

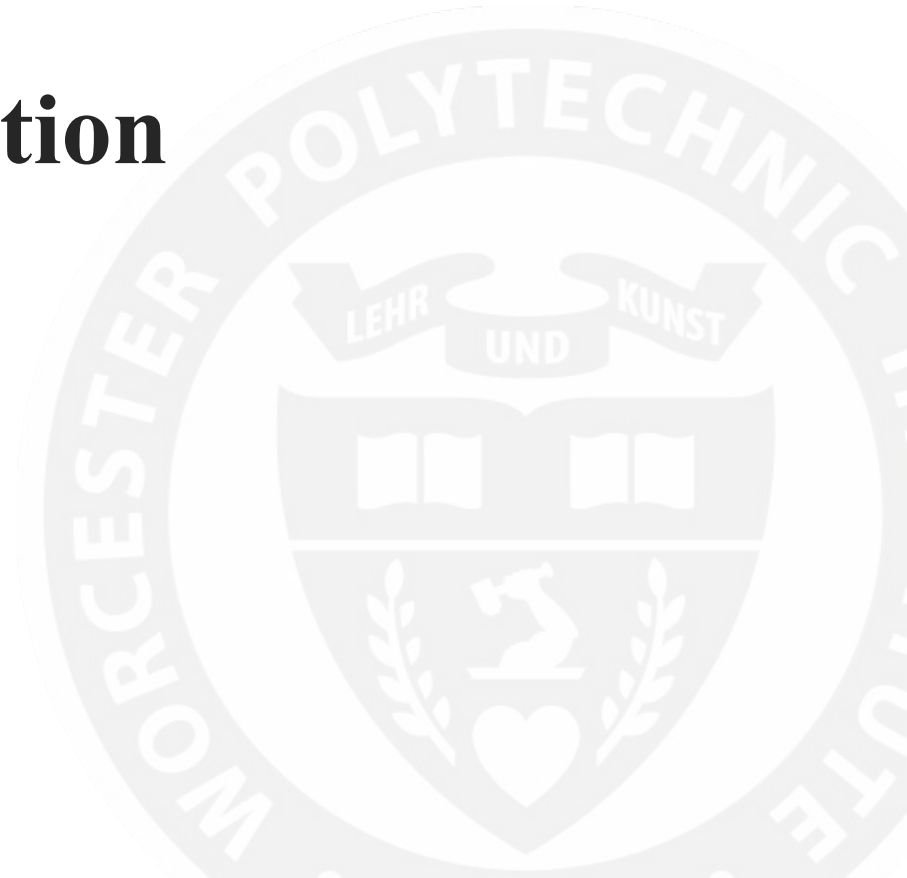


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Supporting Winter Climate Adaptation in Worcester, Massachusetts

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Green Worcester Advisory Committee
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Introduction

- **MS CCA Students:**
Camila Gomez
Hassan Dajana
- **Advisors:**
Sarah Strauss, Professor
Stephen McCauley, Associate Professor
- **Collaborators:**
John Odell, Chief of Sustainability & Resilience
Luba Zhaurova, Director of Projects,
Sustainability and Resilience



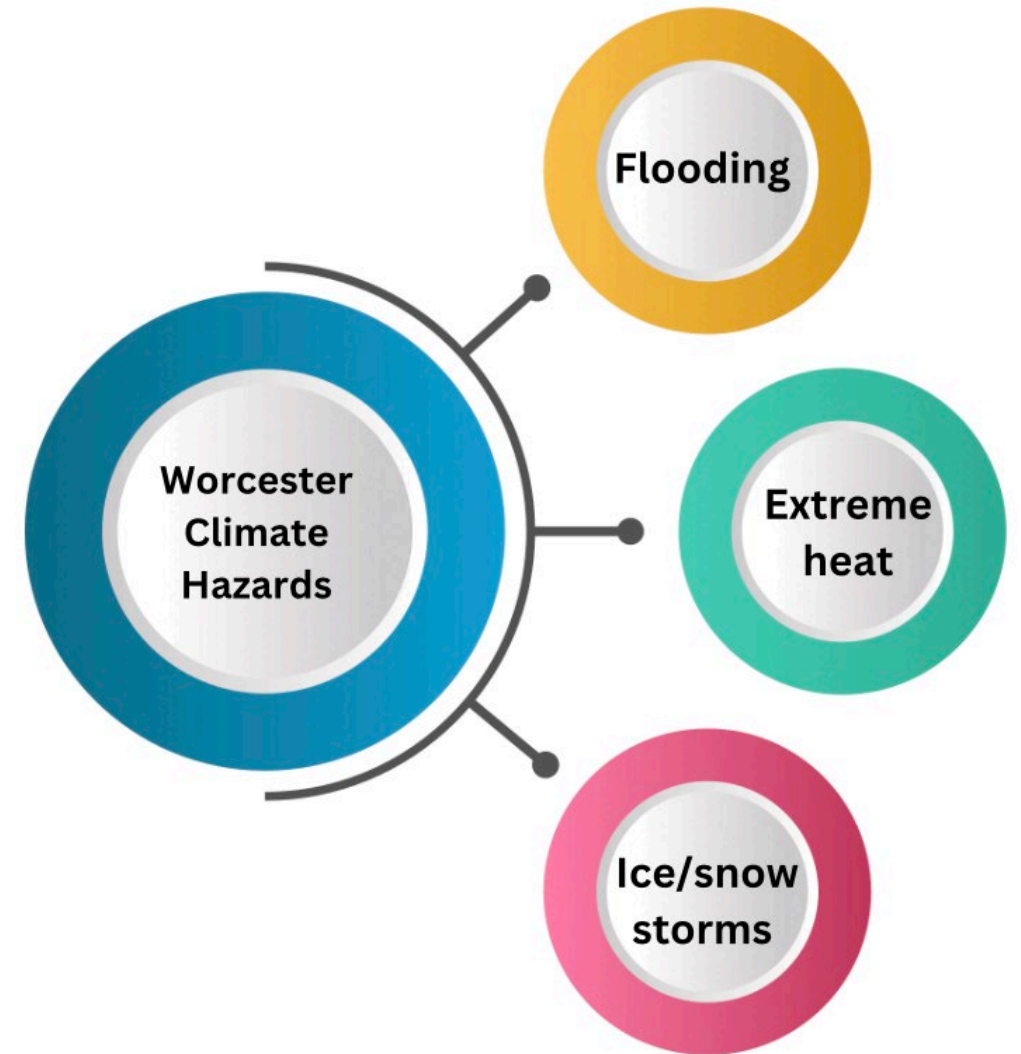
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The City of
WORCESTER

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

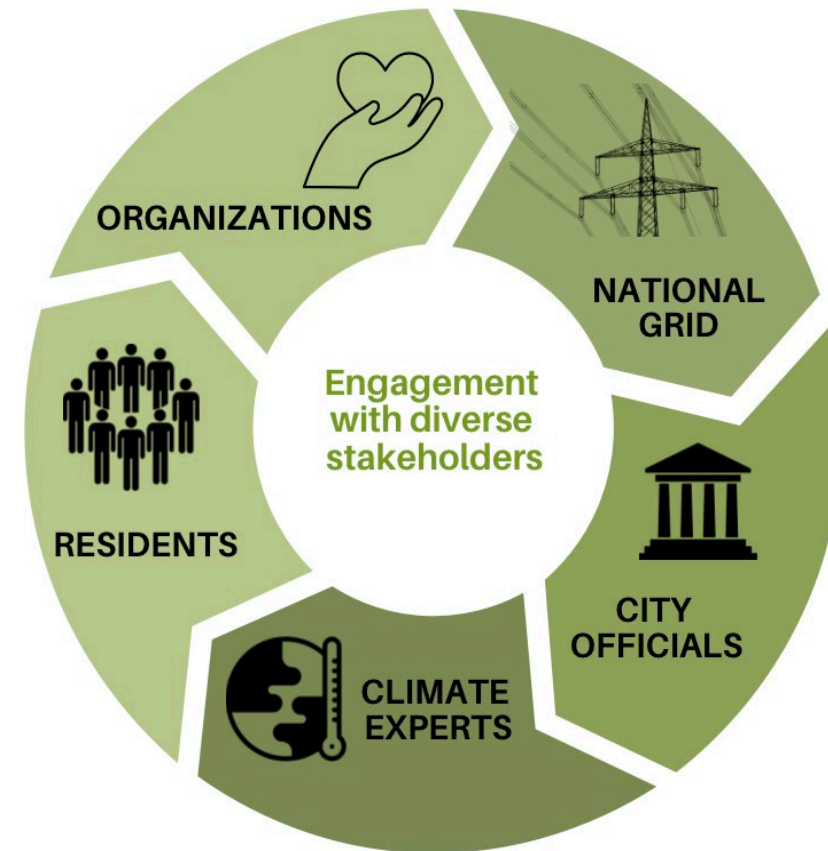


Project Objectives

- Understanding climate change impacts on winter storm events in Worcester
- Assessing the vulnerability of Worcester's critical infrastructure to winter storm events
- Identifying populations and social services vulnerable to winter climate events in Worcester
- Suggesting short and long-term recommendations to enhance resilience to winter climate change

Methods and Stakeholders

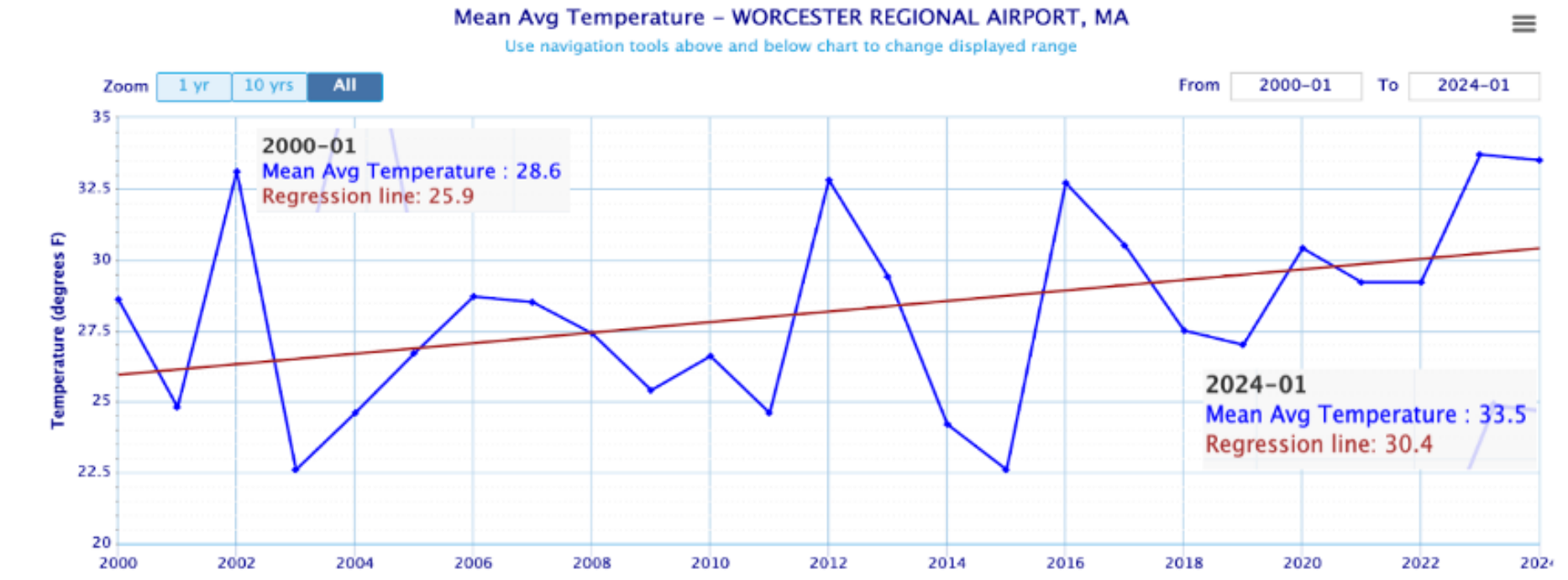
- Archival Research
- Semi-structured interviews (38)
- Resident Survey (565)



Winter Climate Change Trends



Winter months have been experiencing an increase in temperature.



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

Winter months temperature is projected to increase.

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

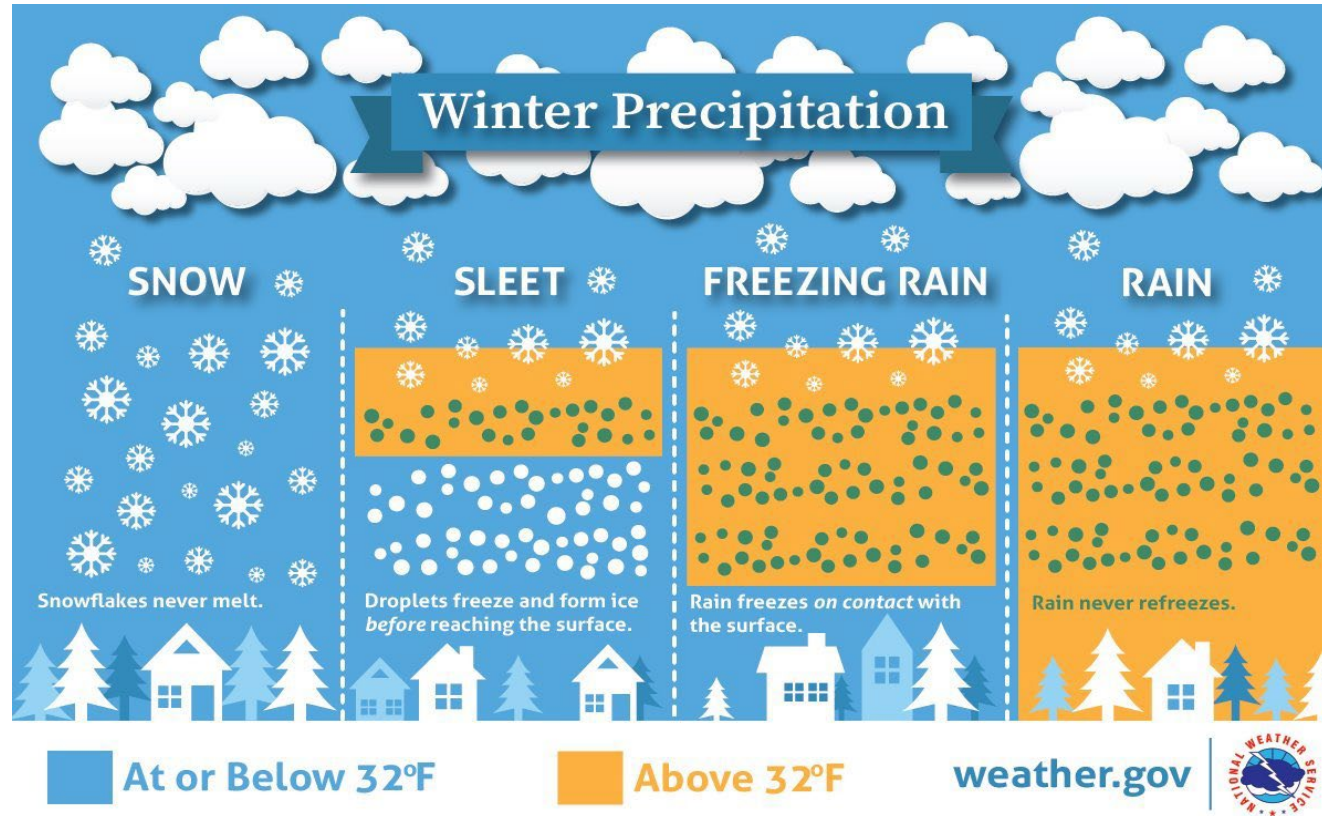
RCP 8.5
High
emissions scenario



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

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

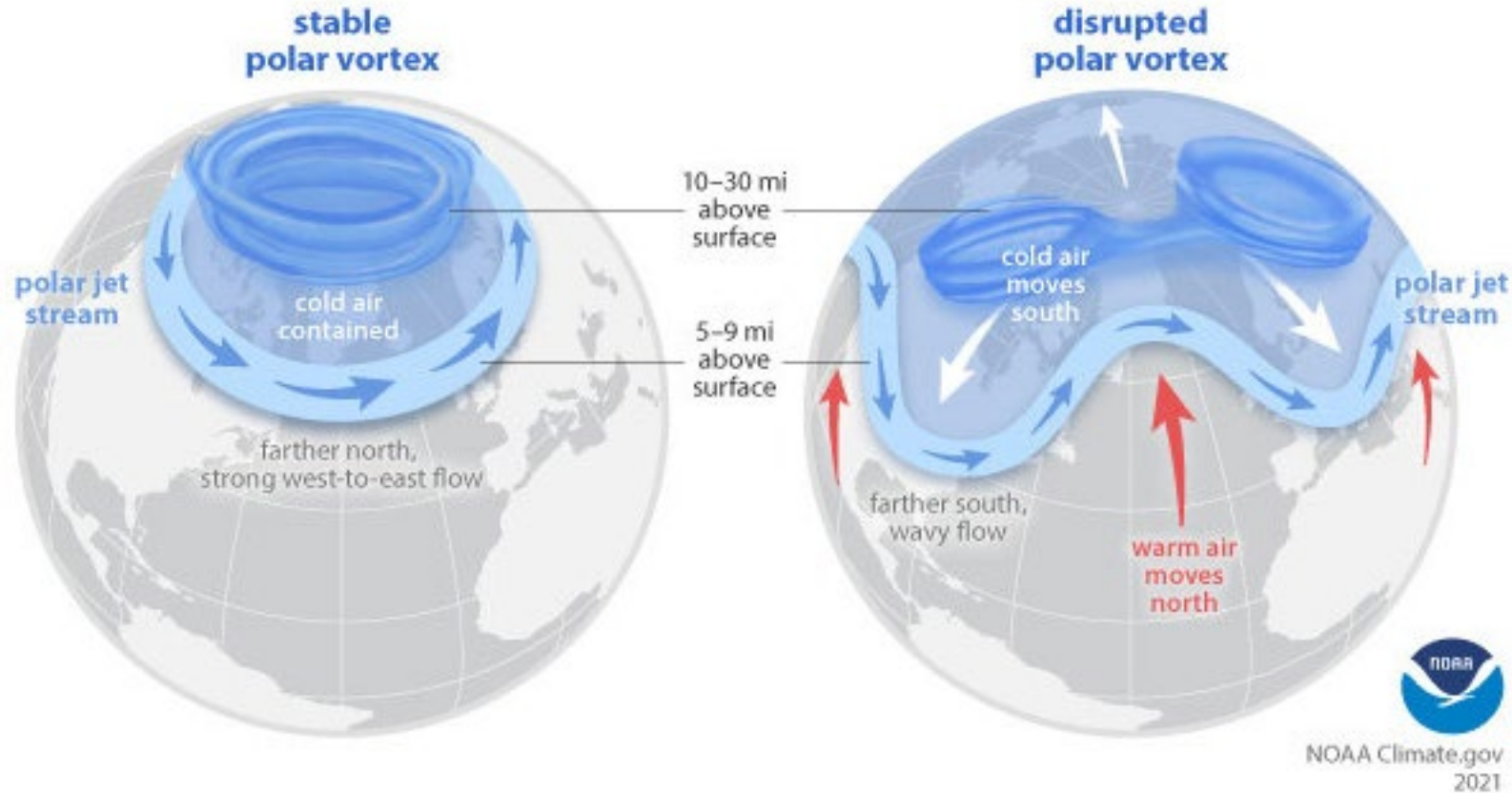
Date	Year	Type	Details
November 25 - 29	1921	Ice Storm	4 inches of ice.
April 19	1925	Ice Storm	14 inches
December 26 - 27	1947	Blizzard	16.9 inches
December 24	1961	Blizzard	24 inches
February 25 - 29	1969	"The 100 Hour Storm"	Total 26.3 inches
February 5 - 7	1978	Blizzard	Total 20.2 inches
February 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, ice



Blizzard 1961, Microfilm

Major winter storms in Worcester
Source: WPL Microfilms

Warmer winters may intensify the unpredictability of winter storms.



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

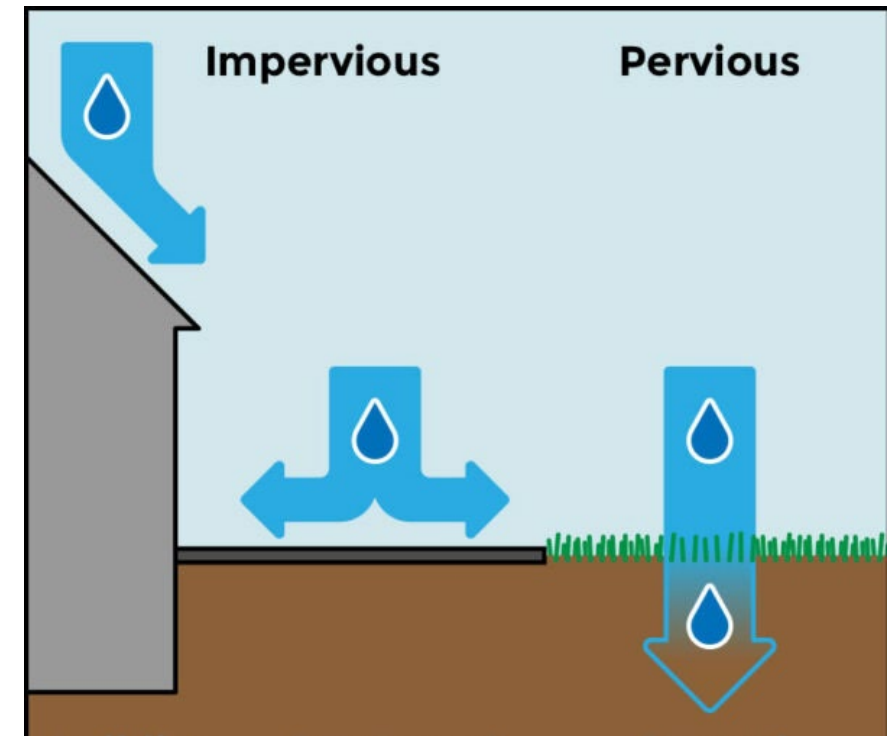
Infrastructure Vulnerabilities



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

"In the cold season, be prepared for more stormwater flooding, that probably goes more into the winter season, and I don't know what kind of drainage and sewer system Worcester has, but hopefully, they're thinking about stormwater management." *Climate expert*

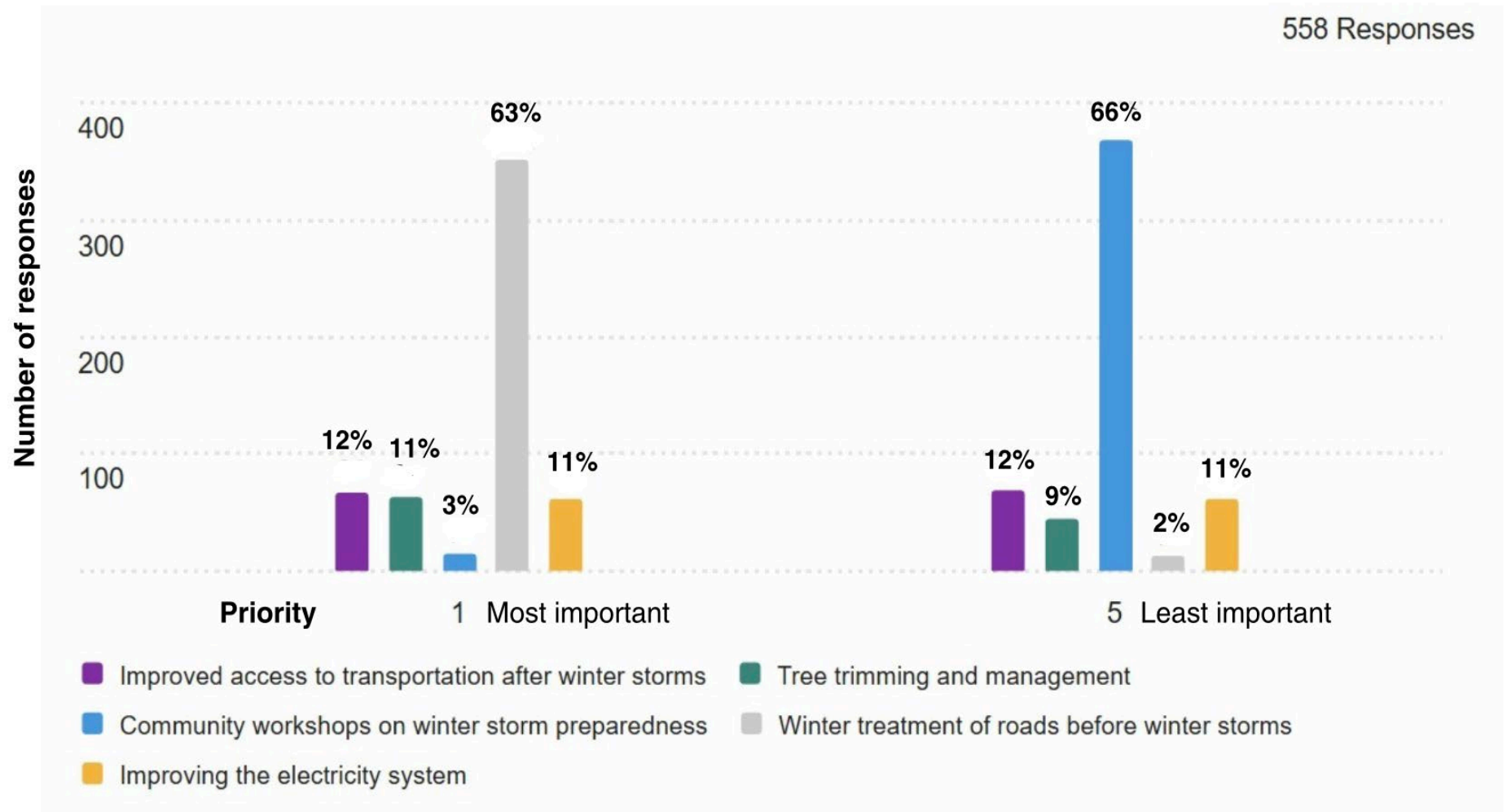
"The ground tends to be a little colder, you don't have the vegetative uptake that you have in the summer, so you don't really have as much storage for the water if it is somewhat frozen... We are less equipped to deal with flooding than we are with snow. So, I think as far as infrastructure priorities, we really have to think about better drainage systems." *Resident*



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.

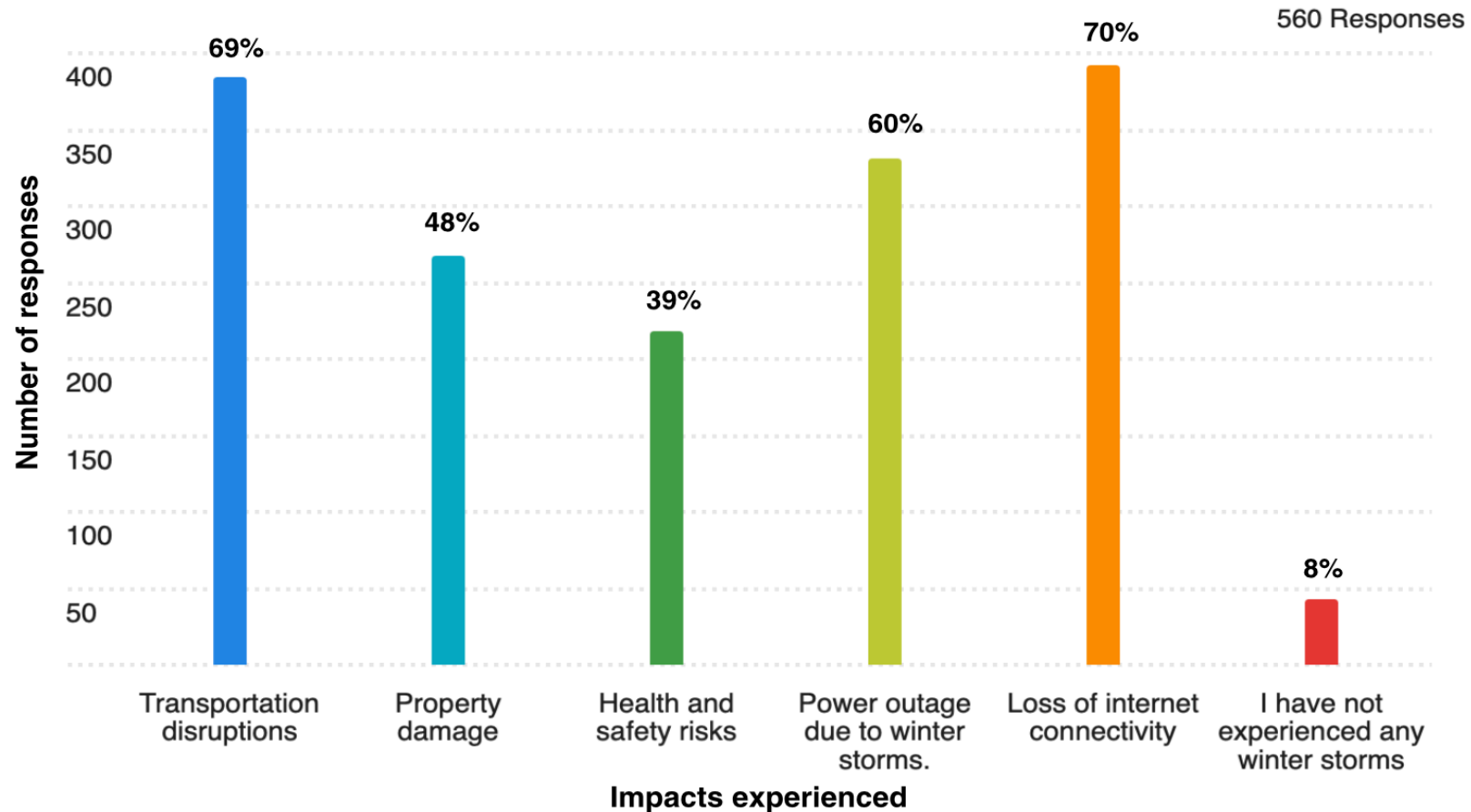


“I would love to build everything underground. I think the last time we did a cost estimate, it was eight times the cost to build underground, and then to build overhead.” *National Grid official*

“We're going to be also looking at potential undergrounding our infrastructure one of the benefits of undergrounding is that you don't expose your infrastructure to bad weather and everything else but at the same time, we got to balance the underground distribution infrastructure because the cost to underground are probably anywhere between depending on the area 10 to 20 times more than overhead” *National Grid official*

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.

"Immigrant communities are folks who don't speak the language. Whom we try to send messages to, and there are so many different languages here that we can't reach them." *City official*

“What does it mean to be ready for a storm? it's one thing to communicate to people, you know, the storm is coming but for people who are genuinely new to this kind of climate, what does it mean to be ready?” *Resident*



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

Elderly and disabled populations face challenges with snow clearing.

“Disabled people can't maintain their properties. I feel like there should be some sort of resource for people that are disabled or elderly,” *Resident*

"Help seniors or disabled with shoveling, shopping, if help is already available, make information more available not just by internet or phone (cell)" *Survey comment.*



Source: Quantum Rehab

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

“Potential warming stations, another emergency shelter.” *Unhoused individual*

“We have a shelter that cannot hold the amount of people that are there, and that people sleep all over and mats all over the floor. I think if there was some type of emergency in the middle of the night in that place, I wonder what would happen and probably have to skip over people.” *City Official*



Winter storms increase the likelihood of school closures.



Source: *The Boston Globe*

“The most important variable of whether we have school or not is the condition of the city, streets and sidewalks for students to be able to access buses to get to and from school.” *City official*

“In lower to middle income families when school is closed, they have daycare, so you have to stay home because the kids are home from school, and you can't pay for daycare.” *Resident*

“We might cancel school because we aren't able to run buses on the streets, and that's a very real impact. It's not just that kids will miss a day of school and will need to make it up later; more importantly, there would be kids who wouldn't get lunch.” *Resident*



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Recommendations



Recommendations for Infrastructure Vulnerabilities

- Review the stormwater and combined sewer systems to manage the increased winter rainfall
- Incorporate salt brine and eco-friendly anti-icing agents
- Implement permeable pavement design in future infrastructure projects
- Select tree species that are resistant to ice and heavy snow
- Continue existing coordination on tree trimming with National Grid
- Expand broadband internet options and provide backup satellite internet
- Modernize electrical infrastructure to improve resilience

Recommendations for Social Vulnerabilities

- Provide multilingual emergency information for winter storms
- Build partnerships with college campuses and organization to increase volunteers available for the disabled and elderly
- Leverage multi-channel and multilingual communication strategy to share services
- Expand warming centers for Unhoused individuals
- Evaluate food insecurity of students, partner with community organizations for short term relief. Partner with local daycares for temporary childcare

Next Steps

- Final Presentation – December 9th
- Report to the city – December 15th
- Other ways to find the research – Digital WPI



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Thank you

Any questions?

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