Hazus 6.0 Baseline Data Updates

Hazus baseline datasets were updated significantly with the Hazus 6.0 release. Use this document to review the Hazus inventory and hazard data updates and explore how they influence Hazus results.

Hazus Inventory Data

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 on FEMA's Map Service Center - Hazus page,

Inventory Information

Hazus baseline inventory datasets consist of demographics, buildings, essential facilities, transportation and utility systems, and vulnerability information required to analyze each natural hazard risk.

Hazus baseline inventory datasets can be categorized as follows:

- *Demographics data:* baseline data for characteristics of the population, including age, income, and housing, among others.
- *General Building Stock (GBS):* baseline data for occupancy and building types; building characteristics; economic values such as structure replacement value, contents replacement value, county modification factors, depreciated building replacement values, business inventory, relocation expenses (i.e., rental and disruption costs), and loss of income.
- *Essential Facilities (EF)*: baseline data for medical care facilities, fire stations, police stations, emergency operations centers (EOC), and schools.
- *Transportation systems*: baseline transportation systems data for highways, railways, light rails, buses, and airports, classified into components such as bridges, stretches of roadway or track, terminals, and port warehouses, among others.
- *Utility systems*: baseline utility systems data for potable water, electric power, wastewater, communications, and liquid fuels (i.e., oil and gas).

Learn more about the Hazus Inventory

For more detailed information on each inventory item and valuation methodology, check out the Hazus Inventory Technical Manual here.

Hazus 6.0 Data Updates

The Hazus Team made significant updates to many of the Hazus baseline datasets. A summary is provided below and detailed information can be found in the Hazus Inventory Technical Manual.

GBS Data Updates

Nationwide Structure Inventory (NSI 2022) from the U.S. Army Corps of Engineers (USACE) served as the primary data source for the GBS updates for the continental United States (CONUS), Alaska, and Hawaii. NSI 2022 is more complete and vastly improves non-residential buildings data when compared to the previously used Hazus GBS datasets. NSI 2022 uses a combination of data sources to derive site-specific building data for the U.S. Data developed by the FEMA Hazus team for the Hazus 5.0 Caribbean model updates were used for Puerto Rico (PR) and the U.S. Virgin Islands (VI) (more detail here). Data developed by FEMA's Natural Hazards Risk Assessment Program (NHRAP) from Open Data DC in 2022 was used as the primary data source for the District of Columbia (DC). For the Pacific Territories, updates were made to existing data using USA Structures and NHRAP lidar building footprints.

Attributes for foundation type and number of stories, from Lightbox Parcel data in NSI 2022, greatly improve replacement cost valuation for CONUS, Alaska, and Hawaii, over previous regionally estimated Census methods. Similarly, multi-family attributions from the parcel data improve the accuracy of multi-family RES3 assignment, classification, and ultimately replacement cost valuation.

For more refinement to the Hazus specific occupancy type classifications, the Hazus Team moved from the previous Standard Industrial Classification (SIC) to the more detailed North American Industry Classification System (NAICS). Use of site-specific building data and occupancy information for schools, colleges, hospitals, medical facilities, and nursing homes greatly improved the counts, area, and valuation data for EDU1, EDU2, COM6, COM7, and RES6 occupancy types. Parking structures (COM10) values are now included. Government (GOV1) occupancy types are more complete and better represented.

2022 data derived from RSMeans was used to update the square footage replacement costs for all occupancy types and county-level modification factors that account for regional cost differences of building materials and construction services. Proportions of custom, good, average, and economy construction styles for single-family residences were updated based on American Community Survey (ACS) 2020 provided household incomes in each Census block relative to the state median income.

2020 data from the Bureau of Economic Analysis (BEA) and Bureau of Labor and Statistics (BLS) highlighted the need for large increases to the inventory valuations used by Hazus. Wage, rental, capital, and other relocation costs were updated using the 2021 Consumer Price Index (CPI).

When compared to Hazus 5.1, the improved data and methodology resulted in a 44% increase nationally for the total building exposure per capita. This is largely due to more complete building stock information available from NSI 2022 and enhanced valuation methodologies.

Demographics Data Updates

Demographics data in Hazus is developed using the U.S. Decennial Census and ACS. In Hazus 6.0, demographics data were updated from the 2010 U.S. Census and ACS values to reflect 2020 U.S. Census and ACS values.

The Hazus Team also developed new methodology to better estimate time-of-day population by using Longitudinal Employer and Household Data (LEHD) from NSI 2022, instead of using regional estimates derived from census data. In addition, school enrollment data from multiple sources were used to develop more accurate school populations. This means education buildings, such as colleges and universities, and working industrial and commercial populations are directly tied to EDU and IND building types at the tract level, whereas before these values were generated using regional estimates.

Dasymetric Data Updates

Dasymetric mapping is a geospatial technique that uses information such as land cover types to more accurately distribute data that have been assigned to selected boundaries like census blocks (Figure 1). In Hazus 6.0, census block developed areas are more accurately defined by using a combination of building footprints and Land Use Land Cover (LULC) data as opposed to LULC data alone. Blocks with no building exposure or population were omitted. This approach vastly improves data accuracy and precision and reduces flood model analysis times for most scenarios. We also leveraged dasymetric approaches to better locate census tract centroids. Centroids are used for the hurricane model and some earthquake scenario types.

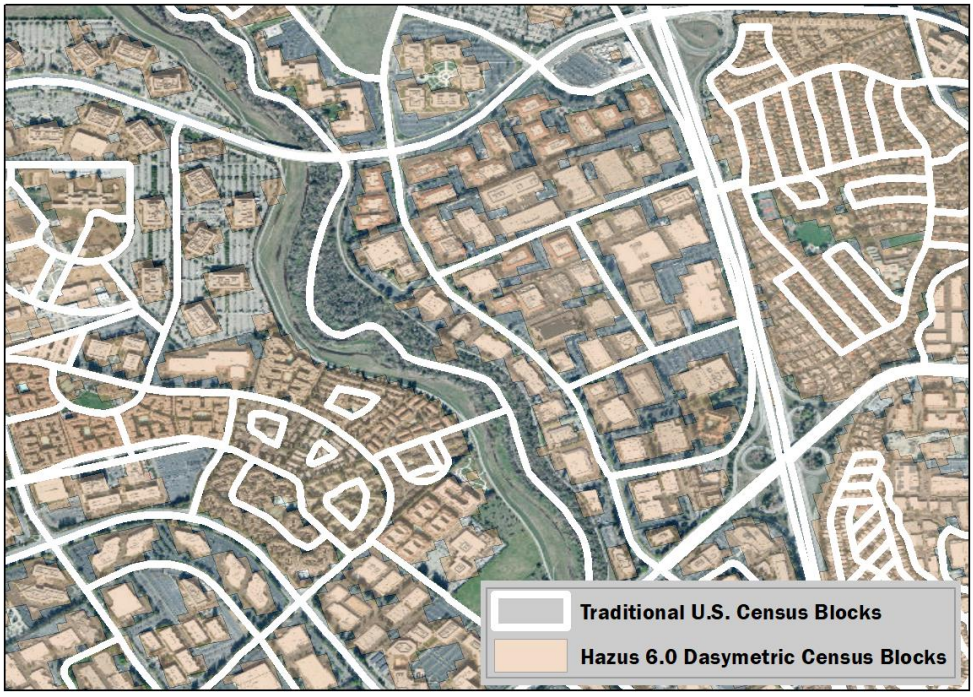

Figure 1. Example of new dasymetric census blocks in Hazus 6.0 compared to the traditional 2020 U.S. census blocks and world imagery.

This means that in Hazus 6.0 we are optimizing analysis and more accurately delineating damages in the areas of the community that includes the built environment.

Essential Facility Data Updates
Hazus utilizes HIFLD Open for hospitals, EOCs, fire stations, police stations and schools.

Building area and valuation attributes were developed using enhanced data and methodology. New area per bed ratios developed for hospitals and medical facilities significantly increase the exposure and replacement cost valuations for hospital infrastructure. Per pupil enrollment data to building area relationships is refined by school type and region. Police and fire valuations are based on station type, as well as urban and rural designations.

Transportation Data Updates
Hazus utilizes HIFLD Open for airport facilities, runways, bus facilities, highway bridges and tunnels, light-rail facilities and routes, railway bridges and segments, and port facilities.

New airport runway valuations leverage information on materials, length, and width to provide enhanced valuations appropriately based on runaway usage and type. Highway bridge updates have reclassified newly retrofitted bridges into less vulnerable bridge classes. Rail segment valuations were updated and for light rail segments the entire replacement cost for each route is provided.

Utility Data Updates
Hazus utilizes HIFLD Open for electric power, natural gas facilities and pipelines, and wastewater facilities. New methods were developed to better classify and value natural gas pipelines, to prevent duplicate records in wastewater facilities, and to refine electric power classifications and facility value based on output and other attributes.

Community Layer, Tribal Reservation, and Watershed Updates
Hazus was updated using the 2022 National Flood Insurance Program (NFIP), Map Production Pro (MPP) jurisdiction layer, and March 31, 2022 Community Status Information for the latest NFIP entry date and participation information. Since the MPP no longer includes tribal areas or Special Land Use Areas (SLUAs), those were incorporated using the 2020 version of the NFIP Community Layer. The watershed layer was updated using the 2022 Hydrologic Unit Code (HUC8) from the USGS Watershed Boundary Dataset and expanded to cover all 56 Hazus states and territories. Updating these layers allows Hazus users to develop accurate Study Regions for communities, tribal areas, and watersheds.

Hazard Data Updates
Hazard data updates improve Hazus modeling capabilities by leveraging best available public data and enhanced methodologies. The following hazard data updates were made for the hurricane and earthquake models.

- Hurricane: For the hurricane model the Hazus Team updated windspeed data from probabilistic and historic storm scenarios. New 2019 National Land Cover Databases (NLCD), including tree canopy data from the 2021 Forest Inventory Analysis, were used to develop updated surface roughness and tree coverage values for both Census tract and block level data. Data obtained for Puerto Rico from the most recent Forest Inventory Analysis data as of 2021 and NLCD tree canopy percentage data resulted in a 3-fold drop in

the average density of stems per acre. The historic storm scenarios available in Hazus increased from 94 to 207 storms and incorporate all available observed data. Updated probabilistic hazard data follows the new American Society of Civil Engineers (ASCE) 7-22 approach, incorporating a 300,000-year record for storms for CONUS. Topographic speedup capabilities are now included in Hawaii, Puerto Rico and the U.S. Virgin Islands.

- Earthquake: For the earthquake model the Hazus Team updated ground shaking data provided by the latest USGS Long-term National Seismic Hazard Data Model (Figure 2). These are updated based on the 2018 data for CONUS and 2021 for Hawaii. It should be noted that older data are still used for Alaska (2007), Puerto Rico (2003), and the U.S. Virgin Islands (2003).

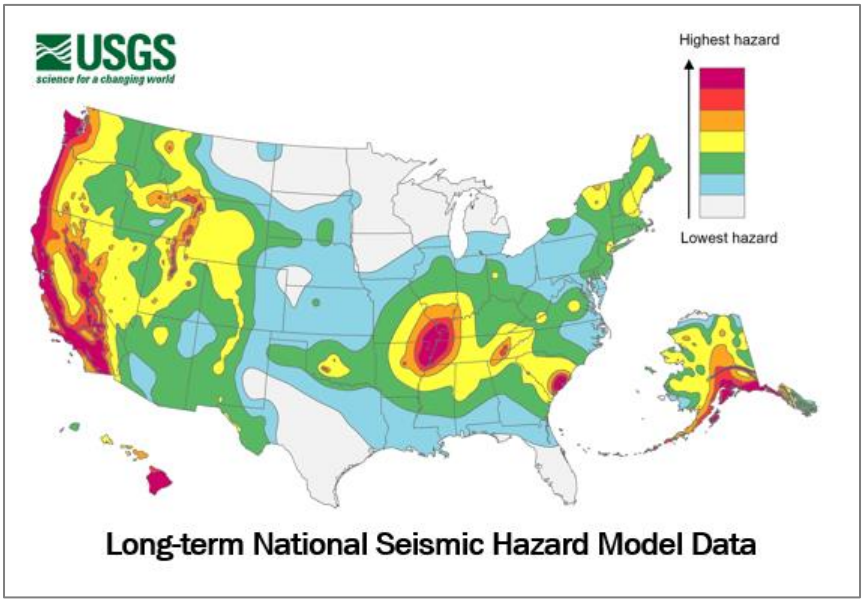

Figure 2. A map of the new ground shaking data from the USGS, used by the Earthquake Model for a probabilistic earthquake analysis.

How Data Updates Impact Results

The Hazus 6.0 baseline data updates directly affect previous Hazus results, shown below. The results below demonstrate expected changes based on the data updates described in this fact sheet. The Ridgecrest earthquake is a good example that reflects the improvements to the non-residential building exposure and valuations including government occupancies in the area impacted by the event. Both the Hurricane Laura coastal surge and Michael wind loss scenarios reflect the national average ~40% overall increase in building exposure and valuations. The Flathead River scenario is in a region where the overall exposure and valuations increased more than 70%, however, the more refined dasymetric geometries results in lower losses since far less developed areas are exposed to lower severity flood events.

Earthquake Model Results

Hazus Loss Library Scenario	Study Region	Total Loss – Hazus Loss Library Results	Total Loss - Hazus 6.0 Results	% Change in Total Loss (▲Increase/▼Decrease)
M 7.1 - Ridgecrest, California	California	$148 Million	$295 Million	99% ▲

Earthquake results are significantly impacted by centroid updates, GBS, and demographics. Another reason for changes to earthquake results is that significant increases in the non-single-family occupancy types generally result in an increase in the severity of building damage since non-single-family buildings, especially in western states, comprise larger percentages of vulnerable building types. Moving to the use of day and night population data from the LEHD estimated at the building level ensures the casualty by occupancy type relationships are far more accurate than the regional census data used previously. Educational, commercial, and industrial casualties now better represent the expected performance for these building types. This means results at the tract level can better support the development of mitigation strategies focused on mitigating vulnerabilities associated with these building types.

Flood Model Results

Hazus Loss Library Scenario	Study Region	Total Loss – Hazus Loss Library Results	Total Loss - Hazus 6.0 Results	% Change in Total Loss (▲Increase/▼Decrease)
Historic Coastal Flood: Hurricane Laura (2020)	Louisiana	$1.8 Billion	$2.4 Billion	33%▲
Flathead River at Columbia Falls, MT (Gage 12363000); Gage Height: 12.5ft	Montana	$10 Million	$9.5 Million	5%▼

Flood results are significantly impacted by the new dasymetric geometries, GBS, demographics, and community layer data updates. As a result of the refined dasymetric geometries, exposure and losses to lower severity flood events will be reduced, however, losses from significant or catastrophic flood events increase because of more complete building data and increases in valuations. Another reason for changes to flood results is that new post-2000 year-built categories were created so higher percentages of post-FIRM construction are estimated when warranted based on the community's initial entry year into the NFIP.

Hurricane Model Results

Hazus Loss Library Scenario	Study Region	Total Loss – Hazus Loss Library Results	Total Loss - Hazus 6.0 Results	% Change in Total Loss (▲Increase/▼Decrease)
Hurricane Michael, Observed for Hurricane Wind	Alabama, Florida, Georgia	$6.2 Billion	$8.6 Billion	39%▲

Hurricane results are significantly impacted by baseline hurricane hazard data updates, GBS, and demographics data updates. Another reason for changes to hurricane results is due to the improved dasymetric data. These were used to better locate tract centroids over developed areas for more accurate estimates of wind speeds and distance to coast in all 36 azimuthal directions.

Tsunami Model Results

Hazus Loss Library Scenario	Study Region	Total Loss – Hazus Loss Library Results	Total Loss - Hazus 6.0 Results	% Change in Total Loss (▲Increase/▼Decrease)
Tsunami, Honolulu City/County Mitigation Plan Great Aleutian Scenario	Honolulu City/County	$7.5 Billion	$20.2 Billion	63%▲

Tsunami results are significantly impacted by new dasymetric geometries, GBS, and demographics data updates. The exterior wall type, number of stories, and year of construction information greatly refined the accuracy of the seismic building types (mid-, low-, and high-rise) and improved seismic code level assignments used to determine the tsunami velocity and depth fragility functions. A defect that underestimated content and non-structural building losses will also result in increased losses for tsunami model users. The use of day and night population data from the LEHD estimated at the building level improves the pedestrian evacuation and casualty model so that it more accurately estimates the population impacted, including new over and under age 65 population updates.

Learn more about the Hazus Inventory

The Hazus Team encourages users to continue to explore the benefits of using new Hazus 6.0 baselines inventories. For additional information about data updates and how they apply to each model read the Hazus Technical and User Manuals and reach out to the Hazus Team with questions.