Appendix A: Des Moines Climate Risk & Vulnerability Assessment

JULY 2023



ADAPT DSM

CLIMATE ACTION FOR EVERYONE

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INTRODUCTION

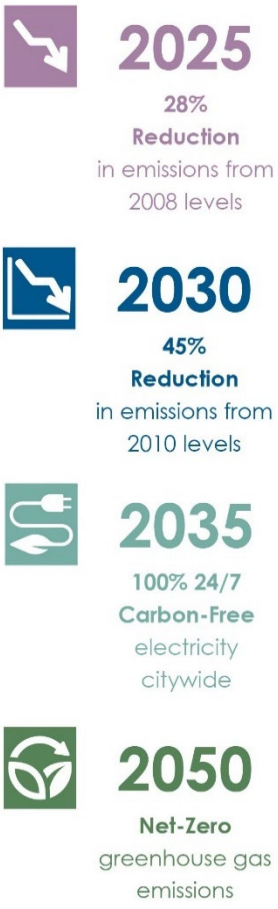


Figure 1. ADAPT DSM Overarching Goals

Des Moines is already facing the effects of climate change and experiencing impacts that threaten our quality of life, our economy, and our future. These climate change impacts are expected to worsen in the coming years, bringing more extreme temperatures, intense storms, and flooding.

ADAPT DSM is the City of Des Moines' community-wide Climate Action and Adaptation Plan (CAAP). The plan is designed as a resource for decision making, policy, and program development to reduce the greenhouse gas emissions that contribute to rising temperatures, and help our community become more resilient to climate hazards and risks. The plan will reinforce goals established through existing City of Des Moines planning documents, including Guide DSM, Plan DSM, and Move DSM and have four overarching goals, seven focus areas, and four cross-cutting themes (Figure 1 and Figure 2).



Figure 2. ADAPT DSM Focus Areas and Cross Cutting Themes

This Risk and Vulnerability Assessment (RVA) represents a first step in the CAAP development process (see Figure 3 below) evaluating the current and future climate risks and vulnerabilities facing the city. The RVA draws on national, regional, and local climate change resources, together with stories and lessons learned from local experts, community leaders, and Des Moines residents. Identifying the major climate risks facing Des Moines, who and what is most vulnerable, and practices that have or have not worked in the past, is a critical step in developing future adaptation strategies that work for everyone in our community.

The RVA includes an assessment of community-wide risks and vulnerabilities in addition to a more specific analysis of municipal facilities. The Community RVA will be used to identify strategies to improve community-wide resilience, with a focus on vulnerable populations and the resources they depend on. The Municipal RVA will be used to identify vulnerabilities in City of Des Moines operations and to develop a prioritized list of improvements to assets and services.

The RVA is designed to align with the Climate Hazards and Vulnerability guidance, taxonomy, and reporting structure developed by CDP, a not-for-profit charity that runs a global environmental disclosure framework. Alignment with CDP guidance ensures consistency with current best practices and will streamline future reporting for the City of Des Moines.

Figure 3: ADAPT DSM Timeline



Climate Change in Des Moines

Des Moines is located in central Iowa and has a humid continental climate characterized by four distinct seasons, below freezing winter temperatures, hot and humid summers, and precipitation throughout the year (Des Moines Area MPO, 2022). The City of Des Moines also experiences an urban heat-island effect, with average temperatures 2.9°F warmer than the surrounding area (Climate Central, 2022).

Des Moines' Current Climate

Humid continental climate	Four distinct seasons	Below freezing winter temperatures	Hot and humid summers	Precipitation throughout the year

Climate change impacts are already being observed in the Des Moines area, including:

Observed Climate Change

Rising Temperatures

- Since the beginning of the 20th century, temperatures in Iowa have risen by more than 1°F (NOAA, 2022).
- Warming in Iowa has been concentrated in the winter and fall, with less observed summer warming (NOAA, 2022).
- Nighttime temperatures in Iowa have increased, with no significant trend in daytime temperatures (NOAA, 2022).
- Iowa temperatures during the 2000s were higher than any historical period on record, except the 1930s Dust Bowl Era (NOAA, 2022).
- 2012 was the hottest year on record in Des Moines, with an average temperature of 52.1°F, 4°F above average (University of Northern Iowa, 2017).

Increased Humidity

- Des Moines summers are getting muggier as the dewpoint temperature rises, leading to more days with a heat index over 105°F (Climate Central, 2022).

Precipitation Changes

- Spring, summer, and annual precipitation in Iowa have been above average in recent years, with an increase in the frequency of 2-inch precipitation events (NOAA, 2022).

The impacts of climate change are projected to continue and worsen in the future. In general, Des Moines can expect to see:

Future Climate Change Projections

Hotter and more humid summers	Milder winters	Increased annual average temperatures between 2 and 12°F by the end of the century, depending on future greenhouse gas emissions trends (Figure 4)

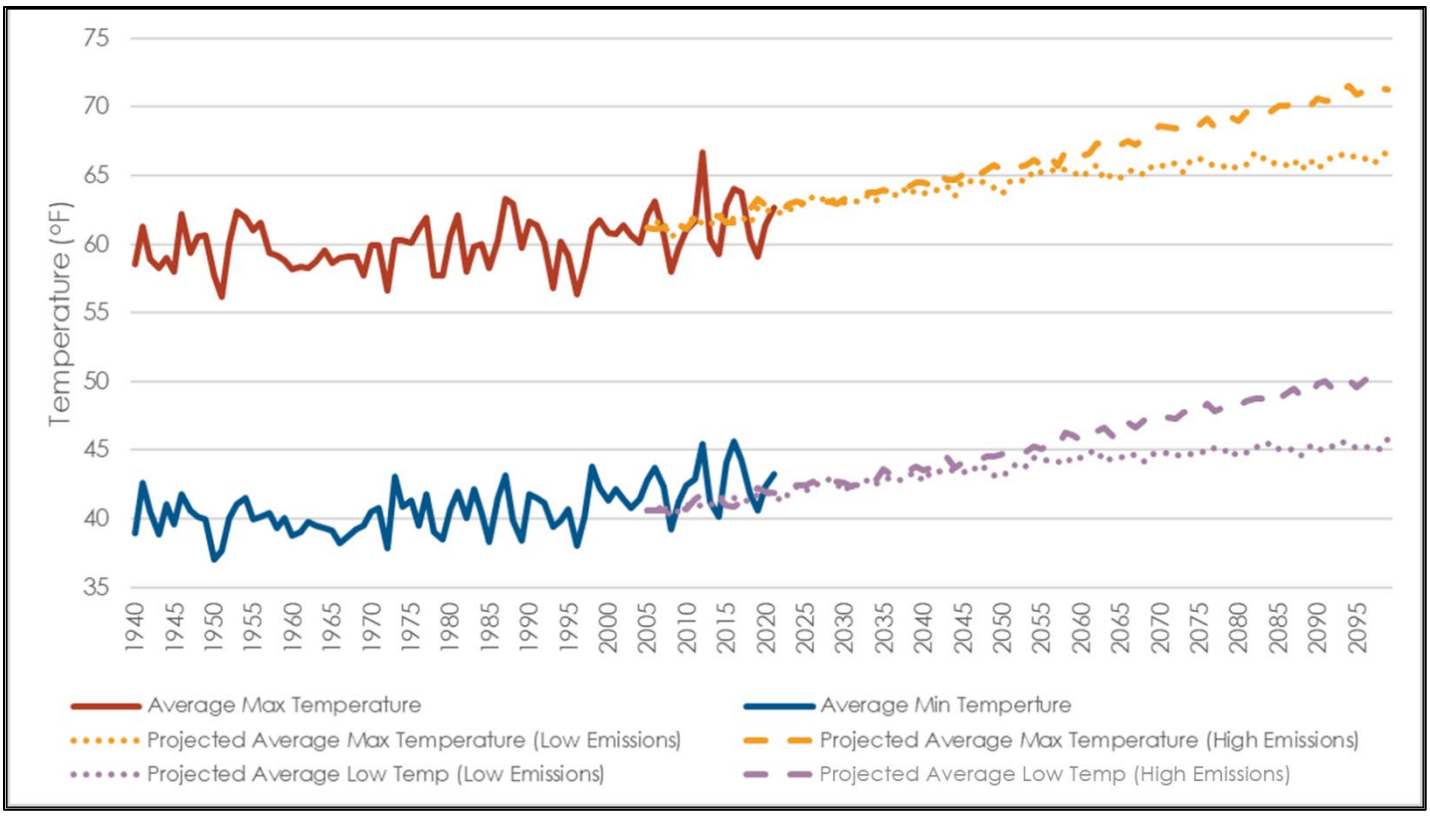


Figure 4: Observed change in average maximum and minimum temperatures in Des Moines (HPRCC) and projected future maximum and minimum temperature under high- and low-emissions scenarios (NOAA Climate Explorer)

As shown in Figure 5, Des Moines can expect average temperatures closer to those currently experienced in Steffenville, MO by mid-century (54.6°F), and to Spavinaw, OK by the end of the century (60.4°F) (High Plains Regional Climate Center Sister Cities Tool, 2022).

Ongoing climate change, including increased temperatures and altered patterns of precipitation will exacerbate the impact of existing climate hazards in Des Moines. Based on a review of climate research, and informed by the direct experience of residents and local experts, the primary climate hazard categories relevant to Des Moines have been identified as:

Extreme Hot Temperatures

Extreme Precipitation & Flooding

Severe Storm & Wind

Water Scarcity & Wildfire

These hazards are covered in more detail in the following sections of this RVA and align with the CDP reporting framework.

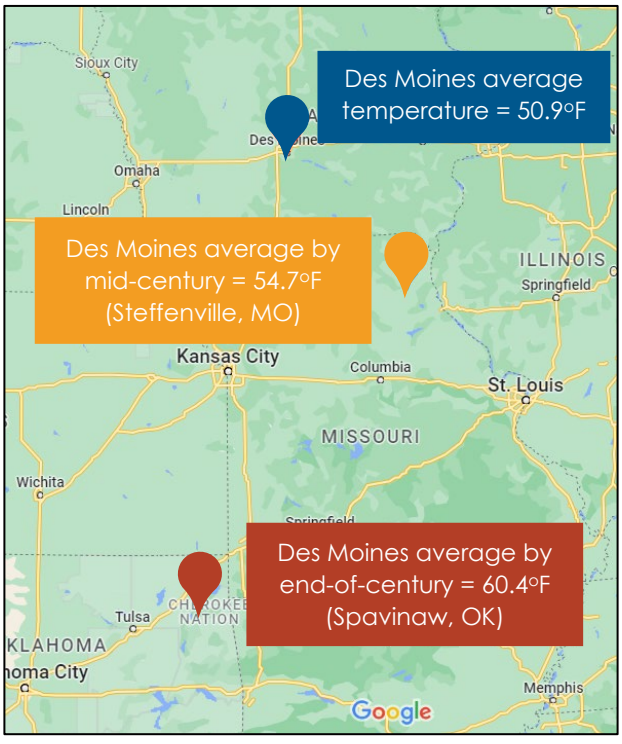


Figure 5: Des Moines "Sister Cities" by mid- and end-of-century (HPRCC Sister Cities Tool, Google Maps)

Other climate hazards that are identified in the CDP reporting framework were deemed to be less relevant to Des Moines, posing a low or secondary risk,

or not directly related to climate change. These are listed in Appendix II. In some cases, these lower risk hazards are related to the major climate hazards identified above and, in this case, they are highlighted in the RVA where relevant.

COMMUNITY RISK AND VULNERABILITY ASSESSMENT

INTRODUCTION AND METHODOLOGY

This Community Risk and Vulnerability Assessment describes the current and anticipated future impacts of Des Moines' major climate hazards. In contrast to the Municipal RVA, which focuses on city-owned facilities, this assessment analyzes how the entire Des Moines community, buildings, infrastructure, and services will be affected by climate impacts. This RVA will help to identify and prioritize strategies to be included in the Climate Action and Adaptation Plan.

METHODOLOGY

Vulnerability to the impacts of climate change varies across time and space, as well as among individuals within communities. The vulnerability of people, individuals, systems, or assets to climate hazards is a function of exposure, sensitivity, and adaptive capacity. In order to assess community climate risk and vulnerability, this report draws on industry best-practices and guidance using the following methodology:

1. Identification of Major Climate Hazards and Categories

As described in the introduction to the RVA, this report draws on existing work to identify major regional climate hazards. Key resources used to identify current climate-related hazards facing Des Moines include the 2019-2024 Polk County-Wide Hazard Mitigation Plan (Polk County, 2019), Iowa State Climate Summary (NOAA, 2022), and Des Moines Area Metropolitan Planning Organization climate change resources (Des Moines Area MPO, 2022). In addition, the RVA references a wide range of scientific research, climate observations, and modeled future projections to determine how the risk associated with each hazard is expected to change over time.

An initial list of individual climate hazards was drawn from the CDP climate reporting framework (CDP, 2021) and screened for relevance to Des Moines. For each hazard, the following were considered:

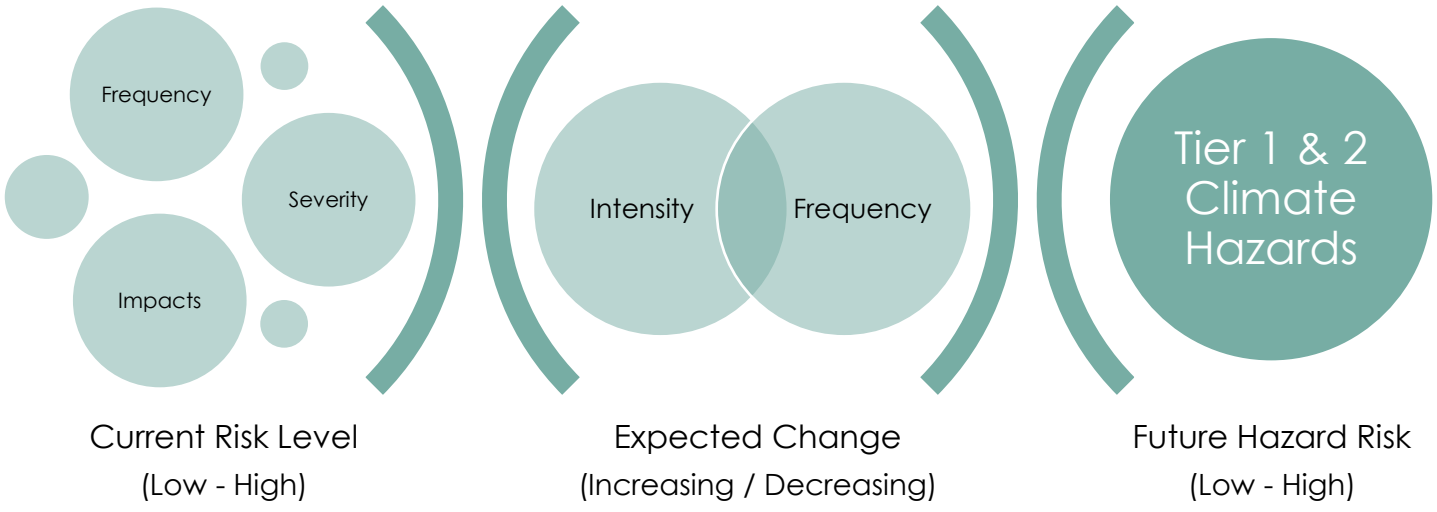


Figure 6: Identification Process for Tier 1 Climate Hazards

The hazards were then ranked by current and expected future risk level to identify the primary (higher risk) and secondary (lower risk) hazards facing Des Moines. Individual hazards were grouped into major climate hazard categories with similar risk levels, patterns, and impacts. A full list of hazards and their classification is included in Appendix II.

Input received from local experts, community stakeholders, and the wider community throughout the RVA development process was reviewed to ensure that the primary climate hazards identified align with local concerns and experiences.

This RVA focuses on the following primary climate hazards facing Des Moines but also identifies related hazards, recognizing the compounding impacts of multiple hazards occurring concurrently.

Extreme Hot Temperatures	Extreme Precipitation & Flooding	Severe Storm & Wind	Water Scarcity & Wildfire
• Extreme hot days • Heat wave	• Flash / surface flood • Hail • Permanent inundation • Rainstorm • River flood	• Severe wind / derecho • Tornado	• Drought • Land fire

2. Description of Exposure and Impacts to Primary Climate Hazards

2.1. Description of exposure

An initial description of the exposure to and impacts of major climate hazards facing Des Moines was developed using published resources including the recent Iowa State Climate Summary (NOAA, 2022) and 2019 Polk County Hazard Mitigation Plan (Polk County, 2019). For hazards with spatially defined impacts, such as flooding, this RVA draws on existing data and mapping to identify critical at-risk areas, infrastructure, community assets, and facilities.

2.2. Identification of vulnerable and impacted systems

There are many physical, social, and environmental factors that influence exposure, sensitivity, and vulnerability to climate hazards within a community. For each primary climate hazard, vulnerable and impacted systems were identified, including:

Buildings and Infrastructure	Environment	Community and Economy
Examples • Community buildings such as schools, community centers, and cultural facilities • Critical utility infrastructure including energy, water, and wastewater systems • Information and communications technology • Transportation networks • Emergency services and medical facilities	*Examples* • Urban forest • Habitats and biodiversity • Riverine systems	*Examples* • Human health and safety • Food systems and security • Businesses, recreation, and tourism • Vulnerable populations and social equity

The determinants of vulnerability are spatially distributed within a community and the RVA draws on existing data to identify areas and populations that may be particularly vulnerable to the impacts of climate change. Since the individual determinants of vulnerability are common across many major climate hazards facing Des Moines, they are mapped and described at the community-scale, rather than on a hazard-by-hazard basis.

2.3. Drawing on local experiences

Finally, this preliminary analysis was then supplemented with the direct experience of local experts, policy makers, and stakeholders received through a series of focus groups, a community survey, and stakeholder discussions. These stories of on-the-ground impacts provided critical insight into the lived experience of local people and helped identify and prioritize strategies to build community-wide resilience.

Understanding the determinants of vulnerability will help to maximize the impact of equitable climate action and adaptation strategies that benefit all residents of our community.

3. Evaluation of Adaptive Capacity to Major Climate Hazards

In addition to evaluating the climatological, spatial, and social factors that may place a population at risk from climate hazards, the RVA considers the capacity of people, assets, or systems to adapt to change. There are many factors and characteristics that can either support or challenge a community's adaptive capacity and an initial list of factors was drawn from the CDP climate reporting framework (CDP, 2021) in each of the following categories:

- Socio-economic
- Physical and environmental
- Governmental
- Services

A qualitative evaluation of factors within these categories was completed using input received from local experts and community stakeholders throughout the RVA development process. Understanding the determinants and current level of adaptive capacity will help to identify strategies to improve community-wide capacity to adapt and thrive in the face of change.

4. Preliminary Identification of Climate Adaptation Strategies

The results of this RVA were then used to develop a preliminary list of community climate adaptation strategies to consider in developing the Climate Action and Adaptation Plan. These strategies are identified at the end of this report.

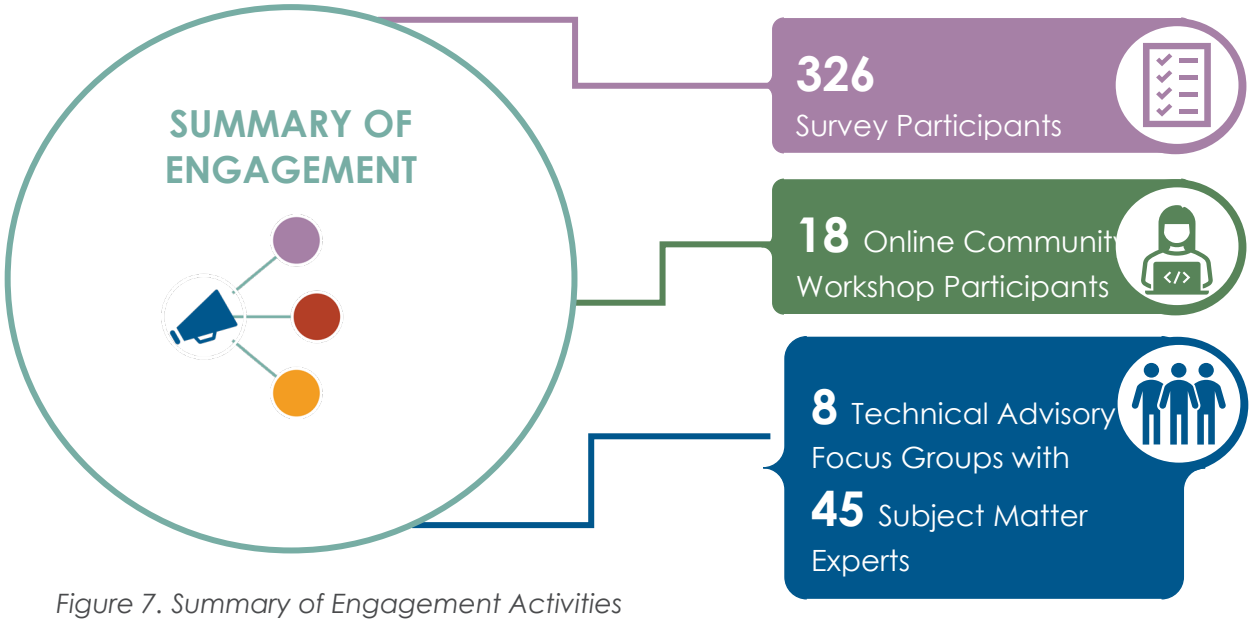


Figure 7. Summary of Engagement Activities

MAJOR CLIMATE HAZARDS IN DES MOINES

The following sections summarize Des Moines Tier 1 climate hazards by describing current and future risks, as well as expected impacts and community vulnerabilities.[1]

EXTREME HOT TEMPERATURES



EXTREME PRECIPITATION & FLOODING



SEVERE STORM & WIND



WATER SCARCITY & WILDFIRE



[1] Note that while the risks are identified and discussed in distinct categories in this report, the risks are inherently related, and these linkages may exacerbate with climate change.



Extreme Hot Temperatures

Des Moines experiences extremely hot days of over 95°F almost every year and periodically experiences heat waves, defined as periods of 3 or more days with temperatures at least 10°F above the average high temperature (Polk County, 2019). Des Moines also experiences an urban heat island effect, with average summer temperatures in the city 2.9°F warmer than surrounding areas (Climate Central, 2022).

Extreme heat events typically occur during June, July, and August and can have significant impacts including risks to human health and safety, increased energy demand and disruption to natural ecosystems and agriculture. Humidity couples with temperature to create the "Heat Index" or "feels like" temperature that is a measure of how hot it feels on the ground. Humid summers in Des Moines frequently lead to high heat index days. For example, on July 5, 2022, the National Weather Service issued heat advisories for all but three Iowa counties with a forecast of 99°F but heat indices as high as 107°F (Joens, 2022).

Extreme Hot Temperatures Tier 1 Hazards

Extreme hot days
Heat wave

RELATED CLIMATE HAZARDS

Convective thunderstorms
Summer precipitation
Ozone pollution
Infectious disease
Drought
Wildfire
Desertification

Climate Hazard	Current Risk Level	Future Risk Level
Extreme Hot Temperatures[2]	Medium	Medium High

[2] Appendix II provides an overview of all hazards considered in this assessment.

Current Risk

The risk of extreme heat events in Des Moines is currently rated as Medium. Observations that were used to determine this rating include:

> "Extreme heat is one of the most deadly weather elements, and it's only getting worse."
> - *Survey Respondent*

- **Frequency of extremely hot days.** Since 1940, Des Moines has experienced 7 days per year with a high temperature of 95°F or above (High Plains Regional Climate Center, 2022).
- **Frequency of heat waves.** Polk County currently faces a 48% annual chance of a heat wave with high heat index days lasting three or more days (First Street Foundation, 2022). The FEMA National Risk Index classifies the risk of a heat wave in Polk County as "relatively low", with an annualized frequency of 2.7 events per year from 2005 – 2017.
- **Observed temperature increases.** The years since 2000 have been the hottest period on record, except for the 1930s "Dust Bowl" era.
- **High humidity and heat index.** Summer humidity is rising, with 13% more atmospheric moisture (Iowa Department of Natural Resources, 2022) and a 1-3°F rise in dew-point temperature during summer months compared to 35 years ago (Iowa State University, 2022).
- **Frequency of heat watches and warnings.** Between May 2005 and 2018 there were 8 heat warnings, 3 heat watches and 48 heat advisories issued by the national weather service (Polk County, 2019).
- **Polk County Hazard Mitigation Plan classification.** The 2019 Polk County Hazard Mitigation Plan classified heat events as very likely and posing a moderate risk to Des Moines (Polk County, 2019).
- **Local experiences of extreme heat.** 81% of survey respondents say that they have experienced extreme temperatures in Des Moines.

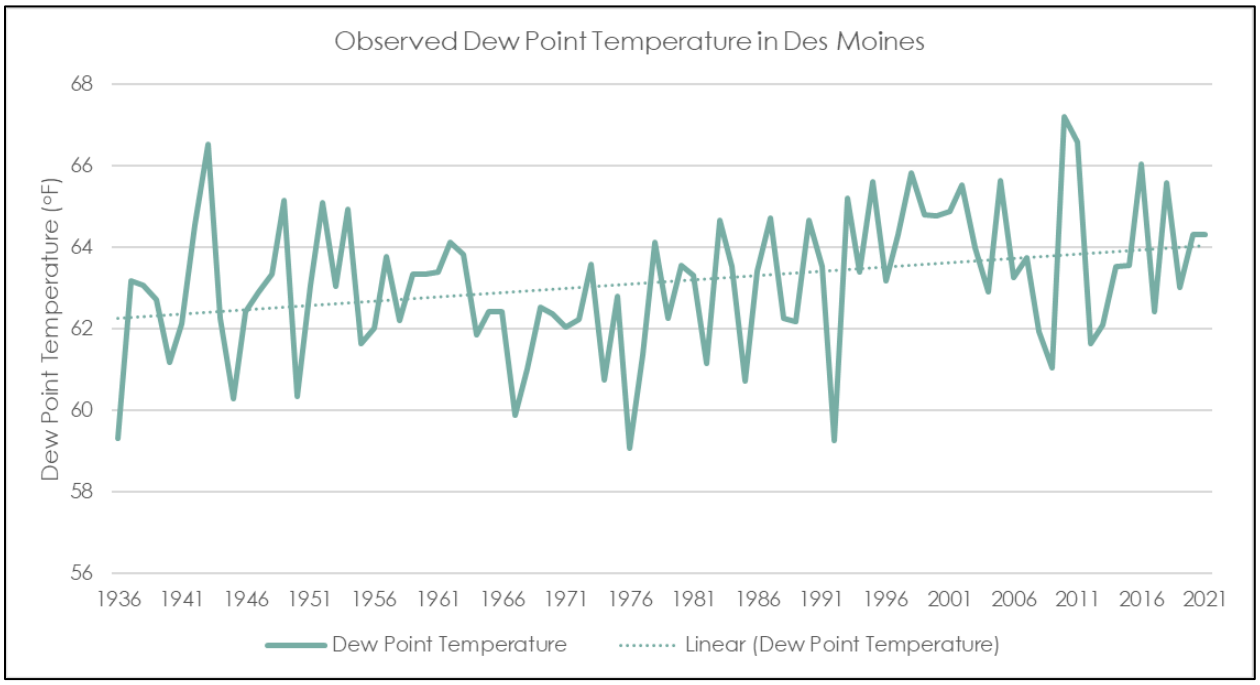


Figure 8. Observed Dew Point Temperature (Iowa State University, 2022)

Future Risk

Of community survey participants, 80% said that extreme temperatures are a concern over the next 10 – 20 years. It is anticipated that both heat waves and extreme hot days will become more frequent and intense by mid-century (NOAA, 2022) due to climate change, leading to a Medium High future risk. Anticipated changes include:

- An increase in the number of days over 95°F from 3-4 in 2000 – 2010 to 16-20 by 2030 – 2040, and 31-68 by end-of-century, as shown in Figure 9 (NOAA, 2022).
- An increase in the likelihood of heat waves occurring from 48% in 2022 to 81% by 2030 (First Street Foundation, 2022).

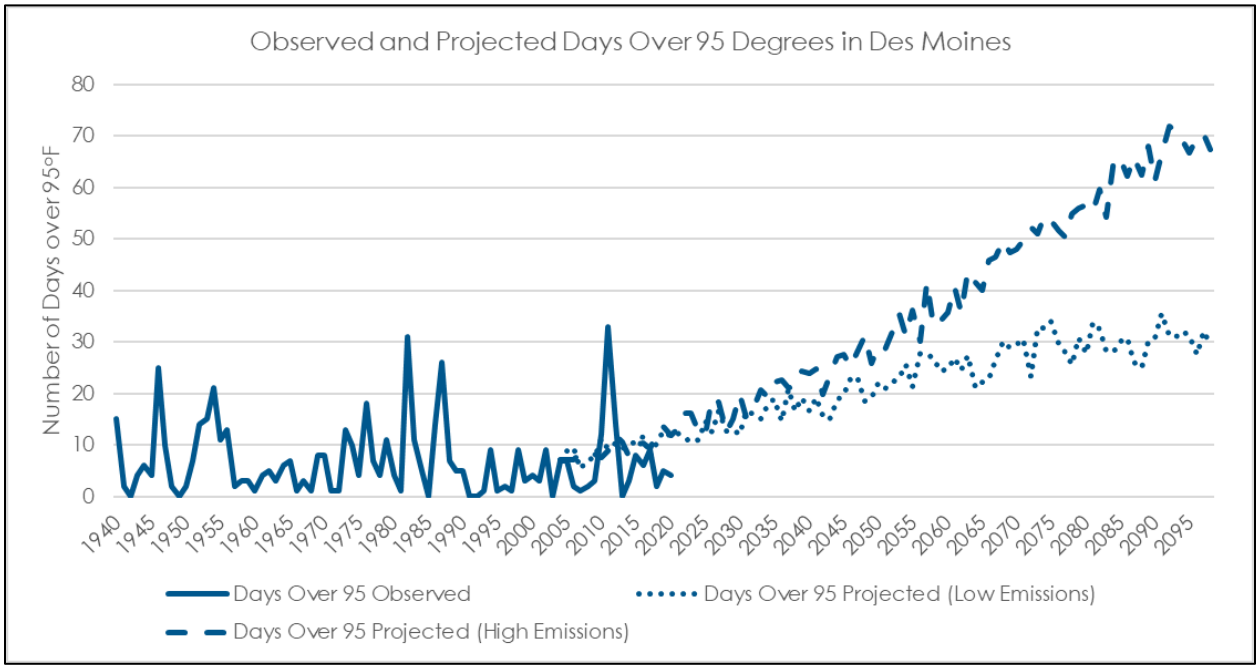


Figure 9. Observed and Projected Days over 95°F in Des Moines



> "I am especially concerned how the risks will impact people in housing without adequate heating/cooling systems who can't afford to change their living situation. I am also very concerned that extreme temperatures will continue to kill houseless people."
> *- Survey Respondent*

Vulnerable and Impacted Systems

Buildings and Infrastructure

Disrupted energy infrastructure

Power demand during hot weather can overload electrical equipment and cause outages. Power outages can have secondary impacts, including dangerously hot indoor conditions, service disruptions, critical equipment failures, and economic impacts.

> "I'm concerned about heat waves and using more air conditioning which then uses more fossil fuel."
> - *Survey Respondent*

Increased energy use

Extreme heat increases demand for building cooling, with implications for energy use and cost. Based on heat projections for Polk County, it is estimated that the number of cooling days (when air conditioning is used to cool indoor spaces) will increase from 151 today to 162 over the next 30 years, increasing energy use for cooling purposes by 16.3% (First Street Foundation, 2022). Figure 10 below shows the observed and projected increase in cooling degree days in Polk County.

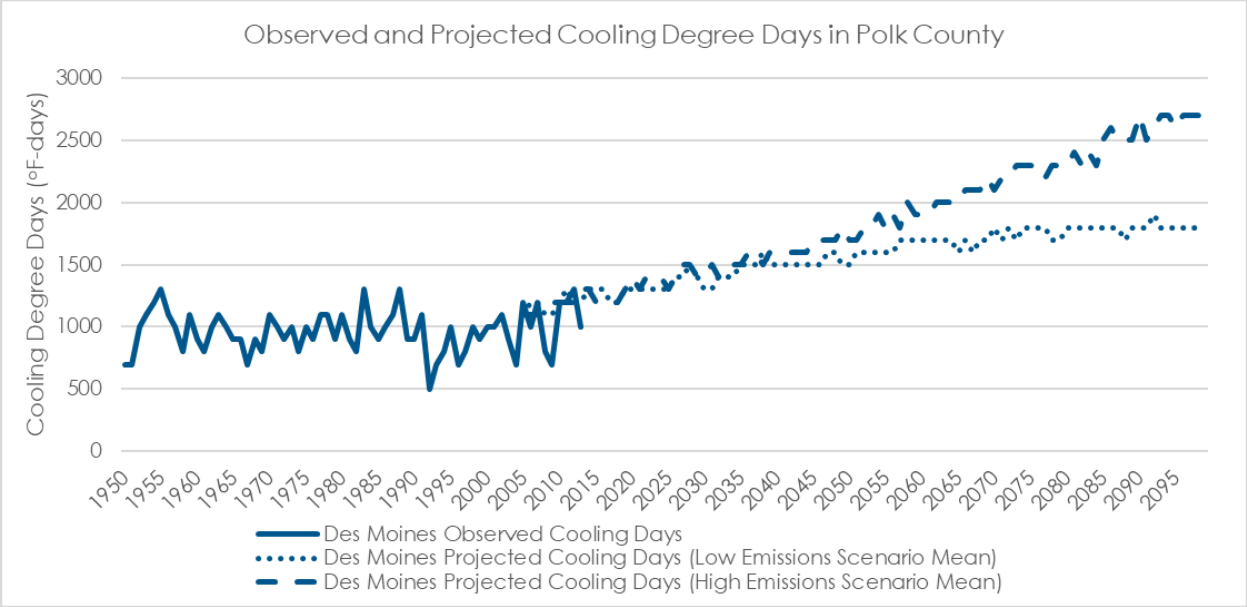


Figure 10. Observed and projected cooling degree days. Cooling degree days is a measure that reflects the amount of energy it takes to cool the indoor environment when daily average temperature exceeds 65°F. Values are calculated by subtracting 65°F from the mean daily temperature and summing those daily values. The higher the number of cooling degree days, the higher the demand for energy for cooling (NOAA, 2022).

Community facility temperatures and capacity

Educational establishments, community centers, and other places of assembly without air conditioning are particularly vulnerable to the impact of extreme heat events. In addition, hospitals and health care facilities that depend on steady temperatures and energy reliability are vulnerable to the impacts of extreme heat and related disruptions to power supply.

Other facilities that are designed with passive cooling or are served by air conditioning and have backup generation, may serve as cooling centers for residents without access to cooling at home and/or work. These facilities play a critical community function during extreme heat events but may also become overwhelmed or experience a disruption in their ability to provide community services.

ENVIRONMENT

Disrupted natural ecosystems

High temperatures can result in heat stress impacts for natural ecosystems and habitats. In addition, high temperatures can increase the production of ground-level ozone, as shown in Figure 11 below. High levels of ozone pollution can further disrupt natural ecosystems and agricultural production (EPA, 2016).

> "[Climate risks] will affect my health and well being and those of my family and all of Des Moines! I am 82 years and the elevated heat affects my breathing."
> - *Survey Respondent*

Decreased water quality

High temperatures of pavement and rooftop surfaces can cause increased warming of stormwater runoff which subsequently raises water temperatures as it is released into streams, rivers, ponds, and lakes. Increased water temperatures can negatively impact the metabolism and reproduction of many aquatic species (EPA, 2021). Additionally, the risk of cyanobacteria increases in warm, slow-moving waters that are rich in nutrients from sources such as fertilizer runoff. Harmful cyanobacteria blooms can block sunlight that other aquatic life needs to survive and can also be toxic to animals and people (CDC NCEH, 2022). Cyanobacteria blooms may also be linked to extreme precipitation events which increased nutrient runoff into water bodies, helping to feed algae growth. In 2020, the Des Moines River was impacted by a cyanobacteria bloom fed by fertilizer runoff (Beeman, 2020).

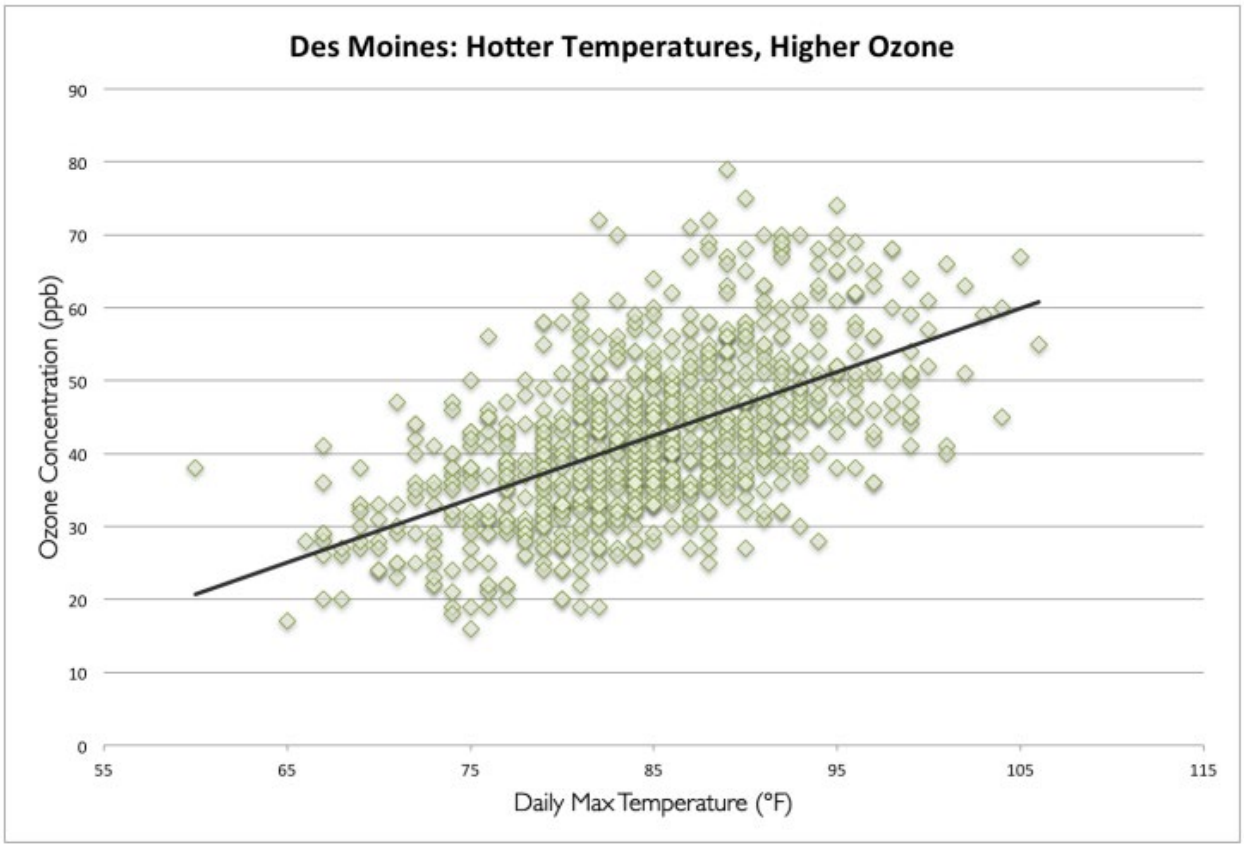


Figure 11. Daily maximum temperature and ground-level ozone concentration in Des Moines (Climate Central, 2022).

Community and Economy

Threats to human health and safety



Extreme heat has impacts for human health and safety, and many cities experience increased death rates during heat waves. Heat waves are associated with increased deaths and hospital admissions due to heat stroke, heart disease, respiratory disease, stroke, and kidney disease (CDC, 2022). While heat-related deaths are generally considered preventable, an average of 702 people in the US died from heat-related causes each year between 2004 and 2018 (CDC, 2020). In addition, there are an average of 67,512 emergency department visits each year due to heat (CDC, 2020), with 838 emergency room visits and 44 hospitalizations in Iowa alone during 2020 (CDC, 2020). Health risks can occur at temperatures as low as 80°F but become significantly more severe with temperatures over 90°F or 100°F.

Certain populations are particularly vulnerable to the health impacts of extreme heat, including:

- Adults aged 65 and older
- Children
- People with chronic diseases such as cardiovascular and respiratory illnesses
- People involved in outdoor activities, including outdoor workers and athletes
- Those less likely to have access to home cooling, or those less likely to use it due to cost constraints, including economically disadvantaged people, marginalized populations, and people living in substandard housing
- Those living in areas with limited access to cooling centers and green space
- Unhoused populations.

Reduced agricultural yields

Heat stress and ozone pollution associated with extreme heat events can disrupt crop growth and livestock productivity with implications for the regional economy and food systems (EPA, 2016). Additionally, drier conditions associated with rising temperatures and extreme heat events creates drier soils and increases the likelihood of a "modern Dust Bowl" scenario. Dust storms, or haboobs, such as those experienced in May 2022 (Lawrence, 2022) and an observed loss of topsoil in Iowa, and across the Midwest, (Dzombak, 2021)may signal a trend toward dust bowl conditions. Dust Bowl conditions similar to those experienced in the 19030s would cause soil degradation and could reduce agricultural yields by 30 to 40% (Scharping, 2021). FEMA's National Risk Index indicates that there is $110,889,000 of agricultural value at risk of heat waves in Polk County.

Climate migration

As climate change impacts other parts of the United States and shapes migration corridors globally, Des Moines may become a receiving community for people migrating due to climate change. The PLACE initiative has taken initial steps to map places of lowest climate risk, that are potentially well-suited for receiving climate migrants and adapting (PLACE Initiative, 2022), and Des Moines is near other counties that are identified as potential receiving areas. Even as Des Moines and surrounding areas face increasing threat of climate hazards such as extreme heat, this is relative to other parts of the country and globe that may be exposed to and experiencing even more extreme temperatures.

Extreme Hot Temperatures Case Study

Notable Iowa heat waves occurred in 2012, 1995, 1988, 1955 and during the summer of 1936 which saw a deadly heat wave killing 5,000 across the U.S. and at least 232 in Iowa alone (Des Moines Register, 2019).

In advance of anticipated very hot weather conditions in June 2022 the Polk County Office of Emergency Management issued a media release reminding residents about precautions to stay safe, and the location of daytime cooling centers, as well as overnight shelters (Polk County Emergency Management, 2022). Additionally, in July 2022, the National Weather Service in Des Moines issued a warning related to a prolonged heat wave in early August, with maximum temperatures of up to 102°F in the city (National Weather Service, 2022).

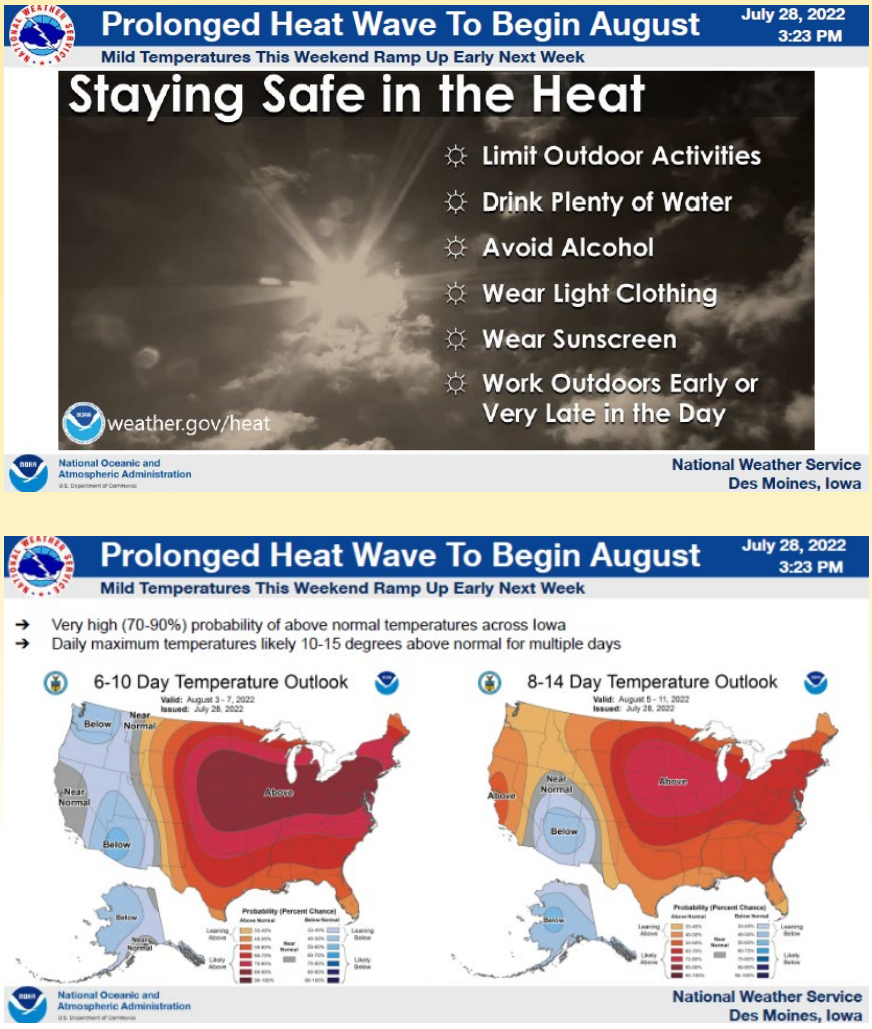


Figure 12. National Weather Service Heat Warning July 28, 2022



Extreme Cold Temperatures

Extreme cold temperatures often accompany severe winter storms in Des Moines. Between September 1939 and March 2022, there were over 1,000 days with a minimum temperature of below 0°F, 200 below 10°F and 16 events with a maximum temperature not exceeding 0°F for multiple days in a row (High Plains Regional Climate Center, 2022).

Extreme cold events can cause impacts to human health and mortality, particularly when combined with high winds during winter storms. Additionally, extreme cold increases demand for building heating, with implications for energy use and cost, and can disrupt infrastructure. Cold temperatures can cause fuel to congeal in storage tanks and supply lines, stopping electric generators, and can cause water and sewer pipes to freeze and rupture. Ice jams can occur when temperatures dip low enough for river systems to freeze and increase the risk of river flooding. In Iowa, ice jams typically occur during early winter months ("freeze-up ice jams") and during spring thaws when the ice melts ("break-up ice jams") (Womack et. al., 2020).

However, with increasing temperatures, cold waves in Iowa are becoming less frequent and intense and there have been a below average number of very cold nights below 0°F since 1990, with the exception of the 2010-2014 period (NOAA, 2022). Warming has also been concentrated during the winter months in Des Moines, further contributing to a reduction in the number of extreme cold events.

Extreme cold days and cold waves are expected to continue to become less frequent and intense as average temperatures rise. This could lead to an increase in the frequency of freezing rain, sleet, or icing events which pose significant safety concerns and can disrupt energy supply, transportation and other services and cause significant damage to trees.



Potential Adaptation Strategies

The Des Moines Climate Action and Adaptation Plan will detail strategies to help the community adapt and be resilient to the impacts of extreme hot temperatures. Preliminary adaptation strategies identified through the Phase 1 community and stakeholder engagement efforts, and through best practice research are listed below.

Climate Change Vulnerability	Potential Strategies
Disrupted Energy Infrastructure	• Ensure reliable and climate-resilient infrastructure (e.g. utility undergrounding, battery storage)
Increased Energy Use	• Improve building performance and comfort and increase efficiency (e.g., weatherization, thermostats, ventilation)
Community Facility Temperatures and Capacity	• Improve building performance and comfort and increase efficiency (e.g., ventilation, cooling) • Amplify climate-related education and individual and community emergency preparedness (e.g., community alerts)
Disrupted Natural Ecosystems	• Increase urban tree canopy and biodiversity (e.g., more, healthier shade trees) • Enhance watershed management and source water protection (e.g., connected open spaces, improved riverbanks and wetlands)
Decreased Water Quality	• Enhance watershed management and source water protection (e.g., stormwater management, erosion control, green infrastructure)
Threats to Human Health and Safety	• Amplify climate-related education and individual and community emergency preparedness (e.g., community alerts) • Create climate resilience hubs/shelters (e.g., cooling centers) • Prepare for climate migration and displaced people (e.g., housing, education, social services, and language needs)
Reduced Agricultural Yield	• Expand local food production (e.g., community and household gardens, working with regional agricultural producers) • Improve food security and nutrition (e.g., food banks, farmers' markets)



Extreme Precipitation and Flooding

For most of Iowa, over 40% of the annual precipitation occurs on the 10 wettest days of the year. Additionally, with several rivers and streams traversing the city, Des Moines is vulnerable to river flooding and flash flooding. Since 1965, Polk County has received 11 Presidential Disaster Declarations that included flooding (FEMA, 2022), and between 1955 and January 2022, there were 283 recorded flooding events impacting Polk County (NOAA NCDC, 2022). Of those flooding events, 110 were due to flash flooding, which typically results in unpredictable, short duration events that can reach full peak in just a few minutes, allowing little or no time for protective measures (Polk County, 2019). Flash flooding is caused by intense rainfall over a brief period and often associated with slow-moving thunderstorms, or thunderstorms repeatedly moving over the same area (Polk County, 2019). Flooding can also be caused by ice jams forming natural dams in moving waterways (Polk County, 2019). Between 1955 and January 2022, there were also 318 reported heavy rain events impacting Polk County (NOAA NCDC, 2022).

Extreme Precipitation & Flooding Tier 1 Hazards

Flash / surface flood
Hail
Permanent inundation
Rainstorm
River flood

RELATED CLIMATE HAZARDS

Sink holes
Landslides
Subsidence

The City of Des Moines is protected by six different levee systems in and round the city that are designed to provide protection against a 1-percent annual chance flood. In addition, Des Moines is located downstream of the Saylorville/Big Creek Lake dam. A levee system or upstream dam failure could cause inundation of areas of Des Moines (Polk County, 2019).

Des Moines also periodically experiences extreme hail events and Polk County has experienced 604 hail events since 1955 (NOAA NCDC, 2022).

Climate Hazard	Current Risk Level	Future Risk Level
Extreme Precipitation and Flooding	High	High

Current Risk

The current risk of extreme precipitation and flooding in Des Moines is high. Observations that were used to determine this rating include:

- **Frequency of extreme precipitation events.** Across Iowa, the frequency of 2-inch extreme precipitation events has increased, with the highest number occurring during the past 16 years (NOAA, 2022).
- **Frequency of riverine flooding events.** The FEMA National Risk Index estimates an annualized frequency of riverine flooding in Polk County of 5.8 events per year, with 158 events on record between 1996 and 2019 (FEMA, 2022).
- **Levee condition and population living in levee protected areas.** An estimated 6,301 people live in areas vulnerable to levee failure (Polk County, 2019). In response to frequent flooding impacts, a Levee Districts Study was completed by the Iowa Department of Homeland Security and Emergency Management in 2022 to examine the condition of levee systems statewide (Benson, 2022). While the study found that 48% of inspected levee systems statewide are rated as unacceptable (operationally deficient), in Polk County one system was rated as "acceptable" (Des Moines, IA - LDB Des Moines River (Birdland)). The remaining seven inspected systems were rated as "minimally acceptable":
    - SE Des Moines & SW Pleasant Hill, IA - Red Rock Remedial Works
    - Des Moines, IA - RDB Des Moines River / LDB Raccoon River (DM-II)
    - Des Moines, IA - RDB Des Moines And Raccoon River (DM-III)
    - Des Moines, IA - RDB Raccoon River (RR-1)
    - West Des Moines, IA (WDM-DM)
    - Des Moines, IA - RDB Walnut/LDB Raccoon R (WDM-DM)
    - Des Moines, IA - RDB Des Moines River (Central Place)
- **Population and buildings located in the flood path.** There are almost 8,000 buildings located in the maximum flood path in the event of the failure of the Saylorville/Big Creek Lake dam, with a total estimated population of 16,683 and a value of close to $1.5bn (Polk County, 2019).
- **Population and buildings located in the flood plain.** An estimated 3,161 people, and buildings with an estimated value of over $338m are located in Des Moines' 0.2% annual flood plain. Recent improvements to the storm sewer in some areas of Des Moines will help to reduce the current risk level in those locations (Polk County, 2019). The FEMA National Risk Index estimates the total expected annual loss from riverine flooding to be $1,846,521 in Polk County.
- **Polk County Hazard Mitigation Plan classification.** The 2019 Polk County Hazard Mitigation Plan classified flash flooding and river flooding as "likely" and posing a "moderate" and "high" risk to Des Moines respectively (Polk County, 2019).
- **Local Experiences of Extreme Precipitation and Flooding.** 72% of survey respondents said that they had experienced extreme precipitation and flooding. Several survey respondents described personal experiences of property damage and loss due to flooding since 2018.

Future Risk

River flooding and flash flooding are expected to become more frequent and intense due to an increase in precipitation and heavy rain events (NOAA, 2022). The latest Intergovernmental Panel on Climate Change (IPCC) report reinforces that the frequency and intensity of heavy precipitation events have increased, and that human-induced climate change is likely the main driver (IPCC, 2021). Temperature increases over the Gulf of Mexico are leading to increased evaporation and more rain in Iowa due to the Great Plains Low Level Jet which brings nighttime summer precipitation to Iowa. There

has also been an observed shift to more intense spring-time rainfall events which is expected to continue (Tackle, 2022). Flooding remains a key concern for Des Moines residents with 67% of survey respondents saying that it is a concern over the next 10 – 20 years.

> "We have already experienced significant damage to our home due to flash flooding, hail, and winds. Seems to be happening more often in last few years. Home was built and positioned in ways that didn't take into account water drainage…"
> *- Survey Respondent*

VULNERABLE AND IMPACTED SYSTEMS

BUILDINGS AND INFRASTRUCTURE

Damage to homes and property

Flooding poses a direct risk to property. Between 1955 and 2020, flooding in Polk County resulted in over $48m in property damage and an additional $75m in crop damage and the FEMA National Risk Index estimates $712,609 in expected annual building value loss due to riverine flooding (FEMA, 2022).

Properties located in, or near, the flood zone are vulnerable to the impacts of flooding and homes with basements and those in older neighborhoods and areas without adequate stormwater infrastructure are particularly vulnerable. As development in the flood plain continues, and the frequency of flood events increases due to climate change, the vulnerability of people, infrastructure, and assets within flood prone areas will continue to increase. Over 3,162 people live in Des Moines' 0.2% annual flood plain and1,558 buildings are located within the floodplain, with a combined value of $334,790,090 (Polk County, 2019). In addition, there are approximately 358 critical or essential facilities located in Polk County's 1% annual chance floodplain (Polk County, 2019), and a number of critical community facilities in the 1% and 0.2% floodplain within Des Moines, as shown in Table 2 below. A full list of critical and important community facilities located in flood risk areas is detailed in Appendix IV.

Table 1. Floodways and Floodplains

Regulatory Floodway:	This is the area that must be reserved in order to allow flood waters to pass along their natural conduit.
1% Annual Floodplain:	This is area that would be flooded during a flood with a 1% annual chance of occurring. A 1% chance annual flood is also known as a base flood or 100-year flood and has a 1 in 100 probability of being equaled or exceeded in any given year.
0.2% Annual Floodplain:	This is the area susceptible to a 0.2-percent-annual-chance flood. A 0.2% chance annual flood is also known as the 500-year flood plain and has a 1 in 500 probability of being equaled or exceeded in any given year.
Levee Protection Area:	This is the area of land protected from flooding by levees. This is the maximum area that would be flooded in the event of levee failure.

All of the facilities located in the Regulatory Floodway, and many of those located in the 1% floodplain, are parks or other recreation facilities that may be designed to withstand flooding and even serve a dual purpose for stormwater management. However, there are several facilities located in the 1% flood plain that could be priority locations for adaptation strategies. These include:

- East Side Library (2559 Hubbell Ave.)
- Polk County River Place facility including the Des Moines Municipal Housing Agency and Polk County Health Services (2309 Euclid Ave.)

Table 2. Des Moines community facilities at risk of flooding

	Regulatory Floodway	1% annual floodplain	0.2% annual floodplain	Levee protection area
Care			1	1
College			1	
Community Center				1
County Government		2		
Education				4
Federal Government				2
Fire Station				1
Housing				4
Library		1		
Local Government		1		12
Local Landmark				1
Marina		1		
Park	4	6		7
Police Station				5
Pool				1
Recreation		2	1	2
TOTAL	**4**	**13**	**3**	**41**

Sources: City of Des Moines Data Portal (2022), ESRI Feature layer of USA Flood Hazard Areas from the Federal Emergency Management Agency (2022)

Disruption and damage to critical infrastructure

Flooding can damage roads, bridges, and other critical infrastructure, making it difficult for people to access essential services. Significant areas of downtown Des Moines are either currently located in the flood plain or would be at risk in the event of a levee failure.

Levee breach

Des Moines is protected from flooding by levee systems. Extreme precipitation and flooding can erode levees and increase the risk of breaching, when part of a levee gives way, creating an opening through which floodwaters may pass (Polk County, 2019). A 2022 Levee Districts Study by the Iowa Department of Homeland Security (Benson, 2022) found many of the levee systems in Polk County to be "minimally acceptable". Table 2 above shows the number and type of community facilities located in the area currently protected by levees, and which would be vulnerable to flooding in the event of levee failure.

Dam failure

Des Moines is located directly downstream of several dams, including the Saylorville Reservoir Dam and Fort Des Moines Park Dam which are classified as high hazard risk dams by the Iowa Department of Natural Resources. Dams are classified as high hazard where failure may create a serious threat of loss of human life and result in serious property damage and disruption. Flooding increases the risk of dam failure and the uncontrolled release of impounded water (Polk County, 2019). There are almost 8,000 buildings located in the maximum flood path in the event of the failure of the Saylorville/Big Creek Lake dam, with a total estimated population of 16,683 and a value of close to $1.5bn (Polk County, 2019).

Environment

Damage to agriculture

Extreme precipitation and flooding saturate soils, increase erosion, and damage crops, with implications for the regional economy and food systems. The FEMA National Risk Index estimates that $13,814,591 of agricultural value is exposed to riverine flooding in Polk County (FEMA, 2022)

Disrupted natural ecosystems

Extreme precipitation and flooding can cause erosion and increase the run-off of fertilizer and other chemicals with negative impacts to aquatic habitats, including cyanobacteria blooms.

> "Flooding has proven to be a recurring problem in DSM, and I reside in Beaverdale, which has older systems to accommodate heavy rainfall. It seems likely that these issues aren't going to improve any time soon."
> *- Survey Respondent*

Community and Economy

Human health and safety

Flash flooding can pose an immediate and severe risk to human life safety. From 1955 – 2020, there have been 3 deaths and 4 injuries reported as a result of flash flooding in Polk County (NOAA NCDC, 2022). Flooding can also cause other serious public health and safety concerns, for example due to damage to building mechanical systems or disrupted water supply systems. Flooding can also result in evacuations and mental health impacts for people displaced from their homes.

People living in, or dependent on community services and assets located in the flood plain are particularly exposed to the risk of extreme precipitation and flooding. **Error! Reference source not found.** on the next page shows the location of flood risk zones within Des Moines, including areas currently protected by levee systems.

Certain populations are particularly vulnerable to the impacts of extreme precipitation and flooding, including:

- People living in substandard housing
- Marginalized and underserved communities
- People with disabilities and those over the age of 65 who are particularly vulnerable to secondary flooding impacts such as loss of power, water supply, or disruption to transportation networks
- Property owners in flood prone areas without flood insurance
- Renters without renters' insurance



> "Flooding and winds have indiscriminate impacts on the general population… everyone is impacted or at lease inconvenienced by flooding and storms/winds."
> *- Survey Respondent*

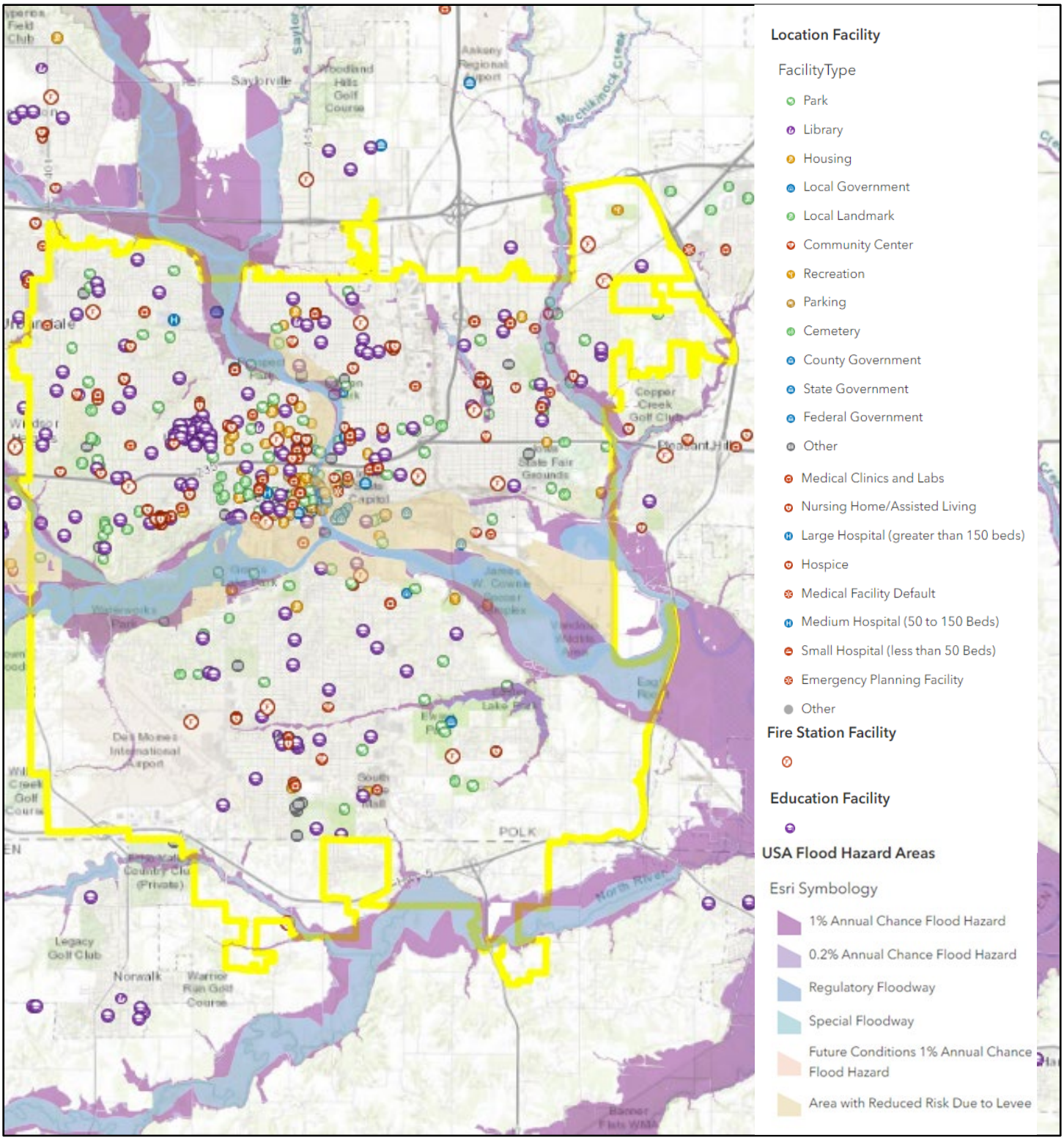


Figure 13. Facilities located within floodplains in Des Moines

Extreme Precipitation and Flooding Case Study

Great Flood of 1993. Perhaps the most significant modern-day flood to impact Des Moines was the "Great Flood of 1993" which resulted in around $2.7bn in damages, evacuation of over 10,000 people and 17 fatalities. The flood occurred after a cold 1992 growing season and wet fall season which led into a snowy winter and wet spring before a very wet summer with some locations seeing 130 days of consecutive rain. Flood waters inundated downtown Des Moines and overwhelmed flood protection measures at the Des Moines Water Works, resulting in loss of public water supply to the Des Moines area for 19 days (National Weather Service Quad Cities IA/IL, 2022).

2008 Levee Failure. In 2008, very high water along the Des Moines River caused a weak spot in the levee in the Birdland Park area to give way. A mandatory evaluation order was given and about 271 homes were affected by the flooding as well as several businesses and a high school (Polk County, 2019).

2001 Hail Storm. On June 12, 2001, the Des Moines metropolitan area was hit with record hail ranging from 1 to 2.75 inch in diameter and causing over $10m in property damages (Polk County, 2019).



Potential Adaptation Strategies

The Des Moines Climate Action and Adaptation Plan will detail strategies to help the community adapt and increase resilience to the impacts of flooding. Preliminary adaptation strategies identified through the Phase 1 community and stakeholder engagement efforts, and through best practice research are listed below.

Climate Change Vulnerability	Potential Strategies
Damage to homes and property	• Reduce flood risk (e.g., stormwater management, property buy outs) • Prepare for climate migration and displaced people (e.g., housing, education, social services, and language needs)
Disruption and damage to critical infrastructure	• Ensure reliable and climate-resilient infrastructure (e.g., levee and bridge improvements, check water and sewer lines, utility undergrounding, battery storage) • Reduce treated water use (e.g., water reuse)
Levee breach	• Ensure reliable and climate-resilient infrastructure (e.g., levee and bridge improvements, check water and sewer lines)
Dam failure	• Ensure reliable and climate-resilient infrastructure ((e.g., levee and bridge improvements, check water and sewer lines)
Damage to agriculture	• Enhance watershed management and source water protection (e.g., regenerative agriculture, soil management) • Expand local food production (e.g., community and household gardens, working with regional agricultural producers) • Improve food security and nutrition (e.g., food banks, farmers' markets)
Disrupted natural systems	• Increase urban tree canopy and biodiversity (e.g., more, resilient tree species) • Enhance watershed management and source water protection (e.g., connected open spaces, riverbank and wetland restoration)
Human health and safety	• Reduce flood risk (e.g., stormwater management, property buy outs) • Amplify climate-related education and individual and community preparedness (e.g., community alerts, emergency evacuation plans) • Prepare for climate migration and displaced people (e.g., housing, education, social services, and language needs) • Create climate resilience hubs/shelters (e.g., flood shelters)

Location Facility



Severe Storm and Wind

Polk County is located in Federal Emergency Management Agency (FEMA) Wind Zone IV, the highest classification denoting areas susceptible to winds of over 250mph (FEMA, 2011). Strong winds can occur year-round in Iowa, and often accompany severe thunderstorms. Des Moines also experiences a particularly destructive high-wind phenomenon called derechos. Derechos are long-lived straight-line windstorms that frequently occur with little warning (NOAA-NWS-NCEP Storm Prediction Center, 2022). Finally, tornadoes are also a common occurrence in Iowa and can occur during any month of the year.

Severe Storm & Wind Tier 1 Hazards

Severe wind / Derecho
Tornado
Thunderstorms

RELATED CLIMATE HAZARDS

Heavy rains
Flash flooding

Climate Hazard	Current Risk Level	Future Risk Level
Severe Storm and Wind	Medium-High	Medium-High

Current Risk

The current risk of severe storm and wind events in Des Moines is rated as Medium-High. Observations that were used to determine this rating include:

- **Frequency of severe storm and high wind events.** Severe storms and wind events are a common occurrence in Des Moines with an average of 10 high wind or thunderstorm wind events per year over the past 66 years (NOAA NCDC, 2022). Polk County has also been included in 6 Presidential Disaster Declarations for severe storms and 1 for a hurricane since 2000, with a total of over $1.6 bn in individual and public federal assistance[3] (FEMA, 2022). The state of Iowa has an average of 30-50 thunderstorms per year (Polk County, 2019) and has been impacted by 47 billion dollar Severe Storm and Winter Storm events since 1980 (National Centers for Environmental Information, 2022).
- **Frequency of tornadoes.** Tornadoes are also relatively common, with almost 1 tornado per year over the past 66 years according to the NCDC Storm Event Database (NOAA NCDC, 2022).
- **Polk County Hazard Mitigation Plan classification.** The 2019 Polk County Hazard Mitigation Plan classified tornadoes as "occasional" and windstorms as "likely", with both posing a "moderate" risk to Des Moines (Polk County, 2019).
- **Local Experiences of Severe Storms and Wind.** 86% of survey respondents said that they had experienced severe storms and wind in Des Moines.

Future Risk

The potential impact of climate change on wind events and tornadoes is not clearly understood. While rising temperatures could suggest an increase in the meteorological conditions conducive to derechos, increased humidity is also expected to yield more low-level clouds that could negatively impact storm initiation and derecho development (NOAA-NWS-NCEP Storm Prediction Center, 2022). Similarly, while atmospheric instability associated with increased humidity could encourage tornadoes, wind shear is expected to decrease, which would discourage tornado formation (EPA, 2016). Severe storms and wind are a key concern for Des Moines residents, with 78% of survey respondents saying that they are concerned about impacts in the next 10-20 years.

Vulnerable and Impacted Systems

Buildings and Infrastructure

Disrupted critical services and infrastructure

Wind events can damage overhead power lines and cause widespread and long-lived power outages. In addition, wind events cause significant transportation disruption, grounding planes, tipping over vehicles, and creating debris that can block roads and damage buildings and infrastructure, making it difficult for people to access essential services. Telecommunications equipment is also vulnerable to severe storms and wind, creating secondary impacts related to disrupted emergency and other communication.

> "I We have seen some of what storm damage can do and the disruption that can happen. As storms become more severe and intense I am not sure our infrastructure will be able to handle it."
> *- Survey Respondent*

[3] Note that federal funding obligations present a limited financial snapshot of the total financial impact of declared disasters.

Damage to Homes and property

Wind events often result in significant property damage and both thunderstorm events and tornadoes have resulted in more property damage in Polk County than any other hazard. Between 1955 and 2022, high wind and thunderstorm wind events caused over $77m in property damage and tornadoes resulted in a further $49m in damages in Polk County (NOAA NCDC, 2022). Lightning associated with thunderstorms can also cause damage to electronic equipment and to structures through triggering of structure fires. Since 1955, lighting has resulted in an estimated $1.4m in property damage (NOAA NCDC, 2022). Buildings particularly vulnerable to the impacts of severe storms and wind include:

- Buildings without secure foundations
- Buildings without storm shelters
- Buildings with a lot of windows
- Buildings with older or damaged roofs
- Buildings with deferred maintenance

> "The severe storms have caused property damage. Des Moines housing inventory has more properties with deferred maintenance. Further damage by storms jeopardizes low-income homeowners struggling with repairs."
> - *Survey Respondent*

Environment

Damage to the urban forest

Severe storms and wind pose a threat to the urban tree canopy by damaging and knocking down trees, contributing to a loss of the essential ecosystem services and protection from the elements that trees provide.

Damage to agriculture and disrupted food systems

Severe storms and wind can damage crops and urban gardens, causing food systems disruption.

Community and Economy

Human health and safety

Severe storm and wind events including thunderstorms and lightning, derechos, and tornadoes pose a direct and immediate threat to human health and safety. Between 1955 and 2022, there were 47 injuries and one death associated with high winds and thunderstorm winds, and a further 2 deaths and 149 injuries associated with tornadoes in Polk County. In addition, wind events can lead to secondary human health and safety impacts as a result of power outages and disrupted services.

> "Climate related disasters affect low-income and people of color more acutely. The more these disasters continue to happen, the greater detriment to our society. Not to mention the actual physical danger from these increasingly violent storms."
> - *Survey Respondent*

Populations particularly vulnerable to the impacts of severe storm and wind events include:

- People involved in outdoor activities such as campers, hikers, and those who work outdoors.
- Marginalized populations and low-income households.
- People living in substandard housing, mobile homes, campers, or other dwellings without secure foundations.
- People over the age of 65 and people with certain illnesses are likely to be disproportionately impacted by the secondary effects of wind events such as power outages and service disruptions.
- People reliant on public transportation.

Potential Adaptation Strategies

The Des Moines Climate Action and Adaptation Plan will detail strategies to help the community adapt and increase resilience to the impacts of extreme hot temperatures. Preliminary adaptation strategies identified through the Phase 1 community and stakeholder engagement efforts, and through best practice research are listed below.

Climate Change Vulnerability	Potential Strategies
Disrupted critical services and infrastructure	• Ensure reliable and climate-resilient infrastructure (e.g., utility undergrounding, battery storage)
Damage to homes and property	• Improve building performance and comfort and increase efficiency (e.g., wind resistant construction)
Damage to the urban forest	• Increase urban tree canopy and biodiversity (e.g., more, wind resistant tree species)
Damage to agriculture and disrupted food systems	• Enhance watershed management and source water protection (e.g., regenerative agriculture, soil management) • Expand local food production (e.g., community and household gardens, working with regional agricultural producers) • Improve food security and nutrition (e.g., food banks, farmers' markets)
Human health and safety	• Amplify climate-related education and individual and community preparedness (e.g., community alerts, emergency evacuation plans) • Create climate resilience hubs/shelters (e.g., cooling centers) • Prepare for climate migration and displaced people (e.g., housing, education, social services, and language needs)

Severe Storm and Wind Event Case Studies

1998 Tornado and Derecho. On June 29, 1998, Polk County was hit by a tornado and derecho event with straight-line winds causing significant damage, including buildings being flattened or damaged, trucks and construction equipment being blown over, and planes at an air field north of Des Moines being flipped. The event injured 83 people and resulted in an estimated $10m in property damages (NWS Storm Data, 1998).

2020 Derecho. On August 10, 2020, a widespread and destructive derecho event swept through the Des Moines Metro area and across the Midwest. The derecho was fueled by a hot and moist environment, and produced wind gusts of up to 99 mph, with 75 mph recorded at the Des Moines International Airport. The event resulted in straight-line wind damage across seven states and also produced 26 weak tornadoes. The costliest severe thunderstorm event in US history, the derecho caused significant damage to structures, trees, and vehicles. In addition, the event left people across the region without power for several days, with over 1.9 million customers affected, including 585,000 in Iowa alone (National Weather Service, 2022).





Water Scarcity and Wildfire

Polk County and Des Moines periodically experience severe and extreme drought conditions which can result in agricultural losses, riverine impacts, and an increased risk of grass and wildland fires. In Des Moines, grass and wildland fires are most likely to occur in areas of wildland urban intermix.

Climate Hazard	Current Risk Level	Future Risk Level
Severe Storm and Wind	Medium	Medium-High

Water Scarcity & Wildfire Tier 1 Hazards

Drought
Land Fire

RELATED CLIMATE HAZARDS

Extreme heat
Flooding
Soil shrinkage

CURRENT RISK

The current risk of water scarcity and wildfire in Des Moines is rated as medium. Observations that influenced this rating include:

- **Frequency of abnormally dry conditions.** Des Moines has experienced periods of abnormally dry conditions almost every year since 2011, and at least moderate drought in 7 of the past 11 years as shown in Figure 14 (US Drought Monitor, 2022). While the most severe drought on record occurred during the 1930s "dust bowl" era, there have been 19 drought events impacting Polk County since 1999 (NOAA NCDC, 2022).

> "I live in a wooded area. Fire would be even worse than high winds blowing some trees down."
> *- Survey Respondent*

- **Development in the wildland urban interface.** Des Moines has 1,484 acres of wildland urban intermix that is vulnerable to wildfire during periods of extremely dry conditions (Polk County, 2019). As shown in Figure 15, growth since 1990 has seen more development, including medium and high-density housing, in the Des Moines' wildland urban interface and intermix areas (University of Wisconsin Silvis Lab, 2022)
- **Local experiences of water scarcity and wildfire.** While only 21% of survey respondents said that they had experienced water scarcity or wildfire in Des Moines, several residents described water scarcity impacts. Water scarcity and toxic algae blooms associated with high temperatures and drought are also a concern for the city's drinking water utility, Des Moines Water Works, particularly during peak summer demand (Eller, 2021).

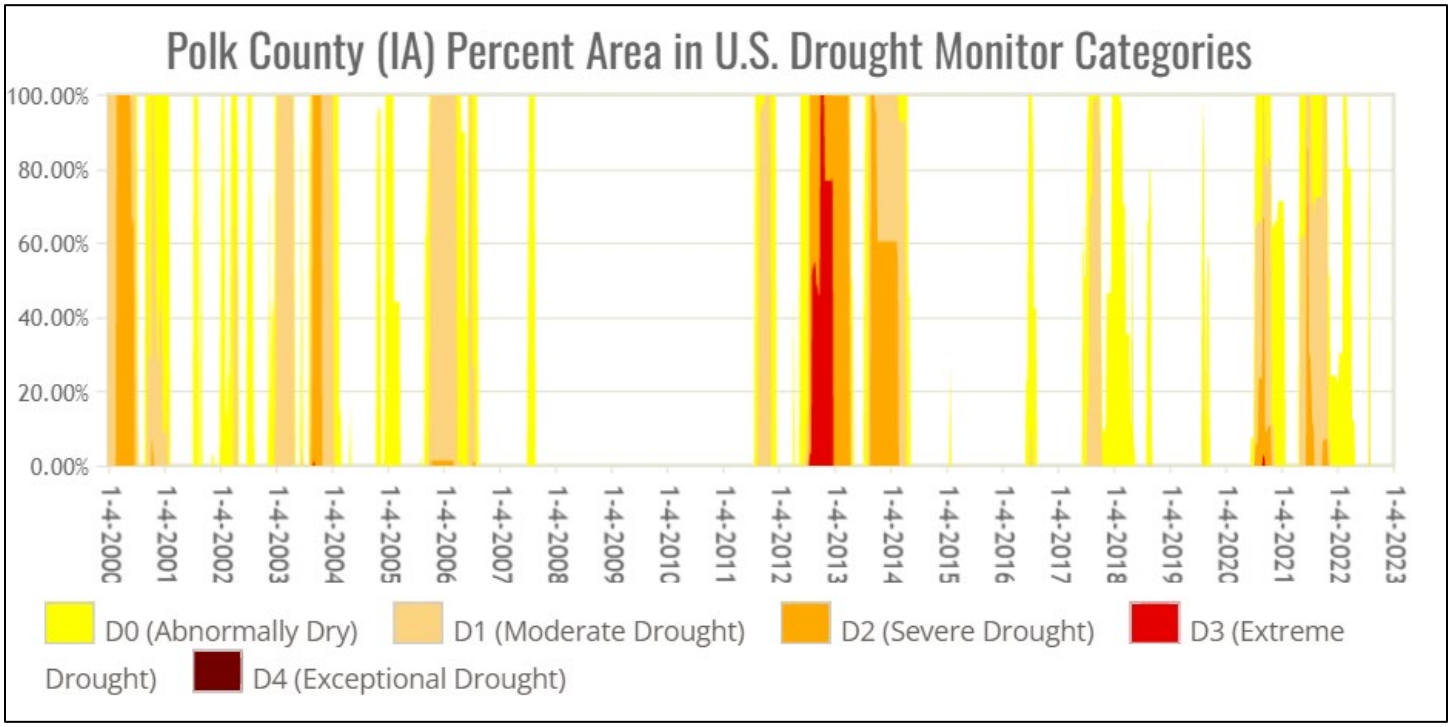


Figure 14. Percent area experiencing drought in Polk County (US Drought Monitor)

Future Risk

The intensity and frequency of future droughts is expected to increase as a result of climate change. Elevated rates of evaporation and loss of soil moisture associate with rising temperatures and reduced snowpack will lead to drier conditions on the ground, regardless of the change in total precipitation (NOAA, 2022). With ongoing development in the wildland urban interface and increasingly intense summer drought, the risk of destructive wildfires is also anticipated to increase (Polk County, 2019). Water scarcity and wildfire is a key concern for Des Moines residents, with 52% of survey responses saying that they are concerned about this hazard when considering the next 10-20 years.

Vulnerable and Impacted Systems

Buildings and Infrastructure

Damage to homes and property

Wildfire poses a direct threat to homes and property located in the wildland urban interface, shown in Figure 15. Home and properties particularly vulnerable to the impacts of wildfire include:

- Cul-de-sacs and areas with a single point of access
- Properties without fire sprinklers
- Properties without mechanical ventilation or air purification
- Properties located far from fire hydrants and/or stations

Disrupted critical infrastructure

Critical community infrastructure and assets such as energy utilities, telecommunications equipment and transportation networks that are located in the wildland urban interface are particularly vulnerable to the impacts of wildfire.

In addition, drinking water supply infrastructure could be impacted by low streamflows and poor water quality associated with water scarcity and wildfire.



Environment

Damage to the urban forest

Drought and wildfire can have significant impacts to urban trees, lawns, and gardens. An increase in dead and dried out fallen trees and underbrush can accelerate wildfires.

Disrupted natural ecosystems

Non-irrigated open spaces, and areas of dense and/or unmanaged vegetation are particularly vulnerable to the impacts of drought and wildfire. Water scarcity can impact habitats and cause displacement of wildlife.

Decreased water quality and riverine impacts

Shallow water during drought events also leads to warmer than normal stream water temperatures which can impact aquatic life (National Weather Service, 2022) and create the conditions for toxic algae blooms (Eller, 2021). Additionally, intense drought can exacerbate flooding impacts through increased stormwater runoff (University of Northern Iowa, 2017). Low water levels can also impact river recreation, creating secondary economic losses.

Agricultural loses

Historically, drought has resulted in more economic property and agricultural damage in Polk County than any other hazard, with over $110m in damages since 1955 (NOAA NCDC, 2022). The impacts of drought can reduce crop and livestock yields, increase insect infestations and cause plant disease and erosion (Polk County, 2019).

Community and Economy

Human health and safety

Wildfire in wildland urban intermix areas can pose a direct threat to human safety and wildfire smoke can create or exacerbate air quality health impacts. While not likely fully attributable to wildfire, 43% of survey respondents said that they have experienced poor air quality in Des Moines and 55% said that they are concerned about poor air quality in the next 10-20 years.

Populations particularly vulnerable to the impacts of water scarcity and wildfire include:

- People whose livelihood relies on natural ecosystems or agriculture
- People living in the wildland urban interface are most exposed to the direct impacts of wildfire
- People particularly vulnerable to the air quality impacts of wildfire smoke, including:
    - Those with respiratory or cardiovascular diseases
    - Low income, marginalized, and underserved populations who may have less access to air filtration and be less able to adapt to the impacts of poor air quality associated with wildfire smoke
    - Those living in areas with poor air quality
- People living in areas with poor air quality may be more susceptible to the compounding effects of wildfire smoke

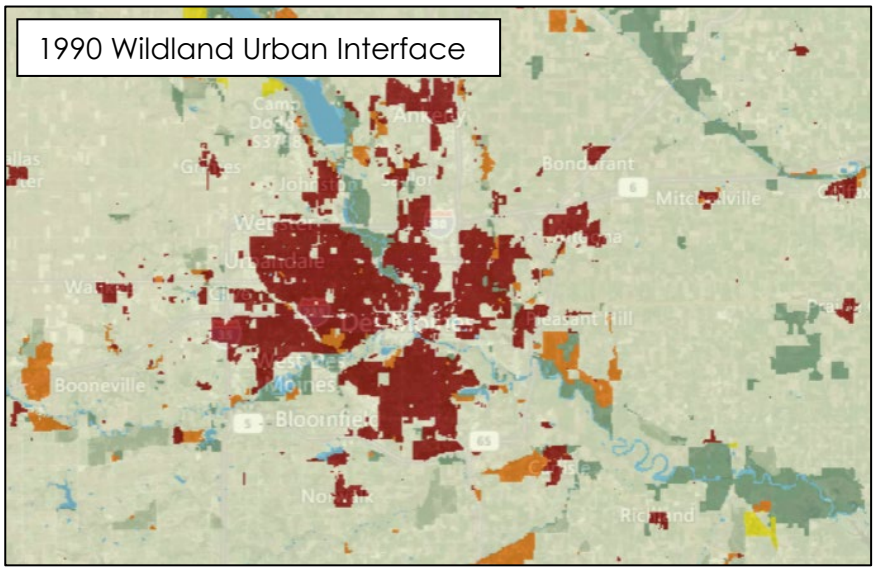


Figure 15. Des Moines Wildland Urban Interface 1990 and 2010 (University of Wisconsin Silvis Lab, 2022).

Water Scarcity and Wildfire Case Study

2012 Drought and Wildfires. An extended period of drought in 2012 caused catastrophic economic losses associated with agriculture in Iowa and across the Midwest. Much of Iowa received less than 50% of normal rainfall for the month of July and record low levels were observed on area streams, rivers and lakes. There were 103 reported grass/wildland fires in Polk County. The monthly mean temperature for July 2012 in Des Moines was the second highest on record, eclipsed only by July of 1936, Drought caused an estimated $45m in crop damages across Polk County during 2012 (NOAA NCDC, 2022).

Potential Adaptation Strategies

The Des Moines Climate Action and Adaptation Plan will detail strategies to help the community adapt and be resilient to the impacts of extreme hot temperatures. Preliminary adaptation strategies identified through the Phase 1 community and stakeholder engagement efforts, and through best practice research are listed below.

Climate Change Vulnerability	Potential Strategies
Damage to homes and property	• Improve building performance and comfort and increase efficiency (e.g., fire resistant construction)
Disrupted critical infrastructure	• Reduce treated water use (e.g., indoor and outdoor water efficiency)
Damage to the urban forest	• Increase urban tree canopy and biodiversity (e.g., more, drought resistant tree species)
Disrupted natural ecosystems	• Enhance watershed management and source water protection (e.g., regenerative agriculture, soil management, connected open spaces, riverbank and wetland restoration) • Increase urban tree canopy and biodiversity (e.g., native plant species)
Decreased water quality and riverine impacts	• Enhance watershed management and source water protection (e.g., green infrastructure)
Agricultural losses	• Enhance watershed management and source water protection (e.g., regenerative agriculture, soil management) • Expand local food production (e.g., community and household gardens, working with regional agricultural producers) • Improve food security and nutrition (e.g., food banks, farmers' markets)
Human health and safety	• Enhance individual and community emergency preparedness (e.g., community alerts, emergency evacuation plans) • Prepare for climate migration and displaced people (e.g., housing, education, social services, and language needs)
Economic losses	• Amplify climate-related education and individual and community preparedness (e.g., ensuring adequate insurance coverage, drought alters)

VULNERABLE POPULATIONS AND ADAPTIVE CAPACITY

In addition to evaluating how physical and environmental exposure to climate hazards is distributed across Des Moines, this assessment considers how socio-economic factors, physical and environmental characteristics, governmental structures, and access to services across Des Moines impacts individual and community-wide vulnerability and capacity to adapt. A full list of factors evaluated for adaptive capacity is included in Appendix III: Factors Affecting Adaptive Capacity.

It is important to note that reference to "vulnerable" populations is in the context of acknowledging system deficiencies, rather than judgement of individuals or their neighborhoods. Understanding the factors that determine vulnerability to climate hazards in Des Moines will help to maximize the impact of targeted, equitable climate action and adaptation strategies.

SOCIO-ECONOMIC

Socio-economic and demographic characteristics, such as race, age, disability status, income, access to a vehicle, English proficiency, home age, and housing type can influence an individual or household's capacity to adjust to a hazard, take advantage of new opportunities, or cope with change. Indices that combine a number of factors to provide an overview of socio-economic vulnerability and access to goods and services can be used to identify potentially vulnerable populations and start developing targeted approaches to increase resilience. The FEMA National Risk Index showin in Figure 16 is one such index and combines Social Vulnerability, Community Resilience and Expected Annual Loss to create a national index of risk to natural hazards.

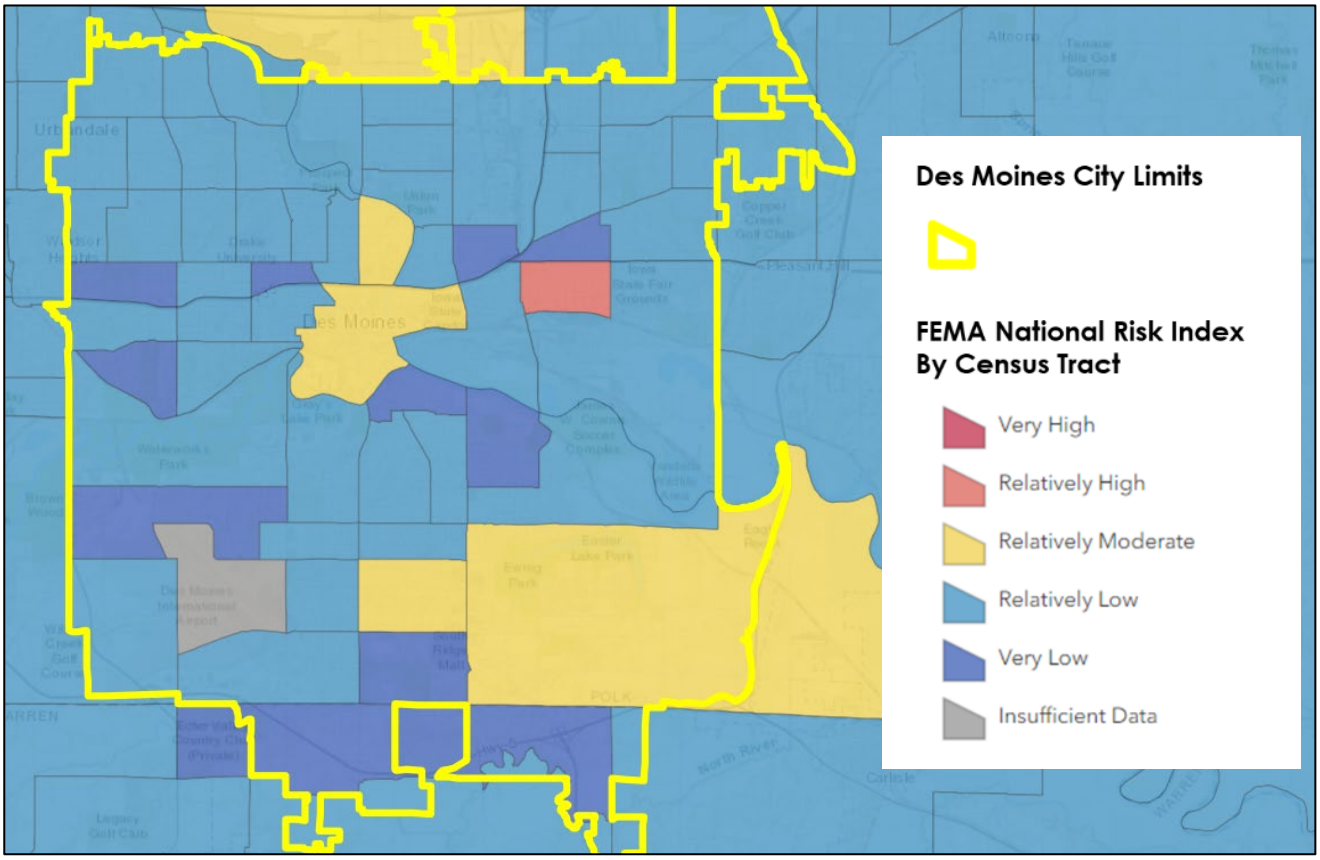


Figure 16. FEMA National Risk Index showing risk of natural hazards as a function of social vulnerability, community resilience, and expected annual loss.

As Figure 16 shows, natural hazard risk in Des Moines is generally relatively low. However, areas in central and eastern Des Moines are at higher risk than other regions of the city, primarily due to high expected annual loss associated with a high density and value of buildings and populations.

The Centers for Disease Control and Prevention (CDC) Social Vulnerability Index uses 15 census variables to indicate potential negative effects on communities caused by external stresses on human health, such as natural disasters or disease outbreaks (CDC, 2020). Figure 17 overlays the CDC Social Vulnerability Index with communities identified as disadvantaged by the Climate and Economic Justice Screening Tool developed by the U.S. Council on Environmental Quality (Council on Environmental Quality, 2022) to identify areas and populations that may be particularly susceptible to the impacts of climate change. The goal of the Justice40 Initiative is to provide 40 percent of the overall benefits of certain Federal investments in seven key areas (climate change, clean energy and energy efficiency, clean transit, affordable and sustainable housing, training and workforce development, the remediation and reduction of legacy pollution, and the development of critical clean water infrastructure) to disadvantaged communities. Looking at both of these resources will help Des Moines focus climate action and adaptation investments in areas of need and leverage Federal investment support.

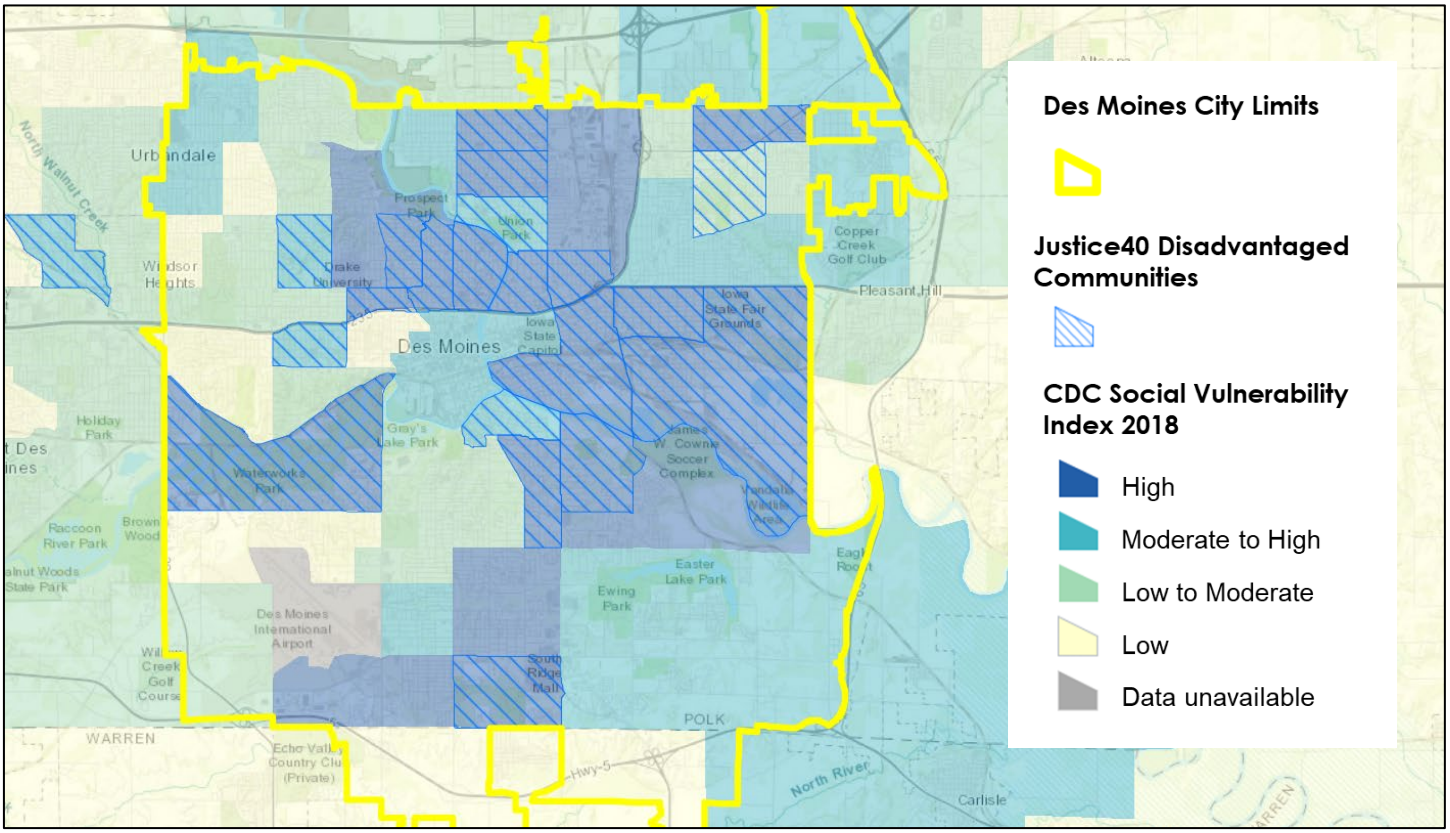


Figure 17. CDC Social Vulnerability Index and Justice 40 Communities.

Areas surrounding central Des Moines, particularly to the East and the North of downtown, have a higher social vulnerability index, and may be more vulnerable to the impact of hazards, pimarily due to indicators of socioeconoomic status (including people living below 150% of the poverty line, unemployment rates, housing cost burden, education and access to health insurance) and household characteristics (including age, disability, single-parent households, and English language proficiency) (CDC, 2020).

SERVICES

Access to basic services also varies across Des Moines and can impact a community's capacity to respond to hazard events and adapt to change. Physical proximity to services such as healthcare, emergency services, social services, education, and public health can impact access and varies spatially throughout Des Moines. Figure 18 shows that community facilities and services are more densely concentrated in downtown and western areas of the city, while eastern and southern Des Moines may be less well served.

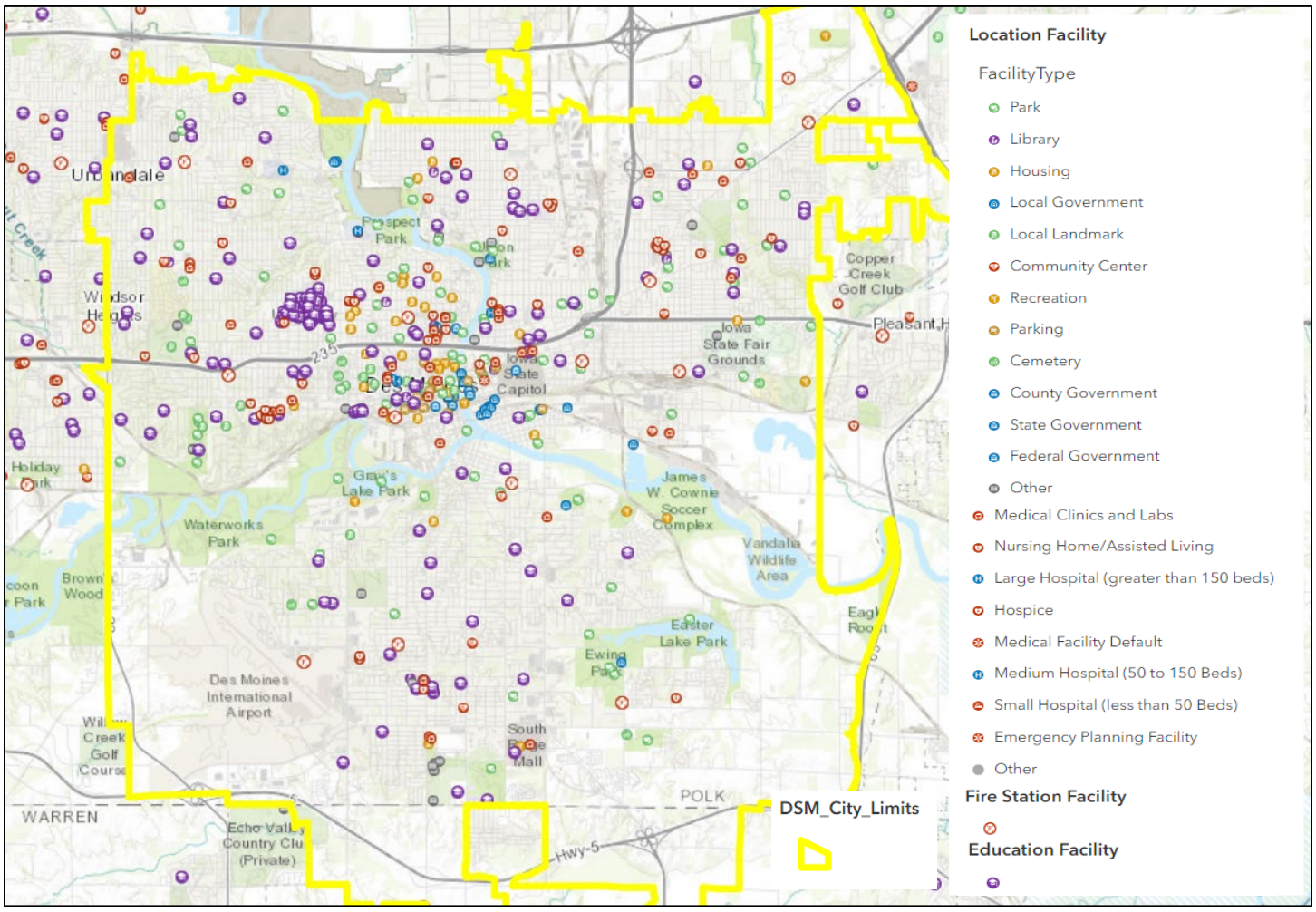


Figure 18. Location of key community facilities and services in Des Moines.

In addition, Figure 19 shows that a significant portion of central Des Moines is medically underserved, according to the Health Resources and Services Administration (HRSA, 2022).

The impact of these patterns in service provision may be compounded further by the socio-economic factors described above. For example, factors such as access to transportation, linguistic isolation, and education may also impact an individual's ability to travel to and navigate services.

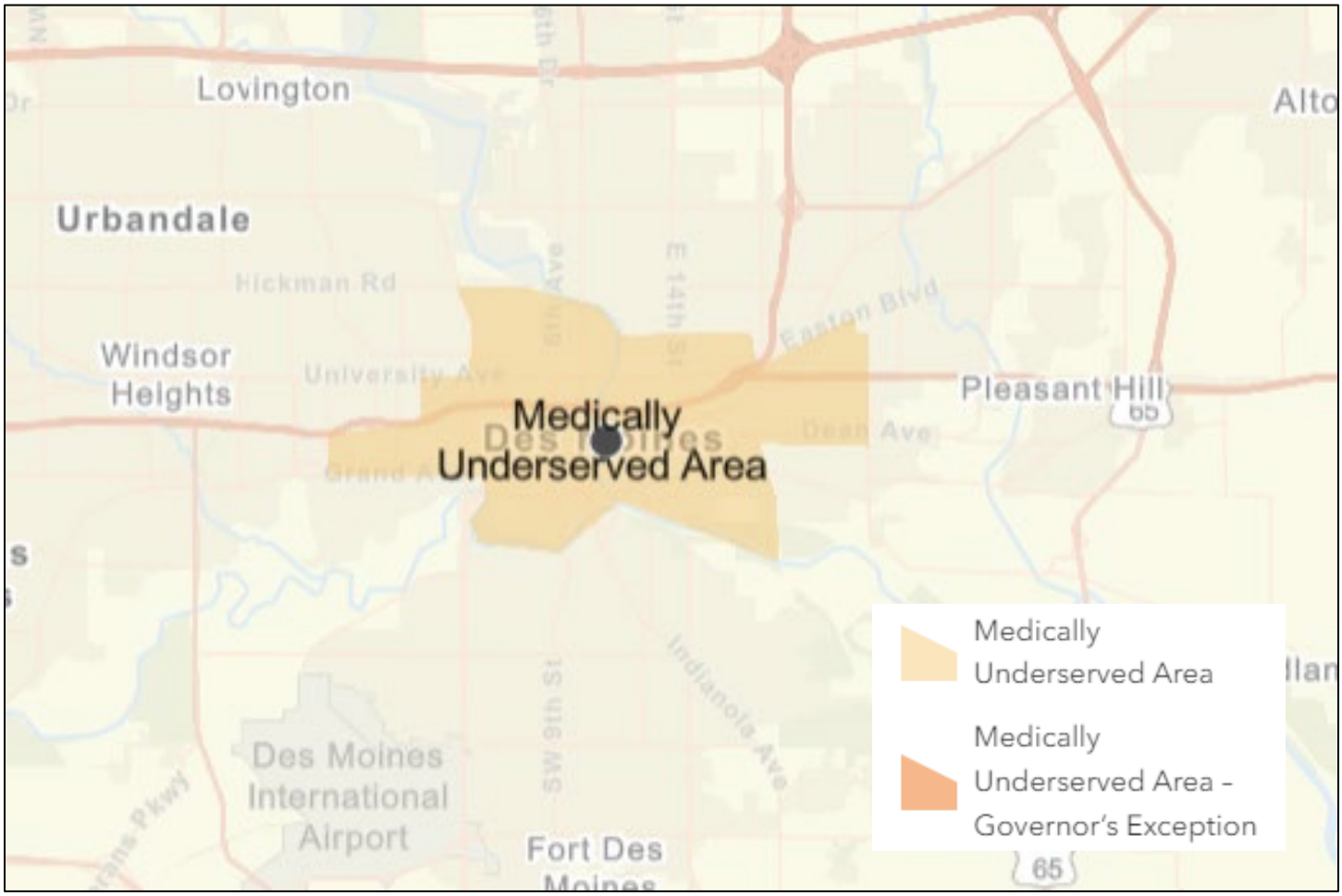


Figure 19. Medically underserved area in Des Moines (HRSA)

GOVERNMENTAL

Governmental systems and structures generally support adapative capacity in Des Moines. Despite a recent decline in the Transparency International Corruptions Perception Index, the US as a whole still has a relatively high level of political engagement and transparency at a global scale (Transparency International, 2021). Polk County had voter turnout higher than the national average during the 2020 election (Transparency International, 2021) and the City of Des Moines has recently added staff capacity and budget to support community climate action and resilience.

PHYSICAL AND ENVIRONMENTAL

The physical environment in Des Moines generally supports adaptive capacity, with no drinking water quality violations and only one unhealthy air quality day in 2022. Des Moines also has low rates of industrial pollution compared to the US average (AARP, 2022). However, the climate hazards described in this RVA are anticipated to worsen over the coming years and could lead to a degradation in environmental conditions and increased strain on infrastructure. For example, the flood protection provided to much of Des Moines by a system of levees is currently being re-evaluated to account for rising discharge levels on the Des Moines River (Polk County, 2019).

PRELIMINARY IDENTIFICATION OF COMMUNITY ADAPTATION STRATEGIES

This section includes a preliminary identification of adaptation strategies based on the results of the Community Risk and Vulnerability Assessment. These strategies will be considered for inclusion in the Des Moines Climate Action and Adaptation Plan (CAAP). Strategies are identified within the CAAP focus areas. No specific adaptation strategies were identified for the Waste Management and Reduction focus area.

Focus Area	Strategy	Extreme Temperatures	Extreme Precipitation & Flooding	Severe Storm & Wind	Water Scarcity & Wildfire	Examples
Energy Supply & Distribution	Increase distributed renewable energy					Rooftop solar, solar gardens
	Expand utility-scale clean energy options					Solar and wind farms
Buildings & Infrastructure	Improve building performance and comfort and increase efficiency	X				Weatherization, thermostats, ventilation, wind and flood resilience
	Advance building electrification					Change natural gas systems and appliances to electric
	Ensure reliable and climate-resilient infrastructure	X	X	X		Utility undergrounding, battery storage, levee and bridge improvements, check water and sewer lines
Transportation & Land Use	Plan for efficient land use and development					Walkable neighborhoods, mixed-use development
	Shift trips to bicycling and walking					Walk or bike to destinations instead of driving
	Increase transit access and ridership					More travel on buses and shuttles
	Advance transportation electrification, decarbonization, and alternative fuels					Switch to electric vehicles and equipment, less idling, clear truck delivery routes

Focus Area	Strategy	Extreme Temperatures	Extreme Precipitation & Flooding	Severe Storm & Wind	Water Scarcity & Wildfire	Examples
Natural Systems & Water Resources	Increase urban tree canopy and biodiversity	X	X	X		Increased tree canopy in heat island areas, native plant species
	Enhanced watershed management and source water protection	X	X		X	Green infrastructure, improved riverbanks and wetlands, regenerative agriculture, soil management
	Reduce flood risk		X			Stormwater management, property buy outs
	Reduce treatedwater use		X		X	Water reuse, indoor and outdoor water efficiency
Waste Management & Reduction	Reduce waste generation					Disposable plastics policies, reuse and repair services
	Increase waste diversion					Expanded recycling services, composting, rood recovery programs
	Expand waste recovery					Waste-to-energy infrastructure
Food Systems & Security	Expand local food production	X	X	X		Community and household gardens, working with Regional agricultural producers
	Improve food security and nutrition	X	X	X		Food banks, farmers' markets
Climate Preparedness & Resilience	Amplify climate-related education and individual and community emergency preparedness	X	X	X	X	Classes, online resources, community alerts, emergency evacuation plans
	Create climate resilience hubs/shelters	X	X	X		Cooling centers, communications kiosks
	Prepare for climate migration and displaced people	X	X	X	X	Housing, education, social services, and language needs

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APPENDIX I: KEY TERMS

There are several key terms that are used throughout this RVA. These terms help build a common foundation of community understanding about climate action and its various components:

Key Term	Definition
Adaptive Capacity	The ability of a person, asset, or system to adjust to a hazard, take advantage of new opportunities, or cope with change (U.S. Climate Resilience Toolkit, 2021).
Climate Action	Activities or tactics to reduce greenhouse gas emissions and strengthen resilience and adaptation to climate-induced impacts.
Climate Adaptation	Activities that help communities cope with the effects of climate change.
Climate Change	Long-lasting changes in average weather conditions encompassing both increases and decreases in temperature as well as shifts in precipitation, severe weather events, and other features of the climate system, including changes accelerated by human activity.
Climate Equity	Climate action that is inclusive of environmental justice and racial and economic equity. Equitable climate actions reduce disparate harms from the effects of climate change by prioritizing frontline communities. Equity is a conduit for climate justice.
Climate Exposure	The presence of people, assets, and ecosystems in places where they could be adversely affected by hazards (U.S. Climate Resilience Toolkit, 2021).
Climate Justice	A shift from a discourse on greenhouse gases and global warming into a civil rights movement with the people and communities most vulnerable to climate impacts at its core.
Climate Mitigation	Interventions to reduce the human impact on the climate system. Specific interventions to reduce greenhouse gas emissions are commonly referred to as "emissions mitigation."
Climate Resilience	The ability and extent to which systems can prepare and plan for, absorb, respond to, recover from, and adapt to the effects of climate-related shocks and chronic stressors.
Climate Risk	Potential adverse consequences for humans and social, ecological, and economic systems resulting from the interaction of climate-related hazards that expose the vulnerabilities of societies and systems.
Climate Sensitivity	The degree to which a system, population, or resources is or might be affected by climate hazards (U.S. Climate Resilience Toolkit, 2021).
Climate Vulnerability	The potential to be adversely affected by climate change due to geographic, social, economic, or other conditions. Reference to "vulnerable" populations is in the context of acknowledging system deficiencies, rather than judgement of individuals or their neighborhoods.
Frontline Community	Population groups and/or areas that experience the first and worst consequences of climate change.
Greenhouse Gas (GHG)	Gases in the atmosphere that absorb and emit radiation and significantly contribute to climate change. The primary greenhouse gases in the earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone.

Appendix II: Climate Hazard Classification

Current Hazard Risk Level

The current risk posed by each climate hazard was determined through evaluation of past frequency, severity, and impacts described in existing plans, historic weather and climate data, and input received from local stakeholders and experts in the field. Current Hazard Risk levels align with the definitions drawn from CDP guidance below (CDP, 2021):

High	The hazard represents the highest level of potential concern for Des Moines. You anticipate that should it occur, the hazard would result in extremely serious impacts to your city and catastrophic interruption to day-to-day life.
Medium high	The hazard represents a high level of potential concern for Des Moines. You anticipate that should it occur, the hazard would result in serious impacts to your city and interruption to day-to-day life.
Medium	The hazard represents a medium level of potential concern for Des Moines. You anticipate that should it occur, the hazard would result in impacts to your city, but that these would be moderately significant to day-to-day life.
Medium low	The hazard represents a lower level of potential concern for Des Moines. You anticipate that should it occur, the hazard would result in impacts to your city, but that these would be less significant to day-to-day life.
Low	The hazard represents the lowest level of potential concern for Des Moines. You anticipate that should it occur, the hazard would result in impacts to your city, but that these would be insignificant in day-to-day life.

Future Hazard Risk Level

The future risk posed by each climate hazard was determined based on the current hazard level and anticipated change in frequency and intensity based on a review of climate science literature. Anticipated future risk is described using the same scale as current hazard risk level.

Tier	Climate Hazard	Current Hazard Risk Level	Future Change	Future Hazard Risk Level	Cascading / Related Risks	Source(s)
Extreme Hot Temperatures						
Tier 1	Extreme hot days	Medium	Increasing	**Medium High**	Thunderstorms Extreme precipitation Ozone pollution Infectious disease	Current Risk: (Iowa State University, 2022) Future Risk: (NOAA, 2022), (Temperate, 2022), (Iowa Department of Natural Resources, 2022)
Tier 1	Heat wave	Medium	Increasing	**Medium High**	Thunderstorms Extreme precipitation Ozone pollution Infectious disease	Current Risk: (Polk County, 2019), (Iowa State University, 2022), (NOAA NCDC, 2022)
Extreme Cold Temperatures						
Tier 2	Cold wave	Medium	Decreasing	**Medium Low**	River flooding	Current Risk: (Polk County, 2019), (High Plains Regional Climate Center, 2022) Future Risk: (NOAA, 2022)
Tier 2	Extreme cold days	Medium High	Decreasing	**Medium**		Current Risk: (Polk County, 2019) (High Plains Regional Climate Center, 2022) Future Risk: (NOAA, 2022)
Tier 2	Extreme winter conditions	Medium	Decreasing	**Medium Low**		Future Risk: (NOAA, 2022)
Extreme Precipitation & Flooding						
Tier 1	Flash / surface flood	Medium	Increasing	**Medium High**	Structure fires Sink holes River flooding	Current Risk: (Polk County, 2019), (NOAA NCDC, 2022) Future Risk: (NOAA, 2022), (Tackle, 2022)
Tier 1	Hail	Medium High	Uncertain	**Medium High**		Current Risk: (NOAA NCDC, 2022), (Polk County, 2019)
Tier 1	Permanent inundation	Medium Low	Increasing	**Medium**		Current Risk: (Polk County, 2019)
Tier 1	Rainstorm	High	Increasing	**High**	Landslides Subsidence Water-borne disease	Current Risk: (Polk County, 2019), (NOAA NCDC, 2022) Future Risk: (Tackle, 2022). (NOAA, 2022)

Tier	Climate Hazard	Current Hazard Risk Level	Future Change	Future Hazard Risk Level	Cascading / Related Risks	Source(s)
Tier 1	River flood	High	Increasing	**High**	Landslides Subsidence Water-borne disease	Current Risk: (Polk County, 2019) (National Weather Service Quad Cities IA/IL, 2022) Future Risk: (NOAA, 2022), (Tackle, 2022)
Tier 2	Heavy snow	Medium	Uncertain	**Medium**	River flooding	Current Risk: (NOAA NCDC, 2022), (FEMA, 2022), (NOAA, 2022), (Polk County, 2019) Future Risk: (NOAA, 2022)
Tier 2	Fog	Low / Uncertain	Uncertain	**Low / Uncertain**		Current Risk: (Polk County, 2019)
Tier 2	Groundwater flood	Low / Uncertain	Uncertain	**Low / Uncertain**		
N/A	Coastal Flood	N/A	N/A	N/A	N/A	
N/A	Monsoon	N/A	N/A	N/A	N/A	
Severe Storm & Wind						
Tier 1	Severe wind/derecho	Medium High	Possible Increase	**Medium High**	Wildfire	Current Risk: (NOAA NCDC, 2022), (FEMA, 2022), (City of Des Moines, 2021)
Tier 1	Tornado	Medium	Possible Increase	**Medium**		Current Risk: (NOAA NCDC, 2022), (City of Des Moines, 2021), (Polk County, 2019) Future Risk: (EPA, 2016)
Tier 1	Lightning / Thunderstorms	Medium Low	Uncertain	**Medium Low**	Wildfire Flash flooding	Current Risk: (NOAA NCDC, 2022), (FEMA, 2022)
N/A	Cyclone	N/A	N/A	N/A	N/A	
N/A	Extra tropical storm	N/A	N/A	N/A	N/A	
N/A	Storm surge	N/A	N/A	N/A	N/A	
N/A	Tropical storm	N/A	N/A	N/A	N/A	
Water Scarcity & Wildfire						
Tier 1	Drought	Medium	Increasing	**Medium High**	Flash flooding	Current Risk: (US Drought Monitor, 2022), (University of Northern Iowa, 2017), (Polk County, 2019) Future Risk: (NOAA, 2022)
Tier 1	Land fire	Low	Increasing	**Medium**		Current Risk:

Tier	Climate Hazard	Current Hazard Risk Level	Future Change	Future Hazard Risk Level	Cascading / Related Risks	Source(s)
						(Polk County, 2019)
Tier 2	Forest fire	Low	Increasing	Medium Low		Current Risk: (Polk County, 2019), (University of Wisconsin Silvis Lab, 2022)
Mass Movement						
Tier 2	Landslide	Medium Low	Increasing	Medium Low	Flash flooding River flooding Rainstorm	Current Risk: (Polk County, 2019)
Tier 2	Rock fall	Low	Uncertain	Low	Flash flooding River flooding Rainstorm	
Tier 2	Subsidence	Medium Low	Increasing	Medium Low	Flash flooding River flooding Rainstorm	(Polk County, 2019)
N/A	Avalanche	N/A	N/A	N/A	N/A	
Biological Hazards						
Tier 2	Air-borne disease	Uncertain	Uncertain	Uncertain		
Tier 2	Insect infestation	Medium Low	Possible increase	Medium Low		
Tier 2	Vector-borne disease	Medium Low	Possible increase	Medium Low		Future Risk: (IPCC, 2022)
Tier 2	Water-borne disease	Medium Low	Possible increase	Medium Low		Future Risk: (IPCC, 2022)
Chemical Change						
Tier 2	Atmospheric CO_2 concentrations	Uncertain	Increasing	Uncertain		
N/A	Ocean acidification	N/A	N/A	N/A	N/A	
N/A	Salt water intrusion	N/A	N/A	N/A	N/A	

APPENDIX III: FACTORS AFFECTING ADAPTIVE CAPACITY

Services		
Factor/Examples	**Supports or Challenges Adaptive Capacity**	**Supporting Data and Notes**
Access to basic services	Both	Access to basic services varies across Des Moines, with access and/or proximity to services supporting adaptive capacity for some residents and lack of accessible basic services challenging adaptive capacity for others. Factors that can challenge access to basic services include location and housing affordability, the availability of affordable transportation, and linguistic isolation.
Access to healthcare	Challenges	A significant portion of Des Moines is located in designated Health Professional Shortage Areas (HPSAs) for primary care providers and central Des Moines is identified by the Health Resources and Services Administration as a medically underserved area (HRSA, 2022).
Access to education	Challenges	Des Moines has higher percentage of people over age 25 with no high school degree (13.3%) compared to the US (11.5%). Des Moines also has lower levels of total population with a bachelor's degree (27.9%) or graduate degree (8.5%) than the US (32.9% bachelors or higher; 12.7% graduate degree) (U.S. Census Bureau, 2020).
Public health	Challenges	Polk County is ranked in the higher-middle range of counties in Iowa for health outcomes including life expectancy and quality of life, but in the lower-middle for health factors such as health behaviors, clinical care, socio-economic factors, and physical environment (University of Wisconsin Population Health Institute, 2022). The Polk County Health Outcomes (Polk County, 2019) and Health Behaviors (Polk County, 2019)maps show how different health factors vary across the city.

Socio-economic		
Factor/Examples	**Supports or Challenges Adaptive Capacity**	**Supporting Data and Notes**
Cost of living	Supports	Des Moines has a relatively low cost of living compared to the national average. For example, an average homeowner in Des Moines spends $6,106, compared to a national average of $6,615 (DSM Partnership, 2022)
Housing	Supports	In 2022, Des Moines residents spent an average of 13.4% of household on housing, down from a 2015 value of 14.9%. This is lower than the U.S. average of 16.3%. Average housing costs in Des Moines were $993 in 2022, compared to a national average of $1,057 (AARP, 2022).
Poverty	Challenges	Approximately 16% of all people in Des Moines live in poverty, higher than the national average of 11.4% (U.S. Census Bureau, 2020).
Inequality	Challenges	Des Moines has a Gini coefficient of income inequality of 0.44, similar to the US value of 0.46 (AARP, 2022). However, Des Moines has a history of redlining and marginalization of minority and vulnerable populations which has historically challenged the city. The city of Des Moines is focusing new efforts on justice, equity, diversity, and inclusion.
Unemployment	Supports	Des Moines has an employment rate of 69.8% among the civilian labor force over 16 years, higher than the national average of 63% (U.S. Census Bureau, 2020)
Migration	Both	In 2022 Greater Des Moines was the fastest-growing major Midwest metro (DSM Partnership, 2022) and the city is seeing an influx of young professionals and families seeking a balanced lifestyle, This growth is due in part to the city's appearance on numerous "Best of" lists, a strong job market, low cost of living, public events, and access to greenspace and recreational opportunities. Migration supports the region's economy but could also place additional strain on the city's housing, education and other community systems and services. Migration may increase as climate change impacts worsen in other areas of the U.S. and the world.
Economic health	Supports	The inflation adjusted Gross Domestic Product (GDP) of the Des Moines-West Des Moines Metropolitan Area has grown by an annual average of 3% since 2002 (U.S. Bureau of Economic Analysis, 2021).
Economic diversity	Supports	Des Moines has a relatively diverse economy with the top three industries in Polk County in Finance and Insurance (13%), Health care and social assistance (11%), and Government (10%) (Headwaters Economic Alliance, 2020).

Governmental		
Factor/Examples	**Predominantly Supports or Challenges Adaptive Capacity**	**Supporting Data and Notes**
Political stability	Both	Recent elections of the mayor and council members in 2019 established a framework for a number of years of leadership to support sustainability initiatives and climate change planning. This helps ensure that initiatives that support climate adaptation and capacity can be developed and executed while experiencing relatively broad support across city government. However, national political polarization has led to increased reliance on state and local governments to address climate change planning. State-level efforts on climate tend to be politicized.
Political engagement / transparency	Supports	As a nation, the US ranks 27th out of 180 countries on the Corruptions Perception Index prepared by Transparency International and while this index has been declining in recent years (Transparency International, 2021), the U.S. still has a relatively high level of political engagement and transparency at a global scale. Polk County saw 73% voter turnout in the 2020 election, slightly higher than the national average. Municipal elections appear to have a voter turnout of 13 – 20% (Polk County Supervisor of Elections, 2022).
Government capacity	Supports	The City of Des Moines has recently added resources and expertise that enabled development of this climate action and adaptation plan. Partnerships with local universities and planning organizations at other government levels will enhance planning capacity. The majority of elected officials are supportive of climate and sustainability planning and will help to support the process.
Budgetary capacity	Challenges	The current patterns demonstrated by localized climate change make it difficult to budget and identify key financial resources to make targeted and impactful improvements. Near term planning efforts will help identify budget needs and prioritize investments. Signs are positive that the City's fiscally conservative budgeting will enable continued investment in climate efforts.
Safety and security	Unknown	

Land use planning	Supports	The City of Des Moines has strong land use plans, policies and regulations in place to guide land use and development patterns. PlanDSM, the City's Comprehensive Plan, will be updated in 2022. The city has also adopted a series of district and neighborhood plans. Future updates to these plans can address climate change vulnerabilities and adaptation strategies more directly.
Access to quality/relevant data	Supports	There are multiple organizations in Des Moines and across Iowa collecting and publishing climate related data.
Community engagement	Supports	The establishment of a resident-led Task Force on Sustainability several years ago has helped foster community support for climate action planning and adaptation efforts. The task force was instrumental in advocating for the creation of a Sustainability Program Manager. This position was filled in May 2020 and is tasked with developing citywide sustainability strategy across city government and within the broader community. Further the City has also partnered with ICLEI, the University of Northern Iowa and Green Iowa AmeriCorps to leverage several externs to contribute to supporting sustainability projects. These externs have assisted with the City's updated GHG inventory, CAAP RFP development and other projects. Externs have already worked with the Sustainability Program Manager to identify key stakeholders and develop a survey to gauge community needs and encourage participation in climate planning efforts.

Physical & Environmental		
Factor/Examples	**Supports or Challenges Adaptive Capacity**	**Supporting Data and Notes**
Rapid urbanization	Challenges	See notes related to Migration above.
Resource availability	Challenges	Competition for limited or costly resources such as food, shelter, energy, and water challenges community adaptive capacity for those who lack financial or physical access to resources.
Environmental conditions	Both	Des Moines generally has a good baseline of environmental conditions with 0% of people exposed to drinking water quality violations, only 1 unhealthy air day and low rates of local industrial pollution in 2022 compared to the US average (AARP, 2022). However, the climate hazards described in this RVA are anticipated to worsen over the coming years and could lead to a degradation in environmental conditions.
Infrastructure conditions / maintenance	Supports	A new local option sales tax provides additional resources for investment in citywide infrastructure projects to improve mitigation and adaptive capacity. Improvement and expansion of alternative transit systems and bicycle networks increase mobility while creating the potential for reduce transportation related emissions. Stormwater programs support both traditional infrastructure and green infrastructure with specific funding mechanisms to support large scale and residential projects.
Infrastructure capacity	Both	Des Moines has funding for infrastructure improvements and expansions, as described above. However, existing infrastructure and standards, including a system of levees and dams that protect Des Moines from flooding may need to be reevaluated in light of future climate projections.

APPENDIX IV: COMMUNITY FACILITIES AND SERVICES LOCATED IN FLOOD RISK AREAS

Data Sources: City of Des Moines Data Portal (2022), ESRI Feature layer of USA Flood Hazard Areas from the Federal Emergency Management Agency (2022)

Name	Address	Facility Type	Facility Owner	USA Flood Hazard
Gray's Lake	1701 Fleur Dr	Park	Des Moines	Regulatory Floodway
Waterworks Park	2201 George Flagg Pkwy	Park	Des Moines	Regulatory Floodway
Sargent Park	3500 E Douglas Ave	Park	Des Moines	Regulatory Floodway
Easttown Park	2559 Hubbell Ave	Park	Des Moines	Regulatory Floodway
Prospect Park	1225 Prospect Rd	Park	Des Moines	1% Annual Chance Flood Hazard
Carney Park	2780 SW 30th St	Park	Des Moines	1% Annual Chance Flood Hazard
James W Cownie Soccer Complex	2600 Hartford Ave	Recreation	Des Moines	1% Annual Chance Flood Hazard
Easton Basin Park	2617 Easton Blvd	Park	Des Moines	1% Annual Chance Flood Hazard
Principal Park	1 Line Dr	Park	Des Moines	1% Annual Chance Flood Hazard
Birdland Park	2100 Saylor Rd	Park	Des Moines	1% Annual Chance Flood Hazard
Birdland Marina	2100 Saylor Rd	Marina	Private	1% Annual Chance Flood Hazard
Grays Lake Terrace Building	2101 Fleur Dr	Recreation	Des Moines	1% Annual Chance Flood Hazard
Pocket Park # 2	2830 E 35th St	Park	Des Moines	1% Annual Chance Flood Hazard
East Side Library	2559 Hubbell Ave	Library	Des Moines	1% Annual Chance Flood Hazard
Des Moines Municipal Housing Agency	2309 Euclid Ave	Local Government	Des Moines	1% Annual Chance Flood Hazard
Polk County River Place	2309 Euclid Ave	County Government	Private	1% Annual Chance Flood Hazard
Polk County Health Services	2309 Euclid Ave	County Government	Polk County	1% Annual Chance Flood Hazard
Sleepy Hollow Sports Park	4051 Dean Ave	Recreation	Private	0.2% Annual Chance Flood Hazard
Taylor House Hospice	3401 E Douglas Ave	Care	Private	0.2% Annual Chance Flood Hazard
University of Iowa	6100 Grand Ave	College	State	0.2% Annual Chance Flood Hazard
Jim Muto Recreation Area	700 Robert D Ray Dr	Park	Des Moines	Area with Reduced Risk Due to Levee
Brenton Skating Plaza	520 Robert D Ray Dr	Recreation	Des Moines	Area with Reduced Risk Due to Levee
Historic Des Moines City Hall	400 Robert D Ray Dr	Local Government	Des Moines	Area with Reduced Risk Due to Levee
Argonne Armory Building	602 Robert D Ray Dr	Local Government	Des Moines	Area with Reduced Risk Due to Levee
Riverview Park	701 Corning Ave	Park	Des Moines	Area with Reduced Risk Due to Levee
Fleet Service Center	212 Raccoon St	Local Government	Des Moines	Area with Reduced Risk Due to Levee
Public Works Yard South	903 SE 22nd St	Local Government	Des Moines	Area with Reduced Risk Due to Levee

Name	Address	Facility Type	Facility Owner	USA Flood Hazard
Shelter - Freedom for Youth Ministries	1425 2nd Ave	Housing	Private	Area with Reduced Risk Due to Levee
Birdland Sports Park	300 Holcomb Ave	Park	Des Moines	Area with Reduced Risk Due to Levee
Birdland Pool	300 Holcomb Ave	Pool	Des Moines	Area with Reduced Risk Due to Levee
Public Works Solid Waste	110 SE 6th St	Local Government	Des Moines	Area with Reduced Risk Due to Levee
US District Courthouse Annex	110 E Court Ave	Federal Government	Federal Government	Area with Reduced Risk Due to Levee
Shelter - Central Iowa Shelter Services	1420 Mulberry St	Housing	Private	Area with Reduced Risk Due to Levee
Parking Meter Shop	216 SE 5th St	Local Government	Des Moines	Area with Reduced Risk Due to Levee
Sign/Paint Shop	216 SE 5th St	Local Government	Des Moines	Area with Reduced Risk Due to Levee
Public Works Complex	216 SE 5th St	Local Government	Des Moines	Area with Reduced Risk Due to Levee
Public Works Vactor Shed	310 SE 4th St	Local Government	Des Moines	Area with Reduced Risk Due to Levee
Christopher Columbus Park	1921 SE 1st St	Park	Des Moines	Area with Reduced Risk Due to Levee
Crivaro Park	1105 E Railroad Ave	Park	Des Moines	Area with Reduced Risk Due to Levee
Shelter - Youth Emergency Services YESS	918 SE 11th St	Housing	Private	Area with Reduced Risk Due to Levee
US District Courthouse	123 E Walnut St	Federal Government	Federal Government	Area with Reduced Risk Due to Levee
Science Center	401 W Martin Luther King Jr Pkwy	Recreation	Private	Area with Reduced Risk Due to Levee
Park and Recreation Service Center	1300 Scott Ave	Local Government	Des Moines	Area with Reduced Risk Due to Levee
City of Des Moines Facility Building	1300 Scott Ave	Local Government	Des Moines	Area with Reduced Risk Due to Levee
Southeast Water Trough	1000 Scott Ave	Local Landmark	Des Moines	Area with Reduced Risk Due to Levee
Cohen Park	1000 Scott Ave	Park	Des Moines	Area with Reduced Risk Due to Levee
Richard A Clark Municipal Service Center	1551 E Martin Luther King Jr Pkwy	Local Government	Des Moines	Area with Reduced Risk Due to Levee
Frisbie Park	6101 Muskogee Ave	Park	Des Moines	Area with Reduced Risk Due to Levee
DaVita Riverpoint Dialysis	501 SW 7th St	Care	Private	Area with Reduced Risk Due to Levee
North High School	501 Holcomb Ave	Education	Des Moines Public Schools	Area with Reduced Risk Due to Levee
Mckinley Elementary School	1610 SE 6th St	Education	Des Moines Public Schools	Area with Reduced Risk Due to Levee
Science Center Preschool	401 W Martin Luther King Jr Pkwy	Education	Des Moines Public Schools	Area with Reduced Risk Due to Levee
Commigo Early Education Center	828 Scott Ave	Education	Des Moines Public Schools	Area with Reduced Risk Due to Levee
Des Moines Fire Station 6	1919 SE 6th St	Fire Station	Des Moines	Area with Reduced Risk Due to Levee

Name	Address	Facility Type	Facility Owner	USA Flood Hazard
DMPD Main Police Station	25 E 1st St	Police Station	Des Moines	Area with Reduced Risk Due to Levee
DMPD Narcotics and Homeland Security	103 E 2nd St	Police Station	Des Moines	Area with Reduced Risk Due to Levee
5-0 Athletic Club	106 SE 1st St	Police Station	Des Moines	Area with Reduced Risk Due to Levee
DMPD Radio Shop	201 SE 4th St	Police Station	Des Moines	Area with Reduced Risk Due to Levee
Police Garage	140 E 2nd St	Police Station	Des Moines	Area with Reduced Risk Due to Levee
ARL Animal Care and Control Center	1615 SE 14th St	Care	Des Moines	Area with Reduced Risk Due to Levee
ARL Animal Care and Control Storage	1615 SE 14th St	Care	Des Moines	Area with Reduced Risk Due to Levee