Vulnerability and Resilience of Human Populations

Session 8

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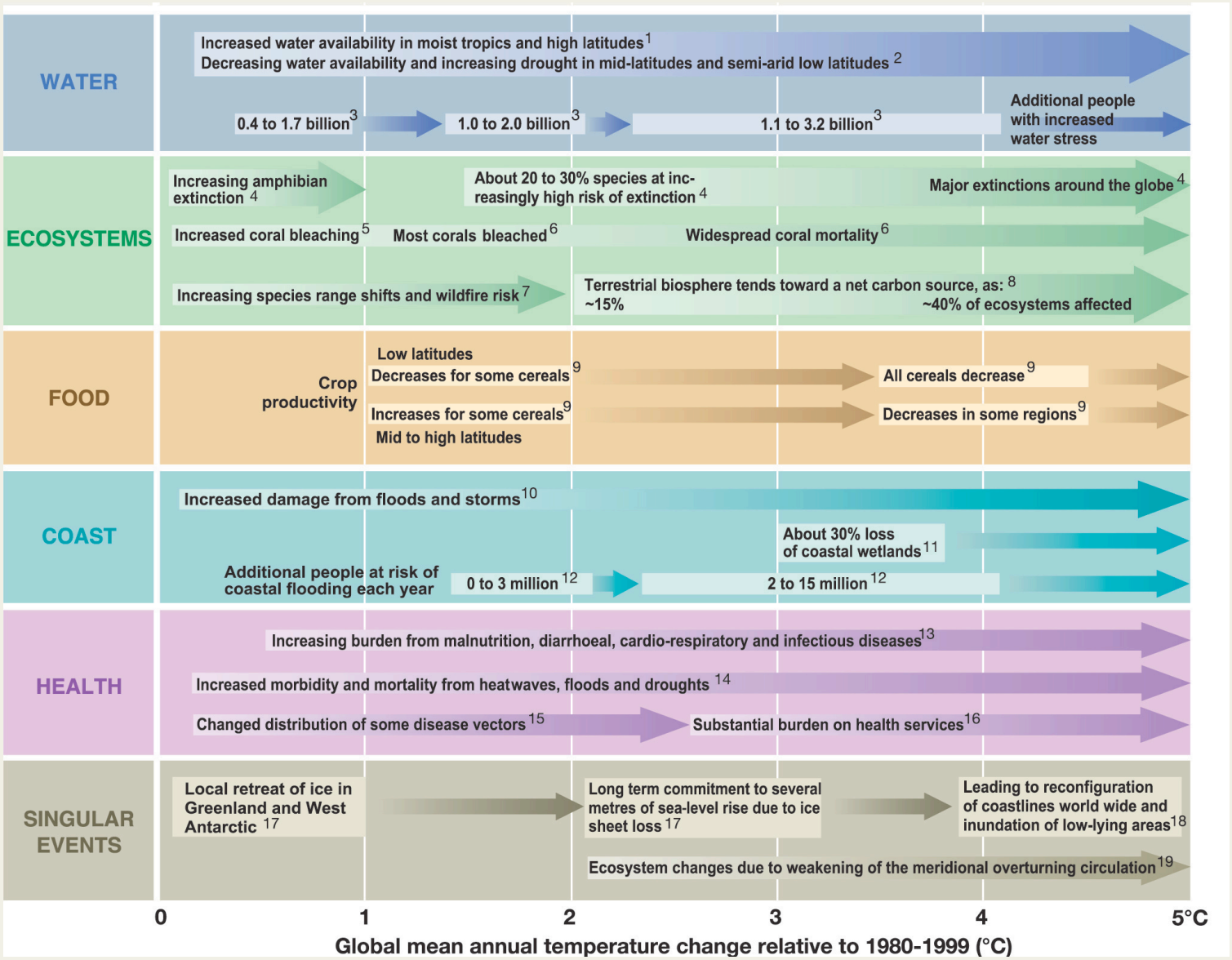
Changing Planet Study Group

June 28 – July 1, 2011

Cooling the Liberal Arts Curriculum
A NASA-GCCE Funded Project



Source: IPCC 2007 WG2, Table 20.8

Who will be impacted by climate change? How?

- Types & severity of impacts will differ for people living in different places, contexts, time periods









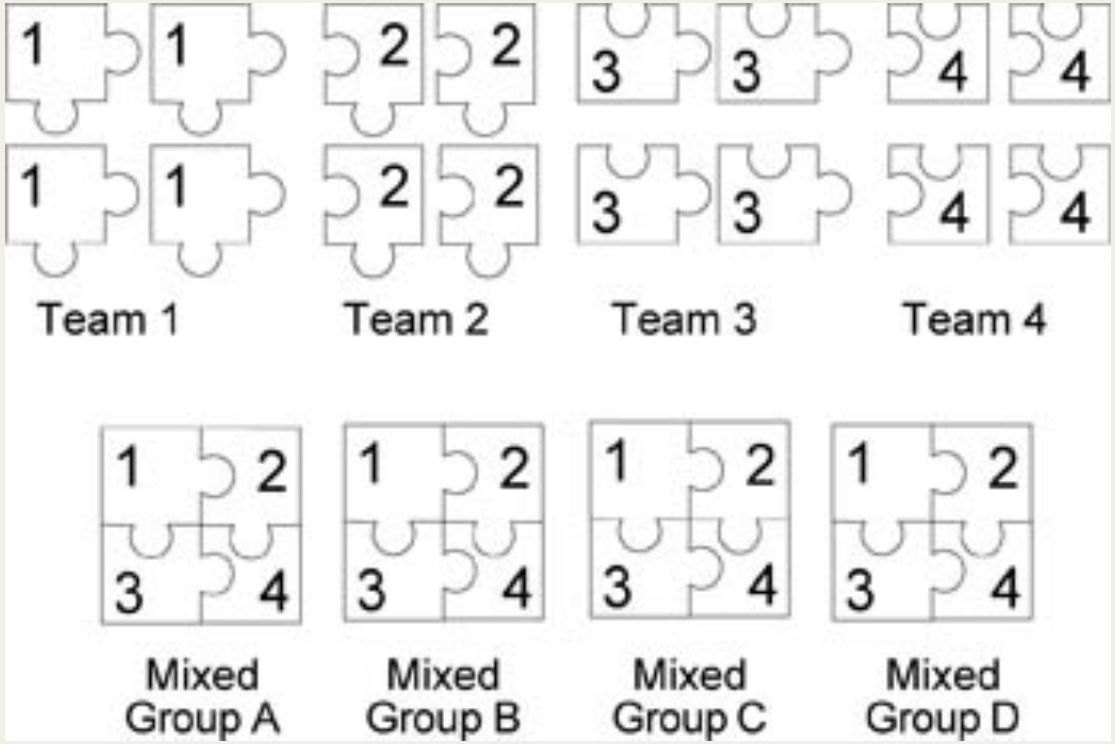

Who is at risk? Who is vulnerable? Vulnerable to what?

- **Vulnerability**: susceptibility to harm from exposure to a hazard or stress.

- Vulnerability is shaped by
  - Exposure
  - Sensitivity
  - Resilience, capacity

- Vulnerability has biophysical and social causes
  - Similarly exposed people can suffer very different consequences
  - Characteristics, conditions of the exposed individual, community, society are important in determining impacts

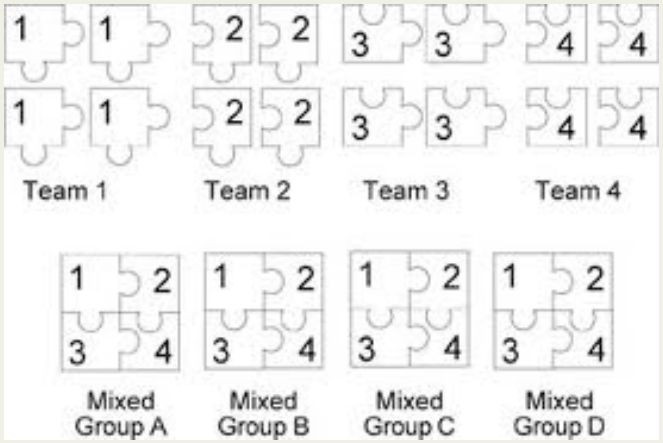
Jigsaw Technique



From Barbara Tewksbury, On the Cutting Edge:
http://serc.carleton.edu/NAGTWorkshops/coursedesign/tutorial/jigsaw.html

Climate vulnerability jigsaw

1. Form case study teams
   - Each team reads and discusses a different case study
   - Identify who is vulnerable, to what are they vulnerable, why they are vulnerable
   - Decide key ideas to teach to the other teams
2. Form new groups, w/ 1 member of each team in each new group
   - Each person teaches the key ideas from her/his case study to members of the group
   - The group discusses commonalities and differences across the case studies
3. Each member of the class writes a synthesis of nature and causes of vulnerability to climate change
4. Jigsaw Plus (optional): Reconvene original case study teams
   - Teams review the nature and causes of vulnerability for their case study
   - Propose and develop joint recommendations for measures to reduce vulnerability
   - Present joint recommendations to the class



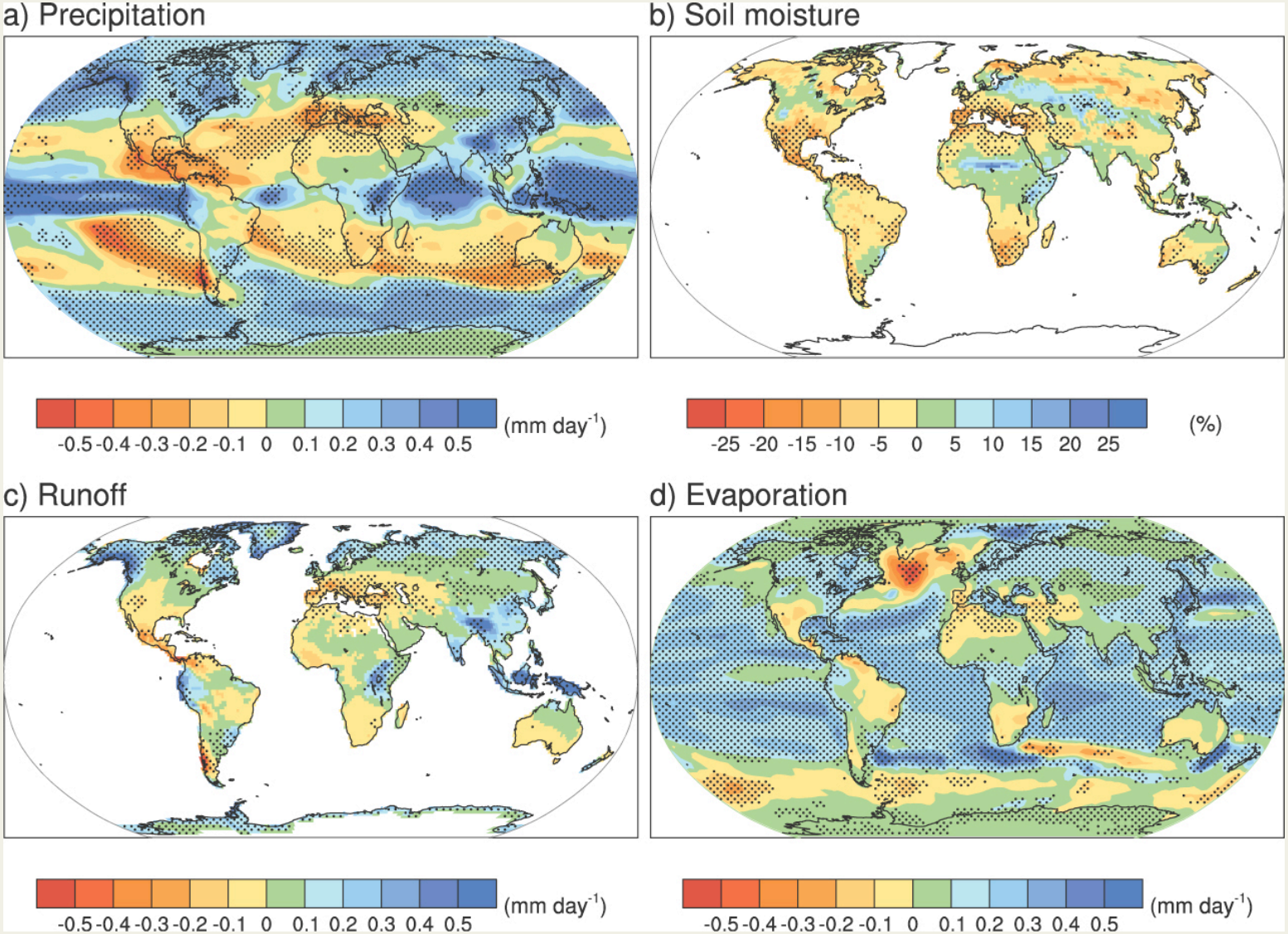
We'll do step 1 of the jigsaw

- Form case study teams; pick a reporter; read the case study
  - Pennsylvania
  - New York City
  - Kivalina, Alaska
  - Heihe River Basin, China
  - Bara Province, Sudan
- Discuss questions about the case study (15 mins)
  - What are the climatic hazards to which people & systems are exposed?
  - Who and what are most vulnerable to the exposures?
  - What are the causes of their vulnerability?
- Discuss ideas for using jigsaws and other pedagogies (15 mins)
  - How would you structure next steps of this jigsaw?
  - Is the jigsaw technique appropriate for your climate related courses? How would you adapt it?
  - What other pedagogies could you use?
- Report back (3 mins each)
  - Learning goals for vulnerability to climate
  - Ideas for using jigsaws and other methods to teach about vulnerability

Exposure to climate change

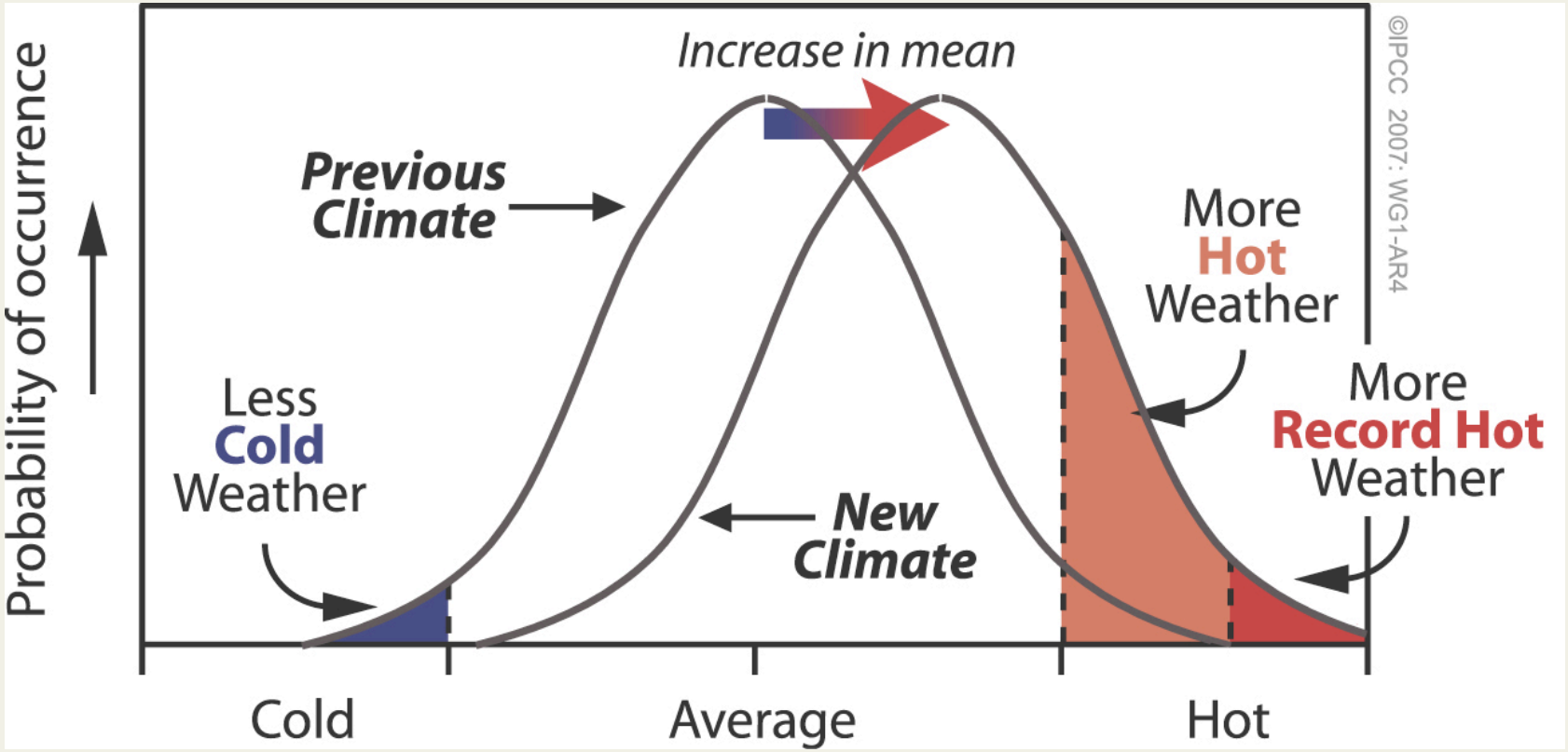
- Changes in
  - Temperatures
  - Precipitation
  - Evaporation, transpiration, ice melt, surface water runoff
  - Droughts, floods
  - Storms, storm surges
  - Sea level
- Changes in averages, variability, extremes
- Changes will vary spatially and temporally
- Magnitude of changes will be greater for greater GHG forcing

Exposure to changes in water availability



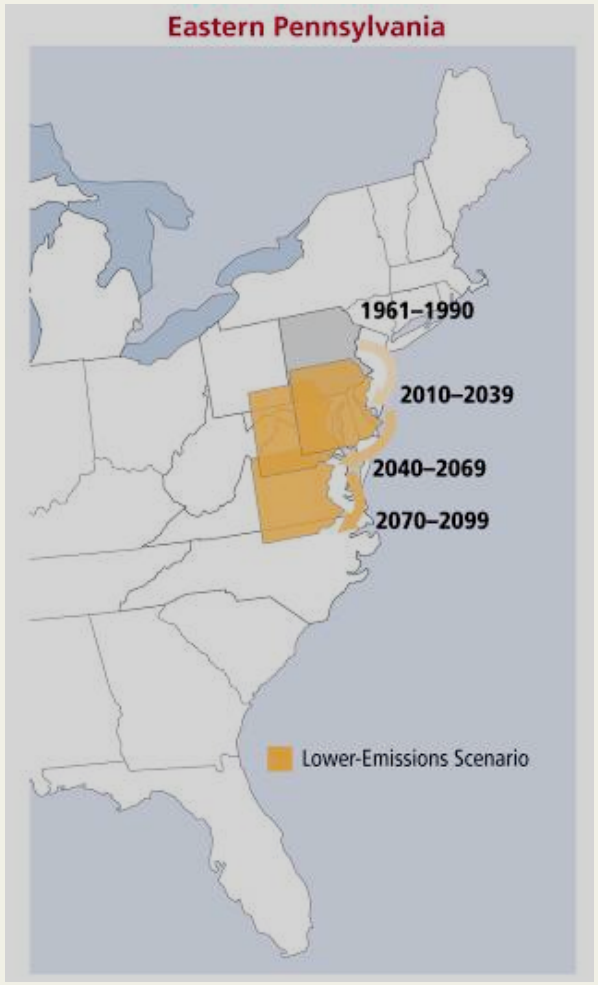
Annual mean changes 2080-2099 relative to 1980-1999, average of multiple models, A1B projections. Source: IPCC 2007 WGI, Figure 10.12.

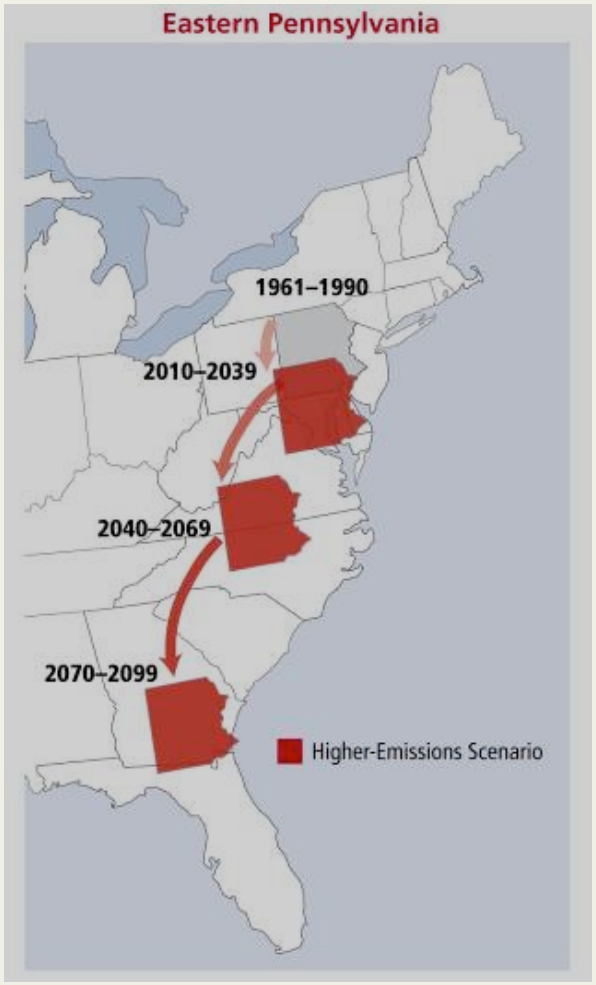
Extreme Weather Events



Source: IPCC 2007 WG1 (Box TS.5, Figure 1)

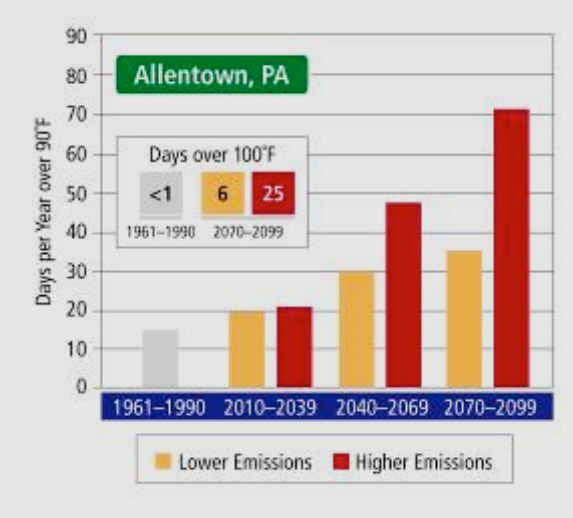
Shifting climate: heat index for Eastern PA

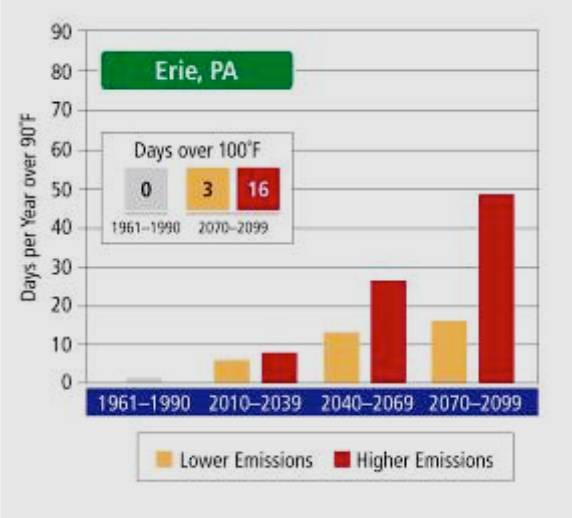


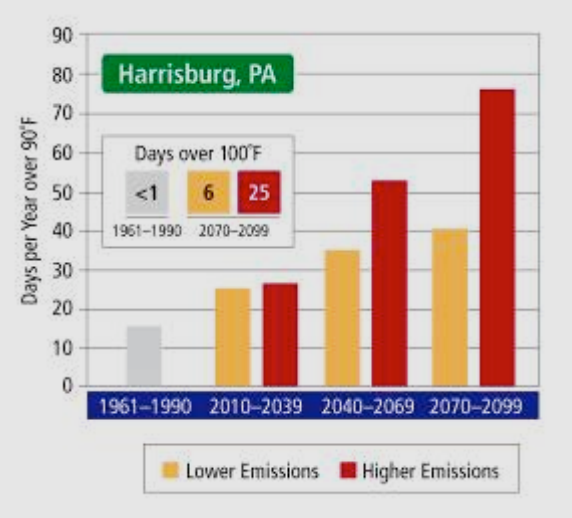


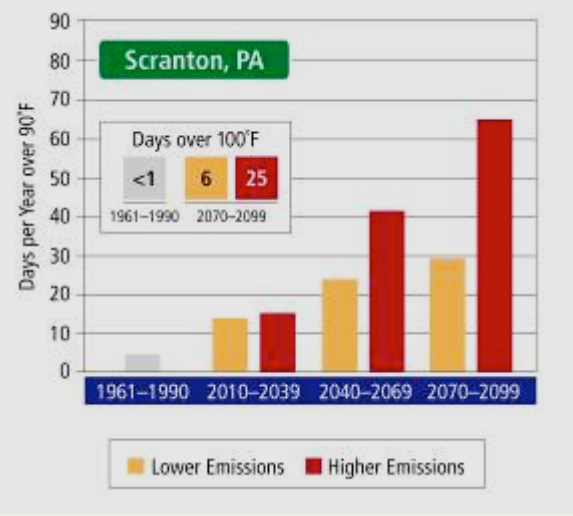
UCS, 2008

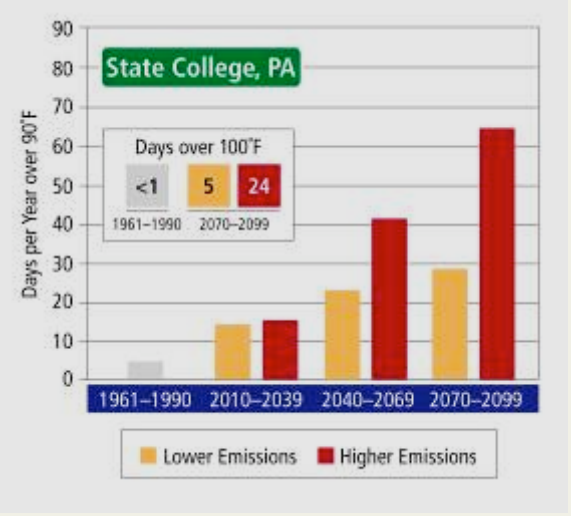
Extreme Heat – Cities and Towns



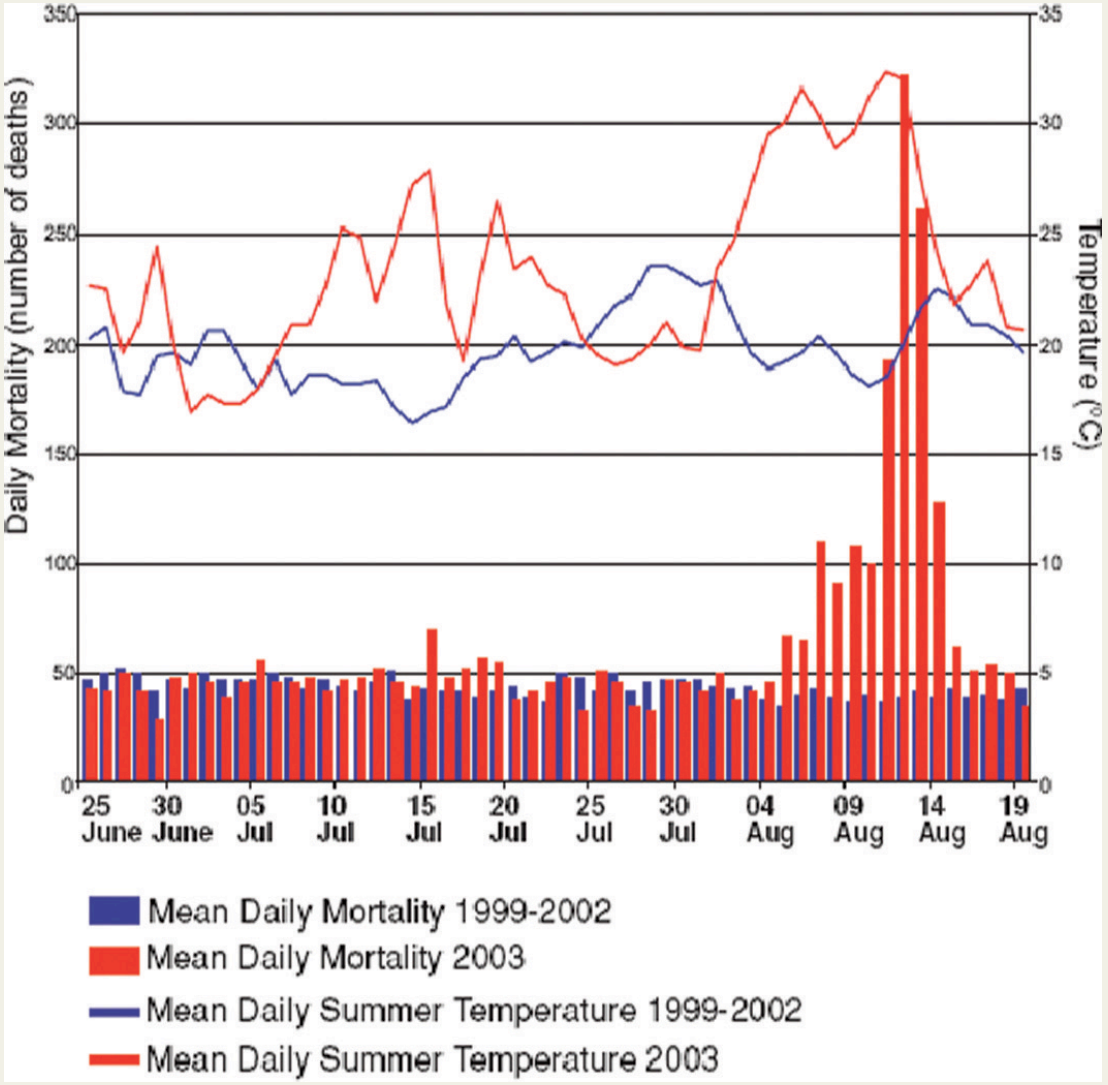








Source: UCS, 2008



Increase in daily mortality in Paris during heatwave of August 2003.
Source: IPCC, 2007, WGII, Figure 8.2

Sensitivity to climate change

- Factors that influence sensitivity
  - Natural resource based livelihoods
  - Condition of natural resources
  - Diversification of income sources
  - Quality of infrastructure

Capacity to cope, adapt to climate change

- Factors that influence capacity
  - Household capital: human, social, natural, manufactured, financial
  - Diversification of livelihoods
  - Health status
  - Social institutions, networks, safety nets
  - Participation in markets
  - Governance: functional or dysfunctional?
  - Multiple stresses that erode capacity

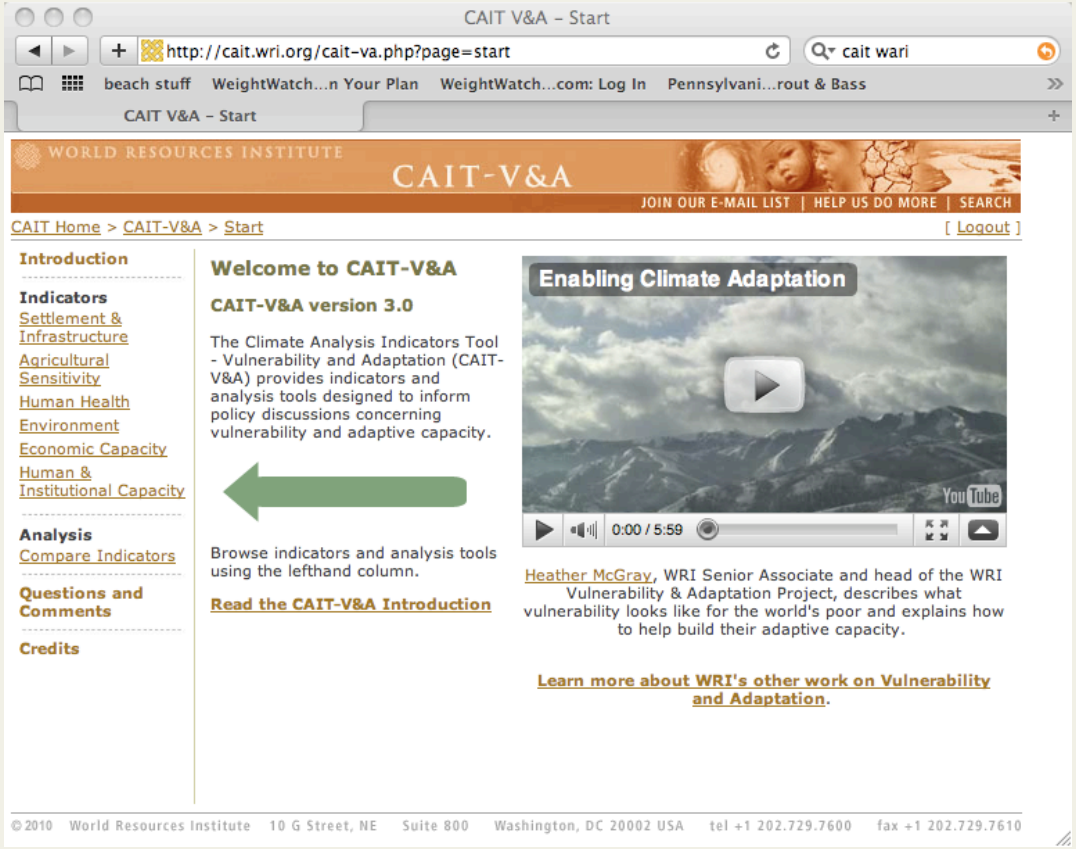
Essential principles of vulnerability
(Or: what should our students learn?)

- Climate change will affect almost everything
  - Positive & negative effects
  - Direct & indirect
- Impacts will differ for different people
- Who is vulnerable has biophysical & social determinants
- Vulnerability is a function of exposure, sensitivity, resilience/ adaptive capacity
- Vulnerability is high where there are significant exposures, high sensitivity & low capacity
- Vulnerability is greatest where
  - there are exposures to multiple stresses
  - natural systems are severely degraded, and
  - human systems are failing
- Highly vulnerable groups include
  - The poor, the marginalized
  - Elderly, young, infirm
  - Natural resource based livelihood groups
  - People in arid & semi-arid interiors
  - People in low lying coasts, small islands, flood plains
  - Coastal cities with weak institutions, weak governance
  - Cities with large informal settlements
- Climate change is a danger now, not just in distant future
- The danger can be reduced by
  - Reducing exposure
  - Reducing sensitivity (diversify livelihoods, hedge risk, share risk)
  - Increasing resilience, capacity

CAIT-V&A: http://cait.wri.org/

Indicators

- Settlement & infrastructure
- Agricultural sensitivity
- Human health
- Environment
- Economic capacity
- Human, institutional capacity



Useful resources

- See references in the workshop notebook, session 8
- IPCC website (www.ipcc.ch)
  - WGII report on impacts, adaptation & vulnerability
- USGCRP website (www.usgcrp.gov)
  - 2009 report Global Climate Change Impacts in US
- PA Climate Change Advisory Committee
  - http://www.depweb.state.pa.us/portal/server.pt/community/climate_change_advisory_committee/10412.
- UCS website (www.ucsusa.org)
  - 2008 report on climate change impacts in Pennsylvania
- WRI website (www.wri.org)
  - CAIT-VA database
  - EarthTrends database (http://earthtrends.wri.org/)

Extra Slides

Investigative Case Based Learning

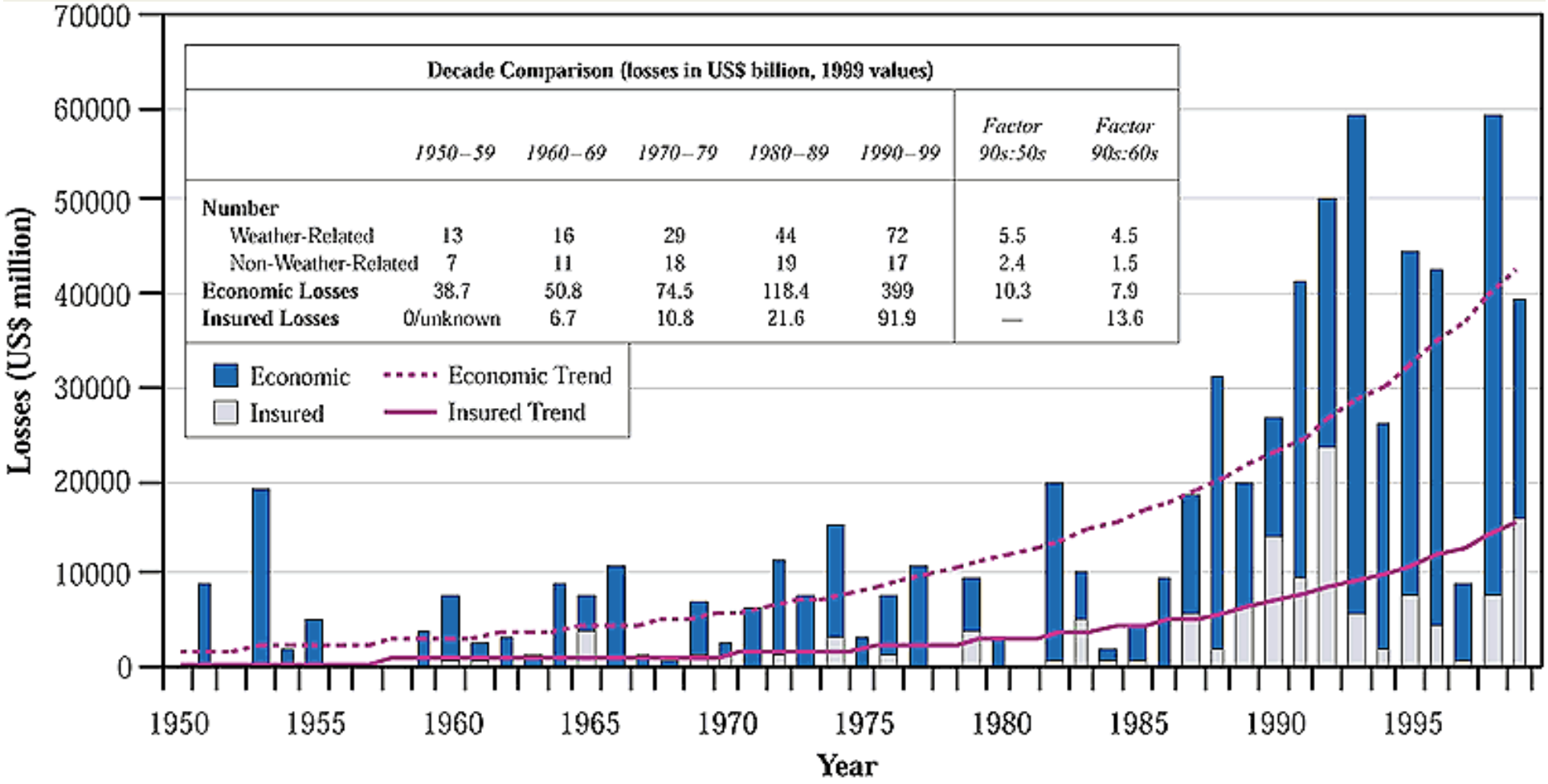
http://serc.carleton.edu/introgeo/icbl/index.html

- **Phase I. Problem Posing: Analyzing a Case**
  - Introduce the case
  - Recognize potential issues
  - Identify major themes
  - Pose specific questions via Know/Need to Know analysis
- **Phase II. Problem Solving: Investigating the Questions**
  - Obtain additional references/resources
  - Define problems further by sharing views and concerns
  - Design and conduct scientific investigations
- **Phase III. Peer Persuasion: Supporting Methods and Reasoning**
  - Produce materials that support understanding of the conclusions

Exposure to changes in extremes

- Cold days: fewer, warmer (*virtually certain*)
- Hot days: more, hotter (*virtually certain*)
- Heat waves: more frequent (*very likely*)
- Heavy rain events: more frequent (*very likely*)
- Drought affected area: increase (*likely*)
- Intense tropical cyclones: increased activity *(likely*)
- Extreme high sea level: more frequent (likely)

Source: IPCC 2007, WG1, S



Decade Comparison (losses in US$ billion, 1999 values)

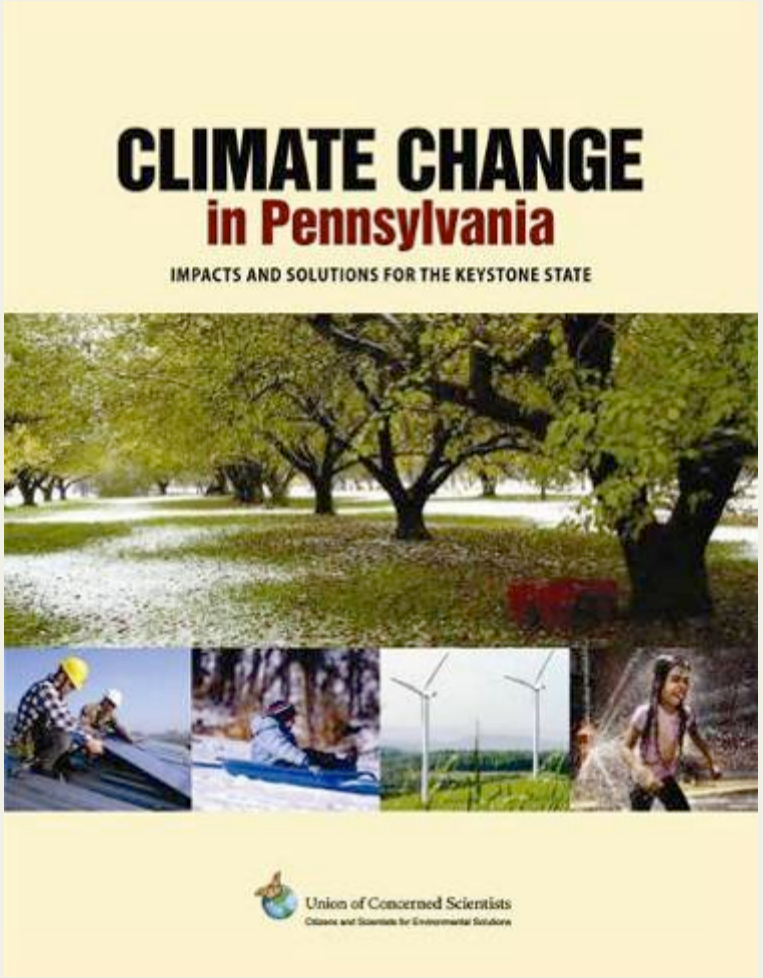
	1950–59	1960–69	1970–79	1980–89	1990–99	Factor 90s:50s	Factor 90s:60s
Number							
Weather-Related	13	16	29	44	72	5.5	4.5
Non-Weather-Related	7	11	18	19	17	2.4	1.5
Economic Losses	38.7	50.8	74.5	118.4	399	10.3	7.9
Insured Losses	0/unknown	6.7	10.8	21.6	91.9	—	13.6

Source: IPCC 2001, WGII, Figure TS-5

July 2007

Northeast Climate Impacts Assessment

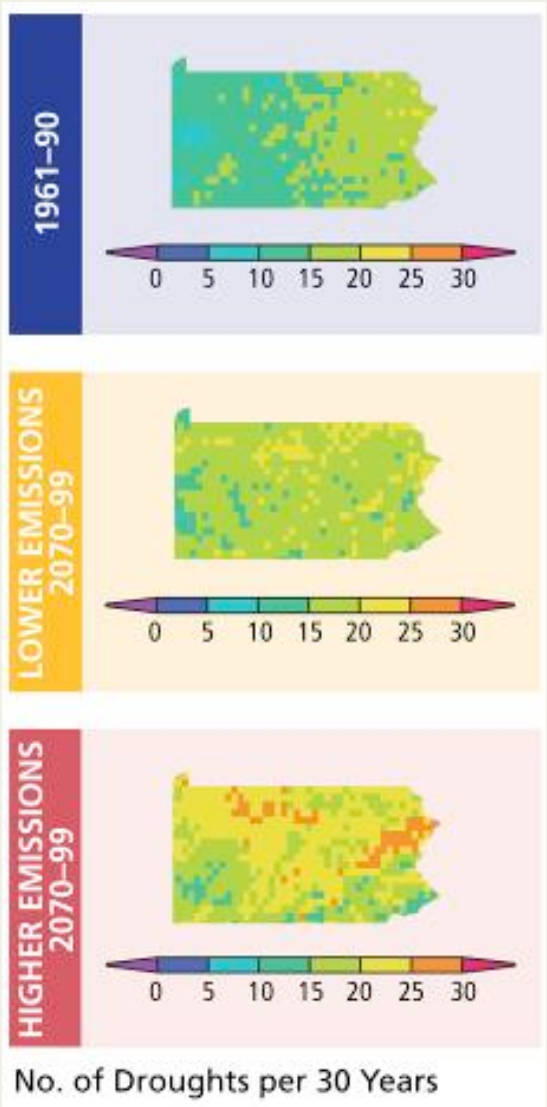
2008 Report from Union of Concerned Scientists



www.northeastclimateimpacts.org/pa

Increasing summer drought

- Hotter summers lead to increased evaporation and reduced soil moisture
- Under higher emissions, short-term droughts projected every 1-2 years in many parts of the state

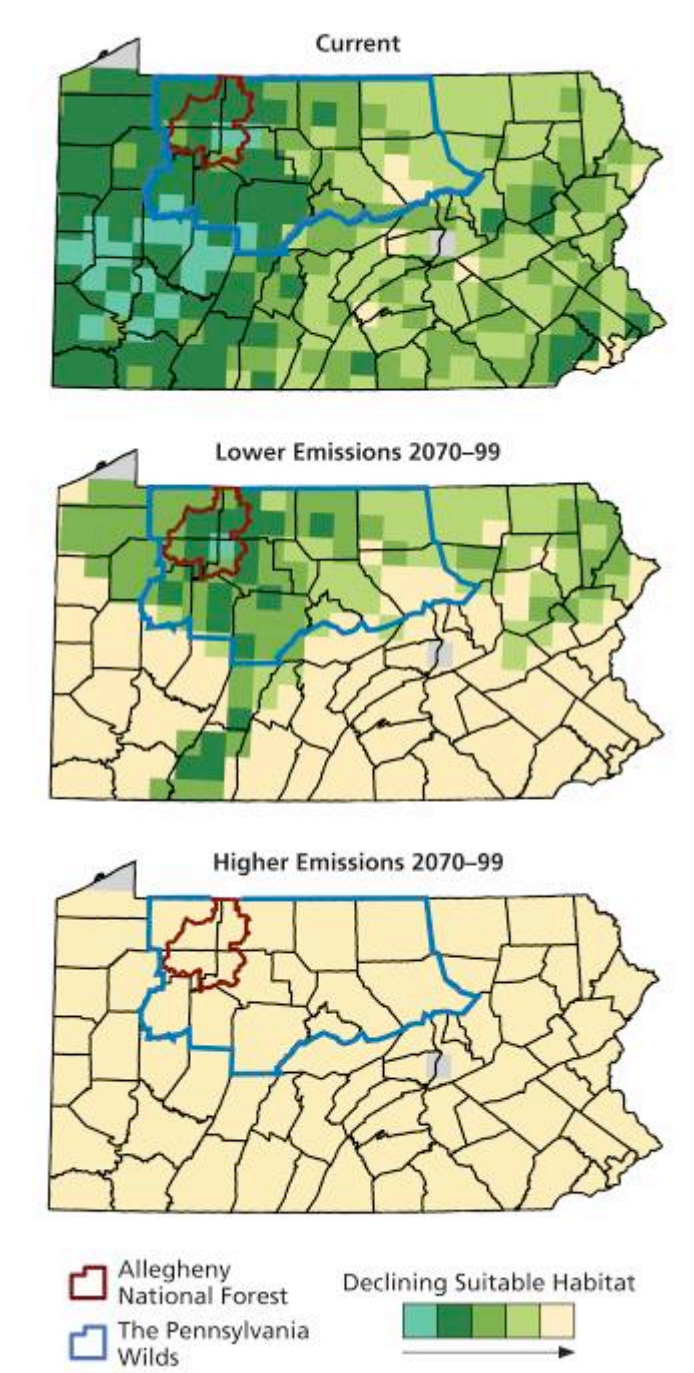


UCS, 2008

Ecosystem Impacts

Black Cherry

- PA fine furniture industry
- Lower emissions – half of suitable habitat lost
- Higher emissions – 80% of suitable habitat lost
- Similar results for maple, beech and birch



Infrastructure – sewage overflow

- With increased rainfall, sewage and stormwater systems in cities may not cope with flooding

iStock.photocom/
2windspa

3 Rivers Wet Weather
Inc

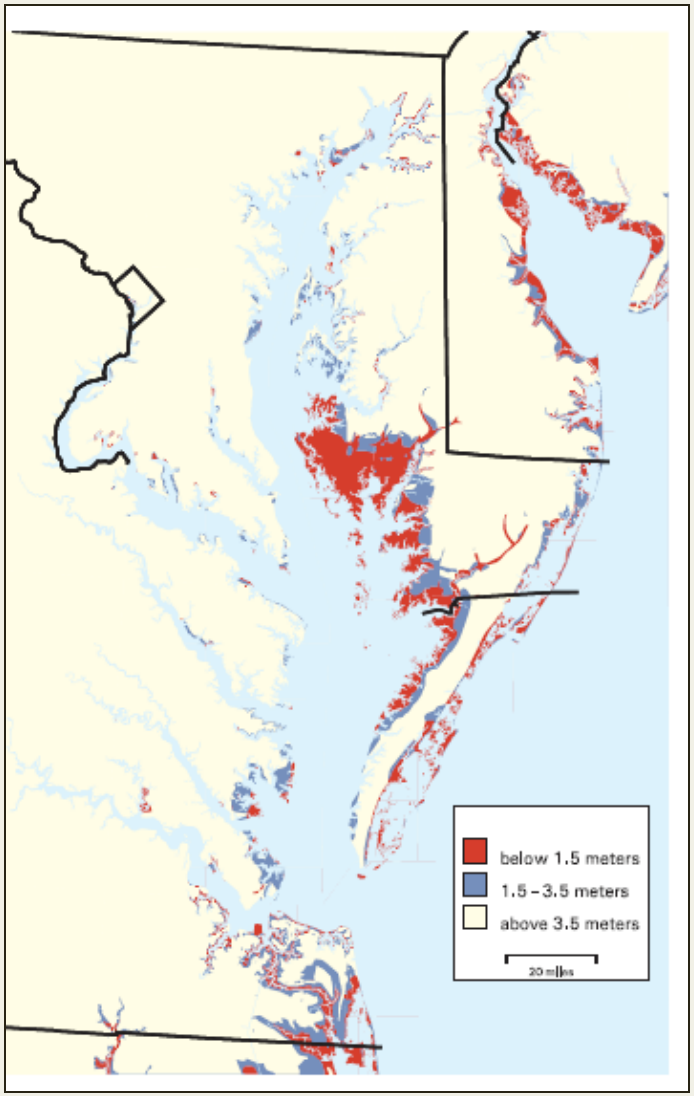
Climate Change & Water

- Increased temperatures
  - Loss of cold water streams

Pictures from: www.swf-wc.usace.army.mil; upload.wikimedia.org

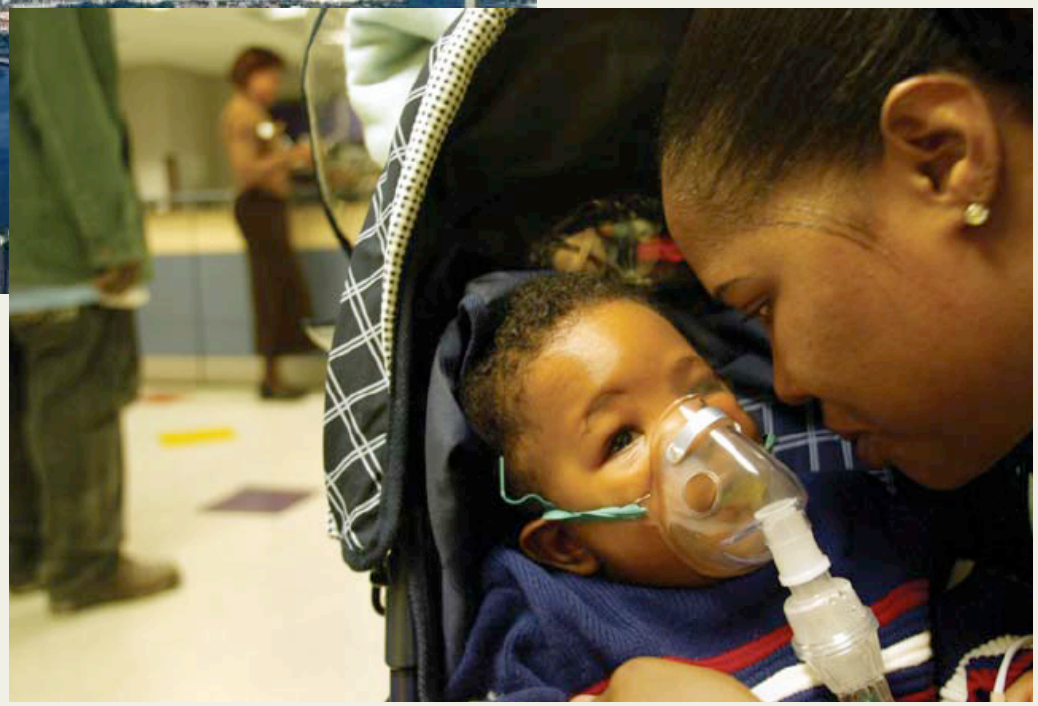
Climate Change & Water

- Sea level rise
  - Salt line migration
  - Loss of coastal areas, wetlands, and vegetative protective areas



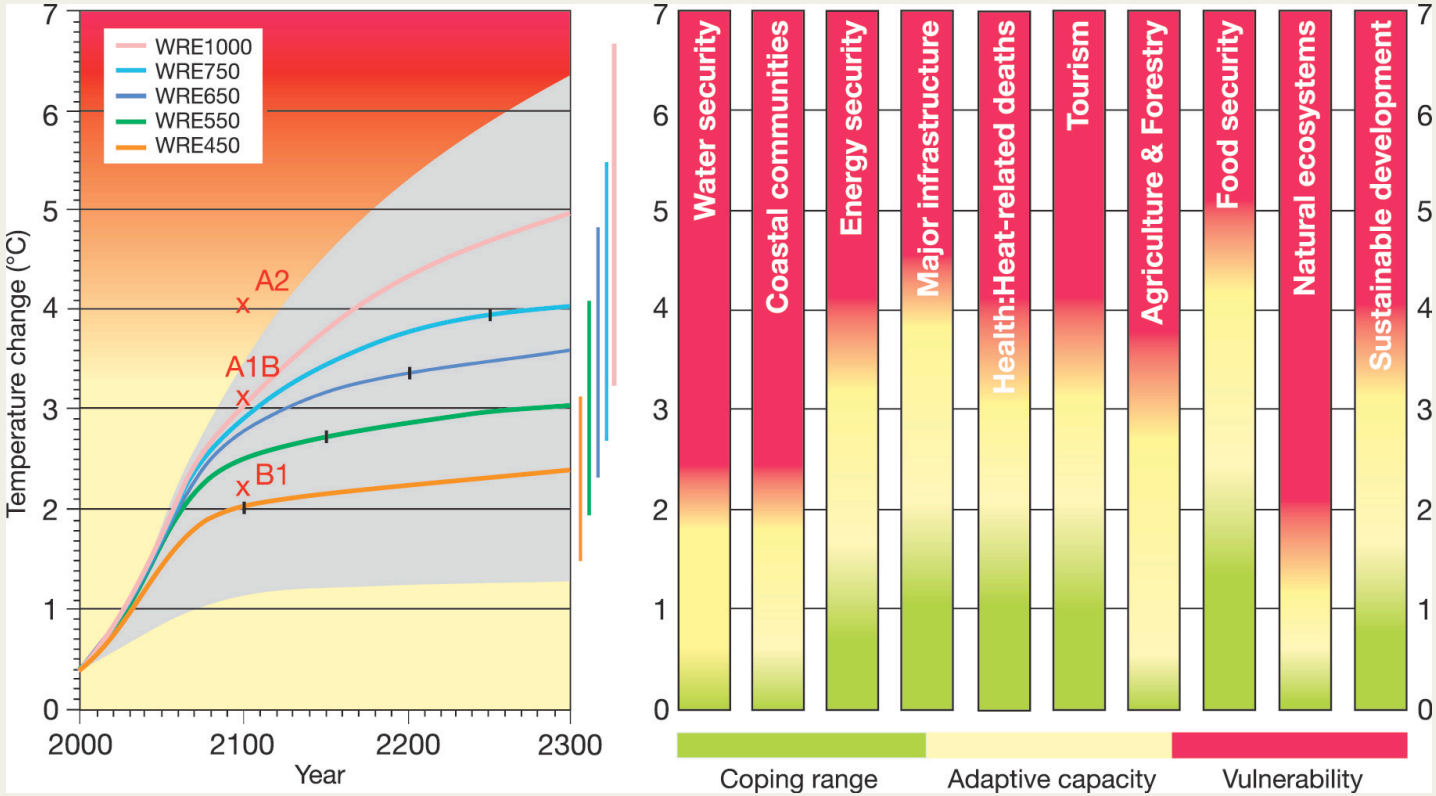
Images from: NOAA & www.annmeekins.com

Air Quality

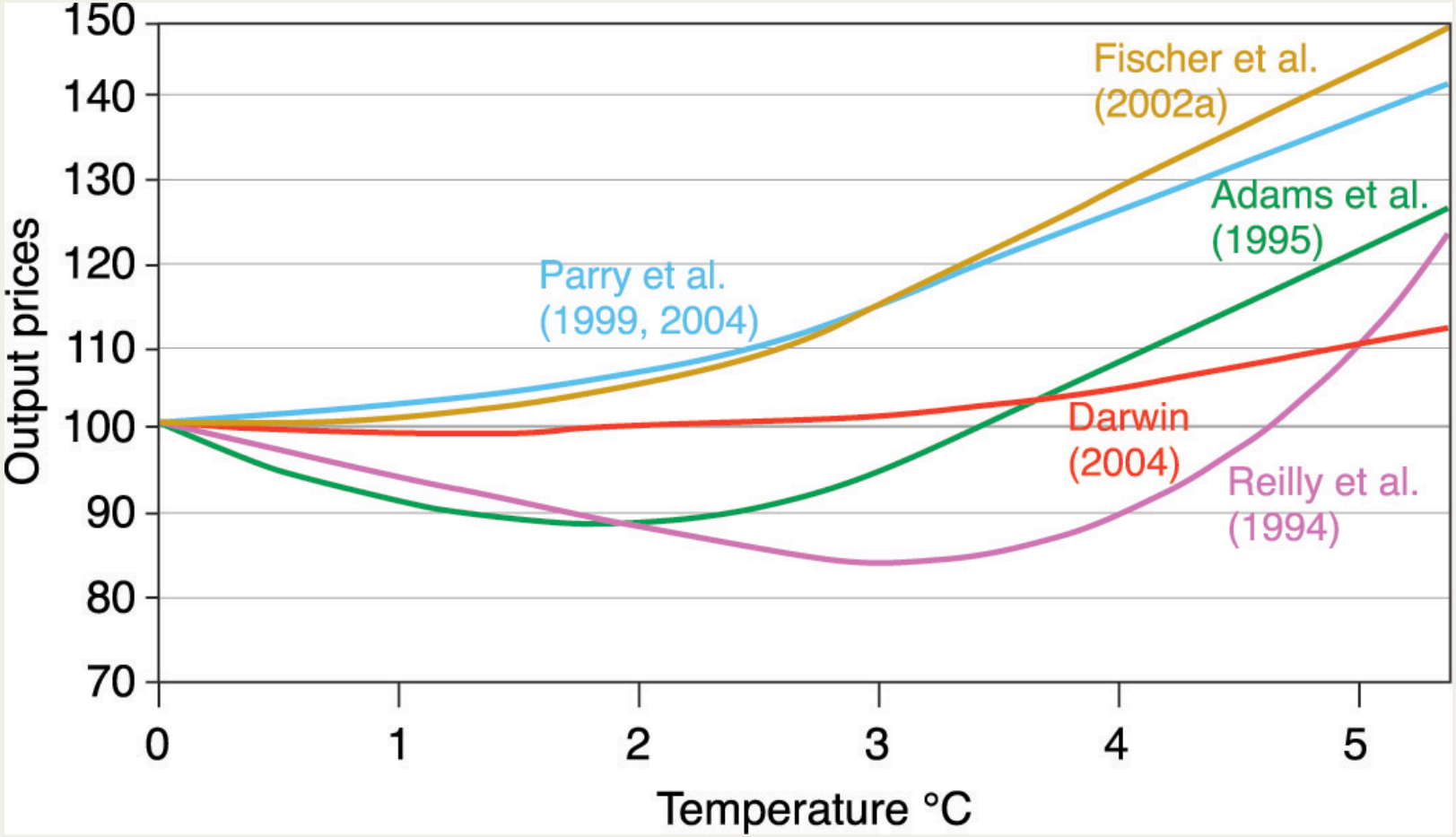


Tony Tremblay

James Estrin/The New York Times/Redux

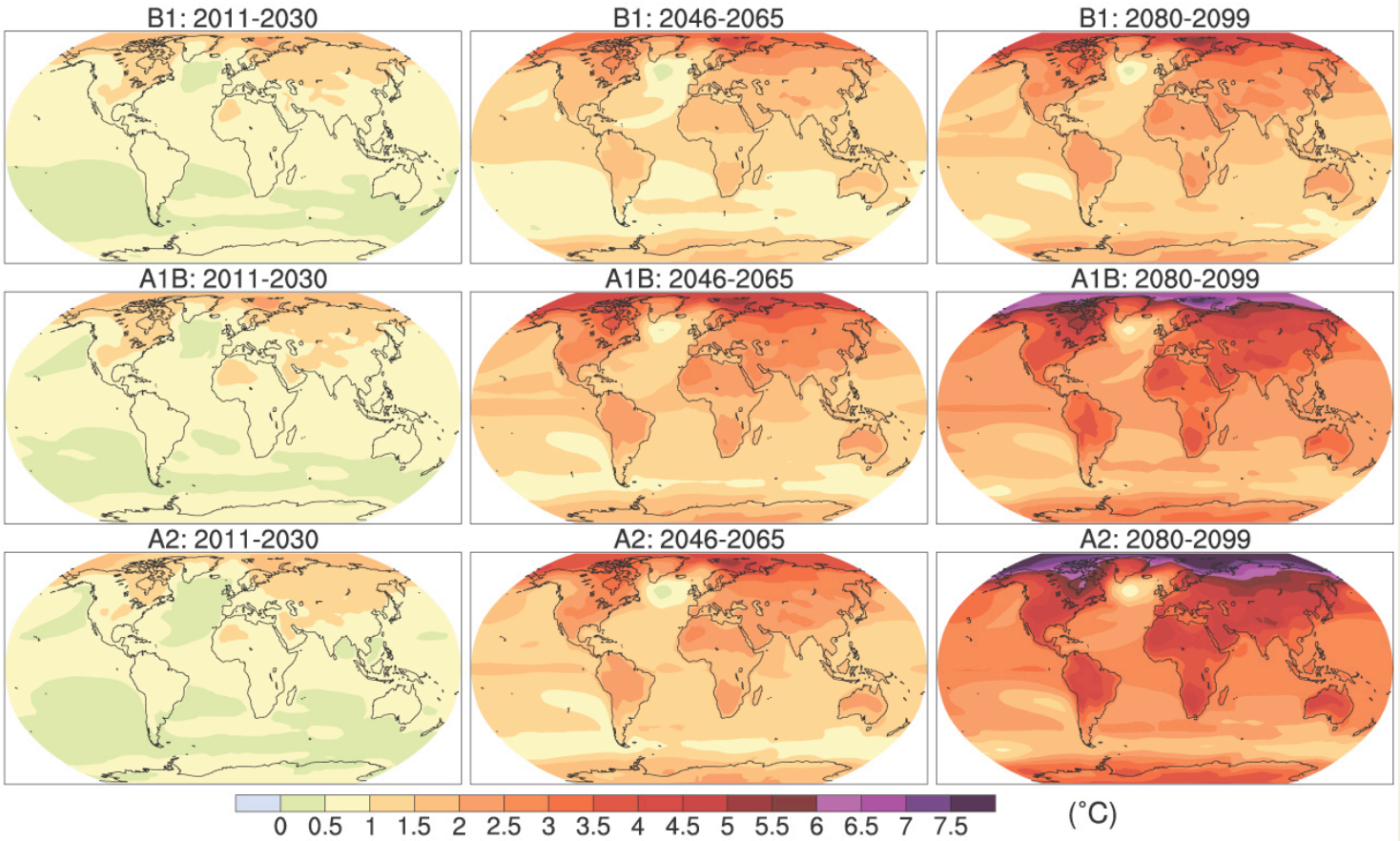


Vulnerability of key sectors in Australia and New Zealand from climate change.
Source: IPCC 2007, WGII, Figure 11.4

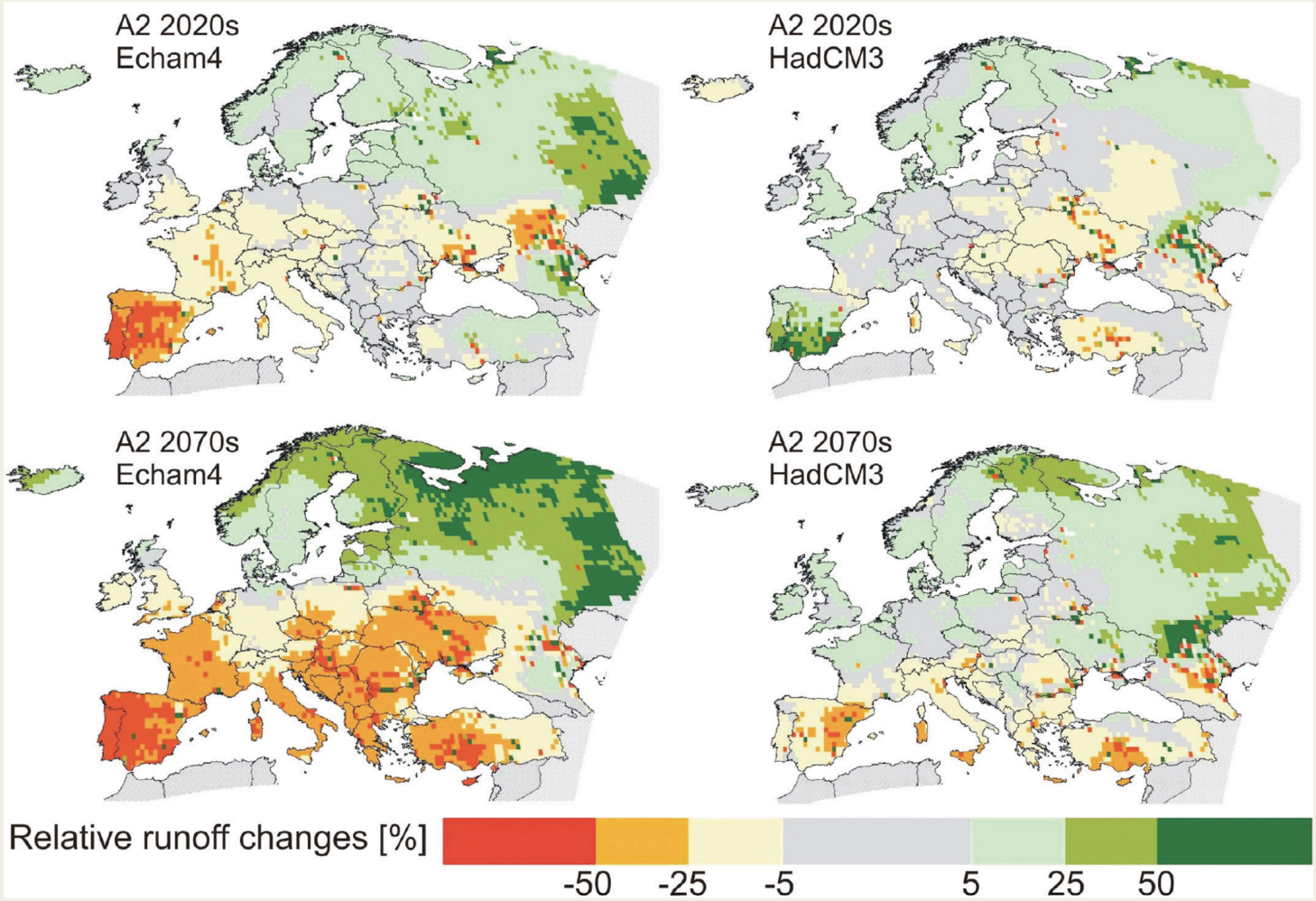


Changes in cereal prices (%) estimated for changes in global mean surface temperature.
Source: IPCC 2007, WGII, Figure 5.3.

Exposure to warming varies depending on where (and when) you live.



IPCC (2007), chapter 10, Figure 10.8. Multi-model mean annual surface warming relative to 1980-1999



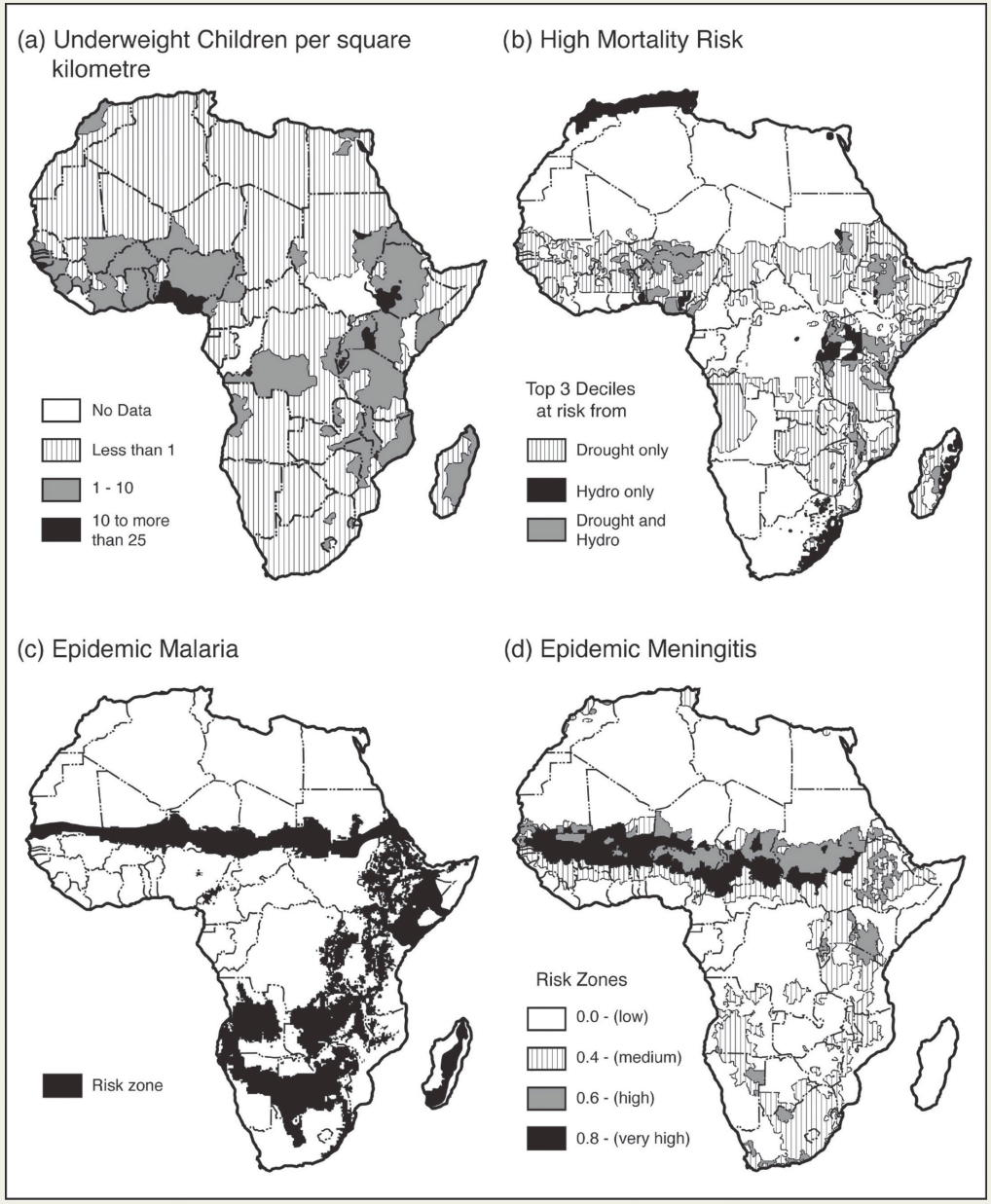
Change in annual runoff in 2020s and 2070s for A2 scenario, relative to 1961-1990.
Source: IPCC 2007, WGII, Figure 12.1

High vulnerability to climate change in Africa

Exposures
- Rising temperatures
- Declining rainfall
- More frequent drought, more extremes
- High population growth
- Conflict
- Disease vectors

Sensitivity
- High dependence on agriculture, natural resources
- Subsistence livelihoods
- Fragile, degraded ecosystems
- Crops near thermal limits

Capacity, Resilience
- Poverty, inequity
- Low education levels
- Inadequate infrastructure
  - access to clean water, sanitation
  - health care system
  - transportation
  - markets
- Poor governance
- Traditional institutions not working



Source: IPCC 2007, WGII, Figure 9.1.