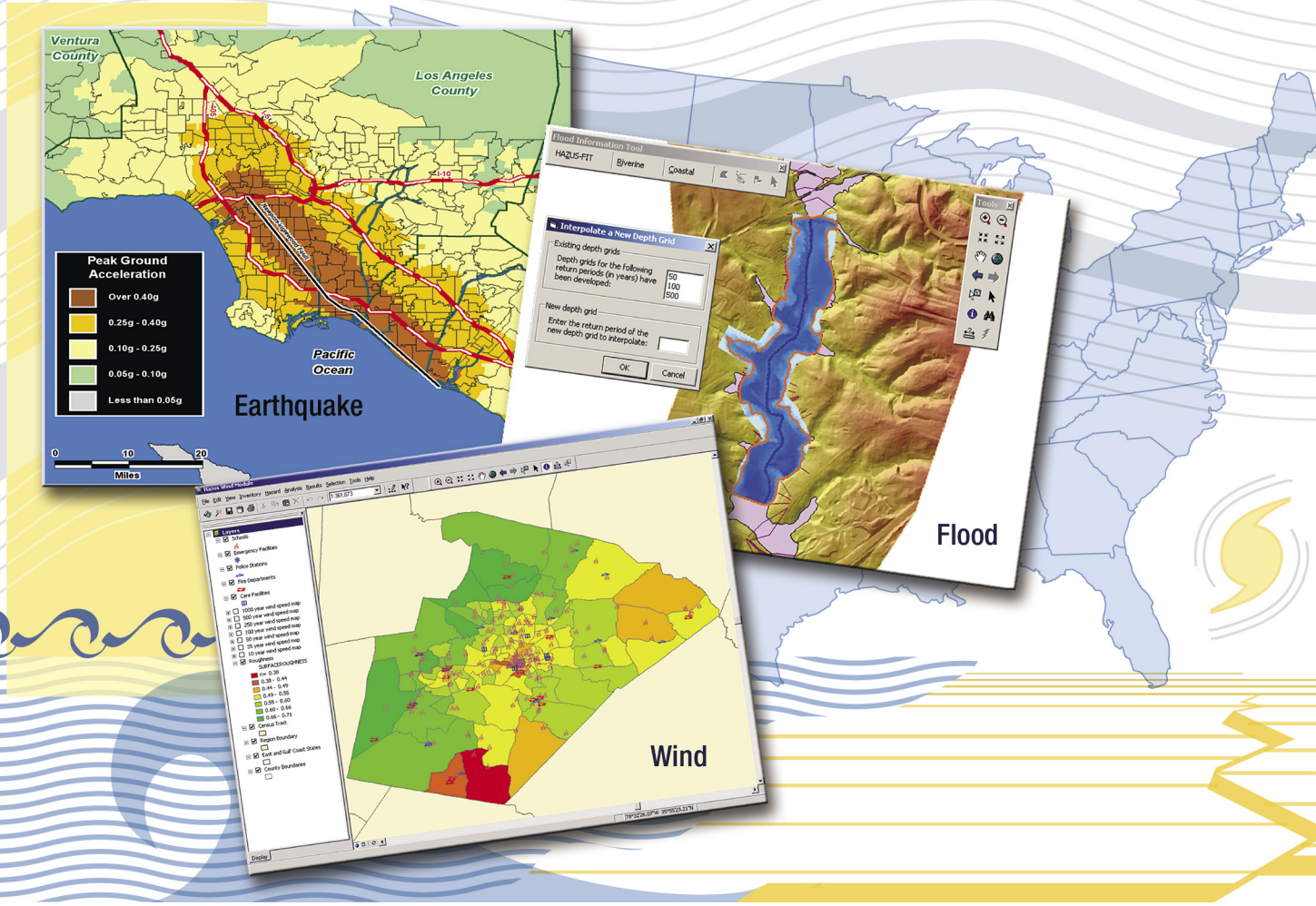

HAZUS®-MH Risk Assessment and User Group Series

Using HAZUS-MH for Risk Assessment

How-To Guide

FEMA 433 / August 2004

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ACKNOWLEDGMENTS

This How-To Guide is designed to help prepare standardized, scientifically-based risk assessments using the Hazards U.S. Multi-Hazard (HAZUS-MH) software. The Federal Emergency Management Agency (FEMA) prepared this guide based on field-implemented HAZUS-MH risk assessment pilot projects across the country that are responding to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000). FEMA prepared this guide for users who have had exposure to HAZUS-MH and are interested in using HAZUS-MH to support risk assessment studies.

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This manual was prepared under contract to FEMA. It will be revised periodically, and comments and feedback to improve future editions are welcome. Please send comments and feedback by e-mail to riskmanagementseriespubs@dhs.gov.

OVERVIEW

This Introduction presents the layout and organization of the How-To Guide, an overview of mitigation planning, information about HAZUS-MH and risk assessments, and activities to help establish your risk assessment team.

Layout and Organization of the How-To Guide

This How-To Guide focuses on the basic steps and tasks necessary to complete your risk assessment. The guide presents pertinent information in text boxes that provide specific software and technical information, key definitions, examples, and references. Hazard icons indicate hazard-specific information for several natural disasters. These text boxes and icons provide guidance and helpful suggestions to accomplish the tasks described in this How-To Guide.

This How-To Guide should be used in conjunction with the HAZUS-MH software; and the user and technical manuals that are provided with your HAZUS-MH software. Other references listed throughout the guide also will assist your risk assessment efforts.

Informational Icons

The following icons indicate the topic of each text box:

The **HAZUS** icon indicates information about the HAZUS-MH software, its advantages, and its uses.

The **Definition** icon identifies key terms, definitions, and acronyms.

The **Example** icon provides examples of how pilot project communities have applied HAZUS-MH in their risk assessments.

The **Note** icon identifies additional technical information, including useful reminders and tips based on lessons learned from the pilot projects.

The **Reference** icon lists additional useful materials and regulatory citations.

The **Wizard** icon refers to two HAZUS-MH utility tools – the Flood Macro Wizard and the Risk Assessment Tool; both tools simplify and shortcut the process of obtaining HAZUS-MH risk assessment outputs.

The **Job Aid** icon indicates resources that can help you complete the risk assessment process using HAZUS-MH.

The **Output** icon indicates outputs for each step of the risk assessment process obtained by implementing the tasks in the How-To Guide and the worksheets included for each step.

Hazard-Specific Icons

The hazard-specific icons provide information and instructions for the following specific natural hazards:

Earthquakes

Coastal Floods

Hurricanes

Riverine Floods

Tornadoes

Landslides

Tsunamis

Wildfires

Contents of the How-To Guide

This How-To Guide is organized into an Introduction, five steps, and seven appendices:

- Introduction
- Identify Hazards (Step 1)
- Profile Hazards (Step 2)
- Inventory Assets (Step 3)
- Estimate Losses (Step 4)
- Consider Mitigation Options (Step 5)
- Appendix A: Acronyms and Abbreviations
- Appendix B: Glossary of Terms
- Appendix C: DMA 2000 Job Aids
- Appendix D: Job Aids for Step 2
- Appendix E: Job Aids for Step 3
- Appendix F: Job Aids for Step 4
- Appendix G: Job Aids for Step 5

The sections of this guide are organized around the five steps of conducting a risk assessment using HAZUS-MH. Each step includes:

- Text and graphics that describe the risk assessment steps
- Instructions and corresponding HAZUS-MH screen captures to support the steps
- Practical implementation examples and lessons learned from field-based pilot projects
- Worksheets and associated job aids as training tools to help you complete each step

The remainder of this Introduction provides an overview of mitigation planning, an introduction to HAZUS-MH, and steps to establish your risk assessment team.

Overview of Mitigation Planning

Hazard mitigation is any action that reduces the destructive and disruptive effects of future disasters. Mitigation efforts generally offer the best and most cost-effective methods of addressing the impacts associated with disasters. To support better mitigation planning for future disasters, Congress enacted the DMA 2000. FEMA is the lead agency supporting implementation of the DMA 2000 requirements and makes funds available to support efforts to meet these requirements. In 2002, FEMA issued regulations and guidelines to implement the DMA 2000 requirements for mitigation planning by states and communities. To be eligible for FEMA funds, state and local entities are required to prepare DMA 2000 Hazard Mitigation Plans for natural hazards. Hazard Mitigation Plans can be developed using the general process shown in Figure 1. In addition, the DMA 2000 Job Aids in Appendix C provide a summary of DMA 2000 requirements and how HAZUS-MH resources can support these requirements.

FEMA developed an Interim Final Rule (for DMA 2000) that specifies the mitigation planning requirements for states and local governments. This rule is available at: http://www.fema.gov/fima/planning10.shtm.

The DMA 2000 Job Aids in Appendix C summarize the rule and list resources available to help you meet DMA requirements.

FEMA developed a series of mitigation planning guides that provide additional information and tools related to DMA 2000 requirements. Information about these guides is available at: http://www.fema.gov/fima/planhowto.shtm.

Additional information, including DMA 2000 Multi-Hazard Mitigation Guidance is available at: http://www.fema.gov/fima/planning_toc4.shtm.

The primary purpose of hazard mitigation planning is to help communities identify the most effective policies, actions, and tools to decrease risk and the potential for future losses in a community. Before implementing mitigation measures, communities must assess potential hazards and

the risks that they pose. For purposes of hazard mitigation, risk assessments estimate the social and economic impact that hazards can have on people, buildings, services, facilities, and infrastructure in a community. The usefulness of a risk assessment is directly dependent upon the quality and appropriateness of the data incorporated.

REFERENCE

Frequently asked questions about the DMA 2000 planning process and its requirements are answered at the following web site: http://www.fema.gov/fima/planfaq.shtm.

Introduction to HAZUS-MH

HAZUS-MH is a nationally applicable software program and standardized methodology for estimating potential losses from earthquake, flood, and hurricane hazards. FEMA developed HAZUS-MH in partnership with the National Institute of Building Sciences (NIBS). Loss estimates produced with HAZUS-MH are based on current scientific and engineering knowledge regarding the effects of earthquake, flood, and hurricane hazards. These loss estimates can support the risk assessment component of your planning effort.

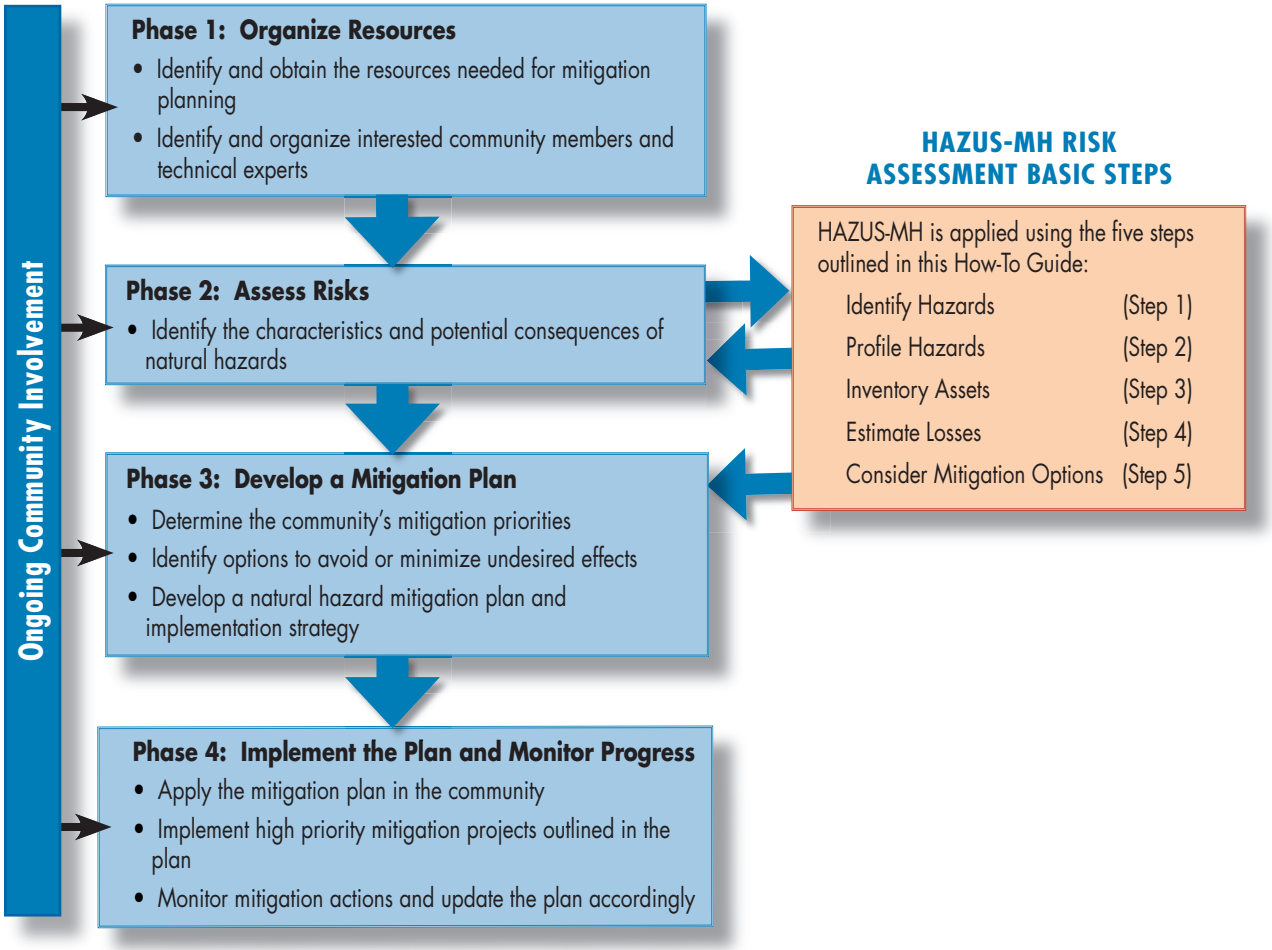

Figure 1 The hazard mitigation planning process

The following user capabilities are recommended for HAZUS-MH:

- Familiarity with Microsoft® Windows-based environments and Geographic Information System (GIS) software (ArcGIS®)
- Knowledge and experience with electronic data manipulation

To order HAZUS-MH software at no cost, complete the order form available at http://www.fema.gov/hazus.

Table 1 shows the computer system specifications required to run HAZUS-MH.

HAZUS-MH includes the largest compilation of geo-referenced data made available by the federal government at no cost. In addition to data provided with HAZUS-MH, a variety of data (presented in further detail throughout the document) are available that can be used in risk assessment studies as follows:

Hazard information to supplement HAZUS-MH provided data may be obtained from sources in the fields of meteorology, hydrology, geomorphology, and seismology.

Inventory data regarding the people and structures at risk are provided in HAZUS-MH from national and regional databases (such as the United States Census) and can be refined with local data.

Vulnerability data regarding areas and assets at particular risk can best be refined at the local level.

Table 1: System Specifications for HAZUS-MH

Area	Minimal	Moderate	Recommended
Computer Speed Memory	Pentium® III, 1 gigahertz (GHz) core speed and 512 megabyte (MB) random access memory (RAM). Allows moderately fast analysis of small communities only.	Pentium® IV, 2 GHz core speed and 512 MB RAM. Allows fast analysis of medium-sized communities and real-time analysis for small communities.	Pentium® IV with 800 MHz system bus and 2.6 GHz (or better) core speed and 1 GB RAM. Allows fast analysis of large urban areas and real-time analysis for all communities.
Computer Storage: Free Hard Disk Space	10 Gigabytes (GB). Allows installation of HAZUS-MH and storage of three scenarios for a medium-sized community.	40 GB. Allows installation of HAZUS-MH and storage of three scenarios for large urban areas.	80 GB. Allows installation of HAZUS-MH and storage of 25 or more scenarios for large urban areas.
Hardware and Software	• CD-ROM reader with 32x minimum read speed • DVD-ROM reader with 12x minimum read speed • Graphics Card with 800x600 minimum resolution • Mouse, keyboard, and computer monitor	• Microsoft® Windows XP or 2000 • ArcGIS® 8.3 GIS software (ArcGIS® 9 in Fall 2004)* • ESRI's Spacial Analyst 8.3	

*HAZUS-MH platform upgrade to version 9

HAZUS-MH has distinct advantages for risk assessment, including:

- Consistent platform and methodology for assessing risk across geographic and political entities
- Framework that can be used to save and update data as population, inventory, and other factors change, and as planning efforts evolve
- Strong mapping capabilities for hazard and inventory data
- Visual mapping and tabular outputs that promote communication and interaction with local stakeholders, a requirement of the mitigation planning process

HAZUS-MH for Risk Assessment

HAZUS-MH can be used to evaluate a variety of hazards and associated risks to support mitigation planning efforts. HAZUS-MH provides natural hazard and inventory data; it estimates losses and has strong mapping and layout capabilities. HAZUS-MH outputs can be presented in map and tabular formats for easy review, use, and communication to stakeholders. HAZUS-MH provides risk assessment outputs and loss estimates for use in:

- Planning for and mitigating the possible consequences of disaster events
- Anticipating the possible nature and scope of emergency response needed to cope with disaster events
- Developing plans for recovery and reconstruction following a disaster

FEMA provides a number of training courses and other resources to support HAZUS-MH. You can learn more about these resources at http://www.fema.gov/hazus/. Look for the "Training/ Conferences" link.

The models in HAZUS-MH are designed to estimate the consequences to a city or other defined study region from three primary types of hazard events - earthquakes, floods, and hurricanes. The resulting loss estimates describe the scale and extent of damage and disruption that may result from a potential hazard event. To generate this information, HAZUS-MH uses data provided with the software and/or user-provided local data to estimate the type and extent of damage for each specific hazard. Also, HAZUS-MH can be used to estimate the exposure of local assets to other hazards not included in the software.

HAZUS-MH Levels of Analysis

HAZUS-MH is a flexible software tool that allows for varied levels of customization, based on your resources and analysis needs. The flexibility provided with HAZUS-MH is described as analysis Levels 1 through 3, which are defined as follows:

Level 1: Level 1 involves using HAZUS-MH provided hazard and inventory data with minimal outside data collection or mapping. You can conduct a Level 1 analysis using the inventory and hazard data sets provided with HAZUS-MH. Limited additional data are required

to complete a Level 1 flood hazard analysis (e.g., for a coastal analysis, the digital elevation model, 100-year still water area, and still water elevation are required). Level 1 analysis, relying on HAZUS-MH provided data, can be an acceptable level of information for mitigation planning.

If a jurisdiction chooses to use HAZUS-MH in support of risk assessment, the minimum level of analysis that is acceptable will vary, depending on the community's resources, data availability, and technical capabilities.

Level 2: Level 2 involves augmenting the HAZUS-MH provided hazard and inventory data with more recent or detailed data for your study region. These additional data are referred to as "local data" throughout this How-To Guide. Use of local data will refine the HAZUS-MH analyses and generally will produce more accurate results.

Level 3: Level 3 involves adjusting the built-in loss estimation models used for the earthquake, flood, and hurricane loss analyses. This typically is done in concert with the use of local data (Level 2 analysis). It is only pursued by advanced users with knowledge of the hazard models developed for HAZUS-MH and when the users need more accurate results or need to solve specific problems.

This How-To Guide focuses on the use of Level 1 and Level 2 analyses using HAZUS-MH. Level 3 analysis techniques are not addressed in detail.

HAZUS-MH Provided Data

HAZUS-MH includes sophisticated models that combine data regarding the vulnerability of the study region to each hazard with data that describe the region's population and social and economic bases. Hazard data include historic events and area characteristics that influence how each hazard impacts a given area. The inventory data for all of the HAZUS-MH models use basic information on population, buildings, and facilities obtained from the United States Census and other national databases.

HAZUS-MH and Local Data

HAZUS-MH includes national data sets that can be supplemented with local data. If local detailed data are available, you may consider using this data to perform more refined studies using HAZUS-MH Level 2 and Level 3 analyses. HAZUS-MH is flexible and allows you to update HAZUS-MH provided data with local data or use a combination of both. Augmenting the HAZUS-MH provided data with local data can improve the accuracy and resolution of your analysis results. However, collecting local data can be time-consuming and costly. Decisions about collecting this information should be balanced against the possible benefits of the data to support mitigation planning.

Evaluation of Hazards Not Included in HAZUS-MH

HAZUS-MH can support the evaluation of some hazards that are not included as models in the current HAZUS-MH software. If your studies and data allow you to map hazard areas for other hazards, you can display these maps using the GIS functionality provided with HAZUS-MH. Also, you can estimate the inventory exposed within the hazard areas for these hazards. If you also have probability data for hazards or strong historical loss data, you can estimate the probability of different levels of losses using techniques outside of the HAZUS-MH software. Approaches to support exposure estimates using hazard area maps are described in Step 4 of this guide.

Risk Assessment Process Using HAZUS-MH

A specific risk assessment process for using HAZUS-MH was documented during the field pilots. This process, shown in Figure 2, outlines the steps, tasks, and subsequent outputs involved in applying HAZUS-MH for your risk assessment. Each of these steps, tasks, and outputs is discussed in more detail in the subsequent steps of this How-To Guide. Note that normally a risk assessment has four steps and concludes with loss estimation; however, for this How-To Guide, a fifth step, Consider Mitigation Options, has been added. The purpose of the added step is to help you with your mitigation planning and assist in identifying, reviewing, and evaluating mitigation measures.

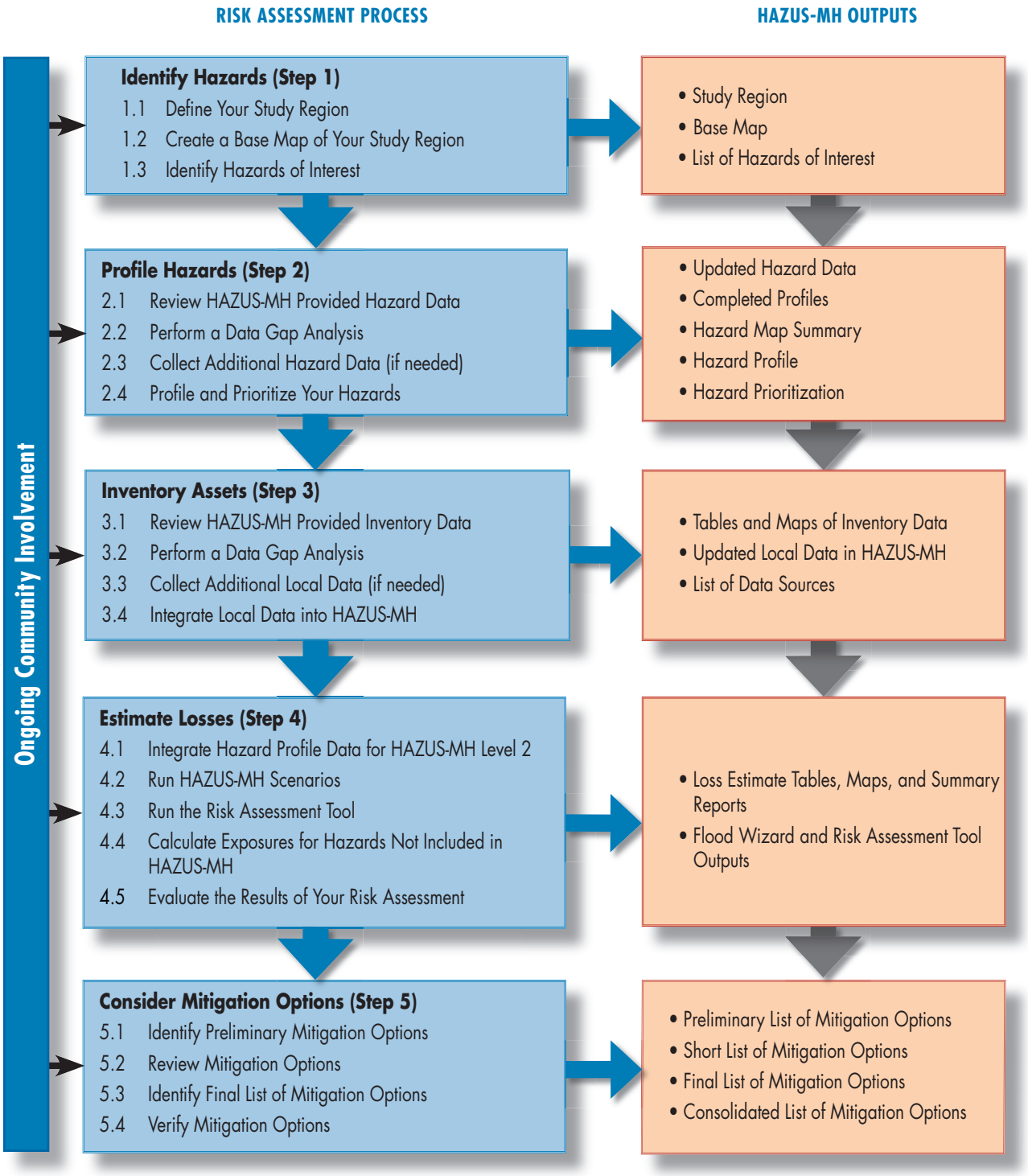

Figure 2 HAZUS-MH risk assessment process and outputs

Establishing Your Risk Assessment Team

Prior to beginning the steps and tasks of your risk assessment, it is prudent to identify and establish your risk assessment team. Table 2 shows the types of personnel who may be useful in mitigation planning and HAZUS-MH risk assessment efforts. Generally, a local planning or emergency management representative will lead this team. The lead person will be primarily responsible for developing the Hazard Mitigation Plan. However, a wide variety of persons may be useful to your team and should be included (e.g., engineers, natural hazard experts, public works directors, and economists). Involving a variety of people from different segments of the community will ensure that all relevant issues and concerns are considered when planning and implementing your risk assessment. It is important to emphasize that because HAZUS-MH runs from a GIS platform, a GIS specialist should be part of the team. Worksheet 1 includes a format for listing your team members and their contact information. Example 1 describes pilot project risk assessment team members. Key team members should meet regularly to develop and implement the risk assessment and subsequent mitigation planning efforts.

Table 2: Members of a Risk Assessment Team

Type of Team Member	Type of Personnel
Members with Specific Responsibilities	Local planning or emergency management representative (team leader)
	Representatives of state and local government agencies
	GIS specialists
	Multidisciplinary subject-matter experts
	Utility companies and public works experts
Support Members (providing advice or technical input)	Community leaders and elected officials
	Business owners and operators and representatives of development organizations
	Representatives of neighborhood groups and other nonprofit organizations
	Interested citizens
	Representatives of Federal Government agencies
	Personnel affiliated with academic institutions

SUMMARY

The introduction should have familiarized you the requirements of DMA 2000 and HAZUS-MH, and how HAZUS-MH can support your risk assessment. Each step of this guide ends with a checklist of activities and outputs that should be completed. Table 3 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 3: Introduction Activities and Outputs Checklist

Activity	Output	Check Completed Items
Understand the DMA 2000 requirements	Understanding of the DMA 2000 requirements	
Obtain your free copy of HAZUS-MH software from the FEMA distribution center	HAZUS-MH software, user manuals, and technical manuals	
Review the system specifications for HAZUS-MH provided in Table 1	System that has the specifications required for the HAZUS-MH software	
Identify key and support members of your risk assessment team	Risk assessment team documented using Worksheet 1	
Review Introduction text and the examples provided	Understanding of how to get started and how HAZUS-MH can support the risk assessment process	

Complete any missing items in your checklist and then continue to Step 1.

GO TO STEP 1: IDENTIFY HAZARDS

WORKSHEET 1: RISK ASSESSMENT TEAM MEMBERS

Worksheet 1 will help you to keep track of your team members and their roles in preparing the risk assessment for your community.

RISK ASSESSMENT TEAM			
NAME	**TITLE**	**TEAM ROLE**	**CONTACT INFORMATION**
Key team members having specific responsibilities for developing and implementing the risk assessment			
Members providing advice or data during the risk assessment study			
Members providing technical input and support during implementation of the risk assessment			

EXAMPLE 1: PILOT PROJECT RISK ASSESSMENT TEAM MEMBERS

This example illustrates focus areas and team members for the pilot projects communities.

Pilot Project Community Risk Assessment Objectives and Focus Areas	Hazard Mitigation Team Members and Risk Assessment Support Team
City of Austin, Texas • Focus on impacts potentially associated with the Colorado River and specific manmade hazards. • City of Austin personnel had some knowledge of HAZUS-MH and a solid GIS foundation.	Primary team members: • FEMA Headquarters and Region VI • State of Texas Department of Public Safety • State of Texas Division of Emergency Management • City of Austin Office of Emergency Management Planning and GIS Departments Partnering agencies: • Austin Water Protection and Development Review Department • Austin Fire Department • Lower Colorado River Authority • Austin Energy • Texas Geographic Society Consultants: • H20 Partners (City of Austin) • FEMA consultants for Austin, Texas
Eight-County Effort for Wyoming • Focus on impacts potentially associated with flood and earthquake hazards. • HAZUS-MH expertise has developed. • Due to the low population density in WY, some Census tract data needed adjustment to smaller areas called Census blocks. • Local expertise was used to integrate local hazard and inventory data into HAZUS-MH.	Representatives are supporting mitigation planning across the state, including the eight counties of interest. Representatives supporting the mitigation team include: • FEMA Headquarters and Region VIII • Wyoming Geological Society • State and county emergency management representatives • FEMA consultants for Wyoming A focus area for this effort included updating local inventory data for essential facilities and translating Census data from the tract level to a block/grid format to support user needs.
Louisville Metro, Kentucky • Focus on impacts potentially associated with flood and earthquake hazards. • Louisville Metro area boundaries were used as the study area. • A strong GIS capability was provided through a local not-for-profit organization. • Area's flood committee was designated as the All-Hazards Mitigation team. • Timing of the pilot project provided a strong foundation to start the mitigation planning process.	Primary team members: • FEMA Headquarters and Region IV • Louisville Metro Emergency Management Agency representatives • Louisville/Jefferson County Information Center (LOJIC, a GIS support entity) • Members of local planning agencies and utility companies • FEMA and local consultants for Louisville Metro, Kentucky Because of the importance of the flood hazard to this area, Louisville Metro determined that the area's flood committee would serve as the foundation for the risk assessment team and long-term mitigation planning team. This group included representatives from the organizations supporting the risk assessment as well as other local flood committee personnel.

EXAMPLE 1: PILOT PROJECT RISK ASSESSMENT TEAM MEMBERS (continued)

Pilot Project Community Risk Assessment Objectives and Focus Areas	Hazard Mitigation Team Members and Risk Assessment Support Team
Marion and Hamilton Counties, Indiana • Focus on impacts potentially associated with flood and earthquake hazards. • The two counties work together on their emergency planning efforts and, therefore, the study area combined the two counties for this pilot.	The pilot project risk assessment team included a range of parties drawn from organizations such as: • FEMA Headquarters and Region V • State of Indiana Emergency Management Agency (SEMA) • IndyGov - City of Indianapolis and Marion County • Hamilton County Emergency Management Agency • FEMA Consultants for Marion and Hamilton Counties, Indiana Partnering agencies: • Indianapolis Mapping and Geographic Infrastructure Systems (IMAGIS) • Indiana University - Purdue University Indianapolis (IUPUI) The lead for mitigation planning efforts is the area emergency management agency.
City of Portland, Oregon • Focus on performing a refined analysis for earthquake and flood, and using HAZUS-MH as a support tool to consider the landslide and wildfire hazards. • Portland includes a strong GIS capability, refined local data for hazards, and a strong knowledge of HAZUS-MH. • The local team was experienced with HAZUS-MH and supported refinement of the HAZUS-MH provided data.	Primary team members: • FEMA Headquarters and Region IX • State of Oregon Office of Emergency Management • Oregon Department of Geology and Mineral Industries (DOGAMI) • City of Portland Office of Emergency Management • FEMA Consultants for Portland, Oregon Partnering agencies: • City of Portland Bureau of Technology Services • City of Portland Bureau of Environmental Services • City of Portland Bureau of Planning • Metro Regional Service • Multnomah County Office of Emergency Management • Clackamas County Emergency Management The earthquake and flood hazards were analyzed using HAZUS-MH. Exposure was calculated for the landslide and wildfire hazards with HAZUS-MH support and local hazard area maps provided by the community.