

# Climate Risk & Vulnerability Assessment

## Introduction

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From flooding to drought, tornados, ice storms, and extreme heat, the Kansas City region has a long history of confronting natural hazards. Understanding how climate change might exacerbate the region's risks and vulnerabilities to extreme weather is fundamental to formulating strategic priorities to achieve our vision of health, resilience and sustainability. This Climate Risk and Vulnerability Assessment (CRVA) sets the stage for community discussions about how these issues may be addressed in the future.

A downscaled climate model for the Kansas City region, published in 2016, forecasts how climate change may affect our region. The metro area can reasonably anticipate changes to heat and precipitation patterns in the coming years. Changes in precipitation are projected to lead to increased frequency, intensity and duration of storm events, causing anticipated impacts such as flooding, stream bank erosion and weakened water quality. Extended periods of rain-free days in the summer months are anticipated to accompany a more than twentyfold increase in the number of extremely hot days.

The impacts and implications of climate change are diverse. Changes in precipitation patterns — be it flood or drought — cause increased risks to infrastructure and property. More extreme heat and flooding also impact public safety. The structure, dynamics and productivity of agricultural and natural systems will be subject to changes in temperature and precipitation regimes. Extreme heat, air and water quality impairments, and increased allergens all pose significant public health challenges, with the greatest burden placed on frontline communities; economic impacts are anticipated to affect vulnerable communities in a disproportionate manner.

### Key Definitions

**Hazard:** The potential occurrence of a natural or human-induced physical event or trend, or their physical impacts, that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. The term hazard usually refers to climate-related physical events or trends or their physical impacts (GCoM, 2019).

**Exposure:** The presence of people; livelihoods; species or ecosystems; environmental functions; services; resources; infrastructure; or economic, social or cultural assets in places and settings that could be adversely affected (GCoM, 2019).

**Vulnerability:** The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (GCoM, 2019).

**Resilience:** The capacity of social, economic and environmental systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation (GCoM, 2019).

**Adaptive Capacity:** The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences (GCoM, 2019).

And yet, the region has a long track record of addressing such issues — from rebuilding Union Station after the flood of 1903 to bouncing back from recurring floods, tornadoes and ice storms. The CRVA allows the overlay of a climate lens to anticipate a new normal and position the region to better anticipate and respond to emerging chronic and acute threats.

## Components of the CRVA

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This CRVA is a starting point to better understand where our risks and vulnerabilities lie. It is not meant to provide detailed insight at a community level but will highlight areas for further exploration within community conversations.

In order to best serve ongoing conversation and planning, the CRVA is organized into the following sections:

- **Community Profile** – This profile gives a snapshot of the assessment area, including sociodemographic information.
- **Climate Outlook** – This section provides an overview of projected impacts the region will likely face as a result of climate change.
- **Natural Hazards** – This section summarizes the hazards of greatest concern to the region, the anticipated risks and impacts of the hazards, as well as associated vulnerable communities that will be most disproportionately impacted.
- **Social Vulnerability Assessment** – This section focuses on geographically identifying the most vulnerable communities in our region, generally, but also through the lens of extreme and urban heat, flooding and tornadoes.
- **Adaptive Capacity** – This section assesses a variety of indicators that challenge the region’s or individual communities’ ability to adapt and build resilience in the face of climate change.
- **Conclusion & Recommendations** – This final section defines next steps in the climate action planning process and provides recommendations on areas that need further exploration, potential climate adaptation and hazard mitigation action areas, and best methods for inclusion of this information in the subsequent phases of the planning process.

## Community Profile

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### Planning Area

The planning boundary for the Climate Action Plan and CRVA include the nine counties in the MARC region with the addition of Douglas County, Kansas. These 10 counties together represent a large and diverse region with a population of over 2.1 million people and over 900,000 housing units.



Figure 1. 10-county planning area for the Regional Climate Action Plan

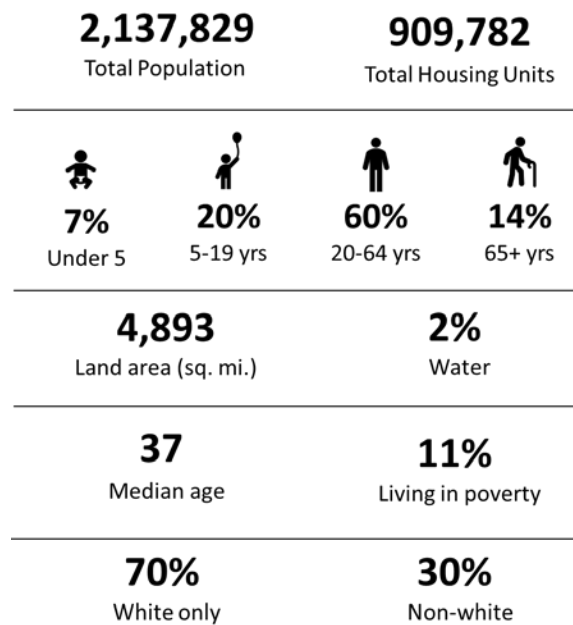
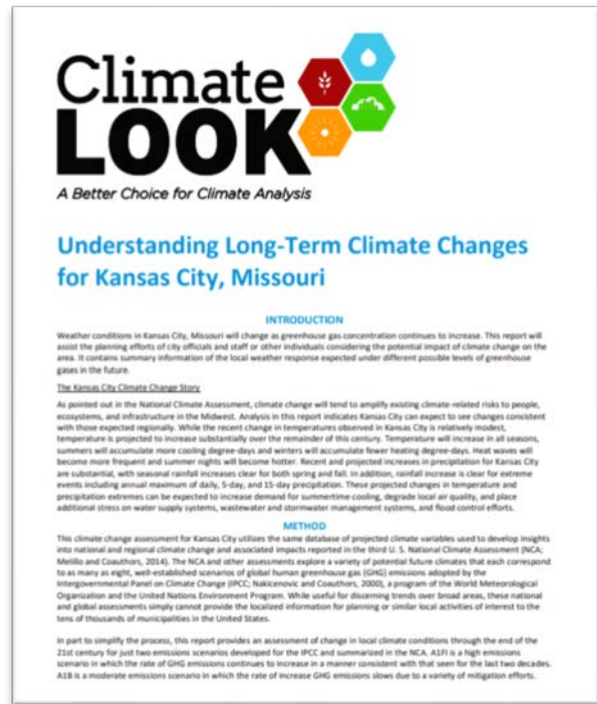


Figure 2. Sociodemographic snapshot of the planning area.

# Climate Outlook for the Kansas City Area

The report *Understanding Long-Term Climate Changes for Kansas City, Missouri* (2016) quantifies potential changes in extreme weather in the region for 2060 and 2100 under two climate scenarios — one that projects the current trend, with high greenhouse gas emission growth, and a second that assumes more moderate emissions growth. This climate change will tend to amplify existing climate-related risks to people, ecosystems and infrastructure in Kansas City and throughout the Midwest. Trends described in the report focus on expected changes in precipitation and temperature.

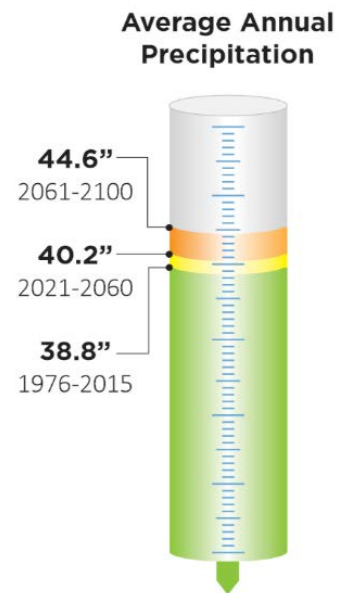
It should be noted that while the report focuses solely on Kansas City, Missouri, the outlook is assumed to be relevant to the entire region for the purposes of this assessment.



## Precipitation

Recent and projected increases in annual precipitation for the Kansas City area are substantial, with concentrated seasonal rainfall during extreme events for both spring and fall, while the length of consecutive dry days will increase substantially in summer months. Extending current trends to 2100:

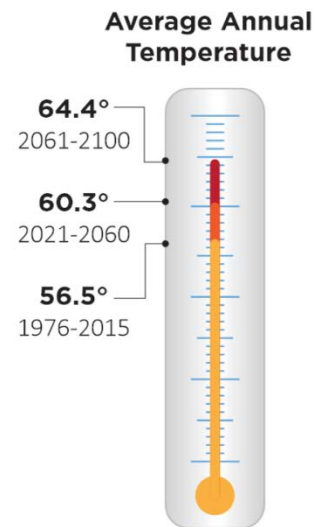
- Average annual precipitation will increase from 38.8" to 44.6" per year.
- Maximum one-day precipitation will increase from 3.4 to 4.0 inches, while five-day and 15-day precipitation will increase from 5.5 to 7.0 inches and 7.5 to 10.4 inches, respectively.
- The number of days with more than 1.5" of precipitation will increase from 5.0 to 9.3.
- The maximum number of consecutive dry days will increase from 30.9 to 39.5 days per year.



## Temperature

While recent changes in temperatures observed in the Kansas City region have been relatively modest, temperature is projected to increase substantially in all seasons over the remainder of this century. Heat waves will become more frequent and summer overnight lows will become hotter. If current trends continue, by 2100:

- The average annual temperature will increase from 56.5°F to 64.4°F.
- The number of days per year in which the temperature exceeds 105°F will increase from 0.7 to 21.9.
- The number of cooling degree days, a reflection of the demand for energy needed to cool a building, will nearly double. Conversely, energy demand for heating will decline by 27%.
- The last spring frost is projected to be more than two weeks earlier, whereas the first fall frost will occur about 11 days later.



Projected changes in temperature and precipitation extremes can be expected to increase demand for summertime cooling, degrade local air quality, and place additional stress on water supply systems, wastewater and stormwater management systems, and flood control efforts. Near-term climate resilience efforts might be best focused on water systems than on heat adaptation, because changes in rainfall are already present and expected to continue, while rising temperatures are an emergent change.

Another report, [Risky Business: The Economic Risks of Climate Change in the United States](#), suggests increased heat will lead to an increase of 5.3% in violent crime solely due to higher temperatures, decreased labor productivity of 2.3%, and increased energy demand of 8–19%. Many reports predict that the impacts of changes in extreme weather will likely affect disadvantaged communities in a disproportionate manner.

## Natural Hazards

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Understanding the natural hazards that pose the greatest risks to the Kansas City region is critical to discussions about vulnerabilities and how plans support the region’s ability to adapt and stay resilient in the face of these hazards. In 2019, MARC began updating its Hazard Mitigation Plan for the Missouri counties in our region. The [Hazard Mitigation Plan](#) (2020) identifies those hazards that pose the greatest risk to our region: flooding, heat, drought, severe thunderstorms, severe winter weather and tornados. The plan also includes information on the experience of the community with these hazards, local government capabilities to address or reduce the risks, and goals and actions local jurisdictions are willing to take over the next five years.

This section summarizes the findings from the hazard profiles in the Hazard Mitigation Plan. The full hazard profiles can be found [here](#). Each of the summarized hazard profiles describe the risk level, past and future impacts, and vulnerable groups associated with the hazard.

### Determining risk level for each hazard

The risk level assigned to each hazard informs the prioritization of the most at-risk assets, systems and groups. Risk is determined based on the probability and consequence of a particular hazard. For each hazard, a number is assigned to both probability and consequence and multiplied to assess the risk level.

$$\text{[Risk = Probability x Consequence]}$$

The assigned probability or consequence is based on the following qualitative scales:

#### Probability of a hazard

The probability of a hazard is the likelihood of occurrence based on the following options:

<i>Probability</i>		
3	<i>High</i>	<i>Extremely likely that the hazard occurs (e.g., greater than 1 in 20 chance of occurrence)</i>
2	<i>Moderate</i>	<i>Likely that the hazard occurs (e.g., between 1 in 20 and 1 in 200 chance of occurrence)</i>
1	<i>Low</i>	<i>Unlikely that the hazard occurs (e.g., between 1 in 200 and 1 in 2,000 chance of occurrence)</i>
0	<i>Do not know</i>	<i>The region has not experienced or observed climate hazards in the past or has no ways of accurately reporting this information based on evidence of data</i>

#### Consequence of a hazard

The consequence of a hazard is the outcome, gravity, or impact based on the following options:

<i>Consequence</i>		
3	<i>High</i>	<i>The hazard represents a high (or the highest) level of potential concern for your jurisdiction. When it occurs, the hazard results in extremely serious impacts to the jurisdiction and catastrophic interruptions to day-to-day life.</i>
2	<i>Moderate</i>	<i>The hazard represents a moderate level of potential concern for your jurisdiction. When it occurs, the hazard results in impacts to your jurisdiction, but these are moderately significant to day-to-day life.</i>

1	Low	The hazard represents a lower (the lowest) level of potential concern for your jurisdiction. When it occurs, the hazard results in impacts to your jurisdiction, but these are deemed less significant (or insignificant) to day-to-day life.
0	Do not know	The region has not experienced or observed climate hazards in the past or has no ways of accurately reporting this information based on evidence or data.

### Risk Matrix

The following risk matrix summarizes the risk level for each hazard and how they compare to one another. Based on this methodology and information from the 2020 Hazard Mitigation Plan, the hazards with the highest level of risk for the region are flooding, heat and drought, with flooding considered the greater risk as the region is already experiencing increased flooding events and associated damage. Severe thunderstorms, tornadoes and winter weather have slightly lower risk levels but still are considered significant.

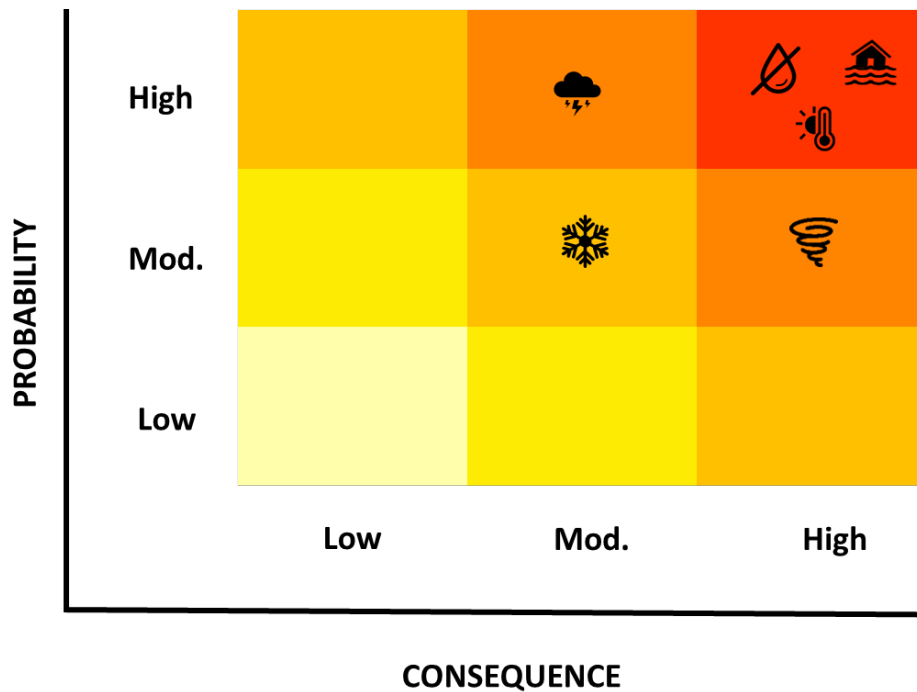


Figure 3. Risk matrix assessing the probability and consequence of each hazard.

## Flooding

Several types of flooding have adversely affected the Kansas City area in the past and are expected to put the region at risk in the future: riverine floods, flash floods and sheet floods. Riverine flooding occurs when rivers, streams, lakes, reservoirs or drainage systems overflow due to excessive rainfall, rapid snowmelt or ice jams. According to FEMA, riverine floods can be either slow- or fast-rising, but generally occur over a period of days, inundating adjacent areas of land. It is these types of floods that can cause the most widespread damage to property. However, flash floods are the most dangerous type of flooding that may affect the Kansas City area. Flash floods — characterized by a rapid accumulation or runoff of surface water — account for most of the flood-related deaths due to the speed at which these floods peak giving little to no warning time. While more difficult to quantify, flooding of homes in neighborhoods not in floodplains and with older or disrupted stormwater and sewer infrastructure, has been occurring and may warrant further exploration and mitigation.

### Past Impacts

Since 1993, the region has suffered a cumulative total 11 deaths, \$1.6 million in crop damages and over \$32 million in property damage as a result of floods, according to the National Center for Environmental Information.

### Future Impacts

In a high emissions scenario, the number of excessive rainfall days (with more than 1.5 inches of precipitation) is expected to increase from 5 to 5.6 by mid-century and 9.3 by end of century. Maximum one-day precipitation is expected to increase from 3.4 to 4 inches, while five-day and 15-day precipitation is expected to increase from 5.5 to 7 inches and 7.5 to 10.4 inches, respectively, by the end of the century.<sup>2</sup> Increased storm-stacking — where rain events occur in quick succession — may contribute to the prevalence of flooding in region.

Risk Level:

High

Change in intensity:



Change in frequency:



Timescale:

Immediate

### Vulnerable Groups

- People with medical/physical conditions or disabilities.
- People who live in flood-prone areas.
- People who are difficult to reach through communications.
- People who are elderly or young children.
- People with a lack of access to transportation.
- Homeowners



## Impacts on sectors, assets and services

Sectors, Assets, and Services	Magnitude of Future Impact <i>Low   Moderate   High   Unknown</i>	Description
<b>Residential</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Housing quality; loss of housing in flood plain; displacement</li> <li>• Residential areas in the flood plain will become less desirable and neighborhoods may degrade</li> </ul>
<b>Energy</b>	<b>Low</b>	<ul style="list-style-type: none"> <li>• Electrical equipment could get flooded</li> </ul>
<b>Public Health</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Mold in basements</li> <li>• Increased environmental hazards (lead, injuries, etc.)</li> <li>• Increased stress and mental health conditions</li> </ul>
<b>Water Supply and Sanitation</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Sewer system overflow or backup</li> <li>• Increased stream bank and bed erosion</li> </ul>
<b>Transport</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Increased frequency of flooded roads</li> <li>• Need for replacement of roads and bridges more frequently</li> </ul>
<b>Emergency Services</b>	<b>Moderate</b>	<ul style="list-style-type: none"> <li>• Emergency access limited by flooded areas/ flooded roads</li> </ul>
<b>Food and Agriculture</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Impact on city through lack of produce from the area</li> <li>• Impact on rural and urban farming</li> <li>• Decreased crop yield will impact economy</li> </ul>
<b>Land Use Planning</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Need for increased planning for stormwater and floodplain management</li> <li>• Lack of green infrastructure and wetlands puts the area at risk</li> </ul>

## Extreme Heat

Almost every summer, heat waves affect the Kansas City metropolitan area. Although the entire region is affected by heat waves, the impact of these prolonged periods of heat and humidity tends to be more severe in urban areas because they absorb and retain more heat than rural or natural areas. In addition, elderly, sick and low-income residents — especially those who live in the urban core or other urbanized areas of the Kansas City region — are more susceptible to heat waves than those who are young, healthy or have access to adequate air conditioning or ventilation.

### Past Impacts

Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. According to NOAA’s Storm Events Database, there have been 27 heat-related deaths and 32 heat-related injuries between 2000 and 2019 within the planning area.

### Future Impacts

In a high emissions scenario, the number of days per year over 105°F is expected to increase from 0.7 to 6.3 by mid-century, and to 21.9 by end of century. The heat wave daytime temperature is expected to increase from 100.3°F to 111.4°F and the nighttime temperature from 79.8°F to 90.2°F by the end of the century. The average annual temperature is expected to increase from 56.5°F to 60.3°F by mid-century, and to 64.4°F by end of century. The number of cooling degree days is projected to nearly double by the end of century.<sup>2</sup> Urban heat will be exacerbated by these evolving heat conditions, impacting neighborhoods with greater coverage of heat-absorbing impervious surfacing and lower tree canopy coverage the most.

**Risk Level:**

**High**

**Change in intensity:**



**Change in frequency:**



**Timescale:**

Medium Term  
(by 2050)

### Vulnerable Groups

- People with medical/physical conditions or disabilities.
- People with a lack of air conditioning or other cooling mechanisms
- People who are difficult to reach through normal communications
- People who are elderly
- People with a lack of access to transportation.
- People who work or conduct leisure activities outside.

## Impacts on sectors, assets, and services

Sectors, Assets, and Services	Magnitude of Future Impact <i>Low   Moderate   High   Unknown</i>	Description
<b>Public Health</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Heat related illness/mortality</li> <li>• Energy bills — increased demand for A/C (expand existing programs)</li> <li>• More high ozone days (air quality)</li> <li>• Vehicular deaths (children in cars)</li> <li>• Insect-borne illness (mosquitos and ticks)</li> <li>• Vulnerable populations more exposed</li> </ul>
<b>Energy</b>	<b>Moderate</b>	<ul style="list-style-type: none"> <li>• Grid stability, stress on system</li> <li>• Power outages will impact economic health</li> <li>• Increased demand for resources and staffing</li> </ul>
<b>Commercial</b>	<b>Moderate</b>	<ul style="list-style-type: none"> <li>• Workforce health and safety; capacity; stress levels</li> </ul>
<b>Law and Order</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Increase in crime</li> </ul>
<b>Society/Community and Culture</b>	<b>Unknown</b>	<ul style="list-style-type: none"> <li>• Climate migration (potential influx/increase in population). This was experienced with Katrina</li> </ul>
<b>Transport</b>	<b>Moderate</b>	<ul style="list-style-type: none"> <li>• Shrinking walk shed</li> <li>• May impact public transit use</li> </ul>
<b>Water Supply and Sanitation</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Extreme heat will put additional stress on water supply systems</li> </ul>
<b>Food and Agriculture</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Wear and tear on machines</li> <li>• Crop loss will impact economy</li> <li>• Changing crops</li> <li>• Soil</li> <li>• Livestock loss</li> <li>• Workforce (health and safety)</li> </ul>

## Drought

The National Drought Mitigation Center defines drought as “a period of abnormally dry weather which persists long enough to produce a serious hydrologic imbalance, such as crop damage or water supply shortage.” The Kansas City metropolitan area has experienced drought as a recurrent climatic feature for a long time with the last peak drought conditions affecting our region in summer of 2018. Our entire region is susceptible to drought; however, there are portions of the region’s counties that are less susceptible and have less surface and groundwater drought due to proximity to the Kansas and Missouri rivers. Other parts of the metropolitan area are highly susceptible to drought.

### Past Impacts

Drought impacts are inherently difficult to quantify. The most recent drought in 2018 had many known impacts to agriculture, such as decreased pasture quality and ability to support grazing livestock, crop damage and loss, and loss of revenue. It can be assumed that local governments, households and businesses spent more on water to maintain existing landscapes, gardens and trees.

### Future Impacts

MARC’s 2020 Hazard Mitigation Plan notes that determining the probability of droughts is difficult and suggests a weekly probability percentage of 20% based only on data from the National Oceanic and Atmospheric Administration storm events database (2000-2019). And the overall magnitude rating for drought is greater than 50%. Regional vulnerabilities to drought stem from a combination of moderate precipitation amounts and relatively short growing season (compared to other parts of the state), relatively high evaporation rates, deep soils, poor groundwater, reliance on surface water and historical occurrences (including current drought conditions). Drought will continue to impact the Kansas City region, most notably in the agricultural sector and areas of the region with high drought susceptibility. Due to the region’s general abundance of potable water via the Kansas and Missouri rivers and alluvial wells, short-term droughts are not likely to have direct, lasting impacts on the entire region, but may have meaningful impacts on individual communities.

**Risk Level:**

**High**

**Change in intensity:**



**Change in frequency:**



**Timescale:**

Immediate

### Vulnerable Groups

- People with low incomes
- Children
- People who are elderly
- People with respiratory problems
- Small and/or rural communities
- Farmers or other agricultural workers

## Impacts on sectors, assets, and services

Sectors, Assets, and Services	Magnitude of Future Impact <i>Low   Moderate   High   Unknown</i>	Description
<b>Water Supply and Sanitation</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Low river or reservoirs; Increase in need for alternate water supply</li> <li>• Increase in need for agricultural water</li> <li>• Poor water quality and more severe algae blooms</li> <li>• Increase in water treatment costs</li> <li>• Water department and Evergy are interconnected; power concerns if water supply is limited</li> <li>• Easing of water restrictions</li> <li>• Greater demand for water</li> <li>• Changes in allowable water contaminants</li> <li>• Water line damage and repairs due to drought stress</li> </ul>
<b>Public Health</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Harmful algae blooms or other threats to water quality</li> <li>• Air quality concerns from increasing ozone and smoke/dust</li> <li>• Loss of human life due to heat stress; Increased respiratory ailments</li> <li>• Increased human disease caused by changes in insect carrier populations</li> <li>• Population migration</li> </ul>
<b>Residential</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Foundations settling/crumbling</li> <li>• Increase in cooling needs</li> <li>• Higher water rates</li> <li>• Stockpiling, water reclamation and reuse</li> <li>• Property subsidence</li> </ul>
<b>Food and Agriculture</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Damage to crop quality and yields</li> <li>• Low yields will impact economy</li> <li>• Increased irrigation costs</li> <li>• Cost of new or supplemental water resource development</li> <li>• Change in agriculture products and processes</li> <li>• Insect infestation</li> <li>• Plant disease</li> <li>• Reduced productivity of rangeland</li> </ul>
<b>Environment, Biodiversity, and Forestry</b>	<b>High</b>	<ul style="list-style-type: none"> <li>• Increased fires</li> <li>• Loss of biodiversity</li> <li>• Loss of trees, urban tree cover</li> <li>• Increased disease for plants and wildlife</li> <li>• Wildlife encroachment into urban areas</li> <li>• Increased stress on endangered species</li> <li>• Loss of wetlands</li> <li>• Migration and concentration of wildlife</li> </ul>

## Severe Thunderstorms

A thunderstorm is a rain shower with thunder and is the result of convection, usually created by heating the surface that carries any moisture in the air in an upward atmospheric motion. Severe thunderstorms contain one or more of the following: hail one inch in diameter or greater, winds gusts over 57.5 mph (50 knots), or a tornado. About 10% of the roughly 100,000 thunderstorms that occur in the U.S. each year reach severe levels (NOAA).

Thunderstorms are most likely to occur in the spring and summer months and during the afternoon and evening hours, but they can occur year-round and at all hours. Thunderstorms frequently form in the late afternoon and at night in the Plains states.

### Past Impacts

From 2014 to 2019, there were 834 hail, lightning and thunderstorm wind events across 67 days in the planning area. Cumulatively, property damages totaled \$1,727,000. There was one death in 2018 due to a lightning strike. (Storm Events Database, NOAA National Center for Environmental Information)

### Future Impacts

Urban and suburban areas are more susceptible to the damaging effects of severe thunderstorms due to larger concentrations of buildings, utilities and other infrastructure. Falling trees and limbs, along with wind and hail, can cause great damage to property, infrastructure and telecommunications and can cause significant disruptions. Based on historical statistics, the probability for a future occurrence anywhere in the region is 93%.

**Risk Level:** Mod. - High

**Change in intensity:** ↑

**Change in frequency:** ↑

**Timescale:** Immediate

### Vulnerable Groups

- People with medical/physical conditions or disabilities.
- People who live in flood prone areas.
- People who are difficult to reach through normal communications.
- People who are elderly or young children.
- People with a lack of access to transportation.
- Homeowners

## Impacts on sectors, assets, and services

Sectors, Assets, and Services	Magnitude of Future Impact <i>Low   Moderate   High   Unknown</i>	Description
Public Health	High	<ul style="list-style-type: none"> <li>Flash flooding and lightning-related fatalities</li> <li>Injuries due to fallen trees and traffic crashes</li> <li>Loss of electricity for extended periods of time in the heat of summer could cause heat exhaustion</li> <li>Large crowds at outdoor venues are also at a higher risk for injury and death unless nearby shelter is accessible</li> </ul>
Energy/Utilities	High	<ul style="list-style-type: none"> <li>Power outages</li> <li>Services provided by above-ground utilities could be disrupted (internet, telephone, etc.)</li> <li>Renewable energy infrastructure and generation could be impacted</li> </ul>
Waste Management	Moderate	<ul style="list-style-type: none"> <li>Storm debris</li> <li>Earlier closing of landfills</li> <li>Wastewater treatment capacity may not be enough to handle severe precipitation</li> </ul>
Transport	High	<ul style="list-style-type: none"> <li>Impacted access</li> <li>Electrification and reliance on the grid for transport</li> <li>Rain-slick roads may result in traffic accidents</li> <li>Roads may also be blocked, and traffic disrupted by downed trees, tree limbs and power lines</li> <li>Heavy rain may reduce visibility and can temporarily disrupt or slow traffic</li> </ul>
Residential	High	<ul style="list-style-type: none"> <li>Destruction and increased need to repair and rebuild</li> </ul>
Emergency Services	Moderate	<ul style="list-style-type: none"> <li>Emergency coordination and communication could be disrupted</li> </ul>
Commerce	Moderate	<ul style="list-style-type: none"> <li>Disruption to flow of goods and services due to property damage or disrupted transportation.</li> </ul>
Natural environment	Moderate	<ul style="list-style-type: none"> <li>Damaging wind and hail events can damage trees and other vegetation, like severe winter storms.</li> </ul>

## Tornados

Tornadoes are formed from large thunderstorms with the most dangerous and destructive tornadoes formed from supercells — or rotating thunderstorms with a well-defined radar circulation called a mesocyclone, according to NOAA's Storm Prediction Center. The degree of damage from a tornado can be quite high, especially considering that the average period of a tornado's ground contact is 30 minutes and the average distance covered by a tornado is 15 miles. However, strong winds typically cause the most significant damage resulting from tornadoes.

Tornadoes can strike anywhere and anytime in the region. In addition to significant property damage, tornadoes can result in great loss of life. The costliest tornado on record in the U.S. occurred in Joplin, Missouri in 2011, with an estimated \$2.8 billion in damage, killing 162 people.

The probability of a tornado strike anywhere in the region is 61%. Based on the Enhanced Fujita Scale (EF), the probability of an EF0 tornado strike is 60% and an EF1 is 64%. As tornado magnitude increases on the EF scale, probable risk decreases. The overall risk level associated with tornado strikes is considered moderate to high.

Science is conflicting as to whether climate change will cause an increase in intensity and frequency of tornadoes, though it should be noted that 2019, globally one of the warmest years on record, was also a top-five year across the U.S. for tornadoes with over 1,500 reported, according to NOAA National Centers for Environmental Information, State of the Climate: Tornadoes for Annual 2019, published online January 2020.

### Past Impacts

According to NOAA's Storm Events Database, there were 51 tornadic events in the planning area between 2010 and 2020. Most of the tornadoes were EF0 or EF1 tornadoes, but cumulatively caused over \$26.2 million in damage, one death and 29 injuries. During this timeframe, the single most damaging event, an EF5 tornado, occurred in 2019 in Leavenworth County and caused \$26 million in property damage.

### Future Impacts

There is a high likelihood that in any given year, the region will experience a tornado event, likely one of lesser magnitude. Tornadoes can cause significant property and crops damage, loss of life and injuries, displacement, and disruption to utilities and emergency services. Counties with a higher population and structural valuations are considered to be more vulnerable.

**Risk Level:** Mod. - High

**Change in intensity:** ?

**Change in frequency:** ?

**Timescale:** Immediate

### Vulnerable Groups

- People with medical/physical conditions or disabilities.
- People who live in low-income households
- People who live in substandard housing
- People who do not have access to basements and shelters
- People who are elderly or young children



## Impacts on sectors, assets, and services

Sectors, Assets, and Services	Magnitude of Future Impact <i>Low   Moderate   High   Unknown</i>	Description
Energy	High/Moderate	<ul style="list-style-type: none"> <li>• Blackouts</li> <li>• Risk to above-ground utilities</li> </ul>
Emergency Services	Moderate	<ul style="list-style-type: none"> <li>• Emergency coordination and communication could be disrupted for high-magnitude events</li> <li>• Large regional area with low-income and vulnerable populations will mean increased need for emergency services</li> </ul>
Residential	High	<ul style="list-style-type: none"> <li>• Lack of insurance will greatly impact some communities</li> <li>• Increased stress due to loss of power, heating and cooling</li> <li>• Significant damage to buildings and infrastructure possible</li> </ul>
Waste Management	High/Moderate	<ul style="list-style-type: none"> <li>• Increased clean-up and waste from debris and downed trees</li> </ul>
Education	Moderate	<ul style="list-style-type: none"> <li>• Potential disruption to education if schools are damaged or inaccessible</li> </ul>
Society/Community and Culture	Moderate	<ul style="list-style-type: none"> <li>• May impact access to transportation and other services</li> <li>• Potential injuries and loss of life, depending on access to shelter and warming systems and warning time.</li> </ul>
Other	Moderate	<ul style="list-style-type: none"> <li>• Loss of crops</li> <li>• Economic impacts depend on how direct to a jurisdiction the strike is</li> </ul>

## Severe Winter Weather

Severe winter weather is an annual occurrence in the Kansas City area but may vary from year to year. Severe winter weather includes snowstorms, ice storms, freezing rain, sleet, periods of extreme cold or a combination of these conditions. The annual snowfall amount for the region is moderate — generally around 20 inches — and may come from a variety of snow conditions, including blizzards, blowing snow, snow squalls, snow showers and snow flurries. Ice storms and sleet are common and can be particularly damaging in significant accumulations.

Winter weather typically occurs in December, January and February. However, in looking at past events, it is possible for severe winter weather to affect the region early in the season, like October, or as late in the season as March.

### Past Impacts


Severe winter storms have caused injuries and loss of life, both directly and indirectly. Direct impacts, such as frostbite and hypothermia, result from severe winter weather when windchill is a factor. Indirectly, severe winter weather can contribute to injury and death, as a result of traffic crashes due to icy or slippery road conditions.


Additional known impacts from past severe winter weather events include property damage from falling trees and branches, power outages, transportation and telecommunications disruptions, and economic losses.

### Future Impacts

The probability of future occurrence is 92% as some of all of the region is highly likely to experience severe winter weather each year. This probability includes any type of severe winter weather. According to the National Climate Assessment (2018), winters are already trending warmer. The warmer and shorter winters may allow for a longer growing season; however, they may also promote the growth of weeds and pests, and shorten the dormancy for many winter crops, which could increase crop losses during spring freezes. Pests, like the emerald ash borer, could cause greater harm to the urban tree canopy. Precipitation may also change with winter warming, where precipitation falls as rain and not snow.

**Risk Level:** Moderate

**Change in intensity:** 

**Change in frequency:** 

**Timescale:** Long Term  
(after 2050)

### Vulnerable Groups

- People with medical/physical conditions or disabilities
- People who live in low-income households
- People who are difficult to reach through normal communications
- People who are elderly or young children
- People who live in substandard housing
- Homeless populations

## Impacts on sectors, assets, and services

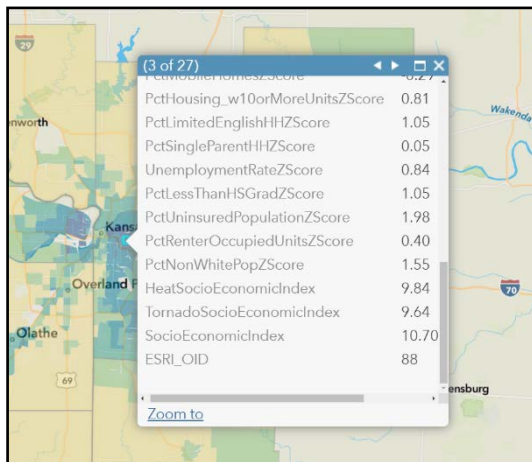
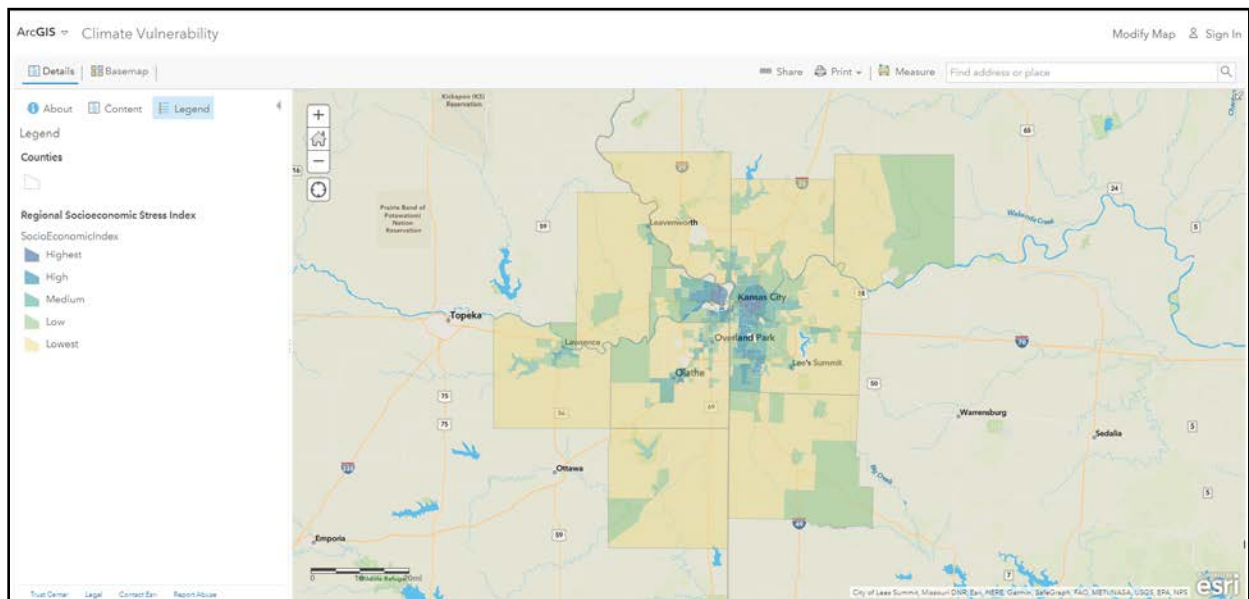
<b>Sectors, Assets, and Services</b>	<b>Magnitude of Future Impact</b> <i>Low   Moderate   High   Unknown</i>	<b>Description</b>
<b>Energy</b>	<b>High/Moderate</b>	<ul style="list-style-type: none"> <li>• Increase in power outages</li> <li>• Increased demand for heating</li> </ul>
<b>Public Health</b>	<b>Moderate</b>	<ul style="list-style-type: none"> <li>• Decreased access to health services during major events</li> <li>• Increased provision of hot foods</li> <li>• Significant impact on homeless population</li> </ul>
<b>Transport</b>	<b>Moderate</b>	<ul style="list-style-type: none"> <li>• Transport of goods and access to services will be impacted</li> <li>• Education will be impacted by closures and lack of access</li> <li>• Labor supply will be limited by severe weather and access</li> <li>• Infrastructure/streets will need additional maintenance</li> </ul>
<b>Food and Agriculture</b>	<b>Moderate</b>	<ul style="list-style-type: none"> <li>• Invasive species and disease will increase</li> <li>• Increased impacts on perennial crops</li> </ul>
<b>Residential</b>	<b>Moderate</b>	<ul style="list-style-type: none"> <li>• Severe weather halts construction and impacts the economy</li> <li>• Older structures are more susceptible to impacts of snow load</li> </ul>
<b>Emergency Services</b>	<b>Moderate</b>	<ul style="list-style-type: none"> <li>• Emergency response could be disrupted for major events</li> <li>• Large regional area with low-income and vulnerable populations will mean increased need for emergency services</li> </ul>

## Vulnerability Assessment

This assessment helps answer questions about where our most vulnerable communities exist in the region and the magnitude of social vulnerability. The findings will help inform planning, equity-focused engagement and relationship building, and identify how and where climate initiatives should be prioritized and targeted. In this assessment, several indicators are used to help pinpoint geographies of overlapping vulnerabilities related to climate change. The vulnerability maps are based on indicators specific to the priority hazards. These maps explore social vulnerability, and vulnerability related to flooding, heat and urban heat island, and tornadoes.

### Interactive Map Tool

An interactive map, including the vulnerability and neighborhoods layers, was created to support local government climate resilience initiatives and can be found [here](#).



By clicking on any census tract on a vulnerability layer, the indicators and z-scores will display in a pop-up window. The z-scores for each indicator describe the position of a raw score in terms of its distance from the mean, when measured in standard deviation units. The z-score is positive if the value lies above the mean, and negative if it lies below the mean. The z-scores relevant to each vulnerability layer are added together to generate the index score. The shade of the census tract is based on the index as indicated in the legend. The darker the color, the higher the stress index.

## Regional Socioeconomic Stress

Areas of socioeconomic stress were determined by factoring five vulnerability indicators into an index: nonwhite population, population below 200% of poverty, population under age 5, population over age 65 and renter occupied housing. While there are many indicators of socioeconomic stress, this set of indicators is commonly used in vulnerability assessment and provides a solid foundation for understanding socioeconomic stress at a regional level. Local governments may want to add additional indicators based on local context.

Within the planning area, 13% of the total population live within census tracts that are considered “highest” or “high” in terms of socioeconomic stress. These census tracts are primarily located in the urban cores of Kansas City, Kansas, and Kansas City, Missouri. However, there are portions of Shawnee and Lenexa, Kansas, along the I-35 corridor, Olathe, Kansas, and Lawrence, Kansas, that have socioeconomically stressed areas as well.

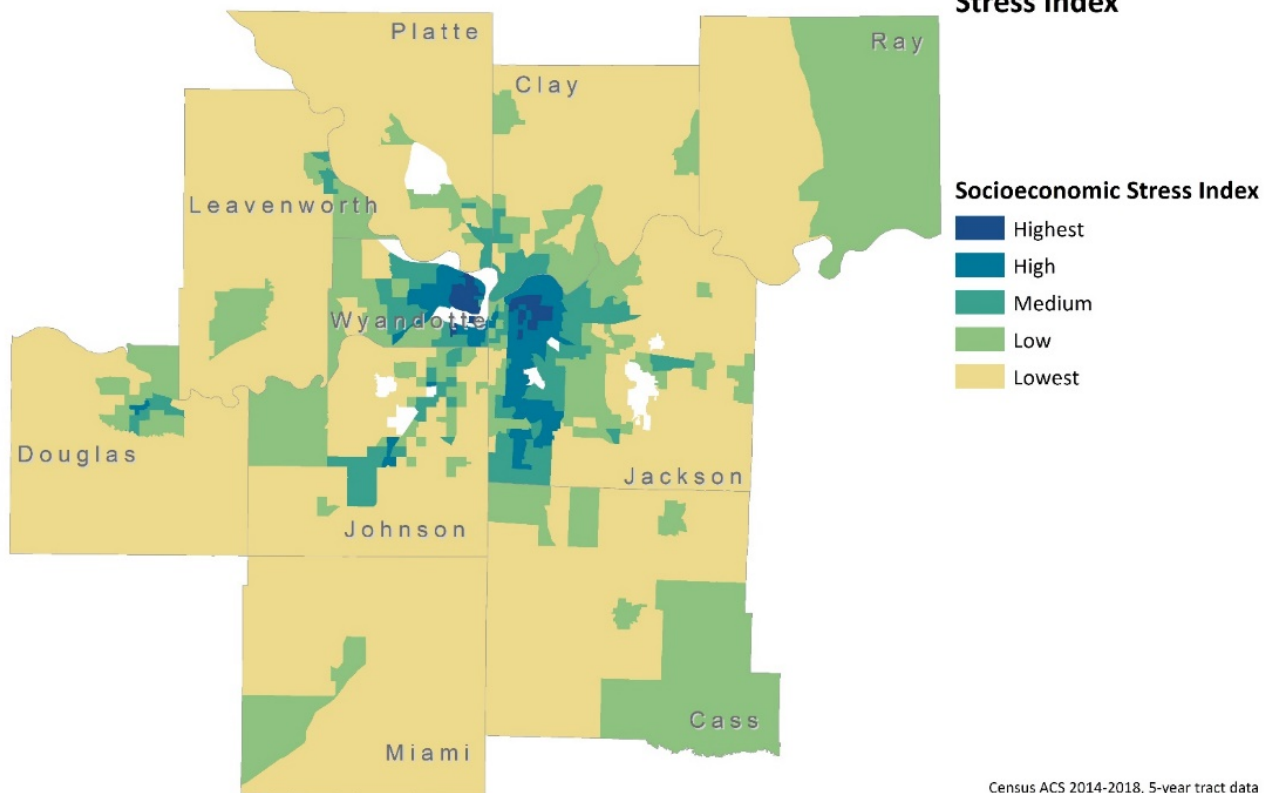
# 13%

Population living in areas of socioeconomic stress

### Vulnerability Indicators

- Nonwhite population
- Population below 200% of poverty
- Population under age 5
- Population over age 65
- Renter Occupied Housing

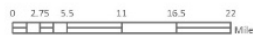
### Regional Socioeconomic Stress Index



**Socioeconomic Stress Index**

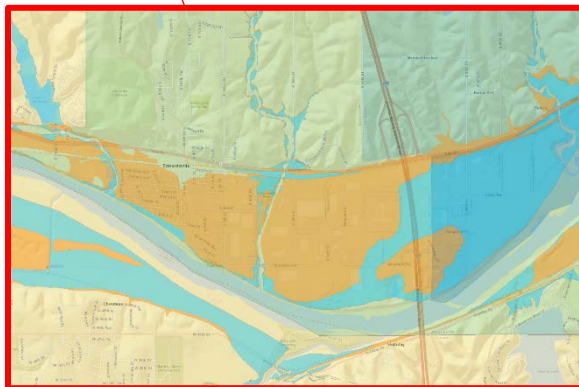
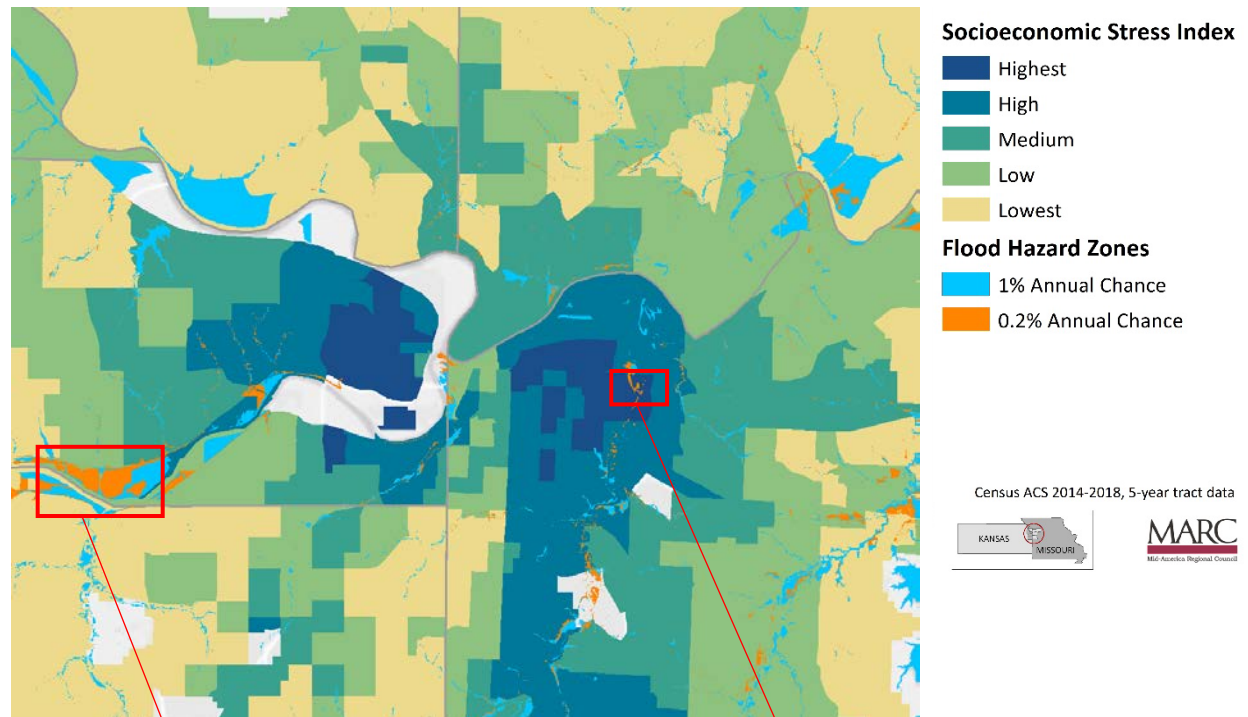
- Highest
- High
- Medium
- Low
- Lowest

Census ACS 2014-2018, 5-year tract data

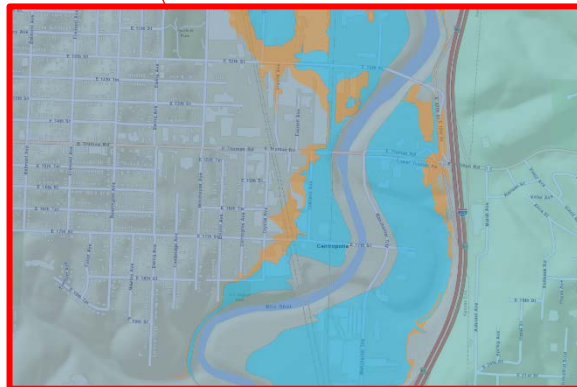


## Flooding and Socioeconomic Stress

Comparing the 100- and 500-year floodplains to areas of high socioeconomic stress can highlight flood vulnerabilities and significant needs for intervention. There are few instances where socioeconomically stressed areas intersect floodplains, however these warrant further exploration. In the first snapshot, the Centropolis neighborhood in Kansas City, Missouri, which is highly socioeconomically stressed, shows the 500-year floodplain encroaching on residential housing. In the second snapshot, the City of Edwardsville, Kansas, while considered low for socioeconomic stress, has significant vulnerabilities to 100- and 500-year flooding.



Edwardsville, Kansas



Centropolis neighborhood in Kansas City, Missouri

## Tornado-Related Socioeconomic Stress

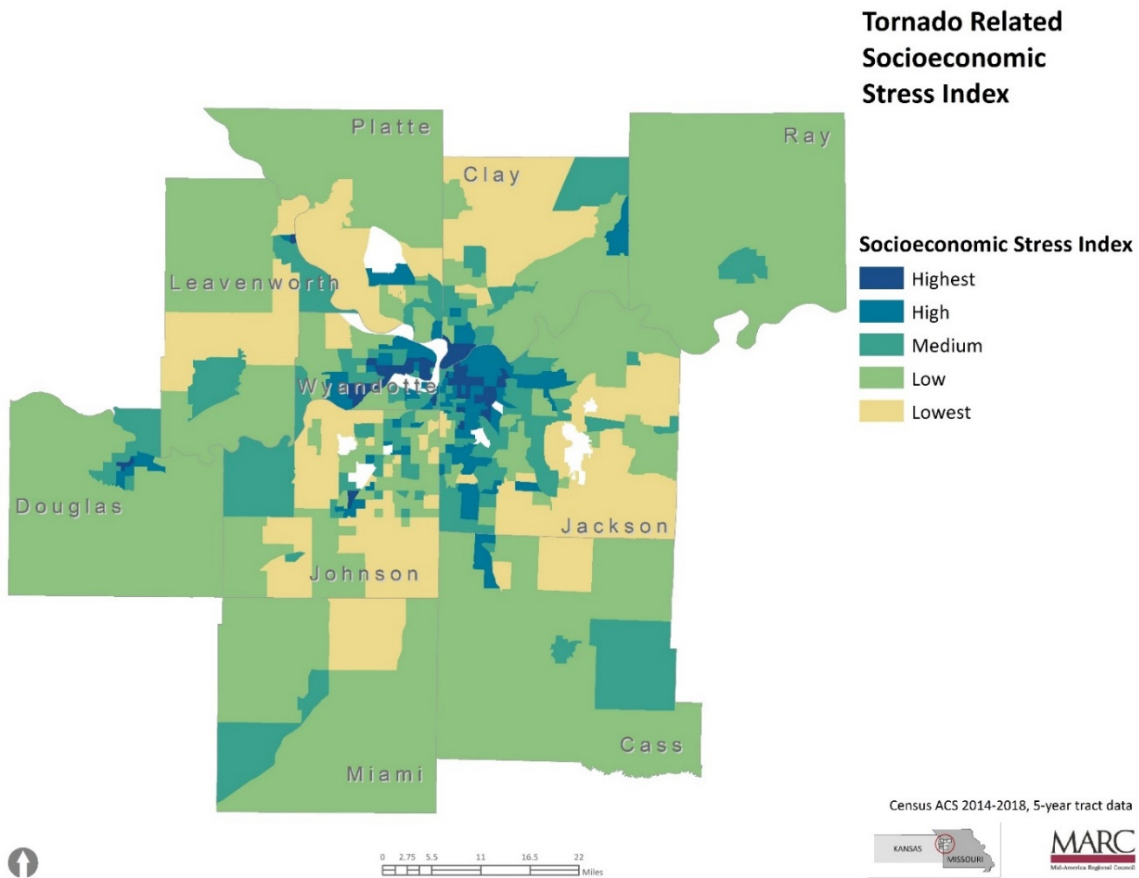
Tornado vulnerability indicators focus on accessibility, housing density and protection, language, and socio-demographics. Due to the distribution of multifamily housing, disabilities and older adults, tornado vulnerability is more widespread throughout the region. However, visually, it is apparent that tornado vulnerability is concentrated in the urban cores of Kansas City, Kansas, and Kansas City, Missouri. About 19% of the population live in census tracts that are considered “highest” or “high” stress socioeconomically.

# 19%

Population living in areas of tornado vulnerability

### Vulnerability Indicators

- People with disabilities
- Zero-vehicle households
- Population speaking English less than very well
- Population below 200% of poverty
- Housing with 10+ units
- Population 65 and over living alone
- Mobile homes



## Heat-Related Socioeconomic Stress

Heat vulnerability is concentrated in older developed areas of the region where poverty tends to be highest, namely the urban cores of Kansas City, Kansas, and Kansas City, Missouri. Every county within the planning area has a least one census tract that is rated “medium” or higher for heat vulnerability. The percentage of the population living in highly vulnerable areas (“highest” and “high”) is approximately 20%.

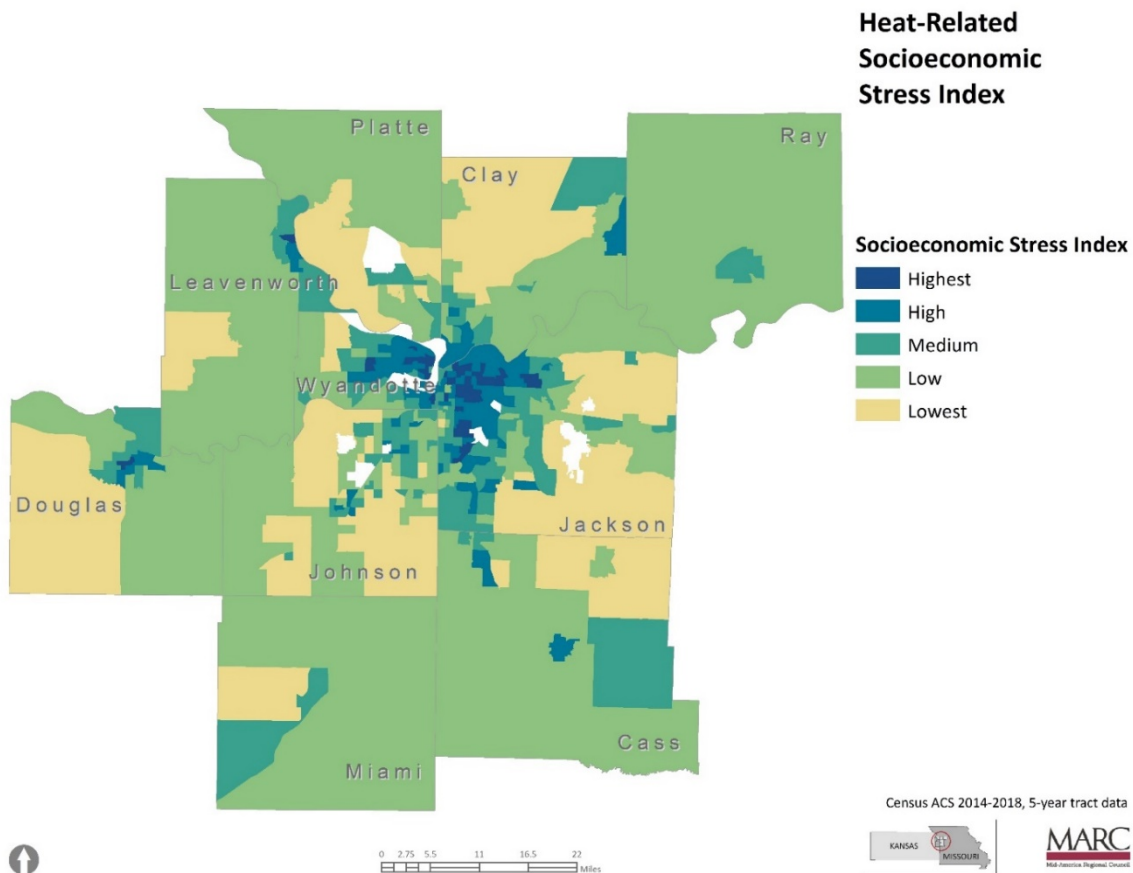
In addition to spatially identifying heat-vulnerable areas, it is important to look at areas that may experience the added vulnerability of urban heat effects. The second map identifies census tracts that have 35% or more impervious landcover, and tracts that have 35% or more impervious landcover plus mitigating tree canopy coverage (40% or greater in landcover). Vulnerability to urban heat is only highlighted in Kansas City, Kansas, and Kansas City, Missouri.

# 20%

Population living in areas of heat vulnerability

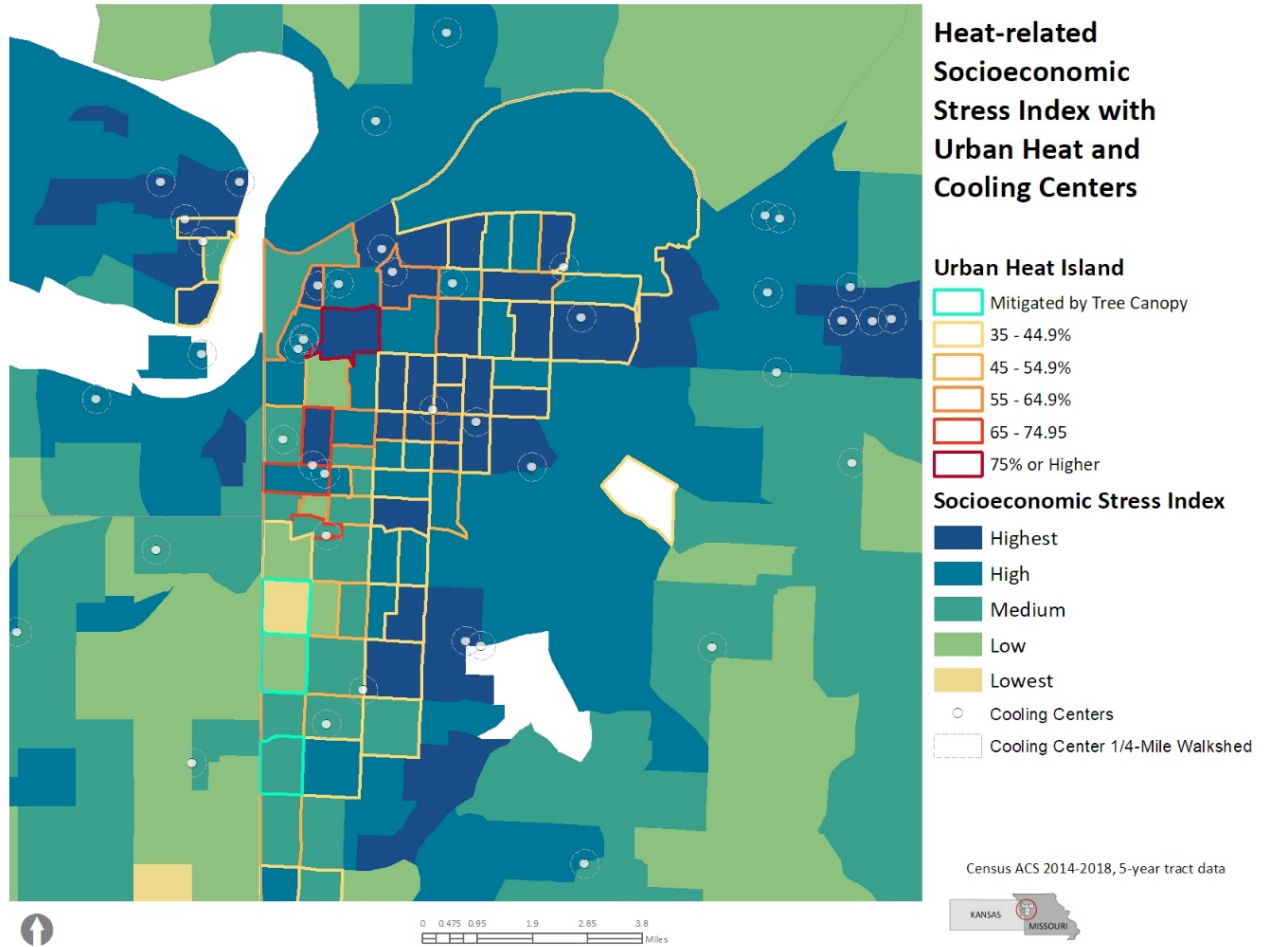
### Vulnerability Indicators

- People with disabilities
- Zero-vehicle households
- Population below 200% of poverty
- Population 65 and over living alone
- Households with more than one occupant per room
- Households built prior to 1960





The areas of both highest heat-related socioeconomic stress and urban heat vulnerability exist on the Main Street corridor in Kansas City, Missouri. While the Main Street corridor does not intersect with areas with high socioeconomic vulnerability, the corridor is the economic center of the region and used for recreation, shopping, medical services, transit connections, etc.



## Adaptive Capacity

Given our vulnerabilities to expected climate-related risks, what is our region’s ability to adapt and build resilience? Do we accept losses, seek new ways to adapt or take advantage of new opportunities that may arise? The answer to adaptation is multifaceted for our region. Knowing where to focus and prioritize adaptation efforts is crucial and this section explores the various factors that influence how we respond.

There are many factors within the human system that impact adaptive capacity. At a high level, these factors fall into several categories:

- Built environment
- Economy
- Natural environment
- Government capacity
- Inequality
- Public health

It is important to note that these categories are relational and can influence each other as they do in the human system. For instance, economic health impacts government capacity, and the built environmental can create certain types of inequalities. In this assessment of capacity, the categories are further divided into various factors in order to dig deeper into these relationships.

<b>Built Environment</b>	<b>Economy</b>	<b>Natural Environment</b>	<b>Government capacity</b>	<b>Racial Inequality</b>	<b>Public health</b>
<ul style="list-style-type: none"> <li>• Infrastructure condition/maintenance</li> <li>• Infrastructure capacity Housing</li> <li>• Land use and development</li> <li>• Urbanization rate</li> </ul>	<ul style="list-style-type: none"> <li>• Cost of living</li> <li>• Access to education</li> <li>• Unemployment</li> <li>• Economic diversity</li> <li>• Economic health</li> </ul>	<ul style="list-style-type: none"> <li>• Environmental condition</li> </ul>	<ul style="list-style-type: none"> <li>• Migration</li> <li>• Community engagement</li> <li>• Interjurisdictional coordination</li> <li>• Technology</li> <li>• Access to relevant data</li> <li>• Budgetary capacity</li> <li>• Resource availability</li> <li>• Safety and security</li> </ul>	<ul style="list-style-type: none"> <li>• Access to basic services</li> <li>• Poverty/Income</li> </ul>	<ul style="list-style-type: none"> <li>• Access to healthcare</li> <li>• Health status</li> <li>• Environmental quality</li> </ul>

Each factor has been assessed for its degree of challenge, or the extent to which the factor may create a challenge or limit our region’s ability to cope with shocks and stresses related to climate-related risks. This assessment is based in part on feedback from stakeholders who attended the Climate Risk and Vulnerability Assessment session during Workshop 1 on Oct. 31, 2019, as well as online public engagement held in May and June of 2020. In areas where feedback was not provided, a degree of challenge was assigned based on available data or studies. The assessment is regional in scope and because there is variation within each factor across the regions, it is recommended that local governments perform adaptive capacity assessments for their own jurisdictions.

## Built Environment

FACTOR	EFFECT ON ADAPTIVE CAPACITY	DEGREE OF CHALLENGE <i>High   Moderate   Low Supportive   Do Not Know</i>
<b>Infrastructure condition/maintenance</b>	<p><b>Transportation:</b> The region faces aging infrastructure that is increasingly prone to damage due to freeze-thaw cycles, flooding and heat. Funding available for transportation today is increasingly uncertain and inadequate to maintain the system at current levels, let alone invest in improvements to address these climate-related challenges.</p> <p><b>Energy:</b> A significant amount of power lines are above ground, especially in older parts of the region. Temporary power outages due to harsh winter and severe storm weather is common but prolonged outages are not.</p> <p><b>Water &amp; Sanitation:</b> Many cities in the region have older infrastructure. Kansas City, Missouri, is overhauling its combined sewer system (though most is separated). Heavy rainfall events cause combined sewer overflows that discharge a mixture of wastewater and stormwater into streams and rivers, degrading their quality. There is a lack of green infrastructure and strong policy guidance.</p> <p><b>Information and Communication Technology:</b> Kansas City, Missouri, and many other cities around the region have invested in smart city technologies and this continues to evolve. In 2012, 75% of the region had broadband and 83% used the internet in some way. Disparities in access constrain adaptive capacity in vulnerable communities.</p>	<b>High</b>
<b>Infrastructure capacity</b>	<p><b>Transportation:</b> The Kansas City region has more freeway lanes miles per capita than any other city in the nation and congestion is minimal. However, multimodal transportation is anemic and disconnected and does not serve the need for redundancy in the transportation system. The lack of affordable transportation choices disproportionately impacts low-income communities. The region's network of EV charging stations is expansive but no charging stations exist in Wyandotte County, Kansas.</p> <p><b>Energy:</b> Existing infrastructure is adequate to serve existing demand but may require upgrades to reflect needs grid flexibility.</p> <p><b>Water &amp; Sanitation:</b> Adequate.</p> <p><b>Information and Communication Technology:</b> Unknown.</p>	<b>Moderate</b>
<b>Housing</b>	30.2% of all households have housing problems, including incomplete kitchens, incomplete plumbing facilities, more than one person per room, or a housing burden greater than 30%. People of color are more likely to experience housing problems. <sup>1</sup>	<b>High</b>

<sup>1</sup> <https://www.marc.org/Regional-Planning/Housing/pdf/7-Disproportionate-Housing-Needs.aspx>

<b>Land use and Development</b>	<p>Current land use and development patterns in the region will hinder adaptive capacity. This is a localized and regional problem. Auto-centric development equates to significant impervious surfacing, including over 100 square miles of surface parking lots throughout the region, contributing to urban heat island, poor water infiltration in many areas, and disconnected riparian corridors.</p> <p>Development and stormwater management practices impact the regional water balance, causing chronic flooding in certain locations of the region.</p> <p>Land use and development significantly impacts the ability to provide adequate transportation options and therefore access to goods and services, impacting our more vulnerable communities most.</p>	<b>High</b>
<b>Urbanization rate</b>	Population growth is modest in the Kansas City area with most growth coming from migration. Most growth by 2050 is expected in Platte, Clay, and Johnson counties.	<b>Supportive</b>

**Economy**

<b>FACTOR</b>	<b>EFFECT ON ADAPTIVE CAPACITY</b>	<b>DEGREE OF CHALLENGE</b> <i>High   Moderate   Low</i> <i>Supportive   Do Not Know</i>
<b>Cost of living</b>	Missouri and Kansas consistently rank in the top ten for lowest average annual cost of living. However, cost of utilities and healthcare are usually above the national average for both states. <sup>2</sup>	<b>Supportive</b>
<b>Access to education</b>	<p>For the region, non-Hispanic Blacks and Hispanics are much more likely to live in low-proficiency school attendance areas than other racial and ethnic groups. This is also true in Kansas City, Missouri, but much less so in the other Community Development Block Grant (CDBG) communities, which have single school districts or very few districts, meaning that people of color are more likely to live in the same school district as other racial and ethnic groups. School district residency requirements make it difficult for students living in low-proficiency school attendance areas to attend schools in higher-proficiency areas. The only way to do that is for families to move into these higher-proficiency districts. However, the lack of affordable housing makes this difficult.</p> <p>The region has numerous affordable educational institution options including trade schools, community colleges and universities. Income level and secondary educational attainment hinder access or ability for further educational attainment. Lack of transportation and affordable housing exacerbates access for some.<sup>2</sup></p>	<b>High</b>
<b>Unemployment</b>	As of August 2019, only 3.3% of metro Kansas City’s labor force was out of work, compared to 3.8% nationally. As evident by the impact of the COVID-19 pandemic, the rate has increased and could be an issue with future pandemics. <sup>3</sup>	<b>Supportive</b>
<b>Economic diversity</b>	The region has a steady local economy that historically weathers economic fluctuations because of its diverse industry segments. The region has several specialization areas where Kansas City may have a competitive advantage relative to other parts of the country. These industry specializations include management of companies and	<b>Low</b>

<sup>2</sup> <https://meric.mo.gov/data/cost-living-data-series>

<sup>3</sup> <https://www.marc.org/Regional-Planning/Housing/pdf/6A-Education.aspx>

	enterprises; professional, scientific and technical services; finance and insurance; transportation and warehousing; wholesale trade, and utilities. <sup>4</sup>	
<b>Economic health</b>	The region is growing but not as fast as its peers. GDP growth is less than half the average of our region's 31-peer average (5.7% compared to 12.5%). Percentage change in quality jobs for the region is 5.8% compared to 9.3% for the 31-peer average. Real median household income growth is 8.5% compared to 11.8% for 31-peer region average. Projections show that the Kansas City region has a slight edge for job growth compared to the U.S., however the impacts of the COVID-19 pandemic creates uncertainty for these projections. <sup>4</sup>	<b>Moderate</b>

## Environment

<b>FACTOR</b>	<b>EFFECT ON ADAPTIVE CAPACITY</b>	<b>DEGREE OF CHALLENGE</b> <i>High   Moderate   Low</i> <i>Supportive   Do Not Know</i>
<b>Environmental condition</b>	Air quality is barely within healthy limits, but future extreme and prolonged heat events could further degrade air quality and greatly impact public health. HUD's Environmental Health Index shows that low environmental index scores (higher exposure) coincide with some of the region's oldest industrial areas, some of which are in or in proximity to the R/ECAP (Racial/Ethnic Concentrated Areas of Poverty) areas. Higher index scores (less exposure) are found in most of the region, particularly in suburban and rural areas. Areas of high environmental hazard coincide in some cases with some concentrations of Black populations, although many areas with the highest environmental hazard exposure have very little population.	<b>Low</b>

## Government capacity

<b>FACTOR</b>	<b>EFFECT ON ADAPTIVE CAPACITY</b>	<b>DEGREE OF CHALLENGE</b> <i>High   Moderate   Low</i> <i>Supportive   Do Not Know</i>
<b>Migration</b>	Migration is a driver of population growth in the region, however population growth at its projected rate in general will not cause significant impacts on adaptive capacity. At this time, there is not enough known about the draw of climate refugees to the region.	<b>Unknown</b>
<b>Community engagement</b>	Community engagement can probably be characterized as low across the region. There are pockets of engaged communities, but most people are not likely to be well-engaged on local government issues.	<b>Moderate</b>
<b>Interjurisdictional coordination</b>	The region has a history of strong collaboration and support across boundaries. Elected officials from all corners of the region have been influential during the COVID-19 pandemic and could continue to play a role in hazard response and communications.	<b>Low</b>
<b>Political Engagement / Transparency</b>	The region is fractured politically. There are needs to: Ensure that regional decisions are not preempted by state-level decisions; Identify a larger number of congressional members to support climate action; Create a joint tax/funding initiative as a political challenge; Create a sense of urgency and make the case for acting now versus in the future	<b>Moderate</b>

<sup>4</sup> <https://www.marc.org/Data-Economy/pdf/2020EconomicForecast.aspx>

<b>Access to Relevant Data</b>	Many local governments have data but the capacity to make use of data may be deficient. MARC continues to assist in developing regional value-added datasets for local and regional analysis, performance, monitoring, etc. Special focus should be given to datasets that support regional climate, population health, asset management and vulnerability analyses	<b>Low</b>
<b>Budgetary capacity</b>	Expansive improvement above and beyond maintenance of assets is often beyond the capacity of city and county general funds without leveraging other financing mechanisms and incurring debt. Moving forward, it will be essential to identify new financing tools for sustainable funding to support mitigation and adaption efforts.	<b>High</b>
<b>Resource availability</b>	For most municipalities, resources to operate and conduct work is not an issue.	<b>Low</b>
<b>Safety and security</b>	Violent crime in the region has many causes but is strongly associated with concentrated poverty. Kansas City, Missouri's high crime rate could be exacerbated by increasing temperatures and limited investment in vulnerable communities.	<b>Moderate</b>

**Inequality**

<b>FACTOR</b>	<b>EFFECT ON ADAPTIVE CAPACITY</b>	<b>DEGREE OF CHALLENGE</b> <i>High   Moderate   Low</i> <i>Supportive   Do Not Know</i>
<b>Access to basic services</b>	The pattern of development in the metropolitan area has caused a distinct split between large segments of people with low incomes and people of color — populations concentrated in the urban cores of Kansas City, Missouri, and Kansas City, Kansas — and the opportunities — jobs, education, services — that are concentrated in the suburbs.	<b>Moderate</b>
<b>Poverty/Income</b>	Average poverty for the 10-county region is 10.8% (2016), lower than the national average of 12.7%. However, Douglas, Wyandotte and Jackson counties have higher than national average poverty.	<b>High</b>

## Public Health

FACTOR	EFFECT ON ADAPTIVE CAPACITY	DEGREE OF CHALLENGE <i>High   Moderate   Low Supportive   Do Not Know</i>
<b>Access to healthcare</b>	Jackson, Wyandotte, Douglas and Ray counties have the highest percentage of people under the age of 65 without health insurance. Jackson County has the highest concentration of uninsured individuals. <sup>5</sup>	<b>Moderate</b>
<b>Health status</b>	The region is getting healthier. Death rates of many diseases are declining. However, vulnerable populations tend to have disproportionate poorer health outcomes. 65% of the metro was overweight or obese (2015). The rates in lower income and minority communities run 100 to 200% higher for obesity, and 50 to 100% higher for diabetes than wealthier census tracts. Suburban communities have similar distributions, but the higher rates are half those in the urban core cities. One in six households in the region is currently food insecure.	<b>Moderate</b>
<b>Environmental quality</b>	Air quality is barely within healthy limits, but future extreme and prolonged heat events could further degrade air quality and greatly impact public health. HUD's Environmental Health Index shows that low environmental index scores (higher exposure) coincide with some of the region's oldest industrial areas, some of which are in or in proximity to the R/ECAP (Racial/Ethnic Concentrated Areas of Poverty) areas. Higher index scores (less exposure) are found in most of the region, particularly in suburban and rural areas. Areas of high environmental hazard coincide in some cases with some concentrations of Black populations, although many areas with the highest environmental hazard exposure have very little population.	<b>Low</b>

## Summary & Recommendations

The Climate Risk and Vulnerability Assessment provides a basis for climate adaptation planning by identifying:

- 1) The primary hazards and their associated risk level.
- 2) Communities that may be most vulnerable to these risks.
- 3) The regional capacity to adapt to the impacts of climate change.

Based on research and findings from the 2020 Hazard Mitigation Plan, flooding and extreme heat are hazards for which mitigation and resilience planning must be prioritized in the Climate Action Plan. Flood events are already increasing in both frequency and intensity in the region, with flash flooding of greatest concern for the higher potential to result in loss of life and significant property damage. Flooding impacts should be further evaluated at the municipal level with special attention given to residential development and critical assets that may become subject to 100-year and 500-year floods, as

<sup>5</sup> [http://www.marc2.org/healthdata/ins\\_statuschrs.htm](http://www.marc2.org/healthdata/ins_statuschrs.htm)

well as the urban residential flooding. Coordination among local municipalities on a watershed basis will continue to be critical in this work.

Increased extreme heat in our region has a slightly longer timeframe than flooding but has greater geographic scale and will thus impact more people and infrastructure. In fact, 20% of the planning area population lives in census tracts that are deemed to have a higher vulnerability to extreme heat. Attention should be paid to the primary underlying conditions that create these vulnerabilities and how resilience efforts may need to respond differently to various indicators of vulnerabilities.

Community vulnerabilities to the major climate threats were spatially identified through GIS-based analysis of various vulnerability indicators. Socioeconomic-based indicators, like age and income, provide one aspect of overall vulnerability. Communities with high socioeconomic stress tend to be more concentrated in the urban cores in Kansas City, Kansas, and Kansas City, Missouri. There are, however, small pockets in other areas of the region. Floodplain layers were spatially analyzed in conjunction with socioeconomic stress index. At a regional scale, it is difficult to identify communities that are more at-risk and vulnerable to the impacts of flooding. However, these neighborhoods do exist, and further research will be needed to identify what hazard mitigation strategies have been, or should be, implemented to safe-guard these areas from extreme flooding, including 500-year floods.

Indicators that contribute to higher levels of vulnerabilities during tornados and heat were also analyzed. Vulnerabilities to both of these hazards are more widespread than socioeconomic stress itself, however, there is more concentration of tornado- and heat-related socioeconomic stress in the urban core. Urban heat indicators, impervious surface and tree canopy coverage were also analyzed and overlaid with heat-related socioeconomic stress. This added stress brought on by heat-absorbing infrastructure and lack of shade from tree canopy highlighted significant vulnerability in the urban core of Kansas City, Missouri. This urban heat will put Individuals who have higher exposure, such as the homeless, people who work outside, transit riders, bicyclists and walkers, at greater risk of negative health impacts.

A high-level adaptive capacity assessment was conducted to identify certain factors that may pose challenges to adaptation. The different factors are divided into six categories: built environment, economy, environment, government capacity, inequity and public health. The assessment of the factors within each category was informed in part by community feedback, as well as qualitative research. The factors with the highest degree of challenge included infrastructure condition and maintenance, housing, land use and development, access to education, budgetary capacity and poverty/income. There are many factors that are ranked “moderate” in terms of degree of challenge in this assessment that may warrant further research.

### Key findings:

- Flooding and extreme heat will pose the greatest risks to the Kansas City region in the near term.
- Urban heat island impacts are concentrated in the downtown/urban core of Kansas City, Missouri. Urban heat could significantly impact the health of individuals who have higher exposure to heat and households in low-income communities, especially where substandard housing is prevalent and tree canopy is minimal.



- Race and poverty are dominant indicators of socioeconomic stress and overall climate vulnerability. Concentrated areas of race and poverty are prevalent in the urban core of the region.
- Our regional adaptive capacity will rely on large-scale, systemwide transformations that positively impacts the built environment, access to opportunities and quality of life.

#### **Adaptation priorities:**

1. Focus adaptation efforts in areas that support greater resilience for vulnerable communities.
2. Address contributing factors to the urban heat island effect and expand comfort resources for residents, such as cooling centers, shade structures and trees.
3. Encourage localized assessments of 500-year flood risks and identify mitigation strategies as required.

#### **Recommendations for next steps:**

1. Map critical assets (transportation systems, electric grid, hospitals, etc.) across the region in relation to areas where hazards may pose the greater risk.
2. Refine vulnerability indicators by integrating regional health data, resource accessibility, etc.
3. Communicate about these risks and preparedness needs to support resilience.
4. Integrate climate action into emergency preparedness.
5. Encourage local jurisdictions to evaluate climate risks, critical infrastructure and social vulnerability within a local context.
6. Update the CRVA by 2024.