What is Hazus: An Introduction to FEMA's Hazus Program

Hazus is a nationally standardized risk modeling methodology that combines expertise from many disciplines to create actionable risk information that increases community resilience. It is distributed as free GIS-based desktop software with a collection of inventory databases for every U.S. state and territory. Hazus identifies areas with high risk for natural hazards and estimates physical, economic, and social impacts of earthquakes, hurricanes, floods, and tsunamis. The Hazus Program, managed by FEMA's Natural Hazards Risk Assessment Program, partners with other federal agencies, research institutions and regional planning authorities to ensure Hazus resources use the latest scientific and technological approaches and meet emergency management community needs.

Hazus produces a variety of actionable risk information:

- **Physical damage** to residential and commercial buildings, schools, critical facilities, and infrastructure
- **Estimated social impacts** including displaced households, shelter requirements, and exposure to floods, earthquakes, hurricanes, and tsunamis
- **Economic impacts** such as business interruptions and reconstruction costs
- **Cost effectiveness** of common mitigation strategies, such as elevating structures in a floodplain

How Hazus Works

Each Hazus model – earthquake, flood, tsunami and hurricane – combines inventory information, hazard extent and intensity data, and damage functions to estimate disaster impacts (Figure 1). Communities have access to default datasets for each of these inputs so they can quantify risk, regardless of data availability. However, users are encouraged to customize their Hazus analyses with best available data from local or authoritative sources whenever possible because the accuracy of risk assessment information is driven by the quality of modeling inputs. Hazus results are based on established science and best available nationwide data. However, like any modeled information, even when improved data are used they still contain uncertainty. Sources of uncertainty include assumptions about the categorization of buildings and flawed empirical relationships between damage, hazards, and buildings. Hazus does not quantify the uncertainty of model results. Quantifying uncertainty requires robust sensitivity analyses – repeated

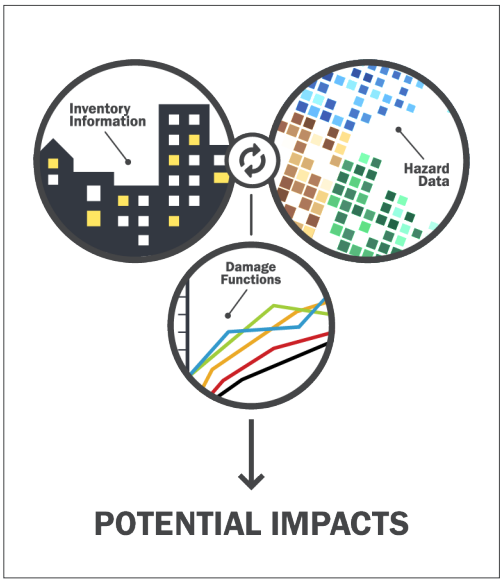

Figure 1: The Hazus Model

FEMA

model runs with changes in single building and hazard parameters – to understand the variability of model results.

Inventory Information

The Hazus General Building Stock, available for download along with Hazus software from FEMA.gov, provides a baseline inventory dataset complete with the vulnerability information required to analyze natural hazard risk. Other sources include the U.S. Army Corps of Engineers National Structure Inventory or local tax assessor offices.

Damage and Fragility Functions

A damage or fragility function is the mathematical relationship between hazard intensity and the amount of damage sustained by a building. Fragility functions measure both the amount and the likelihood of damage. The damage and fragility functions in Hazus were developed by engineering and research communities and are based on observations from past disasters and rigorous science-based evaluations.

Hazard Data

Earthquake: The U.S. Geological Survey produces earthquake hazard data called ShakeMaps that measure earthquake ground shaking as a percent of gravitational acceleration (PGA).

Flood: FEMA's Risk MAP produces flood hazard data called depth grids for probabilistic flood scenarios in communities selected for floodplain mapping projects.

Hurricane: The National Oceanic and Atmospheric Administration (NOAA) National Hurricane Center produces hurricane wind hazard data as gridded measurements of peak wind gust in miles per hour for landfalling U.S. hurricanes and probabilistic storms.

Tsunami: The NOAA Pacific Marine Environmental Laboratory produces tsunami hazard data as gridded measurements of wave depth and strength (momentum flux) for near- and distant-source tsunamis.

Read our Technical Manuals for detailed information about how each Hazus model works.

The Hazus General Building Stock

The Hazus Program provides a nationwide database of estimated building characteristics, summarized at the census block level, to facilitate baseline risk assessment in communities without building-level inventory data (Figure 2). Risk assessment results – especially those developed for flood hazards – are significantly more accurate when produced using building-level information. Building footprint data are increasingly available from local collection efforts or nationwide providers like Microsoft. However, these data often do not include the vulnerability attributes required for natural hazard risk assessment. Building characteristic distributions in the Hazus General Building Stock can serve as a starting point for analysts developing structure-level inventory databases for risk assessments. To learn more about how Hazus inventory information is used to estimate disaster impacts, read the Hazus Inventory Technical Manual.

Example Hazus Census Block: 356 Buildings

30% Residential, 20% Commercial, 10% Industrial

Occupancy Type	Residential	*All Hazards*
Median Year Built	1984	
Replacement Cost	$104/SQFT	
Foundation Type	Basement **25%**, Slab **20%**, Pile **50%**	*Flood*
First Floor Height	4 FT **50%**, 2 FT **20%**	
Number of Stories	3 **30%**, 2 **20%**, 1 **50%**	*Earthquake*
Construction Type	Masonry **50%**, Wood **40%**	
Seismic Design	High	
Wind Design	Roof Straps + Shutters **50%**, No Straps **40%**	*Hurricane*

Figure 2: Hazus General Building Stock

Learn More

The Hazus General Building Stock is a free resource, available for download here.

Hazus for Emergency Management

Mitigation planners, GIS specialists and emergency managers use Hazus for mitigation, recovery, preparedness and response. Hazus determines potential losses from disasters to identify the most effective mitigation actions to minimize losses. It also supports the risk assessment requirement in the mitigation planning process. Planners also use Hazus during real-time response efforts to estimate impacts from incoming storms or ongoing earthquake sequences.

PREPAREDNESS & RESPONSE

- The hurricane model can help assess **which hospitals will be functional** in the days following a storm.
- The earthquake model can help assess **which bridges will function** right after shaking has occurred.
- The flood model can help assess which **emergency routes might be flooded** during a storm.
- The tsunami model can identify which **residential areas will be hard to evacuate** and in need of early warning systems.

MITIGATION & RECOVERY

- **The hurricane model** can assess the benefits of hurricane straps, shutters, tie-downs, and different roof types.
- **The earthquake model** can assess the benefits of seismic retrofits and strengthening building codes.
- **The flood model** can assess the benefits of structure elevation, community buyouts, and floodplain development.
- **The tsunami model** identifies inundation areas, at-risk structures, and critical evacuation routes.

Hazus Resources

The Hazus program offers technical guidance, training, and information about ongoing and recent projects to help stakeholders complete successful risk assessments. Please review the resources listed below for assistance using Hazus and reach out to the Hazus Team with questions.

- Self-Guided Course Materials
- Sign Up for Risk Assessment Guidance
- User & Technical Manuals
- YouTube Videos
- GitHub Resources
- Contact the Hazus Team

Hazus is going open source!

Check out our growing collection of simple risk assessment tools on GitHub.