Supporting Winter Climate Adaptation in Worcester, Massachusetts

MS Thesis - Community Climate Adaptation Program

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December 9, 2024

Introduction

- **MS CCA Students:**
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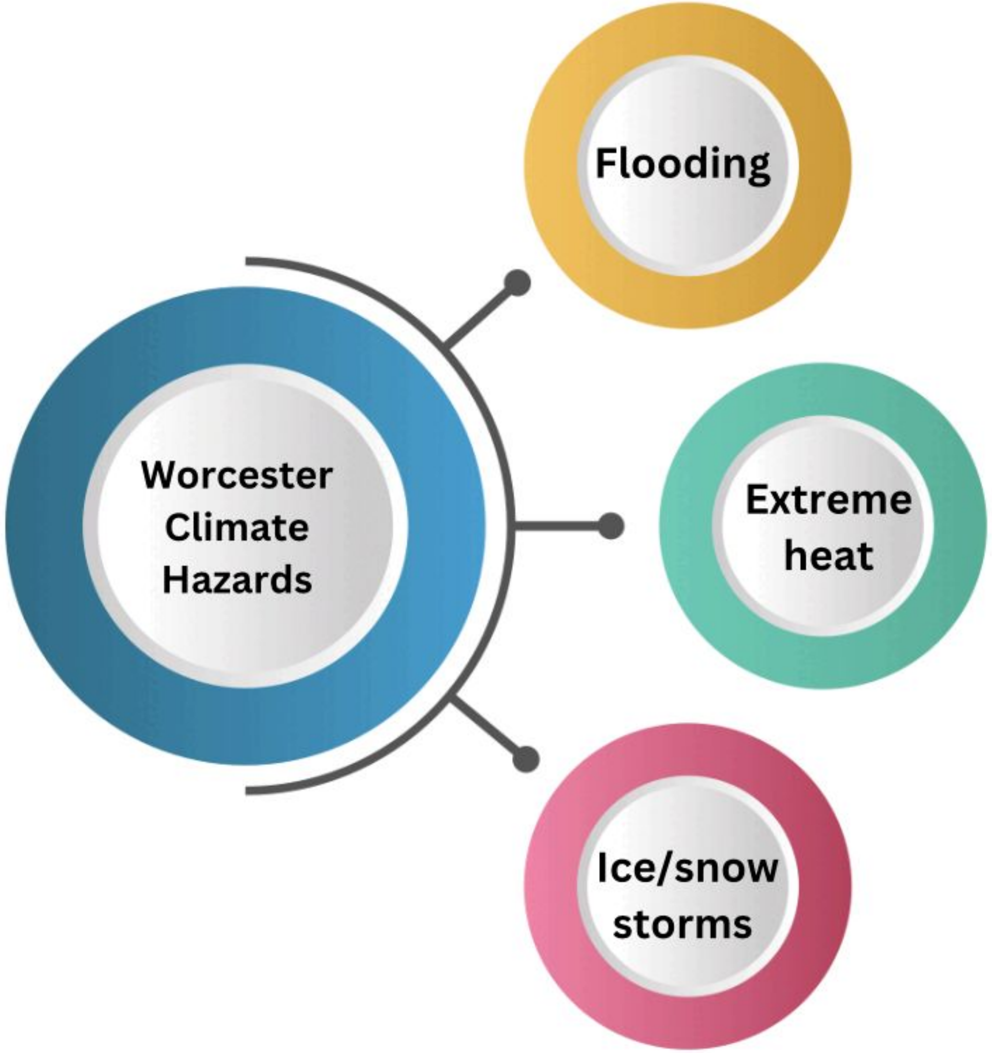
WPI

The City of WORCESTER

Background

- Municipal Vulnerability Preparedness Plan (2019)
- The Green Worcester Sustainability and Resilience Strategic Plan (2020)
- **Research gap:** The impact of climate change during the winter months
- **Goal:** Support the winter adaptation plan for the city of Worcester



Project Objectives

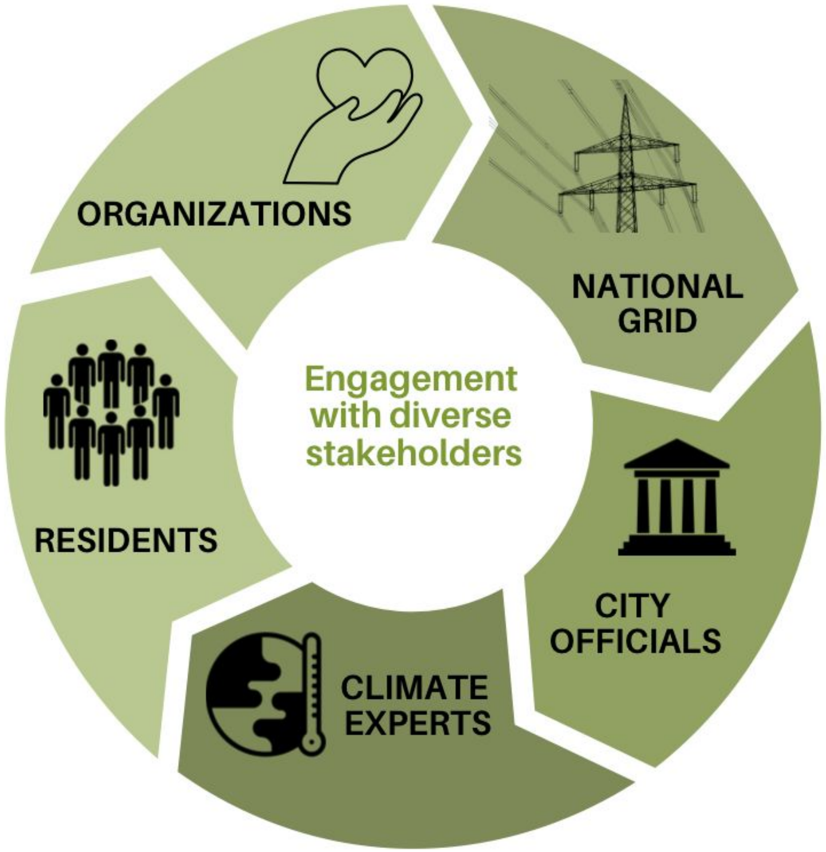
1. Understanding climate change impacts during winter months in Worcester
2. Assessing the vulnerability of Worcester's critical infrastructure to winter storm events
3. Identifying populations and social services vulnerable to winter winter storms events
4. Suggesting short and long-term recommendations to enhance resilience to winter climate change

Methods and Stakeholders Groups

Archival research

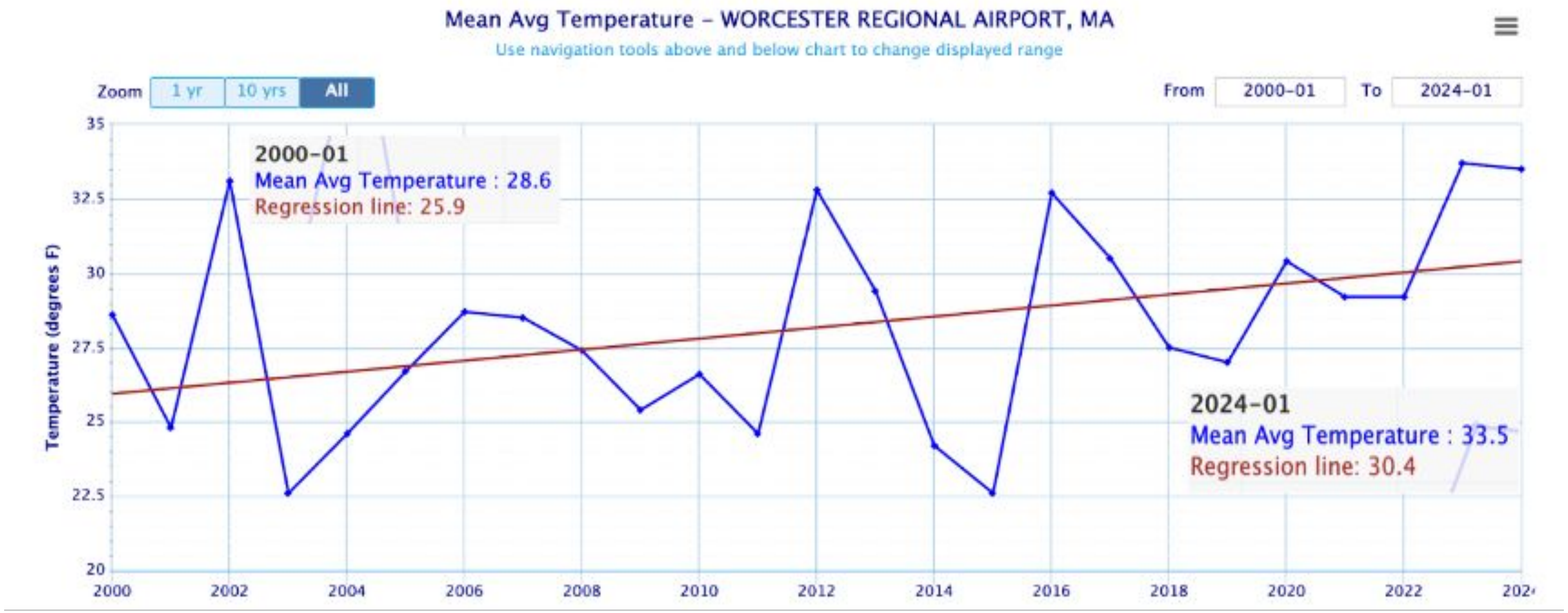
Semi-structured interviews (38)

Resident survey (565)



Winter Climate Change Trends

Historical trends indicate an increase in winter temperature.



Average temperature (°F) from 2000 to 2024 for Worcester, MA
Source: Weather station at Worcester regional airport

Future projections show a continued rise in winter temperatures.

RCP 4.5
Moderate
emissions scenario

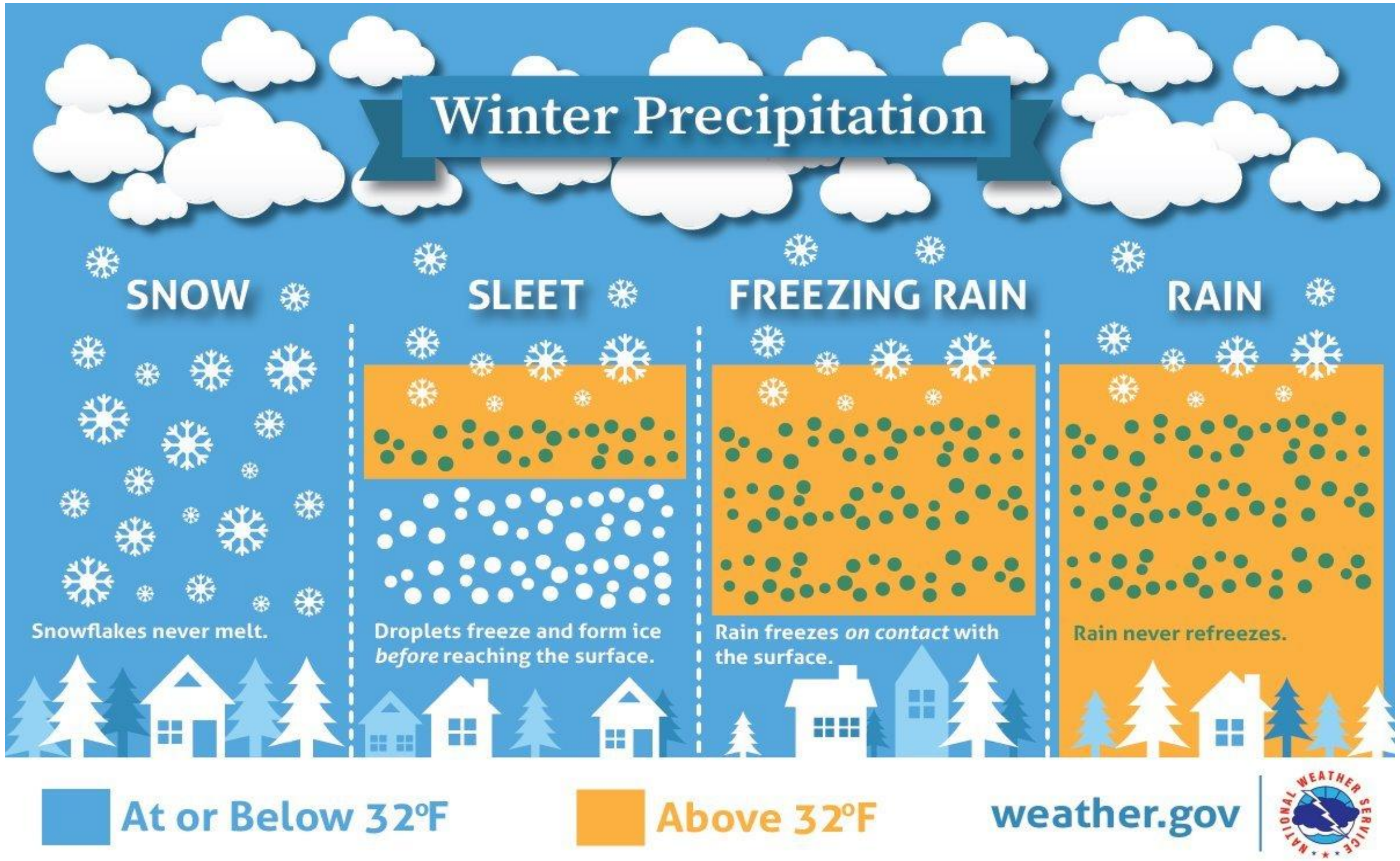
Projections RCP 4.5	Temperature (°F)
2030	32.16 °F
2050	33.06 °F
2070	33.96 °F
2090	33.96 °F

RCP 8.5
High
emissions scenario

Projections RCP 8.5	Temperature (°F)
2030	32.16. °F
2050	34.86 °F
2070	36.66 °F
2090	38.46 °F

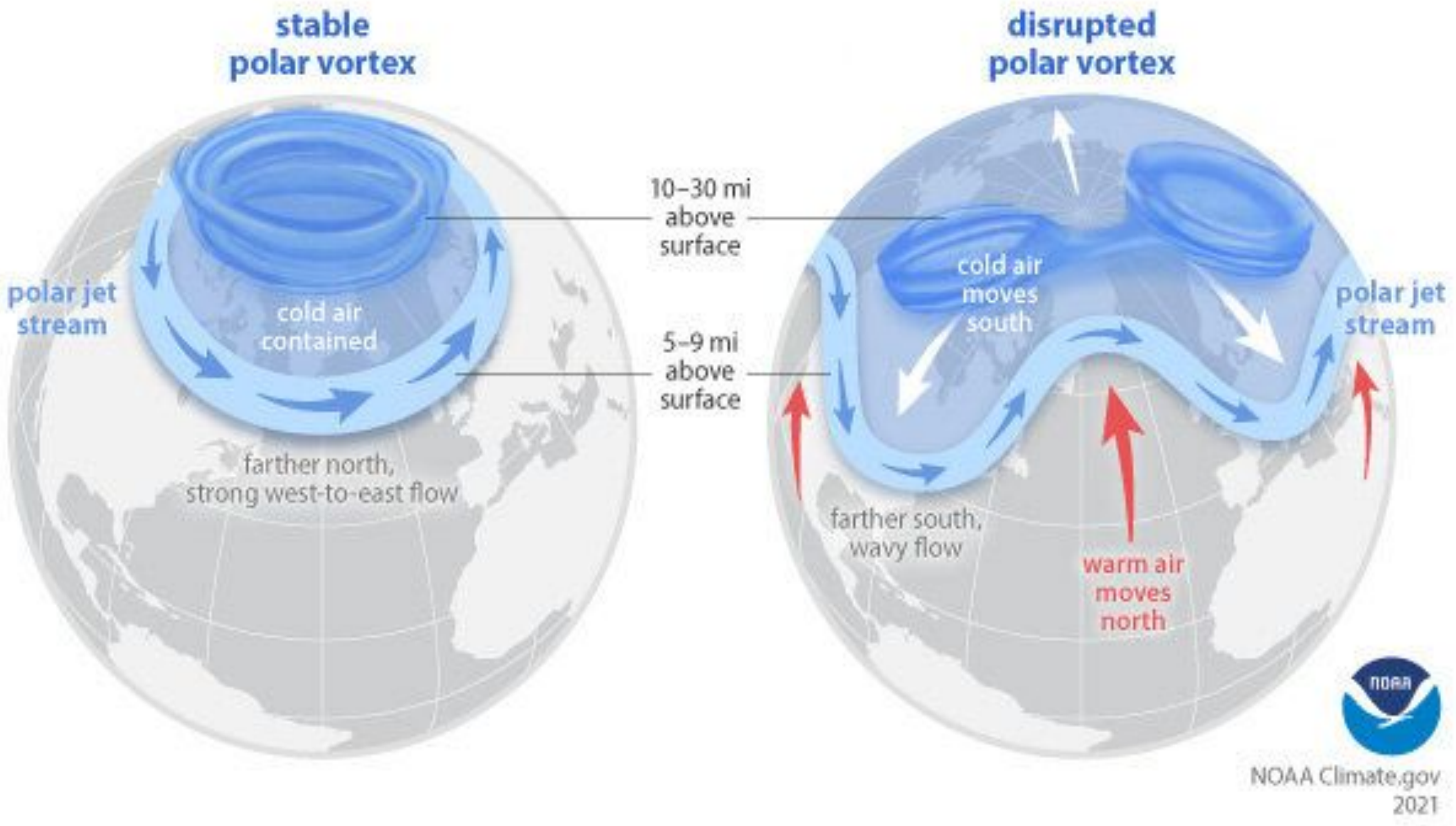
Climate projections for Worcester, MA under RCP 4.5 and 8.5
Source: MA Executive Office of Energy and Environmental Affairs (EEA)

Increased atmospheric water vapor is changing winter precipitation patterns.



Winter precipitation types
Source: NOAA's National Weather Service

Warmer winters may intensify the unpredictability of winter storms.



Stable Polar Vortex and Disrupted Polar Vortex
Source: NOAA Climate.gov

Winter storms have significant variability in impact, intensity, and frequency.

Date	Year	Type	Details
November 25-29	1921	Ice Storm	4 inches
April 19	1925	Ice Storm	14 inches
December 26-27	1947	Blizzard	16.9 inches
December 24	1961	Blizzard	24 inches
February 25-29	1969	"The 100 Hour Storm"	26.3 inches
February 5-7	1978	Blizzard	20.2 inches
February 11	1983	Blizzard	21 inches
April 28	1987	Snowstorm	17 inches
December 10-12	1992	Nor'easter	27 inches
Mar 13-14	1993	Winter storm	20.1 inches
December 22-26	1994	Cyclone	Intense cyclone
January 6-10	1996	Blizzard Juno	33.5 inches
March 30 - April 1	1997	April Fool's Blizzard	33 inches
February 14-19	2003	Blizzard	27.5 inches
January 20-23	2005	Blizzard	40 inches
February 11-13	2006	Blizzard	22 inches
December 11-12	2008	Ice storm	1 inch

Major winter storms in Worcester
Source: WPL Microfilms

SNOW,
SNOW,
SNOW!

By Nancy Sandrof

WHETHER WE like it or not, snow is an integral part of the New England landscape. With the latest forecast of same quivering on the air waves, most of us remember from past experience that practically six months of the year are taken up either with talking about it or shoveling it. With so much involvement, perhaps we should look deeper into this chilly, wet phenomenon known as snow.

Snow formation depends on a cloud temperature of 10 degrees Fahrenheit and on enough water vapor in the air. And don't you believe it when people tell you that there is more snow at the poles than anywhere else. Just as we suspected, more snow forms in the temperate zones where there is more moisture in the air. Ten inches of snow equals one inch of rain. You get your heaviest snowfalls when the temperature hovers between 24 and 30 degrees.

At this point it is customary to drag in the tired old Blizzard of '88, but we won't. You're probably as sick of hearing about it every winter as we are. Besides, the heaviest single snowfall that ever occurred in the entire history of the U.S. fell in Silver Lake,. Colorado in 1921, when 100 inches of the stuff descended in 85 hours!

Even the torrid zones get snow. Mt. Kenya, for example, located at the equator and 17,000 feet high, bears snow all year round. In Alaska, however, a mountain only 5.000 feet high is permanently capped with snow. The Empire State Building would have to be eight times higher than it is before it could have a permanent snowcap in our latitude.

MANTLE of white covers quiet hillside in Oxford.

IT IS INTERESTING to know that the type of snowflake you get depends on the kind of climate in which you live. For instance, high temperature and low atmospheric pressure at low altitudes combine to produce large, moist flakes.

The combination of high altitudes, high pressure, on the other hand, and low temperature, will give you tiny, tightly - compounded flakes. There are two types of snow flakes: tabular and columnar.

The lacy variety and the fancy star shapes so commonly shown in photographs are tabular. The hexagonal variety is commonest of all, but once in a while, you encounter a triangular type, as well. A rarity, though it has been known to show up, is a four and even five-sided snowflake. Why they are mostly hexagonal, we cannot say, and neither can anyone else. But it is agreed that this shape is due to the tripartite composition of the water molecule.

Having dealt with the physical composition and shape of snow let's look into the word itself. In Old English it's snaw, so that we don't have far to look for its derivation. Other languages do not stray far either, with few exceptions. In Dutch it's sneeuw, in German schnee, in Icelandic snaer or snjor, the Swedes say sno, the Danes snee, the Lithuanians snegas, the Russians snieg. In Irish and Gaelic it's sneachd, and in Latin, nix, nivis. It is neige in French, neve in Italian, and nieve in Spanish.

Webster defines the white stuff as "watery particles congealed into white or transparent crystals or flakes in the air, and falling to the earth, exhibiting a great variety of very beautiful and perfect forms."

The State of Nevada got its name from the "snowy mountain range," or the Sierra Nevada, part of which is in it.

In 1793 the French revolutionary calendar was adopted, though abandoned a short time later. This had one month called Nivose, yet another word for snow. This month lasted from Dec. 21 to Jan. 19. t that time it was succeeded by another month called Pluviose (remember Jupiter Pluvius?)

Paradise Ranger Station in California averages 47 feet a year; Worcester area gets 58.9 inches

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Blizzard 1961, Microfilm

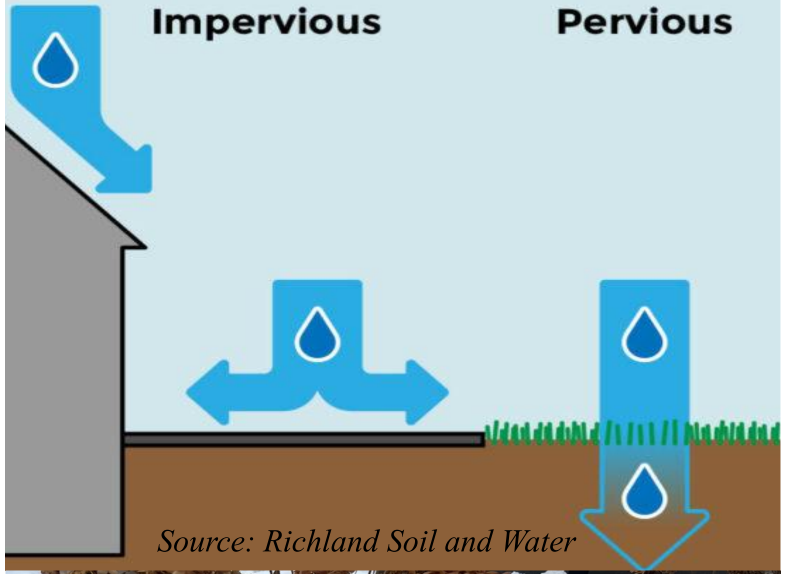
Infrastructure Vulnerabilities

Increased winter rainfall will lead to more runoff on impervious surfaces which can overflow drainage systems.

Impervious surfaces

Increase runoff

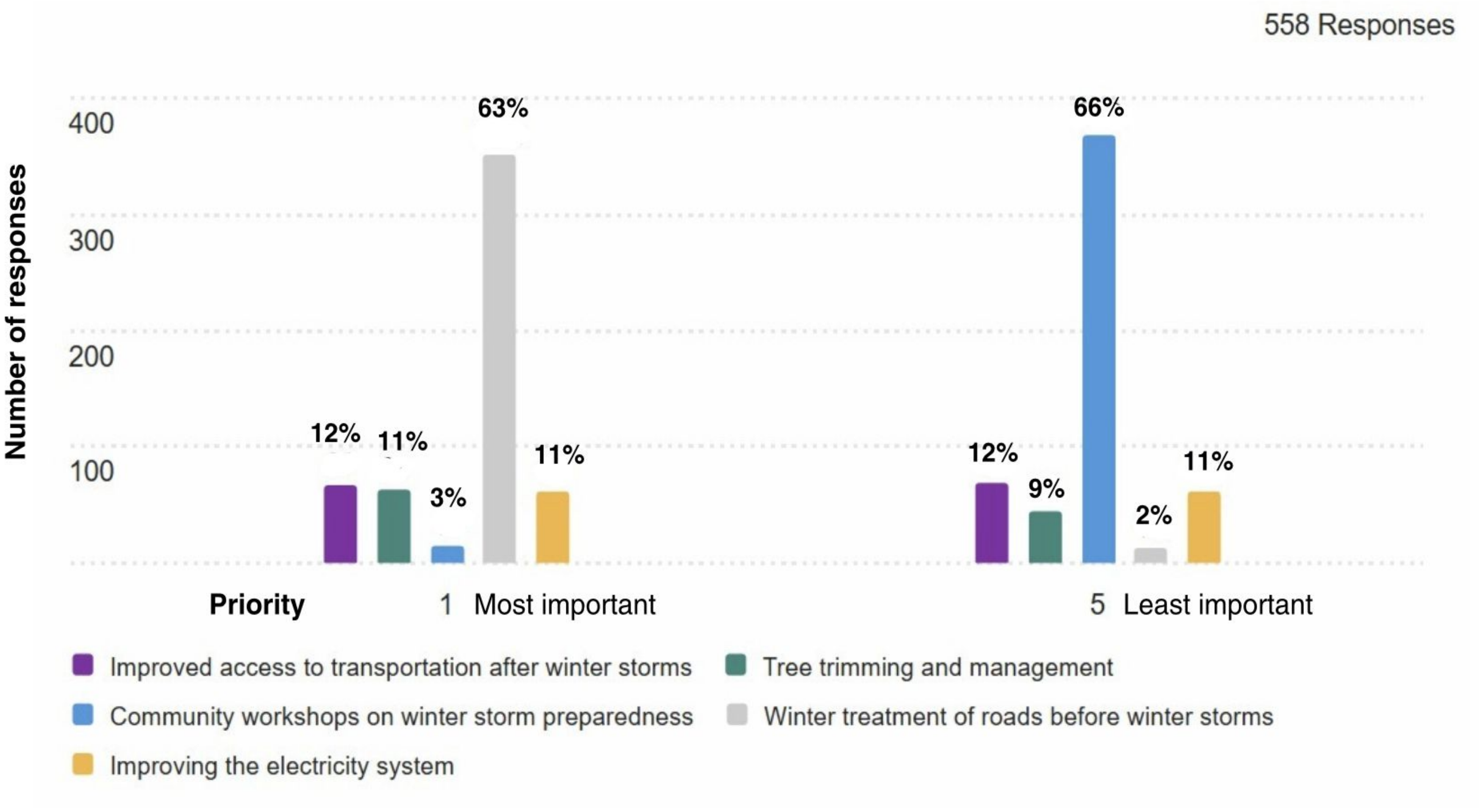
Stormwater flooding



Source: Richland Soil and Water

Worcester's roads are susceptible to damage during the winter season due to freeze-thaw cycles.

Community priorities in response to winter storms



Source: Communities' Perception of Winter Storm - Resident Survey

Heavy snow and ice accumulation on branches often causes breakage.

Sensitive		Intermediate		Resistant	
Cherry	7%	Pin oak	5%	Norway maple	28%
Honey locust	4%	Red maple	4%	Littleleaf linden	5%
Callery pear	3%	Red oak	3%	Northern white cedar	3%
Silver maple	4%				

Ice Storms Susceptibility of top 10 tree species in Worcester
Source: Worcester Urban Forest Master Plan and (Hauer et. al, 2006)

Undergrounding power lines improves grid resilience, but it is cost-prohibitive.

Undergrounding power lines

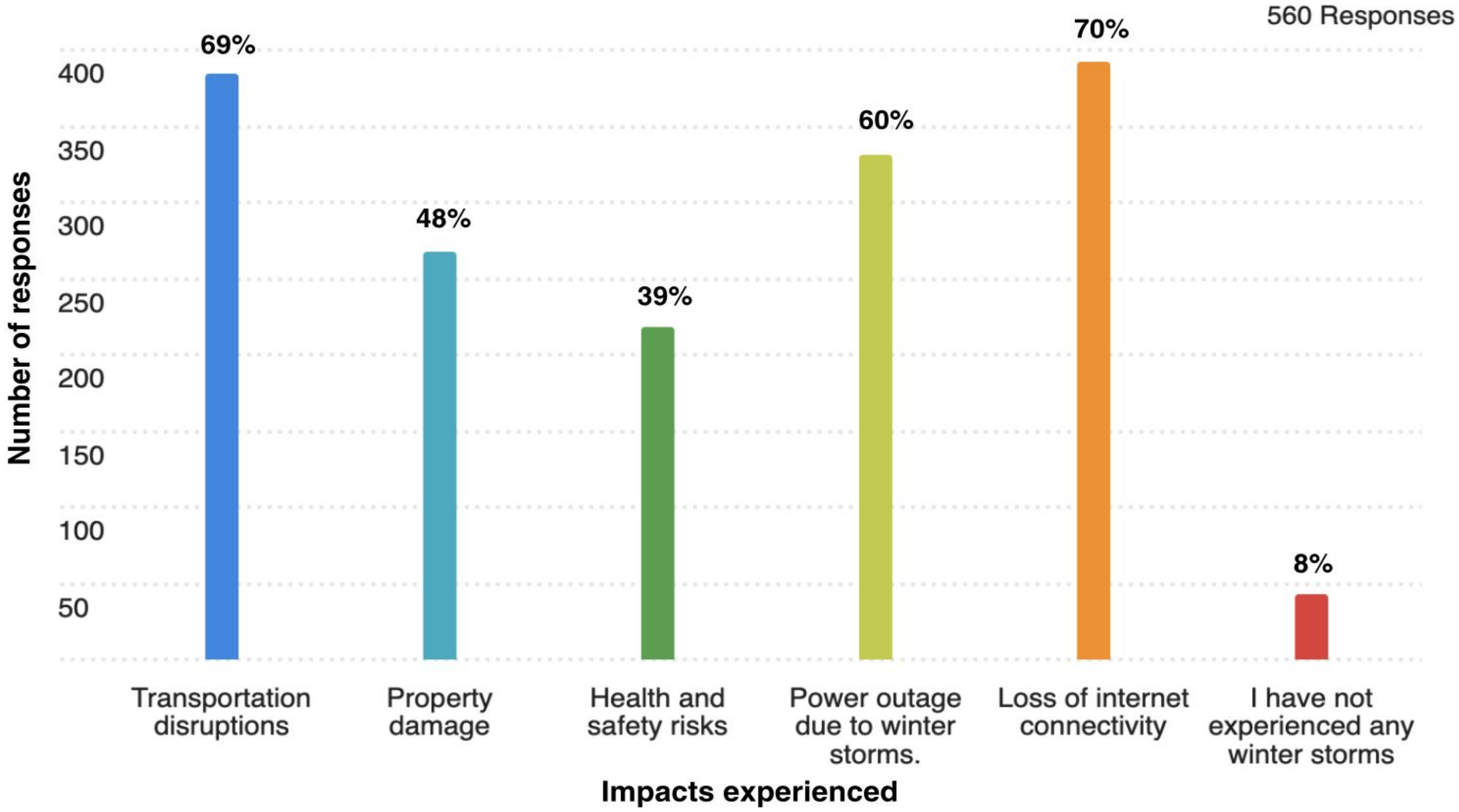
Cost-prohibitive

Backyard power lines

Street facing powerlines

Loss of internet connectivity during winter storms is a concern among the residents.

Impacts experienced due to winter storms



Source: Communities' perception of winter storms - resident survey

Social Vulnerabilities

Non-English speakers and newcomers are especially vulnerable during New England winters.

Language barriers

Preparedness

Source: Ben Garver/The Berkshire Eagle, via Associated Press

Elderly and disabled populations face challenges with snow clearing.

Assistance

Information dissemination

Source: Quantum Rehab

Unhoused populations are particularly vulnerable, as exposure to severe cold and ice conditions impacts their health disproportionately.

Space Capacity

Exposure

Winter storms increase the likelihood of school closures.

- Student safety
- Daycare constraints
- Food insecurity

Source: The Boston Globe

Adaptation Strategies

Adaptation Strategies for Infrastructure Vulnerabilities

Drainage systems

- Review the stormwater and combined sewer systems to manage the expected increased winter rainfall
- Investigate incorporating permeable surfaces in areas prone to flooding
- Evaluate incorporating bioretention systems for stormwater flooding

Roads

- Assess the incorporation of eco-friendly de-icing agents
- Determine the possibility of implementing permeable pavement design in future infrastructure projects
- Consider employing roadway materials that can support rapid temperature fluctuations

Adaptation Strategies for Infrastructure Vulnerabilities

Trees

- Select tree species that are resistant to ice and heavy snow
- Continue existing coordination on tree trimming with National Grid

Electrical Infrastructure

- Conduct a cost-benefit analysis of targeted modernizations in areas at high risk

Telecommunication Networks

- Evaluate expanding broadband internet options
- Explore the feasibility of having backup satellite internet service

Adaptation Strategies for Social Vulnerabilities

Non-English speakers and Newcomers

- Make multilingual emergency information for winter storms more accessible (ALERTWorcester)
- Actualize the Emergency Communications website with seasonal risks
- Provide education programs and guides on emergency preparedness

Elderly and Disabled

- Build partnerships with college campuses and organizations to boost volunteer participation
- Leverage multi-channel communication strategies to share services

Adaptation Strategies for Social Vulnerabilities

School closures

- Evaluate food insecurity of students and partner with community organizations for short-term relief during extended closures

- Partner with local daycares for temporary childcare

Unhoused

- Review opportunities to expand warming centers

Conclusion and Next Steps

- Short-term, low-cost interventions
  - Evaluate expanding broadband internet options
  - Review the stormwater and combined sewer systems to manage the expected increased winter rainfall
  - Build partnerships with college campuses and organizations to boost volunteer participation
  - Select tree species that are resistant to ice and heavy snow
  - Make multilingual emergency information for winter storms more accessible (ALERTWorcester)
  - Review opportunities to expand warming centers

Thank you

Any questions?

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