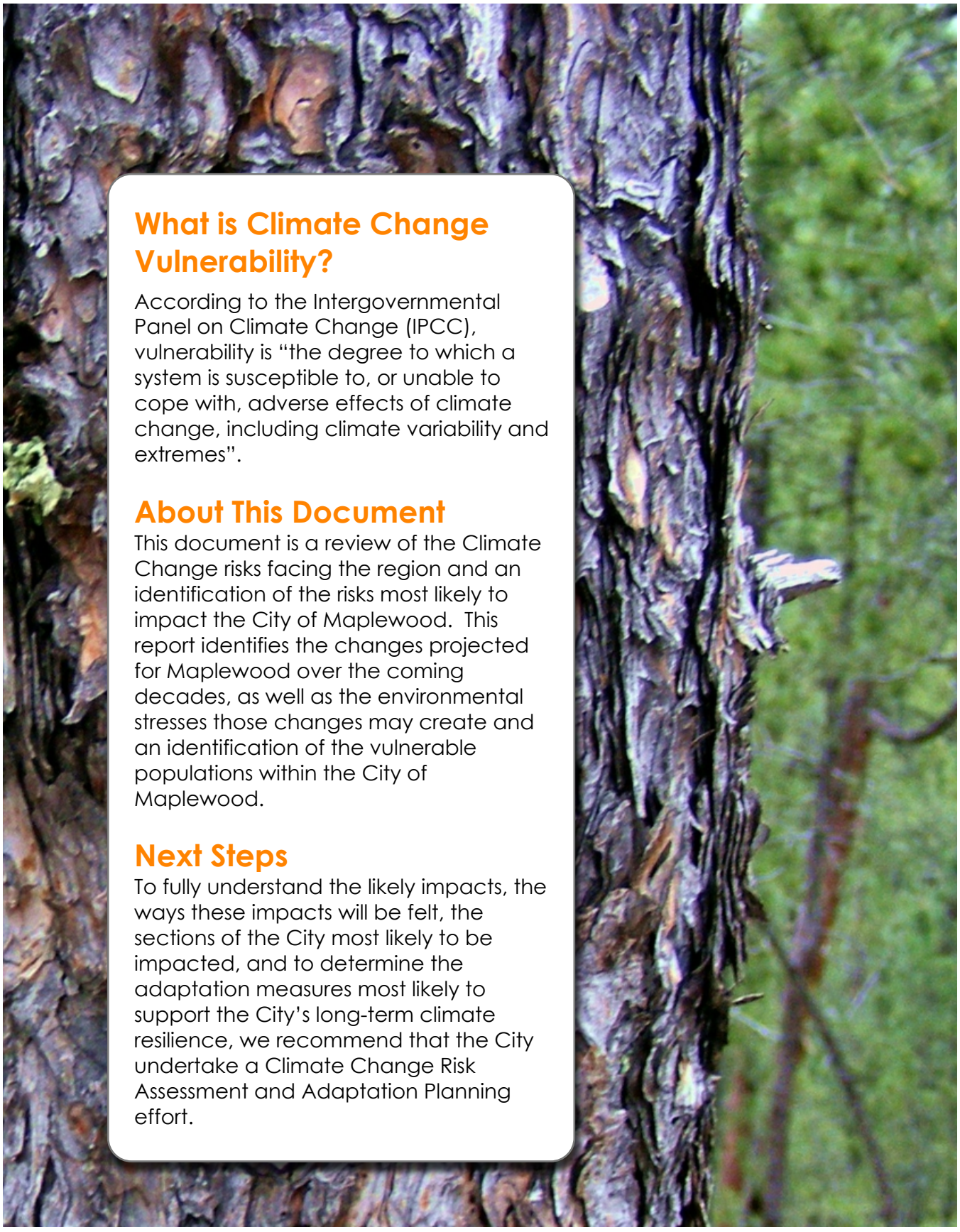
Maplewood MINNESOTA

Climate Change Vulnerabilities Review

Prepared by: making change personal paleBLUEdot LLC

Introduction



What is Climate Change Vulnerability?

According to the Intergovernmental Panel on Climate Change (IPCC), vulnerability is "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes".

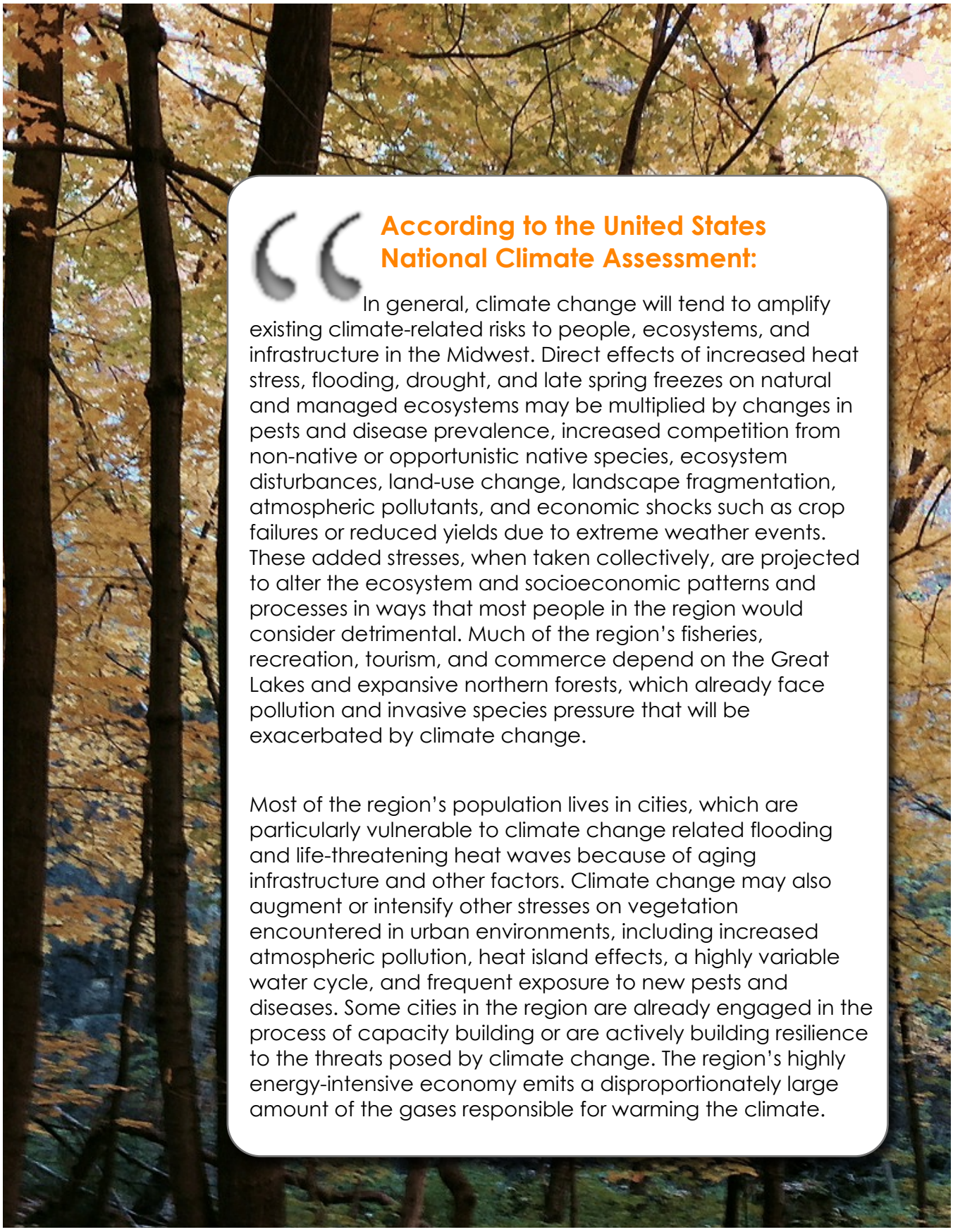
About This Document

This document is a review of the Climate Change risks facing the region and an identification of the risks most likely to impact the City of Maplewood. This report identifies the changes projected for Maplewood over the coming decades, as well as the environmental stresses those changes may create and an identification of the vulnerable populations within the City of Maplewood.

Next Steps

To fully understand the likely impacts, the ways these impacts will be felt, the sections of the City most likely to be impacted, and to determine the adaptation measures most likely to support the City's long-term climate resilience, we recommend that the City undertake a Climate Change Risk Assessment and Adaptation Planning effort.

Climate Risks in the Midwest



According to the United States National Climate Assessment:

"In general, climate change will tend to amplify existing climate-related risks to people, ecosystems, and infrastructure in the Midwest. Direct effects of increased heat stress, flooding, drought, and late spring freezes on natural and managed ecosystems may be multiplied by changes in pests and disease prevalence, increased competition from non-native or opportunistic native species, ecosystem disturbances, land-use change, landscape fragmentation, atmospheric pollutants, and economic shocks such as crop failures or reduced yields due to extreme weather events. These added stresses, when taken collectively, are projected to alter the ecosystem and socioeconomic patterns and processes in ways that most people in the region would consider detrimental. Much of the region's fisheries, recreation, tourism, and commerce depend on the Great Lakes and expansive northern forests, which already face pollution and invasive species pressure that will be exacerbated by climate change.

Most of the region's population lives in cities, which are particularly vulnerable to climate change related flooding and life-threatening heat waves because of aging infrastructure and other factors. Climate change may also augment or intensify other stresses on vegetation encountered in urban environments, including increased atmospheric pollution, heat island effects, a highly variable water cycle, and frequent exposure to new pests and diseases. Some cities in the region are already engaged in the process of capacity building or are actively building resilience to the threats posed by climate change. The region's highly energy-intensive economy emits a disproportionately large amount of the gases responsible for warming the climate.

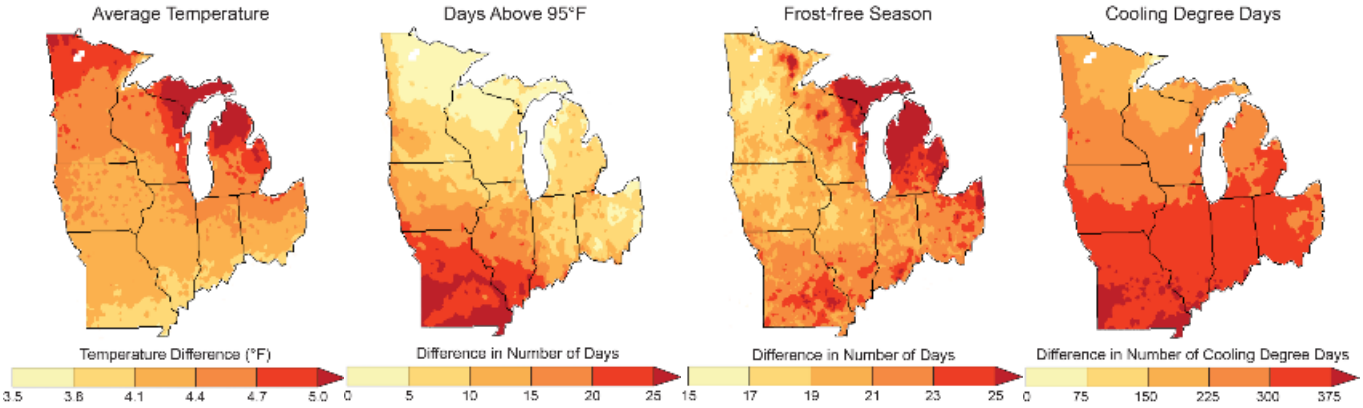
Climate Risks in the Midwest

> In the year 2065, on current trends, damage from climate change will exceed global GDP.
>
> Andrew Dlugolecki, General Insurance Development

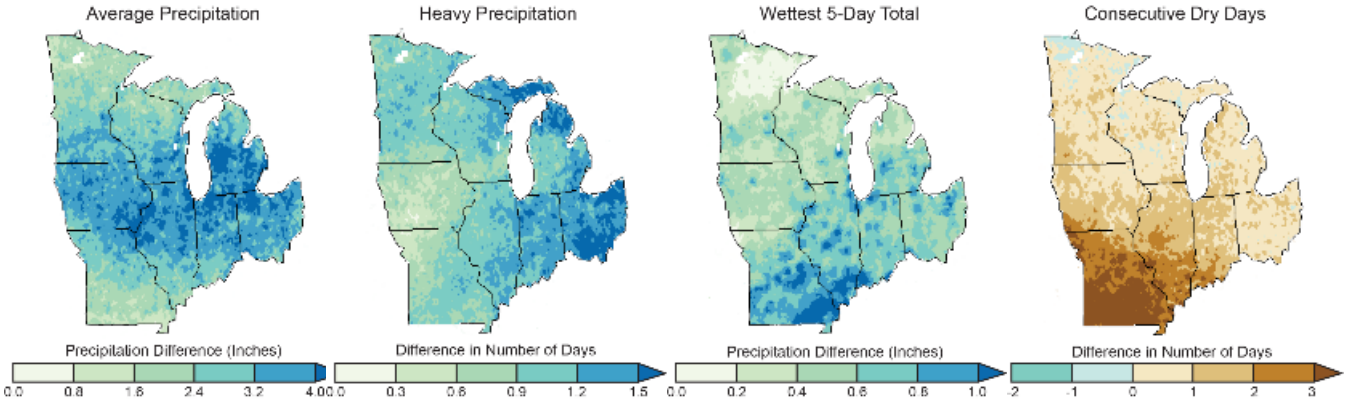
Climate Risks in the Midwest

According to the US National Climate Assessment, based on current emissions trends, by mid-century (2040 - 2070) the Midwest region is projected to experience a climate that is…

Hotter…



…with more rain …and drought



Primary Issues for Midwest

1: Impacts to Agriculture

Increases will continue in growing seasons, likely boosting some crop yields. Increases in extreme weather, number of very-hot days, flooding, and days without precipitation will likely decrease other yields. Overall, Midwest productivity is expected to decrease through the century.

2: Forest Composition

Rising air and soil temperatures, and variability in soil moisture will stress tree species. Forest compositions will change as habitats are driven Northward by as much as 300 miles. Due to these ecosystem disruptions, the region's forests may cease acting as a carbon sink, exacerbating greenhouse gas emission impacts.

3: Public Health Risks

Increases incident rate of days over 95 degrees, and humidity are anticipated to contribute to degradations in air and water quality. Each of these will increase public health risk, especially for at-risk populations.

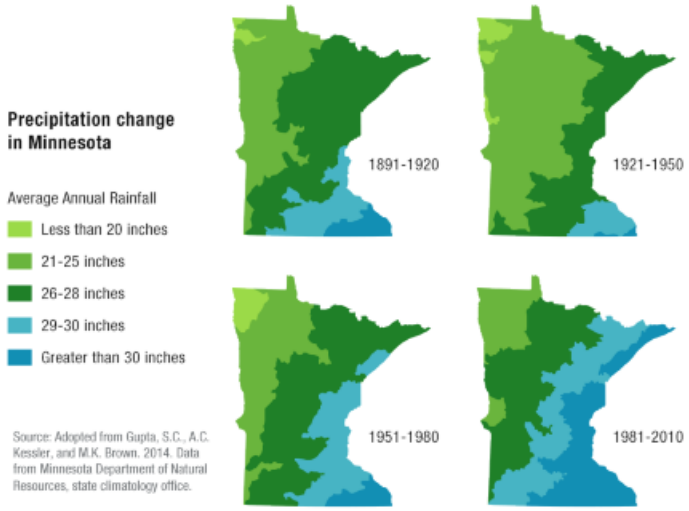
4: Increased Rainfall and Flooding

The frequency and size of extreme rainfall events and flooding has increased over the last century. In addition, the number of days without precipitation have increased. These trends are expected to continue, causing erosion, declining water quality, and impacts on human health, and infrastructure.

Climate Risks in Minnesota

Precipitation

According to the State of Minnesota Climatology office, DNR and the National Climate Assessment, the majority of the State receives 5-15% more annual rainfall than a century ago.
(Graphic: Jaime Chrismar MPRnews.org)

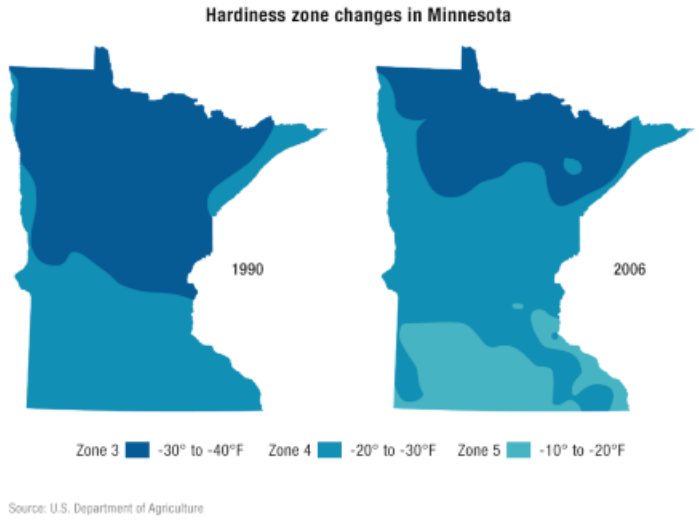


Mega-Rains

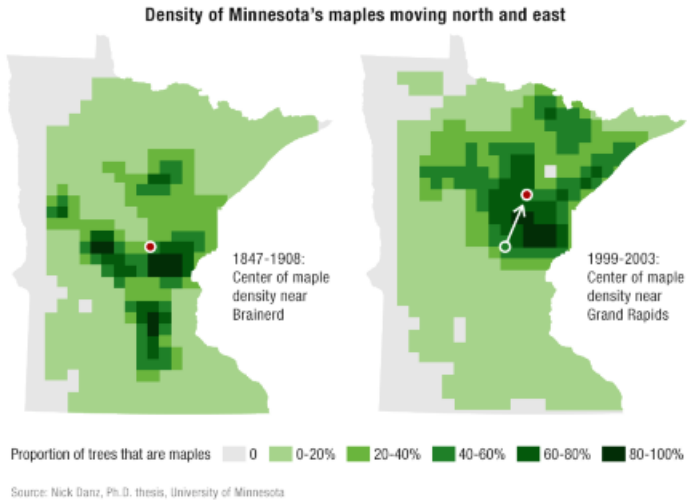
Since 1860 Minnesota has had 15 "Mega-rain" events: storms with 6+ of rain over 1,000 saure miles or more. 5 of those storms have occurred since 2000, illustrating a increased rate of occurrence. Mega-Rain events represent a strain on stormwater infrastructure as they deliver a minimum of 13.9 billion cubic feet of rainwater in very short periods of time.

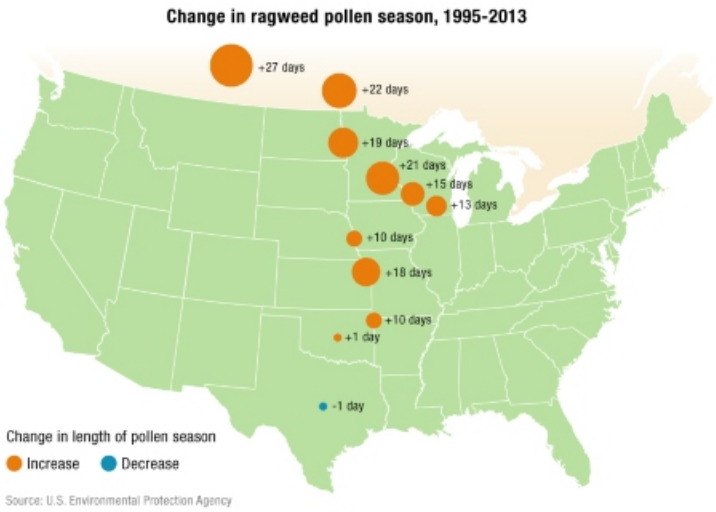
Changing USDA Zones

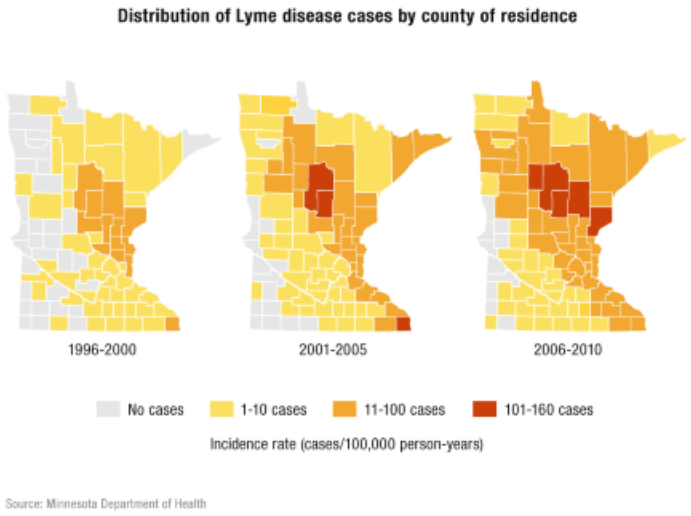
In addition to warmer weather, Minnesota is experiencing less spring snow cover in April resulting in more rapidly warming soil. The cumulative effects is a shift of USDA Hardiness zones to the North. In 1990 Maplewood was a Zone 4, today it is a Zone 5.
(Graphic: Jaime Chrismar MPRnews.org)



Climate Risks in Minnesota







Impacts of Climate Changes

In the natural world, changes in climate, of course, can change the favorablility of a region towards plant, animal, and insect species. These species impacts, then can have impacts on human health and economy, such as:

Trees Moving North

Maple forests, among other species, are moving northward, with the densest forests now occuring in the "arrowhead" section of the State rather than central region. Beyond the impacts on the ecosystem, this shift is expected to impact Minnesota's Maple syrup production in the coming years.
(Graphic: Jaime Chrismar MPRnews.org)

Human Allergies

With the shift in hardiness zones and increasing growing season, increases in pollen quantity and duration have been experienced and projected to continue. Beyond inflammation and irritation associated with allergic reactions, some studies indicate pollen can affect the cardiovascular and pulmonary system.
(Graphic: Jaime Chrismar MPRnews.org)

Vector Borne Disease

Vector borne diseases are spread through insects and are highly sensitive to climatic factors. Warmer weather influences survival and reproduction rates of vectors, in turn influencing the intensity of vector activity throughout the year. The increase in Lyme disease cases are an illustration of the impacts of a warming Minnesota climate will have on vector borne disease intensity.
(Graphic: Jaime Chrismar MPRnews.org)

Maplewood Climate

Maplewood Climate History

Since 1951, Maplewood has experienced:

Increase in annual average temperature: **3.2°F**

Increase in annual precipitation: **21%**

Increase in heavy precipitation events: **58%**
(Highest 5 flood stages from the Mississippi River have occurred in the last twenty years)

Increase in growing season: **16 days**

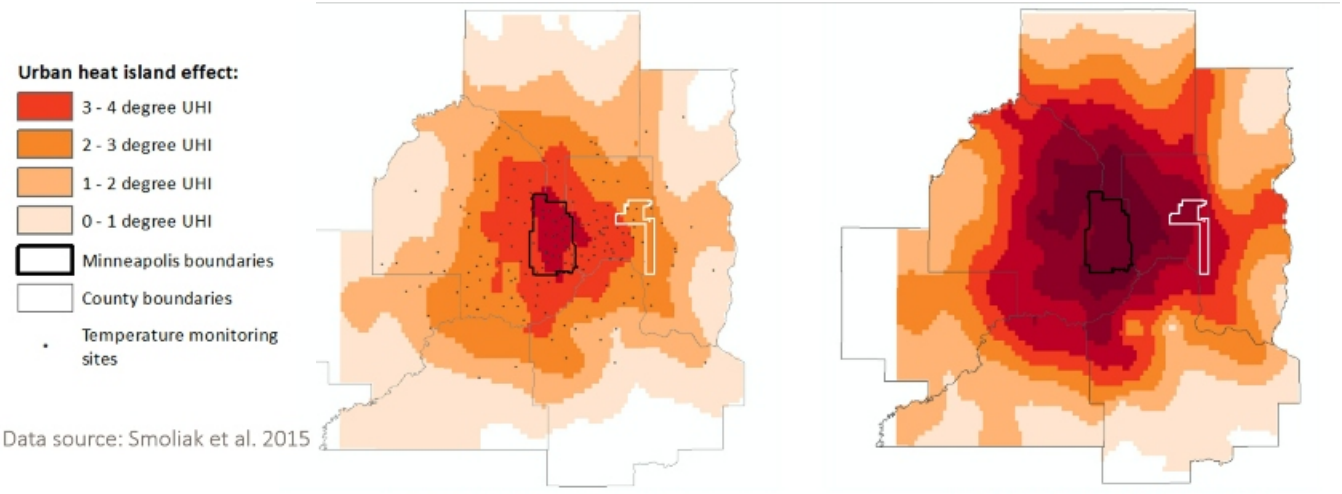
Maplewood Climate

Urban Heat Island

Urban dwellers are more at risk for heat-related illnesses than rural dwellers. Due to the "urban heat island effect," urban areas are usually hotter and cool off less at night than rural areas. Urban heat islands can increase health risks from extreme heat by increasing the potential maximum temperatures residents are exposed to and the length of time that they are exposed to elevated temperatures. The level of the urban heat island effect of a region is largely driven by the amount of impervious surface (pavement and buildings). This heat island effect serves to increase the impact of climate change effects in urban areas.

A study funded by the Institute on the Environment found:

- Temperatures in the urban core average 2 °F higher in summer than in surrounding areas
- The differential spiked as much as 9 °F higher during a heat wave in July 2012
- Urban heat island effect is stronger at night in summer and during the day in winter
- In urban areas when snow cover is less pervasive, daytime urban winter temperatures are higher than rural areas by an average of 2 °F.



Above is a graphic showing the measured metro heat island effect on July 2, 2012. The graphic on the left shows the day-long average temperature variation and on the right shows night-time difference. The City of Maplewood is outlined in white.

Impervious Surface Area

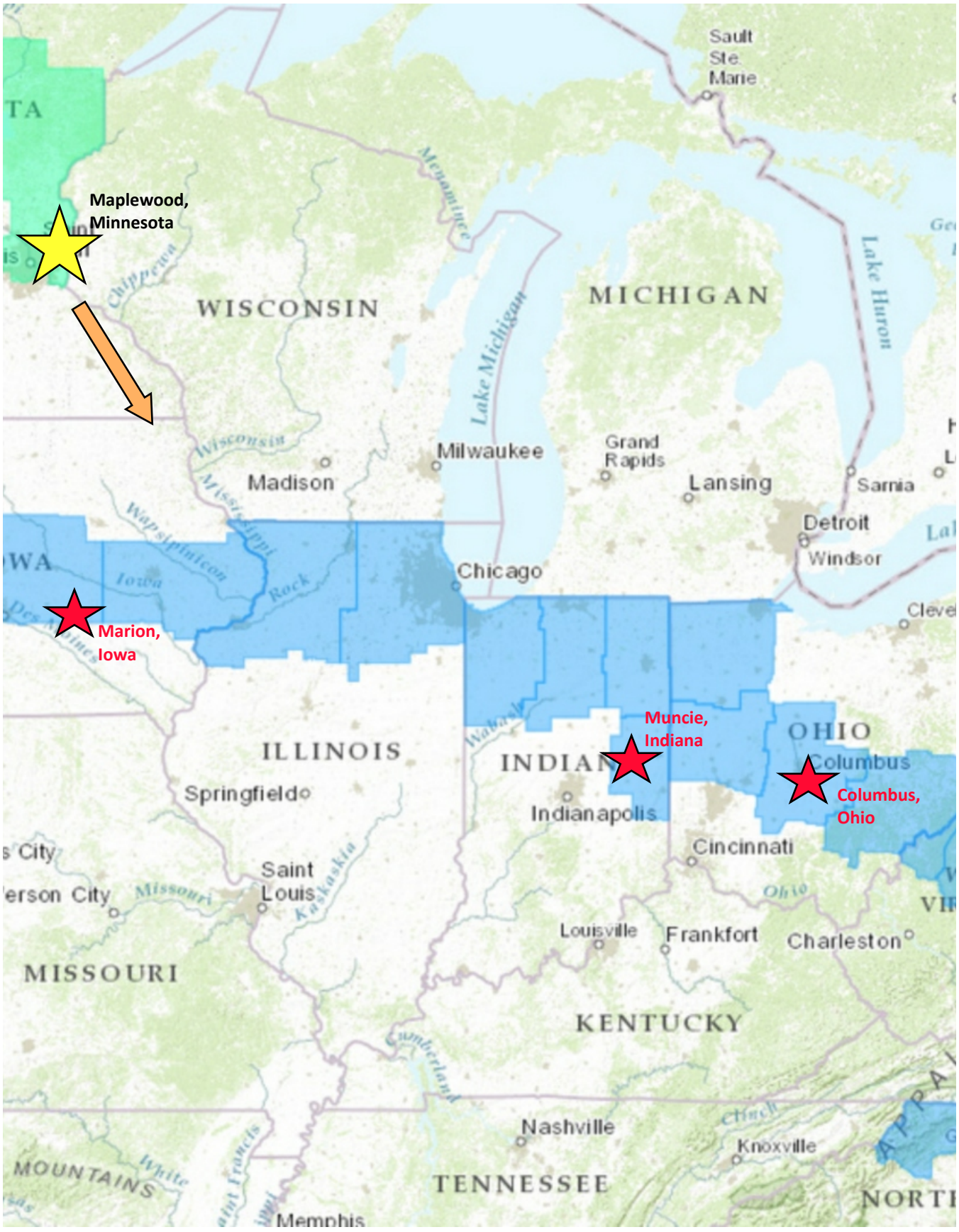
Total impervious area ...State Wide:	1.88%
...Metro area:	11.25%
...Ramsey County:	27.6%
...Maplewood:	27.8%

Maplewood on The Move

Projected changes in annual average temperatures and growing seasons will result in a change in the overall climate of Maplewood. Summertime conditions for mid-twenty first century in Maplewood are projected to be similar to the conditions currently felt 300 miles or further to the South. According to the University of Michigan Climate Center, by 2040 summertime conditions in Maplewood are anticipated to be similar to those today in Marion Iowa, Muncie Indiana, Columbus Ohio, and Wilkesboro North Carolina. On the map to the right, all areas shaded in blue represent Climate Peers whose current summer conditions match Maplewood's projected summer conditions by mid-century (2040-2070).

(Source: University of Michigan Climate Center)

Maplewood Climate



Maplewood Vulnerabilities

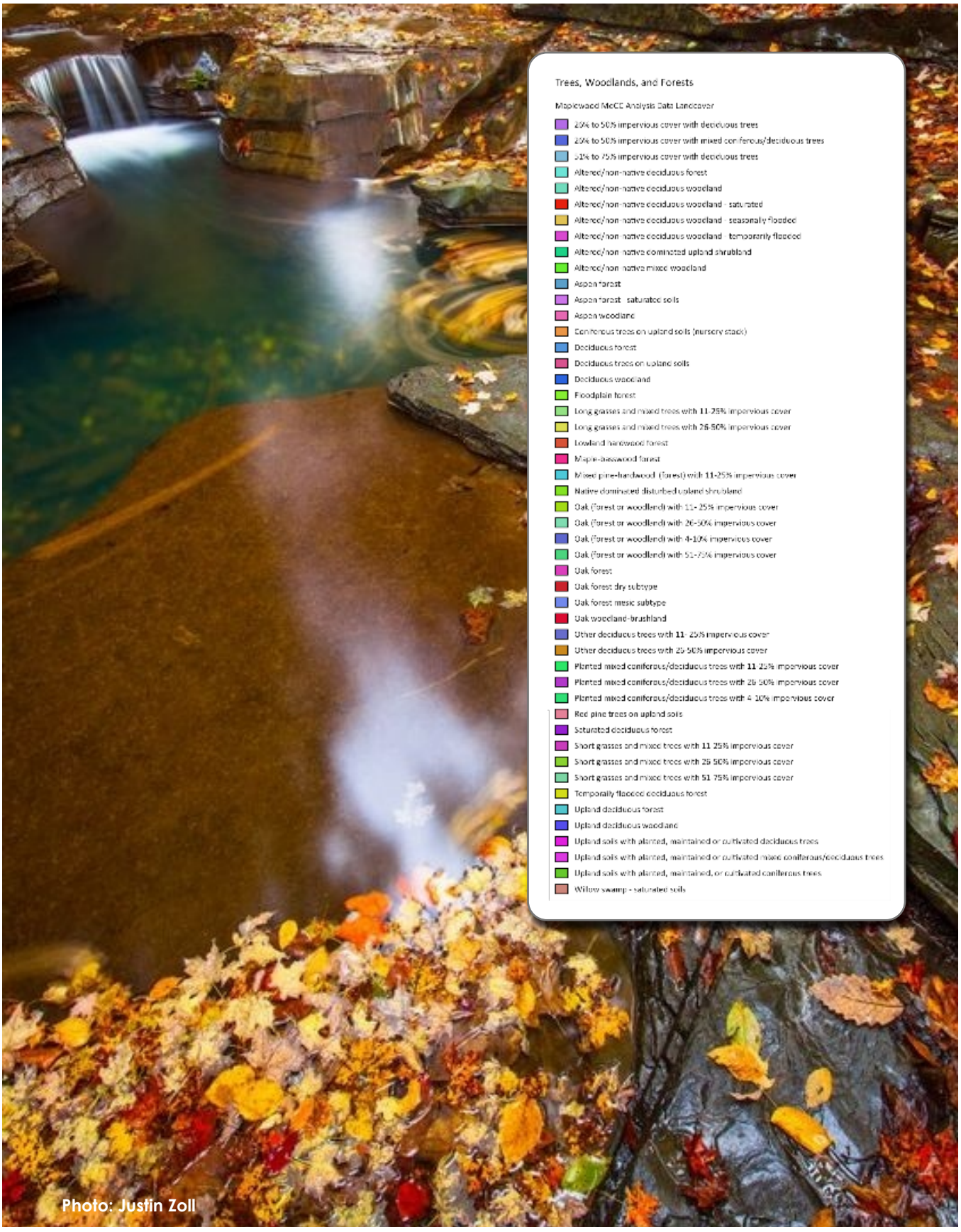
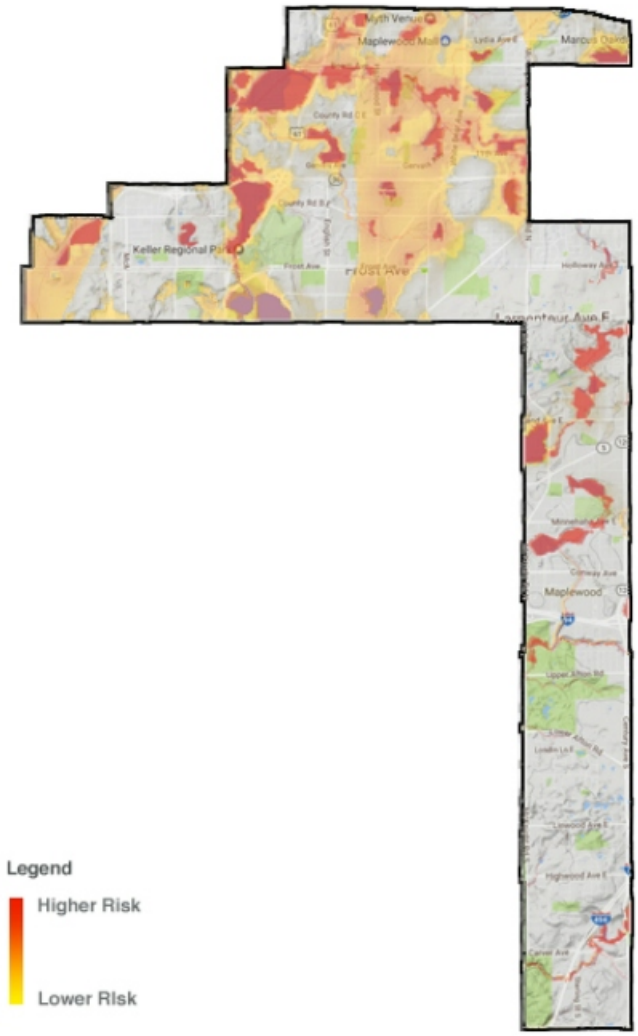


Photo: Justin Zoll

Maplewood Vulnerabilities



Urban Tree Canopy Vulnerability

Trees have a degree of vulnerability to changes in temperature ranges, precipitation patterns, soil temperature and moisture levels, and changes to winter processes and growing season length. According to the US Forest service, urban forests are very susceptible to a number of climate change factors including species invasion, and insect and pathogen attack. Species projected to have negative stressors in the Maplewood region include Aspen, Birch, Ash, Balsam, and Spruce. Extended drought conditions may also negatively impact other species such as Sugar Maple, Red Maple, and Basswood. Finally, increased growing seasons will result in taller trees which may be more susceptible to damage in extreme weather events. The map above shows the woodland, forest, and general tree cover of Maplewood. (Source: Minnesota DNR)

Flood Vulnerability

According to the US National Climate Assessment, the ten rainiest days can contribute up to 40% of the annual precipitation in our region. The Maplewood area can anticipate an increase of 10-20% in the total annual precipitation, while the amount of precipitation in summer months may actually decline. Under this scenario, it is likely that certain periods of the year, like spring, may be significantly wetter with storms producing heavier rains. In anticipation of that, it is appropriate to review the areas of the City with flood risk and to review current stormwater management capacity against future extreme rainfall event projections. The map above shows the flood risk areas throughout the City. (Source: National Flood Services)

Maplewood Vulnerabilities

Understanding Risks

Some of the risks associated with the projected climate change impacts for the Maplewood region include:

Warmer summers

Pollution control risks:
Wildfires may lead to soil erosion

Habitat risks
Greater evaporation
lower groundwater tables
Switching public water supply between surface and groundwater sources may affect the integrity of water bodies

Fish Wildlife and Plant risks:
Species that won't tolerate warmer summers may die/migrate
Biota at the southern limit of their range may disappear from ecosystems
Species may be weakened by heat and become out-competed
Essential food sources may die off or disappear, affecting the food web
Species may need to consume more water as temperature rises

Recreation and Public Water Supply Risks
More people using water for recreation may raise the potential for pathogen exposure
Warmer temperatures may drive greater water demand
Evaporation losses from reservoirs and groundwater may increase

Warmer winters

Pollution Control risks:
Increased fertilizer and pesticide use due to longer growing season.
Reduced winter snow and spring flow volume resulting in raised pollutant concentration in receiving waters.

Habitat risks:
Less snow, more rain may change the runoff/infiltration balance; base flow in streams may change
Changing spring runoff with varying snow.

Fish Wildlife and Plant risks:
Species that used to migrate away may stay all winter and species that once migrated through may stop and stay
Pests may survive winters that used to kill them and Invasive species may move into places that used to be too cold
Some plants need a "setting" cold temperature and may not receive it consistently
A longer growing season may lead to an extra reproductive cycle
Food supplies and bird migrations may be mistimed

Recreation and Public Water Supply Risks
Summer water supplies that depend on winter snow pack may be reduced or disappear
Cold places may see more freeze/thaw cycles that can affect infrastructure

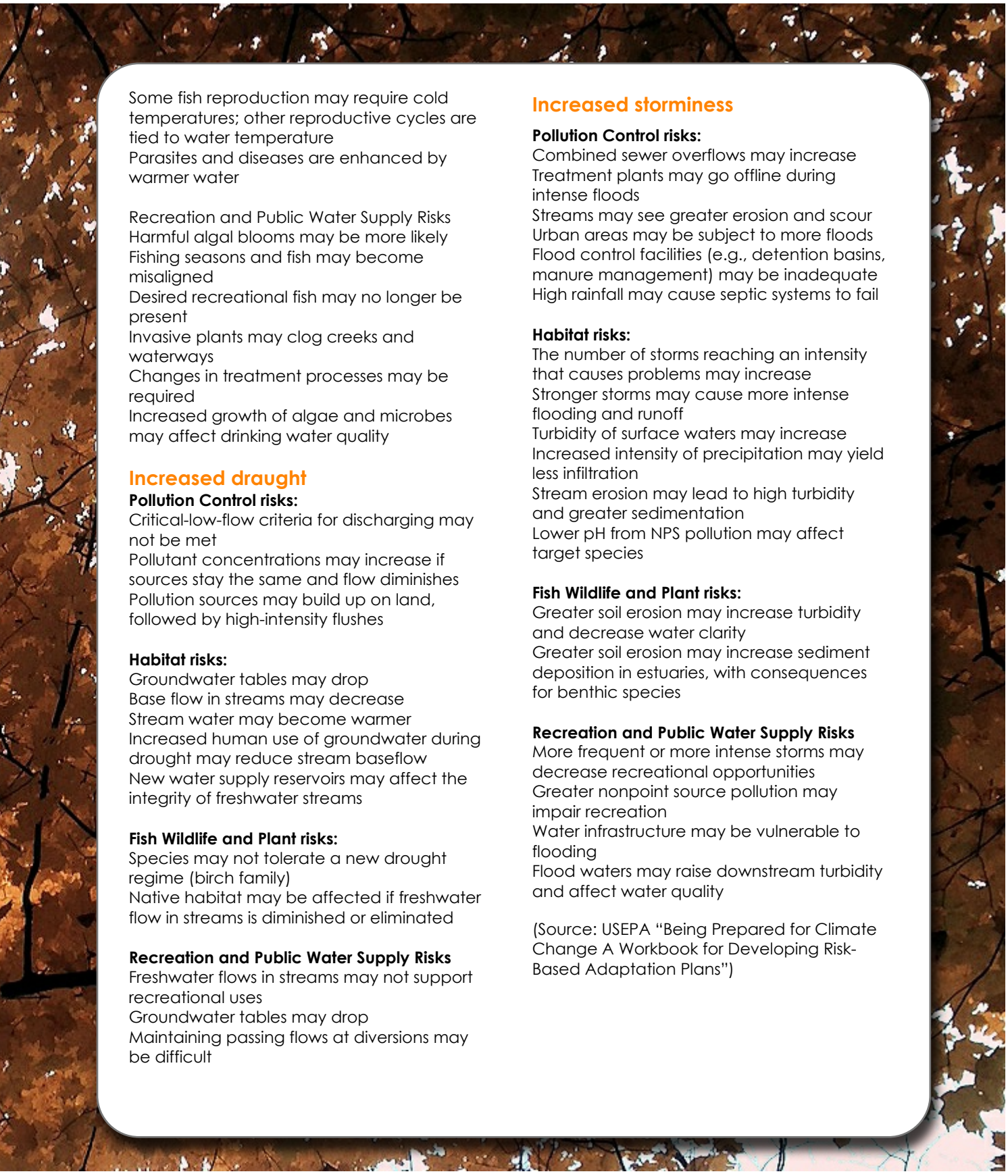
Warmer water

Pollution Control risks:
Temperature criteria for discharges may be exceeded (thermal pollution)
Warmer temperatures may increase toxicity of pollutants
Higher solubility may lead to higher concentration of pollutants
Water may hold less dissolved oxygen
Higher surface temperatures may lead to stratification
Greater algae growth may occur
Parasites, bacteria may have greater survival or transmission

Habitat risks:
Warmer water may lead to greater likelihood of stratification
Desired fish may no longer be present
Warmer water may promote invasive species or disease

Fish Wildlife and Plant risks:
Newly invasive species may appear
Habitat may become unsuitably warm, for a species or its food
Heat may stress immobile biota
Oxygen capacity of water may drop

Maplewood Vulnerabilities



Some fish reproduction may require cold temperatures; other reproductive cycles are tied to water temperature
Parasites and diseases are enhanced by warmer water

Recreation and Public Water Supply Risks
Harmful algal blooms may be more likely
Fishing seasons and fish may become misaligned
Desired recreational fish may no longer be present
Invasive plants may clog creeks and waterways
Changes in treatment processes may be required
Increased growth of algae and microbes may affect drinking water quality

Increased draught

Pollution Control risks:
Critical-low-flow criteria for discharging may not be met
Pollutant concentrations may increase if sources stay the same and flow diminishes
Pollution sources may build up on land, followed by high-intensity flushes

Habitat risks:
Groundwater tables may drop
Base flow in streams may decrease
Stream water may become warmer
Increased human use of groundwater during drought may reduce stream baseflow
New water supply reservoirs may affect the integrity of freshwater streams

Fish Wildlife and Plant risks:
Species may not tolerate a new drought regime (birch family)
Native habitat may be affected if freshwater flow in streams is diminished or eliminated

Recreation and Public Water Supply Risks
Freshwater flows in streams may not support recreational uses
Groundwater tables may drop
Maintaining passing flows at diversions may be difficult

Increased storminess

Pollution Control risks:
Combined sewer overflows may increase
Treatment plants may go offline during intense floods
Streams may see greater erosion and scour
Urban areas may be subject to more floods
Flood control facilities (e.g., detention basins, manure management) may be inadequate
High rainfall may cause septic systems to fail

Habitat risks:
The number of storms reaching an intensity that causes problems may increase
Stronger storms may cause more intense flooding and runoff
Turbidity of surface waters may increase
Increased intensity of precipitation may yield less infiltration
Stream erosion may lead to high turbidity and greater sedimentation
Lower pH from NPS pollution may affect target species

Fish Wildlife and Plant risks:
Greater soil erosion may increase turbidity and decrease water clarity
Greater soil erosion may increase sediment deposition in estuaries, with consequences for benthic species

Recreation and Public Water Supply Risks
More frequent or more intense storms may decrease recreational opportunities
Greater nonpoint source pollution may impair recreation
Water infrastructure may be vulnerable to flooding
Flood waters may raise downstream turbidity and affect water quality

(Source: USEPA "Being Prepared for Climate Change A Workbook for Developing Risk-Based Adaptation Plans")

Maplewood Vulnerabilities

Vulnerable Populations in Maplewood

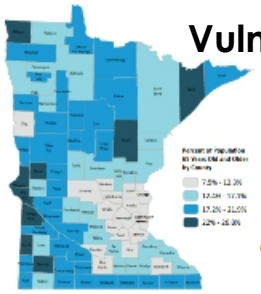
According to the Minnesota Department of Health, some populations are especially vulnerable to climate health risks due to particular sensitivities, high likelihood of exposure, low adaptive capacity, or combinations of these factors. To assist a City in identifying adaptive measures to support their community in the impacts of climate change, t is important to understand and identify the most vulnerable populations within the community.

The graphs to the right indicate the percentage of population for some of the most vulnerable groups in Minnesota., Metro Twin Cities, and the City of Maplewood. Groups of particular concern for the City are seniors, seniors living alone, lower income families/individuals, and families/individuals without a vehicle.

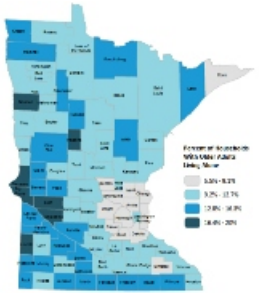
(Source: State of Minnesota Department of Health)

Maplewood Vulnerabilities

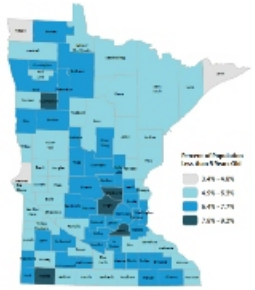
Vulnerable Populations:



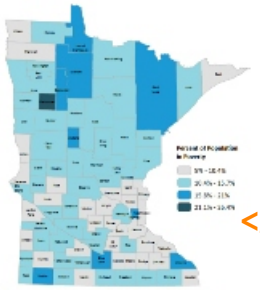
	…In Minnesota	…Twin City Metro	…City of Maplewood
65 Years and Older	12.6%	11.9%	16.3%



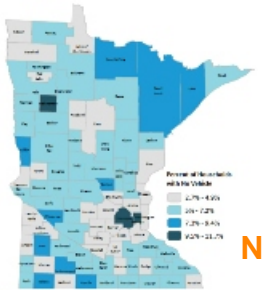
Seniors Living Alone	9.4%	9.7%	11.6%



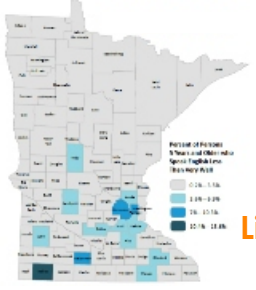
Under 5 Years	6.7%	6.8%	6.2%



<200% Poverty	25.5%	32.4%	26.0%

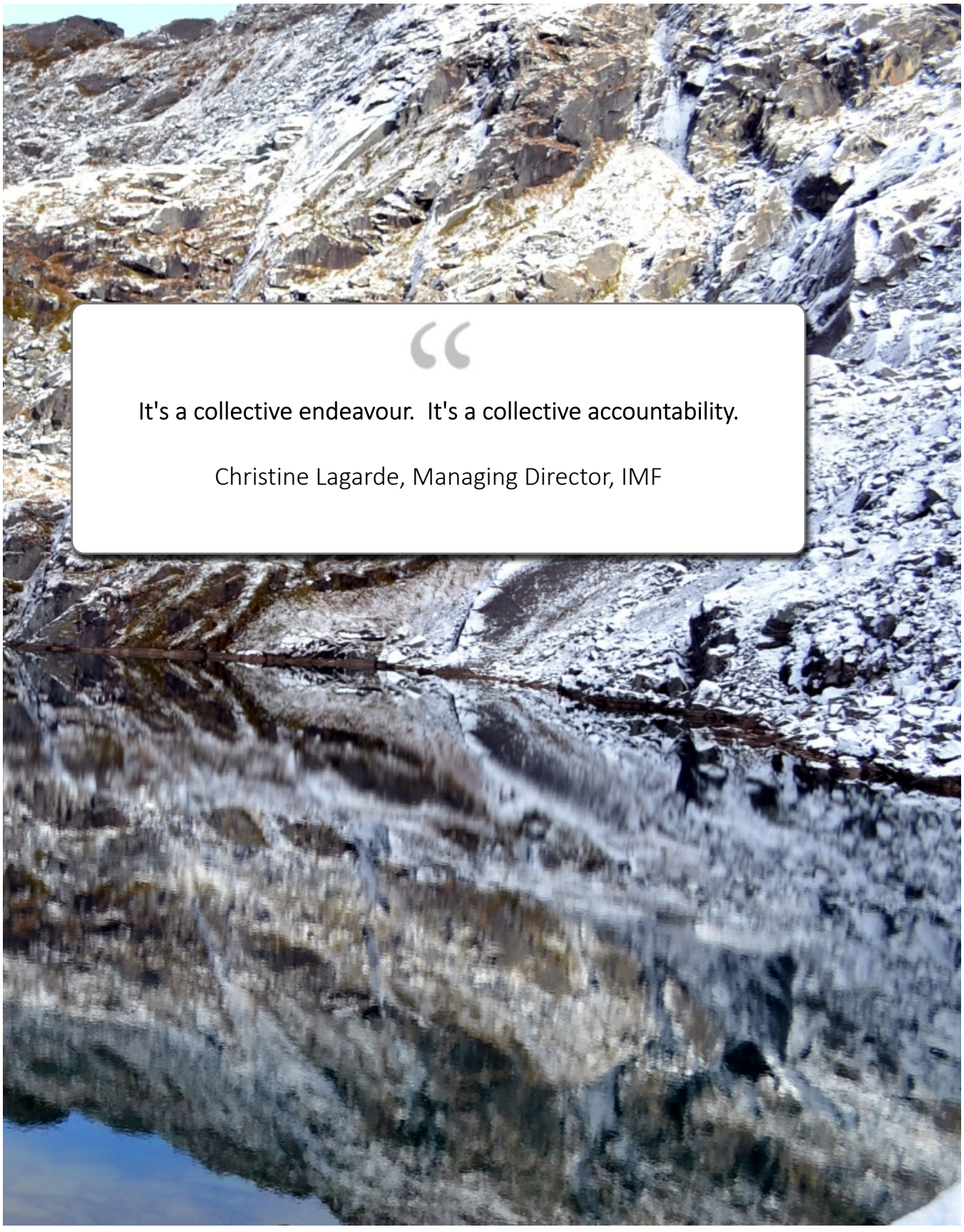


No Vehicle	7.9%	8.2%	9.4%



Limited English	4.2%	6.3%	7.6%

Conclusions



> It's a collective endeavour. It's a collective accountability.
>
> Christine Lagarde, Managing Director, IMF

Conclusions

The City of Maplewood has already seen climate changes. The projections for the City's climate by the middle of this century indicate continued increases in temperatures. Additionally, precipitation patterns are anticipated to change, providing an increase in the overall rainfall as well as an increase in the number of days without rain - exacerbating both flooding and drought potential. The City's location as a "first ring" suburb is prone to heat island effects which act as a multiplier on the overall region's climate extremes.

The projected changes to Maplewood climate represent stressors for both the environment and people. Urban tree canopies as well as urban populations have unique vulnerabilities associated with the projected climate changes for the City of Maplewood.

Risks to Maplewood's Environment

The risks to the City of Maplewood's physical environment include:

- Stresses on the City's Urban Tree Canopy, and subsequent increase in heat island effect exacerbating the effects of temperature extremes.
- Stresses on the City's lakes, streams, and wetlands including threats to aquatic species and water quality
- Stresses on the City's storm water management infrastructure with increased flood risk potential.

Risks to Maplewood's Residents

Climate impacts also represent potential health risks to vulnerable sectors of the City of Maplewood's residents. Some of these population sectors, in fact, represent a higher portion of the City's population, and therefore risk potential, than that of the metro area or even the State as a whole, including:

- Individuals 65 and older (137% of the metro-wide portion of population)
- Seniors living alone (123% of the State average portion of population)
- Individuals living at or below 2x "poverty income"
- Individuals without vehicle access (115% metro wide average)
- Individuals with limited English proficiency (180% of State average, and 121 of metro-wide average)

Next Steps

We recommend that the City of Maplewood conduct a Climate Adaptation Study and Plan. This effort should focus on identifying the specific geographic features, habitats, city infrastructure, and city neighborhoods with higher concentrations of the demographic sectors most vulnerable to the projected climate change risks. Once identified, this study should assess the storm water management capacities, urban tree canopy conditions, and social support/infrastructure supporting the higher risk sections of the City and make recommendations for any modifications appropriate to increase the climate resilience of the community.

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