

Risk MAP CDS
Hazus 4.0
User Release Notes

Version 1.0

March 20, 2017

Document Management History

Revision History

Version Number	Date	Summary of Changes	Team/Author
1.0	03/20/2017	Initial version	Risk MAP CDS

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1. Introduction

Hazus Release 4.0 is a full versioned software release, implementing the major addition of the Tsunami hazard module, described below. Three minor defect fixes are also included within Flood and Earthquake. Hazus 4.0 is compatible with ArcGIS 10.4 and is supported for 64-bit Windows 7 and Windows 8.1, and Windows 10 operating systems.

Hazus 4.0 will be released via the [FEMA Flood Map Service Center \(MSC\) Hazus download webpage](#) for free public download. Updated state and new territory databases for the five states and five territories available for Tsunami will also be available for download. The scheduled release date is March 20, 2017

The purpose of this document is to describe the functional changes and known issues found in the Hazus 4.0 release and to provide clarification on new methodology implemented in Tsunami.

Please note, there are no User or Technical Manuals, or training courses, for Hazus Tsunami at this time. The Tsunami methodology was first developed and documented in 2013, and is available for download here: [FEMA Flood Map Service Center \(MSC\) Hazus download webpage](#)

It is assumed the users of Hazus Tsunami already have a basic functional understanding of other Hazus hazard modules, as well as the physical properties of tsunamis and the types of risks they pose.

2. Contents of the Release

Installation:

- After uninstalling Hazus 3.2 or any other version of Hazus, it is always recommended to uninstall all Microsoft SQL Server components as well. To do this, go to Windows Control Panel → Uninstall Programs and remove any instances of Microsoft SQL Server or related products
- Users should make sure to delete the C:\HazusData folder after uninstalling Hazus 3.2 to avoid duplicate Hazard Data Input folders being created
- When installing ArcGIS 10.4, a patch must be applied for Hazus 3.2 or 4.0 to properly display ArcGIS attribute tables from the ArcMap Table of Contents. All other Hazus capability will function without this patch; the patch is only for the proper display of attribute tables. The patch is available at: <http://support.esri.com/download/7427>
- Users should use a location other than the root C:\ drive for extracting the HAZUS_APP zip. When extracting the zip file, extract the files to an existing folder, or a new folder such as C:\HazusApp

Tsunami Model – Aggregation:

- **The ArcGIS Spatial Analyst Extension must be enabled to use Tsunami**
- Hazus Tsunami offers two types of hazard analysis based on the location of the

source earthquake that caused the tsunami:

1. Distant Source (**Tsunami Only**), where the earthquake occurs far enough from land or deep enough in the ocean such that coastal areas will only see impact from inundation, but not ground shaking. For this type of study region, select only the Tsunami checkbox in the aggregation wizard
 2. Near Shore (**Combined Tsunami & Earthquake**), where the earthquake is near enough to the landmass that coastal areas will experience impacts from both earthquake and tsunami – for this type of analysis, select both Earthquake and Tsunami checkboxes in the aggregation wizard
- Much like Hazus Hurricane is only available for states vulnerable to hurricanes, Hazus Tsunami is only available for a selection of high risk U.S. States and Territories. Hazus Tsunami is only available for the following states/territories:
 1. Alaska
 2. Washington
 3. Oregon
 4. California
 5. Hawaii
 6. Northern Mariana Islands (Tsunami only)
 7. American Samoa (Tsunami only)
 8. Guam (Tsunami only)
 9. Puerto Rico
 10. U.S. Virgin Islands (Tsunami only)

If the user selects either Tsunami or Tsunami + Earthquake for their study region, the state list in the aggregation wizard will be filtered to these states. **Please note at this time, standalone earthquake analysis is not complete for the U.S. territories and should not be run independent of tsunami analysis. The functionality to run the standalone earthquake analysis is available for the territories, but results should not be used until development and testing on that analysis component is complete**

- If an Earthquake + Tsunami study region is aggregated for any of the states listed above, the user will be asked to select which hazard to open first in the study region. Hazus will default to Earthquake and users must first run the Earthquake analysis before switching to Tsunami to produce combined losses.
- Hazus supports aggregation of multi-hazard study regions (Earthquake, Flood, Hurricane and Tsunami), however, the user can streamline study region size and aggregation if hazards are separated

Tsunami Model – Inventory Data:

- Hazus Tsunami General Building Stock (GBS) does not use the aggregate Census

data used by other models. Instead, Tsunami GBS is comprised of the U.S. Army Corps of Engineers' National Structure Inventory (USACE NSI) point data. NSI point data creates notional structures, or "points," in the developed portion of each census block to represent the numbers and types of building that occur in the Census Block based on size, occupancy type, construction material, etc. Additional information can be found at the links in the introduction of this document.

NSI data is in the process of being posted online. Once complete, the inventory will be available at: <http://www.hec.usace.army.mil/fwlink/?linkid=7>

Prior to completion of the NSI USACE site, NSI data can be downloaded here: https://data.femadata.com/FIMA/NSI_2010/

The NSI data dictionary is available at: https://data.femadata.com/FIMA/NSI_2010/NSI../2010NSIRawDataDictionary.docx

- Quality checks on the NSI data for territories were focused mainly on potential inundation areas from tsunamis. In these areas, users can expect to see the best agreement between NSI data points and site specific building data.
- Metadata for the NSI data can be accessed through the Hazus menus under Inventory → General Building Stock and selecting any of the four parameters. Once a table is open, right click anywhere in the table and select "Meta Data." Note, for states and building types where point data were already available, Hazus uses the default state data
- In the territories, since Census Block housing and demographic data are unavailable, a 1 x 1 km grid derived from 2014 Landscan is used as a substitute to display inventory and results
- For any combined (TS + EQ) results, these results can be viewed in Tsunami only
- When viewing Results, please note the values for damage are **building counts aggregated by damage state probabilities**. This may lead to "counts" of damaged buildings with decimals, giving the appearance that fractions of buildings were counted. This methodology has been used in Hazus for a number of years and was vetted by the Tsunami Committee

Tsunami Model – User Data:

- Hazus Tsunami relies on varying levels of user input for the hazard, much like Hazus Flood. The table below summarizes Tsunami User Data options under the Hazard menu. For definitions of the terms, please see the documentation linked in the introduction of this document:

	Hazard Data Required	Input Data Files and Formats
Level 1	Runup Only - Mean Sea Level (MSL)	1. Maximum Runup height grid in raster format 2. DEM raster (download option for USGS provided similar to flood module)
	Quick Look - Single Maximum Runup	1. DEM raster and single maximum runup value (MSL)
Level 2	Depth Above Ground Level (AGL) and Velocity	Maximum Depth grid and Velocity grid in raster format ---OR--- Maximum Depth and velocity NetCDF NOAA SIFT (.nc) files
Level 3	Depth AGL (ft) and Momentum Flux (ft ³ sec ²)	1. Median Depth grid in raster format 2. Median Momentum Flux grid in raster format

**Note, in the User Data wizard, there are multiple opportunities depending on Analysis Level and file format to specify the units of the data you are using (Level 3 assumes user provided data are already in required units). The user has the flexibility to specify the units on the files they are importing. There is no system validation on units performed by Hazus*

*****Additionally, sample case study data is available for all analysis levels on the MSC website, to demonstrate best practices in preparing tsunami hazard data. For notes on file preparation, please see Appendix A***

- Due to changes made in Hazus 3.2 and CDMS it is strongly recommended that users utilize CDMS when importing user-defined facilities (UDF) For Tsunami-only study regions, the UDF import option in the study region has limited view-only capability for feature classes only. Users are advised to import UDF through CDMS prior to aggregation. If working with the Earthquake hazard, users are encouraged to use AEBM as much as possible whenever user data is available for use in Hazus
- Similarly, when viewing combined (Tsunami + Earthquake) results, note that viewing UDF results through EQ will contain EQ only impacts and the economic loss estimate may be unreliable due to the shift towards AEBM. Recall combined (TS + EQ) results can only be viewed through Tsunami. Only a single probability of structural damage state parameter informs UDF damage in the EQ interface.
- When using CDMS to import UDF in feature class format, all table names must be at least FOUR characters for successful import
- For any combined (TS + EQ) results, these results can be viewed in Tsunami only

Tsunami Model – Evacuation and Casualty Module:

- Hazus Tsunami makes use of a USGS methodology for estimating evacuation times based on warning times and road networks, and potential loss of life. Details are available at: <https://geography.wr.usgs.gov/science/vulnerability/tools.html>. **Prior**

to running the Casualty model, the user must first run the tsunami analysis. Hazus will prompt you to do this if it is not already done. To run the Casualty module:

1. Open a Tsunami study region and go to Analysis → Casualty
2. Select the option to “Download TIGER Roadway Network”
3. Go to Analysis → Casualty → Level 1. The following data will be required:
 - A DEM for the study region
 - A road network provided by user or from the TIGER file downloaded in Step #2
 - Hazard Boundary: This is the inundation hazard boundary (depth > 0) that can be provided by the user or the tsHazard polygon in the Study Region folder may be used as a default. This is subtracted from the Study Region and the remaining study region area becomes the Safe Zone. However, users should review this input to determine if slivers along the coast or other small pockets that intersect the road network might result in areas that would not be considered safe areas for evacuation and remove those.
 - Fatality Boundary: This is the portion of the inundation hazard where the flood depths are expected to be 2 meters or greater in depth (Fatality Rate = 99%). This can be provided by the user or the tsFatality polygon in the Study Region folder may be used as a default. This is subtracted from the Study Region and the remaining study region area becomes the Partial Safe Zone. However, users should review this input to determine if slivers along the coast or other small pockets that intersect the road network might result in areas that would not be considered safe areas for evacuation and remove those.
4. In the Casualty Level 1 dialog box, enter values for Arrival Time, Time to Maximum Runup, and Warning Time. Holding the cursor over each entry box will provide a brief description of the fields and where additional information is available from NOAA, if needed. Note: Warning time cannot exceed arrival time; if you enter values inconsistent with this, Hazus will prompt you to change them
5. Complete the remaining wizard screens by entering any non-default parameters you wish to adjust. Note, the casualty analysis will run upon completion of the wizard
6. To view Casualty results, go to Results → Casualties and results are provided for 3 levels of community preparedness, night and day, as well as over and under age 65.

- Like other “Level 1” analyses in Hazus, Casualty Level 1 is considered an estimation tool with minimal requirements for data input. A more comprehensive tool is available by using Casualty Level 2

- The Casualty Level 2 menu utilizes the travel time to the Safe Zone (depth <0) and to the Partially Safe Zone (depth >2m) provided by the USGS Pedestrian Evacuation Analysis tool
- The USGS Pedestrian Evacuation Analysis tool must be run on a machine with ArcGIS Advanced license

Flood Model:

- No changes to the flood model were made as a part of this release

Earthquake Model:

- An existing defect in the AEBM Individual Building Report was resolved; the report now displays correctly
- A change was made to the buffers surrounding ShakeMap grid cells. Previously, there is existed a possibility for overlap of the buffers, causing point structures (EF or UDF) to report falsely inflated PGA values
- A friendly reminder to avoid using the EQ study region interface to add or edit UDF data. It is recommended to use the AEBM module through CDMS as much as possible. Any UDF which must be imported through the study region must be in spatial table (feature class) MDB format. Access MDBs are no longer supported for import directly into the study region

Hurricane Model:

- No changes to the hurricane model were made as a part of this release

Shell and Utility Items:

- The entire Hazus application is currently compatible with ArcGIS 10.4. Additional changes were made in Hazus 3.2 to minimize the dependency on ArcGIS versions. For this reason, Hazus may be installed on and used on versions later than 10.4; however, these versions are not certified or supported by the Hazus program. Installation and use of Hazus on ArcGIS 10.4.1 or later versions are done at the user's risk, with no guarantee Hazus 4.0 or Tsunami will run on 10.4.1 or later

CDMS and Data Changes:

- New state data is available for the Tsunami states and territories. Please download from MSC before running Tsunami. If using old data, your tsunami study region won't aggregate
- **Sample case study data is available for all analysis levels on the MSC website, to demonstrate best practices in preparing tsunami hazard data. For notes on file preparation, please see Appendix A**

3. Known Issues

This section outlines issues that are known to occur in Hazus 4.0, but were present prior to 4.0 development. Workarounds are provided where applicable.

- If an Esri Basemap is added to a Hazus study region, and then the .mxd saved and reopened, Hazus menu options will not appear. This is a known issue in ArcMap and can be limited by **installing the Esri Data Interoperability Extension, but not enabling it**. This workaround is not guaranteed and must be done at the user's risk
- A latent defect exists in the Hazus flood model which prevents Hazus from appropriately determining whether a riverine or coastal damage function should be used for a user-defined facility (UDF) in a combined riverine-coastal or coastal-only scenario. When working in coastal regions, an incorrect default damage function will be applied to an individual facility. Two workarounds are available:
 - Determine the correct damage function ID (3-digit unique identifier) from the damage function library according to the UDF characteristics, and whether a riverine or coastal hazard is being applied. Specify the damage function ID in the provided column within the UDF data entry window. Confirm the specific occupancy, number of stories, and foundation type (which indicates whether a basement is present) of the damage function matches that of the UDF.
 - In the damage function library, search for the desired depth damage function. Select this function (selected function will display in green in the preview window above the list of functions). Selected functions will also appear highlighted in yellow on the Structure/Contents/Inventory summary tabs. Hazus will apply the selected functions to the UDF list. Confirm the specific occupancy, number of stories, and whether a basement is present of the function matches those of the UDFs. Note: this bullet is applicable for UDF analysis only. Applying this workaround to GBS analysis is not recommended, and can result in incorrect GBS results.
- CDMS users at the FEMA's Emergency Management Institute (EMI) and users with similar workstation security settings may be unable to export to Excel. Please contact the Hazus Help Desk for a workaround: hazus-support@riskmapcds.com
- The table below lists the high priority latent defects which were identified during development or testing of past Hazus releases. The term "latent" refers specifically to a defect that pre-existed and is reproducible in previous versions of the Hazus software (Hazus 3.2 or earlier). This is not a complete list of open defects in Hazus; however, users should be aware of these high-priority issues. Each item will be reviewed and prioritized to be addressed in later releases, and are currently under consideration for inclusion in Hazus 4.1.

ID	Description	Functional Area
18969	Pipeline data does not export correctly from CDMS; no spatial data is created in the export	CDMS
21593	When inventory building counts are larger than 30,000; an empty table is displayed	Inventory
15845	When running a basic flood analysis, the A/CA/V zones created by Hazus are incorrect.	Flood
15822	Custom depth damage functions are not being applied correctly in the flood model	Flood
15819	The egress and utility shelter parameters in the flood model do not work	Flood
15815	The demographic shelter parameters in the flood model do not work	Flood
17500, 19840	Some study regions produce all problem reaches during the hydrology process in the flood model.	Flood
17742	Oklahoma dasymetric data crashes the analysis in the flood model	Flood
18997	When running a riverine analysis for Hawaii, all reaches are problem reaches	Flood
19008	UDF analysis for coastal-only flood study regions will use riverine damage functions. To avoid this, use the workaround provided earlier in this section	Flood
19002	User-Defined Facility flood results for RES1 specific occupancy are not generating correctly	Flood
16190	Historical coastal surge produces an error in some instances	Hurricane
18868	In a probabilistic hurricane analysis, wind speeds and building results decrease for the 1000-year return period compared to other return periods. The 1000-year event should have the highest wind speeds and worst damage	Hurricane
18893	Probabilistic hurricane analysis for Hawaii does not work.	Hurricane
18999	Losses to medium and large hospitals are disproportionately larger than losses for small hospitals	Hurricane
19040	Wind Building Characteristics Distribution does not show up for the Census Blocks for the hurricane model.	Hurricane
19041	New mapping schemes for essential facilities in hurricane are not saved, or applied to the individual facilities	Hurricane
19050	Damage to manufactured housing following a hurricane is less than that of more sturdy structures	Hurricane

19055	The Deep Water Surge option for surge analysis fails for user-defined or Hurrevac storms	Hurricane
19063	Users cannot edit tunnel damage functions in the earthquake model	Earthquake
19003	Electric power system performance does not populate in the earthquake model	Earthquake
15704, 15705, 16177	Indirect economic loss does not work in any model	All

Appendix A

Hazard Input Sample Data and User Tips

Since Hazus Tsunami utilizes authoritative hazard data sets from external providers, rather than creating hazard data, sample data from NOAA Pacific Marine Environmental Laboratory (PMEL) are provided so that users can review and understand input requirements for all 3 level of analysis.

Sample data are prepared for each level of analysis based on data provided for 5 of the PMEL forecast inundation model communities: <http://nctr.pmel.noaa.gov/sim.html>

Community	County	Scenario	Level 1	Level 2	Level 3
Homer, AK	Kenai	M 9.2 1964 Alaska	hom_dem_ft hom_maxR_ft	hom_maxdg_ft hom_maxv_ftsec	hom_dg_ft_median hom_flux_ft3sec2_med ian
Crescent City, CA	Del Norte	M 9.0 Cascadia	crc_dem_ft crc_maxR_ft	crc_maxdg_ft crc_maxv_ftsec	crc_dg_ft_median crc_flux_ft3sec2_med ian
Kahului, HI	Maui	M 9.0 Cascadia	kah_dem_ft kah_maxR_ft	kah_maxdg_ft kah_maxv_ftsec	kah_dg_ft_median kah_flux_ft3sec2_me dian
Giribaldi, OR	Tillamook	M 9.0 Cascadia	gar_dem_ft gar_maxR_ft	gar_maxdg_ft gar_maxv_ftsec	gar_dg_ft_median gar_flux_ft3sec2_med ian
Westport, WA	Grays Harbor	M 9.0 Cascadia	wes_dem_ft wes_maxR_ft	wes_maxdg_ft wes_maxv_ftsec	wes_dg_ft_median wes_flux_ft3sec2_me dian

Notes:

- Level 1: DEMs include post-earthquake ground deformation (feet) for near source scenarios; Max runup (maxR, feet) relative to Mean Sea Level (MSL)
- Level 2: Depth grids are maximum depths (maxdg) in feet above ground level; maximum velocity (maxv) in feet/sec.
- Level 3: Depth grids are median depths in feet above ground level; momentum flux is median values in ft^3sec^2 .

The hazard data (runup and velocity) were developed using NOAA's SIFT (Short-term Inundation Forecasting for Tsunamis) system: <http://nctr.pmel.noaa.gov/tsunami-forecast.html>

For additional information, including access to SIFT products please see: <http://nctr.pmel.noaa.gov/>

In addition, each tsunami State and Territory have also developed or are actively working on the development of tsunami hazard data. Many of these datasets are available on line or can be obtained through State contacts. A summary of some of the State efforts is here: http://nctr.pmel.noaa.gov/hazard_assessment.html

The National Tsunami Hazard Mitigation Program (NTHMP) provides a comprehensive lists of State Agency partners:

<http://nws.weather.gov/nthmp/statesandterritories.html>

as well as official NTHMP Coordinating Members:

<http://nws.weather.gov/nthmp/documents/OfficialDesignees.pdf>

User Tips for Tsunami Hazard Inputs:

- Each State provides hazard data in different GIS formats and units, although the Hazus GUI helps provide the ability to convert units, the input need to be in either an ArcGRID or NetCDF NOAA SIFT output format.
- Performance can be substantially improved with input grids masked to the area of interest and using only positive depth values. Use Spatial Analyst Extract by Mask to limit size of input grids.
- Using a small (<1 km) coastal buffer when preparing inundation grids will help ensure that slivers of “dry” land along the coast will not be left to produce potentially erroneous “safe” zones for the casualty module.
- Review and remove any slivers of “dry” land from input hazard polygons using editing tool before performing Level 1 casualty analysis.
- Download tools are included to assist in obtaining DEM from the USGS and road network from Census, however, if your study region is multi-county, the user will need to mosaic or merge these datasets prior to analysis.
- When using the Level 1 Quick Look function with a single runup height and DEM, masking the DEM to the study region will improve performance and remove the potential for anomalous results in the offshore portions of the depth grid.
- A deformed or post-earthquake DEM should be used or provided for near source scenarios.
- A projection is required for input grids.
- Input grids require regular spacing—if you have an irregular spaced grid, it should be resampled to produce regular spacing.

- The Level 3 interface assumes the user has prepared the median depth and flux in the English units required by Hazus and Hazus will not modify these inputs.