VERMONT
AGENCY OF NATURAL RESOURCES

Climate Change Adaptation White Paper Series

Transportation and Climate Change in Vermont

Jacob Ebersole, February 2013

Introduction

It is hard to overestimate the utility of our transportation network. Our local and state roads and bridges allow us to travel almost anywhere in the state, at any time, through almost every weather condition. The interstate highway is a vital high-speed corridor connecting us to the rest of New England. Rail provides a critical conduit for freight and also provides passenger service to New England and the New York metropolitan area.

Our transportation infrastructure is vulnerable to a number of the predicted effects of climate change. The unprecedented flooding of 2011 made this fact overwhelmingly clear. Tropical Storm Irene damaged 500 miles of road and 200 bridges on the state highway system alone. Road damage isolated thirteen Vermont communities entirely, and total infrastructure damage was on the order of $250 - 300 million (Pealer, Sacha). The expected increase in frequency of extreme precipitation events in the future will only leave transportation infrastructure more susceptible to failure from erosion and flooding.

In response to this growing threat, the Vermont Agency of Transportation (VTrans) has taken a number of steps to assess the risk to transportation infrastructure, to prioritize those locations most at risk, and to develop plans to mitigate the risks.

Impacts and Vulnerabilities

The principle elements of the climate that affect physical infrastructure include temperature, water and wind. When these variables change to the point that they extend beyond the typical ranges that designers consider, the results can lead to reduced service life of the specific structure, reduced performance or other un-intended consequences such as increased operation and maintenance costs. (p. 4, Keller et. al).

There is already an abundance of evidence that climate changes are occurring in Vermont (Betts, 2011). Many of these changes will have consequences for Vermont's transportation infrastructure and for VTrans' operational capacity. Anticipated climate challenges for VTrans include:

- **Increased extreme heat events**, leading to the premature deterioration of infrastructure. Paved roads and bridges are particularly vulnerable to damage from heat stress.
- **Change in the range of maximum and minimum temperatures**, resulting in an elevated frequency of freeze-thaw events. This will create more potholes and frost heaves, as well as deteriorate bridge expansion joints.
- **Greater variation in seasonal precipitation**, causing winter maintenance demands to change due to more or less snow or an increase in freeze events. More rain in winter months is likely to increase the prevalence of landslides and runoff-induced floods. At the same time, elevated soil moisture levels could damage the structural integrity of roads, bridges, and tunnels.
- **Increased intense precipitation and storm events**, triggering more frequent flooding and erosion of low lying roads, railroads and other infrastructure. Culvert capacity will likely be exceeded more frequently. Bridges will face increased wind stress as well as increased scouring from higher stream flow. Extreme wind events will also result in more downed trees and power lines, as well as more debris blocking roadways and waterways.

What's already being done?

In 2008, VTrans published its Climate Action Plan. While this plan focused primarily on methods to reduce green house gas emissions in the transportation sector and within VTrans, it also addressed adaptation planning. The plan called for greater research on Vermont specific climate changes and related effects on transportation infrastructure. It also documented the necessity of identifying and prioritizing infrastructure most vulnerable to climate change. The devastating flooding of 2011 provoked further reassessment of climate change adaptation strategies in the transportation sector. The most recent strategic plan for VTrans, updated shortly after Tropical Storm Irene, includes an explicit commitment to environmental stewardship and preparation for extreme weather events. As a result, many projects that seek to reduce climate vulnerabilities in the state's transportation system have already been initiated. Some of these projects are:

- LiDAR (Light Detection And Ranging) mapping of primary transportation and river corridors to improve the precision of flood models. This project is an expansion of previous collaborations between VTrans and the Agency of Natural Resources to identify infrastructure in high-risk flood or erosion zones.
- "Flood Resiliency Training Programs" to educate key audiences on river dynamics, impacts of floods on infrastructure, and related best management practices.

- The development of "Transportation Resiliency Plans" on a watershed basis to identify infrastructure most at risk of flood damage, and to evaluate strategies to mitigate that risk. This will allow the state to efficiently prioritize spending on infrastructure adaptation.
- Collection of condition and performance data on state-owned transportation infrastructure to improve the state asset inventory. This project was recently completed along the interstate system and will serve as a valuable resource to inform project prioritization decisions.
- VTrans and the Institute for Sustainable Communities have introduced the "Resilient Vermont Project" to increase Vermont's resilience to extreme weather events. The project seeks to compile an inventory of resilience building activities across the state, and prioritize investments and actions that will improve resilience.
- VTrans has developed a computerized tool that can rapidly assess culvert vulnerability. This will allow the state to expedite support during emergencies and efficiently reassess culvert vulnerabilities.

Next Steps

While the aforementioned projects are a step in the right direction, there remain many opportunities for VTrans to improve the adaptive capacity of Vermont's transportation system. Expansion of data gathering and monitoring programs would improve the agency's ability to recognize and respond to climate threats. Updating project prioritization guidelines and best practices would similarly aid in mitigating climate change risks. Improvements in these areas are of particular value because they are likely to provide benefits under any climate scenario. Some specific actions might include:

- Establish an electronic database of Project Worksheets (PWs) and Detailed Damage Inspection Reports (DDIRs) to improve identification of vulnerable infrastructure and speed the federal funding process in the event of a disaster. PWs and DDIRs are forms used by FEMA and FWHA respectively that define work and cost estimates of projects seeking reimbursement.
- Conduct research to identify climate related thresholds at which specific types of infrastructure are subject to significant deterioration. This will improve decision making on matters such as when to institute higher construction standards for new projects or when to reassess infrastructure for vulnerabilities.
- Further expand the quality and quantity of the data in the state's asset inventory. Look to standardize data held by different agencies and stakeholders. An improved ability to track state infrastructure will allow changes to be made to vulnerable assets before they fail. This effort should be supplemented by increased support of local asset inventory creation and maintenance.

- Develop analytical vulnerability and risk assessment tools. Examples include a real-time flood monitoring system, or tools to assess the costs associated with differing infrastructure under various potential climate scenarios.
- Update project prioritization guidelines to take into account vulnerability to flooding and fluvial erosion.
- Update the hydraulics manual to include refined best practices given the threats posed by climate change.

Many of these changes will not be easy to implement. Limited budgetary resources are a perpetual challenge to long-term resilience investments. Scientific uncertainties regarding regional climate forecasts, political and economic barriers, and regulatory hurdles all further the difficulty of adaptation planning. To minimize the creation of additional financial burdens, VTrans should work to incorporate adaptation efforts and best practices into regular system reinvestments. At the same time, "no-regret" management decisions that will prove valuable in any number of future climates should be pursued whenever possible. These frameworks, combined with the specific actions outlined above, will enhance the adaptive capacity of Vermont's transportation system and bolster the ability of VTrans to respond to climate threats in all present and future scenarios.

Much of this paper was adapted from the VTrans 2012 report "Adapting Vermont's Transportation Infrastructure to the Future Impacts of Climate Change." Readers looking for an expansion on the material presented above are encouraged to view the full report here.

References

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