Des Plaines Vulnerability Assessment

Introduction

Climate vulnerability refers to the degree to which a community is exposed to climate change, is sensitive to its impacts, and is able to adapt to those impacts.[1] This assessment explores climate-related hazards affecting the City of Des Plaines, as well as the community's projected future exposure and adaptive capacity. The vulnerabilities identified in this report will be integrated into the Des Plaines Comprehensive Plan, which will identify a wide range of strategies for local implementers.

The goal of the grant is to assist communities to incorporate local climate science into community planning. CMAP and the APA thought Des Plaines would benefit by being one of five local pilot communities due to timing in preparing the new Comprehensive Plan. The project partners intend to develop, test, and refine a data-driven framework for climate-smart comprehensive and capital infrastructure plans. An outcome of the project might be the development of long-term options in mitigating natural hazards such as flooding through better land use planning.

This assessment was developed in partnership with the National Oceanic and Atmospheric Administration (NOAA), the American Planning Association (APA), and Illinois-Indiana Sea Grant, with the goal of identifying new ways to integrate climate science into the local planning process. The methodology and data sources used to develop this analysis will be compiled by the American Planning Association and integrated into a guidebook for local planners. This report adds to the conversation about climate resilience, an emerging field in city planning.

Key Findings

- Des Plaines' residential neighborhoods are vulnerable to increased precipitation and flooding. Des Plaines is susceptible to flooding both from its rivers and streams (riverine flooding), and from rain overwhelming the stormwater drainage system (urban flooding.) As climate change leads to increased precipitation in future years, flooding is likely to occur more frequently in areas that have historically experienced flooding. Approximately one third of single-family residential parcels in Des Plaines are located within the floodplain of the Des Plaines River or smaller streams. Many of these vulnerable residential parcels are also located in areas the City has designated as priorities for stormwater investments due to repetitive property damage from past floods.

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

- Des Plaines has a substantial population that is highly vulnerable to climate-related hazards. The city has a sizeable population over the age of 65, a group that is expected to grow by the middle of the 21st century. Des Plaines also has a growing foreign-born population with limited English proficiency that is currently in need of better access to community services and amenities. Age, language, and accessibility barriers present challenges for responding to natural hazards associated with extreme temperatures and flooding.
- Des Plaines' economic competiveness is vulnerable to the projected impact of climate change on the transportation system. Freight and industrial markets within Des Plaines and the surrounding area depend on efficient air, road, and rail systems. Climate models project increased extreme heat, flooding, and severe summer or winter storms that threaten to damage infrastructure and disrupt the movement of goods and people, which may result in negative local and regional economic impacts.

Community Profile

The City of Des Plaines is located in Cook County, approximately 19 miles northwest of downtown Chicago. Neighboring communities include Mount Prospect, Park Ridge, Elk Grove Village, and Chicago, as well as unincorporated lands to the northeast in Maine Township and the southwest in Elk Grove Township. It shares its southern border with O'Hare International Airport.

The Des Plaines River and the railroad played critical roles in the community's early growth and development. The river was once a wide, grassy swale but was drained with ditches to create viable land for farming and housing. The transition of this land attracted the development of industrial and transportation infrastructure. Settlers moved to the valley surrounding the river in the mid-1800s, when construction materials supplied by nearby sawmills were used to build a railroad line through the community.[2] The presence of a regional rail line and a steam-powered gristmill made it a booming farming and railroad town through the late 1800s and early 1900s. The downtown business district of the City grew around the railroad and mill, along the Des Plaines River.[3] Des Plaines incorporated as a Village in 1869 and became a city in 1925.[4] The river that played a large role in driving the city's development has had other effects as well; throughout its history, Des Plaines has experienced flooding that has disrupted transportation and damaged infrastructure.[5]

[2] Encyclopedia of Chicago, "Des Plaines, IL," 2005. http://www.encyclopedia.chicagohistory.org/pages/376.html.

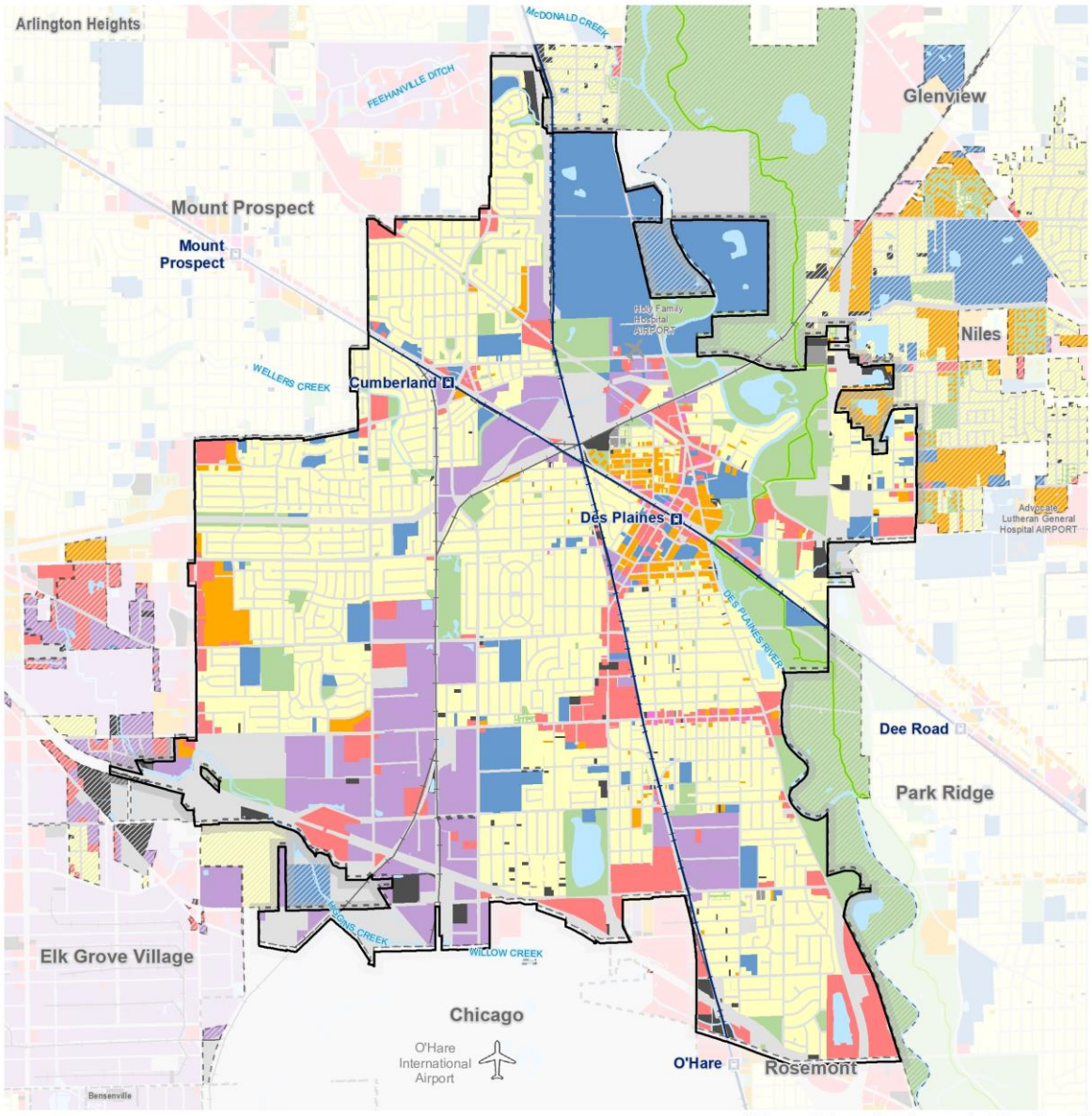
[3] City of Des Plaines, "History," http://www.desplaines.org/government/about/history.htm.

[4] City of Des Plaines, "Hazard Mitigation Plan," November 2013, www.desplaines.org/civicax/filebank/blobdload.aspx?blobid=24234.

[5] Encyclopedia of Chicago, "Des Plaines, IL," 2005. http://www.encyclopedia.chicagohistory.org/pages/376.html.

As of 2010, Des Plaines has a stable population with over 58,000 residents. The City is a diverse, mixed-income community that serves as both a bedroom community for commuters to Chicago and as a job center of its own. Des Plaines has significant numbers of Latino and Asian residents, totaling approximately one third of the population combined. The City's median household income is $63,528, which is slightly higher than that of Cook County ($54,598), but lower than that of the region overall ($71,031). Des Plaines' population is somewhat older than that of the region as a whole, with a median age of 42, compared to 36 for Cook County and 37 for the Chicago region. Most of the approximately 29,000 Des Plaines residents who are employed commute less than ten miles. Located near O'Hare Airport as well as several highways and rail lines, Des Plaines has attracted manufacturing and wholesale trade businesses that provide 15.8 percent and 10.4 percent of the 38,000 jobs located within the City. Health care and social assistance as well as wholesale trade business are other major industries in Des Plaines, and top employers include the Oakton Community College, Honeywell, Universal Oil Products, Rivers Casino, and Abbot Laboratories.

Figure 1. Des Plaines Land Use



Chicago Metropolitan Agency for Planning, 2016.

Existing Land Uses

- Single Family Residential
- Multi-Family Residential
- Commercial
- Urban Mix with Residential Component
- Industrial
- Institutional
- Open Space
- Water
- Transportation/Utilities/Communication/Other
- Under Construction
- Vacant

- City of Des Plaines
- Municipal Limits
- Unincorporated Areas
- County Boundary
- Metra Stations
- Metra Rail Lines
- Freight Rail Lines
- Cook County Forest Preserve Trail

0 0.25 0.5 1 Miles

Climate and Natural Hazards

The City of Des Plaines experiences a continental climate characterized by warm summers as well as cold and dry winters.[6] This historical climate is the basis for the kinds of temperatures, precipitation patterns, and weather events that Des Plaines has experienced for most of its recorded history. Summer months have an average temperature of 72 degrees Fahrenheit, which tends to peak in July with average daily high temperatures of 84 degrees Fahrenheit. Winter months have an average temperature of 26 degrees Fahrenheit and typically drop significantly in January, when daily low temperatures average 16.5 degrees Fahrenheit. The City receives an average of 37 inches of rain and 37 inches of snowfall per year. Spring and summer months (May through August) tend to experience the most accumulated rainfall.[7,8]

The effects of climate change have already been observed in the region, which has experienced an increase in overall temperature and associated changes in weather patterns. While weather-related hazards have always been present in northeastern Illinois, warming temperatures and related effects have led to clear changes in the frequency and intensity of some hazardous events. The Great Lakes region has warmed by two degrees Fahrenheit since 2000, which is a faster rate of increase than in any other decade since 1900.[9] Despite fluctuations in average annual temperature since 1959, the overall trend has been a clear and significant increase in average temperatures (Figure 2).

Climate vs. Weather

Weather is characterized by the variability in atmospheric conditions over a short period of time, such as a few hours or days. Thunderstorms, cold spells, droughts, and blizzards are all examples of weather.

Climate refers to long-term atmospheric trends, typically averaged over 30-years. In other words, climate reflects the weather of a place averaged over a long period of time.

It can be tempting to point to weather events as a sign that climate change is or is not happening, but the evidence of climate change is much harder to spot. Climate scientists analyze records going back many decades to find evidence of long-term changes. These changes may make individual weather events stronger, or more frequent, but the weather events themselves do not constitute a change in climate.

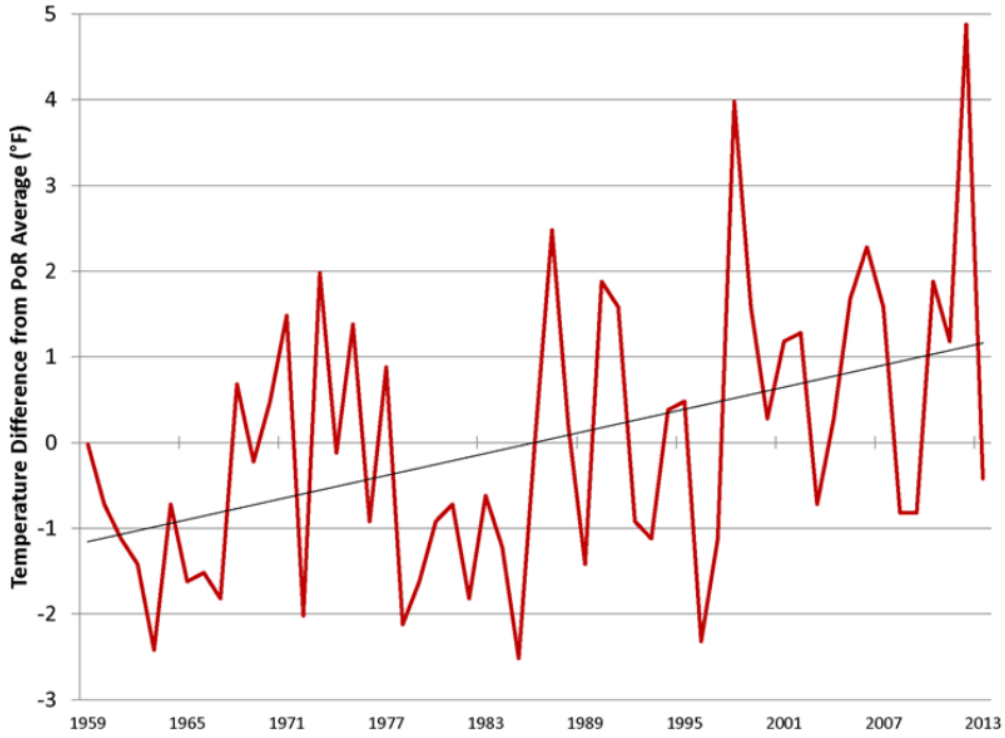
[6] Jim Angel, "Climate of Illinois Narrative," State Climatologist Office for Illinois, http://www.isws.illinois.edu/atmos/statecli/General/Illinois-climate-narrative.htm.

[7] National Centers for Environmental Information, "Data Tools: 1981-2010 Normals – Chicago O'Hare International Airport, IL, US" National Oceanic and Atmospheric Administration, https://www.ncdc.noaa.gov/cdo-web/datatools/normals.

[8] Climate normals for Des Plaines are based on data collected at the Chicago O'Hare International Airport, IL station between the years, 1981-2010. This station was selected because of its proximity to the study area.

[9] 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.

Figure 2. Average Temperature of the Chicago Region, 1959-2010 (NCA, 2014)



The Midwest as a whole has been experiencing in increase in precipitation and heavy storm events as regional temperatures rise. As air warms, its ability to retain water vapor increases, which allows for more frequent and more powerful storms.[10] Within the atmosphere, air can hold four percent more water vapor with each degree Fahrenheit of temperature increase.[11] Between 1979 and 2009, northeastern Illinois saw 40 percent more precipitation than during the previous 30-year period.[12] The increased precipitation has occurred as part of larger storms, with the amount of precipitation falling in very heavy storm events increasing by 37% between 1958 and 2012.[13] The number of days per year with greater than one inch of precipitation in Cook County fluctuates from year to year, but the trend has been increasing (Figure 3).

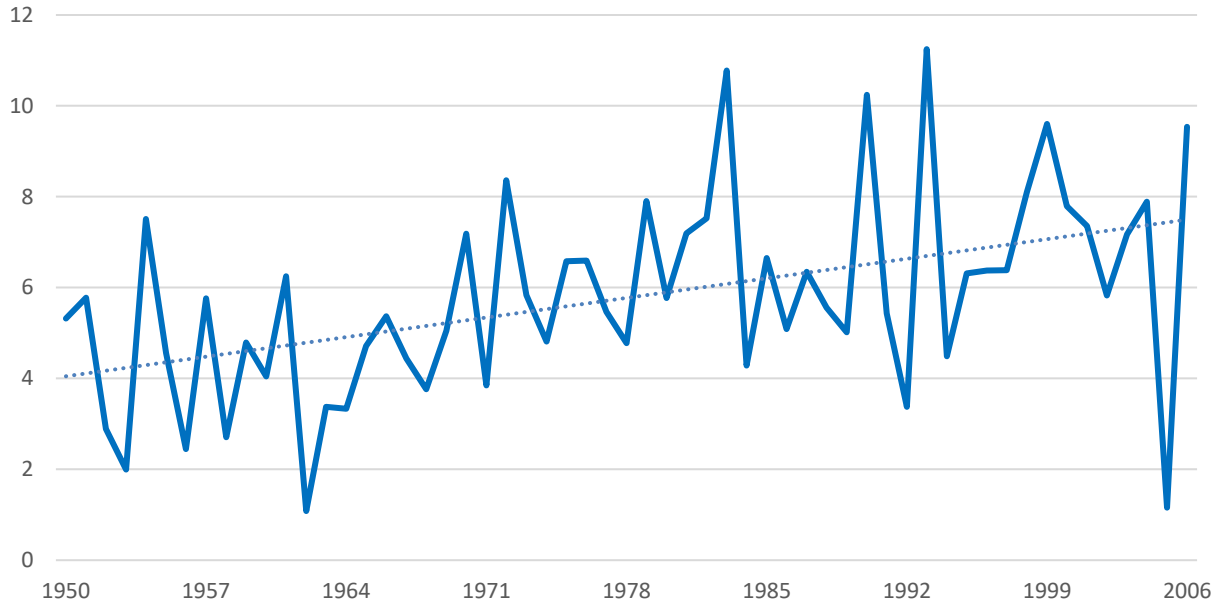
[10] Illinois Department of Natural Resources, 2015, "Urban Flooding Awareness Act," https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

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

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

[13] 'Very heavy storm events' is defined as the heaviest 1% of all daily events.

Figure 3: Number of days with more than 1 inch of precipitation in Cook County



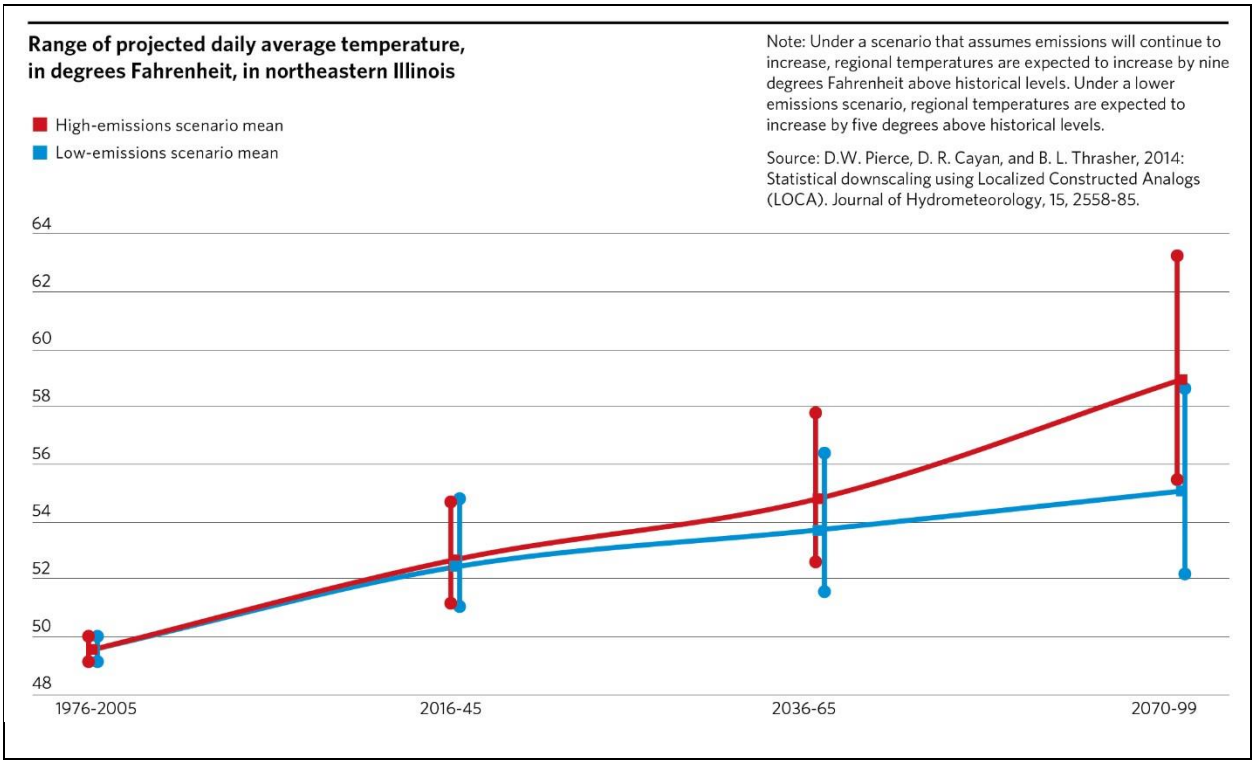
Source: U.S. Climate Resilience Toolkit

The current trend of rising temperatures is primarily due to increasing concentrations of greenhouse gases in the Earth's atmosphere.[14] Given the relationship between greenhouse gas emissions and major shifts in temperature and precipitation, scientists have developed complex models based on different emissions scenarios to predict future climatic conditions. These predictions are often referred to as climate projections. The most commonly used models for generating climate projections were developed by the International Panel on Climate Change. Generally, these models include a low-emissions scenario that assumes drastic reductions in global greenhouse gas emissions, and a high-emissions scenario that assumes emissions will continue to increase. Under the scenario that assumes drastically reduced emissions (blue line in Figure 44), the average temperature in northeast Illinois is projected to increase by three to nine degrees Fahrenheit by the end of the century.[15] Under the scenario that assumes moderately high emissions (red line in Figure 4), the average temperature in Illinois is projected to increase by six to thirteen degrees Fahrenheit by the end of the century.

[14] Intergovernmental Panel on Climate Change, "Climate Change 2014: Synthesis Report," https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf.

[15] Illinois State Climatologist Office, derived from the B1 (low emissions) scenario of the 4th IPCC report.

Figure 4. Projected Temperature Change in NE Illinois under Low and High Emission Scenarios



Under either of these cases, climate models project that by the end of the century, northeastern Illinois will likely experience a warm temperate climate that has greater variation in annual precipitation and high humidity.[16] Experts project an additional four to eight inches of rain annually during wet years, and a reduction of four to eleven inches during dry years by 2100. These models also suggest that a larger proportion of precipitation will fall during fewer but more intense storms. This trend would result in longer periods of drought-like conditions, periodically interrupted by heavy rain, and that the periods of increased rain will primarily occur in the winter and spring (Figure 55).

[16] [16] Institute for Veterinary Public Health, "World Maps of Köppen-Geiger Climate Classification: Overserved and Projected Climate shift 1901-2100 Depicted by World Maps of the Köppen-Geiger Climate Classification," 2011, http://koeppen-geiger.vu-wien.ac.at/shifts.htm

Figure 5. Projected Precipitation Change by Season for 2071-2099 (compared to 1970-1999)

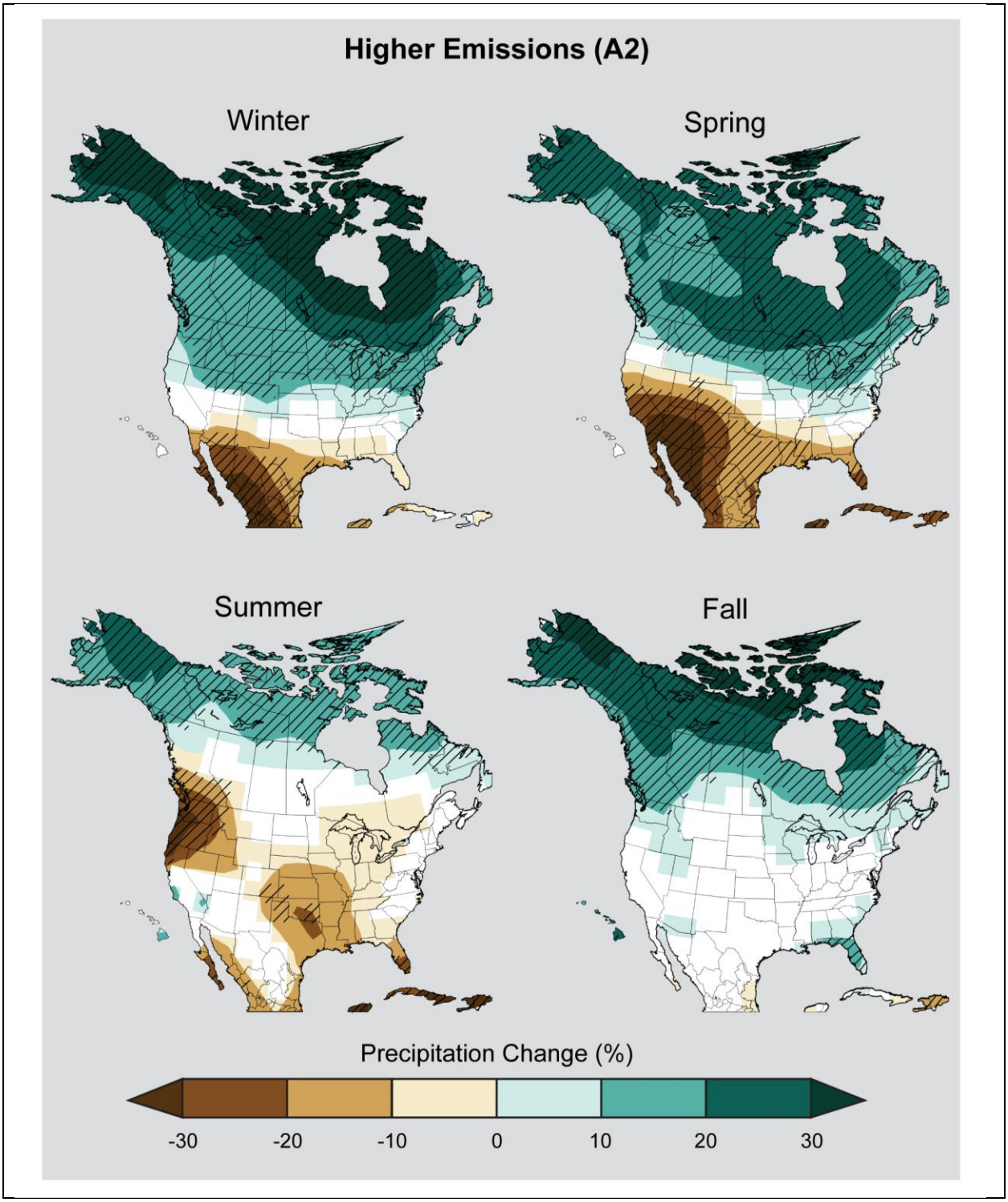


Figure 5 shows projected change in seasonal precipitation under an emissions scenario that assumes continued increases in emissions (A2).Hatched areas indicate that the projected changes are significant and consistent among models. White areas indicate that the changes are not projected to be larger than could be expected from natural variability. In general, the northern part of the U.S. is projected to see more winter and spring precipitation, while the southwestern U.S. is projected to experience less precipitation in the spring. (Figure and caption source: NOAA NCDC / CICS-NC).

Flooding

City stakeholders, including the Public Works Department, considers flooding to be one of the challenges that faces Des Plaines.[17] While flooding is a natural process, development and changing precipitation patterns have increased the amount of water that natural and manmade systems must accommodate and changed the way water flows through the landscape. In Des Plaines, climate change will likely lead to an increase in precipitation, especially during the winter and spring, exacerbating a hazard that already affects the community. Climate models suggest the increase in precipitation will be concentrated in a smaller number of intense storms, leading to heavy rainfall that will strain the capacity of stormwater systems and natural stormwater drainage.

Municipalities manage flood risk through a variety of policies, including stormwater regulations designed to limit impervious surfaces and ensure proper drainage during rainfall events. These regulations are created using historical flooding data that do not reflect recent or projected changes in precipitation. As the climate continues to change, these regulations, including the regulatory floodplain—commonly known as the 1 percent annual chance floodplain or 100-year floodplain—will become increasingly out of date, further increasing the community's exposure to flood risk.

The reasons flooding occurs are complex and are the result of a combination of factors, including flat topography and saturated soils, stronger, more frequent storms, loss of natural landscapes, and development in flood-prone areas. Parts of Des Plaines experience riverine flooding when waters overflow the banks of the Des Plaines River and other streams within the area. Other parts of the community also experience urban flooding, which occurs when rainfall overwhelms the capacity of the drainage systems, such as storm sewers or drainage ditches. Urban flooding can result in water pooling in streets and yards, basement flooding, and basement back-ups. (A fuller discussion of flooding can be found in the vulnerability and risk assessment below, as well as in the stormwater appendix to the Comprehensive Plan.)

Riverine Flooding

Des Plaines is situated within the lower portion of the Des Plaines Subbasin that spans more than 1,400 square miles across Illinois and Wisconsin.[18] Upstream precipitation in the larger river system can cause significant flooding as the river carries rainfall toward Des Plaines, particularly when multiple rainfall events occur within a ten-day period.[19] The areas most likely to suffer from riverine flooding are defined by the river's floodplains, the land surrounding the river where water flows when it overtops the river's banks (Figure 6). Floodplains are an

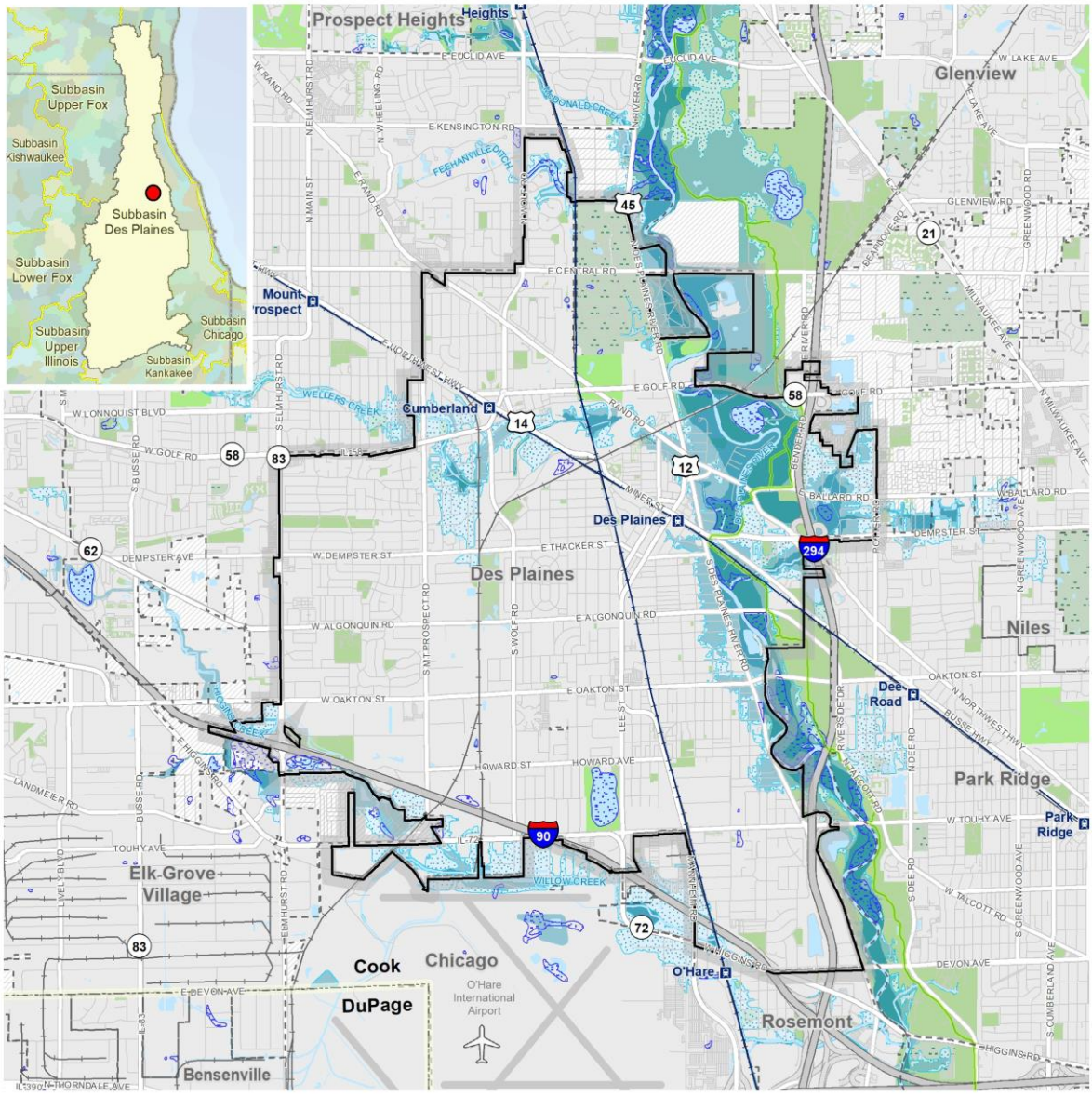
[17] Personal communication with Derek Peebles, Civil Engineer at the City of Des Plaines

[18] The Fox River watershed area at Stratton Dam is 1250 squares miles and 1400 square miles at Algonquin Dam. See https://www.dnr.illinois.gov/WaterResources/Pages/StrattonLockandDam.aspx

[19] Illinois Department of Natural Resources website, Stratton Lock and Dam. See https://www.dnr.illinois.gov/WaterResources/Pages/StrattonLockandDam.aspx

important part of the natural process of flooding, and the types of vegetation and landscapes that naturally occur in floodplains are typically resilient to periods of inundation.

Figure 6. Floodplains in Des Plaines



Prior to modern floodplain and stormwater management regulations, development in Des Plaines and throughout the Chicago region occurred in flood-prone areas, such as floodplains, wetlands, and other low-lying areas along the Des Plaines River, Farmers Creek, Feehanville Ditch, Higgins Creek, Weller Creek, and Willow Creek. These development patterns not only put the structures at risk, but also increased the risk of flooding throughout the river system by interfering with natural drainage and water flow patterns.

Floodplains

Floodplains are areas adjacent to waterways that are susceptible to inundation by floodwater and are based on modeled rain events, such as the 100-year or 500-year storms. However, the underlying data used to create some of the Chicago region's floodplain maps relies on outdated rainfall data, which results in maps that may not accurately reflect riverine flood risk.

Floodway: the area that is most prone to flooding as it is reasonably expected to come in contact with or convey floodwater.

100-year floodplain: commonly known as the regulatory floodplain, is an area that has a 1% chance of flooding in a given year or a one-in-four chance of flooding during a 30-year mortgage. In northeastern Illinois, the 100-year storm is defined as 7.5 inches of rain over a 24-hour period.

500-year floodplain: area that has a 0.2% chance of flooding in a given year. The 500-year flood is the national standard for protecting critical facilities.

Des Plaines recently recovered from the storm-related events that occurred in July 2017, when the Des Plaines River reached its fourth highest crest on record at 19.88 feet.[20] Major flood stage at this location is reached when waters rise to 19 feet. In May 2013, President Obama declared that a major disaster (DR-4116) occurred from the severe storms, straight-line winds, and flooding experienced from April 16 to May 5, 2013 in Illinois, including Cook County. Heavy rainfall fell on April 17 and 18, resulting in urban and riverine flooding. The weather gauge at the Des Plaines station recorded a total of 9.08 inches over a 17-day period (5 days preceding and 11 days following the April 17-18 event),[21] which is a volume of rainfall that is estimated to fall only once every 40 years (i.e., the "40-year storm".)[22] Intense storms like this can result in more flooding as the soils become completely saturated and sewers quickly reach capacity. In

[20] National Weather Service, "Advanced Hydrologic Prediction Service for USGS Des Plaines River Gauge near Des Plaines," http://water.weather.gov/ahps2/hydrograph.php?wfo=lot&gage=DSPI2

[21] U.S. Army Corps of Engineers, "Post Flood Survey Report: April 2013 Chicago Area Riverine and Basement Flooding," April 2017, http://www.lrc.usace.army.mil/Portals/36/docs/projects/April%202013%20Flood%20Report/April%202013%20Post%20Flood%20Survey%20Report_FINAL_APRIL2017.pdf

[22] Masters, Jeff. Extreme Drought to Extreme Flood: Weather Whiplash Hits the Midwest. April 19, 2013. See www.wunderground.com/blog/JeffMasters/comment.html?entrynum=2389

addition, this storm hit the region after a wet April, which meant the region was at a higher risk of flooding due to already saturated soils, full detention ponds, and higher water levels of rivers and streams. The Des Plaines River U.S. Geological Survey (USGS) stream gauging station near Des Plaines recorded its highest level event on record, 20.92 feet,[23] which was reached approximately 40 hours after the middle of the storm event (April 17 at 10 pm).[24]

Urban flooding

Unlike riverine flooding, which is primarily influenced by proximity to a river, urban flooding is more directly related to specific site conditions, such as topography, impervious cover, drainage capacity, and hydric soils. Urban flooding can occur when stormwater runoff overwhelms the capacity of stormwater and sewer systems, forcing excess runoff to flow across the landscape to nearby low-lying points. Much of Des Plaines was built and designed before the adoption of modern stormwater management standards. Therefore, many residential properties were developed within depressions in the landscape or on hydric soils that may result in the pooling of rainwater in backyards and basements. Some parts of the city also have combined sewers, which can have poor drainage capacity. Areas where this type of sewer system is still in use are more susceptible to basement flooding from backups.

Unlike riverine flooding, where FEMA floodplain maps identify risk areas, urban flooding locations are less widely known. To gain a better understanding of urban flooding in northeastern Illinois, CMAP created an urban flood susceptibility index (FSI) for developed areas that uses reported flood locations and topographic, land cover, and other data to determine the relative flood susceptibility of communities in the region.[25] The index is not intended to replace more technical floodplain mapping or modeling efforts, and should instead be used to identify general areas within a planning study where flood susceptibility could be greater, helping to identify areas that may be of need of further mitigation activities.

Figure 7 shows the results from the regional urban flood susceptibility index (FSI) for the City of Des Plaines. The map shows how flooding susceptibility varies across different drainage areas that are fully or partly within the city. The analysis calculated the mean flooding susceptibility score for each drainage area, or catchment.[26] The scores were then translated into an index of 1 (low susceptibility) through 10 (high susceptibility.) These areas could potentially become more vulnerable to flooding if development in the floodplain remains or expands and precipitation patterns continue to change.

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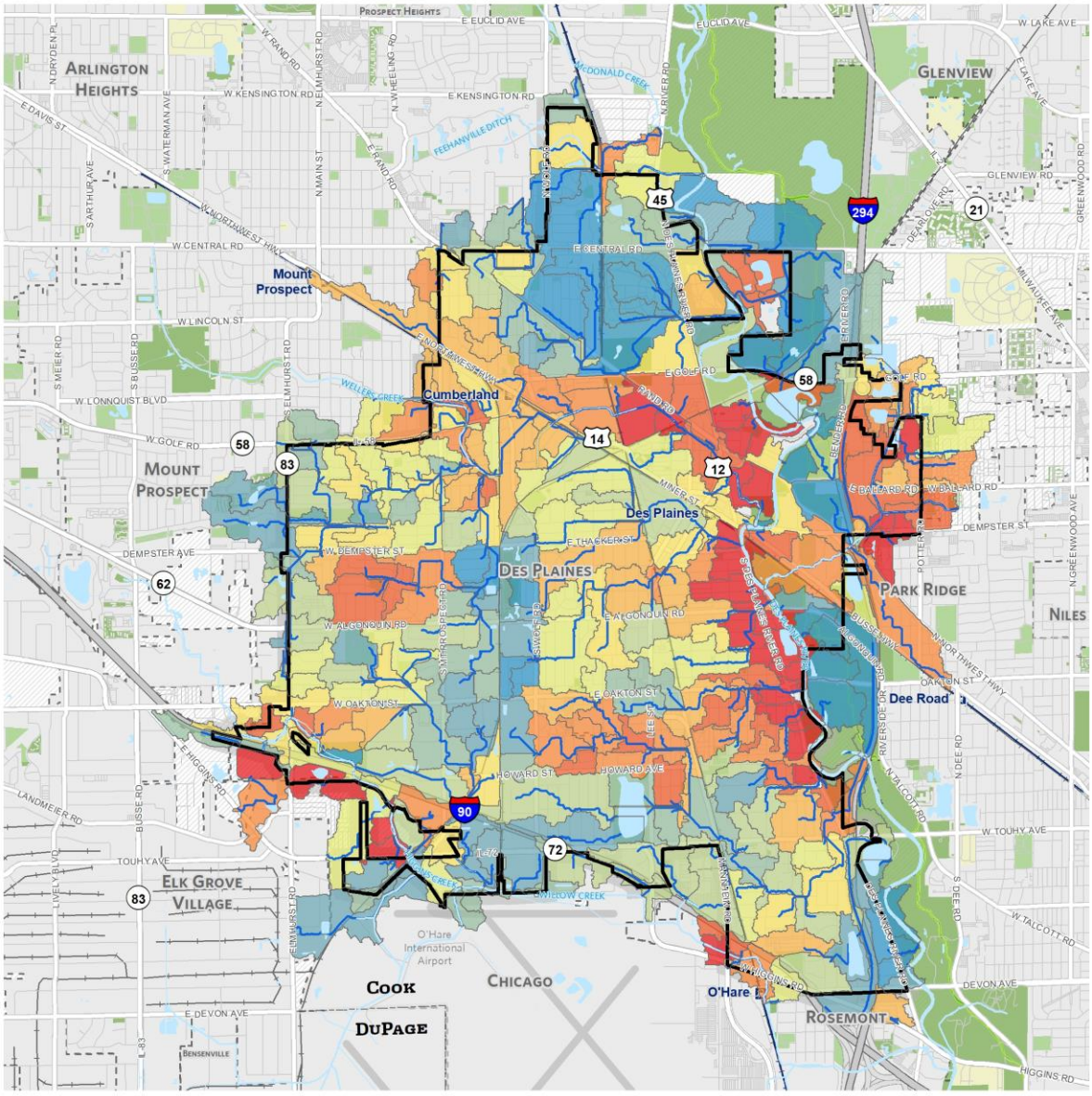
[23] National Weather Service, "Advanced Hydrologic Prediction Service for USGS Des Plaines River Gauge near Des Plaines," http://water.weather.gov/ahps2/hydrograph.php?wfo=lot&gage=DSPI2

[24] U.S. Army Corps of Engineers, "Post Flood Survey Report: April 2013 Chicago Area Riverine and Basement Flooding," April 2017, http://www.lrc.usace.army.mil/Portals/36/docs/projects/April%202013%20Flood%20Report/April%202013%20Post%20Flood%20Survey%20Report_FINAL_APRIL2017.pdf

[25] CMAP, Regional Flooding Susceptibility Index Appendix and Data, https://datahub.cmap.illinois.gov/dataset/on-to-2050-layer-flood-susceptibility-index

Figure 7. Urban flood susceptibility in Des Plaines.



Severe Summer Storms

Severe storms, some capable of producing lightning, hail, strong winds, and tornadoes, are common in Des Plaines. Atmospheric conditions within the Midwest, particularly during the summer months, are ideal for generating severe storms that bring one or more of these weather elements. Severe thunderstorms and strong winds are considered to be major threats to the city's economic and public safety.[27] Figure 8 shows the increase in the occurrence of severe storms between 1954 and 2017—an observed trend that is consistent with what is projected for the future. [28] During this time period, Cook County reported 1,391 severe summer storms, 12 of which were severe thunderstorms and 12 were hailstorms reported by Des Plaines.[29] Electrical blackouts caused by severe storms are also relatively common throughout the city. In 2015, derecho winds caused the collapse of a wooden high-tension tower, which was later replaced with a steel tower. A severe thunderstorm in 2010 brought heavy rain and winds that caused major flooding and the collapse of 29 power poles, which left 2,700 business and homes without power until poles could be replaced and power restored. While the link between climate change, thunderstorms, and tornadoes is less well defined than some hazards, the region is expected to see modest increases in the frequency and severity of these severe storm events as the century progresses.[30]

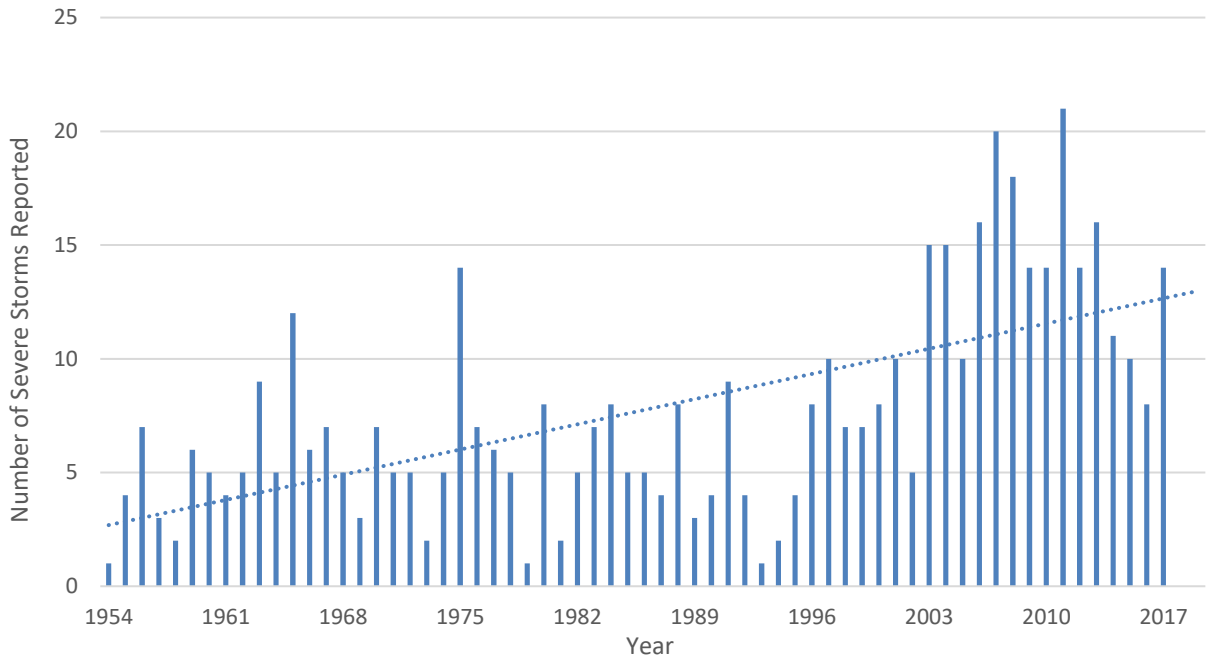
[27] City of Des Plaines, "Hazard Mitigation Plan," November 2013, http://www.desplaines.org/civicax/filebank/blobdload.aspx?blobid=24234

[28] NOAA, National Centers for Environmental Information, Storm Events Database, Illinois, McHenry County, 1960-2016, https://www.ncdc.noaa.gov/stormevents/.

[29] Ibid.

[30] 2014 National Climate Assessment, https://nca2014.globalchange.gov/report/our-changing-climate/heavy-downpours-increasing

Figure 8. Severe summer storms reported in Cook County, 1954-2017



Snow and Ice

Throughout the Midwest, snowfall and ice accumulation are common hazards that disrupt daily life. Severe winter storms can bring heavy snowfall, extremely cold temperatures, and freezing rain that can cause road closures, traffic delays, and car crashes.[31] Melting snow can also lead to severe flooding, particularly if the ground is frozen. Between 1997 and 2017, there were 70 recorded severe winter weather-related events in Cook County: 27 winter storms, 14 extreme cold/wind chill events, four blizzards, one ice storm, and 24 heavy snowfall events.[32] According to the City's Hazard Mitigation Plan, these storms have been debilitating to the City. Storm-related impacts have caused prolonged road closures and hazard conditions, closed schools, strained snow removal resources, and contributed to seven recorded deaths.[33]

[31] The Illinois Emergency Management Agency defines severe winter storms as a) storms that produce at least six inches of snow within 48 hours or less, b) ice storms in which 10% of National Weather Service station report glaze, or c) snow or ice storms that result in death, injury, or property damage. These storms can be single events or they can be a combination of events (e.g. a moderate snowfall followed by freeze rain and extremely cold temperatures) that occur over the course of a few hours or multiple days.

[32] NOAA, National Environmental Satellite, Data & Information Service, National Climatic Data Center, Storm Events Database, Illinois, Cook County, 1950-2017, https://www.ncdc.noaa.gov/stormevents/

[33] Ibid.

Climate models suggest that northeastern Illinois will see an increase in winter precipitation.[34] Even if warmer temperatures mean that some winter precipitation will fall as rain rather than snow, the overall increase in precipitation will likely mean there will be enough snow and ice that managing it will remain a significant challenge. Heavy snowfall events may also increase due to warmer temperatures, as snow crystal size increases as the temperature approaches the freezing point. Warmer average temperatures may also result in more frequent freezing rain and freeze-thaw events.[35] A freeze-thaw event occurs when precipitation collects in small cracks in hard rock surfaces, freezes and expands under cold temperatures, and then melts. The expansion of ice during the freezing period causes further splitting of the rock, damaging the hard surface.

Extreme Heat

The projected increase in regional temperatures will likely manifest as an overall increase in average temperatures as well as a greater number of very hot days. Between 1981 and 2010, Des Plaines saw approximately 14 days that reached 90 degrees Fahrenheit or greater each year.[36] By mid-century, the region could see between 41 and 52 days over 90 degrees annually.[37] Average low temperatures on summer days are expected to see a substantial increase as well. In the past, the region has experienced 13.5 nights over 70 degrees Fahrenheit per year. By mid-century, these nights may occur 30 to 40 times each year, meaning that evenings and nighttime will provide less relief from high temperatures.[38] Humidity is expected to similarly increase, which may intensify the impact of warm periods and heat waves.

As temperatures increase from climate change, there is a high probability that Des Plaines residents will experience more episodes of extreme heat. In areas with dense development, the urban heat island effect further exacerbates extreme heat. In these areas, impervious surfaces – including roads, parking lots, rooftops, and other paved surfaces – heat up during the day, and remain warm long into the night. This phenomenon is evident in Des Plaines, where industrial and commercial areas show some of the city's highest land surface temperatures, while open space areas have some of the lowest (Figure 99). In northeastern Illinois, areas with greater than 50 percent impervious coverage have been found to be five to six degrees warmer than the

[34] Under a higher emissions scenario (A2), global climate models (GCMs) project average winter and spring precipitation by late this century (2071-2099) to increase 10% to 20% relative to 1971-2000, while changes in summer and fall are not expected to be larger than natural variations. For more information see, NCA Midwest.

[35] Jaffe, Martin and Mary Woloszyn, "An Initial Assessment of Winter Climate Change Adaptation Measures for the City of Chicago," Sea Grant Land and Policy Journal, Vol. 6, No. 2.

[36] Illinois State Water Survey, "Official 1981-2010 Climate Normal for Chicago O'HARE AP," https://www.isws.illinois.edu/statecli/newnormals/normals.USW00094846.txt.

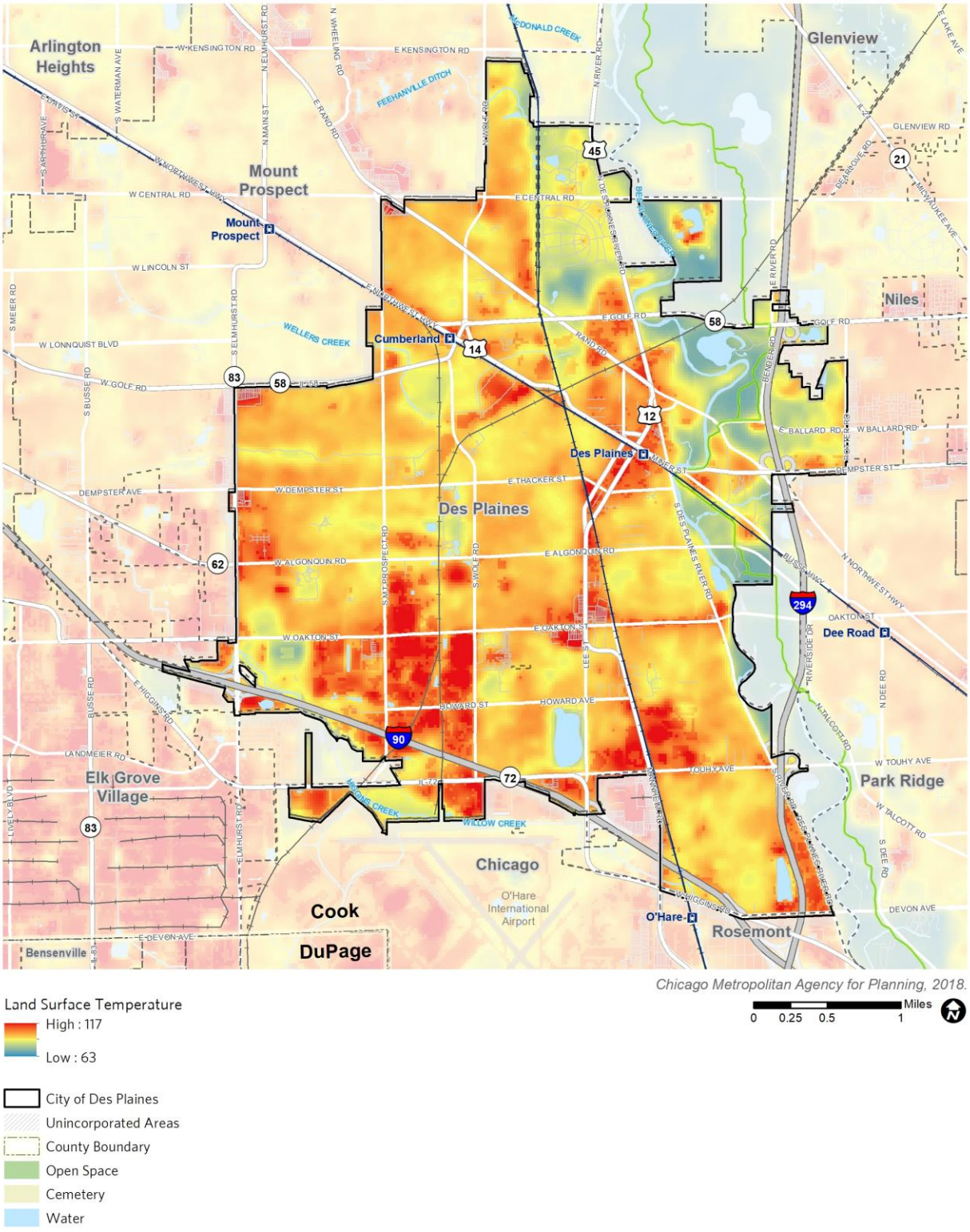
[37] 2014 National Climate Assessment, "Localized Constructed Analogs (LOCA) viewer," Scenarios for the National Climate Assessment, January 2018, https://scenarios.globalchange.gov/loca-viewer/

[38] CMAP, "Climate resilience strategy paper," 2016, http://www.cmap.illinois.gov/documents/10180/517388/Climate+Resilience+Strategy+Paper.pdf/dd610883-d00f-407d-808b-484f9800a3f6.

regional average.[39] Under normal conditions, the impact of this increase in negligible, but during periods of extreme, persistent heat, a difference of five degrees can result in significantly higher risk of dehydration, heat exhaustion, and other health-related impacts. Street trees and other heat-reducing green infrastructure can mitigate the heat island effect in developed areas.

[39] CMAP, "Climate Resilience Strategy Paper," http://www.cmap.illinois.gov/documents/10180/470714/Climate%20Resilience%20Strategy%20Paper/dd610883-d00f-407d-808b-484f9800a3f6.

Figure 9. Land Surface Temperature within the City of Des Plaines

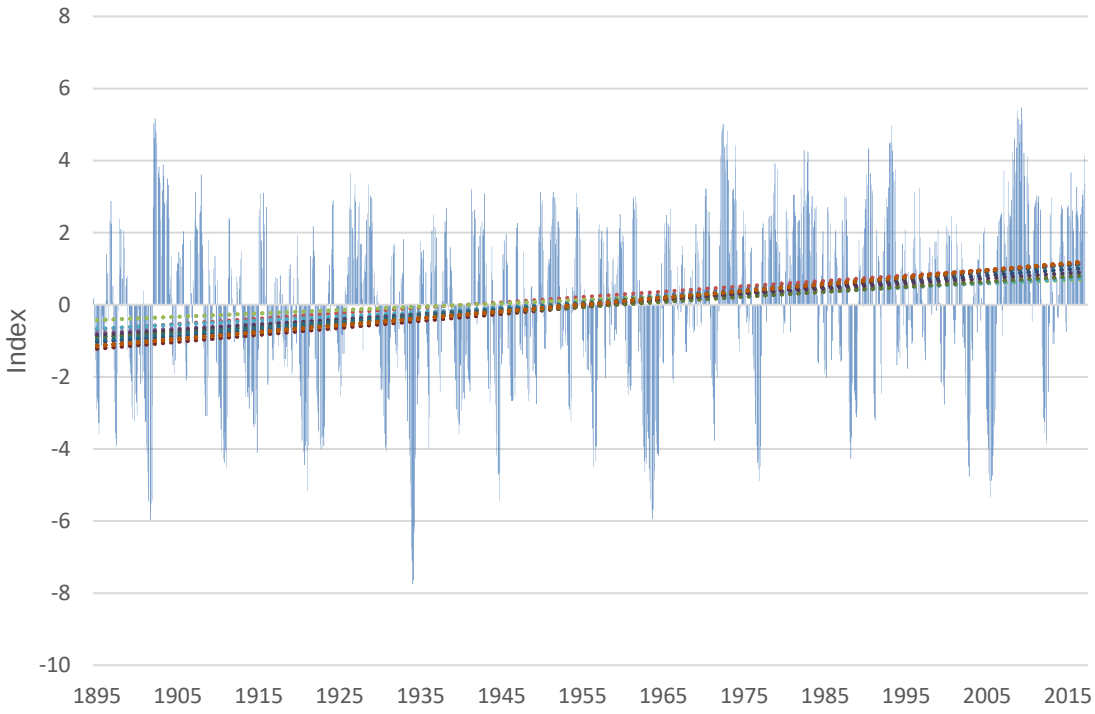


Source: CMAP analysis of LST data, measurements taken July 21, 2014

Drought

Prolonged periods of dry weather, often worsened by extreme heat, can result in drought. In recent years, drought conditions have become a growing concern for northeastern Illinois. **Error! Reference source not found.**10 shows drought frequency in northeastern Illinois by m onth from 1895 to 2015. During this period, droughts have become more frequent, and more severe. Cook County experienced major droughts in 2005 and 2012.

Figure 10. Illinois Palmer Drought Severity Index for 1985-2015



Source: Midwestern Regional Climate Center, http://mrcc.isws.illinois.edu/CLIMATE/.
This image shows monthly Palmer Modified Drought Index scores for northeastern Illinois. Because scores are shown separately for each month, twelve trend lines are included. From 1895-2015, trend lines for all twelve month trended upwards.

As the climate continues to change, the Chicago region is expected to see longer and more frequent droughts, periodically interrupted by large storms. When heavy rain or snowmelt occurs during dry conditions, erosion and flooding become major concerns, as dry soils are typically less stable and have a lower capacity to absorb stormwater. The summer months are expected to see the largest increase in periods of extreme heat, which will likely lead to the largest increase in drought conditions. These conditions can also threaten aquatic life and result in fish kills among species that rely on colder water temperatures.

Vulnerability and Risk Assessment

Natural hazards will create meaningful challenges to the City of Des Plaines' infrastructure, residents, and economy during the years to come. In many cases, the City can mitigate the impacts of these hazards through cost-effective measures to reduce vulnerability and encourage resilience. Evaluating the community's risk and vulnerability to specific hazards and impacts can help determine how and where these challenges will most likely arise, and whom they are likely to affect.

The following section of this report assesses the vulnerability of the residents, infrastructure, and economy of Des Plaines to the impacts of climate change based on their exposure to climate-related hazards, the likelihood of an impact occurring, and the plans and programs in place to adapt to hazards.

Critical Infrastructure

Roads, sidewalks, bridges, sewers, power lines, and other forms of infrastructure are critical to providing essential services and functions to a community, especially during and after a natural hazard. These built infrastructure systems are complemented by natural systems, including wetlands, prairies, and forests, that help to manage stormwater, reduce air pollution, and provide recreational opportunities. Identifying what natural and human-made systems and facilities are vulnerable to climate-related hazards is an important first step to protecting them and creating a more resilient city.

Transportation

The City's transportation system, which primarily consists of roads and rail, is moderately vulnerable to the impacts of climate-induced hazards. Although the multiple bus, rail, and automobile options that residents can access contributes to community resilience, the infrastructure that supports these transportation systems is at risk due to climate-related threats.

The City's residents and local businesses rely on the transportation system for commuting, personal travel, and commercial purposes. Of the nearly 29,000 employed residents, approximately 23 percent work in the City of Chicago, 22 percent in nearby communities, and 10 percent work within Des Plaines. Many residents continue to drive alone to work (79 percent), with a majority traveling less than ten miles. With the majority of Des Plaines' employed residents commuting to work by car, disruptions to roadways due to weather events can become an economic burden on the City and individuals. The impact is especially severe when disruptions occur on the city's most heavily used roadways. Roadways carrying the highest volumes of vehicles include I-294 and I-90, as well as Touhy Avenue, Mannheim Road/Lee Street, Golf Road, and Elmhurst Road, many of which are maintained by IDOT. Significant traffic volumes are also seen on Rand Road, Golf Road, Oakton Street, and Des Plaines River Road. Impacts on freight movement can also be significant. Truck volumes are greatest along I-294 and I-90 as well as Touhy Avenue, Mannheim Road/Lee Street, and

Elmhurst Road. In addition to Oakton Street and Northwest Highway, all of these roads are state-designated truck routes.

Flooding and severe winter weather can significantly delay the movement of people and goods in Des Plaines, exacerbating the difficulties presented by congestion and aging infrastructure. Major roads, intersections, and railways that cross the Des Plaines River or are located within the floodplain are most vulnerable to these hazards. These exposed routes includes Metra's UP-Northwest line and the Union Pacific railroad, as well as Des Plaines River Road, Central Road, Golf Road, Ballard Road Dempster Street, Oakton Street, and Touhy Avenue. Road closures and travel delays are often the most immediate impacts of extreme weather on these roads and railways. The Regional Transportation Authority's Flooding Resilience Plan for Bus Operations highlighted that PACE bus routes servicing the City of Des Plaines that are impacted by riverine flooding include 208, 2019, 221, 226, 230, and 234. In the event of severe flooding on the street, many of these buses need to be rerouted, which adds costs to PACE operations.[40]

Flooding from the April 2013 storms resulted in 37 road closures in Des Plaines. Although the majority of the closures were along Des Plaines River Road, there were also closures on the Northwest Highway (one just north of the Cumberland Metra station), US-12, Golf Road, Dempster Street, and Oakton Street. In addition to carrying significant traffic volume, all of these streets are designated truck routes that serve industrial business within the community as well as within the Greater O'Hare Subregional Freight-Manufacturing Cluster. Some studies have measured the economic impact of weather-related travel delays. According to the City's 2013 Hazard Mitigation Plan, the U.S. Army Corps of Engineers found that the cost of lost travel time due to closed Des Plaines River bridges in northern Lake County was $383,000 per day.[41] The plan further found that this figure is potentially higher for Des Plaines commuters because the routes are more heavily used.

Rising temperatures are likely to directly impact transportation infrastructure, potentially increasing maintenance costs. Roadways, bridges, and railways are vulnerable to extreme heat, which may cause buckling or cracking. More frequent freeze-thaw events during the winter months may accelerate the formation of cracks and potholes in roadways, parking lots, and sidewalks, increasing maintenance costs and possibly leading to more traffic delays. Maintenance of the Corridor's transportation infrastructure will be a critical investment to increase climate resilience. Because of the multiple jurisdictions responsible for vulnerable roadways, adequately preparing the transportation system will require the participation of several levels of government, as well as private property owners.

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[40] Regional Transportation Authority. *Flooding Resilience Plan for Bus Operations*. Prepared by AECOM. May 2018, http://www.cmap.illinois.gov/documents/10180/861660/2018-06-07-ENR-5.0-Flooding+Resilience+Plan+for+Bus+Operations.pdf/bdbc5ad7-a810-bc48-53d8-850bb38ecbae

[41] This figure is based on the distance people in Lake County had to drive at $0.28 per mile and the median income for the Des Plaines River area.

Temperature and precipitation trends may also negatively affect nonmotorized transportation. Persistent heat also reduces air quality, and makes walking a less attractive option. This effect may result in people taking more local trips by automobile, leading to more congestion. This impact is especially likely in areas with limited pedestrian amenities, such as sidewalks, benches, and street trees. Installing and maintaining green infrastructure can help to mitigate climate-related impacts on air quality and non-motorized transportation.

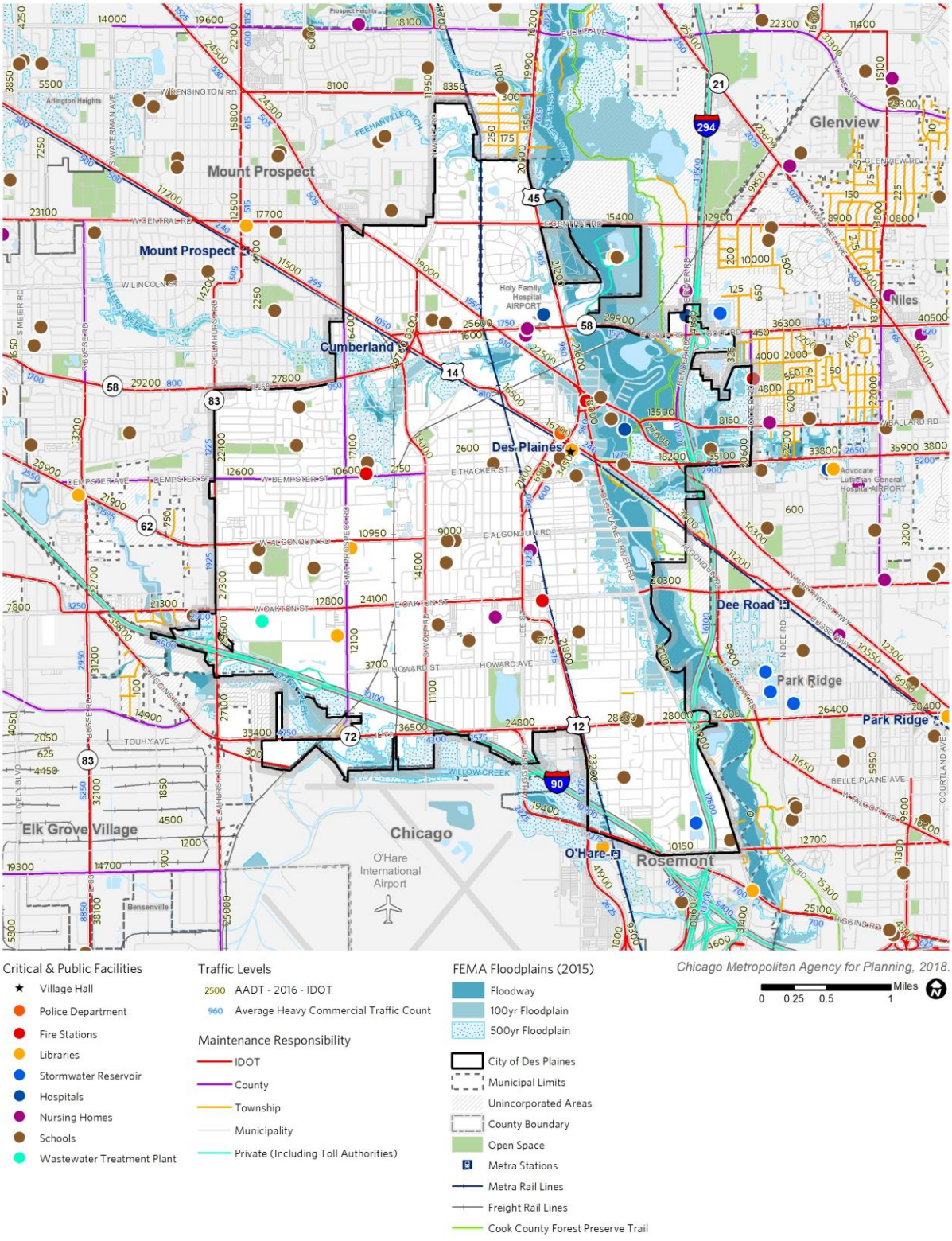
Critical Facilities

Some of the City of Des Plaines' critical facilities and emergency services are more vulnerable to natural hazards than others. A critical facility can be a physical location or infrastructure that provides services and functions that are essential to a community, especially during an emergency and/or after a natural hazard.[42] Such facilities include fire stations, hospitals, nursing homes, and wastewater treatment plants. Critical facilities often require uninterrupted provision of basic utilities—power, water, communications, etc.—to ensure systems and equipment remain in operation. Other public facilities that can serve important roles include schools, libraries, and community centers.[43] These facilities can function as shelters or evacuation centers in the event of a hazard that displaces residents.

[42] Federal Emergency Management Agency, "Critical Facilities and Higher Standards Fact Sheet" https://www.fema.gov/media-library-data/1436818953164-4f8f6fc191d26a924f67911c5eaa6848/FPM_1_Page_CriticalFacilities.pdf

[43] US Legal, "Public facility law and legal definition," 2016, https://definitions.uslegal.com/p/public-facility/

Figure 11. Facilities and transportation infrastructure in Des Plaines



Many of the City's critical and public facilities are highly vulnerable to climate-related hazards because they are in an exposed location or their services are particularly sensitive to disruption. The City also considers facilities with large roof structures, such as fire stations, to be more susceptible to damages caused by severe storms that bring heavy precipitation, thunderstorms, tornadoes, or heavy snowfall as well.[44] However, given the high likelihood of future flooding and the geographic extent of flood susceptibility throughout the city, the risk that flooding could disrupt emergency services ranks as one of the most important areas of climate vulnerability for Des Plaines.

Public facilities located within the 1 percent chance annual floodplain (i.e., the 100-year floodplain) are the most vulnerable to flooding, and may be difficult to access during flood events. Fire Station 61, one of the City's main fire stations, is located within the 100-year floodplain and typically needs to be evacuated during high rainfall events.[45] Other facilities located in the floodplain (including the 100-year and 500-year floodplain) include three schools, and the City's History Center.[46] Two facilities in the floodway includes the Chicago Behavioral Hospital and the Guardian Angel Orthodox Day School. According to the City's Hazard Mitigation Plan, facilities located in the floodplain (including the floodway) have implemented flood protection measures. The Plan also highlights that there are two critical facilities (actual facilities were not disclosed) with basements that are susceptible to basement flooding and sewer backups, which have also have taken measures to ensure valuables and electrical-dependent controls and machinery are not exposed to floodwaters. Despite these measures, these services may still be disrupted or difficult to access as a result of flooding surrounding the site and along connecting roadways.

Based on the projected increase in precipitation and storm events during the spring and winter, more facilities within the Des Plaines will become vulnerable to the impacts of flooding. These increases could occur due to more frequent flooding in locations already identified as vulnerable, such as within floodplains, or due to new exposure in areas that have not historically seen significant flooding. Other facilities that function as key gathering places and providers of community services—Oakton Community College, the Des Plaines Public Library, City Hall, the City's police department—are located just outside the regulatory floodplain, which is currently based on outdated rainfall data. A few of these are also within one foot of FEMA's Base Flood Elevation, which are considered to be more at risk of first floor or surface flooding. In addition to potential property damage, access to and from these sites will also be impacted.

[44] City of Des Plaines, "Hazard Mitigation Plan," November 2013, https://www.desplaines.org/civicax/filebank/blobdload.aspx?BlobID=24234.

[45] Ibid.

[46] Schools include: North Elementary, Science and Arts Academy, and A Mother's Touch Learning Academy.

Energy

The energy and electricity systems that power Des Plaines' homes and businesses are vulnerable to a number of climate-related hazards. Dependable electrical service is important for the local economy and everyday life, making disruptions highly consequential for a wide range of stakeholders, including those who are sensitive to the loss of heat and air conditioning. In Des Plaines, the vulnerability of the energy grid is mostly due to the effect that storms can have on transmission systems. There are no towers or power stations located within the city limits, but electricity is transmitted mostly via overhead wires, which are vulnerable to damage from strong winds, tornadoes, and freezing rain from severe storms. Because summer storms are likely to increase in intensity and frequency and winter storms are more likely to include freezing rain, the City is at risk for more outages in the future.

Areas within the City with mature trees and overhead power lines are likely to be the most vulnerable to power outages. Historically, Des Plaines residents and businesses have experienced power outages from downed trees and snapped wires. In June of 2010, a severe thunderstorm brought heavy rain and strong winds that knocked down 29 power poles on Lee and Oakton Streets. It took nine days for Commonwealth Edison to replace poles and restore power to over 2,700 residents impacted by the power outage; a year later, downed trees and debris from a small tornado caused another power outage that affect 16,000 customers.[47] In the event of these outages, residents have been known to provide generator power to neighbors despite safety risks associated with sharing power.[48]

Vulnerability to electricity disruptions often depends on the availability of secondary or backup power systems. When power outages do occur, residents without electricity may be exposed to extreme heat or cold, depending on the season, and may have difficulty communicating with service providers. Critical facilities, including police, fire, and the sewer and water plants, typically maintain backup generators that allow them to remain operation during power outages. There is no publically available information to confirm whether or not critical facilities within Des Plaines retain these systems. However, it is clear that the City understands their importance. In 2011, the City administered a Home Generator Reimbursement Program, which provided residents with partial reimbursement for purchasing a portable or permanent home backup generator between the June 2011 and January 2012. Dedicated funding for this program was exhausted within hours of it being administered because of its popularity.[49]

Water Supply

Des Plaines is well positioned to maintain a reliable water supply. The City of Des Plaines operates a municipal water supply and purchases Lake Michigan water from the City of Chicago. Lake Michigan's water levels are not projected to significantly change due to climate

[47] City of Des Plaines, 2013 City of Des Plaines Hazard Mitigation Plan, November 2013, https://www.desplaines.org/civicax/filebank/blobdload.aspx?BlobID=24234

[48] Ibid.

[49] Ibid.

change,[50] and Des Plaines' water demand of 7.969 millions of gallons per day (mgd) are considered secure and low risk. The City also sells some of its water to the Illinois American Water Company, which services the Waycinden subdivision.

According to the city's Hazard Mitigation Plan, the City has ample water supply and does not consider drought to be a hazard to the community, especially since there is no agricultural land within the city limits. However, the City should be aware that despite stable overall water levels, Lake Michigan is vulnerable to some climate-related threats and hazards. In order to maintain the water availability that has been a central ingredient to the region's economic prosperity, the region will need to implement best practices for water management and water quality. Severe storms with heavy precipitation sometimes flood the Chicago River system, forcing the Metropolitan Water Reclamation District to open the locks at the confluence of the River and Lake Michigan and release a combination of stormwater and untreated wastewater into the Lake. Storms of this magnitude are likely to occur more frequently as the atmosphere continues to warm.

Stormwater and Sewer Systems

The City maintains two types of sewer systems – separate and combined. The separate sewer system is made up of sanitary and storm sewers that are separated from each other and convey sewage and stormwater, respectively; the combined sewer system collects both sanitary and stormwater in the same pipe.[51]

The projected increase in precipitation and storm events will put additional strain on both of these aging systems. Much of the region's sewer infrastructure was designed using outdated rainfall data that does not accurately reflect current and future rainfall conditions. For example, between 1961 and 2000, a 10-year storm produced an average of 4.29 inches of precipitation over 24-hours, and a 100-year storm produced 6.80 inches of precipitation over 24-hours. By mid-century, Des Plaines is projected to experience 5.26 inches from a 10-year, 24-hour storm and 8.06 inches from a 100-year, 24-hour storm.[52,53] It is already evident that these systems do not have the capacity to handle additional stormwater.

Combined sewer areas have long been recognized as the most susceptible to flooding given that excessive stormwater runoff volumes can cause overflows of combined sewage and stormwater. When flows exceed sewer design capacities, areas can experience basement backups and combined sewer overflows. Figure 12 illustrates that there are four combined sewer area

[50] CMAP, "Climate Resilience Strategy Paper," 2017.

[51] The two local systems then feed into the sub-regional combined sewer system maintained by MWRD, where wastewater is eventually treated at their Kirie or Stickney Water Reclamation Plants.

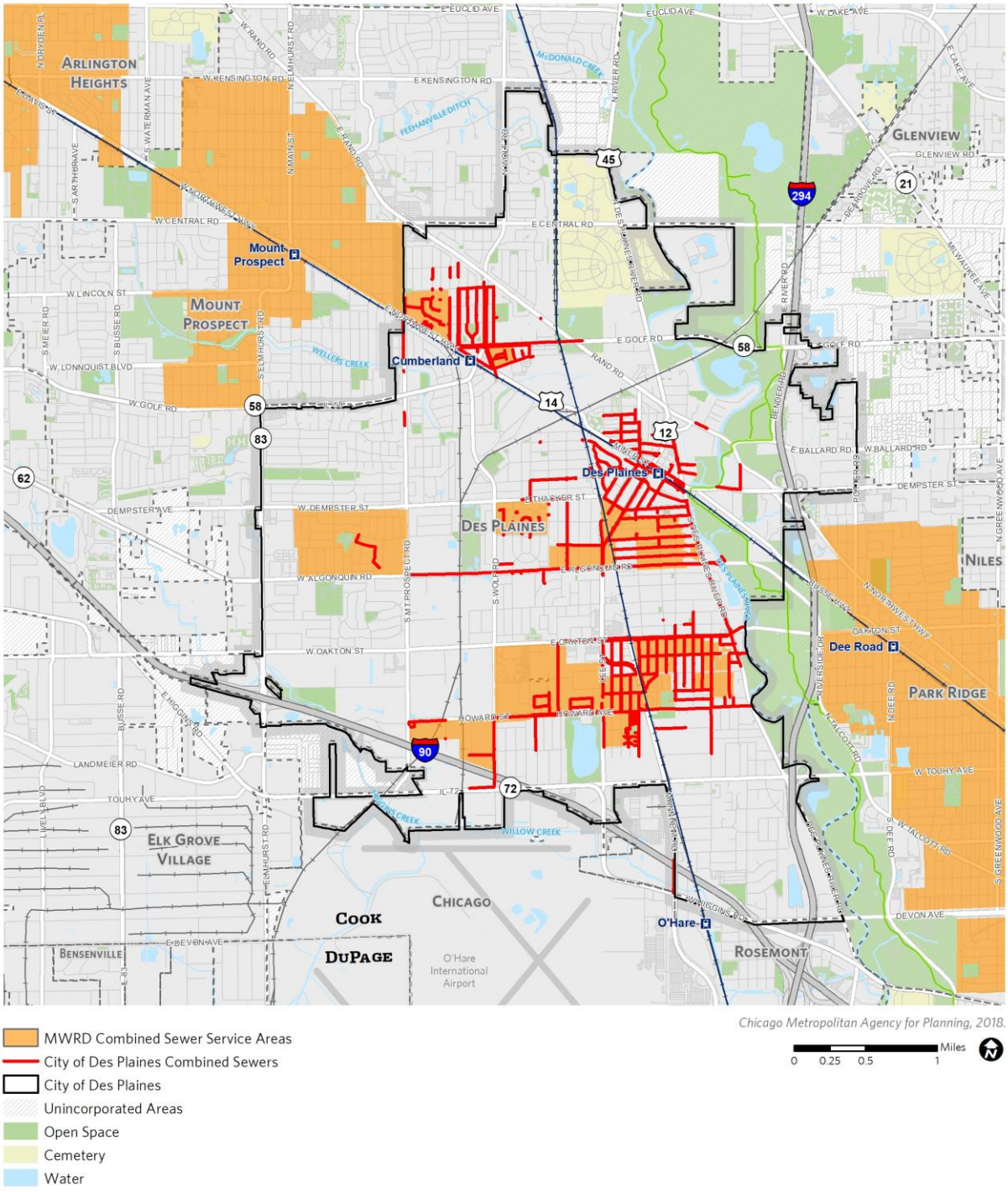
[52] Momcilo Markus, James R. Angel, Gregory J. Byard, Chen Zhang, Zoe Zaloudek, and Sally McConkey. *Communicating the Impacts of Potential Future Climate Change on the Expected Frequency of Extreme Rainfall Events in Cook County, Illinois*. Illinois State Water Survey, 2016.

[53] Based on the A1B IPCC climate scenarios. See https://ipcc.ch/pdf/special-reports/spm/sres-en.pdf.

clusters throughout the City where sewers are owned by either the City or MWRD.[54] Sanitary systems are less susceptible; however, they can experience basement backups caused by stormwater or groundwater seeping through cracked or defective pipes, joints, and manholes. The City is working to convert all of its combined sewers to separated sewers, which would lessen the overall system's vulnerability to climate-related impacts.

[54] Clusters are approximate areas with a high concentration of combined sewers.

Figure 12. Combined sewer areas in Des Plaines.



Private Property

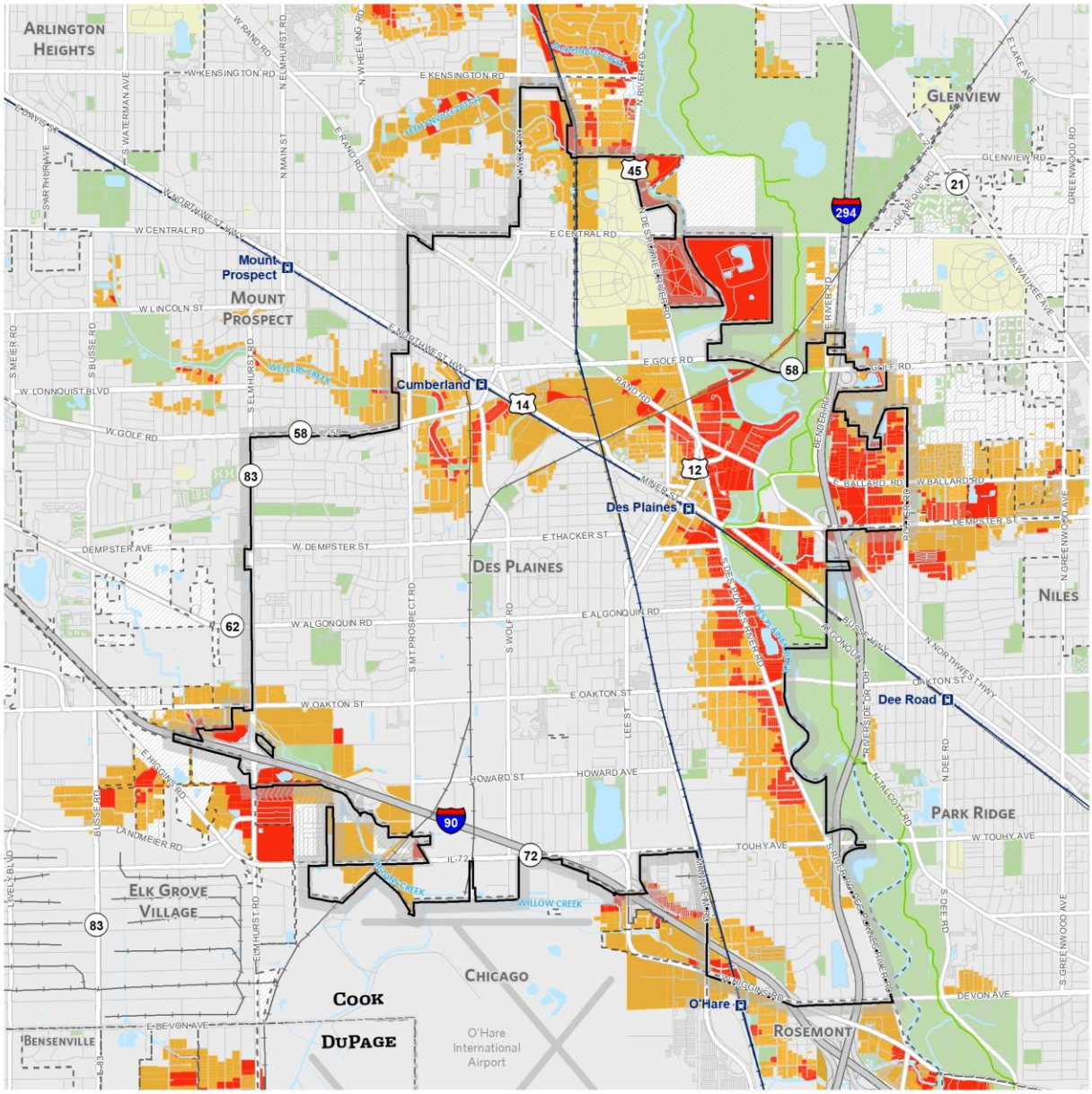
Both urban and riverine flooding pose the greatest climate-related threat to private property, particularly for structures located in the floodway and 100-year floodplain, combined sewer areas, and depressional areas. Since much of Des Plaines was built prior to the adoption of modern floodplain and stormwater management standards, many of its structures were built within the floodway or floodplains of the Des Plaines River or Higgins, Willow, and Wellers Creeks, as well as in depressions and hydric soils that attract ponding of rainwater.

Within the City's limits, there are 457 residential properties in the floodway and 1,167 in the 100-year floodplain. While structures on these properties are at the greatest risk of riverine flooding, buildings in low-lying areas outside of the floodplain are at risk as well. Figure 13 identifies all properties that are prone to first-floor flooding, as well as residential properties that are prone to basement flooding, because of their location and elevation relative to the nearest Base Flood Elevation (BFE).[55, 56] Properties with a base elevation that is within one foot of the BFE are considered to be more at risk of first floor or surface flooding; those with a base elevation that is within six feet of the BFE is considered to be more at risk of basement flooding or seepage.

[55] Based on CMAP's 2013 parcel-based land use data and excludes open space, agriculture, and water.

[56] Since structure data is not available, calculations are based on the base elevation of the properties' centroid. Base flood elevation (BFE) is the expected level of floodwater during a 100-year flood event. See FEMA's website for more information, https://www.fema.gov/base-flood-elevation.

Figure 13. Properties within 1500ft of the 100-year floodplain and within 1ft and 6ft of FEMA's Base Flood Elevation (BFE)



* Properties are also within 1500' of the 100-yr Floodplain.

The City has estimated that the average cost of damages associated with a single flood event is equivalent to 6.5% of the value of each building and its contents.[57, 58] When accounting for the all of the City's single family homes located within the floodplain, this equates to an estimated total of $57,468,450 in property damages.[59] Areas that flood repeatedly are also impacted by the social costs associated with structural degradation and depreciating property values.

Properties that are more vulnerable to urban flooding are likely to be located within combined sewer areas[60] and/or intersect depressions within the city's landscape. Figure 14 illustrates the extent of depressions and intersecting residential properties, which are scattered throughout the community. In some areas, depressions are present in the front or back yard, which may reduce the property's vulnerability to structural flooding. However, some properties are situated inside large depressions, which could put them at greater risk for basement flooding, backups, or seepage. This is the case for multiple residential properties west of the NCS Metra line, as well as within the southeast corner of the study area.

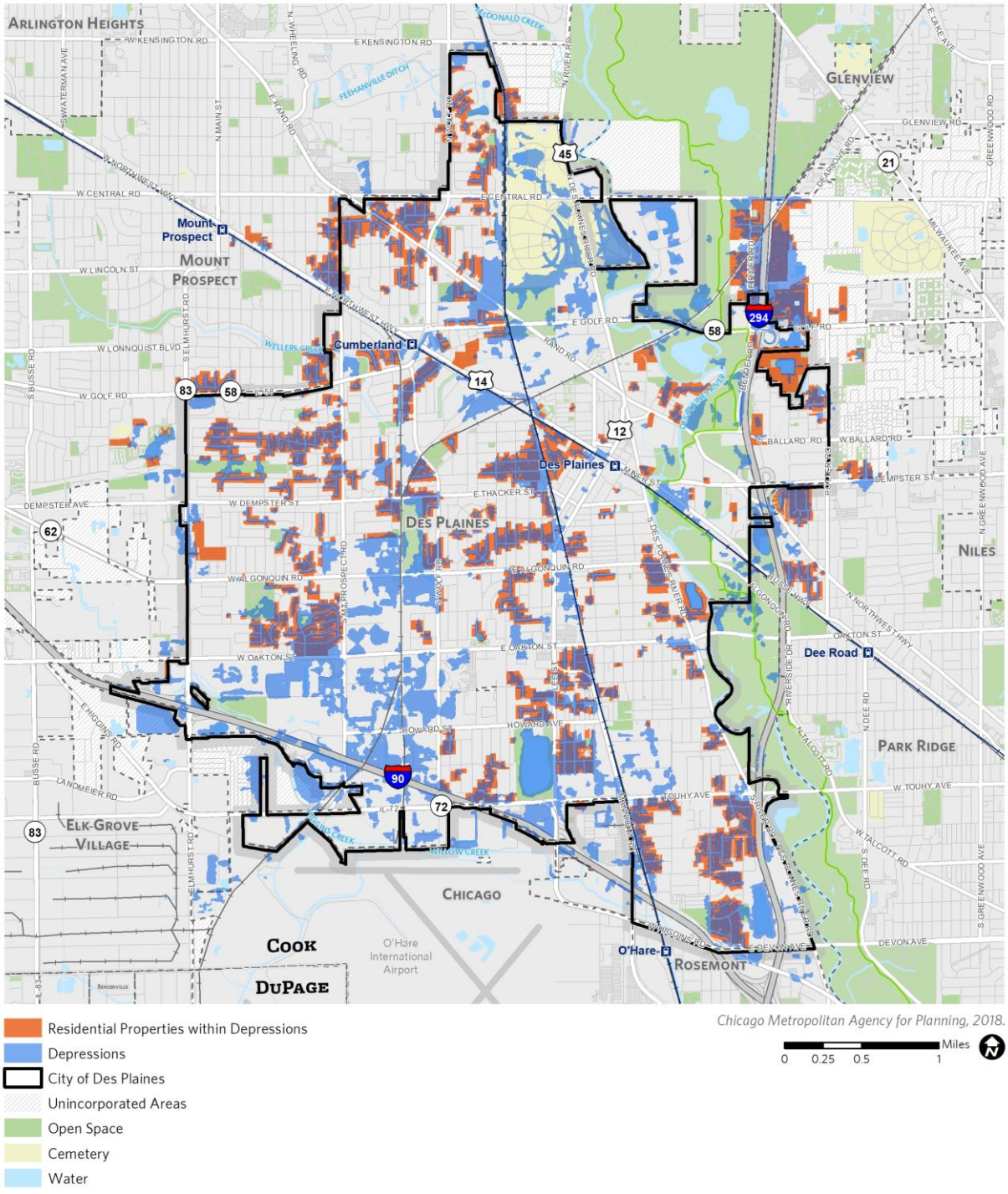
[57] Cost estimates are based on a flood event that has a 2-10% chance of occurring with within a year, i.e. a 10- to 50-year flood event.

[58] City of Des Plaines. 2013. Hazard Mitigation Plan. See www.desplaines.org/civicax/filebank/blobdload.aspx?blobid=24234

[59] City of Des Plaines. 2013 Hazard Mitigation Plan, https://www.desplaines.org/civicax/filebank/blobdload.aspx?BlobID=24234

[60] See the stormwater and sewer systems section of the Vulnerability and Risk Assessment.

Figure 14. Residential Properties within Depressions in City of Des Plaines



Buildings exposed to floodwaters are vulnerable to acute structural damage as well as chronic challenges related to mildew and mold. Households located outside of the floodplain often do not have flood insurance, which can leave property owners in these areas needing to cover the full cost of flood cleanup on their own. In addition to property damage and economic hardship, owners and tenants in these properties are also vulnerable to a decrease in quality of life.

While flooding presents a high level of vulnerability on property and structures, the City does have regulatory measures in place to prevent and mitigate the associated impacts. According to the City's Hazard Mitigation Plan, the City's building code regulations for protection from flooding, earthquakes, tornadoes, high winds, and snow storms are progressive and up-to-date; and City staff have been rated highly for enforcement. There are also several government programs that are available in Des Plaines that aim to reduce the vulnerability of private property to flooding, including FEMA's National Flood Insurance Program and Community Rating System and Illinois Emergency Management Agency's (IEMA) property acquisition program. The City has also identified 16 repetitive loss property areas that have been used to prioritize property acquisitions and stormwater management and mitigation projects. (More details can be found in the stormwater section of the Plan's Existing Conditions Report and the Stormwater Appendix.)

In addition to flooding, climate change projections predict an increase in other weather elements that can damage property. Straight-line winds, which include downdrafts, downbursts, and microbursts, are fairly common during a thunderstorm, and are often responsible for thunderstorm-related damages. These winds can down trees, cause temporary power outages, and tear roofing and siding materials from structures. Similarly, hail can puncture roofs, break windows, and damage other property such as vehicles and boats that may be exposed outside. The structures and people living within mobile home parks, such as Oasis in the southwest corner of the City, are most vulnerable to these climate-related impacts associated with severe wind and thunderstorms.[61] Direct lightning strikes can trigger fires and damage structures as well as cause injury or death. Five of the reported severe thunderstorm and wind conditions during 1954-2017 resulted in over $500,000 in property damages.[62] In addition to severe summer storms, severe snow storms can cause power outages and collapse roofs, extremely low temperatures can cause pipes to burst, and freeze-thaw events can deteriorate building foundations over time.

Green Infrastructure

Green infrastructure, including open space, street trees, and other natural features, are important components of Des Plaines' resilience to climate change. Green infrastructure assets within the city include neighborhood parks, the Des Plaines River, and over 500 acres of Cook County Forest Preserve land. These areas provide Des Plaines with a range of ecosystem

[61] City of Des Plaines, 2013 Hazard Mitigation Plan,

[62] NOAA, National Environmental Satellite, Data & Information Service, National Climatic Data Center, Storm Events Database, Illinois, Cook County, 1954-2017, https://www.ncdc.noaa.gov/stormevents/

services, including flood control, water purification, groundwater recharge, and carbon storage, in addition to recreational and ecotourism opportunities. Along the Des Plaines River and smaller streams, undeveloped land allows stormwater to infiltrate, reducing runoff to storm sewers, and also serves as a buffer that protects nearby properties when the river overflows its banks. The green space and trees throughout the neighborhood also help to mitigate the urban heat island effect.

While green infrastructure can mitigate the impact of climate change, it is also vulnerable to its effects. The plants and animals that live in Des Plaines' natural areas evolved to local conditions over thousands of years, and may face significant challenges as the region's climate becomes warmer, wetter, and more variable. Changes in the regional climate may reduce the ability of these ecosystems to provide critical services, and create an opening for new invasive species to crowd out native species.[63] In 2016, in partnership with CMAP, Chicago Wilderness worked with the City of Des Plaines and other Des Plaines River communities to develop a multijurisdictional green infrastructure map and accompanying recommendations for two sub-regions of the Des Plaines River basin.[64] Through this process, Des Plaines expressed interest in improving its green infrastructure assets by restoring the floodplains on the west side of the Des Plaines River.[65] Restoring these floodplains, along with other capital investments to green infrastructure by the City, Cook County, and the Cook County Forest Preserves, can help expand the benefits of green infrastructure and increase its resilience. Multijurisdictional watershed planning projects can help partners identify beneficial green infrastructure projects and help communities access funding for implementation.

Social Vulnerability

Natural hazards do not affect everyone in the same way, or to the same degree. Key social, demographic, and economic characteristics may cause certain residents and visitors to be more vulnerable to the impacts of natural hazards than others. Identifying the groups that are likely to be most vulnerable to the impacts of natural hazards is a crucial step to building and planning for more resilient communities.

Although all residents are exposed to climate-related hazards, the City's elderly populations are the most vulnerable. Des Plaines has a higher share of older residents, ages 65 and over, than Cook County as a whole (17.7% versus 12.6%), and a median age of 42 compared to 36 for Cook

[63] Hellmann, Jessica J., Knute J. Nadelhoffer, Louis R Iverson, Lewis H. Ziska, Stephen N Mathews, Philip Myers, Anantha M. Prasad, and Matthew P. Peters, "Climate change impacts on terrestrial ecosystems in metropolitan Chicago and its surrounding, multi-state region," Journal of Great Lakes Research, 2010, 36, 74-85, https://naldc.nal.usda.gov/download/49775/PDF.

[64] Chicago Wilderness, 2016. Des Plaines River GI Mapping Project, http://c.ymcdn.com/sites/www.chicagowilderness.org/resource/collection/26E68198-A56F-4805-99CF-0037455FC939/Des_Plaines_Communities_GI_Project_Report_Updated_8-19-16_Compressed.pdf

[65] Floodplains west of the Des Plaines River generally bound by Bender Rd., S Des Plaines River Rd., and South of Gold Rd.

County as a whole. If current demographic trends continue, the number of older residents in the community will increase.

Older residents are more sensitive to certain hazards due to background health issues, and are at greater risk because limited mobility can affect their ability to relocate to unaffected locations. In Illinois, extreme heat has led to the most deaths from a natural disaster.[66] Elderly populations, in particular, are more susceptible to the impacts of extreme heat, which is projected to become more common, as well as extreme cold.[67] Under extreme conditions certain activities—clearing snow or travelling by foot or car—can lead to injury such as heart attacks, hypothermia, or broken limbs. While senior citizens live independently throughout Des Plaines, several nursing homes and assisted living facilities located near the Des Plaines River are in or near the 1% annual chance floodplain. Provision of emergency services (including evacuation assistance) and adequate access to hospitals, heating/cooling facilities, and nursing homes in the event of severe storms and flooding critical for all residents, but can be especially challenging to provide to older adults. Stakeholders in the Des Plaines Comprehensive Plan process have identified transportation challenges faced by older adults, including difficulties traveling to and from home for daily needs and recreation, and various barriers to walking. As Des Plaines plans its transportation system, it should consider these difficulties for older residents and how they will be affected by projected increases in temperatures and severe storms, including winter storms.

Other population groups that are vulnerable to natural hazards include those that are in poverty, children under 5, those isolated by language barriers, or those with low education levels. Aside from a substantial foreign-born population,[68] these population groups are not present in Des Plaines at a higher rate than in the region as a whole; the City has comparable educational and income levels to the Chicago area. However, individuals in these groups are part of the community, and may require special services. Three facilities—Oakton Community College, Shrine of Our Lady of Guadalupe, and the Maryville Academy—that provide services to these groups are surrounded by or located in the 100-year floodplain, and may be difficult to access in the event of or after a natural hazard.[69] Even without the presence of a natural hazard, awareness and participation of these services is lacking among Des Plaines residents. The Maryville Academy and an associated consortium of agencies surveyed 200 immigrants that recently arrived in Des Plaines about services, and concluded that few respondents participated in human services programs, however, their interest in participation was high.[70] This result

[66] City of Des Plaines, "Hazard Mitigation Plan," 2013, www.desplaines.org/civicax/filebank/blobdload.aspx?blobid=24234.

[67] Ibid.

[68] See the *Diversity and Immigration* section in Des Plaines' Existing Conditions Report for more details.

[69] Services include the provision of shelter, ESL classes, social networks, and other supportive services for children without parents, undocumented residents, and newly arrived immigrants.

[70] Maryville. (September 2015). *Serving the Needs of the Latino Population in the Northwest Suburbs: Challenges and Opportunities. Survey Results.* Des Plaines

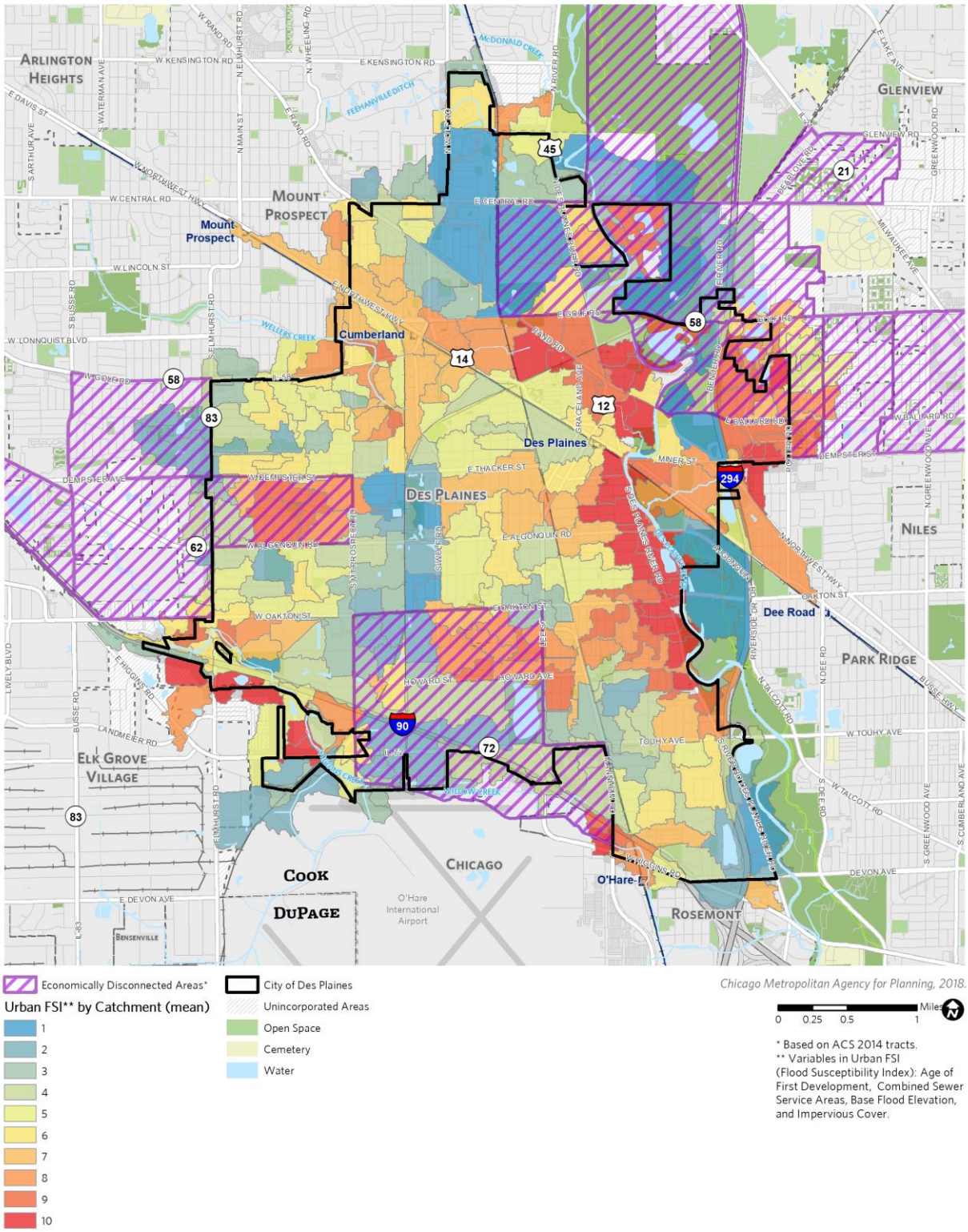
showed a gap in the demand-supply for immigrant integration services and a lack of awareness of their existence in the community.

Some areas of Des Plaines also feature concentrations of population groups that are vulnerable to a range of economic and environmental consequences due to their socioeconomic situations. By analyzing regional demographic and economic data, CMAP has mapped "economically disconnected areas" (EDAs). These areas have concentrations of low-income households, minority populations, and people with limited English proficiency.[71] While there are a few areas within Des Plaines that fall within an EDA, the Waycinden subdivision and a neighborhood in the western part of the City are two locations that stand out because they also highly susceptible to urban flooding in comparison to the city at large (Figure 15).[72] These neighborhoods may experience increased flooding in the future, and residents may be in need of greater assistance to deal with this vulnerability.

[71] EDAs are U.S. Census tracts that have concentrations of either a) low-income households and minority population, or b) low-income households and limited English proficiency population. For a more detailed explanation of CMAP's methodology, please see CMAP's Inclusive Growth Strategy Paper, http://www.cmap.illinois.gov/documents/10180/515753/Inclusive+Growth+strategy+paper/0f01488d-7da2-4f64-9e6a-264bb4abe537

[72] The neighborhood that west of Mt. Prospect Road between Thacker Street and Algonquin Road

Figure 15. Economically disconnected areas and flood susceptibility.



Economic Impacts

Des Plaines' local economy relies on high-performing infrastructure and transportation networks that protect and move people and goods safely and efficiently. When natural hazards damage supporting infrastructure or interrupt the transportation systems, the adverse economic impacts can affect the city and the region as a whole. Often, these impacts can be mitigated in advance through strategic, cost-effective interventions. Identifying the most critical economic impacts is a useful strategy for prioritizing these interventions.

Weakened market and growth potential

Severe weather and the associated climate-related impacts pose significant risk to the infrastructure, networks, and labor force of the Greater O'Hare Subregional Freight-Manufacturing Cluster that makes the Des Plaines an attractive place to locate. O'Hare International Airport, directly southwest of Des Plaines, has two cargo facilities that process approximately 1.6 million tons of freight worth over $170 billion each year.[73,74] These yearly totals have the potential to decline with as climate change impacts transportation infrastructure and networks as well mobility in the form of flight delays, cancellations, and weight restrictions imposed during periods of high temperatures.

Road and rail freight access that attracts businesses to Des Plaines may also be vulnerable. Heavier precipitation can increase ruts, scouring and deterioration of pavements, while extreme heat and drought can lead to the buckling of rail and paved surfaces (including runways). Air freight, in particular, may even face cargo restrictions and flight cancellations during periods of extreme heat. In 2012, drought and heatwave conditions led to severe rail buckling that caused a freight train hauling coal from Wyoming to Wisconsin to derail in Glenview along the Union Pacific Railroad on a viaduct crossing Shermer Road, directly northeast of Des Plaines.[75] Critical infrastructure and transportation routes that serve the Cluster (e.g., several key truck routes and the Canadian Pacific (CF) rail line) may face similar conditions. Transportation networks can also experience power outages from severe storms, which can cause major delays to land and air freight routes as well as employee commutes. While Des Plaines is not responsible for the maintenance and planning of much of this transportation infrastructure, its reliability and performance will impact Des Plaines' local economy.

From a more local perspective, flooding poses a threat to commercial and industrial properties within Des Plaines that may seem attractive for redevelopment. There are 68 industrial parcels (23.5% of the City's industrial land) and 315 commercial parcels (35% of the City's commercial

[73] CMAP, "O'Hare Subregional Freight-Manufacturing Drill-Down Report," May 2014, http://www.cmap.illinois.gov/documents/10180/27283/2014-5-12-O-Hare-Subregional-Freight-Manufacturin-+Drill-Down-report.pdf/231356b3-2edc-40ac-b1bb-7ee9cab04c0d

[74] Federal Aviation Administration, "Preliminary CY 2016 All-Cargo Airports," 2015, https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/media/preliminary-cy16-cargo-airports.pdf

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

land) that intersect the one percent annual chance floodplain, and are vulnerable to flooding. Although the City of Des Plaines and County want to see new development and have development regulations in place to help minimize flood susceptibility on site and within the surrounding area, the threat will intensify as precipitation and storm events trend upward. Commercial areas are also vulnerable to the urban heat island effect. As the number of days with very high temperatures rises, it will be increasingly important to install and maintain native street trees and other heat-reducing green infrastructure to make pedestrian-oriented shopping areas more comfortable.

Business Closures

As Des Plaines continues to experience the effects of a changing climate, it will be important that all business owners are aware of the threats and potential impacts of increasing trends in precipitation and heavy storm events. Heavy precipitation from severe summer storms can trigger overbank and basement flooding, and severe winter storms can cause power outages and structural damage—both of which can result in temporary and permanent business closures. FEMA statistics indicate that 40-60 percent of small businesses never reopen after being impacted by a natural disaster,[76] such as a flooding event or damages caused by severe summer or winter storms.

Commercial properties within Des Plaines are moderately vulnerable to climate-related impacts, particularly flooding. As mentioned in the section above, approximately 23% of the commercial properties in the City are located within the one percent annual chance floodplain. Nearly all of these parcels are located in the city's major commercial corridors including segments of Lee Street, Oakton Street, and Rand Road. The City has estimated that the average cost of damages caused by a single flood event[77] is equivalent to 6.5% of the value of the building.[78] Based on the City's commercial properties located in the floodplain, the total estimated property damage of such an event would be $12,759,500.[79] The total estimated damage for a single commercial property from a winter storm event would be $9,670. These business are also likely to experience greater flood-related damages because of their exposure to both urban and riverine flooding. The Des Plaines River can take several days to crest and then recede back to its normal level. In the event of a riverine flood, these properties have a greater risk of experience prolonged flooding, and therefore, a steep increase in property damages.

[76] FEMA, Make Your Business Resilient," https://www.fema.gov/media-library/assets/images/116921.

[77] Cost estimates are based on a flood event that has a 2-10% chance of occurring with within a year, i.e. a 10- to 50-year flood event.

[78] City of Des Plaines, "Hazard Mitigation Plan" 2016, [URL]

[79] Ibid.

Looking forward

The analysis contained within this assessment will inform the recommendations presented in the Des Plaines Comprehensive Plan. In many cases, the impacts of natural hazards can be mitigated through cost-effective measures to reduce vulnerability and encourage resilience, while for others it is a matter of planning for response and recovery. As the City of Des Plaines plans for its future in light of climate change, it should prioritize actions to improve flood resilience, stormwater management, and natural resource protection, as well as their regional coordination and economic competiveness.

Flood mitigation and stormwater management

Flooding will continue to impact the City of Des Plaines and require coordination among many levels of government, residents, businesses, and other stakeholders. The City, in partnership with the Metropolitan Water Reclamation District (MWRD), Cook County, and Illinois Emergency Management Agency (IEMA) should continue to leverage resources to acquire flood-prone properties from willing sellers. The City should continue to support regional stormwater management projects as well as lead local mitigation efforts through their capital improvement program. Additionally, the City should continue to participate in FEMA's National Flood Insurance Program and Community Rating System (CRS) as well as help residents implement flood proofing measures to protect homes and ensure public safety.

Water quality and natural resources management

An increase in precipitation and flooding may increase runoff, which could degrade the water quality and habitat of the Des Plaines River, its tributary streams, and wetlands without adequate restoration and management of the existing green infrastructure network. Stormwater management can also reduce the temperature of runoff and mitigate the impact to water quality and aquatic habitat. The City should continue to invest in stormwater management, wetland restoration along the Des Plaines River, and watershed planning. These efforts will be critical to sustain the ecosystem services the City's natural resources provide. The City's Forestry Department, Des Plaines Park District, and the Forest Preserves of Cook County should invest in invasive species management, select hardier trees to withstand increased precipitation and prolonged drought, and continue to practice routine pruning to withstand severe summer and winter storms.

Government and regional coordination

Government and regional coordination will continue to play an important role in building resilient communities in the face of climate change—climate-related natural hazards have the ability to put unnecessary strain on municipal resources. Road maintenance in the face of widely varying weather conditions from extreme heat to winter storms will also be critical, especially given that many roads that run through Des Plaines are not under the city's jurisdiction. City government and its partners should also prioritize outreach to community members who are most vulnerable to climate-related hazards to ensure they can access programs and assistance.

Economic growth and competitiveness

Des Plaines is located in one of the strongest industrial real estate markets in the Midwest because of its inclusion in the O'Hare Subregional Freight-Manufacturing Cluster.[80, 81] In order to maintain the strength of this market and continue to attract businesses, the city should pursue plans, regulations, and investments that mitigate the impact of natural hazards on key properties. As temperatures rise and precipitation events become more frequent and severe, Des Plaines and its Greater O'Hare Cluster counterparts will likely need to increase infrastructure spending to ensure the safety and efficiency of these major transportation networks that support their local and regional economy. It will be equally important for the city to educate local business owners on the potential impacts of increased precipitation and heavy storm events as well as provide incentives to maintain existing businesses and attract new ones.

Transportation redundancies

While transportation infrastructure in Des Plaines is vulnerable to the impacts of climate change, the large number of options for multiple modes of travel is a key component of community resilience. Distributed transportation infrastructure can build redundancies at multiple scales by providing more than one way for the transportation system to function and reducing sole reliance on a single transportation mode. Communities should prioritize redundancies in places that are likely to be most affected by climate disruptions. Transit-supportive densities can provide the demand necessary for multimodal hubs, while safe pedestrian and bicycling infrastructure can increase redundancies for short-distance trips.

[80] CMAP, "City of Des Plaines Existing Conditions Report – DRAFT"

[81] The O'Hare Subregional Freight-Manufacturing cluster is made up of 24 municipalities, 26 ZIP codes, two counties, and O'Hare International Airport. The City of Des Plaines in one of the 24 municipalities included in the cluster. See CMAP's "O'Hare Subregional Freight-Manufacturing Drill-Down Report" for more information.