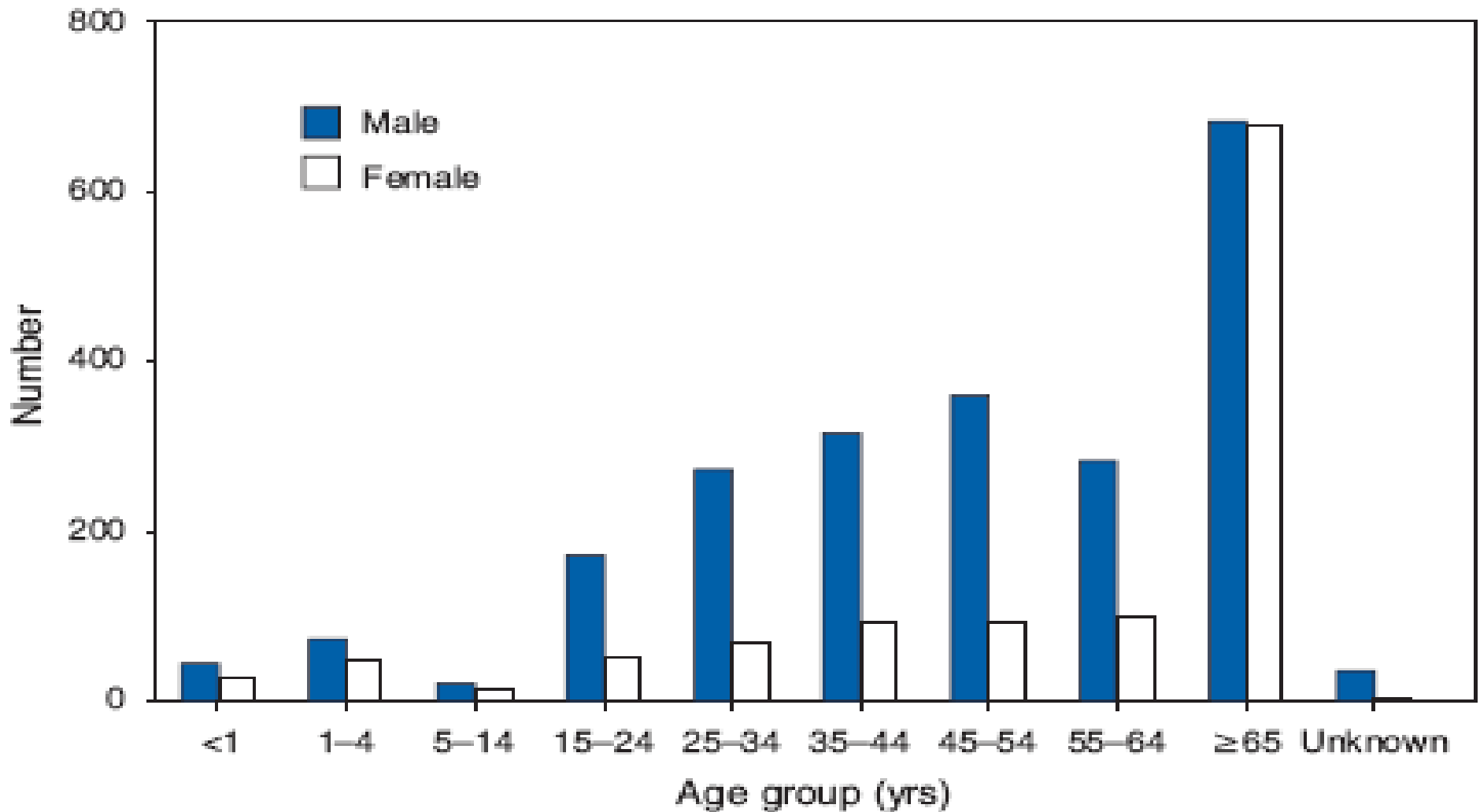


Wellenius et al. (2017) Heat-Related Morbidity and Mortality in New England: Evidence for Local Policy. Environmental Research. DOI: 10.1016/j.envres.2017.02.005

Heat Waves

- Increased risk for:
 - Myocardial Infarction
 - Stroke
 - Acute and chronic kidney injury
 - Cognitive function deficit and suicide

FIGURE. Number of heat-related deaths,* by sex and age group — United States, 1999–2003



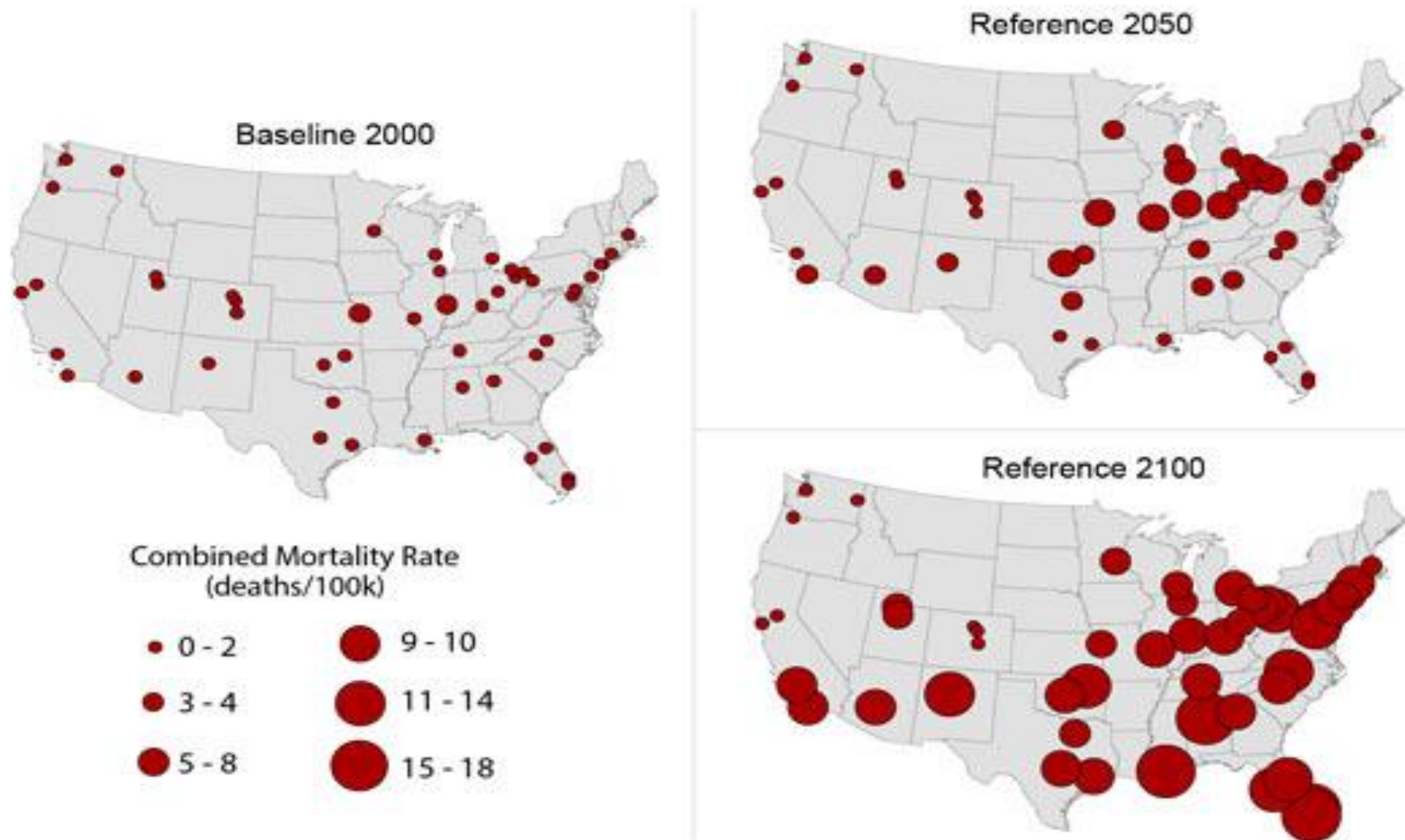
* Exposure to extreme heat is reported as the underlying cause of or a contributing factor to death (N = 3,442).

Groups at Increased Risk from Heat Waves

- **Elderly**
 - **sweat less, less thirst drive/non-ambulatory/**
Cardiopulmonary and renal conditions
 - **Multiple medications**
 - **Thermoregulation**
- **Children (0-4) and older kids – thermoregulatory issues and activities**
- **Sports Enthusiasts – may overdo**
- **Laborers – may be placed at greater risk**
- **Homeless – may not recognize the danger or have resources to cope**
- **Poverty and lack of air conditioning**
- **Urban settings with pavement and lack of trees**
- **Chronic conditions such as COPD and CHF**

Projected Extreme Temperature Mortality in Select Cities Due to Unmitigated Climate Change

Estimated net mortality rate from extremely hot and cold days (number of deaths per 100,000 residents) under the Reference scenario for 49 cities in 2050 and 2100. Red circles indicate cities included in the analysis; cities without circles should not be interpreted as having no extreme temperature impact.



For more information, visit EPA's "Climate Change in the United States: Benefits of Global Action" at www.epa.gov/cira.

Prevention of Heat Morbidity/Mortality

- Communication by clinical teams: reach vulnerable populations
- Public Health warning systems of impending heat waves
- Temporary housing for vulnerable population
- Timely education about the risk of heat illness
- Community outreach teams organized by local public health authorities

Respiratory Effects



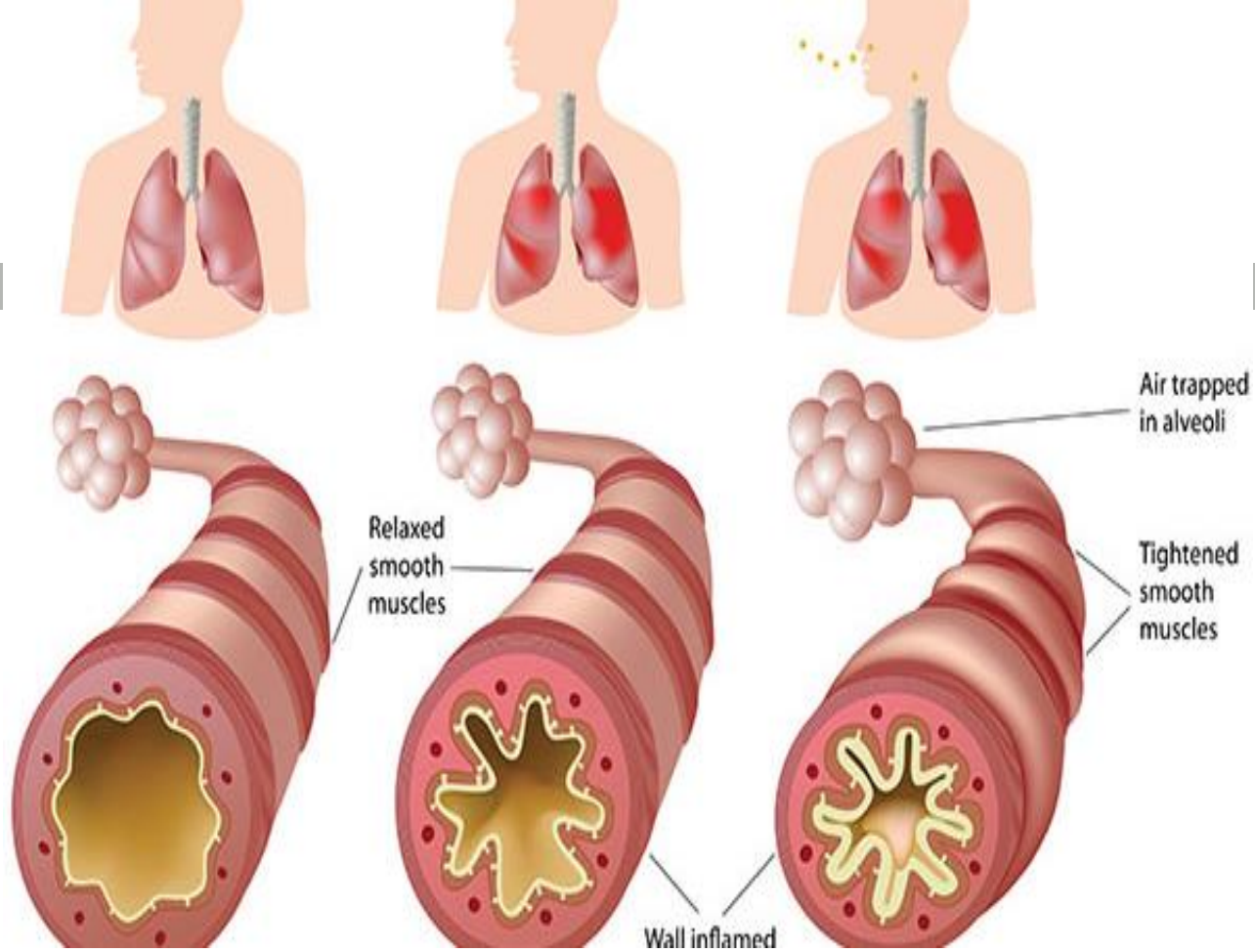
American tourists wearing masks to filter out smoke from forest fires surrounding Moscow, Russia. Summer 2010.



Respiratory Effects

Particulate matter and ozone

- Source: Autos, power plants and forest fires
- 43 million in US and 92% of the world live in areas in excess of WHO limit of 10micrometers/mm³.
- In 2016 7 million deaths attributable to air pollution (WHO), dangerous level increase by 11.2% since 1990.
- Ozone will increase to 60 ppb by 2030/irritable to alveoli/air trapping/more vulnerable to particulates
- There is some evidence of increased risk of neurodegenerative diseases such as Parkinson/Dementia.



Pathogenesis: Ozone irritates the lungs and makes people more vulnerable to the effects of small **particles** and **allergens**.*

(*Rom WN, et al. Global Warming: A Challenge to all American Thoracic Society Members. Am J Respir Crit Care Med 2008; Vol 177: 1053-1057)

Air Pollution

- Reduces life expectancy by 1.9 years in Egypt, 1.5 years in India, 9 months in Russia and 4 months in the U.S.
- Study of 25000 people in China showed decline in cognition of math and verbal skills.
- Most affecting the elderly, men and lower education level.
- Increased risk of stroke, CAD and myocardial infarction
- Increased risk but causal relationship to be proven.

Allergies and Asthma



Allergies and Asthma

- 55% of US and European population tests positive for allergens and 34 million people with asthma
- Increased length of pollen season in North America and Europe
- Increased CO₂ production leads to increase growth of allergen producing weeds, grasses, trees and fungus.
- Rain and floods leads to increase mold and fungal growth

Child Disease.

TABLE 2. LENGTH OF AEROALLERGEN PRODUCTION SEASON IN NUMBER OF DAYS AT THE MEDIAN OF CLIMATE MODEL PROJECTIONS

TIME HORIZON	TREE BLOOM	FIRST FREEZE	SEASON LENGTH
1978 - 2007 baseline	May 3	October 25	177
2022	April 27	November 3	190
2052	April 20	November 9	203
2084	April 12	November 12	214

AIR QUALITY

Allergies and Asthma

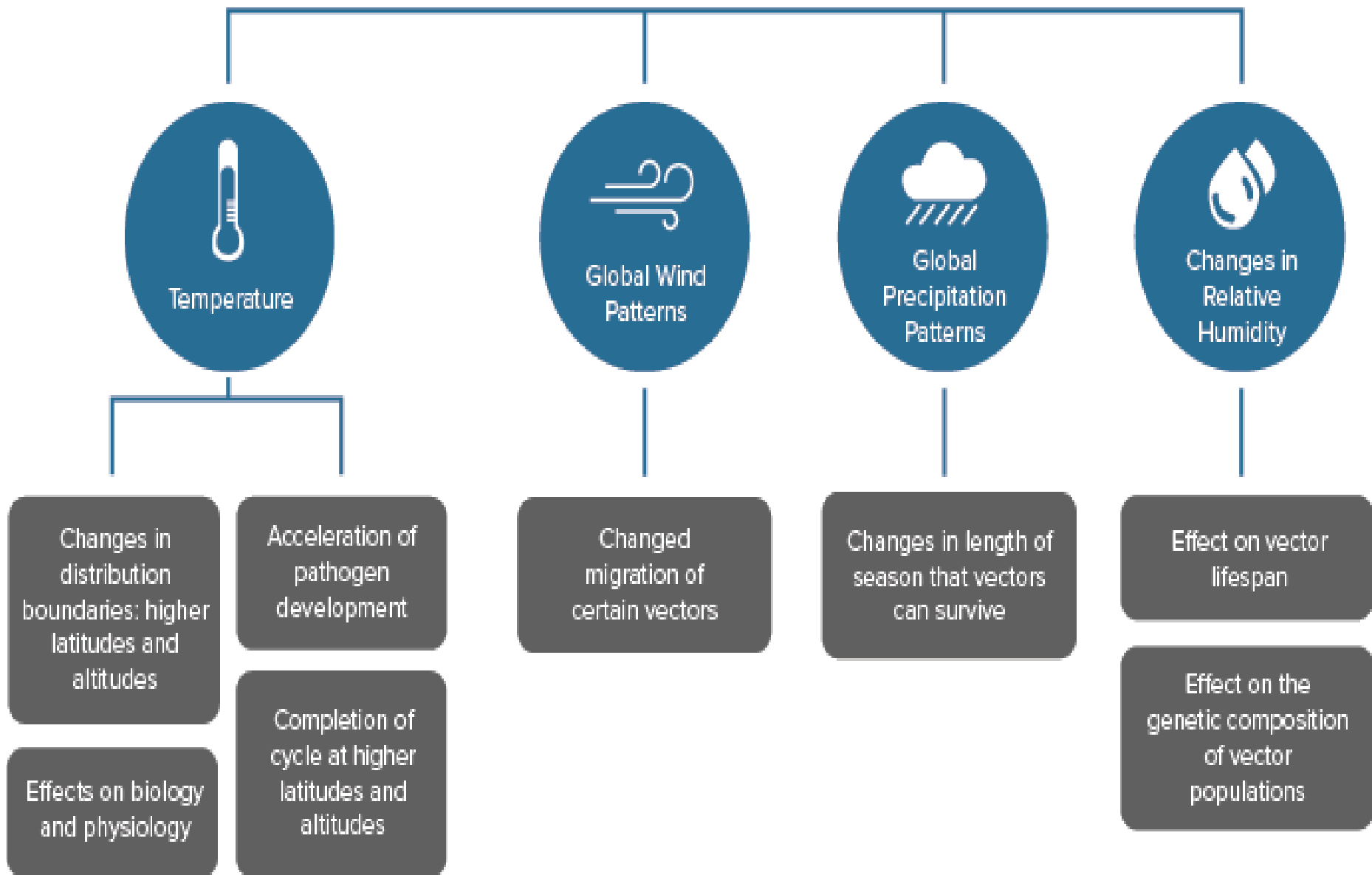
- **Allergies:** 11 million office visits per year
- \$11.2 billion per year to treat
- **Asthma/COPD:** 2 million ED visits/.5 million hospitalization/3600 deaths
- 56 billion dollars per year

Advise to patients with lung disease

- Pay attention to local weather trends and smog alerts, excessive heat, wildfires.
- Avoid excess physical activity and stay indoors
- N95 masks reduce particulate inhalation especially in wildfires.
- Ask patients about knowledge of air pollution
- Inform patients about symptoms (phlegm, dyspnea)
- Counsel to carry an inhaler and stay indoors.

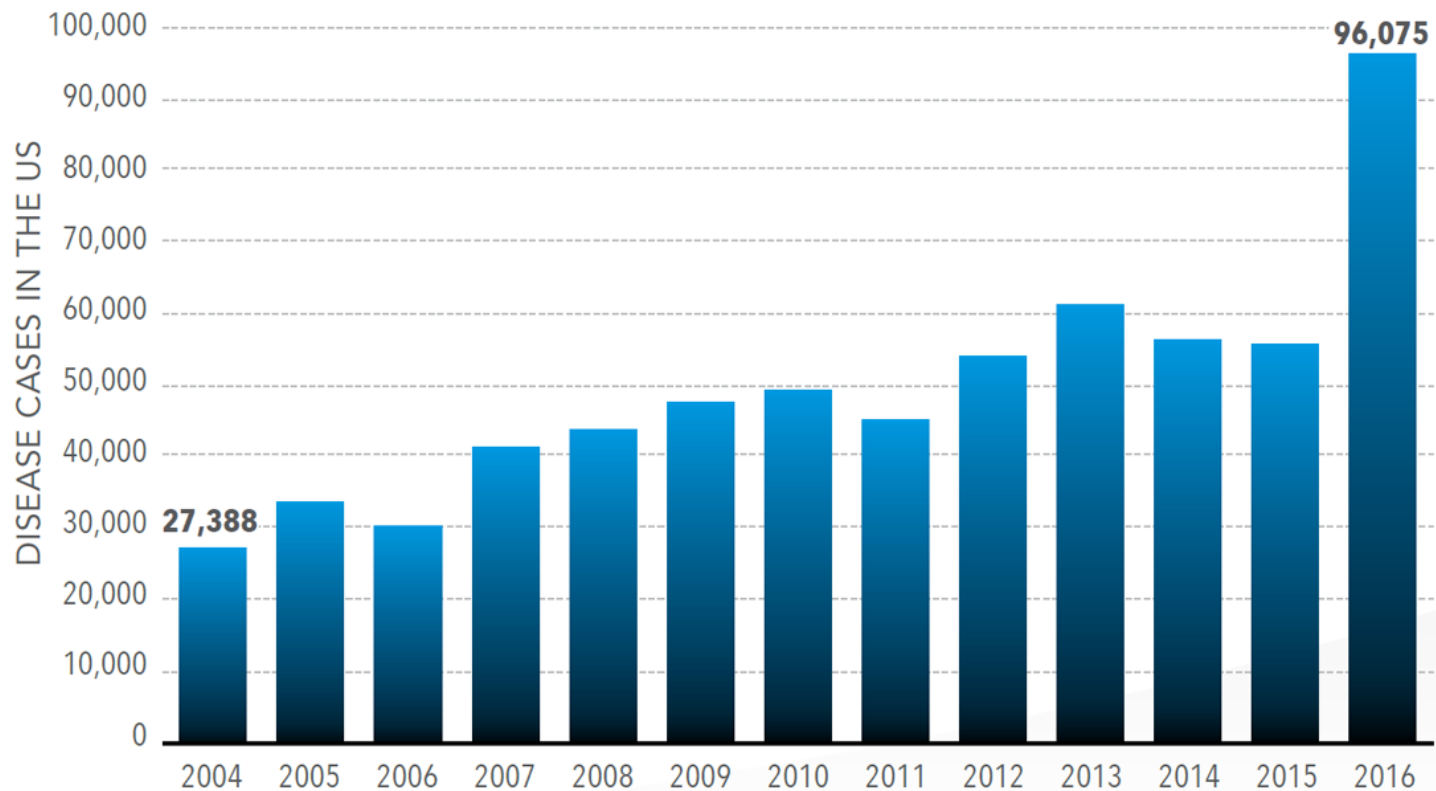
Infectious Disease

Direct Climate Change Effects on Disease Vectors



Vector-borne disease cases on the rise...

Disease cases from infected mosquitoes, ticks, and fleas have tripled in 13 years.



WHO Vector Borne Diseases in North American/European Region

Mosquito:

- Dengue 58.4 million cases/
- 10000 deaths in 2016
- Chikungunya
- Malaria
- West Nile Fever
- Zika



Sandfly borne:

Leishmaniasis

Tick borne:

Lyme/Anaplasma/Babesia

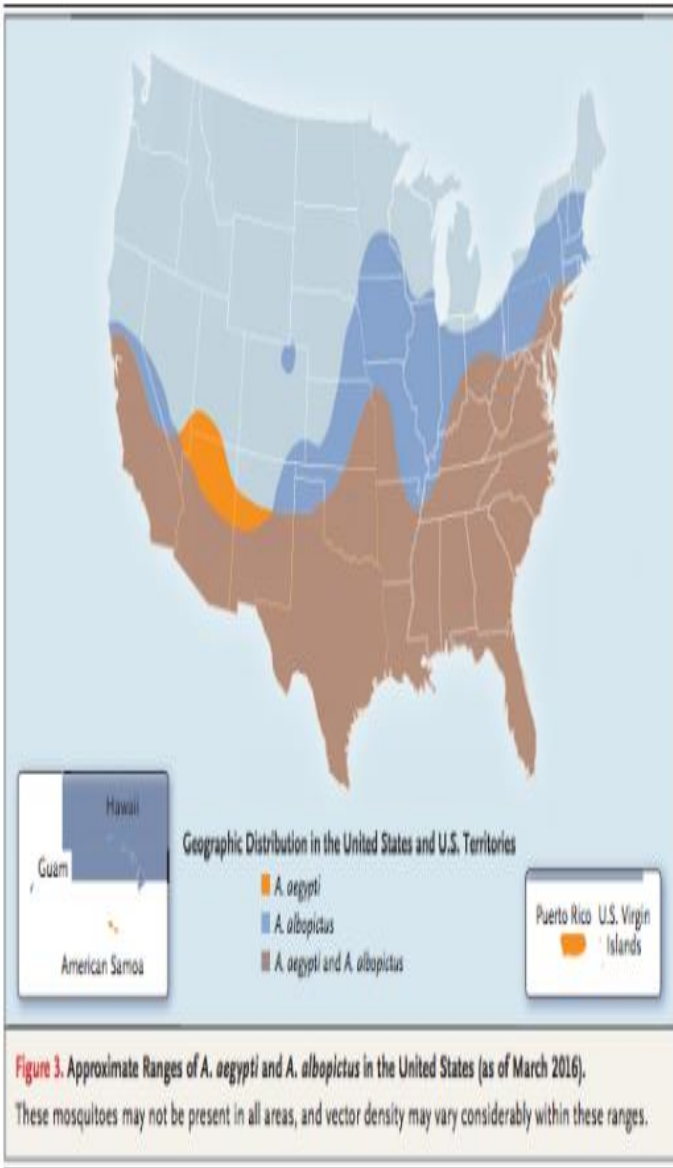


Figure 3. Approximate Ranges of *A. aegypti* and *A. albopictus* in the United States (as of March 2016). These mosquitoes may not be present in all areas, and vector density may vary considerably within these ranges.

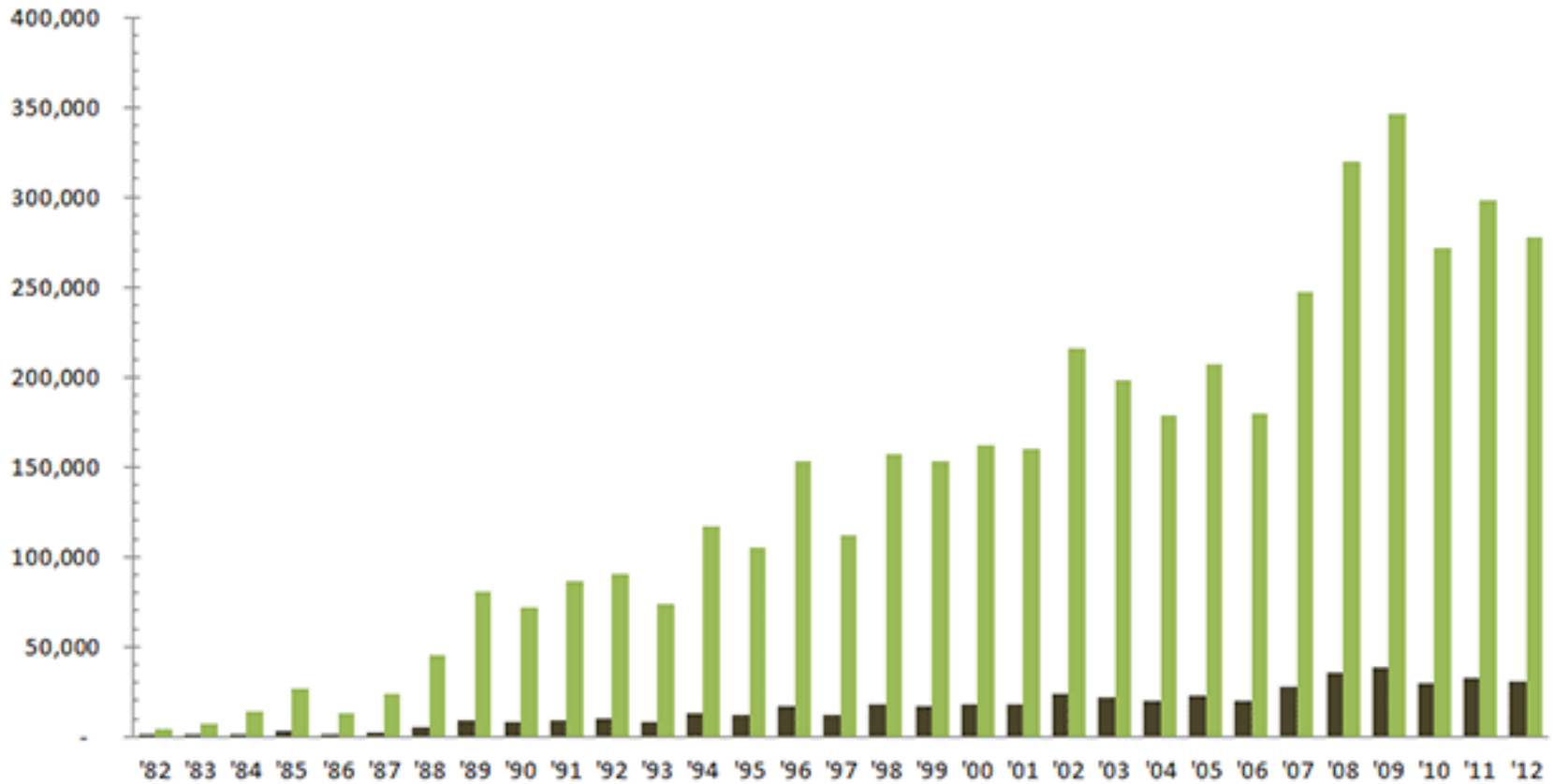


ersen L. et al. Zika Virus
 M 2016
 is article was published on March 30,
 16, at NEJM.org.
 DOI: 10.1056/NEJMe1602113



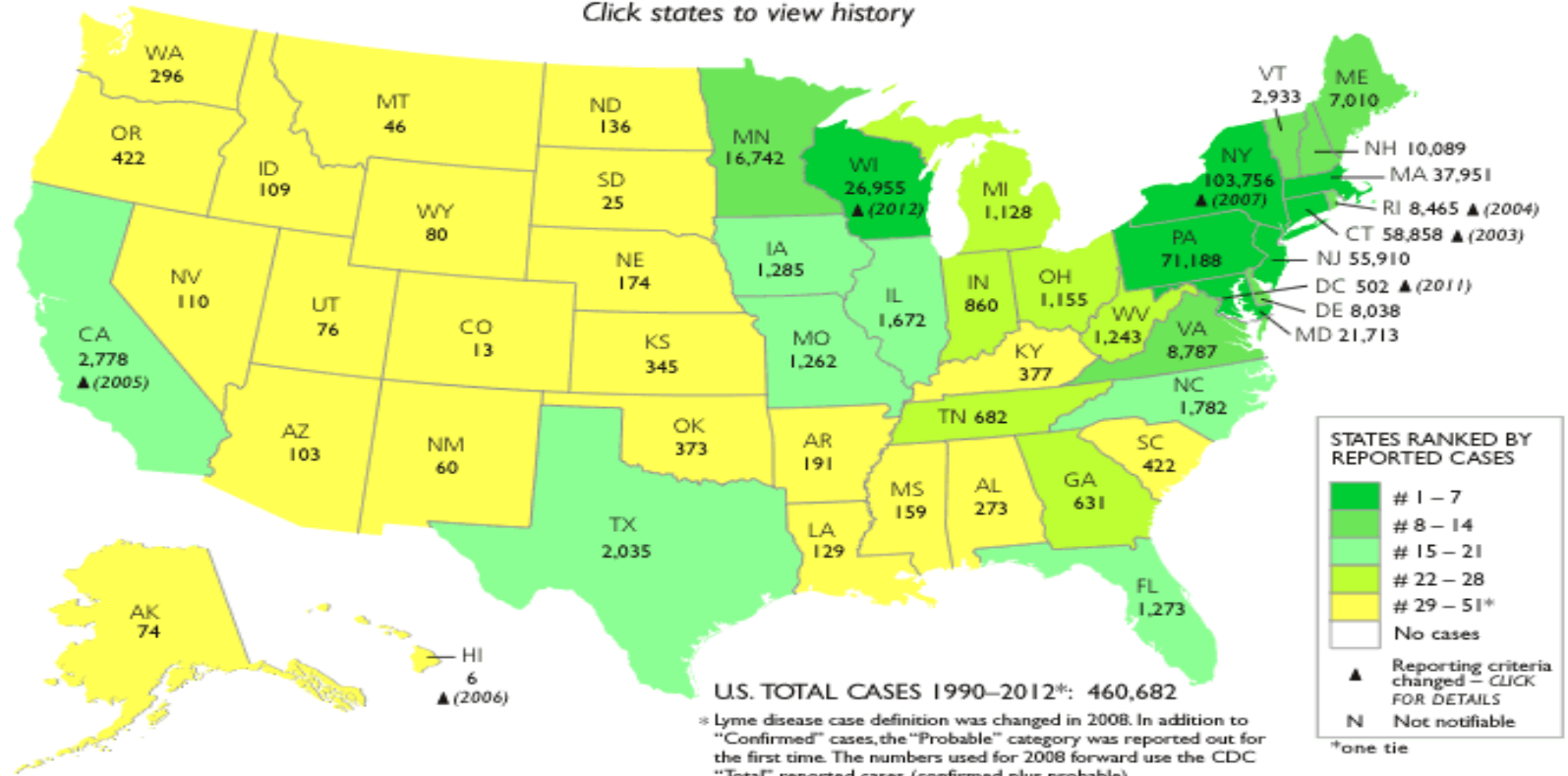
Annual Cases of Lyme Disease in the US

■ Number of CDC-Reported Cases ■ CDC-Estimated Total Diagnosed Cases



TOTAL LYME CASES REPORTED BY CDC 1990–2012*

Click states to view history

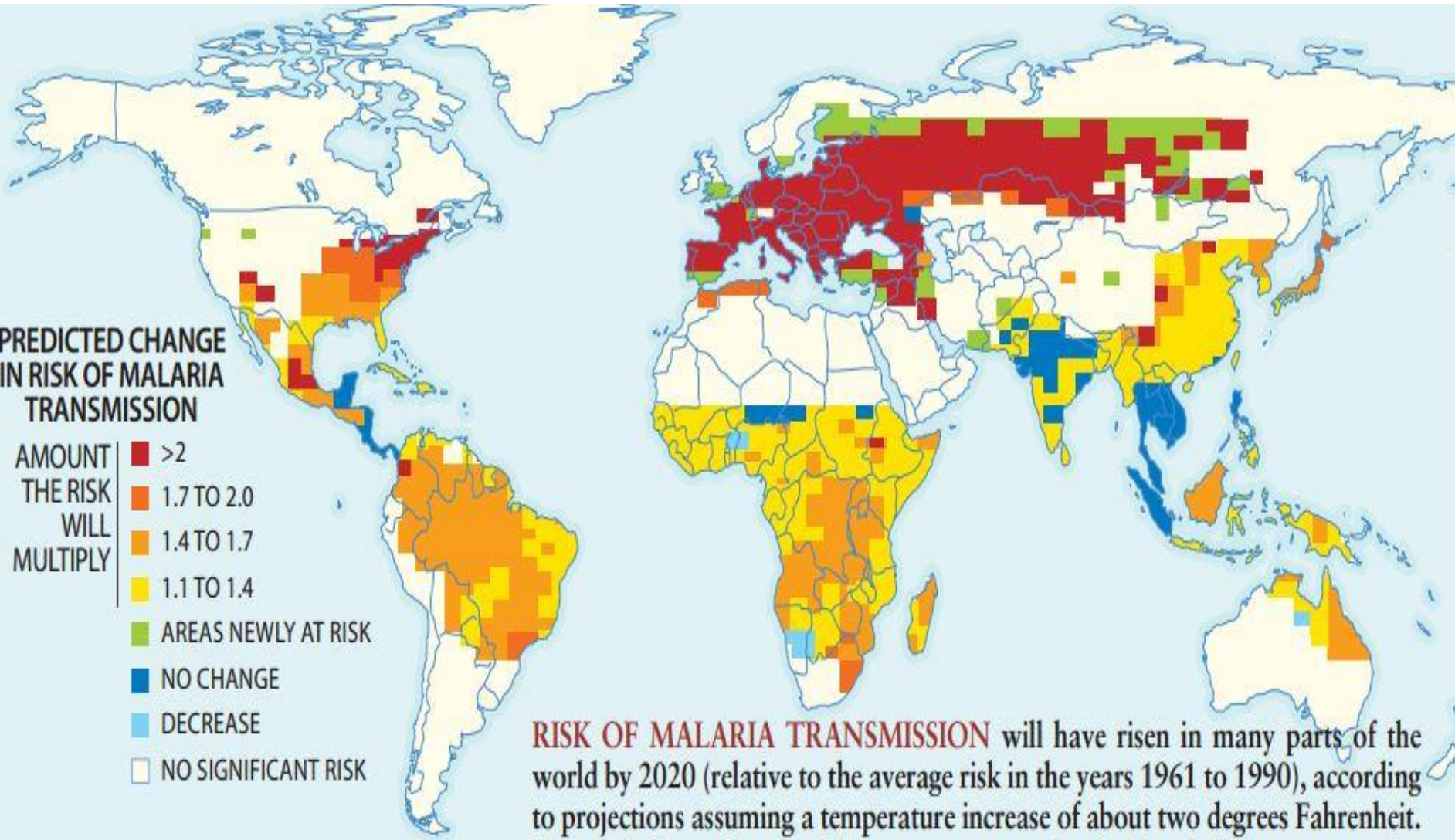


Source: Data compiled from CDC pub data (MMWR) ©2013 Lyme Disease Association, Inc.

<http://module.lymediseaseassociation.net/Maps/index.html#>

**PREDICTED CHANGE
IN RISK OF MALARIA
TRANSMISSION**

- AMOUNT THE RISK WILL MULTIPLY
- >2
 - 1.7 TO 2.0
 - 1.4 TO 1.7
 - 1.1 TO 1.4
 - AREAS NEWLY AT RISK
 - NO CHANGE
 - DECREASE
 - NO SIGNIFICANT RISK



RISK OF MALARIA TRANSMISSION will have risen in many parts of the world by 2020 (relative to the average risk in the years 1961 to 1990), according to projections assuming a temperature increase of about two degrees Fahrenheit. The analysis was based solely on temperature threshold and did not assess other factors that could influence malaria's spread.

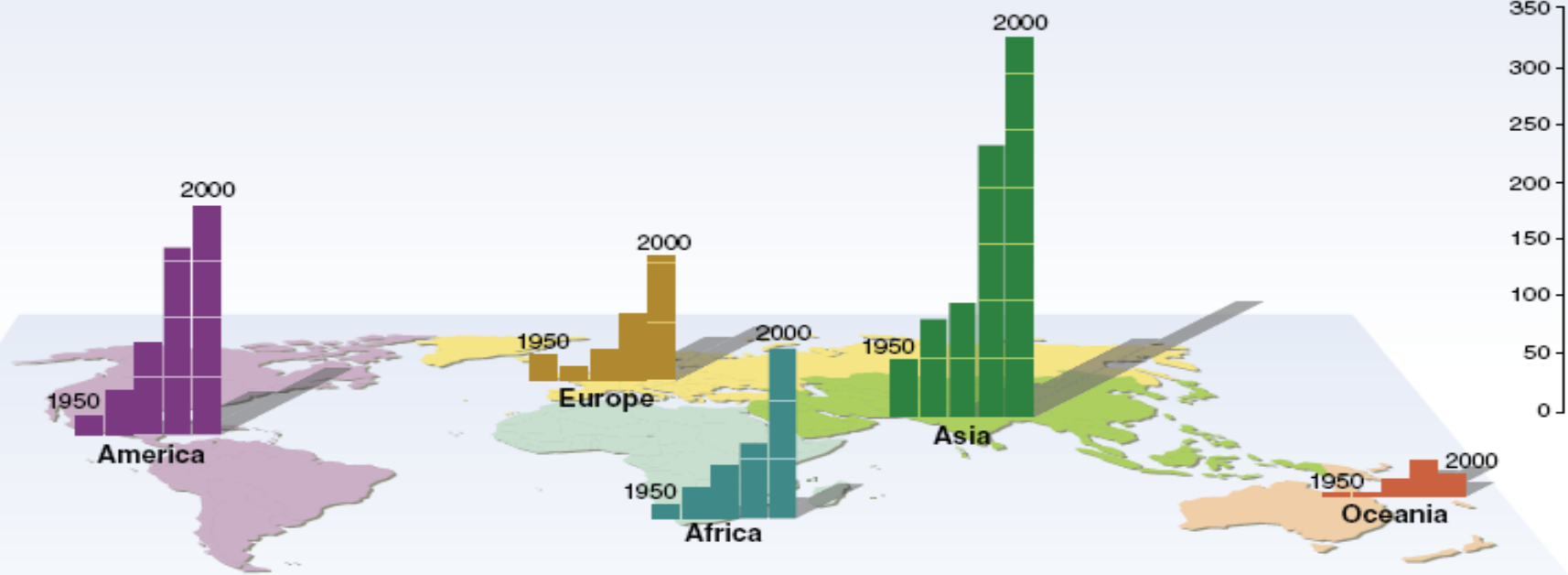
Waterborne Diseases



American College of Physicians
Leading Internal Medicine, Improving Lives

Floods

Number of events
Data plotted by decade



Source: Millennium Ecosystem Assessment



Heavy Downpours are Increasing Exposure to Disease



Climate change increases heavy downpours.

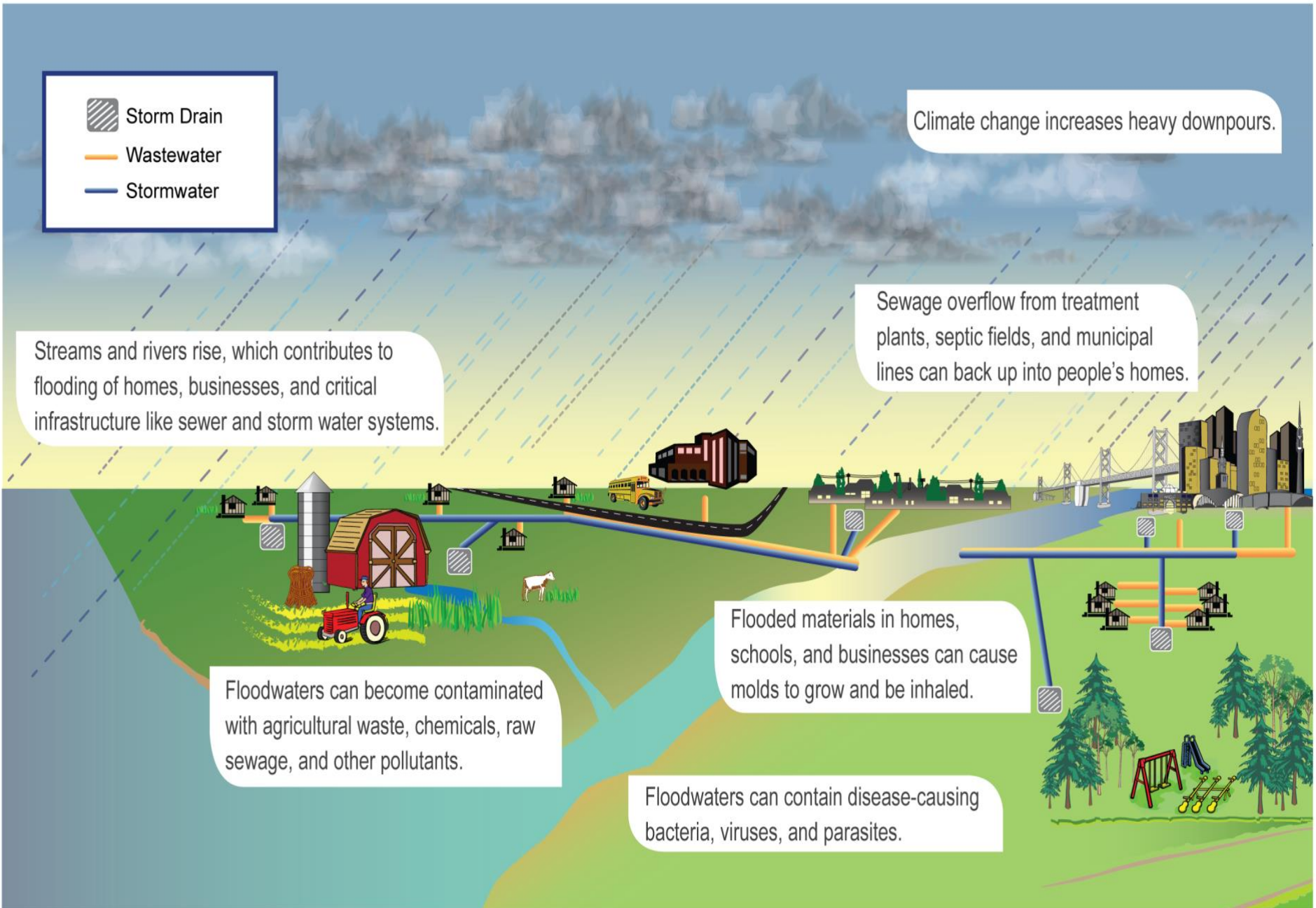
Streams and rivers rise, which contributes to flooding of homes, businesses, and critical infrastructure like sewer and storm water systems.

Sewage overflow from treatment plants, septic fields, and municipal lines can back up into people's homes.

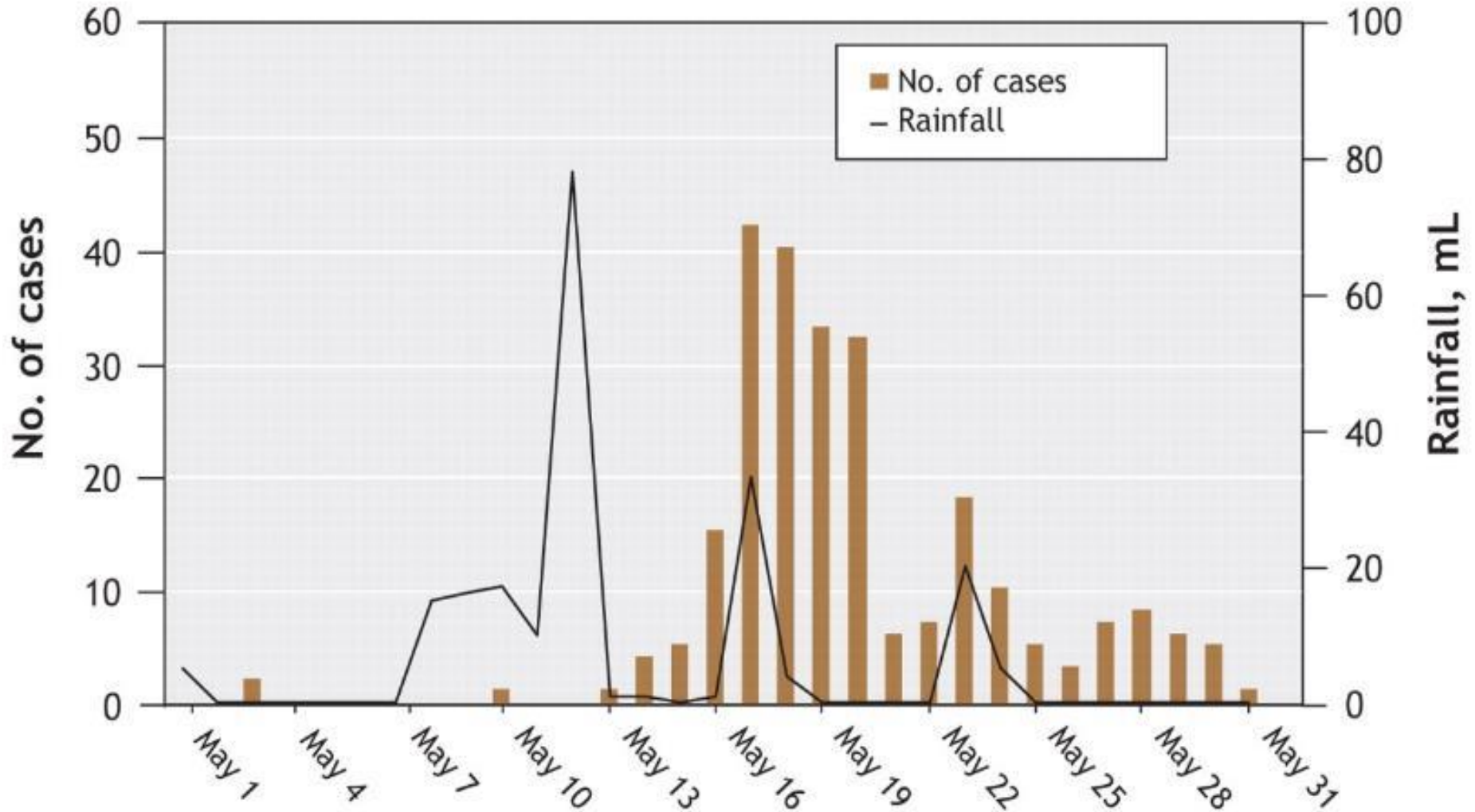
Floodwaters can become contaminated with agricultural waste, chemicals, raw sewage, and other pollutants.

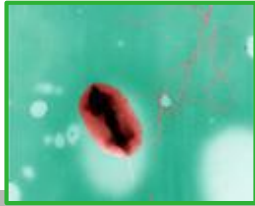
Flooded materials in homes, schools, and businesses can cause molds to grow and be inhaled.

Floodwaters can contain disease-causing bacteria, viruses, and parasites.



Association between precipitation and waterborne disease outbreaks/Toxigenic E. Coli





Bacterial Contamination

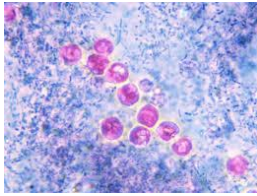


- **Toxigenic E. Coli (O157:H7)** from contaminated food and water
- Bloody diarrhea, vomiting-may lead to kidney failure and even death
- **Campylobacter**-common cause of food poisoning from meats/unpasteurized dairy products/contaminated water.
- **Salmonella**-common cause of food poisoning
- **Leptospira**-spread through the urine of infected animals, rodents, through the soil and water, and during flooding. Infections in urban kids increasing.
- Higher temperatures are associated with higher rates of production and disease.

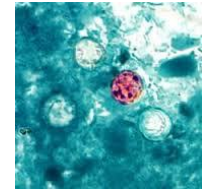


Bacteria: Vibrio Species & Legionella

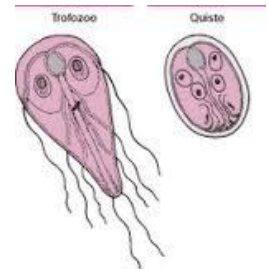
- **Vibrio** is strongly influenced by climate-both fresh and marine waters
- **V. Cholera** causes estimated 3-5 million cases and 100,000-120,000 deaths yearly world-wide. Young children in endemic areas most affected.
- Virulent V. parahaemolyticus strain found in Maryland shellfish & Alaskan oysters in Price William Sound (furthest north) -big public health concern.
- Climate warming can increase pathogen development and survival rates, disease transmission and host vulnerability.
- **Legionella** (Legionnaire's Disease)-respiratory illness transmitted solely by water. Warm water and perhaps other factors, like association with amoebas, influence the potential to colonize water systems.



Parasitic Disease



- **Cryptosporidium**-2,000-3,000 cases annually in the U.S.- through livestock waste & contaminated water
- Cryptosporidium oocysts detected in 65% to 97% of surface waters tested in the U.S.
- Common disinfectants, like chlorination is ineffective
- 1993 outbreak in Milwaukee was the largest outbreak ever documented in the U.S. with 400,000 cases and 100 deaths.
- In 1997, 2,566 cases were reported from 45 states
- **Giardia lamblia**-second most common parasite in the U.S.
- Cyst found in raw surface water from animal and human feces
- 39% of filtered drinking water found Giardia (17%) and Crypto (27%)
- **Cyclospora**-often associated with fresh produce from contaminated water-Big outbreak in 2013 from salad bar/cilantro in TX, NE and IA.

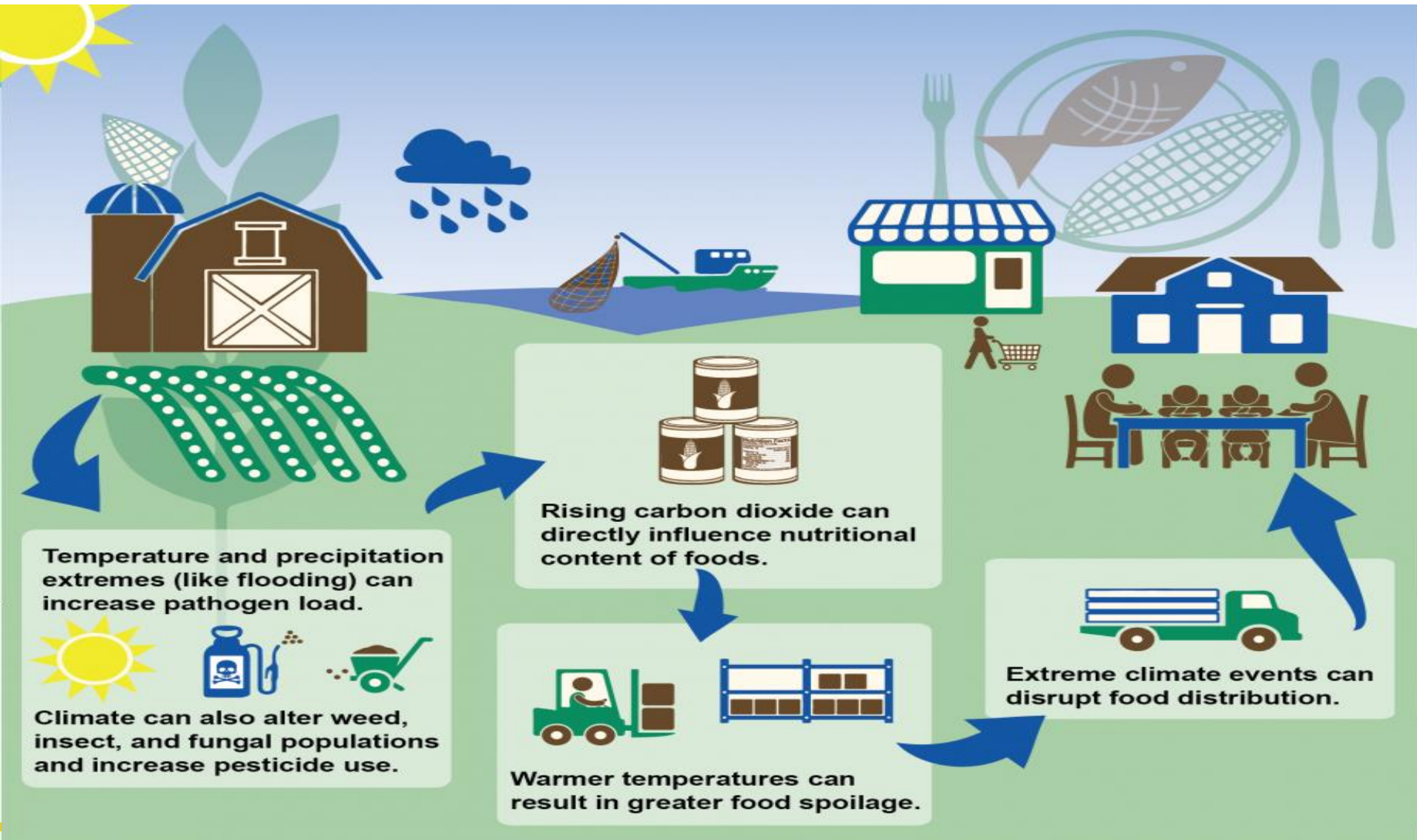


Viruses

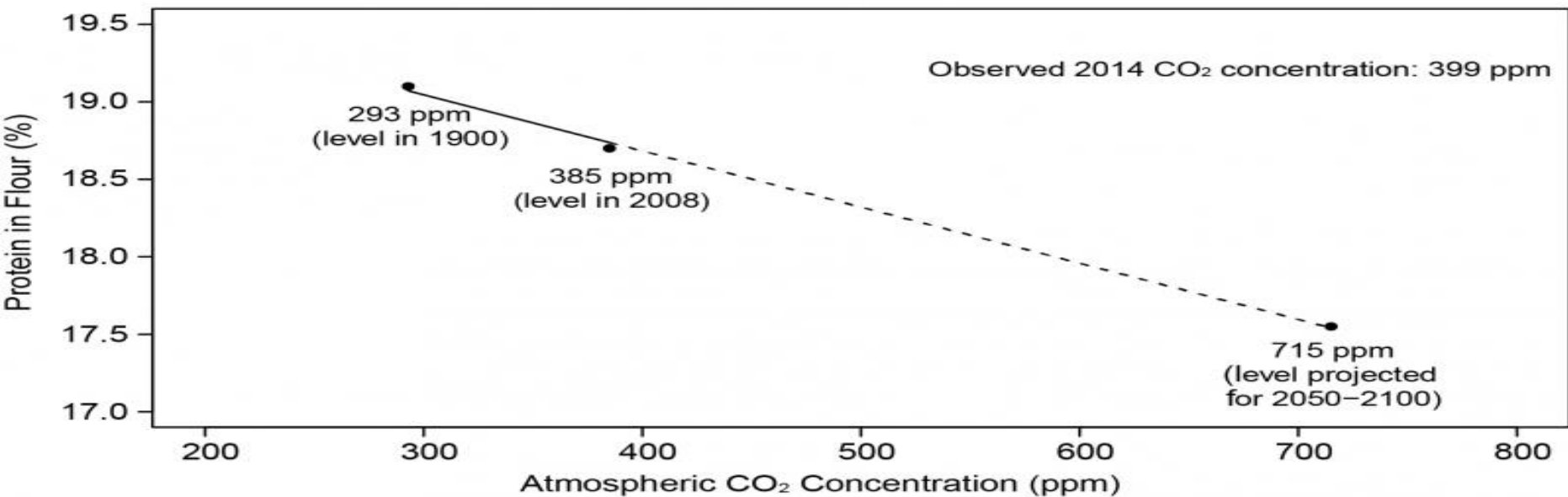
- **Viruses** are heat resistant and likely to survive sewer treatment processes. Viruses found in shellfish contaminated with wastewater and fecal sources.
 - Hepatitis A
 - Noro virus
 - Norwalk virus

Food Security

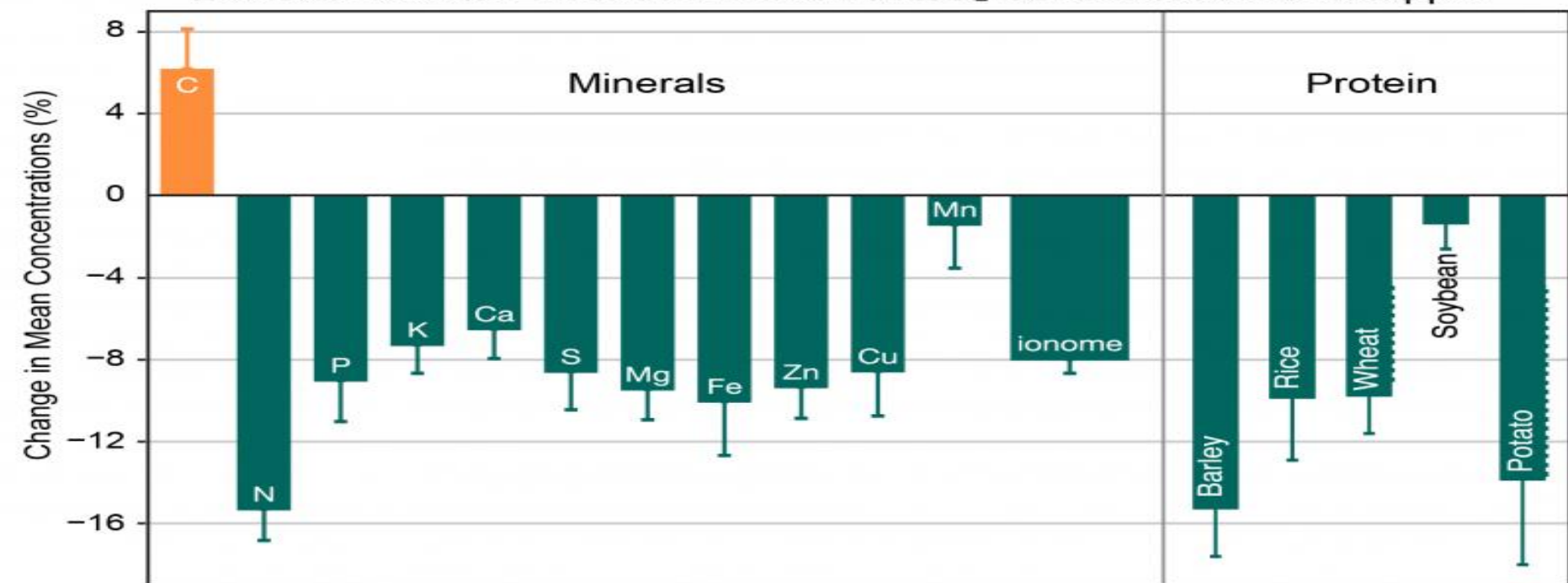
Food Security



Protein Content in Wheat Flour



Concentration of Essential Minerals at CO₂ Concentration of 689 ppm



PROTEIN SCORECARD

What you put on your plate has a large impact on the environment. Research by WRI and its partners shows that meat and dairy are generally more resource-intensive to produce than plant-based foods, increasing pressure on land, water and the climate. Small dietary shifts—such as switching from beef to pork, or poultry to beans—can significantly reduce agricultural resource use and greenhouse gas (GHG) emissions. Use this scorecard to lower your diet's impacts in a way that works for you.

Read more at wri.org/shiftingdiets

join the conversation [#ShiftingDiets](https://twitter.com/ShiftingDiets)

	FOOD	IMPACT (GHG emissions per gram of protein)	COST (Retail price per gram of protein)
LOW	Wheat		\$
	Corn		\$
	Beans, chickpeas, lentils		\$
	Rice		\$
	Fish		\$\$\$
	Soy		\$
	Nuts		\$\$\$
	Eggs		\$\$
MEDIUM	Poultry		\$\$
	Pork		\$\$
	Dairy (milk, cheese)		\$\$
HIGH	Beef		\$\$\$
	Lamb & goat		\$\$\$

Lighter shade shows emissions from agricultural production, darker shade shows emissions from land-use change.

How Much Protein Do You Need?

The average daily adult protein requirement is **56g** for a man and **46g** for a woman but many people consume much more than they need.

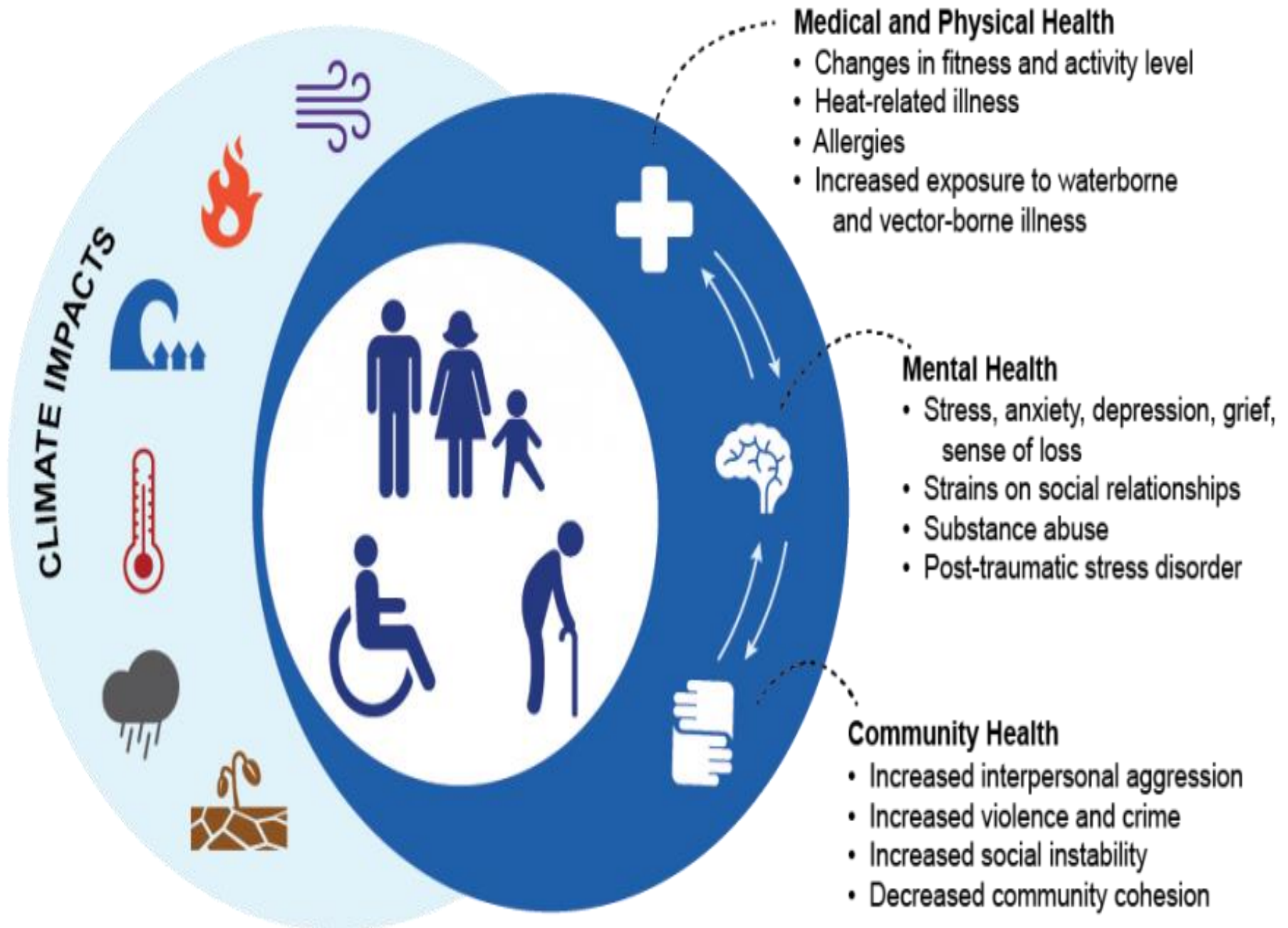


Sources: GlobAgri-WRR model developed by CIRAD, Princeton University, INRA, and WRI (GHG data);

Compromised Food and Water security

- Increased crop losses from diseases such as fungi, bacteria and viruses
- Decreased nutrient content in iron , zinc and protein.
- Global climate change will decrease food production by 2% per year in the face of a 14% per year increase in demand.
- 6% decline in global wheat yield and 10% rice for 1 C rise in temperature.
- Reduced water supply from droughts with 100 million people in areas of water shortage.

Mental and Emotional Effects



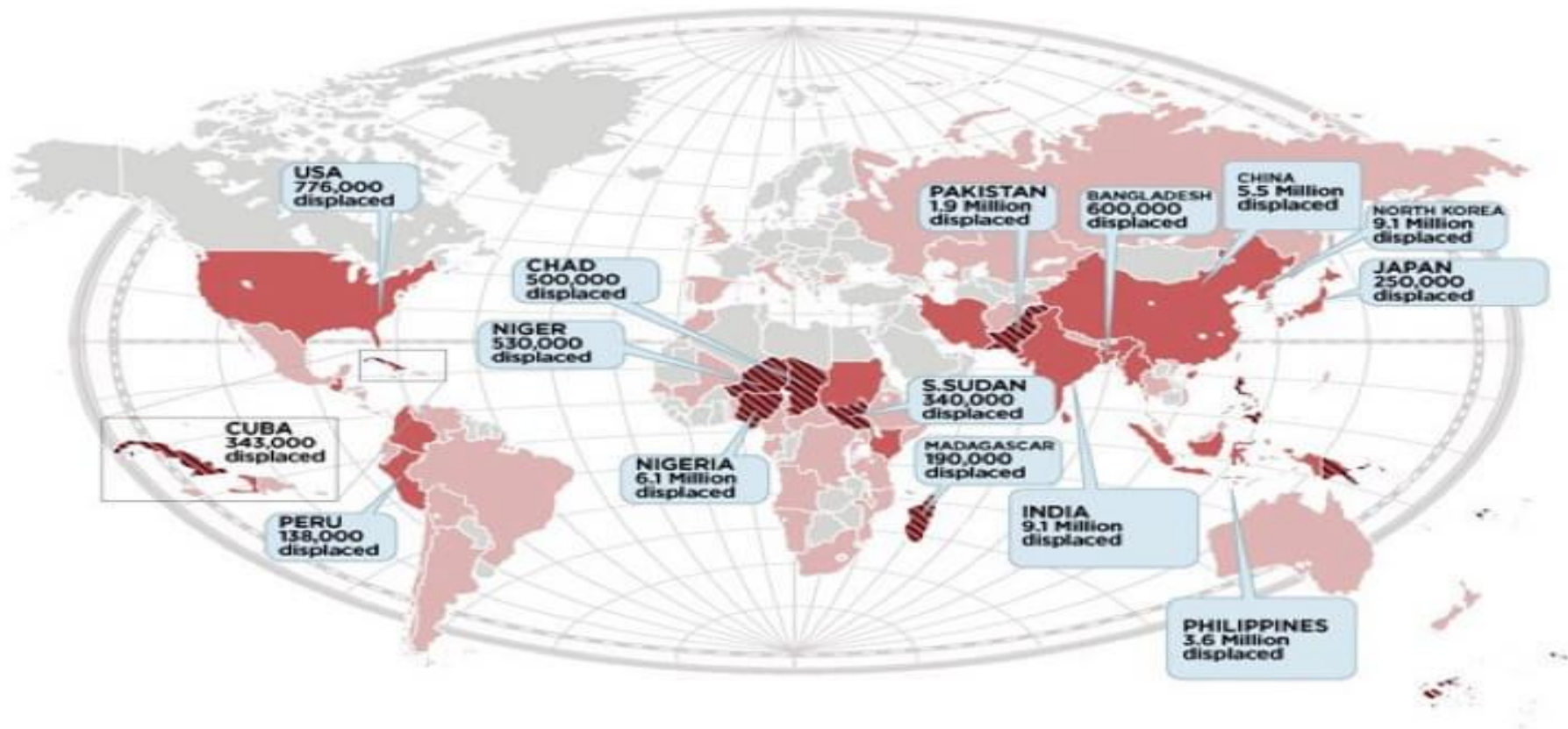
Effects of Hurricane Katrina

49% developed an anxiety or mood disorder
1 in 6 developed posttraumatic stress disorder



Mass Migration

IN 2012, EXTREME WEATHER DROVE
MORE THAN 32 MILLION PEOPLE
FROM THEIR HOMES



98% OF CLIMATE REFUGEES WERE FROM DEVELOPING COUNTRIES.

Mass Migration

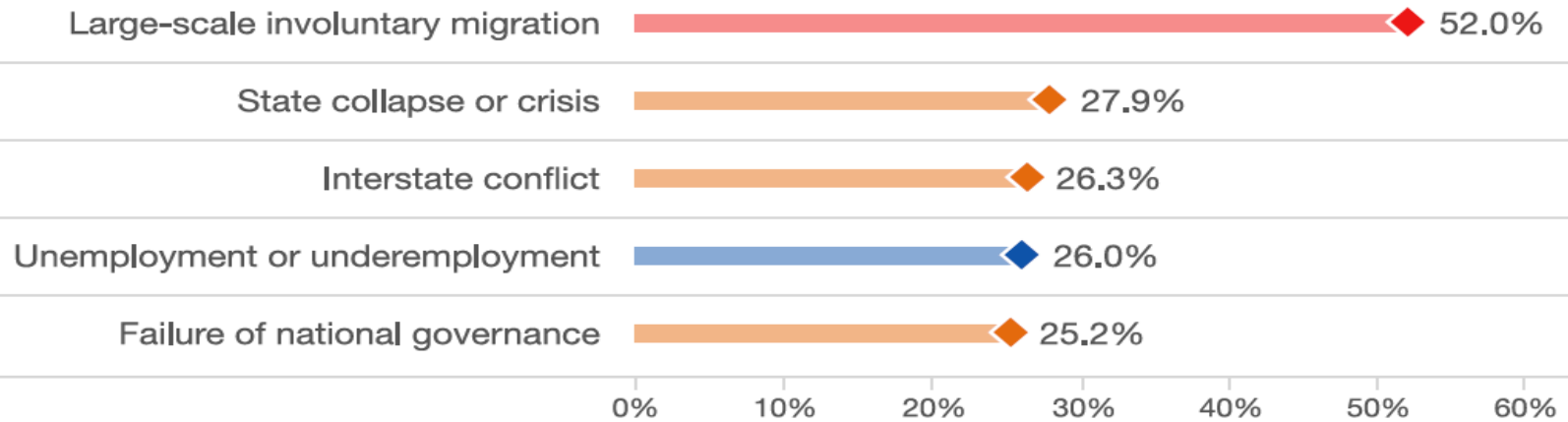
Over one billion people will need to migrate within 21st century due rising sea level. 200 million between 2008 and 2017



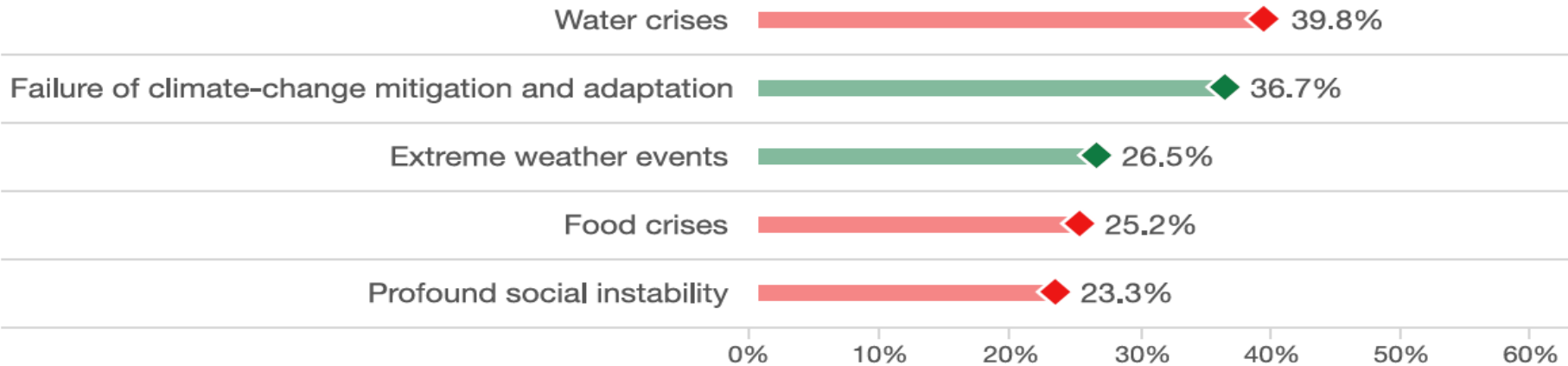
The Global Risks of Highest Concern, 2016

Percent of participants mentioning the respective risk to be of high concern for the time frame of 18 months or 10 years, respectively. Participants could name up to five risks in each time frame. In each category, the risks are sorted by the total sum of mentions.

For the next 18 months

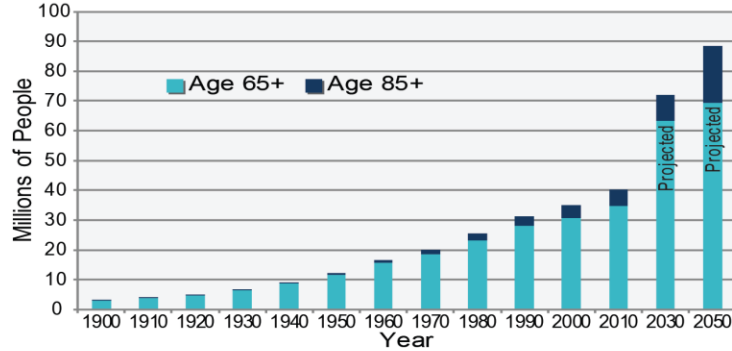


For the next 10 years

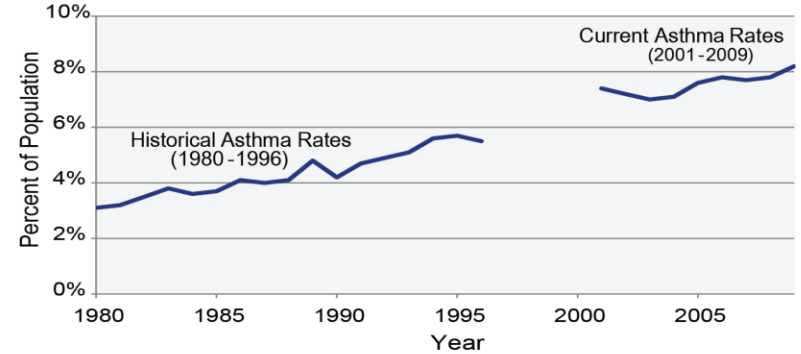


Elements of Vulnerability to Climate Change

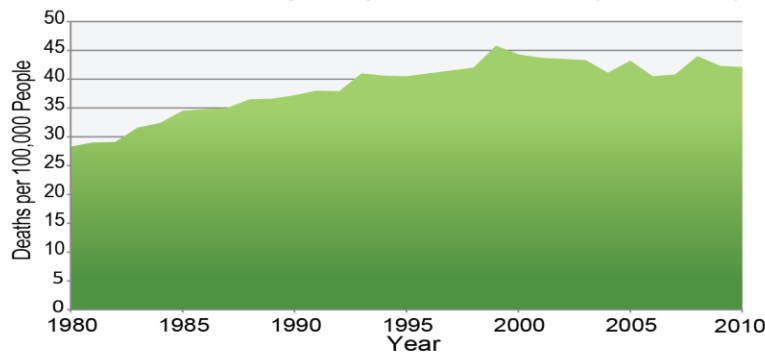
Aging Population in the U.S.



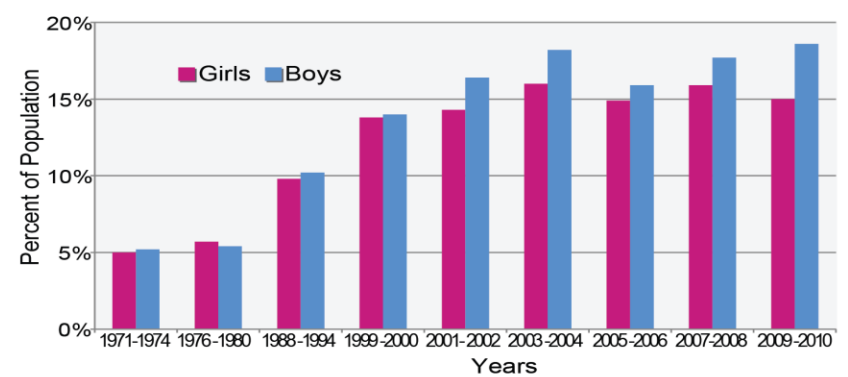
U.S. Asthma Rates (1980-2009)



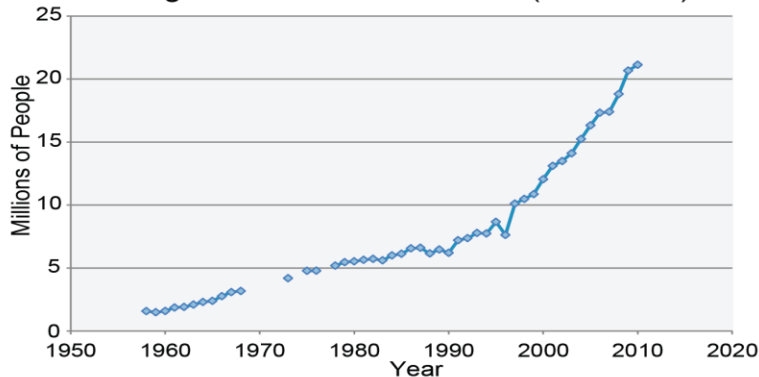
U.S. Chronic Respiratory Disease Deaths (1980-2010)



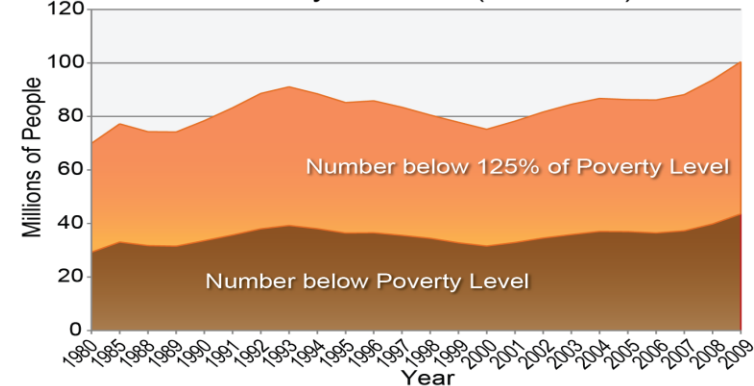
U.S. Obesity Rates in Children and Adolescents (1971-2010)



Diagnosed Diabetes in the U.S. (1958-2010)



Poverty in the U.S. (1980-2009)



Note: only 4 years of data available in 1980s

WHO predicts 250,000 deaths per year from 2030-2050

- Malaria
- Dengue
- Diarrheal disease
- Heat stress
- Under nutrition
- Heaviest Burden:
 - Children, women, older people, the poor, individuals of color, disabilities, diabetes, obesity, respiratory diseases

The Biggest Health Opportunity of the 21st Century

Health Opportunity/Lost

- From 1979-1997 the world came close to an agreement to curb global carbon emissions.
- There has been no fundamental breakthrough in climate physics since 1979.
- In 1979 the World Climate Conference in Geneva, a seven nation agreement to curb carbon emissions.
- In 1989 a meeting in the Netherlands called for a binding treaty. None was signed.
- In 1997 in Kyoto an international treaty was

Solutions

Paris Accord 2015



GCC Agreement

- United Nations Framework Convention on Climate Change in 2015 adopted the Paris Agreement of the Conference of Parties.
- Keep global temperature rise to less than two degrees and preferably 1.5 degrees Celsius.
- The agreement states: “parties should promote their obligations on the right to health when addressing global climate change”
- WHO agreement includes reporting to WHO/UNFCCC on sustainable development goals

**There is hope and there
is movement!**

The Health Care Industry is One of the Largest Consumers of Energy

- “If the health sector were a country, it would be the [fifth-largest emitter on the planet.](#)”
- U.S. health sector spends over [\\$9 billion](#) annually on energy costs
- . Hospitals in the United States produce a massive amount of garbage/waste (>2.3 million tons per year
- “30% cut in healthcare electricity’s carbon pollution by 2030 would reduce greenhouse gas emissions, preventing an estimated 4,130 premature deaths, 85,000 asthma attacks, 4 million respiratory symptom events and 3,750 hospital visit incidents and save about \$1.2 billion in medical costs.” – [Health Care Climate Council](#)



Case Study: Boston Green Ribbon Commission Health Care Working Group

- 22 Boston-area hospitals participate. Commission's goal is 25% drop in GHG emissions by 2020, 80% by 2050
- Member hospitals achieved cuts in electricity, natural gas use, GHG reductions for all fuels.
- Sector energy use dropped by 6% from 2011-2013, "equal to eliminating GHG impact of an average car traveling over 85 million miles."
- Mass General cut GHG emissions by 35% in 2014, Boston Medical on track for a 45% cut in 2020, Brigham & Women's will reach 35% in 2020.
- **"Cost savings are conservatively estimated at \$11.9 million, enough to pay for healthcare for 1055 Massachusetts Medicare enrollees."**
(1)



How Can You Help “Green” Your Facility?

(Source: [Health Care without Harm](#))

- Energy efficient lighting
- Recycle and purchase recycled products
- Electric car charge station
- Clean energy sources (wind and solar)
- Environmentally sustainable building materials and construction.
- Reduce fleet emissions
- Waste conservation and disposal
- Green Building (LEED or Energy Star Programs)



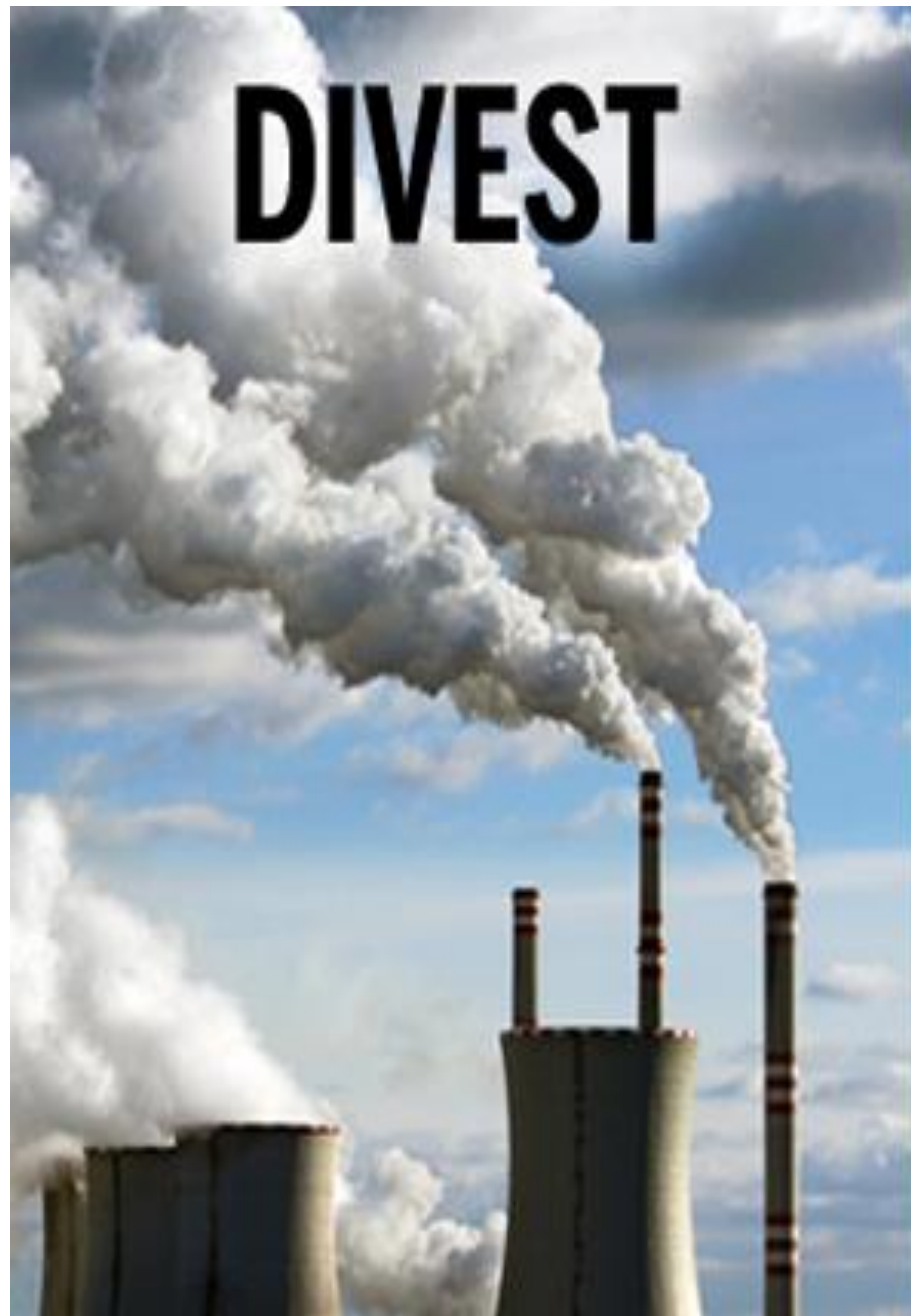
Public Health Initiatives

- Heat Wave warning systems
 - Awareness of community based resources such as the CDC, EPA, WHO and U.S. Department of Homeland Security.
- Disaster Preparedness Guidelines for patients with chronic disease.
- Early evacuation, medical supplies and equipment

Personal Initiatives

- Commuting less
- Electric Cars
- Walking/Biking
- Healthy foods, less meat, local food
- Limiting air travel
- No water bottles
- Plant a Tree

DIVEST



INVEST



**Solar Panel factories a 3 billion dollar per year
and 3 million employees industry**

