State Mitigation Planning Key Topics Bulletins: Risk Assessment

June, 2016

FEMA

On the Cover: High flood waters in Valley Park, Missouri caused the busy intersection of I-44 and Route 141 to be closed on January 1, 2016.
Image: Steve Zumwalt/FEMA

TABLE OF CONTENTS

INTRODUCTION

The Federal Emergency Management Agency (FEMA) released the State Mitigation Plan Review Guide (the Guide) in March 2015. This Guide, which became effective March 6, 2016, presents FEMA's official policy on and interpretation of the natural hazard mitigation planning requirements for states established in the Code of Federal Regulations (44 CFR Part 201). The State Mitigation Planning Key Topics Bulletins ("Bulletins") are a series of brief documents aimed at informing states on how to meet the regulatory and policy requirements described in the Guide. The series covers all components of the mitigation planning process. The Bulletins are not intended to clarify policy, but instead to provide state officials approaches and resources for updating state hazard mitigation plans.

In order to reduce risk for the economy and population the state needs a comprehensive understanding of the risks and vulnerabilities they face. USA, Illinois, Chicago skyline from Lincoln park.

RISK ASSESSMENT OVERVIEW

What is a Statewide Risk Assessment?

Risk, for the purpose of hazard mitigation planning, is the potential for damage or loss created by the interaction of natural hazards with assets, such as people, buildings, infrastructure, and/or natural and cultural resources. The risk assessment is a process by which the state hazard mitigation planning team determines which hazards are of concern and assesses the potential impacts of those hazards on a statewide scale. The risk assessment helps communicate vulnerabilities, develop priorities, and inform decision-making, both for the hazard mitigation plan and for other emergency management efforts.

The risk assessment provides the factual basis for activities proposed in the mitigation strategy. The hazards and associated impacts and vulnerabilities identified in the risk assessment should be the hazards, impacts, and vulnerabilities the mitigation strategy seeks to address.

GUIDING PRINCIPLE #3: FOCUS ON REDUCING RISKS

FEMA established four guiding principles for the development of state hazard mitigation plans in the Guide. Guiding Principle #3, **Focus on Reducing Risks**, sets the standard that state risk assessments must be current, relevant, and include new or updated hazard information in order to best address risks. Reducing risk requires an understanding of both current and long-term vulnerabilities to best assist with prioritizing mitigation actions and policies that reduce risk.

State, Local, and Tribal Plan Risk Assessments

It is important to recognize that the state hazard mitigation plan can and should serve as a resource for the development of local and tribal plans. The hazard descriptions presented in the state plan will likely provide the basis for local and tribal plan development, and local and tribal plan developers should be encouraged to use the state hazard mitigation plan when creating and/or updating the risk assessment. Doing this allows plan developers from all jurisdictions to start from a common place. Additionally, by basing their risk assessment on existing information, plan developers may be able to reduce the amount of resources spent on completing their risk assessment so they can focus more resources on the mitigation strategy. In addition, the state can advise local and tribal plan developers on datasets and methodologies to standardize and streamline the roll-up of jurisdictional information into the state hazard mitigation plan. This Bulletin addresses the relationship between state and local plan vulnerability assessments in more detail under Step 4.

STEPS TO CONDUCT THE RISK ASSESSMENT

Each state can develop its own methodology to complete the risk assessment, but there are generally four steps in the process. First, states must identify and describe hazards. The intent of this step is to understand natural hazards across the state to identify which hazard risks have been or may be the most significant and the locations that have been or may be most adversely affected. This step also helps states understand the probability of future hazard events. Second, states must identify their assets in terms of people, state-owned and leased structures, and critical facilities. The intent of this step is simply to develop a comprehensive inventory of assets for use in subsequent steps. Third, states must analyze risks in order to understand the locations and assets that may be vulnerable to hazards. Finally, states must summarize vulnerability for state assets and for jurisdictions most threatened by the identified hazards and most vulnerable to damage and loss associated with hazard events. This fourth step helps states understand the vulnerability of assets critical for state resilience, as well as the vulnerability of local and tribal jurisdictions as a basis for identifying and prioritizing mitigation actions.

STEP 1: Identify and Describe Hazards

The first step of the risk assessment is to identify and profile all natural hazard occurrences, and provide an overview of the probability of future hazard events. The goal of this first step is to identify and understand the characteristics of the state's most significant risks. Manmade or human-caused hazards may be included in the risk assessment, but are not required. FEMA will neither review these hazards nor require the removal of this extra information prior to plan approval.

Identify the **type** of hazards as well as a review of recently declared disasters; new or updated studies and reports; newspaper articles; and/or local hazard mitigation plans. This is an excellent opportunity to leverage the expertise and knowledge of the state planning team and the seven key sectors identified in the Guide to gather information. The plan must include all natural hazards with the potential to cause harm or difficulty in the state; it should not only include high-risk or recent hazards. Hazards that have not occurred in several years may still have the probability to affect the state and should, therefore, be included. If a commonly recognized hazard in the state is not included, the plan must include the rationale for its omission.

DATE SOURCES FOR YOUR RISK ASSESSMENT

There are a number of federal and non-governmental entities that collect data and study natural hazards and risks in the United States, which can be integrated into the analysis to strengthen a risk assessment. These data sources include the following:

- The U.S. Forest Service maintains the National Avalanche Center and the Wildland Fire Assessment System.
- The National Drought Mitigation Center provides drought monitoring, decision support tools, and general resources on drought hazards.
- Scientists from the National Aeronautics and Space Administration (NASA) update an open-source catalog of rainfall-induced landslides.
- The U.S. Geological Survey (USGS) maintains data and analysis on earthquake hazards, geomagnetism, landslides, wildfires, and volcanoes. USGS's Coastal and Marine Geology Program is also studying coastal erosion and shoreline change.
- The U.S. Department of Agriculture (USDA) shares insured crop losses, many of them due to natural hazard events, going back to 1948.
- The National Hurricane Center provides data and analyses for hurricane events.
- The Council of Western State Foresters and the Western Forestry Leadership Coalition conducted the West-Wide Wildfire Assessment for 17 western states and the Pacific Islands.
- The U.S. Army Corps of Engineers (USACE) maintains three resources for flood-related risks: the Ice Jam Database, the National Inventory of Dams, and the National Levee Database.

Federal government agencies should not be the only source of information for your risk assessment; many times, your state's natural resources, environmental protection, economic development, or community development agencies and departments have excellent data and resources. Entities like a Department of General Services or Procurement frequently maintain inventories of state-owned and leased facilities that would help build the inventory of state assets. Consider reaching out to these state partners early in the planning process to leverage their data. A comprehensive list of resources is available on pages 19-23.

After hazards have been identified, the state hazard mitigation plan must describe the geographic **location** of the identified hazards and identify areas vulnerable to damage from each hazard. At a minimum, the plan can provide a narrative of the hazard location, but using maps strengthens the risk assessment and is strongly encouraged. Any geospatial data used for mapping can also be leveraged in the plan's vulnerability assessment. When a hazard affects the entire state, the plan should describe the possible statewide impacts. The location of hazard areas can be simply defined as the absence/presence of the hazard, but they can also be further defined as high- or low-hazard areas. Some hazards affect specific locations, like the 1-percent-annual-chance flood hazard area delineated on FEMA's Flood Insurance Rate Map (FIRM) or the U.S. Geological Survey's (USGS) areas of landslide susceptibility and earthquake hazard zones.

Each identified hazard must have a description of the **extent** of the event. Extent means the strength or magnitude of the hazard – it describes the characteristics of the hazard regardless of specific impacts to people and property from the hazard. Measures of extent include depth of flooding, wind speed, and peak ground acceleration due to an earthquake. It is helpful to use an established scientific scale, like the Modified Mercalli Scale for earthquakes, the Saffir-Simpson scale for hurricanes, or the Enhanced Fujita Scale for tornadoes. Extent can also incorporate characteristics such as

the speed of onset or the duration of a hazard event, which can further contribute to vulnerability and potential impact from hazards. For example, a 5-month drought has a smaller extent than a 5-year drought. Similarly, a flood that peaks and retreats in a few hours usually causes less damage than a comparable event that lasts for multiple days.

The state hazard mitigation plan must also describe the **previous occurrences** of each hazard event. The history of events should be as complete as possible. The previous occurrences discussion should include when and where past hazard events occurred, as well as the types of damages incurred and the duration and magnitude of each event. Consider including a narrative of the worst instance of a hazard event that has occurred in the state to help you anticipate potential damage from future events. Some hazards do not have enough data on future probability, so past events may be the most relevant indicator of future hazard areas and potential impacts.

Because the state hazard mitigation plan is a multi-year strategy for reducing losses, it is essential that the plan discuss the **probability of future hazard events**. Probability is the likelihood of a hazard event occurring in the future. The risk assessment must provide a summary of the probability of future hazard events that includes projected changes in occurrences in terms of location, extent, intensity, and/or frequency.

The mitigation planning regulations require consideration of the probability of future hazard events as part of the risk assessment. This was reinforced in 2011 through FEMA's Climate Change Adaptation Policy (2011-OPPA-01) which directs FEMA programs and policies to integrate considerations of climate change adaptation. The challenges posed by climate change, such as more intense storms, frequent heavy precipitation, heat waves, drought, extreme flooding, and higher sea levels, could significantly alter the type and magnitude of hazards impacting affecting states in the future and, as such, states must take this into account when building long-term mitigation strategies.

Changes in weather patterns and climate may have effects on a state's vulnerability to hazards. These effects may include the probability of hazard occurrence, as well as the extent or location of the hazard. Examples could include:

- An increase in occurrences of low-grade flooding, or the occurrence of flooding in areas where flooding had not previously occurred due to sea level rise, an increased number of storms, or increased precipitation during each storm.

INCORPORATING FUTURE CONDITIONS IN STATE HAZARD MITIGATION PLANS

The Guide establishes the standard that all state hazard mitigation plans' discussion of hazard probabilities must include considerations of changing future conditions, including the effects of long-term changes in weather patterns and climate on the identified hazards. This is not a change in the CFR, which has always required consideration of the probability of future hazard events. It is, however, a new emphasis.

- Lasting drought conditions, experienced in some areas more frequently, that affect water availability and agriculture, as well as notable flooding occurrences from infrequent and intense rain storms in areas where flooding does not usually occur.

These instances of hazard occurrence may not meet a threshold for a disaster declaration, and so may not be immediately identified as having an effect on the state's vulnerability. However, over the long term these changes in frequency, location, and extent may alter a hazard's impact, and the jurisdictions' and state's vulnerability to that hazard.

States have latitude in the method selected to estimate the probability and impact of future events. There are a number of resources that identify models to help states predict how changing future conditions and climate change may affect their known hazards, and they are included at the end of this document. Additionally, many states and regions have begun climate modeling or scenario planning to better identify the localized effects of changing weather patterns and climate. States should use the information, data, and analyses from these resources to qualitatively and quantitatively identify the effects climate change may have on the future probability, and impact, of each of their identified hazards.

States can approach the integration of this data by developing "good, better, and best" risk assessments that account for changing future conditions. The state's approach will be based on the amount of available state-specific data, analysis capabilities, and capacity to integrate the data into their assessments.

- **Good:** Inclusion of qualitative information about how changing weather patterns and climate can impact the probability of future occurrence of each of the plan's identified hazards.
- **Better:** Integration of national or regional models that identify quantitative changes in the frequency or probability of future occurrence of each hazard in the plan.
- **Best:** Integration of state-wide, or more localized, analyses, based on down-scaled temperature and precipitation data, of the probability of future occurrence of each hazard in the plan, as well as identification of the effect climate change will have on the overall impact of each hazard in the state.

The exact method of incorporating future conditions information will vary by hazard type. The analyses and available data that can be used to inform a state's risk assessment is growing on an annual basis. While in their current update a state may be able to identify mostly qualitative data to inform their findings of future probability, they can gather valid quantitative data before the next update to improve the assessment of future conditions on a state's risk.

California drought in the Cuyama Valley. Image: Getty

The findings from risk assessments that consider the effects of a changing climate on their future hazards and vulnerabilities should be used in developing a mitigation strategy, as well as in prioritizing and successfully implementing projects to reduce hazard impacts. Additionally, the findings from these risk assessments should be shared with state and local officials, as the identification of increased vulnerabilities affects policy and development, as well as local land use and decision-making.

If there is no other data available on the probability of future occurrences of hazard events, states have a number of options to summarize future probability:

- States can use statistical probabilities or projected changes, when known. For example, the National Climate Assessment provides data on projected changes in the number of extremely hot days, projected changes in soil moisture, and projected change in heavy precipitation events.
- States can use a historical analysis to indicate future events when there is no other data available on potential future events. This approach should be used with caution; recent trends indicate that the type, frequency, and/or magnitude of hazard events will change in the future as the climate continues to change. For example, an event that has occurred 20 times over 50 years has a 40 percent annual probability:

$$\frac{20 \text{ events}}{50 \text{ years}} = 0.4 \text{ events per year, or } 40\% \text{ annual probability}$$

- States can define the likelihood of a hazard occurring in terms of a general descriptor like unlikely, likely, or highly likely. If general descriptors are used, the plan must define the descriptors. For example, "highly likely" could be defined as "equals a nearly 100-percent chance of occurrence next year" or "happens every year." It is recommended that these general descriptors only be used in instances where statistical probabilities or historical analyses are not available.

Throughout the risk assessment, FEMA encourages states to include summaries, evaluations, and overviews that result from data analysis. Raw data should be included, as needed, to support summaries and conclusions, and should also be included in appendices or annexes. Conversely, when the state hazard mitigation planning team identifies data gaps or limitations, the plan should note the deficiency and include a mitigation action to remedy the issue.

Mud deposit at Bombay Beach in California
Image: Adam Dubrowa/FEMA

STEP 2: Identify Assets

After identifying and describing the possible hazards, states must identify their assets. This inventory of assets helps to answer the question, "Who and/or what will be affected by the identified hazards?" State assets may include state-owned or operated buildings, infrastructure, and critical facilities. The asset inventory should also consider people, and the distribution of the state's population.

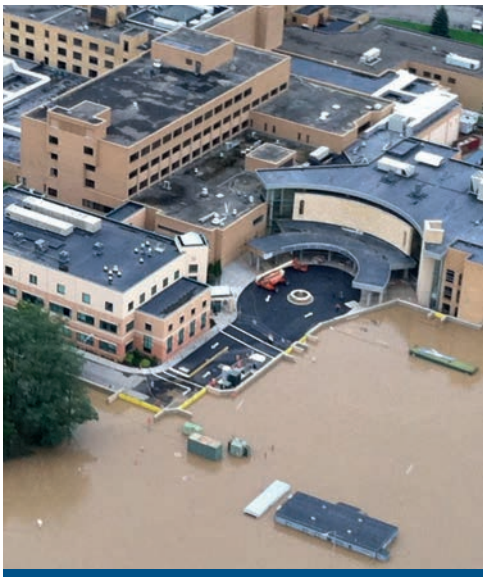
It can be challenging to gather information on state assets. FEMA encourages state officials to identify and agree upon the definition and categories of state assets that will be used in the plan with the state planning team at the start of the planning process.

Critical facilities are the structures that states determine must continue to operate before, during, and after an emergency and/or hazard event, and which are vital to public health and safety. Examples of critical facilities may include, but are not limited to:

- Emergency operations centers, police and fire stations, and storage facilities, including data storage.
- Structures that house occupants with restricted mobility or access and/or functional needs, such as hospitals, institutions, and shelters.
- Utility generating, transmission, and storage facilities and related infrastructure, such as power and/or water treatment plants.
- Transportation facilities, such as ports, roads, airports, railroads, bridges, and/or tunnels.

Conversations about data availability should occur early in the planning process to allow adequate time to acquire and process the data. Typically, the state agency or department responsible for insuring property also maintains data on state assets. Population data are readily available from the U.S. Census Bureau. State emergency management agencies may have data on emergency operations centers and first responder locations. The state planning team should work with state departments of transportation to gather information on transportation infrastructure, and utility oversight entities will likely be able to contribute information related to utility generation, transmission, and storage. State departments of health or human services frequently accredit healthcare and social assistance entities, and will likely have data on the number and location of structures that house occupants with restricted mobility or access and/or functional needs.

If state-level, recent data are not available, states can turn to the inventories and databases included in FEMA's Hazus-Multi-Hazard (Hazus-MH) program as a possible data source. Hazus MH inventories contain a number of useful data points, including hospitals, police stations, fire stations, schools, emergency operations centers, dams, nuclear power plants, highway systems, railway systems, light rail



Floodwall Protected this vital property from flood waters that devastated other parts of the city, even as rising water from the Susquehanna River engulfed the parking lot of Binghampton, NY s Our Lady of Lourdes hospital during Tropical Storm Lee.
Image: FEMA

FEMA has obligated more than $89 million in funding for repairs to New Orleans Sewerage and Water Board s Eastbank Sewerage treatment facility.
Image: Manuel Broussard/FEMA

State asset inventories should include information on whether the assets have been mitigated or built to withstand hazard events. In this example, the Plaquemines Parish Government Building was constructed on pilings and includes storm panels that withheld winds up to 120 miles per hour. Image: FEMA

systems, buses, ports, ferries, airports, potable water, wastewater, oil, natural gas, electric power, and communication systems. For more information on the Hazus-MH databases, visit the Summary of Databases in Hazus-Multi Hazard.

When creating an inventory of state assets, state planning teams should make every effort to gather location data for each asset. Having location data for state assets, including latitude/longitude or addresses, will be important for assessing the vulnerability of these assets. It is not essential to map every state asset in the body of the plan, but the plan should summarize the location of state assets by region and/or county. State plan preparers should also consider categorizing the state assets and critical facilities by type or sector and summarizing the results of the vulnerability analyses by county or jurisdiction in the plan. Raw data can be documented in an appendix, especially if there are privacy and/or homeland security concerns associated with the identification of state assets and critical facilities. States should also collect or estimate the assessed or replacement value of each asset. Assessed or replacement value can typically be identified by the state department or agency who maintains the asset, or maintains insurance for the asset. Beyond the location and value of assets, other key attributes include the age of the asset, ownership information, construction type, number of stories, and backup power abilities. These attributes can foster a more meaningful analysis; for example, an asset's age may point to structural vulnerabilities or the construction standards used for building. Backup power abilities can indicate a less vulnerable structure that is able to operate throughout an event.

STEP 3: Analyze Risks

States will use the information gathered in Steps 1 and 2 to inform their analysis of the risk to their assets from each identified hazard. The purpose of the risk analysis is to inform states about the areas and assets that are vulnerable to hazards. This information will become the basis of an informed mitigation strategy to reduce these risks. This analysis is accomplished by determining each hazard's potential impacts on state assets, assessing the vulnerability of the assets based on these potential impacts, and estimating the losses from each hazard.

LEVERAGING THE RISK ASSESSMENT IN AND FOR OTHER PLANS

While the state hazard mitigation plan requires a risk assessment that meets the criteria established in 44 CFR 201, risk assessment is also field of practice that can apply to other planning efforts. Consider the following ways you can connect the hazard mitigation plan's risk assessment to other plans and policies:

Threat Hazard Identification and Risk Assessment (THIRA): In order to conclude the THIRA process, states must complete an analysis of each hazard to determine the impact an occurrence would have on the population and property in an area; this information is included as the "Give Threats and Hazards Context" requirement in the THIRA submission. States should enhance efficiency between the analyses for determining THIRA content and the hazard mitigation plan's risk assessment. This will ensure consistency between the risk and vulnerability assessments in these plans and will align the planning outcomes of both.

Emergency Operations Plans: Emergency Operations Plans and emergency management functional plans include information on how to save lives and protect property if a hazard event occurs; response agencies should be aware of the risks and vulnerabilities inherent in each hazard so they can identify potential impacts on their activities before and during an event.

Post-Disaster Recovery Plans: After a disaster, states and communities undertake large planning efforts to rebuild their residential and economic bases to be more resilient. The vulnerability assessment from the hazard mitigation plan can serve as a good starting point for this planning process, but the findings from the recovery planning efforts of impacts, risks, and vulnerabilities after the disaster will also help inform the mitigation plan update.

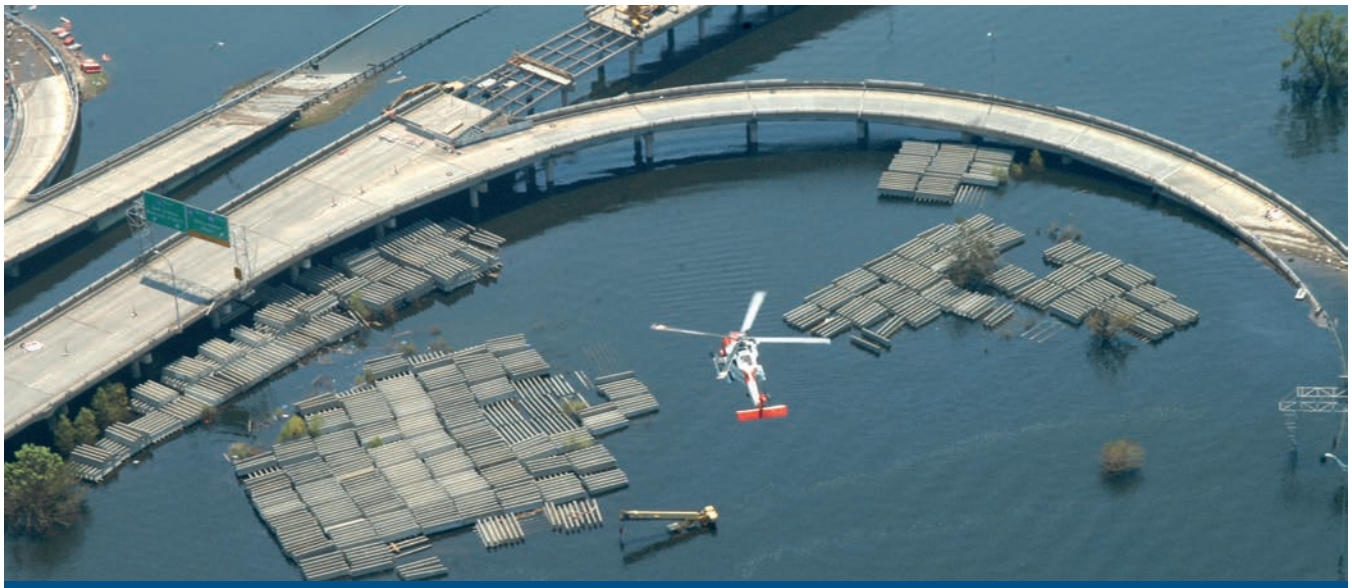
Climate Adaptation Plans: Climate adaptation plans identify climate change vulnerabilities and establish a prioritized set of strategies to lessen the long-term impact of climate change. The future conditions assessment from the hazard mitigation plan should inform the climate adaptation plan and vice-versa. Also, the assets identified in the risk assessment may be candidates for adaptation strategies.

When describing the potential impact of each hazard, states should discuss the type and degree of damage expected to assets, infrastructure, and natural environmental systems. Determining the impact includes analyzing the location, extent, and probability of a future event for each hazard, as well as the location of the affected assets. States can identify impacts based on any of the following methods:

- **Historical occurrences analysis** may include data and a discussion of past insurance claims, reported property losses, or recorded injuries and fatalities from hazards. Reporting on the impacts of past events can indicate the impact of future events of a similar size. Common data sources for historical occurrences include flood insurance claims from FEMA's Community Information System; insured crop losses from the USDA Risk Management Agency; and the National Oceanic and Atmospheric Administration's (NOAA) Storm Events Database. States should work with their environmental and natural resource agencies to identify the availability of risk data related to historical events.
- **Exposure analysis** identifies assets located in identified hazard areas, usually by using geographic information system (GIS) overlays. Completing an exposure analysis in GIS is an efficient way to identify the state assets that are within the impact area of each hazard. This analysis will highlight which assets and communities may be affected by the hazard. It also results in a map of the vulnerable areas, and the assets within these areas, to visually demonstrate the areas of risk.
- **Scenario analyses** predict the impact of hazard events and can be completed using modeling software, like Hazus-MH. Modeling or scenario software determines a hazard's impact based on the defined extent and location of the occurrence, and then uses the data to identify the assets and communities that would be impacted by this occurrence. Hazus-MH data are available for flood, earthquake, and hurricane wind events.

States can use multiple methods and supplement their analysis with risk assessments or factors developed during other planning efforts. For example, states may have used hazard scenarios to identify impacts to complete the "Give Threats and Hazards Context" step of the Threat and Hazard Identification and Risk Assessment (THIRA) process. States should review the THIRA to determine whether the factors identified in the document can help inform hazard mitigation planning.

In addition to identifying impacts, states must address the vulnerability of state assets located in hazard areas and estimate potential losses to those assets. States can estimate potential losses by determining the values of state assets and including these in exposure or scenario analyses. The losses can then be summarized by type or location. The value of assets can be determined based on their assessed or replacement value, depending on available data. States can also consider any values identified for assets related to the loss of content, loss of function, or displacement.



In addition to identifying populations potentially impacted in hazard areas, mitigation plans can describe the vulnerability of critical infrastructure and transportation networks, like this roadway inundated by Hurricane Katrina. Image: Liz Roll/FEMA

STEP 4: Summarize Vulnerability

States must comprehensively describe their vulnerability to the identified hazards from two distinct perspectives: the state on the whole, and at the local and Tribal levels, as applicable. This step is a culmination of the information gathering and analysis completed in the previous three steps; the more accurate and comprehensive a state's vulnerability assessment is, the better informed they will be when identifying mitigation actions that reduce risk and protect their assets and communities.

From a statewide perspective, the risk assessment must include an analysis of the potential impacts of hazard events to state assets and a summary of the assets most vulnerable to the identified hazards. The state must include a summary of the potential losses to assets and structures from each hazard determined in the state's risk analysis. Losses should be considered estimates, as assets located in hazard areas may experience a range of losses, from minor loss-of-use to major structural damage.

States can also summarize vulnerability by ranking the identified hazards based on the factors related to the risk they face to each hazard, including the impact of the hazard, the probability of its occurrence, the amount of warning time before a hazard occurs, the duration of the hazard event, and the extent of the hazard. This is a quantitative method of comparing hazards, where each factor is assigned a numerical value based on its severity and its impact on communities and assets. The values are then compared across all identified hazards. This method of ranking ensures an apples-to-apples comparison between hazards, and can help states prioritize their vulnerabilities and determine the best mitigation strategies.

States can use problem statements as a way to provide a narrative for their vulnerability findings. Problem statements identify the specific areas of vulnerability, such as a jurisdiction that may experience major losses due to a hurricane, an asset that is inaccessible or that will lose partial functionality during a flood, or a region that is in a seismic hazard area that is subject to severe ground shaking. These statements help the users of the plan fully understand the impacts of a hazard, and the areas that are most vulnerable to these impacts.

States must include an overview and analysis of the vulnerability of jurisdictions to the identified hazards and the potential losses to vulnerable structures at the local level. This means that state plans must identify, as applicable, the local and tribal jurisdictions that are most vulnerable to each of the identified hazards. This includes identifying the jurisdictions most at risk to each hazard as determined by the state's risk analysis, as well as summarizing the findings of the risk assessments from the jurisdictional plans. The inclusion of local findings in the state's assessment ensures that all structural and population impacts identified by locally maintained data are considered. This summarization will help states compare the impact and losses across the state from each hazard, and across all hazards, to better prioritize mitigation actions in the areas subject to hazards that cause the most losses. This local plan roll-up can be a challenge, as local hazard mitigation plans vary in structure, analysis methods, and identified hazards. To make capturing local information more manageable, states should consider capturing local vulnerability and loss information during the state's review of local hazard mitigation plans. Encouraging local officials to use the state's risk assessment data and analysis methodology will also make local plan roll-up smoother, because all plans will use a common basis of information for the risk assessment.

Volunteers from Samaritans Purse and United Methodist Volunteers work together to build a Cold Climate Home for a disaster Survivor in Galena, Alaska. Image: Adam DuBrowa/FEMA

UPDATING THE RISK ASSESSMENT

All states have completed at least one hazard mitigation plan, so all future plans will be updates. This section highlights risk assessment update requirements and considerations.

Incorporating Changes in Development

State hazard mitigation plans must be revised to reflect changes in development, including recent development, potential and projected land use and development, or conditions that may affect risk and vulnerability to the state and jurisdictions, such as changes in population demographics. This includes both changes in development since the last approved plan and changes expected to occur in the future.

Describing changes in development since the previous plan should be based on where growth or decline in population and development has occurred, as well as the areas where successful implementation of mitigation projects have reduced risk. Development that occurred in a previously identified hazard-prone area will, in all likelihood, result in the finding of increased vulnerability of the area's assets and population. Growth and development may also affect the land use and natural resources in the area, in addition to introducing more population and structures to the area of hazard impact. All of these things can increase vulnerability and loss. On the other hand, successfully implemented mitigation projects will lessen vulnerability or potential losses. These can be projects that were funded through mitigation grant programs, but are not limited to these. Jurisdictions or state agencies may have also implemented projects that reduced a community's or an asset's risk to a hazard, or they may know of additional projects that non-governmental or philanthropic organizations, or individuals, undertook in the last five years.

Changing future development patterns will affect the state's vulnerability to hazards; population growth in an area can strain existing or aging infrastructure. For example, dams or reservoirs nearing or past their design life may not be sufficient to protect expanding communities from flood hazards. In addition to summarizing the current vulnerability found in the state and jurisdictional risk analyses, states must identify the factors of change that can affect the state's vulnerability to hazards. A later section of this bulletin provides considerations for including climate change into the risk assessment as a factor of change. Other factors the state must identify include:

- **Potential or projected development:** State agencies responsible for identifying environmental impacts or maintaining economic growth statistics may have information on where growth is expected based on past trends, or areas that have been identified for targeted growth in the future. States should also include information on areas of growth from local risk assessments, especially growth in areas that are already hazard-prone or vulnerable. New development can also change the land use in jurisdictions across the state, which may affect an area's vulnerability.
- **Projected changes in population:** States can complete population projections by analyzing past population trends. One of the state agencies identified above may also have projections based on trends and other factors. Population projections should not be completed on a statewide basis, but at a regional or jurisdictional level to better demonstrate how areas of growth and decline may affect an area's vulnerabilities.
- **Other identified conditions:** Many other conditions may affect a future vulnerability to hazards, including aging infrastructure or changes in natural resources that may have offered natural protection from hazards. Information about changes in natural resources may be available from state departments working with environmental related missions.

Identifying these changes in the risk assessment will ensure they are considered when developing the mitigation strategy to reduce these vulnerabilities in the future.

Other Considerations for Risk Assessment Updates

The state hazard mitigation plan update process is an opportunity to build upon the previous state plan to enhance the findings of the risk assessment and improve the state's resilience. State Planning Teams are encouraged to look across the whole community of partners to identify new or updated data sources or analysis methods. This may include updated Flood Insurance Studies and Flood Risk Products, state-initiated hazard studies, or other new federal data sources. For example, in 2014 the USGS updated its seismic mapping for the lower 48 states to incorporate new findings on earthquake characteristics. Hazus-MH has also undergone significant updates throughout 2015. Better data and analysis methods can help strengthen the risk assessment to better identify the vulnerabilities that state assets and communities face to each hazard. This new information will better inform the state's mitigation strategy to reduce overall risk. While identifying additional previous occurrences is a necessary component of the risk assessment update, focusing on these occurrences alone is not sufficient to update the state's risk to hazards.

A state's current risk assessment should serve as the foundation for the update. State planning teams will begin by reviewing the assessment to identify any areas where the analyses can be enhanced by using better data or more quantitative methods of determining impact and potential estimated losses. For example, if the state has access to better data about the assets, including their replacement values, this data should be used in the potential loss estimates and vulnerability summaries for each hazard. Additionally, the state may have increased its capability to complete GIS and model-based analyses. The impacts determined from the scenario-based models or from identifying the exposure of specific assets to hazards will enhance the state's findings by better identifying specific areas of vulnerability.

At the beginning of the update process, the state must determine if changes in hazards have impacted the state. The state should gather data on the hazards that have occurred since the previous plan, including those that resulted in disaster declarations, as well as those that did not meet the threshold for a declaration, but caused significant or repeated damage, like frequent, low-grade, or nuisance flooding, areas of subsidence events, or areas of frequent landslides. With this information, states should review each of the identified hazards in the previous plan and ask the following questions:

- Have hazards occurred that have had severe impacts on the state which were not identified in the last plan?

USING RISK MAP PRODUCTS IN THE RISK ASSESSMENT

Risk Mapping, Assessment, and Planning (Risk MAP) studies provide communities with detailed flood risk information via flood risk products – the Flood Risk Map, Flood Risk Report, and Flood Risk Database. States play a role in the Risk MAP process, and departments that act as a Cooperating Technical Partner or coordinate the State National Flood Insurance Program (NFIP) should be involved in the collection and integration of Risk MAP data into the plan. Key products that may be incorporated include:

Flood Depth and Analysis Grids: Illustrates the depth of flooding for a set of return periods, such as the annual chance grid, the one-per-cent-annual-chance grid, and the 30-year probability grid.

Changes Since Last FIRM: Shows areas where the floodplain and floodway have increased or decreased to enable planners to better identify how the vulnerability of structures and assets have changed.

Flood Risk Assessment: Presents estimated losses based on flood severity and identified values of structures in the floodplain.

Areas of Mitigation Interest: Identifies physical factors that may contribute to flooding and flood losses. This dataset in particular can help pinpoint mitigation actions.

States should encourage local officials to use these products to enhance their plans, better communicate flood risk to the public, and identify and prioritize mitigation actions to reduce their risk.

- Has the extent or location of the hazard occurrences changed?
- Has the frequency that the hazard occurs increased or decreased?

States must answer these questions and use their findings to update the location, extent, previous occurrences, and probability of future occurrence in the plan.

Part of reviewing the information in the previous plan will include a validation of the state-owned or operated buildings, infrastructure, and critical facilities. States must determine if these assets are operational, if there has been a change in the function of an asset, or if additional assets have been built or identified as critical. Additionally, states should validate the locational and value assessment data in the previous plan to ensure it is accurate and up-to-date for the risk analysis.

Many roads, such as this one in South Carolina, have hazard warning signs. Image: Bill Koplitz/FEMA

RESOURCES

The following is an inventory of resources that states can, and should, use to inform their risk assessments. State departments and agencies, regional or local non-governmental organizations, and local jurisdictions also have data that are state specific and analyses that are downscaled to the state level. Academic research institutions can also be an excellent source, particularly for understanding the effects of climate change. These resources are critical to informing a comprehensive risk assessment, and should be used to supplement, or supplant if appropriate, the data gathered from the resources identified here.

Risk assessment is a rapidly-evolving field; as such, the resources available to conduct a risk assessment will continue to grow, and this list is not exhaustive. Visit FEMA's Hazard Mitigation Planning web site for additional and up-to-date resources.

General Risk Assessment Resources

NOAA – NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION (NCEI)

The NCEI was formed in 2015 through the merger of the National Climatic Data Center (NCDC), the National Geophysical Data Center (NGDC), and the National Oceanic Data Center (NODC). For the purpose of developing or updating a risk assessment, the Storm Events Database is among NCEI's most useful resources. This database documents occurrences of storms and other significant weather phenomena, including details about dates of occurrence, intensity, loss of life, injuries, property damage, and crop damage. This database can be used to document past occurrences of hazard events, estimate the likelihood of future occurrences, and assess vulnerability. However, one limitation of this database is that it contains information on a limited number of hazards, and the time period of available events varies by event type. Additionally, some content in the Storm Events Database is gathered from sources outside of the National Weather Service (NWS), such as the media, law enforcement, other government agencies, individuals, and others. The NWS does not guarantee the accuracy or validity of this information.

National Centers for Environmental Information: https://www.ncei.noaa.gov/

Storm Events Database: https://www.ncdc.noaa.gov/stormevents/

NOAA – STORM PREDICTION CENTER (SPC)

The NOAA's Storm Prediction Center (SPC) forecasts severe thunderstorms and tornadoes and monitors hazardous winter weather and fire events. SPC products are commonly used by the NWS, emergency managers, meteorologists, the aviation industry, and others to prepare for severe weather events. In addition to forecasting and monitoring weather events, the SPC conducts research and issues publications about severe weather, including tornado and severe weather summaries, tornado-related fatality data, and information about trends in severe storms. This information can be used to describe the location and extent of hazards, document past occurrences, and assess vulnerability.

Storm Prediction Center: http://www.spc.noaa.gov/

FEMA – FLOOD MAP SERVICE CENTER AND GEOPLATFORM

FEMA's Flood Map Service Center (MSC) is the official public source of flood hazard information produced in support of the National Flood Insurance Program. This resource can be used to access effective and historic regulatory FEMA products, including FIRMs, Flood Insurance Studies (FIS), and Letters of Map Change. The effective National Flood Hazard Layer (NFHL) data can also be downloaded from the MSC. The MSC also houses non-regulatory Flood Risk Products for various communities. Flood Risk Products, which include Flood Risk Maps, Flood Risk Reports, and Flood Risk Databases, supplement regulatory products and help communicate flood risk to communities. These resources can help with developing or updating a flood risk assessment. Additionally, FEMA's GeoPlatform hosts the NFHL in an online format and provides other geospatial data and analytics regarding hurricanes and typhoons, tornadoes, earthquakes, and flood, which may be helpful during the development of a risk assessment.

FEMA's Map Service Center: https://msc.fema.gov/portal

GeoPlatform: http://fema.maps.arcgis.com/

DATA.GOV

Data.gov is managed and hosted by the U.S. General Services Administration, Office of Citizen Services and Innovation Technologies and contains various government datasets, including over 100,000 GIS datasets. Data from agencies such as NOAA, FEMA, USGS, U.S. Census Bureau, U.S. Fish and Wildlife Service, and the USACE are all available to download on data.gov. Much of the data related to climate and hazards could help support the development of a risk assessment.

Data.gov: http://www.data.gov/

FEMA – "USING HAZUS-MH FOR RISK ASSESSMENT"

The Hazus-MH program can be used to evaluate risk associated with a variety of hazards. Hazus-MH uses GIS technology to estimate the physical, economic, and social impacts of disaster events. This tool is particularly useful when estimating potential losses during a risk assessment. This How-To Guide is intended to help users conduct risk assessments with the Hazus-MH software. FEMA prepared this guide based on Hazus-MH risk assessment pilot projects that were implemented throughout the country. The guide is structured to help users identify hazards, profile hazards, inventory assets, estimate losses, and consider mitigation options.

Using Hazus-MH for Risk Assessment: http://www.fema.gov/media-library/assets/documents/5231

FEMA – MULTI-HAZARD RISK ASSESSMENT

FEMA's Multi-Hazard Risk Assessment web page provides information and resources to assist with conducting a multi-hazard risk assessment. This web page lists multi-hazard, hurricane, flood, wildfire, and earthquake resources that can be used as starting points when conducting or updating a risk assessment.

Multi-Hazard Risk Assessment: https://www.fema.gov/multi-hazard-risk-assessment

USGS EARTHQUAKE HAZARDS PROGRAM

The USGS Earthquake Hazards Program focuses on providing earthquake science information for reducing loss of life and property from earthquakes through understanding of their characteristics and effects and by providing the data needed to mitigate earthquake losses. The USGS Earthquake Hazards Program seeks to improve earthquake hazard identification and risk assessment methods, maintain and improve earthquake monitoring, and improve the understanding of earthquake occurrences, effects, and consequences. The Program provides real-time data feeds of earthquakes worldwide with a focus on urban areas, and provides an extensive catalog of publications, maps, and datasets to improve overall understanding of earthquake risk.

USGS Earthquake Hazards Program: http://earthquake.usgs.gov/earthquakes/

USGS LANDSLIDE HAZARDS PROGRAM

The USGS Landslide Hazards Program supports the Agency's mission to provide reliable scientific information to minimize loss of life and property from natural hazard events. The Landslide Hazards Program has been gathering information, conducting research, responding to emergencies, and providing scientific data to the public and the scientific community since the mid-1970s. The Landslide Hazards Program provides archives of occurrences, maintains the National Landslide Hazards Map, and compiles news and research about landslide hazards.

USGS Landslide Hazards Program: http://landslides.usgs.gov/

Climate Change Resources

FEMA CLIMATE CHANGE ADAPTATION POLICY

In 2011, FEMA established an agency-wide directive to integrate climate change adaptation planning and actions into agency programs, policies, and operations. The policy highlights initial actions FEMA will take to integrate climate change adaptation considerations into its programs, operations, and grants.

FEMA Climate Change Adaptation Policy Statement: https://www.fema.gov/media-library/assets/documents/33082

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) – FIFTH ASSESSMENT REPORT AND DATA DISTRIBUTION CENTER (DDC)

Formed in 1988, the IPCC is the international body for assessing science related to climate change. The Fifth Assessment Report evaluates the scientific basis of climate change, including its impacts and future risks as well as options for adaptation and mitigation. The DDC provides historic climate, socio-economic, and environmental data, as well as projections for future scenarios. These resources can inform discussions on climate change in relation to hazard events in a risk assessment and may include valuable information to consider when conducting a vulnerability assessment and estimating the probability of future hazard occurrences.

Fifth Assessment Report: https://www.ipcc.ch/report/ar5/

Data Distribution Center: http://www.ipcc-data.org/

NOAA – CLIMATE DATA PORTAL

NOAA's Climate Data Portal provides science and information about climate-related events and risks. This resource includes various climate datasets, as well as a Climate Data Primer. The Climate Data Primer is intended to help users understand and explore climate data, including how climate data are measured, processed, classified, and interpreted. This resource also discusses practical applications of climate data. The Climate Data Primer and the data available through the Climate Data Portal can support the development of a risk assessment of climate-related hazards.

Climate Data Portal: http://www.climate.gov

Climate Data Primer: https://www.climate.gov/maps-data/primer/climate-data-primer

NATIONAL CLIMATE ASSESSMENT

The National Climate Assessment presents an in-depth look at climate change impacts on the United States. This resource discusses how the climate is changing and its impacts on various regions and sectors. The report also presents an overview of response strategies, including mitigation. The information about climate change and its various impacts may be useful to refer to when developing a risk assessment, particularly when discussing location and extent.

National Climate Assessment: http://nca2014.globalchange.gov/

U.S. CLIMATE RESILIENCE TOOLKIT

The U.S. Climate Resilience Toolkit provides tools and information to support communities with improving resiliency and managing climate-related risks and opportunities. The toolkit inventories free training resources to assist with using climate tools and data and offers various data visualization tools. Among these tools is the Climate Explorer, which visualizes inundation from sea level rise and the affected people and assets. This tool can be used in a risk assessment to identify location, extent, and range of magnitude, and assess vulnerability.

U.S. Climate Resilience Toolkit: http://toolkit.climate.gov/

U.S. GLOBAL CHANGE RESEARCH PROGRAM (USGCRP)

The USGCRP was established in 1989 to assist with understanding, assessing, predicting, and responding to human and naturally induced processes of global change. The USGCRP includes various resources, reports, data, multimedia, and indicators that could inform a risk assessment. Among these resources are a number of visualizations of global climate change from member agencies. These visualizations can assist in evaluating and communicating future risk. The USGCRP also includes a robust reports library of scientific assessments, annual reports, research plans, fact sheets, brochures, and other resources that can be used to inform the future conditions assessment. This tool can assist communities in these geographic areas with conducting or updating a risk assessment.

U.S. Global Change Research Program: http://www.globalchange.gov/