

Public Health Heats Up:

The Impacts of Climate Disruption on the Risk of Infectious Diseases

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BEWARE
CLIMATE
CHANGE

WHEN?



Frogs: Global Warming's First Victims

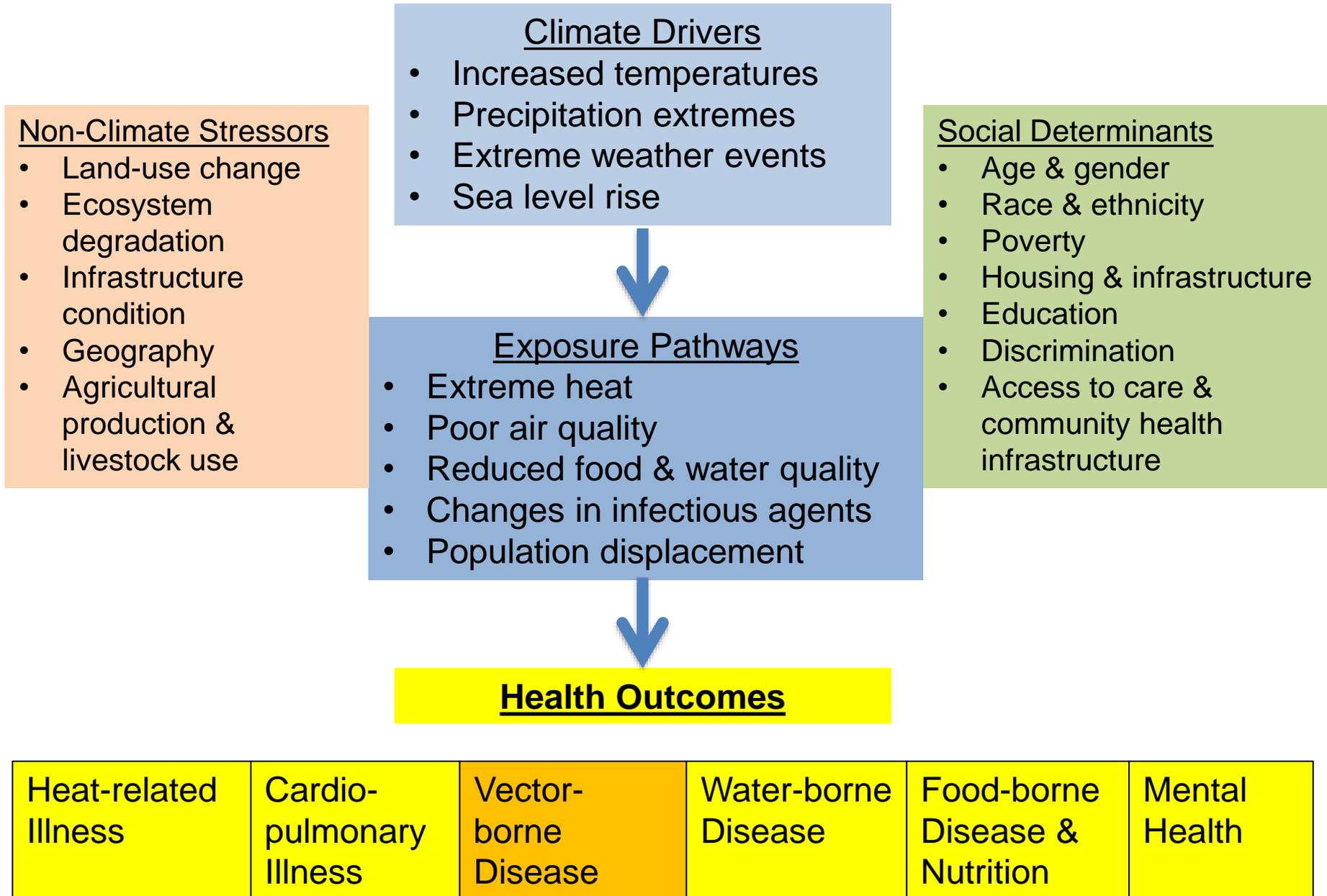


Changes in climate have been associated with:

- Population declines in Costa Rica
- Breeding phenology in Great Britain
- Physiological changes in female toads, leading to increased female mortality rates and decreased fecundity in survivors

- Widespread amphibian extinctions
- Temperatures at many highland localities shifting towards the growth optimum of fatal fungus, chytrid *Batrachochytrium dendrobatidis*
- Unusual climatic conditions can alter development and increase frog susceptibility to various pathogens.
- Environmental stressors that can cause declines include loss of habitat, disease, pollutants, climate change

Climate Change and Health



The Impact of Climatic Factors on Vectorborne Zoonotic Diseases

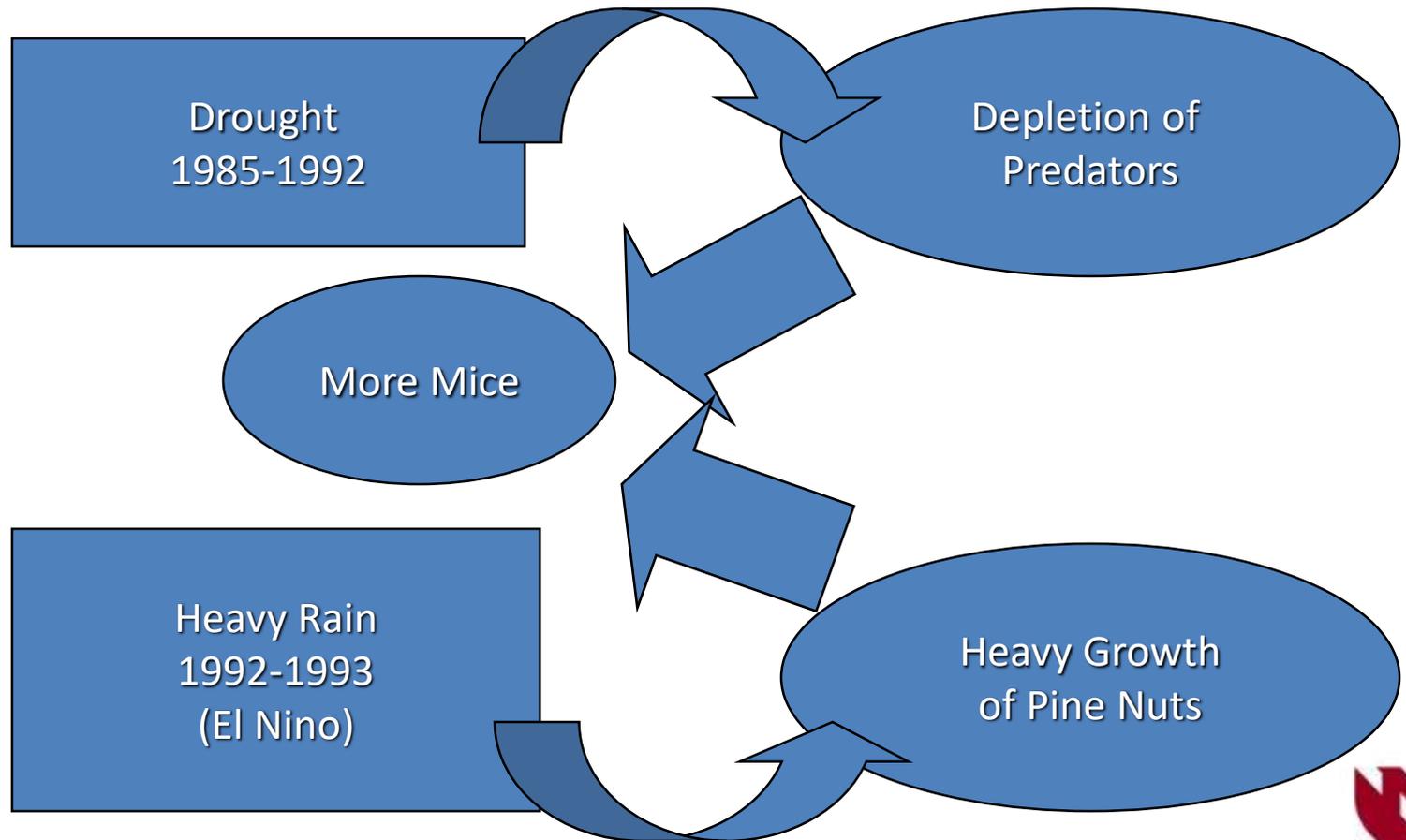
- Climatic factors (e.g., temperature, moisture) affect the distribution and abundance of vectors and vector-borne pathogens
- Climatic factors affect disease transmission efficiency (vector competence)
- Climatic variables and perturbations can affect disease occurrence patterns



Climate Change Infectious Disease Consequences

Category	Examples	Rationale
Vector-Borne	Malaria, Dengue, WNV, RVF, TBE, Lyme, Zika	Vector Distribution
Water-Associated	Cholera, Crypto, Lepto	Flood Runoff, Water Temperature
Foodborne	Salmonella, E. coli	Sanitation Issues
Airborne	Q-Fever, Meningococcus	Higher Relative Humidity
Soil-Associated	Anthrax, Clostridia	Temp, RH, Moisture
Rodent-Borne	Lassa, Hantavirus	
Multistage Parasites	Fascioliasis	Intermediate Hosts

Ecology of HPS



Droughts

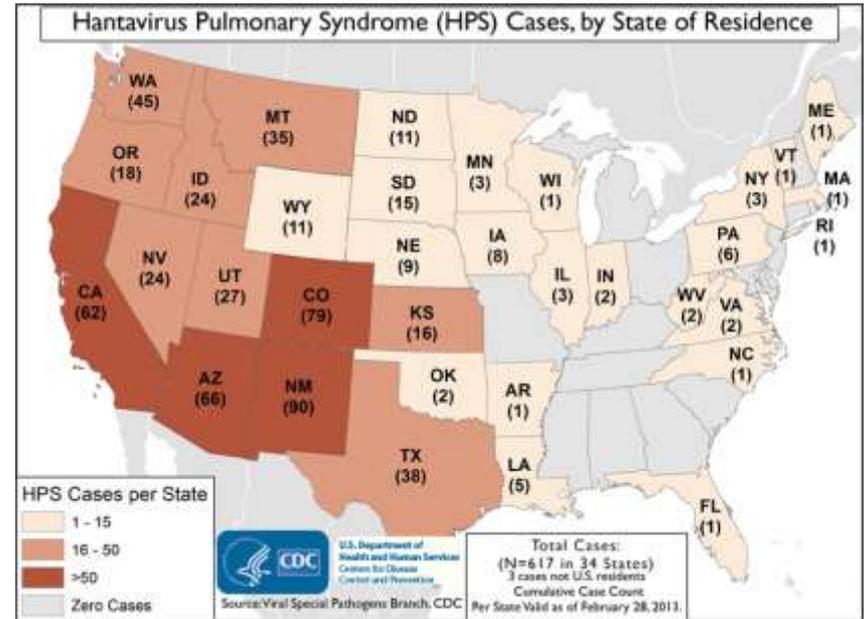
Reducing water quantity can reduce water quality from increased pollutant concentration, stagnation, and higher temperatures than can encourage pathogen growth.

Drought has also increased the incidence of West Nile virus disease.

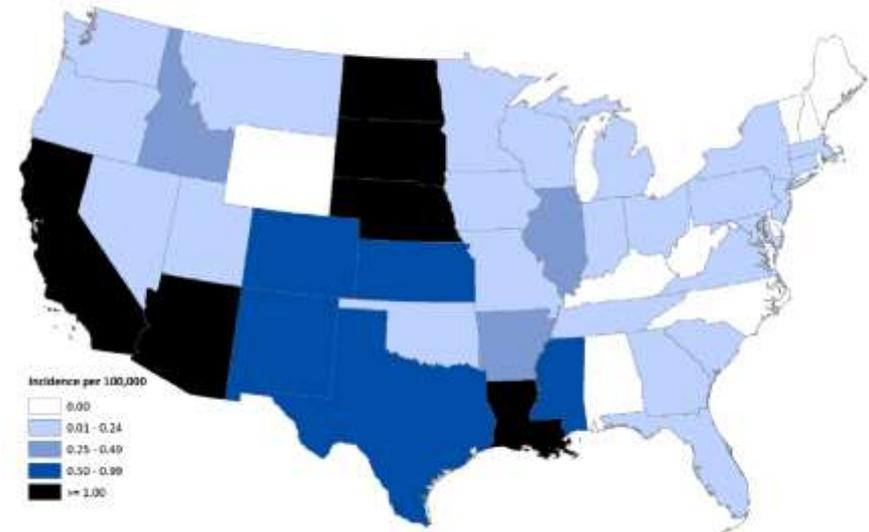
- During droughts mosquitoes find the remaining water sources and transmit the virus to other species

Droughts followed by periods of heavy rainfall have been associated with an increase in rodent populations

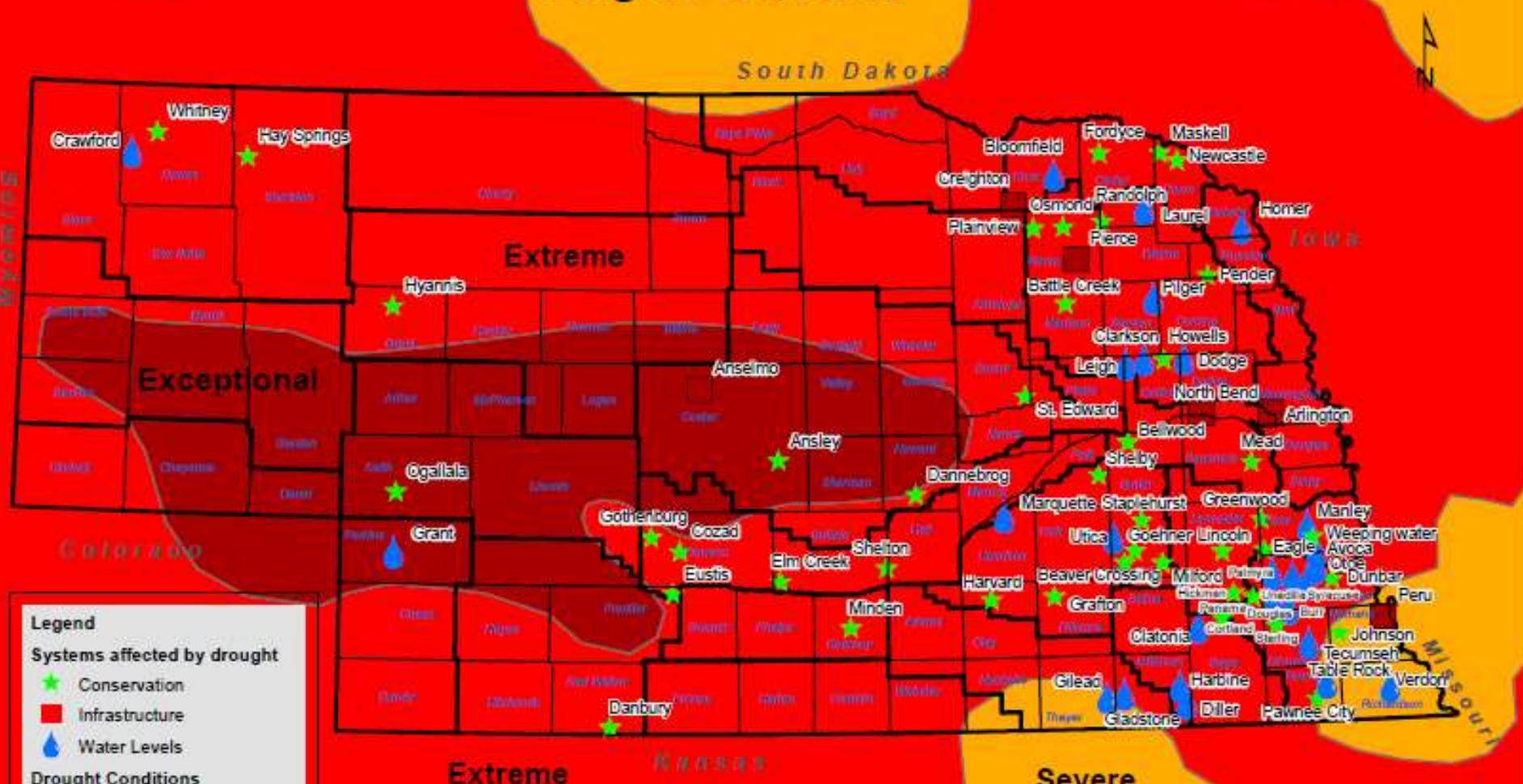
- Could potentially increase prevalence of hantavirus



West Nile virus neuroinvasive disease incidence reported to ArboNET, by state, United States, 2014



Drought Map of Nebraska August 31, 2012



Legend

Systems affected by drought

- ★ Conservation
- Infrastructure
- 💧 Water Levels

Drought Conditions

- Abnormally Dry
- Moderate Drought
- Severe Drought
- Extreme Drought
- Exceptional
- Normal Conditions
- Natural Resource Districts



Data Source:
National Drought Mitigation Center
University of Nebraska-Lincoln

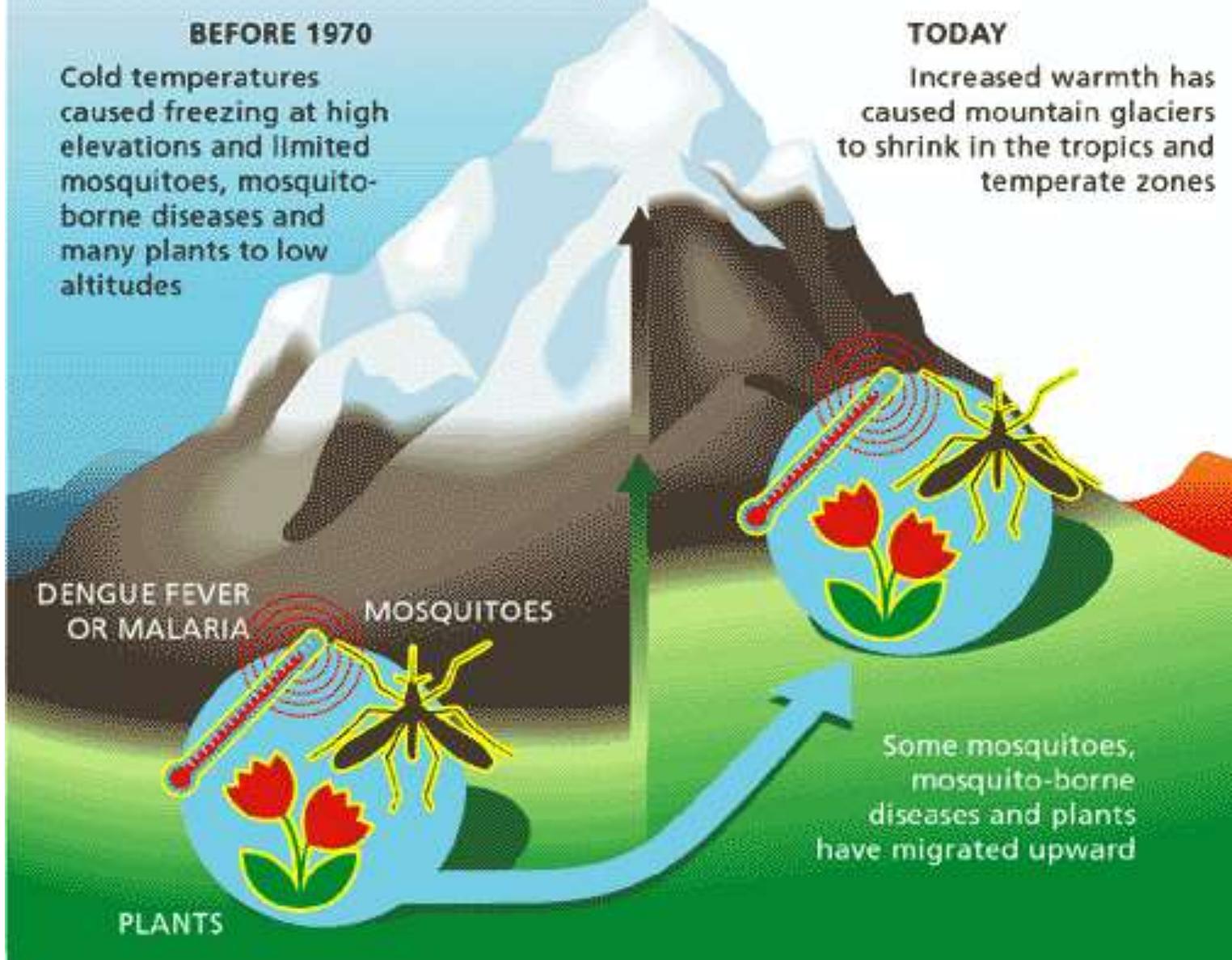
Map created by DHHS GIS BIT

BEFORE 1970

Cold temperatures caused freezing at high elevations and limited mosquitoes, mosquito-borne diseases and many plants to low altitudes

TODAY

Increased warmth has caused mountain glaciers to shrink in the tropics and temperate zones



DENGUE FEVER
OR MALARIA

MOSQUITOES

PLANTS

Some mosquitoes,
mosquito-borne
diseases and plants
have migrated upward

HEALTH PROFESSIONALS AND SCIENTISTS WARN OF SPREADING INFECTIOUS DISEASES.

Global Warming's **greatest** threat may also be the **smallest.**



Nebraska Medicine



Aedes in the USA

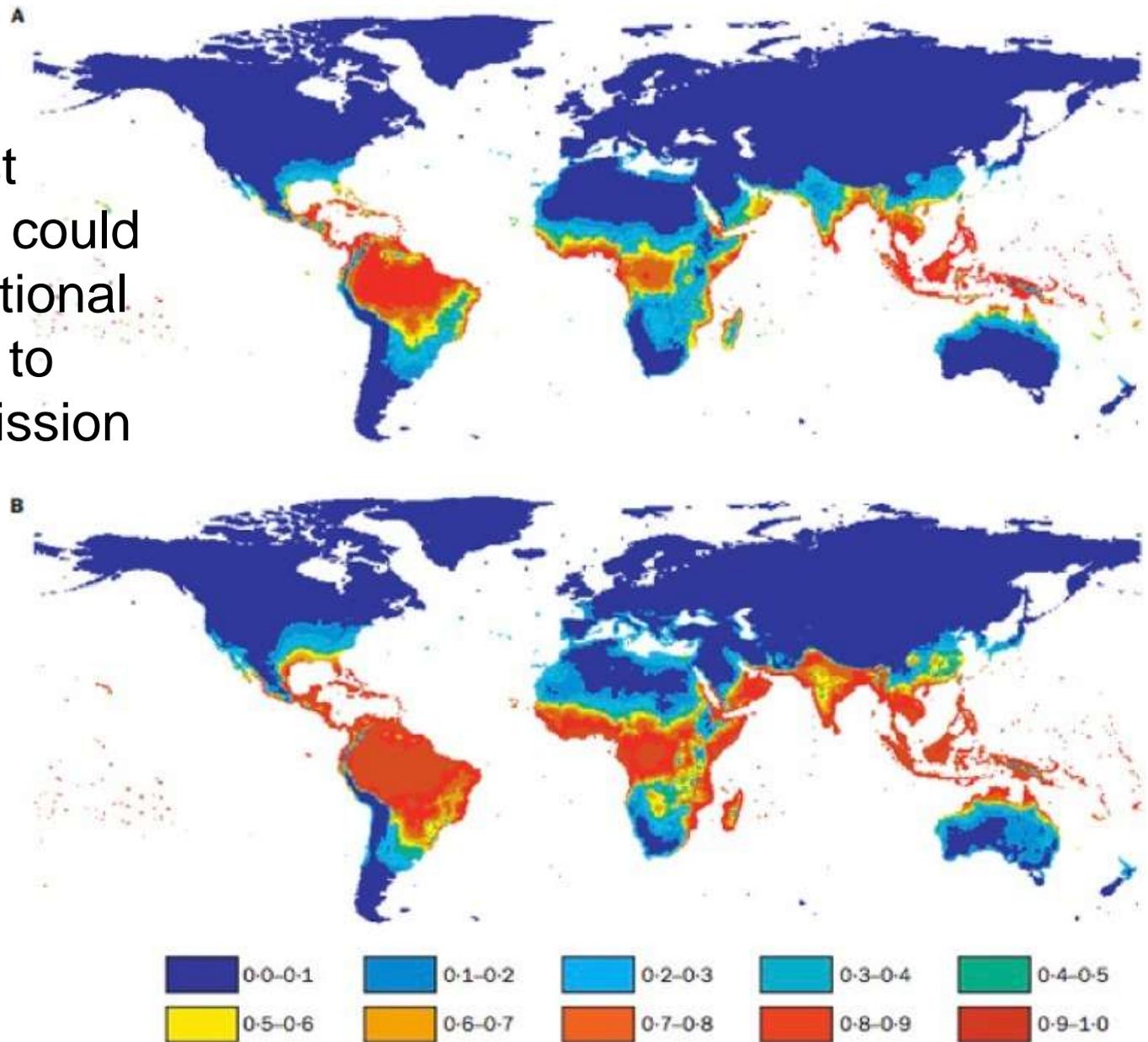
Approximate distribution of *Aedes aegypti* in the United States*



Approximate distribution of *Aedes albopictus* in the United States*



Studies suggest climate change could expose an additional 2 billion people to dengue transmission by 2080.



Source: WHO.
<http://www.who.int/mediacentre/factsheets/fs266/en/>

Estimated Population at Risk for Dengue Fever in 1990 (A) and 2085 (B) Based on Climate Data from 1961 to 1990

Dr. Simon Hales (<http://image2.thelancet.com/extras/01art11175web.pdf>)/The Lancet

How does climate effect Malaria?

Plasmodium species grow faster at higher temperatures (optimal between 27-30° C).

Vectorial capacity of mosquitoes increases as temperature increases (optimal temperature between 22-30° C).

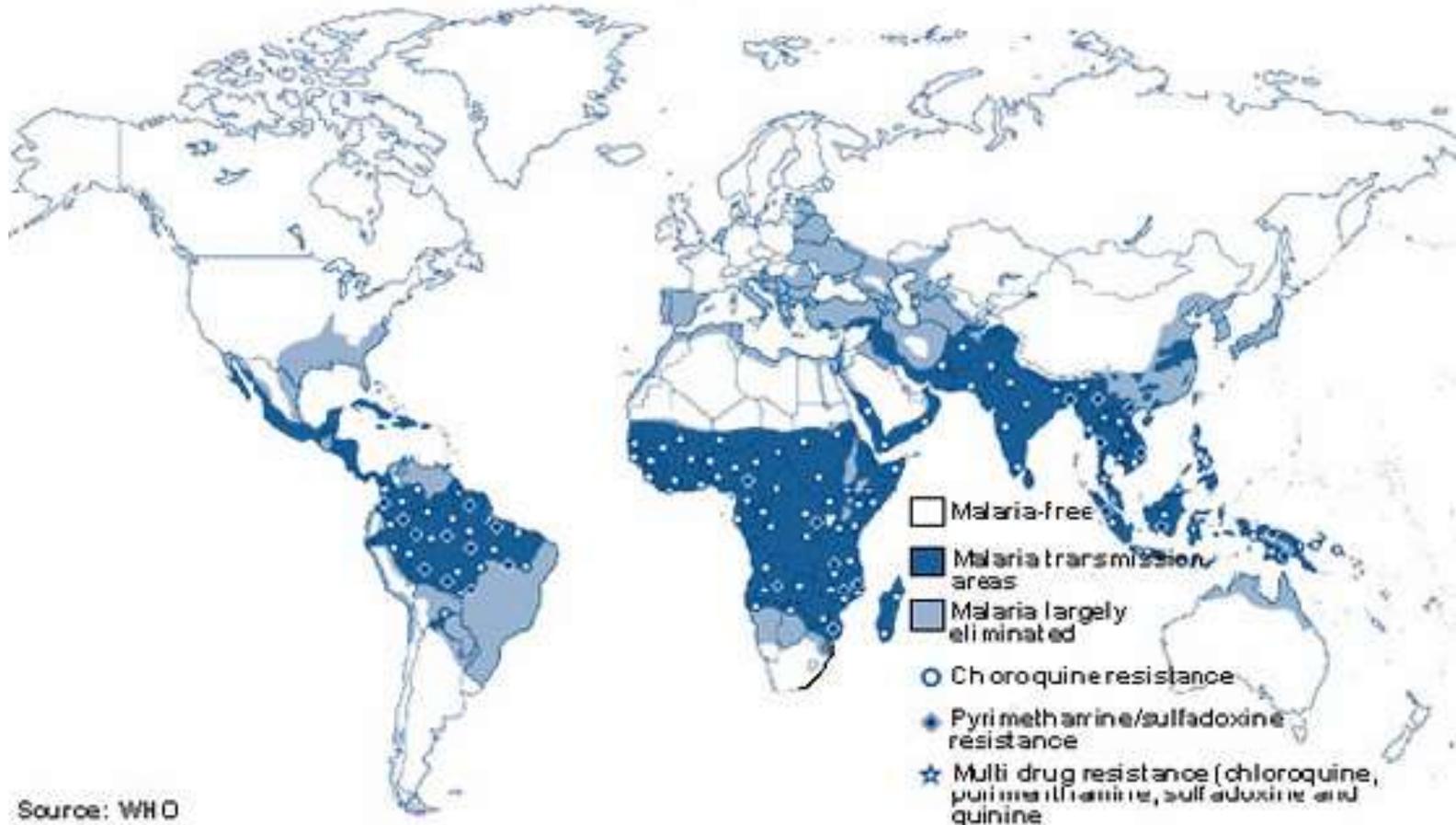
Mosquito lifespan increases with higher temperatures

Females increase blood meal frequency at higher temperatures.

Aquatic life cycle of mosquitoes reduced from 20 to 7 days.

The Intergovernmental Panel on Climate Change (IPCC) predicts that the global population at risk for malaria will increase by 220-400 million in the next century.

Malaria - key affected areas



Source: WHO

Is there any Good News?

Clinical
Infectious
Diseases



HIVSA
hivmo

BRIEF REPORT

Climate Change and the End of the Respiratory Syncytial Virus Season

Gavin Christopher Donaldson

Academic Unit of Respiratory Medicine, University College London, Royal Free and University College Medical School, London, United Kingdom

The seasons associated with laboratory isolation of respiratory syncytial virus (RSV) (for 1981–2004) and RSV-related emergency department admissions (for 1990–2004) ended 3.1 and 2.5 weeks earlier, respectively, per 1°C increase in annual central England temperature ($P = .002$ and $.043$, respectively). Climate change may be shortening the RSV season.

ning of the school year has been ruled out as a trigger of the RSV season onset, and it is unclear whether atmospheric pollution has had an influence on the onset of epidemics of RSV infection [4, 5]

Epidemiological evidence of a link between RSV and temperature is also controversial: 2 studies reported an inverse association between temperature and RSV-related hospital admissions [4, 6]. However, 2 other studies did not find a close relationship between temperature and the season's onset [7, 8]. The strongest argument against the suggestion of a causal link with temperature is that epidemics of RSV infection occur in tropical regions, where temperatures are higher when these epidemics occur (which is normally in the rainy season) [9]. However, in the United Kingdom and Scandinavia, no link has been found between RSV season and humidity or rainfall [4, 7].



New Disease Emerge; Old Diseases Expand: Changes in Lyme Disease Case Distribution, US

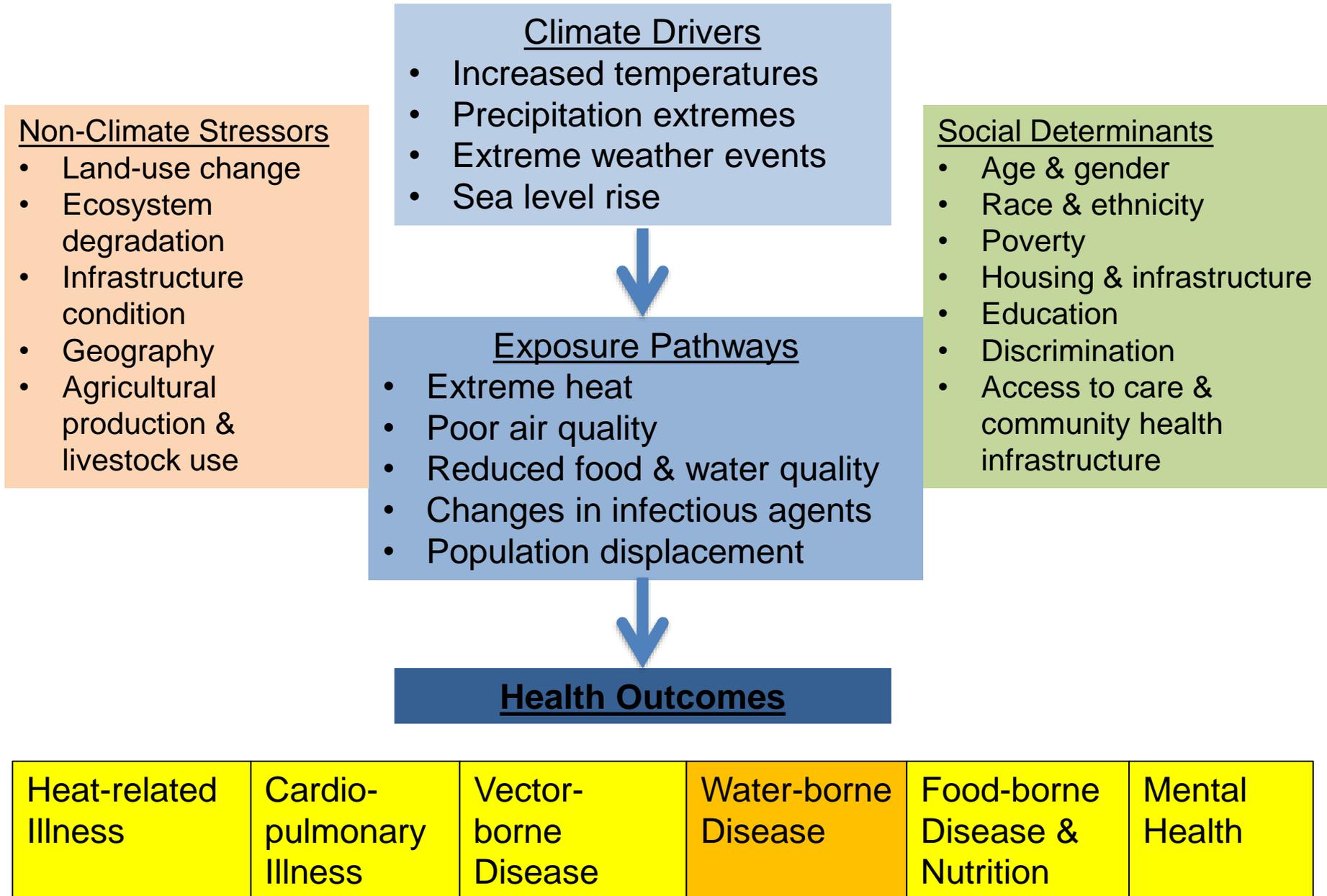
2001



2013



Climate Change and Health



Hydrologic Extremes and Waterborne Disease

Milwaukee 1993:

- Cryptosporidiosis epidemic
- 405,000 cases, 54 deaths
- Preceded by heaviest rainfall in 50 years (Curriero et al., 2001)
- \$31.7M in medical costs
- \$64.6M in lost productivity

Corso et al., 2003



Heavy Downpours Are Increasing Exposure to Disease



Climate change increases heavy downpours.

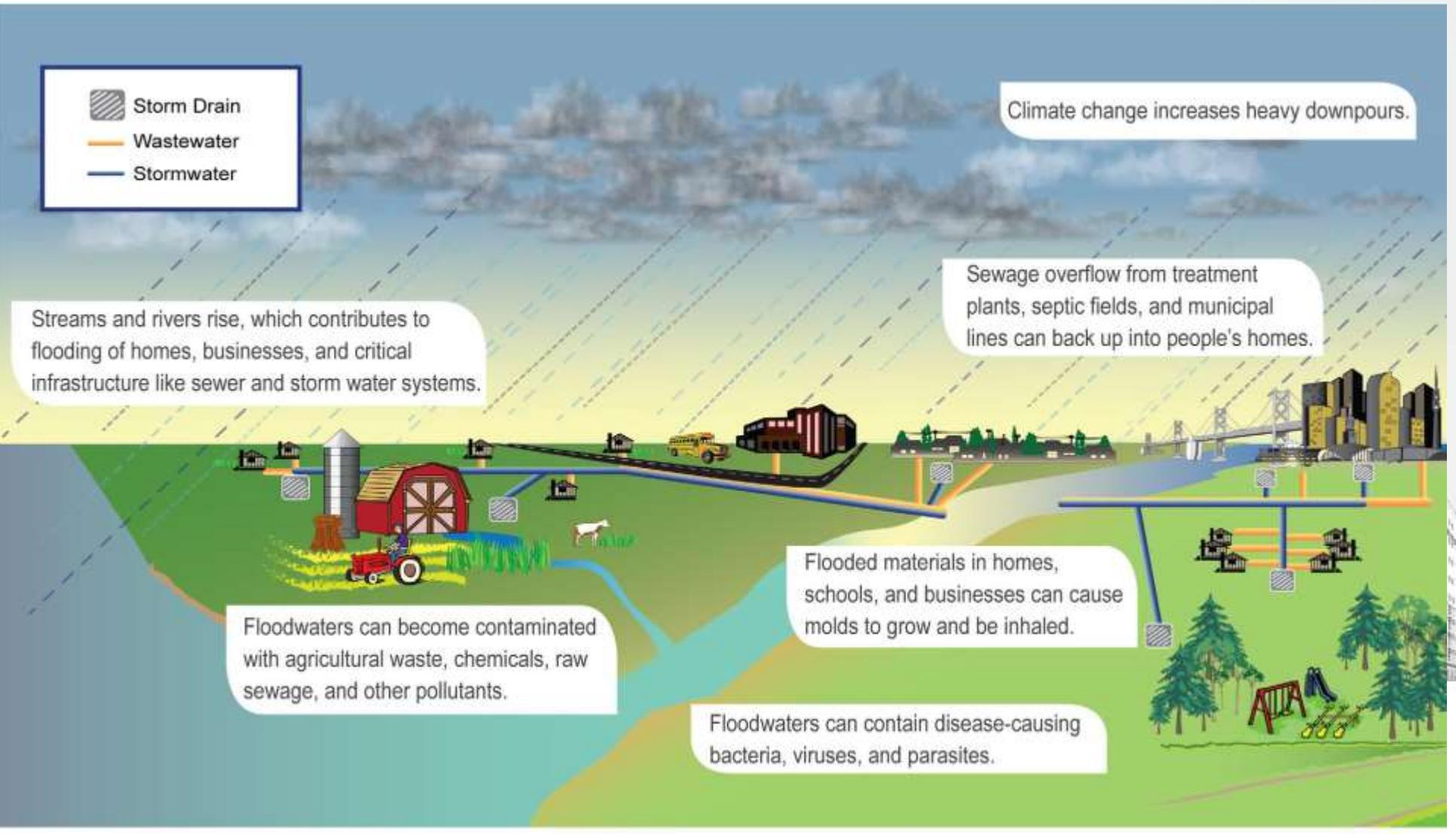
Streams and rivers rise, which contributes to flooding of homes, businesses, and critical infrastructure like sewer and storm water systems.

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

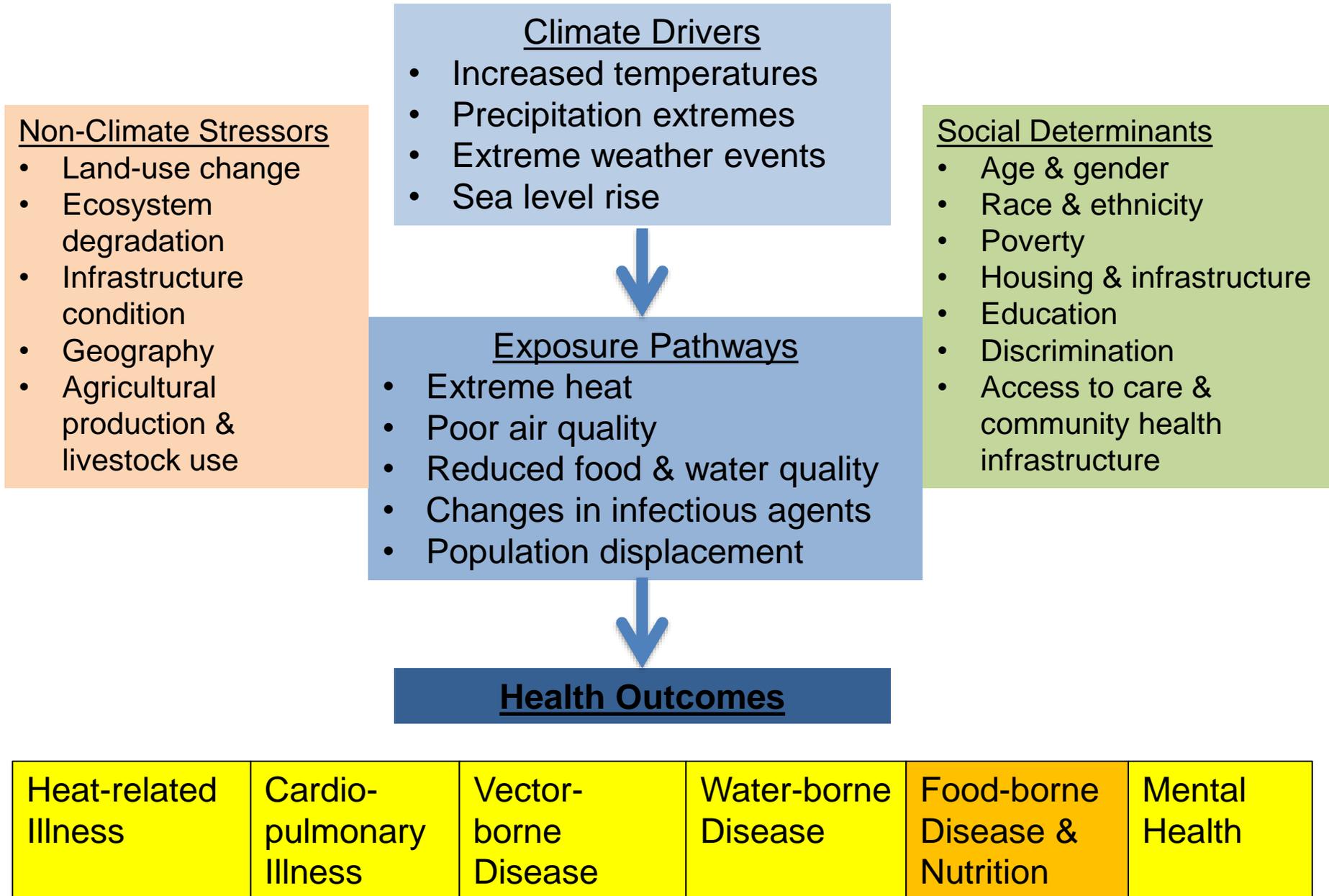
Floodwaters can become contaminated with agricultural waste, chemicals, raw sewage, and other pollutants.

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

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



Climate Change and Health



Rising Temperatures Can Decrease Food Safety

Rising temperatures and changes weather extremes is expected to intensify pathogen and toxin exposure, increasing the risk and incidence of foodborne illnesses.

Some pathogens thrive in warm, humid conditions

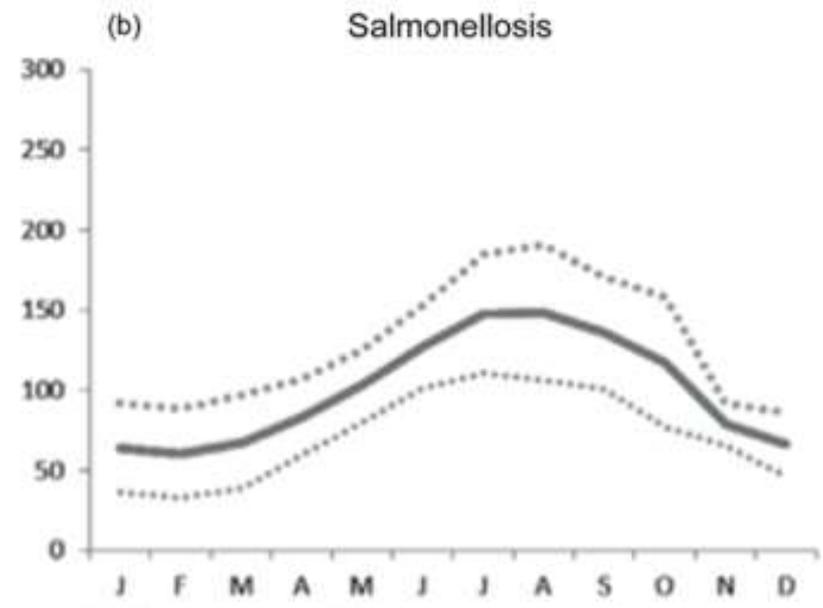
- *Salmonella*
- *Escherichia coli* (*E. coli*)
- *Campylobacter*

Foodborne illnesses peak in the summer

- Warmer weather
- Food preparation outdoors
- Leaving food outside at picnics and BBQs

Salmonella on raw chicken will double in number approximately every hour at 70°F, every 30 minutes at 80°F, and every 22 minutes at 90°F.

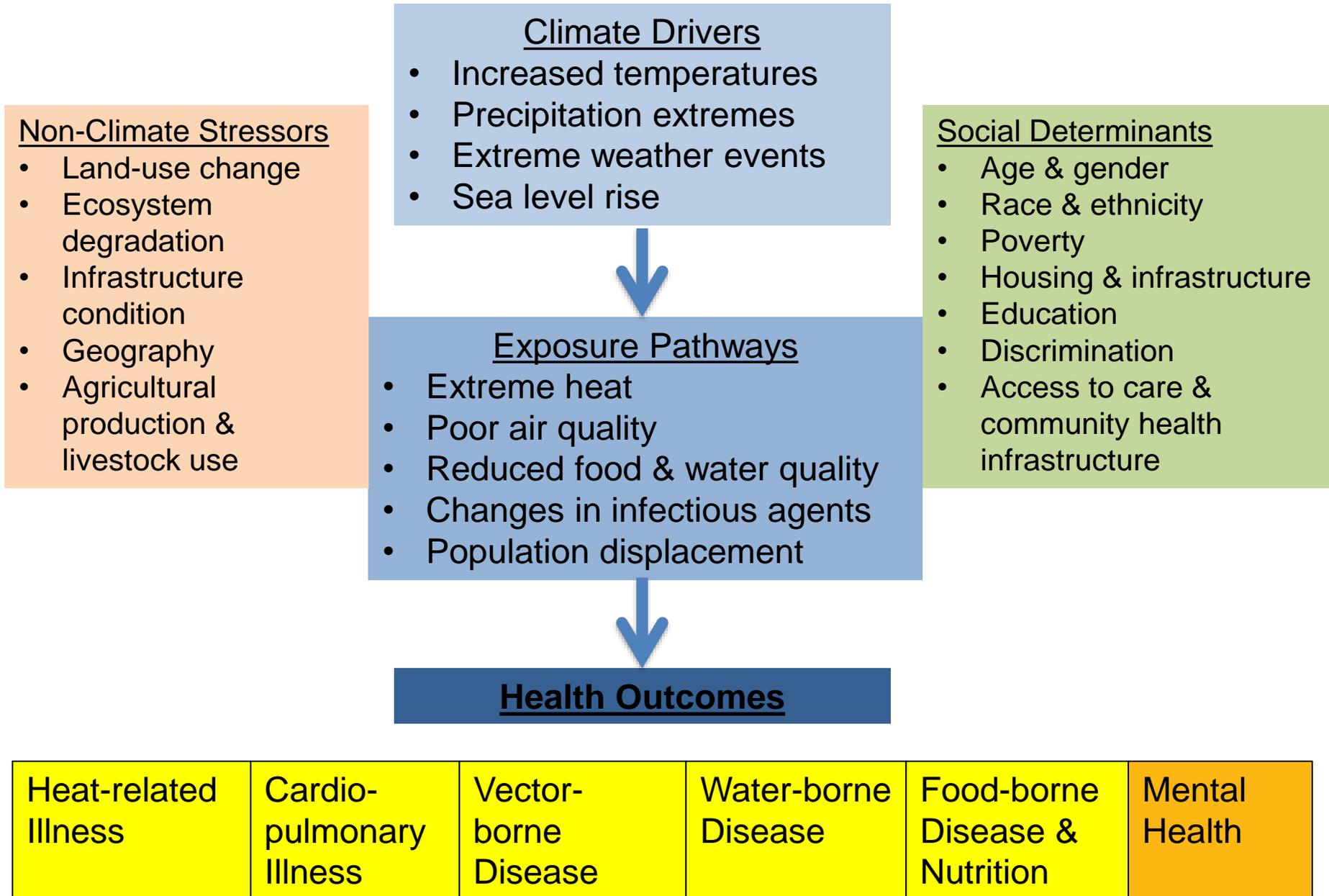
Seasonality of *Salmonella*



Sources:

1. Baranyi, J., and M. L. Tamplin, 2004: ComBase: a common database on microbial responses to food environments. *Journal of Food Protection*
2. Oscar, T., 2009: Predictive model for survival and growth of *Salmonella* Typhimurium DT104 on chicken skin during temperature abuse. *Journal of Food Protection*

Climate Change and Health

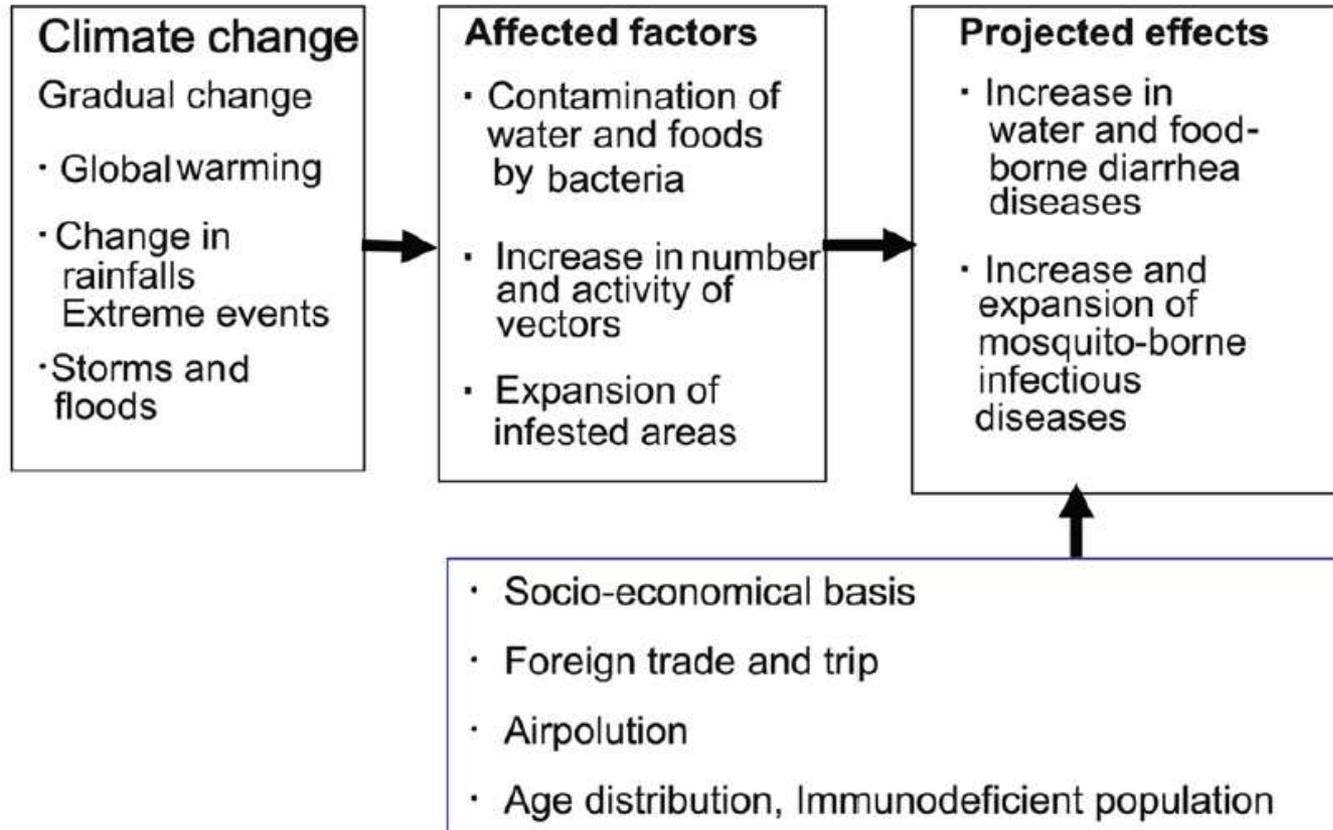


A 2°C Temperature Increase Can Make People Angrier



- Spikes in temperature and precipitation can increase the risk of personal violence and social upheaval
- While climate is not the sole or primary cause of violence, it undeniably exacerbates existing social and interpersonal tension in all societies, regardless of wealth or stability.

Summary





CLIMATE SUMMIT

WHAT IF IT'S
A BIG HOAX AND
WE CREATE A BETTER
WORLD FOR NOTHING?

- ENERGY INDEPENDENCE
- PRESERVE RAINFORESTS
- SUSTAINABILITY
- GREEN JOBS
- LIVABLE CITIES
- RENEWABLES
- CLEAN WATER, AIR
- HEALTHY CHILDREN
- etc. etc.





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