Climate change and health

CH Chen
“Environmental Hypotheses of Pliocene Human Evolution”
Scope

• Looks at how environmental change (Climate dynamics in particular) and human evolution coincided during Pliocene.

• Hominins: name of the taxonomy that humans, chimpanzees and their common ancestors come from.
Adaptive Environmental Hypotheses

1. The environment having no connection to evolutionary change, therefore, there may be evolutionary change even when the environment is not changing (stable).

2. Evolutionary change happens in small periods of time where the environment is changing in one direction.

3. Evolutionary change mainly happens when the environment is going through highly variable periods (changes back and forth)
Adaptive Environmental Hypotheses of Human Evolution

Environmental Hypotheses of Human Evolution

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Variable</td>
<td>Stable habitat</td>
<td>Progressive habitat change</td>
<td>More variable habitat</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Result of Adaptive Hypothesis

• Lineages (adaptations) now differ in their ability to endure environmental fluctuation.
Species Turnover Environmental Hypotheses

Turnover Hypotheses are hypotheses that deal with origination and extinction of multiple clades (biological taxa).

Hypotheses:

• It Happens quite quickly due to climatic change.

• It Happened gradually, constant turnover
Biogeographic Hypothesis

• Faunal Community formation as well as break up due to large climatic or tectonic events.
Adaptive Changes in Pliocene Hominins

1. Mobility: known due to changing limb proportions, object transport by toolmakers and biogeographic spread between regions.

2. Foraging: known by accumulation of flaked stone and hammers.

3. Diet: known by changing dental proportions, use of tools to access food from large animals.
Habitat of Hominins

• Different Hominins species lived quite differently, early in the Pliocene period hominins lived more in woodland and forest, later on a shift towards open vegetation.

• This change in habitat which effected their evolution was linked to climate.
Conclusions

• There are specific adaptations that can be associated with changes in environment even though it is hard to go from correlation to cause effect.

• Certain characteristics seen in Hominins are thought to be due to “Variability Selection” (Hypothesis C from before).

Variable Selection: adaptation evolved due to increased environmental variability.
Conclusions

Examples of Adaptations due to Environmental Variability:

• Earliest bipedal motion (using two legs over 4)
• Earliest tool/food transport as adaptation to wider variability in vegetation and in food availability.
• Stone tool making correlated with high variability in animals.
What changes climate?

• Changes in:
  – Sun’s output
  – Earth’s orbit
  – Drifting continents
  – Volcanic eruptions
  – Greenhouse gases
18,000 years before present

Modern day (August)

Northern Hemisphere Ice coverage

Legend
- Continental ice
- Sea ice
- Land above sea level

Fig. 4-7, p. 67
Present

65 million years ago

225 million years ago

135 million years ago

Fig. 4-6, p. 66
Earth’s Long-Term Climate Changes

• Cooling and warming periods – affect evolution and extinction of species
  – Change ocean levels and area
  – Glaciers expanding and contracting
  – Climate changes

• Opportunities for the evolution of new species

• Many species go extinct
Increasing greenhouse gases trap more heat.
Greenhouse gases

- Nitrous oxide
- Carbon dioxide
- Methane
- Sulfur hexafluoride

- Water
Could the warming be natural?
Is it real?

Jan-Dec Global Surface Mean Temperature Anomalies

Land and Ocean

Ocean

Land

°C

°F

NCDC / NESDIS / NOAA
Observed change in average surface temperature (1900-2012)

IPCC, 4th AR
Effects: Snow and ice

Grinnell Glacier, Glacier National Park
1900 and 2008
Melting Sea Ice

- Ice cover 23% smaller than previous minimum; 39% smaller than average


- In September 2007, an area the size of Florida (69,000 square miles) melted (NSIDC 2007)
Effects on precipitation

Multi-model Simulation of Changes in Dry Days
Years 2080-2099 Minus Years 1980-1999 (middle emissions scenario)
Effects on ecosystems
Temperature Increases for Various Emission Scenarios

- High emissions scenario
- Middle emissions scenario
- Low emissions scenario
- Commitment to warming without additional CO₂
- 20th century
Aspen, CO Forecast:
Partly cloudy today
High: 28°F
Low: 13°F
Increasing clouds over night. Colder tomorrow.

Projected Temperature Increases
Middle Emissions Scenario, 2080 - 2099

°F
0 1.8 3.6 5.4 7.2 9 10.8 12.6
°C
0 1 2 3 4 5 6 7

IPCC
Sea-level rise projections: a few inches to a few feet

• 2 ft: U.S. would lose 10,000 square miles
• 3 ft: Would inundate Miami
• Affects erosion, loss of wetlands, freshwater supplies
• Half of the world’s population lives along coasts
• Big question: Ice sheets
Climate Change and Health

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.
2007 IPCC Conclusions

- Warming of the climate system is unequivocal
- **Very high confidence** that global average net effect of human activities since 1750 one of warming
- Human-caused warming over last 30 years has **likely** had a visible influence on many physical and biological systems
- Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would **very likely** be larger than those observed during the 20th century.”
Why should we care?

Present Day (1990s) vs Possible Future (2090s)

Surface Air Temperature

°C
-20 0 4 8 12 16 20 24 28 32 36

°F
-4 25 32 39 46 54 61 68 72 75 79 82 86 90 97

NCAR
Global Warming

Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007
The day is not far.......
As the temperature of oceans rise, so will the probability of more frequent and stronger hurricanes.
Increased probability and intensity of droughts and heat waves
Drought in Kenya killed Thousands of Cattles
Climate Change Impacts

**Health Impacts**
- Heat-related deaths
- Infectious diseases
- Air quality-respiratory illnesses

**Agriculture**
- Crop yields
- Irrigation demand
- Pest management

**Forest Impacts**
- Health, composition and productivity

**Water Resources**
- Changes in precipitation, water quality, and water supply

**Coastal Areas**
- Erosion and inundation of coastal lands
- Cost of protecting vulnerable lands

**Wildlife**
- Loss of diversity
- Species range shifts

**Temperature**

**Precipitation**

**Sea Level Rise**
Scope of climate change

1. Agriculture
2. Biodiversity & Ecosystem Services
3. Built Environment
4. Business, Industry & Services
5. Energy
6. Floods & Coastal Erosion
7. Forestry
8. Health
9. Marine & Fisheries
10. Transport
11. Water

• Agriculture & Forestry
• Business
• Health & Wellbeing
• Buildings & Infrastructure
• Natural Environment

“Health is one of the most affected areas by climate change” ...

... and it is being affected now
Heat & cold waves: 5,671

15,000 excess deaths in France, 35,000 elsewhere in Europe, triggered by two weeks of heatwave. Sixty percent of deaths were >75 years (IPCC, 2007)
Drought, 185

Heat & cold waves: 5,671

Floods, 7,637

Air quality, ~800,000

Shellfish poisoning, 300

Skincare, ~65,000

Vector-borne disease, ~2,000,000

Storms, 13,650
WHO: five major health impacts of climate change

1. Malnutrition
2. Deaths and injuries caused by storms and floods. (Flooding can also be followed by outbreaks of diseases, such as cholera)
3. Water scarcity / contamination (droughts and sudden floods) – increased burden of diarrheal disease.
4. Heat waves – direct increases in morbidity and mortality; indirect effects via increases in ground-level ozone, contributing to asthma attacks.
5. Vector-borne disease – malaria and dengue.
Vulnerable population groups

- Chronic medical conditions including mentally ill, clients with special needs
- Social isolation
- Poor & vulnerable communities
- Being confined to bed
- Certain medical treatments
- Some types of occupation, outdoor workers
- Very young children
- Elderly suffer the greatest effects of heat-waves (impact on mortality greater in women)
Health inequalities between rich and poor

- Climate change will have **greatest effect** on those who have the least access to world’s resources and who have contributed least to its cause.

**The rich world:**
more expensive, inconvenient, uncomfortable, disrupted and colorless, more unpleasant and unpredictable.

Poor will die
Why suffering more for the poor?

- The health systems are:
  - Disorganized
  - Inefficient
  - Under-resourced

“The toxic combination of bad policies, economics, and politics – people do not enjoy the good health that is biologically possible.”
What diseases are the most climate sensitive?

- heat stress
- effects of storms
- air pollution effects
- asthma
- vector-borne diseases
- water-borne diseases
- food-borne diseases
- sexually-transmitted diseases
Distribution of four climate-sensitive health effects

Relative changes in diarrhea, malaria, inland and coastal flooding, and malnutrition from 2000 to 2030

(Patz et al., 2008)
Effect of climate change on health

• Changing pattern of the disease
• Water and food insecurity
• Vulnerable shelter and human settlements
• Extreme climatic events
• Population growth and migration
Changing patterns of disease

- The heat waves
- Heat related stress and heat stroke
- Heat island effect
- Vector borne diseases and Rodent borne diseases
- Cancers
- Vectors access areas previously free from diseases
Potential Health Effects of Climate Change

Climate change:
- Temperature rise
- Sea level rise
- Hydrologic extremes

- Heat stress, cardiovascular failure
- Injuries, fatalities
- Asthma, cardiovascular disease
- Respiratory allergies, poison ivy
- Malaria, dengue, hantavirus, encephalitis, Rift Valley fever
- Cholera, cryptosporidiosis, campylobacter, leptospirosis
- Malnutrition, diarrhea, harmful algal blooms
- Anxiety, post-traumatic stress, depression, despair
- Forced migration, civil conflict
Heat waves, or extreme heat events, are characterized by several days of temperatures greater than 90° F; warm, stagnant air masses; and consecutive nights with higher-than-usual minimum temperatures.

Account for more deaths annually than hurricanes, tornadoes, floods, and earthquakes combined.

Extreme weather events, sea-level rise, destruction of local economies, resource scarcity, and associated conflict due to climate change are predicted to displace millions of people worldwide. (200 million people worldwide by 2050)
Air Pollution

• Pollution determined by emissions & weather
• Increases in ozone:
  o extra deaths &
  o hospital admissions
• Air quality decline:
  o severity of asthma
• Ozone levels dependent on pollution control in Europe

• Between 2003 – 2020, increase in ozone levels will result in a 51-53% increase in attributable deaths and hospital admissions for respiratory diseases, threshold assumptions of 35-50ppb (attributable to climate change)
Aeroallergens

- Climate change may result in earlier seasonal appearance of respiratory symptoms and longer duration of exposure to aeroallergens (pollen and fungal spores).
- Changes in plant distribution can expose the population to pollen from more plants with different flowering seasons.
- Climate change / extreme weather events can change fungal speciation, distribution and allergenicity.
- Develop integrated system for modelling atmospheric concentrations of pollen, combining measurements with numerical forecast models.
Indoor Environment

- Climate change may exacerbate health risks and inequalities associated with building overheating, indoor air pollution, effects from flooding, dampness and biological contamination.

- Characterise the health risks and benefits associated with current and future building infrastructure under climate change scenarios.

- Research into how climate change mitigation and adaptation measures may affect the indoor environment (e.g. air quality and biological contamination in buildings).
Air quality affected through several pathways

- Increases in regional ambient concentrations of ozone, PM2.5s fine particles, & dust.
- Increase production & allergenicity of aeroallergens (pollen mold & spores)

Aeroallergens act with other harmful air pollution worsen respiratory disease (Allergic rhinitis asthma and chronic obstructive pulmonary disease)

Ozone causes direct, reversible lung injury; increases premature mortality; worsens respiratory diseases such as asthma and chronic obstructive pulmonary disease (COPD); and may cause lasting lung damage.

PM2.5s are associated with respiratory and cardiovascular diseases, including asthma, COPD, and cardiac dysrhythmias

Global rise in asthma is an early health effect of climate change.
Exposure to ultra violet radiation

Likely increases in:

• Sunburn
• Skin cancer
• Possibly cataracts
Ultraviolet Radiation

• Climate change may affect ambient levels of UVR, but the critical factors affecting human exposure are lifestyle and behaviour.

• Understanding the likely changes in ground level UV radiation and the balance between the risk of skin cancer versus a beneficial increase in outdoor activity.

• Research into whether warmer summers will encourage more healthy outdoor activities and increased vitamin D production.

• UVR related public health messages for specific target groups such as young people and the elderly.
Incidence of ‘All Skin Cancer’
England and Wales 1993-2002, and projections to 20251
Males, Females and all persons
Directly aged standardised registration rates

1 Exponential projections based on data for the ten years 1993-2002

Note: International Classification of Disease and related health problems (ICD) definition of all skin cancers - ICD9 172-173, ICD10 C43-C44.

Cardiovascular Disease and Stroke

- Dysrhythmias are primarily associated with extreme cold as well as heat.
- Stroke incidence increases with increasing temperature.
- Ozone are also associated with acute myocardial infarction.
- Particulate matter associated with systemic inflammation, deranged coagulation, thrombosis, blood vessel dysfunction, atherosclerotic disease, compromised heart function, deep venous thromboses, & pulmonary embolism.
- Increased burden of PM$_{2.5}$ is associated with increased hospital admissions and mortality from cardiovascular disease, as well as ischemic heart disease.
- Elderly and isolated individuals are at greatest risk.
CLIMATE CHANGE AND EMERGING AND RE-EMERGING INFECTIOUS DISEASES
Examples of Recent Emerging Zoonoses
(modified after Brown, 2004)

• Ebola virus
• Bovine Spongiform Encephalopathy (Mad Cow)
• Nipah Virus
• Severe Acute Respiratory Syndrome (SARS)
• Alveolar Echinococcosis
• Monkeypox
• Rift Valley Fever
• Highly Pathogenic Avian Influenza (Bird Flu)
• “Swine Flu” (H1N1)
• Monkey Herpes B virus (Ghana; January 2011)
Re-emerging Zoonotic Diseases (After Bengis et al 2004)

• Viral
  • Rabies and related Lyssavirus infections
  • Rift Valley Fever
  • Marburg Virus

• Bacterial
  • Bovine Tuberculosis
  • Brucella species in wild animals
  • Tularaemia
  • Plague
  • Leptospirosis
Factors contributing to emergence /re-emergence of infectious diseases I

Include genetic, biological, and social, political economic factors.

1. Microbial adaptation and change
2. Human susceptibility to infection
3. Climate and weather
4. Changing ecosystems
5. Human demographics and behaviour
6. Economic development and land use
7. Technology and industry
8. Breakdown of public health measures
9. Poverty and social inequality
WHAT’S all the Buzz about?
Vector-borne Diseases and Climate Change

Linh Pham, Ph.D., NIEHS
Vector Borne Diseases

- It is likely that the range, activity and vector potential of ticks and mosquitoes will increase in this century.
- Climate change may act on disease vectors (and their pathogens) both directly through a rise in temperature or change in precipitation.
- and indirectly through our adaptation to climate change, e.g. creation of coastal wetlands and habitat expansion.
Common Vectors That Transmit Disease

Mosquito

Tick

Mouse

Deer
Examples of Vector-Borne Diseases

- West Nile Virus
- Malaria
- Dengue
- Lyme Disease
- Hanta Virus
- Yellow Fever
- Rocky Mountain Spotted Fever
- Bubonic Plague

Characteristic bull rash caused by Lyme disease
West Nile Virus Transmission Cycle

**Mosquito Vector**

West Nile Virus

**Bird Reservoir Host**

West Nile Virus

**Incidental Exposure**

Incidental Exposure
How Weather Affects Vector-Borne Diseases

- Temperature
- Humidity
- Surface water
- Tropical and subtropical regions
- Predator patterns
How Weather Affects Vector-Borne Diseases

- Temperature
- Humidity
- Surface water
- Tropical and subtropical regions
- Predator patterns

**Climate Change**
- Larger geographic area where disease is common
- Intensity and duration of outbreaks
- Altered seasonal distributions
How Climate Change Affects Vector-Borne Diseases

- Mosquitoes develop more rapidly
- Mosquitoes bite more frequently
- Viral load in mosquitoes is higher
- Because more people are infected, more mosquitoes become carriers that transmit disease
Vector-borne and Zoonotic Diseases

Distribution of vectors will change arising from:
- Increasing temperature
- Changing rainfall
- Cyclones, flooding
- Changes in animal host/reservoir populations
- Rising sea levels
- Extreme tides
- Loss of coastal margins

Malaria and dengue fever to re-emerge.
Introduction & spread of new agents, such as West Nile virus.
Some VBZD agents like Lyme disease & Hantavirus, which show evidence of seasonality & the range of these diseases could change with a changing climate
Food and Water Borne Disease

• Most water and food-borne pathogens show seasonal variation, which may be directly or indirectly influenced by weather.

• Warmer weather will allow pathogens (e.g. Salmonella) to grow more readily in food, and will favour pests and fungal mycotoxins that affect food safety.

• Understanding of how seawater temperature can affect the risk of people being exposed to algal blooms and associated marine toxins.

• Climate change is likely to elevate food prices which may reduce the nutritional status of some population groups.
Food borne diseases

- Increased occurrence of *Vibrio infection*, especially seafood-borne disease associated with *V. vulnificus* & *V. parahaemolyticus*.

- Ocean acidification also lead to more virulent strains of existing pathogens & emergence of new pathogens.

- Drought encourage crop pests such as aphids, locusts, and whiteflies, as well as the spread of the mould *Aspergillus flavus* & thereby exacerbate malnutrition, poverty, and the need for human migration.

- Greater use of herbicides, fungicides, & insecticides, resulting in potential immediate hazards to farm workers.
Waterborne disease

• Increased risk from the:
  a) Concentration of nutrient and chemical contaminants
  b) Formation of toxic algal bloom
  c) Surface water contamination with human waste
  d) Changes in ocean and coastal ecosystems
  e) Changes in ph, salinity
  f) Contaminant runoff, leaching of arsenic, fluoride, and nitrates from fertilizers & lead contamination
  g) Water security.

• Severe outbreaks of cholera.
Neurological diseases

Exposure to neurotoxins (e.g. domoic acid) in seafood, fresh & marine waters, pesticides & herbicide effects & heavy metals leads to onset and exacerbation

- Amnesia,
- Numbness,
- Neurological deficits
- Learning disabilities
- Liver damage,
- Skin and eye irritation,
- Respiratory paralysis,
- PD- and AD-like symptoms,
- Epilepsy.
Cancers

• Leaching of toxic chemicals and heavy metals from storage sites & contamination of water with chemicals.

• Depletion of stratospheric ozone resulting in increased UV radiation exposure increased risk of skin cancers (BCC & SCC) & cataracts.

• Increased UV radiation with certain polycyclic aromatic hydrocarbons (PAHs) phototoxicity & DNA damage.
# Health impact of extreme events

<table>
<thead>
<tr>
<th>Impact type</th>
<th>Health impact</th>
<th>Potential impact pathway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Impacts to Humans</strong></td>
<td>Fatalities, injuries</td>
<td>• Direct physical injuries from extreme events.</td>
</tr>
<tr>
<td></td>
<td>Heat stress</td>
<td>• Direct temperature related effects from heatwaves.</td>
</tr>
<tr>
<td><strong>Natural Environment</strong></td>
<td>Gastro-intestinal diseases, diarrhoea,</td>
<td>• Run-off events from heavy rainfall - risk of contamination by disease pathogens such</td>
</tr>
<tr>
<td></td>
<td>vomiting</td>
<td>as Cryptosporidium spp.</td>
</tr>
<tr>
<td></td>
<td>Water stress</td>
<td>• Contamination from wildlife and stock deaths in drought, bushfires.</td>
</tr>
<tr>
<td><strong>Water supply</strong></td>
<td>Water stress</td>
<td>• Effect on quantity and quality of water to reservoirs - increase sediment, nutrient</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and debris flow.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Changes to land cover - change in runoff patterns.</td>
</tr>
<tr>
<td><strong>Vector borne</strong></td>
<td>Ross River Virus disease (RRv)</td>
<td>• Extreme events will impact on the complex ecological cycles of the diseases, as well</td>
</tr>
<tr>
<td></td>
<td>Barmah Forest Virus disease (BFv)</td>
<td>as our ability to respond. Direction of impacts likely to be positive and negative.</td>
</tr>
<tr>
<td></td>
<td>Dengue</td>
<td>• Changes to climate may allow exotic diseases and vectors to establish.</td>
</tr>
<tr>
<td></td>
<td>Murray Valley Encephalitis (MVE)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other exotic diseases</td>
<td></td>
</tr>
</tbody>
</table>
# Health impact of extreme events

<table>
<thead>
<tr>
<th>Category</th>
<th>Issue</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food borne</td>
<td>Food poisoning</td>
<td>- High temperatures may increase proliferation of bacterial pathogens including Salmonella, Campylobacter and Listeria spp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Heavy rainfall events - increased risk of Cryptosporidiosis.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Temperature increase may cause increase in mycotoxins and aflatoxins.</td>
</tr>
<tr>
<td>Food production</td>
<td>Changes to diet</td>
<td>- All extreme events particularly in relation to reduced water from rainfall, destroy or damage a wide range of crops and livestock - changes in cost and availability of food.</td>
</tr>
<tr>
<td>Air quality</td>
<td>Respiratory effects</td>
<td>- Bushfires - increase air pollutants.</td>
</tr>
<tr>
<td></td>
<td>Asthma</td>
<td>- Droughts/wind - increase dust.</td>
</tr>
<tr>
<td></td>
<td>Allergic reactions</td>
<td>- Heat events - increase smog.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Links between high temperature and ground ozone levels.</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Very difficult to determine.</td>
<td>- Wide range of potential impacts on biodiversity, particularly drought and bushfires.</td>
</tr>
<tr>
<td>Other</td>
<td>Chemical exposure</td>
<td>- Damage to chemical pipelines, storage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Drought increases concentration of soil and water contaminants.</td>
</tr>
</tbody>
</table>
Social Impacts

Lifestyle and behaviour are likely to be affected in the following ways:

– Increases in crime - particularly involving aggression
– Accidents - workplace and traffic
– Decline in physical health
– Hot nights may cause sleep deprivation
– Recreational opportunities - changes to exercise patterns
– Changes in alcohol consumption
– Stress
– Lack of cold water- reduced ability to cool down
Extreme weather-related events (natural disasters)

Lead to:
• Social disruption
• Homelessness
• Injuries, deaths, disability
• Impacts on food and water supply
Disasters and Mental Health

• Individual vulnerabilities:
  – Proximity to the disaster
  – Low socioeconomic status
  – Low social connectedness
  – Existing mental illness

• Community vulnerabilities:
  – Outdated emergency plans
  – Shortage of mental health resources at time of event
  – Repeated exposure to disaster or crisis
Disasters and Mental Health

- Poor mental health outcomes are not only attributable to exposure to the event
  - Displacement
  - Unstable or unknown housing circumstances
  - Lack of access to support services
  - Loss, particularly of employment, possessions
Disasters and Mental Health

• Specific post-disaster mental health outcomes may include:
  – Confusion
  – Depression
  – Anxiety
  – Grief
  – Post-traumatic stress disorder

• Case Study: Hurricane Katrina
  – Many victims have experienced stress disorders
  – Very high rates of suicide attempts (78.6 times higher than baseline rate)
  – High rates of suicide completion (14.7 times higher than baseline rate)
  – High rates of depression
  – Domestic violence/child abuse
Loss

• Climate change can contribute to several sources of loss:
  – Loss of bio-diversity
  – Loss of habitat
  – Extinction of species
  – Crop failure
  – Water shortage
  – Drought
  – Loss of livelihood
  – Forced migration/displacement and the loss of place
  – Loss of property, pets, possessions
• Loss can impact our sense of self and disrupt our sense of place
• A series of losses is particularly devastating
  – Distinct bereavement for each loss
  – Impacts slow to dissipate without support
Climate Change and Violence

- As temperature rises, so does the incidence of violence
  - Increase in murders, assaults, violent suicide, and domestic violence when the weather is hot
  - Predicted: 24,000 assaults or murders in the US per year for every 2° F increase in average temperature

- Stress of experiencing natural disaster can lead to violence
Knowing is not enough; we must apply.
Willing is not enough; we must do. (Goethe)
WHAT CAN WE DO?
Public Health Action on Climate Change: Key Steps

• Surveillance and data collection
• Modeling and forecasting
• Direct actions to protect the public
• Communication
• Training and capacity building
• Research
## The Role of Public Health

<table>
<thead>
<tr>
<th>Psychological First Aid</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calm and Comfort</td>
</tr>
<tr>
<td></td>
<td>Connectedness</td>
</tr>
<tr>
<td></td>
<td>Self-empowerment</td>
</tr>
<tr>
<td></td>
<td>Hope</td>
</tr>
</tbody>
</table>
Discussion…

From **YOUR EXPERIENCES** or **INTERESTS**:  
• What diseases might have a climate link and what climate variables might impact on which diseases?  
• How would these be investigated/researched?  
• What additional information would you seek?  
• How would you integrate this into **OTHER** determinants of risk?  
• What other factors should be considered and why?
Thank You!