5.1 METHODOLOGY AND TOOLS

2021 HMP Changes

- The Tompkins County Hazard Mitigation Plan will serve as the foundation for the larger, connected Tompkins County Resiliency and Recovery Plan.
- The Tompkins County Hazard Mitigation Plan risk assessment was updated using best available information.
  - New methodology and approaches for the flood and severe storm hazard were employed using Hazus Level 2 analysis to quantify estimated damages as described below.
  - 2014-2018 American Community Survey 5-year estimates were utilized.
  - Building footprints provided by Tompkins County ITS, updated parcels and tax assessor information from the 2019 New York State Public Parcel dataset created by NYS Office of Information Technology Services GIS Program Office (GPO) and NYS Department of Taxation and Finance's Office of Real Property Tax Services (ORPTS), tax assessor information provided by Tompkins County, and RS Means 2019-dollar values were used to develop a structure-level building inventory and estimate replacement cost value for each building.
  - A critical facility list was generated and reviewed by the Steering Committee and Planning Committee (Planning Partnership) which included all County jurisdictions.
  - Lifeline facilities were identified by each jurisdiction to align with FEMA's lifeline categories to enable prioritization of projects that address the protection of these facilities.
  - Hazus was used to estimate potential impacts from the hazards due to flooding and high-wind (severe storm) events.
  - Best available hazard data was used as described in this section.

The following summarizes the asset inventories, methodology and tools used to support the risk assessment process.

5.1.1 Asset Inventories

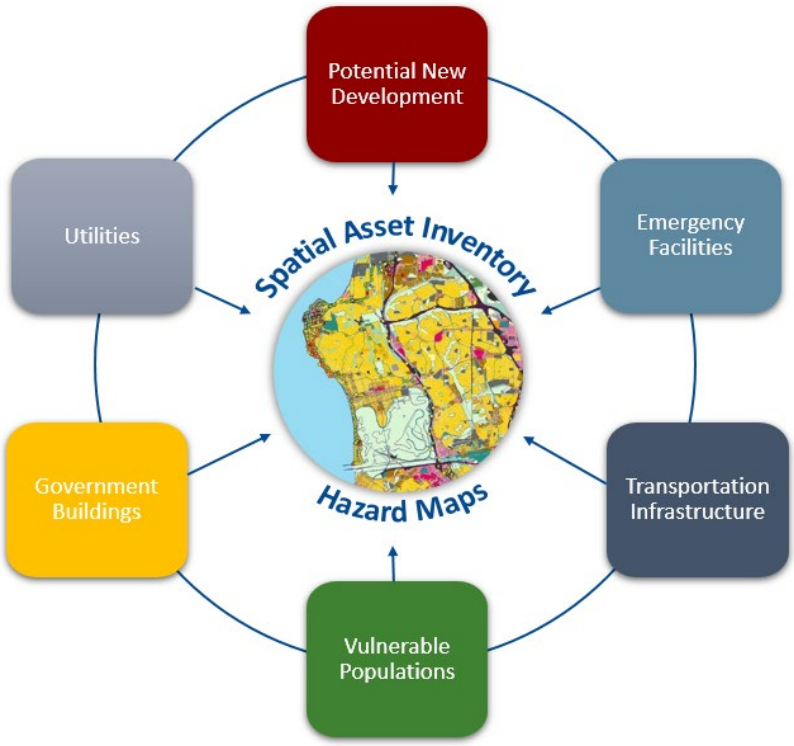
The risk assessment included the collection and use of an expanded and enhanced asset inventory to estimate hazard exposure and vulnerability.

Tompkins County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Tompkins County assessed exposure vulnerability of the following types of assets: population, buildings and critical facilities/infrastructure, new development, and the environment. Some assets may be more vulnerable because of their physical characteristics or socioeconomic uses. To protect individual privacy and the security

of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

5.1.1.1 Population

Total population statistics from the 2014-2018 American Community Survey 5-year estimate were used to estimate the exposure and potential impacts to the County's population instead of the 2010 U.S. Census block estimates. Population counts at the jurisdictional level were averaged among the residential structures in the County to estimate the population at the structure level. The population statistics from the 2014-2018 American Community Survey 5-year estimates were modified for population exposure to reflect the total population reported for the county of Tompkins; village populations were subtracted from towns populations. This estimate is a more precise distribution of population across the County compared to only using the Census block or Census tract boundaries. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate for planning purposes.



As discussed in Section 4 (County Profile), research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. Vulnerable populations in Tompkins County included in the risk assessment include children, elderly, population below the poverty level, non-English speaking individuals, and persons with a disability.

5.1.1.2 Buildings

The building stock inventory was updated using County and jurisdiction spatial data. To develop the building inventory, parcels from the Tompkins County ITS and 2019 Tax Assessor data from the NYS GIS Program Office, NYS Department of Taxation and Finance's Office of Real Property Tax Services (ORPTS) were used. Attributes provided from the tax assessor data were used to further define each structure in terms of occupancy class, construction type, year built, foundation type, etc. Default information was used to fill in the gaps for buildings that could not be assigned attributes from the assessor's data or from the data provided by the County and jurisdictions. The centroid of each building footprint was used to estimate the building location. If a building footprint was not located due to limited spatial data, parcels that had assessor's information supporting the

presence of a building were given a centroid to represent the location of a structure. Structural and content replacement cost values (RCV) were calculated for each building utilizing available assessor data and RS Means 2019 values; a regional location factor for Tompkins County was applied (0.99 for residential structures and 1.00 for all other structure types). Replacement cost value is the current cost of returning an asset to its pre-damaged condition, using present-day cost of labor and materials. Total replacement cost value consists of both the structural cost to replace a building and the estimate value of contents of a building. The occupancy classes available in Hazus were condensed into the following categories (residential, commercial, industrial, agricultural, religious, governmental, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address both multi-family and single-family dwellings.

5.1.1.3 Critical Facilities/Community Lifelines

A critical facility inventory, which includes critical essential facilities, community lifelines, utilities, transportation features and user-defined facilities was provided by the Tompkins County ITS Office and was reviewed by the Planning Partnership and County jurisdictions. The review involved an evaluation for accuracy, additions or deletions of new/moved critical assets, identification of backup power for each asset (if known) and whether the facility is considered a lifeline in accordance with FEMA's definition (see inset); refer to Appendix E (Risk Assessment Supplement). To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

> A **lifeline** provides indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security (FEMA).

5.1.1.4 Environment and Land Use Area

National land use land cover data created by the U.S. Geological Survey (USGS) in 2016 was used to assess land use characteristics of the County. This dataset was converted from a raster to a vector polygon, which informed spatial areas of residential, non-residential, and natural land use areas. Residential land-use types incorporated all classes listed as developed land use, except for those identified as vacant (i.e., Developed – Low Intensity, Developed – Medium Intensity, Developed – High Intensity). Non-residential land-use types included all other classes. Within non-residential land-use types, natural land areas were extracted into a new category, which includes barren land, forest, water, and wetlands. The natural land areas were referenced to calculate the total acres of natural land area exposed to hazard areas of concern.

5.1.1.5 New Development

In addition to summarizing the current vulnerability, Tompkins County examined some of the recent and anticipated new development that can affect the County's vulnerability to hazards. Identifying these changes and integrating into the risk assessment ensures they are considered when developing the mitigation strategy to reduce these vulnerabilities in the future. An exposure analysis was conducted using anticipated and recent

new development provided by each jurisdiction for the flood hazard. The development is presented in Section 9, as a table in each annex.

5.1.2 Methodology

To address the requirements of the Disaster Mitigation Act of 2000 (DMA 2000) and better understand potential vulnerability and losses associated with hazards of concern, Tompkins County used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Three different levels of analysis were used depending upon the data available for each hazard as described below. Table 5.1-1 summarizes the type of analysis conducted by hazard of concern.

1. **Historic Occurrences and Qualitative Analysis** – This analysis includes an examination of historic impacts to understand potential impacts of future events of similar size. In addition, potential impacts and losses are discussed qualitatively using best available data and professional judgement.
2. **Exposure Assessment** – This analysis involves overlaying available spatial hazard layers, or hazards with defined extent and locations, with assets in GIS to determine which assets are located in the impact area of the hazard. The analysis highlights which assets are located in the hazard area and may incur future impacts.
3. **Loss estimation** — The FEMA Hazus modeling software was used to estimate potential losses for the following hazards: flood, earthquake, hurricane. In addition, an examination of historic impacts and an exposure assessment was conducted for these spatially-delineated hazards.

Table 5.1-1. Summary of Risk Assessment Analyses

Hazard	Population	General Building Stock	Critical Facilities	New Development
Disease Outbreak	Q	Q	Q	Q
Drought	Q	Q	Q	Q
Extreme Temperature	Q	Q	Q	Q
Flood	E, H	E, H	E, H	E
Harmful Algal Bloom	Q	Q	Q	Q
Infestation and Invasive Species	Q	Q	Q	Q
Severe Storm	E, H	E, H	E, H	Q
Severe Winter Storm	Q	Q	Q	Q

E – Exposure analysis; H – HAZUS analysis; Q – Qualitative analysis

5.1.1.6 Hazards U.S. – Multi-Hazard (HAZUS)

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes, known as Hazards U.S. or Hazus. Hazus was developed in response to the need for more effective national-, state-, and community-level planning and the need to identify areas that face the highest risk and potential for loss. Hazus was expanded into a multi-hazard methodology, Hazus with new models for estimating potential losses from

wind (hurricanes) and flood (riverine and coastal) hazards. Hazus is a Geographic Information System (GIS)-based software tool that applies engineering and scientific risk calculations, which have been developed by hazard and information technology experts, to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

Hazus uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems and utility systems. To generate this information, Hazus uses default Hazus provided data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (inundation, fire, threats posed by hazardous materials and debris) and direct economic and social losses (casualties, shelter requirements, and economic impact) depending on the hazard and available local data. Hazus' open data architecture can be used to manage community GIS data in a central location. The use of this software also promotes consistency of data output now and in the future and standardization of data collection and storage. More information on Hazus is available at http://www.fema.gov/Hazus.

In general, modeled losses were estimated in the program using user-defined flood depth grids for the flood analysis and probabilistic analyses were performed to develop expected/estimated distribution of losses (mean return period losses) for hurricane wind and seismic hazards. Hazus serves simply as a starting point for assessing community risk. The probabilistic model generates estimated damages and losses for specified return periods (e.g., 100- and 500-year). Table 5.1-2 displays the various levels of analyses that can be conducted using the Hazus software.

Table 5.1-2. Summary of HAZUS Analysis Levels

Hazus Analysis Levels	
Level 1	HAZUS provided hazard and inventory data with minimal outside data collection or mapping.
Level 2	Analysis involves augmenting the HAZUS provided hazard and inventory data with more recent or detailed data for the study region, referred to as "local data"
Level 3	Analysis involves adjusting the built-in loss estimation models used for the hazard loss analyses. This Level is typical done in conjunction with the use of local data.

5.1.1.7 Disease Outbreak

Unsurprisingly as this update was prepared during the COVID-19 pandemic, disease outbreak was identified as a new hazard of concern in the 2021 update for Tompkins County. All of Tompkins County is exposed to disease outbreak events. A qualitative assessment was conducted for the disease outbreak hazard. Research from the Centers for Disease Control and Prevention, New York State Department of Health, Tompkins County Health Department, New York Department of Environmental Conservation, Cornell University, and the U.S. Census Bureau were referenced to assess the County's vulnerability to disease outbreak events.

5.1.1.8 Drought

To assess the vulnerability of Tompkins County to drought and its associated impacts, a qualitative assessment was conducted. The United States Department of Agriculture (USDA) Census of Agriculture 2017 was used to estimate economic impacts. Information regarding the number of farms, land area in farms, etc. was extracted from the report and summarized in the vulnerability assessment.

The associated wildfire hazard is included in the drought hazard. Therefore, the Wildland-Urban Interface (Interface and Intermix) obtained through the SILVIS Laboratory, Department of Forest Ecology and Management, University of Wisconsin – Madison, was referenced to delineate wildfire hazard areas. The University of Wisconsin – Madison wildland fire hazard areas are based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database. For this risk assessment, the high-, medium-, and low-density interface areas were combined and used as the "Interface" hazard area, and the high, medium-, and low-density intermix areas were combined and used as the "Intermix" hazard areas.

Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses associated with this hazard. To determine what assets are exposed to wildfire, GIS data were overlaid with the hazard area; Assets with their centroid located in the hazard area were totaled to estimate the totals and values exposed to a wildfire event.

Additional resources from the Centers for Disease Control and Prevention, the 2019 New York State Hazard Mitigation Plan, Responding to Climate Change in New York State (ClimAID Report), the Northeast Regional Climate Center and the National Oceanic and Atmospheric Administration were further used to assess the potential impacts to the population from a drought event.

5.1.1.9 Extreme Temperatures

All of Tompkins County is exposed to extreme temperature events. A qualitative assessment was conducted for the extreme temperatures hazard. Information from the Centers for Disease Control and Prevention, the U.S. Fire Administration, the 2019 New York State Hazard Mitigation Plan, Responding to Climate Change in New York State (ClimAID Report), the Northeast Regional Climate Center and the U.S. Geological Survey were used to assess the potential impacts extreme temperature events have on the County's assets.

5.1.1.10 Flood

The 1-percent annual chance flood event was examined to evaluate the County's risk from the flood hazard. This flood event boundary (Special Flood Hazard Area) is generally considered by planners and evaluated under federal programs such as the NFIP. In general, structural impacts include damage to building frames as well as building content.

The following data was used to evaluate exposure and determine potential future losses for this plan update:

- Tompkins County does not yet have Digital Flood Insurance Rate Maps (DFIRMs). Q3 datasets are often used for communities without DFIRM datasets to assess risk. Q3 data from FEMA for Tompkins County dated from the 1970s/1980s was used for this analysis.
- The 1-percent annual chance flood depth grid for the whole county was generated by combining an existing depth grid for the City of Ithaca generated as a part of the City of Ithaca's recent Flood Inundation Study along with the Q3 FEMA data and a Digital Elevation Model generated from contour lines.

The resulting depth grid was integrated into ESRI ArcGIS v10.5.1 for an exposure analysis and the Hazus v4.2 riverine flood model for a loss analysis. This analysis used the Q3 flood boundary, updated general building stock inventory, identified new development, updated critical facility inventory, updated population data using the American Community Survey 5-Year Population Estimates (2014-2018), and the 2010 U.S. Census population data to estimate exposure and losses caused by the 1-percent annual chance flood event. Assets (population, building stock, critical facilities, new development) with their centroid in the floodplain were totaled to estimate the numbers and values exposed to a flooding event. To estimate potential losses, a Level 2 Hazus riverine flood analysis was performed for the 1-percent annual chance flood event. The updated building and critical facility inventories were incorporated into Hazus. Hazus calculated the estimated potential losses to the population (sheltering needs) using the 2010 U.S. Census population data and potential damages to the general building stock and critical facility inventories based on the depth grid generated and the default Hazus damage functions in the flood model.

Flood induced ground failure is also included in the flood hazard. To assess the vulnerability of ground failure Tompkins county a quantitative assessment was conducted using ESRI ArcGIS v10.5.1 and a Karst Layer from United States Geological Survey. To estimate potential exposure to ground failure areas, assets (population, building stock, critical facilities, new development) with their centroid in the hazard areas were totaled to estimate the numbers and values exposed to the ground failure hazard boundary.

Information from the 2019 New York State Hazard Mitigation Plan, Responding to Climate Change in New York State (ClimAID Report), the Northeast Regional Climate Center and the U.S. Geological Survey were used to assess the potential impacts flood events have on the County's assets.

5.1.1.11 Harmful Algal Blooms

Due to the range of environmental, health and economic concerns related to the increased preponderance of Harmful Algal Blooms, it was identified as a new hazard of concern in the 2021 update for Tompkins County. Those assets located closest to water resources are at greatest risk to being impacted by harmful algal bloom events. A qualitative assessment was conducted for the harmful algal blooms hazard. Resources from the Centers for Disease Control and Prevention, Community Science Institute, Cornell University Water Resources Institute, Tompkins County, and the Environmental Protection Agency were referenced to assess the County's risk to harmful algal bloom events.

5.1.1.12 Infestation and Invasive Species

All of Tompkins County is exposed to infestation and invasive species. Resources from the New York State Department of Environmental Conservation, 2019 New York State Hazard Mitigation Plan, Responding to Climate Change in New York State (ClimAID Report) and the Northeast Regional Climate Center data were referenced to assess the potential impacts to the County's assets.

5.1.1.13 Severe Storm

All of Tompkins County is exposed to a range of different severe storm events. In general, structural impacts include damage to roofs and building frames, rather than building content. A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Tompkins County for the 100- and 500-year mean return period events. The probabilistic Hazus hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identifies those with tracks associated with Tompkins County. Hazus contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Default demographic and updated building and critical facility inventories in Hazus were used for the analysis. Although damages are estimated at the census tract level, results were presented at the municipal level. Since there are multiple census tracts that contain more than one jurisdiction, the general building stock inventory was leveraged to extract the percent of each tract that falls within individual jurisdictions. The percentage was multiplied against the results calculated for each tract and summed for each jurisdiction.

For this HMP the severe storm hazard includes thunderstorms, lightning, hail, tornadoes, high winds, and hurricanes/tropical storms. Information from the 2019 New York State Hazard Mitigation Plan, Responding to Climate Change in New York State (ClimAID) Report, and the Northeast Regional Climate Center data were used to assess the potential impacts severe storm events have on the County's assets.

5.1.1.14 Severe Winter Storm

All of Tompkins County is exposed and vulnerable to the winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. A percentage of the custom-building stock structural replacement cost value was utilized to estimate damages that could result from winter storm conditions (i.e., 1-percent, 5-percent, and 10-percent of total replacement cost value). The potential losses for this hazard provide a conservative estimate for losses associated with winter storm events as quantitative data on losses are not available for this hazard. Information from the 2019 New York State Hazard Mitigation Plan, Responding to Climate Change in New York State (ClimAID) Report, and the Northeast Regional Climate Center data were used to assess the potential impacts severe winter storm events, including ice storms, have on the County's assets.

5.1.1.15 Considerations for Future Plan Updates

The following items are to be discussed for considerations for the next plan update to enhance the vulnerability assessment:

- All Hazards
  - Utilize updated and current demographic data. If 2020 U.S. Census demographic data is available at the U.S. Census block level during the next plan update, use the census block estimates and residential structures for a more precise distribution of population, or the current American Community Survey 5-Year Estimate populations counts at the Census tract level.
- Flood
  - Utilize any formal updates to the Flood Insurance Rate Map (FIRM)
  - The general building stock inventory can be updated to include attributes regarding first floor elevation and foundation type (basement, slab on grade, etc.) to enhance loss estimates.
  - Conduct Hazus analysis for anticipated updated DFIRMs when available.
  - Conduct a Hazus loss analysis for more frequent flood events (e.g., 10 and 50-year flood events).
  - Use FEMA's Flood Assessment Structure Tool (FAST) tool for a quicker, simpler flood analysis at the structure level.
  - Further refine the repetitive loss area analysis.
  - Continue to expand and update urban flood areas to further inform mitigation
- Drought
  - General building stock inventory can be updated to include attributes such as roofing material or fire detection equipment or integrate distance to fuels as another measure of wildlife vulnerability.
- HABs
  - Closely track developing HABs analysis and strategies at NYSDEC and incorporate applicable information and mitigation strategies into plan update.
- Extreme Temperatures
  - Track extreme temperature data for injuries, deaths, shelter needs, pipe freezing, agricultural losses, and other impacts to determine distributions of most at risk areas.
- Severe Storm Events
  - The general building stock inventory can be updated to include attributes regarding protection against strong winds, such as hurricane straps, to enhance loss estimates.
  - Estimate storm surge related losses using the Hazus flood model, if the data is available.
  - If available during the next plan update, update the risk assessment using a comprehensive coastal erosion hazard area map and updated sea level rise inundation areas.
  - Collect data on historic costs incurred to reconstruct buildings, cultural resources and/or infrastructure due to coastal erosion impacts.

- Integrate evacuation route data that is currently being developed.

5.1.3 Data Source Summary

Table 5.1-3 summarizes the data sources used for the risk assessment for this plan.

Table 5.1-3. Risk Assessment Data Documentation

Data	Source	Date	Format
Population data	U.S. Census Bureau; American Community Survey 5-Year Estimates	2010; 2018	Digital (GIS) format
Building footprints	Tompkins County	2019/2020	Digital (GIS) format
Tax Assessor data	NYS Office of Information Technology Services GIS Program Office (GPO), NYS Department of Taxation and Finance's Office of Real Property Tax Services (ORPTS), and Tompkins County Tax Assessor	2019	Digital (GIS/Tabular) format
Critical facilities	Tompkins County Steering Committee and Planning Committee	2019/2020	Digital (GIS) format
Q3 Flood Mapping	Tompkins County GIS	1970/1980	Digital (GIS) format
Landslide Susceptibility (Karst Topography)	USGS	2014	Digital (GIS) format
1-Percent Annual Chance Depth Grid	Tetra Tech	2020	Digital (GIS) format
Wildfire Fuel Hazard	University of Wisconsin - Madison	2010	Digital (GIS) format
2-Meter Resolution Digital Elevation Model	Tompkins County	2008	Digital (GIS) Format
Flood Inundation Map for Ithaca	USGS	2018	Digital (GIS) Format
New Development Data	Tompkins County Planning Department	2020	Digital (GIS) Format
NY County Boundaries (Basemap)	ESRI	2002	Digital (GIS) Format
NY Railroads (Basemap)	New York State Department of Transportation (NYS DOT)	2013	Digital (GIS) Format
NY Road Centerlines (Basemap)	New York State Geospatial Information Systems (NYS GIS)	2020	Digital (GIS) Format
NY Hydrography (Basemap)	New York State Office of Cyber Security (NYS OCS)	2008	Digital (GIS) Format

5.1.1.16 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

1) Approximations and simplifications necessary to conduct such a study
2) Incomplete or dated inventory, demographic, or economic parameter data
3) The unique nature, geographic extent, and severity of each hazard
4) Mitigation measures already employed by the participating municipalities
5) The amount of advance notice residents have to prepare for a specific hazard event
6) Uncertainty of climate change projections

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk. Over the long term, Tompkins County will collect additional data to collect additional data, update and refine existing inventories, to assist in estimating potential losses.

Potential economic loss is based on the present value of the general building stock utilizing best available data. The County acknowledges significant impacts may occur to critical facilities and infrastructure as a result of these hazard events causing great economic loss. However, monetized damage estimates to critical facilities and infrastructure, and economic impacts were not quantified and require more detailed loss analyses. In addition, economic impacts to industry such as tourism and the real-estate market were not analyzed.