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Swiss Agency for Development and Cooperation SDC

METEODAT

UNIVERSITÄT BERN

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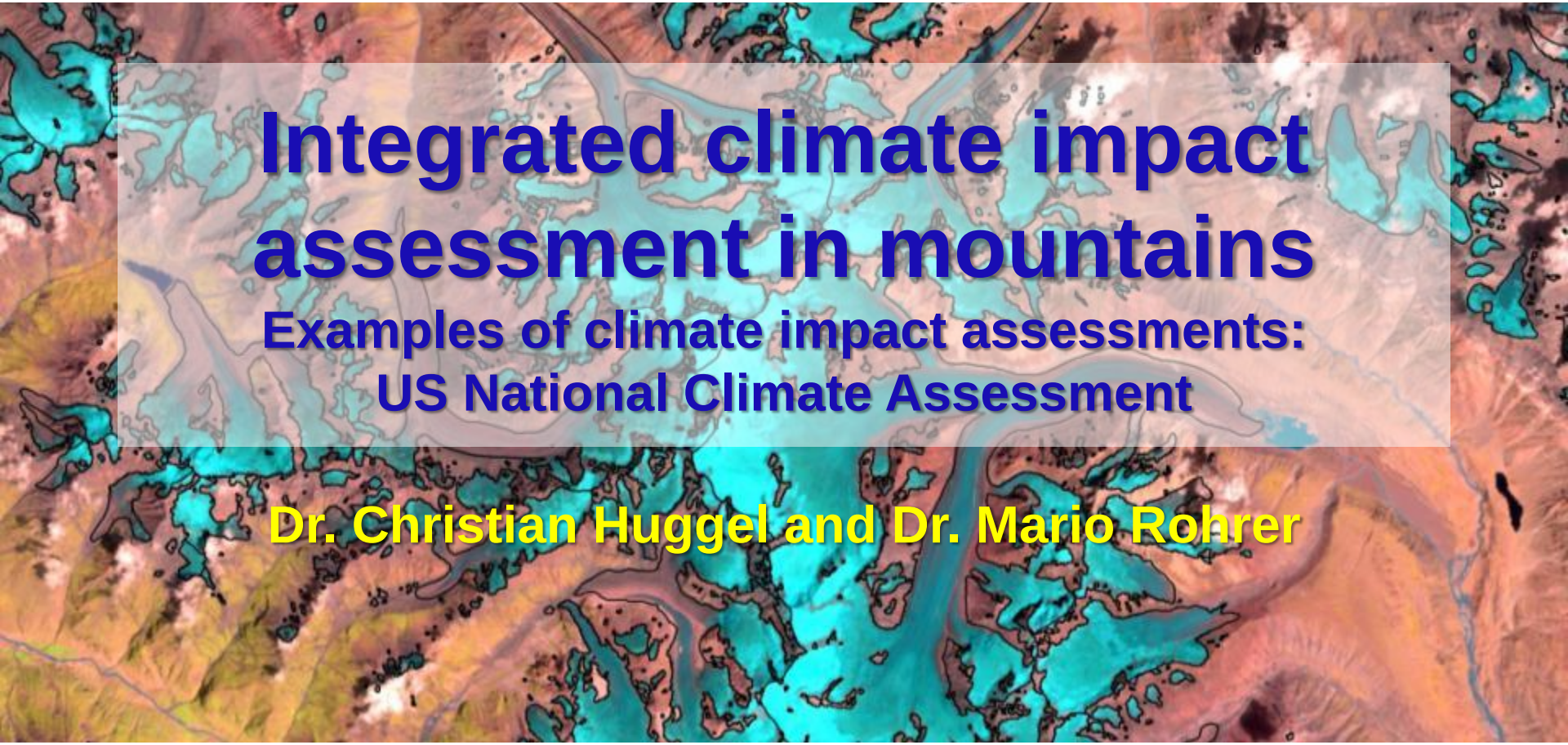
University of Zurich[UZH]



Integrated climate impact assessment in mountains

Examples of climate impact assessments: US National Climate Assessment

Dr. Christian Huggel and Dr. Mario Rohrer

IHCAP – Indian Himalayas Climate Change Adaptation Programme
Capacity building programme “Cryosphere” Level-2 (2015)

US Nat Climate Assessment

Sectoral and across-sectoral approach

Sectors covered by the assessment:

- Water resources
- Energy supply
- Transportation
- Agriculture
- Forestry
- Ecosystems, biodiversity and ecosystem services
- Human health

US Nat Climate Assessment

Sectoral and across-sectoral approach

Across-sector assessment:

- Water, energy, and land use
- Tribal culture, lands, and resources
- Land use and land cover
- Biogeochemical cycles and implications for ecosystems
- Rural communities
- Urban infrastructure and vulnerability

US Nat Climate Assessment

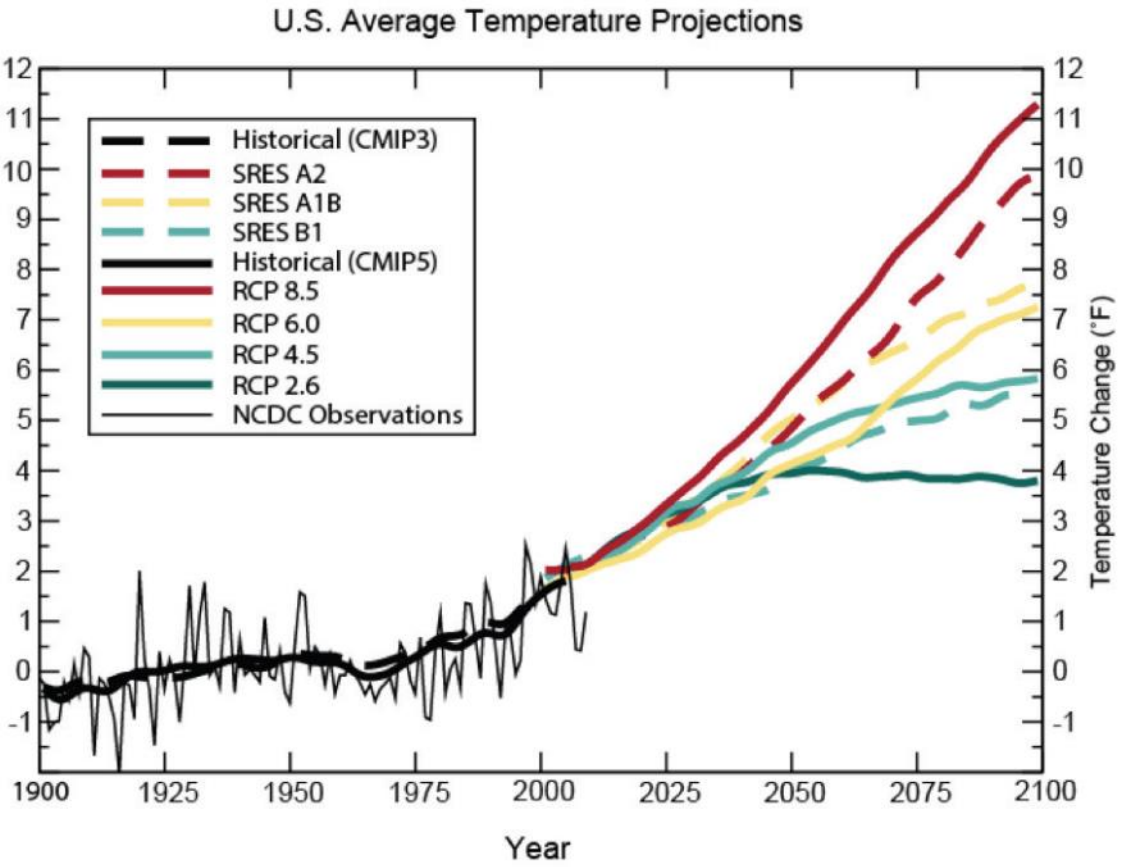
Sectoral and across-sectoral approach

Structure and consideration for the sectoral approach:
- Observed impacts
- Projected (future) impacts
- Risk analysis (what is at risk?) (and analysis of opportunities)

Structure and consideration for the cross-sector approach:
- Connections between sectors, and how impacts can be amplified or attenuated from one sector to another
- Influence of people‘s decisions on cascade of events, affecting vulnerabilities or resilience
- Interrelation of adaptation and mitigation

US Nat Climate Assessment

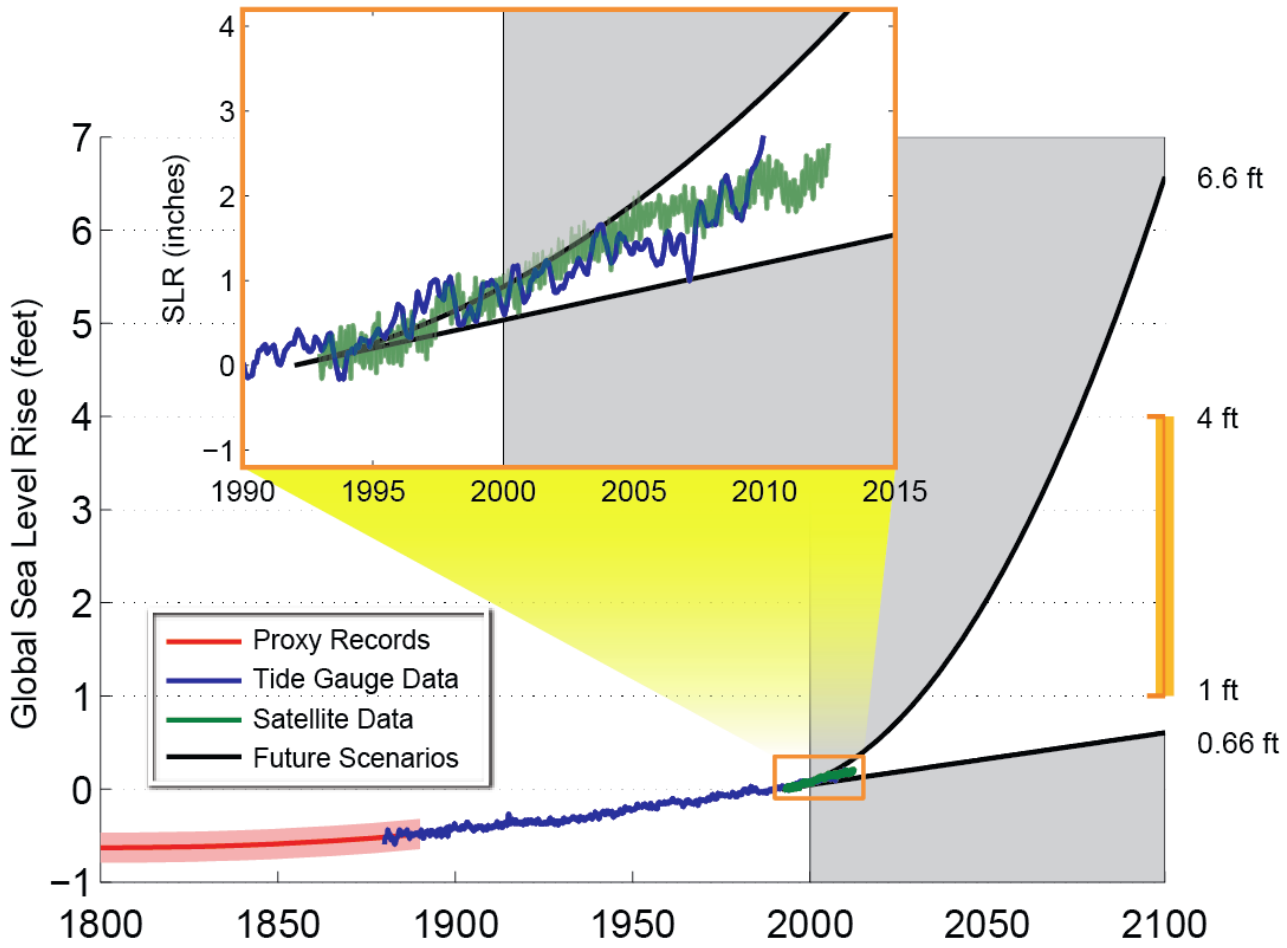
Climatic basis



Reference for figures and text if not indicated otherwise:
Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2

US Nat Climate Assessment

Climatic basis



US Nat Climate Assessment

Glaciers and sea level

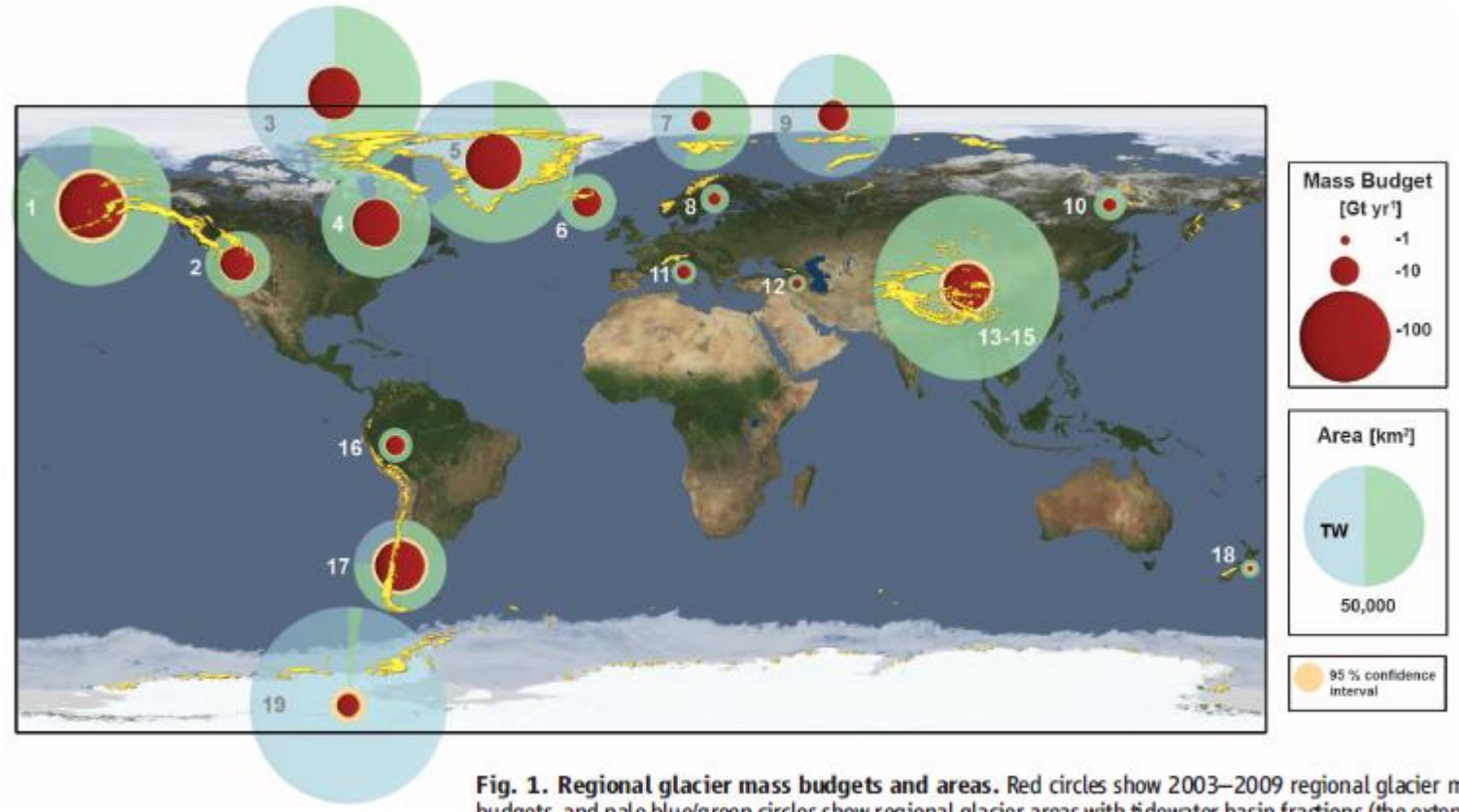


Fig. 1. Regional glacier mass budgets and areas. Red circles show 2003–2009 regional glacier mass budgets, and pale blue/green circles show regional glacier areas with tidewater basin fractions (the extent of ice flowing to termini in the ocean) in blue shading (Table 1). Peach-colored halos surrounding red circles show the 95% CI in mass change estimates, but can only be seen in regions that have large uncertainties.

Gardner et al. 2013

US Nat Climate Assessment

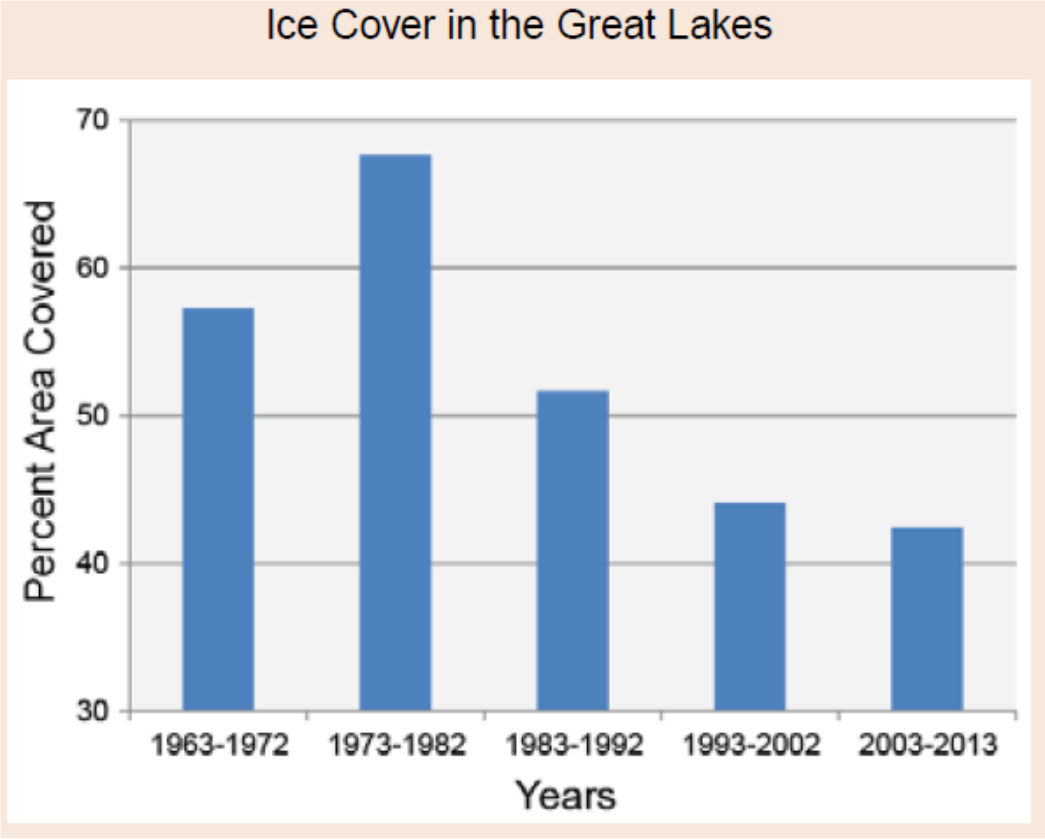
Glaciers and sea level

	Region	Total area (km^2)	Tidewater area (km^2)	Mass budget (kg m^{-2} $year^{-1}$)	Mass budget (Gt $year^{-1}$)	Method	Ref.
1	Alaska	87,100	11900	−570 ± 200	−50 ± 17	G	New, (*4*, *9*, *10*)
2	Western Canada/United States	14,600	0	−930 ± 230	−14 ± 3	gl	(*2*)
3	Arctic Canada north	104,900	48,800	−310 ± 40	−33 ± 4	I, G	New, (*4*, *13*)
4	Arctic Canada south	40,900	3,000	−660 ± 110	−27 ± 4	I, G	New, (*4*, *13*)
5	Greenland	89,700	31,300	−420 ± 70	−38 ± 7	I	New
6	Iceland	11,100	0	−910 ± 150	−10 ± 2	G, gl	New, (*2*, *4*)
7	Svalbard	34,000	14,900	−130 ± 60	−5 ± 2	I, G	New, (*4*, *8*)
8	Scandinavia	2,900	0	−610 ± 140	−2 ± 0	gl	(*2*)
9	Russian Arctic	51,600	33,400	−210 ± 80	−11 ± 4	I, G	New, (*4*, *14*)
10	North Asia	3,400	0	− 630 ± 310	−2 ± 1	gl	(*2*)
11	Central Europe	2,100	0	−1060 ± 170	−2 ± 0	gl	(*2*)
12	Caucasus and Middle East	1,100	0	−900 ± 160	−1 ± 0	gl	(*2*)
13–15	HMA	118,200	0	−220 ± 100	−26 ± 12	I, G	New, (*4*)
16	Low latitudes	4,100	0	−1080 ± 360	−4 ± 1	gl	(*2*)
17	Southern Andes	29,400	7,000	−990 ± 360	−29 ± 10	G	New, (*4*, *25*)
18	New Zealand	1,200	0	−320 ± 780	0 ± 1	gl	(*2*)
19	Antarctic and sub–Antarctic	133,200	130,200	−50 ± 70	−6 ± 10	I	New
Total, excluding Greenland and Antarctic		506,600	119,000	−420 ± 50	−215 ± 26		
Global total		729,400	280,500	−350 ± 40	−259 ± 28		

Gardner et al. 2013

US Nat Climate Assessment

Lake ice changes



US Nat Climate Assessment

Sectoral and across-sectoral approach

Every sector of the U.S. economy is affected in some way, either directly or indirectly, by climate changes, including changes in temperature, rising sea levels, and more extreme precipitation events and droughts. But none of these sectors exist in isolation, and **each sector connects directly and indirectly to other sectors**. Forestry activities affect, and are affected by, water supply, changing ecosystems, impacts to biological diversity, and energy availability. **Water supply and energy use are completely intertwined**, since water is used to generate energy and energy is used to pump, treat, and deliver water. **Human health is affected by water supply, agricultural practices, transportation systems, energy availability, and land use** – among other factors. Human social systems and communities are also directly affected by extreme weather events and changes in natural resources like water; they are also affected both directly and indirectly by ecosystem health.
The 2014 National Climate Assessment addresses some of these topics individually, and others using a cross-sectoral approach that focuses on the **climate-related risks and opportunities that occur across sectors** – as well as within them. For example, there are specific chapters focusing on water, energy production and use, agriculture, human health, and ecosystems and biological diversity. Six cross-cutting chapters address how climate change can interact with multiple sectors. These cover the following topics:

- Water, energy, and land use
- Tribal culture, lands, and resources
- Land use and land cover
- Biogeochemical cycles and implications for ecosystems
- Rural communities
- Urban infrastructure and vulnerability

US Nat Climate Assessment

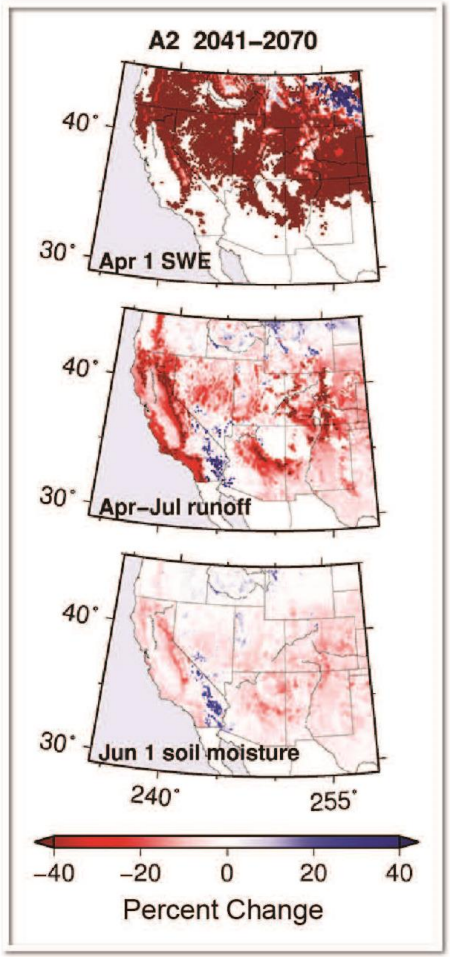
Sectoral and across-sectoral approach

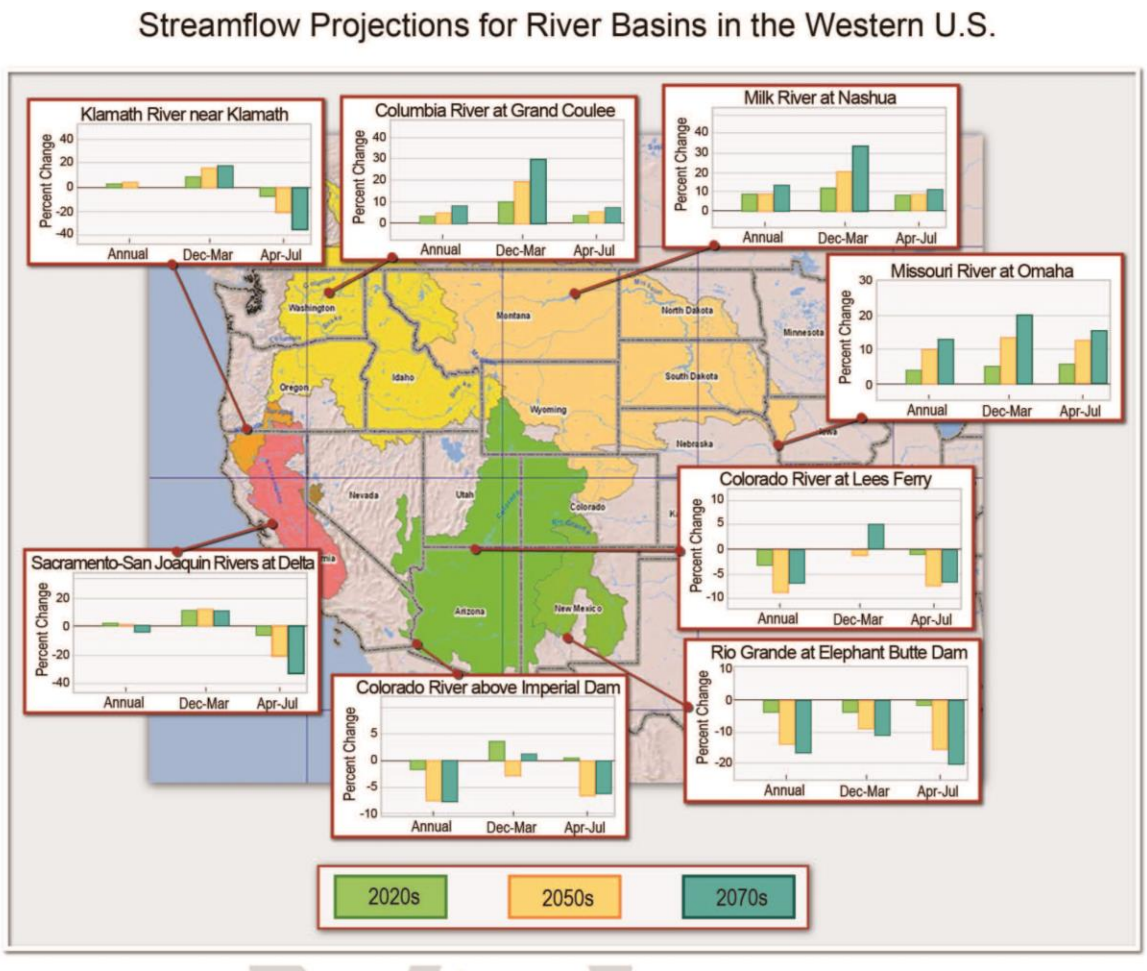
A common thread across these chapters is the connections across the sectors and the way that changes in one sector are amplified or attenuated through connections with other sectors. Another theme considers how decisions that people make daily can influence a **cascade of events** that affect individual and national vulnerability and/or resiliency to climate changes across multiple sectors. This "**systems approach**" tries to connect, for example, how **adaptation and mitigation strategies are themselves dynamic and interrelated systems** that intersect with the sectors described here, like the way adaptation plans for future coastal infrastructure are correlated to the kinds of mitigation strategies that are put into place today. These chapters also address the importance of **underlying vulnerabilities and the ways they may influence the risks associated with climate change**.

The chapters in the following section start with an assessment of what is at risk within the selected sectors, and include both observations of existing impacts associated with climate change and impacts that are expected to result from climatic changes projected by climate models.

US Nat Climate Assessment

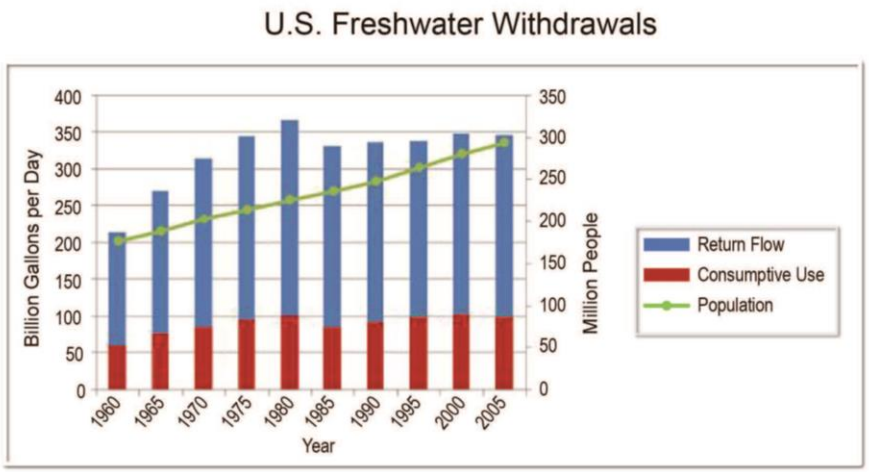
Water resources

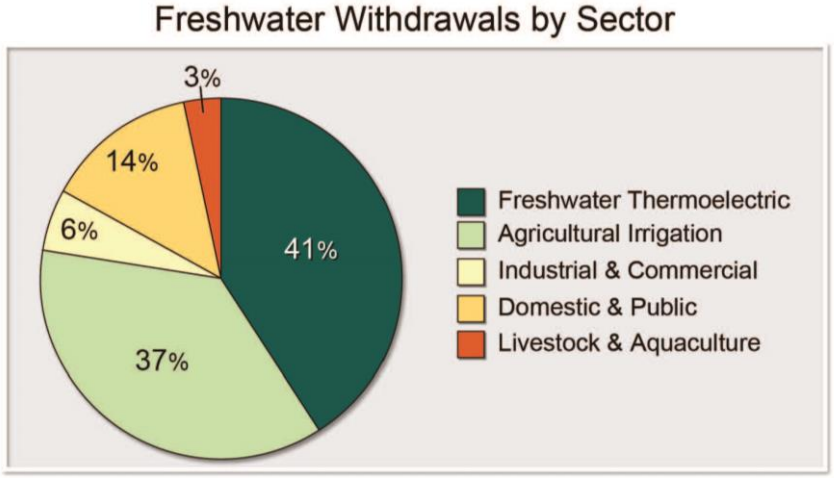




US Nat Climate Assessment

Water resources

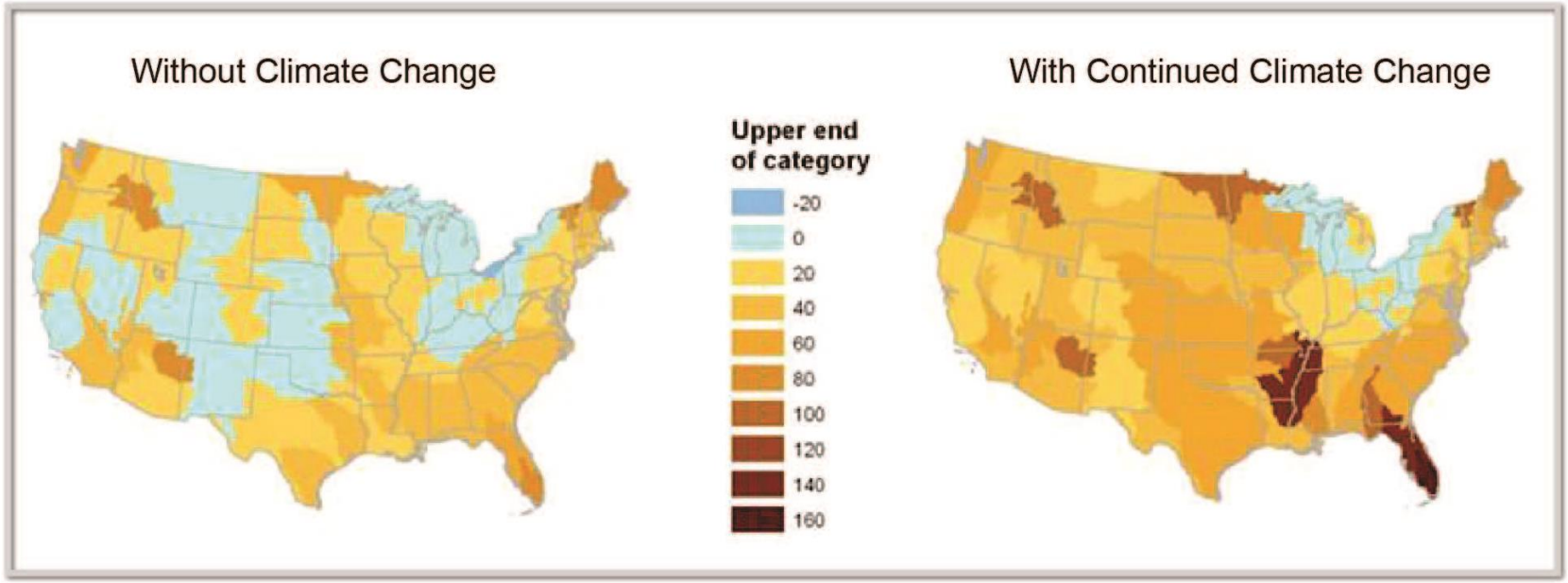




US Nat Climate Assessment

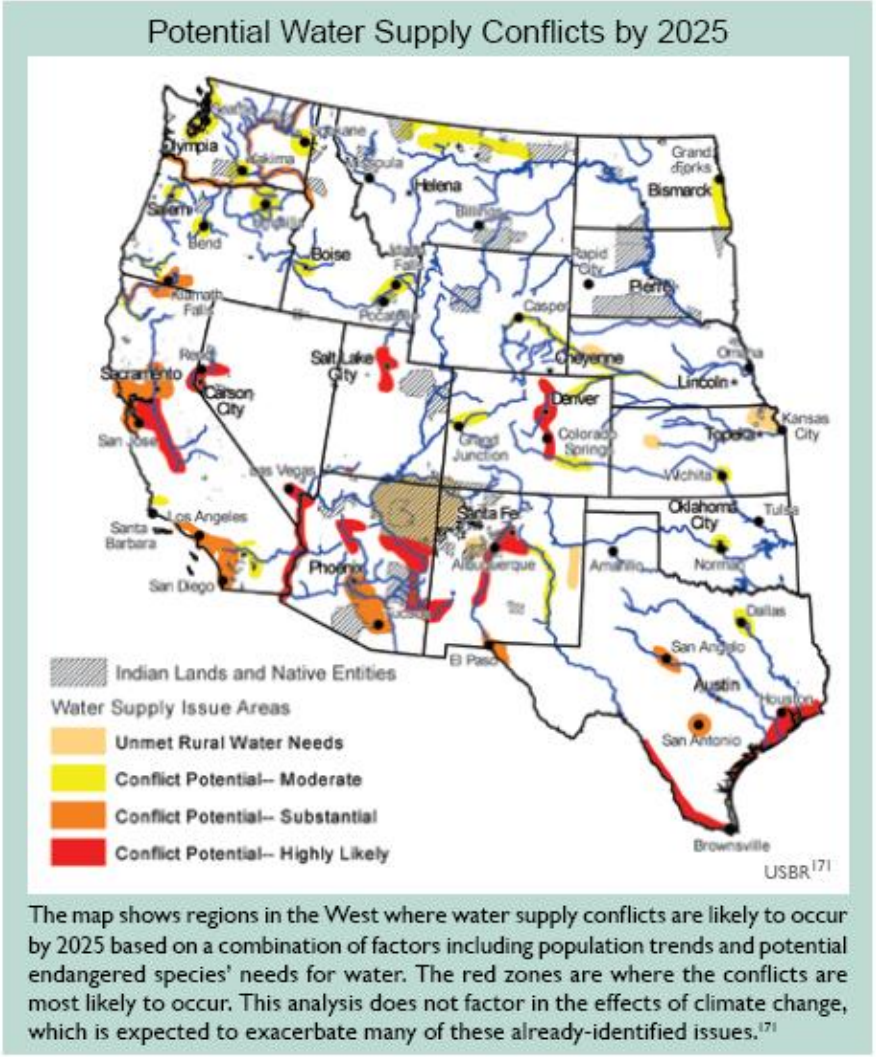
Water resources

Projected Changes in Water Withdrawal



US Nat Climate Assessment

Water resources



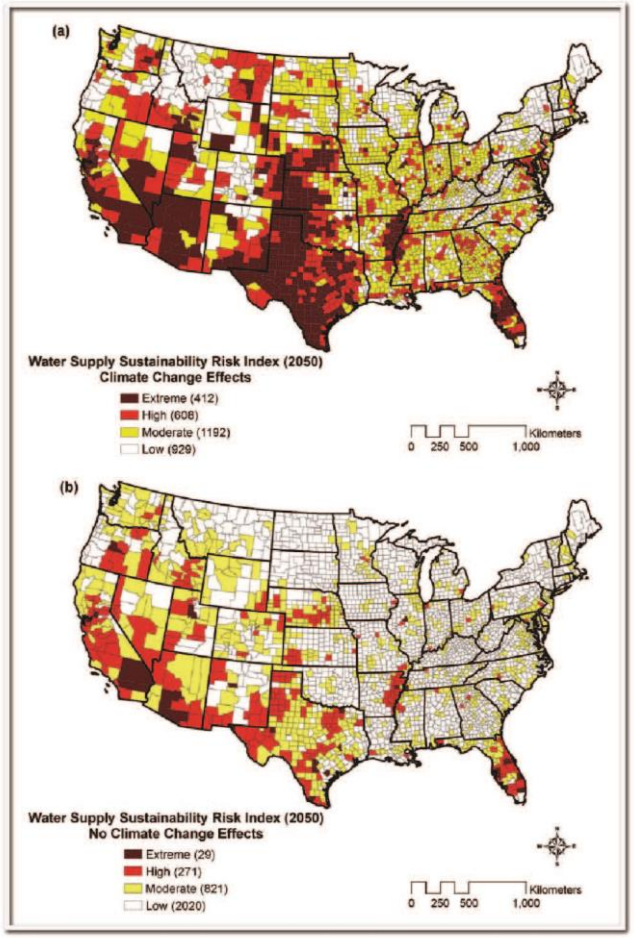
The map shows regions in the West where water supply conflicts are likely to occur by 2025 based on a combination of factors including population trends and potential endangered species' needs for water. The red zones are where the conflicts are most likely to occur. This analysis does not factor in the effects of climate change, which is expected to exacerbate many of these already-identified issues.[171]

US-GCRP, 2009

US Nat Climate Assessment

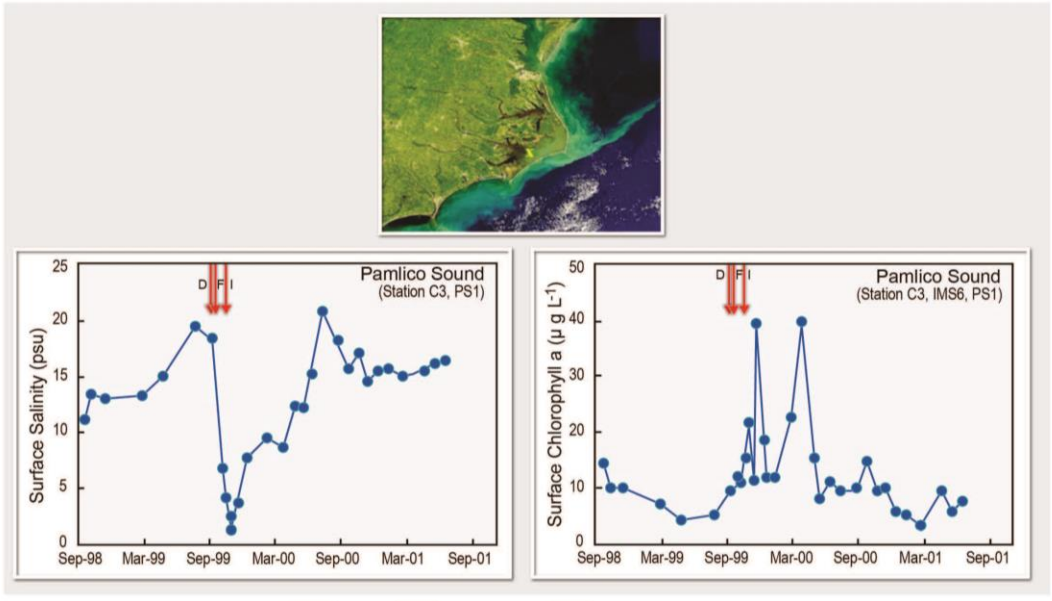
Ecosystems

Water Supplies Projected to Decline



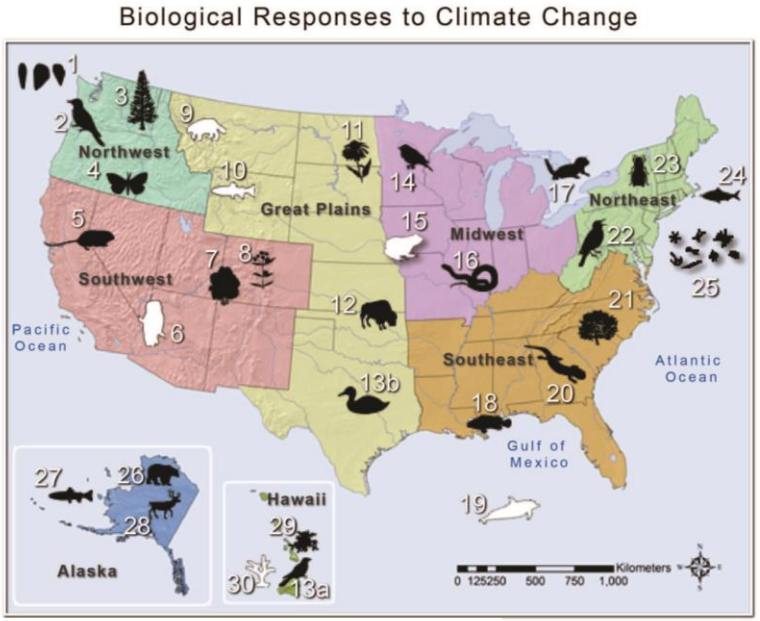
Salinity and chlorophyll changes after Hurricane events

The Aftermath of Hurricanes



US Nat Climate Assessment

Ecosystems

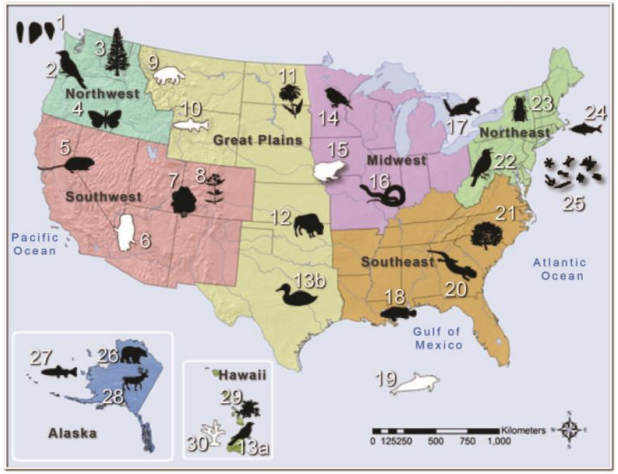


1. Mussel and barnacle beds have declined or disappeared along parts of Northwest coast (Harley 2011).
2. Northern flickers arrived at breeding sites earlier in Northwest in response to temperature changes along migration routes (Wiebe and Gerstmar 2010).
3. Conifer forests in many western forests have died from warming-induced changes in the prevalence of pests and pathogens (van Mantgem et al. 2009).
4. Butterflies that have adapted to specific oak species have not been able to colonize new tree species when climate change-induced tree migration changes local forest types (Pelini et al. 2010).

US Nat Climate Assessment

Ecosystems

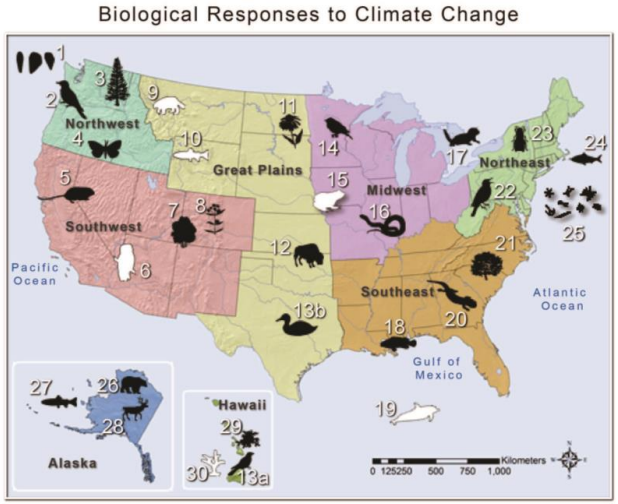
Biological Responses to Climate Change



5. In response to climate-related habitat change, many small mammal species have altered their elevational ranges, with lower-elevation species expanding their ranges and higher-elevation species contracting their ranges (Moritz et al. 2008).
6. *Owl populations in Arizona and New Mexico are projected to decline during the next century and are at high risk for extinction due to future climatic changes, while the southern California population is not projected to be sensitive to future climatic changes* (Peery et al. 2012).
7. Quaking aspen-dominated systems are experiencing declines in the western U.S. after stress due to climate-induced drought conditions during the last decade (Anderegg et al. 2012).
8. Warmer and drier conditions during the early growing season in high elevation habitats in Colorado are disrupting the timing of various flowering patterns, with potential impacts on many important plant-pollinator relationships (Forrest and Thomson 2011).
9. *Population fragmentation of wolverines in the northern Cascades and Rocky Mountains is expected to increase as spring snow cover retreats over the coming century* (McKelvey et al. 2011).
10. *Cutthroat trout populations in the western U.S. are projected to decline by up to 58%, and total trout habitat in the same region is projected to decline by 48%, due to increasing temperatures, seasonal shifts in precipitation, and negative interactions with non-native species* (Wenger et al. 2011).
11. First flowering dates in 178 plant species from North Dakota have shifted significantly in more than 40% of all species examined (Dunnell and Travers 2011).

US Nat Climate Assessment

Ecosystems



25. Increases in maximum and decreases in the annual variability of sea surface temperatures in the North Atlantic Ocean have promoted growth of small phytoplankton and led to a reorganization in the species composition of primary (phytoplankton) and secondary (zooplankton) producers (Beaugrand et al. 2010).
26. Changes in female polar bear reproductive success (decreased litter mass, and numbers of yearlings) along the north Alaska coast have been linked to changes in body size and/or body condition following years with lower availability of optimal sea ice habitat (Rode et al. 2010).
27. Water temperature data and observations of migration behaviors over a 34-year time period showed that adult pink salmon migrated earlier into Alaskan creeks, and fry advanced the timing of migration out to sea. Shifts in migration timing may increase the potential for a mismatch in optimal environmental conditions for early life stages, and continued warming trends will likely increase pre-spawning mortality and egg mortality rates (Taylor 2008).

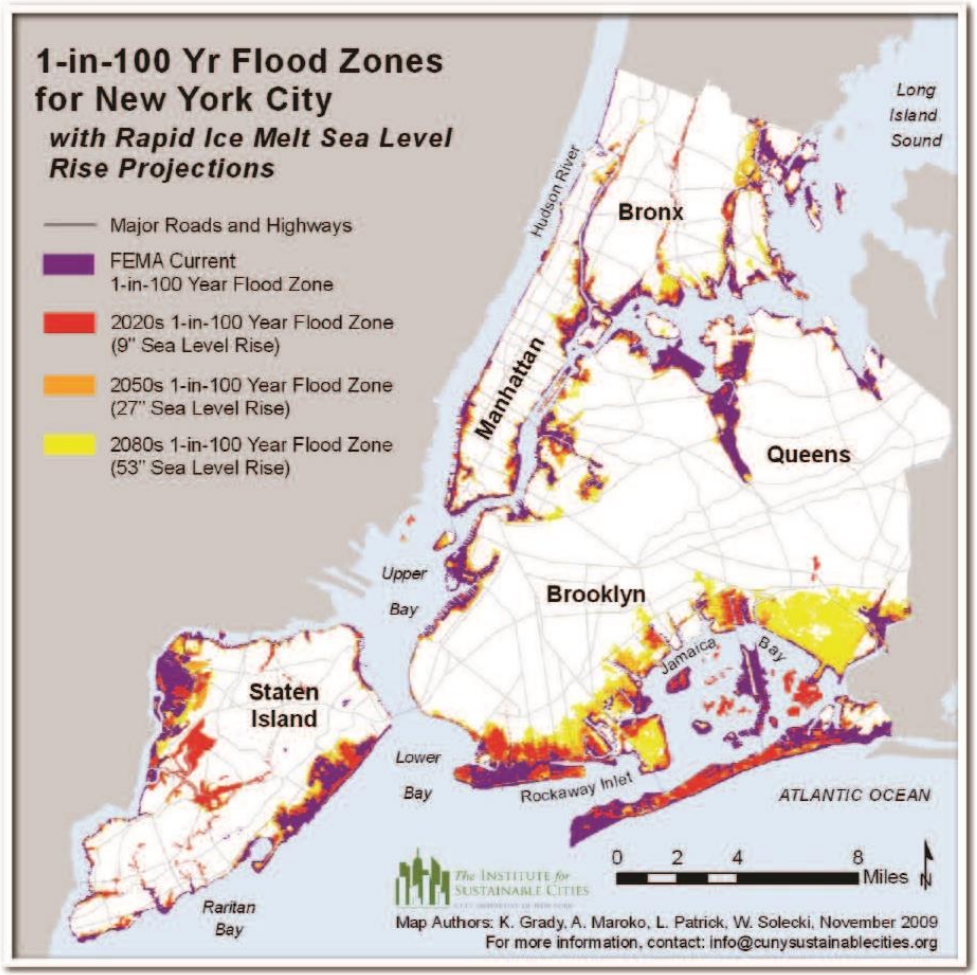
US Nat Climate Assessment

Ecosystems

US Nat Climate Assessment

Urban systems

New York City and Sea Level Rise



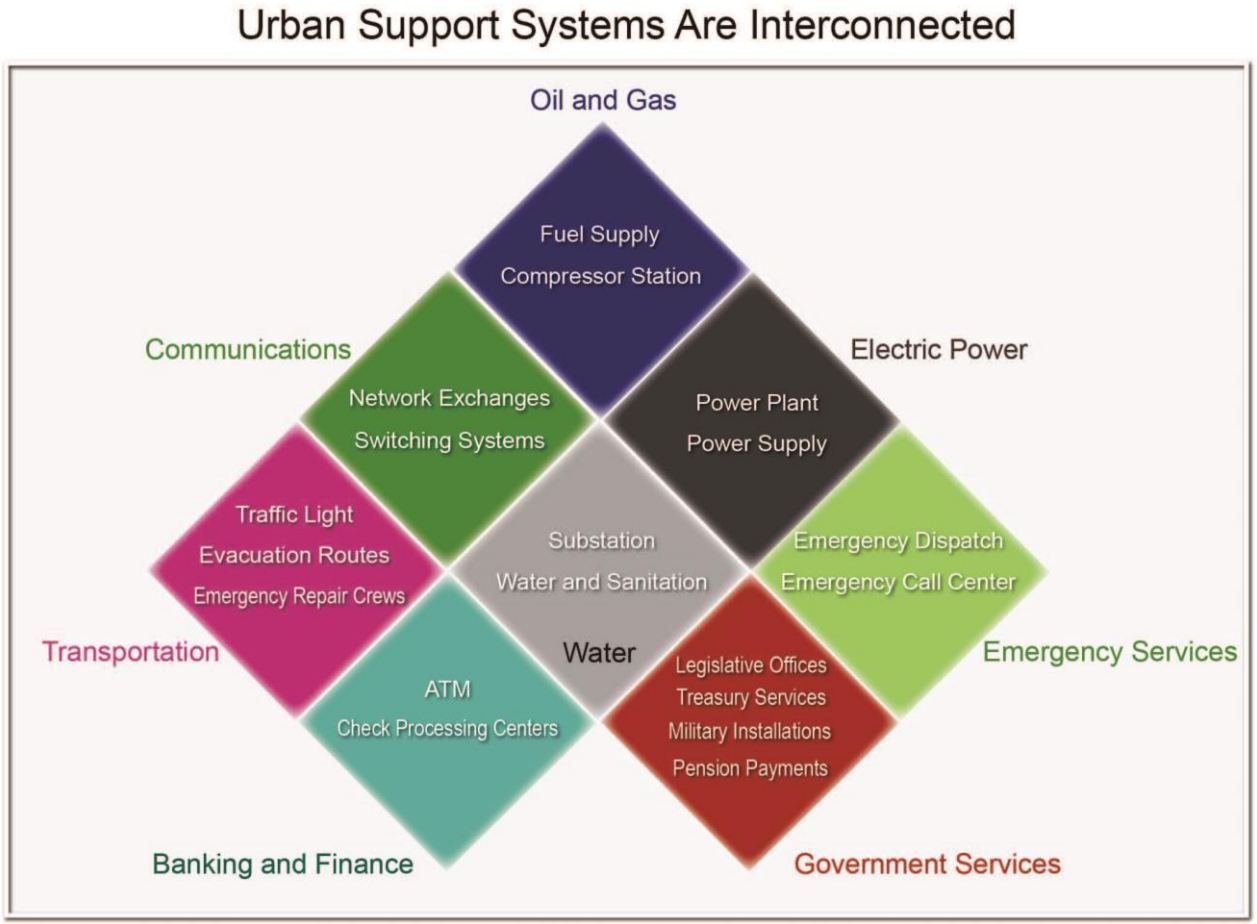
US Nat Climate Assessment

Urban systems

US-GCRP, 2009

US Nat Climate Assessment

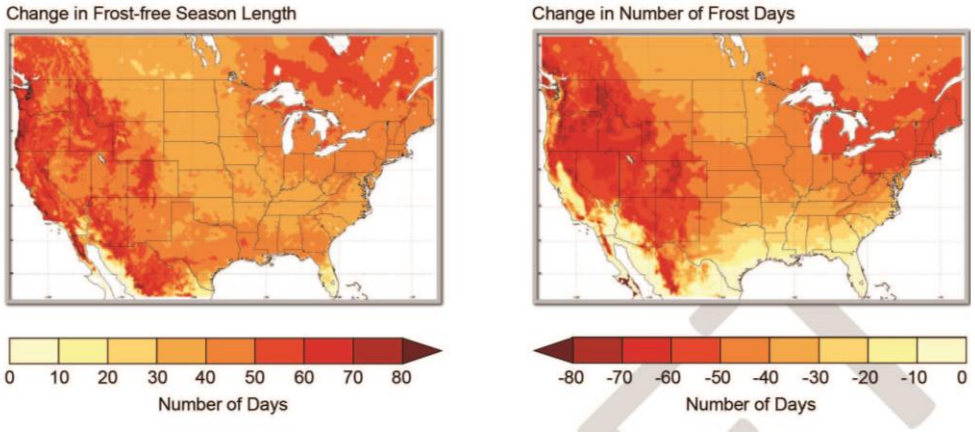
Urban systems



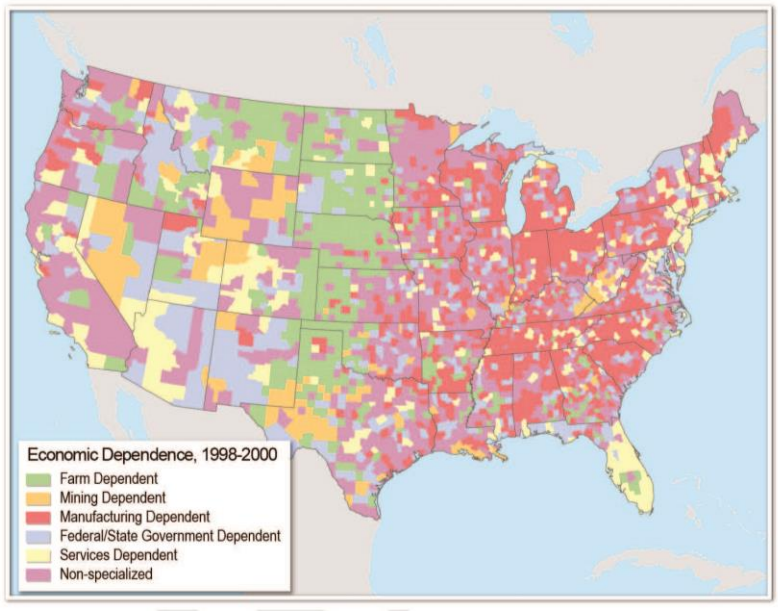
US Nat Climate Assessment

Rural regions and systems

Growing Season Lengthens



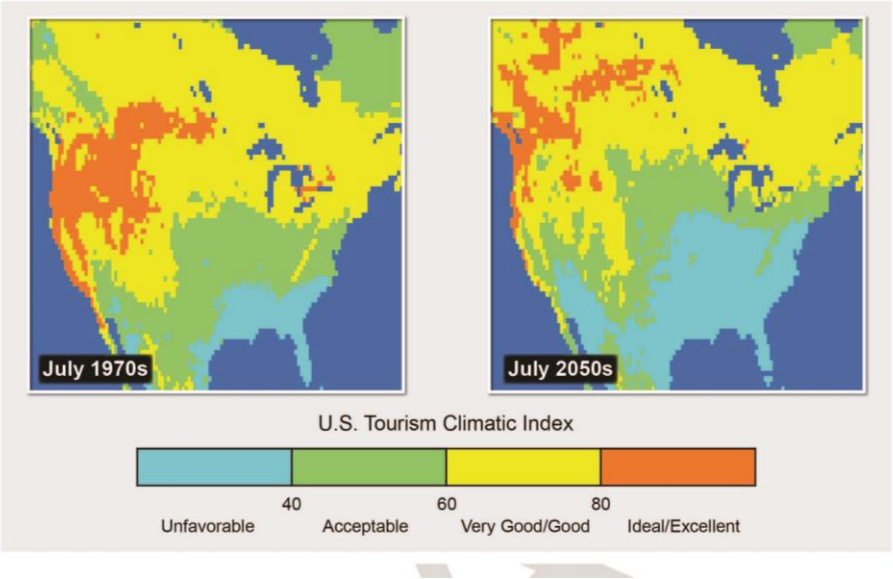
Economic Dependence Varies by Region



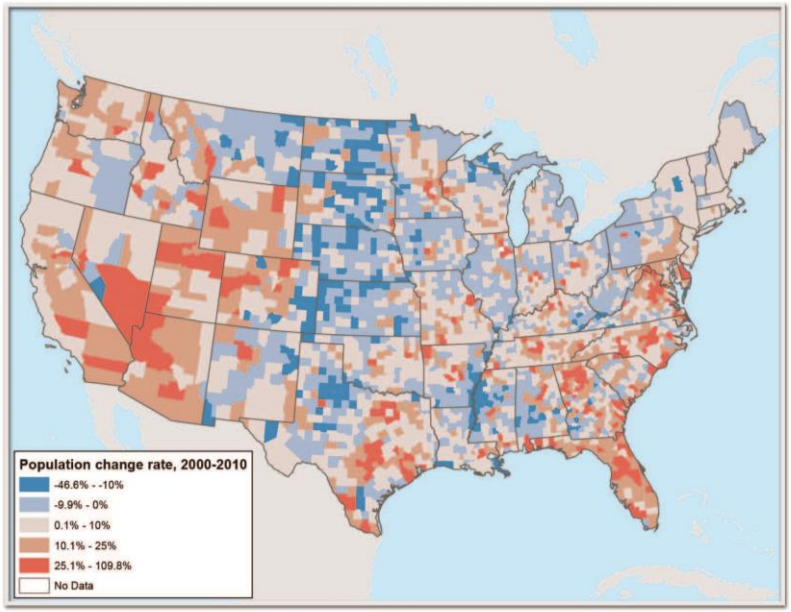
US Nat Climate Assessment

Rural regions and systems

Climate-Change Impacts on Summertime Tourism

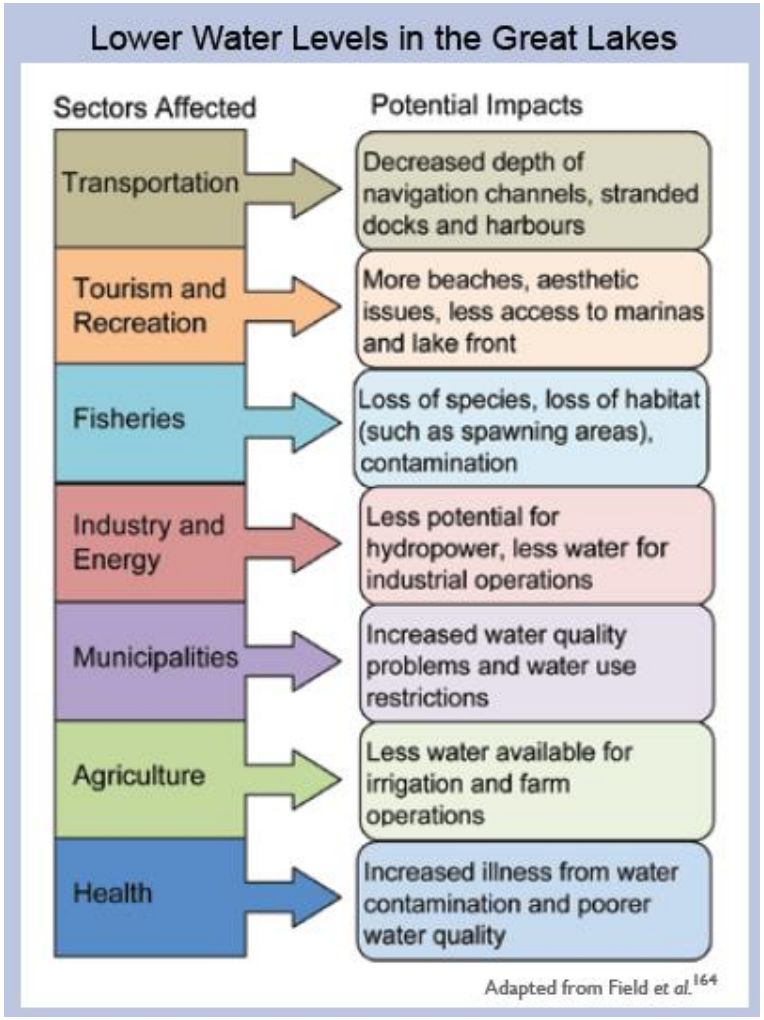


Many Rural Areas are Losing Population



US Nat Climate Assessment

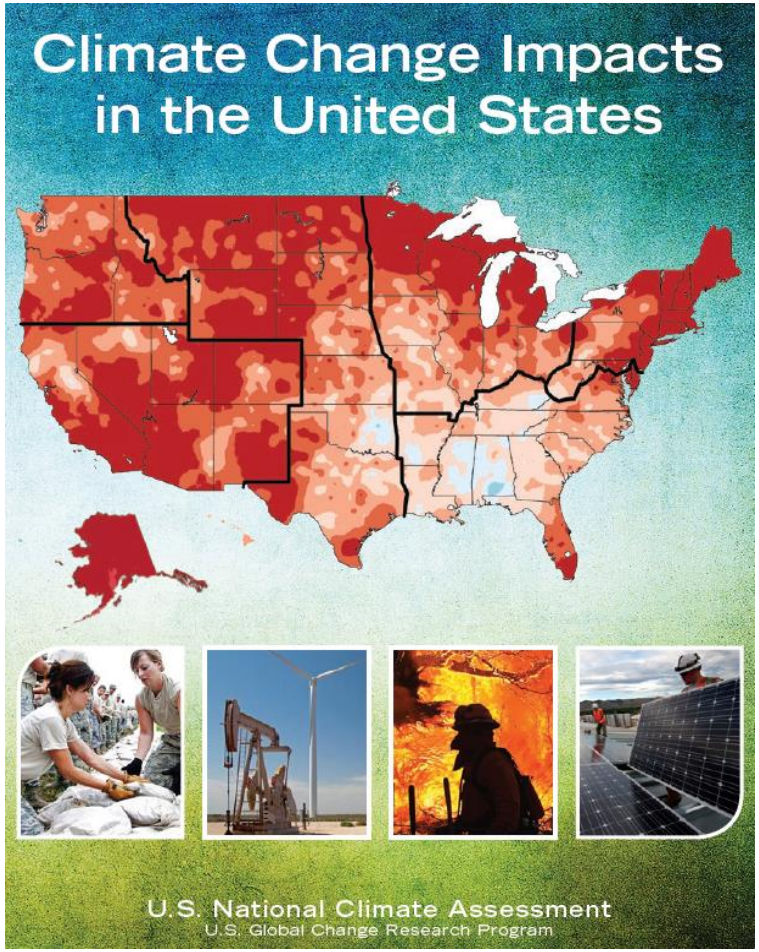
Across-sector effects



US-GCRP, 2009

US Nat Climate Assessment

Online at:
nca2014.globalchange.gov



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