CHICAGO METROPOLITAN AGENCY FOR PLANNING | **ON TO 2050** STRATEGY PAPER

Climate Resilience

CMAP

Contents

Climate Change and the Chicago Region: Moving Toward a Resilience Framework

Our climate is changing at a global scale. In northeastern Illinois, these changes include more frequent and severe weather, extreme heat, and drought. The effects of climate change have significant implications for the built environment, economies, ecosystems, and people in this region. Flooding has led to major road, rail, and utility outages, sewer overflows, mold, damaged property, disruptions to freight traffic, and financial losses for local businesses. Heat waves have caused illnesses, hospitalizations, and deaths in vulnerable communities, and drought has had significant adverse effects on the region's agricultural sector and natural areas.

This strategy paper provides recommendations to build climate resilience through land use planning, infrastructure planning, natural resource management, economic development, and capacity building. Its policy directions will inform how ON TO 2050, the new regional plan, can help northeastern Illinois become more resilient by adapting to and mitigating effects of climate change. For the purpose of this strategy paper and ON TO 2050, climate resilience is defined as, "the ability for the region and its communities to prepare for and recover from acute shocks and chronic stresses and transform its infrastructure, natural systems, and social structures to be more responsive."

Stakeholder Engagement

Climate resilience was not directly addressed in GO TO 2040, the predecessor to ON TO 2050, and is therefore a new topic for the agency. To inform this exploration, CMAP convened a Resource Group about once per month for nine months. Co-chaired by the Chicago Community Trust, the group included 15 stakeholders with a wide range of backgrounds, including transportation, stormwater management, land use, energy, public health, environmental justice, emergency response and hazard mitigation, urban design, landscape architecture, and planning. Through activities, discussions, and site visits, the group developed a shared mission and vision of regional climate resilience, generated policy ideas, and provided feedback on deliverables. Through a grant from the Trust, Foresight Design Initiative facilitated visioning sessions and provided significant guidance in designing meeting activities and objectives. The Resource Group process laid a strong foundation for the future collaboration needed to implement the variety of resilience strategies in this paper.

In addition, the development of this strategy included targeted stakeholder engagement efforts. The CMAP staff team solicited feedback on the strategy from its working committees, particularly the Land Use and Environment and Natural Resources working committees. Two business community roundtables on regional resilience were also facilitated by the Foresight Design Initiative; the first introduced CMAP's strategy development and gathered initial feedback on the relationship of resilience to the private sector, and the second focused on

discussing the preliminary strategies. Feedback from these engagement opportunities helped shape and refine the recommendations of this report.

Climate Change in Northeastern Illinois

In this report, climate change refers to long-term and persistent changes in the climate of the Chicagoland region, such as increased temperatures, longer periods of drought, and increased heavy storm events. Weather refers to short-term conditions of sunshine, precipitation, temperature, and humidity, all of which vary daily and seasonally. When averaged over decades, weather patterns allow us to understand climate and how it is changing. Northeastern Illinois has already experienced, and is projected to see even greater, changes in temperature and precipitation from climate change. In recent years, weather events in the region have included record-breaking flooding, heat, and drought.[1] The region broke the record for most consecutive days above 100 degrees during the Midwestern drought in 2012,[2] followed by a presidential-declared flood disaster in 2013.[3] While seasonal vacillations are not always predictable, models can project overall trends in the region's climate.

This strategy paper draws on a variety of sources for climate data and projections. The Intergovernmental Panel on Climate Change (IPCC) is the primary international body tasked with assessing climate science. The IPCC periodically publishes comprehensive assessments of climate change that include both historical data and projected changes. The most recent Fifth Assessment Report was published in 2014. The IPCC models climate projections based on scenarios of high- and low-emissions futures. National and regional climate models are based on the IPCC models. Every four years, the United States Global Change Research Program is required to conduct a National Climate Assessment (NCA)[4] that updates data about climate science and impacts across the country. The changes in climate described below come from historical data and downscaled regional, state, and local projections of future conditions that the Midwest Regional Climate Center and Illinois State Climatologist have derived from the latest NCA in 2014. Because downscaled models vary in methodology and geography and no definitive model exists, data are presented at various scales. While there are variations within the region, the general climate trends for northeastern Illinois largely mirror those across the state.

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[1] CMAP, June 2013, "Climate Adaptation Guidebook for Municipalities in the Chicago Region," Appendix A: Primary Impacts of Climate Change in the Chicago Region, http://www.cmap.illinois.gov/documents/10180/14193/Appendix+A+-+Primary+Impacts+of+Climate+Change+in+the+Chicago+Region.pdf/2a85b021-f3bd-4b98-81d1-f64890adc5a7.

[2] U.S. Department of Agriculture, 2013, "U.S. Drought 2012: Farm and Food Impacts," http://www.ers.usda.gov/topics/in-the-news/us-drought-2012-farm-and-food-impacts.aspx.

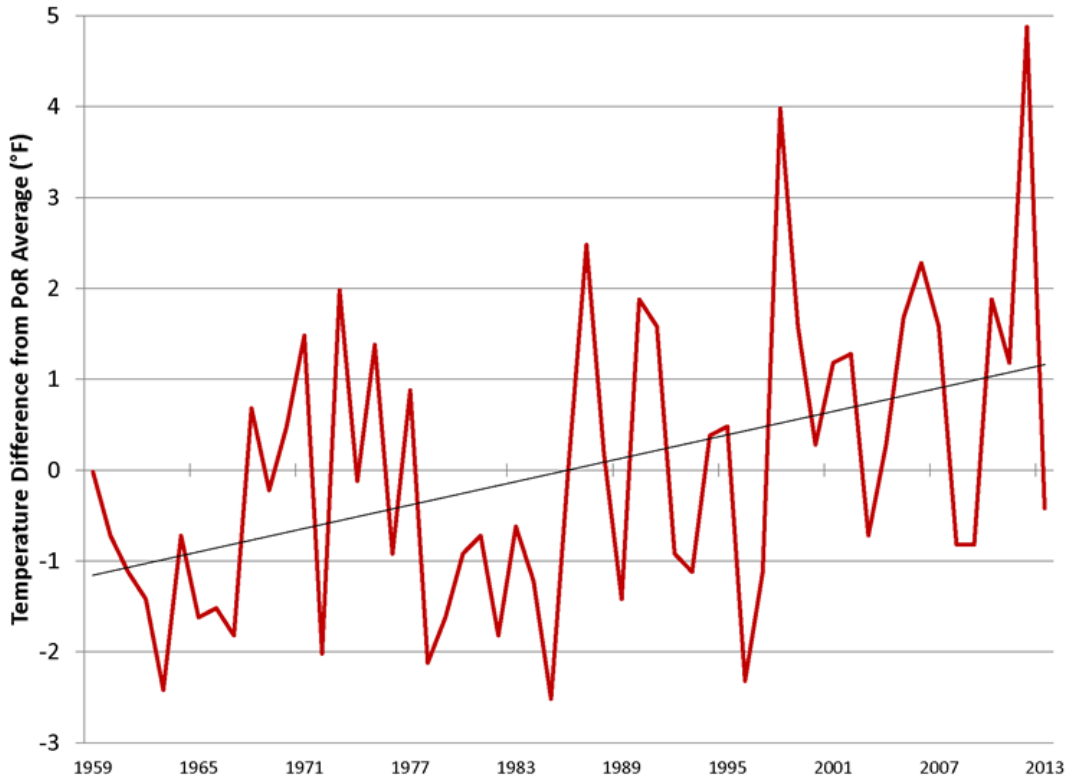
[3] Federal Emergency Management Agency, "Illinois Severe Storms, Straight-Line Winds and Flooding (DR-4116)," http://www.fema.gov/disaster/4116.

[4] 2014 National Climate Assessment, http://nca2014.globalchange.gov/.

Temperature

Average temperatures are getting hotter. The rate of warming has been pronounced in recent years: the Midwest has warmed by 2 degrees Fahrenheit since 2000, faster than any other decade since 1900.[5]

Figure 1. Average Temperature of the Chicago Region, 1959-2010 (2014 NCA)



This graph illustrates the difference from the average temperature for O'Hare International Airport.

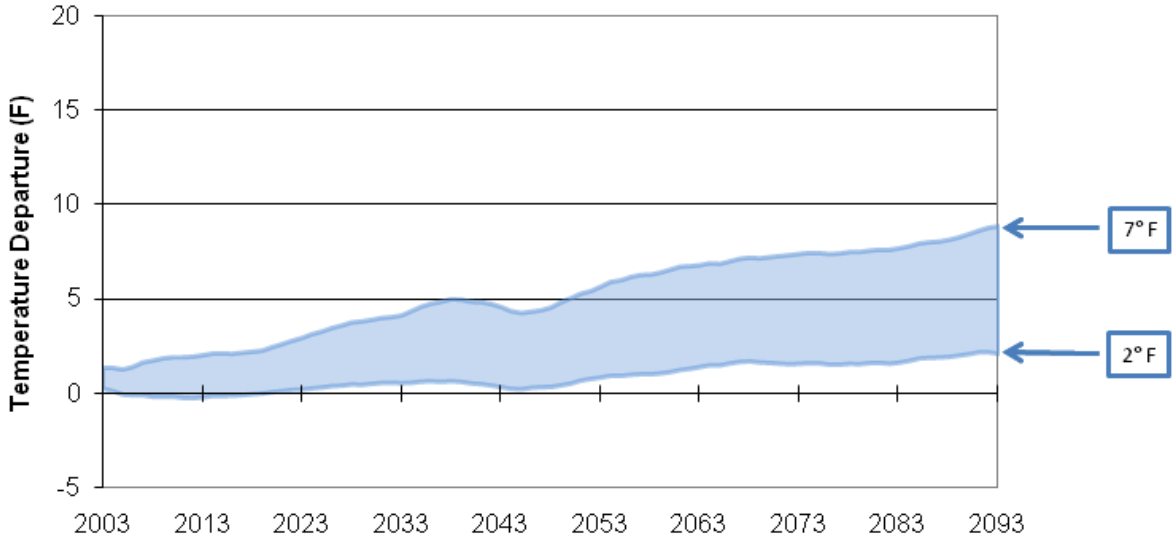
Source: Illinois State Climatologist, derived from 2014 National Climate Assessment.

Although these increases may seem minor, even a few degrees of average temperature change greatly increases the risks and severity of extreme weather, heat, and drought. By the end of the century, temperatures in Illinois are expected to increase by 7 to 12 degrees Fahrenheit.[6]

[5] Great Lakes Integrated Sciences and Assessments, "Synthesis of the Third National Climate Assessment for the Great Lakes Region," http://glisa.umich.edu/media/files/Great_Lakes_NCA_Synthesis.pdf.

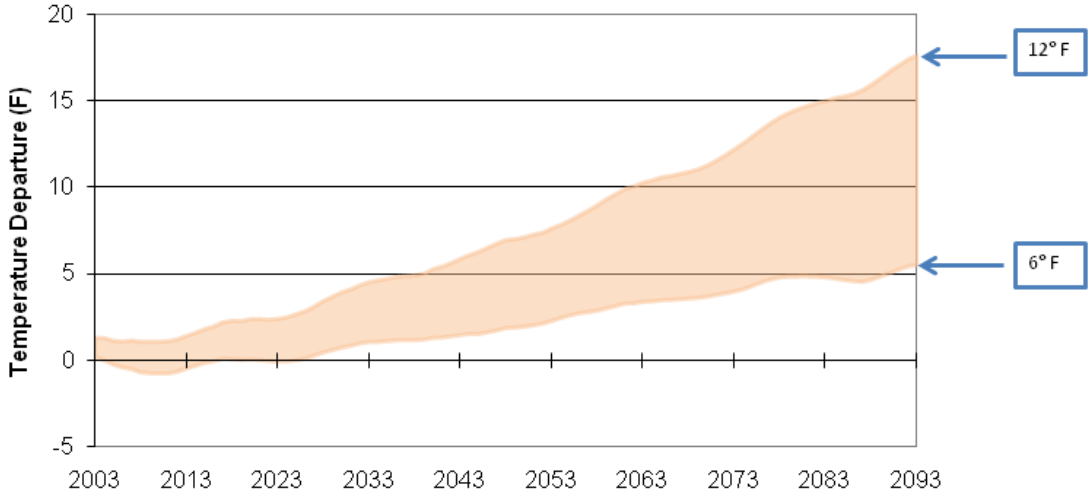
[6] Illinois State Climatologist, "Future Climate Change Scenarios for Illinois," http://www.isws.illinois.edu/atmos/statecli/climate-change/scenarios.htm.

Figure 2. Range of Future Temperature Increase for Illinois in a Low-Emissions Scenario, 2003-93 (2014 NCA)



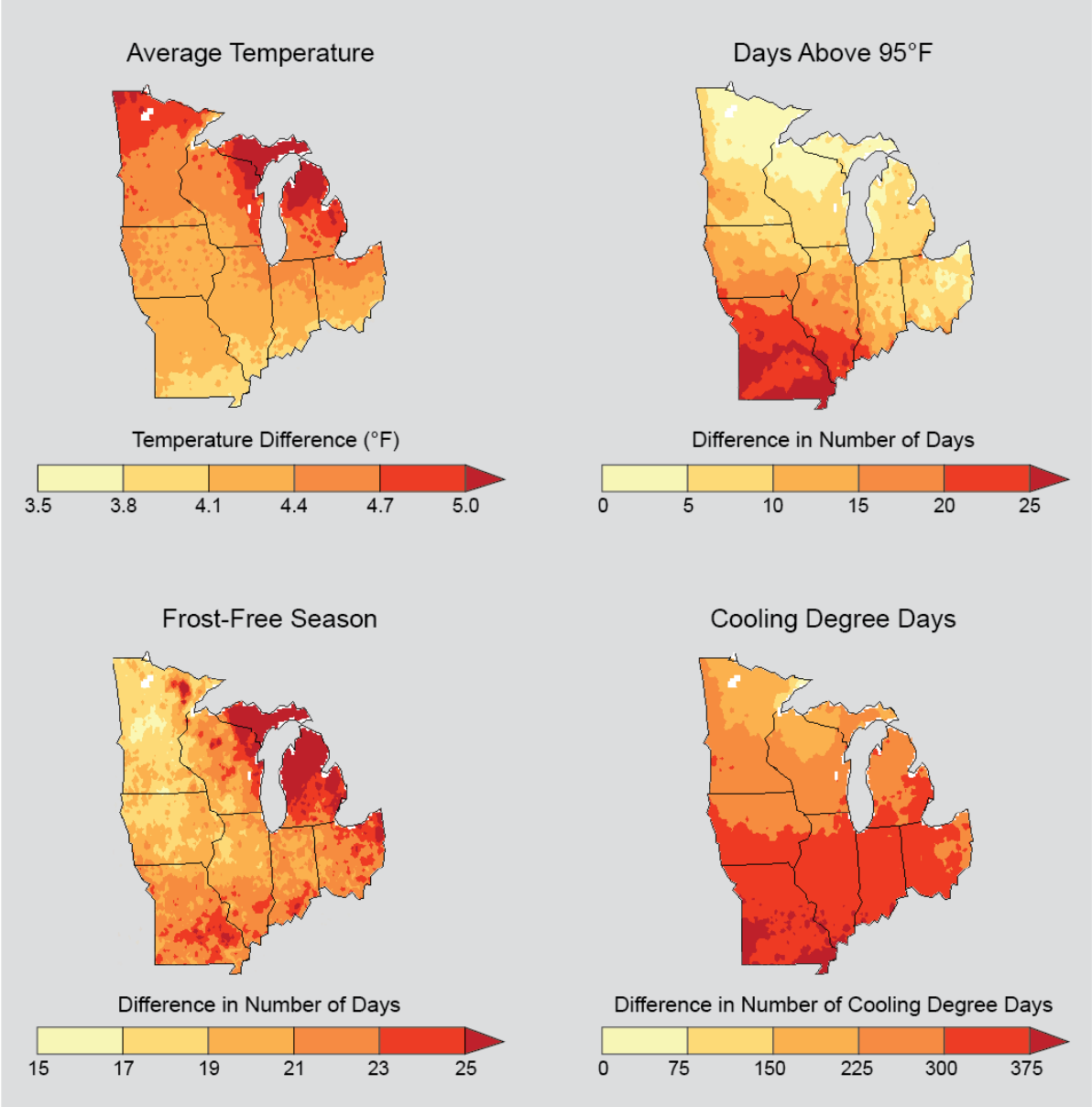
Under a scenario that assumes drastically reduced emissions, the average temperature in Illinois is projected to increase by two to seven degrees Fahrenheit by the end of the century. Source: Illinois State Climatologist Office, derived from the B1 (low emissions) scenario of the 4th IPCC report.

Figure 3. Range of Future Temperature Increase for Illinois in a High-Emissions Scenario, 2003-93 (2014 NCA)



Under a scenario that assumes moderately high emissions, the average temperature in Illinois is projected to increase by six to twelve degrees Fahrenheit by the end of the century. Source: Illinois State Climatologist Office, derived from the B2 (high emissions) scenario of the 4th IPCC report.

Figure 4. Projected Mid-Century Temperature Changes in the Midwest

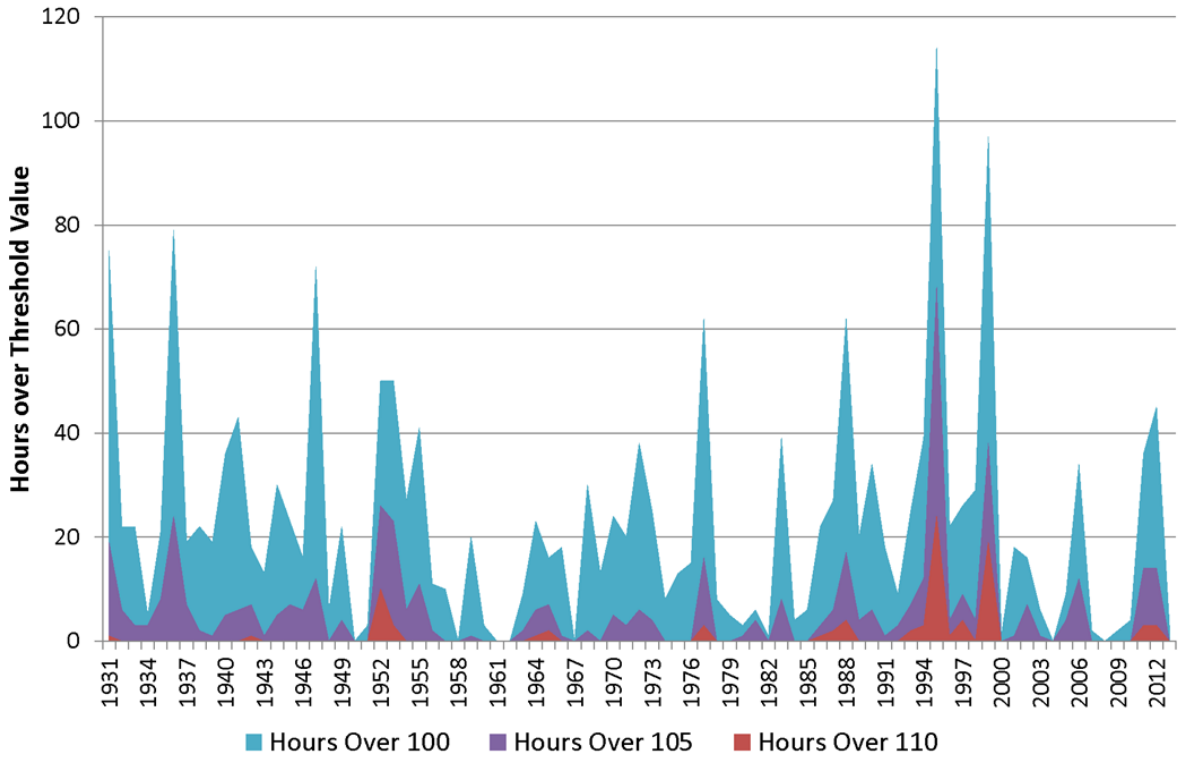


If emissions continue to rise (IPCC's A2 scenario), projections show that average annual temperatures will increase by mid-century. The Midwest is also expected to see an increase in number of days above 95 degrees Fahrenheit, longer frost-free seasons, and more cooling degree days. Cooling degree days are days where the average temperature is above 65 degrees Fahrenheit, which increases the likelihood of air conditioning use; the number of days shown in the chart reflects the increase in the total number of cooling degree days under the A2 emissions scenario for 2041-2070 relative to the 1971-2000 reference period.

Source: 2014 National Climate Assessment, Kenneth Kunkel, Cooperative Institute for Climate and Satellites – NC, http://nca2014.globalchange.gov/report/regions/midwest.

Warming is not occurring consistently. Historically, the Chicago region has only had three days over 95 degrees Fahrenheit each year. By mid-century, the region is expected to have at least 10 to 15 days over 95 degrees Fahrenheit annually.[7] Weather advisories focus on daytime highs, but most heat-related deaths occur due to persistent nighttime heat.[8] In fact, the region's nights are also warming at a faster pace than its days. While the region has historically had 13.5 nights above 70 degrees Fahrenheit per year, it may expect 30 to 40 nights with such conditions in the future. The region's hot temperatures are often accompanied by high humidity (as measured by heat index), making warmer temperatures feel more oppressive. A heat index over 110 degrees Fahrenheit (indicated in red in Figure 5) was rare for most of the 20th century, but has significantly increased in recent years.

Figure 5. Historical Heat Index Trends



Summers with extremely high heat indexes have increased in recent years, based on annual temperature readings from June through September at Chicago Midway Airport. Most notably, the region is experiencing more hours over 100 degrees Fahrenheit. The 1995 and 1999 heat waves were record breaking. Source: Illinois State Climatologist.

[7] 2014 National Climate Assessment, Kenneth Kunkel, Cooperative Institute for Climate and Satellites – NC, http://nca2014.globalchange.gov/report/regions/midwest.

[8] Center for Climate and Energy Solutions, December 2011, "Extreme Weather and Climate Change," http://www.c2es.org/publications/extreme-weather-and-climate-change.

Winters are also warming. Climate models project a decrease in freezing temperatures by mid-century. One study of the Chicago region estimates a 50 to 90 percent decline in days below 0˚F by the end of the 21st century.[9] As a result of warmer winters, ice coverage has diminished in the Great Lakes by 63 percent since the 1970s.[10] These winter temperature patterns may also lead to more freeze-thaw events (the cycle of moving from below- to above-freezing conditions). Freeze-thaw cycles lead to wear and tear on the built environment, causing more rapid deterioration of roadways and other infrastructure.

Precipitation

The Chicago region is experiencing heavier precipitation. Because air can hold four percent more water vapor with each degree Fahrenheit of temperature increase, a warming climate also means more precipitation.[11] In the Midwest, the amount of precipitation falling in very heavy precipitation (defined as the heaviest one percent of all daily events) increased by 37 percent between 1958 and 2012.[12] The percentage increase is higher than natural variations in precipitation levels and is second only to the Northeast.

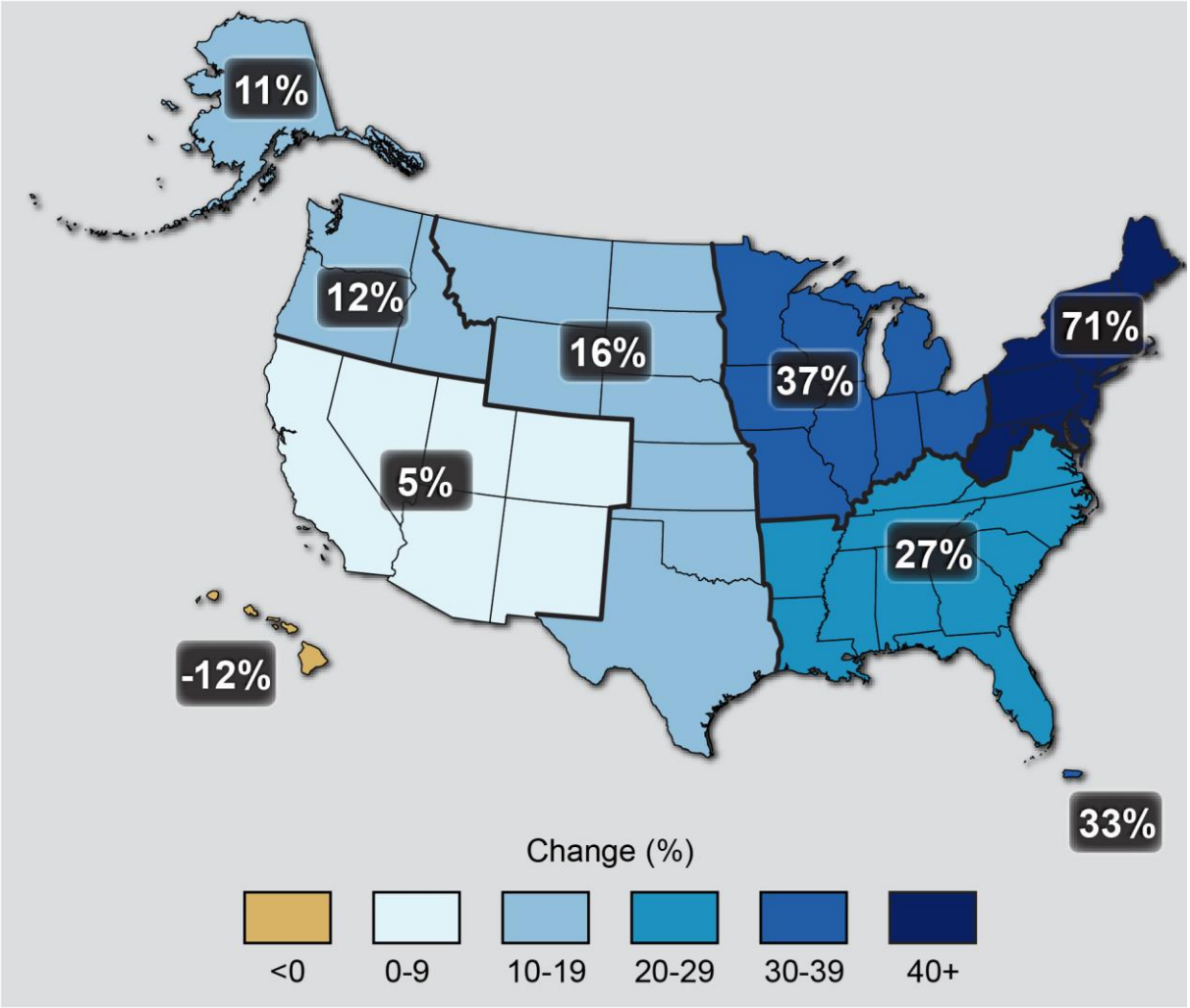
[9] Varvus, S. and Van Dorn, J. 2010. Projected future temperature and precipitation extremes in Chicago. *Journal of Great Lakes Research*, Supplement 2, Vol. 36, 22-32.

[10] Wang, J., X. Bai, H. Hu, A. Clites, M. Colton, and B. Lofgren, 2012: "Temporal and spatial variability of Great Lakes ice cover, 1973-2010." Journal of Climate, 25, 1318-1329, doi:10.1175/2011JCLI4066.1. Also see the 2014 National Climate Assessment, http://nca2014.globalchange.gov/report/our-changing-climate/melting-ice.

[11] Illinois Department of Natural Resources, 2015, "Urban Flooding Awareness Act," https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

[12] National Climate Assessment, 2014, "Heavy Downpours Increasing," http://nca2014.globalchange.gov/report/our-changing-climate/heavy-downpours-increasing.

Figure 6. Observed Change in Very Heavy Precipitation, 1958-2012 (2014 NCA)



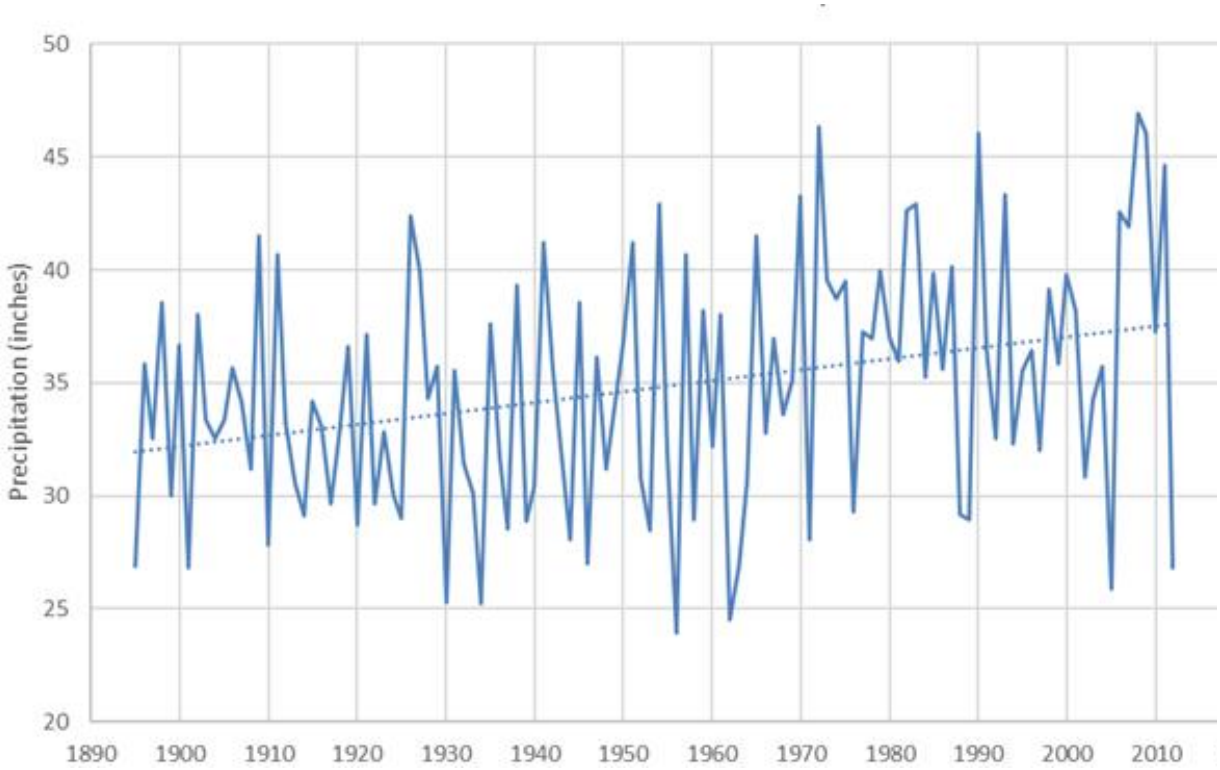
The Midwest has seen a 37 percent increase of very heavy precipitation events, defined as the heaviest one percent of all daily events) between 1958 and 2012. Source: 2014 National Climate Assessment, http://www.globalchange.gov/browse/multimedia/observed-change-very-heavy-precipitation-0.

Some models estimate that 24-hour[13] and seven-day rainfalls[14] in the Midwest will double by the end of this century. Both annual precipitation and intensity of weather events (the amount of rainfall from a single precipitation event) have also been on the rise.

[13] Rainfall accumulation within 24 hours.

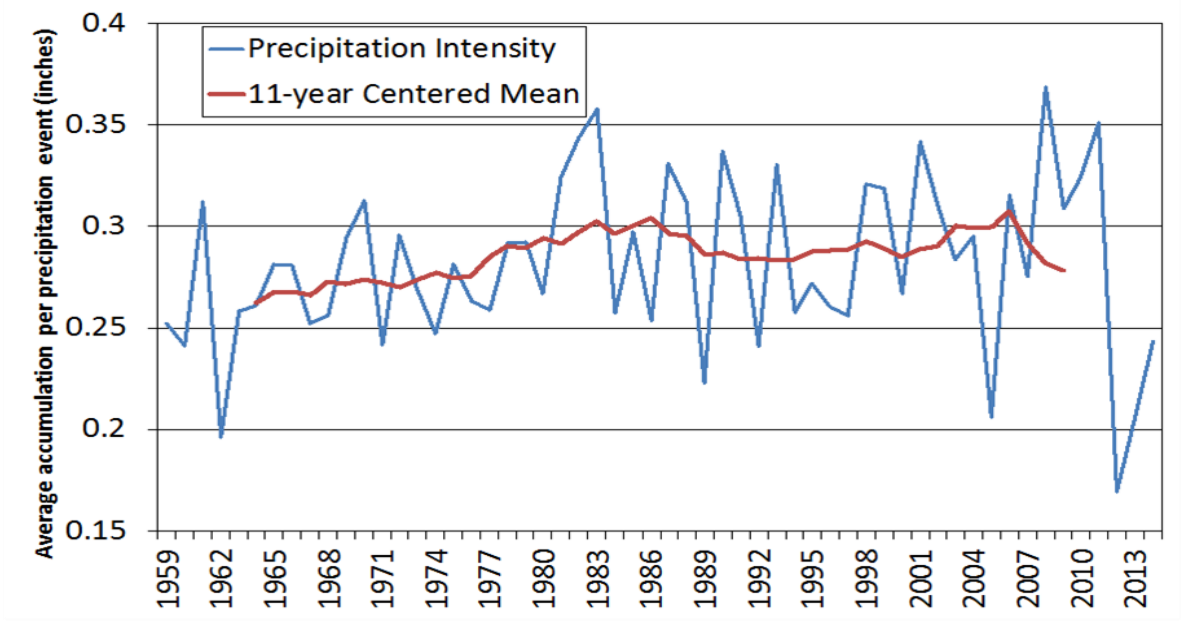
[14] Rainfall accumulation within seven days.

Figure 7. Annual Precipitation in Northeast Illinois



The annual precipitation in northeastern Illinois has increased throughout the century, but that there are still significant vacillations between years of heavy rains and droughts. Source: Illinois State Climatologist Office, http://www.sws.uiuc.edu/atmos/statecli/climate-change/NE-IL-trends/rainfall.htm.

Figure 8. Precipitation Intensity, 1959-2013 (2014 NCA)



In recent decades, the region has seen storm events with greater precipitation intensity, defined as the average accumulation per weather event. The data in this graph were measured at Chicago O'Hare International Airport. Source: Illinois State Climatologist, based on 2014 National Climate Assessment.

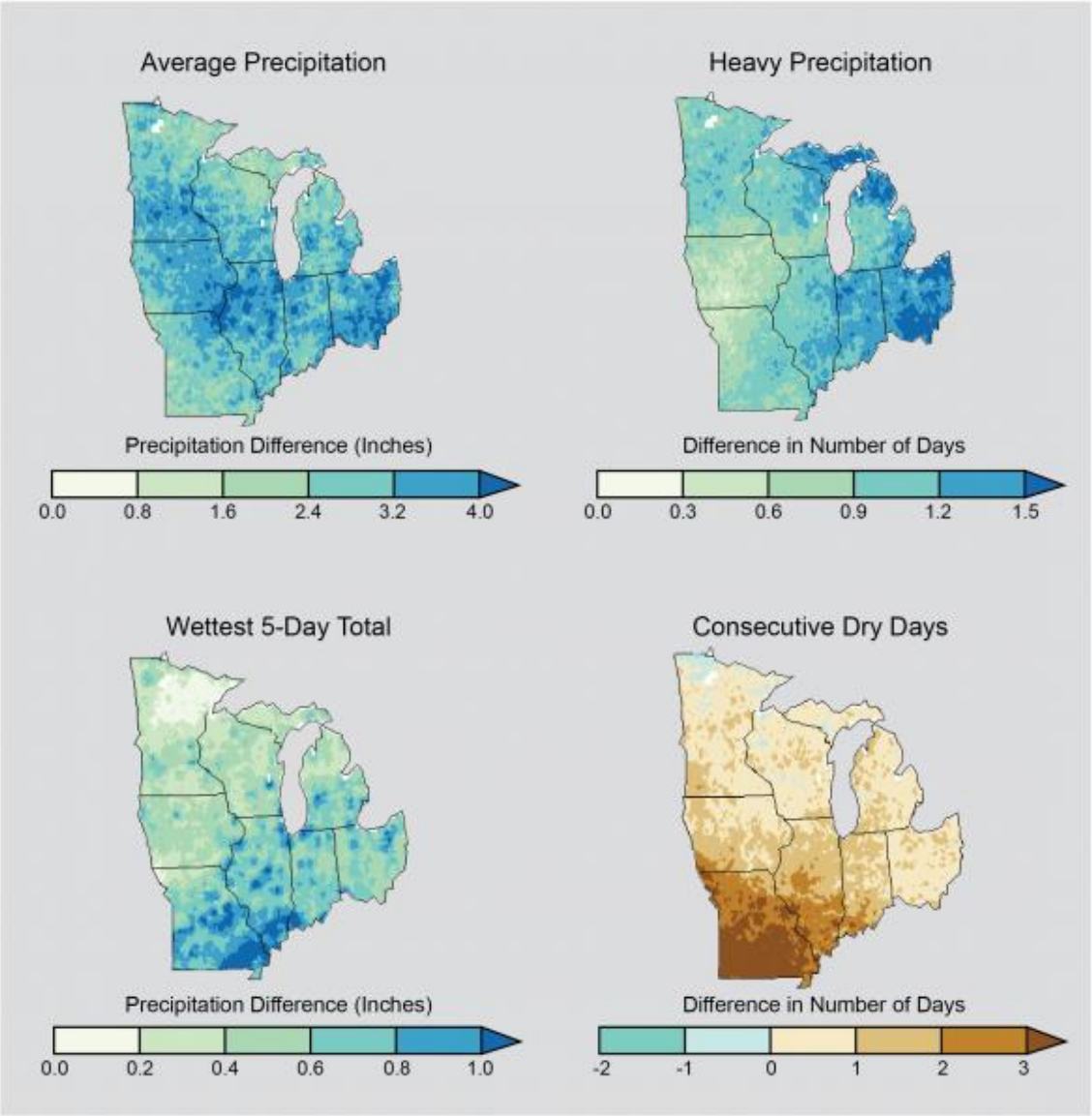
Between 1979 and 2009, the region experienced 40 percent more precipitation than the prior 30-year period. Storm events are also getting bigger: Up to 40 percent of total annual precipitation in recent years came from the top 10 rainiest days.[15] Historical analysis of heavy precipitation events in Chicago indicate that the threshold for the once-rare 24-hour, 100-year storm has been met or exceeded three times in Chicago since the 1980s.[16] As defined by the Illinois State Water Survey, a 100-year storm in northeastern Illinois is 7.58 inches of rainfall in 24 hours; there has historically been a one percent chance of such an event in any given year.[17] Under a continued high emissions scenario, annual precipitation and heavy precipitation are both projected to increase.

[15] Illinois Department of Natural Resources, 2015, "Urban Flooding Awareness Act," https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

[16] CMAP, June 2013, "Climate Adaptation Guidebook for Municipalities in the Chicago Region," Appendix A: Primary Impacts of Climate Change in the Chicago Region, http://www.cmap.illinois.gov/documents/10180/14193/Appendix+A+-+Primary+Impacts+of+Climate+Change+in+the+Chicago+Region.pdf/2a85b021-f3bd-4b98-81d1-f64890adc5a7.

[17] Huff, F. A., and J. R. Angel, 1989. Rainfall Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois (Bulletin 70), Illinois State Water Survey, http://www.isws.illinois.edu/atmos/statecli/PDF/b70-all.pdf.

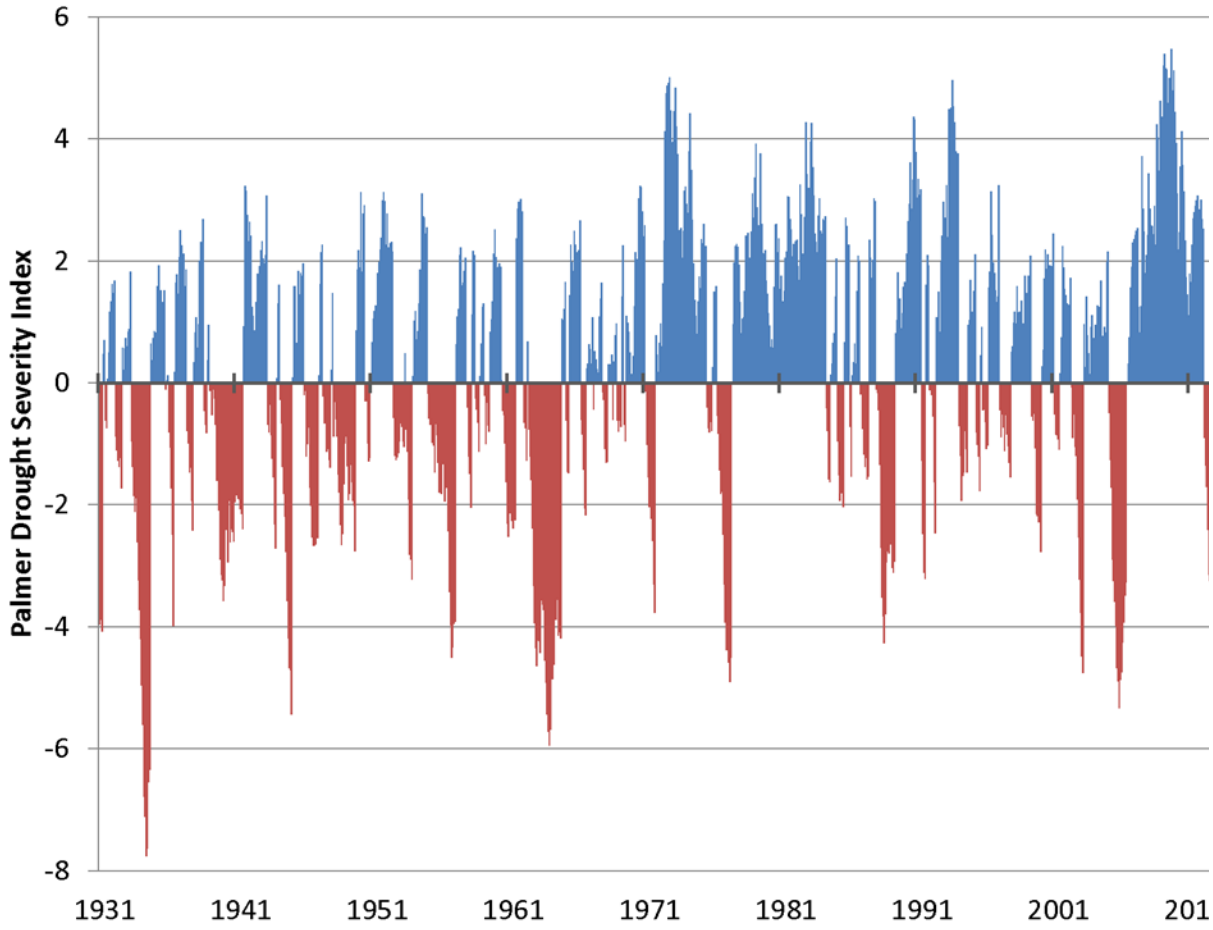
Figure 9. Projected Mid-Century Precipitation Changes



If emissions continue to rise (under the IPCC A2 scenario), the Midwest is expected to experience more total precipitation each year in the form of rainfall and snowfall. Each map shows the difference between current and projected data for four factors: average precipitation, heavy precipitation, wettest five-day totals, and consecutive dry days. Heavy precipitation refers to the top two percent of all rainfalls each year and the wettest five-day total refers to precipitation from the wettest consecutive five-day period over the course of a year. Alongside the overall trend of precipitation increase, the Midwest is also expected to see an increase in the number of consecutive dry days without precipitation. This means a great risk of flash floods due to dry ground conditions between heavier rain events. Source: 2014 National Climate Assessment. http://www.globalchange.gov/browse/multimedia/when-it-rains-it-pours.

Changes in climate have also resulted in droughts. Although they have been less frequent compared to the first half of the 20th century, recent decades show wider swings between droughts and heavy precipitation.

Figure 10. Historical Drought, Palmer Drought Severity Index, Northeastern Illinois, 1931-2011



The Palmer drought severity index measures the dryness of ground conditions based on precipitation and temperature, and is used as a measure of drought. This graph shows the Palmer drought severity index for northeastern Illinois (climate division 2). While the region has seen more overall precipitation, these years have been punctuated by years of significant drought. Source: Illinois State Climatologist, based on 2014 National Climate Assessment.

Despite the total increases in precipitation levels, the Midwest is also poised to experience more consecutive dry days.[18] Taken together, the region's rainfall and drought projections mean that

[18] 2014 National Climate Assessment, http://www.globalchange.gov/browse/multimedia/when-it-rains-it-pours.

the region faces higher risks of flash floods due to heavier rains per storm and extended dry periods between storm events that impede infiltration.

Warmer winter temperatures will also retain more humidity in the atmosphere, resulting in more winter precipitation falling in the form of rain rather than snow.[19] While snowfall may decrease, climate models predict that the snow storms that do occur will be more intense, with more snowfall accumulation per event and denser, heavier snow.[20]

Climate Impacts by Planning Topic

The temperature and precipitation changes described are important because of potential effects on the region's built environment, natural resources, economies, communities, and people. The following section discusses expected climate effects on a variety of planning topics, including transportation, land use, natural resources, regional economy, and climate-vulnerable populations. This overview highlights the vulnerabilities of the region's assets and residents to climate change. Vulnerability is defined by the Intergovernmental Panel on Climate Change (IPCC) as a factor of three variables: the degree to which something or someone (1) is *exposed* to climate change, (2) is *sensitive* to those impacts, and (3) has *adaptive capacity (*ability to adjust) to moderate the potential impacts.[21] For example, soil type, hydrology, impervious coverage, and other physical attributes increase a community's exposure to flooding and heat. However, even when two communities face similar levels of exposure to climate change, they may experience different levels of effects. Characteristics of sensitivity such as age, income, and household composition mean that some people are more susceptible than others.. And finally, socioeconomic factors such as social cohesion and access to resources influence a community's ability to mitigate or prepare for climate change.

This section is not a comprehensive climate vulnerability assessment, which typically provides much more detailed analyses for specific assets. However, this summary of physical, natural, and social vulnerabilities to climate change will allow regional partners to identify areas where resilience actions are needed.

[19] Jaffe, M. and Woloszyn, M. 2014. An Initial Assessment of Winter Climate Change Adaptation Measures for the City of Chicago. *Sea Grant Law and Policy Journal*, Vol. 6, No. 2, pp. 5-25.

[20] Jaffe, M. and Woloszyn, M. 2014. An Initial Assessment of Winter Climate Change Adaptation Measures for the City of Chicago. *Sea Grant Law and Policy Journal*, Vol. 6, No. 2, pp. 5-25.

[21] Intergovernmental Panel on Climate Change, 2007, "Synthesis Report," https://www.ipcc.ch/publications_and_data/ar4/syr/en/mains5-2.html.

Transportation

According to the region's most recent greenhouse gas (GHG) emissions inventory, the transportation sector accounts for nearly a quarter of the region's emissions.[22] GO TO 2040 promotes investments in low-carbon transportation alternatives that reduce emissions, including transit, bicycling, and walking, to reduce emissions. Continued investments in low-carbon transportation options are needed to mitigate climate change.

The effects of climate change on transportation infrastructure are also increasingly significant. Higher temperatures are causing more pavements to buckle and rut, and heavier rains are expected to increase scouring and deterioration of bridges.[23] The 2012 drought and heat wave led to such severe railway buckling that a train was derailed in Glenview.[24] Transportation infrastructure design standards will need to be recalibrated to withstand new thresholds of heat, freeze-thaw cycles, and buckling from changing temperature and precipitation patterns. Moreover, road and rail networks have experienced outages during extreme weather events, disrupting freight routes and employee commutes. The costs of simply maintaining and modernizing the region's infrastructure is high: The Metropolitan Planning Council (MPC) estimates that it will take $43 billion over 10 years to improve all of the roads, rails, and bridges in Illinois that are in poor condition.[25] The investments needed to make systems more climate resilient will be even greater.

Land Use

Land use and development patterns, which shape the built and natural environments, directly affect a community's emissions. For instance, compact developments and mixed use communities encourage walking and bicycling, which reduces transportation emissions. Land use patterns also influence a community's exposure to climate effects. Many built-out communities have large areas of impervious coverage. When it rains, stormwater flows across rooftops, roadways, and other surfaces that do not allow for percolation, carrying many pollutants with it. This runoff can have particularly detrimental effects when contaminated land is present, leeching pollutants into the soil and groundwater.

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[22] CMAP, May 2012, "Chicago 2010 Regional Greenhouse Gas Emissions Inventory," http://www.cmap.illinois.gov/documents/10180/27573/Chicago_2010_Regional_Greenhouse_Gas_Emissions_Inventory_05-22-12.pdf/adf2a647-246e-48e0-aead-2766fa3281e8.

[23] CMAP, June 2013, "Climate Adaptation Guidebook for Municipalities in the Chicago Region," http://www.cmap.illinois.gov/documents/10180/14193/FY13-0119+Climate+Adaptation+toolkit+lowres.pdf/98b5e57c-453f-4111-bc02-6e2cdea0dabc.

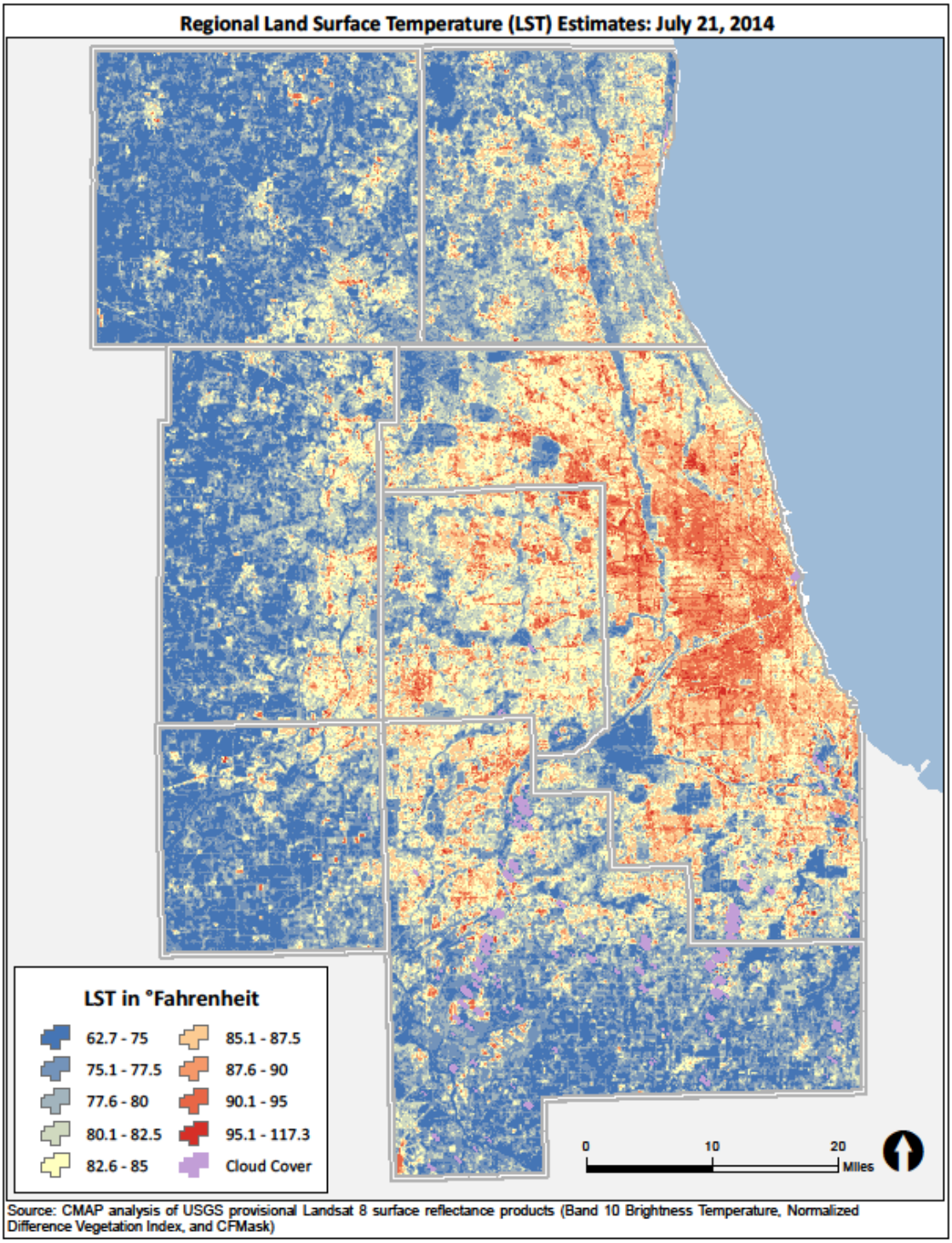
[24] Village of Glenview, "Union Pacific Road/Shermer Road," http://glenview.il.us/Pages/Union-Pacific-RailroadShermer-Road.aspx.

[25] Metropolitan Planning Council, 2016, "Illinois' Transportation Crisis," http://www.metroplanning.org/uploads/cms/documents/mpc_tranportation_crisis_fact_sheet_2016_04_01.pdf.

Impervious surfaces also retain heat and intensify the urban heat island effect, in which a metropolitan area is warmer than surrounding undeveloped areas. Hotter surface temperatures can cause heat-related illnesses, deaths, respiratory issues, air conditioning-related energy demand spikes, and ozone and thermal pollution. When ambient air temperature is the same across the region, areas with higher imperviousness experience hotter land surface temperatures that contribute to urban heat island effect. A regional analysis of land surface temperature demonstrates the correlation between impervious coverage and urban heat island effect. Lands with high- and medium-intensity developments, defined as having greater than 50 percent impervious surfaces, are five to six degrees hotter than the regional average (see Table 1).

Although there is a clear correlation between imperviousness and urban heat island effect, there are many strategies to mitigate heat while encouraging development. Urban forestry and other site-scale green infrastructure practices can be integrated into street and site design. Parkways and rights-of-way are appropriate places for adding street trees, the most effective vegetative cover for reducing urban heat island effect.

Figure 11. Land Surface Temperature in the Region



Land surface temperature, which directly correlates to imperviousness, varies across the region. For this land surface data, as well as a more detailed description of CMAP's analysis process, please refer to the Data Hub: https://datahub.cmap.illinois.gov/dataset/land-surface-temperature-estimates-july-21-2014.

Table 1. Temperature by Land Cover Class in the Chicago Region

Land Cover Class[26]	Acreage	Percent	Average land surface temperature (LST) (°F)	Difference from regional LST (°F)
Developed, High Intensity	139,196.7	5.4%	86.5	6.6
Developed, Medium Intensity	302,821.9	11.7%	85.0	5.1
Developed, Low Intensity	611,845.9	23.7%	82.4	2.5
Planted/Cultivated	881,436.9	34.1%	81.7	1.7
Barren	11,342.4	0.4%	81.5	1.6
Herbaceous/Shrublands	60,863.0	2.6%	80.3	0.3
Wetlands	76,196.7	3.0%	78.6	-1.3
Forest	187,242.0	7.3%	78.3	-1.7
Water	55,330.0	2.1%	78.0	-1.9
Total Acreage / Avg LST	**2,583,865.7**	**100.0%**	**79.9**	0.0

Source: CMAP analysis of 2011 National Land Cover Dataset and Landsat 8

Agriculture

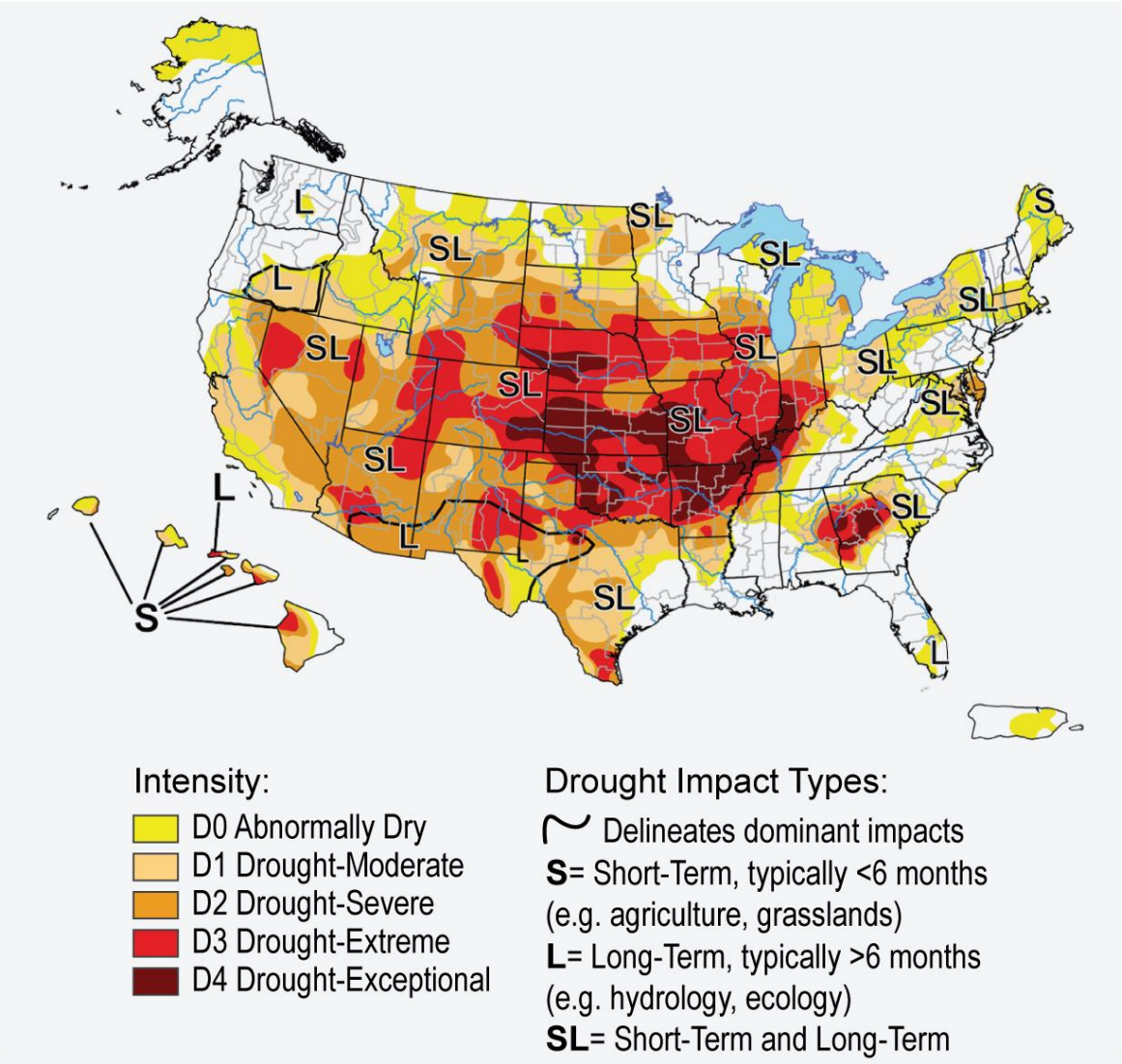
Agricultural production is sensitive to changes in climate. Although warmer winters may result in longer growing seasons and thus higher agricultural economic returns in the region, other climate impacts such as heat waves, drought, and extreme precipitation events can have the opposite effect on agricultural resources, causing significant crop failure and lost revenue. Although total annual precipitation is expected to increase, this will occur mostly during the winter and spring seasons, which could delay cultivation and planting. Midwestern summers are expected to be drier, and the average number of days in the region without precipitation is likely to increase. Irrigation for agriculture is projected to see the largest relative increase in water demands compared to any other water use.[27] Drought has already had significant recent agricultural effects. The 2012 drought was responsible for more than $3 billion of crop losses from heat and hot winds in Illinois, which led to the highest amount of crop losses in the country that year.[28]

[26] For definitions of each land cover class, see the NLCD Legend here: http://www.mrlc.gov/nlcd06_leg.php.

[27] CMAP, 2010, "Water 2050," http://www.cmap.illinois.gov/documents/10180/14452/NE+IL+Regional+Water+Supply+Demand+Plan.pdf/26911cec-866e-4253-8d99-ef39c5653757.

[28] Natural Resources Defense Council, August 2013, "Record-Breaking $17.3 billion in Crop Losses Last Year; Significant Portion Potentially Avoidable," http://www.nrdc.org/media/2013/130827.asp. University of Illinois at Urbana-Champaign, March 2013, "Drought and Crop Insurance Loss Experience in 2012," http://farmdocdaily.illinois.edu/2013/03/drought-crop-insurance-loss-2012.html.

Figure 12. U.S. Drought Monitor, August 14, 2012 (2014 NCA)



Severe droughts in 2012 affected much of the Midwest that caused both short-term impacts on agricultural crops and grasslands, as well as long-term impacts on hydrology and ecology. Source: 2014 National Climate Assessment, http://www.globalchange.gov/browse/multimedia/us-drought-monitor-august-14-2012.

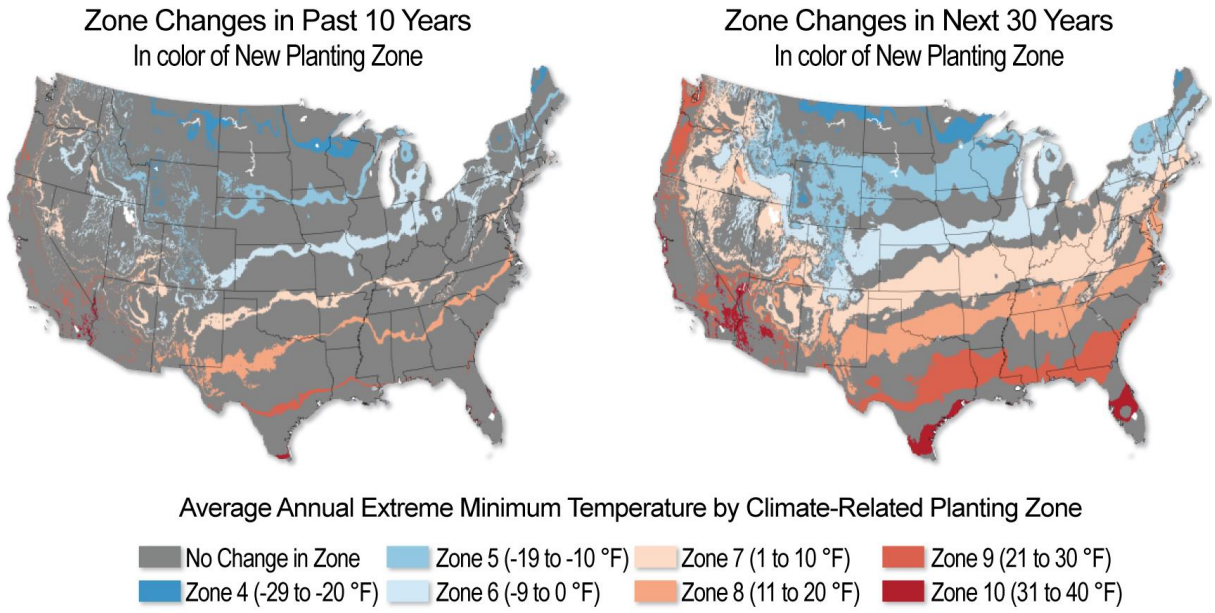
Impacts of climate change could be significant for the region's commodity crop growers. What is less certain is the degree to which these crop systems could adapt to anticipated changes through the use of more resilient strains of corn and beans, different agricultural practices, and irrigation and land drainage strategies. Climate change will also have a significant impact on regional and national food systems. California, Florida, Mexico, and other geographies that the region relies on heavily to produce its food could suffer devastating effects from climate change. The loss of food production in these areas could be an impetus for other geographies, both

within and outside of the Chicago region, to begin growing food. However, the region may not currently be well equipped or positioned to quickly shift agricultural land to food production should it be necessary. Recent analysis of the local food supply system suggests that less than five percent of the region's food comes from the southern Lake Michigan foodshed.

Natural Resources

Climate changes alter where species can thrive. Plant hardiness zones identify the regions that plants and ecosystems are able to thrive within based on temperatures, precipitation levels, and climates. Climate effects have already caused incremental changes to plant hardiness zones in the last 10 years, and more drastic changes are expected by mid-century.

Figure 13. Historic and Projected Shifts in Plant Hardiness Zones (2014 NCA)



The color bands shown in the left-hand map depict regions that have experienced changes in plant hardiness zones over the last decade, indicating that species that once were able to thrive in those areas will no longer be able to survive under changing climate conditions. The map on the right shows that by 2050, a majority of areas across the country are projected to have significantly altered conditions that support different kinds of ecosystems. Source: 2014 National Climate Assessment, http://nca2014.globalchange.gov/report/appendices/climate-science-supplement/graphics/shifts-plant-hardiness-zones.

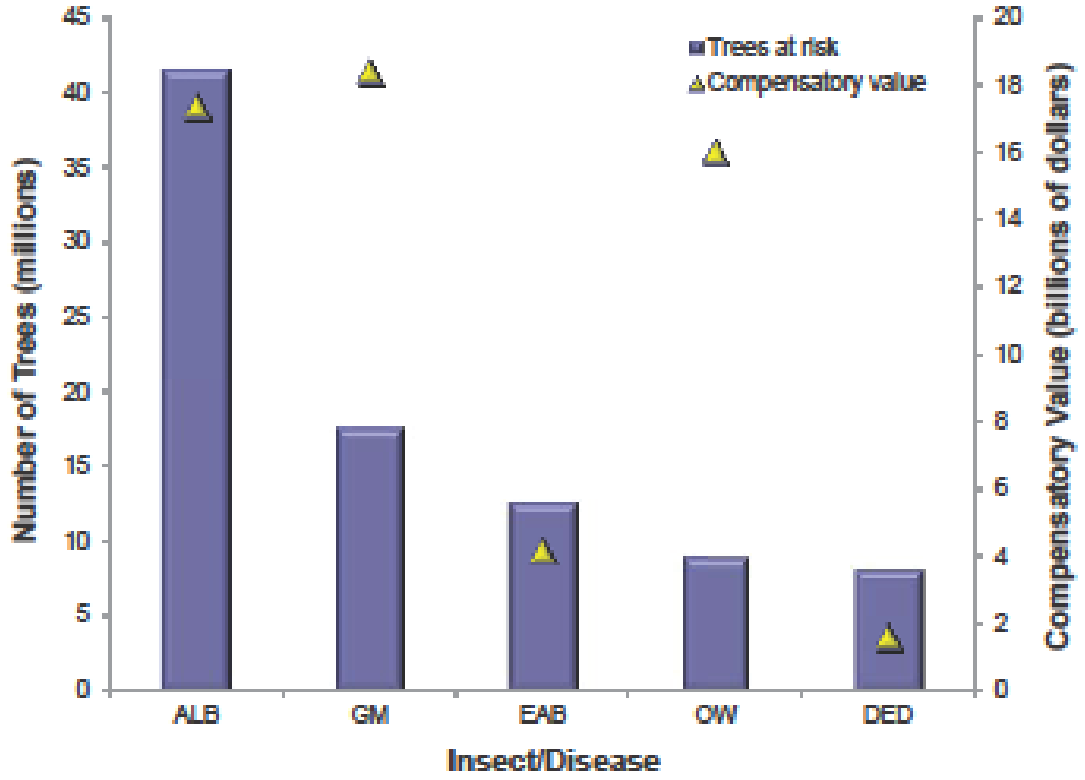
When plant hardiness zones change, species that were once able to thrive in those areas may no longer be able to survive as the climate changes. These projections should inform how natural resource and land managers can cultivate resilient ecosystems that can thrive with changes in climate. The climate risks to natural resources are also exacerbated by development patterns that fragment and degrade existing ecosystems.

Increased temperatures are expected to exacerbate the presence of invasive species that are non-native to the region, including Asian longhorn beetle, and other diseases that have affected the region's urban forestry. More severe storms and flooding are likely to increase non-point source pollution of the region's aquatic ecosystems and wetlands. At the same time, an increase in projected summertime droughts will lead to ecosystem stress and habitat loss. Ecological changes will also affect migratory and reproductive cycles of the region's native aquatic, avian, and terrestrial wildlife, not to mention introduce new invasive species and diseases to the region.

These impacts have significant financial implications. The Chicago Regional Trees Initiative (CRTI) estimates that one to three million trees have been removed in the Chicago region due to emerald ash borer infestation.[29] The cumulative costs of tree removal, inoculation, and reforestation are significant, and most communities have not yet replaced all of their lost trees. In addition, dead but unfelled trees may pose additional risks in terms of property damage, injury, and power outages during storm events. Figure 14 shows the number of trees at risk to various invasive insects or diseases, as well as the compensatory value of replacing those trees if lost.

[29] Chicago Tribune, December 25, 2014, "Emerald Ash Borer impact hits peak in Chicago area," http://www.chicagotribune.com/suburbs/evanston/ct-emerald-ash-borer-met-20141225-story.html.

Figure 14. Risk and compensatory value of trees with five most threatening insects and diseases in the Chicago region, 2010.



This graph illustrates the number of trees at risk of various diseases, as well as the compensatory value (in billions of dollars) of potential tree losses. ALB: Asian longhorned beetle. GM: gypsy moth. EAB: emerald ash borer. OW: oak wilt. DED: Dutch elm disease. Source: US Department of Agriculture, 2013, Urban Trees and Forests of the Chicago Region, http://www.fs.fed.us/nrs/pubs/rb/rb_nrs84.pdf.

Water Resources

Flooding is one of the region's primary climate change impacts. As an inland region, northeastern Illinois does not experience storm surges or sea level rise, but it instead faces chronic events that cumulatively affect health and safety, housing, infrastructure, economic competitiveness, and ecosystems. For instance, typical spring storms have led to major road, rail, and utility outages, mold in basements, severe erosion, sewer overflows, and closures of local businesses.

From 1969 to 2009, flooding accounted for 41 percent of disaster losses in Illinois.[30] Intense and severe weather events are only expected to increase with climate change. Claims filed through the National Flood Insurance Program (NFIP) in Illinois have increased sharply in the last 15

[30] Spatial Hazard Events and Losses Database for the United States, "Illinois Hazard Losses, 1960-2009," http://hvri.geog.sc.edu/SHELDUS/sheldus80_img/charts/loss/JPG/Illinois.jpg.

years, largely driven by three significant storm events in 2008, 2010, and 2013.[31] Flooding also has water quality implications. Runoff from flooding will also lead to more non-point source pollution of waterbodies. The 2014 NCA projects a 120 percent increase in combined sewer overflow discharges into Lake Michigan from all of its bordering states by the end of the century.[32]

Flooding is exacerbated by many factors. First, urbanization has increased the prevalence of flooding. In particular, the region has seen an increase of urban flooding, which occurs irrespective of the floodplain.[33] Flooding in urban areas has resulted in $1.975 billion of documented damages in the CMAP region[34] from 2007-2014 alone, accounting for 85.2 percent of payouts in the entire state.[35]

[31] Illinois Department of Natural Resources, 2015, "Urban Flooding Awareness Act," https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

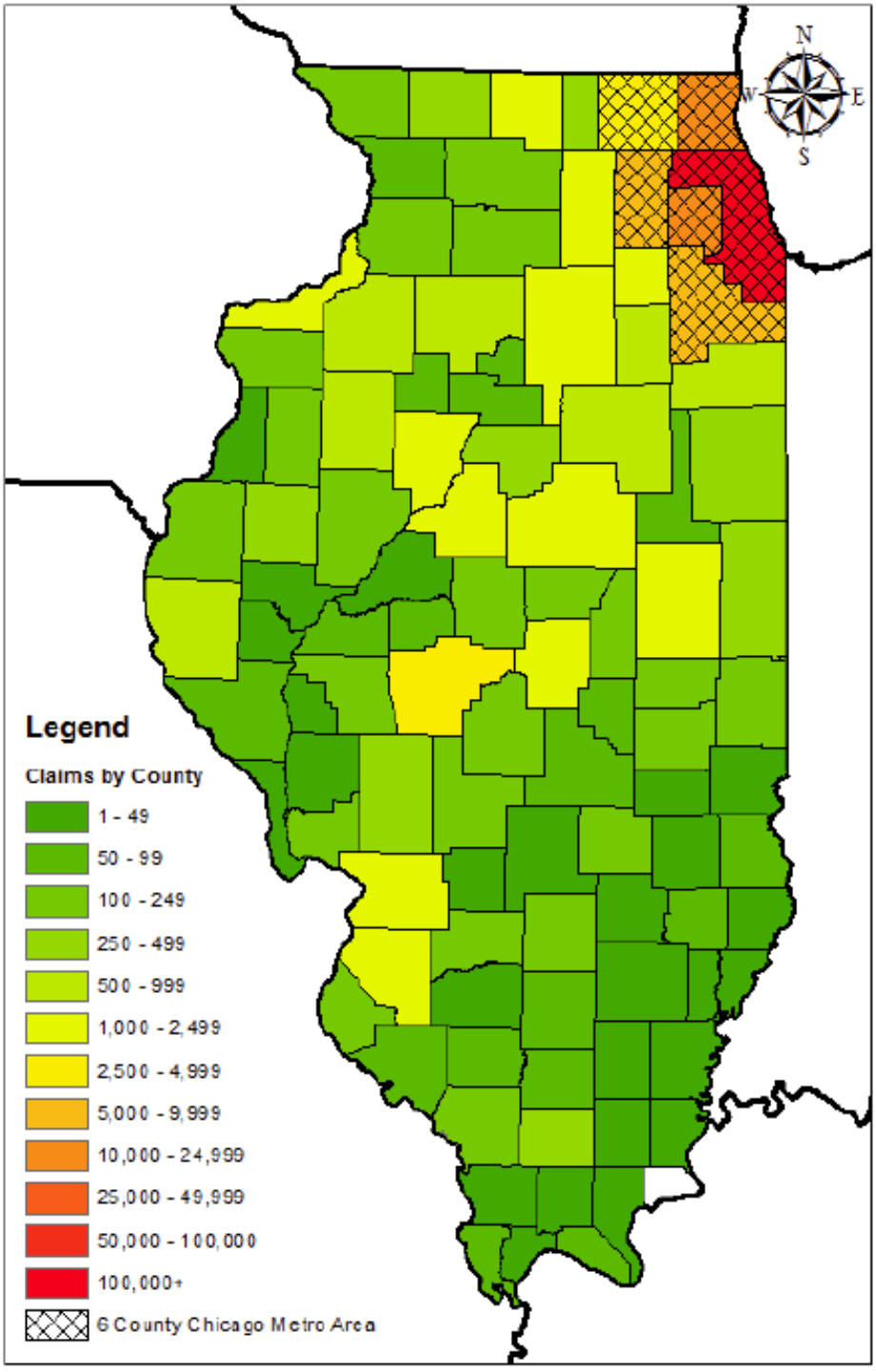
[32] National Climate Assessment, 2014, http://nca2014.globalchange.gov/.

[33] Urban flooding is defined in the Urban Flooding Awareness Act as flooding that "(1) includes situations in which stormwater enters buildings through windows, doors, or other openings, (2) water backup through sewer pipes, showers, toilets, sinks, and floor drains, (3) seepage through walls and floors, and (4) the accumulation of water on property or public rights-of-way."

[34] The UFAA report only provides for six of the CMAP region's seven counties. These numbers are based on National Flood Insurance Program and private insurance claims.

[35] For more detail about the costs and prevalence of urban flooding, see Appendix D of the Urban Flooding Awareness Act Report, https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Appendices.pdf.

Figure 15. Flood Claims by County in Illinois



Northeastern Illinois has had more flood claims than other parts of the state between 2007 and 2014. Source: Illinois Department of Natural Resources Urban Flooding Awareness Act, https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

These figures, which are based on flood insurance claims, are likely an underestimate of the costs and prevalence of urban flooding. Second, stormwater and sewer infrastructure is often not built to accommodate heavy precipitation events. The current standards that most communities use to design stormwater and sewer systems are outdated and underestimate the occurrence of extreme rainfall that can overwhelm stormwater systems and cause flooding in homes, businesses, and roads.[36] Many regulations and programs like NFIP are only equipped to address floodplain-based flooding. The magnitude of urban flooding has encouraged many organizations, including CMAP, to explore green infrastructure and land use practices that can support compact communities while managing the impacts of urban flooding.

Changes in temperature and precipitation affect both the water levels and quality of waterbodies in the region. Projections do not indicate significant changes to Lake Michigan water levels,[37] but several other changes are anticipated. Water quality will be a significant issue for Lake Michigan and the region's rivers and streams. Higher temperatures and increased runoff from greater precipitation are leading to more algal blooms and combined sewer overflow events that impair water quality.[38] With decreasing ice coverage on the Great Lakes, shorelines are more vulnerable to erosion and habitat degradation.[39]

In addition to effects on surface water, climate change and development will also affect water withdrawal rates from the groundwater supply. Water demand from all sectors is expected to increase by up to 12 percent under a high-emissions scenario.[40] Alongside increases in overall precipitation levels, the projected increases of drought periods also highlight the need for balancing water uses in a range of precipitation scenarios that may vary seasonally.

Regional Economy

Climate change will have some positive effects on the regional economy. For example, warmer winters and decreased ice coverage in the Great Lakes will lead to longer shipping seasons. At the same time, climate-related weather disasters are costly. The NCA estimates that from 1980-2012, Illinois experienced about two- to three-dozen climate-related disasters that cost over $1 billion each.

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[36] CMAP, June 2013, "Climate Adaptation Guidebook for Municipalities in the Chicago Region," Appendix A: Primary Impacts of Climate Change in the Chicago Region, http://www.cmap.illinois.gov/documents/10180/14193/Appendix+A+-+Primary+Impacts+of+Climate+Change+in+the+Chicago+Region.pdf/2a85b021-f3bd-4b98-81d1-f64890adc5a7.

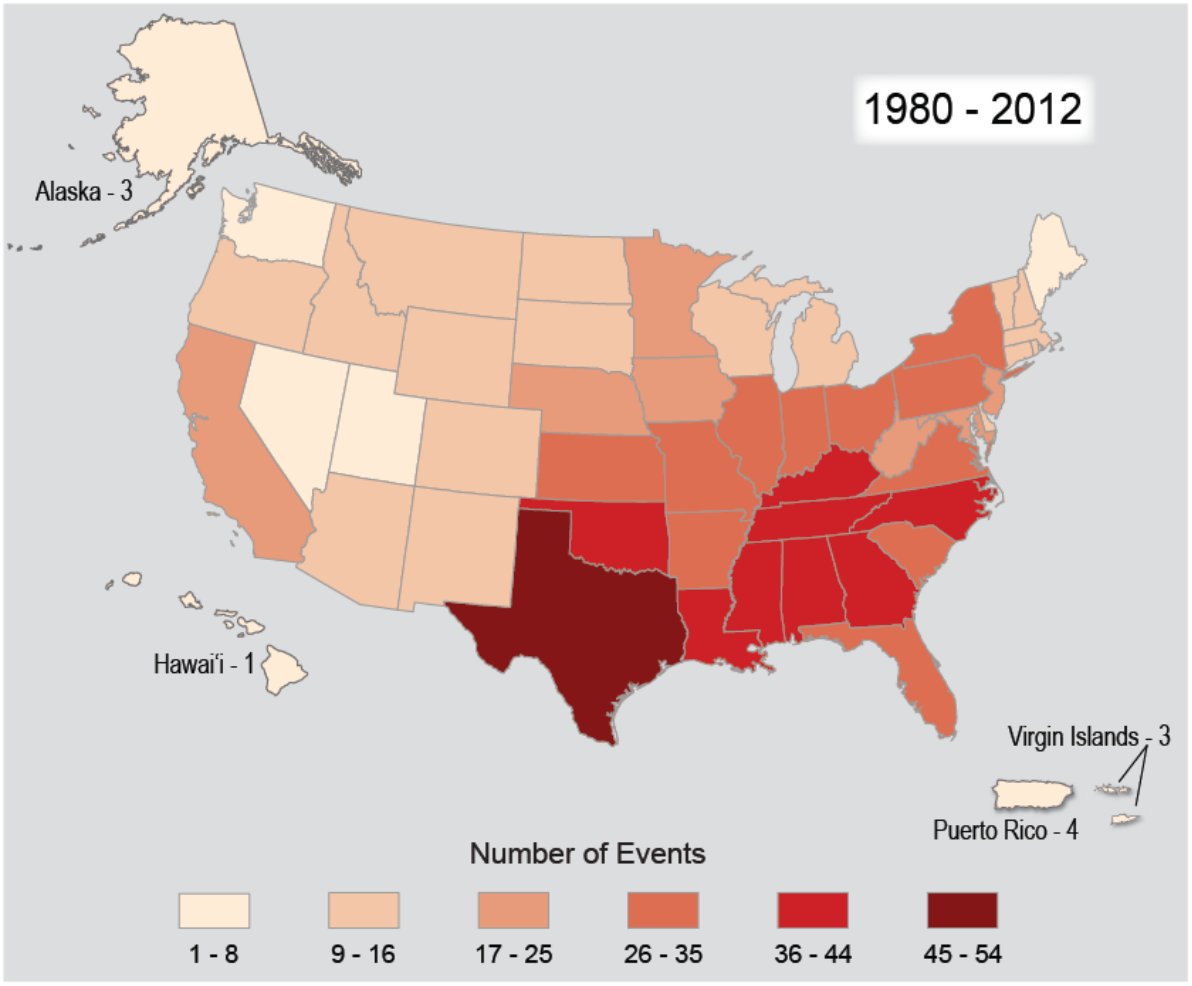
[37] Ibid.

[38] 2014 National Climate Assessment, http://nca2014.globalchange.gov/report/regions/midwest.

[39] Ibid.

[40] CMAP, 2010, "Water 2050," http://www.cmap.illinois.gov/documents/10180/14452/NE+IL+Regional+Water+Supply+Demand+Plan.pdf/26911cec-866e-4253-8d99-ef39c5653757.

Figure 16. Climate Disasters with Minimum Cost of $1 Billion, 1980-2012 (2014 NCA)



In the last 30 years, Illinois has been affected by weather and climate disasters that have cost over a billion dollars per disaster. Source: 2014 National Climate Assessment, http://nca2014.globalchange.gov/highlights/regions/southeast/graphics/billion-dollar-weatherclimate-disasters-1980-2012 (adapted from NOAA, Billion-Dollar Weather and Climate Disasters, http://www.ncdc.noaa.gov/billions/events).

Extreme weather and long-term climate changes can have significant effects on the regional economy, especially on the region's freight and manufacturing sectors. Each year, a quarter to a third of all rail freight in the country passes through metropolitan Chicago and half of all intermodal shipments originate or terminate here.[41] Disruptions to supply chains—whether

[41] Sources vary. Organisation for Economic Co-operation and Development (OECD), 2012, "The Chicago Tri-State Metropolitan Area: OECD Territorial Review Synopsis," http://alliancerd.org/wp-content/uploads/2014/02/OECD-Territorial-Review-Chicago-Synopsis-2012.pdf.

locally or in other places around the world—affect industry productivity in the Chicago region. Moreover, flooding and transportation or electricity outages can affect local business operations and employee commutes.

CMAP's past economic and freight policies have not directly considered the impacts of climate change on economic growth, but research shows they can be quite costly. The Federal Reserve Bank of Chicago estimates that the transportation and utility outages and other effects of extreme weather conditions have contributed to Chicago's slow rate of growth, including declines in sales and manufacturing production.[42]

Climate-Vulnerable Populations

From public health to reduced property values, climate change has many human impacts in the region. Widespread and chronic flooding has damaged homes—sometimes irreparably—causing evacuations, health issues from mold, emotional distress, and significant costs. A Center for Neighborhood Technology survey in Cook County found that a majority of respondents reported increased stress (84 percent), lost hours of work to clean up (74 percent), and lost valuables (63 percent) as a result of flooding.[43]

Heat waves, too, have led to heat-related illnesses and mortality. The Chicago region experienced a historic heat wave in 1995 that led to 700 heat-related deaths, followed by another heat wave in 1999 with more than 100 deaths. The 1995 heat wave resulted in major reforms to Chicago's emergency response programs: The city formed a Commission on Extreme Weather Conditions, developed a comprehensive Extreme Weather Operations Plan, and established better coordination among emergency responders call centers, and traffic management.[44,45] Emergency management improvements have reduced heat-related deaths, but vulnerability to extreme heat will increase as heat waves become more frequent due to climate change. One study of heat mortality risk found that, compared to the number of heat-related deaths experienced in 2005, a five-degree Fahrenheit increase of average daily temperatures would result in an additional 1,900 heat-related deaths per summer across all 105 U.S. cities included in

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[42] Board of Governors of the Federal Reserve System, 2014, "Summary of Commentary on Current Economic Conditions by Federal Reserve District," http://www.federalreserve.gov/monetarypolicy/beigebook/beigebook201403.htm

[43] Center for Neighborhood Technology, May 2014, "The Prevalence and Cost of Urban Flooding," http://www.cnt.org/sites/default/files/publications/CNT_PrevalenceAndCostOfUrbanFlooding2014.pdf.

[44] CMAP, June 2013, "Climate Adaptation Guidebook for Municipalities in the Chicago Region," http://www.cmap.illinois.gov/documents/10180/14193/Appendix+A+-+Primary+Impacts+of+Climate+Change+in+the+Chicago+Region.pdf/2a85b021-f3bd-4b98-81d1-f64890adc5a7.

[45] Miller Ruben, Bonnie and Gorner, Jeremy, July 15, 2014, "Fatal heat wave 20 years ago changed Chicago's emergency response," http://www.chicagotribune.com/news/ct-chicago-heat-wave-20-years-later-met-20150715-story.html.

the study.[46] This estimated additional heat-related mortality rate due to increased temperatures would be three times the nationwide rate in 2012.

A variety of socioeconomic factors make certain communities especially vulnerable to climate change. Sometimes, vulnerabilities are based on individuals' circumstances. For instance, elderly residents, people with chronic diseases, and people without access to air conditioning are particularly susceptible to heat waves.[47] Some socioeconomic vulnerabilities are spatially correlated with the hottest areas. Residents living in the region's top 10 percent hottest Census tracts based on average land surface temperature tend to be disproportionately people of color, have limited English language proficiency, have a family income below the poverty line, and have no health insurance coverage (see Table 2). While age is a significant factor of vulnerability to heat, there is no geographic correlation between heat and the elderly. Studies have found significantly lower urban tree canopy coverage in low-income communities and communities of color.[48] Potential reasons for this trend may relate to systemic factors, such as long-term disinvestment or lack of access to planning resources, which may result in fewer trees and less vegetative cover.

[46] Bobb JF, Peng RD, Bell ML, Dominici F, 2014, "Heat-related mortality and adaptation to heat in the United States," http://dx.doi.org/10.1289/ehp.1307392.

[47] Center for Disease Control, "Climate Change and Extreme Heat Events," http://www.cdc.gov/climateandhealth/pubs/ClimateChangeandExtremeHeatEvents.pdf.

[48] See, for instance, Schwarz, K., Fragkias, M., Boone, C., Zhou, W., McHale, M., Grove, J., O'Neil-Dunne, J., McFadden, J., Buckley, G, Childers, D., Ogden, L., Pincetl, S., Pataki, D., Whitmer, A., Cadenasso, M., April 1, 2015, "Trees Grow on Money: Urban Tree Canopy Cover and Environmental Justice," http://dx.doi.org/10.1371/journal.pone.0122051.

Table 2. Heat Vulnerability

Socioeconomic Characteristic[49]	Regional Population		Top 10 Percent Hottest Census Tracts Based on Land Surface Temperature	
	Count	Percent	Count	Percent
Total Population	8,459,768	100%	511,171	100%
Elderly Population (over 65 years)	1,013,640	12.0%	45,368	9.2%
People of Color[50]	4,030,135	47.6%	381,249	73.7%
Limited English Proficiency[51]	1,029,670	12.2%	144,993	27.2%
Family Income below Poverty Level[52]	1,160,842	13.7%	101,134	19.7%
No Health Insurance Coverage	1,146,328	13.6%	125,787	23.0%

Source: 2010-14 American Community Survey, 2010 U.S. Census, and CMAP analysis derived from Landsat 8.

The Climate Resilience Landscape

This climate resilience strategy paper builds on efforts CMAP has taken to address climate change since the adoption of GO TO 2040. Initial work emphasized the effects of land use and transportation investments on GHG mitigation. Regional partners across many sectors have been active in addressing resilience, but this section focuses on the driving policies, programs, and tools that enable CMAP itself to address climate resilience.

Climate Change Work at CMAP

The recommendations of GO TO 2040 are accompanied by specific regional indicators and targets that relate to GHG reduction. Relevant indicators include GHG emissions, acres of conservation open space, trail greenway mileage, and transit capacity and access. GO TO 2040 calls for a reduction of GHG emissions to 47 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) by 2040. This represents about a 60 percent decrease of GHG emissions compared

[49] 2009-2013 American Community Survey.

[50] Includes Latino/Hispanic.

[51] Includes populations over 5 years old who speak English "less than very well."

[52] Determined for all people except institutionalized people, people in military group quarters, people in college dormitories, and unrelated individuals under 15 years old. Poverty thresholds vary depending on family size and composition, but not by geography. The people included in this measure are below the appropriate threshold for their family context.

to 2000 levels. While the plan does not include a standalone topic or chapter specifically focusing on climate change, GHG emissions reduction targets are included in the Energy section of the GO TO 2040 plan. More broadly, climate mitigation benefits are emphasized throughout the plan as co-benefits of land use, environmental, housing, and transportation recommendations.

Emissions Inventories
To initially assess emissions and ultimately track GO TO 2040 implementation progress on climate mitigation, CMAP has supported two regional GHG emissions inventories. The first was an inventory of 2005 GHG emissions conducted in 2008 in partnership with the Center for Neighborhood Technology. The second was an inventory of 2010 GHG emissions completed in 2012 in partnership with the City of Chicago and ICF International.

Transportation Programming
As the agency's largest program, transportation planning and programming provides the most direct avenue for CMAP to address climate change. CMAP administers the Congestion Mitigation and Air Quality (CMAQ) Program, which funds surface transportation projects that improve air quality and reduce emissions, and the Transportation Alternatives Program (TAP), which provides funding to support pedestrian and bicycle infrastructure.

Local Technical Assistance Program
CMAP's Local Technical Assistance (LTA) program has shaped local responses to climate change primarily through sustainability planning. CMAP has provided LTA assistance to counties and municipalities to develop various sustainability plans. These plans have covered a range of environmental issues, including climate mitigation, open space preservation, watershed planning, and transit-supportive planning. Based on these experiences, CMAP has also developed a Sustainability Planning White Paper and Indicators Guide (2015) to assist communities that wish to undertake their own sustainability plans and identify appropriate indicators to measure progress.

To respond to growing local community interest in adapting to climate change, in 2013 CMAP developed a Climate Adaptation Guidebook for Municipalities in the Chicago Region. It describes the process of adaptation planning, provides an overview of climate trends and projections in the Chicago region, and highlights zoning and other regulatory strategies to create more adaptable municipal infrastructure in the face of a changing climate. In mid-2016, CMAP and the American Planning Association were also jointly awarded a $300,000 grant from the National Oceanic and Atmospheric Administration to help five communities integrate climate change considerations into ongoing LTA planning projects. This type of approach could provide a primary avenue for CMAP to advance local resilience planning in the future.

Stormwater Analysis
CMAP is developing a methodology for stormwater analysis to inform land use strategies that address urban flooding. The analysis uses a variety of data, including topography, soil type, known flooded properties, historic stream locations, and land cover, to identify flow paths of stormwater runoff. Supported by the MacArthur Foundation and Cook County, this approach is being integrated into local projects through CMAP's LTA program.

Energy Impact Illinois
CMAP's implementation of climate mitigation strategies was also supported through Energy Impact Illinois, a partnership of CMAP, CNT Energy, City of Chicago, ComEd, Nicor, and others to enact energy efficiency improvements across the region. Funded from 2010-14 by an Energy Efficiency Block Grant from the Department of Energy, this program contributed to retrofits of over 8,000 units with at least 15 percent savings per retrofit, and led to the creation of over 2,000 jobs in the region. While the program covered both residential and commercial retrofits, the bulk of the improvements were in single-family homes.

Regional Resilience Coordination
CMAP has been collaborating with governments, non-profit partners, private sector leaders, and philanthropic organizations to build long-term resilience across the region. The Calumet Stormwater Collaborative, facilitated by the Metropolitan Planning Council, has been an effective sub-regional forum to improve stormwater planning in south suburban Cook County. The HUD National Disaster Resilience Competition, for which the City of Chicago, Cook County, DuPage County, and the State of Illinois were eligible, catalyzed cooperative regional efforts directly around resilience. CMAP's role as a convener of the partnership has directly informed the agency's approach to the topic of climate resilience.

External Policies Driving Climate Resilience

A few key national and international climate change policies have effects for climate resilience in northeastern Illinois. In 2013, the Obama Administration released a Climate Action Plan to outline a national climate strategy, with recommendations for carbon reduction, adaptation, and international leadership to foster global climate action. This launched several federal resources and programs for climate resilience:

- National Climate Resilience Toolkit provides guidance on how to conduct local climate resilience planning.
- Frameworks to assess transportation vulnerability to climate change from the Federal Highway Administration and Federal Transit Administration have led to local transportation asset management studies from IDOT and CTA that examine road, bridge, and rail vulnerabilities to climate change and disaster.

- 2014 National Climate Assessment (NCA)provides updated data for modeling and scenario planning, including regional downscaled models that inform our understanding of historical trends and project climate impacts in the future.

President Obama also signed Executive Order 13690, "The Federal Flood Risk Management Standard," on January 30, 2015. The order directs federal agencies to reduce flood risk for federal investments in the floodplain and update their flood-risk reduction standards.[53]

At the UN climate negotiations in December 2015, 187 countries adopted the universal and legally binding Paris Agreement that calls for key outcomes that support climate action. The United States pledged to reduce its emissions by 26 to 28 percent relative to 2005 levels by 2025, and by 80 percent by 2050.[54] The federal government has established several initiatives to achieve these targets. First is the Clean Power Plan, the first federal regulation that limits carbon pollution.[55] It calls for a 32 percent reduction of emissions from power plants based on 2005 levels by 2030. Under the plan, each state has a customized carbon reduction goal and decides how best to meet that target. The Illinois state plan, currently under development, requires a 30 percent reduction of carbon pollution from its power plants by 2030. The Clean Power Plan also requires significant public engagement and education on the topic of climate change.[56] In addition, fuel efficiency standards and investments in renewable energy and energy efficiency will further reduce emissions. These national actions provide resources and policy directions for state, regional, and local governments. ON TO 2050 can contribute to national efforts by developing robust policies to build resilience in the Chicago region.

[53] Federal Emergency Management Agency, 2016, "Federal Flood Risk Management Standard," https://www.fema.gov/federal-flood-risk-management-standard-ffrms#.

[54] In comparison, GO TO 2040's GHG target calls for a reduction in GHG emissions to 60 percent below 2000 levels by 2040.

[55] The U.S. Supreme Court has issued a stay blocking implementation of the Clean Power Plan until litigation over its legality has concluded. The District of Columbia Circuit Court of Appeals will make a decision in fall 2016, and a final decision from the Supreme Court (if needed) could take until 2018. See Scientific American, September 28, 2016, "EPA's Clean Power Plan Does Well in Court," http://www.scientificamerican.com/article/epa-s-clean-power-plan-does-well-in-court/.

[56] See more resources on Illinois requirements from EPA at http://www3.epa.gov/airquality/cpptoolbox/illinois.pdf and Natural Resources Defense Council at https://www.nrdc.org/sites/default/files/CPP-Illinois-Compliance-IB.pdf.

Regional Climate Resilience Framework

Guiding Principles of a Resilient Region

Strategies to build regional climate resilience must address a range of issues, from standards for the built environment to practices for natural resource management to open channels of communication. Through a series of visioning activities, the Climate Resilience Resource Group chose three overarching principles as a framework for the region to develop resilience strategies: (1) responsive and robust infrastructure, (2) participatory and integrated processes, and (3) equitable reduction of vulnerability. Together, these guiding principles acknowledge the interconnected physical, ecological, and social systems that make up the region.

Responsive and robust infrastructure

To be more resilient, infrastructure should be more responsive to a wider range of climatic conditions. Infrastructure includes buildings, electricity grids, transportation networks, sewer pipes, and green infrastructure. In a resilient region, infrastructure is designed, operated, maintained, and retrofitted to withstand climate impacts for the entire course of its designed life using the latest climate data and projections.

Resilient infrastructure may also look different. Traditional infrastructure often contains highly centralized systems such as power plants, wastewater treatment facilities, and transportation control centers—all of which are still vital components of our region's infrastructure. From smart grids to green stormwater infrastructure, many types of infrastructure are moving toward networked systems that connect distributed and centralized components. Distributed infrastructure can take many forms, but all share certain benefits compared to their traditional, centralized counterparts: They are made up of several networked components that take up smaller footprints and allow more flexibility in siting and design. For instance, compared to water treatment facilities, green stormwater infrastructure can be scaled for small curb bump-outs and backyards. Just as green stormwater infrastructure can supplement, but not fully replace, sewer pipes, both distributed and centralized forms of infrastructure are necessary. Distributed infrastructure can build redundancies at multiple scales by providing multiple ways for a system to function and reducing sole reliance on a central facility.

Participatory and integrated processes

Resilience planning addresses both physical characteristics of the region and how information is communicated and decisions are made. Infrastructure management and operations have undergone technological advances, but gaps in cross-jurisdictional coordination that leverages these technologies remain. For example, platforms such as 911 calls and routing applications provide real-time information on car accidents, but most transportation agencies are not directly notified of these incidents and are therefore slow to respond. Cooperation across entities with varied boundaries, authorities, and inconsistent methods of data collection can be challenging.

To address these issues, regional stakeholders must foster a better culture of collaboration to implement resilience strategies.

Regional partners can improve how they communicate by reducing silos across jurisdictions and sectors. Better standardization of data collection and more effective mechanisms for sharing information among peer agencies can improve the ability of stakeholders to communicate. Partners can also expand what they communicate by relying on multiple forms of information, from technical to experiential, to guide decision making. For instance, hydrologic modeling paired with resident-generated data of flooding impacts can provide decision makers with a more holistic understanding of the contributing factors to flooding. Furthermore, processes that cultivate expertise from all sectors from the outset ensure widespread ownership of the outcomes that is critical to implementation. In addition, a more inclusive approach to data collection increases the capacity of vulnerable residents to participate in analysis and decision making. Engaging all residents in decision making and policy development will ensure that equity is embedded in resilience strategies and that residents have the necessary information to become active stewards of resilience efforts.

Equitable reduction of vulnerability

Climate impacts do not affect all communities in the region equally. A community's geographic location, physical and socioeconomic characteristics, and capacity can significantly influence its degree of vulnerability to climate change. At the broadest level, our region should emphasize strategies that reduce effects, particularly in communities that are least equipped to respond to climate change. At a community scale, resilient municipalities should ensure the provision of critical services in all conditions. Capacity building and physical planning practices should strengthen social cohesion among residents, particularly vulnerable populations, to create the community networks necessary to withstand and recover from climate impacts.

Regional Climate Resilience Strategies

The three guiding principles above set the foundation for the policies needed to build resilience to climate change in northeastern Illinois. The strategies fall under seven main themes:

- Planning for Climate Change
- Promoting Climate-Resilient Infrastructure
- Building Resilient Transportation Networks
- Addressing Climate Change through Natural Resource Management
- Building Resilience in the Energy Sector
- Fostering Economic Resilience
- Building Capacity for Resilience Planning

The strategies presented below (and summarized below in Table 3) recommend actions that CMAP should take to improve resilience and identify specific agency programs or projects that can implement the recommendations. CMAP functions broadly include transportation programming, the Local Technical Assistance program, guidebooks, policy research, and ongoing or upcoming work to develop ON TO 2050. Strategies that should be led primarily by other regional partners with limited involvement from CMAP are described in Appendix B.

Table 3. Summary of Climate Resilience Strategies

Theme	Strategy
Planning for Climate Change	Achieve greater livability through resilience planning
	Integrate resilience policies into existing planning processes
	Update development regulations to prepare for a changing climate
Promoting Climate-Resilient Infrastructure	Update infrastructure design standards
	Encourage infrastructure that provides multiple benefits
	Protect critical assets
Building Resilient Transportation Networks	Strengthen transportation infrastructure to withstand climate changes
	Ensure multiple transportation options
	Adopt smarter transportation infrastructure management
Addressing Climate Change through Natural Resource Management	Increase biodiverse ecosystems
	Support adaptive management of water resources
	Build climate resilience through green infrastructure
Building Resilience in the Energy Sector	Increase low- and zero-emissions generation
	Strengthen energy infrastructure for a changing climate
	Support decentralized energy generation and distribution
Fostering Economic Resilience	Reduce community vulnerability to climate change
	Increase the resilience of freight networks
	Build resilience for the region's economic clusters
	Prepare agricultural resources for climate change

Building Capacity for Resilience Planning	Build community capacity
	Provide data to build climate literacy and facilitate informed decisions
	Explore a platform for coordinating regional resilience initiatives

Planning for Climate Change

CMAP should pursue integrated land use and infrastructure planning that accounts for current and future climatic conditions. The land use and infrastructure decisions made today have significant implications for the region's future mobility, natural systems, and patterns of development. A built environment that is designed to withstand and respond to expected and unforeseen climatic conditions can improve the livability of our communities. In addition, equitable planning processes that include all residents can create more robust recommendations and increase awareness of and preparedness for resilience considerations and strategies. ON TO 2050 can provide underlying regional data and policy direction needed to inform local planning efforts, as well as guidance for regional and local partners for taking actions that build resilience to climate change.

Achieve greater livability through resilience planning

As defined in GO TO 2040, livable communities are healthy, safe, and walkable. They provide a variety of transportation choices, recreational spaces, access to jobs and education, cultural offerings, and opportunities to participate in public processes. As climate change affects the region, communities must build resilience to continue to foster livability. Resilient and livable communities should mitigate GHG emissions that contribute to climate change and prepare for the increasing impacts of climate change.

Infill development, improved pedestrian and bicycle infrastructure, increased investments in public transit, and more efficient consumption of energy all contribute to climate mitigation, not to mention reduced congestion. ON TO 2050 should re-emphasize GO TO 2040's recommendations for climate mitigation as part of a regional resilience strategy. Resilient and livable communities should anticipate negative impacts of climate change and enact strategies to thrive in the face of changing conditions. Through investments in resilient infrastructure and planning, residents of resilient communities will have strong social networks; access to multiple transportation alternatives; and reduced vulnerabilities to heat-related illnesses. The strategy recommendations detailed in subsequent sections will help communities become more resilient and livable by 2050.

Integrate resilience policies into existing planning processes

Climate resilience planning is an emerging topic for many communities in the region. Building a resilient region entails a wide range of strategies for physical, social, and ecological systems. While some communities may choose to develop standalone climate action or resilience plans,

there are many opportunities to integrate climate resilience considerations into other planning efforts.

Local governments conduct many types of planning processes, such as comprehensive plans, sub-area plans, capital improvement plans (CIPs), watershed plans, hazard mitigation plans, and issue-based plans such as sustainability, transportation, or economic development plans. Given the range of planning efforts that may govern a single community, it is important to align local plans so that they reinforce consistent resilience policies across scales and topic areas. Different units of government are responsible for different kinds of planning. Municipalities typically oversee comprehensive plans, sub-area plans, and CIPs while counties conduct stormwater, watershed, and hazard mitigation plans. Park districts and forest preserve districts also often have separate planning processes that oversee parks, open spaces, and natural resource management.

All too often, these planning processes are uncoordinated. At the broadest level, county hazard mitigation plans provide information about climate and other risks facing a community. Hazard mitigation plans, which provide significant climate risk data but are not typically reviewed for comprehensive plans, are a helpful starting point to align local plans with county policies. Local planning projects conducted through CMAP's LTA program, as well as by government and consultants, should emphasize the vertical and horizontal alignment of climate recommendations within local plans at community and county levels.

Each of these planning processes should also consider how climate change affects the plan's priorities. For example, future land use plans that consider current and projected precipitation patterns can promote community growth in low flood risk areas or recommend design strategies for developments that are susceptible to flooding. CIPs can guide short-term investment priorities that support stronger and smarter infrastructure. Economic development plans can examine the financial impacts of climate-related disruptions on local economies, recommend resilient supply chain practices, and encourage growth in green industries. Standalone resilience plans are also an option for communities that are interested in pursuing more detailed analysis and strategies on resilience. These plans typically address the threats of climate, but some also touch upon economic resilience or other external factors. *Resilient New Orleans* and *A Stronger, More Resilient New York* are two such examples. The City of Chicago has also received a grant from the Rockefeller Foundation's 100 Resilient Cities initiative to hire a new Chief Resilience Officer and develop its own resilience plan.[57] The LTA program should serve as a primary mechanism to develop an approach for integrating climate change into local planning efforts.

[57] 100 Resilient Cities, "Chicago's Resilience Challenge," http://www.100resilientcities.org/cities/entry/chicago.

Update development regulations to prepare for a changing climate
To conduct climate-informed land use planning, municipalities and counties can update building codes, floodplain and stormwater regulations, zoning ordinances, subdivision standards, and other regulations pertaining to physical developments so that buildings, landscaping, and site planning take climatic conditions into consideration. For instance, updated ordinances can promote appropriate structural design standards and landscaping practices that increase the resilience of the built environment in flood-prone areas. Counties, in coordination with municipal governments, create stormwater ordinances that set minimum standards for stormwater management in new developments. These strategies can also further climate mitigation goals by promoting energy efficiency and compact development. CMAP can be a regional leader in climate-ready regulations by incorporating climate considerations in LTA projects that relate to regulations, such as stormwater assessments and zoning and subdivision updates. CMAP and other planning entities should identify best practices and new strategies to meet resilience goals while continuing to encourage reinvestment.

Promoting Climate-Resilient Infrastructure

From road and rail buckling to bridge scouring to flooding, the region's infrastructure has experienced significant damages from extreme heat, heavy precipitation, and increasing freeze-thaw cycles. To be more resilient, infrastructure should be designed to accommodate a wider range of climate conditions. This can be achieved not only by updating design standards and using more resilient materials for infrastructure construction, but also by building multiple scales of redundancies in the face of shocks and stresses. The overarching strategies in this section apply to a range of infrastructure types, including water, stormwater, sewer, transportation, energy, and green infrastructure, the last three of which are also discussed in more detail in later sections.

Update infrastructure design standards
Most of the region's roads and stormwater systems were designed using climate data that no longer match the hotter and wetter conditions that the region has seen. To improve long-term performance, infrastructure should be built or retrofitted for the climate conditions anticipated across its intended lifespan.

Design standards are meant to improve the lifespan and usability of infrastructure. The Urban Flooding Awareness Act Report, conducted by the Illinois Department of Natural Resources (IDNR) in 2015, highlights the regulatory lag between climate science and infrastructure design policies. The Illinois State Water Survey's Bulletin 70, the most widely accepted rainfall data used to determine infrastructure design standards, relies on data that are over 30 years out of date. IDNR calls for an update to Bulletin 70 that incorporates current rainfall gauge data and a regular update process every 10 to 15 years. ON TO 2050 should support this recommendation. State and local infrastructure agencies should conduct comprehensive reviews of design

manuals (such as IDOT's Bureau of Local Roads and Streets Manual) to ensure that the underlying data used in their design standards are in line with best available information and that other aspects of physical design allow for resilience best practices. State and federally funded projects could also be required to use forward-thinking design standards to ensure wise use of public funds. CMAP does not have a direct role in implementing this strategy but considers it an important step to be undertaken by other implementers.

Encourage infrastructure that provides multiple benefits

Infrastructure has also typically been designed to serve single-purpose functions: Stormwater pipes are designed to convey runoff and the electrical grid is designed for delivering power. Infrastructure can build resilience by supporting multiple benefits and planning objectives. Complete and green streets are a great example of roadway design that can integrate green infrastructure, urban forestry, pedestrian and bicycle safety, and placemaking. Multi-purpose infrastructure planning results from integrated planning processes that enable collaboration across departments and sectors. Complete streets implementation, for instance, requires coordination between transportation agencies, stormwater engineers, and planners, civic groups promoting active transportation, and neighboring businesses. Multi-purpose infrastructure also makes economic sense as a more efficient use of capital investments when accounting for the full range of benefits.[58]

Various design guidelines are beginning to encourage projects that provide multiple benefits. For instance, the Chicago Department of Transportation's Sustainable Urban Infrastructure policies and guidelines codify lessons learned from the city's pilot projects into a single resource that actively promotes green infrastructure in public rights-of-way to build resilience. In addition to physical design guidelines, partners can introduce more integrated processes that foster multi-purpose investments. Regularly scheduled coordination meetings, for instance, can allow departments to collaborate on capital projects.

CMAP and the region's transportation project programmers can prioritize infrastructure that provides co-benefits in performance-based programming. As part of ON TO 2050, CMAP and local governments can work to identify existing barriers to multi-benefit capital projects and update the appropriate standards and project selection processes to enable infrastructure that can provide co-benefits such as stormwater management or heat island reduction.

Protect critical assets

Centralized facilities, such as energy generation and distribution facilities, hospitals, water and wastewater treatment plants, telecommunication facilities, and transportation control centers, are vital components of our region's infrastructure. Facility operators can conduct and

[58] Chicago Department of Transportation, 2013, "Sustainable Urban Infrastructure: Policies and Guidelines, Vol. 1," http://www.cityofchicago.org/content/dam/city/depts/cdot/Sustainable%20Transportation/SUIGv1.pdf.

implement climate vulnerability assessments for critical regional and community facilities to improve physical and operational preparedness for climate impacts. When available, partners should look to guidelines from regulators such as the Federal Emergency Management Agency (FEMA) or the Department of Homeland Security for standards of critical facilities protection.

Partners that directly control assets are the main implementers of this strategy, but CMAP can also facilitate coordination of critical asset protection through regional groups. CMAP can promote this strategy through its membership in the Calumet Stormwater Collaborative, which works to reduce the negative effects of flooding in southern Cook County. CMAP's participation on a Steering Committee for IDOT's transportation vulnerability assessment is one example of how CMAP can support infrastructure agencies in carrying out this work. At the community level, CMAP can help municipalities identify important local assets and make recommendations in LTA-supported plans that take context-specific needs and climate impacts into account. CMAP can also continue its strong emphasis on robust community engagement and education to draw all residents into planning processes.

Building Resilient Transportation Networks

Well-functioning, integrated, and low-emissions transportation systems are a critical part of a resilient region. GO TO 2040 policies for compact development and active transportation help reduce vehicle-miles traveled (VMT) and GHG emissions from the transportation sector. GO TO 2040 also calls for investments that will transform the region's transportation system into a modern, world class network. The ON TO 2050 plan offers an opportunity to reiterate some of these goals through a climate resilience lens, while also adding new policies that reduce the vulnerability of transportation networks to climate change.

Strengthen transportation infrastructure to withstand climate changes

Transportation modernization efforts should promote infrastructure that is built for the climate of its designed lifespan. As noted earlier, the region's transportation infrastructure has already experienced many negative effects of climate change, which are only expected to worsen in the future. This toll will continue to reduce the capacity and performance of transportation systems.[59]

CMAP should incorporate climate-resilient investments in its capital project evaluation and transportation programming. CMAP already considers the GHG impacts of capital projects. CMAP will also explore other climate resilience criteria, such as additional design requirements for projects in flood-prone areas. Strategy development around transit modernization will address issues of climate resilience for transit systems. Similar considerations can be applied to other areas of transportation asset management at all scales. Local transportation agencies and

[59] 2014 National Climate Assessment, http://nca2014.globalchange.gov/report/sectors/transportation.

public works departments can also address this policy through capital improvement planning and routine transportation maintenance. The Regional Transportation Authority (RTA) is also undertaking a Bus Route Flooding Resiliency study to assess flooding impacts on Pace and CTA bus routes. At the state level, IDOT is conducting a climate vulnerability assessment of its statewide transportation assets, which may serve as a good starting point to pinpoint the types of investments needed to make the Chicago region more resilient to climate impacts. These and other transportation agencies should periodically conduct such studies as climate data are updated. CMAP's strategy paper on asset management provides a more direct avenue to address issues of infrastructure investments and maintenance.

Ensure multiple transportation options

The physical condition of transportation infrastructure is not the only aspect of a resilient system. Residents that have access to a diversity of transportation options are less vulnerable to external factors, such as road closures, as well as individual factors, such as car breakdowns or lack of car ownership. When roads or transit lines are disrupted, multimodal transportation options ensure continued mobility access. Alternative routing around affected roadway segments can direct drivers to other streets, as well as other modes of transportation. RTA's forthcoming bus route study will also examine alternative routing in the case of flooding, and will include a rerouting plan for buses on the most affected routes as well as a system for notifying passengers. While our region boasts many transportation options, the routes and schedules of transportation networks can be better coordinated. Moreover, the levels of service could be strategically increased in transit-supportive communities that have sufficient densities and promise for ridership.

GO TO 2040 lays a strong policy foundation for a multimodal transportation system that serves transit riders, bicyclists, pedestrians, and drivers. ON TO 2050 should support more multimodal transit services as a strategy to increase redundancies in the transportation system. Land use planning that encourages transit-supportive densities can provide the demand necessary for multimodal hubs. Safe pedestrian and bicycling infrastructure can increase redundancies for short-distance trips. These strategies are also important for climate mitigation, as they offer low-carbon alternatives that reduce automobile use.

Communities should prioritize redundancies in places that are likely to be most affected by climate disruptions. This may mean increasing transportation options to major employment centers or increasing ad hoc services to emergency shelters or cooling centers in events of flooding or extreme heat. Communities should also ensure that their most vulnerable residents have access to multiple transportation options. Divvy, the region's bike sharing program, provides an example of improving mobility in vulnerable communities through network expansions and affordability programs. Divvy is not only increasing the number of bike stations

in low-income communities, but has also initiated a Divvy for Everyone (D4E) program that offers discounted annual memberships for low-income households.[60]

Coordination across transportation agencies is necessary to build multimodal redundancies. For instance, disruptions in Metra services can be alleviated by Pace or CTA bus services. The RTA, which oversees planning and funding for all of the region's transit agencies, should continue to provide leadership for coordinated multimodal planning. CMAP can support these efforts through its transportation programming function, as well as transportation recommendations in LTA projects.

Adopt smarter transportation infrastructure management technologies and practices
A resilient transportation network maintains service continuity through disruptions. Transportation agencies are exploring how smart infrastructure technologies for traffic management can improve resilience. Currently, transportation control centers have limited ability to monitor conditions in the field when flooding, accidents, or other disruptions occur. Improved communications systems can allow for information to be relayed to and from control centers, field devices, and operators.

For instance, real-time monitoring and communications can smoothly reroute traffic in times of emergencies, congestion, special events, signal outages, or road closures. Some efficiencies can be gained by coordinating management practices. For instance, the Lake County Division of Transportation worked with the county's emergency call centers to establish automatic notifications of traffic incidents. Before this system, the Division of Transportation was often unaware of incidents that affected traffic or damages to their equipment during crashes. Now, the Division has been able to more efficiently respond to incidents. Although this seems simple, Lake County is so far the only county in the Chicago region with this integrated practice.[61]

Other management practices can be improved through new technology. Technologies such as sensors on roads and traffic signals can also enable adaptive signal control and variable message signs for efficient routing. These practices enable decision makers to direct commuters toward alternative routes or transportation modes. One example of this strategy in practice is a partnership between the Commonwealth of Kentucky and Waze, a real-time community-based traffic and navigation app that uses user-generated data on accidents, flooded roads, construction, and other traffic disruptions to route drivers. Through a newly established Waze Connected Citizens program, the Kentucky Transportation Cabinet provides the app with data from road sensors and planned capital projects and Waze provides the Transportation Cabinet

[60] Divvy, "Divvy for Everyone," https://www.divvybikes.com/d4e.

[61] CMAP briefing, 2013, "Public Safety Answering Point (PSAP) to Transportation Operator Data Integration," http://www.cmap.illinois.gov/documents/10180/211812/RTOC_PSAP_Integration_Outreach.pdf/4642be34-f5b6-446e-a187-77878f921b4f.

with incident reports.[62] With up-to-date crowd-sourced information, the Transportation Cabinet is able to more efficiently respond to issues on the road. This partnership enables two-way data sharing that ultimately improves the resilience of the transportation network.

CMAP can use transportation network analyses to refine its understanding of how extreme weather affects transportation behavior. In addition to identifying roads that are most vulnerable to flooding, such analyses can also identify potential alternative routes, highlight road segments that warrant flood-proofing, determine the impact of road outages on commuting patterns, and increase the overall resilience of the street network. Further research on infrastructure management will be explored in separate strategy development efforts on highway operations, transit modernization, and technological advances in transportation.

Addressing Climate Change through Natural Resource Management

Heat, flooding, and drought have significant implications for the region's natural resources. The prairies, savannahs, wetlands, forests, and lake and riverine systems in northeastern Illinois house a diversity of native flora and fauna. These natural resources have a range of functions in protecting the region from climate change, including stormwater management and the mitigation of GHG emissions, but they must also be actively managed and protected as the climate changes.

Increase biodiverse ecosystems

Communities can increase resilience by encouraging more biodiverse ecosystems, which mitigate climate change through carbon sequestration. Vegetation and soils store carbon, thereby reducing GHG emissions. A CMAP-supported Chicago Wilderness study estimating ecosystem service values for six services within the CMAP seven-county region found that a large tree can remove more than 1,000 pounds of CO_2 per year. In total, the region's green infrastructure contributes to carbon sequestration valued at an estimated $11.5 million each year.[63] GO TO 2040 calls for a target of conserving 400,000 acres of open space by 2040. This goal should remain a key strategy to address climate change in ON TO 2050. The strategy paper on Integrating Green Infrastructure, also produced by CMAP as part of ON TO 2050 development, provides a more in-depth discussion of conservation policies.

Both terrestrial and aquatic ecosystems should also be managed to prepare for a changing climate. Biodiverse ecosystems can better withstand invasive species and diseases and endure the impacts of extreme flooding and drought. Many of the region's native species are naturally

[62] State of Kentucky, January 7, 2015, "Kentucky Transportation Cabinet among first partners of Waze Connected Citizens program," http://migration.kentucky.gov/Newsroom/kytc/2015-01-07+WAZE+Connected.htm.

[63] CMAP, November 2014, "Green Infrastructure Vision: Version 2.3 Ecosystem Service Valuation," http://bit.ly/2fjk77S.

flood- and drought-tolerant. Although many native ecosystems have been replaced by development or non-native landscaping, communities and stewardship groups are increasingly promoting native lands restoration and landscaping that can cultivate healthy ecosystems for a range of weather conditions.

At the local level, CMAP can increase biodiversity by promoting landscaping ordinances and conservation design practices that support native species and by helping communities to prepare for change in the types of species that can thrive in the region. The City of Chicago Urban Tree Planting List provides a good example of how a municipality can provide recommendations on tree species that are most suited for various contexts, including hardiness, biodiversity, salt tolerance, and climate change readiness.[64] CMAP should also continue to work with regional partners on research, analysis, and cross-jurisdictional implementation of resilient natural resource strategies. As a member of Chicago Wilderness, for instance, CMAP can work with partners to protect priority species from climate change and improve native habitats across the region. CMAP leadership also participates on the Executive Advisory Council of the Chicago Regional Trees Initiative (CRTI), which provides collaborative opportunities to increase the health and diversity of the region's urban forest. CRTI's Regional Tree Census can help CMAP and other local partners identify biodiversity priorities and its collaborations with the tree industry can set forestry management standards. CMAP can also support local land acquisitions that have restoration goals by identifying areas with high potential for restoration and promoting restoration through its local planning work.

Support adaptive management of water resources

The Great Lakes comprise 84 percent of North America's surface freshwater supply and 21 percent of the global surface freshwater supply and serve not only as a vital source of drinking water, but also an important habitat for aquatic species. With many parts of the country and world facing significant water shortages, the Great Lakes are one of northeastern Illinois' most invaluable natural assets. Currently, 77 percent of the population in the Chicago region relies on Lake Michigan for its drinking water.[65]

CMAP guided development of the Water 2050 regional plan for planning for the region's water supply and demand. Adopted in 2010, the plan recommends that our region should account for the uncertain impacts of climate change on water resources by practicing adaptive management, which supports more iterative processes that allow decision makers to address

[64] City of Chicago, "Urban Tree Planting List," http://www.cityofchicago.org/content/dam/city/depts/streets/supp_info/Forestry/Forestry%202013/Chicago_Urban_Tree_Planting_list_2012.pdf.

[65] CMAP, 2010, "Water 2050," http://www.cmap.illinois.gov/documents/10180/14452/NE+IL+Regional+Water+Supply+Demand+Plan.pdf/26911cec-866e-4253-8d99-ef39c5653757.

the range of flood-to-drought conditions anticipated in the future.[66] Through the continued monitoring, evaluation, and learning associated with adaptive management, decision makers can adjust their actions with increasingly better data and understanding.[67] The policies to improve water efficiency and reduce water consumption provided in GO TO 2040 also remain important to building resilience in the water sector. CMAP is still in the process of determining how the agency should address water in ON TO 2050 and should build these climate change considerations into the final water policy framework.

Build climate resilience through green infrastructure

In addition to maintaining the health of the region's rich natural assets, the next plan should encourage green infrastructure as a first line of defense against climate effects. At regional, community, and site scales, green infrastructure can reduce the impacts of flooding and urban heat island effect. The strategy directions presented here build on the framework presented in the separate strategy paper on Integrating Green Infrastructure, emphasizing its benefits for climate resilience.

Green infrastructure builds ecological redundancies at multiple scales. At the regional scale, interconnected natural areas make up the region's green infrastructure network. Site-scale green infrastructure practices use vegetation, soils, and natural processes to provide or mimic natural ecological functions, such as bioswales that capture stormwater. Like transportation redundancies for climate resilience, green infrastructure at all scales ensures a diverse array of ecological functions for specific sites, communities, and the entire region. Green infrastructure also provides a level of redundancy for gray stormwater infrastructure when storm sewers are overwhelmed by runoff. Green infrastructure can also play a significant role in reducing urban heat island effect. As CMAP's analysis of land surface temperature shows (see Table 1 and Figure 12), highly developed lands are 6.6 degrees Fahrenheit hotter and forested lands are 1.9 degree Fahrenheit cooler than the average regional temperature. Increasing the tree canopy through urban forestry initiatives is an effective strategy for reducing urban heat island effect and mitigating the negative impacts of development.

GO TO 2040 supports the integration of green infrastructure into land use and site planning for stormwater management. ON TO 2050 can build on those practices to encourage the use of green infrastructure for a wider range of climate resilience benefits, including carbon sequestration, reduction of urban heat island effect, and continued water quality improvements and flood control. Currently, CMAP is developing a robust methodology for identifying areas

[66] CMAP, 2010, "Water 2050," http://www.cmap.illinois.gov/documents/10180/14452/NE+IL+Regional+Water+Supply+Demand+Plan.pdf/26911cec-866e-4253-8d99-ef39c5653757.

of the region that are more susceptible to flooding. This initiative will help communities target green infrastructure and other land use-based solutions for critical areas. CMAP can apply this analysis to zoning and planning in future LTA projects to improve the effectiveness of stormwater recommendations in local plans. A forthcoming stormwater strategy will provide an opportunity to translate these practices into regional policies.

Building Resilience in the Energy Sector

Energy generation and consumption is inextricably tied to climate change. Energy from fossil fuels is a primary driver of climate change, and increased need for cooling due to higher average and peak temperatures will raise the burden on the region's electricity grid. GO TO 2040 emphasized the importance of energy efficiency and renewable energy generation, but ON TO 2050 could build on those policy areas to recommend leveling the playing field for existing and emerging zero emission generation resources. This year, a separate CMAP effort will more fully explore potential regional energy policies for ON TO 2050 by developing an energy strategy paper that should build on the resilience framework presented in this strategy paper. Among other issues, the energy strategy paper should consider the following:

- **Increase low- and zero-emissions generation**. Solar, wind, and nuclear energy generation produce no emissions; other types of renewable energy produce less emissions than traditional fossil fuel-based sources. Given the Clean Power Plan's pending requirements to reduce statewide carbon emissions, communities and utilities are likely to increase reliance on low- and zero-emissions energy. As recommended in GO TO 2040, local governments can update zoning codes to permit rooftop renewable energy generation as well as standalone renewable energy systems. As part of the energy strategy, CMAP could explore the best approach for setting carbon emission reduction targets for the energy sector, along with strategies to achieve those goals.

- **Strengthen energy infrastructure for a changing climate.** As many residents have experienced firsthand, inclement weather is one of the most common causes of power outages in the region. Energy utilities and local governments have been improving storm hardening efforts to protect energy infrastructure from the effects of extreme weather. In new developments, utilities are typically buried underground, but overhead utilities in older communities remain vulnerable. The energy strategy paper can explore how the energy utilities, local governments, and private companies can design and maintain energy infrastructure to better withstand extreme weather.

- **Support decentralized energy generation and distribution.** Energy infrastructure decentralization can also build resilience to climate change by increasing redundancies in electricity generation and distribution. Decentralized energy infrastructure can take many forms, including rooftop renewables, microgrids, and greater use of cogeneration.

Rooftop solar and wind can provide power for homes and commercial facilities to reduce the burden on the grid during peak times. Microgrids are localized power grids that can connect to the main grid or function independently. District energy systems use steam and hot or chilled water to heat buildings and are commonly used in downtown areas or large campuses. Cogeneration, or combined heat and power (CHP), is a form of distributed energy that produces both heat and electricity from a single fuel source (including both renewables and fossil fuels). These alternatives can improve energy efficiency, reduce GHG emissions, and build resilience by diversifying the energy supply. Renewable energy sources can also help to mitigate the negative public health and environmental impacts of traditional sources of power, which disproportionately impact vulnerable populations. Decentralized systems can be especially useful to increase the resilience of important facilities, such as hospitals, industrial facilities, or downtown districts. The energy strategy paper can provide regulatory, financial, and other recommendations to encourage more widespread distributed energy infrastructure.

Fostering Economic Resilience

Climate impacts affect the vitality of our regional economy. A resilient economy can withstand climate-related weather disruptions and other types of crises, shocks, and changes. CMAP can help to build economic resilience that reduces vulnerability to climate change by addressing vulnerabilities of the region's communities and industry clusters.

Reduce community vulnerability to climate change

Economic and climate resilience are closely related. Many of the communities that are hardest hit by climate impacts have also faced significant disinvestment. It is more cost-effective to invest in climate preparedness than to pay for damages. A study by the Multihazard Mitigation Council (part of the National Institute of Building Sciences) estimated that each dollar spent on advanced planning to reduce the impact of disasters saves four dollars of recovery expenses.[68] As shown in research on chronic flooding by the Center for Neighborhood Technology (CNT), the continual diversion of resources to respond to climate impacts is eroding the economic bases of many communities in the region.[69] It is essential to ensure that those in greatest need can meaningfully participate in resilience planning and build community resilience to climate impacts. CMAP is developing a strategy to address inclusive growth, which will define strategies to help include more of the region's residents in the economy. The inclusive growth strategy development will include an analysis of the distribution of the region's most

[68] Multihazard Mitigation Council, 2005, "Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities," https://c.ymcdn.com/sites/www.nibs.org/resource/resmgr/MMC/hms_vol1.pdf.

[69] Center for Neighborhood Technology, May 2014, "The Prevalence and Cost of Urban Flooding," http://www.cnt.org/sites/default/files/publications/CNT_PrevalenceAndCostOfUrbanFlooding2014.pdf.

vulnerable residents and provide recommendations for improving access to economic opportunity for those residents. As a next step, CMAP should conduct a more targeted analysis to better understand the effects of climate change on the vulnerable communities identified through the inclusive growth work. By integrating the climate resilience and inclusive growth analyses, CMAP can develop strategies that can simultaneously build resilience for the region's most environmentally and economically vulnerable residents. These strategies should be developed in conjunction with vulnerable residents as well as partners to ensure implementation.

Increase the resilience of freight networks

Resilient mobility strategies should address the movement of both people and goods through the region. Northeastern Illinois is the country's largest rail hub and depends on a well-functioning freight system to support the national and regional economy. Severe weather events can disrupt supply chains and shipping routes, which can lead to significant economic implications that extend beyond the Chicago region. In 1999, a major blizzard shut down Chicago region's rail lines, disrupting goods movement nationwide and passenger rail services for months.[70] The national impacts of this winter storm highlighted the need for improved collaboration among railroads and government agencies to reduce vulnerabilities in the freight system. The partnership of freight railroads, passenger railroads, and federal, state, and local transportation agencies resulted in the Chicago Region Environmental and Transportation Efficiency (CREATE) program. Today, CREATE is recognized as an effective public-private initiative for addressing shared day-to-day and long-term issues, such as congestion, infrastructure management, and investments in the rail system.

The intersection of freight and climate change is an emerging national topic,[71] but it has not been explored in great detail at the regional level. CMAP has conducted significant research on freight, one of the region's "clusters" or areas of economic specialization. As that policy analysis continues, the agency should explore the potential implications of climate change on the regional freight network and strategies that can improve the freight system's resilience to climate change. Efforts like the CREATE program could provide inter-agency platforms for developing coordinated actions that build resilience.

Build resilience for the region's economic clusters

Climate change will affect the many industries that make up the region's diverse economy. From small, local businesses to multinational companies, many economic leaders in northeastern Illinois are already taking steps to build resilience. As highlighted by the business

[70] New York Times, May 7, 2012, "Freight Train Late? Blame Chicago," http://www.nytimes.com/2012/05/08/us/chicago-train-congestion-slows-whole-country.html.

[71] U.S. DOT, "Potential Impacts of Climate Change on Freight Transportation," http://climate.dot.gov/documents/workshop1002/caldwell.pdf.

community roundtables on regional resilience held as part of developing this strategy paper, companies are addressing resilience in many ways. These strategies include reducing the vulnerability of supply-chain operations to extreme weather; investing in manufacturing of resilience-building products such as mold-resistant materials; incorporating site-specific resilient design practices on business properties; instituting more flexible human resources practices to accommodate weather-related disruptions for employees; and building resilience-oriented branding to increase public awareness. ON TO 2050 can help to better understand climate change effects on the regional economy and engage the region's private sector actors on strategies to build resilience. CMAP can also partner with the private sector to provide better data and projections on climate issues, enabling businesses to make a more compelling case to leadership about resilience initiatives. To build on CMAP's extensive prior policy analysis on regional economic clusters, CMAP is planning to conduct further research on economic resilience. This research will build on the resilience framework provided through the climate resilience effort to explore various frameworks for economic resilience.

Prepare agricultural resources for climate change

The region produces many agricultural crops, but corn and soybean fields dominate the agricultural landscape. Little of the food consumed by residents in the region comes from within the region or the broader southern Lake Michigan foodshed. Warmer average temperatures have been lengthening growing seasons, enabling greater agricultural productivity. At the same time, increased frequency of freeze-thaw cycles will lead to crop losses and greater survival rates of invasive pests that are detrimental to crop yields. Precipitation extremes may also cause significant crop losses due to drought and fields that are too saturated to cultivate properly. More broadly, climate impacts to agricultural systems outside of the Chicago region may affect its future food supply.

ON TO 2050 is expected to support the agricultural and local food policies laid out in GO TO 2040, emphasizing greater local food production, farmland preservation, improved access to fresh, nutritious, and affordable food for underserved communities, while providing improved data and information about the local food system. Food access has been and is likely to remain locally driven, and CMAP will continue to depend on its partners to implement related strategies. Some refinement of GO TO 2040's approach to these issues is underway; a related project, the Lands in Transition strategy paper, is examining the state of our agricultural landscapes and strategies for agricultural and natural resources protection. CMAP is also funding an evaluation of the current and potential levels of food production through the Regional Food Systems Study.

Future policy work for ON TO 2050 could include investigating the barriers to greater local food production, such as access to land, infrastructure, and financing. Resilient farmland

management practices such as cover crops, no-till cultivation, and smarter irrigation practices,[72] which can also improve land and water health and be mutually supportive to natural resource and biodiversity goals, are also likely to be important to increase food security as climate change occurs. ON TO 2050 can also promote farming enterprises that best advance resilience objectives, such as local food producers, organic croppers, and sustainable agriculture practitioners. CMAP has a limited role in implementing these practices but can work with local stakeholders to access resources on resilient agricultural practices.

Building Capacity for Resilience Planning

Adaptive capacity—the ability to respond to changing circumstances—is a key component of building resilience to climate change. Regional partners can reduce vulnerabilities to climate change by ensuring that processes and operations are flexible and can respond to changing conditions. CMAP can better prepare regional partners to implement resilience strategies by building community capacity and providing opportunities for collaboration and resource sharing.

Build community capacity

Many recommendations of the climate resilience strategy are targeted at local government partners. Local governments can play a significant role in addressing climate change. Regional, national, and global initiatives such as C40, Urban Sustainability Directors Network, ICLEI—Local Governments for Sustainability, Prairie State Network, Greenest Region Compact, and the Calumet Stormwater Collaborative provide networks for local governments to exchange best practices to address climate change and other environmental issues.

Many communities that are experiencing significant climate impacts, however, lack the capacity and resources to sufficiently address climate impacts. Capacity constraints can lead to systemic barriers in addressing a variety of planning issues, from reinvestment to climate change. In a resilient region, communities throughout northeastern Illinois should have equal opportunities to access resources in order to conduct climate resilience planning. This entails having data and information about climate change, conducting climate resilience planning, and accessing financial resources to implement resilience initiatives. CMAP can also play a role in communicating with communities and residents about climate change and resilience to communities and residents to generally raise awareness about the subject matter and available resources.

CMAP's Climate Adaptation Guidebook for Municipalities in the Chicago Region provides a basic overview of climate changes and strategies for public works infrastructure. In 2014, CMAP

[72] Natural Resources Defense Council, August 2013, "Soil Matters Issue Paper," http://www.nrdc.org/water/soil-matters/files/soil-matters-ip.pdf.

also partnered with the Midwestern Regional Climate Center and Illinois State Climatologist Office to host a Resilient Chicago workshop that featured presentations from a variety of experts on the ecological, infrastructure, and public health impacts of climate change. CMAP can add to these resources by providing direct trainings on climate resilience planning through the LTA program. CMAP is also exploring ways to build municipal capacity, which will be described in an ON TO 2050 strategy paper. While the scope of that effort will cover municipal capacity broadly, its recommendations will be applicable to resilience planning.

Provide data to build climate literacy and facilitate informed decisions
Regional stakeholders, from local elected officials to business leaders, need access to up-to-date data on climate science to make informed decisions. The Illinois Climatologist Office, Illinois State Water Survey, and Midwestern Regional Climate Center, among other entities, are charged with providing high-quality historical and projected climate data and monitoring climate changes. Many stakeholders, however, do not know about these resources or may not understand how data on precipitation or temperature changes can be applied to decision making.

CMAP, in partnership with these and other institutions, can play a role in translating climate science to policy making and planning. This strategy paper has resulted in new regional data about land surface temperature and social vulnerabilities to climate change. CMAP should continue to analyze climate impacts, such as regional stormwater flows. These data can be summarized through a forthcoming environmental snapshot that summarizes environmental conditions in the region and hosted on CMAP's Data Sharing Hub. CMAP can also develop a consistent analytical approach for integrating climate vulnerability analyses into existing conditions research for comprehensive, capital improvement, and other plans completed through the LTA program. The agency has already begun initial work on an automated tool for planners to assess the climate vulnerability of a community's roadways, land uses, and populations. Ultimately, these actions build greater awareness about climate change and provide targeted guidance on how to make data-driven decisions. CMAP can also seek to increase awareness of climate data and information among other organizations to facilitate the inclusion of climate considerations into planning and programming efforts; analytical methodology and assumptions should be clearly stated to make data as accessible as possible.

Explore a platform for coordinating regional resilience initiatives
Many resilience strategies require coordinated sub-area, regional, or statewide action. Private, public, and non-profit partners across a variety of sectors have limited opportunities or incentives for cooperation. A regional partnership might be an effective way to ensure coordination of the many resilience-building policies, advocacy efforts, research needs, and sharing of best practices needed to implement the ultimate recommendations of ON TO 2050. Whether it takes the form of a collective, a coalition, or a network, this platform can open channels for dialogue, knowledge exchange, and relationship building across regional

stakeholders. The Climate Resilience Resource Group, convened as an ad hoc group to provide feedback on the development of this strategy paper, has been an effective outlet for cross-sector engagement. The Resource Group should identify whether a continued platform would be helpful for long-term resilience building, and if so, the objectives and structure of such a group.

Next Steps

The policy framework presented in this document sets the direction for climate resilience in ON TO 2050. Because climate resilience relates to many aspects of planning, from transportation and land use to community and economic development, this framework presents many resilience considerations for other planning topics in ON TO 2050 as well. CMAP expects these recommendations to inform future strategy papers, snapshots, technical assistance projects, policy updates, research products, and data sharing. The recommendations of ON TO 2050 are expected to synthesize these climate resilience strategies into a comprehensive vision for the region.

CMAP cannot achieve climate resilience goals without its regional partners who are critical to the implementation of climate resilience practices. This document also includes recommendations aimed at partners in local and state governments, non-profits, philanthropy, and the private sector. Further discussions on the most effective way to continue regional collaboration will be essential to build regional resilience.

Appendix A: Partner-Led Strategies

Strong partnerships are critical for the implementation of ON TO 2050. Many of the ideas generated through the Climate Resilience Resource Group are best led by regional partners, from local governments to non-profit advocates to funders. The following table identifies strategies that should be primarily led by partner organizations. These actions complement the strategies most relevant for CMAP (strategies also directed at CMAP are italicized).

Table 4. Partner-Led Climate Resilience Strategies

Strategies		Lead implementers
Planning for Climate Change	***Achieve greater livability through resilience planning*** ***Integrate resilience policies into existing planning processes*** ***Update development regulations to prepare for a changing climate*** Local governments have an especially vital role in planning for resilience. Policies, programs, and development regulations can be put in place to ensure that all planning processes work toward resilience goals. Planning processes should strive to engage all community residents, especially excluded populations.	Municipal and county governments, housing organizations, citizens
	Implement resilient building designs. Private developers and architects should design buildings and landscaping to reduce flooding impacts, increase energy efficiency, ensure compact development, and follow other principles of resilient design.	Developers, designers, USGBC, taxing districts
Promoting Climate Resilient Infrastructure (includes buildings, transportation networks, energy infrastructure,	***Update infrastructure design standards*** ***Encourage infrastructure that provides multiple benefits*** ***Protect critical assets*** With appropriate standards and funding in place, infrastructure agencies at local, county, and state levels should take the lead in making resilient infrastructure projects a reality. This includes updating outmoded design standards to be more resilient and incorporate multiple benefits. New development, redevelopment, and routine infrastructure maintenance projects provide opportunities to implement more resilient systems.	IDOT, RTA, CTA, Metra, Pace, Tollway, IDNR, county departments of transportation and stormwater, utilities, civic organizations, local, state, and federal governments

stormwater and sewer pipes, and green infrastructure)	**Provide accessible funding for resilient infrastructure.** Many traditional funding sources are not equipped to support collaborative processes to build multi-purpose infrastructure. Common funding barriers include unclear or onerous application requirements for new forms of infrastructure; inability to work across jurisdictions; difficulty aligning multiple funding sources for projects in the same place; and restrictive funding that prohibits interagency collaboration. These challenges inhibit innovative and efficient infrastructure planning. For instance, applications for the State Revolving Fund are still geared toward gray wastewater systems, making it confusing to apply for green infrastructure projects even though they are now eligible for funding. Sometimes simple updates, such as establishing clear checklists or enabling joint applications for multijurisdictional projects, can make it significantly easier to fund resilient infrastructure projects. Funding entities should also explore ways to align funding across agencies to streamline capital project construction and support more resilient infrastructure projects.	Local, state, and federal infrastructure funding agencies (such as RTA, IDOT, IDNR, IEPA, FHWA, FEMA, and HUD), philanthropic organizations, Community Rating System
Building Resilient Transportation Networks	***Strengthen transportation infrastructure to withstand climate changes*** ***Ensure multiple transportation options*** ***Adopt smarter transportation infrastructure management*** While CMAP can influence transportation policy and funding through CMAQ and TAP, transportation agencies have a primary role to play in managing assets and providing multiple options to increase redundancies.	IDOT, RTA, Metra, Pace, Tollway, CTA, county and municipal departments of transportation
Addressing Climate Change through Natural Resource Management	***Increase biodiverse ecosystems*** ***Support adaptive management of water resources*** ***Build climate resilience through green infrastructure*** Resiliently managing the wide range of natural resources in the region requires collaboration across many issue areas including water supply, water quality, natural resource management, and agriculture. Attention should be given to managing both aquatic and terrestrial ecosystems and natural resources.	Forest preserve districts, land banks, land owners, natural resource managers, MWRD, ComEd, farmers, IEPA, IDNR, environmental non-profits, local governments, Illinois State Water Survey

	Develop smarter green infrastructure technologies. Emerging research is exploring the use of real-time data collection in monitoring green infrastructure performance for heat and flood control. On-site sensors can be installed in or near site-scale green infrastructure to monitor temperature, air quality, or rates of stormwater capture. For example, sensors installed alongside green stormwater infrastructure can allow operators to determine when and where parts of the system are overwhelmed so they may adjust the flow of stormwater into the system accordingly. GO TO 2040 identifies uncertainties around green stormwater infrastructure performance as a major barrier to implementation. The collection of performance data can also allow operators to evaluate the effectiveness and improve the design of green stormwater infrastructure. Research institutions, such as UI Labs, Argonne National Laboratory, and universities, can serve as key implementers of this strategy. Additional research and development opportunities exist for other forms of infrastructure as well.	Research institutions, philanthropic organizations, architecture and engineering firms
Building Resilience in the Energy Sector	***Increase low- and zero-emissions generation*** ***Strengthen energy infrastructure for a changing climate*** ***Support decentralized energy generation and distribution*** The resilient energy strategies in this strategy paper should be primarily implemented by energy utilities. Already, ComEd has taken many strides to modernize the electricity grid by moving to a smart grid system. Smart grids automatically detect issues and reroute electricity to reduce power outages. Smart grid systems are not just useful for emergency situations; they have also improved day-to-day efficiencies in meter reading and billing. These improvements have enabled the electricity grid to be more responsive to unforeseen problems and more efficient in reducing peak electricity demand, thereby mitigating GHG emissions. The utility's roll-out of smart meters—a component of the smart grid—across the region should be complete for CMAP's seven-county region by 2018. Utilities and municipalities can work together to remove regulatory barriers and lower costs of clean energy generation and distribution, from small-scale rooftop solar panels to district energy systems.	ComEd, Peoples Gas, Nicor, other energy utilities, municipalities, Citizens Utility Board, non-profit organizations, philanthropic organizations, private sector
Fostering Economic Resilience	***Reduce community vulnerability to climate change*** ***Increase the resilience of freight networks*** ***Build resilience for the region's economic clusters*** ***Prepare agricultural resources for climate change*** The region's private sector can be a driver of economic resilience. Many businesses see climate change as a risk management issue and have taken strides to reduce weather-related disruptions on their supply chains. Businesses can also take advantage of emerging economic opportunities that come with building resilience, such as manufacturing more durable construction materials or developing smart city technologies.	Private sector, municipalities, counties, non-profit organizations, chambers of commerce, community development corporations, World Business Chicago, freight operators

Building Capacity for Resilience Planning	**Improve cross-jurisdictional coordination.** Departments and sectors too often operate in silos, speaking different languages, pursuing unaligned goals, and working on different timelines. Coordination is currently difficult because entities often have different data management practices, procedures, or authorities than their counterparts in other parts of the region. Resilience strategies require that organizations who may not traditionally work together coordinate to share information, financial and staff resources, align timelines, and build a culture of collaboration. The types of coordination to strengthen should include partnerships between departments within counties or municipalities, units of local government; state and local governments; public, private, and non-profit sectors; and disciplinary sectors such as public health, planning, and emergency management. Strategies to improve cross-jurisdictional coordination may range from straightforward practices, such as establishing regular coordination meetings, to more long-term activities, such as establishing regional data collection standards and sharing protocols.	Municipal, county and state governments, private sector, non-profits, disciplinary sectors
	Build relationships between the public and private sectors. Cross-sector relationships are also important for building resilience. Private companies are increasingly providing innovative services, such as transportation and infrastructure management. Public-private partnerships provide significant opportunities for better sharing of best practices and data. The partnership between Waze and the Commonwealth of Kentucky, referenced in the strategy paper, is one example of an effective public-private partnership to improve resilience in the transportation sector.	Public agencies, private companies that use infrastructure technologies
	Increase social cohesion. Community-based organizations should take a leading role in reducing social isolation and vulnerability to climate change. Community centers, service providers, faith-based organizations, and other community leaders can educate the public about individual actions they can take to build resilience against climate impacts, such as flood-proofing homes, checking in on elderly neighbors, and securing sufficient flood insurance coverage. Community-based organizations can also connect people to broader opportunities that build community resilience, such as planning processes, advocacy, and other forms of civic engagement. Particular emphasis should be paid to those who are most vulnerable to climate change by social service providers and other groups that work directly with vulnerable populations. These types of capacity building activities can better prepare residents for addressing climate impacts and ensure resilience building at the most local levels.	Community-based organizations

Improve early warning alert systems. Several early warning practices, such as advisory notices for flash floods and alerts for transit delays, already exist. Improvements, however, can increase the level of detail of alerts and ensure communication to more people. For instance, to reach a wider audience, DuPage County is partnering with Walgreens stores to broadcast extreme weather warnings on the retailer's ubiquitous LED signs. Other potential opportunities include meteorologist warnings on local news and communicating alerts through common transportation routing apps, such as Google Maps, to direct people toward mass transit options or away from affected areas. Centralized and easy-to-understand dashboard systems may also be helpful ways to provide real-time information and guidance to the public.	National Weather Service, local governments, and other community partners
Increase education and awareness about climate resilience. According to a 2015 national survey, 37 percent of Americans believe climate change is a serious and pressing issue, representing an 8 percentage point increase from 2010.[73] These shifts in public opinion can be strong driving forces for change. Many partners point to the importance of public perception and education on climate change actions as a key factor for building regional resilience. Residents can contribute to resilience implementation by retrofitting backyards with green infrastructure, choosing low-carbon transportation options, reducing personal energy consumption, and participating in resilience planning processes. However, many residents may be unfamiliar with green infrastructure practices or have limited understanding about climate impacts in the region. Education campaigns can build public awareness about climate change and provide recommendations for building resilience at an individual scale. In turn, a more informed public can champion resilience strategies at community, regional, and national levels.	Civic and non-profit organizations, schools, higher education, Illinois-Indiana Sea Grant extension programs

[73] Chicago Council on Global Affairs, November 30, 2015, "Slight Rise in U.S. Public Concerns about Climate," https://www.thechicagocouncil.org/publication/slight-rise-us-public-concerns-about-climate-0?utm_source=Informz&utm_medium=Email&utm_campaign=Council.

Appendix B: Acronym List

CTA: Chicago Transit Authority
IDNR: Illinois Department of Natural Resources
IDOT: Illinois Department of Transportation
IEPA: Illinois Environmental Protection Agency
FEMA: Federal Emergency Management Agency
FHWA: Federal Highway Administration
HUD: U.S. Department of Housing and Urban Development
MWRD: Metropolitan Water Reclamation District of Greater Chicago
RTA: Regional Transportation Authority
USGBC: U.S. Green Building Council

233 South Wacker Drive, Suite 800
Chicago, Illinois 60606
312-454-0400
ONTO2050@cmap.illinois.gov

www.cmap.illinois.gov

The Chicago Metropolitan Agency for Planning (CMAP) is our region's official comprehensive planning organization. The agency and its partners are developing ON TO 2050, a new comprehensive regional plan to help the seven counties and 284 communities of northeastern Illinois implement strategies that address transportation, housing, economic development, open space, the environment, and other quality-of-life issues. See www.cmap.illinois.gov for more information.

ON TO 2050 strategy papers will explore potential new topics or refinements to existing GO TO 2040 recommendations. These documents and data-driven snapshot reports will define further research needs as the plan is being developed prior to adoption in October 2018.

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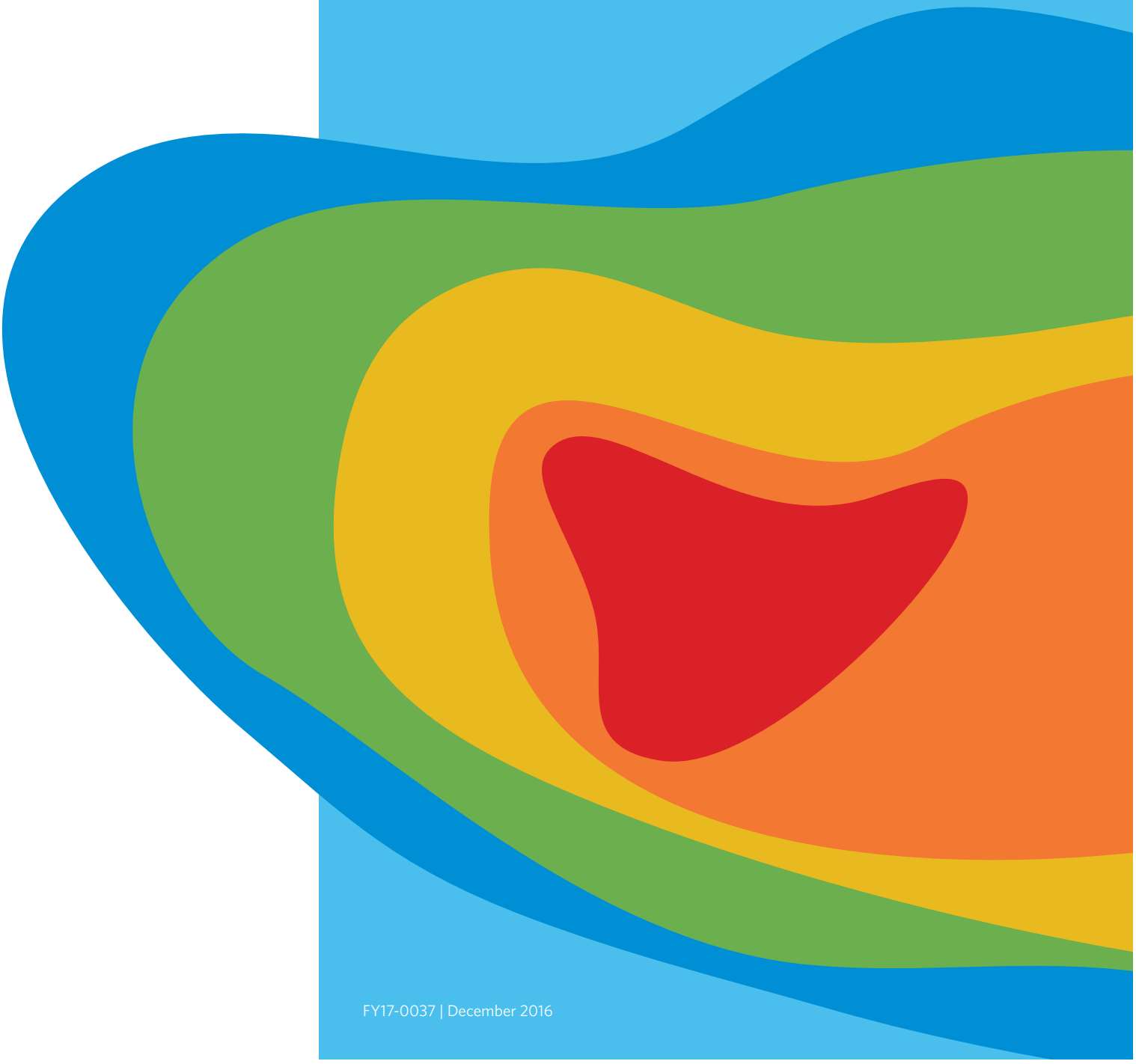

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