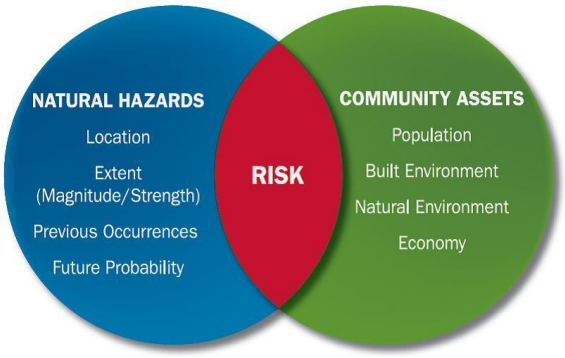
3 HAZARD IDENTIFICATION AND RISK ASSESSMENT

Developing strategies and implementation tools for mitigating hazards first requires an evaluation of a community's risk and vulnerability to particular hazards. This chapter provides information on the various hazards that affect Colorado communities, the fundamental steps involved in assessing risk and vulnerability to those hazards, and tips for effectively applying the results of a risk assessment. The procedures outlined in this chapter are often referred to as the Hazard Identification and Risk Assessment (HIRA) Process. Common data sources are summarized at the end of this chapter in *Summary of Common Hazard Data Sources.*

HOW DO I ASSESS LOCAL RISKS FROM HAZARDS?

WHAT IS "RISK?"

Hazards are part of the world around us and their occurrence is inevitable. Floods, landslides, wildfires, windstorms, and other hazardous events are natural phenomena in Colorado over which humans have limited control. These events result in periodic damage to the environment: fire can destroy forests, floods can erode stream banks and result in channel migration, and a host of geologic hazards can severely alter the natural landscape. However, despite their destructiveness, these occurrences are not unexpected, and can even reflect healthy regeneration of natural systems.



FEMA uses this Venn diagram to illustrate the concept of risk as the relationship, or overlap, between hazards and community assets (modified from USGS and Oregon Partnership for Disaster Resilience Models).

Source: FEMA, Local Hazard Mitigation Handbook (2013)
fema.gov/media-library-data/20130726-1910-25045-9160/fema_local_mitigation_handbook.pdf

It is only when the human environment intersects with these natural phenomena that a hazard risk is created and a so-called "natural disaster" may result. A disaster occurs when human settlement and infrastructure, such as buildings and roads, exists in the path of the forces of nature, resulting in potentially hazardous situations. Our built environment is not nearly as recuperative or resilient as the natural one. A hazard can result in physical damage, economic disruption, and other significant impacts to an entire community for many years following the event.

Disasters can also occur as a result of human activity, such as the storage or movement of hazardous chemicals, regardless of natural conditions. While the source or cause of risk and disasters may be

natural or human-caused, this planning guide focuses primarily on Colorado's most significant *natural* hazards.

While we cannot prevent natural hazards, we do have some means to anticipate their occurrence and manage what comes afterward—and we certainly can minimize the risk from human-caused hazards. Local planners in particular have a range of tools and techniques to minimize or avoid the potential adverse consequences from foreseeable hazards. The focus of this guide is to assist citizens in planning ahead before a hazard event occurs, so that communities can lessen risk and hopefully prevent hazardous events from becoming disasters.

CONDUCTING A RISK ASSESSMENT

The first step in preparing for hazards is to conduct a local risk assessment, which helps identify the potential impacts of hazards on a community's physical, social, economic, and environmental assets. When done correctly, the assessment helps decision makers and stakeholders understand the most locally significant hazards and unique risks, including current and possible future vulnerabilities. Just as important, the risk assessment supports the development of mitigation measures to reduce future risk. While specific approaches may vary depending on available capabilities and resources, the outcome, conclusion, or end goal of any meaningful risk assessment should be implementation of the community's risk reduction and mitigation strategies.

The FEMA-Recommended Steps for Risk Assessment

Since 2001, more than 27,000 communities across the United States have conducted local risk assessments in compliance with federal regulations per the Disaster Mitigation Act of 2000. Although there are many methods to identify and assess local hazard risks, most generally follow the same key steps and result in similar types of information. The current standard process typically used by Colorado communities follows guidelines issued by FEMA and the Colorado Division of Homeland Security and Emergency Management. There are four recommended steps, as described below. Detailed guidance for completing each step is provided in FEMA's *Local Mitigation Planning Handbook* (2013).

- **Step 1: Describe Hazards.** Identify hazards that may affect the community. Describe the type, location, extent, previous occurrences, and probability of future events.
- **Step 2: Identify Community Assets.** Identify the community's assets at risk to hazards. Assets may be categorized generally as people, economy, built environment, and natural environment.
- **Step 3: Analyze Risks.** Evaluate vulnerable assets, describing potential impacts and estimating losses for each hazard through exposure analysis, historical analysis, and/or scenario analysis.
- **Step 4: Summarize Vulnerability.** Document and summarize the community's most significant hazard risks and vulnerabilities in order to inform the mitigation strategy.

Involving Everyone in Risk Assessment

Identifying local hazards and assessing risk requires input from a number of stakeholders and data from a variety of sources. This will include plans and personnel that might not immediately come to mind.

A collaborative, multi-sector, inclusive process is necessary. For example, a risk assessment should engage fire service and emergency managers, community planners, city engineers, law enforcement, regulators, natural resource and/or hazard experts (geologists, foresters, hydrologists, floodplain managers, fire behavior analysts, etc.), GIS specialists, community leaders, local residents, community organizations, and others. Similarly, data sources may include the Local Hazard Mitigation Plan, emergency management plan, comprehensive/master plan, hazard-specific plans and historical data, critical infrastructure plans, census information, and any other resources that help describe the hazard and identify community assets (or "values at risk").

Some information is not up for debate—historical analyses of flood or fire, for example, is factual. Other inputs, including values and estimated losses, can become more subjective. While finding consensus may be difficult, the process of engaging multiple stakeholders ensures that everyone better understands the risk assessment outcomes and is better prepared to help prioritize mitigation efforts. Building these relationships before a disaster occurs will also pay dividends during and after the disaster.

Developing Your Own Local Risk Assessment

Early in developing a risk assessment, planners should collect and review local sources that have already addressed local hazards. The sources will likely be many and varied in terms of their relevance, accuracy, and usefulness, so the first key action is to collect and review what is readily available. This may include emergency operations plans, comprehensive plans, natural resource plans, or hazard-specific plans (e.g., floodplain management plans, community wildfire protection plans) if available, as well as any other technical reports or studies.

Planners should also consult local emergency manager(s) at the municipal and/or county level. These officials will be familiar with local hazard risks and will likely have a wealth of local data, including information on past hazard events and previously completed hazard analyses and risk assessments. They will also have other recommended local contacts such as floodplain administrators, engineers, and building code officials. Another primary source to consult is the State Hazard Mitigation Officer (SHMO) at the Colorado Division of Homeland Security & Emergency Management, who will be familiar with the latest risk assessment resources for Colorado communities and also maintains a statewide risk assessment as part of the *Colorado Natural Hazards Mitigation Plan* (2013).

Many additional existing resources that describe Colorado hazards are described later in this guide in the *hazard profiles in the appendix*. Assessing local hazard risks is a continuous process that should be driven by ongoing coordination among local community staff and stakeholders. While FEMA-approved Local Hazard Mitigation Plans are required to go through regular updates every five years, Colorado communities are encouraged to be proactive with more frequent and routine assessments of local hazards as new information or resources become available.

We Don't Have GIS. How Can We Map our Hazard Risk?

For many communities in Colorado, the use of GIS is either cost-prohibitive or otherwise limited by resources or expertise. There are several options to explore to help communities establish a more robust spatial analysis of hazards without the use of GIS.

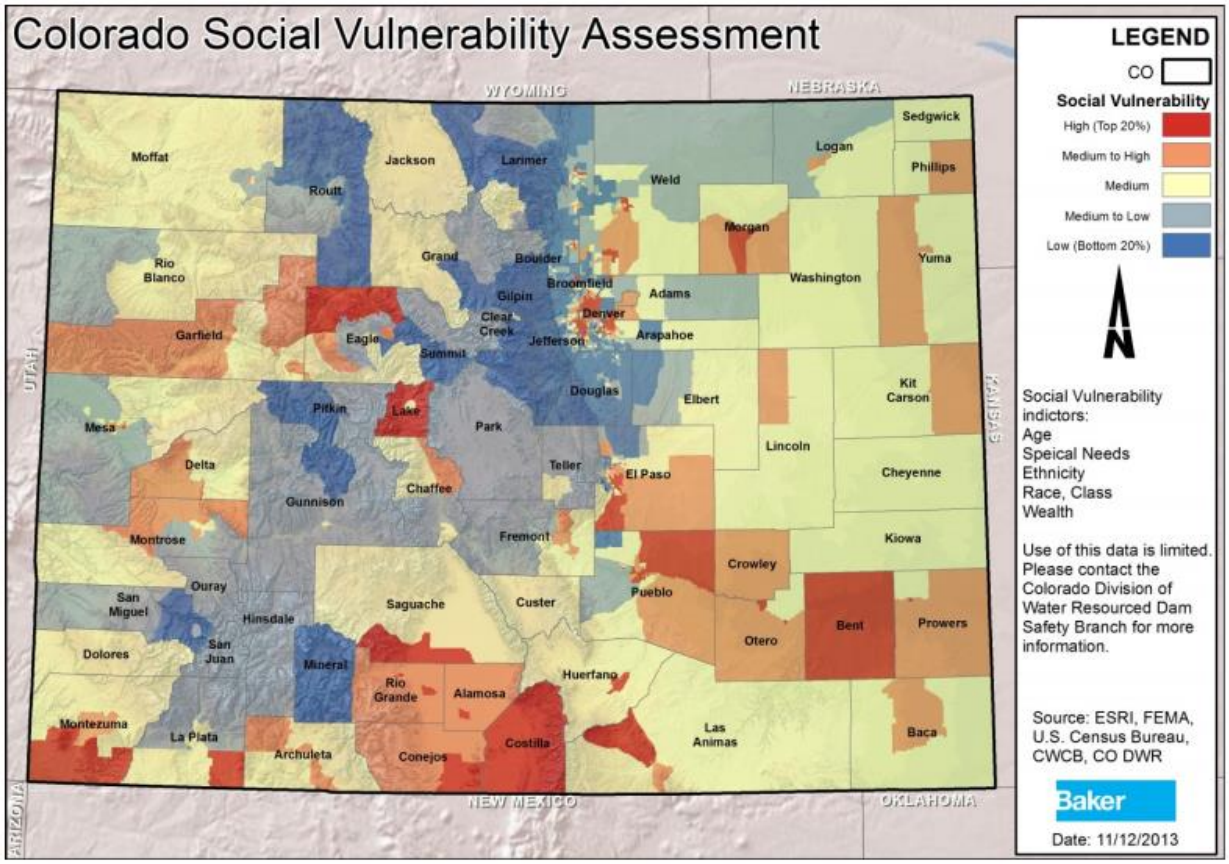
1. ***Contact the state.*** *The Division of Homeland Security and Emergency Management is familiar with available mapping resources, and can point communities in the right direction to locate already existing maps. Contact the local hazard mitigation planning program manager at dhsem.state.co.us/emergency-management/mitigation-recovery*
2. ***Generate free maps online.*** *Link to online resources that provide free data, and many of them can be mapped to the region or even local level depending on the hazard. One example: EPA's MARPLOT, which is the mapping program for the CAMEO software suite, which is used widely to plan for and respond to chemical emergencies. Learn more about the CAMEO software suite at epa.gov/cameo/marplot-software.*
3. ***Establish an IGA for shared GIS services.*** *Working with a neighboring municipality or county that is already equipped with GIS can be an efficient and affordable way to secure accurate hazard mapping analysis. An intergovernmental agreement (IGA) can define the parameters of the work, assign responsibilities, and establish requirements for any monetary contributions.*
4. ***Contact a University.*** *Undergraduate or graduate programs in urban planning or geography may have students or classes interested in assisting with your hazard identification and risk assessment mapping needs.*

ASSESSING VULNERABLE POPULATIONS

Another important element of the risk assessment is identifying any particularly vulnerable populations in the community. The consequences of a disaster event extend well beyond physical damages, often causing or amplifying human suffering, economic loss, and social disruption. This is especially true for those who may not easily access the resources typically offered to assist with individual actions before, during, or after an emergency or disaster event.

These vulnerable populations may include children, the elderly, the physically or mentally disabled, non-English speakers, or the medically or chemically dependent. They may include those in low-to-moderate income households with limited mobility or means to pay for personal protections such as insurance or other risk mitigation activities, and even more limited means to cover disaster losses. They may also include transient populations such as students, homeless, migrant farm workers, and visitors that may be less familiar with local hazards and less prepared to protect themselves during an event.

A variety of data sources are available to help collect and assess the demographic and socioeconomic characteristics of people within the community, particularly statistical data provided by the U.S. Census Bureau at the tract, block group, and block levels. Similar to the way in which data on buildings, infrastructure, and critical facilities are used to assess the potential exposure of physical assets to hazard risks, census data can be used to identify and analyze vulnerable populations. Although methods vary, one widely recognized and replicated approach is the Social Vulnerability Index (SoVI®) developed by the University of South Carolina's Hazards & Vulnerability Research Institute. The index is a comparative metric that synthesizes 30 variables, primarily from census data, that research suggests contribute to increased social vulnerability. An example of a Colorado application of the SoVI® technique is shown below.



Using the Social Vulnerability Index, the Colorado Division of Water Resources Dam Safety Branch conducted a Colorado social vulnerability analysis at the census-tract level. Local socioeconomic and demographic data were used to identify spatial patterns in social vulnerability across the state and have been applied to the hazards identified in the Colorado Natural Hazards Mitigation Plan. The tan and red areas reflect higher social vulnerability, and the yellow and blue areas reflect lower social vulnerability.

Source: Colorado Natural Hazards Mitigation Plan (2013)
dhsem.state.co.us/sites/default/files/2013%20Colorado%20Natural%20Hazards%20Mitigation%20Plan%20-%20Final.pdf

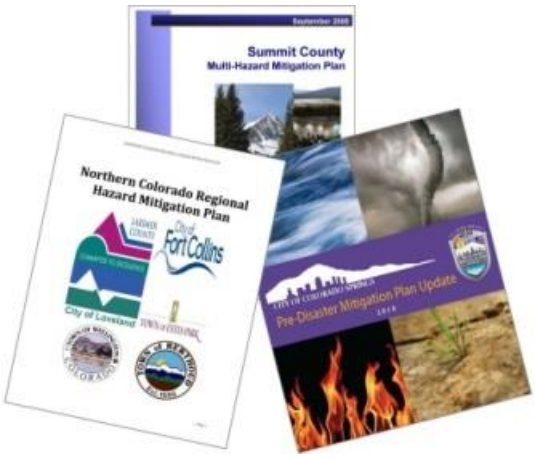
Regardless of the approach, the outcome of assessing vulnerable populations should be the identification of people most susceptible to harm and loss from hazards, as well as information that can be used to reduce vulnerability. In addition to resident locations, facilities that house or support people with functional needs such as medical care facilities, nursing homes, daycares, and others should be considered. Whether through illustrative maps, data tables, or simply a listing of particular locations or segments of the population, the objective is to ensure that specific vulnerabilities are incorporated in the risk assessment and addressed in the mitigation strategy.

LOCAL HAZARD MITIGATION PLANS

What Are Local Hazard Mitigation Plans and Why Are They Important?

Local Hazard Mitigation Plans consolidate all the hazard-related information prepared by the community, including descriptions of potential hazards, risk assessments, identification of vulnerable populations, and mitigation strategies.

As of August 2015, 75 percent of Colorado's 64 counties have an approved local mitigation plan (*Region VIII*, 2015). Because these plans expire after five years, the number of jurisdictions covered by an active plan fluctuates annually. Local Hazard Mitigation Plans are typically completed at the county scale, though some are completed by municipalities (e.g., the cities of Aurora, Boulder, Colorado Springs, Denver, and Westminster) or special districts (e.g., South Metro Fire Protection District). Occasionally, multiple jurisdictions collaborate to prepare regional mitigation plans; examples include plans adopted by the Denver Regional Council of Governments (Adams, Arapahoe, Broomfield, Clear Creek, Douglas, Gilpin counties and the City and County of Denver), and counties in Northeast Colorado (Cheyenne, Kit Carson, Lincoln, Logan, Morgan, Phillips, Sedgwick, Washington, Weld, and Yuma counties). FEMA guidance has become more strict in recent years, requiring greater detail as to the unique vulnerabilities and specific mitigation solutions for each city and town that participates in a plan, which has resulted in more active municipal participation in the creation of county-wide plans and a greater number of single-jurisdiction plans.



Cover images of the Summit County, Northern Colorado, and City of Colorado Springs Local Hazard Mitigation Plans.

Source: Adapted by Clarion Associates

The development of a Local Hazard Mitigation Plan provides an excellent opportunity for intergovernmental collaboration, in which planners, emergency managers, engineers, public works, and other local and regional officials can jointly develop complementary policies and actions. For example, Manitou Springs is currently preparing a new hazard mitigation plan in conjunction with a new comprehensive plan, which will help link land use decision-making and natural hazard risk reduction.

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Action #	Mitigation Action Description	Hazard	Responsible Agency
Objective A: Identify and initiate improvements to public safety, response, and recovery programs to reduce risk and vulnerability.			
A-1	Upgrade aging infrastructure such as transportation, drainage, utilities, and others that could be affected during a major natural disaster.	All Hazards	OEM, CSU, and Engineering
A-2	Evaluate repetitive loss properties and potential solutions to mitigate existing conditions.	Flood	OEM, PPRBD
A-3	Update and maintain the Jimmy Camp Creek and Cottonwood Creek Drainage Basin Planning Studies.	Flood	Engineering
A-4	Evaluate funding alternatives to achieve United States Army Corps of Engineers (USACE) certification of the Templeton Gap Floodway (levee).	Flood, Dam & Levee Failure	Engineering
Objective B: Follow through with and leverage existing organizations, programs, and procedures to implement the PDM Program.			
B-1	Continue to expand the capabilities and participation of the Emergency Management Committee and Volunteer Committee.	All Hazards	OEM
B-2	Develop a strategy to integrate the PDM plan with the City's strategic plan and other long-term planning documents.	All Hazards	Planning
B-3	Complete GIS and other automated inventories for stormwater, problem drainage areas, DFIRM and other City assets.	Flood	Engineering
B-4	Coordinate with Colorado Springs Utilities to review their current water conservation and drought programs.	Drought	CSU and OEM

This excerpt from the City of Colorado Springs mitigation strategy summarizes mitigation actions by hazard and responsible agency. Additional details are provided in a plan appendix.

Source: City of Colorado Springs. Pre-Disaster Mitigation Plan Update, Chapter 5, 2010
dhsem.state.co.us/sites/default/files/City%20of%20Colorado%20Springs%2010.2010.pdf

Is Our Jurisdiction Covered by a FEMA-Approved Local Hazard Mitigation Plan?

Information on jurisdictions currently covered by a Local Hazard Mitigation Plan can be accessed in several ways. To find out which jurisdictions are covered by a FEMA-approved Local Hazard Mitigation Plan:

- **Contact your local emergency manager.**

  A list of Colorado's emergency managers, by county, is provided here: dhsem.state.co.us/emergency-management/local-emergency-managers. Local emergency managers are most familiar with the current status of any mitigation planning efforts (either completed or underway) and are knowledgeable on how best to become involved in a future mitigation planning process.

- **Visit the State of Colorado's Division of Homeland Security & Emergency Management webpage on Regional and Local Hazard Mitigation Plans.**

  dhsem.state.co.us/emergency-management/mitigation-recovery/mitigation/regional-local-hazard-mitigation-plans. This site lists the status of FEMA-approved mitigation plans in the state. The site also provides quick links to each mitigation plan, if available electronically.

- **Contact your regional or statewide contacts for mitigation programs.**

  Visit dhsem.state.co.us/emergency-management/mitigation-recovery/mitigation for access to the State Hazard Mitigation Officer, the Mitigation Planning Program Manager, and regional contacts for specific areas across the state. These resources have access to up-to-date status reports on a particular jurisdiction's FEMA-approved mitigation plan.

WHAT HAZARDS MAY AFFECT MY COMMUNITY?

This guide describes the individual hazards that may affect communities in Colorado. Each hazard is described in further detail in the appendix and includes the following elements:

- **A description of the hazard.** The description of each hazard includes a definition and general background information.
- **A description of the hazard's presence in Colorado.** This includes information on the history and severity of the hazard in Colorado communities.
- **A summary of related hazards.** Many of the hazards described in this guide can cause other hazards to occur, or can be exacerbated by the presence of other hazards.
- **Assessing the risk for certain hazards.** For some of the hazards, there are unique challenges associated with preparing risk assessments. This subsection addresses those challenges by presenting alternative approaches and methodologies.
- **Appropriate data sources for establishing a basis for a risk assessment.** Colorado communities have access to several sources of data for identifying hazard areas and determining vulnerability to each hazard. This component includes primary resources for preparing risk assessments. Some of the data sources are applicable to multiple hazards.
- **Applicable planning tools and strategies.** References to applicable tools and strategies that are profiled in the Chapter 4, *Planning Tools and Strategies*.

SUMMARY OF COMMON HAZARD DATA SOURCES

The table below summarizes the resources mentioned throughout this chapter that are applicable to multiple hazards.

	Avalanche	Drought	Earthquake	Flood	Hazardous Materials	Extreme Heat	Landslide / Rockfall	Soil Hazards	Wildfire	Wind	Winter Storm
Colorado Climate Center		✓		✓						✓	✓
Colorado Geological Survey			✓				✓	✓			
Colorado Natural Hazards Mitigation Plan	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Department of Homeland Security – Ready.gov	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Federal Emergency Management Agency			✓	✓		✓			✓	✓	
National Centers for Environmental Information		✓								✓	✓
National Weather Service						✓				✓	✓
United States Geological Survey			✓				✓				

COLORADO CLIMATE CENTER

The Colorado Climate Center is housed in the Department of Atmospheric Science at Colorado State University. It is a source of useful information on natural hazards in Colorado and provides an excellent resource to learn about climate in Colorado. ccc.atmos.colostate.edu

COLORADO GEOLOGICAL SURVEY

The Colorado Geological Survey is the primary State agency for providing information and maps on geologic hazards such as landslides, mud/debris flows, rockfall, and soil hazards. coloradogeologicalsurvey.org

COLORADO HAZARD MAPPING & RISK MAP PORTAL

The Colorado Water Conservation Board (CWCB) hosts this website as a portal to view information for the Colorado Hazard Mapping Program and, in the future, Colorado's Risk MAP Program. The Colorado Hazard Mapping Program provides a mitigation and land use framework for areas likely to be impacted by flooding, erosion, and debris flow. The Risk MAP Program delivers quality data to increase public awareness and lead to actions that reduce risk to life and property. The interactive map component of the website allows the user to click on area-specific activities and projects. coloradohazardmapping.com

COLORADO NATURAL HAZARDS MITIGATION PLAN

The *Colorado Natural Hazards Mitigation Plan* is the State's FEMA-approved plan that serves as a foundation for the State's program to reduce risks to people, property, and infrastructure from natural hazards. The Plan is administered and updated by the Colorado Division of Homeland Security and Emergency Management. dhsem.state.co.us/emergency-management/mitigation-recovery/mitigation/state-colorado-natural-hazards-mitigation-plan

DEPARTMENT OF HOMELAND SECURITY – READY CAMPAIGN

The Department of Homeland Security (DHS) launched the *Ready* in February 2003 as a national public service advertising campaign to provide education related to preparation and response to natural and man-made disasters. Although the focus of the site is on preparedness and response, the site provides ample information about the types of hazards that may affect communities around the country. ready.gov

FEDERAL EMERGENCY MANAGEMENT AGENCY

FEMA provides information related to hazard mitigation planning, including identifying hazards and preparing a risk assessment. fema.gov/hazard-mitigation-planning-resources

NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION

The National Centers for Environmental Information (NCEI) was formed in 2015 as a merger of NOAA's three existing National Data Centers: the National Climatic Data Center (NCDC), the National Geophysical Data Center, and the National Oceanographic Data Center. NCEI is where storm event data previously collected by NCDC is now provided. This is a rich data source for climate and historical weather information. This site contains historical event data on a host of natural hazards. ncdc.noaa.gov/stormevents

NATIONAL WEATHER SERVICE

The National Weather Service (NWS) is the official provider of U.S. weather, marine, fire, and aviation forecasts. The NWS issues warnings and provides data, products, forecasts, and information related to meteorology. The NWS is a component of the National Oceanic and Atmospheric Administration (NOAA). The NWS maintains a glossary of information on more than 2,000 terms, phrases, and abbreviations used by the NWS. weather.gov/glossary

UNITED STATES GEOLOGICAL SURVEY

The United States Geological Survey (USGS) is the primary federal reference for national data regarding landslide and earthquake hazards. usgs.gov/natural_hazards