Climate Mitigation, Adaptation and Resilience in Cincinnati

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Introduction

- Cincinnati is like many Midwest Cities.
  - Climate Mitigation Efforts (reducing GHG emissions) have been a Priority for Years.
  - Climate Adaptation and Resilience are New Priorities

Mitigation – The Green Cincinnati Plan

- Adopted 2008; Revised and Re-Adopted 2013
- Goals –
  - Reduce Carbon Emissions 2% Per Year
  - Create Jobs
  - Save Money
  - Improve Public Health
  - Improve Quality of Life

Mitigation – The Green Cincinnati Plan

- Results
  - Reduced Carbon Emissions 8% by 2012 (4 years) while producing other benefits.
  - Example: Energy Services Performance Contracts
  - Example: Solar Power Purchase Agreement
  - Example: Electricity Aggregation

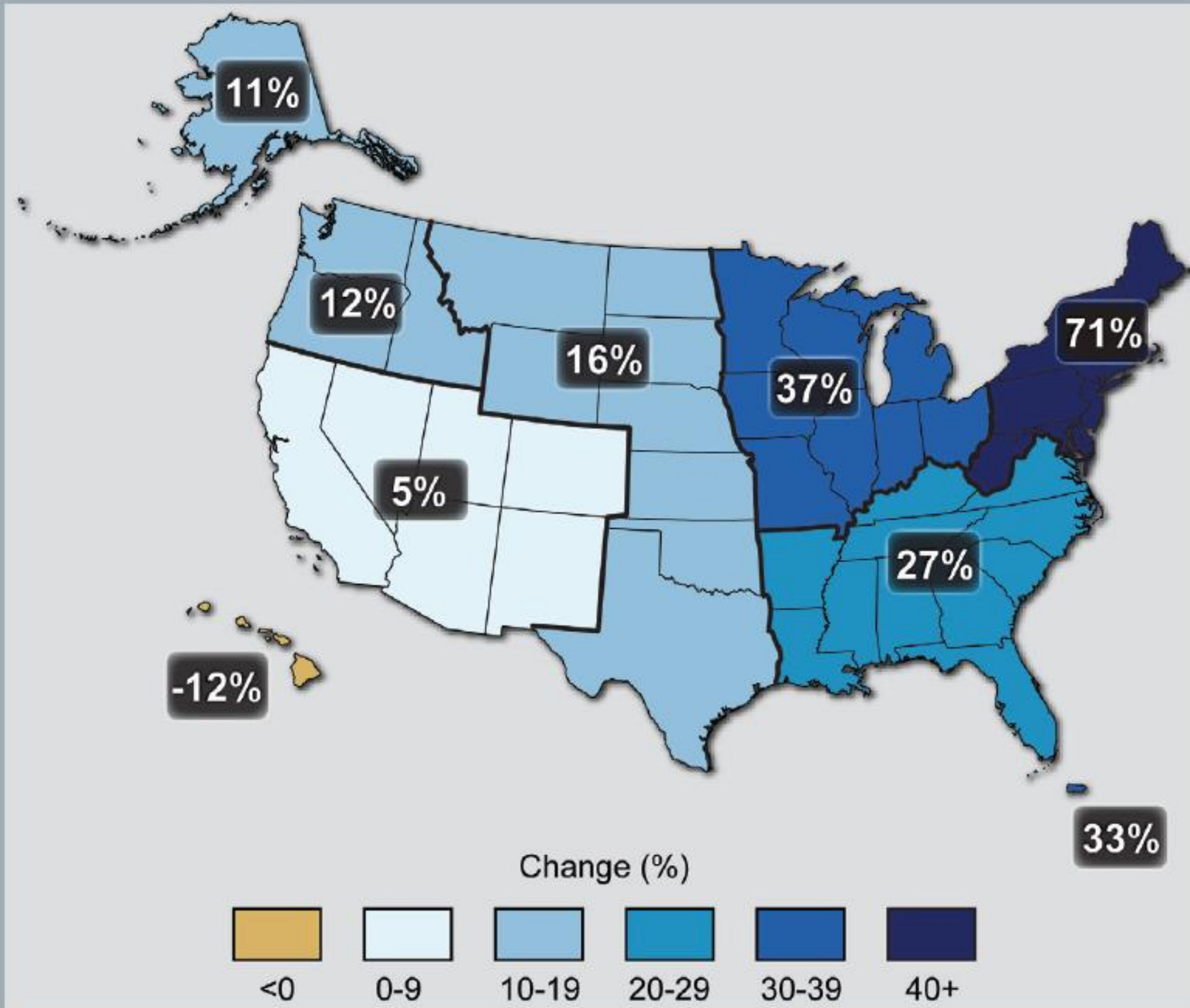
Climate Adaptation

- Our Climate has Changed, And Will Change More
- What Will Those Changes Be in Cincinnati? How do we Prepare for Those Changes?
- For Cincinnati, It’s Not: Sea Level Rise; Coastal Storms; Wildfires; Acute Water Shortages.
- Key Information – National Climate Assessment Report; Hamilton County Multi-Hazard Mitigation Plan

Local Threats from Climate Change

- Acute Threats
  - Heat Waves; Wind Storms; Floods; etc.
- Chronic Threats
  - Droughts; Invasive Species; Tree Loss; Crop Losses; Exotic Diseases; etc.
- Local Effects of Global Climate Disruption
  - Food Shortages; Energy Shortages; Displaced Populations; etc.

Observed Change in Very Heavy Precipitation



Percent changes in the amount of precipitation falling in very heavy events (the heaviest 1%) from 1958 to 2012 for each region. There is a clear national trend toward a greater amount of precipitation being concentrated in very heavy events, particularly in the Northeast and Midwest. (Figure source: updated from Karl et al. 2009[c]).

Projected Change in Heavy Precipitation Events

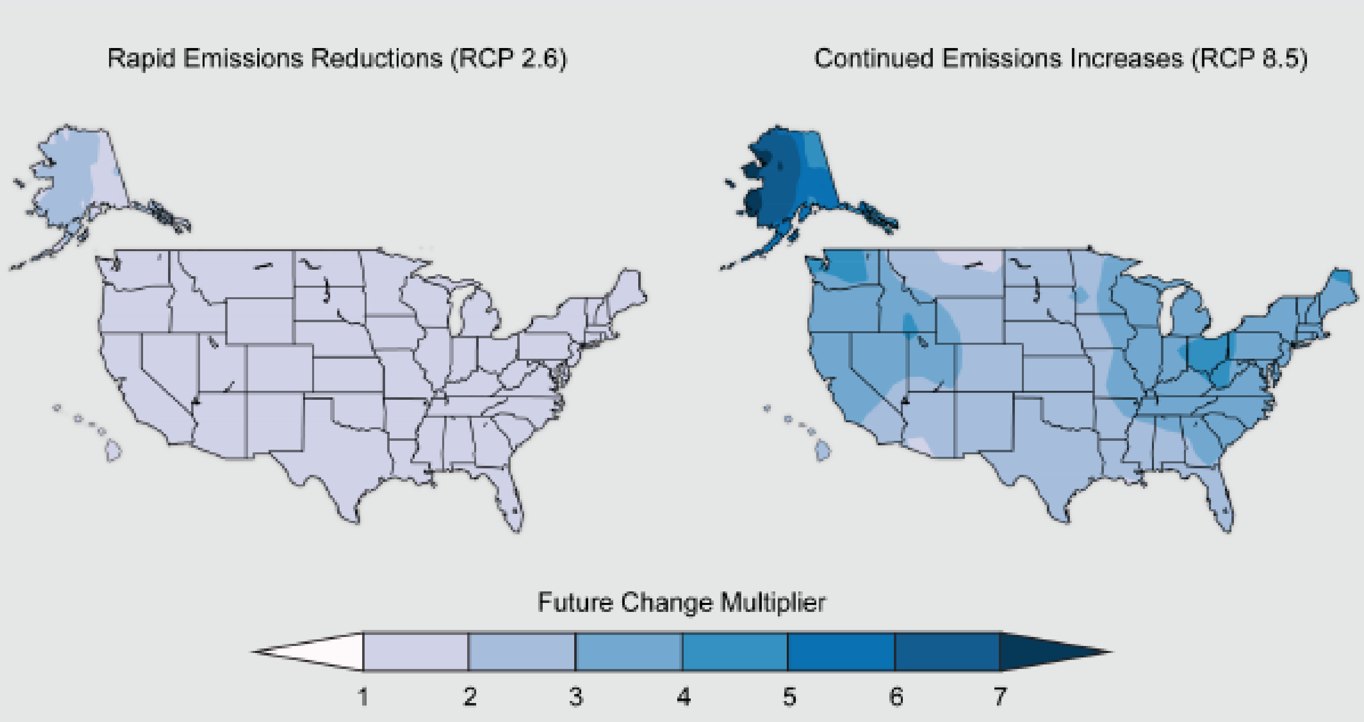


Figure 9.6. Maps show the increase in frequency of extreme daily precipitation events (a daily amount that now occurs just once in 20 years) by the later part of this century (2081-2100) compared to the latter part of the last century (1981-2000). Such extreme events are projected to occur more frequently everywhere in the United States. Under a rapid emissions reduction scenario (RCP 2.6), these events would occur nearly twice as often. For a scenario assuming continued increases in emissions (RCP 8.5), these events would occur up to five times as often. (Figure source: NOAA NCDC / CICS-NC).

Projected Changes in Seasonal Precipitation

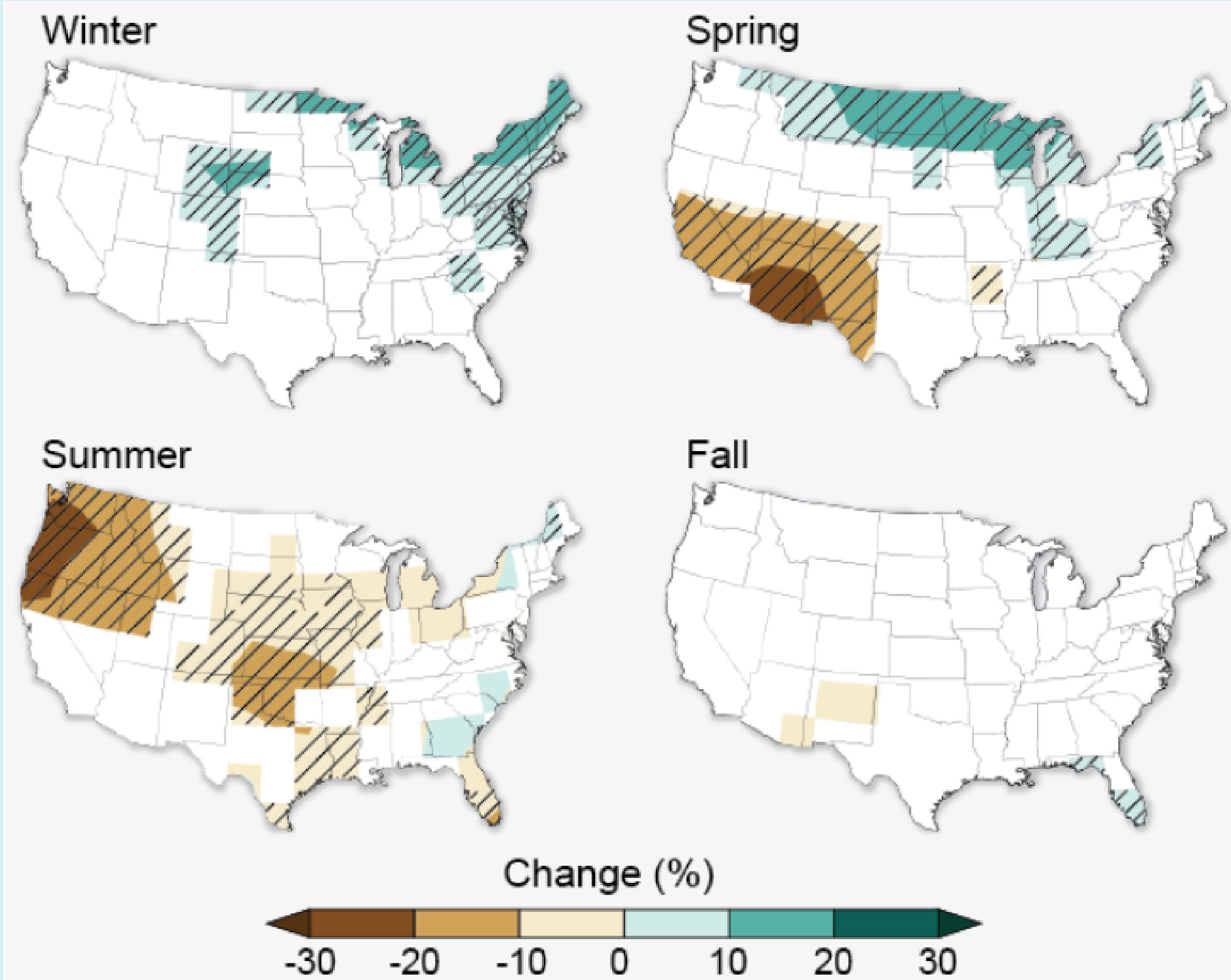


Figure 4.4. Climate change affects precipitation patterns as well as temperature patterns. The maps show projected changes in average precipitation by season for 2041–2070 compared to 1971–1999, assuming emissions of heat-trapping gases continue to rise (A2 scenario). Note significantly drier conditions in the Southwest in spring and Northwest in summer, as well as significantly more precipitation (some of which could fall as snow) projected for northern areas in winter and spring. Hatched areas indicate that the projected changes are significant and consistent among models. White areas indicate that the changes are not projected to be larger than could be expected from natural variability. (Figure source: NOAA NCDC / CICS-NC).

When it Rains, it Pours

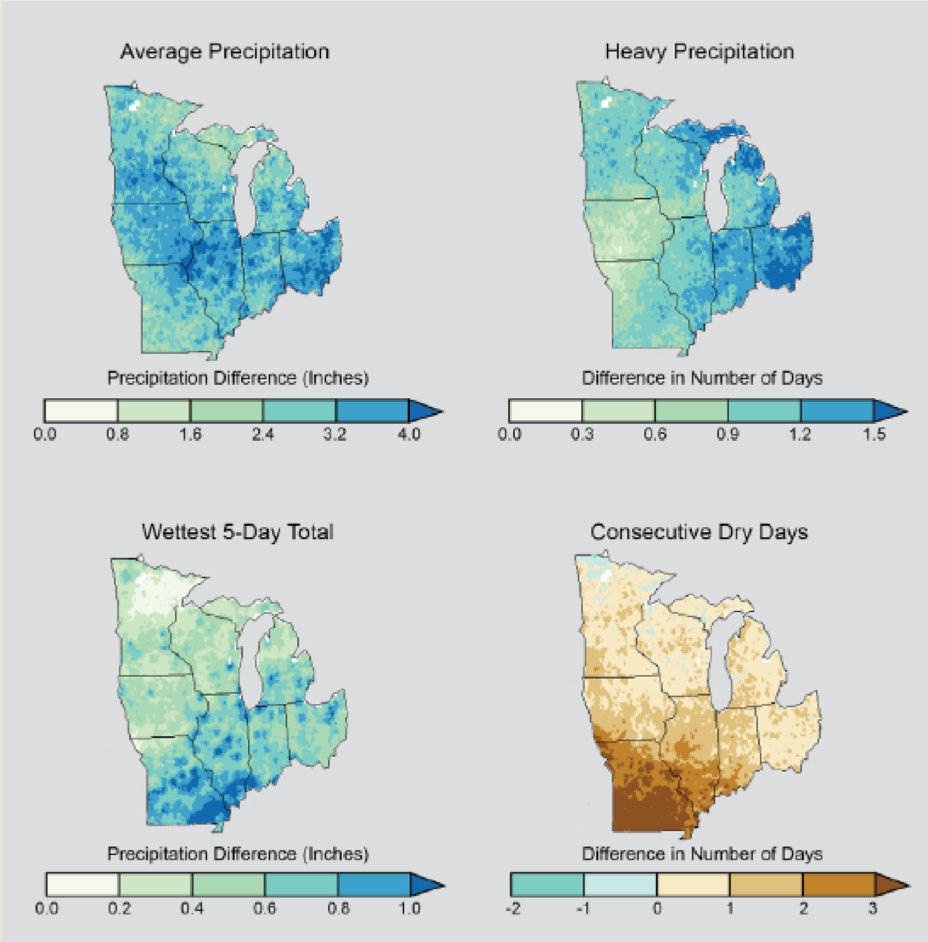


Figure 18.6. Precipitation patterns affect many aspects of life, from agriculture to urban storm drains. These maps show projected changes for the middle of the current century (2041-2070) relative to the end of the last century (1971-2000) across the Midwest under continued emissions (A2 scenario). Top left: the changes in total annual average precipitation. Across the entire Midwest, the total amount of water from rainfall and snowfall is projected to increase. Top right: increase in the number of days with very heavy precipitation (top 2% of all rainfalls each year). Bottom left: increases in the amount of rain falling in the wettest 5-day period over a year. Both (top right and bottom left) indicate that heavy precipitation events will increase in intensity in the future across the Midwest. Bottom right: change in the average maximum number of consecutive days each year with less than 0.01 inches of precipitation. An increase in this variable has been used to indicate an increase in the chance of drought in the future. (Figure source: NOAA NCDC / CICS-NC).

Projected Temperature Change of Hottest Days

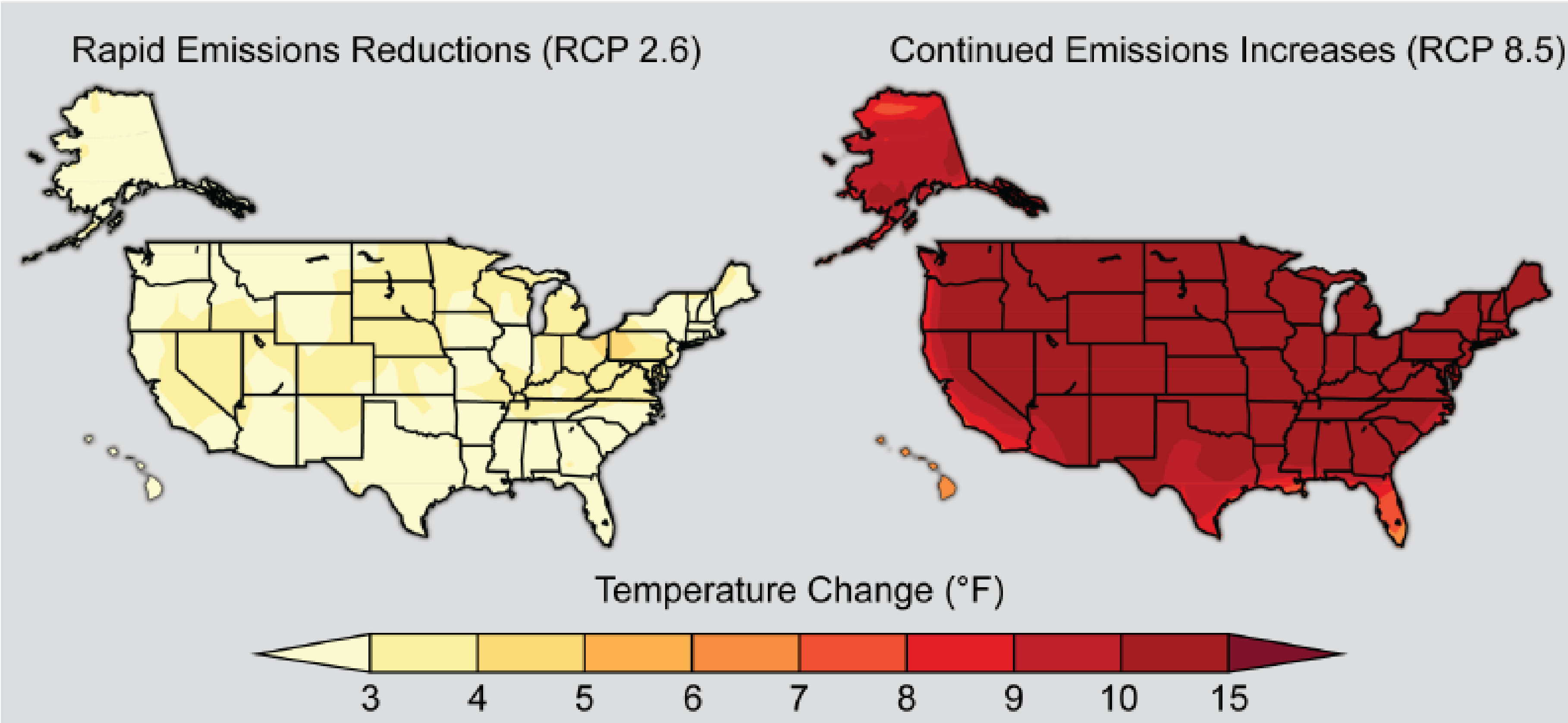


Figure 9.4. The maps show projected increases in the average temperature on the hottest days by late this century (2081-2100) relative to 1986-2005 under a scenario that assumes a rapid reduction in heat-trapping gases (RCP 2.6) and a scenario that assumes continued increases in these gases (RCP 8.5). The hottest days are those so hot they occur only once in 20 years. Across most of the continental United States, those days will be about 10ºF to 15ºF hotter in the future under the higher emissions scenario. (Figure source: NOAA NCDC / CICS-NC).

Projected Mid-Century Temperature Changes in the Midwest

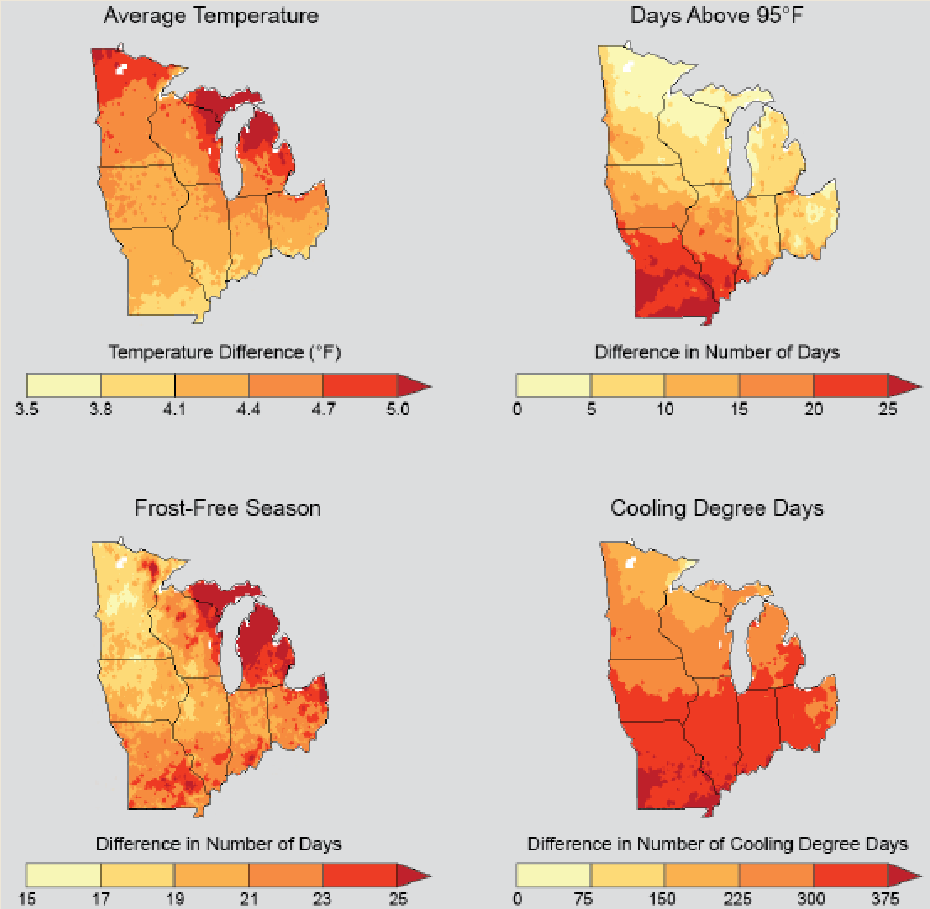


Figure 18.2. Projected increase in annual average temperatures (top left) by mid-century (2041-2070) as compared to the 1971-2000 period tell only part of the climate change story. Maps also show annual projected increases in the number of the hottest days (days over 95°F, top right), longer frost-free seasons (bottom left), and an increase in cooling degree days (bottom right), defined as the number of degrees that a day's average temperature is above 65°F, which generally leads to an increase in energy use for air conditioning. Projections are from global climate models that assume emissions of heat-trapping gases continue to rise (A2 scenario). (Figure source: NOAA NCDC / CICS-NC).

Projected Changes in Key Climate Variables Affecting Agricultural Productivity

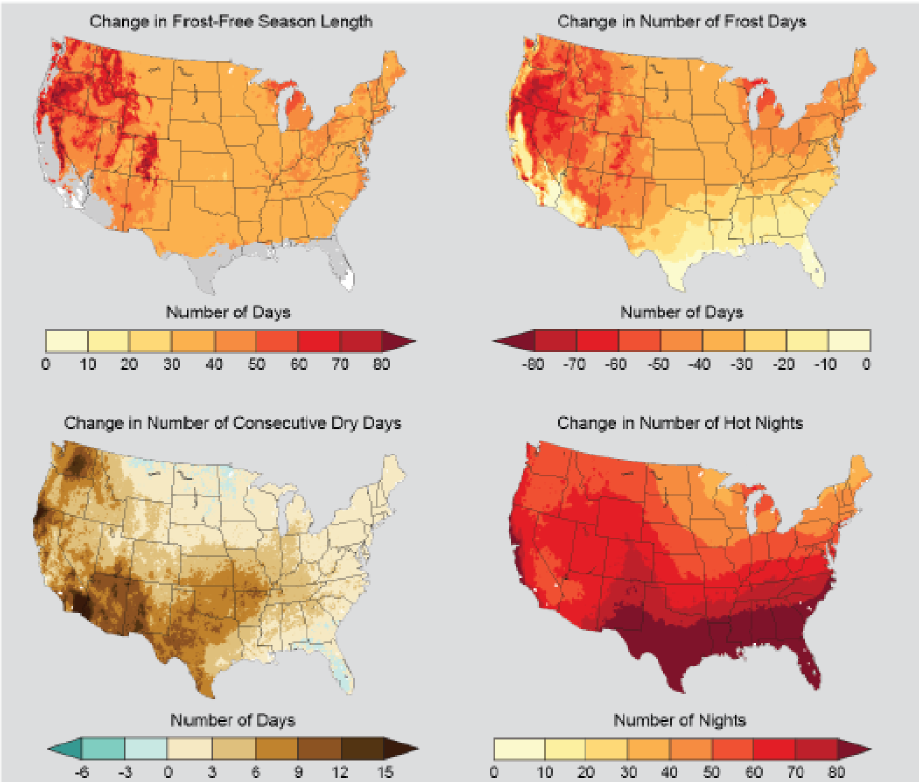


Figure 6.5. Many climate variables affect agriculture. The maps above show projected changes in key climate variables affecting agricultural productivity for the end of the century (2070-2099) compared to 1971-2000. Changes in climate parameters critical to agriculture show lengthening of the frost-free or growing season and reductions in the number of frost days (days with minimum temperatures below freezing), under an emissions scenario that assumes continued increases in heat-trapping gases (A2). Changes in these two variables are not identical, with the length of the growing season increasing across most of the United States and more variation in the change in the number of frost days. Warmer-season crops, such as melons, would grow better in warmer areas, while other crops, such as cereals, would grow more quickly, meaning less time for the grain itself to mature, reducing productivity.[9] Taking advantage of the increasing length of the growing season and changing planting dates could allow planting of more diverse crop rotations, which can be an effective adaptation strategy. On the frost-free map, white areas are projected to experience no freezes for 2070-2099, and gray areas are projected to experience more than 10 frost-free years during the same period. In the lower left graph, consecutive dry days are defined as the annual maximum number of consecutive days with less than 0.01 inches of precipitation. In the lower right graph, hot nights are defined as nights with a minimum temperature higher than 98% of the minimum temperatures between 1971 and 2000. (Figure source: NOAA NCDC / CICS-NC).

"Key Message 6: Food Security

Climate change effects on agriculture will have consequences for food security, both in the U.S. and globally, through changes in crop yields and food prices and effects on food processing, storage, transportation, and retailing. Adaptation measures can help delay and reduce some of these impacts."
http://nca2014.globalchange.gov/ (page 162)

Crop Yields Decline under Higher Temperatures

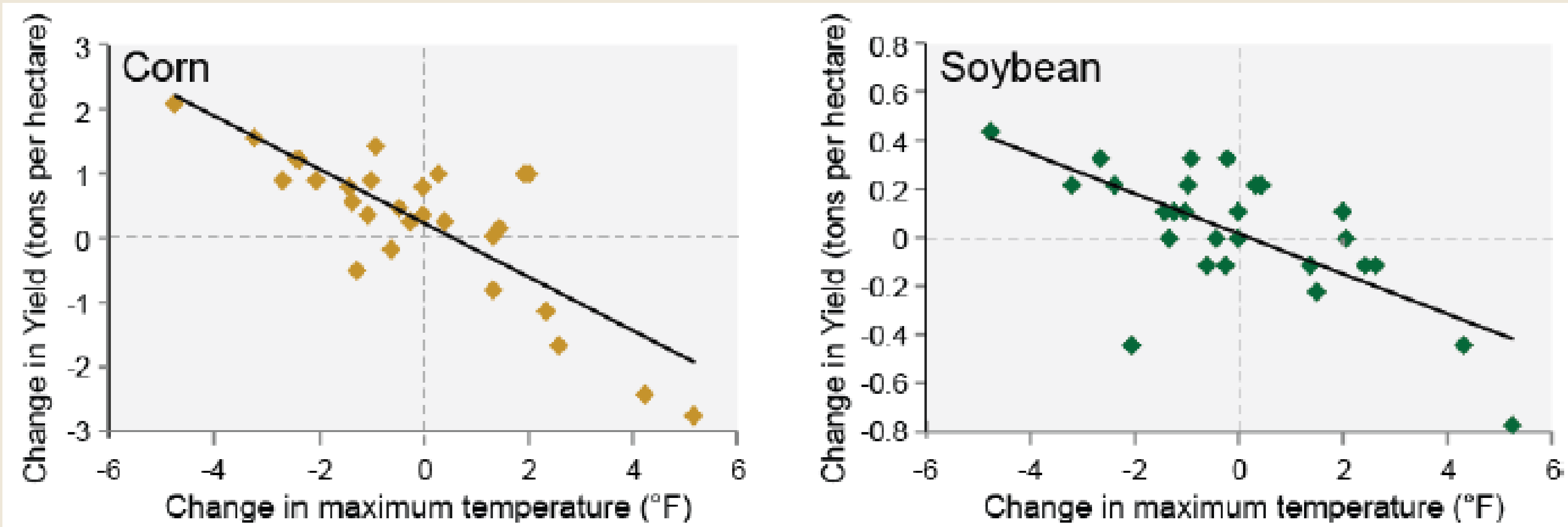


Figure 18.3. Crop yields are very sensitive to temperature and rainfall. They are especially sensitive to high temperatures during the pollination and grain filling period. For example, corn (left) and soybean (right) harvests in Illinois and Indiana, two major producers, were lower in years with average maximum summer (June, July, and August) temperatures higher than the average from 1980 to 2007. Most years with below-average yields are both warmer and drier than normal.[26,27] There is high correlation between warm and dry conditions during Midwest summers[28] due to similar meteorological conditions and drought-caused changes.[29] (Figure source: Mishra and Cherkauer 2010[26]).

Forest Vulnerability to Changing Climate

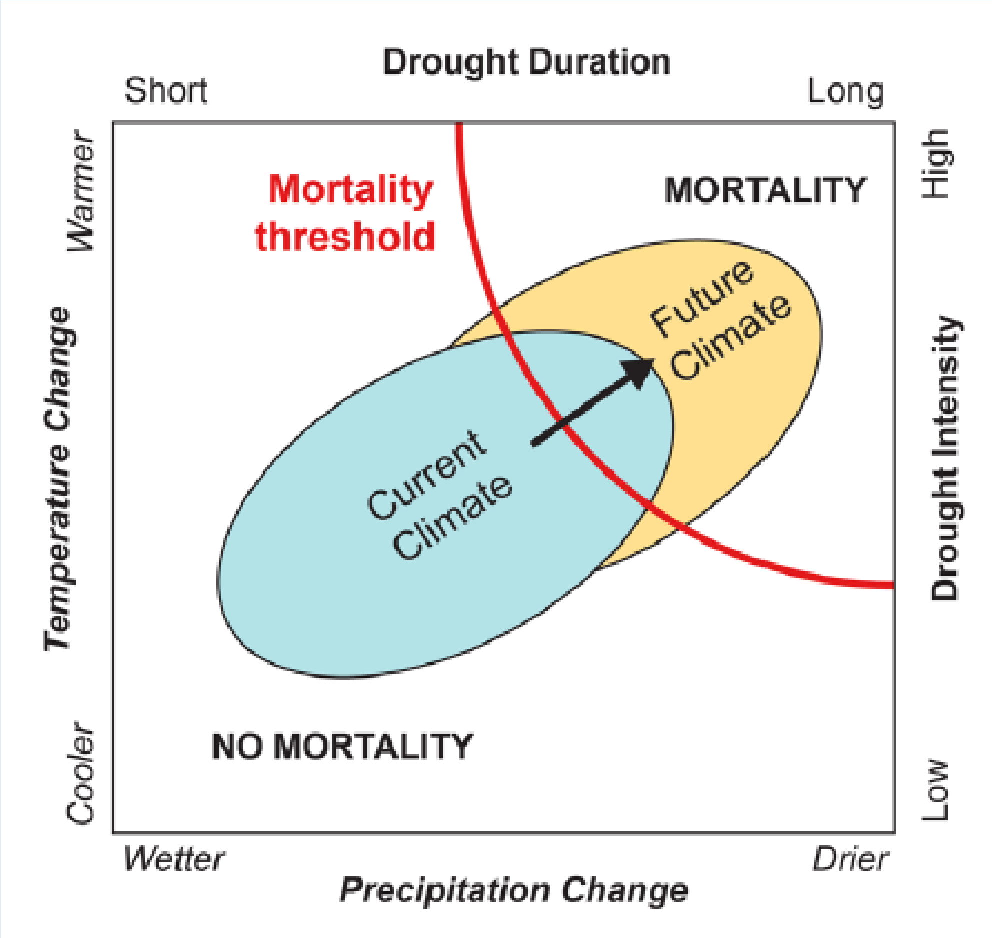


Figure 7.3. The figure shows a conceptual climate envelope analysis of forest vulnerability under current and projected future ranges of variability in climate parameters (temperature and precipitation, or alternatively drought duration and intensity). Climate models project increasing temperatures across the U.S. in coming decades, but a range of increasing or decreasing precipitation depending on region. Episodic droughts (where evaporation far exceeds precipitation) are also expected to increase in duration and/or intensity (see Ch. 2: Our Changing Climate). The overall result will be increased vulnerability of forests to periodic widespread regional mortality events resulting from trees exceeding their physiological stress thresholds.[11] (Figure source: Allen et al. 2010[11]).

Projected Changes in Tick Habitat

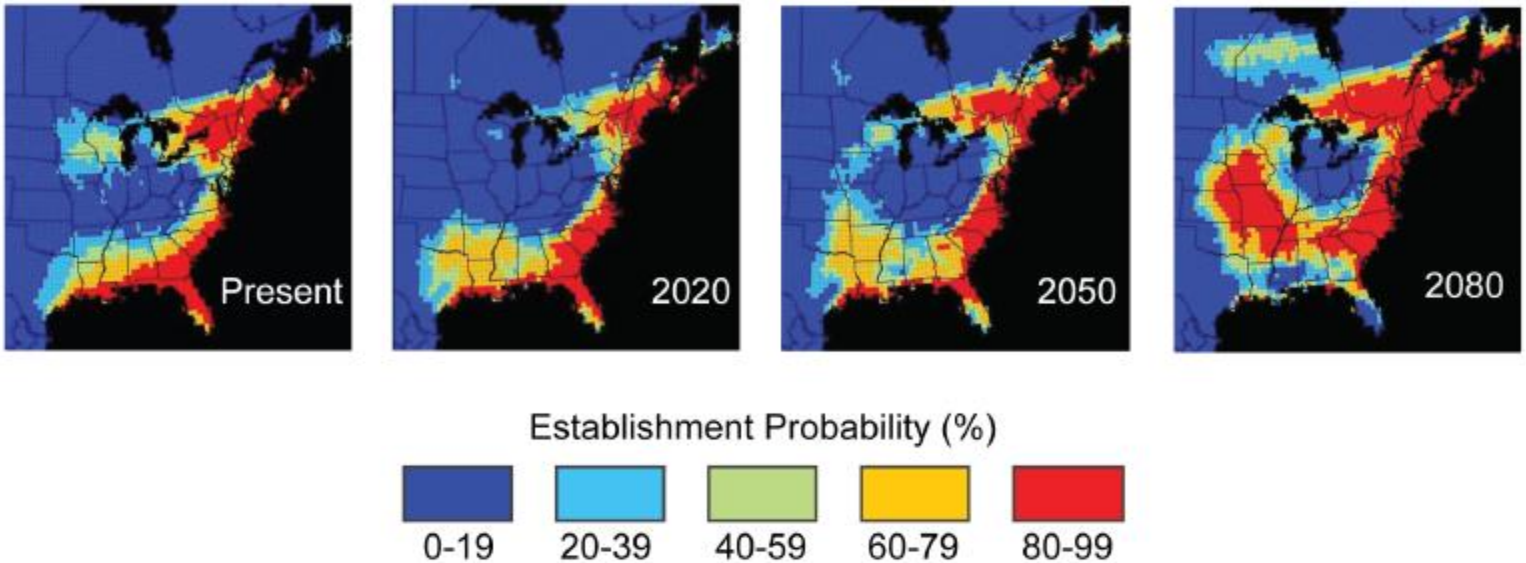


Figure 9.5. The maps show the current and projected probability of establishment of tick populations (*Ixodes scapularis*) that transmit Lyme disease. Projections are shown for 2020, 2050, and 2080. The projected expansion of tick habitat includes much of the eastern half of the country by 2080. For some areas around the Gulf Coast, the probability of tick population establishment is projected to decrease by 2080. (Figure source: adapted from Brownstein et al. 2005[90]).

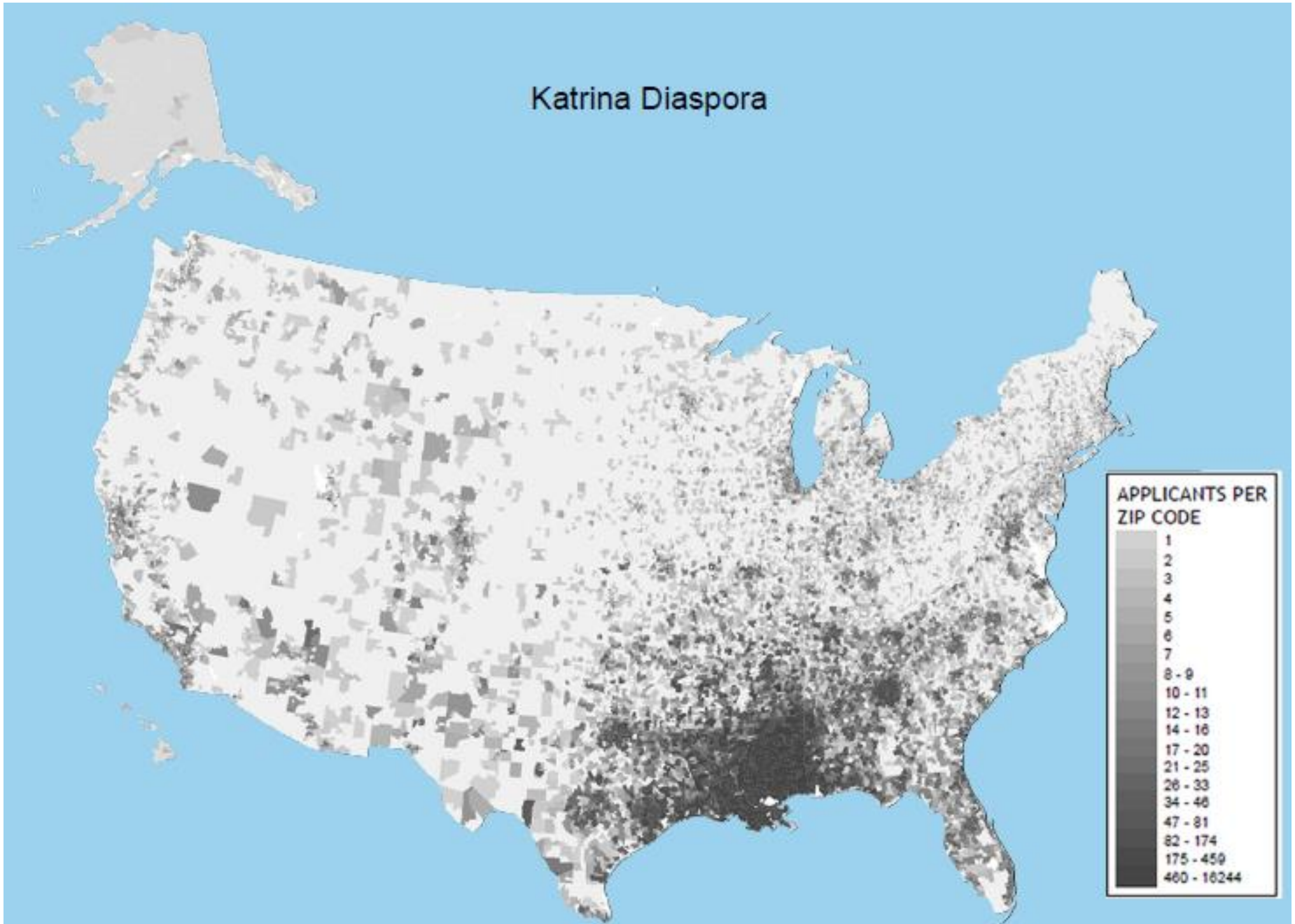


Figure 9.10. This map illustrates the national scope of the dispersion of displaced people from Hurricane Katrina. It shows the location by zip code of the 800,000 displaced Louisiana residents who requested federal emergency assistance. The evacuees ended up dispersed across the entire nation, illustrating the wide-ranging impacts that can flow from extreme weather events, such as those that are projected to increase in frequency and/or intensity as climate continues to change (Ch. 2: Our Changing Climate, Key Message 8). (Figure source: Kent 2006[150]).

Elements of Vulnerability to Climate Change

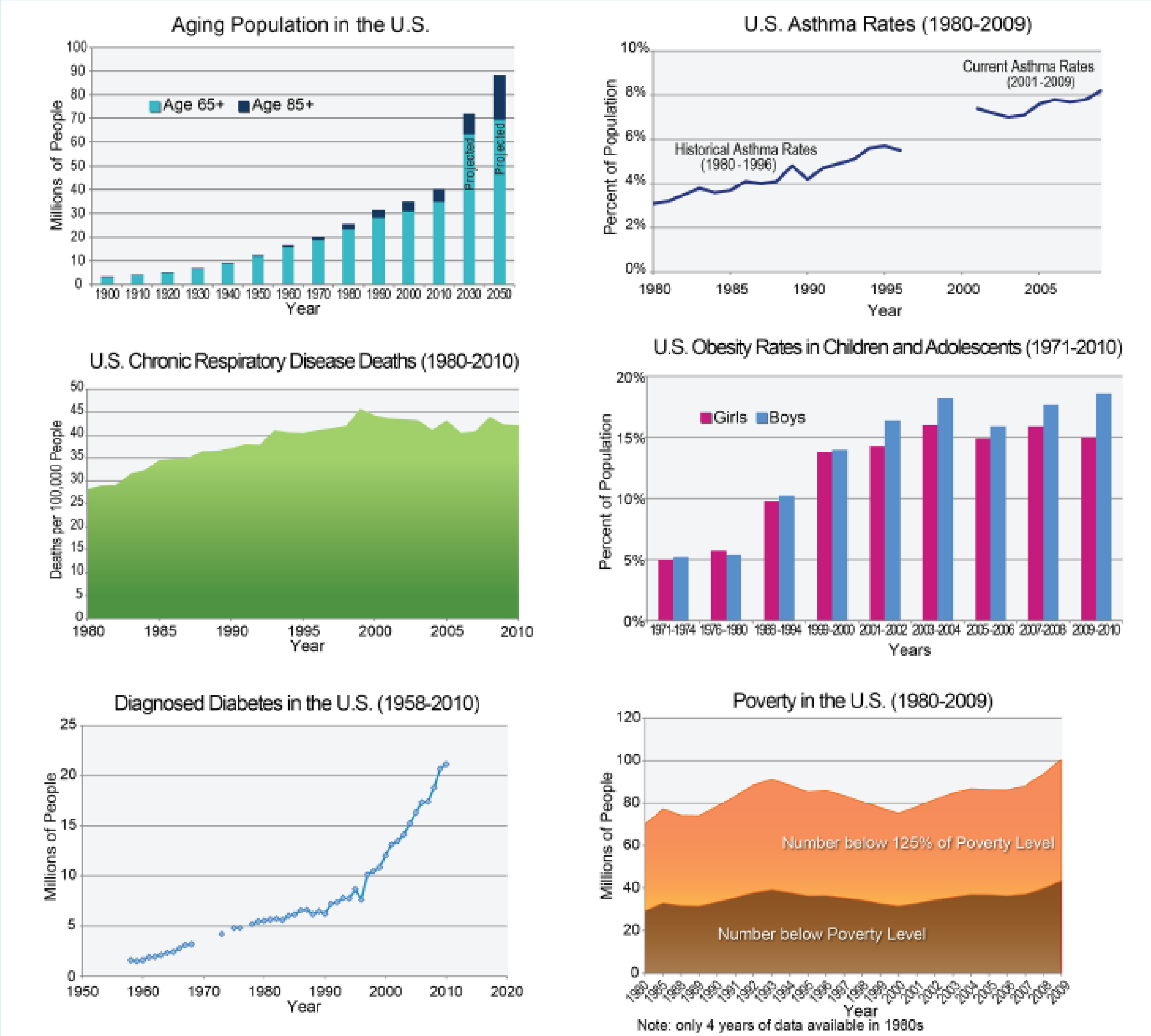


Figure 9.9. A variety of factors can increase the vulnerability of a specific demographic group to health effects due to climate change. For example, older adults are more vulnerable to heat stress because their bodies are less able to regulate their temperature. Overall population growth is projected to continue to at least 2050, with older adults comprising an increasing proportion of the population. Similarly, there are an increasing number of people who are obese and have diabetes, heart disease, or asthma, which makes them more vulnerable to a range of climate-related health impacts. Their numbers are also rising. The poor are less able to afford the kinds of measures that can protect them from and treat them for various health impacts. (Data from CDC; Health E-Stat; U.S. Census Bureau 2010, 2012; and Akinbami et al. 2011[137]).

18 MIDWEST

Key Messages

1. In the next few decades, longer growing seasons and rising carbon dioxide levels will increase yields of some crops, though those benefits will be progressively offset by extreme weather events. Though adaptation options can reduce some of the detrimental effects, in the long term, the combined stresses associated with climate change are expected to decrease agricultural productivity.

2. The composition of the region's forests is expected to change as rising temperatures drive habitats for many tree species northward. The role of the region's forests as a net absorber of carbon is at risk from disruptions to forest ecosystems, in part due to climate change.

3. Increased heat wave intensity and frequency, increased humidity, degraded air quality, and reduced water quality will increase public health risks.

4. The Midwest has a highly energy-intensive economy with per capita emissions of greenhouse gases more than 20% higher than the national average. The region also has a large and increasingly utilized potential to reduce emissions that cause climate change.

5. Extreme rainfall events and flooding have increased during the last century, and these trends are expected to continue, causing erosion, declining water quality, and negative impacts on transportation, agriculture, human health, and infrastructure.

6. Climate change will exacerbate a range of risks to the Great Lakes, including changes in the range and distribution of certain fish species, increased invasive species and harmful blooms of algae, and declining beach health. Ice cover declines will lengthen the commercial navigation season.

2013 Hamilton County Multi-Hazard Mitigation Plan

Figure 1-1: FEMA-Declared Emergencies and Disasters in Ohio (2000-2012)

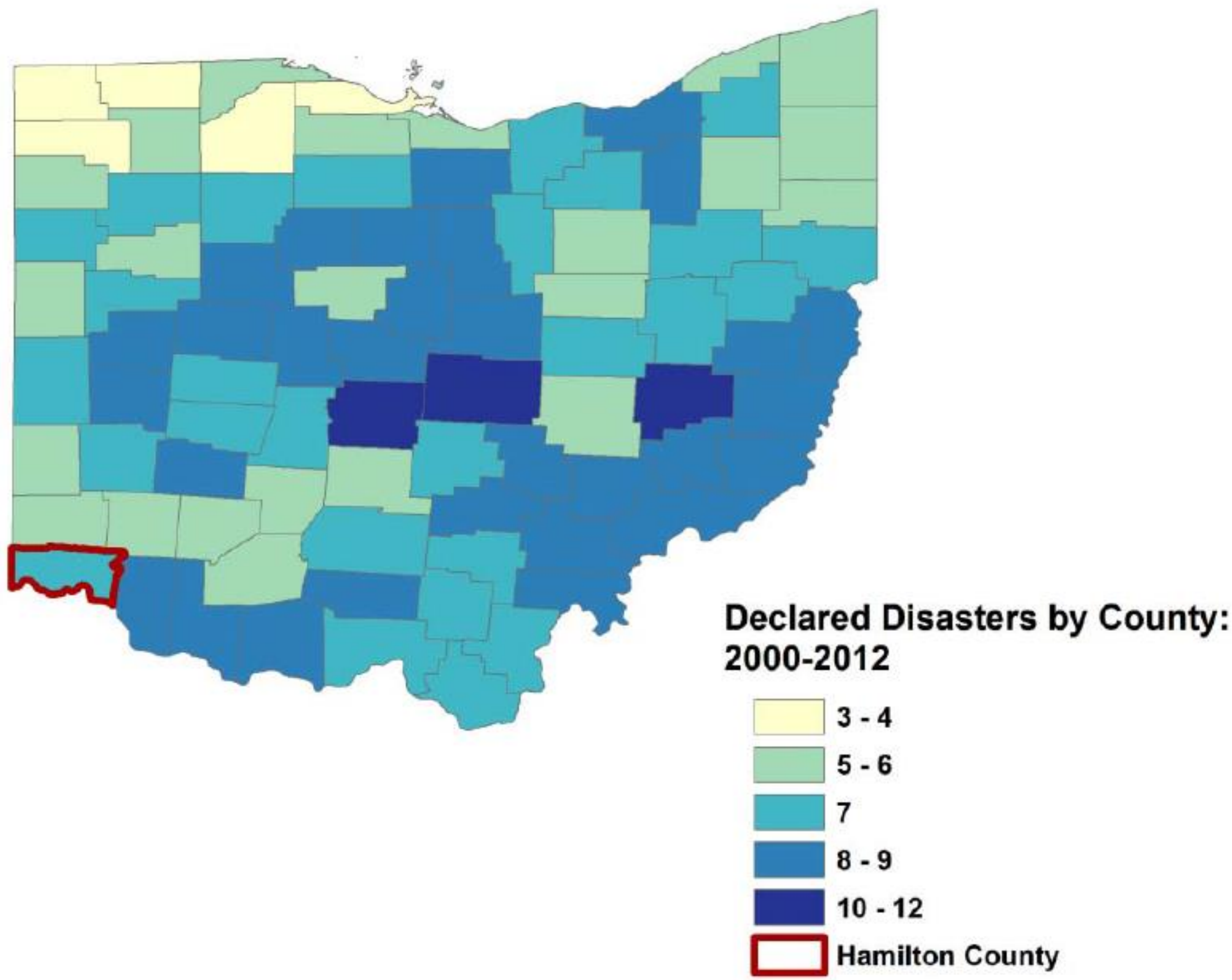
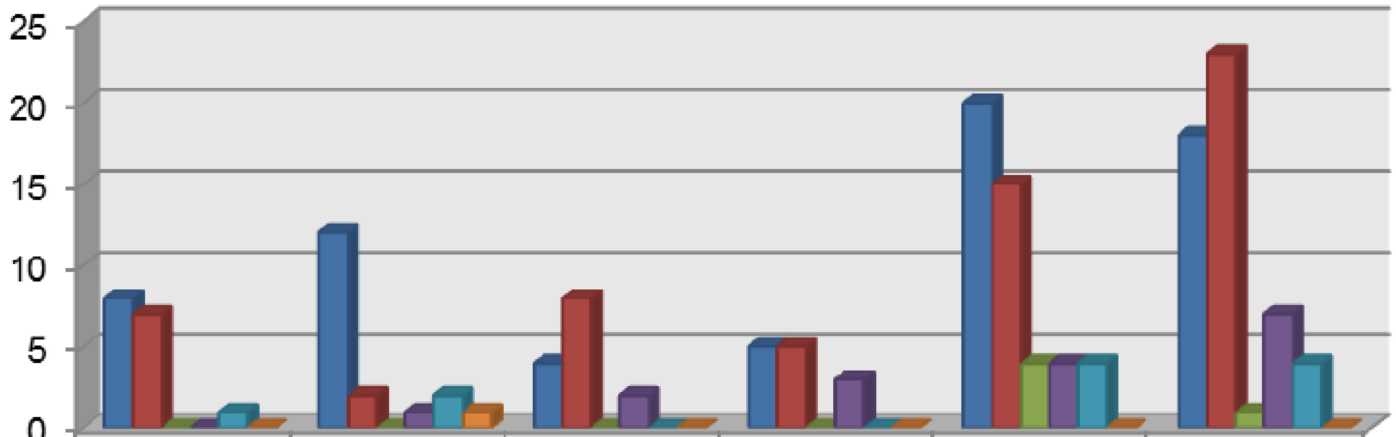


Figure 5-1: Events Reported to NCDC (2007-2012)



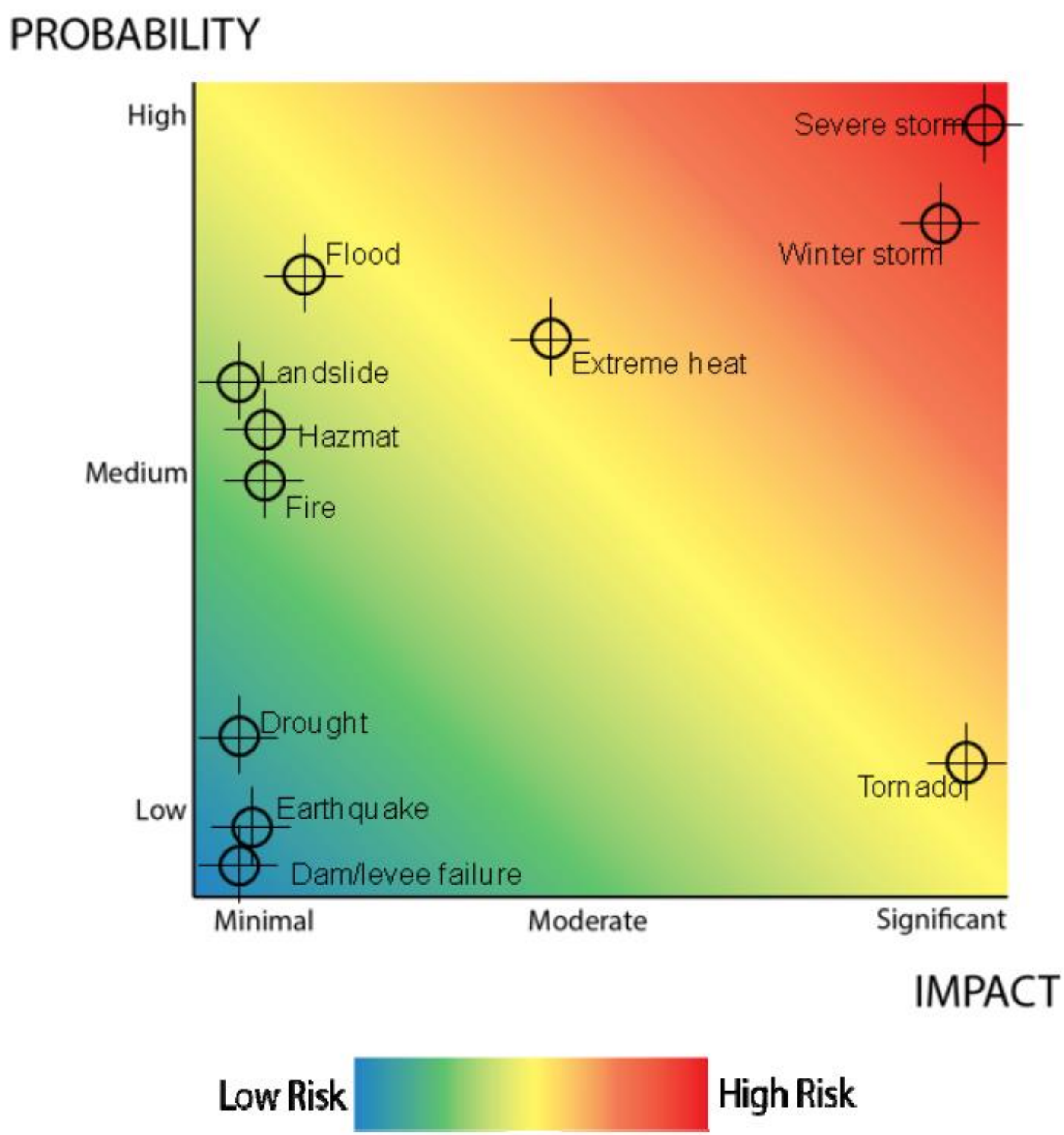
	2007	2008	2009	2010	2011	2012
TSTM WIND	8	12	4	5	20	18
HAIL	7	2	8	5	15	23
HEAVY RAIN	0	0	0	0	4	1
FLASH FLOOD	0	1	2	3	4	7
FLOOD	1	2	0	0	4	4
TORNADO	0	1	0	0	0	0

Table 5-1: Guidelines for Determining Probability and Impact

PROBABILITY	
Low	0-5 events in 10 years
Medium	6-10 events in 10 years
High	11+ events in 10 years

IMPACT	
Minimal	>Incident results in only minor injuries and no fatalities
	>Damage contained to a single incident scene and immediate area
	>Up to 5% of community facilities are damaged, destroyed, or inaccessible
	>Community able to effectively respond to incident with community resources and personnel
	>Complete shutdown of community facilities and loss of services for up to 3 days; community operations may be cancelled or relocated temporarily
Moderate	>Incident results in a number of minor injuries, limited serious injuries, and few, if any, fatalities
	>Damage to critical infrastructure and property over a small area of community
	>Up to 25% of community facilities are damaged, destroyed, or inaccessible
	>Community is able to effectively respond to the incident with standard local mutual aid support
	>Complete shutdown of community facilities and loss of services for up to 1 week; some community operations must be cancelled or relocated temporarily
Significant	>Incident results in numerous serious injuries and multiple fatalities
	>Damage to critical infrastructure and property over a large area of community
	>Up to 50% of community facilities are damaged, destroyed, or inaccessible
	>Community has reached the limit of their response capabilities. Significant local mutual aid support required.
	>Complete shutdown of community facilities and loss of services for up to 2 weeks; community operations must be cancelled or relocated for an extended period of time.

Figure 5-2: Hamilton County Hazard Rankings



Green Cincinnati Plan

- Adaptation Recommendations
  1) Prepare for Prolonged Heat
  2) Choose Plants for Changed Growing Zones
  3) Mitigate Urban Heat Island
  4) Harden Infrastructure for Stormier Weather

Local Threats from Climate Change

- Acute Threats
  - Heat Waves; Wind Storms; Floods; etc.
- Chronic Threats
  - Droughts; Invasive Species; Tree Loss; Crop Losses; Exotic Diseases; etc.
- Local Effects of Global Climate Disruption
  - Food Shortages; Energy Shortages; Displaced Populations; etc.

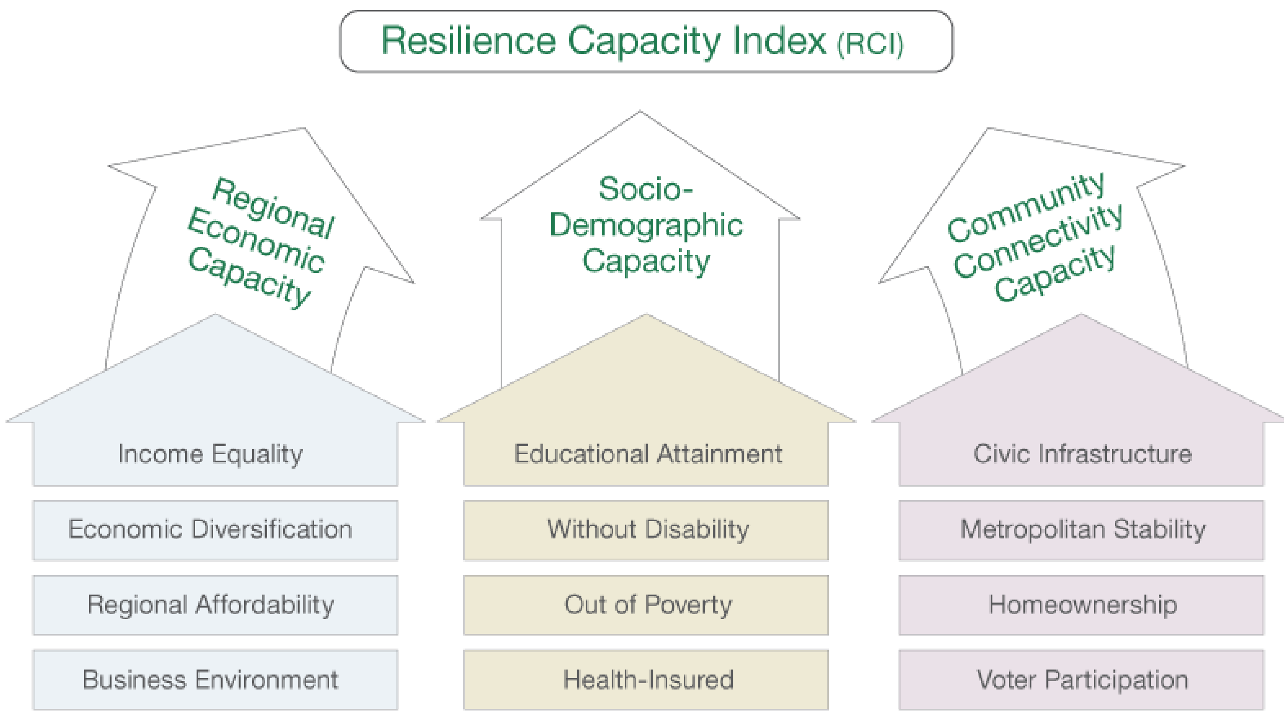
Addressed in MHMP | Partially Addressed | Not Addressed

Resilience

- How Quickly Will We Recover From a Disaster?
- How Much Help Will We Need?
- How Do We Increase Our Capacity to Withstand Shocks?

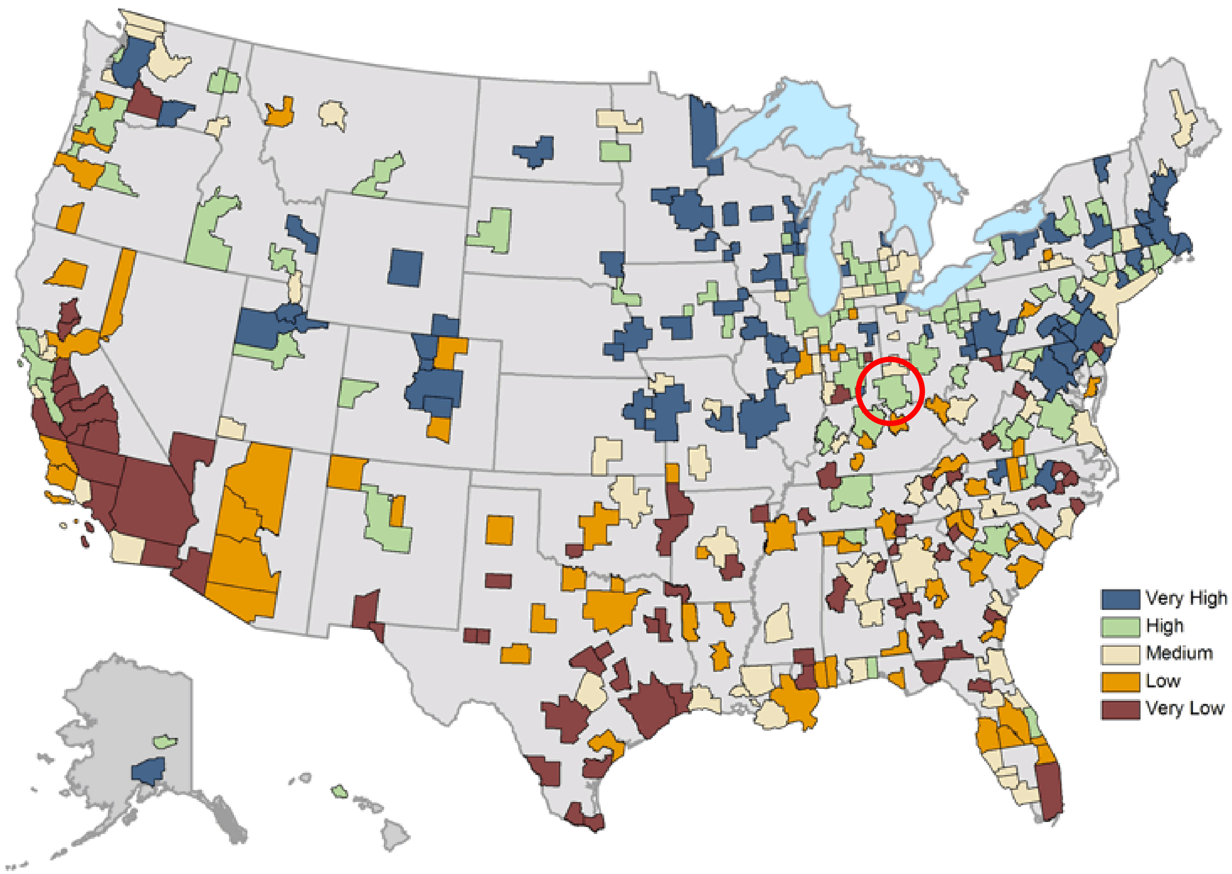
Resilience Capacity Index

One way to assess a region's resilience is by its qualities to cope with future challenges, a concept we label **resilience capacity**. Developed by Kathryn A. Foster, member of the BRR research network and director of the University at Buffalo Regional Institute, the **Resilience Capacity Index (RCI)** is a single statistic summarizing a region's score on 12 equally weighted indicators—four indicators in each of three dimensions encompassing Regional Economic, Socio-Demographic, and Community Connectivity attributes. As a gauge of a region's foundation for responding effectively to a future stress, the RCI reveals regional strengths and weaknesses, and allows regional leaders to compare their region's capacity profile to that of other metropolitan areas. See **Data and Rankings** for index scores, ranks, and maps for the overall RCI and its underlying dimensions ("capacity types"). For details on index creation and indicators, see **FAQs** and **Sources and Notes**.



RCI Map

The RCI exhibits a distinct geographic pattern. Metropolitan regions in the Northeast and Midwest regions tend to have High, Very High, or Medium resilience capacity, in contrast to the propensity for Very Low, Low, and Medium resilience capacity for metropolitan regions in the South and Southwest. Northeastern and Midwestern regions generally earn high scores for one or more indicators in each of the three categories of resilience, including regional affordability, health-insured, homeownership and metropolitan stability. In contrast, places that have experienced rapid population growth and considerable population churn, as characterizes many metros of the South and West, often earn low resilience scores particularly for several Community Connectivity indicators, including voter participation, homeownership and metropolitan stability. **Read More**



The RCI was developed by the University at Buffalo Regional Institute, State University of New York.

Compare Metros

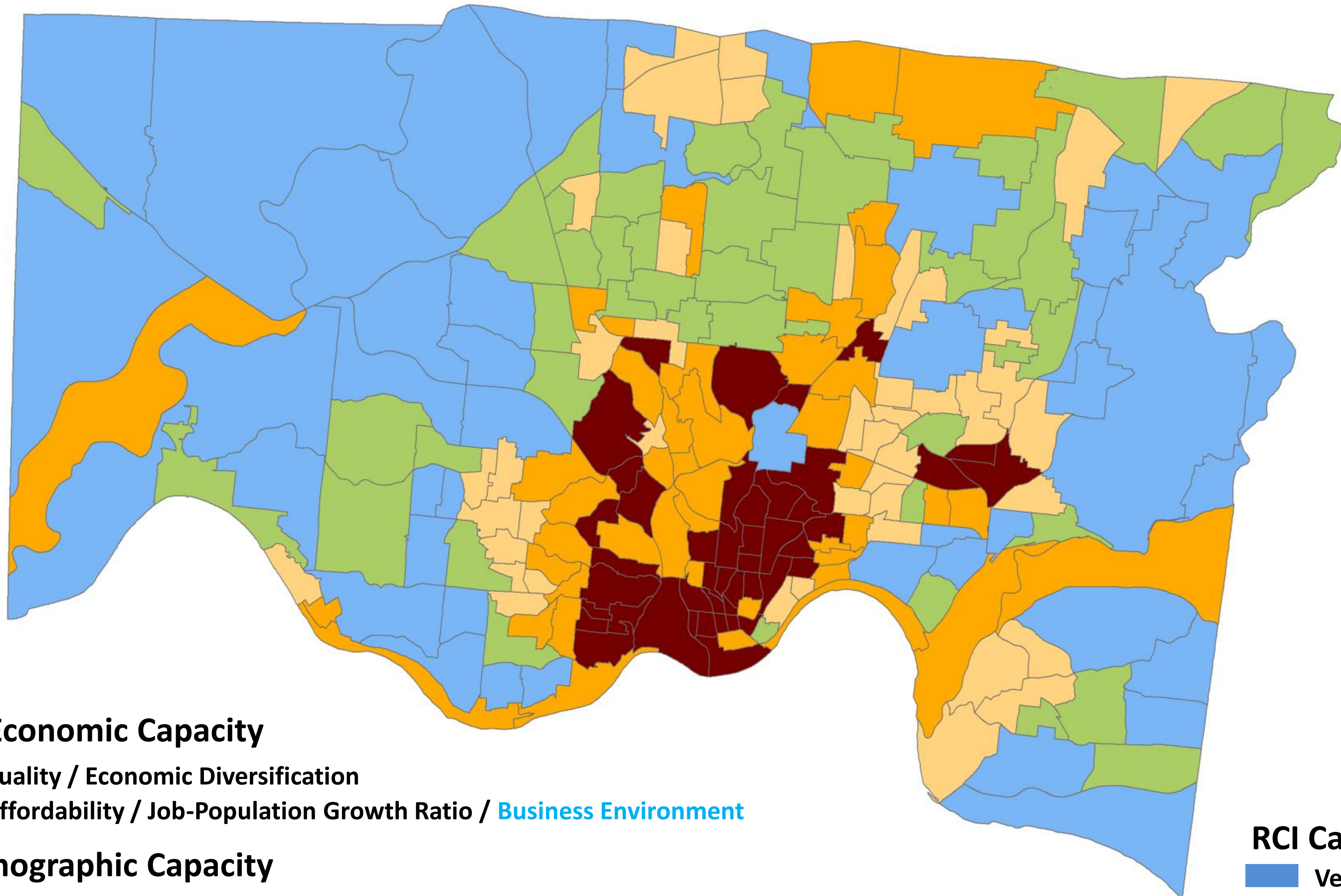
Reading across the rows reveals how the selected metropolitan regions compare by region and population class as well as by z-scores and ranks for Overall RCI, Regional Economic Capacity, Socio-Demographic Capacity, and Community Connectivity Capacity. To change selections, "choose different metros to compare" to return to the Compare Metros selection page and modify the metropolitan selections.

Choose different metros to compare

Item		Cincinnati	Columbus	Cleveland
Region		Midwest	Midwest	Midwest
Pop. Size Class		Large	Large	Large
Overall RCI	Z-Score	0.30	0.29	0.20
	Rank	97	102	132
Regional Economic Capacity	Z-Score	0.19	0.20	-0.08
	Rank	139	130	211
Socio-Demographic Capacity	Z-Score	0.34	0.38	0.05
	Rank	112	105	158
Community Connectivity Capacity	Z-Score	0.38	0.29	0.65
	Rank	107	125	50

The RCI was developed by the University at Buffalo Regional Institute, State University of New York.

Resilience Capacity Index – Hamilton County, Ohio



Regional Economic Capacity

Income Equality / Economic Diversification

Regional Affordability / Job-Population Growth Ratio / Business Environment

Socio-Demographic Capacity

Education Attainment / Without Disability / Out of Poverty / Health Insured

Community Connectivity Capacity

Metropolitan Stability / Home Ownership / Voter Participation / Civic Infrastructure

RCI Category

- Very High
- High
- Medium
- Low
- Very Low