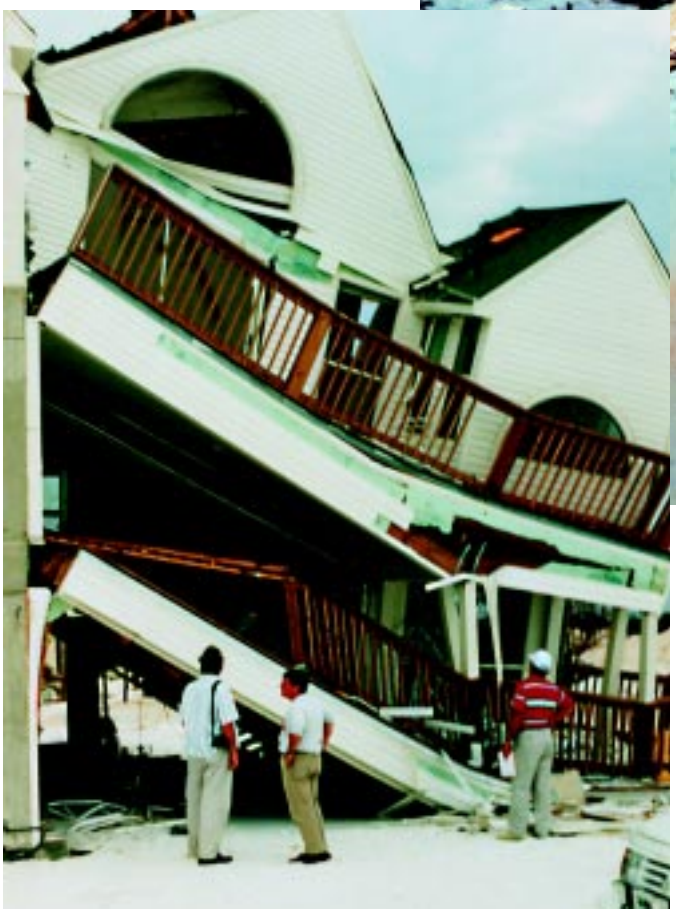
Battling Hazards with a

When it comes to preparing for hazards, communities need straight answers to complex questions:

By Deepa Srinivasan, AICP



Illustrations by the Federal Emergency Management Agency

Which buildings, roads, and bridges may be damaged and how great would the damage be? Which roads may be shut down? Which areas may be affected if utilities go down? Which businesses will close? Without answers to these questions, communities are hampered in their efforts to plan responsibly for future development, safe and effective evacuation routes, and appropriate emergency shelter locations—and to take steps that will make their communities safer places to live and work.

Sensitivity to hazards has certainly increased since September 11, 2001. Now there seems to be more recognition of national vulnerability to both manmade and natural hazards. As a result, planners are reevaluating their communities' exposure to risks and seriously considering proactive hazard mitigation measures.

Any impetus for undertaking hazard mitigation planning was given a boost in October 2000, when the Disaster Mitigation Act (DMA 2000) was signed into law.

DMA 2000 encourages and rewards predisaster planning and calls for increased coordination between state and local government plans. Interim final regulations published in February 2002 require communities

Brand New Tool

FEMA's new software can be used to assess risks from various hazards. Examples of damage from past disasters (from top left): the 1994 Northridge earthquake, Hurricane Fran in 1996; and Hurricane Opal in 1995.

to complete mitigation plans in order to receive hazard mitigation funds.

Often the greatest challenge in developing such plans is gaining an understanding of the issues (how a community should prepare for, mitigate, respond to, and recover from hazards). All of these issues are interrelated, which makes data gathering, evaluation, maintenance, and standardization such a complicated task.

How can HAZUS-MH help?

An important part of comprehensive community planning is understanding risks that may affect the physical, social, and economic components of a community. Planners who understand the community's vulnerability to natural hazards can make development decisions in light of those hazards and the risks associated with them.

At the national level, the Federal Emergency Management Agency (FEMA) works with states, communities, and tribal organizations to encourage planning and construction practices that uphold the safety of citizens and protection of property. In 1997, to address the growing concerns of communities, FEMA developed HAZUS (Hazards U.S.), a nationally standardized, GIS-based, risk assessment and loss estimation tool to be used in planning and preparing for, responding to, and recovering from hazard events.

Until now, HAZUS has been used solely to estimate potential earthquake losses. This spring, however, FEMA will introduce HAZUS-MH (Multi-Hazard). For the first time, planners will be able to use the HAZUS software to evaluate development decisions in the context of potential risks from floods, earthquakes, and hurricane winds. Planners can use their existing GIS systems in conjunction with HAZUS to integrate natural hazards information.

The upcoming release of HAZUS-MH will also include links to models that can be used to assess manmade disasters. These models can estimate damage to people and property from dam failures and hazardous chemical plumes, for example.

The beauty of HAZUS is that it provides estimates of hazard-related damage before a disaster occurs and takes into account various impacts of a hazard event. These impacts can be defined as follows:

- Physical damage—damage to residential and commercial buildings, schools, critical facilities, and infrastructure.
- Economic loss—lost jobs, business interruptions, repair and reconstruction costs.
- Social impacts—impacts to people, including requirements for shelters and medical aid.

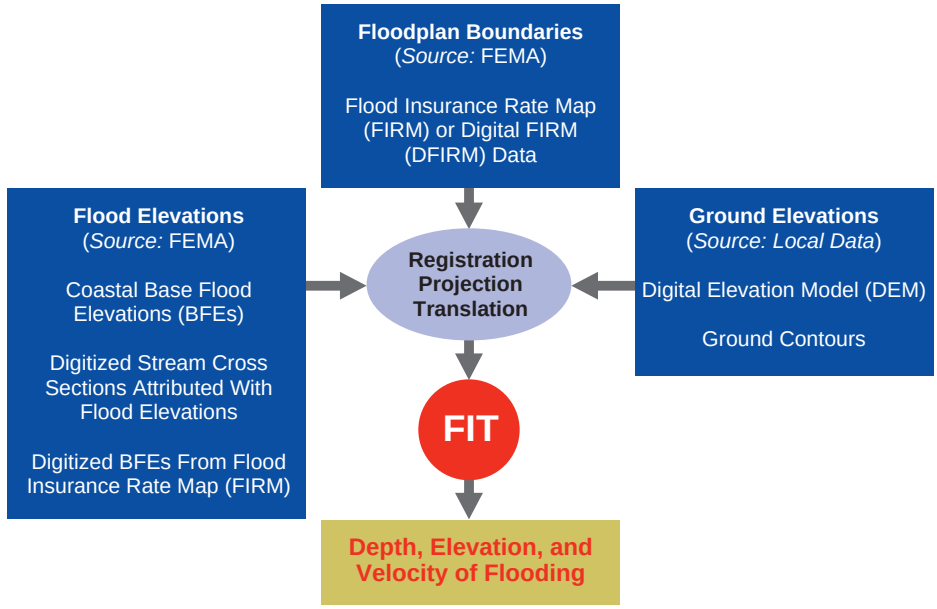
HAZUS-MH combines information about hazards with an inventory of buildings and infrastructure to assess risk and estimated losses. The program provides users with extensive national inventories of essential facilities, general building stock, and infrastructure and in-

cludes information about vulnerability and replacement costs.

In a nutshell, planners can use HAZUS-MH to build safer, stronger communities by:

- anticipating the scope of disaster-related damage,
- identifying areas at risk from hazards that may require special land-use or building codes,
- assessing the vulnerability of housing and essential facilities,
- estimating potential losses from specific natural disasters,
- prioritizing mitigation projects, and
- using this information to develop damage prevention, preparedness, response, and recovery plans.

Several communities throughout the U.S. have successfully used HAZUS to assess and mitigate risks. A few such places are described below.



Here's how the HAZUS-MH flood information tool works.

Wyoming assesses earthquake risks

The state of Wyoming is using HAZUS to support hazard mitigation planning in all 23 of its counties. Currently, a statewide Level I analysis is being conducted, based on seismological traits and information on active faults and historic earthquakes in each county. A Level I analysis uses national databases included in the HAZUS program and describes, in general terms, the geology of the region, the building inventory, and the economic and demographic structure of the community.

Level II analysis will follow this spring. In general, a Level II analysis uses more detailed information about local geology, building inventory, and infrastructure, thereby producing more accurate risk and loss estimates. Wyoming's statewide risk assessment will include state-specific information about slope stability, landslides, windborne deposits, underground mines, and wildfire hazard potential, and will estimate the potential loss of life and the potential dollar amount of damage to buildings and infrastructure in each of the 23 counties.

"We are eagerly awaiting HAZUS-MH. While the original HAZUS is based on census tract information, the new version will include information at the census block level, at a greater level of detail. Also, we will be able to replace the 1990 census data with 2000 data to obtain more accurate results," says Jim Case, director of the geological hazards section of the Wyoming State Geological Survey. Wyoming will be one of the first states to get block data cross-referenced with building assessments.

From his experience with HAZUS, Case notes that "the HAZUS software and its analytical programs are very sound, so long as the databases used are complete." This Wyoming case study will be used to support HAZUS applications in rural regions throughout the country.

Four Simple Steps to Hazard Mitigation Planning

- Organize resources. Identify technical experts and interested members of the community.
- Assess risks. Pinpoint the characteristics and potential consequences of a specific hazard.
- Develop a mitigation plan. After the risk assessment, set priorities and find possible ways to avoid or minimize undesired effects.
- Implement the plan and monitor progress. To ensure the success of an ongoing program, it is crucial to conduct periodic evaluations and to revise the basic hazard mitigation plan.

Pasadena beefs up its safety element

Since 1975, the state of California has required that a safety element be included in city and county general and comprehensive plans. The city of Pasadena has recently used HAZUS in the safety element of its general plan to support policy recommendations.

Pasadena has been concerned about hazards such as earthquakes, landslides, and mud flows; dam or reservoir failures; wildland and structural fires; and contamination of soil and groundwater resources from hazardous materials from research facilities in the city. Mapping of vulnerable areas is a large part of the mitigation effort. Fault zones that cross the city, areas of potential landslides and unstable slopes, and areas susceptible to fire and flooding hazards were identified.

"In Pasadena, the HAZUS results indicated that the city is extremely vulnerable to seismic shaking as a result of an earthquake on any of the three active faults closest to the city," says Tania Gonzalez of Earth Consultants International, Inc., who helped develop the safety element. "Many of their older buildings, including commercial, industrial, and critical facilities, are not expected to perform adequately, with a resultant high number of casualties."

She adds: "Based on these findings, the city has adopted a policy that will require all hazardous structures (such as tilt-ups and soft-stories) to be identified. The city will also prepare a plan for the structural retrofit of these buildings. I do believe that the Pasadena City Council approved these policies without an issue because the HAZUS results were so compelling." The policies were approved in July.

HAZUS user groups

A HAZUS user group is a cooperative venture or partnership involving public and private sector organizations in a city, county, region, or state. It combines the powerful data analysis capability of the HAZUS software with the knowledge and judgment of risk managers, GIS professionals, and scientists and engineers. Members of a HAZUS user group may include representatives of federal, state, and local governments, utilities, nonprofit orga-

nizations, and universities. Currently, about a dozen user groups have been established in nine states.

In 1998, FEMA funded an initiative called Development of HAZUS Earthquake Risk Assessment Capabilities for the San Francisco Bay Area. The purpose of this project was to bring together the GIS community with earthquake experts and risk managers from an 11-county project area and to develop HAZUS earthquake risk assessment capabilities for the region. This activity evolved into the San Francisco Bay Area HAZUS User Group (BAHUG).

Today, BAHUG is a public-private partnership involving more than 100 organizations and corporations. BAHUG is the national model for FEMA's continuing efforts to expand the use of HAZUS and the network of HAZUS user groups across the country.

The flood model

Flooding is common throughout the U.S. In the HAZUS-MH Flood Model, flood hazard is determined by nationwide data sets and consists of broad analyses of possible flooding based on hydrologic information. The flood model allows users to characterize the flooding expected in their communities and then estimate the expected levels of damage to buildings and infrastructure.

With HAZUS-MH, the most basic form of mitigation analysis is a "what-if" scenario. An example would be assessing the risk of a 100-year flood to a community's existing building inventory and identifying areas where buildings are expected to incur the greatest damage and economic loss.

The HAZUS Flood Information Tool (FIT), a component of the flood model, enables the user to customize the model by importing additional flood hazard data specific to the area of study (ground elevations, flood elevations, floodplain boundary information). These data are frequently available to communities participating in the National Flood Insurance Program.

The flood information tool ensures that the data are provided in the format required by the HAZUS flood model. With the enhanced data, the flood information tool can calculate more accurate flood depths, elevations, velocities, and return periods for riverine and coastal floods.

Austin's watershed flood study

In July 2000, the city of Austin, Texas, used the flood information tool along with a database of property values by parcel, finished floor elevations, and flood depth information generated by HAZUS to calculate the potential amount of flood damage from local streams within four watersheds in the area. What emerged was valuable information about how much each of the homes in the area would be damaged. This information will be used to set priorities for Austin's capital improvements and mitigation projects.

In an effort to justify a flood diversion tunnel, Austin in September 2000 also used HAZUS to analyze flood damage along Lower Waller Creek, pinpointing specific buildings. In addition, the city was able to conclude that most of the damage would affect buildings of high value but low finished floor elevations.

Austin awaits the final release of HAZUS-MH, which will include an economic analysis module. This module will allow the city to use the flood information tool and HAZUS-MH in the following ways:

HAZUS-MH and the hazard mitigation plan will provide an objective analysis of flood risks throughout the city and will allow the city to set priorities for future projects and maintenance programs. In addition, structure and roadway inundation mapping produced by HAZUS-MH will be valuable for emergency response planning and operations. The software also will provide estimated annual economic losses to support funding decisions.

Finally, the flood model will allow users to plan for debris removal and assistance following floods, estimate the number of displaced households and shelter requirements, and provide for multiple levels of analysis with national level data sets as well as data supplied by local users and experts.

Pilots

Austin is also one of six pilot communities to conduct a HAZUS-driven risk assessment that complies with the DMA 2000 requirements. First, HAZUS is used to determine the hazards to which the community is susceptible. Then an inventory is taken using the existing GIS database and the HAZUS Building Information Tool (BIT) to integrate high-resolution data for point facilities and tax assessor information for the general building stock.

HAZUS uses two types of data from the GIS database: point-specific data (critical facility locations, dams) and data aggregated to a census block or tract (census information such as building square footage and occupancy class).

After the high-resolution GIS inventory data from the city are upgraded, they are put into HAZUS, which then assigns vulnerabilities to buildings and critical facilities and determines how each building would perform under a specific hazardous condition (during a flood, elevated structures would be less vulnerable than non-elevated structures). This will determine losses (number of residential buildings affected, cost, and functionality of critical facilities).

Hurricane model

The HAZUS-MH Hurricane Model allows users to estimate hurricane winds and potential damage and economic loss to residential, commercial, and industrial buildings in states along the Atlantic and Gulf coasts. It is used to estimate direct economic loss, post-storm shelter requirements, and building and tree debris.

This model is more advanced than other hurricane loss estimation models in that it incorporates wind laboratory data. In addition, the model estimates wind-induced loads, building response, and damage and loss rather than simply using historical loss data to model loss as a function of wind speed.

FEMA will continue to enhance the hurricane model by adding analytical capabilities for such additional hurricane hazards, such as storm surges.

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Resources

HAZUS-MH is available free of charge. For more information about obtaining and using HAZUS-MH, visit the HAZUS page on the FEMA website at www.fema.gov/hazus, or send an e-mail to hazus@fema.gov.

HAZUS-MH training will be conducted at FEMA's National Emergency Training Institute (EMI), on the National Emergency Training Center campus in Emmitsburg, Maryland, 75 miles north of Washington, D.C. Courses will focus on all steps of the loss estimation process, from inventory verification and improvement to loss analysis; how to use HAZUS results for mitigation as well as readiness, response, and recovery activities; and useful GIS concepts.

Courses will be given March 24–27, April 14–17, April 28–May 1, June 23–25, August 11–14, August 25–28, and September 22–25. Contact: Lillian Virgil at 301-447-1490. For more information on national and regional HAZUS training opportunities, visit www.fema.gov/hazus/tr_main.htm.