FEMA

# The Science Inside: Flood Model

HAZUS-MH is a multi-hazard risk assessment software tool that combines science, engineering, mathematical modeling, and GIS technology to estimate the potential loss of life and property damage from natural hazards (earthquake, hurricane winds, and flood). FEMA has partnered and collaborated with many agencies and organizations to make HAZUS-MH the Nation's premier hazard loss estimation methodology. See the HAZUS-MH Technical Manuals for a detailed explanation of the science inside.

| Partner—HAZUS-MH Inventory | Science | Comments |
|---|---|---|
| **U.S. Census Bureau**, Census of Population and Housing, 2000: Summary Tape File 1B Extract and Summary Tape File 3. | Provides data for Single Family Dwelling RES1, Manufactured Home RES2, and 6 Multi Family Dwelling RES3 flood-specific occupancies (Flood Manual Chapter 3) and demographics. | There are more than 8 million Census Blocks in the USA. The flood model General Building Stock (GBS) square footage inventory is aggregated by Census Block. The entire composition of the GBS within a given Census Block is assumed to be evenly distributed throughout the block. Census Block is a small enough entity to provide an accurate and detailed local mitigation flood study, yet large enough to bypass individual homeowners' privacy concerns. |
| **Dun & Bradstreet**, Business Population Report aggregated by Standard Industrial Classification (SIC) and Census Block, May 2006. | Provides data for the remaining residential (Temporary Lodging RES4, Institutional Dormitory RES5, Nursing Home RES6), Commercial, Industrial, Agricultural, Religious, Government and Education buildings—with residential, a total of 33 flood-specific occupancy classes. (Flood Manual Chapter 3) | |
| **Department of Energy (DOE)**<br>Housing Characteristics 1993. Office of Energy Markets and End Use, DOE/EIA-0314 (93), June 1995.<br>A Look at Residential Energy Consumption in 1997, DOE/EIA-0632(97), November 1999<br>A Look at Commercial Buildings in 1995: Characteristics, Energy Consumption, and Energy Expenditures, DOE/EIA-0625(95), October 1998. | The three DOE reports helped define regional variations in characteristics such as number and size of garages, type of foundation, and number of stories. The inventory's baseline floor area is based on a distribution contained in the DOE's Energy Consumption Report. The valuation of single-family residential homes accounts for income as a factor on the cost of housing. | |
| **Federal Insurance and Mitigation Administration (FIMA), U.S. Army Corps of Engineers (USACE),** and the **USACE Institute for Water Resources (USACE IWR)** | Damage is estimated in percent and is weighted by the area of inundation at a given depth for a given census block or tract, with consideration for the specific occupancy classifications, building type, and income. (Flood Manual Chapter 5.3.1) | |
| **RS Means**, Construction Cost Data, 2006 http://www.rsmeans.com/ | RS Means is used to calculate location-specific damage cost estimates from square footage data. | |

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| **U.S. Geological Survey (USGS)**<br>30-meter National Elevation Dataset<br>Stream gage data<br>Hydrologic analysis using USGS-developed regional regression equations | Used to provide the Digital Elevation Model in a Level 1 Analysis. The resulting GIS model is in a grid format with each cell attributed to either a given flood depth or depth frequency information such as the mean, standard deviation, and coefficient of skew of the probability density function that describes the depth-frequency relation. The collection of cells where the flood elevation equals the ground elevation forms the floodplain boundaries.<br>HAZUS-MH algorithms define the extent of the floodplain and interpolate flood elevations between user-supplied digital cross sections. This automatically provides the most detailed digital topographic and flood elevation data available to the user. | For users with knowledge of the local flood hazard and a familiarity with ESRI's ArcGIS, HAZUS-MH offers the Flood Information Tool (FIT). FIT is an ArcGIS extension designed to process user-supplied flood hazard data (e.g., ground elevations, flood elevations, and floodplain boundary information) to compute the extent, depth, and elevation of flooding for riverine and coastal hazards. |
| **Federal Emergency Management Agency (FEMA)**<br>FEMA (1995, 2002) Guidelines and Specifications<br>Digital Flood Insurance Rate Maps (DFIRMs)<br>Q3 digital flood maps<br>Storm Surge Inundation Maps (2003) | Using the FIT tool, loss estimations based on the National Flood Insurance Programs (NFIP) flood maps are possible.<br>Likewise with the FIT tool, three FEMA-type models (dune/bluff erosion, wave height, wave runup) are available to calculate water surface elevations (including wave effects), flood depths and flood hazard zones.<br>HAZUS-MH can compute coastal flood hazards for flood return periods between 10 years and 500 years. HAZUS contains simplifications to FEMA's erosion, WHAFIS, and RUNUP models which allow users to estimate flood hazards with less input and knowledge than that required by FEMA's models. | Coastal flood hazard computations made by HAZUS-MH extend and improve some aspects of FEMA's models by incorporating more recent scientific developments, such as improved wave regeneration coefficients.<br>HAZUS-MH allows the user to examine the effects of long-term erosion and shore protection through "what-if" analyses. |
| **Other Partners and Resources**<br>USACE (2003) Coastal Engineering Manual<br>The H. John Heinz III Center for Science, Economics and the Environment<br>U.S. Water Resources Council<br>National Research Council<br>National Oceanic and Atmospheric Administration (NOAA)<br>NOAA's National Weather Service<br>Old Dominion University<br>University of Wisconsin | Erosion assessment used by HAZUS-MH accounts for multiple dunes, unlike normal FEMA erosion assessment procedure.<br>Wave runup model applied by HAZUS-MH is a modified version of FEMA's RUNUP 2.0 model, using procedures outlined in the USACE manual.<br>HAZUS-MH wave overtopping results are estimated using wave runup height and freeboard, and do not require overtopping rates to be calculated.<br>HAZUS-MH uses standard wave growth equations (USACE, 1984) and wind speeds approximated from the National Bureau of Standards (1979).<br>The wave height model uses an improved wave regeneration algorithm. The WHAFIS wave height regeneration algorithm is based on a typical case (fixed water depth and wind speed) analyzed by the National Academy of Sciences (1977), and its fetch factors are a function of fetch length only. The wave height model fetch factors are a function of fetch length, coast, and return period (the latter two parameters introduce a dependence on wind speed). | Wave runup will not be calculated for open wetland shore types, or for any store type profile which fails to rise above the flood stillwater elevation (submerged profile). |