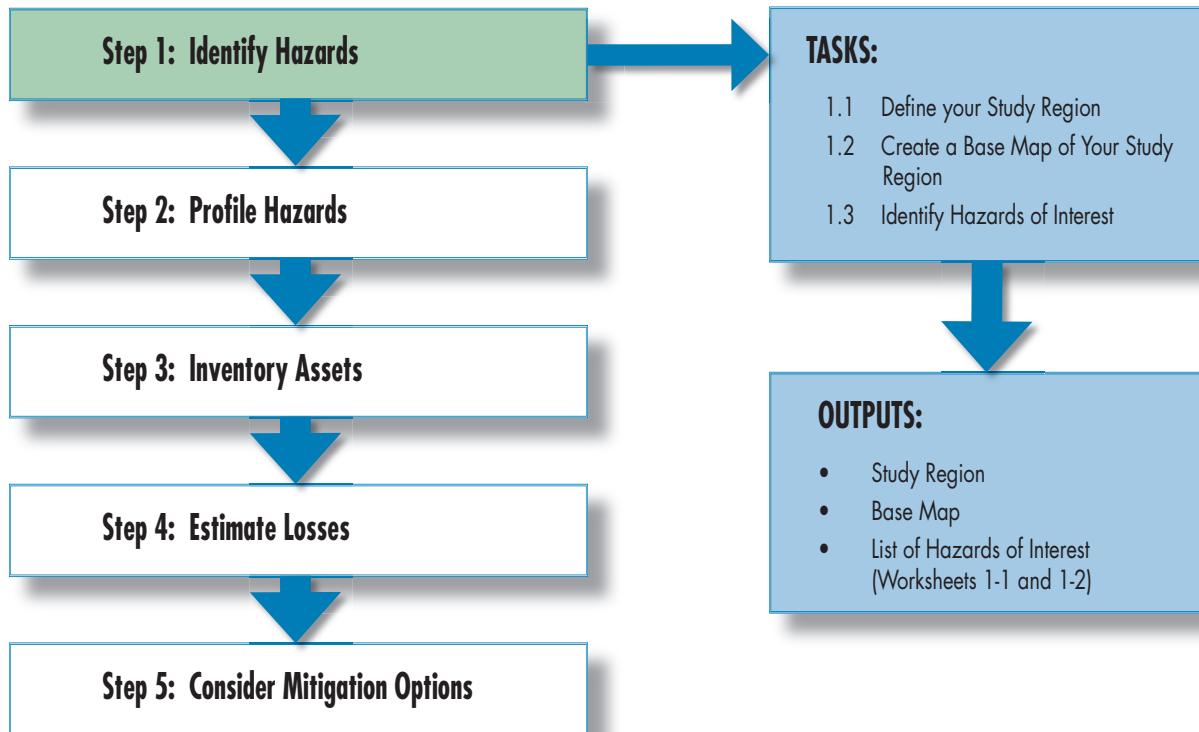


# STEP 1: IDENTIFY HAZARDS

# 1

## OVERVIEW

The first step in the risk assessment process is to identify hazards that are of interest in your area. This will help you focus on the most important hazards facing your community or region.



**Figure 1-1 Step 1 tasks and outputs**

Your hazards of interest will be influenced by the extent of your study region, which will be established as part of Task 1.1. Task 1.2 involves developing your study region base map, which includes important features for your community. Task 1.3 involves listing the potential hazards of interest for your study region. This step discusses each of these tasks. Examples of how pilot project communities addressed this step are also provided. Worksheets 1-1 and 1-2 at the end of this step can help your risk assessment team identify and document hazards on which to focus your risk assessment. The tasks and outputs for Step 1 are shown in Figure 1-1.

### Define Your Study Region (Task 1.1)

Before identifying the principal hazards in your area, you must first define the boundaries of your study region. Defining your study region means identifying

**DEFINITION**

FEMA defines a hazard as “a source of potential danger or adverse condition.” Natural phenomena like earthquakes and floods represent hazards when they have a potential to harm people or property. When a hazard occurs in a particular location, it is referred to as a hazard event.



The HAZUS-MH Setup DVD-ROM is required to create a study region. This DVD-ROM comes with the software and includes HAZUS-MH data for your area.

the specific geographic area that your risk assessment will address. Your study region may encompass a single jurisdiction or may focus on a multi-

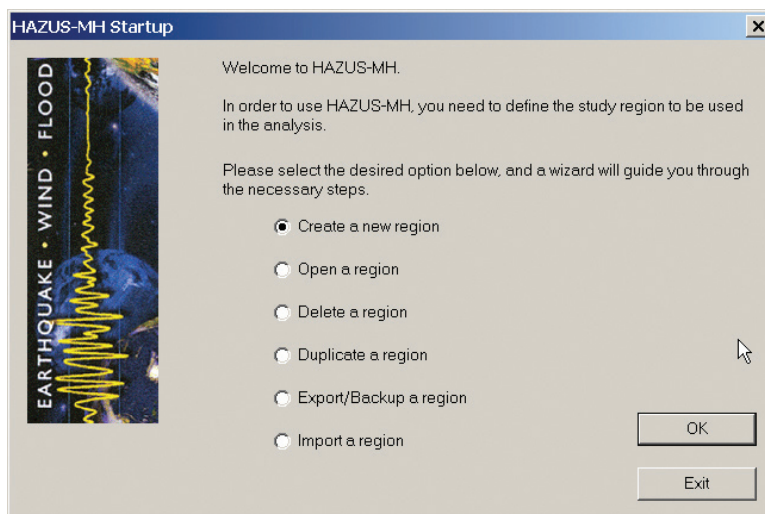
jurisdictional geographic area. Considerations for both single- and multi-jurisdictional study regions are described below.

1. **Single-jurisdiction boundaries.** For this approach, you will define the area within your jurisdictional boundaries (e.g., city or town limits) as your study region. This is appropriate in cases where the organization of emergency management functions and the local data available focus on one community or a single jurisdictional area.
2. **Multi-jurisdictional boundaries.** Where counties, cities, towns, and communities implement multi-jurisdictional mitigation planning efforts and risk assessments by pooling resources, the study region could be defined by the geographic boundaries of the participating jurisdictions. This approach should be considered when counties, cities, or towns are in close proximity; when emergency planning is coordinated across jurisdictions; and when a region faces a common or shared hazard threat. For example, an area such as a watershed could be defined as a study region, to support analysis of hazard impacts on an area managed by multiple organizations to protect specific, natural resources.

## Start HAZUS-MH

To create a study region in HAZUS-MH, first launch HAZUS-MH on your computer by double-clicking the HAZUS-MH icon. The startup menu will be

the first dialogue box displayed when you run HAZUS-MH for the first time. Figure 1-2 displays the first dialogue box that appears when HAZUS-MH is launched. Options for beginning will appear as choices. Select “Create a new region,” and click on the “OK” button.



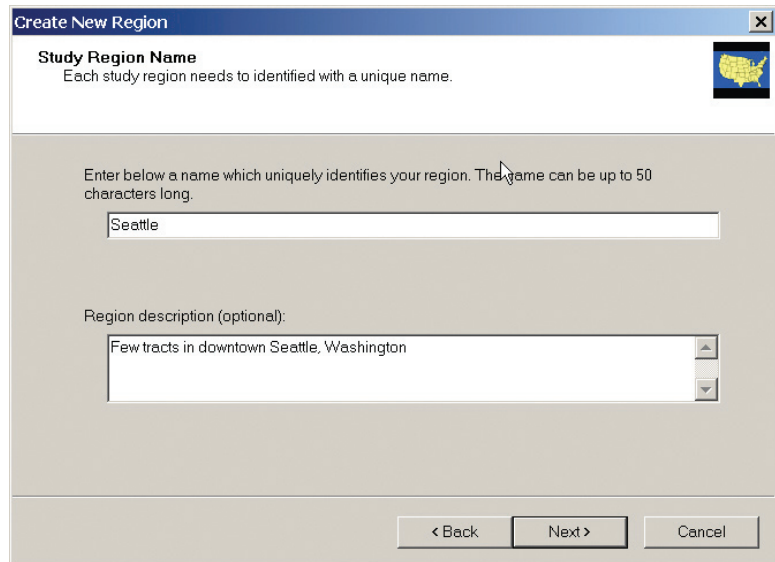
**Figure 1-2** HAZUS-MH startup menu

## Create a Study Region

After the “Create a new region” function has been activated, the Setup Wizard will guide you through the steps required to

create a study region. Figure 1-3 shows the first menu that will be displayed; this menu allows you to enter a name and a description for your study region.

Figure 1-4 shows the next menu, which requests that you select the types of hazards to be analyzed. This menu represents the current hazard models included in HAZUS-MH. It is recommended that you select all of the hazards when setting up your study region. Once you define your study region and select hazards, you cannot add more hazards as you progress. If you want to drop hazards later in the process, you can simply stop using the menus for those hazards in HAZUS-MH. It should be pointed out that your selection of hazards in HAZUS-MH is not related to Task 1.3, where you will identify all of the hazards of interest that threaten your study region.




**Figure 1-3 Entering the study region name**

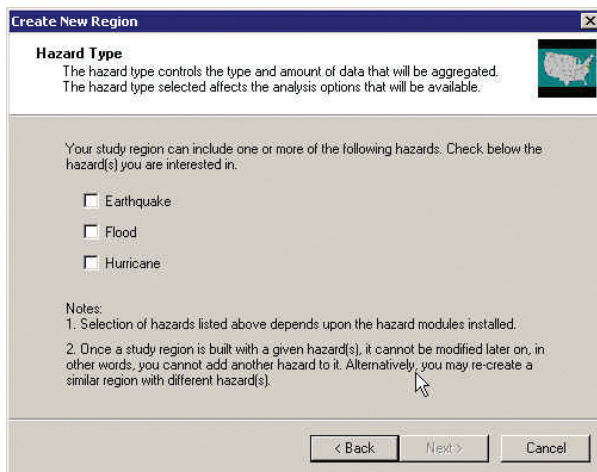
## Select a Level of Aggregation

The next activity is to select an aggregation level, as shown in Figure 1-5. You can select the state, county, or Census tract level. HAZUS-MH allows aggregation at different levels, the smallest of which is generally the Census tract for the

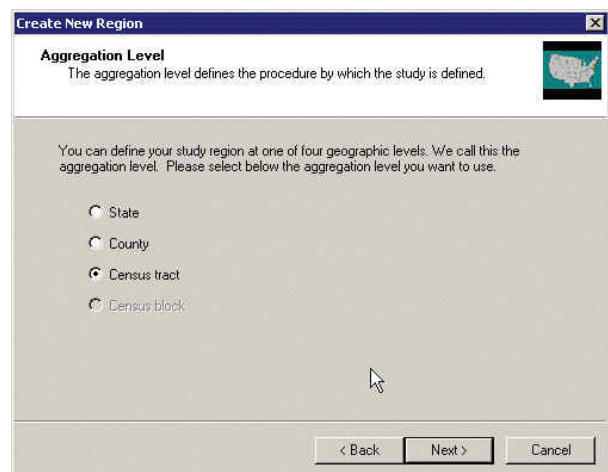
NOTE



It is important that adequate disk space be available before you start the aggregation process. The minimum recommended disk space is 10 GB, which will provide the capacity for three scenarios for a study region.



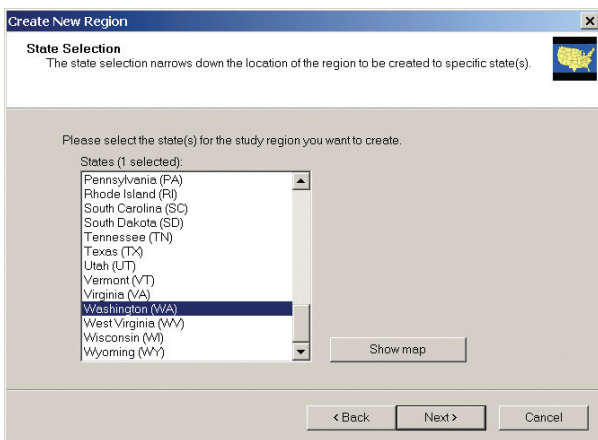
**Figure 1-4 Selecting hazards**



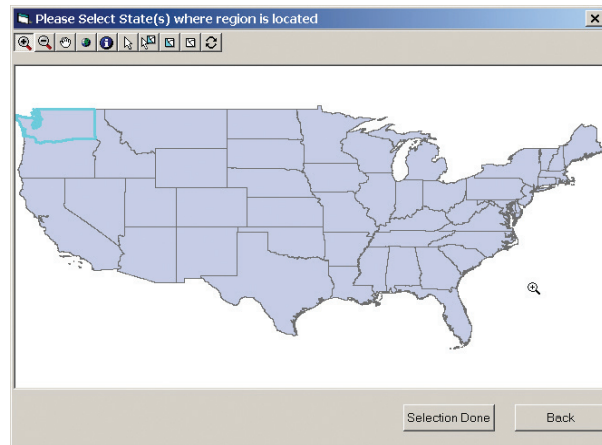
**Figure 1-5 Aggregation level menu**

earthquake and hurricane modules, and the census block for the flood module. The aggregation level is either equal to or smaller than the study region. A smaller aggregation level provides more detail. The aggregation level represents the scale at which population and general building stock values will be evaluated to estimate losses for your risk assessment study (Step 4).

Figure 1-6 shows the menu list for selecting the state or states included in your study region. Only one state should be selected unless your study region crosses state lines. To select a state, simply click on the state's name in the pull-down menu. To select multiple states, hold down the <Ctrl> key and click on the names of all the states to be included. In Figure 1-6, the user has selected the State of Washington. When you have finished selecting the state or states, click on the "Next" button.



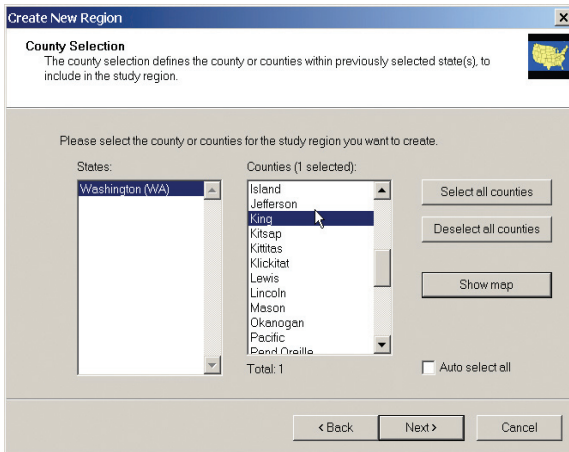
**Figure 1-6** State selection list



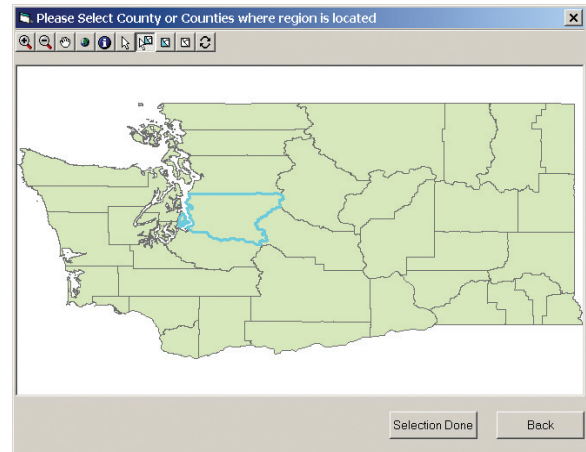
**Figure 1-7** State selection map

Alternatively, you can select the state or states in your study region by clicking on the "Show map" button and then on the applicable areas on the map shown in Figure 1-7. To select multiple states, hold down the <Ctrl> key while clicking on the desired states. Click on the "Selection Done" button when you are finished to move to the next activity.

After the state or states have been chosen, you will be prompted to select the relevant counties within each state included in the study region by clicking on the names of those counties in the menu, as shown in Figure 1-8. You can select multiple counties by holding down the <Ctrl> key and clicking on the names of the desired counties. When you have finished selecting the counties, click on the "Next" button. Alternatively, you can click on the "Show map" button and choose the counties from a map of the state as shown in Figure 1-9. Click on the "Selection Done" button when you are finished to move to the next activity.



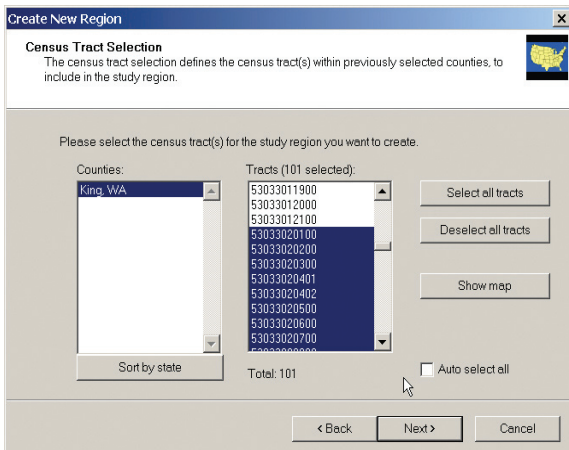
**Figure 1-8 County selection list**



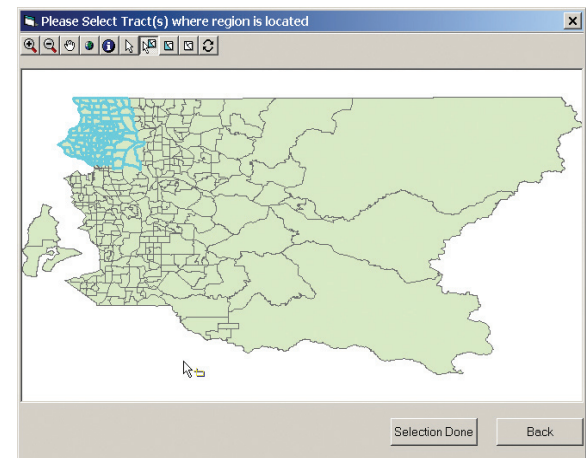
**Figure 1-9 County selection map**

After a county or counties have been selected, a list of all of the Census tracts in each selected county will appear (see Figure 1-10). Alternatively, you can select the Census tracts that define your study region from the list of tracts or from a map (see Figure 1-11). Census tracts selected for the study region do not have to be sequentially numbered or adjoining. The map is useful when you know the areas of interest, but not all of the specific Census tract numbers of interest.

When you have selected the Census tracts for your study region, click on the “Next” or “Selection Done” button, as applicable. A processing status window will appear and will indicate the progress of aggregation. At this point, you will be prompted to load a DVD-ROM containing the HAZUS-MH provided inventory data for your state(s) of interest. The DVD-ROM is provided with the HAZUS-MH software.



**Figure 1-10 Census tract selection list**



**Figure 1-11 Census tract selection map**

**Congratulations! You have now defined your study region and can proceed to create your base map.**

FEMA HAZUS-MH courses can help you learn more about using GIS to support HAZUS-MH. Additional information on HAZUS-MH training opportunities can be found at:

[http://www.fema.gov/hazus/tr\\_main.shtm](http://www.fema.gov/hazus/tr_main.shtm)

## Create a Base Map of Your Study Region (Task 1.2)

Once your study region is defined, you will use HAZUS-MH to create a base map that graphically presents the defined area. The base map should be shared with your risk assessment team to support hazard identification and to provide a common frame of reference throughout the risk assessment. The base map also is useful for describing your study region to stakeholders and for focusing the risk assessment team on identifying hazards. Base map layers might include the study region boundary, jurisdictional boundaries, and geographic frames of reference, including roads, water bodies, hospitals, and schools.

### Base Map Using HAZUS-MH Provided Data

HAZUS-MH will include maps with features that are important to your study region. You may want to create several map layers showing different features for your intended audiences. You can create a base map showing HAZUS-MH provided data such as demographic or economic information derived from the most recent Census. You can also show buildings, roads, rivers, coastlines, and place names. The data layer functions in HAZUS-MH will help you map and view HAZUS-MH provided data. Base maps always should include a north arrow, legend, title, date, and scale.

### Base Maps Using Local Data

Local data can be added to your HAZUS-MH base map to supplement provided data, establish location and main characteristics of key natural and physical inventories, and reflect features important to your community. HAZUS-MH runs from Environmental Systems Research Institute Inc.'s (ESRI's) ArcGIS platform. Before local GIS data are imported into HAZUS-MH, they must be in a format compatible with ArcGIS. The GIS data also must be projected in the correct coordinate system. To be compatible with HAZUS-MH, data often must be converted and projected, as described below.

**Data Conversion.** Local source data selected for use in the HAZUS-MH base map may be in hard copy or electronic format. Hard copy maps need to be digitized and converted to the ArcGIS format. A digitizing tablet will be required for this activity. For more information on the digitizing process, consult your tablet's instruction manual. These electronic data will include

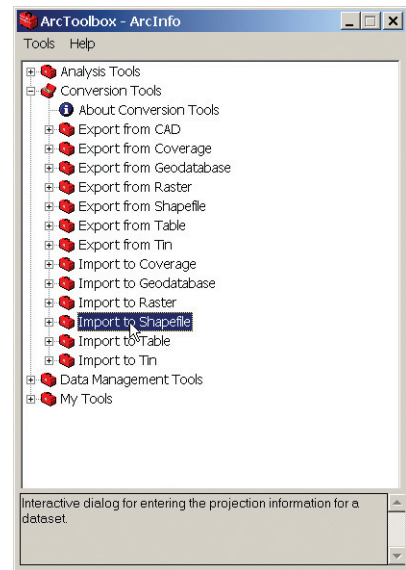
electronic maps and data tables. Electronic data may have been developed using a number of software packages such as MapInfo, Intergraph, and AutoCAD. If you have a GIS layer



**Digitizer:** A device used to convert hard copy maps into an electronic format. The digitizer consists of an electronic tablet that is overlain with the paper map. A puck is then used to trace the map features and electronic data are created.

that needs to be converted into the ArcGIS format, follow the directions below.

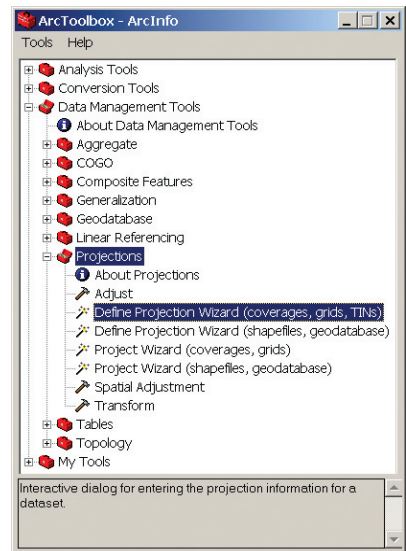
1. Open the ArcGIS folder and select the ArcToolbox icon.
2. Select “Conversion Tools” and then “Import to Shapefile” (see Figure 1-12).
3. Select the option that corresponds to your data. For example, if you are converting data from MapInfo to ArcGIS, you would select the “MapInfo (MIF) to Shapefile” option.
4. Select your source data file. For the example above, you would select the MapInfo file.
5. Select a prompted menu and choose the destination folder. This is the location where the new shapefile will be created. The folder’s name and location are not constrained by HAZUS-MH. You should develop a folder system that is clear to you and others on your team who may need to access this information.
6. Select “OK” in the menu box.



**Figure 1-12 ArcToolbox data conversion utility**

**Data Projection.** All data used by HAZUS-MH must be in the same projection, or coordinate system. Your local base map data needs to be in the Latitude/ Longitude (Lat/Long) coordinate system, (WGS84) datum, and in decimal degrees. If your data are not in the correct projection, follow the directions below.

1. Open the ArcGIS folder and select the ArcToolbox icon.
2. Select “Projections” and then “Define Projection Wizard (overlaps/grids/TINs)” (see Figure 1-13).
3. Select your shapefile by browsing to its location.
4. Select “Next,” and then select the coordinate system in which your shapefile resides. If you are unsure about your current data projection, view the metadata file. Typically, this file is named after your shapefile and has a “.met,” “.html,” or “.xml” extension. For example, if you had a soil map called “soils.shp,” the metadata file would be called “soils.html.” The metadata file should show the projection used.
5. Select “Next” and then “Finish.” You have now assigned the current projection to your data set.
6. Select “Projections” and then “Project Wizard (shapefiles).”



**Figure 1-13 ArcToolbox data projection utility**

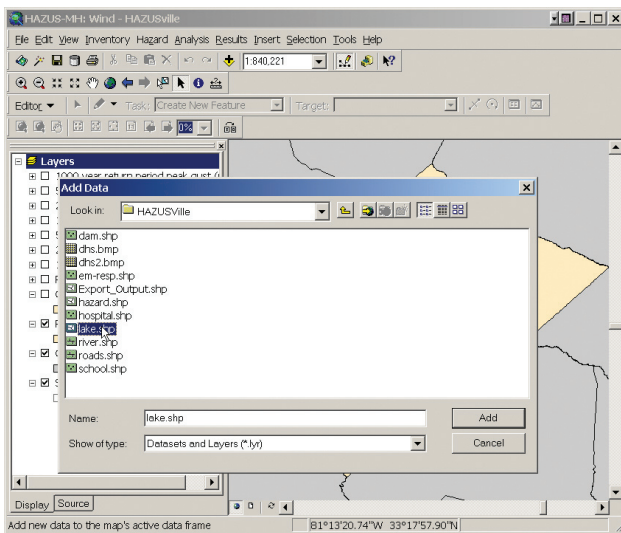
7. Select your shapefile by browsing to its location.
8. Select “Next,” and then browse to the folder where the new shapefile will be created.
9. Select “Next,” and then select the Lat/Long projection.
10. Select “OK” and then “Next” and your correctly projected shapefile will be created.

## Display Local Data on Your Base Map

You can now bring your local base map data directly into your HAZUS-MH study region. Select “Add Layer” under “File” on the HAZUS-MH main menu, and browse to your local data (see Figure 1-14). Your data can be displayed on the base map using the same standard symbols that you use for other mapping purposes. All of the ArcGIS functionality is preserved when you

bring the data into HAZUS-MH.

After all of the layers are visible and symbolized logically, select “View” from the main menu, then “Layout View.” A base map containing your study region will be generated with a title, description, legend, scale, date, and the HAZUS-MH logo. This layout can be used “as-is” or can be further developed and edited to complement other maps you create. To save your base map, select “File” from the main menu, then “Save.”



**Figure 1-14** Adding local base map data

**■** *Congratulations! You have now created your base map and can proceed to identify hazards of interest.*

## Identify Hazards of Interest (Task 1.3)

Task 1.3 will help you to identify hazards of interest in your study region and to focus on further risk assessment efforts. This initial list of hazards of interest is intended to ensure the risk assessment team has considered the range of likely hazards that could impact your study region. This list will typically be developed based on community input, the professional judgment of the team, and local knowledge of past hazard events.

This list can be developed by collecting data, having meetings with knowledgeable personnel, and using your own information regarding hazards



that are, or might become, priority concerns in your area. Your initial list of hazards will be used to document all of the hazards considered; those dropped from consideration in Step 1; and those carried forward for further evaluation under Step 2, Profile Hazards.

This section presents an overview of various natural hazards that could occur in your study region. This section also discusses how you can manage your hazard data and provides a foundation for further study in Step 2.

## **Potential Hazards of Interest and HAZUS-MH**

The general perception of natural hazards is that earthquakes occur in California, floods in many riverine and coastal locations, tornadoes in the Midwest, and hurricanes along the Atlantic and Gulf coasts. Although there is some truth to this perception as it relates to the highest probabilities for each hazard, hazard maps show that the entire United States is vulnerable to one or more of these primary natural hazards. Earthquakes are predominant in the West, but also threaten specific regions in the Midwest, Northeast, and Southeast. Riverine floods occur along rivers, largely but not exclusively in the Midwest, and coastal flooding is associated with storm surges caused by high winds. Flash floods caused by sudden, intense rainstorms may occur anywhere. Extreme winds are regional (e.g., hurricanes along the Atlantic and Gulf coasts, the Caribbean, and the South Pacific; tornadoes typically in the Midwest; and downslope winds adjoining mountain ranges), but high winds can also occur anywhere.

Hazards that may affect your study region are discussed below. The hazards include those that can be evaluated using HAZUS-MH and those that can be evaluated with HAZUS-MH support. Hazards that can be evaluated using HAZUS-MH are earthquakes, floods (coastal and riverine), and hurricanes; therefore, these three hazards are presented first. Step 2 provides a detailed discussion and sources of information on the hazards.



### **Earthquakes**

The surface of the earth consists of solid masses, called tectonic plates, that float on a liquid core. The areas where separate plates meet each other are called faults. An earthquake is a sudden movement of the earth's crust caused by the abrupt release of strain that has accumulated over a long period of time. Records show that some seismic zones in the United States experience moderate to major earthquakes approximately every 50 to 70 years, while other areas have recurrence intervals for the same size earthquake of about 200 to 400 years. Records also show that building inventories in 39 states

are vulnerable to earthquake damage. Most of the well-known areas of strain, or faults, are located in the Western United States, where most recent earthquakes have occurred. However, the Eastern and Central United States are also vulnerable to devastating earthquakes. Earthquake risk is related to the following factors: a) ground motion; b) fault rupture under or near a building, often occurring in buildings located close to faults; c) reduction of the soil bearing capacity under or near a building; d) earthquake-induced landslides near a building; and e) earthquake-induced waves in bodies of water near a building (tsunami on the ocean and seismic seiche on lakes).

Earthquakes are low probability, high-consequence events. Although they may occur only once in the lifetime of a particular asset, they can have devastating effects. Moderate earthquakes occur more frequently than major earthquakes. Nevertheless, a moderate earthquake can cause serious damage to unreinforced buildings (i.e., unreinforced masonry buildings, buildings constructed without seismic requirements, or buildings designed to obsolete standards), building contents, and non-structural systems, and can cause serious disruption in building operations. Major earthquakes can cause catastrophic damage, including collapse and massive loss of life.

Earthquake fault rupture causes ground motion over a wide area. This ground motion acts as a powerful force on the building inventory. The most drastic effects occur chiefly near the causative fault where there is often appreciable ground displacement as well as strong ground shaking. As the shaking propagates to the surface, it may be amplified depending on the intensity of shaking, topography, nature of the rock, and, above all, by the surface soil type (earthquake damage tends to be more severe in areas of soft soils) and depth. Impact to the building can depend on the type of earthquake waves (i.e., whether they are quick and abrupt or slow and rolling).

Structures subject to earthquake risk must be designed for higher force resistance if they are located on poor soils. Most structures are principally designed to resist the force of gravity, but resistance to earthquake forces requires specialized earthquake engineering. Horizontal earthquake forces cause rapid movement of the foundation and displacement of upper levels of the structure. When inadequately designed to resist or accommodate these earthquake forces, structures fail, leading to serious structural damage, and, in the worst case, total collapse.

Moderate and even very large earthquakes are inevitable, although very infrequent, in areas of normally low seismic activity. Consequently, in these regions buildings are seldom designed to deal with an earthquake threat; therefore, they are extremely vulnerable. In many parts of the United States, the greatest earthquake risk is associated with buildings that were designed and constructed before the use of modern building codes. For many parts of the United States, this includes structures built as recently as the early 1990s. In other

places, such as California, the earthquake threat is quite familiar and adequate building codes have taken this threat into consideration since the mid-1970s.

An earthquake is a primary hazard included in HAZUS-MH. In addition, hazard event data are included with the software. You can determine earthquake risk by using the data provided in HAZUS-MH.




## Floods (Coastal and Riverine)

Flooding is a common hazard in the United States, affecting over 20,000 local jurisdictions. Several evaluations have estimated that 10 percent of the Nation's land area is subjected to flooding. Some communities have very little land that is identified as exposed to flooding, although others lie entirely within the floodplain. Floods are fairly specific and predictable in their location, and effective design against floods is less a matter of design concept than of siting. A building can be located in such a way that floods will never be a problem; however, our floodplains are full of existing buildings.

Flooding is a natural process that may occur in a variety of forms: long-duration flooding along rivers that drain large watersheds; flash floods that send a devastating wall of water down a mountain canyon; and coastal flooding that accompanies high tides and on-shore winds, hurricanes, and Nor'easters. Flooding is only considered a problem when human development is located in flood-prone areas. Problems can result, exposing people to dangerous situations and property to damage, but also disrupting the natural function of floodplains and redirecting surface flows onto lands that are not normally subject to flooding.

The flood hazard can be characterized by a relationship between the depth of flooding and the annual chance of inundation to that depth. Depth, duration, and velocity of water are the primary factors contributing to flood losses. Other impacts associated with flooding that contribute to losses include channel erosion and migration, sediment deposition, bridge scour, and the impact of flood-borne debris.

Flood frequency studies define the flood hazard in terms of the chance that a certain magnitude of flooding is exceeded in any given year. What is commonly called the 100-year flood is not a flood that occurs every 100 years, but is a flood that has a 1 percent chance of occurring in any year. Flood magnitude is usually measured as discharge value, flood



Manmade hazards are an increasing concern. FEMA has developed the Risk Management Series to help communities assess and address these hazards. Documents are available at:

<http://www.fema.gov/fima/rmsp.shtm>

elevation, or depth. For example, the 100-year flood elevation is the elevation at the point of interest that has a 1 percent annual chance of being exceeded by floodwaters. Using the flood hazard frequency convention, flood hazard is defined by a relation between depth of flooding and annual chance of inundation greater than that depth. This relation is called a depth-frequency curve.

Coastal flooding refers to the inundation of land areas along the oceanic coast caused by sea waters over and above normal tidal action. Coastal flooding is experienced along the Atlantic, Gulf, and Pacific coasts, and many larger lakes, including the Great Lakes. Coastal flooding is influenced by storm surges associated with tropical cyclonic weather systems (hurricanes, tropical storms, tropical depressions, typhoons), extratropical systems (Nor'easters), and tsunamis (surges induced by seismic activity). Coastal flooding also is generally characterized by wind-driven waves. Wind-driven waves affect reaches along the Great Lakes shorelines, where wind blowing across the broad expanses of water generate wind-driven waves that can rival those experienced along oceanic coastal shorelines. Some Great Lakes shorelines experience coastal erosion, in part associated with fluctuations in water levels.

Riverine flooding is due to the accumulation of runoff from rainfall or snowmelt such that the volume of flow exceeds the capacity of waterway channels and therefore, water spreads out over the adjacent land. Riverine flooding flows downstream under the force of gravity. Inundation, duration, and velocity are functions of many factors, including watershed size and slope, degree of upstream development, soil types, nature and extent of vegetation, steepness of the topography, and characteristics of the storm (or depth of snowpack and rapidity of melting).

Riverine and coastal flood hazards are primary hazards included in HAZUS-MH. You can determine riverine and coastal flood hazards risk by using the data provided in HAZUS-MH.



A hurricane is a severe tropical storm that forms in the southern Atlantic Ocean, Caribbean Sea, Gulf of Mexico, or eastern Pacific Ocean under the following conditions: warm, tropical oceans; moist air; and light winds. If the right conditions last long enough, a hurricane can result and can produce violent winds, enormous waves, torrential rains, and floods. On average, six Atlantic hurricanes occur each year. When hurricanes move onto land, associated rain, strong winds, and large waves can damage buildings, trees, and cars.

Hurricanes are grouped into five categories according to their prevailing wind speeds, with Category 5 hurricane winds exceeding 155 miles per hour (mph) and having a minimum sustained speed of 74 mph. High sustained winds may cause extensive structural damage to buildings and houses. These winds can also roll cars, blow over trees, and erode beaches (both by blowing sand and by blowing waves against the beach).

Hurricanes can trigger storm surges, tornadoes, and extensive and damaging inland flooding. While storm surge is always a potential threat, more people have died from inland flooding associated with hurricanes in the last 30 years. Intense rainfall, as much as 10 to 12 inches in 48 hours, is not directly related to the wind speed of tropical storms. In fact, some of the greatest rainfall amounts occur from weaker storms that drift slowly or stall over an area. Inland flooding can be a major threat to communities hundreds of miles from the coast as intense rain falls from these huge tropical air masses.

In terms of wind interaction with buildings, hurricanes create both positive and negative (i.e., suction) pressures. A particular building must have sufficient strength to resist the applied wind loads in order to prevent wind-induced building failure or damage. The magnitude of the pressure is a function of building exposure. Building exposure is based on characteristics of the ground roughness and surface irregularities in the vicinity of a building that influence the wind loading. Exposure can be explained in terms of the roughest terrain and the smoothest. Rough terrain includes urban, suburban, and wooded areas. Smooth terrain includes flat open terrain with scattered obstructions and areas adjacent to water surfaces in hurricane-prone areas. The smoother the terrain, the greater the wind loads. Important factors regarding building vulnerability include:

- Topography (abrupt changes in topography)
- Building height (relationship between the wind speed and the height of the building above the ground)
- Internal pressure (wind can cause either an increase in the pressure within the building, known as positive pressure, or it can cause a decrease in pressure, known as negative pressure)
- Aerodynamic pressures (interactions between the wind and the building affecting primarily the roof corners)

Hurricanes are a primary hazard included in HAZUS-MH. Historic event data are included with the software. You can determine hurricane hazards risk by using the data provided in HAZUS-MH.



## Landslides

Landslides are rock, earth, or debris flows on slopes due to gravity. They can occur on any terrain, given the right conditions of soil, moisture, and the angle of slope. Integral to the natural process of the earth's surface geology, landslides serve to redistribute soil and sediments in a process that can include abrupt collapses or slow gradual slides. Landslides are a widespread geologic hazard and result in about \$2 billion in damages and more than 25 fatalities annually. They pose a serious threat to highways and buildings and commonly occur in association with other major natural disasters such as earthquakes and floods. Landslides can be triggered by other hazards, but also can take place independently.

Landslides can occur in developed or undeveloped areas, and in any area where the terrain was altered for roads, houses, utilities, buildings, or even for backyard lawns. Factors affecting landslides can be geophysical or manmade. The resulting slurry of rock and mud may pick up trees, houses, and cars, thus blocking bridges and tributaries and causing flooding along its path. Any area composed of weak or fractured materials resting on a steep slope can, and will likely, experience landslides. Landslides occur in all 50 states with varying frequency and more than half of the states have rates sufficient to classify landslides as a significant natural hazard.

As discussed in Step 4, HAZUS-MH can support your exposure assessment of the landslide hazard.



## Tornadoes

Tornadoes are one of nature's most violent storms. A tornado can be defined as a rapidly rotating column of air extending from the base of a thunderstorm to the ground. In an average year, approximately 1,000 tornadoes are reported across the United States, resulting in 80 deaths and over 1,500 injuries. The most violent tornadoes, with wind speeds of 250 mph or more, are capable of tremendous destruction. Damage paths can be more than 1 mile wide and 50 miles long. Tornadoes can occur anywhere in the United States, but they are most common in the Great Plains region that includes parts of Texas, Oklahoma, Kansas, and Nebraska. Tornadoes are responsible for the greatest number of wind-related deaths each year in the United States.

Tornadoes come in all shapes and sizes. In the southern states, peak tornado season is March through May; peak months in the northern states are dur-

ing the summer. Tornadoes can also occur in thunderstorms that develop in warm, moist air masses in advance of eastward-moving cold fronts. These thunderstorms often produce large hail and strong winds, in addition to tornadoes. During the spring in the central plains, thunderstorms frequently develop along a “dryline,” which separates warm, moist air to the east from hot, dry air to the west. Tornado-producing thunderstorms may form as the dryline moves east during the afternoon hours. Along the front range of the Rocky Mountains, in the Texas panhandle, and in the southern high plains, thunderstorms frequently form as air near the ground flows “upslope” toward higher terrain. If other favorable conditions exist, these thunderstorms can produce tornadoes. Tornadoes occasionally accompany tropical storms and hurricanes that move over land. They are most common to the right and ahead of the path of the storm center as it comes onshore.

As discussed in Step 4, HAZUS-MH can support your exposure assessment of the tornado hazard.



## **Tsunamis**

Tsunamis are a series of very long waves generated by rapid, large-scale disturbances of the sea. Most tsunamis are generated by sea floor displacements resulting from large undersea earthquakes. Oceanographers often refer to tsunamis as seismic sea waves because they are usually the result of a sudden rise or fall of a section of the earth’s crust under or near the ocean. A seismic disturbance can displace the water column, creating a rise or fall in the level of the ocean above. This rise or fall in sea level is the initial formation of a tsunami wave. Tsunami waves can also be created by volcanic activity and landslides occurring above or below the sea surface. These types of activities produce tsunamis with much less energy than those produced by submarine faulting. The size and energy of these tsunamis dissipates rapidly with increasing distance from the source, thus resulting in more localized devastation.

Tsunamis can quickly inflict great damage on shore areas near their source. Some tsunamis can cause destruction across an entire ocean basin within hours. Most tsunamis occur in the Pacific region, but they can occur in every ocean and sea. There have been tsunamis in most oceans of the world, but most notably in the Pacific Ocean. The coastline of Hilo, Hawaii, has seen inundation several times and a major earthquake in Alaska in 1964 resulted in a tsunami with a height of 6 meters in Crescent City, California, killing several people.

Just like other water waves, tsunamis begin to lose energy as they rush onshore; part of the wave energy is reflected offshore, while the shoreward-propagating wave energy is dissipated through bottom friction and turbulence. Despite these losses, tsunamis still reach the coast with tremendous amounts of energy. Tsunamis have a great potential to cause erosion, stripping beaches of sand that may have taken years to accumulate and undermining trees and other coastal vegetation. Capable of inundating, or flooding, hundreds of yards inland past the typical high-water level, the fast-moving water associated with the inundating tsunami can crush homes and other coastal structures. Tsunamis may reach a maximum vertical height onshore above sea level, often called a run-up height, of 10, 20, and even 30 meters.

As discussed in Step 4, HAZUS-MH can support your exposure assessment of the tsunami hazard.



A wildfire is an undesirable fire occurring in the natural environment and is a serious and growing hazard over much of the United States. Wildfires pose a great threat to life and property, particularly when they move from forest or rangeland into developed areas. An average of 5 million acres burns every year in the United States as a result of wildfires, causing millions of dollars in damage. Each year more than 100,000 wildfires occur in the United States, almost 90 percent of which are started by humans; the rest are caused by lightning. Weather is one of the most significant factors in determining the severity of wildfires. The intensity of fires and the rate with which they spread is directly related to wind speed, temperature, and relative humidity. Climatic conditions such as long-term drought also play a major role in the number and the intensity of wildfires.

As discussed in Step 4, HAZUS-MH can support your exposure assessment of the wildfire hazard.

### **Other Hazards**

Other hazards that may affect your study region include avalanches, coastal erosion, dam failures, drought, expansive soils, extreme heat, hailstorms, land subsidence, severe winter storms, volcanoes, and manmade hazards. For some of these hazards, the HAZUS-MH framework can support mapping of hazard areas and exposure assessments.



## Documenting Hazards of Interest

Worksheet 1-1 provides a tool to help you list hazards of interest and historic data sources that are readily available. Worksheet 1-2 summarizes the hazards you explored and the hazards you decided to carry forward for additional analysis in Step 2. Worksheets 1-1 and 1-2 can be used as tools to explain hazards that impact the community to team members, decision-makers, and community stakeholders. Example 1-1 illustrates how Worksheets 1-1 and 1-2 were used for a FEMA pilot project in Austin, Texas.

At this stage, you can mark potential areas of concern (e.g., areas where floods or tornadoes have occurred in the past) on your base map, either electronically or by hand-drawing the areas. Later, you can refine these maps or import hazard area maps as part of Step 2, Profile Hazards.



*Congratulations! You have now a list of preliminary hazards of interest in your study region.*

## SUMMARY

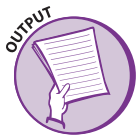
During Step 1 you should have defined your study region, created a base map, and identified the potential hazards for your area. Table 1-1 will help you make sure you have completed these activities. Review the list below and add check marks in the third column where you have completed the activities or outputs indicated.

Table 1-1: Identify Hazards Activities and Outputs Checklist

Activity	Output	Check Completed Items
Define your study region (Task 1.1)	HAZUS-MH study region with hazards selected <ul style="list-style-type: none"> <li>• Defined study region</li> <li>• Data files aggregated at the proper level</li> </ul>	
Create a base map of your study region (Task 1.2)	Base map with local GIS data incorporated into HAZUS-MH <ul style="list-style-type: none"> <li>• Local data properly converted and projected</li> <li>• Base map with HAZUS-MH provided layers</li> <li>• Local data layers added to the base map</li> </ul>	
Identify hazards of interest (Task 1.3)	Worksheet 1-1 (Identify Your Hazards) <ul style="list-style-type: none"> <li>• List of hazards of interest for your study region</li> <li>• Include hazard event descriptions and corresponding list of data sources, as available</li> </ul> Worksheet 1-2 (Summary of Hazard Identification) <ul style="list-style-type: none"> <li>• Summarize hazards of interest</li> <li>• Summarize the data you collected for those hazards</li> </ul>	

Complete any missing items in your checklist, and then continue to Step 2.

## GO TO STEP 2: PROFILE HAZARDS



## WORKSHEET 1-1: IDENTIFY YOUR HAZARDS

To complete Worksheet 1-1, first check the box in the “Hazard of Interest” column next to each potential hazard that could occur in your study region. If you are unsure about a hazard, select it at this stage of the process.

**Hazard or Event Description** - For hazards for which you have some preliminary data, list that information below. This will serve as a starting point to identify the hazards that affect your community and to fill out Worksheet 1-2. Information you may list below includes the type of hazard and any summary information on the dates of hazard events, numbers of injuries, costs, areas impacted, and damages and losses that occurred (see example).

Potential Hazard	Hazard of Interest	Description	Source of Information
Avalanche			
Coastal Erosion			
Dam Failure			
Drought			
<b>Earthquake</b>			
Expansive Soils			
Extreme Heat			
<b>Flood (Coastal)</b>			
<b>Flood (Riverine)</b>			
Hailstorm			
<b>Hurricane</b>		<b>Example: Hurricane Hugo.</b> Sept. 21-22, 1989. Charleston, SC. Struck Francis Marion National Forest, about 20 miles northeast of the city. Highest storm surge near Cape Romain (15–20 feet, 10-12 feet near the Harbor). Left wide path of damage with hurricane conditions as far inland as Charlotte, NC. Highest winds were in northern Charleston County where Category 4 conditions were experienced. Winds of 78-100 mph recorded at Charleston Airport. Much higher downtown (120 mph). Highest wind speed recorded by Coast Guard Cutter in Cooper River (138 mph winds). Over \$7 billion in damages and 82 deaths associated with this event.	NOAA web site, historic newspapers
<b>Landslide</b>			
Land Subsidence			
Severe Winter Storm			
<b>Tornado</b>			
<b>Tsunami</b>			
Volcano			
<b>Wildfire</b>			
Other*			
Other*			

Notes: HAZUS-MH includes hazard event data for the earthquake and hurricane hazards. \* Specify hazard for other hazards of interest in your area. Hazards in bold are discussed further in Step 2. Hazards in italics are included in HAZUS-MH.



## WORKSHEET 1-2: SUMMARY OF HAZARDS IDENTIFICATION

**Hazard or Event Description** - Worksheet 1-2 will help you summarize findings from Worksheet 1-1. Use column A to indicate the initial hazards identified by the team. Use column B to show hazards of interest carried forward for further study based on group discussion and available information regarding the relative risk of each hazard in your study region. Summarize event data in the table.

A	B	HAZARD	Hazard	Years	No. of Events	Impacts	Available Data Sources and Maps
<input type="checkbox"/>	<input type="checkbox"/>	Avalanche	Avalanche				
<input type="checkbox"/>	<input type="checkbox"/>	Coastal Erosion	Coastal Erosion				
<input type="checkbox"/>	<input type="checkbox"/>	Dam Failure	Dam Failure				
<input type="checkbox"/>	<input type="checkbox"/>	Drought	Drought				
<input type="checkbox"/>	<input type="checkbox"/>	Earthquake	<b>Earthquake</b>				
<input type="checkbox"/>	<input type="checkbox"/>	Expansive Soils	Expansive Soils				
<input type="checkbox"/>	<input type="checkbox"/>	Extreme Heat	Extreme Heat				
<input type="checkbox"/>	<input type="checkbox"/>	Flood (Coastal)	<b>Flood (Coastal)</b>				
<input type="checkbox"/>	<input type="checkbox"/>	Flood (Riverine)	<b>Flood (Riverine)</b>				
<input type="checkbox"/>	<input type="checkbox"/>	Hailstorm	Hailstorm				
<input type="checkbox"/>	<input type="checkbox"/>	Hurricane	<b>Hurricane</b>				
<input type="checkbox"/>	<input type="checkbox"/>	Landslide	<b>Landslide</b>				
<input type="checkbox"/>	<input type="checkbox"/>	Land Subsidence	Land Subsidence				
<input type="checkbox"/>	<input type="checkbox"/>	Severe Winter Storm	Severe Winter Storm				
<input type="checkbox"/>	<input type="checkbox"/>	Tornado	<b>Tornado</b>				
<input type="checkbox"/>	<input type="checkbox"/>	Tsunami	<b>Tsunami</b>				
<input type="checkbox"/>	<input type="checkbox"/>	Volcano	Volcano				
<input type="checkbox"/>	<input type="checkbox"/>	Wildfire	<b>Wildfire</b>				
<input type="checkbox"/>	<input type="checkbox"/>	Other	Other*				
<input type="checkbox"/>	<input type="checkbox"/>	Other	Other*				

Notes: Hazards in bold are discussed further in Step 2. Hazards in italics are addressed as HAZUS-MH models.



## EXAMPLE 1-1: IDENTIFY HAZARDS SUMMARY WORKSHEET FOR AUSTIN, TX

This example summarizes the hazard identification and selection process conducted by the risk assessment team in Austin, TX (a pilot project community). The table summarizes preliminary data available to support further analysis of each of the hazards of interest.

A	B	HAZARD
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Dam Failure
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Drought
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Earthquake
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Extreme Heat
<input type="checkbox"/>	<input type="checkbox"/>	Flood (Coastal)
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Flood (Riverine)
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Hail Storm
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	HazMat Release - fixed
<input checked="" type="checkbox"/>	<input type="checkbox"/>	HazMat Release - mobile
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Major Utility Failure
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Severe Winter Storm
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Fuel Pipeline Breach
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Terrorism
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Tornado
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Traffic Disruption
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Urban Fire
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Hurricane

### Summary of Hazards of Interest for Austin

Hazard	Years	No. of Events	Impacts	Available Data Sources and Maps
Flood (Riverine)	1869 to 2001	64	35 deaths (1915) 215 deaths (1921) \$3 M (1981) \$4.5 M (1991)	FIRM, USGS DEM, AWPDRD, historical data, HAZUS-MH
Hurricane	1897 to 2002	50	1 wind storm caused 1 death, 3 caused 17 injuries	ASCE wind speed and NOAA hurricane track maps, historic data, HAZUS-MH
Dam Failure	1889 to 2002	2	Failure Old Austin (1900) Failure Rebuilt Austin (1915)	Historical records, LCRA inundation maps
Fuel Pipeline Breach	1969 to 2001	1 event	7 deaths, 14 injuries \$3.7 M (for the event)	Historical knowledge, DOT data, map of pipelines
Urban Fire	1990 to 2001	151	Average of 4 deaths/year	Historical knowledge, City of Austin Fire Department, maps of past events
HazMat Release (fixed site)	1993 to 2000	223	N/A	DOT data, maps of Haz Mat sites (Austin data, EPA and HAZUS-MH)
Hailstorm	1980 to 2001	86	\$90 M (1984) \$100 M (1993)	NOAA hail strike maps
Tornado	1897 to 2001	37	94 deaths total 12 deaths (1897)	NOAA tornado strike maps, Austin data
Severe Winter Storm	1980 to 2001	68	\$1.8 M (1996) 3 deaths and 400 traffic accidents (1998)	Austin data

Acronyms used in the summary worksheet that are not defined elsewhere in this How-To Guide:

AWPDRD – Austin Water Protection and Development Review Department

LCRA – Lower Colorado River Authority

Source: Modified from FEMA 386-2, Worksheet 1