Transportation Resilience

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Overview

- How we think about climate’s impact and building resilience
- Current MnDOT practices that build climate resilience
- Ongoing MnDOT Efforts
  - Vulnerability Assessment
  - Integration of Climate Vulnerability
  - Collaborative Projects
What is Resilience?

Resilience can be seen as the ability of the physical environment to respond to forces; we as the people can equip the physical environment to respond to forces in a positive way. Therefore, the questions we need to ask are: is the physical environment increasing the quality of life? Is the physical environment aiding natural systems? We can implement green infrastructure that not only aids in the combat of climate change but also increases the quality of life for neighborhoods, communities, and all of Providence.
Shift in Average Annual Precipitation

https://www.dnr.state.mn.us/climate/historical/annual.html
Shift in Average Annual Winter Low

30-Year Average Minimum Winter Temperature

https://www.dnr.state.mn.us/climate/historical/annual.html
<table>
<thead>
<tr>
<th>Climate Impacts</th>
<th>Likelihood this will change in MN over the next 20 years</th>
<th>Potential Negative Implications for the Transportation System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Precipitation / Flooding</td>
<td>Very High</td>
<td>- Slope failures and erosion (More mudslides, sink holes, road bed failure)</td>
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<tr>
<td></td>
<td></td>
<td>- <strong>Increased large-scale river flooding and localized flooding</strong> (bridge scour, roadway erosion, inundation, construction disruption, etc.)</td>
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<td></td>
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<td>- More frequent and extensive inundation of low-lying areas (both temporary and permanent)</td>
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<tr>
<td>Warmer Winters</td>
<td>Very High</td>
<td>- Increase in overnight icing and in freeze/thaw cycles, leading to reduced pavement conditions and life cycles length</td>
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<tr>
<td></td>
<td></td>
<td>- <strong>Increase in average winter precipitation</strong> and more extreme precipitation</td>
</tr>
<tr>
<td>New Species Ranges (mainly due to warmer winters)</td>
<td>High</td>
<td>- Soil erosion from vegetation loss</td>
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<tr>
<td></td>
<td></td>
<td>- Increase in invasive species populations</td>
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<tr>
<td></td>
<td></td>
<td>- Wetland site failure</td>
</tr>
<tr>
<td>Drought</td>
<td>Medium</td>
<td>- Roadside vegetation stress and increases soil erosion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Low stream and ground water flow</td>
</tr>
<tr>
<td>High Heat</td>
<td>Medium-low</td>
<td>- Pavement and rail buckling</td>
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<td></td>
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<td>- Increase in vehicles overheating and electrical system malfunctions</td>
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<td></td>
<td></td>
<td>- Limitations on construction hours</td>
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<tr>
<td>Wildfires</td>
<td>Low</td>
<td>- Immediate and significant threat to human safety</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Increased risk of future flooding and slope failure</td>
</tr>
<tr>
<td>Severe Wind</td>
<td>Low</td>
<td>- Severe wind-related road closures, blown down trees, signs</td>
</tr>
</tbody>
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## MnDOT Resilience Practices

<table>
<thead>
<tr>
<th>Program Area</th>
<th>Current Practices</th>
</tr>
</thead>
</table>
| Planning                      | • Flash Flood VA and Extreme Flood VA  
• Slope Stabilization Guide and Slope VA (multi-phased) |
| Design and Environmental Review | • Bridge Manual (draft language)  
• MN AOP Guide  
• Geomorphic Design |
| Construction                  | • Stormwater Erosion Control  
• State Flood Mitigation Program  
• Sustainable Pavements |
| Maintenance & Operations      | • Living Snow Fences  
• Salt Management  
• Native and Resilient Plants  
• On-site Solar Energy  
• Asset Management |
| Emergency Response            | • State Aid Betterment  
• Emergency Management and Response |
| Overarching Initiatives       | • Advancing Transportation Equity  
• Active Transportation and Complete Streets  
• EV and EV Infrastructure |
Example of Practice with Resilience Co-benefits

Overview of Traditional VS Geomorphic Design Approach

Basic Approach

Traditional Approach

Geomorphic Approach

https://www.dnr.state.mn.us/climate/historical/annual.html
Example of Practice with Resilience Co-benefits

- New Aquatic Organism Passage guidance

- “What’s good for the fish is good for the climate”

Minnesota Guide for Stream Connectivity and Aquatic Organism Passage Through Culverts

Authors: Matthew Herrick, Christian Lenhart, Jessica Kozarek and John Nieber

Research Report 2019-02
January 2019

Natural substrate on the bottom of the stream and adequate water depth demonstrate that this culvert provides AOP by connecting the upstream and downstream reaches of this stream.
<table>
<thead>
<tr>
<th>Adaptation Action</th>
<th>Status</th>
<th>Action Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete System-wide Climate Vulnerability Assessment</td>
<td>In Progress</td>
<td>Develop a set of climate projections and use them to assess infrastructure vulnerability using them.</td>
</tr>
<tr>
<td>Incorporate findings into Asset Management</td>
<td>Planned</td>
<td>Integrate findings of the vulnerability assessments into asset management (BRIM and TAMS)</td>
</tr>
<tr>
<td>Update Design Guidelines</td>
<td>Planned</td>
<td>Review design guidelines using climate projections and incorporate changes to maintain performance into the future</td>
</tr>
<tr>
<td>Protect Environmental Justice and Vulnerable Populations</td>
<td>In Progress</td>
<td>Improve metrics for vulnerable population to incorporate it into decision-making</td>
</tr>
<tr>
<td>Downscaled Climate Data</td>
<td>Not started</td>
<td>Allows for more detailed and region-specific climate forecasting. MnDOT play a support role</td>
</tr>
<tr>
<td>Actions with Adaptation Co-benefits</td>
<td>In Progress</td>
<td>Identify, support, and pilot projects with potential to increase resilience</td>
</tr>
<tr>
<td>Resilience Research</td>
<td>In Progress</td>
<td>Continue to develop state specific research to address data and information gaps</td>
</tr>
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Ongoing Projects

Climate change increases infrastructure vulnerability

- Ongoing Extreme Flood VA will result in climate projections and a formula for analyzing asset vulnerability
- Incorporate findings into BRIM and TAMS
- Use findings to update design guidance
Resilience Co-Benefits

- Social Vulnerability – climate adaptation benefits of reducing vulnerability (health, equity, access, etc.)
- More resilient transportation system supports healthy community (ex: mode redundancy)
- Compost as stormwater mitigation, and sequester carbon
- Better understand the impacts of changes in freeze/thaw cycles
Thank you

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Resilience at the Federal Level

• Senate Bill, America’s Transportation Infrastructure Act

• AASHTO is aware of the need – MnDOT is part of the Steering committee

• MN FHWA has Identified resilience as a risk to MnDOT
  • Corridor Resilience Assessment on TH52 (built from work in CO and UT)
  • Peer Exchange with other state DOTs
Review of Other State DOTs

- Vulnerability Assessment is the critical first step
- Select climate projections
- District-level adaptation plans (Caltrans)
- State Adaptation Plan has helped other DOTs advance efforts
- Resilience Hub – having centralized location for all related info advances work more quickly and accelerates collaboration (ex: resilientma.org)
Example of How Climate Change Shifts Practices

Asset Management

Potential Resilience Collaborations

Projects with Resilience Co-benefits

- Compost as stormwater mitigation, and sequester carbon
- Increase/improve use of vegetation to stabilize slopes

Research Projects

- Better downscaled climate data
- Change in Freeze/Thaw cycles
- Others?
Summary of Next Steps

- Extreme Flood Vulnerability Assessment and develop set of climate projections
  - Incorporate the findings into BRIM and TAMS
  - Update Design Guidelines: review current design guidelines and identify where climate projections can be incorporated

- Improve the use of social vulnerability in decision making
  - Gather feedback on the district reports
  - Establish EJ and Social Vulnerability metrics that are consistent and inclusive, and incorporate into decision-making processes

- Pilot Corridor Resilience Assessment