Chittenden County Multi-Hazard Analysis and URM Building Summary

Prepared by: Vermont Geological Survey, January 2021.

Vermont is among four New England states at risk of moderate seismic activity (USGS, 2018). As part of the State Hazard Mitigation Plan (SHMP) development process, Vermont Emergency Management asked the 11 Regional Planning Commissions (RPCs) to rank hazards based on perceived vulnerability. Earthquake hazard scored low and received the lowest average score (SHMP 2018, p 49). In addition, only 27/170 approved Local Hazard Mitigation Plans address earthquake hazard. Clearly, outreach to build awareness of these low frequency, high impact events and to communicate preparedness, mitigation and risk reduction options is warranted. This summary is designed to communicate risk and impacts for seismic events with the potential to cause damage, particularly in northwestern Vermont and to support the State Hazard Mitigation Plan.

Northwestern Vermont, including Chittenden County, are at a higher risk of experiencing a damaging earthquake than the rest of the State (USGS, 2018). Damage is projected to be mainly non-structural or due to the contents of buildings (breaking glass, movement of heavy furniture, falling plaster, broken chimneys, etc.). Some regions, buildings and infrastructure are more vulnerable than others in this area based on technical information and reports from the past decade: https://dec.vermont.gov/geological-survey/hazards/earthquakes/seismicprojects.

The Northeast States Emergency Consortium (NESEC) prepared a multi-hazard analysis report for Chittenden County in 2019. The report's objective was to 1) compare and contrast earthquake hazards with flooding and landslide events, 2) identify estimated number and type of structures affected in each hazard scenario tested, and 3) generate maps and tables detailing the results.

The 2019 report can be found here:

https://dec.vermont.gov/sites/dec/files/geo/HazDocs/Chittenden%20County%20Report.pdf

The NESEC also prepared a 2018 report for Chittenden County to estimate the number and potential location of Unreinforced Masonry Buildings (URM) in the area to identify increased risks from seismic hazards. URM structures are at heightened risk during earthquake events and may result in increased loss of life and damage. The goal of this report was to 1) identify total estimated number of URM buildings in Chittenden County, 2) determine URM building locations, and 3) map the results.

The 2018 report can be found here:

https://anrweb.vt.gov/PubDocs/DEC/GEO/HazDocs/ChittendenURMProject2018.pdf

Results

Earthquakes

A hypothetical 5.8 magnitude earthquake centered in Plattsburgh, NY was used to run simulations and model results for Chittenden County. This model was based on worst-case but credible scenarios developed by Dr. John Ebel (Boston College, Weston Observatory) from the magnitude 5.1 earthquake that occurred near Plattsburgh, NY in 2002.

1. *Shaking Intensity and Damage (NESEC 2019 Report, Figure 1)*

   - Moderate shaking (Modified Mercalli Scale 5/10) is felt by nearly everybody and waking many if asleep. Windows and dishes may be broken and unstable objects like books and light furniture may be overturned.
   - Strong shaking (Modified Mercalli Scale 6/10) is felt by all and frightens many. Heavy furniture may be moved and plaster may fall. Damage is considered slight.
   - Very strong shaking (Modified Mercalli Scale 7/10) is felt by those in Milton, Colchester, Burlington, Winooski, South Burlington, Shelburne and Charlotte. Damage is not widespread in buildings of good construction and design but may be slight to moderate in well-built ordinary structures. Damage is considerable in poorly built or badly designed structures. Chimneys may be broken.
   - It is estimated that the above shaking categories (V, VI and VII) will affect about 91,241 people.

2. *Buildings Located within Strong or Very Strong Shaking Areas (NESEC 2019 Report, Figure 2)*

   - A total of 46,039 buildings located within strong or very strong shaking areas, spread out across 15/18 communities. Out of the 46,039 buildings, 80% are residential, 6% commercial, and 2% recreational. The cities/towns with the highest number of buildings affected are Burlington (12,609 buildings), South Burlington (7,592 buildings) and Colchester (6,628 buildings).

Unreinforced Masonry Buildings (URM) (NESEC 2018 Report)

URM buildings have been identified by FEMA (2009) as particularly vulnerable in earthquake scenarios and result in the potential for increased damage and loss of life. Moderate earthquakes (magnitudes 4.4-5.0) can be significantly damaging to these buildings, even if more modern and well-constructed buildings experience no ill-effects. URM-s use unreinforced masonry load bearing walls that can collapse during an earthquake and are also more susceptible to damage from other hazards like fire and wind from hurricanes. Identifying where and how many URM buildings are in a particular location can help inform emergency planners where to concentrate efforts for future mitigation.

The estimated URM building count for Chittenden County is 3,088 buildings. Winooski, Burlington, South Burlington, Essex and Williston have the highest density of URM buildings (URM buildings per square mile).

Floods

A 500-year flood inundation scenario was used by the NESEC to determine the effect such an event would have on all major rivers in Chittenden County (NESEC 2019 Report, Figure 5). Most communities in Chittenden County have rivers and buildings located in the predicted flooded area for a total of 467 buildings. Approximately 778 people would be located within the flood inundation area, especially concentrated along the Winooski River. More than half of the affected buildings are residential.

Landslides

Landslide point data, provided to NESEC by the Vermont Geological Survey, was used in conjunction with a 30-meter buffer zone suggested by the Vermont State Geologist to create a realistic representation of landslide sensitive areas within Chittenden County. A total of 39 buildings were located within a landslide prone area, the majority being residential.

Multi-Hazard Analysis

There were no buildings exposed to all three hazards at once. 146 buildings were exposed to more than one hazard: 36 for earthquake and landslide and 110 for earthquake and flood. No buildings were exposed to landslide and flood. However, the Federal Emergency Management Agency's (FEMA) HAZUS-MH Loss Estimation Software (HAZUS-MH) did not take into account that earthquakes can cause floods and landslides, and that landslides may cause floods. Milton, Colchester and Burlington were the most impacted towns/cities by more than one hazard.

Conclusions/Recommendations from NESEC

It is noted by the NESEC that this analysis comprised hypothetical scenarios and may not reflect the actual impact of the occurrence of the hazards examined in this study. Additionally, the HAZUS-MH census data only shows dasymetric areas, or the densest population concentrations, within a census block. This limitation, coupled with lack of population distribution information, may overlook some populated areas.

The 2017 Chittenden County Hazard Mitigation Plan states the risk of earthquake is low enough to not invest in any mitigation techniques. Though earthquakes in Vermont are infrequent, Chittenden County is located in the highest-risk zone in Vermont. The City of Burlington would be most at risk due to the large population and high number of unreinforced masonry buildings, which perform worst in earthquakes. The NESEC and Vermont Geological Survey suggest that these low frequency, high impact events be considered in future Hazard Mitigation Plans.

The landslide point data, versus size-specific polygon data, limits the accuracy of the landslide analysis. As point data, each site has the same characteristics. Though a 30-meter buffer zone surrounding each point is reasonable for approximating exposure, this uniform approach does not necessarily represent the natural environment.

Disclaimer

Scenarios are based on FEMA HAZUS-MH Version 4.2, utilizing 2010 census data and current scientific and engineering knowledge. Point data of landslides was provided by the Vermont Geological Survey. There will be uncertainties in any loss estimation technique, and as such, these results are purely estimations.

References

The Northeast States Emergency Consortium, 2018, Using FEMA's HAZUS-MH to Estimate the Number and Potential Location of Unreinforced Masonry Buildings (URM) in Chittenden County Vermont: https://anrweb.vt.gov/PubDocs/DEC/GEO/HazDocs/ChittendenURMProject2018.pdf (accessed January 2021).

The Northeast States Emergency Consortium, 2019, Chittenden County, Vermont Multi-Hazard Analysis: https://dec.vermont.gov/sites/dec/files/geo/HazDocs/Chittenden%20County%20Report.pdf (accessed January 2021).