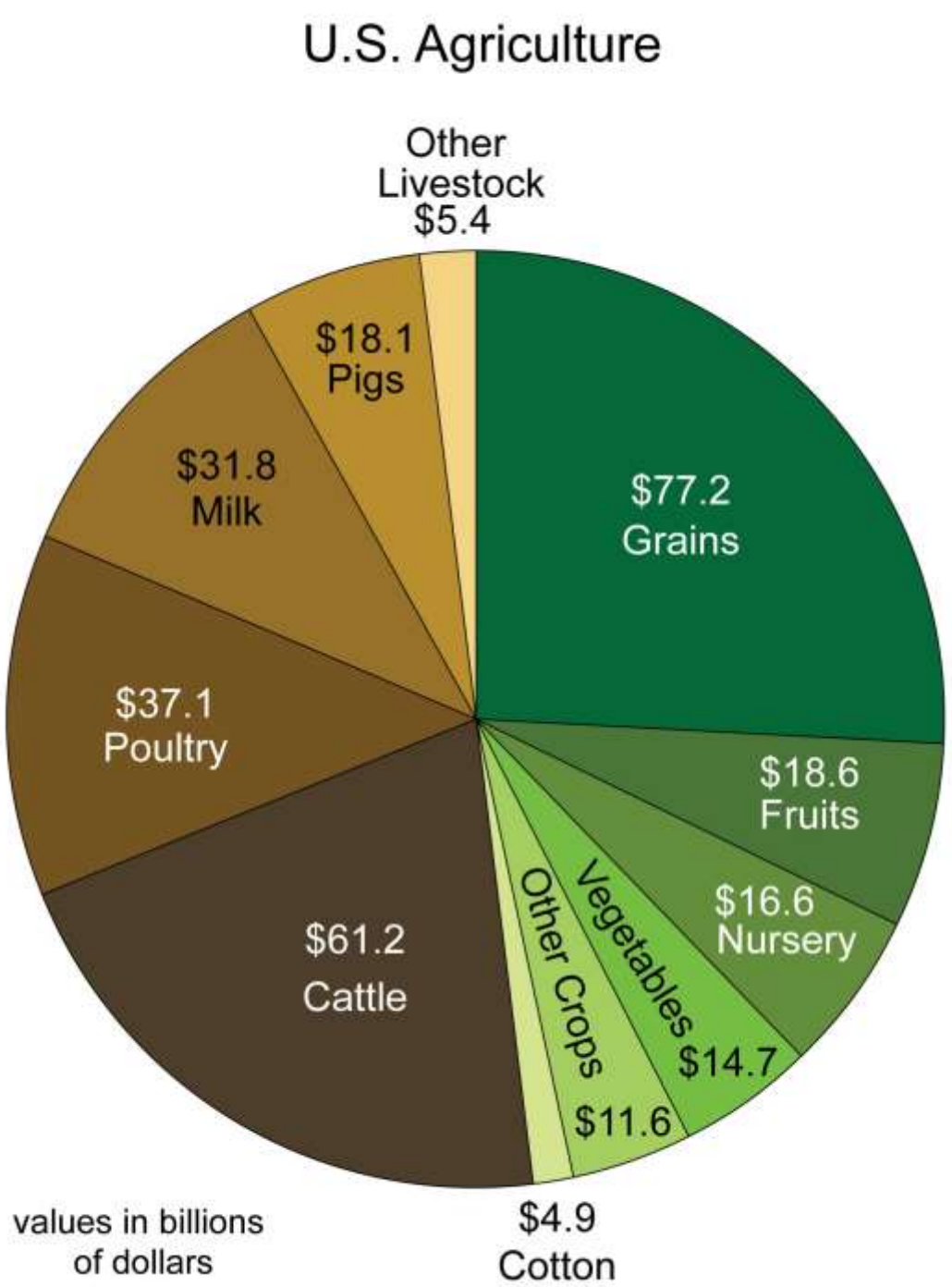
Agronomy 406
World Climates

April 12, 2018

Climate change and agriculture.

Climate change and human health.

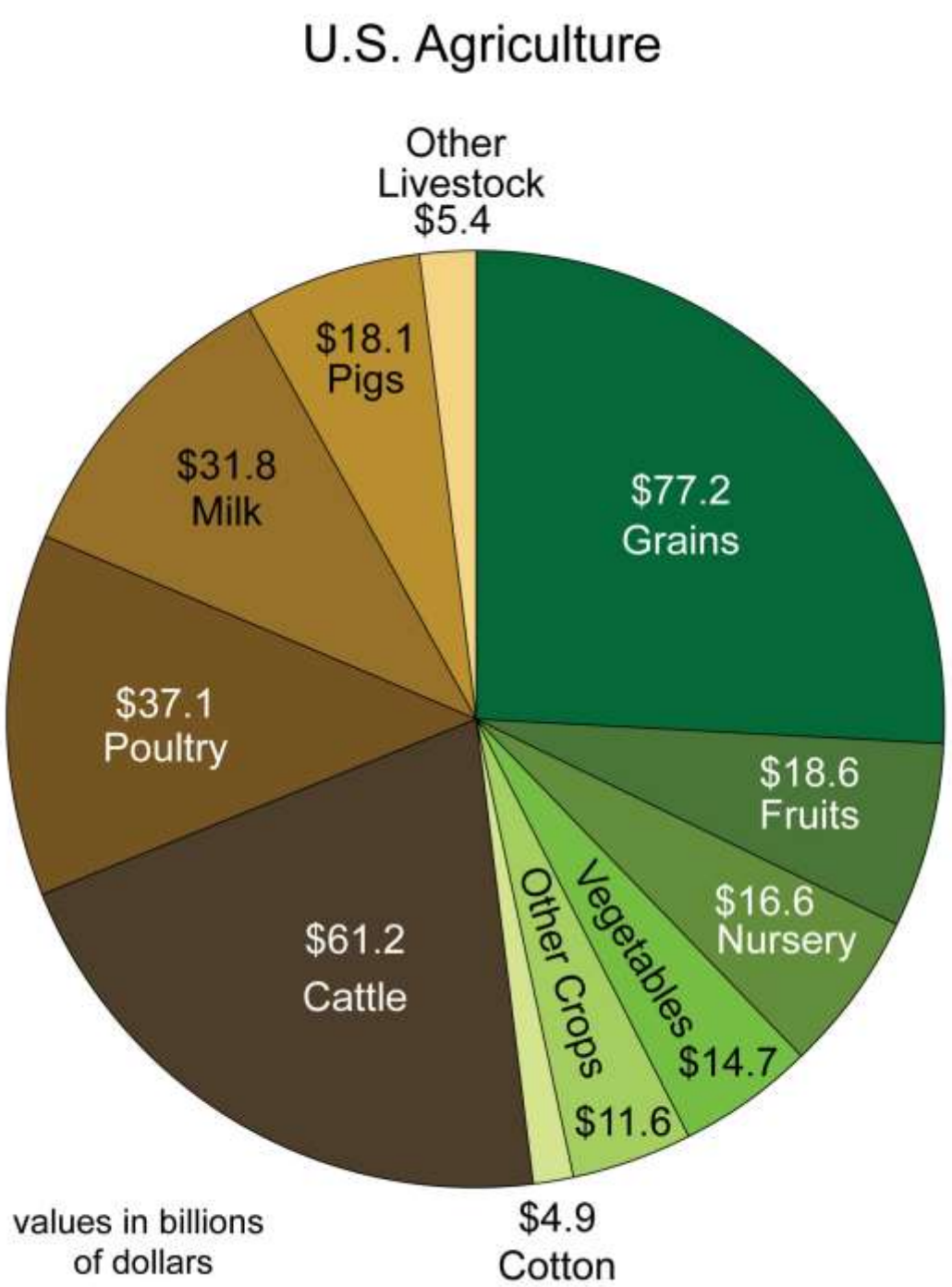
- How do you think climate change will impact U.S. agriculture?



2014 NCA

- Total ~$330 billion per year

- Direct effect:
  - Extreme weather events
  - Changes to yield, development
- Indirect effect:
  - Pests/pathogens that will benefit from climate change



2014 NCA

2014 National Climate Assessment's Key Points

1. Increasing Impacts on Agriculture
    a. Climate disruptions to agriculture productions have increased in past 40 years, and are projected to increase over next 25.

2. Weeds, Diseases and Pests

3. Extreme Precipitation and Soil Erosion

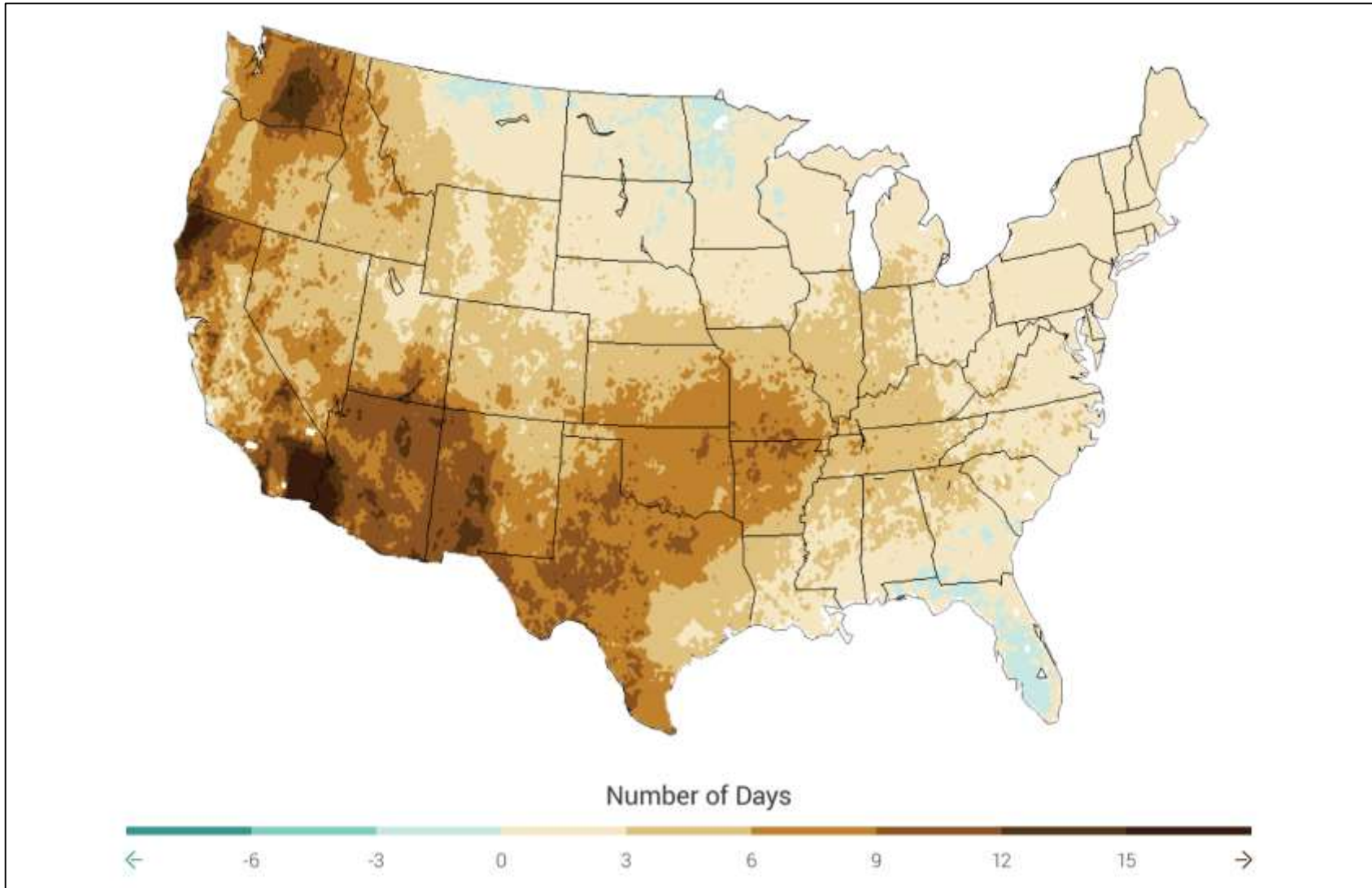
4. Heat and Drought Damage

5. Rate of Adaption
    a. Agriculture has adapted, but will need to adapt faster to keep up with climate change over next 25 years.

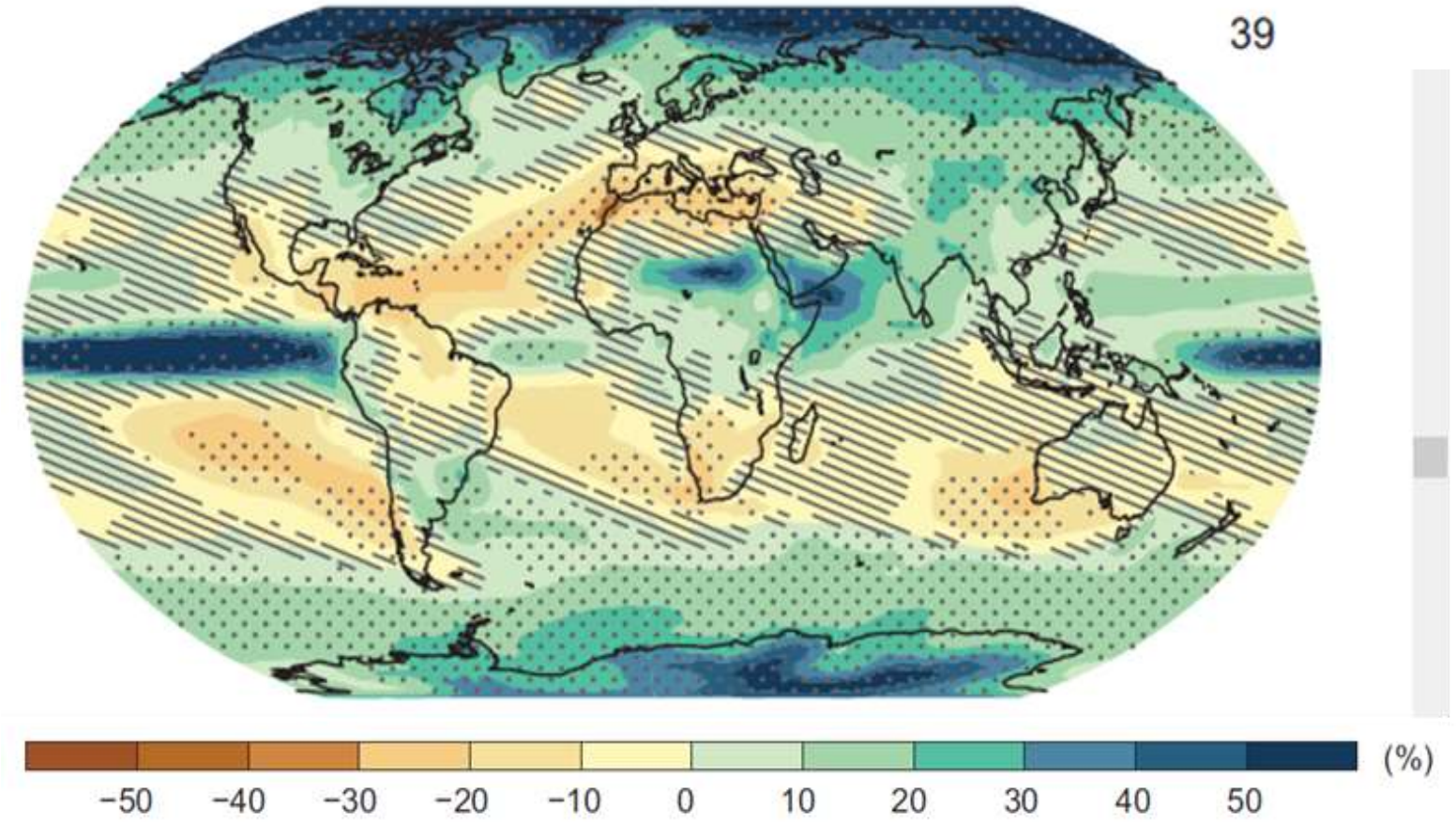
6. Food Security
    a. Stress on crop yields will put stress on food security through food prices, effect on processing, storage, transportation and retailing.

Consecutive Dry Days

Comparing 2070-2099 vs 1971-2000
Based on scenario where heat-trapping continue to increase
2014 NCA

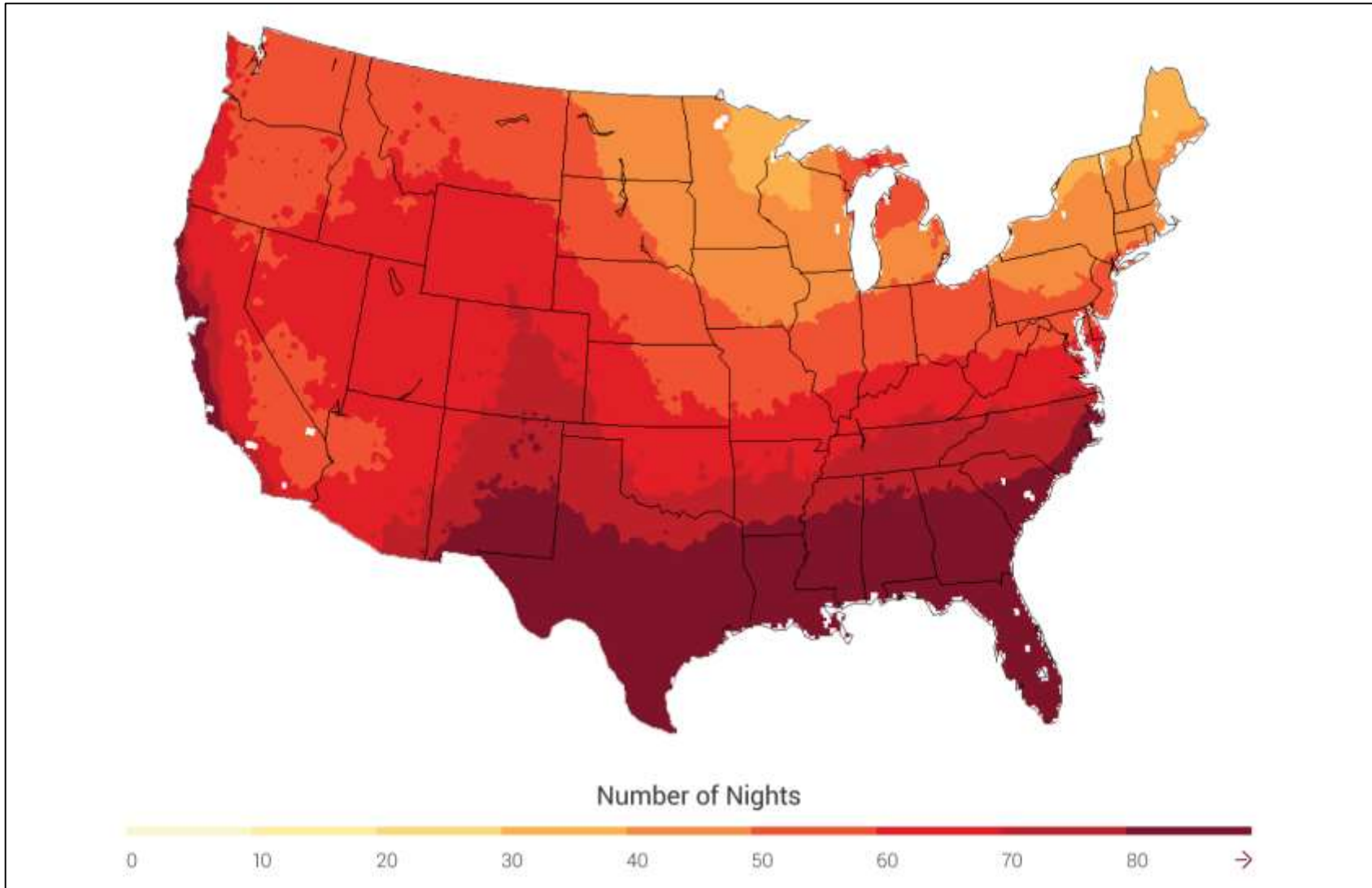


Precipitation change, 2081-2100 versus 1986–2005

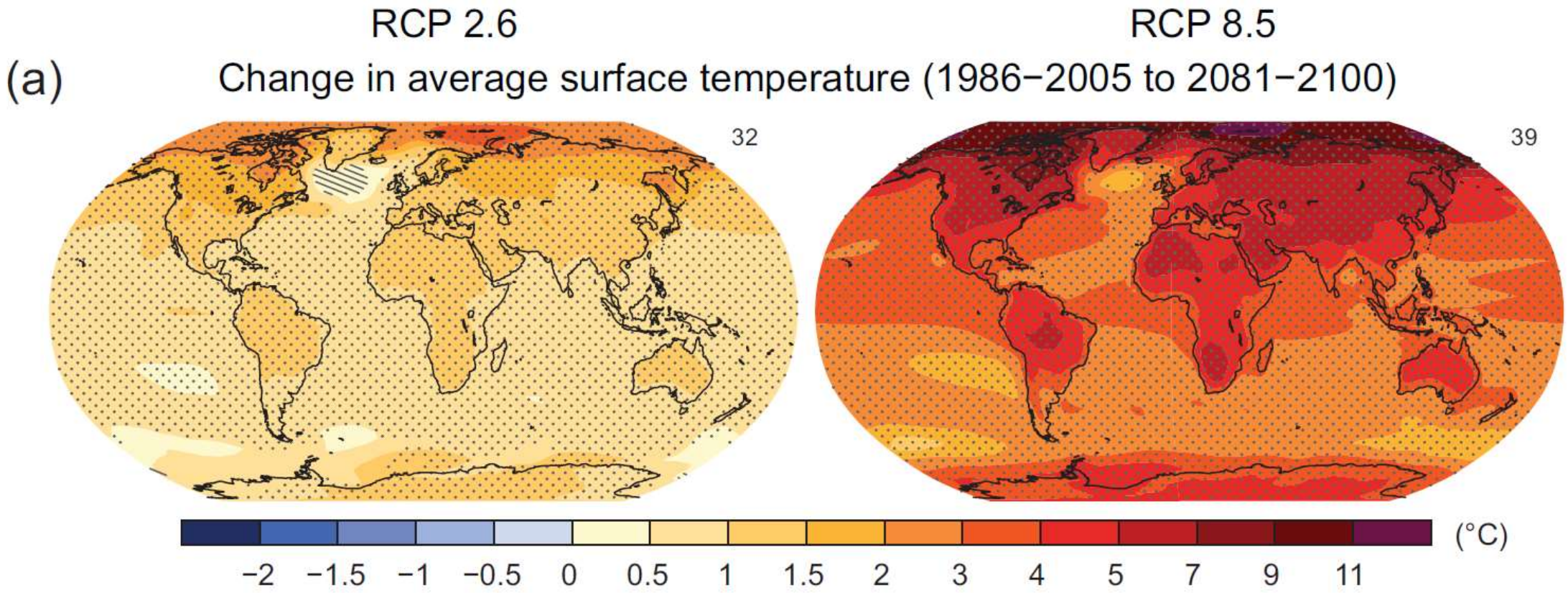


Number of Hot Nights

Comparing 2070-2099 vs 1971-2000
Based on scenario where heat-trapping continue to increase
2014 NCA



Change in temperature

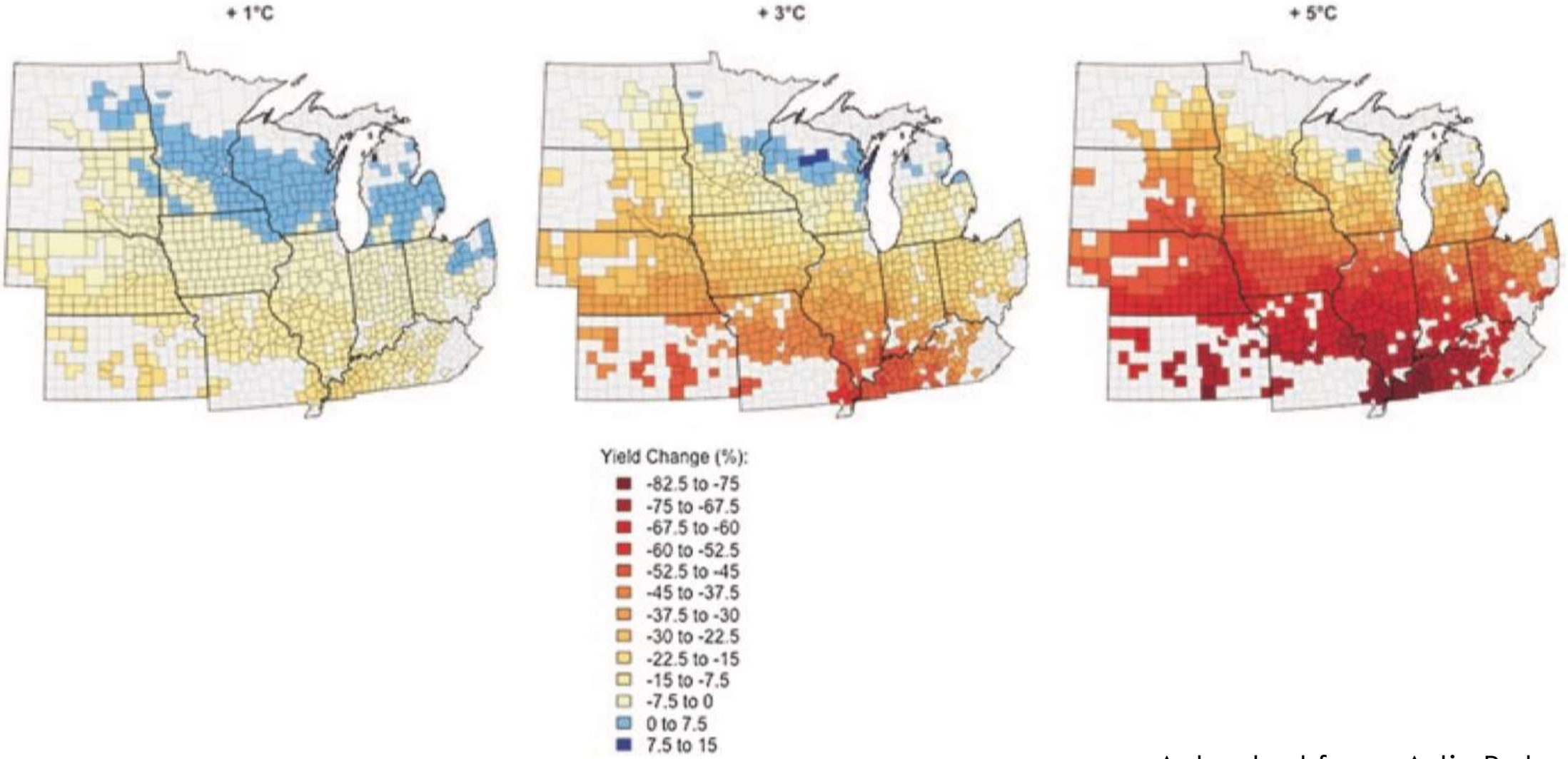


Maize

- Grows where/when temps are warmer than 15˚C and frost-free
- Very sensitive to frost
- Tolerates hot/dry conditions as long as there is sufficient water available and temps are below 45˚C
- Requires 500-800mm of water per season

UN Food and Agriculture Organization Summaries: Maize, Soybean

Maize



Adapted from Artiz-Bobea 2018

Trouble brewing …

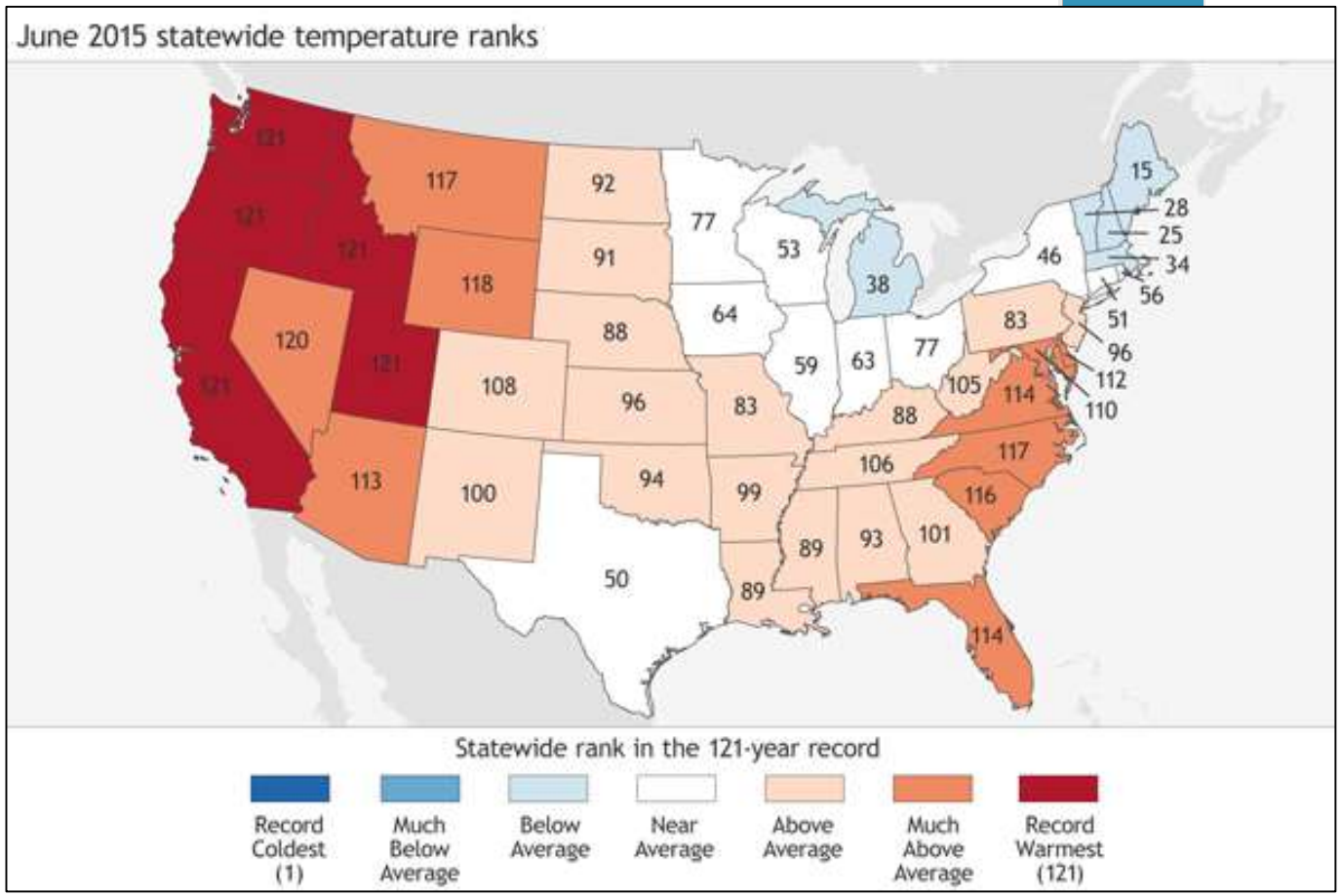
- Two ingredients for beer
  - Hops, barley

- Hops
  - Grown in Washington, Oregon and Idaho in U.S.
    - Irrigation comes primarily from melting of snowpack in mountains
- Barley
  - Upper Midwest, Northern Rockies
  - Greatly impacted by heat and drought!

- **How will climate change impact beer?**

Trouble brewing …

- Summer of 2015 was both hot and dry!
- However, farmers were able to adapt and still had average yields
- Uncertainty comes when this becomes the norm



Map adapted from analysis from NCEI (formally NCDC)

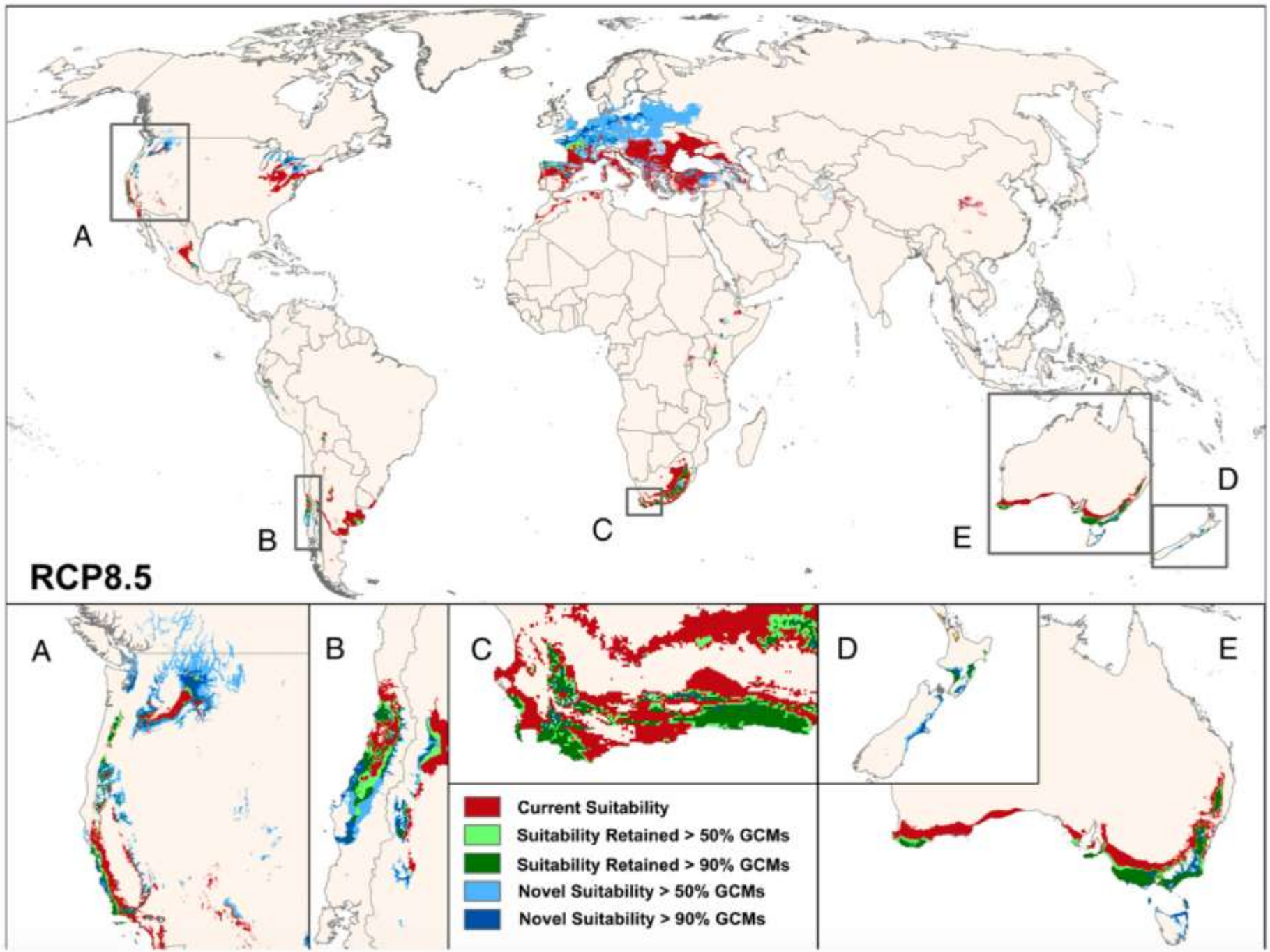
Climate change through the grapevine

- Climate growing zones range from 2-10˚C

- Some varieties could simply move poleward, while others could be lost
  - By 2100, U.S. could lose 81% of its premium wine grape farmland
  - In California, warming temperatures and reduction in fresh water could reduce the amount of land suitable for grape harvesting

- Rise in CO2 could change wine quality
  - Increase biomass, increase sugar (thus alcohol) and decrease acid levels
  - All change taste and quality of wine!

- Increased temperatures bring insects and insect-borne diseases to vineyards



Taken from Hannah et al. 2013

FOOD FOR THOUGHT

Sorry Folks, Climate Change Won't Make Chocolate Taste Better

December 19, 2017 · 1:39 PM ET

SIMRAN SETHI

- Most research focuses on quantity , rather than quality

Chocolate

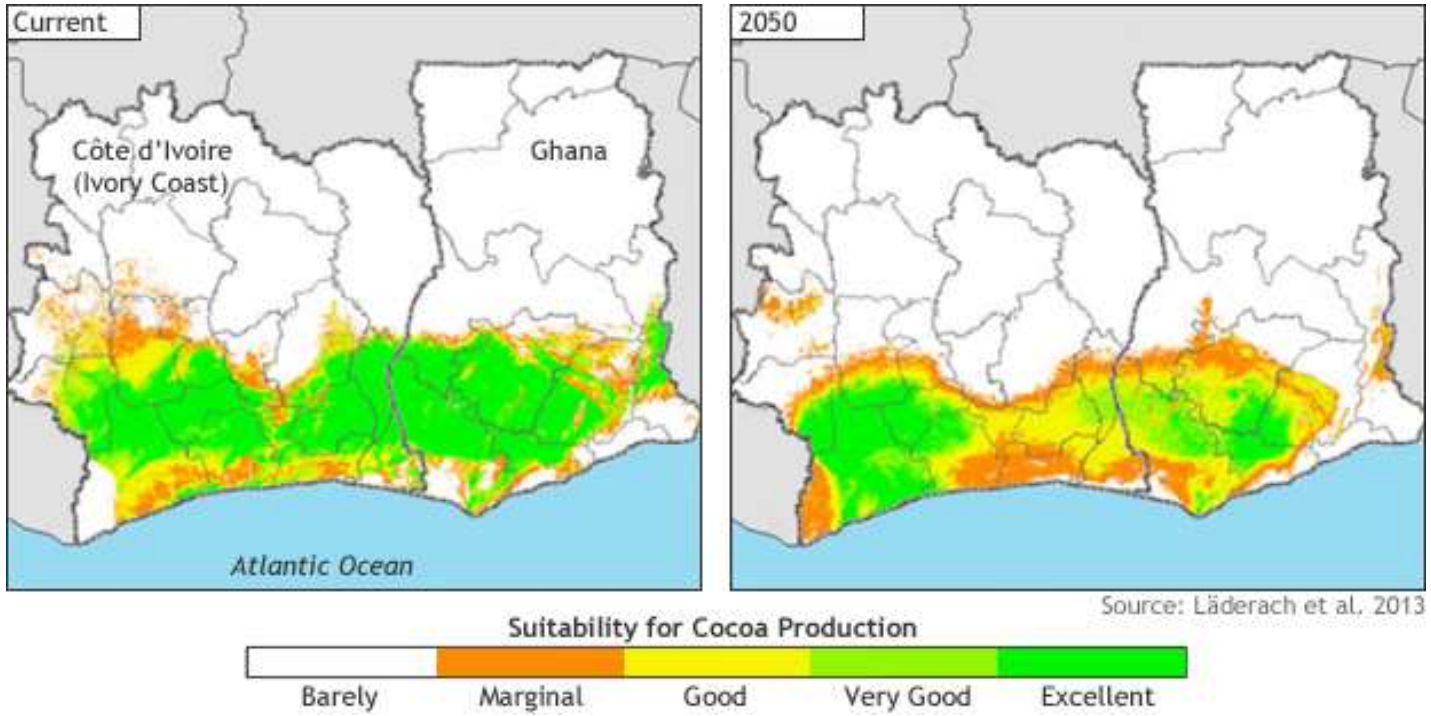
- Cacao can only grow within about 20˚ north and south of the equator
- Fairly uniform temperatures, high humidity, ample rain …. Rainforests

- Cacao can withstand an increase in temperature

Will cacao be negatively impacted by climate change?

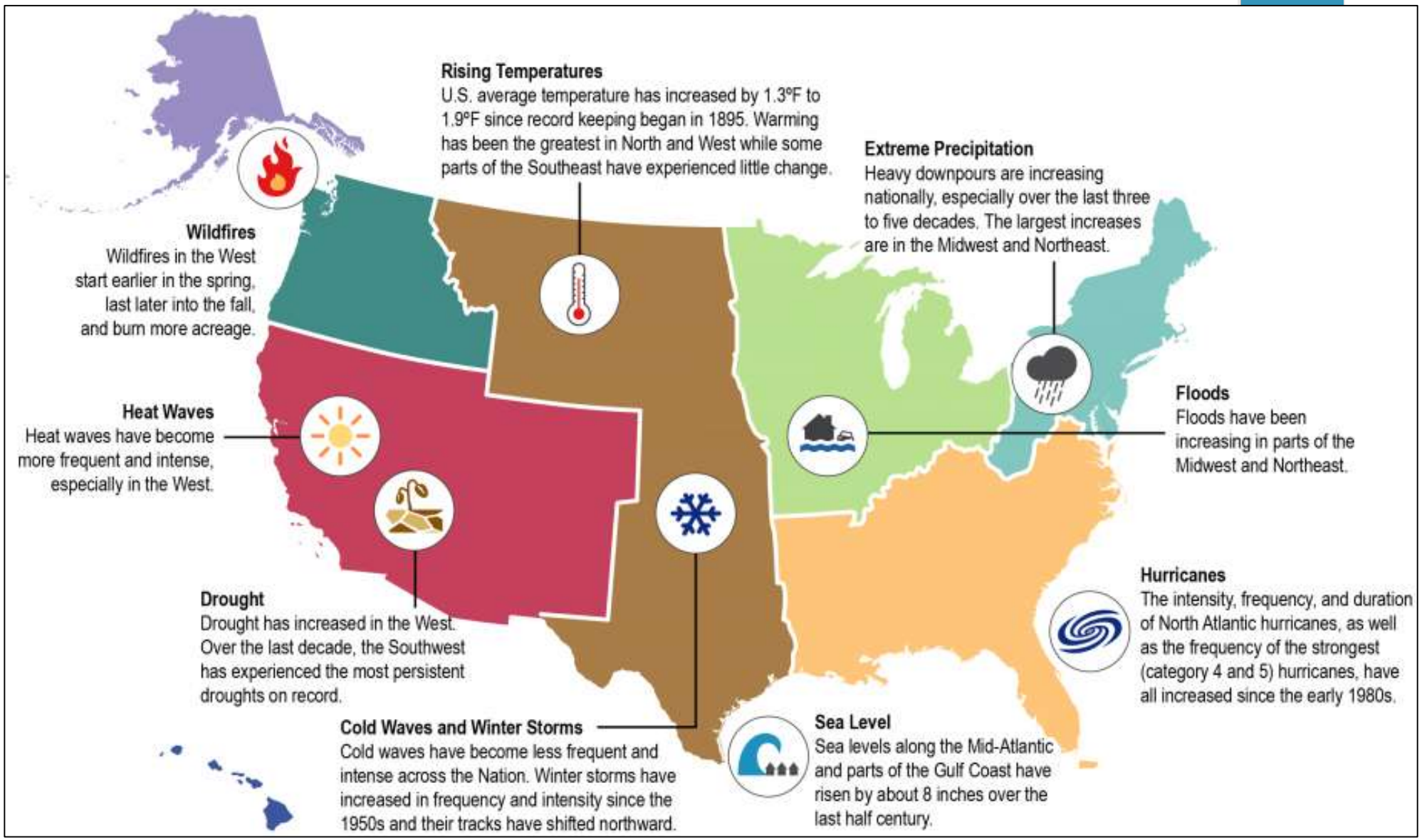
Chocolate

- Cacao can only grow within about 20˚ north and south of the equator
- Fairly uniform temperatures, high humidity, ample rain …. Rainforests
- Cacao can withstand an increase in temperature
- Increased temperatures will likely not be accompanied with more precipitation
  - <u>Thus, humidity decreases</u>

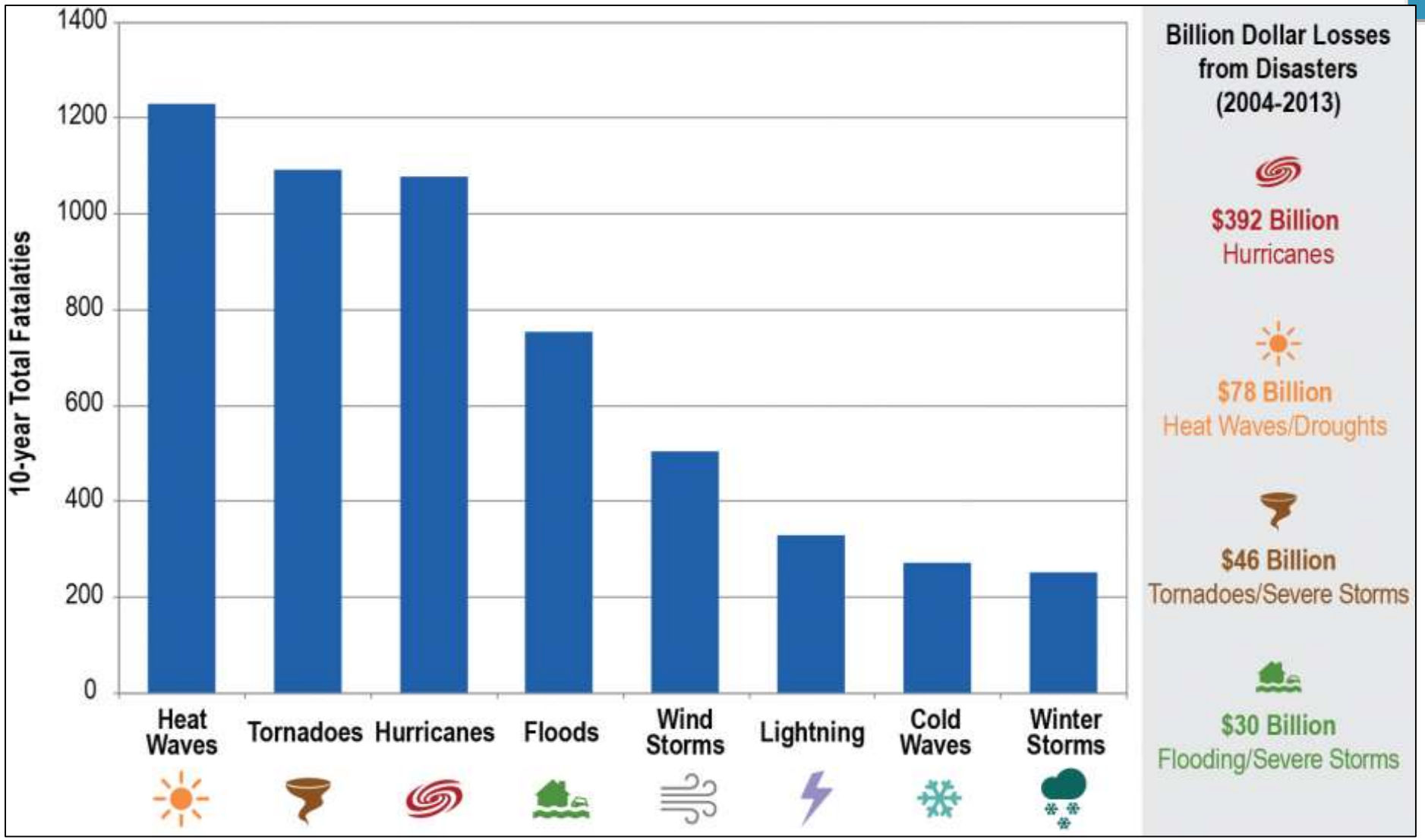


climate.gov

Climate change and human health



Climate change and human health



Climate change and human health

What are other ways climate change can impact human health?

Climate change and human health

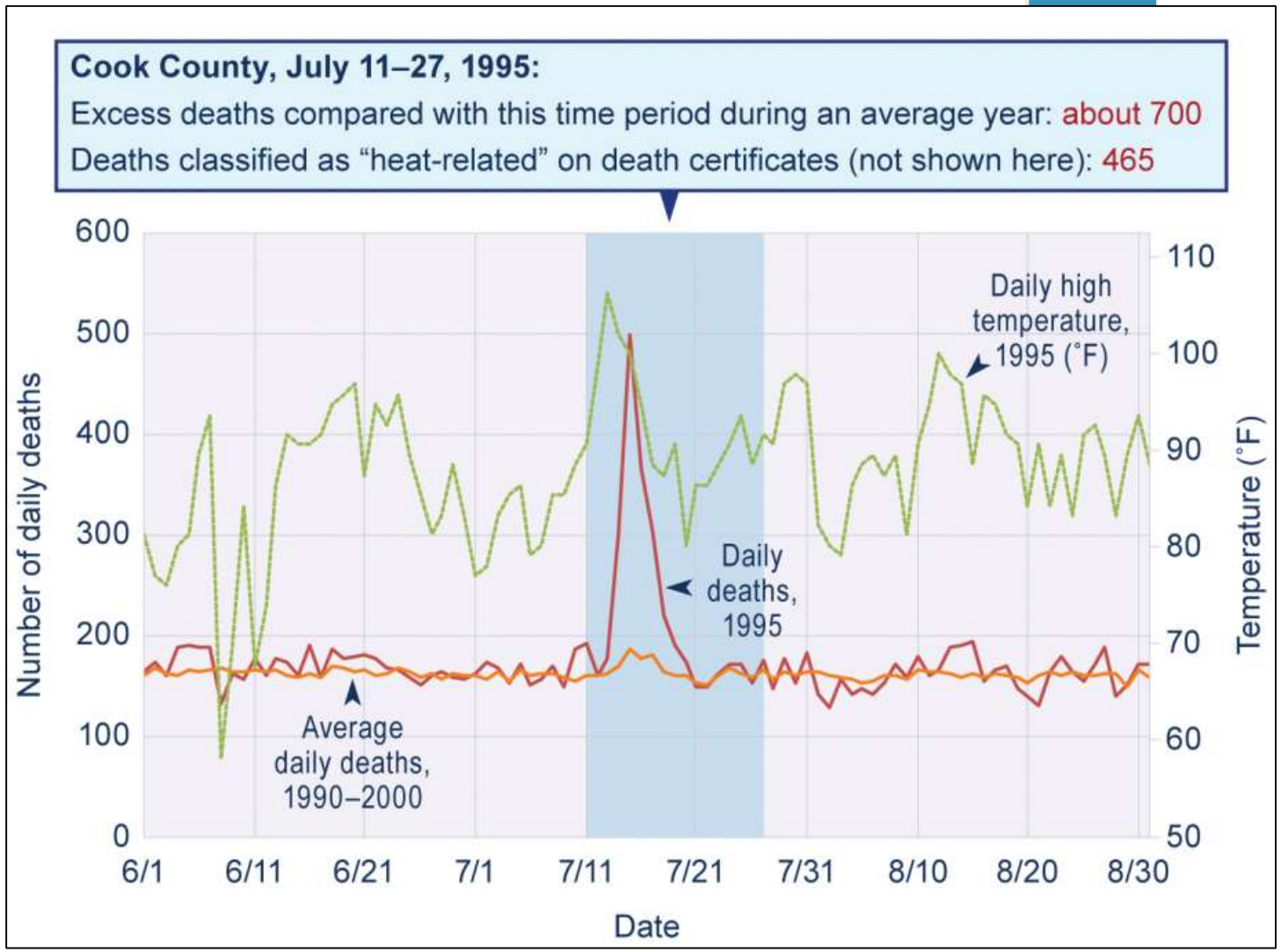
- Climate change threatens human health and well-being
  - Air pollution
  - Allergens
  - Wildfires
  - **Temperature extremes**
  - **Precipitation extremes**
  - **Disease carried by vectors**
  - **Food-borne illness**
  - **Food security**
  - Mental health and stresses

- Climate change can change human health in 2 ways:
  - changing the severity or frequency of health problems already related to high impact weather events
  - by creating unprecedented or unanticipated health concerns in places where they have not previously occurred

Temperature extremes

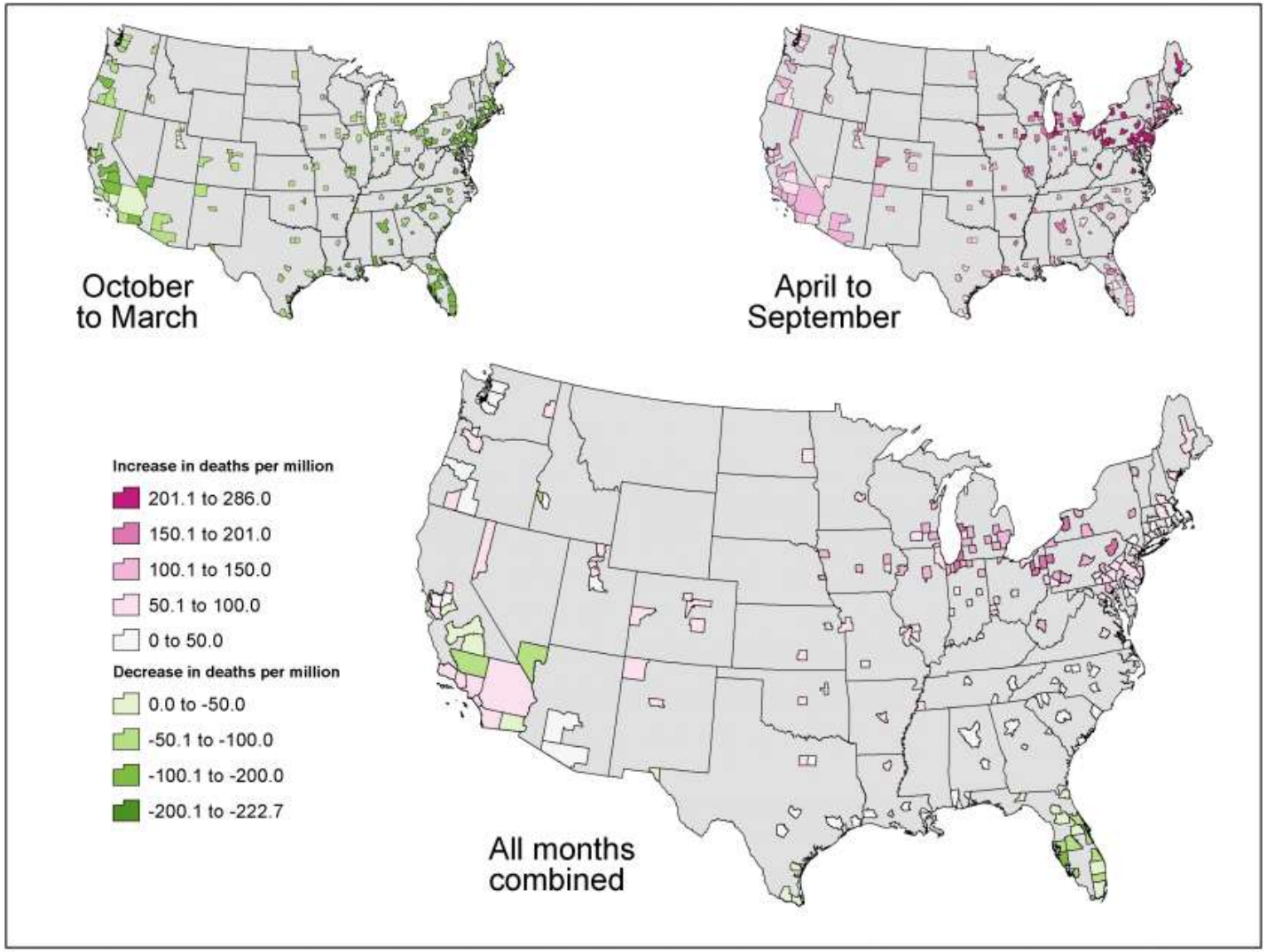
- Illnesses and death result from changes in seasonal averages, compromising the body's ability to regulate its internal temperature
  - Heat exhaustion/stroke, hypothermia/frostbite, worsen chronic conditions

- Observed impact of temperature deaths
  - Chicago heat wave, 1995



EPA 2014, taken from USGCRP 2016

Temperature extremes



Schwartz et al. 2015, taken from USGCRP 2016

Temperature extremes

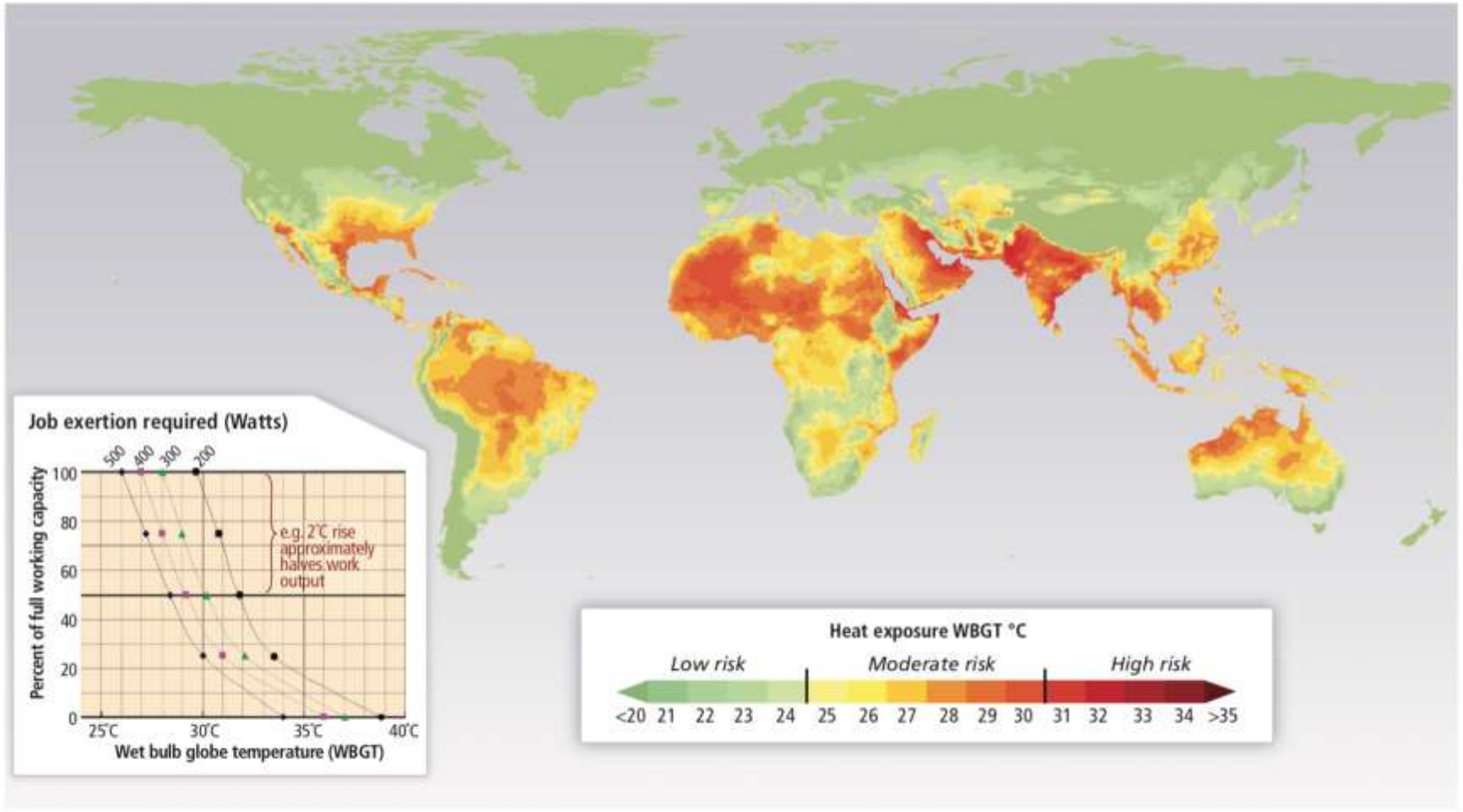


Figure 11-5 | The 1980–2009 average of the hottest months globally, measured in web bulb globe temperature (WBGT), which combines temperature, humidity, and other factors into a single index of the impact on work capacity and threat of heat exhaustion. The insert shows the International Organization for Standardization standard (ISO,1989) for heat stress in the workplace that leads to recommendations for increased rest time per hour to avoid heat exhaustion at different work levels. This is based on studies of healthy young workers and includes a margin of safety. Note that some parts of the world already exceed the level for safe work activity during the hottest month. In general, with climate change, for every 1°C that T_{max} goes up, the WBGT goes up by about 0.9°C, leading to more parts of the world being restricted for more of the year, with consequent impacts on productivity, heat exhaustion, and need for air conditioning to protect health (Lemke and Kjellstrom, 2012).

Lemke and Kjellstrom, 2012 taken from IPCC 2014

Precipitation Extremes

-How can precipitation extremes be beneficial for a region?

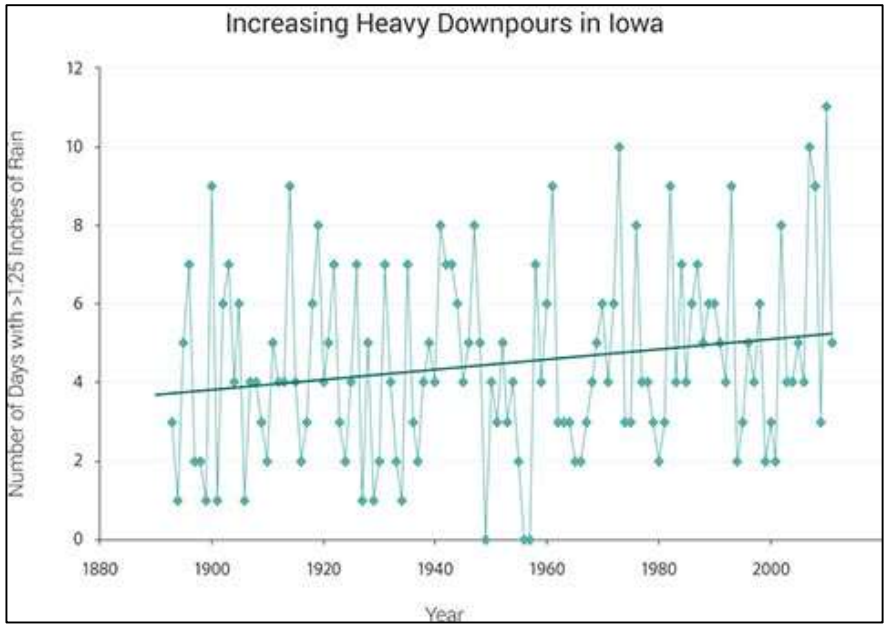
- **-Floods?**
- **-Droughts?**

Precipitation extremes

- Frequency of heavy precipitation events already increased and is projected to continue to increase
  - Floods are the 2nd deadliest of all weather-related hazards

- Risks extend past drowning
  - Standing water in buildings can lead to mold, air quality concerns

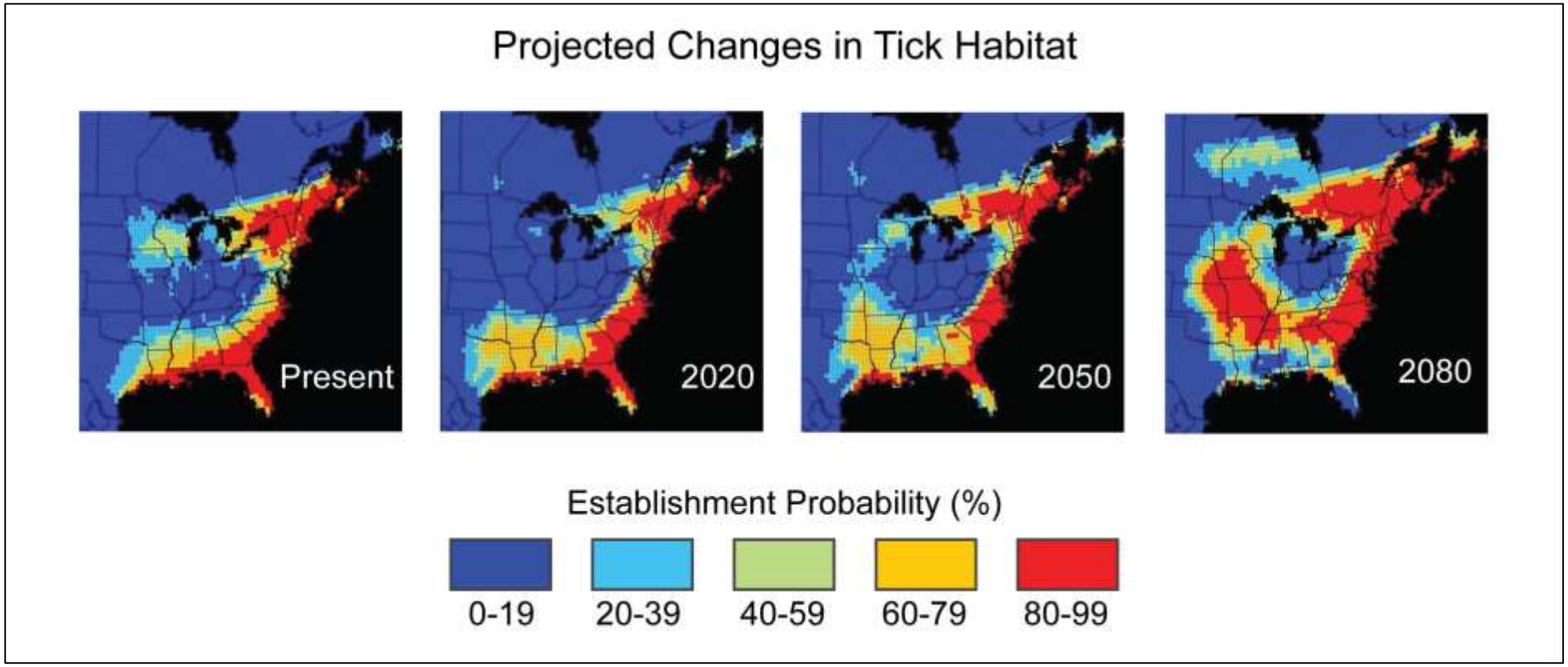
- Droughts increase risk to wildfires, dust storms, extreme heat events ,flash flooding etc. etc.
  - Valley fever



Takle 2011 taken from 2014 NCA

Disease carried by vectors

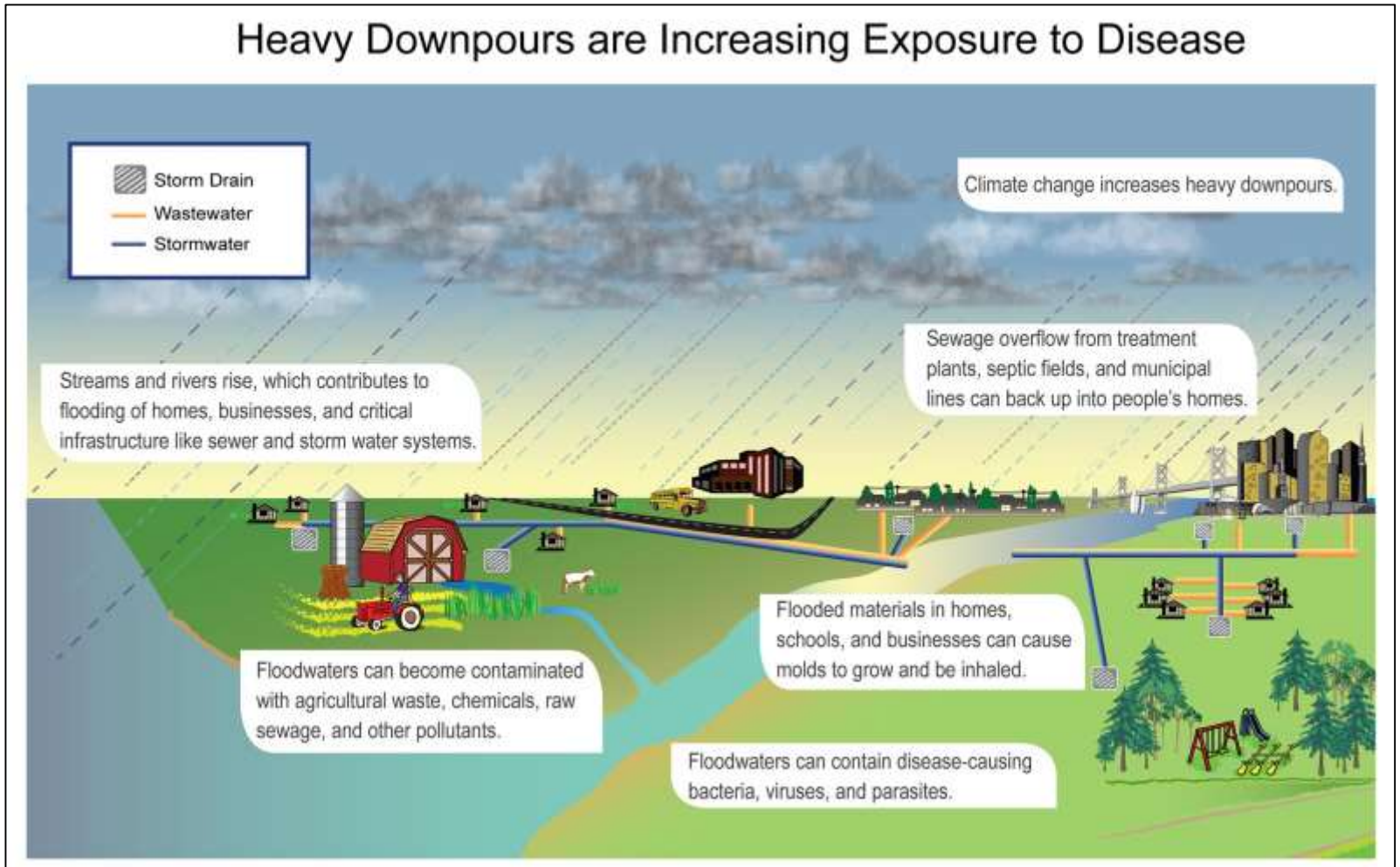
- Distribution of fleas, ticks, mosquitoes etc. depend partially on climate
  - Lyme disease, West Nile virus among others
- Example: ticks and Lyme disease
  - Change in distribution as more areas become favorable
  - Change in season as earlier onset of warm spring temperatures and delayed frosts
  - Higher tick densities due to milder winters



Adapted from taken from Brownstein et al. 2005. 2014 NCA

Food borne diseases

- Air and water temperature, precipitation and extreme rainfall events are known to affect transmission of food and water borne diseases
  - Example … Salmonella more common when temperatures are higher



NOAA NCEI (formally NCDC) . 2014 NCA

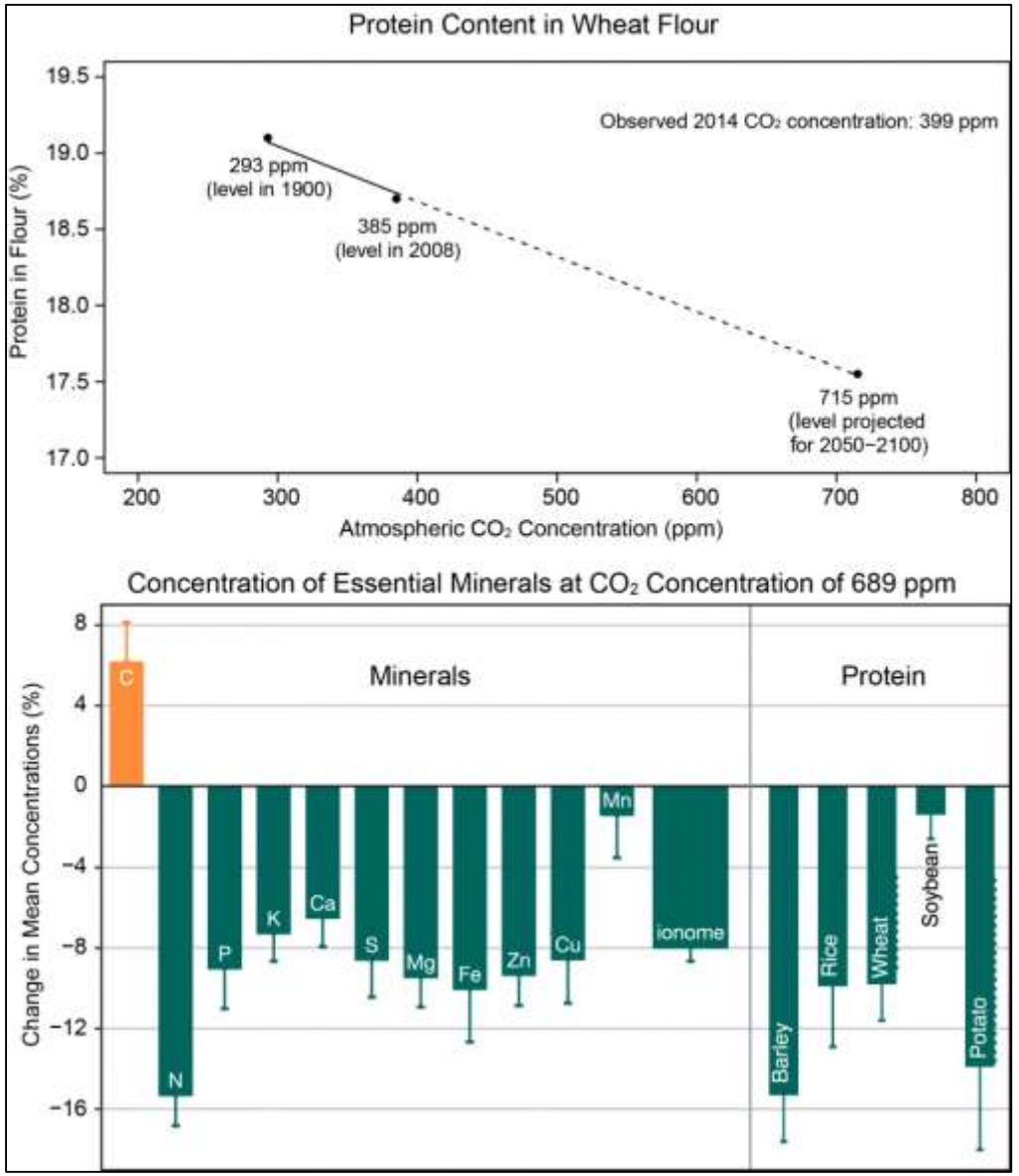
Food security

- Insecurity rises with rising food prices; people turn to nutrient poor but calorie rich food
- Nutritional value of some food may decline
  - Increased atmospheric CO2 is related to decreased protein in crops such as barley, sorghum and soy
- Food security does depend on more than climate change, such as socioeconomics, politics, etc. but will serve to exacerbate disadvantaged communities

Crimmins (EPA), taken from USGCRP 2016

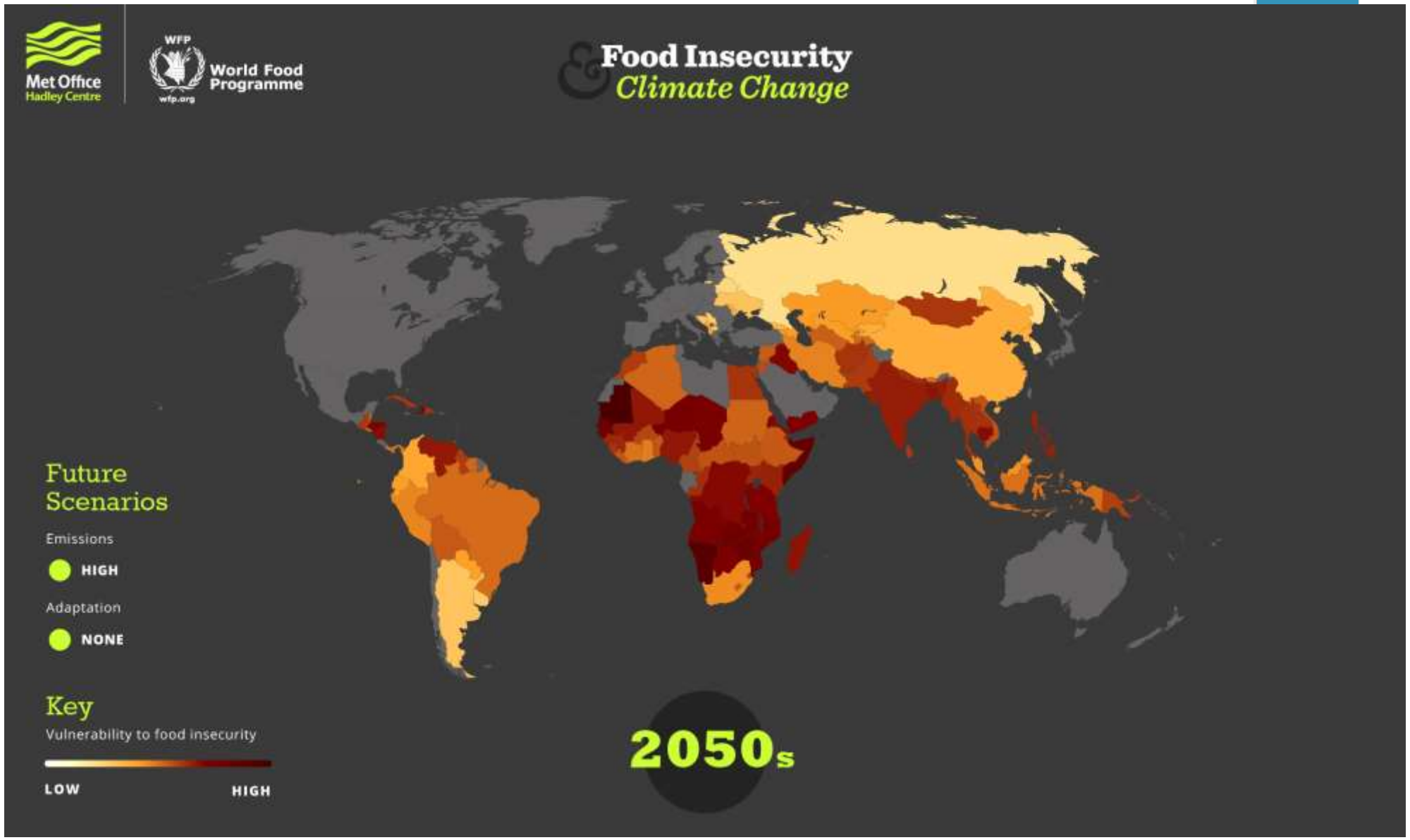
Food security

- Insecurity rises with rising food prices; people turn to nutrient poor but calorie rich food
- Nutritional value of some food may decline
  - Increased atmospheric CO2 is related to decreased protein in crops such as barley, sorghum and soy
- Food security does depend on more than climate change, such as socioeconomics, politics, etc. but will serve to exacerbate disadvantaged communities



Crimmins (EPA), taken from USGCRP 2016

Food security



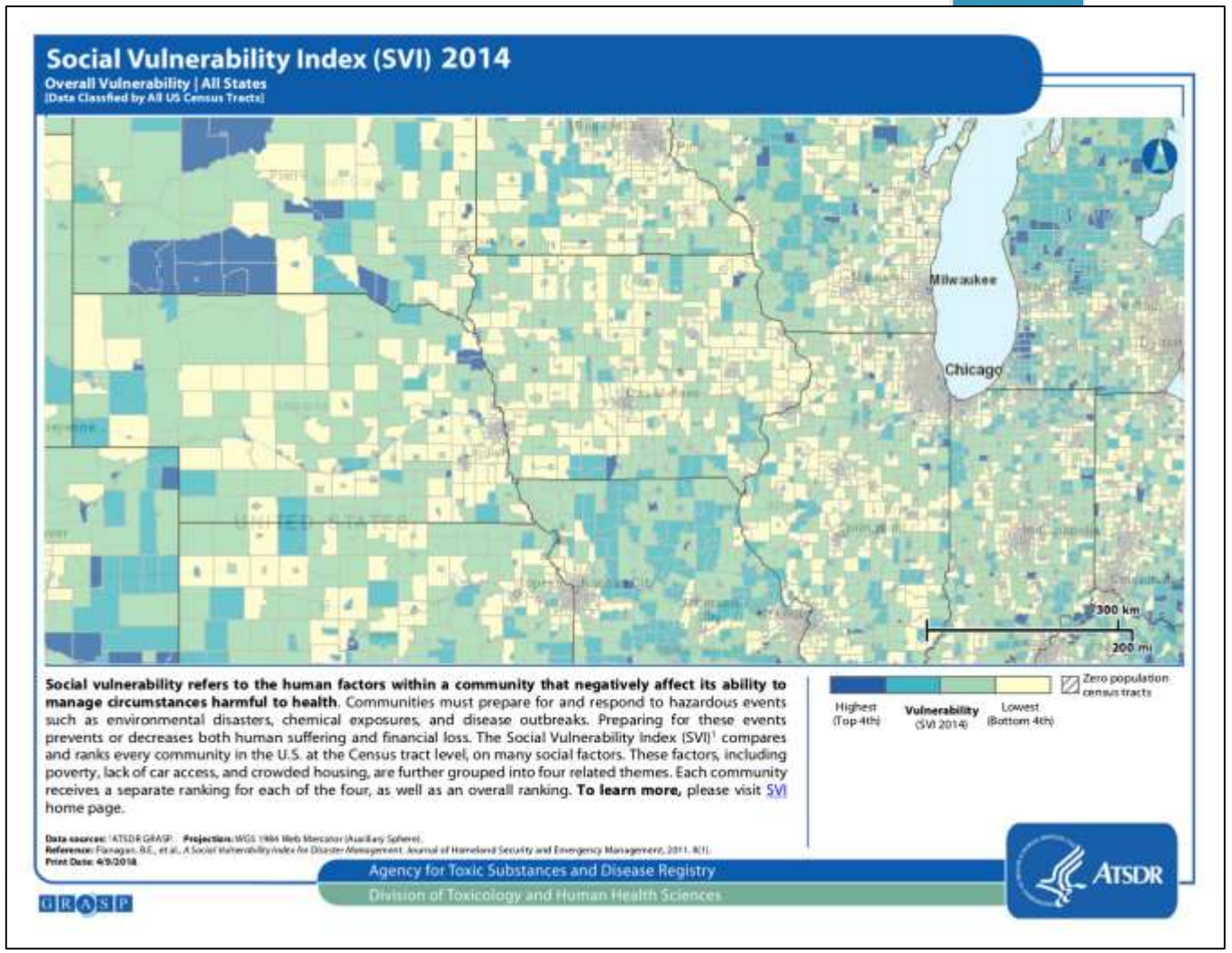
Climate change and human health

-How will climate change impact the human health in Iowa?

Climate change and human health

- Populations of concern

- Most Vulnerable at Most Risk
  - Climate change will amplify some of the existing health threats the nation now faces
  - Certain people and communities are especially vulnerable, including children, the elderly, the sick, the poor, and some communities of color.



Climate change and human health

So …. What do we do to mitigate risks?

References

- Luber, G., K. Knowlton, J. Balbus, H. Frumkin, M. Hayden, J. Hess, M. McGeehin, N. Sheats, L. Backer, C. B. Beard, K.
  L. Ebi, E. Maibach, R. S. Ostfeld, C. Wiedinmyer, E. Zielinski-Gutiérrez, and L. Ziska, 2014: Ch. 9: Human Health. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 220-256. doi:10.7930/J0PN93H5.

- Smith, K.R., A. Woodward, D. Campbell-Lendrum, D.D. Chadee, Y. Honda, Q. Liu, J.M. Olwoch, B. Revich, and R. Sauerborn, 2014: Human health: impacts, adaptation, and co-benefits. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 709-754.

- USGCRP, 2016: *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, DC, 312 pp. http://dx.doi.org/10.7930/J0R49NQX

References

- Hannah, L, et al. 2013. Climate change, wine, and conservation. Proc Natl Acad Sci USA. 110:6907–6912
- Hatfield, J., G. Takle, R. Grotjahn, P. Holden, R. C. Izaurralde, T. Mader, E. Marshall, and D. Liverman, 2014: Ch. 6: Agriculture. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 150-174. doi:10.7930/J02Z13FR.
- Ortiz-Bobea A. (2018) U.S. Maize Yield Growth and Countervailing Climate Change Impacts. In: Lipper L., McCarthy N., Zilberman D., Asfaw S., Branca G. (eds) Climate Smart Agriculture. Natural Resource Management and Policy, vol 52. Springer, Cham

- https://www.climate.gov/news-features/climate-and/climate-beer
- http://www.climatecentral.org/gallery/graphics/theres-trouble-brewing-for-beer
- https://www.sciencedirect.com/science/article/pii/S2212977414000222
- https://www.npr.org/sections/thesalt/2017/12/19/571966327/sorry-folks-climate-change-wont-make-chocolate-taste-better
- https://www.climate.gov/news-features/climate-and/climate-chocolate