Hazus Hurricane Model User Guidance

Hazus 5.1

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FEMA

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
.dat	Census tract centroid hurricane wind data file
.hpr	Hazus Packaged Region, file extension used for exported Hazus study regions
.mdb	geodatabase file
AOML	Atlantic Oceanographic and Meteorological Laboratory
C	concrete
CECBH	Concrete, Engineered Commercial Building, High-Rise
CECBL	Concrete, Engineered Commercial Building, Low-Rise
CECBM	Concrete, Engineered Commercial Building, Mid-Rise
CERBH	Concrete, Engineered Residential Building, High-Rise
CERBL	Concrete, Engineered Residential Building, Low-Rise
CERBM	Concrete, Engineered Residential Building, Mid-Rise
DEM	digital elevation model
EF	Enhanced Fujita
FEMA	Federal Emergency Management Agency
GBS	General Building Stock
GBT	General Building Type
GIS	geographic information system
H*Wind	hurricane surface wind database
HPLF	high potential loss facilities
HRD	Hurricane Research Division
Hrs	hours
HUD	U.S. Department of Housing and Development
Hurrevac	hurricane evacuation tool
Kt	knot
LULC	land use/land cover
m	meter
M	masonry
mbar	millibar
MECBH	Masonry, Engineered Commercial Building, High-Rise
MECBL	Masonry, Engineered Commercial Building, Low-Rise
MECBM	Masonry, Engineered Commercial Building, Mid-Rise
MERBH	Masonry, Engineered Residential Building, High-Rise
MERBL	Masonry, Engineered Commercial Building, Low-Rise
MERBM	Masonry, Engineered Commercial Building, Mid-Rise
MH	manufactured home

MH76HUD	Manufactured Home, 1976 HUD
MHPHUD	Manufactured Home, Pre-HUD
MLRI	Masonry, Low-Rise Industrial/Warehouse/Factory Buildings
MLRM	Masonry, Low-Rise Strip Mall
MMUH	masonry multi-unit housing
mph	miles per hour
MSF	Masonry, Single-Family
NAVD	North American Vertical Datum
NHC	National Hurricane Center
NIBS	National Institute of Building Sciences
NOAA	National Oceanic and Atmospheric Administration
OWSJ	open web steel joist
RM	reinforced masonry
S	steel
SBT	Specific Building Type
SECBH	Steel, Engineered Building, High-Rise
SECBL	Steel, Engineered Commercial Building, Low-Rise
SECBM	Steel, Engineered Commercial Building, Mid-Rise
SERBH	Steel, Engineered Residential Building, High-Rise
SERBL	Steel, Engineered Residential Building, Low-Rise
SERBM	Steel, Engineered Residential Building, Mid-Rise
SFBC	South Florida Building Code
SLOSH	Sea, Lake, and Overland Surges from Hurricanes (model)
SPM	Single-Ply Membrane
SPMBL	Steel, Pre-Engineered Metal Building, Large
SPMBM	Steel, Pre-Engineered Metal Building, Medium
SPMBS	Steel, Pre-Engineered Metal Building, Small
SWAN	Simulating WAves Nearshore (model)
SWR	Secondary Water Resistant
UDF	User- Defined Facilities
URM	unreinforced masonry
W	wood
WBC	Wind Building Characteristic
WMUH	Wood, Multi-Unit Housing
WSF	Wood, SingleFamily, One Story

Section 1. Introduction

1.1 Background

The Hazus Hurricane Loss Estimation Methodology provides state, local, tribal, and territorial (SLTT) officials with a decision support software for estimating potential losses from hurricane events. This loss estimation capability enables users to anticipate the consequences of hurricanes and develop plans and strategies for reducing risk. The Geographic Information Systems (GIS) based software can be applied to study geographic areas of varying scale with diverse population characteristics and can be implemented by users with a wide range of technical and subject matter expertise.

This Methodology has been developed, enhanced, and maintained by the Federal Emergency Management Agency (FEMA) to provide a tool for developing hurricane loss estimates for use in:

- Anticipating the possible nature and scope of the emergency response needed to cope with a hurricane-related disaster.
- Developing plans for recovery and reconstruction following a disaster.
- Mitigating the possible consequences of hurricanes.

The use of this standardized methodology provides nationally comparable estimates that allow the federal government to plan hurricane responses and guide the allocation of resources to stimulate risk mitigation efforts.

This *Hazus Hurricane Model User Guidance* outlines the background and instructions for developing a Study Region and defining a scenario to complete a hurricane loss estimation study using Hazus. It also provides information on how to modify inventory, improve hazard data and analysis parameters for advanced applications, and guidance on calculating and interpreting losses.

The *Hazus Hurricane Model Technical Manual* and its Appendices document the methods used in calculating losses. A companion document, the *Hazus Inventory Technical Manual* (FEMA, 2021), provides more detailed methodology and data descriptions for the inventory shared by each hazard model. Together, this User Guidance and the Technical Manuals provide a comprehensive overview of the Hurricane Model.

1.2 Hazus Users and Applications

Hazus can be used by various types of users with a wide range of informational needs. A SLTT government official may be interested in the costs and benefits of specific mitigation strategies, and thus may want to know the expected losses if mitigation strategies have (or have not) been applied. Health officials may want information regarding the demands on medical care facilities and may be interested in the number and severity of casualties for different hurricane scenarios. Emergency response teams may use the results of a loss study in planning and performing emergency response

exercises. They might be interested in the operating capacity of emergency facilities such as fire stations, emergency operations centers, and police stations. Emergency planners may want estimates of temporary shelter requirements for different hurricane scenario events. Federal and state government agencies may use loss analysis to obtain quick estimates of impacts in the hours immediately following a hurricane, to best direct resources to the disaster area. Insurance companies may be interested in the estimated monetary losses so they can determine asset vulnerability.

Hurricane loss estimation analyses have a variety of uses for various departments, agencies, and community officials. As users become familiar with the loss estimation methodology, they can determine which Hazus Methodology is the most suitable for their needs, and how to appropriately interpret the study results.

The products of Hazus analyses have several pre- and post-hurricane applications in addition to estimating the scale and extent of damage and disruption. Examples of pre-hurricane applications of the outputs include:

- Development of hurricane hazard mitigation strategies that outline policies and programs for reducing hurricane losses and disruptions indicated in the initial loss estimation study. Strategies can involve rehabilitation of existing buildings (e.g., adding shutters), building code enforcement, development of appropriate zoning ordinances for land use planning in areas of surge inundation, and the adoption of advanced wind building codes.

- Development of preparedness (contingency) planning measures for hurricane preparedness and education seminars.

- Anticipation of the nature and extent of response and recovery efforts, including the identification of alternative housing, the location, availability and scope of required response services, and the establishment of a priority ranking for restoration of essential facilities.

Post-hurricane applications of the outputs include:

- Projection of immediate economic impact assessments for state and federal resource allocation and support, including support for state and/or federal disaster declarations by calculating direct economic impact on public and private resources, local governments, and the functionality of the area.

- Activation of immediate emergency recovery efforts, including search and rescue operations, provision of emergency housing shelters, and rapid repair and availability of essential facilities.

- Application of long-term reconstruction plans, including the identification of long-term reconstruction goals, implementation of appropriate wide-range economic development plans for the impacted area, allocation of permanent housing needs, and the application of land use planning principles and practices.

Table 1-1 lists the Hurricane Model outputs. See Section 8 for details on each type of output.

Table 1-1 Hurricane Model Outputs

Output	Description
Maps of wind hazards	▪ Peak gust (3-second) wind speed for each Census tract ▪ Maximum sustained (1-minute) wind speed for each Census tract
General Building Stock (GBS)	▪ Damage probabilities by occupancy ▪ Damage probabilities by building type ▪ Cost of building repair or replacement ▪ Loss of contents ▪ Business inventory loss ▪ Loss of rental income ▪ Relocation costs ▪ Business income loss ▪ Employee wage loss
Essential facilities	▪ Damage probabilities ▪ Probability of functionality ▪ Loss of beds in hospitals
Debris	▪ Building debris generated by weight and type of material ▪ Tree debris generated by weight or volume
Social losses	▪ Number of displaced households ▪ Number of people requiring temporary shelter
High potential loss facilities (HPLF)	▪ Locations of dams ▪ Locations of nuclear plants ▪ Locations of military facilities ▪ Locations of other identified HPLF
Transportation and utility lifelines	▪ Locations of transportation facilities ▪ Locations of lifelines

Once the inventory has been developed, making modifications and running new analyses are simple tasks. The ease with which reports and maps can be generated makes the software useful for a variety of applications.

1.3 Assumed User Expertise

Users can be divided into two groups: those who perform the analysis and those who use the analysis's results. For some analyses, these two groups occasionally consist of the same people, but generally, this will not be the case. However, the more interaction that occurs between these two

groups, the better the analysis will be. End users of the loss estimation analysis need to be involved from the beginning to make results more usable.

Any risk modeling effort can be complex and would benefit from input from an interdisciplinary group of experts. A hurricane loss analysis could be performed by a representative team consisting of the following:

- Meteorologists
- Wind engineers
- Structural engineers
- Architects
- GIS specialists
- Economists
- Social scientists
- Emergency planners
- Policy makers

These individuals are needed to develop hurricane scenarios, develop and classify building inventories, provide and interpret economic data, provide information about the local population, and provide input on the types of loss estimates that are needed to fulfill the goals of the study.

If a SLTT agency is performing the analysis, some of the expertise may be found internally. Experts are generally found in several departments: building permits, public works, planning, public health, engineering, information technologies, finance, historical preservation, natural resources, and land records. Although internal expertise may be most readily available, the importance of external participation of individuals from academic institutions, citizen organizations, and private industry cannot be underestimated.

1.4 When to Seek Help

The results of a loss estimation analysis should be interpreted with caution because baseline values have a great deal of uncertainty. Baseline inventory datasets are datasets that are provided with Hazus. Further information on these can be found in the Hazus Inventory Technical Manual (FEMA, 2021). If the loss estimation team does not include individuals with expertise in the areas described above, it is advisable to retain objective reviewers with subject matter expertise to evaluate and comment on map and tabular data outputs.

If the loss estimation team does not include individuals with expertise in the areas listed in Section 1.3, one or more consultants will likely be needed to help interpret the results. It is also advisable to retain objective reviewers with relevant expertise to evaluate the map and tabular data outputs. A meteorologist or wind engineer will be needed to provide deterministic scenario data or review each storm's parameters.

If the user intends to modify the baseline inventory data or parameters, assistance from an individual with expertise in the subject is required. For example, if the user wishes to change baseline percentages of specific building types for the region, collaborating with a structural engineer with knowledge of regional design and construction practices is helpful. Similarly, if baseline figures in the economic loss models need editing, input from an economist is required.

1.5 Technical Support

Technical Support contact information is provided in the Hazus application at **Help > Obtaining Technical Support**, technical assistance is available via the Hazus Help Desk at FEMA-Hazus-Support@fema.dhs.gov or 1-877-FEMA-MAP (1-877-336-2627). The FEMA Hazus website also provides answers to Frequently Asked Questions, and information on software updates and training opportunities.

The application's **Help** menu references the help files for ArcGIS. Because Hazus was built as an extension to ArcGIS functionality, knowing how to use the ArcGIS and ArcGIS Help Desk will help Hazus users.

Technical support on any of the four hazards is available in the contacts shown via **Help > Obtaining Technical Support**.

1.6 Uncertainties in Loss Estimates

Although the software offers users the opportunity to prepare comprehensive loss estimates, it should be recognized that uncertainties are inherent in any estimation methodology, even with state-of-the-art techniques. Any region or city studied will have an enormous variety of buildings and facilities of different sizes, shapes, and structural systems that have been built over a range of years under different building codes and practices.

Due to this complexity, there is inherent uncertainty in modeling the structural resistance of most buildings and other facilities. Further, there are not sufficient data from past hurricanes or wind tunnel experiments to determine precise estimates of damage based on known wind speeds, even for specific buildings and other structures. To deal with this complexity and lack of data, buildings are grouped into categories based upon key characteristics. The relationships between key features of wind speeds and average degree of damage with associated losses for each building category are based on current data and available theories.

The results of a hurricane loss analysis should not be looked upon as a prediction. Instead, they are only an estimate, as uncertainty inherent to the model will be influenced by the quality of inventory

data and the hazard parameters. This is particularly true in areas where hurricane events are infrequent or where recorded data is scarce.

Section 2. Overview of the Hurricane Model

This brief overview of the Hurricane Methodology is intended for SLTT officials contemplating a hurricane loss analysis.

The Hazus Methodologies will generate an estimate of the consequences to a city or region from a hurricane scenario or from a 100,000-year ensemble of probabilistic events. The resulting "loss estimate" will generally describe the scale and extent of damage and disruption that may result from the modeled hurricane event. The following information can be obtained:

- *Quantitative estimates of losses* in terms of direct costs for repair and replacement of damaged buildings, direct costs associated with loss of function (e.g., loss of business revenue, relocation costs), household displacements, shelter requirements, quantity of debris, and regional economic impacts.

- *Functionality losses* in terms of loss-of-function and restoration times for hospitals, police stations, fire stations, and emergency operations centers.

To generate this information, the Methodology includes:

- Classification systems used in assembling inventory and compiling information on the General Building Stock (GBS), the components of transportation and utility systems, and demographic and economic data.

- Vulnerability functions for estimating type and extent of damage and for summarizing losses.

- National and regional databases containing information for use as baseline (built-in) data useable in the calculation of losses if there is an absence of user-supplied data.

These systems, methods, and data have been combined in a user-friendly GIS software for this loss estimation application.

The Hazus software uses GIS technologies for performing analyses with inventory data and displaying losses and consequences on applicable tables and maps. The Methodology permits estimates to be made at several levels of complexity, based on the level of inventory data entered for the analysis (i.e., baseline data versus locally enhanced data). The more concise and complete the inventory information, the more accurate the results.

The following figure provides a graphic representation of the modules that the Hazus Hurricane Model Methodology is comprised of, and their interrelation in deriving estimates.

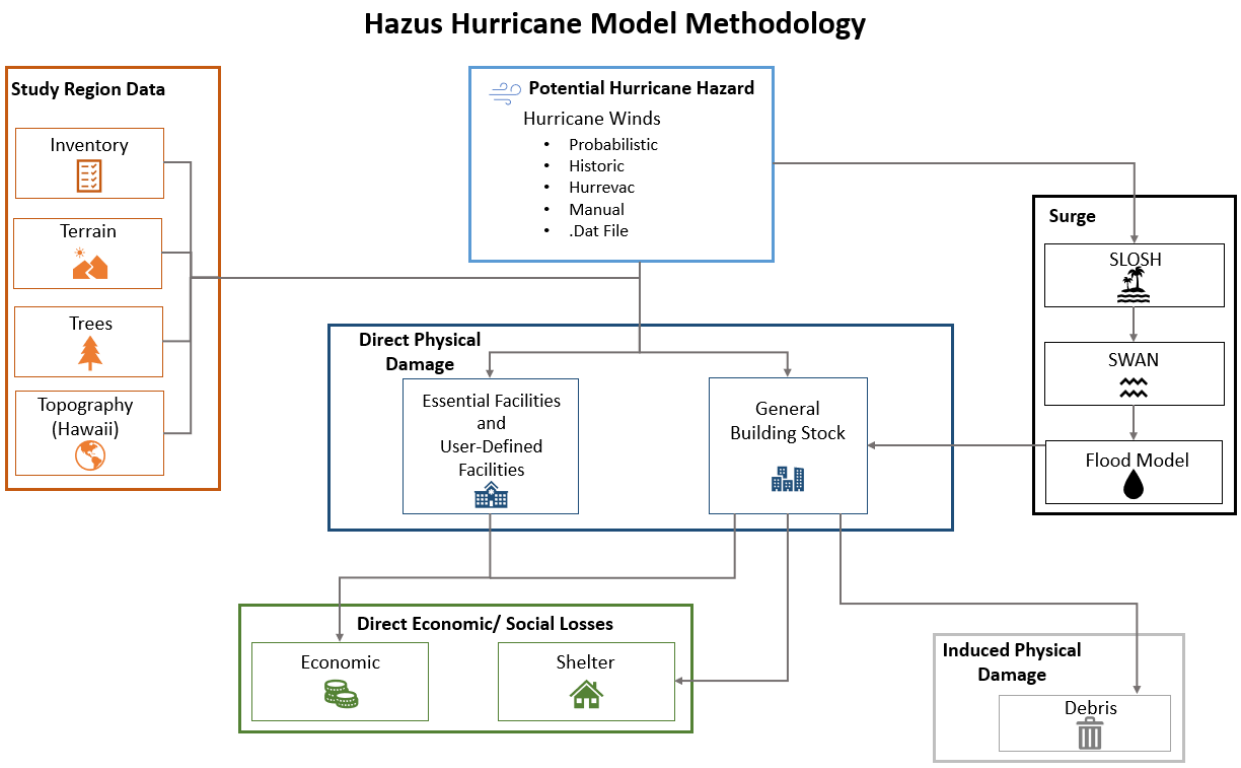


Figure 2-1 Conceptual Steps in Assessing and Mitigating Losses due to Natural Hazards

While Figure 2-1 shows the conceptual relationships, the steps used in the Hazus Hurricane Model are as follows:

- *Select the area to be studied*. The Hazus Study Region (the region of interest) is created based on Census block, Census tract, county, or state level aggregation of data. The area generally includes a city, county, or group of municipalities. It is generally desirable to select an area that is under the jurisdiction of an existing regional planning group.

- *Integrate local inventory data*. Include essential facilities, General Building Stock (GBS), or user-defined facilities.

- *Specify the hurricane hazard scenario*. In developing the scenario hurricane, consideration should be given to credible hurricane sources and potential hurricane tracks, wind speeds, and surge inundation areas using the NHC and Hazus datasets, or subject matter experts.

- *Update the tree and surface roughness parameters* if improved data are locally available. The tree database contains information on predominant tree type, density, and height categories.

- *Use the formulas embedded in Hazus*. Compute probability distributions for damage to different classes of buildings and facilities. Then, estimate the loss-of-function, displaced households, and short-term shelter requirements.

- *Compute estimates of direct economic loss*. Use a comprehensive set of economic loss functions which incorporate tree blowdown losses to single-family homes and manufactured housing.

- *Estimate the amount and type of debris*.

- *Calculate combined wind and storm surge hazard losses, if applicable*.

The user plays a major role in selecting the scope and nature of the output of a loss estimation analysis. A variety of maps can be generated for visualizing the extent of the losses. Generated reports provide numerical results that may be examined at the level of the Census tract or aggregated by county or region. For study regions that have been created to model both wind and flood hazards, results are provided at the Census block level.

2.1 Hurricane Hazards in the Hurricane Model

The hurricane-related hazards considered by the Hazus Methodology in evaluating damage, resultant losses, and displaced population are introduced in this section. Additional details are provided in subsequent sections. Most damage and loss caused by a hurricane is directly or indirectly the result of wind and storm surge forces. Thus, Hazus evaluates the geographic distribution of wind speed and surge depth as a result of a specific hurricane scenario.

The following five features of hurricanes can have an adverse effect on structures and facilities and are assessed in Hazus:

- Wind pressure: It is important to understand how wind loads get applied to a building's walls and roof. This includes characterizing the hurricane itself in terms of wind speed and wind direction, as well as how the building is configured and built.

- Windborne debris: A significant amount of the damage to buildings and facilities associated with hurricane winds is produced by windborne debris impacting the buildings and damaging the building exterior, including roof covering, windows, doors, and other openings. Two windborne debris models are used in the model. The first applies to residential environments, and the second is a commercial building model for predicting the damage produced by windborne gravel.

- Rainwater penetration: A majority of the hurricane damage to the interior and contents of buildings results from rain entering the buildings through damage to the roof, fenestrations (i.e., windows and doors), or cladding. The effects of rainwater penetration are included in the development of the damage and loss functions used to predict the combined effects of wind pressure, windborne debris, and rainfall acting on a structure.

- Tree blowdown: Trees have both positive and negative effects in the presence of extreme winds. On the positive side, trees provide shelter to structures, reducing the likelihood of damage produced by the direct action of wind. On the negative side, the existence of many trees surrounding a building increases the likelihood of a tree striking and damaging the building. Using the hurricane characteristics and a tree database, Hazus uses tree blowdown probability

curves and empirical damage models to determine additional residential damage and loss due to tree blowdown. The tree fall models are applied as an additive term for building and contents losses to small residential structures (i.e., single-family homes and manufactured housing).

- Storm Surge: Storm surge can have a major impact on structures along the coast that are impacted by wind and water. Hazus uses a customized version of the NOAA Sea, Lake and Overland Surges from Hurricanes (SLOSH) model to estimate storm surge depths. Hazus also provides a methodology that combines the wind and flood losses so that they are not double counted.

A critical component in the modeling of wind effects, damage, and loss to buildings and facilities is the assessment of the surface roughness. As the ground surface becomes rougher, the wind speeds near the ground decrease while the upper-level wind speed remains the same. The wind loads experienced by buildings located in a typical suburban, treed, or urban environment are much lower than those experienced by buildings located in relatively unobstructed regions such as waterfront and open field locations. The wind loads experienced by one- and two-story structures located in forested areas may be as low as one half of those experienced by similar structures located in an open environment.

2.2 Definitions of Structures

There are differences between the terminology used to designate distinctions between types or categories of structures. The term “structure” refers to all constructions, such as a building, bridge, water tank, shed, carport, or other man-made things that are at least semi-permanent. A building is a structure with a roof and walls that is intended for use by people and/or inventory and contents, such as a house, school, office, or commercial storefront. A facility corresponds to a particular place, generally a building, with an intended purpose such as a school, hospital, electric power station, or water treatment facility. Some facilities are defined as ‘essential facilities’ meaning the facility is critical to maintaining services and functions vital to a community, especially during disaster events. The buildings, essential facilities, and transportation and utility systems considered by the methodology are as follows:

- *General building stock*: The key General Building Stock (GBS) databases in Hazus include square footage by occupancy and building type, building count by occupancy, and building type, building and content valuation by occupancy and building type, and general occupancy mapping. Most of the commercial, industrial, and residential buildings in a region are not considered individually when calculating losses. Buildings within each Census tract are aggregated and categorized. Building information, derived from Census and employment data, is used to form groups of 39 hurricane specific building types and 33 specific occupancy classes (additional information on the Hazus baseline GBS inventory data is provided in the Hazus Inventory Technical Manual (FEMA, 2021). The degree of damage and loss is computed for each grouped combination of specific building type and occupancy class. Wind and surge losses are provided individually and combined in the results.

- *Essential facilities:* Essential facilities are the facilities that are vital to emergency response and recovery following a disaster. These facilities can include, but are not limited to, medical care facilities, emergency operations centers, police stations, fire stations, and schools. For this class of structures, damage state probabilities and loss-of-function are evaluated on a building-by-building basis in the wind model. There may be significant uncertainties in each estimate. The flood (surge) model provides a damage percentage and loss. Hazus doesn't provide a combined wind and surge damage or loss for essential facilities.

- *Transportation systems*: Transportation systems, (including highways, railways, light rail, bus systems, ports, ferry systems, and airports) are classified into components such as bridges, stretches of roadway or track, terminals, and port warehouses. Impacts to transportation systems are not included in the wind or surge models.

- *Utility systems*: Utility systems, including potable water, electric power, wastewater, communications, and liquid fuels (oil and gas), are treated in a manner similar to transportation systems. Impacts to utility systems are not included in the wind model. Damage, loss, and a functionality assessment can be modeled for potable water, wastewater, natural gas, and electric power facilities in the flood (surge) model.

- *High potential loss facilities*: In any region or community, there will be certain types of structures or facilities for which damage and losses will not be (reliably) evaluated without facility-specific supplemental studies. These facilities include dams and levees, nuclear power plants, and military installations Impacts to high potential loss facilities are not included in the wind or surge models.

- *User-defined facilities*: User-Defined Facilities (UDF) are buildings at specific locations that are added to the inventory. Generally, there are few UDF in a Census tract, making it easier to obtain specific information for each facility. Damage is evaluated on an individual building basis even though the uncertainty in each estimate is large.

2.3 Levels of Analysis

Hazus is designed to support two general types of analysis (Basic and Advanced) split into three levels of data updates (Levels 1, 2, and 3). Figure 2-2 provides a graphic representation of the various levels of analysis.

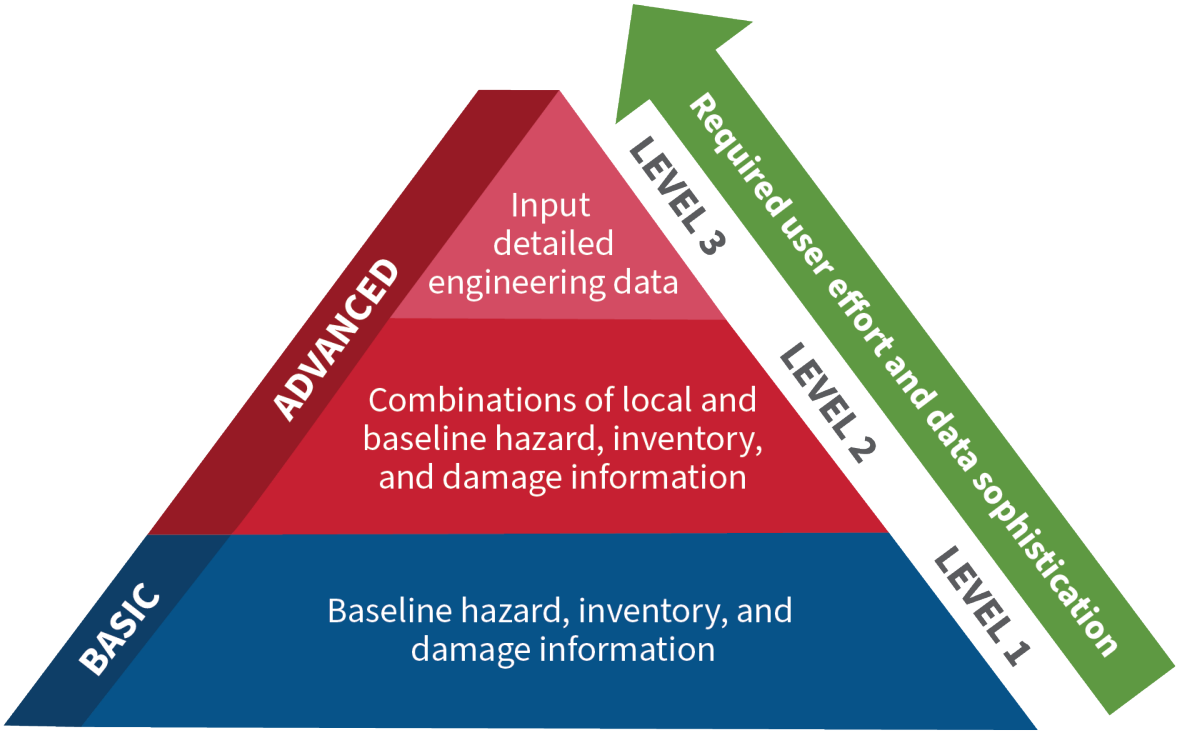


Figure 2-2 Levels of Hazus Analysis

2.3.1 Analysis Based on Baseline Information

The basic level of analysis uses only the baseline databases built into the Hazus software and Methodology for building square footage and value, population characteristics, costs of building repair, and certain basic economic data. This level of analysis is commonly referred to as a Level 1 analysis. In a Level 1 (Basic) analysis, the tree inventory and surface roughness databases are derived from national datasets. Direct economic and social losses associated with the GBS and essential facility damage state probabilities are computed.

Other than defining the Study Region, selecting the hurricane(s), and making decisions concerning the extent and format of the output, an analysis based on baseline data requires minimal effort from the user. As indicated, the estimates involve large uncertainties when inventories are limited to the baseline data. This level of analysis is suitable primarily for preliminary evaluations and crude comparisons among different Study Regions with a Census tract as the smallest regional unit. A Level 1 (Basic) analysis could be used for comparisons and preliminary evaluations to assist in identifying potential mitigation actions within a community, which could be useful if evaluating funding priorities for projects.

2.3.2 Analysis with User-Supplied Inventory

Results from an analysis using only baseline inventory data can be improved upon greatly with at least a minimum amount of locally developed input. Improved results are highly dependent on the quality and quantity of improved inventory data. The significance of the improved results also relies on the user's analysis priorities. This level of advanced analysis is commonly referred to as a Level 2/Level 3 (Advanced) analysis. The following inventory improvements impact the accuracy of Level 2/Level 3 (Advanced) Analysis results:

- Preparation of a detailed inventory of all essential facilities.
- Use of locally available data or estimates of the square footage of buildings in different occupancy classes.
- Use of locally available data concerning construction costs or other economic parameters.
- Use of local expertise to modify the mapping scheme databases that determine the percentages of specific building types associated with different occupancy classes and the wind characteristics of buildings.
- Development of maps of tree inventories and surface roughness. These maps, if available, are used for evaluating the effects of these local conditions on damage and losses.

Section 3. Getting Started Part 1: Hazus Startup Screen

The Hazus startup screen is the first screen users will see after launching Hazus.

3.1 Hazus Startup

Before running a loss estimation analysis, users must define a Study Region. The Study Region in Hazus is the geographic unit for which data are aggregated, the hurricane hazard is defined, and the analysis is carried out.

Hazus will prompt users to create a new region or import a previously created region. Users can also open, delete, duplicate, back up, and export an existing region.

3.2 Create New Region

In the Hazus startup screen (Figure 3-1), users will take the first step in defining the Study Region. In Figure 3-1, "Create a new region" has been selected. Select **OK** to activate the window shown in Figure 3-2. In this dialog, select the Study Region's hazard type for the analysis.

Click **Next** to open the window shown in Figure 3-3 and name the region and create a description. Click **Next**, which will open the window shown in Figure 3-4. Select Hurricane and click **Next**.

Figure 3-1 Select Create a New Region in Hazus Startup

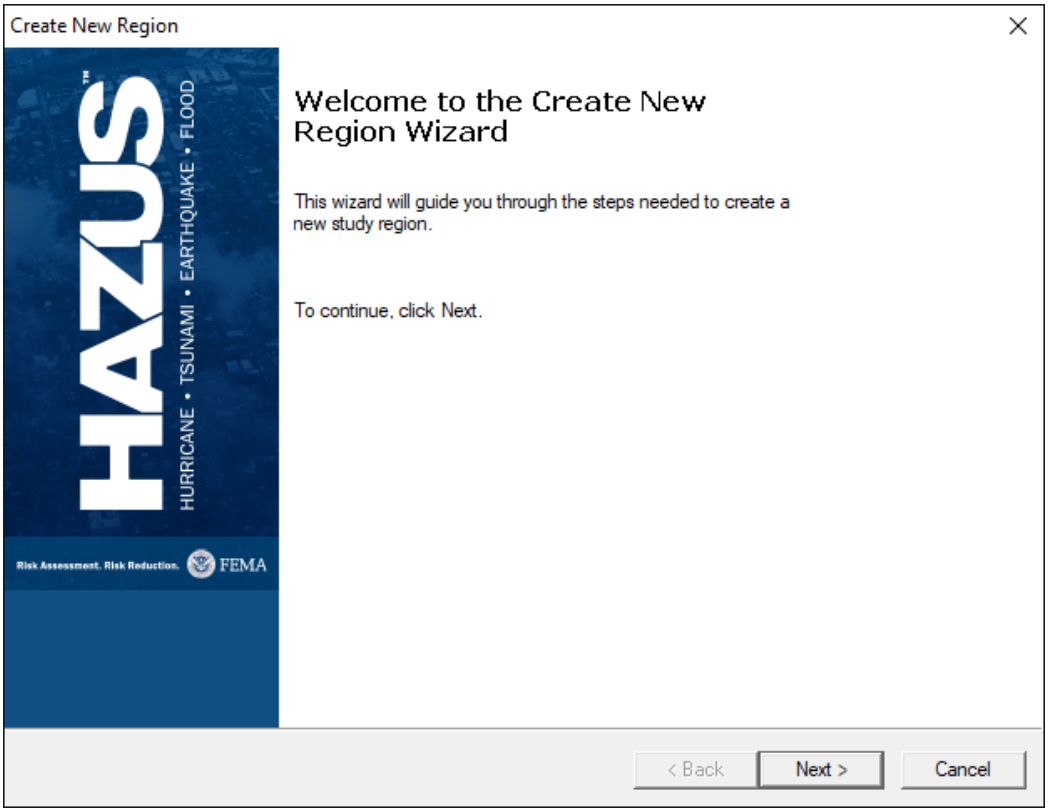


Figure 3-2 Select Create New Region in Wizard

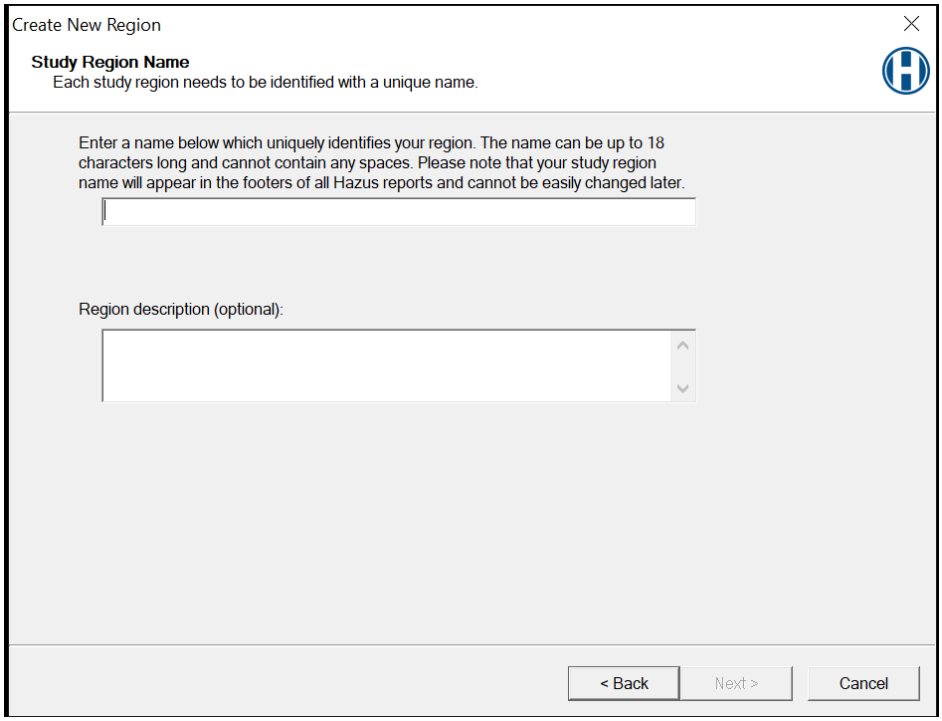


Figure 3-3 Create a Study Region Name

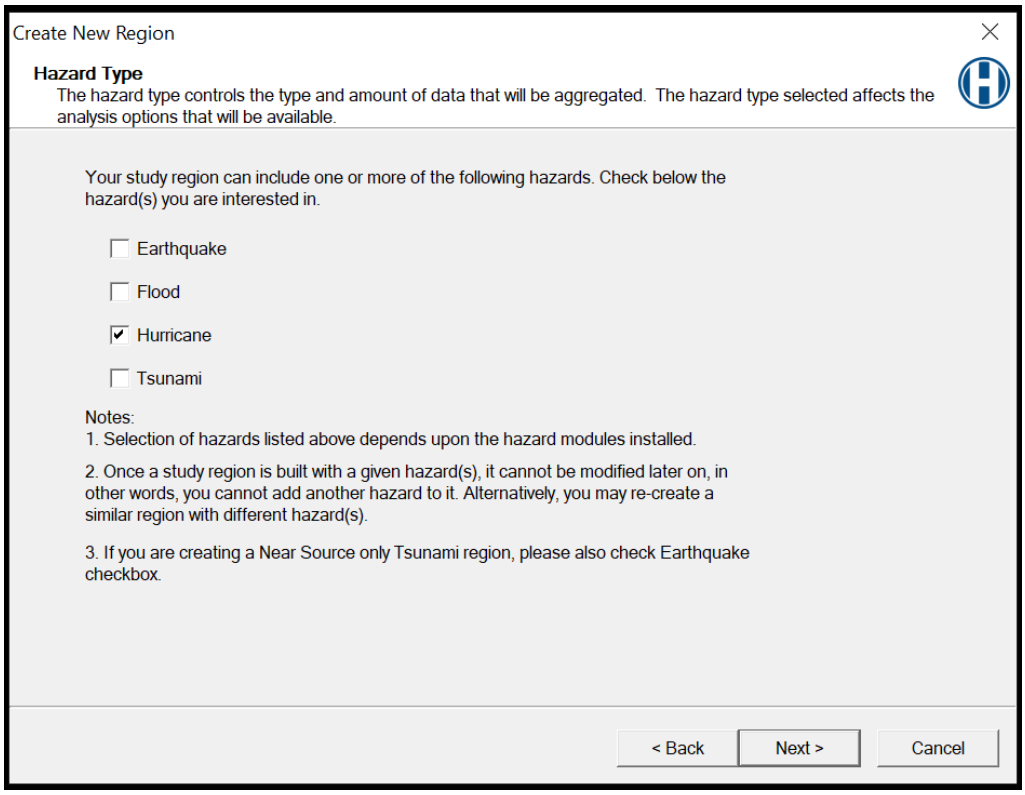


Figure 3-4 Select Hazard Type for New Region

3.2.1 Select the Scenario Operation

After creating the Study Region, a pop-up will appear asking if the user would like to create a new region using the Hurricane Scenario Wizard. Select **No**, as it is recommended that users define the study region themselves.

3.2.2 Select Aggregation Level

After selecting the scenario, define the new region by geographic level (state, county, or Census tract), also called aggregation level. See Figure 3-5**.** Click **Next** to select the state (see Figure 3-6). Select the state, which will open county selection window shown in Figure 3-7. After selecting the county and clicking **Next,** begin aggregation by clicking **Finish** on the screen that will appear next (not shown). The program will process until the region has been created. Click **OK** in the pop-up window that confirms that the Study Region was created.

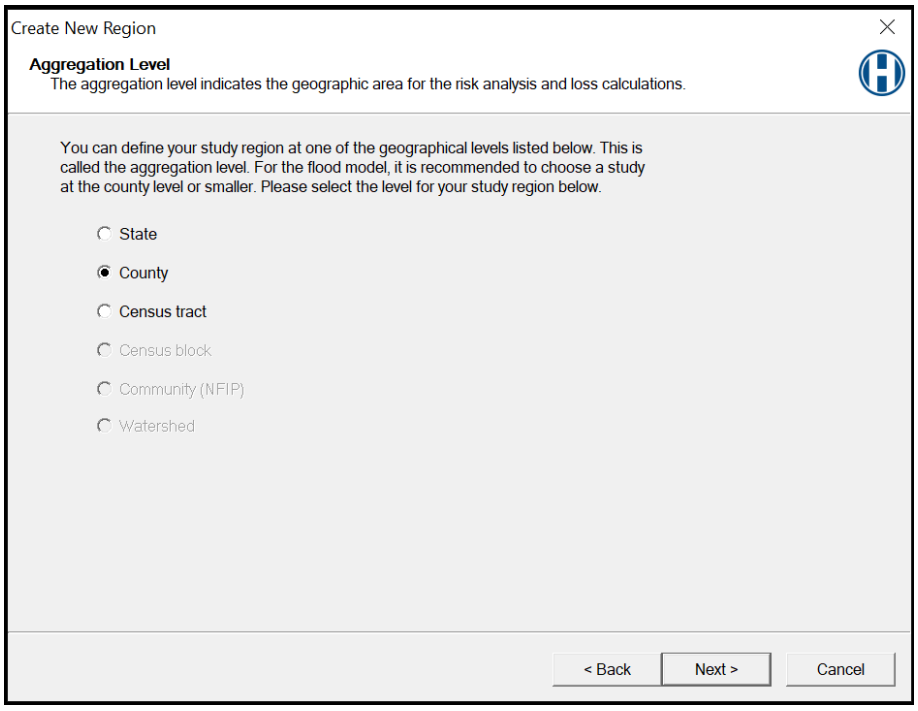


Figure 3-5 Select Desired Aggregation Level

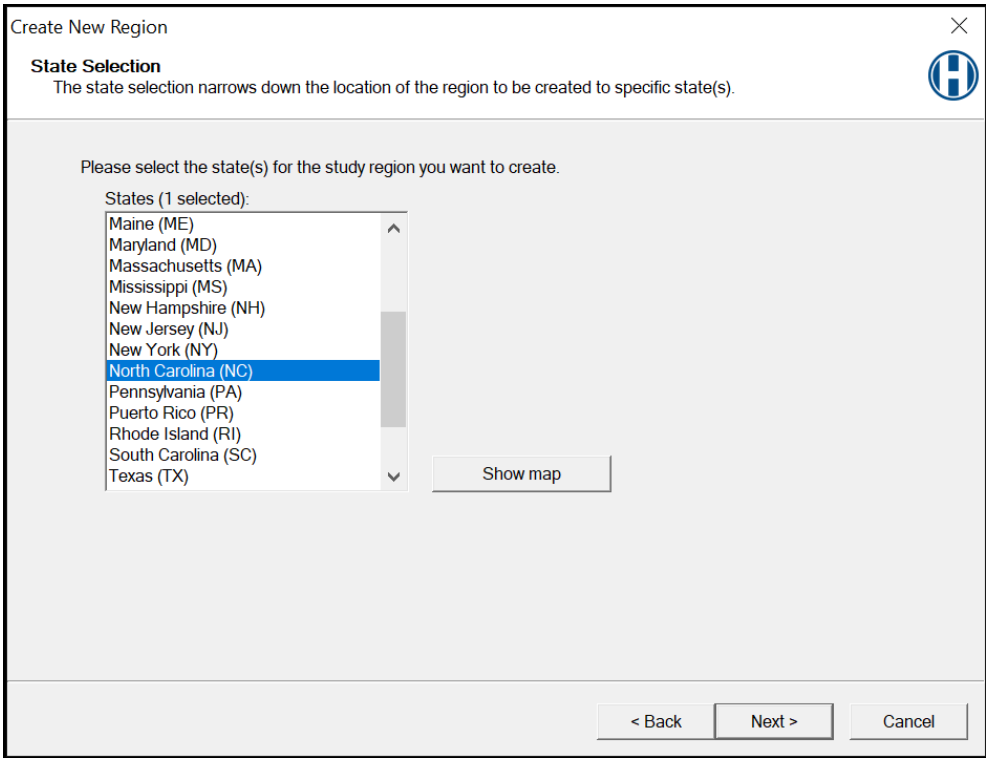


Figure 3-6 Select Appropriate State for the New Region

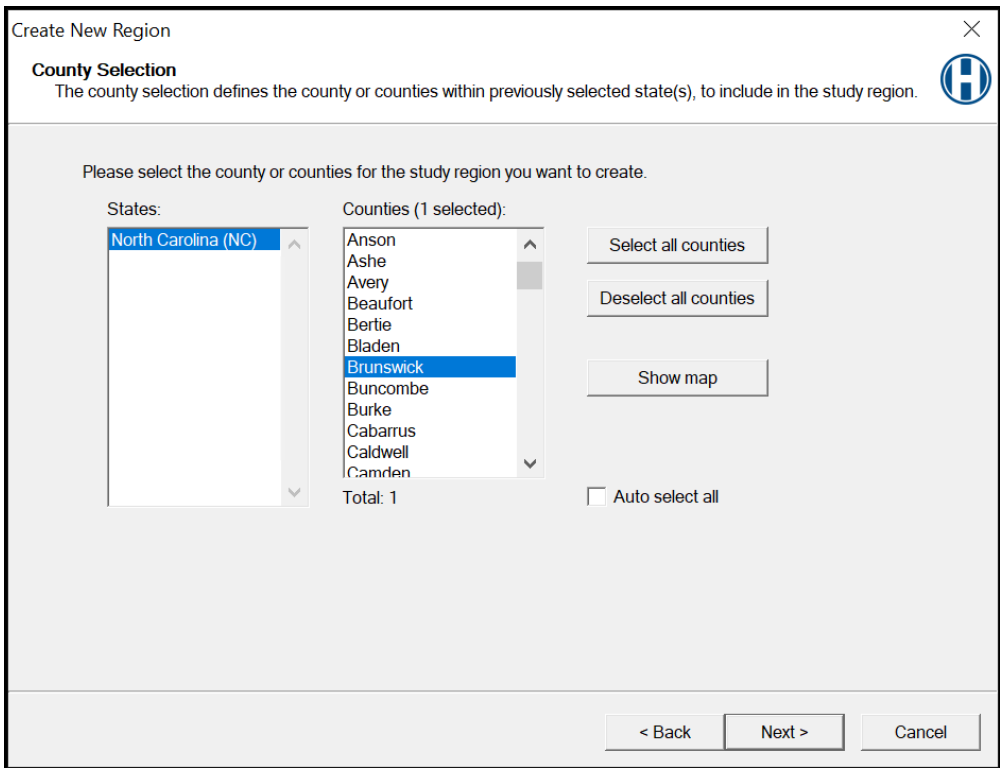


Figure 3-7 Select County for the New Region

3.3 Delete Region

The **Delete Region** option shown in Figure 3-8 will not be available until a region has been created or imported. Select Delete Region and click **OK,** as shown in Figure 3-9.

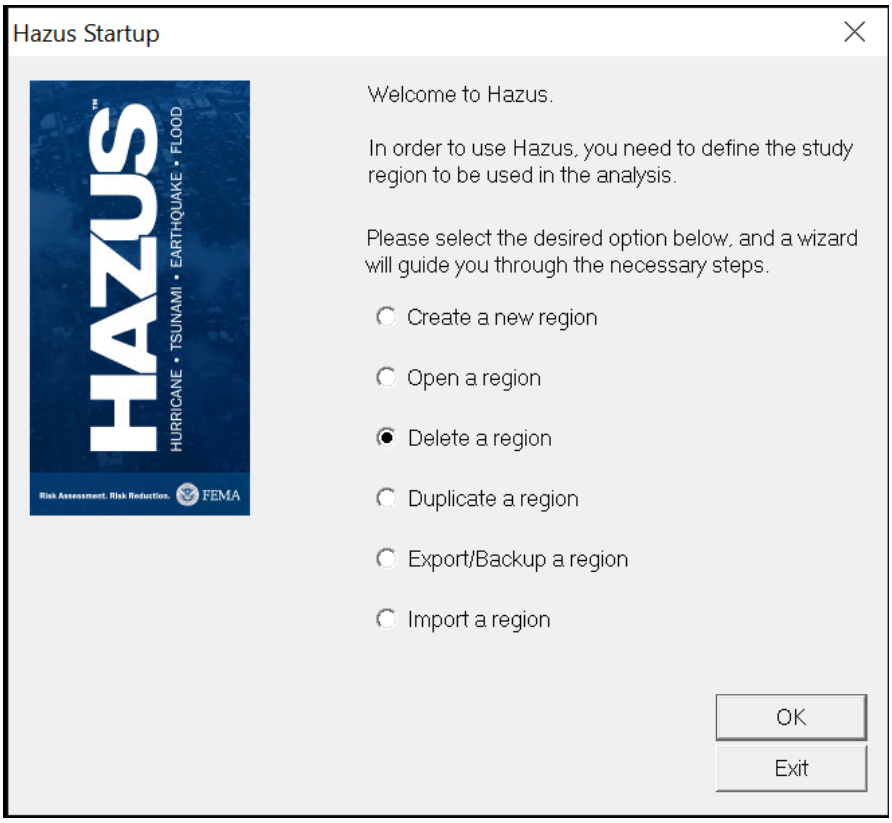


Figure 3-8 Delete a Region

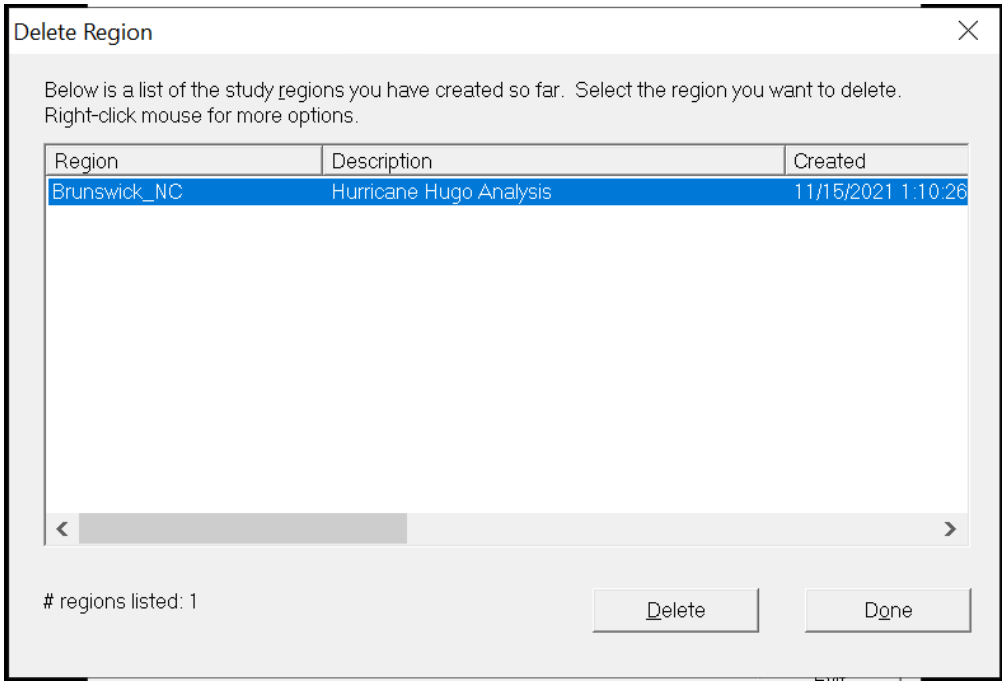


Figure 3-9 Select Region to Delete

3.4 Duplicate Region

The **Duplicate Region** option shown in Figure 3-10 will not be available until a region has been created or imported. Select Duplicate Region and click **OK**. The selected region can be duplicated, as shown in Figure 3-11**.**

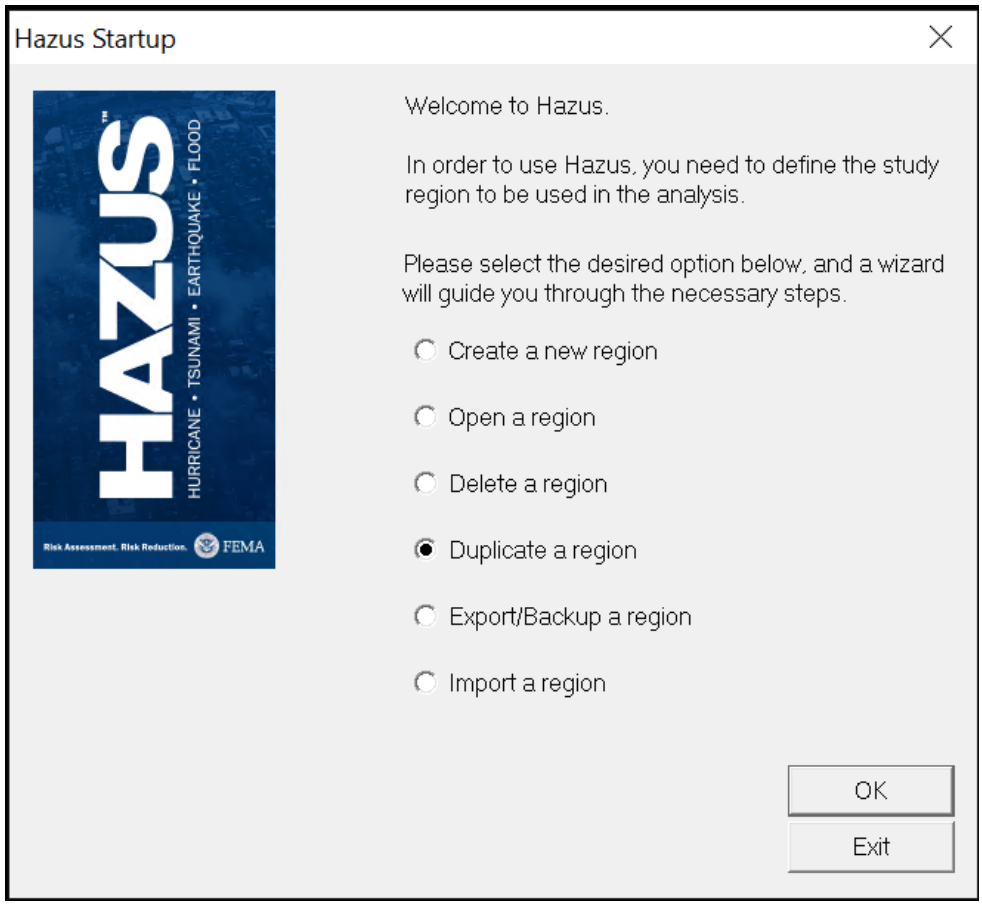


Figure 3-10 Duplicate a Region

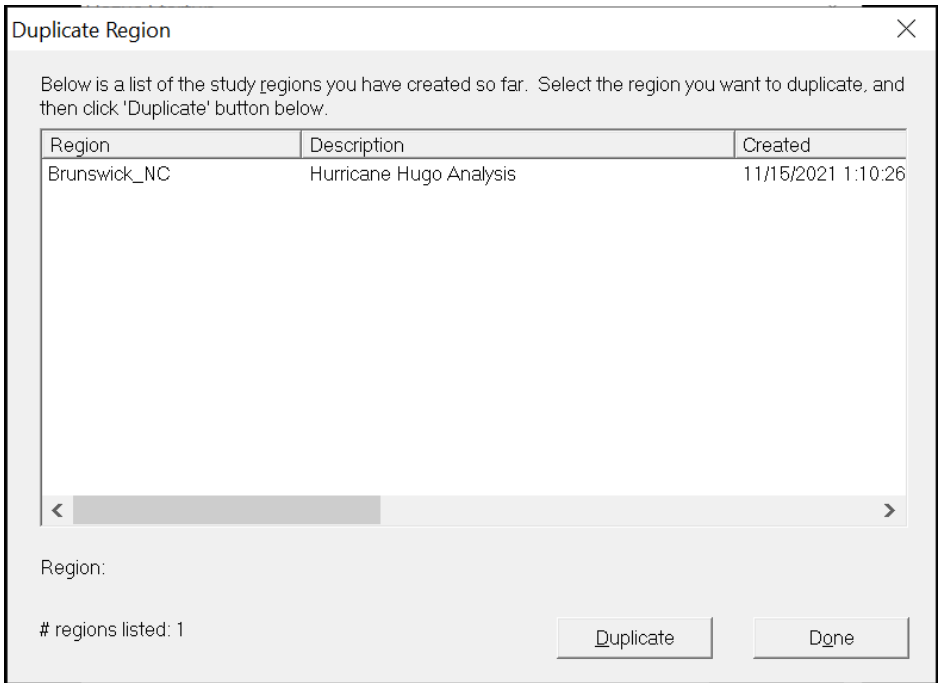


Figure 3-11 Select Region to Duplicate

3.5 Export Region

The **Export/Backup a Region** shown in Figure 3-12 will not be available until a region has been created or imported. Select Export/Backup a Region and click **OK**. The user can then export/backup a region, as shown in Figure 3-13.

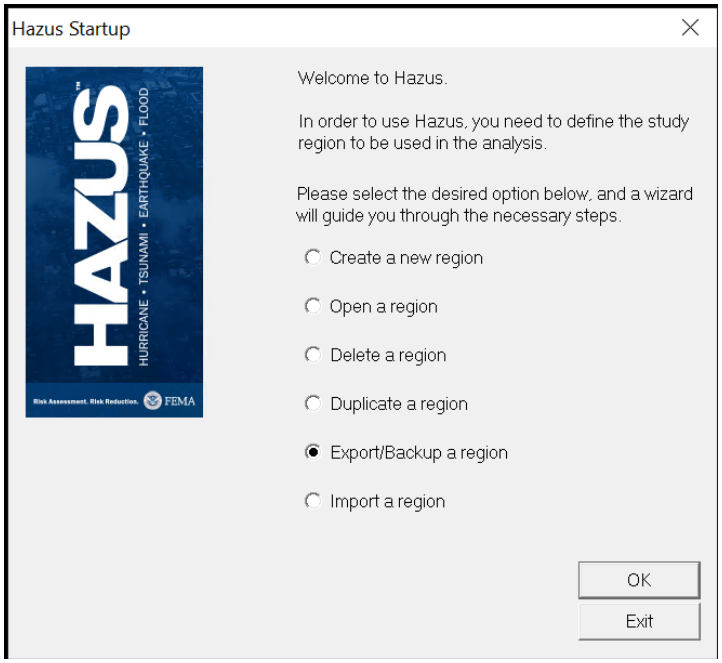


Figure 3-12 Export or Backup a Region

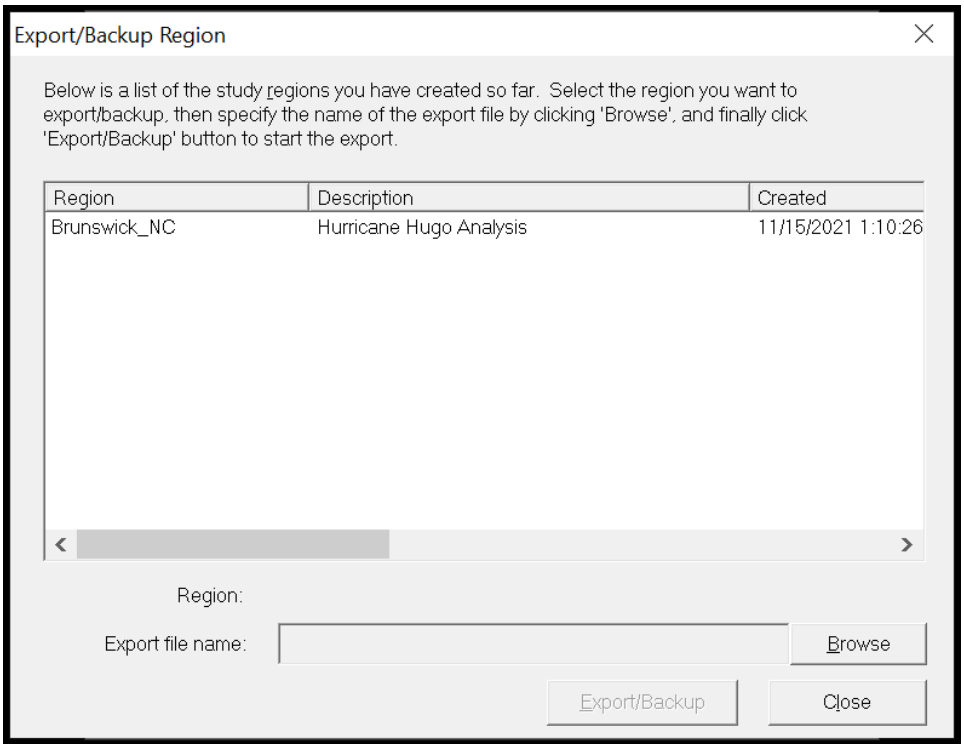


Figure 3-13 Select Region to Export or Backup

3.6 Open Region

Open the newly created region in the Hazus startup, as shown in Figure 3-14. This will open the Open Region Wizard, shown in Figure 3-15, and allow selection of the Study Region created in the previous steps. Select the region that was created in the previous steps, as shown in Figure 3-16, and click **Next**. Click **Finish** on the screen that will appear next (not shown) and the region will open.

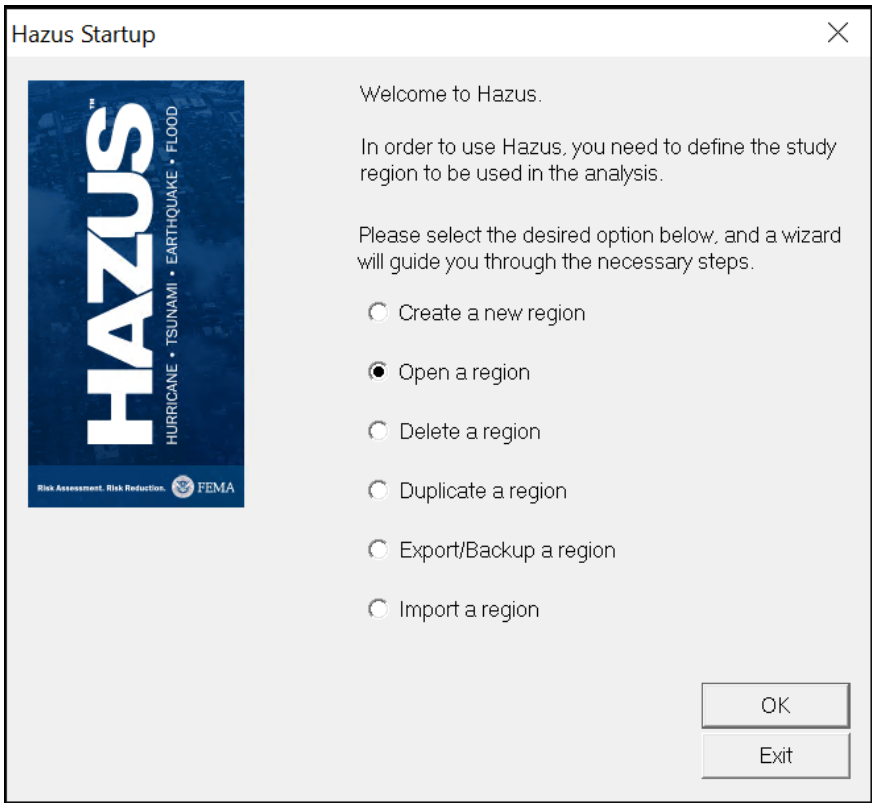


Figure 3-14 Open a Region

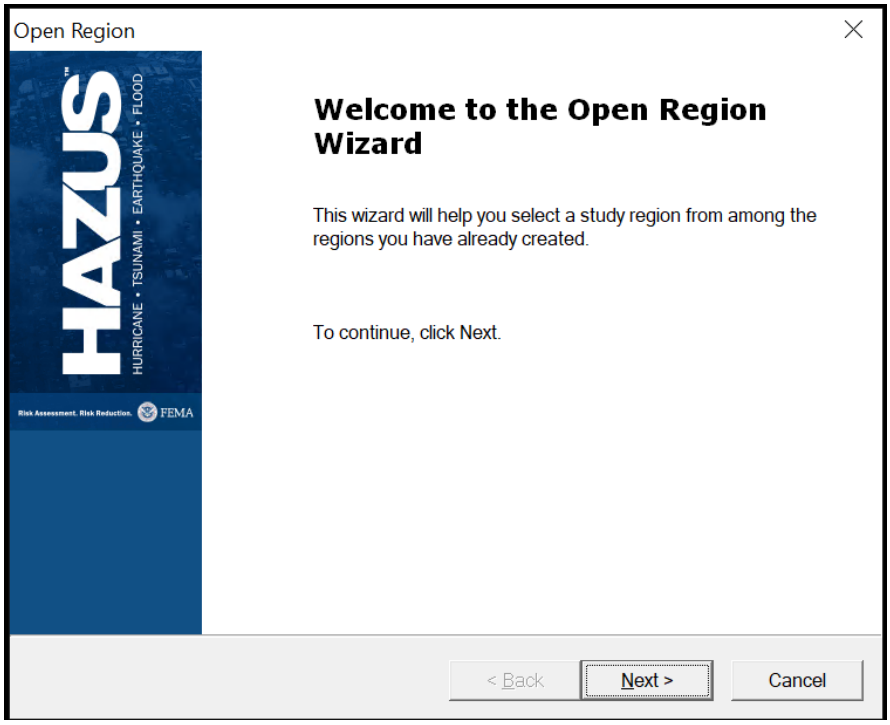


Figure 3-15 Open Region Wizard

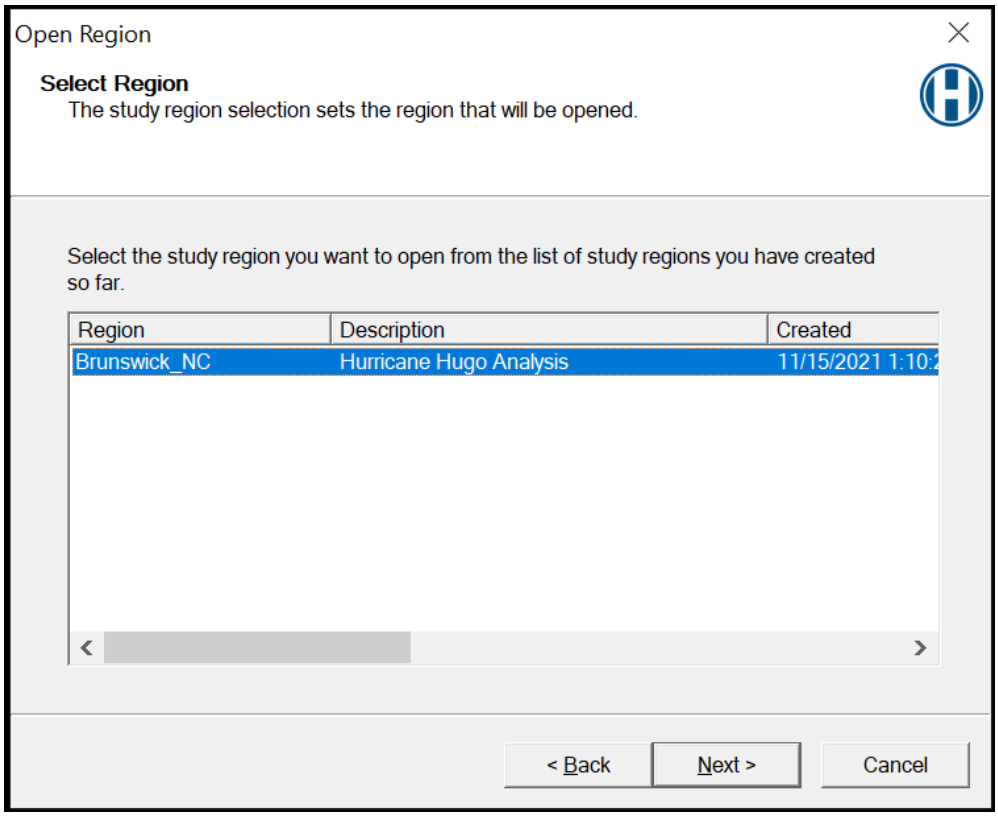


Figure 3-16 Select Region to Open

3.7 Import Region

Select **Import a Region** and click **OK**. A file explorer will open. Select an export Hazus file (.hpr) as shown in Figure 3-17. Name the imported region as shown in Figure 3-18. Hazus is designed to only allow importing Hazus files from the current Hazus version and the immediate previous version.

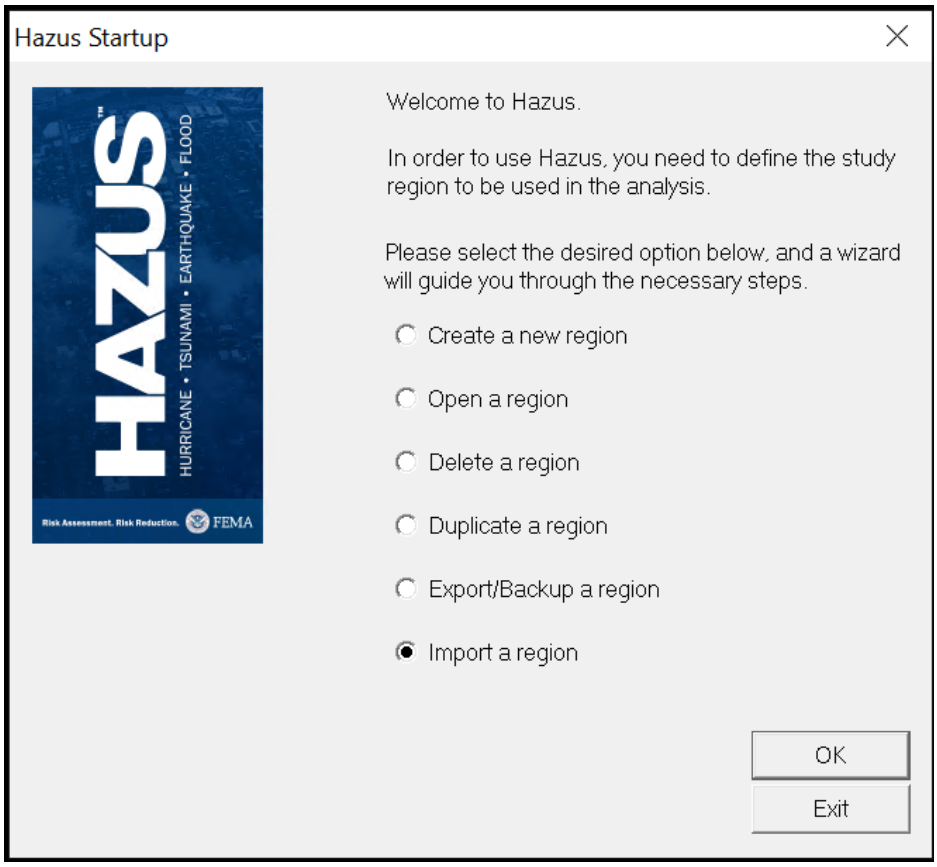


Figure 3-17 Import a Region

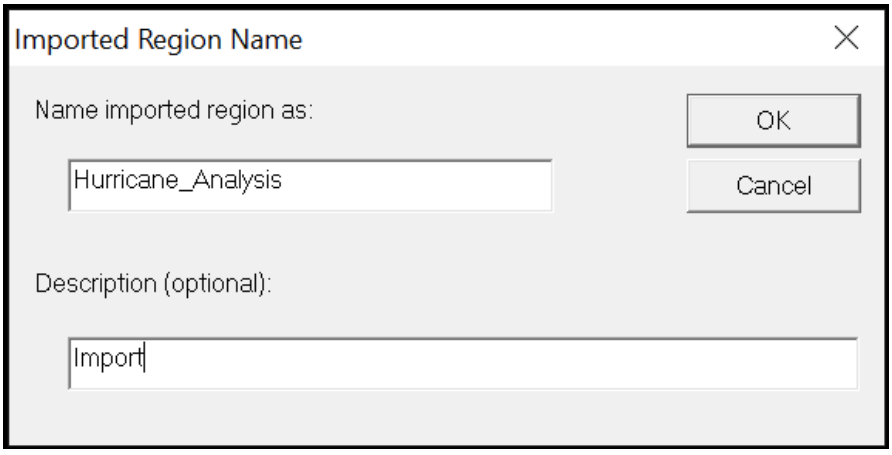


Figure 3-18 Provide the Name for the Imported Region

Section 4. Getting Started Part 2: Basic Hazus Analysis

The Hurricane Model allows practitioners to estimate the economic and social losses from hurricane winds. The information provided by the model will help state and local officials evaluate, plan for, and mitigate the effects of hurricane winds. The Hurricane Model provides practitioners and policy makers with a tool to help reduce wind damage, reduce disaster payments, and make wise use of the nation's emergency management resources.

Section 4 shows how to run a basic Hurricane Probabilistic Hurricane Level 1 GBS Analysis. Refer to the Technical Manual for information on the simulation modeling that produced the probabilistic wind field data used in the analysis.

Launch Hazus and select **Open a Region** (Figure 4-1). Information on the other options is provided in Section 3. Click **OK**, which will open the **Welcome to the Open Region Wizard** (Figure 4-2).

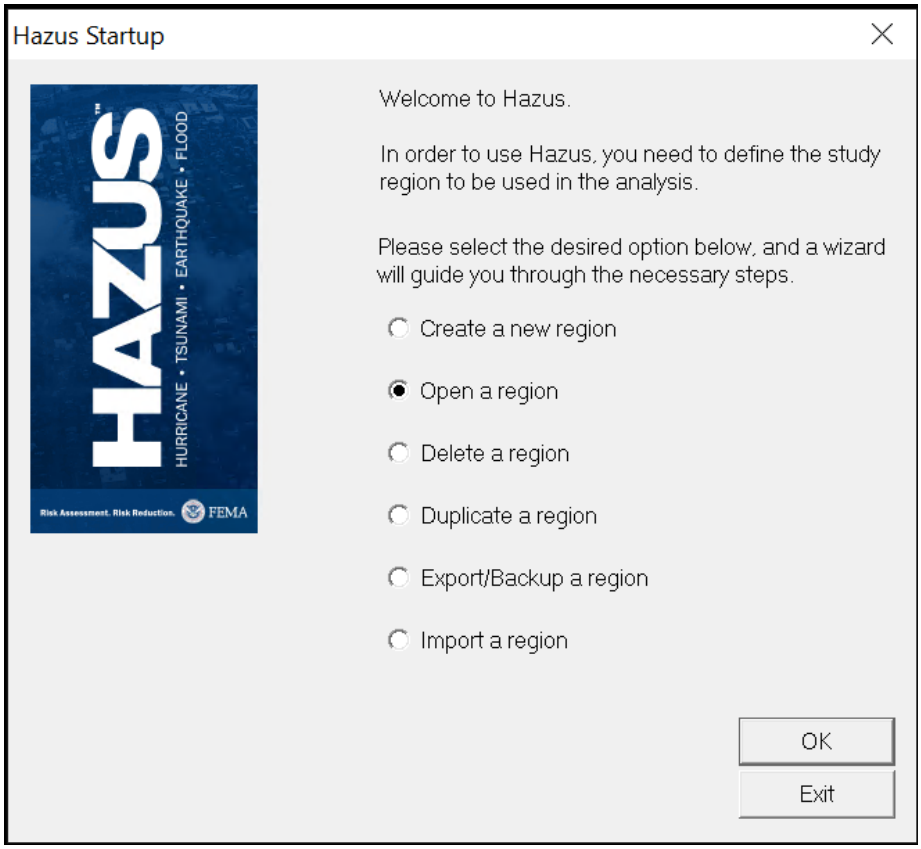


Figure 4-1 Open a Region

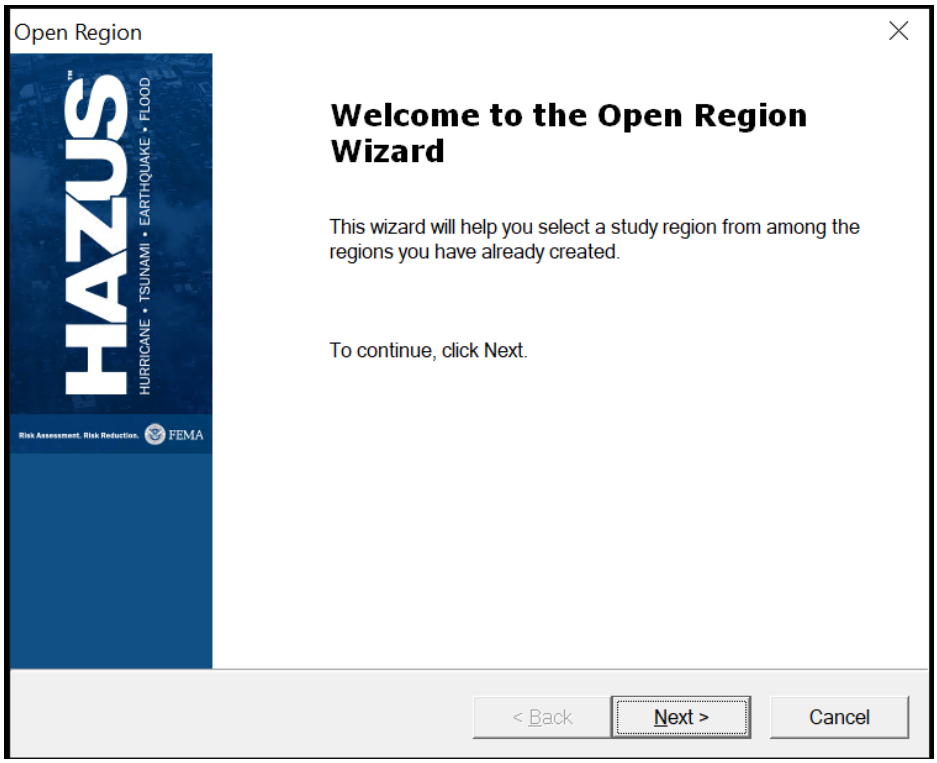


Figure 4-2 Open Region Wizard

Select **Next**. In the **Select Region** window (Figure 4-3), select the region.

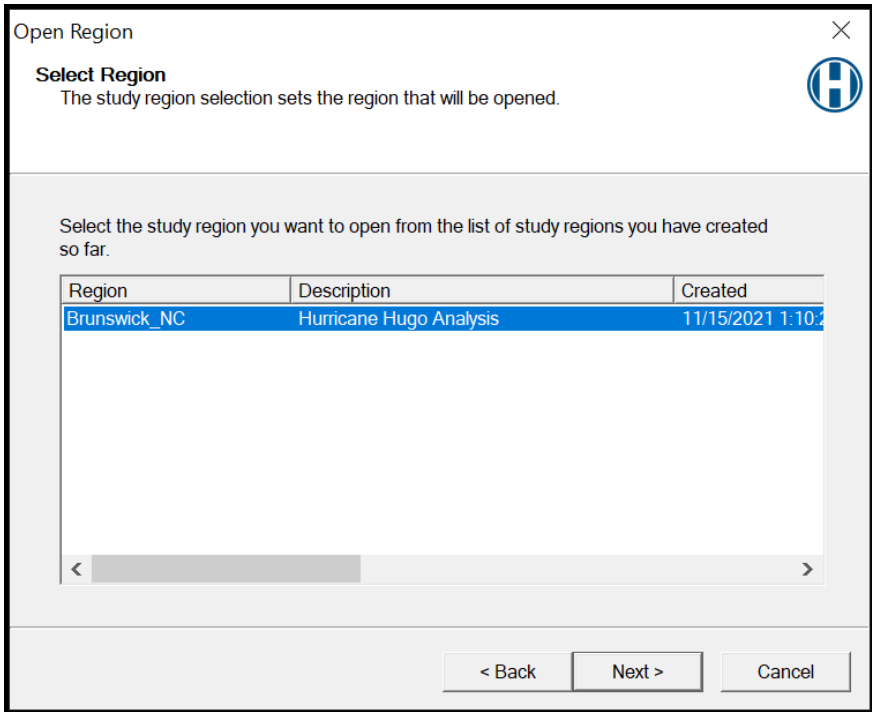


Figure 4-3 Select the Region to Open

Click **Next,** which will open the **Completing the Region Review Wizard** (Figure 4-4). Here the user can review the region and hazard that the user selected. Select **Finish.** An ArcMap showing the Study Region will open (Figure 4-5).

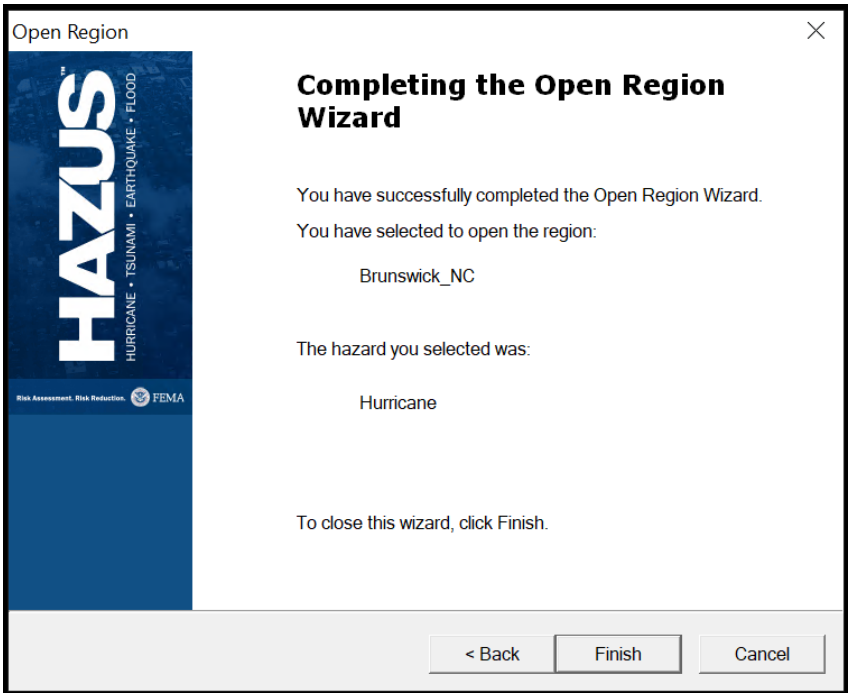


Figure 4-4 Confirm the Selected Region

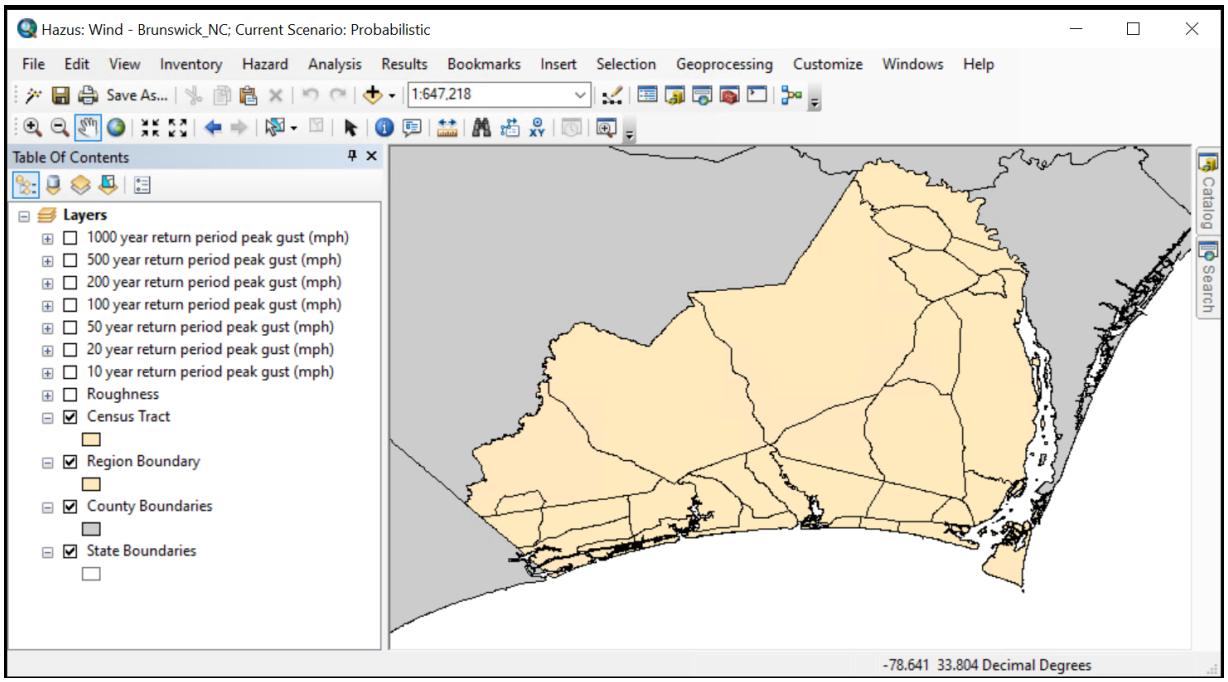


Figure 4-5 Example – Hurricane Model in ArcMap

To choose a probabilistic run, open the **Hazard** drop-down menu and select **Scenario** (Figure 4-6).

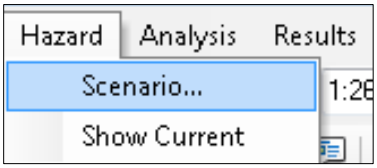


Figure 4-6 Select Scenario in Hazard Menu

Selecting **Scenario** will open the **Hurricane Scenario Management Wizard** (Figure 4-7). Select **Next**, which will open the **Scenario Operation** window (Figure 4-8). Choose the Probabilistic Option and choose **Next**.

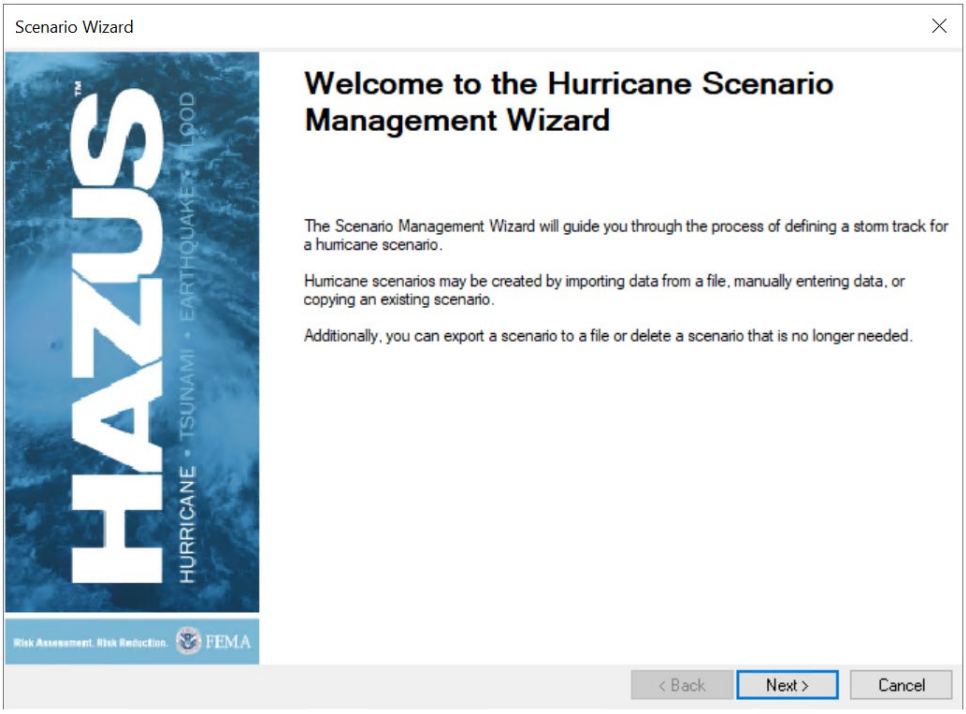


Figure 4-7: Hurricane Scenario Management Wizard

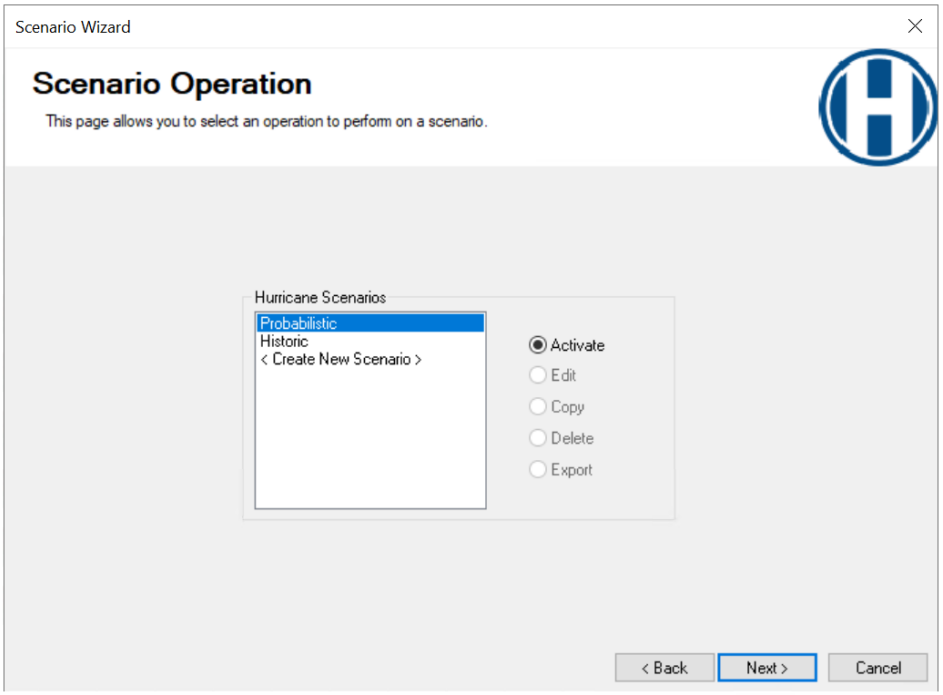


Figure 4-8 Select Probabilistic Hurricane Scenario

In the **Activate Scenario** window (Figure 4-9), select **Yes** and then choose **Next**, and **Finish** on the following window (not shown) which will activate the probabilistic scenario.

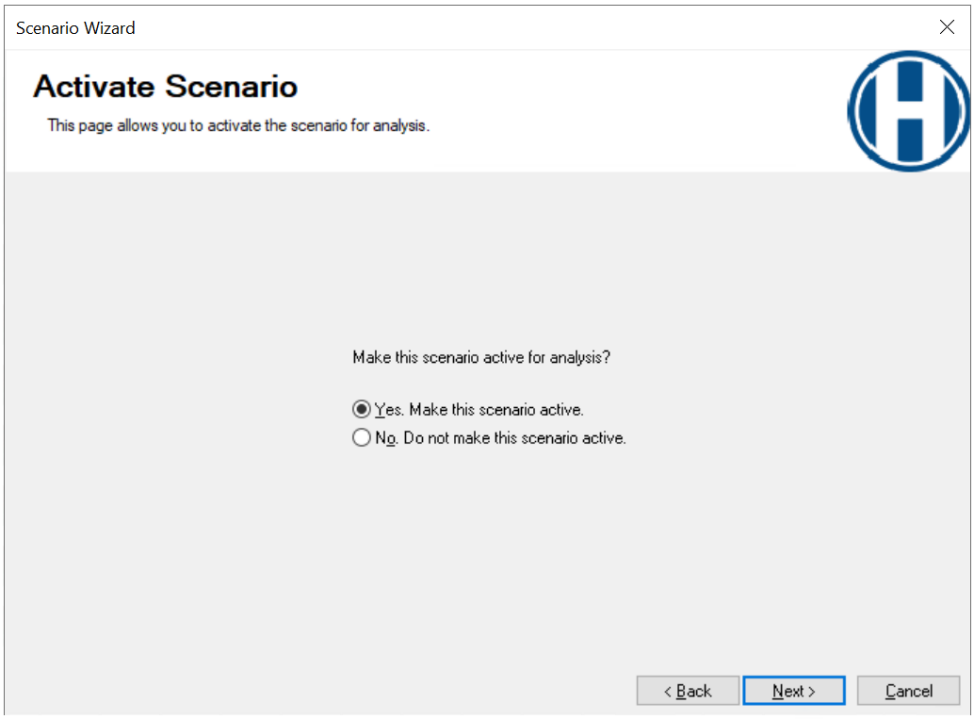


Figure 4-9 Select Yes to Activate Scenario

Now that the scenario has been activated, the user can run the analysis. Open the **Analysis** drop-down menu and choose **Run** (Figure 4-10).

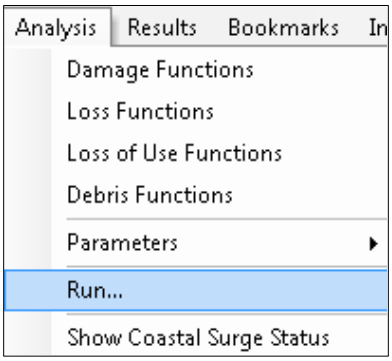


Figure 4-10 Select Run in Analysis Menu

The **Analysis Options** window (Figure 4-11) will allow the user to select the inventory items that will be analyzed for the Study Region. Select the inventory items and then select **Run Analysis**. The program will start the analysis and show a progress bar (Figure 4-12). When the run has finished, the **Analysis Completed** window (Figure 4-13) will appear. The user will now be able to access all the information that is discussed in Section 8 through the Results Menu.

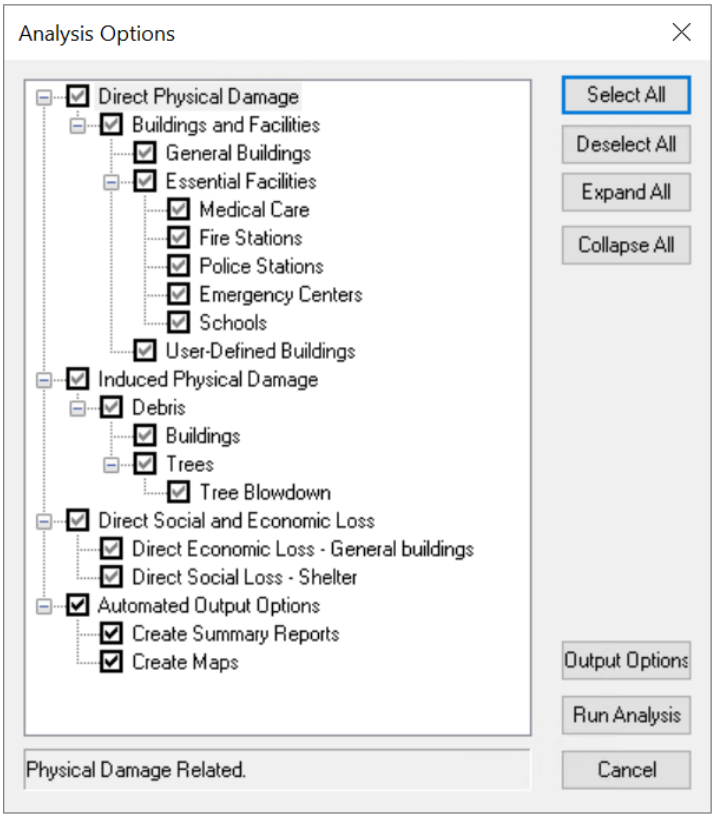


Figure 4-11 Select Inventory Items and Run Analysis

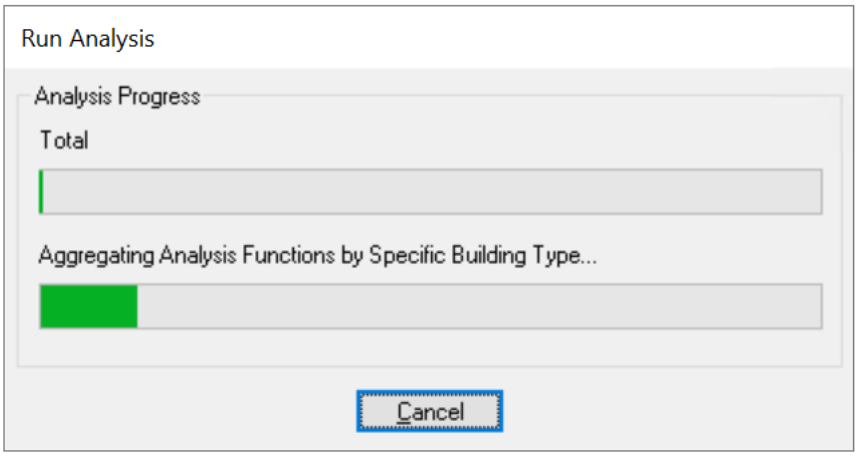


Figure 4-12 Analysis Progress

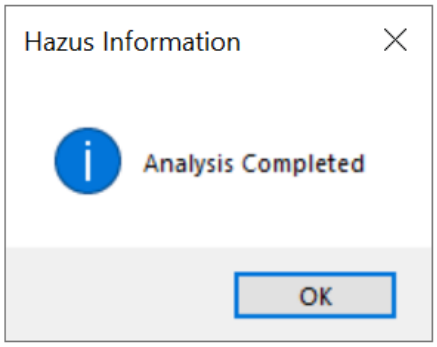


Figure 4-13 Analysis Completed

Section 5. Model Menu: Inventory

The **Inventory** menu, shown in Figure 5-1, has inventory types and subtypes that allow the estimation of the amount of exposure and potential damage in the Study Region. The screenshots in this Section show all the options for the inventory menu.

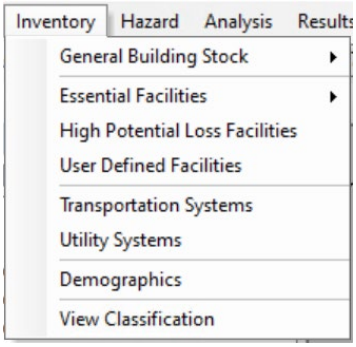


Figure 5-1 Inventory Menu

5.1 General Building Stock

The first type of inventory is **General Building Stock**. The subtypes are Square Footage, Building Count, Dollar Exposure, General Building Type Mapping, Specific Building Type Mapping, and Wind Building Characteristics Distribution, as shown in Figure 5-2.

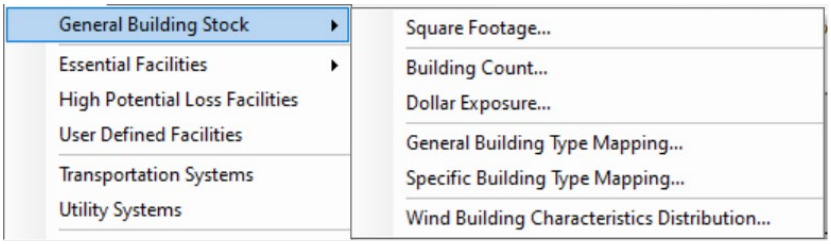


Figure 5-2 Inventory / General Building Stock Menu

5.1.1 Square Footage

Square Footage, opened through the menu shown in Figure 5-3, allows the user to see the type of square footage distribution in thousands of square feet per the Census tracts, as shown in Figure 5-4.

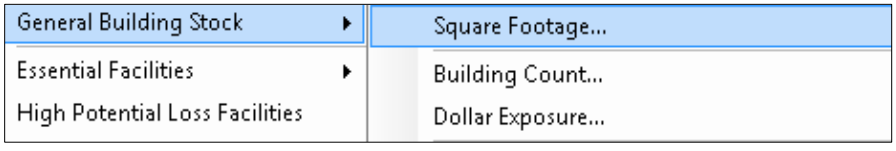
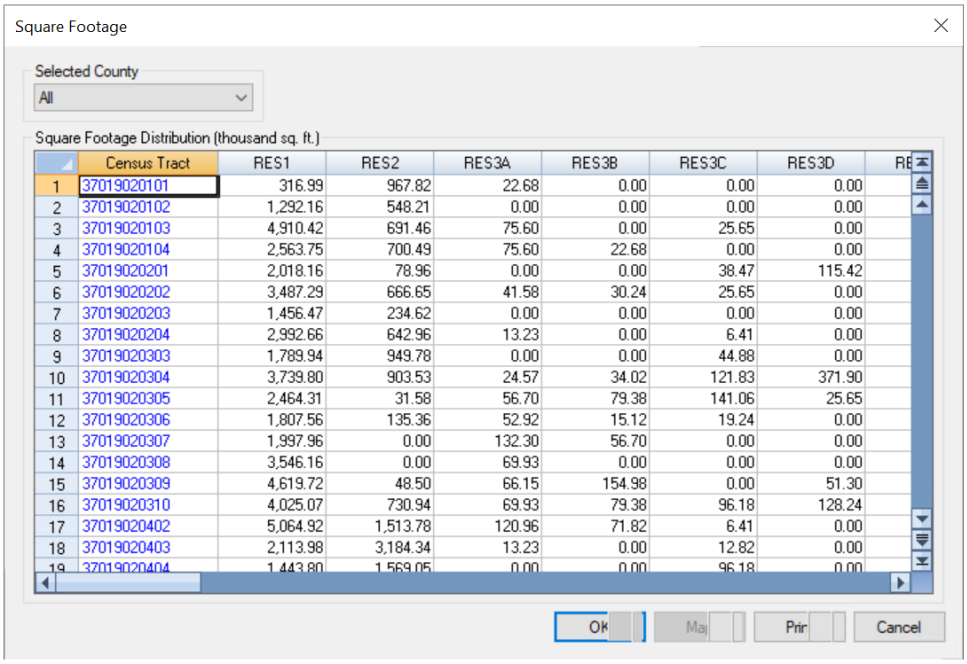


Figure 5-3 General Building Stock / Square Footage Menu



	Census Tract	RES1	RES2	RES3A	RES3B	RES3C	RES3D	RE
1	37019020101	316.99	967.82	22.68	0.00	0.00	0.00	
2	37019020102	1,292.16	548.21	0.00	0.00	0.00	0.00	
3	37019020103	4,910.42	691.46	75.60	0.00	25.65	0.00	
4	37019020104	2,563.75	700.49	75.60	22.68	0.00	0.00	
5	37019020201	2,018.16	78.96	0.00	0.00	38.47	115.42	
6	37019020202	3,487.29	666.65	41.58	30.24	25.65	0.00	
7	37019020203	1,456.47	234.62	0.00	0.00	0.00	0.00	
8	37019020204	2,992.66	642.96	13.23	0.00	6.41	0.00	
9	37019020303	1,789.94	949.78	0.00	0.00	44.88	0.00	
10	37019020304	3,739.80	903.53	24.57	34.02	121.83	371.90	
11	37019020305	2,464.31	31.58	56.70	79.38	141.06	25.65	
12	37019020306	1,807.56	135.36	52.92	15.12	19.24	0.00	
13	37019020307	1,997.96	0.00	132.30	56.70	0.00	0.00	
14	37019020308	3,546.16	0.00	69.93	0.00	0.00	0.00	
15	37019020309	4,619.72	48.50	66.15	154.98	0.00	51.30	
16	37019020310	4,025.07	730.94	69.93	79.38	96.18	128.24	
17	37019020402	5,064.92	1,513.78	120.96	71.82	6.41	0.00	
18	37019020403	2,113.98	3,184.34	13.23	0.00	12.82	0.00	
19	37019020404	1,443.80	1,569.05	0.00	0.00	96.18	0.00	

Figure 5-4 Square Footage Table

5.1.2 Building Count

Building Count (Figure 5-5) allows the user to review the building count per Census tract **By Occupancy** and **By Building Type** for specific and general occupancies, as shown in Figure 5-6.

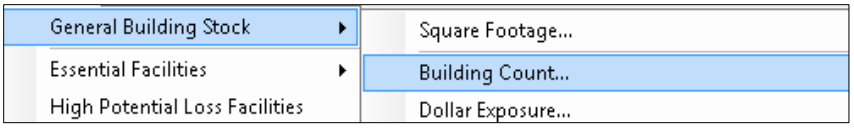


Figure 5-5 General Building Stock / Building Count Menu

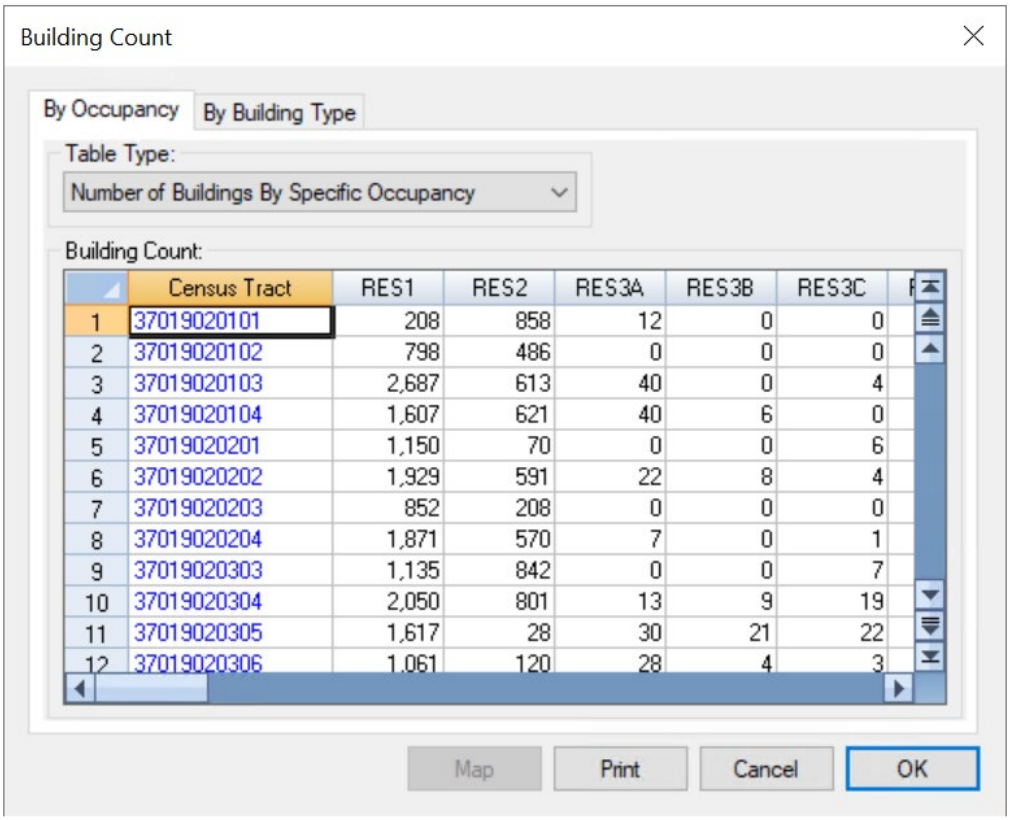


Figure 5-6 Building Count (by Occupancy) Table

5.1.3 Dollar Exposure

Dollar Exposure (Figure 5-7) allows the user to review **Building** exposure per Census tract in thousands of dollars, **Contents**, and **Total**. In the **Building** menu, the user can select **Specific Occupancy,** as shown in Figure 5-8, and **General Occupancy, Specific Building Type,** and **General Building Type for Building.**

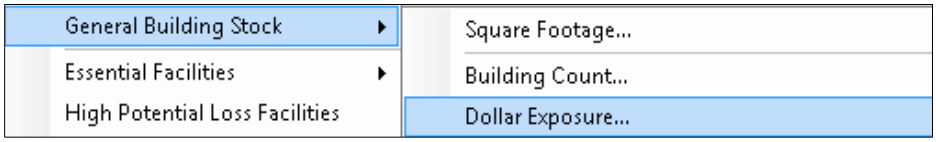
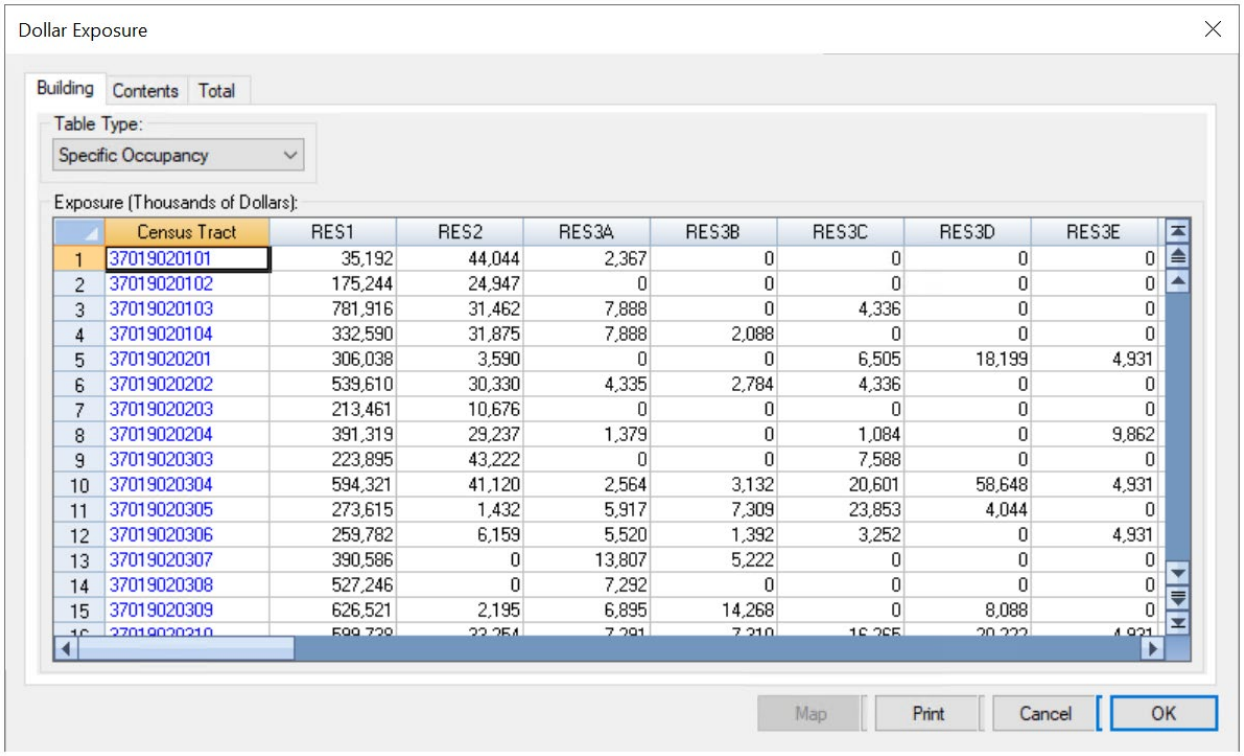


Figure 5-7 General Building Stock > Dollar Exposure Menu



	Census Tract	RES1	RES2	RES3A	RES3B	RES3C	RES3D	RES3E
1	37019020101	35,192	44,044	2,367	0	0	0	0
2	37019020102	175,244	24,947	0	0	0	0	0
3	37019020103	781,916	31,462	7,888	0	4,336	0	0
4	37019020104	332,590	31,875	7,888	2,088	0	0	0
5	37019020201	306,038	3,590	0	0	6,505	18,199	4,931
6	37019020202	539,610	30,330	4,335	2,784	4,336	0	0
7	37019020203	213,461	10,676	0	0	0	0	0
8	37019020204	391,319	29,237	1,379	0	1,084	0	9,862
9	37019020303	223,895	43,222	0	0	7,588	0	0
10	37019020304	594,321	41,120	2,564	3,132	20,601	58,648	4,931
11	37019020305	273,615	1,432	5,917	7,309	23,853	4,044	0
12	37019020306	259,782	6,159	5,520	1,392	3,252	0	4,931
13	37019020307	390,586	0	13,807	5,222	0	0	0
14	37019020308	527,246	0	7,292	0	0	0	0
15	37019020309	626,521	2,195	6,895	14,268	0	8,088	0

Figure 5-8 Dollar Exposure (By Building Occupancy) Table

5.1.4 General Building Type Mapping

General Building Type Mapping (Figure 5-9) allows the user to assign, view, and edit the distribution of general building types in each occupancy type and Census tract, as shown in Figure 5-10. General building type mapping schemes can be assigned at the state, county, and Census tract levels.

As shown in Figure 5-10, select one or more counties and select **Census Track List** to see a list of the Census tracts in the selected counties. To change the mapping scheme assigned to one or more Census tracts, highlight the states, counties, and Census tracts of interest, select the desired mapping scheme from the drop-down list in the top right corner of the window and click **Apply**.

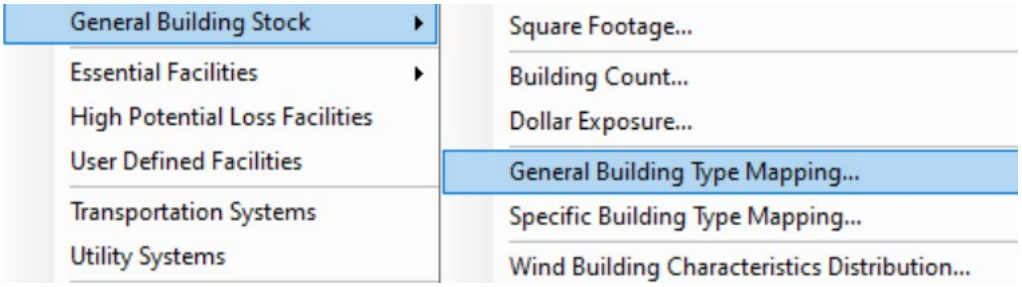


Figure 5-9 General Building Stock > General Building Type Mapping Menu

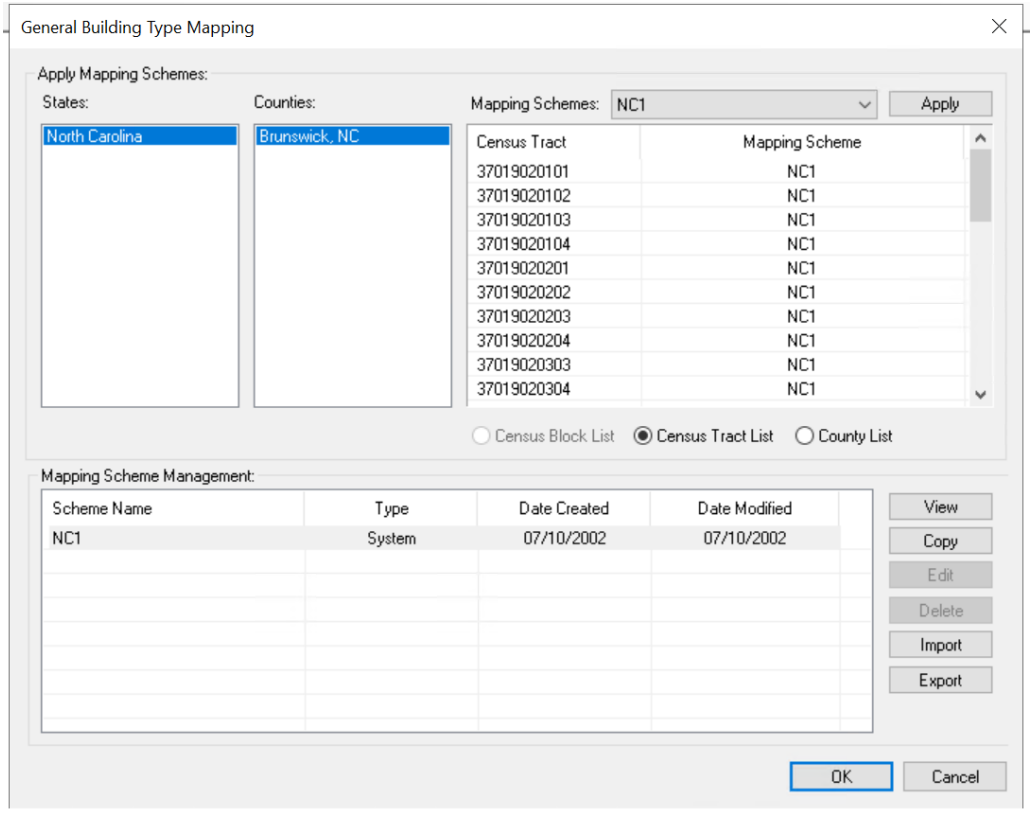


Figure 5-10 General Building Type Mapping Schemes

5.1.5 Specific Building Type Mapping

The Specific Building Type Mapping menu (Figure 5-11) allows the user to assign, view, and edit the distribution of building types in each occupancy and Census tract. The data in these dialogs are specific to the Hurricane Model. Selecting **Specific Building Type Mapping** will open the window shown in Figure 5-12.

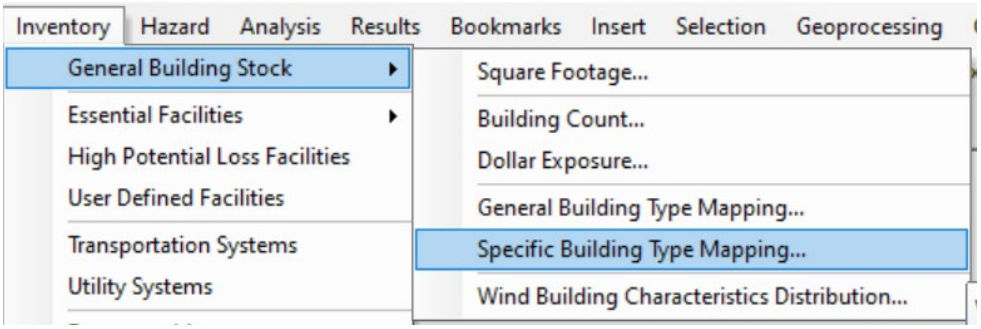


Figure 5-11 General Building Stock > Specific Building Type Mapping Menu

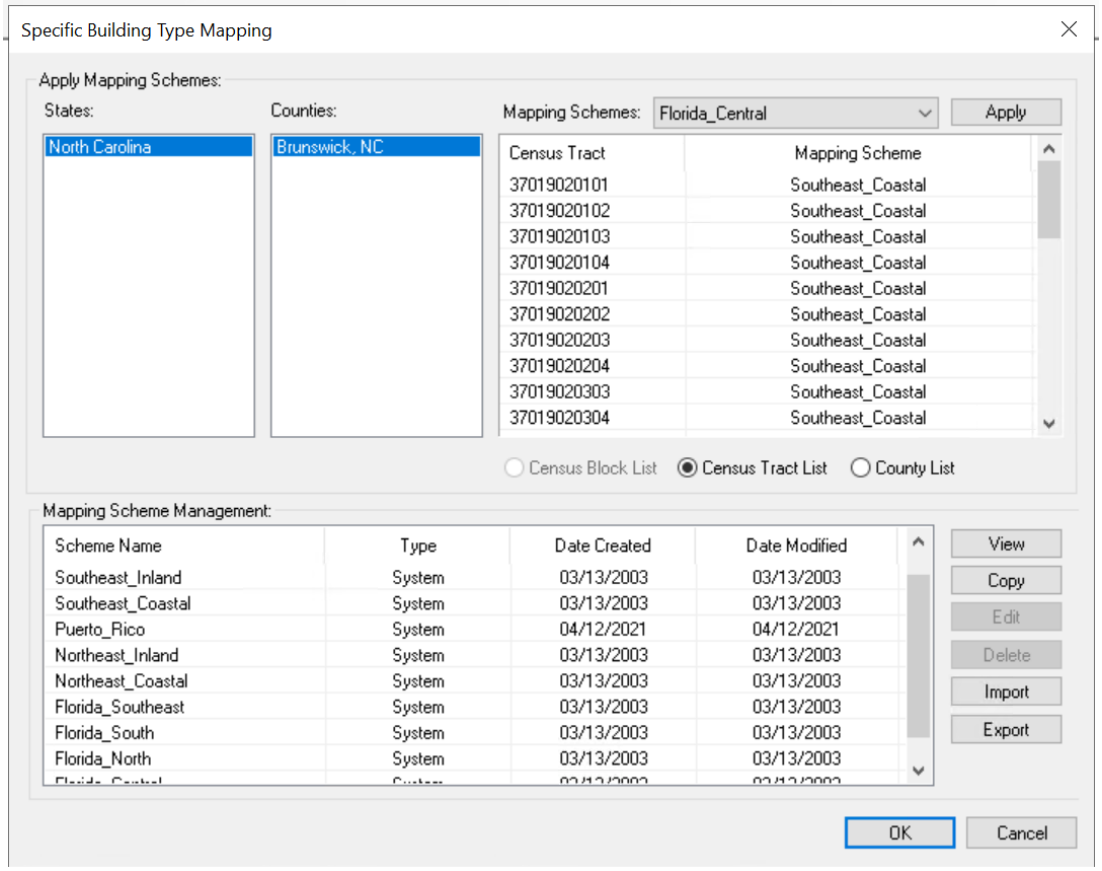


Figure 5-12 Specific Building Type Mapping Schemes

5.1.6 Wind Building Characteristics Distribution

The Wind Building Characteristics Distribution menu (Figure 5-13) allows the user to assign, view, and edit the distribution of wind building characteristics in each building type and Census tract. The data in these dialogs are specific to the Hurricane Model. Selecting the Wind Building Characteristics Distribution will open the table shown in Figure 5-14.

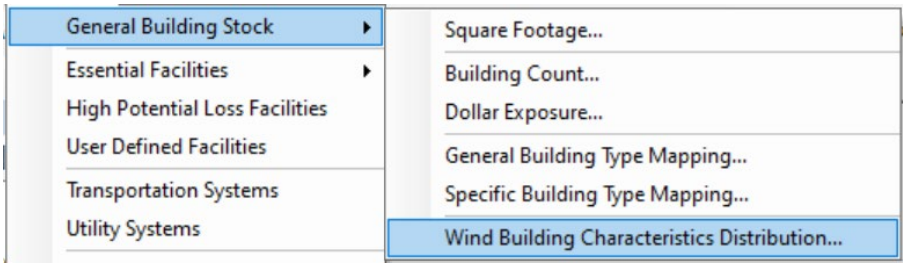


Figure 5-13 General Building Stock > Wind Building Characteristics Distribution Menu

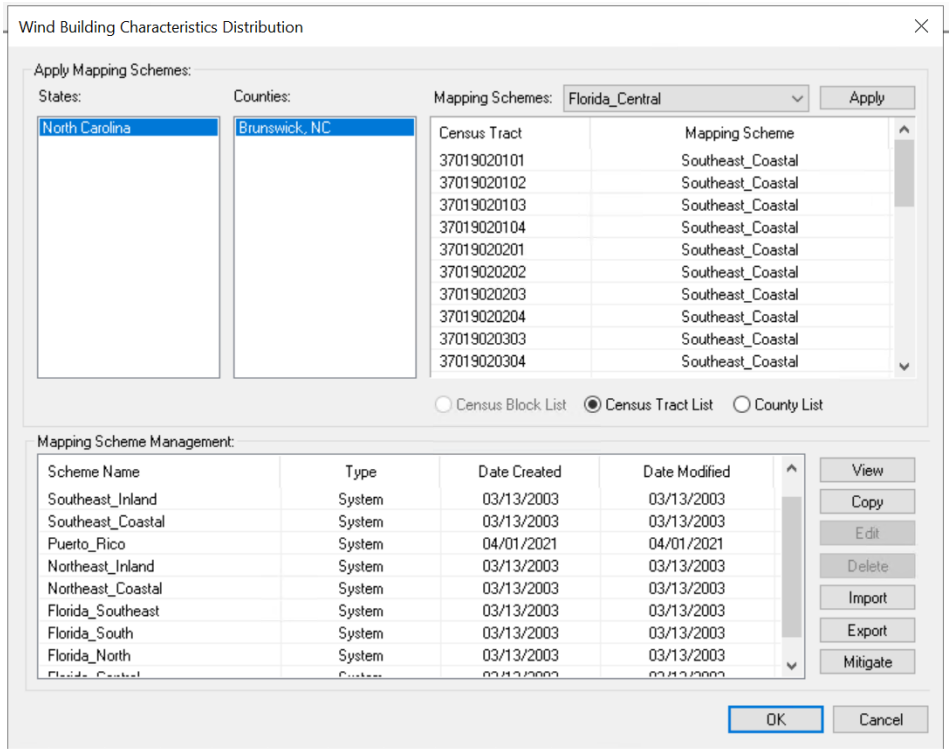


Figure 5-14 Wind Building Characteristics Distribution Schemes

5.2 Essential Facilities

Essential facilities include medical care facilities, fire stations, police stations, emergency response centers, and schools.

5.2.1 Inventory

To view the essential facilities inventory in the Study Region, select **Essential Facilities** (Figure 5-15). Selecting **Inventory** will open the window shown in Figure 5-16.

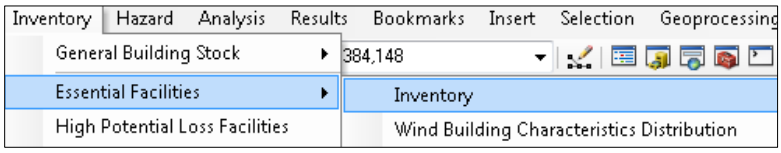


Figure 5-15 Inventory > Essential Facilities Menu

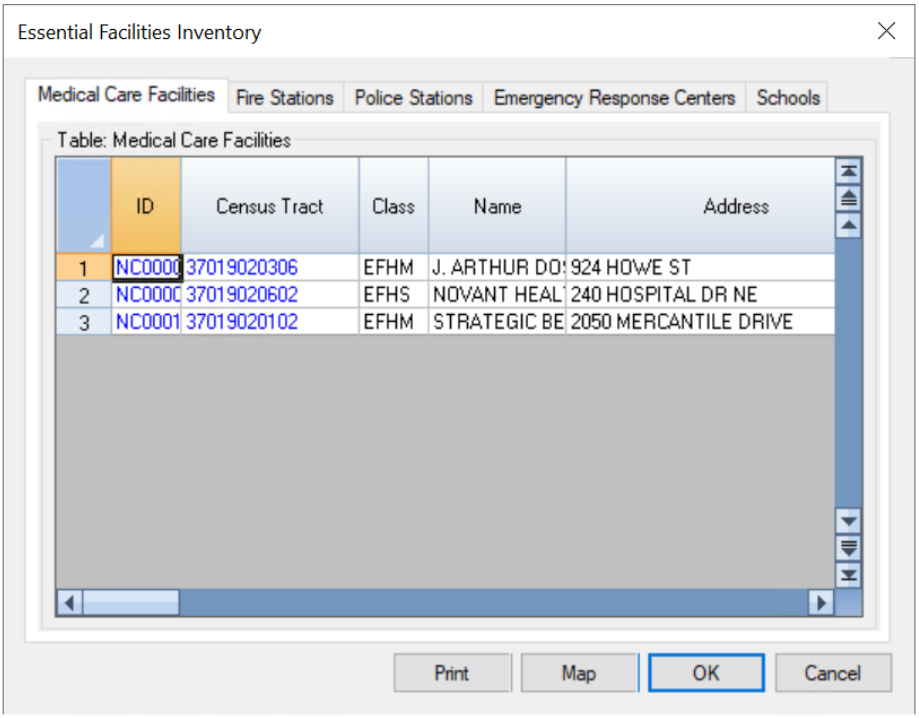


Figure 5-16 Essential Facilities (Medical Care Facilities) Table

5.2.2 Wind Building Characteristics Distribution

Wind Building Characteristics Distribution (Figure 5-17) allows the user to assign, view, and edit the distribution of wind building characteristics for essential facilities. The data in these dialogs are specific to the Hurricane Model. Selecting the **Wind Building Characteristics Distribution** will open the table shown in Figure 5-18.

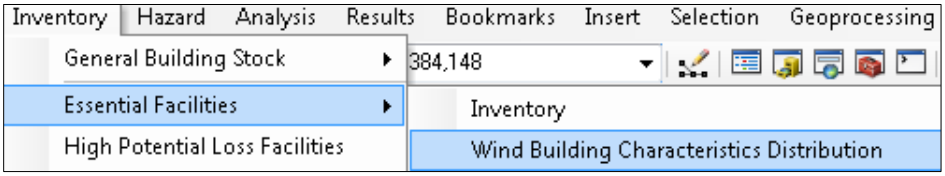


Figure 5-17 Essential Facilities > Wind Building Characteristics Distribution Menu

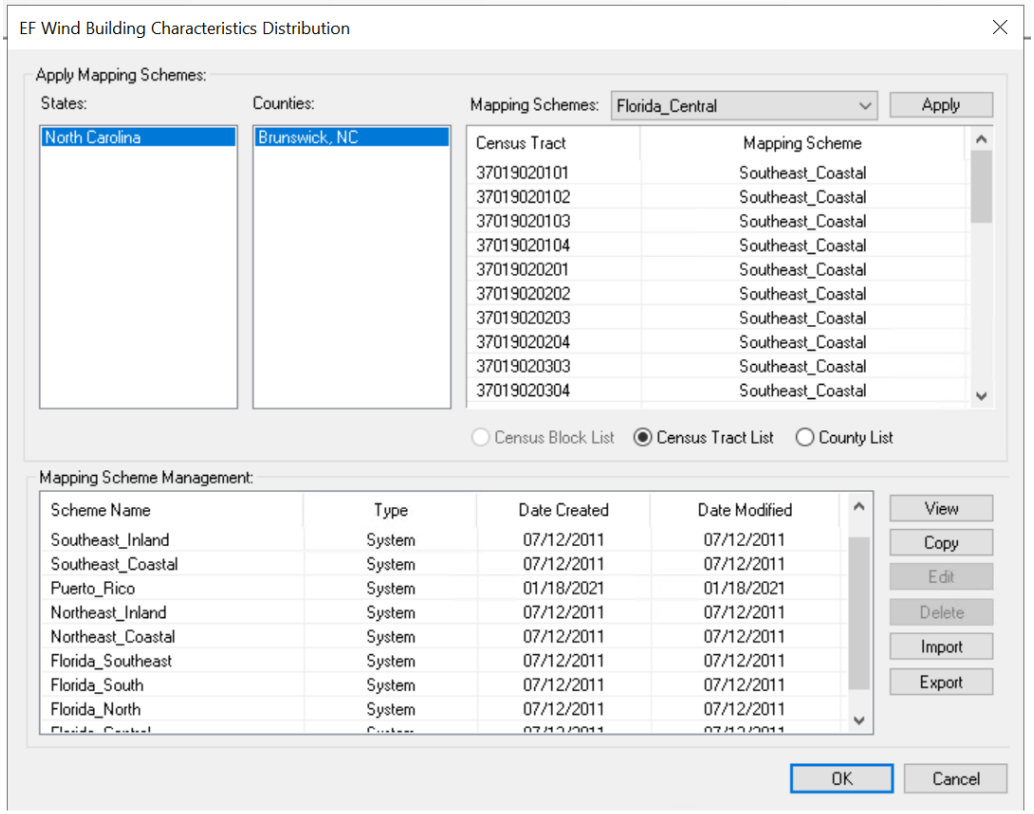


Figure 5-18 Essential Facilities > Wind Building Characteristics Distribution Schemes

5.3 High Potential Loss Facilities

High Potential Loss Facilities (HPLF) (Figure 5-19) allows the user to view and map the default database for the Study Region. Damage and loss are not computed for HPLF in the current version of the Hurricane Model. Selecting **High Potential Loss Facilities** will open the table shown in Figure 5-20. HPLF include dams and levees, nuclear power facilities, and military installations.

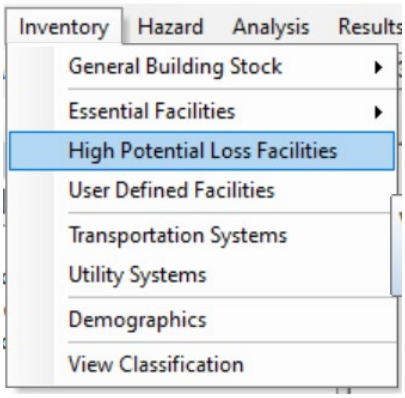


Figure 5-19 Inventory > High Potential Loss Facilities Menu

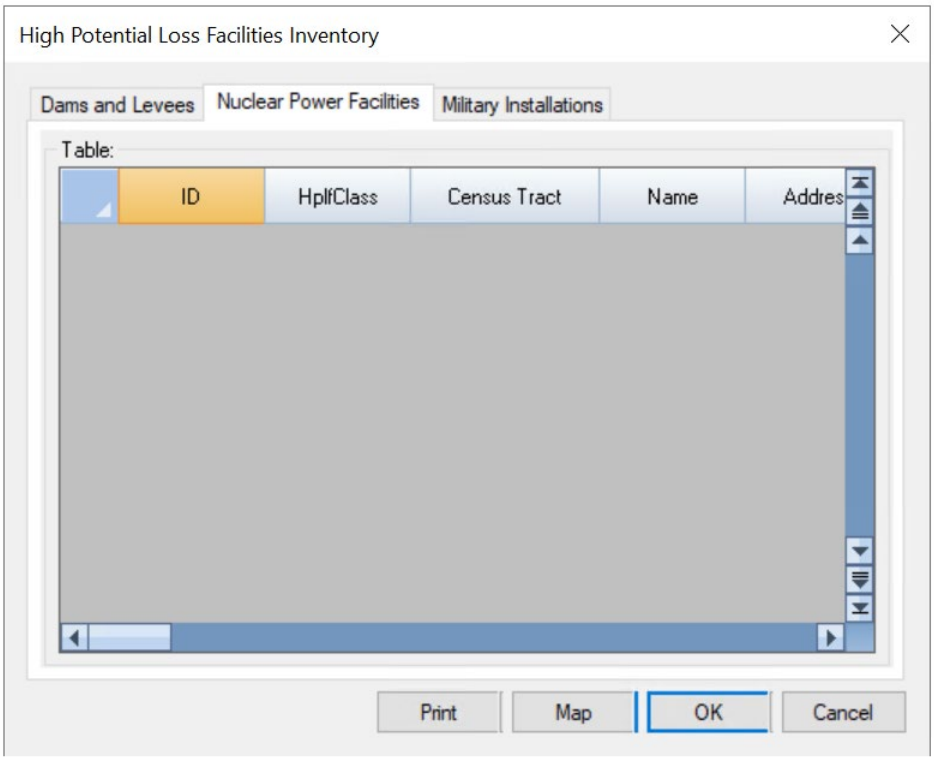


Figure 5-20 High Potential Loss Facilities (Nuclear Power Facilities) Table

5.4 User-Defined Facilities

User-defined facilities (UDF) are buildings at specific locations that the user adds to the inventory. Hazus uses "user-defined facilities" and "user-defined structures" interchangeably. Damage is evaluated on a building-by-building basis for user-defined facilities. Due to limited functionality of the current Hurricane Model, the hurricane UDF analysis is limited to hurricane damage state estimates and does not estimate dollar losses.

Selecting **User-Defined Facilities** (Figure 5-21) will open the table shown in Figure 5-22.

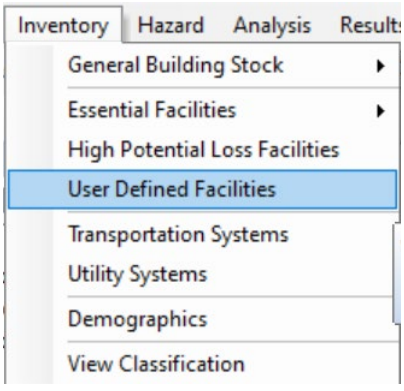


Figure 5-21 Inventory > User-Defined Facilities Menu

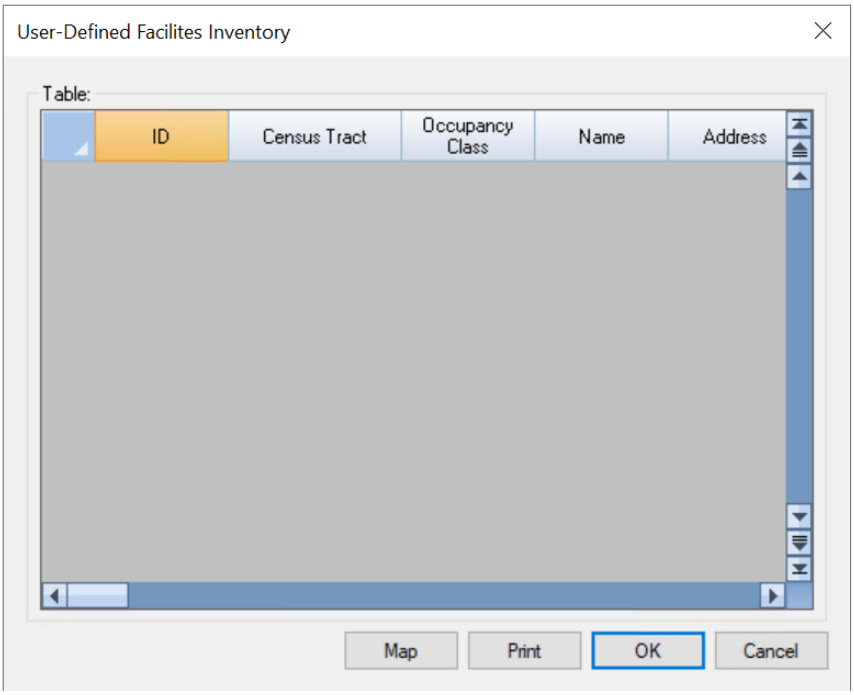


Figure 5-22 User-Defined Facilities Table

See Section 9 for information on the advanced Hazus analysis user-defined inventory, which allows the user to import custom data into Hazus.

5.5 Transportation Systems

Transportation lifelines, including highways, railways, light rail, bus systems, ports, ferry systems and airports, are divided into components such as bridges, stretches of roadway or track, terminals, and port warehouses. Selecting **Transportation Systems** (Figure 5-23) will open the window shown in Figure 5-24.

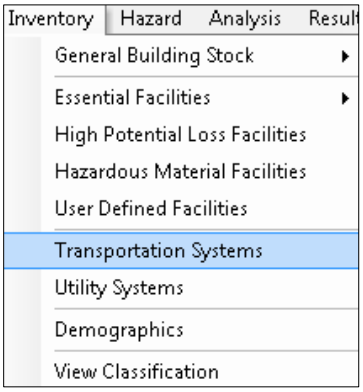


Figure 5-23 Inventory > Transportation Systems Menu

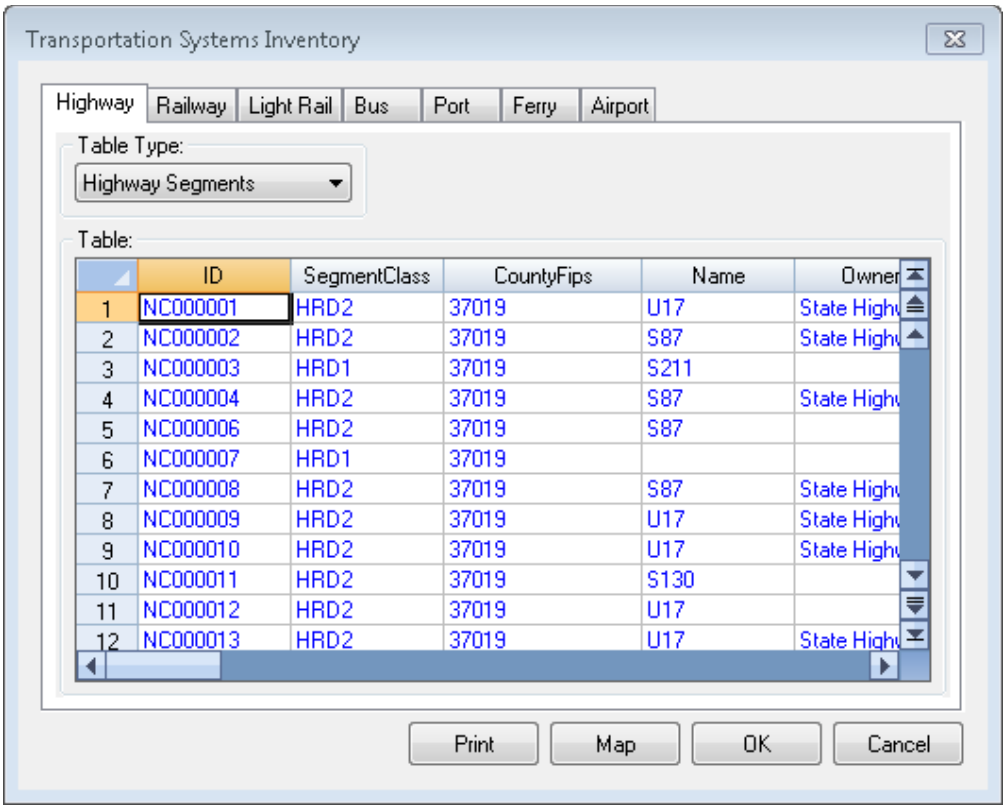


Figure 5-24 Transportation Systems (Highway) Table

5.6 Utility Systems

Utility lifelines, including potable water, electric power, wastewater, communications, and liquid fuels (oil and gas), are modeled similar to transportation lifelines. Examples of utility lifeline are electrical substations, water treatment plants, tank farms, and pumping stations. Selecting **Utility Systems** (Figure 5-25) will open the window shown in Figure 5-26.

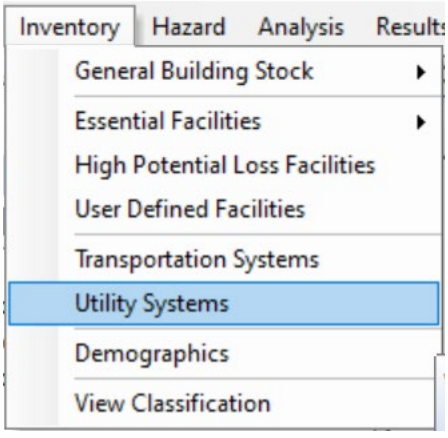


Figure 5-25 Inventory > Utility Systems Menu

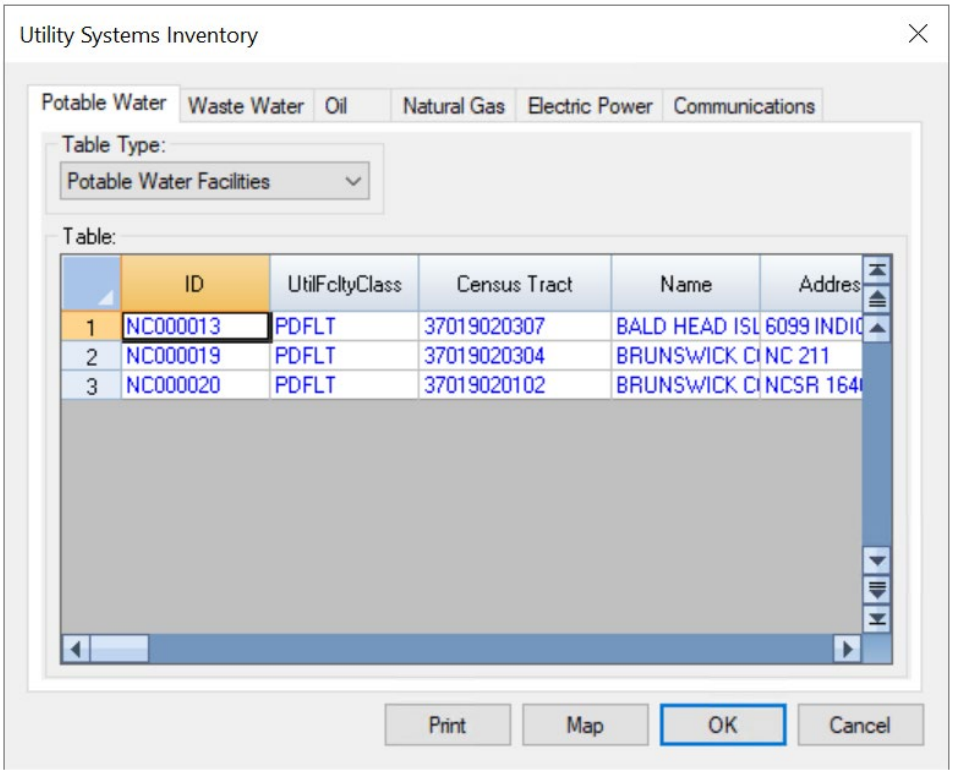


Figure 5-26 Utility Systems (Potable Water) Table

5.7 Demographics

Population statistics are used in estimating losses such as displaced households, and shelter needs. Population location, as well as ethnicity, income level, age, and home ownership, is needed to make these estimates. The 2010 Census data are included with Hazus. Users may be able to obtain updated information from the Census Bureau or from a regional planning agency. See Section 9 for information on user-defined demographic and inventory data. Selecting **Demographics** (Figure 5-27) will open the window shown in Figure 5-28.

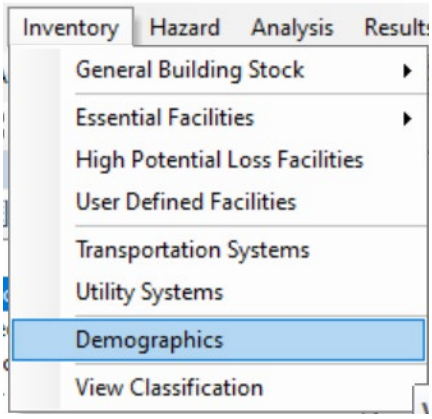


Figure 5-27 Inventory > Demographics Menu

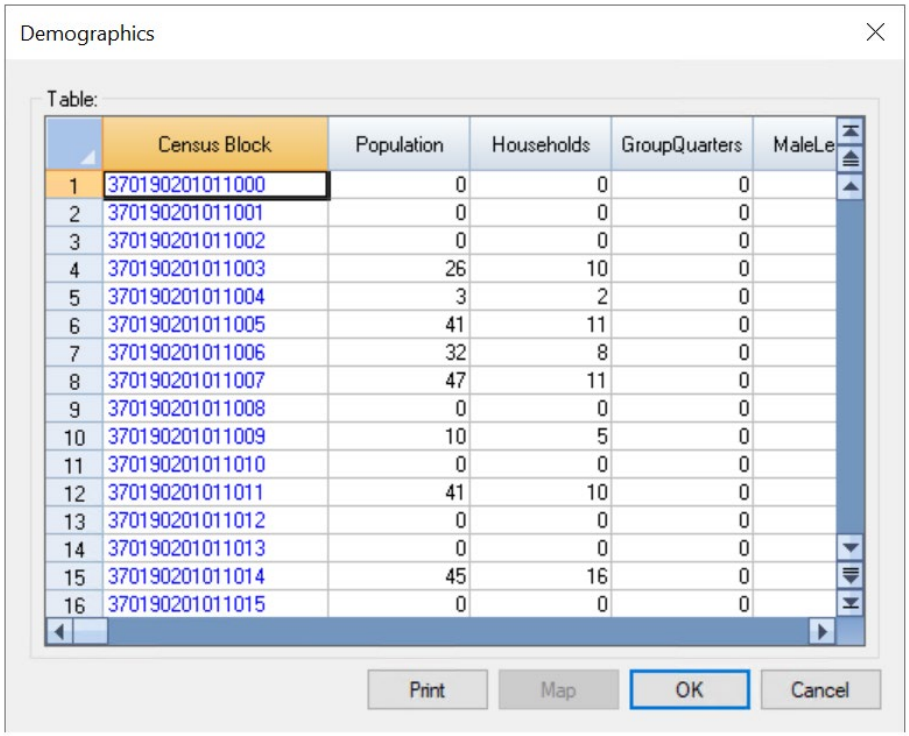


Figure 5-28 Demographics Table

5.8 View Classification

View Classification (Figure 5-29) allows users to view definitions of the classification categories. Selecting **View Classification** will open the window shown in Figure 5-30.

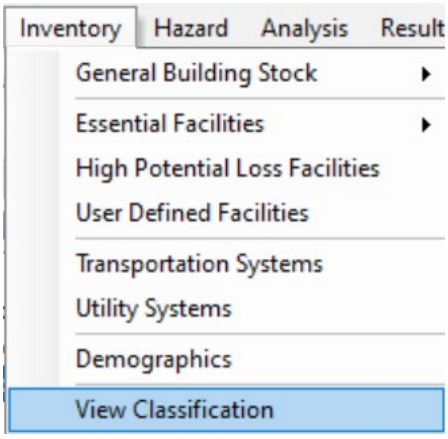


Figure 5-29 Inventory > View Classification Menu

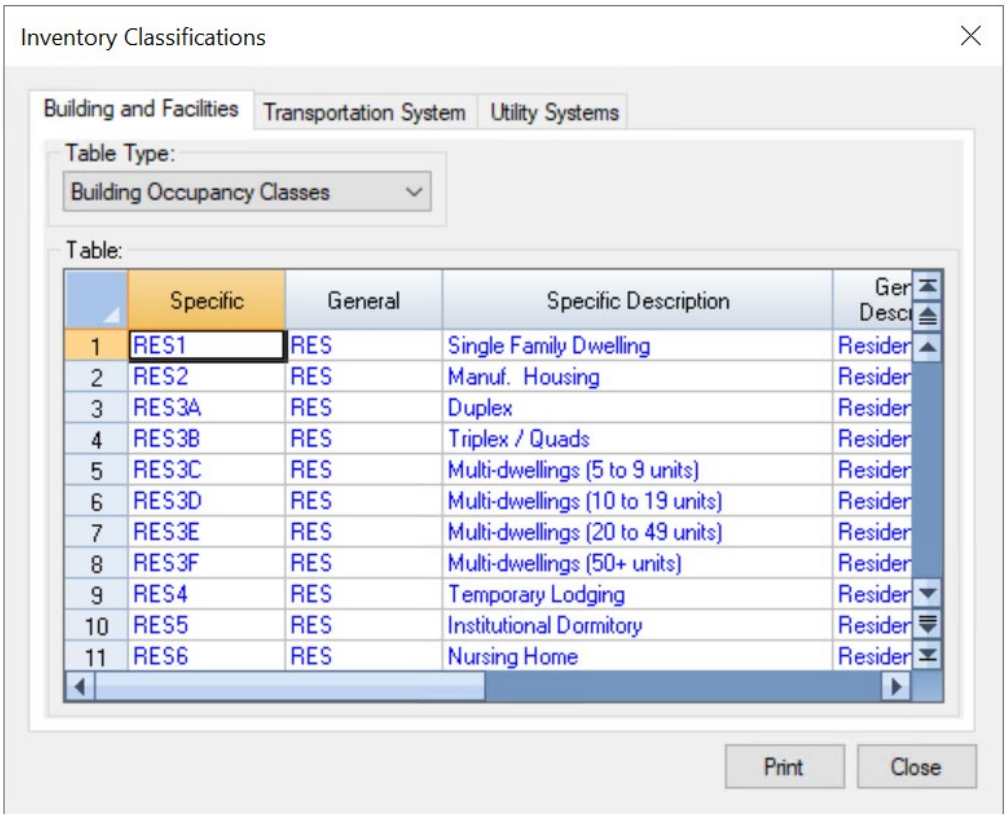


Figure 5-30 View Classification (Building and Facilities) Table

Section 6. Model Menu: Hazard

The two basic scenario options in the Hurricane Model are (1) a probabilistic hurricane scenario and (2) a single deterministic hurricane track. Deterministic tracks can include both historic and hypothetical hurricane tracks that are user-defined or imported from an external source. The inputs required for both options are described in this Section.

6.1 Probabilistic Scenario

The probabilistic scenario is the default hazard scenario option in the Hurricane Model. The scenario considers the associated impacts of many thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic and Central Pacific hurricanes. Refer to the Technical Manual for information on the data the probabilistic scenario is based on.

The probabilistic scenario option is the active scenario until a different type of scenario is made active for the Study Region.

After selecting **Scenario** in the **Hazard** menu (Figure 6-1), the **Scenario Wizard** (Figure 6-2) will open. The wizard will guide the user through defining a storm track for the probabilistic scenario. Click **Next**.

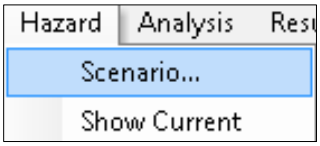


Figure 6-1 Select Scenario in Hazard Menu

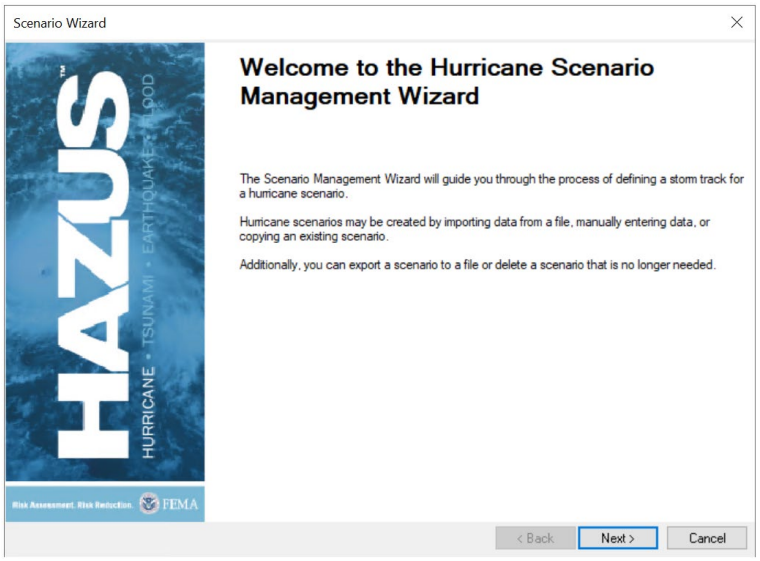


Figure 6-2 Scenario Wizard

The probabilistic scenario is the first option in the Scenario Operation menu (Figure 6-3). Choose this option and click Next.

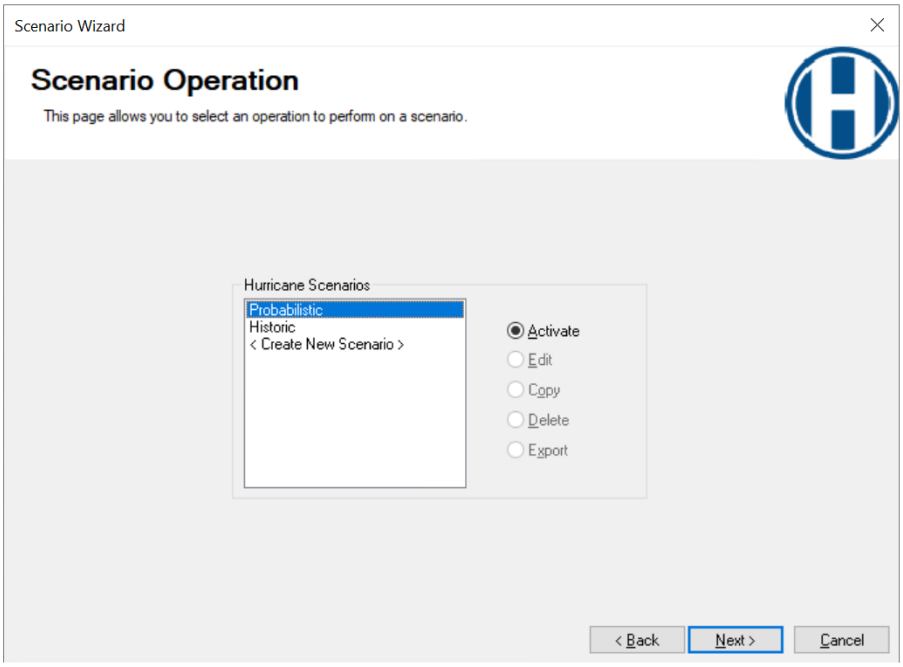


Figure 6-3 Select Probabilistic in Scenario Operation

Select the first option in the **Activate Scenario** menu (Figure 6-4) to activate the probabilistic scenario option. Click **Next**.

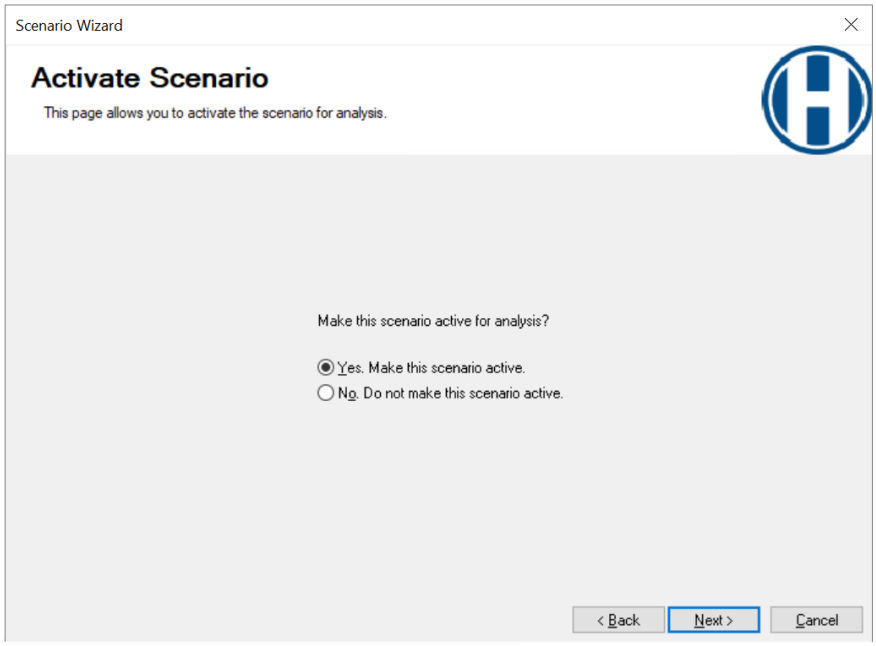


Figure 6-4 Select Yes to Activate Scenario

6.2 Historic Scenario

The historic scenario is another scenario option in the Hurricane Model. Activating the historic hurricane hazard allows users to select from the historical storms that are preloaded into the program. Only historical storms that affected the Study Region should be selected. The historic scenario walkthrough begins with the screen shown in Figure 6-5.

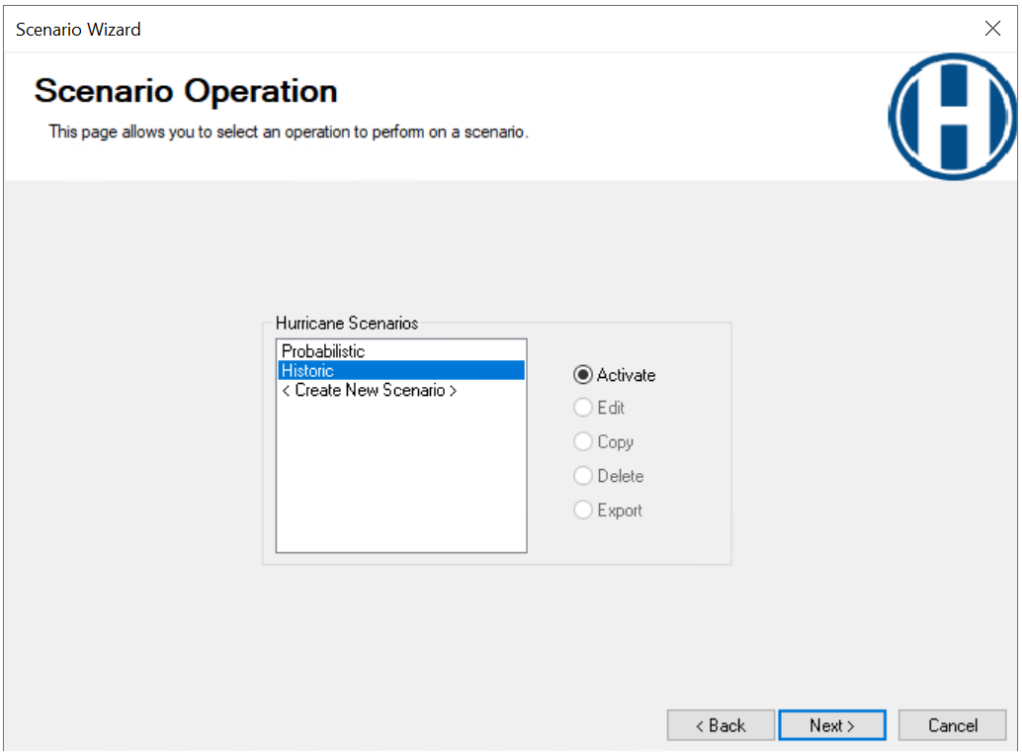


Figure 6-5 Select Historic in Scenario Operation

Next, the user will see the **Select Historic Storm Scenario** menu (Figure 6-6). This menu contains a predefined list of historic storms that includes the following information:

- Year
- Name
- Peak gust
- States affected
- Landfall states

Select the desired storm for the Study Region and click **Next**.

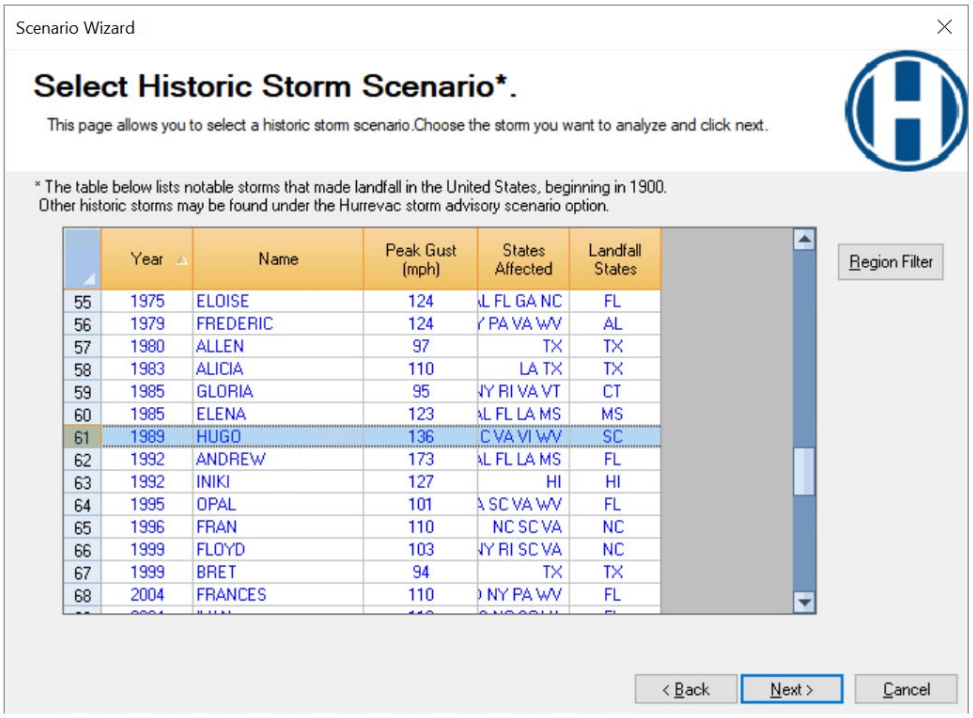


Figure 6-6 Select Desired Storm in Historic Storm Scenario

Next, the user will see the **Scenario Review** window (Figure 6-7), which has the scenario information. Click **Next**. When the **Activate Scenario** window (Figure 6-8) appears, select the first option (to make the scenario active) and click **Next**.

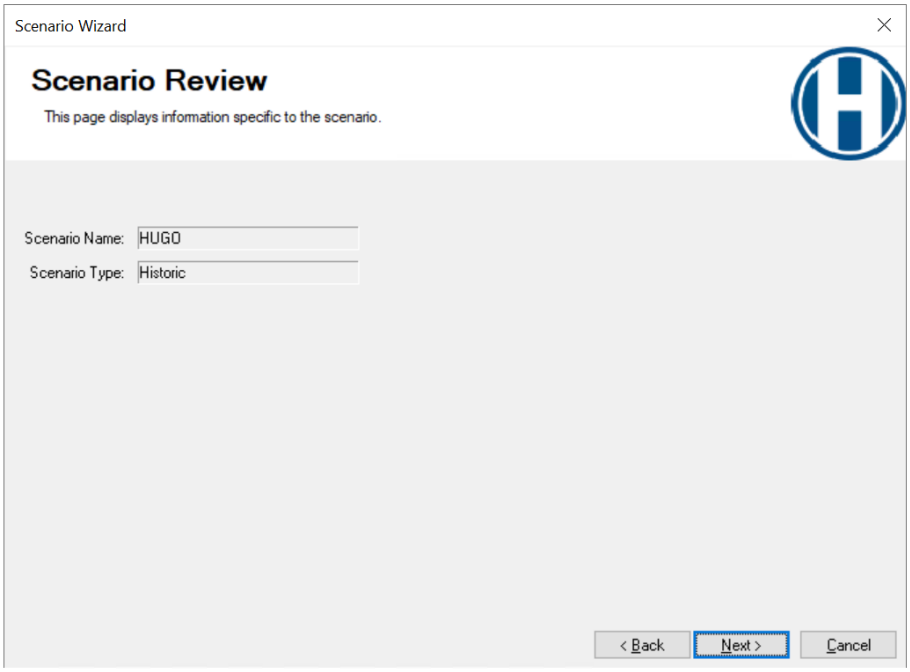


Figure 6-7 Select Next in Scenario Review

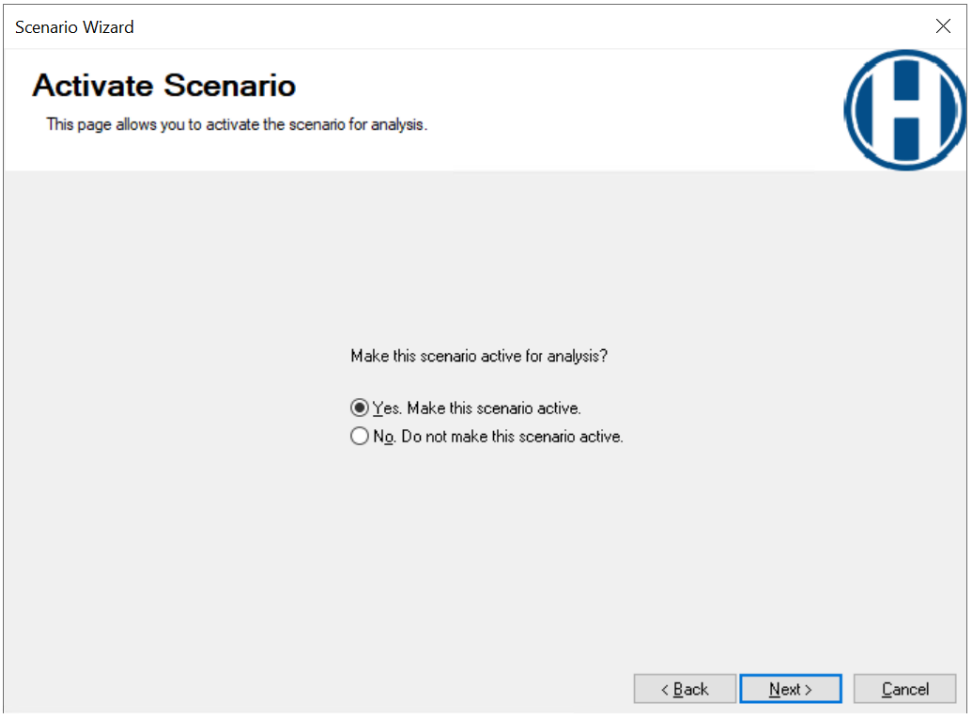


Figure 6-8 Select Yes to Activate Scenario

6.3 Create New Scenario

The **<Create New Scenario>** is another scenario option in the Hurricane Model (Figure 6-9). Creating a new hurricane scenario will allow the user to select (shown in Figure 6-10) from the following options:

- Define Storm Track Manually
- Import from Exported File (storm created in previous Hazus Study Region)
- Import Census tract Data File
- Import a historic Hurrevac Storm File Advisory

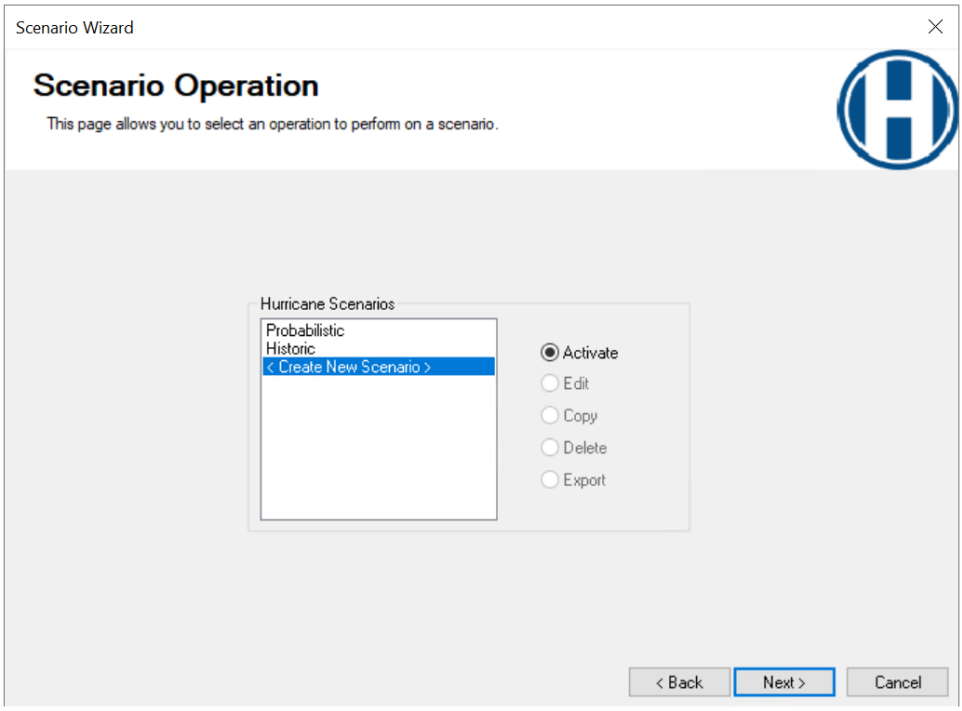


Figure 6-9 Create New Scenario Operation

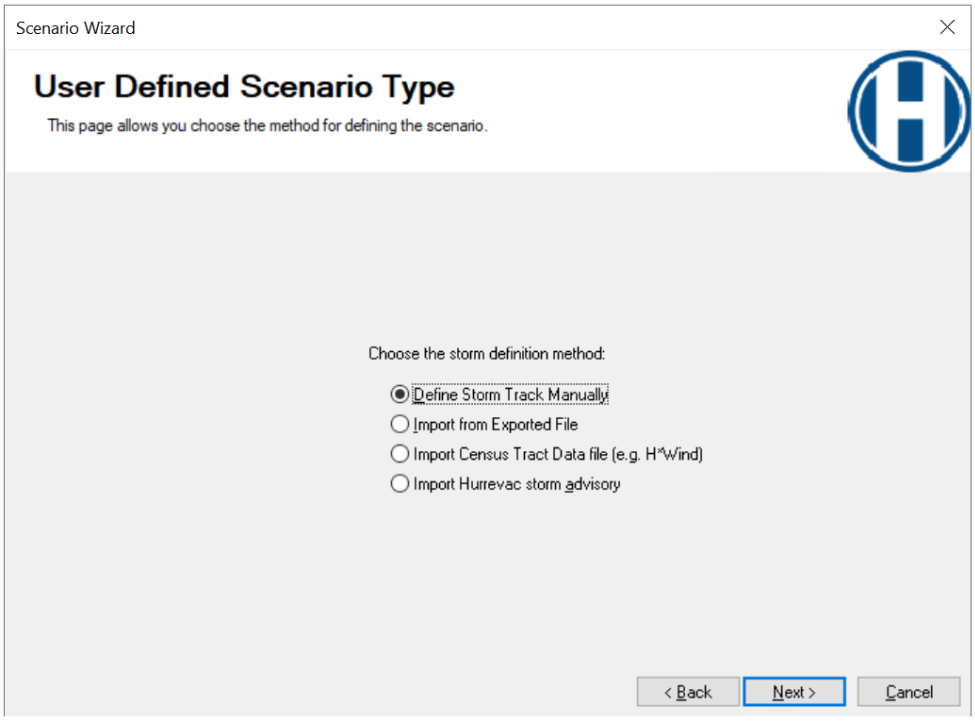


Figure 6-10 Select Preferred Storm Definition Method

6.3.1 Define Storm Track Manually

Define Storm Track Manually allows users to enter their own hurricane track data. Because this is a detailed process, step-by-step instructions on entering the data comprise a Section of this User guidance (Section 10).

6.3.2 Import a Storm

Import from Exported File (Figure 6-11) allows the user to import a scenario from a saved file, which will allow the user to name and import a saved scenario.

Select **Import from Exported File** in the **User-Defined Scenario Type** window (Figure 6-11) and click **Next**.

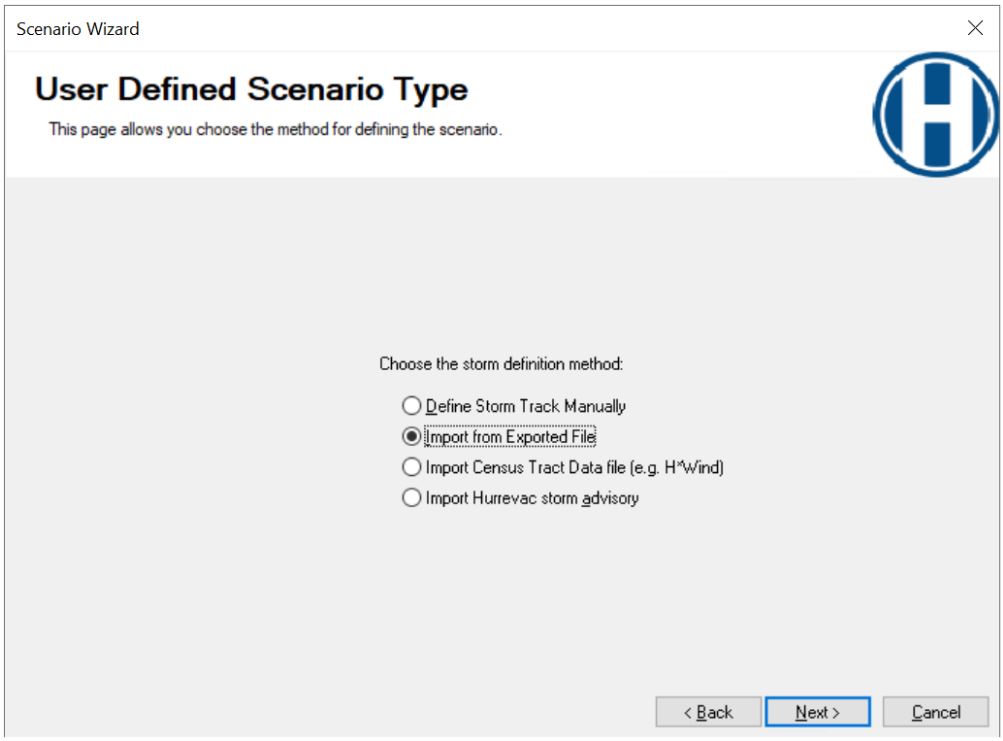


Figure 6-11 Select Import from Exported File

The default name of the imported scenario will be the date. The user can rename the imported scenario (Figure 6-12). Click **Next**.

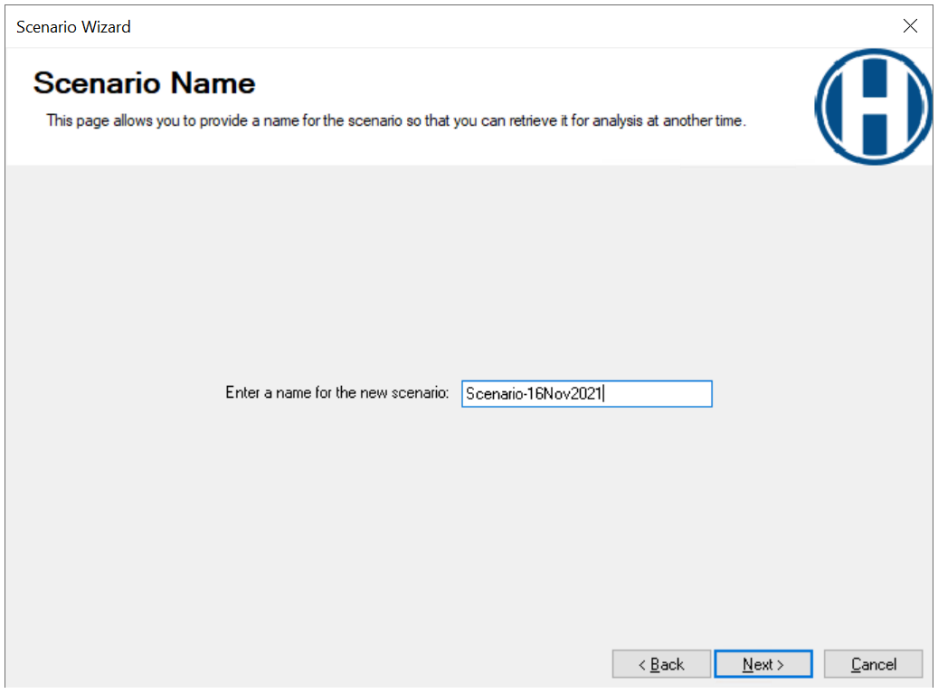


Figure 6-12 Provide Scenario Name for Imported File

Next, the user will see the **Import Storm Track** window. Select **Browse** and find the desired file to import (Figure 6-13). After selecting the file, click **Next**. The **Windfield Calculation** will be run, and the user can activate the scenario.

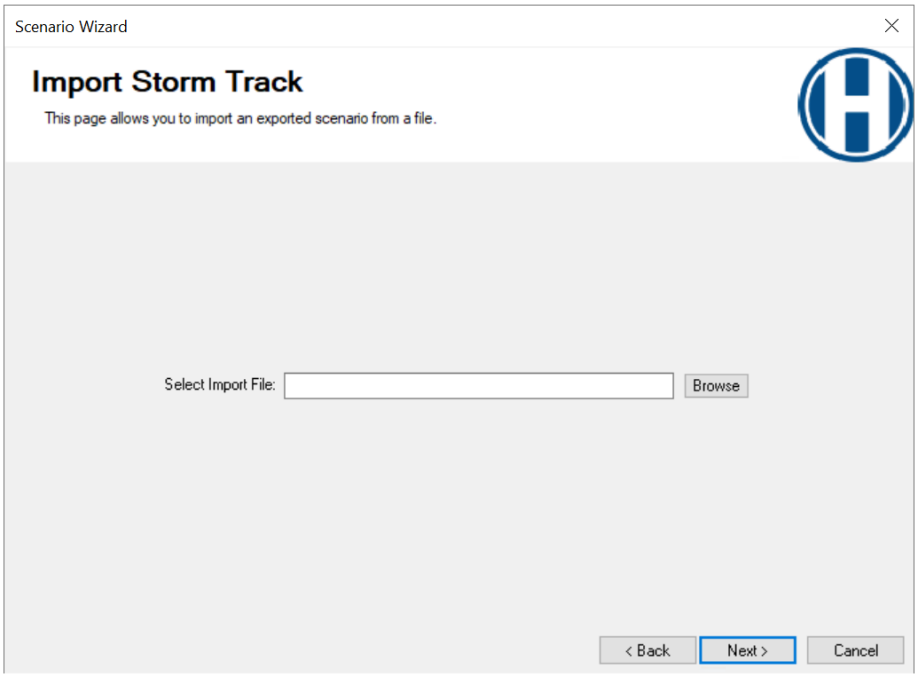


Figure 6-13 Select Desired Import File for Storm Track

6.3.3 Import Census Tract Data File

Similar to importing a file that had been previously exported from Hazus, a user can import into Hazus a hurricane wind data file in the .dat format with information at the Census tract centroid. The .dat file must already be available and must be created using the format established originally by NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) Hurricane Research Division (HRD) for their retired H*wind Program. Contact the Hazus Help Desk for more information on the .dat format.

To import a .dat file, select the **Import Census Tract Centroid Data file** (see Figure 6-14), enter a scenario name on the following screen (Figure 6-15), and select the file on the following screen (Figure 6-16) and click **Next**.

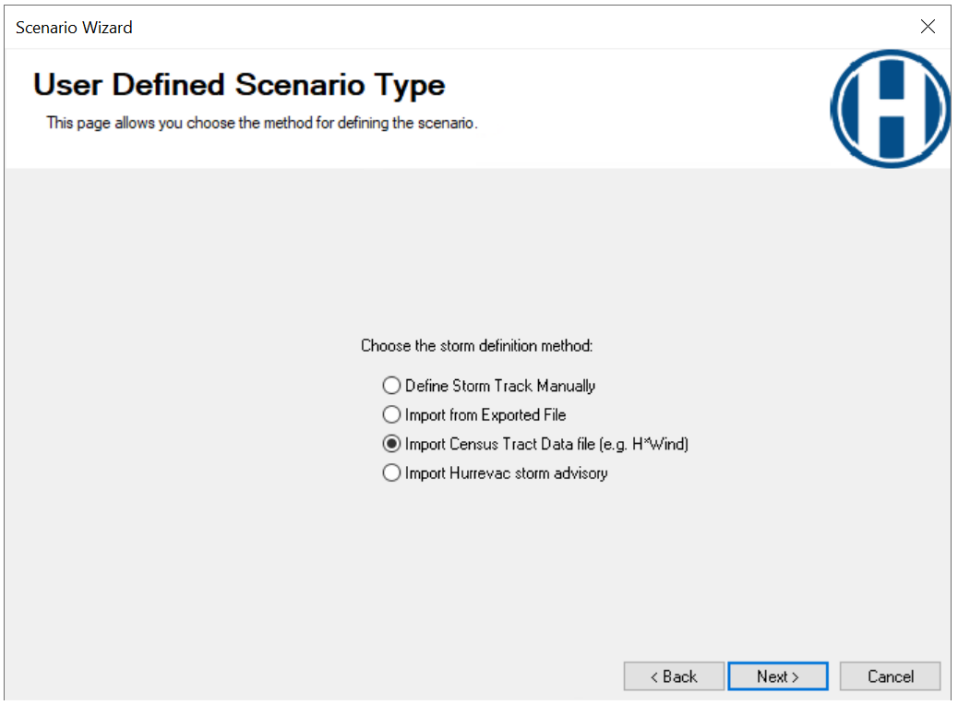


Figure 6-14 Select Import Census Tract Data File

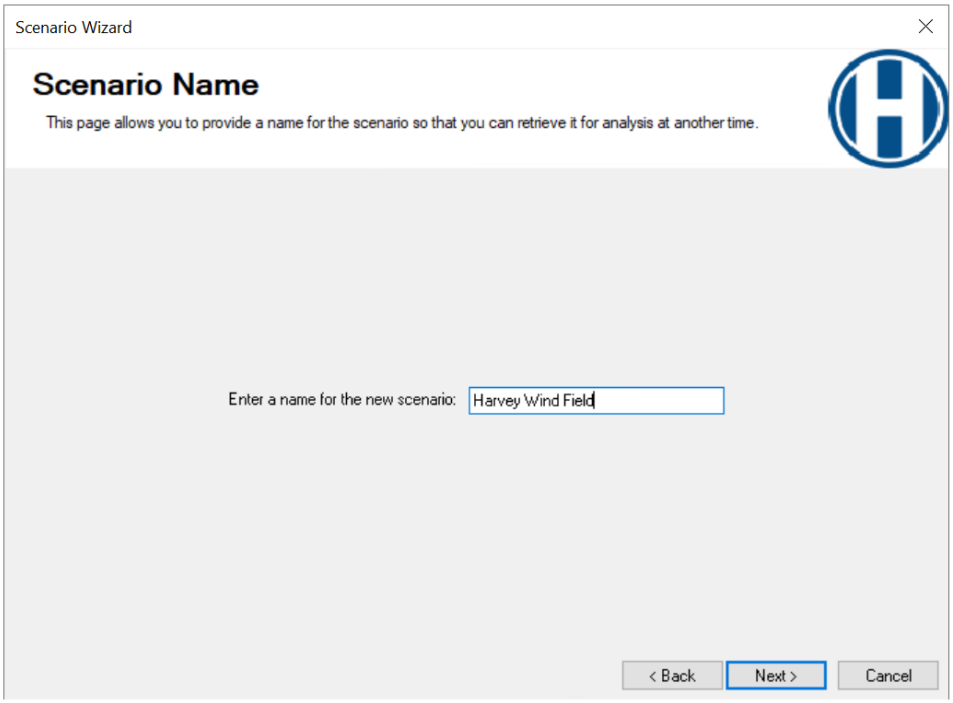


Figure 6-15 Provide Scenario Name for Imported Census Tract Data File

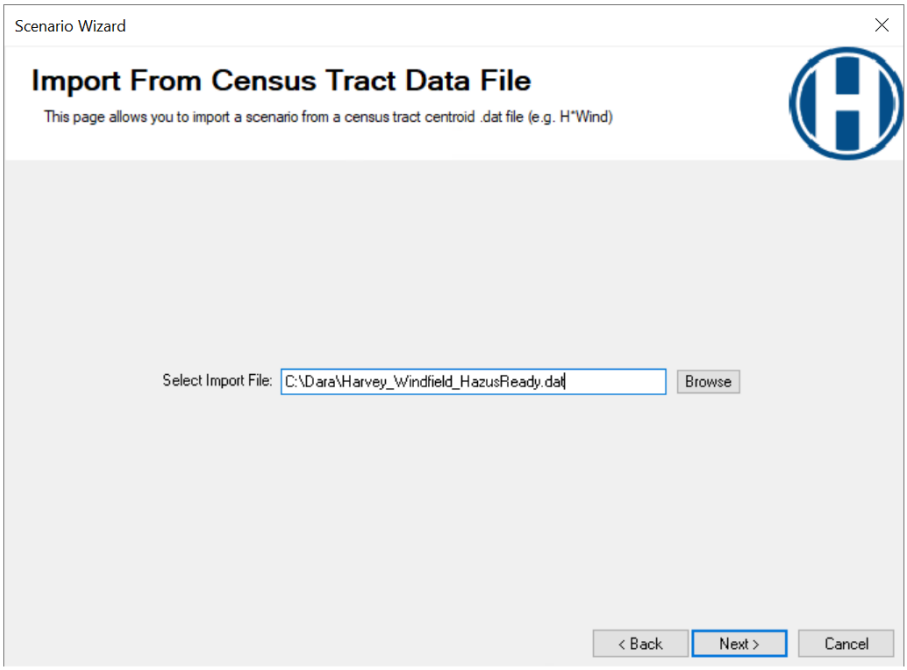


Figure 6-16 Select Desired Import File for Census Tract Data File

After the file imports, click **Next** on the screen shown in Figure 6-17 to complete the import process, which can be confirmed on the final status review screen shown in Figure 6-18. The storm tract data

review data will not populate when importing a Census tract data file. To build this table, Hazus utilizes the hurricane track information, however, in this case users are assigning observed wind speeds to Census tracts directly. Therefore, the hurricane track is not needed for this step.

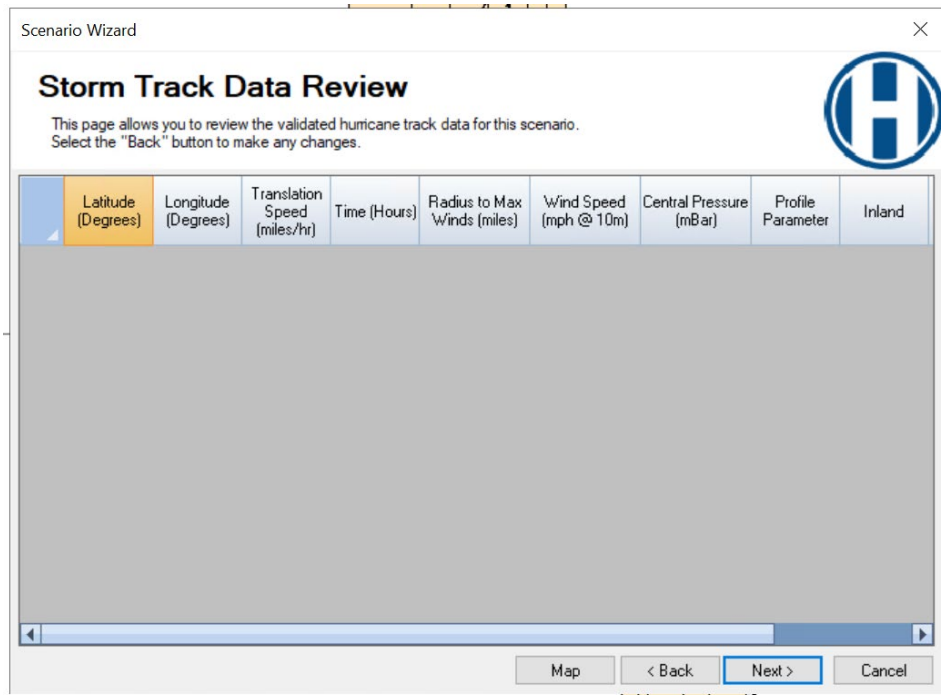


Figure 6-17 Select Next to Load Imported Data

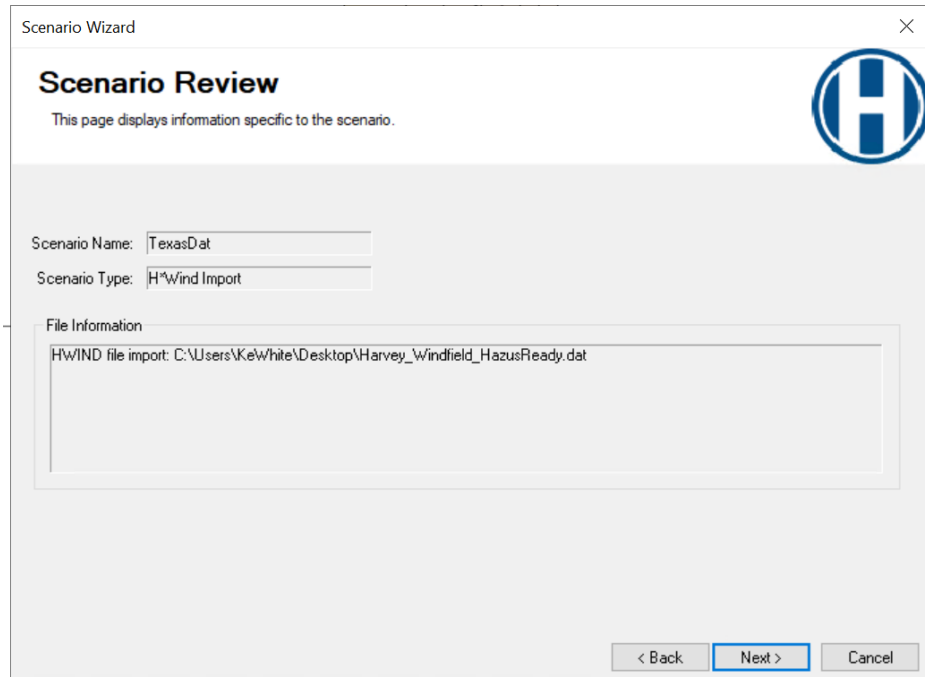


Figure 6-18 Select Next to Finish Loading Imported File

6.3.4 Import a Hurrevac Storm Advisory

Instead of using the **Import Hurrevac storm advisory** option in the **User-Defined Scenario Type** window, users are directed to use the Hurricane Hazard Import Tool (HHIT) to import Hurrevac storm advisory data for the Atlantic or the Pacific. Hurrevac no longer maintains or supports the data feed which Hazus can access through this menu. While these menu options may still be functional in Hazus, users should use the HHIT tool, a standalone script which runs independently of Hazus. To obtain the latest version, visit the Hazus MSC page under the Open Source Tools section to download the tool Zip file.

After downloading the HHIT package, save it to a location on your local machine and navigate to the HHIT folder. Be sure to review any ReadMe or Requirements documents to ensure you have the latest version of supplementary tools installed. These documents will also provide step-by-step instructions for using the HHIT tool.

Prior to obtaining and running HHIT, it is recommended that users familiarize themselves with the types and formats of Hurrevac data available for analysis. Visit the Hurrevac website to sign up for an account and explore the data options.

From the HHIT folder, locate the file called “hurricane-hazard-import-tool.py” and double-click to launch. The tool interface will open (Figure 6-19). You can then select a storm from the dropdown options, or if you obtained a unique numeric storm ID from the Hurrevac website, it can be entered here. Once complete, click **Load to Hazus**.

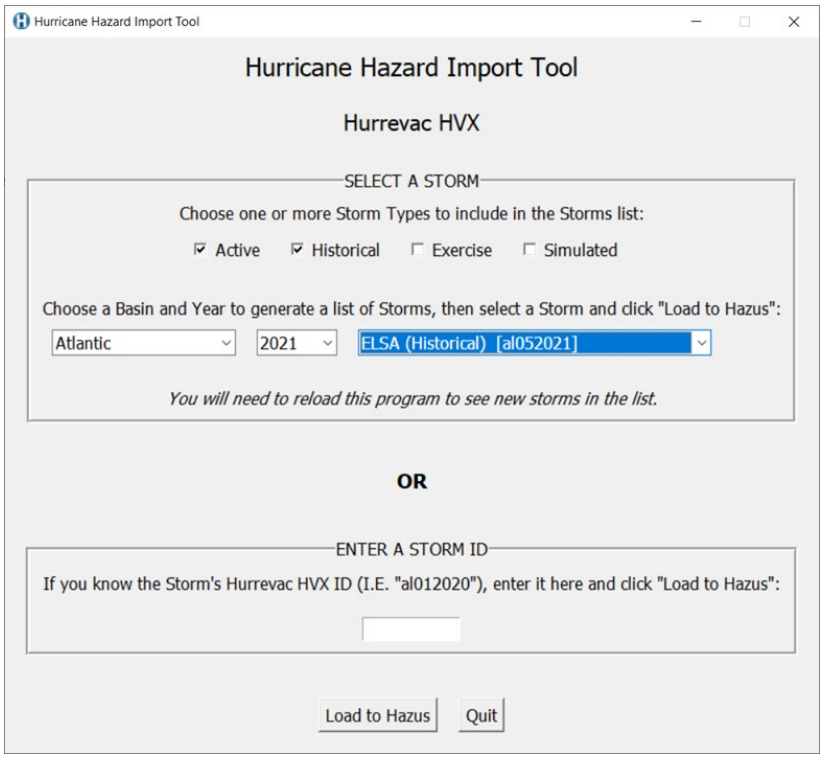


Figure 6-19 Hurricane Hazard Import Tool

If the **Load to Hazus** is successful, the user will receive a pop-up confirmation window. This window directs the user with next steps highlighted in yellow and labeled 1, 2 and 3 (Figure 6-20). The user will complete these steps in the main Hazus user interface.

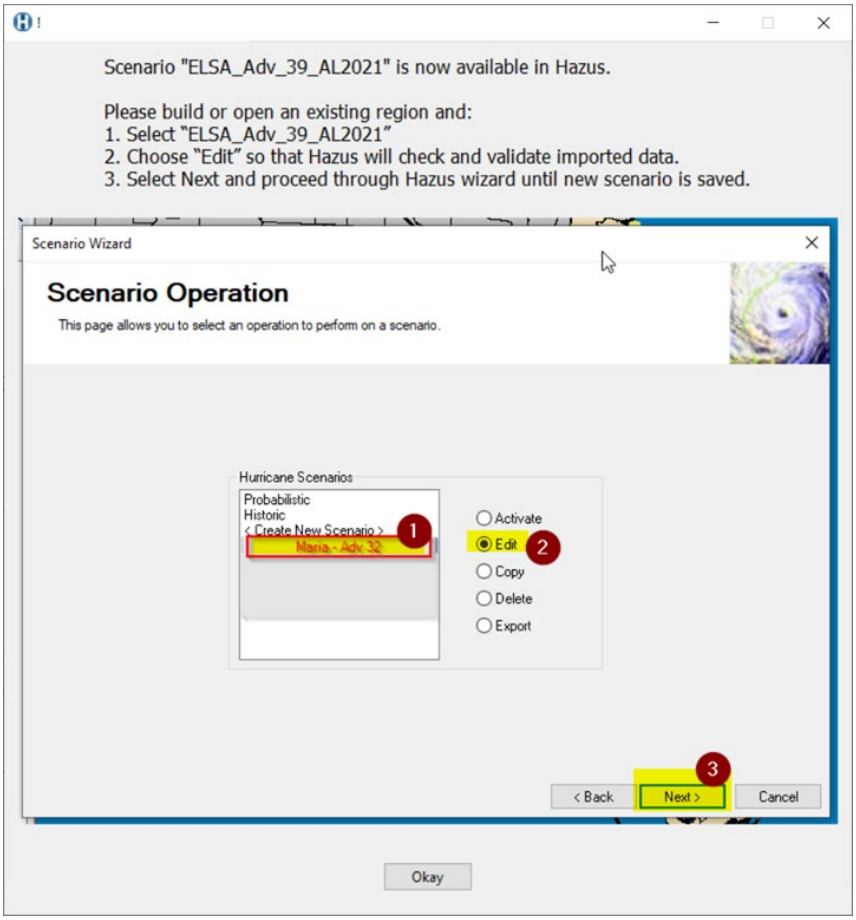


Figure 6-20 Hurrevac Confirmation Pop-up Window with Next Steps

After receiving the pop-up confirmation window in the HHIT tool, go to Hazus and open an existing or create a new Hurricane Study Region that contains the geography of the Hurrevac storm selected in the previous step. Go to the **Hazard** menu, select **Scenario** and click **Next**. After selecting the storm from the **Hurricane Scenarios** list, select the **Edit** radio button and click **Next** (Figure 6-20). This will bring up the **Storm Track Definition Method** window (Figure 6-21). Here the user can choose to enter the storm's location at specific times or with translation speeds, the radius to maximum winds or radius to hurricane force winds, and maximum wind speeds or profile parameters.

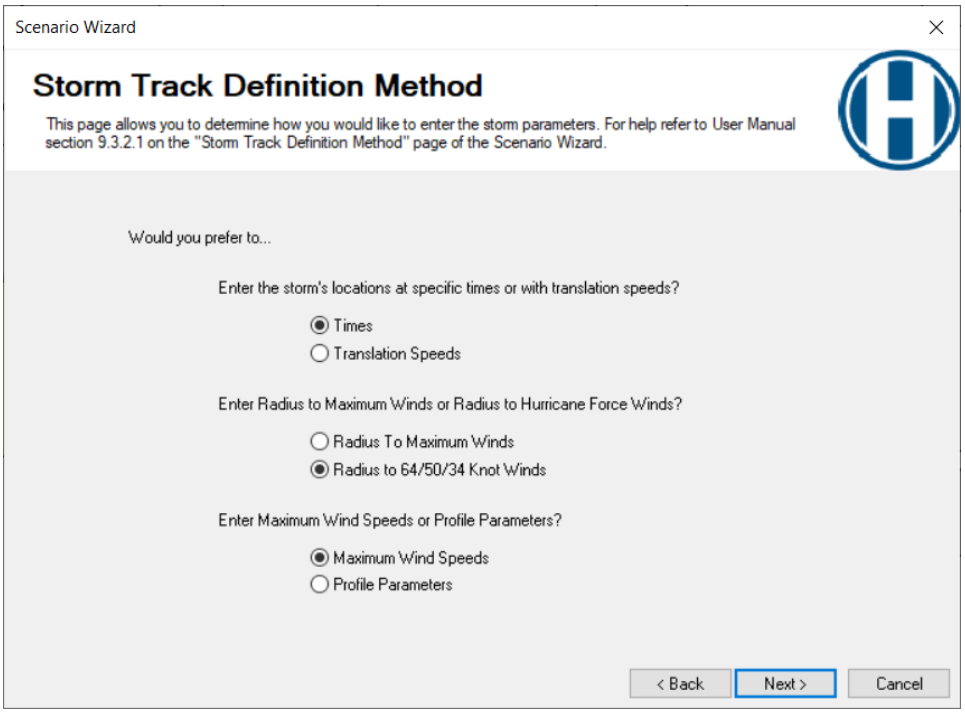


Figure 6-21 Hurrevac Storm Track Definition Method

Select the desired storm parameters' radio buttons and click **Next**. This will bring up the **Edit Storm Track** table (Figure 6-22).

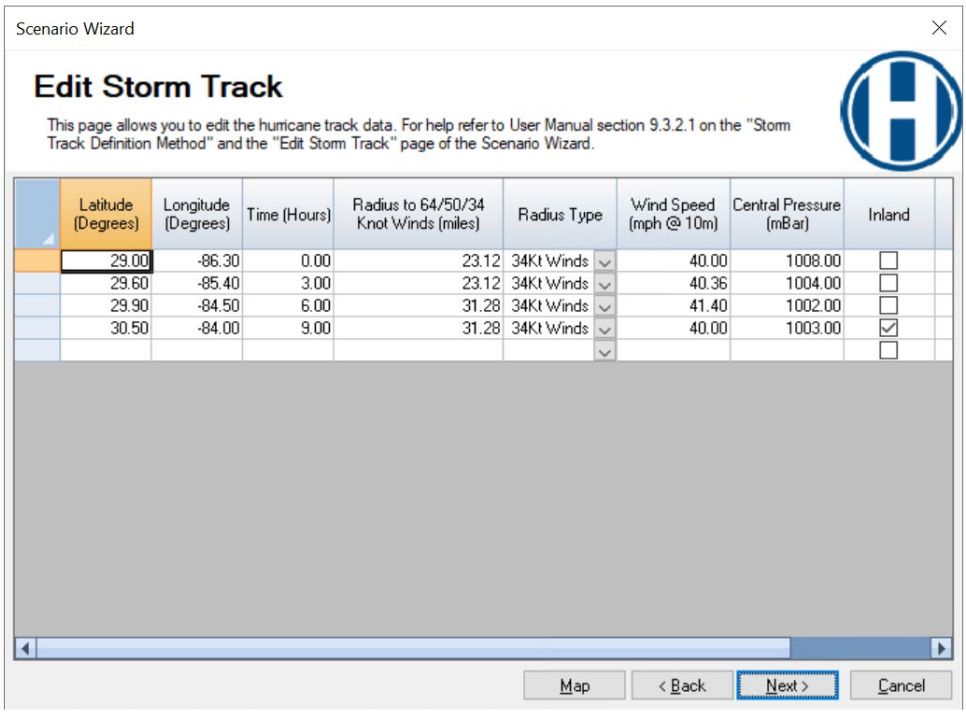


Figure 6-22 Edit Storm Track

The user can make any desired edits to the storm track in the **Edit Storm Track** table. When an existing forecast/advisory is selected or a new forecast/advisory is downloaded, the hurricane radii and wind speeds in the forecast/advisory files are reduced by the default factors given in the Settings.xml file (typically installed to the C:\Program Files (x86)\Hazus\ directory), with default values of 0.90 = HurrevacVmaxFactor, 0.77 = HurrevacRHurr64Factor, and 0.68 = HurrevacRHurrr50Factor. Consult the Technical Guidance or the contact the Hazus Help Desk for more information on these adjustments.

A user may also need to edit values when the storm track data are incomplete. Hazus expects radius to 64Kt force winds to be between 0 and 200 miles, radius to 50Kt force winds to be between 0 and 300 miles, and radius to 34Kt force winds to be between 0 and 400 miles. If values are outside these ranges, Hazus will show an error message (Figure 6-23) when the user clicks **Next** in the **Edit Storm Track** table.

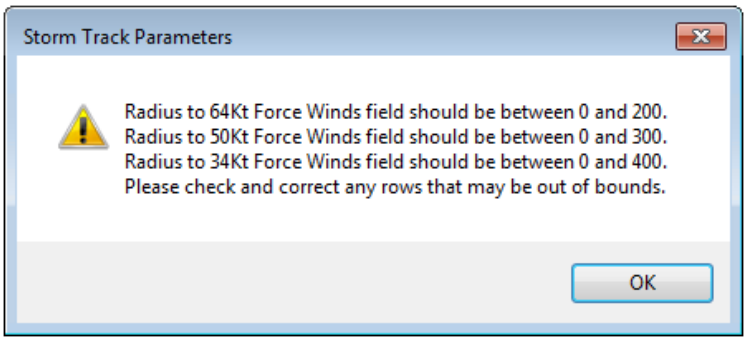


Figure 6-23 Correct Errors for Edited Storm Track

Once all storm track edits have been finalized click **Next** to continue and Hazus will compute the Windfield Calculation. The results will appear in the **Storm Track Data Review** window (Figure 6-24).

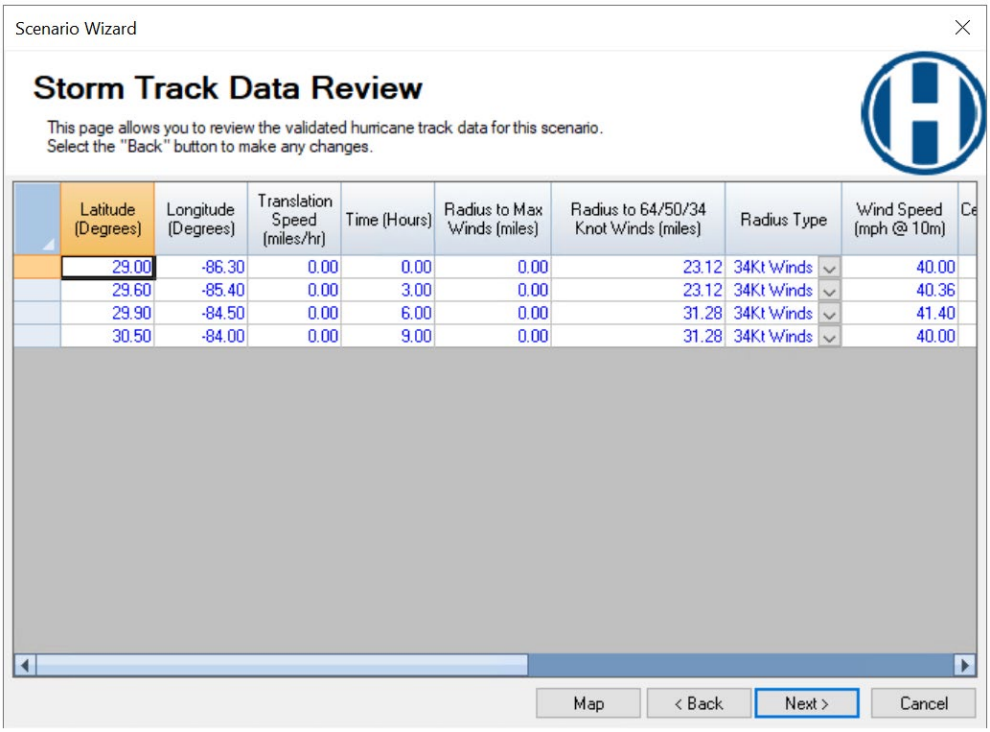


Figure 6-24 Storm Track Data Review

Click **Next** after examining the **Storm Track Data Review** results to bring up the **Scenario Review** window (Figure 6-25).

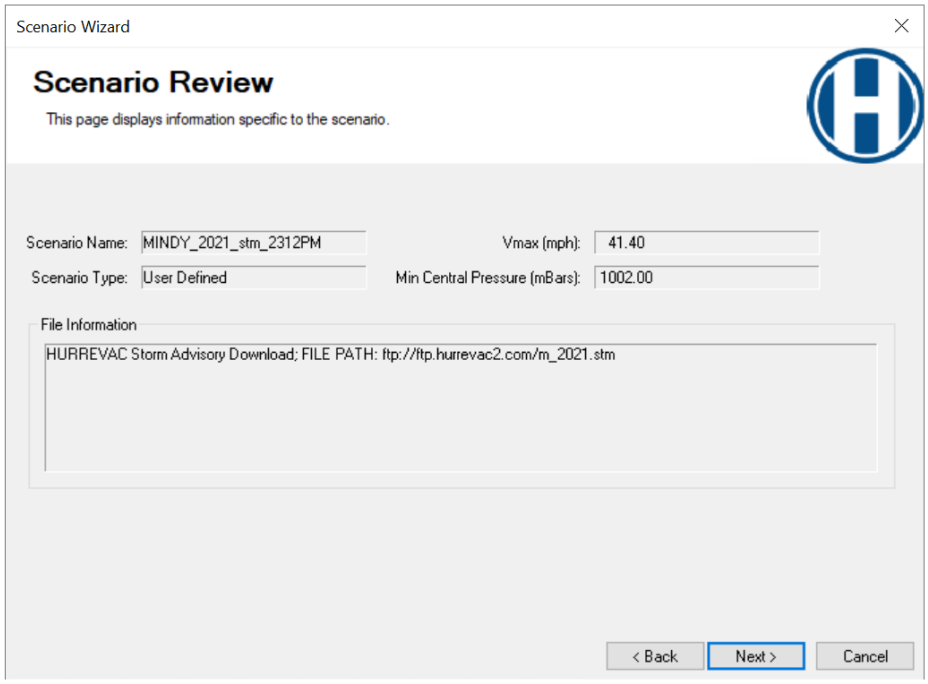


Figure 6-25 Scenario Review Information

The **Scenario Review** window shows the overview of the scenario and the file information. Clicking **Next** will allow the user to activate the newly created scenario, as shown in Figure 6-26. Select **Yes. Make this scenario active**, then click **Next**.

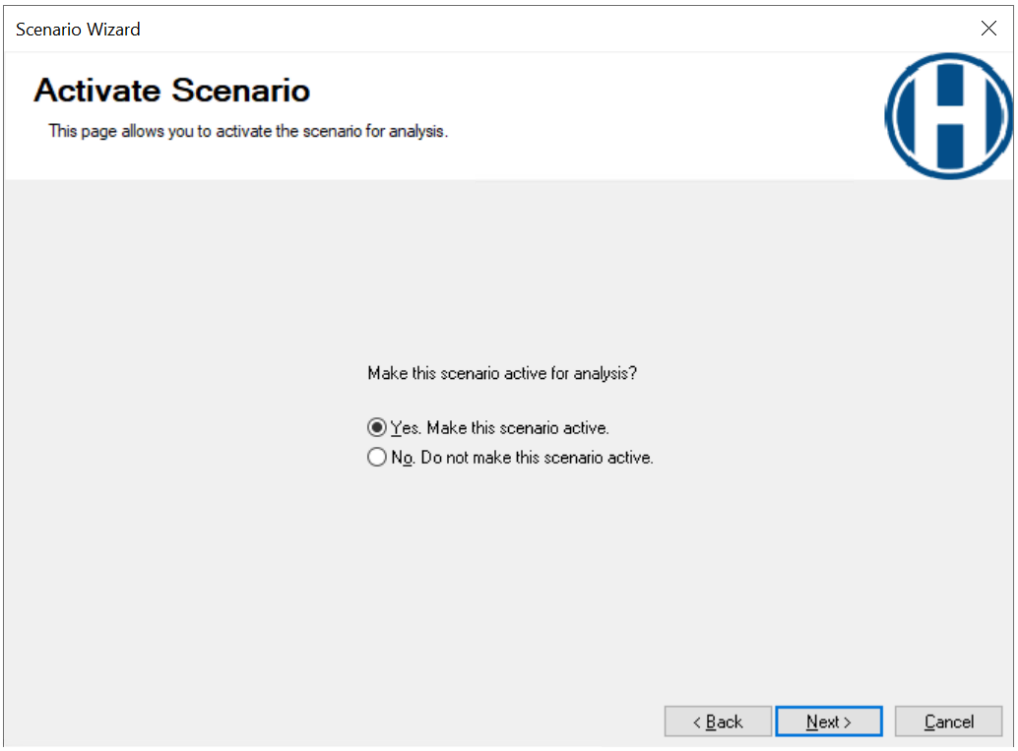


Figure 6-26 Activate Scenario

Lastly, click the **Finish** button on the Scenario Wizard to close the wizard and activate the scenario in the Study Region (Figure 6-27).

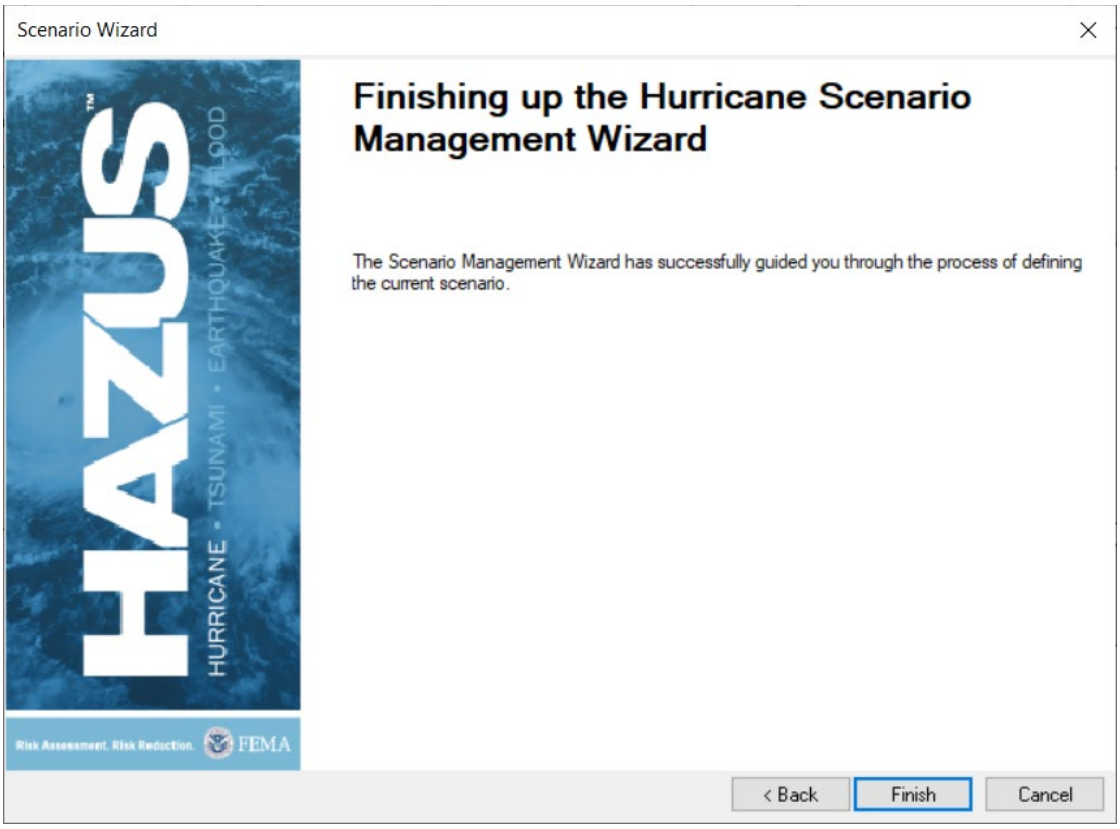


Figure 6-27 Finish Hurricane Scenario Wizard

6.4 Viewing the Defined Hazard

The **Show Current** option in the **Hazard** menu (Figure 6-28) allows the user to view the active scenario in the **Current Hazard** window (Figure 6-29). No changes to the scenario can be made in the **Current Hazard** window.

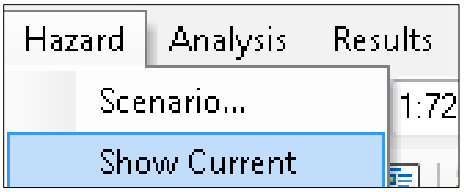


Figure 6-28 Storm Selection Menu

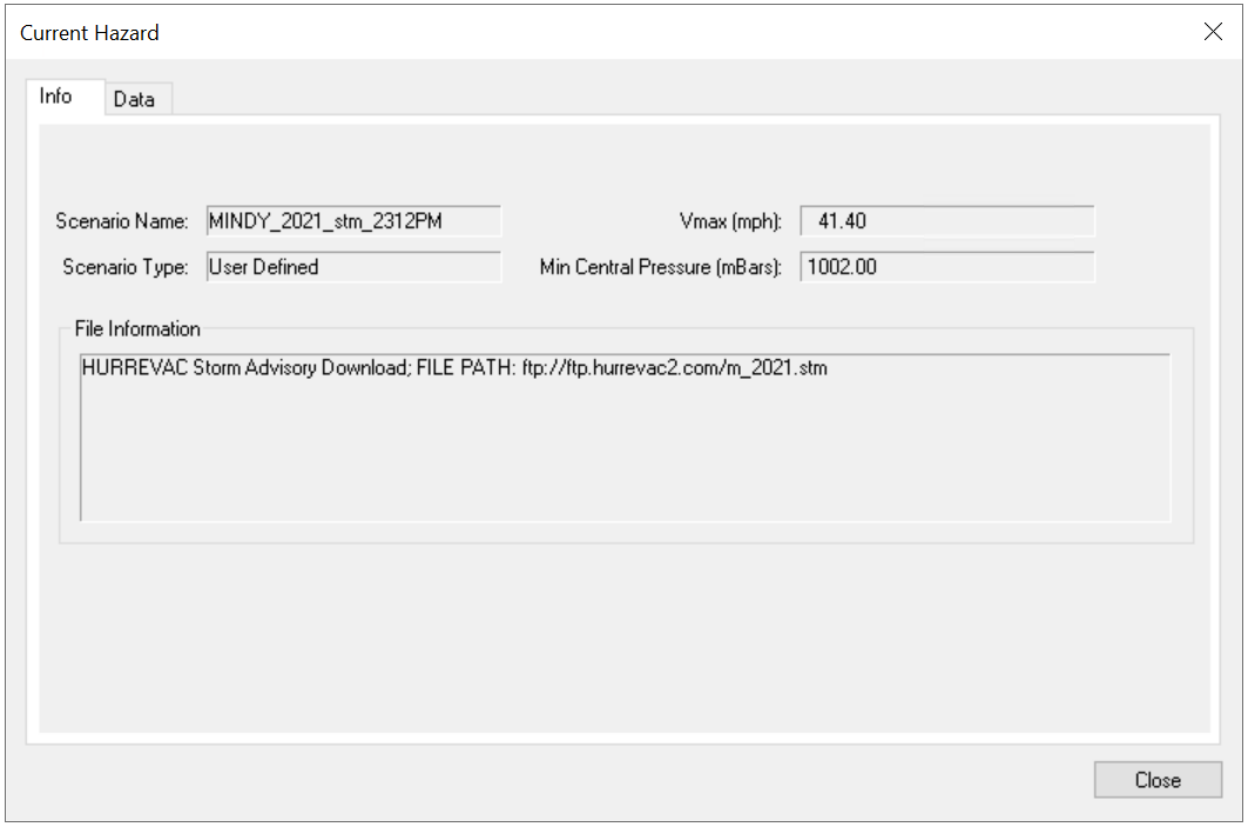


Figure 6-29 Review Current Hazard Information

Section 7. Model Menu: Analysis

The four basic classes of analysis functions used in the Hurricane Model are as follows:

- Damage Functions (building damage)
- Loss Functions (building and contents loss)
- Loss of Use Functions (building loss of use)
- Debris Functions (building debris)

Figure 7-1 shows the four functions. The functions cannot be modified, but users can see graphs of the functions. The functions are described in this Section.

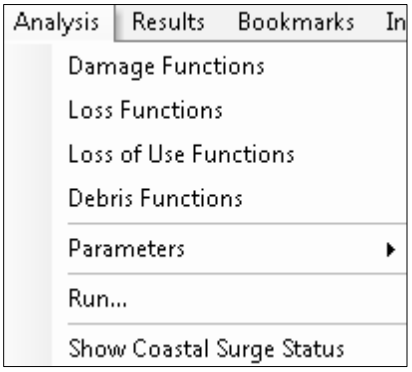


Figure 7-1 Analysis Menu

7.1 Building Damage Functions

Selecting **Analysis** and then **Damage Functions** (Figure 7-1) will display graphs of the probabilities of four damage states for each wind building type as a function of peak gust wind speed, as shown in Figure 7-2.

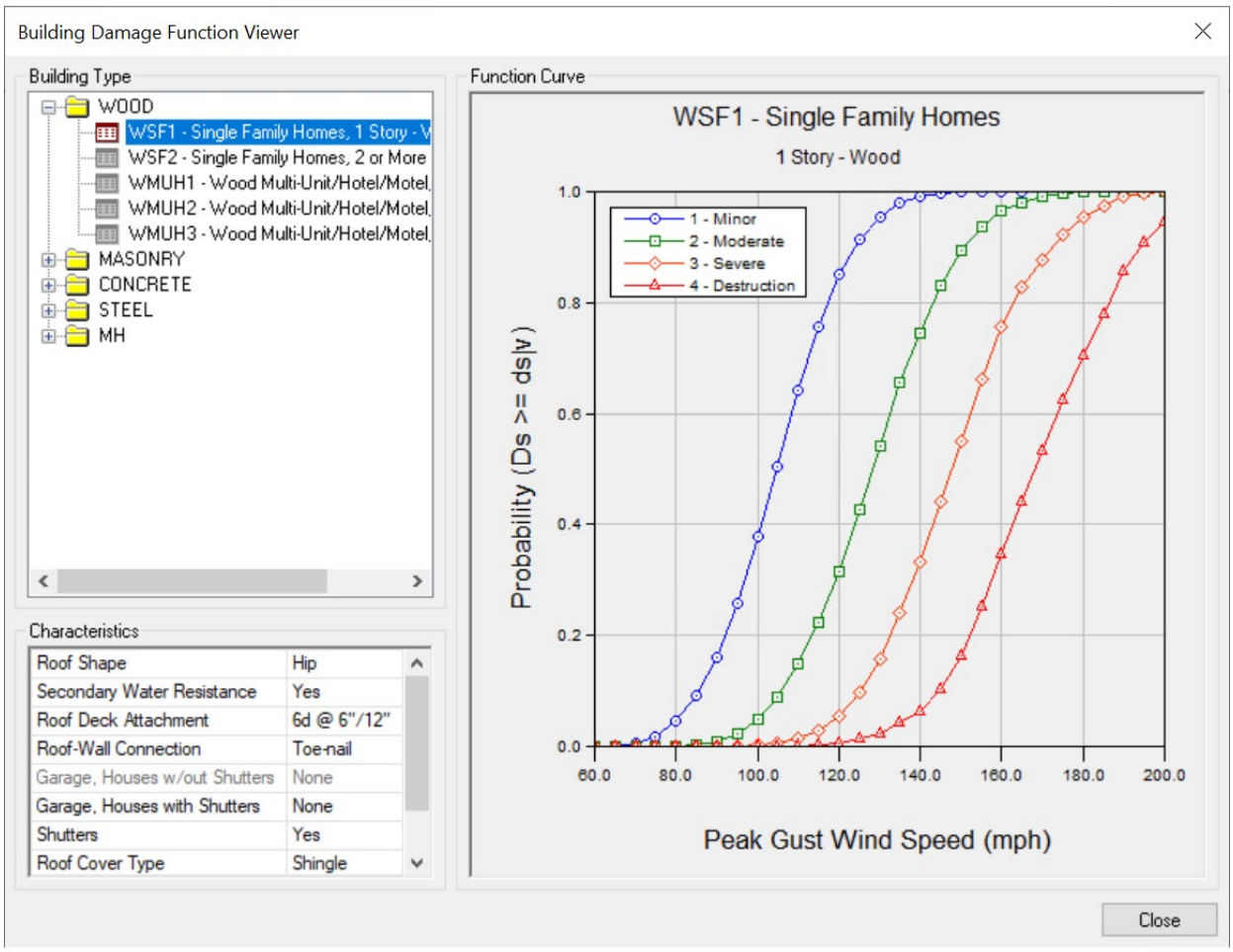


Figure 7-2 Example – Building Damage Function Viewer

7.2 Building and Contents Loss Functions

Selecting **Analysis** and then **Loss Functions** (Figure 7-1) will display graphs of the building, contents, or combined loss ratios for each wind building type as a function of peak gust wind speed (Figure 7-3).

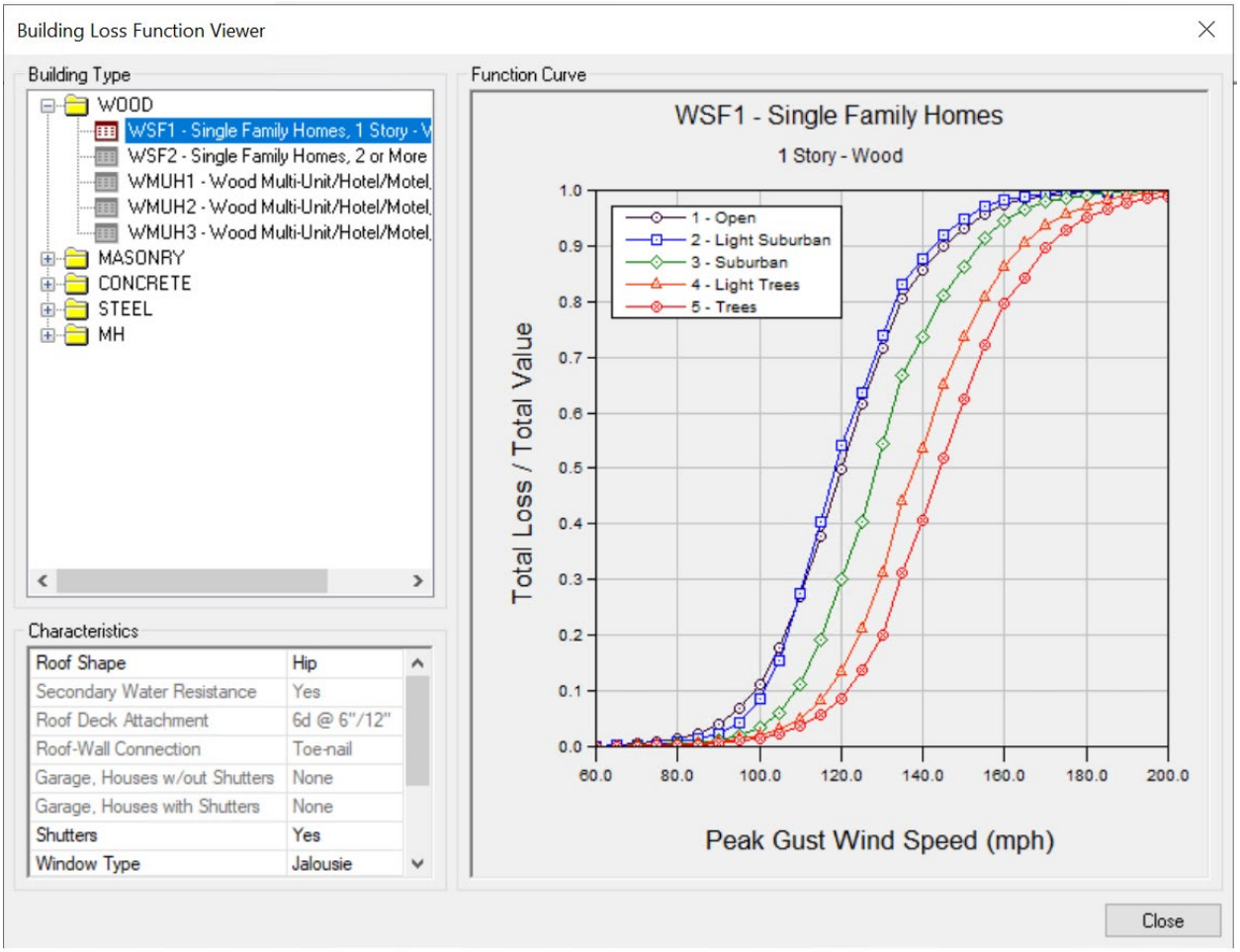


Figure 7-3 Example – Building Loss Function Viewer

7.3 Loss of Use Functions

Selecting **Analysis** and then **Loss of Use Functions** (Figure 7-1) will display graphs of the expected number of days needed to restore the function of each wind building type as a function of peak gust wind speed (Figure 7-4).

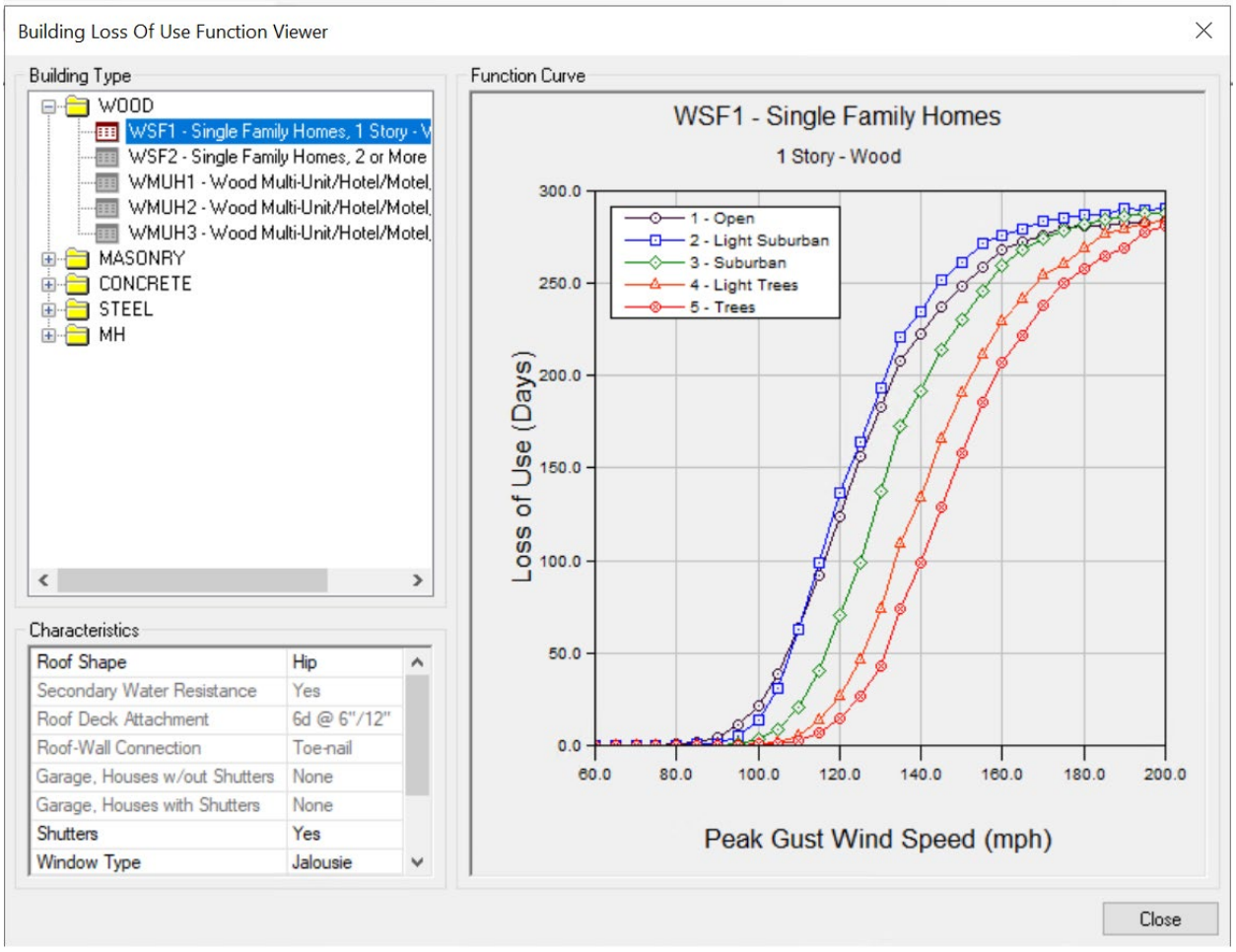


Figure 7-4 Example – Building Loss of Use Function Viewer

7.4 Building Debris Functions

Selecting **Analysis** and then **Debris Functions** (Figure 7-1) will display graphs of the expected debris weights (per unit floor area) generated by each wind building type as a function of peak gust wind speed (Figure 7-5).

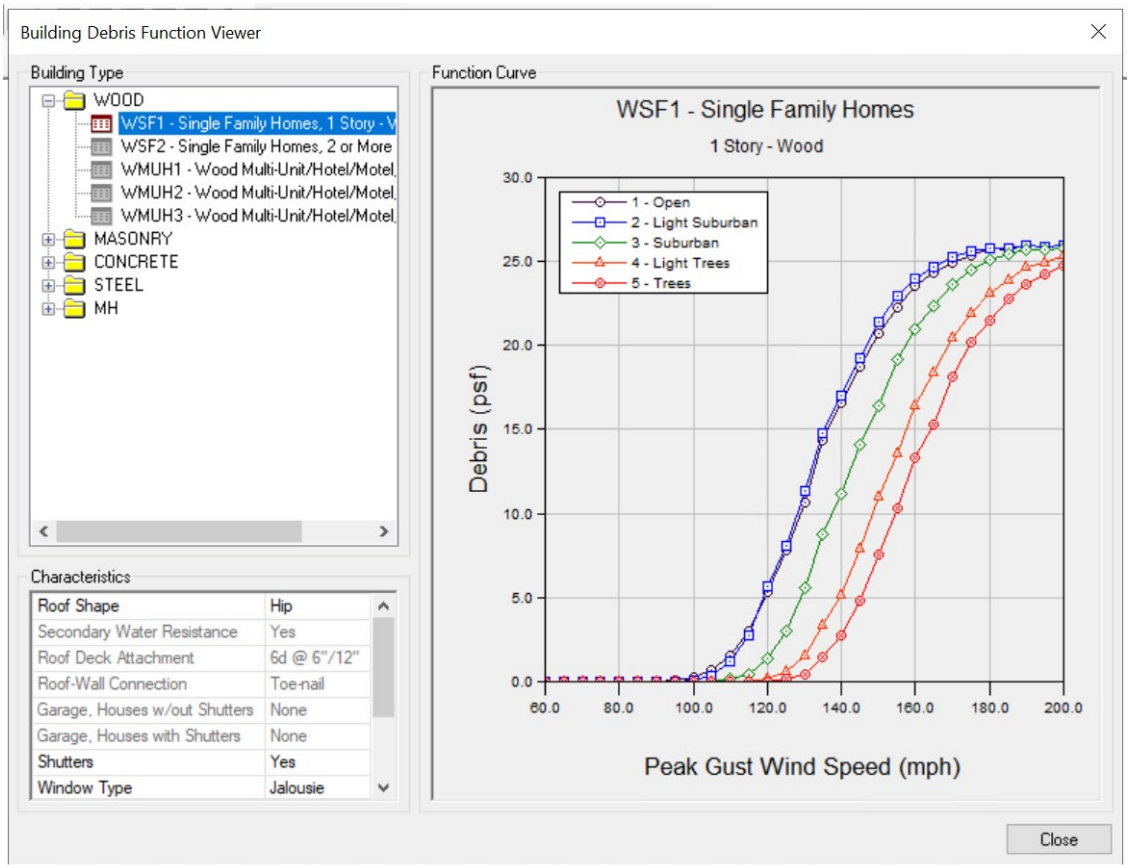


Figure 7-5: Example – Building Debris Function Viewer

Building debris is divided into two types:

- Debris Type 1 – Brick, wood, and other debris
- Debris Type 2 – Reinforced concrete and steel members

Debris Type 1 includes all debris except wrecked, reinforced concrete and steel members. It includes glass, furniture, equipment, plaster walls, brick, and wood. Type 1 can be moved and broken up by a bulldozer or handheld tools, but Type 2 cannot. Type 2 debris (long steel members and large pieces of concrete) must be broken up using cranes and other heavy equipment before it can be transported.

7.5 Parameters

Selecting **Analysis** and then **Parameters** (Figure 7-6) allows the user to define tree coverage, terrain data, shelter, and building economic parameters. See Section 12 for information on each parameter.

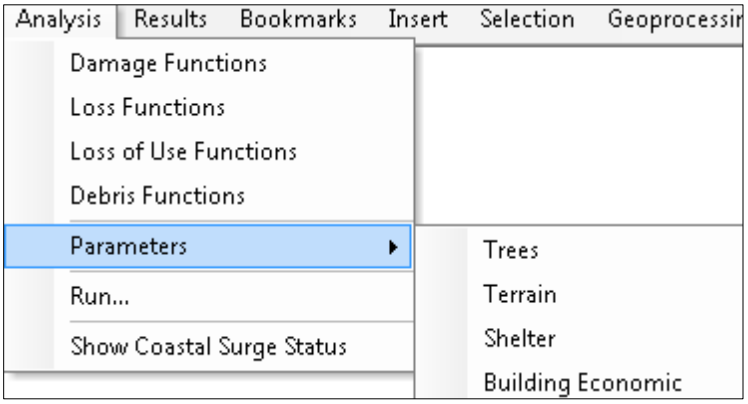


Figure 7-6 Analysis > Parameters Menu

7.6 Run

When the Study Region inventory, hazard, and analysis parameters have been specified, the analysis can be run. Select **Analysis** and then **Run** (Figure 7-7) to display the **Analysis Options** dialog shown in Figure 7-8.

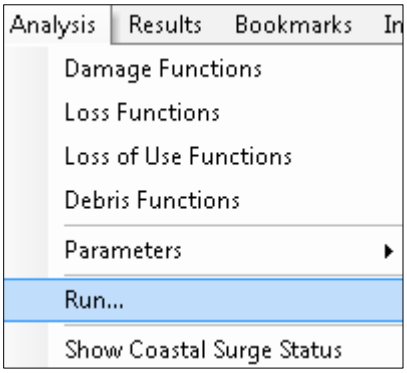


Figure 7-7 Analysis > Run Menu

The **Analysis Options** window shown in Figure 7-8 allows the user to exclude inventory items or outputs and to review intermediate results.

7.6.1 Run Analysis

When satisfied with the inventories, select **Run Analysis**. The user will now be able to access all the information listed in the **Results Menu** (see Section 8).

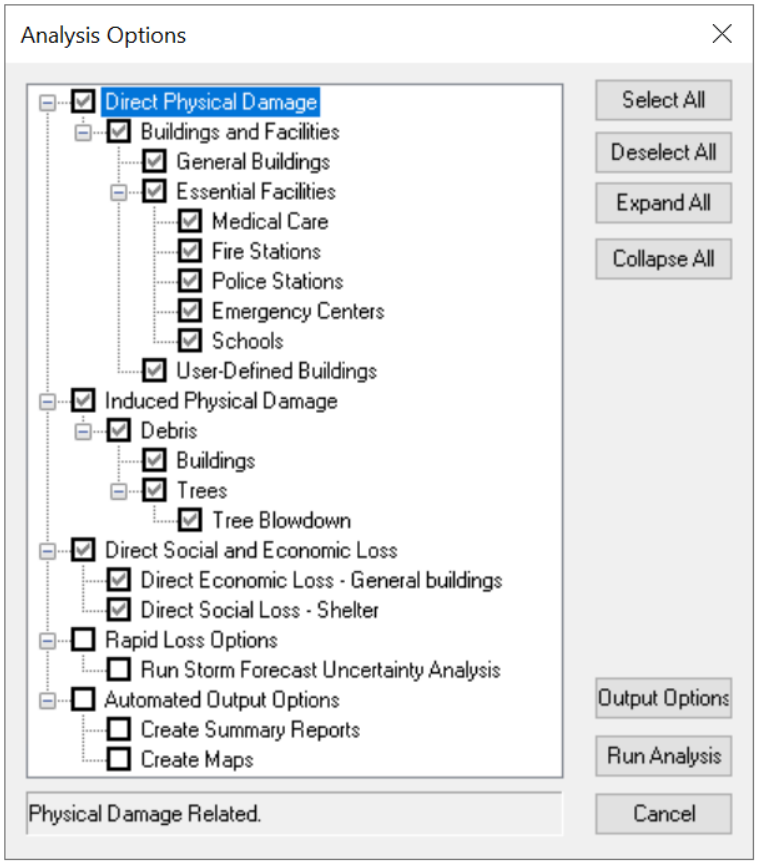


Figure 7-8 Select Inventory and Run Analysis

7.6.2 Automated Output Options

If Automated Outputs Options at the bottom of the **Analysis Options** window is checked, as shown in Figure 7-8, the Hurricane Model will automatically produce a set of specified summary reports and map layers at the conclusion of the analysis and save them to a subfolder in the Study Region folder with the name of the hurricane scenario. Selected layers will be added to the map.

Select the preferred summary reports on the first page of the Automated Output Options dialog (Figure 7-9).

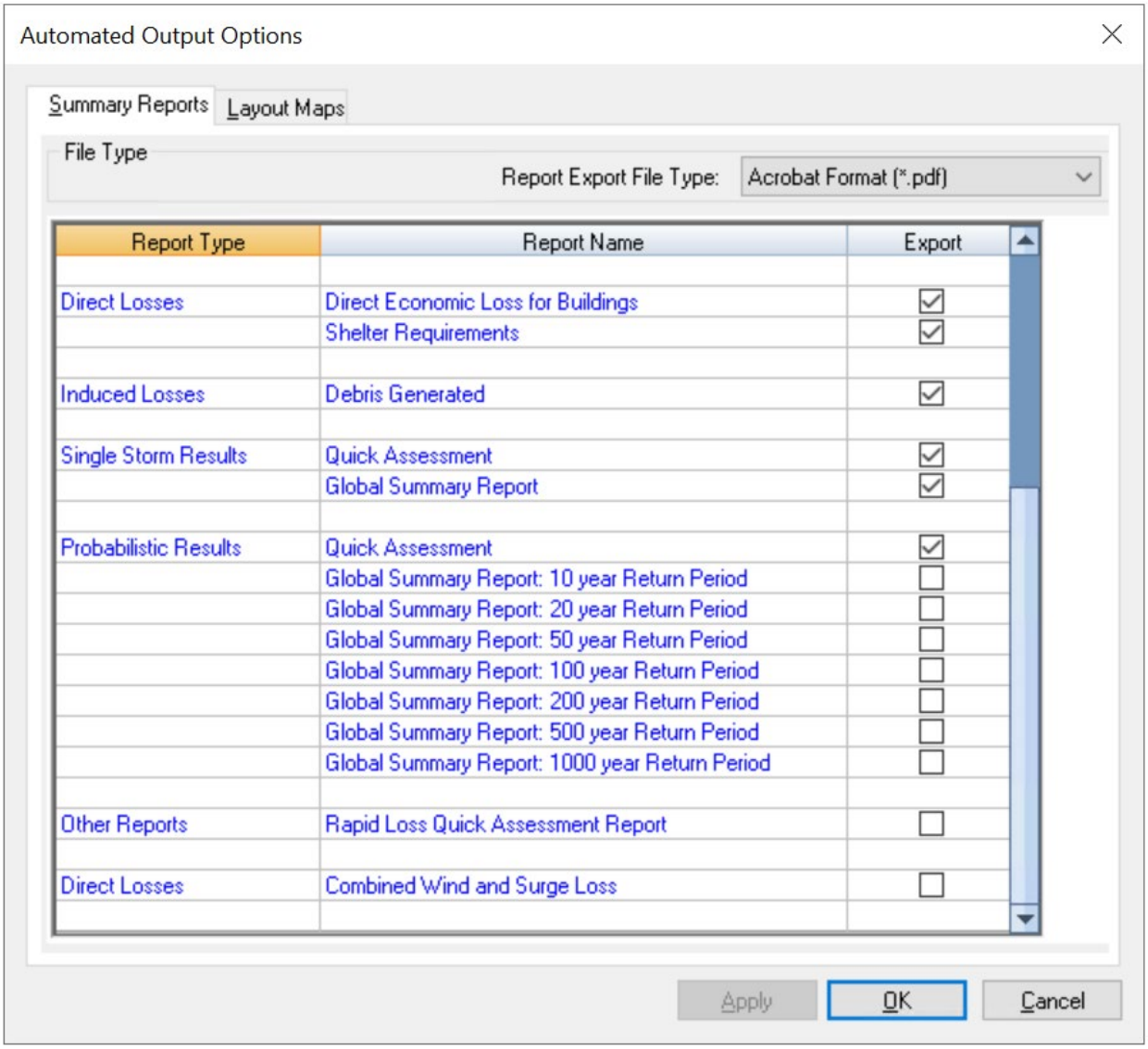


Figure 7-9 Select Preferred Report on Automated Output Options, Page 1

The users can select the preferred map layers on the second page of the **Automated Output Options** dialog (Figure 7-10). Select the **Results Type** and **Results Filter** to see the **List of Columns** that can be mapped and then check the preferred data columns. Click on the right-hand side of the **Results Filter** table to change the filter setting. The **Map Layer Summary** at the bottom of the window lists the currently selected map layers. When the **Automatic Outputs Option** is selected (Figure 7-8), the selected map layers will be created automatically and added to the GIS map table of contents.

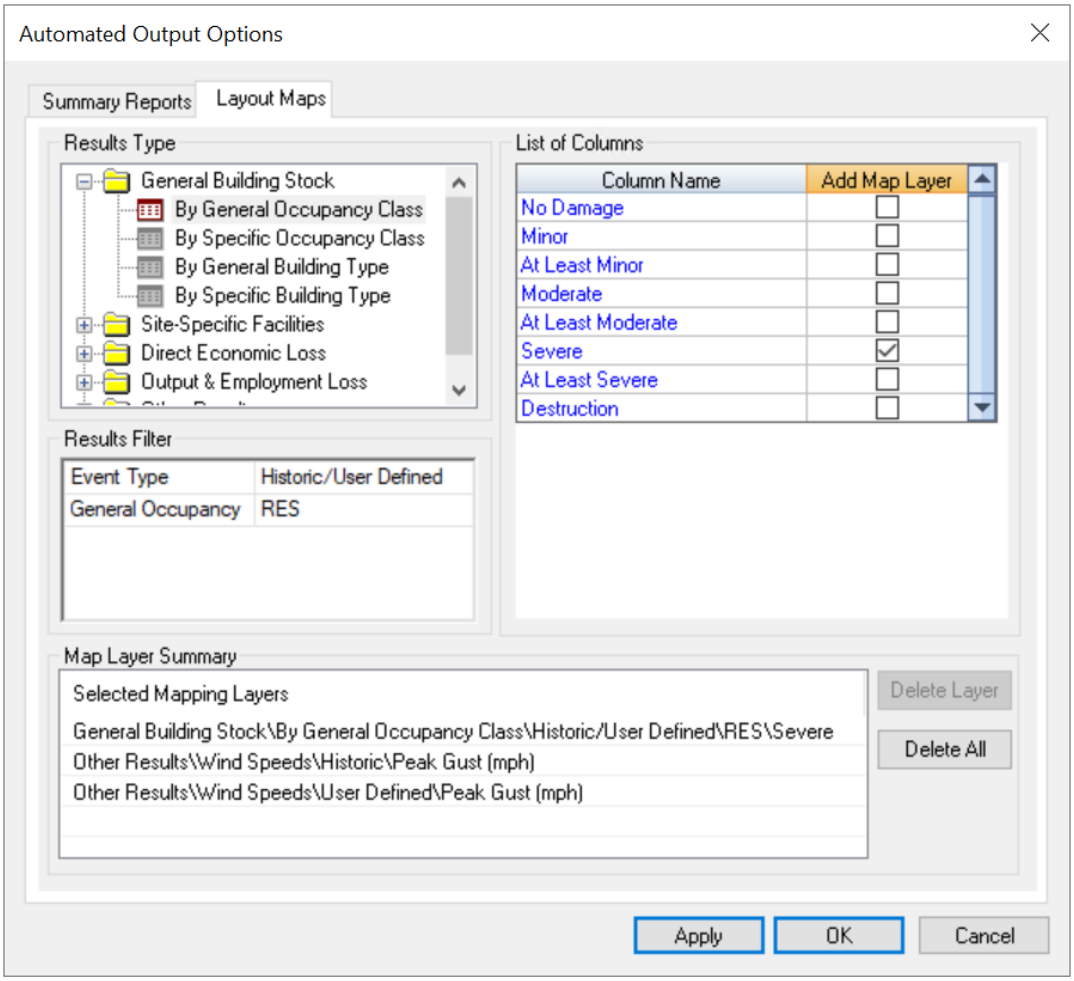


Figure 7-10 Select Preferred Map Layers on Automated Output Options, Page 2

7.7 Storm Surge Status

See Section 11 for the instructions to run the Storm Surge Model. When the storm surge analysis is complete, click on **Analysis** and then **Show Coastal Surge Status** to confirm that the analysis was successful. The window shown in Figure 7-11 will appear.

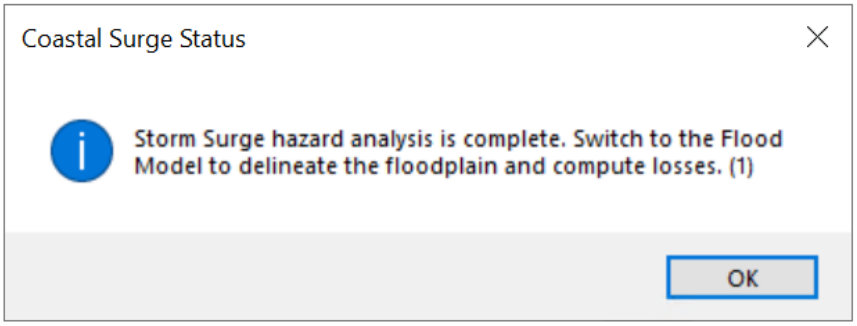


Figure 7-11 Coastal Surge Status Window

Section 8. Model Menu: Results

The types of outputs from a Hurricane Model analysis are shown in Figure 8-1 and are as follows:

- Storm Track
- Wind Speeds
- General Building Stock
- Combined Wind and Surge Loss
- Essential Facilities
- User-Defined Facilities
- Debris
- Shelter
- Summary Reports

Outputs are in result tables, maps, and reports and are numerical or graphical.

After running a single-track or probabilistic analysis, the user can access the output in the **Results Menu** (Figure 8-1). Table 8-1 summarizes the outputs from a Hurricane Model analysis.

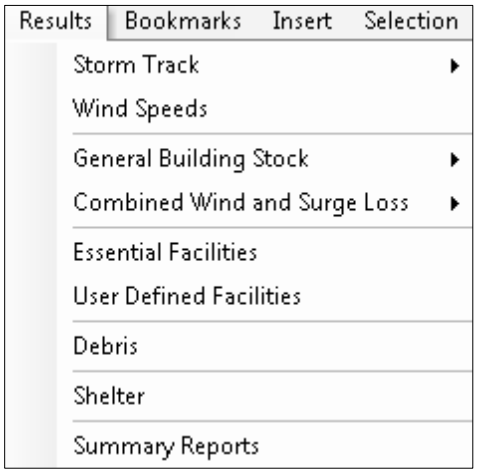


Figure 8-1 Results Menu

Table 8-1 List of Hurricane Model Outputs

Output	Description
Maps of wind hazards	▪ Peak gust (3-second) wind speed for each Census tract ▪ Maximum sustained (1-minute) wind speed for each Census tract
General Building Stock (GBS)	▪ Damage probabilities by occupancy ▪ Damage probabilities by building type ▪ Cost of building repair or replacement ▪ Loss of contents ▪ Business inventory loss ▪ Loss of rental income ▪ Relocation costs ▪ Business income loss ▪ Employee wage loss
Essential facilities	▪ Damage probabilities ▪ Probability of functionality ▪ Loss of beds in hospitals
Debris	▪ Building debris generated by weight and type of material ▪ Tree debris generated by weight or volume
Social losses	▪ Number of displaced households ▪ Number of people requiring temporary shelter
High potential loss facilities (HPLF)	▪ Locations of dams ▪ Locations of nuclear plants ▪ Locations of military facilities ▪ Locations of other identified HPLF
Transportation and utility lifelines	▪ Locations of transportation facilities ▪ Locations of lifelines

Hurricane Model outputs have several pre- and post-hurricane applications. Examples of possible pre-event applications are as follows:

- The development of hurricane hazard mitigation strategies that outline policies and programs for reducing the hurricane losses and disruptions that are indicated in the loss estimation study. The strategies may involve upgrading existing buildings (e.g., addition of shutters) or the adoption of new building codes.

- Anticipation of the nature and scope of response and recovery efforts including identifying short-term shelter and debris management requirements

Examples of post-event applications are as follows:

- Projection of immediate economic impact assessments for state and federal resource allocation and support including supporting the declaration of a state and/or federal disaster by calculating direct economic impact on public and private resources, local governments, and the functionality of the area.

- Activation of immediate emergency recovery efforts including provision of emergency housing shelters and initiating debris clean-up efforts.

- Application of long-term reconstruction plans including the identification of long-term reconstruction goals, the institution of appropriate wide-range economic development plans for the entire area, allocation of permanent housing needs, and the application of land use planning principles and practices.

Once the inventory has been developed and imported, making modifications and running new analyses are simple tasks. The ease with which reports and maps can be generated makes the software useful for a variety of applications.

8.1 Storm Track

Storm Track results show a historical storm scenario (Figure 8-2 and Figure 8-3). For a probabilistic scenario, there is an option for each return period event, as shown in Figure 8-4. In the case of probabilistic, the representative track shown illustrates the track from the stochastic assessment that produces the greatest economic loss for the return period for the study region. The probabilistic tracks are not available for the Caribbean or Hawai'i. The line layer can be exported as a shapefile or geodatabase feature class.

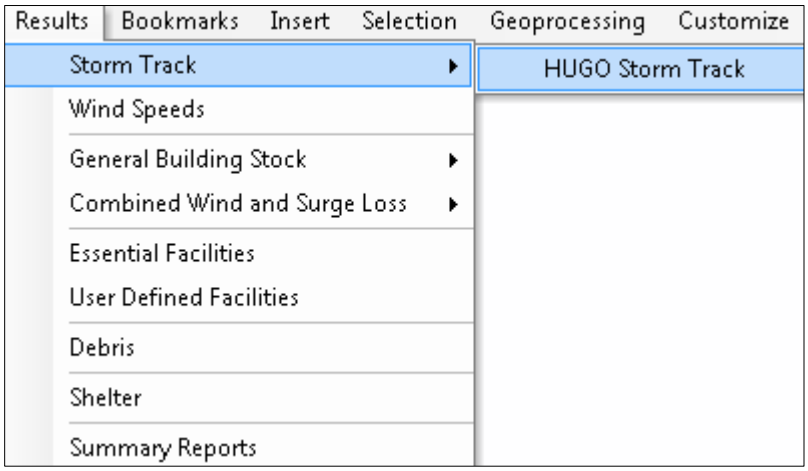


Figure 8-2 Results > Storm Track Menu

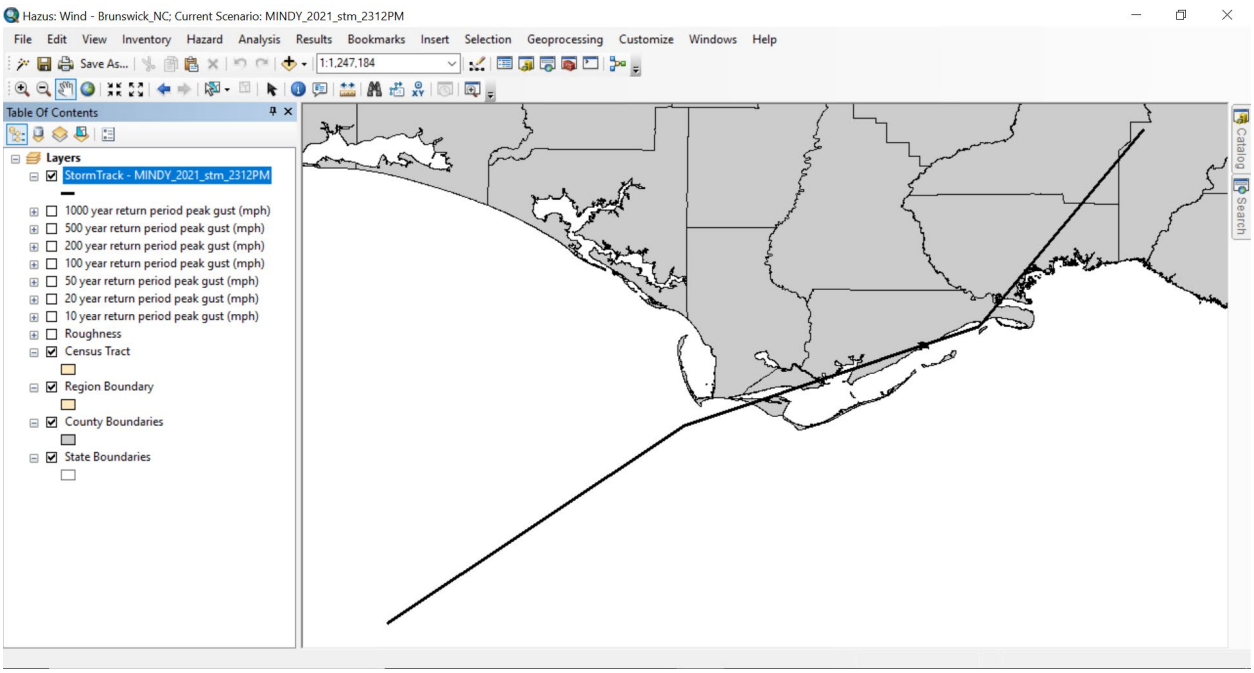


Figure 8-3 Example – Historical Storm Track

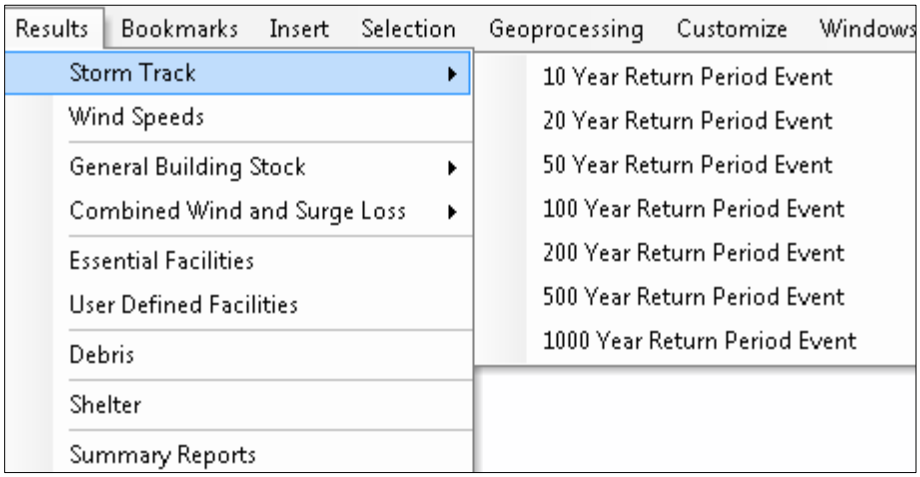


Figure 8-4 Example – Probabilistic Storm Track

8.2 Wind Speeds

Selecting Results and then Wind Speeds (Figure 8-5) brings up a table that allows the user to see and map the peak wind speeds for the current hazard by Census tract (Figure 8-6). The wind speeds that are shown are the estimated maximum 3-second gusts in open terrain at 10 meters above ground at the centroid of each Census tract for specific hurricane events. Hazus searches through the 100,000-year simulated database for all storms events that intersect the Study Region. The total losses for each storm event are ranked and then used to determine the specific hurricane for each annual chance event. The wind speeds for that specific hurricane are then used as the basis to determine the wind speed values and losses at the individual Census tract level. This may result in some individual Census tracts having lower wind speeds for less frequent events, such as the example shown in Figure 8-6 where a set of Census tracts have lower wind speeds for the 1000-yr event as compared to the 500-yr event.

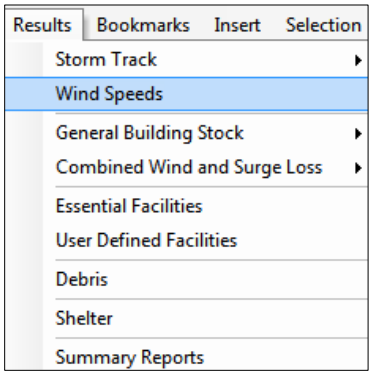
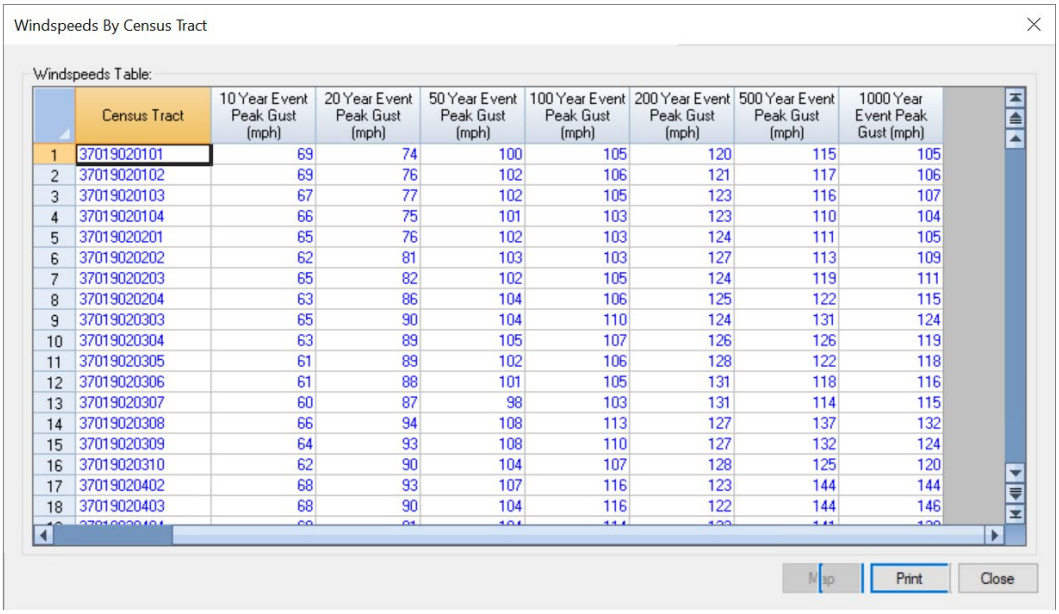


Figure 8-5 Results > Wind Speeds Menu



	Census Tract	10 Year Event Peak Gust (mph)	20 Year Event Peak Gust (mph)	50 Year Event Peak Gust (mph)	100 Year Event Peak Gust (mph)	200 Year Event Peak Gust (mph)	500 Year Event Peak Gust (mph)	1000 Year Event Peak Gust (mph)
1	37019020101	69	74	100	105	120	115	105
2	37019020102	69	76	102	106	121	117	106
3	37019020103	67	77	102	105	123	116	107
4	37019020104	66	75	101	103	123	110	104
5	37019020201	65	76	102	103	124	111	105
6	37019020202	62	81	103	103	127	113	109
7	37019020203	65	82	102	105	124	119	111
8	37019020204	63	86	104	106	125	122	115
9	37019020303	65	90	104	110	124	131	124
10	37019020304	63	89	105	107	126	126	119
11	37019020305	61	89	102	106	128	122	118
12	37019020306	61	88	101	105	131	118	116
13	37019020307	60	87	98	103	131	114	115
14	37019020308	66	94	108	113	127	137	132
15	37019020309	64	93	108	110	127	132	124
16	37019020310	62	90	104	107	128	125	120
17	37019020402	68	93	107	116	123	144	144
18	37019020403	68	90	104	116	122	144	146

Figure 8-6 Wind Speeds by Census Tract Table

8.3 General Building Stock Results

Selecting **Results** and then **General Building Stock** (Figure 8-7) allows the user to see and map the general inventory damage results by occupancy and building type.

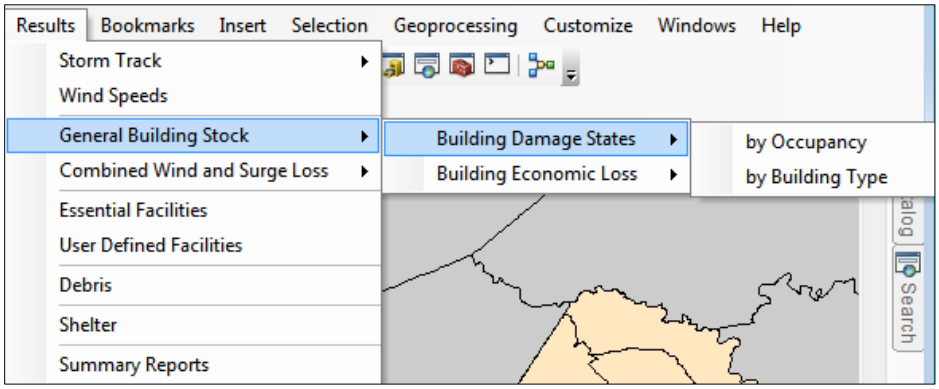


Figure 8-7 Results > General Building Stock by Building Damage States Menu

8.3.1 Building Damage States by Occupancy Class

Figure 8-8 shows the GBS occupancy class results table where the user can see and map the general inventory damage results by general or specific occupancy class. The values in the table represent the expected fraction of building square footage in each damage state.

For probabilistic scenarios, the drop-down box allows the user to select one of seven sample return period events from different occupancies and return periods to see damage state probabilities by Census tract.

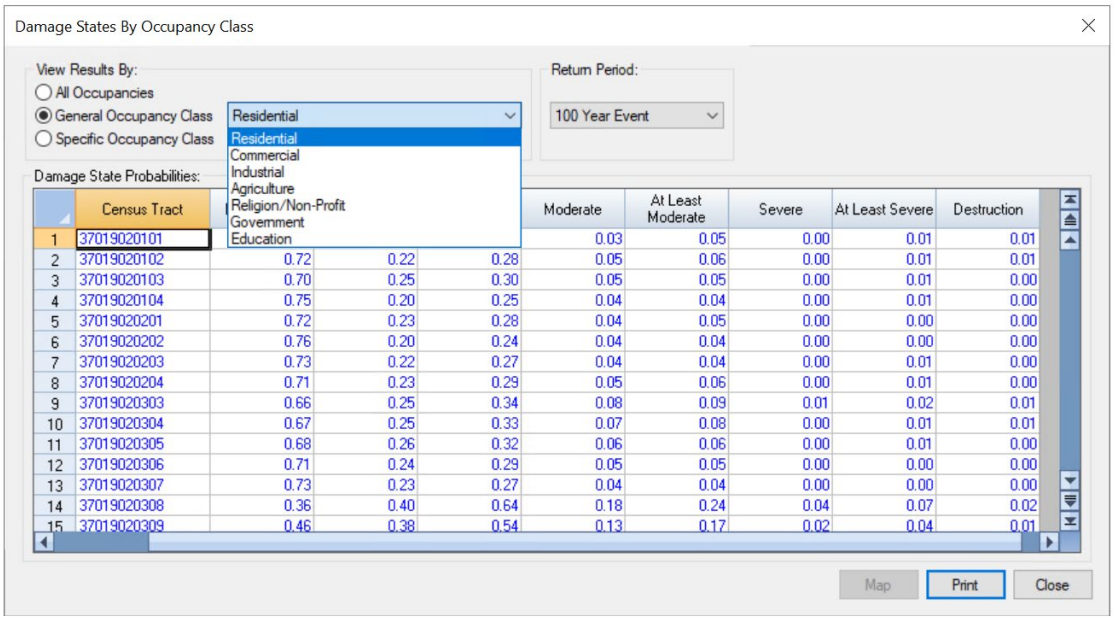
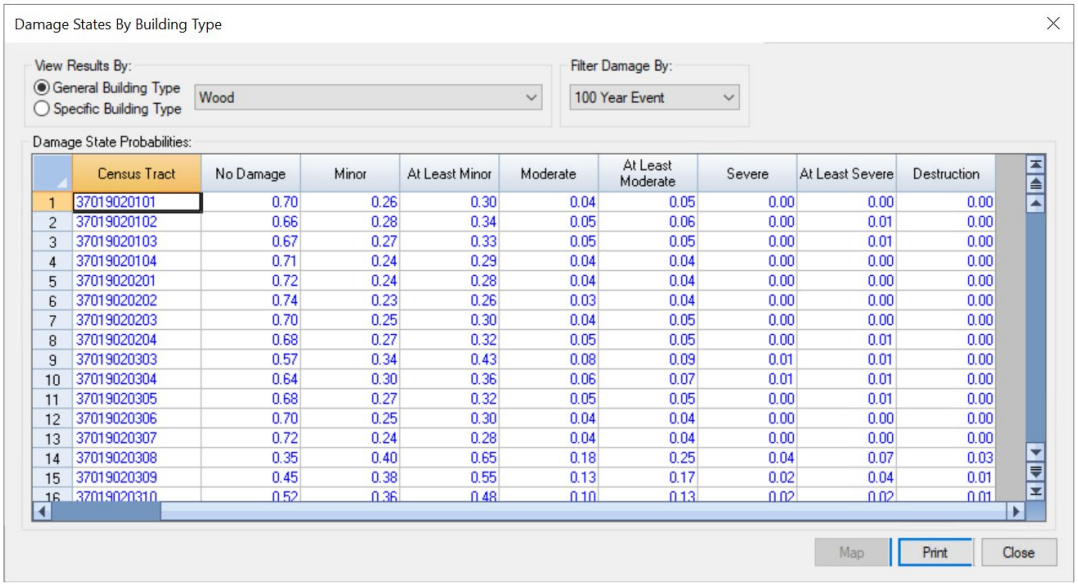


Figure 8-8 Damage States by Occupancy Class Table

8.3.2 Building Damage States by Building Type

Figure 8-9 shows damage states by building type, allowing the user to see the general building type and the building type by Census tract.

For probabilistic scenarios, the drop-down box allows the user to select one of seven sample return period events from different occupancies and return periods to see damage state probabilities by Census tract.



	Census Tract	No Damage	Minor	At Least Minor	Moderate	At Least Moderate	Severe	At Least Severe	Destruction
1	37019020101	0.70	0.26	0.30	0.04	0.05	0.00	0.00	0.00
2	37019020102	0.66	0.28	0.34	0.05	0.06	0.00	0.01	0.00
3	37019020103	0.67	0.27	0.33	0.05	0.05	0.00	0.01	0.00
4	37019020104	0.71	0.24	0.29	0.04	0.04	0.00	0.00	0.00
5	37019020201	0.72	0.24	0.28	0.04	0.04	0.00	0.00	0.00
6	37019020202	0.74	0.23	0.26	0.03	0.04	0.00	0.00	0.00
7	37019020203	0.70	0.25	0.30	0.04	0.05	0.00	0.00	0.00
8	37019020204	0.68	0.27	0.32	0.05	0.05	0.00	0.01	0.00
9	37019020303	0.57	0.34	0.43	0.08	0.09	0.01	0.01	0.00
10	37019020304	0.64	0.30	0.36	0.06	0.07	0.01	0.01	0.00
11	37019020305	0.68	0.27	0.32	0.05	0.05	0.00	0.01	0.00
12	37019020306	0.70	0.25	0.30	0.04	0.04	0.00	0.00	0.00
13	37019020307	0.72	0.24	0.28	0.04	0.04	0.00	0.00	0.00
14	37019020308	0.35	0.40	0.65	0.18	0.25	0.04	0.07	0.03
15	37019020309	0.45	0.38	0.55	0.13	0.17	0.02	0.04	0.01
16	37019020310	0.52	0.36	0.48	0.10	0.13	0.02	0.02	0.01

Figure 8-9 Damage States by Building Type Table

8.3.3 Building Damage Economic Loss by Occupancy

GBS outputs can also be shown for economic loss (Figure 8-10). For example, Figure 8-11 shows **General Building Stock Building Economic Loss by Occupancy**. In the first tab (**Direct Economic Loss**), the user can see economic loss values by general and specific occupancy class for each Census tract. The second tab (**Output & Employment**) shows losses in thousands of dollars for general and specific occupancy classes for each Census tract. Values can be filtered by each return period.

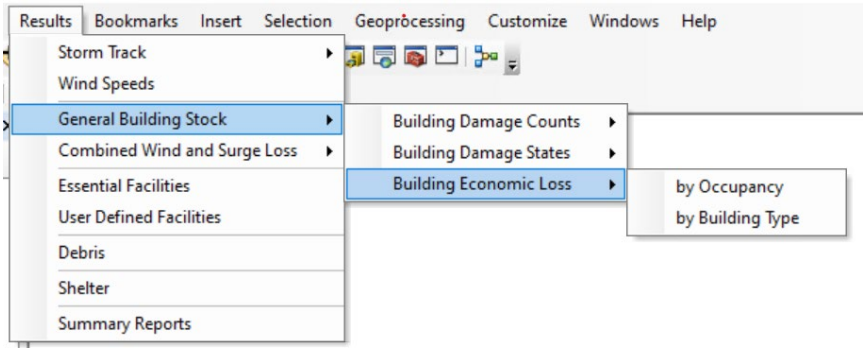
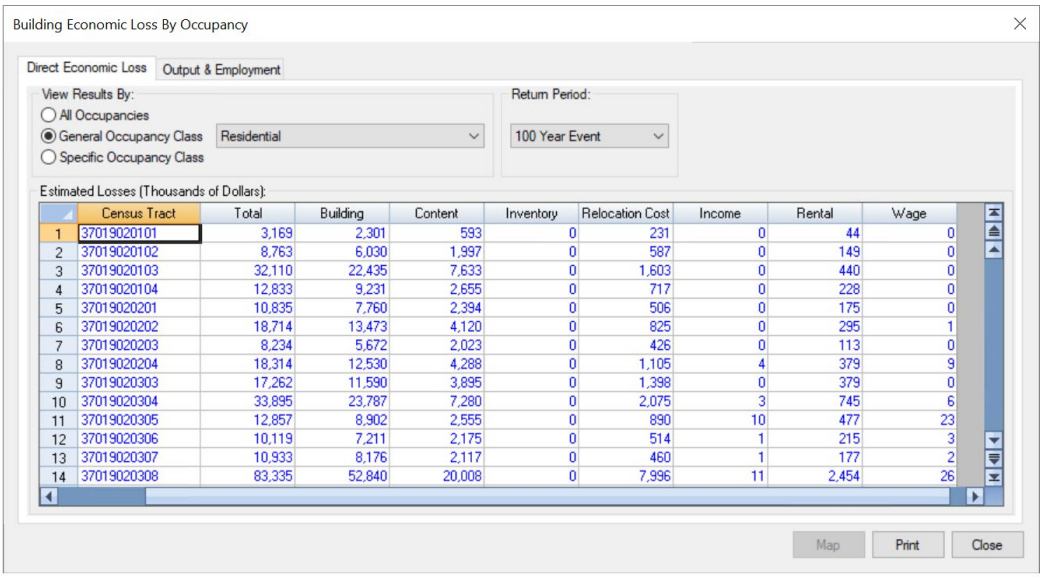


Figure 8-10 Results > General Building Stock by Building Economic Loss Menu



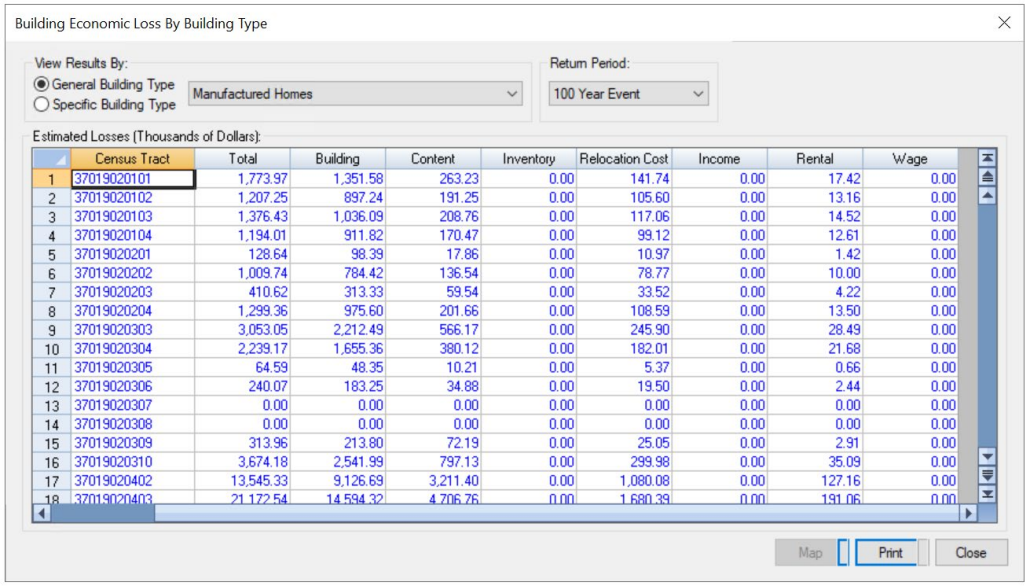
	Census Tract	Total	Building	Content	Inventory	Relocation Cost	Income	Rental	Wage
1	37019020101	3,169	2,301	593	0	231	0	44	0
2	37019020102	8,763	6,030	1,997	0	587	0	149	0
3	37019020103	32,110	22,435	7,633	0	1,603	0	440	0
4	37019020104	12,833	9,231	2,655	0	717	0	228	0
5	37019020201	10,835	7,760	2,394	0	506	0	175	0
6	37019020202	18,714	13,473	4,120	0	825	0	295	1
7	37019020203	8,234	5,672	2,023	0	426	0	113	0
8	37019020204	18,314	12,530	4,288	0	1,105	4	379	9
9	37019020303	17,262	11,590	3,895	0	1,398	0	379	0
10	37019020304	33,895	23,787	7,280	0	2,075	3	745	6
11	37019020305	12,857	8,902	2,555	0	890	10	477	23
12	37019020306	10,119	7,211	2,175	0	514	1	215	3
13	37019020307	10,933	8,176	2,117	0	460	1	177	2
14	37019020308	83,335	52,840	20,008	0	7,996	11	2,454	26

Figure 8-11 Building Economic Loss by Occupancy Table

8.3.4 Building Damage Economic Loss by Building Type

Figure 8-12 shows General Building Stock Building Economic Loss by Building Type. The user can see economic loss values by general and specific building type in thousands of dollars for each Census tract.

For probabilistic scenarios, the drop-down menu allows the user to select annualized losses or one of seven sample return period events.



	Census Tract	Total	Building	Content	Inventory	Relocation Cost	Income	Rental	Wage
1	37019020101	1,773.97	1,351.58	263.23	0.00	141.74	0.00	17.42	0.00
2	37019020102	1,207.25	897.24	191.25	0.00	105.60	0.00	13.16	0.00
3	37019020103	1,376.43	1,036.09	208.76	0.00	117.06	0.00	14.52	0.00
4	37019020104	1,194.01	911.82	170.47	0.00	99.12	0.00	12.61	0.00
5	37019020201	128.64	98.39	17.86	0.00	10.97	0.00	1.42	0.00
6	37019020202	1,009.74	784.42	136.54	0.00	78.77	0.00	10.00	0.00
7	37019020203	410.62	313.33	59.54	0.00	33.52	0.00	4.22	0.00
8	37019020204	1,299.36	975.60	201.66	0.00	108.59	0.00	13.50	0.00
9	37019020303	3,053.05	2,212.49	566.17	0.00	245.90	0.00	28.49	0.00
10	37019020304	2,239.17	1,655.36	380.12	0.00	182.01	0.00	21.68	0.00
11	37019020305	64.59	48.35	10.21	0.00	5.37	0.00	0.66	0.00
12	37019020306	240.07	183.25	34.88	0.00	19.50	0.00	2.44	0.00
13	37019020307	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	37019020308	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	37019020309	313.96	213.80	72.19	0.00	25.05	0.00	2.91	0.00
16	37019020310	3,674.18	2,541.99	797.13	0.00	299.98	0.00	35.09	0.00
17	37019020402	13,545.33	9,126.69	3,211.40	0.00	1,080.08	0.00	127.16	0.00
18	37019020403	21,172.54	14,594.32	4,706.76	0.00	1,680.39	0.00	191.06	0.00

Figure 8-12 Building Economic Loss by Building Type Table

8.4 Combined Wind and Surge Loss Results

Combined Wind and Surge Loss Results, selected in Figure 8-13 and shown on Figure 8-14 allows the user to see and map combined wind and surge losses computed in the Hazus Flood Model using surge and wave grids from the Hurricane Storm Surge analysis option. See Section 11 for information on running a storm surge analysis.

Storm surge results cannot be generated for probabilistic or from .dat files.

Note that combined wind and surge results are available for building, content, and inventory losses but not for relocation, income, rental, or wage losses. The radio buttons and dropdown menus allow the user to filter the losses by occupancy or building type.

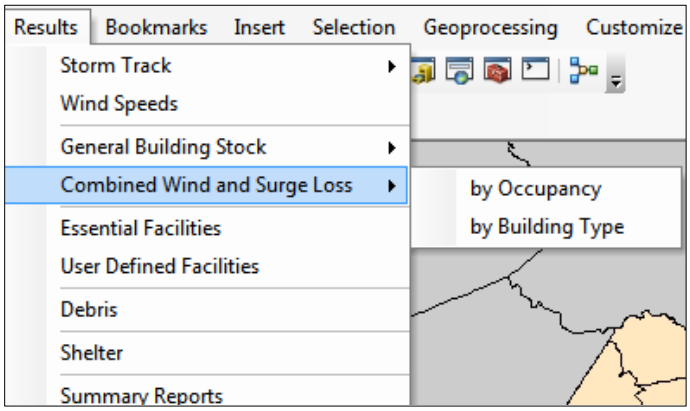
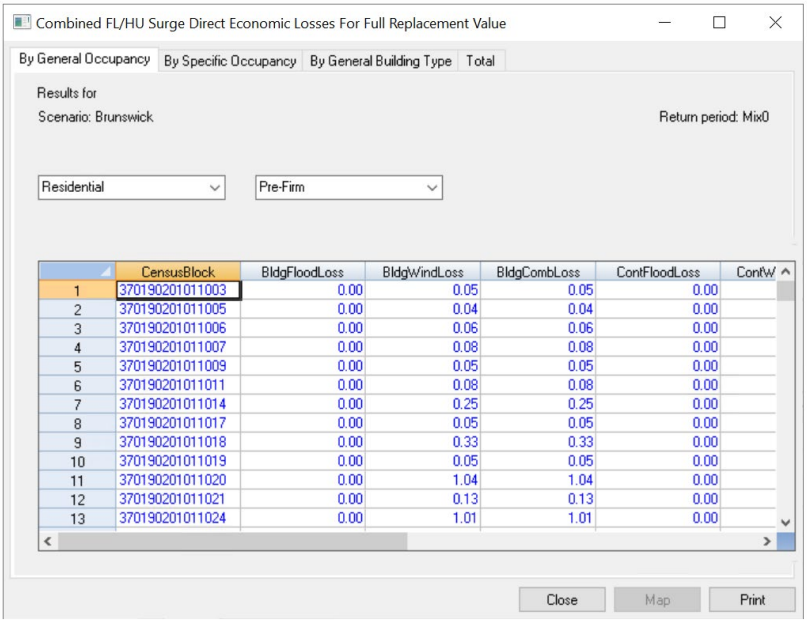


Figure 8-13 Combined Flood and Hurricane Surge Loss Menu



	CensusBlock	BldgFloodLoss	BldgWindLoss	BldgCombLoss	ContFloodLoss	ContW
1	370190201011003	0.00	0.05	0.05	0.00	
2	370190201011005	0.00	0.04	0.04	0.00	
3	370190201011006	0.00	0.06	0.06	0.00	
4	370190201011007	0.00	0.08	0.08	0.00	
5	370190201011009	0.00	0.05	0.05	0.00	
6	370190201011011	0.00	0.08	0.08	0.00	
7	370190201011014	0.00	0.25	0.25	0.00	
8	370190201011017	0.00	0.05	0.05	0.00	
9	370190201011018	0.00	0.33	0.33	0.00	
10	370190201011019	0.00	0.05	0.05	0.00	
11	370190201011020	0.00	1.04	1.04	0.00	
12	370190201011021	0.00	0.13	0.13	0.00	
13	370190201011024	0.00	1.01	1.01	0.00	

Figure 8-14 Combined Flood and Hurricane Surge Loss Results Table

8.5 Essential Facilities Results

Essential Facilities Results, selected in Figure 8-15 and shown in Figure 8-16 allows the user to see and map the damage and loss-of-use results for hospitals, police stations, fire stations, emergency operations centers, and schools.

For probabilistic scenarios, the drop-down menu allows the user to select one of seven sample return period events.

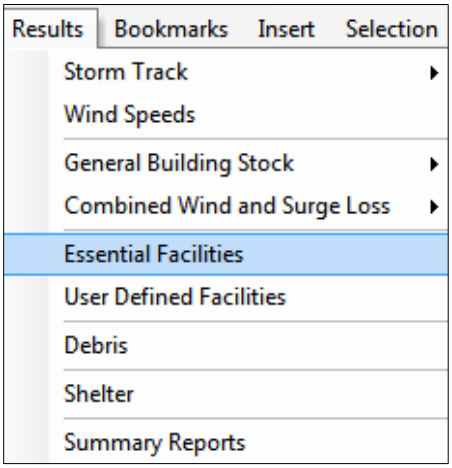


Figure 8-15 Essential Facilities Results Table

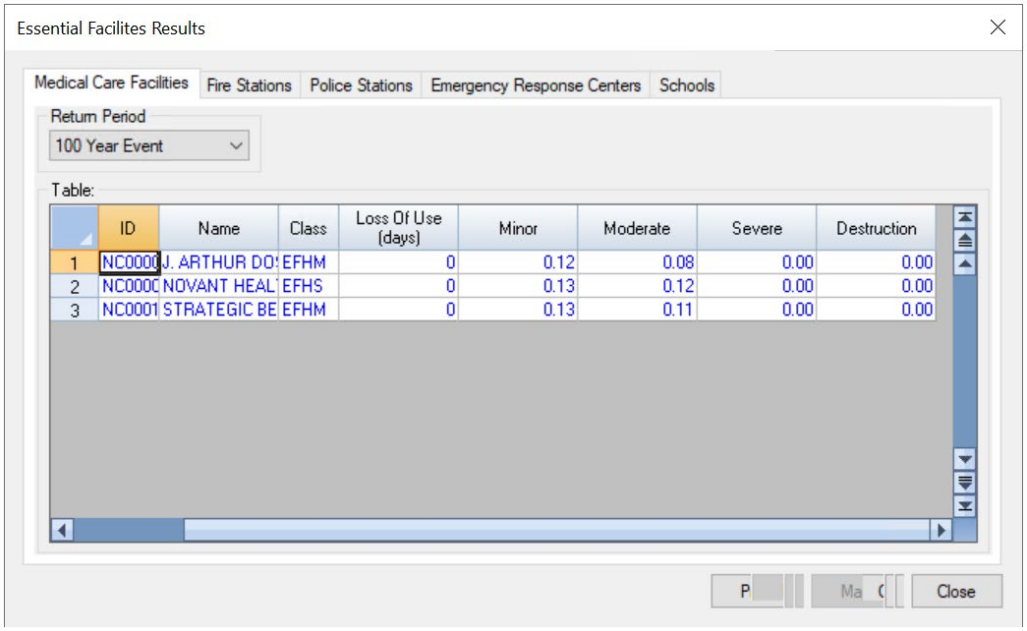


Figure 8-16 Essential Facilities Results Table

8.6 User-Defined Facilities Results

User-Defined Facilities Results, selected in Figure 8-17 and shown in Figure 8-18, allow the user to see and map only the damage stage results for individual, user-specified facilities.

For probabilistic scenarios, the drop-down menu allows the user to select one of seven sample return period events as shown in Figure 8-18.

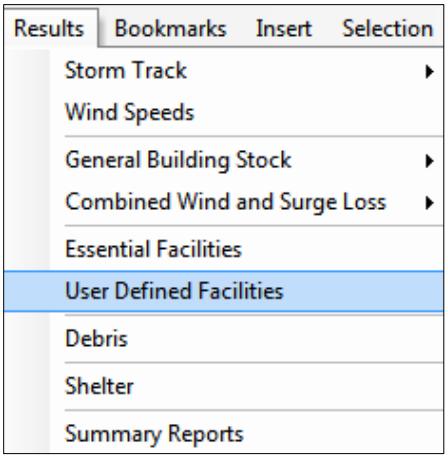


Figure 8-17 User-Defined Facilities Results Table

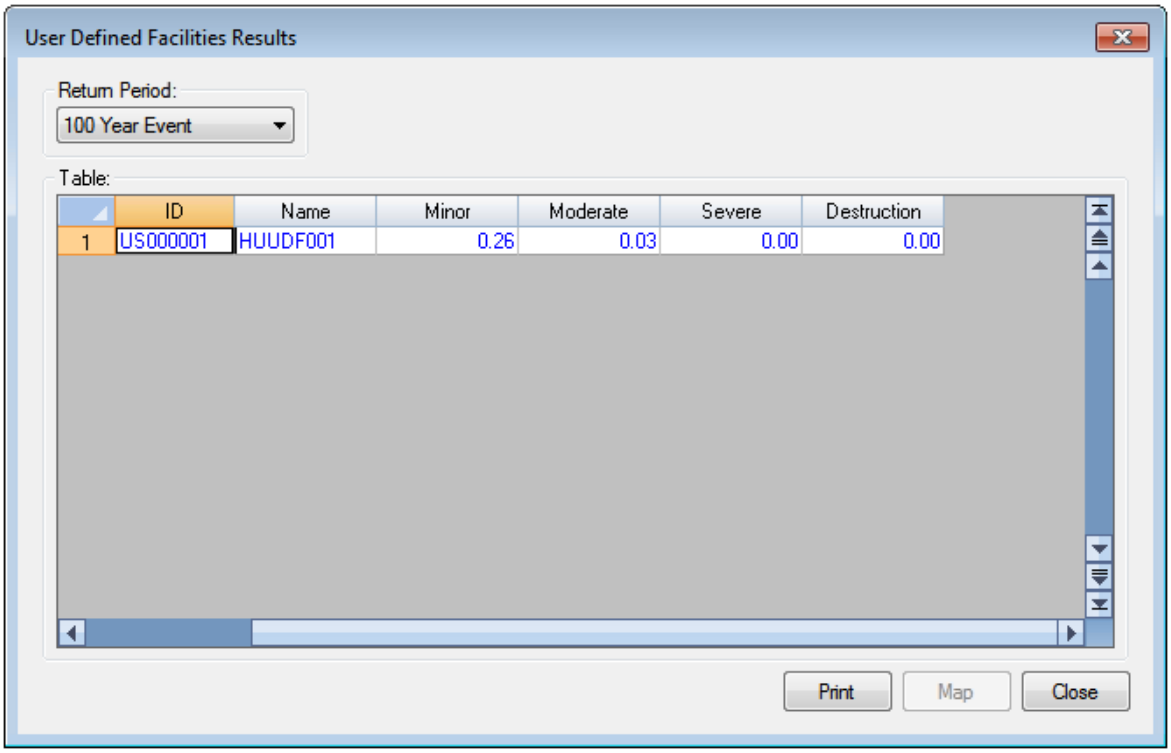


Figure 8-18 User-Defined Facilities Results Table

8.7 Debris Analysis Results

Debris Analysis Results, selected in Figure 8-19 and shown in Figure 8-20, allows the user to see and map building and tree debris results by Census tract.

For probabilistic scenarios, the drop-down menu allows the user to select one of seven sample return period events.

The eligible tree debris columns (**Eligible Tree Weight** and **Eligible Tree Volume**) provide estimates of the weight and volume of downed trees that would likely be collected and disposed of at public expense. The eligible tree debris estimates produced by the Hurricane Model tend to underestimate reported volumes of debris brought to landfills for some of the events that occurred in the past several years. The underestimate suggests that that there are sources of vegetative and non-vegetative debris that are not modeled in Hazus.

For landfill estimation purposes, it is recommended that the Hazus debris volume estimate be treated as an approximate lower bound. Based on actual reported debris volumes, it is recommended that the Hazus results be multiplied by three to obtain an approximate upper bound estimate. It is also important to note that the Hurricane Model assumes a bulking factor of 10 cubic yards per ton of tree debris. If the debris is chipped prior to transport or disposal, a bulking factor of 4 is recommended.

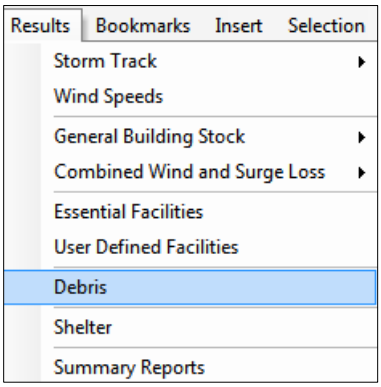


Figure 8-19 Debris Analysis Results Table

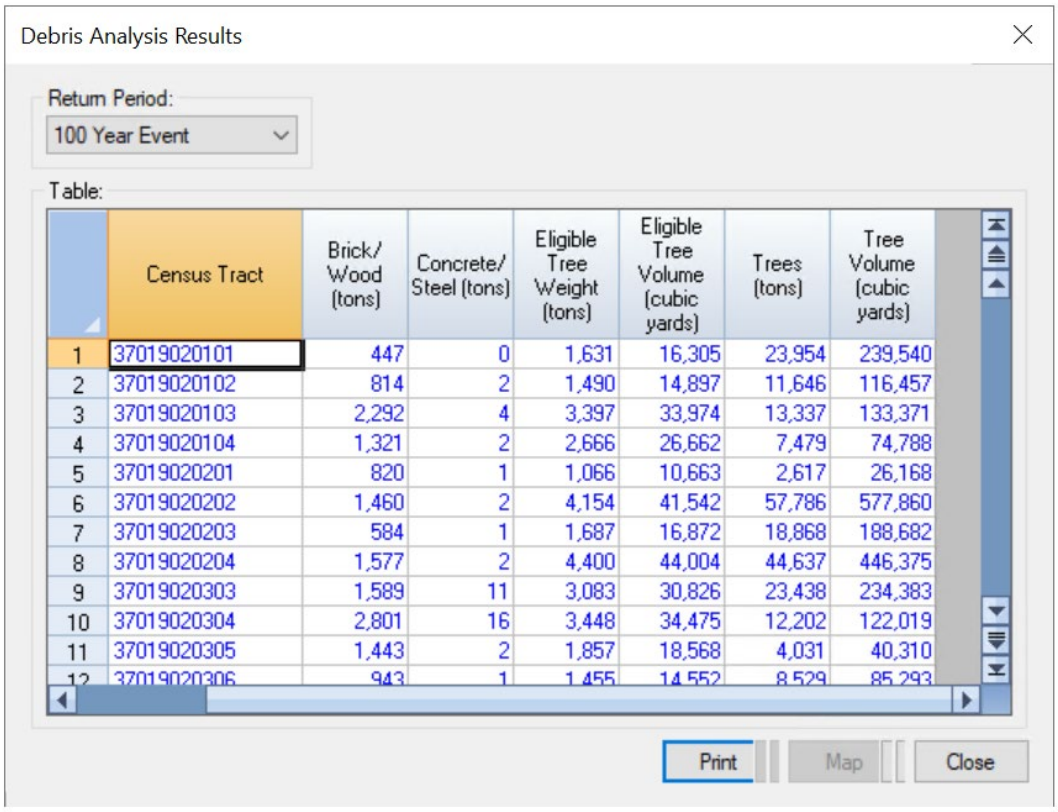


Figure 8-20 Debris Analysis Results Table

8.8 Shelter

The **Shelter Analysis Results**, selected in Figure 8-21 and shown in Figure 8-22), allow the user to see and map the estimated number of displaced households and the estimated short-term shelter needs by Census tract.

For probabilistic scenarios, the drop-down menu allows the user to select one of seven sample return period events.

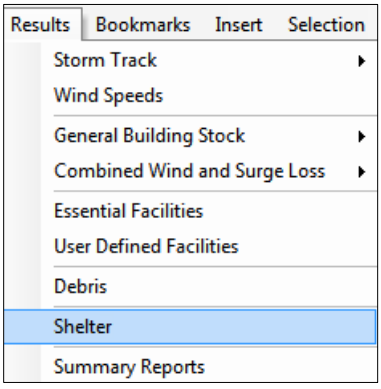


Figure 8-21 Shelter Analysis Results Table

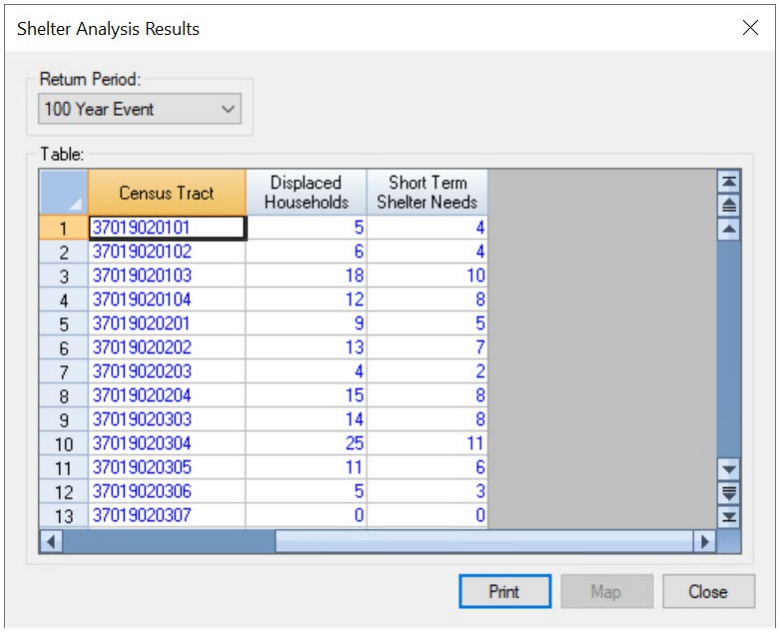


Figure 8-22 Shelter Analysis Results Table

8.9 Mapping a Results Table

To thematically map a given table, select its column by clicking on the header and then clicking the Map button at the bottom of a table (as shown in Figure 8-23) and closing the dialog. The resulting layer is shown in the wind speed example in Figure 8-24. Colors, legends, and titles can be altered easily. Any mapped layer can be exported as a shapefile or geodatabase feature class.

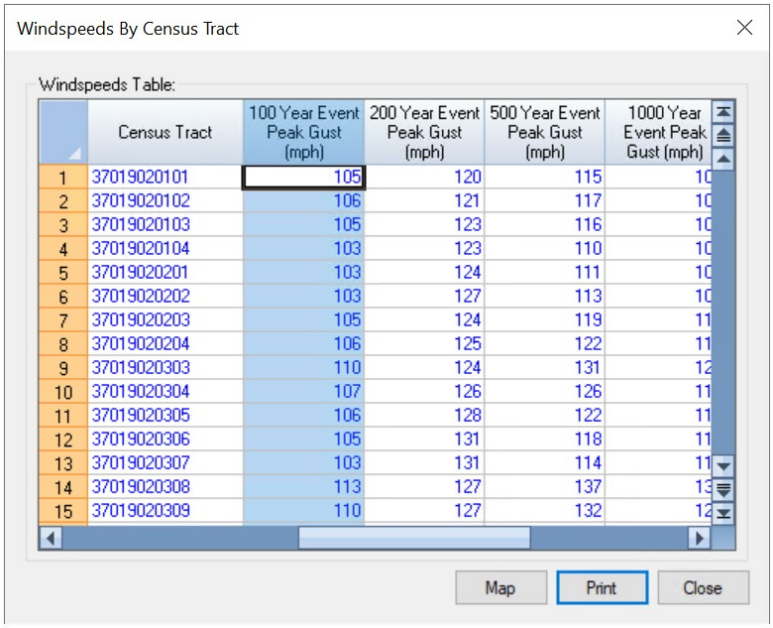


Figure 8-23 Example – Select Wind Speeds to Map

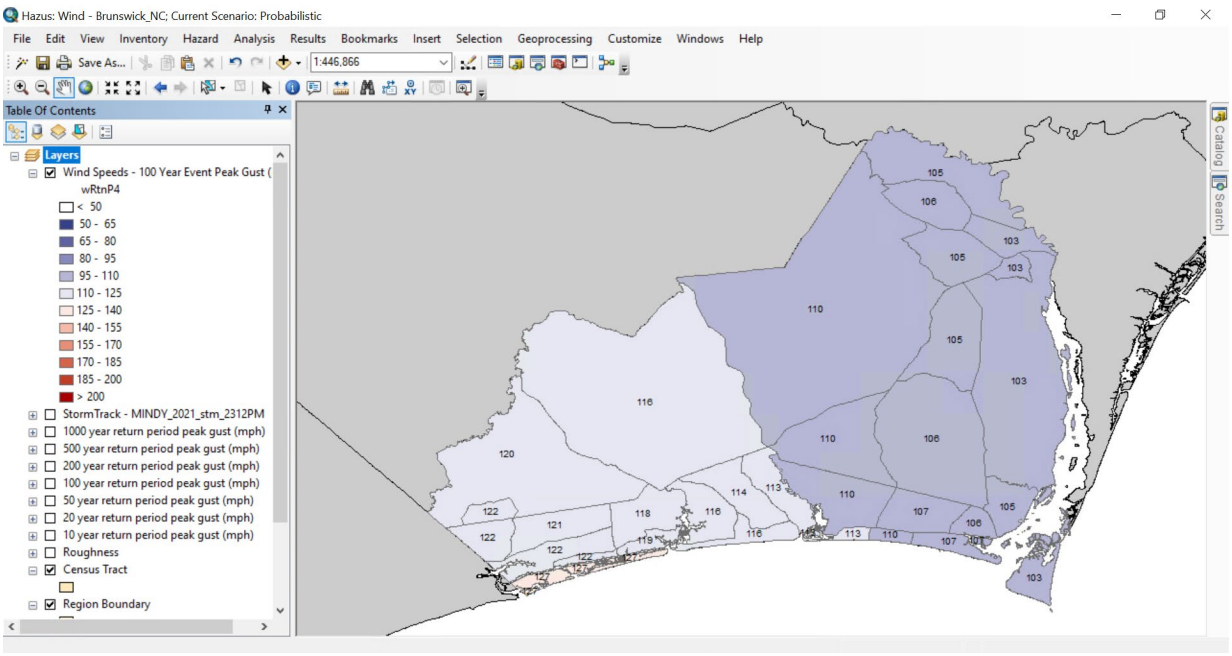


Figure 8-24 Example – Mapping Results for Selected Wind Speeds

8.10 Summary Reports

A variety of summary reports are available for viewing and printing through the **Summary Reports** menu (Figure 8-25 and Figure 8-26). After selecting a report, click **View** and a sample report will appear (Figure 8-27). It may take several minutes for reports to generate after making the selection.

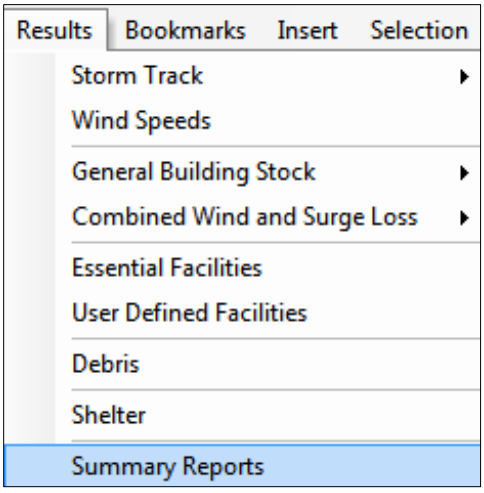


Figure 8-25 Results > Summary Reports Menu

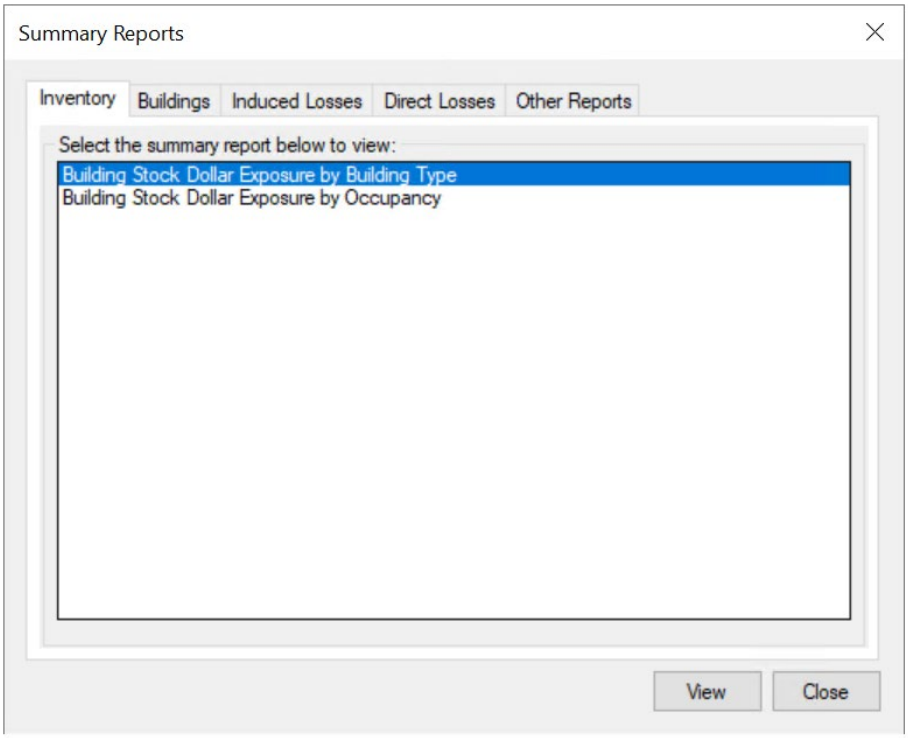


Figure 8-26 Select Desired Summary Report

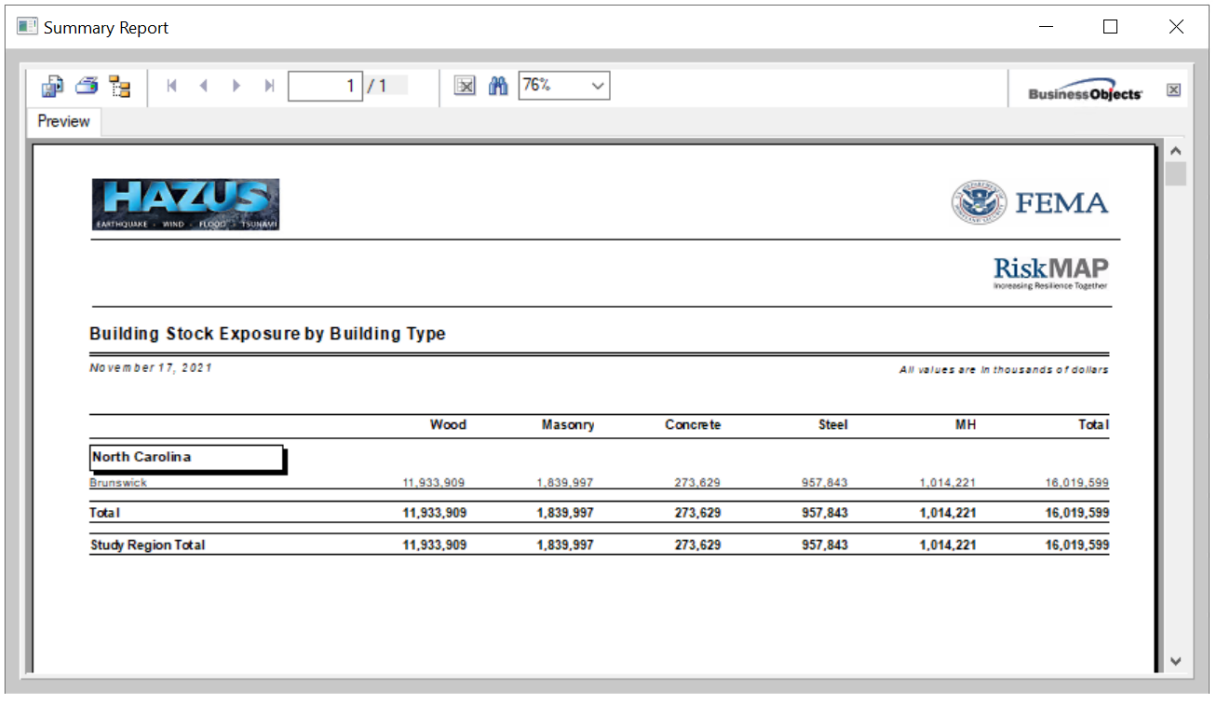


Figure 8-27 Example – Summary Report for Building Stock Exposure by Building Type

Section 9. Advanced Hazus Analysis: User-Defined Inventory Data

The Hazus baseline data inventory provides several data sets that provide immediate analysis, but in certain Study Regions, more relevant custom data sets may be needed. User-Defined Facilities (UDF), accessible via the option **Inventory > User-Defined Facilities** (Figure 9-1), enables user-specific data sets to be analyzed through the Hazus methodologies allowing for more accurate results.

GBS, as well as site-specific data (like UDF data), should be edited within the Hazus Comprehensive Data Management System (CDMS) Tool, which installs with the Hazus software. CDMS allows the transfer of data into and out of the master Hazus statewide datasets, provides validation of new data into the system, and allows users to query and print information within the system. Transfer of data into the CDMS data repository supports both site-specific inventory and aggregated data. More details on CDMS can be found in the Hazus Comprehensive Data Management System (CDMS) User Guidance.

9.1 Importing User-Defined Facilities Data

In Hazus, the default UDF table is typically empty, and the user must populate it with data specific to the area that is being analyzed by using CDMS to add data to the state database. It is assumed that the user will obtain custom data from another source, utilize CDMS, and ensure the data have populated the minimum required fields.

Since the input data could be in any schema, Hazus CDMS will guide the user from the input format to the target format. Selecting the correct target fields is the most critical step in the import process since it affects the data used, and therefore the results obtained. Once the data is entered through CDMS, it can be viewed the study region Inventory menu.

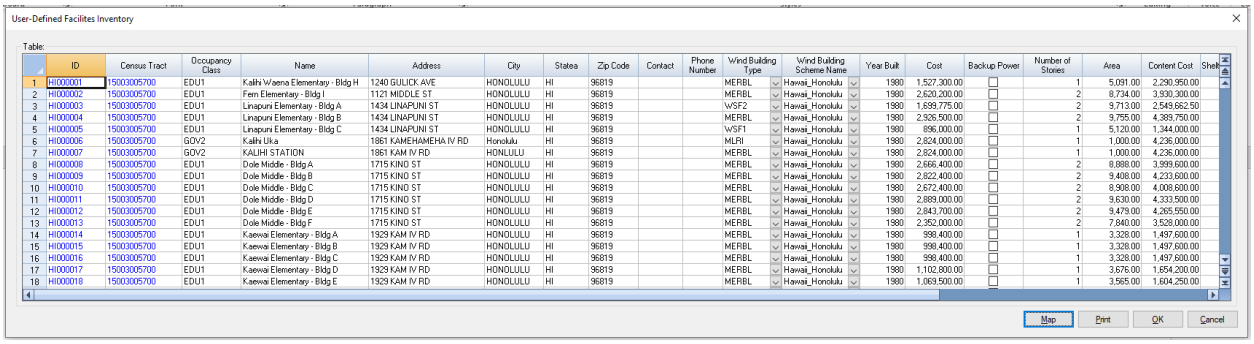


Figure 9-1 Sample Hazus UDF Data

9.2 Required Attributes for User-Defined Facilities

The Hurricane Model does not currently perform economic loss analysis for UDF points. Instead, the model uses the UDF location to query the damage state information for the Census tract where the UDF point is located, as shown in Figure 9-3. Therefore, the minimum attributes required for hurricane analysis of UDF, shown in Table 9-1, are limited to the UDF point location and the Wind Building Type and several fields derived from these values (Census tract, Occupancy Type and the Wind Building Scheme Name).

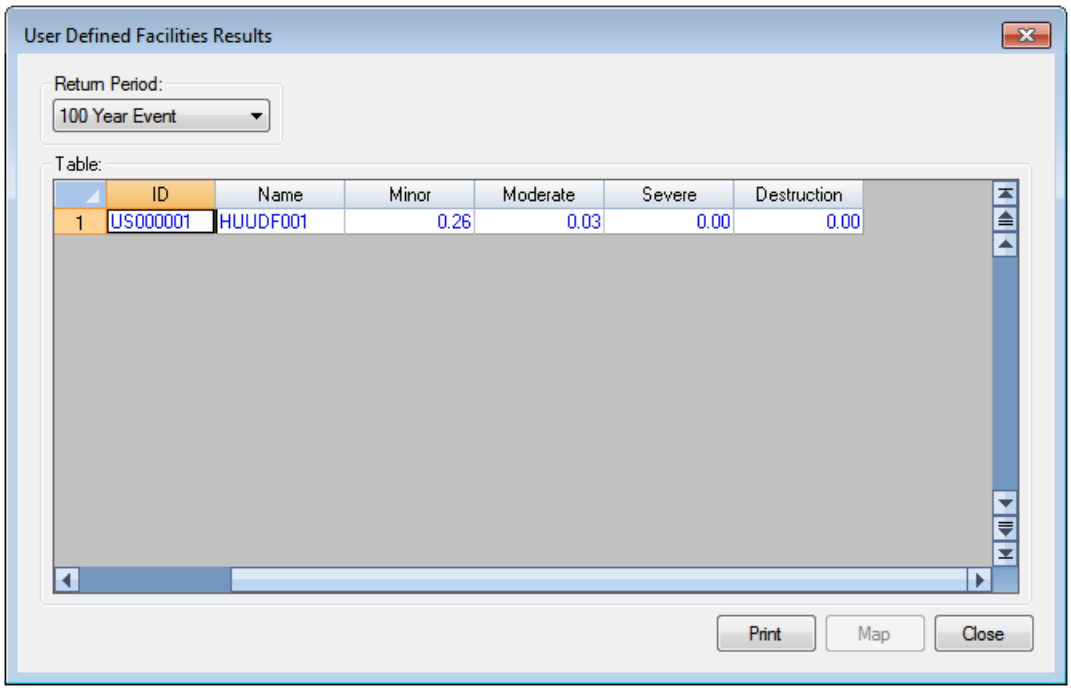


Figure 9-2 User-Defined Facilities Results Table

Table 9-1 List of Hurricane UDF Required Attributes

Attribute	Description	Why Is the Attribute Needed?
Record Identifier (ID)	A unique identifier for each record. Hazus creates its own value for each record (it does not prompt the user for one since there is no guarantee it is unique).	Hazus results will be displayed by the primary key generated when the data is imported.
Census Tract	Hazus will derive the Census tract based on location information.	Hazus uses the Census tract information to look up the underlying information for wind damage modeling, such as tree cover.

Attribute	Description	Why Is the Attribute Needed?
Occupancy	Hazus will derive occupancy based on user supplied Wind Building Type.	Hazus analysis functions are a function of the occupancy and/or wind building type, per the Hazus classification.
Wind Building Type	Wind building type per the Hazus classification	Hazus uses the Wind Building Type to select the wind damage functions for wind damage analysis.
Wind Building Scheme Name	Hazus will derive based on location.	Hazus uses the scheme to derive wind damages.
Location	The location of the facility can be supplied as latitude/longitude if user directly enters values or directly (if the table imported is a feature class).	Hazus needs the location data to identify whether the facility is within the Study Region and to query underlying databases to conduct wind damage modeling.

Section 10. Advanced Hazus Analysis: User-Defined Storm

Hazus allows users to manually enter a storm path with user-defined information. This step requires selecting options and inputting a storm path track. To find the page, follow these steps:

- Using the Scenario Wizard, select **Define Storm Track Manually**, as shown in Figure 10-1
- Click **Next**.

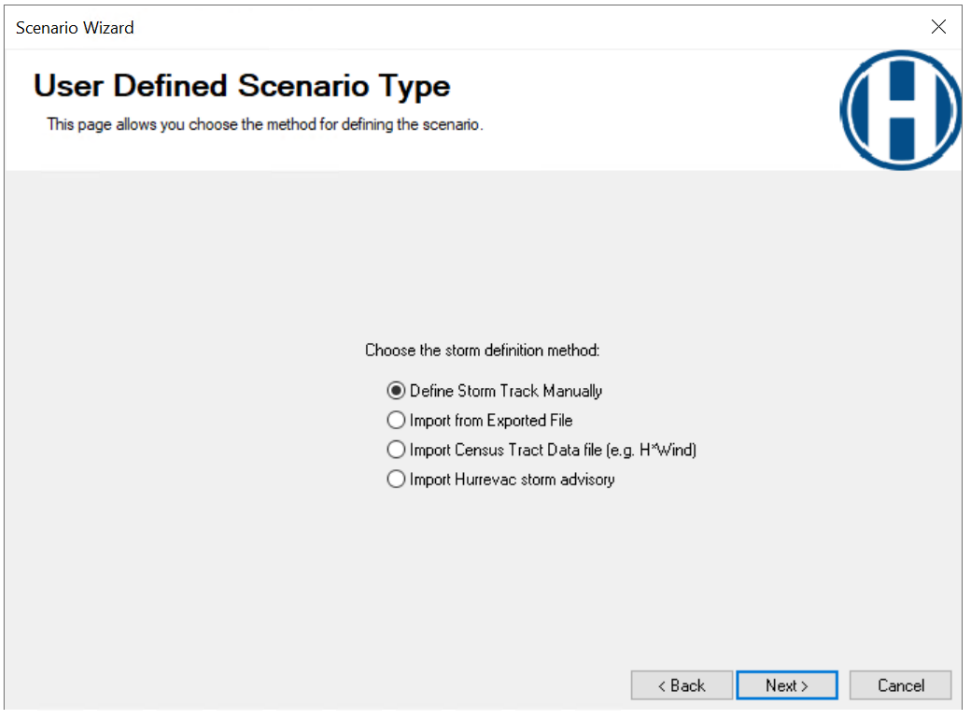


Figure 10-1 Select Define Storm Track Manually

Next, choose from the following in the **Storm Track Definition Method** window (Figure 10-2):

- Storm's locations at specific **Times** or with **Translation Speeds**
- **Radius to Maximum Winds** or **Radius to Hurricane Force Winds**
- **Maximum Wind Speeds** or **Profile Parameters**

Then click **Next**.

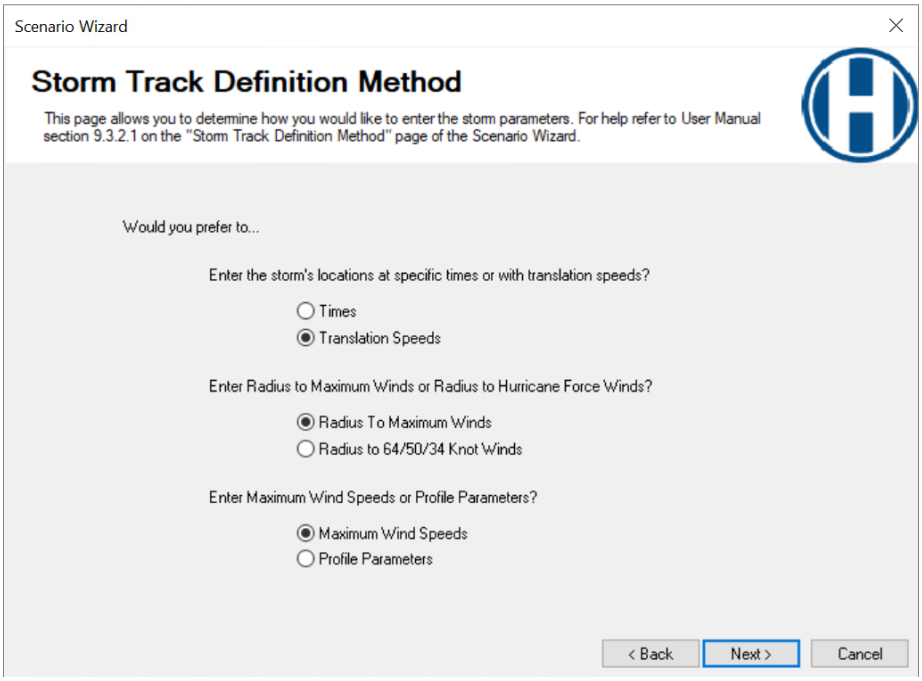


Figure 10-2 Select Preferences for Storm Track Definition Method

The next window will show the **Edit Storm Track** table (Figure 10-3). The table will be blank, and the user will need to fill out the attributes of the storm track except for the information that will populate automatically. The attributes will be based on the options the user selected in the Figure 10-2.

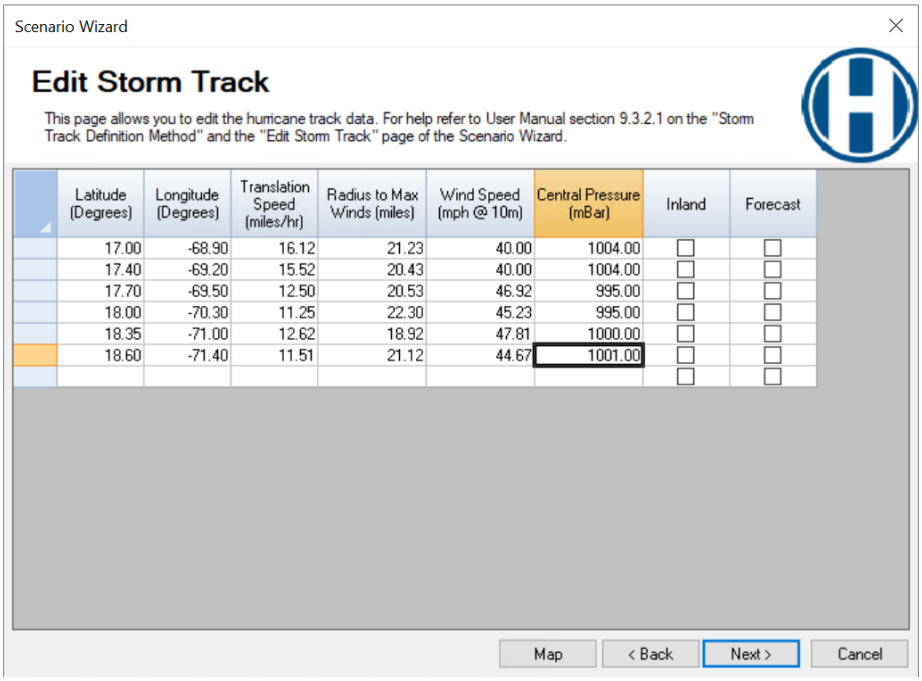


Figure 10-3 Insert Required Storm Track Data

The user will provide the inputs listed below. Pay careful attention to the units of measure in the column headings.

- **Latitude** – Based on the selected storm track. All values will be in decimal degrees (North is positive).
- **Longitude** – Based on the locations of points on the selected storm track. All values will be in decimal degrees (East is positive).
- **Times** (not shown in Figure 10-3) – Elapsed time in hours at each point along the track. The first point should be zero.
- **Translation Speed** – Forward speed of the storm in mph at each point along the track. Typical translation speeds are 5 to 25 mph.
- **Radius to Maximum Winds** – Distance in miles from the center of the storm to the location of highest winds. Typical values are 6 to 60 miles. Intense storms generally have smaller radii to maximum winds.
- **Radius to Hurricane Winds**, 50 knot winds or 34 knot winds (not shown in Figure 10-3) – Greatest distance in miles from the center of the storm to hurricane-force winds (i.e., 74 mph sustained), 50 knot winds or 34 knot winds. These values are provided in NOAA National Hurricane Center (NHC) Hurricane Forecast/Advisories. Typical values are 10 to 200 miles.
- **Maximum Wind Speed** – Maximum 1-minute sustained wind speed in mph of the storm at the current location. For reference, the following are the 1-minute sustained wind speeds for the five hurricane categories.
    - Category 1: 74 to 95 mph
    - Category 2: 96 to 110 mph
    - Category 3: 111 to 129 mph
    - Category 4: 130 to 156 mph
    - Category 5: >157 mph
- **Profile Parameters** (Holland B parameter) (not shown in Figure 10-3) – Distribution of atmospheric pressures as a function of distance from the center of the storm. Values are 0.5 to 2.5 with a typical value of 1.3.
- **Central Pressure** – Surface level atmospheric pressure in mbar at the center of the storm. For reference, the following are the general central pressure ranges for the five hurricane categories.
    - Category 1: >979 mbar

- Category 2: 965 to 979 mbar
- Category 3: 945 to 964 mbar
- Category 4: 920 to 944 mbar
- Category 5: <920 mbar

- **Inland** – Yes/no checkbox. The point is inland, and the input data are from an NHC forecast or advisory. Hazus uses this information to estimate the Radius to Maximum Winds using the NHC Radius to Hurricane Winds.

- **Forecast** – Yes/no checkbox. The point is a forecast position, and the user needs to estimate a range of expected losses, considering forecast uncertainties. Hazus uses this information to simulate a variety of potential tracks given the last known position and intensity. To run an analysis with the forecast uncertainties, the track must be defined using Time (not Translation Speed) and Maximum Wind Speed (not Profile Parameter). The times of the forecast points must be T+9 hrs, T+21 hrs, T+33 hrs, T+45 hrs, T+60 hrs and T+69 hrs, where T is the time of the last known position. These are the time increments used in the official NHC forecasts and advisories. Note that it is not necessary to include all the forecast positions from the advisory. The minimum number of permitted forecast points is one (T+9 hrs), and the maximum is five (T+69 hrs).

Once all information has been entered, click **Next** to process the Windfield Calculations. After the Windfield Calculations have been processed, Hazus will generate a review page, the **Storm Track Data Review** table shown in Figure 10-4.

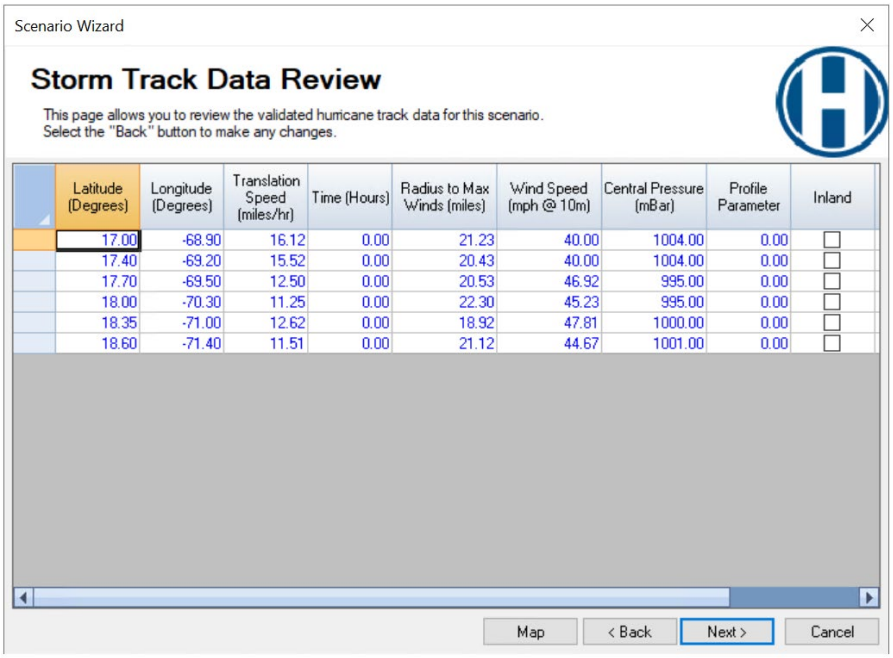


Figure 10-4 Review Storm Track Data

After reviewing the information, click **Next** to bring up the **Scenario Review** table, shown in Figure 10-5. This will display information about the results of the scenario. After reviewing the information, click **Next** to activate the scenario.

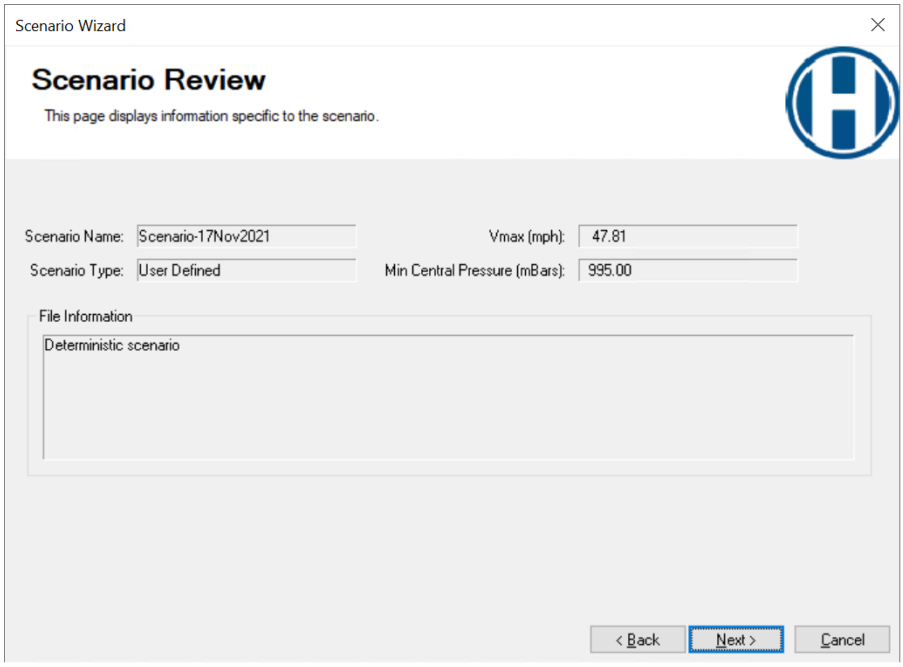


Figure 10-5 Review Scenario

Section 11. Advanced Hazus Analysis: Hurricane Surge Scenario

The Hazus tool can run a combined hurricane and flood hazard analysis for coastal areas. To run a combined hurricane and flood hazard, a multi-hazard (flood and hurricane) Study Region that includes a shoreline must be built. To build the Study Region, follow the workflow shown in Table 11-1. The inputs will be used to determine the extent of flooding due to a wind-driven storm and estimate the flood losses associated with the hurricane.

Table 11-1 Workflow to Build Multi-Hazard Study Region

Model	Inputs
Hurricane	▪ Define/Select Hurricane Scenario ▪ Run Analysis with Surge-Only or Surge and Waves ▪ Display Wind-Only Losses
Flood	▪ Select Coastal Surge ▪ Define Topography ▪ Define Scenario ▪ Delineate Floodplain ▪ Run Flood-Only Analysis ▪ Run Combined Loss Analysis
Hurricane or Flood	▪ Display Combined Losses

11.1 Storm Surge Scenario Options

The storm surge scenario options are available for four hurricane scenario types:

- User-defined, including the Hurricane Hazard Import Tool (HHIT)
- Hazus import
- Historic
- Hurrevac historic storms; also see Section 6.3.3

The storm surge scenario options are not available for:

- .dat file
- Probabilistic

To run a storm surge analysis, the Study Region must have been created for both Hurricane and Flood Hazard analysis. As shown in Section 3, start with Create New Region Wizard (Figure 11-1). Check both **Flood** and **Hurricane** hazard boxes and click **Next**.

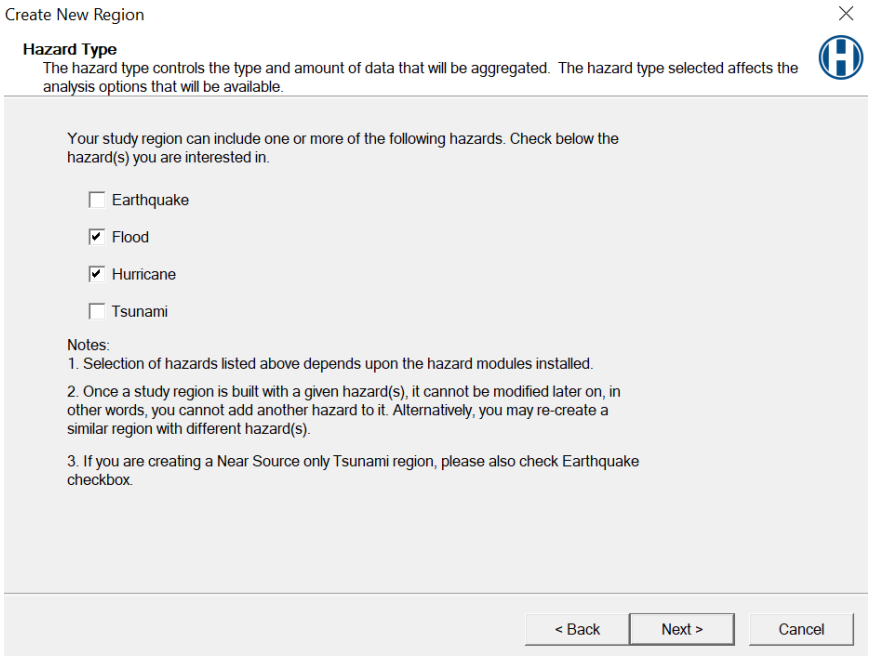


Figure 11-1 Select Hazards for New Region

Specify the Study Region and finish the Create New Region wizard.

NOTE: Limiting storm surge Study Regions to a single county is recommended. In some cases, a single county (e.g., Miami-Dade) may need to be split into two regions.

Open a region and select the new multi-hazard. When prompted, select the Hurricane Model to open first, as shown in Figure 11-2. Click **Next** and then click **Finish** to open the region.

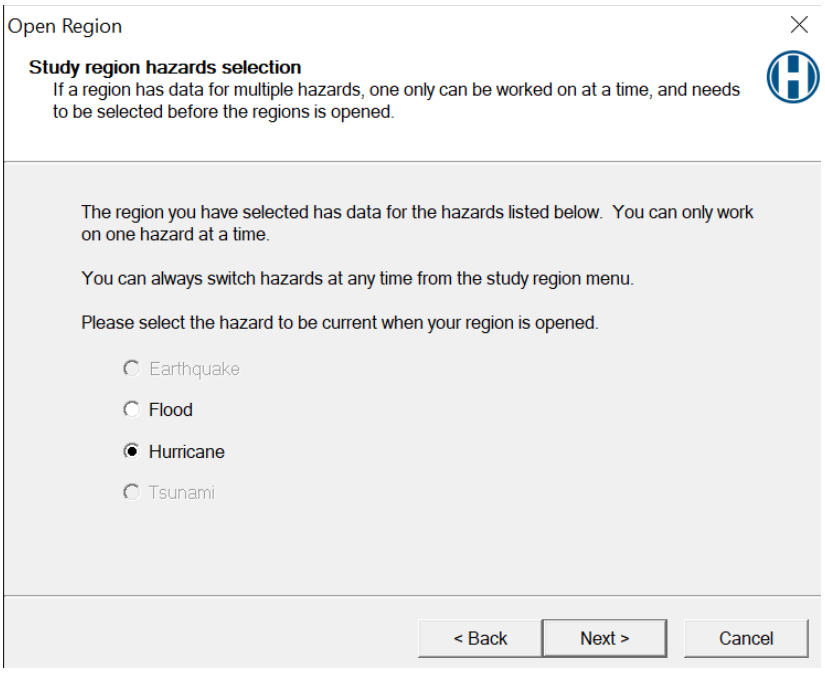


Figure 11-2 Select Hurricane Model First in Study Region

Analysis > Set Optimized Analysis Mode must be "Off," as shown in Figure 11-3 so that the wind analysis is performed at the Census block level.

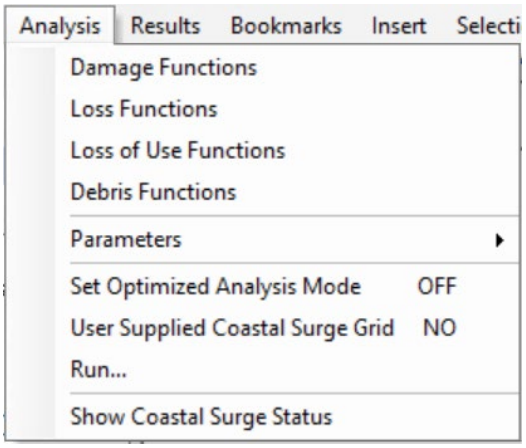


Figure 11-3 Ensure Optimized Analysis Mode is Off

Check **Hazard > Show Current** to make sure the scenario is set to manual, Hazus import, historical, or Hurrevac import (Figure 11-4). If the scenario needs to be changed, use **Hazard > Scenario** to open the Scenario Management Wizard discussed previously (Figure 11-5).

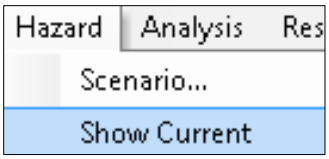


Figure 11-4 Review Scenario in Hazard > Show Current

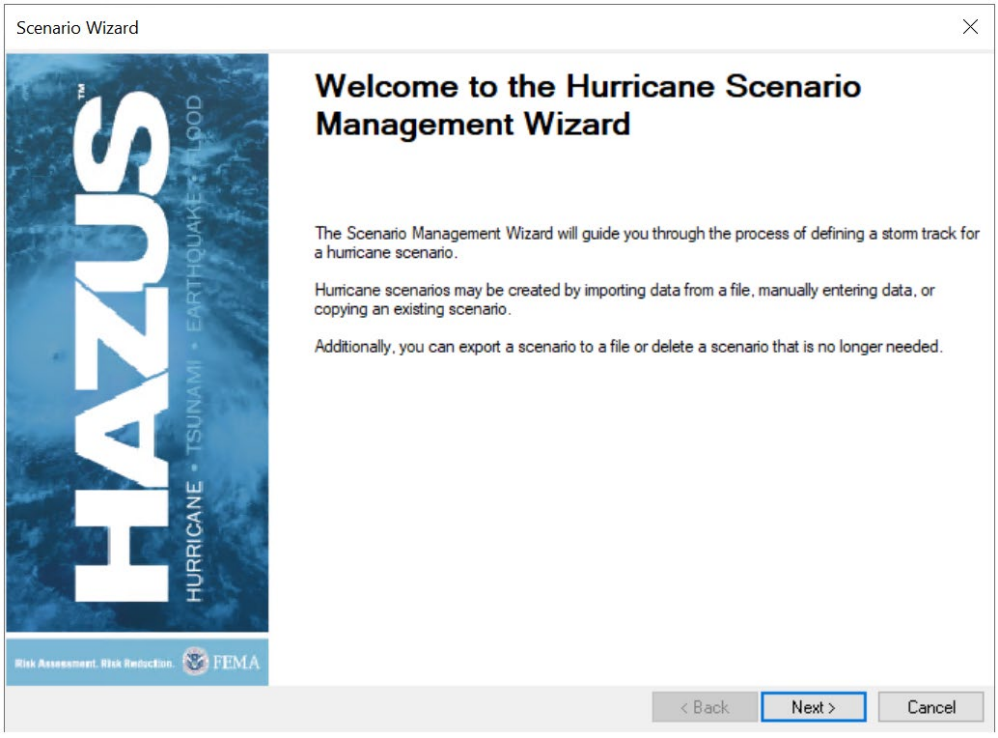


Figure 11-5 Scenario Management Wizard

11.2 Run Storm Surge Analysis

Open the **Analysis Options** from the **Analysis > Run** menu (Figure 11-6). When storm surge is selected, as shown in Figure 11-7, a storm surge analysis using the NOAA SLOSH model is executed in the Hurricane Model to produce estimates of coastal still water elevations. Note that the storm track that is used should extend beyond the outer boundary of the applicable SLOSH basin grids.

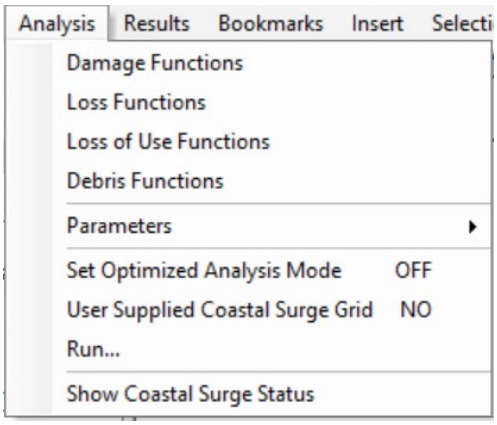


Figure 11-6 Analysis Run Storm Surge Menu

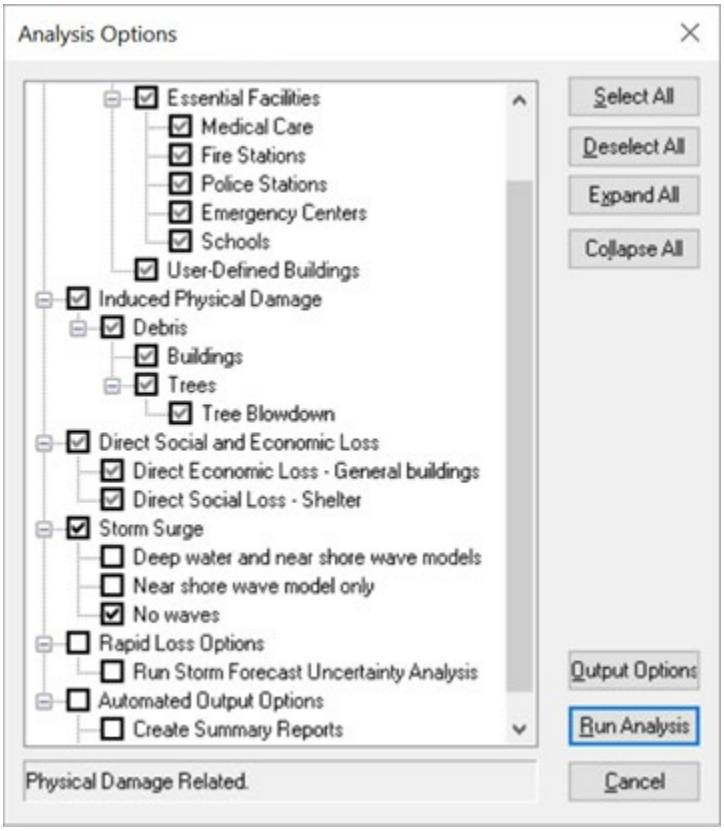


Figure 11-7 Analysis Options for Storm Surge

In addition, there are options for running coupled surge and wave analysis using the Delft University SWAN model if checked (refer to the Technical Manual for more details on the modeling approaches used for SWAN and SLOSH):

- **Deep water and near shore wave models.** A coarse analysis of the entire northwest Atlantic basin is run, and the results are then coupled into one or more nearshore wave grids, which are

superimposed on the relevant SLOSH basin(s). This option is the most detailed and slowest running. The storm track used should also extend all the way out to 60 degrees west longitude when this option is selected.

- **Near shore wave model only**. This option runs a coupled surge and wave analysis within the relevant SLOSH basin(s) only. This option is faster than the first option but still significantly slower running than the "no waves" option.

- **No waves**. This option skips the SWAN model entirely. For this case, the Flood Model assumes depth-limited waves at the coastline rather than using significant wave heights produced by SWAN. This is the fastest option.

When appropriate boxes have been checked in the Analysis Options, click **Run Analysis**.

At the start of the analysis, the Hurricane Model prompts the user for an **initial water level** in feet with respect to the NAVD 1988 datum shown in Figure 11-8. This represents the water level along the coast that would have been expected (in the absence of the hurricane) near the center of the Study Region at the time of hurricane landfall. The initial water level can be estimated by using NOAA tide forecasts plus the pre-storm tidal anomaly (i.e., the difference between the forecast and observed water level 2 days before landfall).

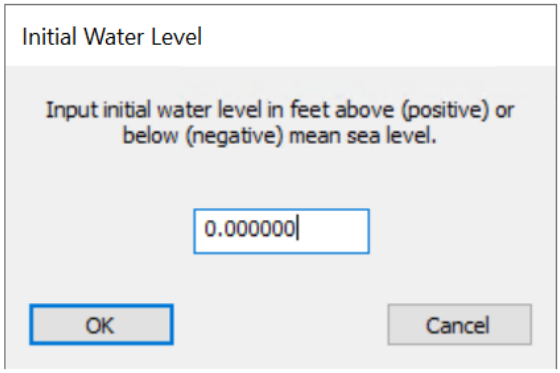


Figure 11-8 Provide Initial Water Level

When running a storm surge hazard analysis (Figure 11-9) in the Hurricane Model, a second progress dialog will appear after the wind-only damage and loss calculations are completed (Figure 11-10).

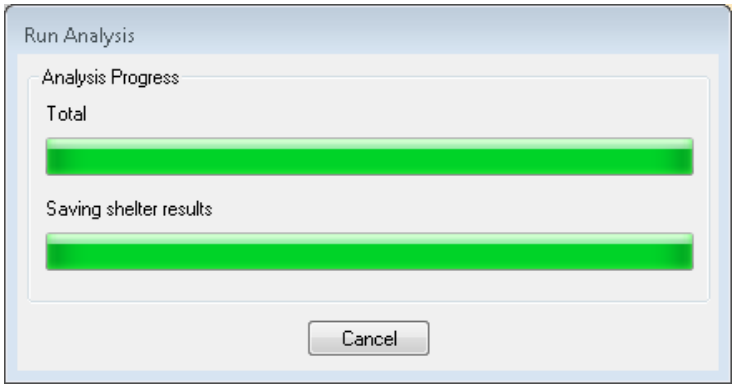


Figure 11-9 Run Analysis Progress Status Window

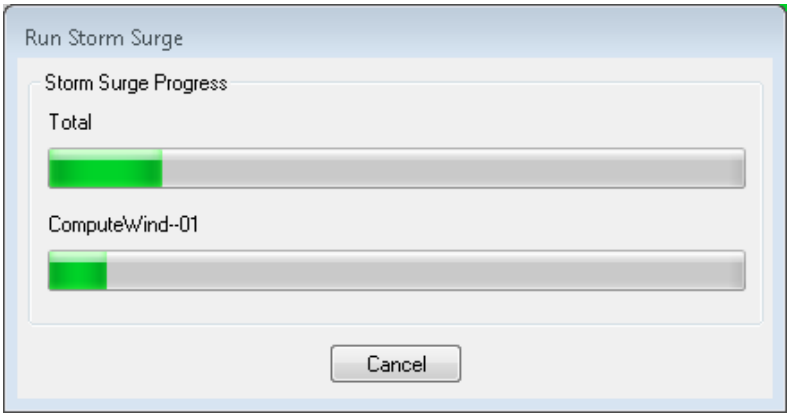


Figure 11-10 Run Storm Surge Progress Status Window

When a hurricane coastal storm surge analysis is run, two sets of direct building losses are produced: one set for the wind damage by itself and a second set for the combined wind and surge damage. When the storm surge analysis is complete, click the **Analysis > Show Coastal Surge Status** to confirm that the analysis was successful, as shown by the status box in Figure 11-11.

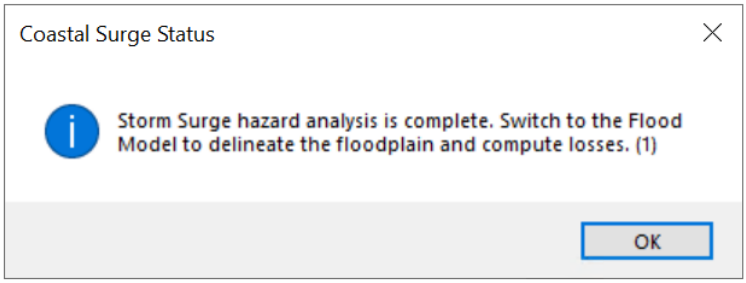


Figure 11-11 Coastal Surge Status Window

To obtain the combined wind and surge losses, users must run a Storm Surge analysis and calculate the combined losses in the Flood Model. See further instructions in the *Hazus Flood Model User Guidance*.

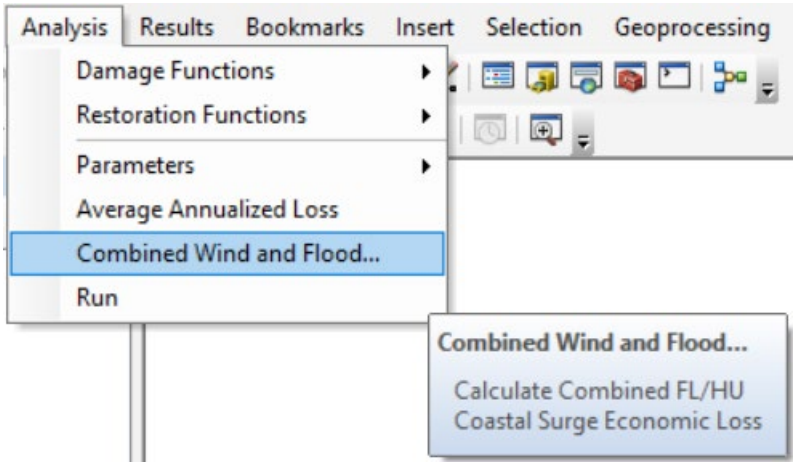


Figure 11-12 Combined Wind and Flood Analysis Menu

11.3 Storm Surge

After the Hurricane Model has been run, reopen the Study Region in the Flood Model, as shown in Figure 11-13. Click **Next** and then click **Finish** to open region.

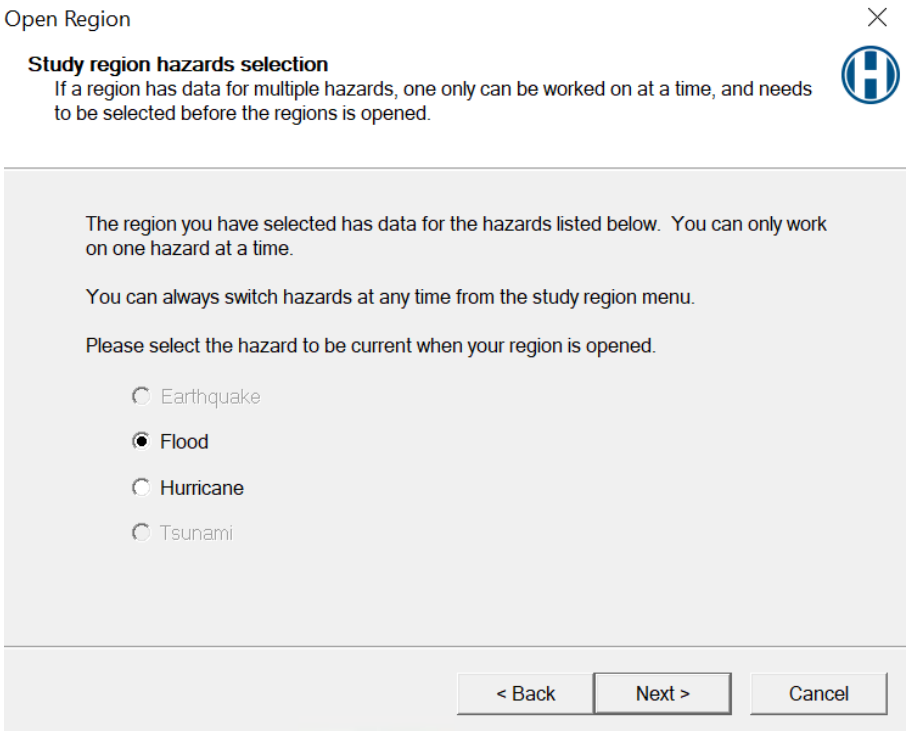


Figure 11-13 Select Flood Model in Study Region

Open the Hazard menu and select Flood Hazard Type (Figure 11-14).

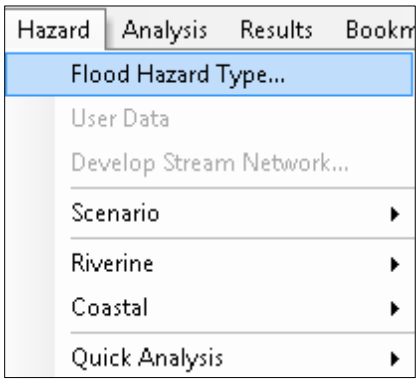


Figure 11-14 Select Flood Hazard Type

Select the Flood Hazard type “Storm Surge” and click OK (Figure 11-15).

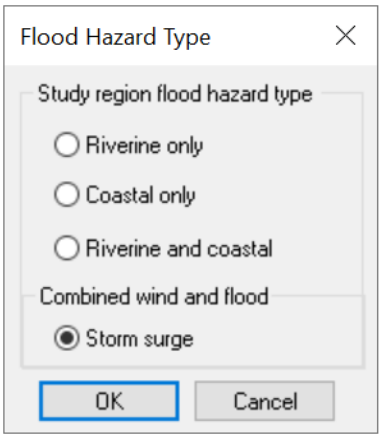


Figure 11-15 Select Storm Surge

After the hazard type is set, the user must import a digital elevation model (DEM) for the Study Region by opening the Hazard menu and selecting the User Data dialog (Figure 11-16).

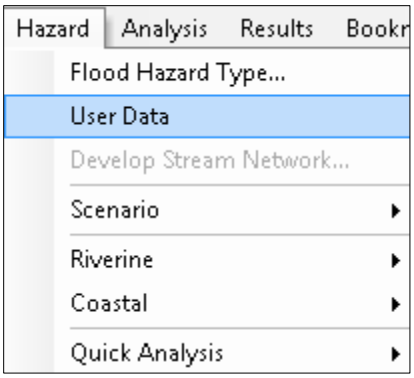


Figure 11-16 Select User Data to Import DEM

The User Data dialog will only contain two tabs, DEM and Storm Surge. Use the Browse button to add the DEM to the Model (Figure 11-17). Figure 11-18 shows the Storm Surge tab, where the Surge Elevation Grid (SLOSH) and Significant Wave Height Grid (SWAN) that were produced by the Hurricane Model are in the Study Region folder as surge.flt, surge.hdr (SLOSH), and waveht.flt, waveht.hdr (SWAN). When the DEM is uploaded, click OK. See the Hazus Flood Model Manual for more details about obtaining DEM data.

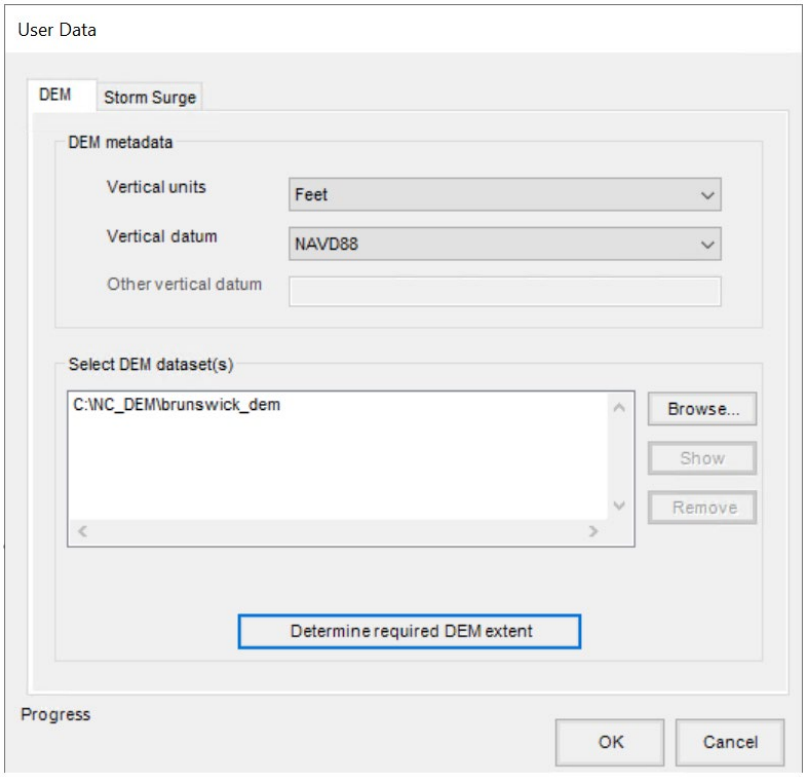


Figure 11-17 Add User Data DEM to Model

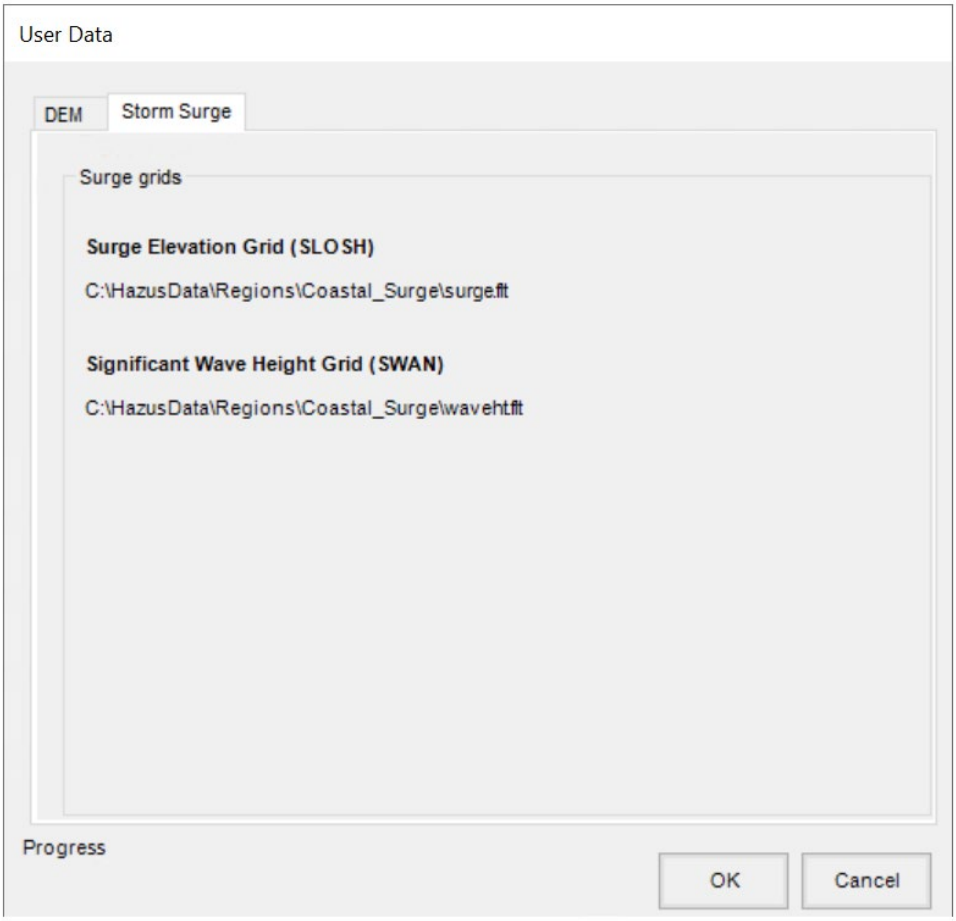


Figure 11-18 Review User Data in Storm Surge Tab

When the DEM uploads successfully, the user needs to create a new scenario next, using **Hazard > Scenario > New** (Figure 11-19). Enter a unique name for the scenario and click **OK** (Figure 11-20). In storm surge scenarios, the surge and wave height files are automatically selected, and users do not need to select or save any features because the Hurricane Model supports only one scenario per Study Region.

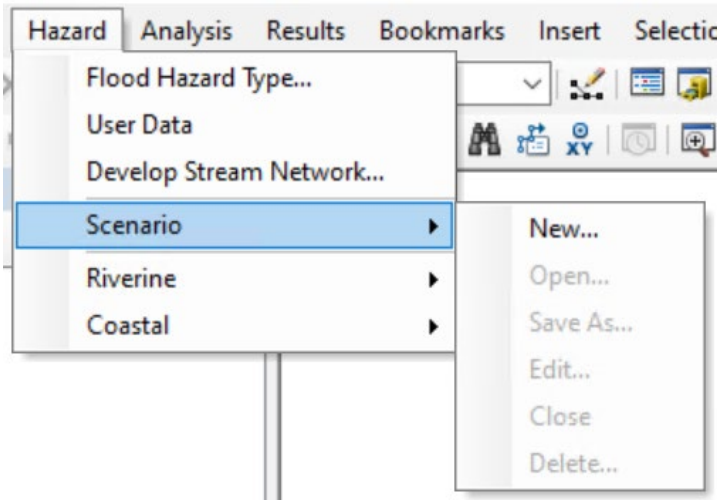


Figure 11-19 Select New Scenario in Hazard Menu

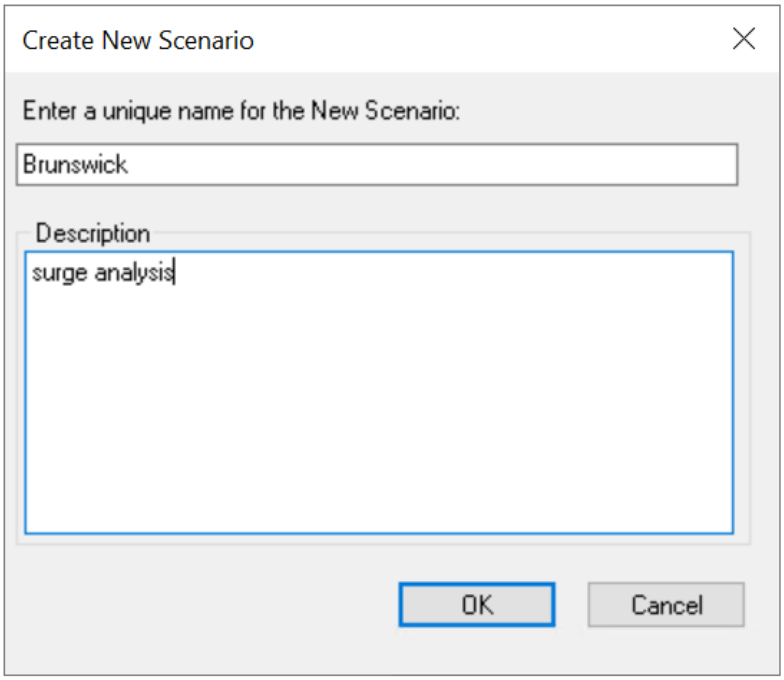


Figure 11-20 Provide Name for New Scenario

If the user selected “No Waves” in the Storm Surge analysis for the Hurricane Model, only the surge elevation grid was created for the Study Region. The wave height grid (waveht.flt) was not produced and the shoreline needs to be characterized. In this case, after creating a new scenario, the shoreline limits dialog will pop-up, as shown in Figure 11-21.

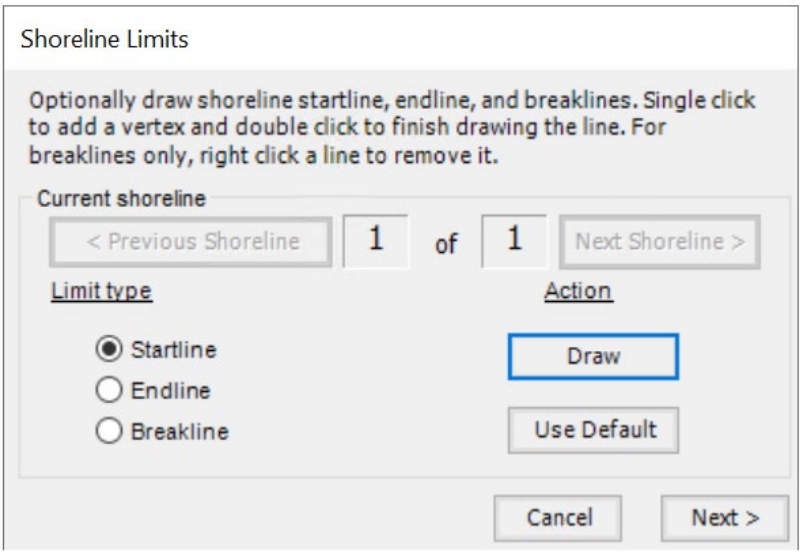


Figure 11-21 Input Shoreline Limits

After clicking **Next** there will be an additional shoreline characterization dialog, as shown in Figure 11-22. The Shoreline Type tab has one required input (wave exposure). If a User-Defined Storm Surge grid was provided, the shoreline characterization steps are not required.

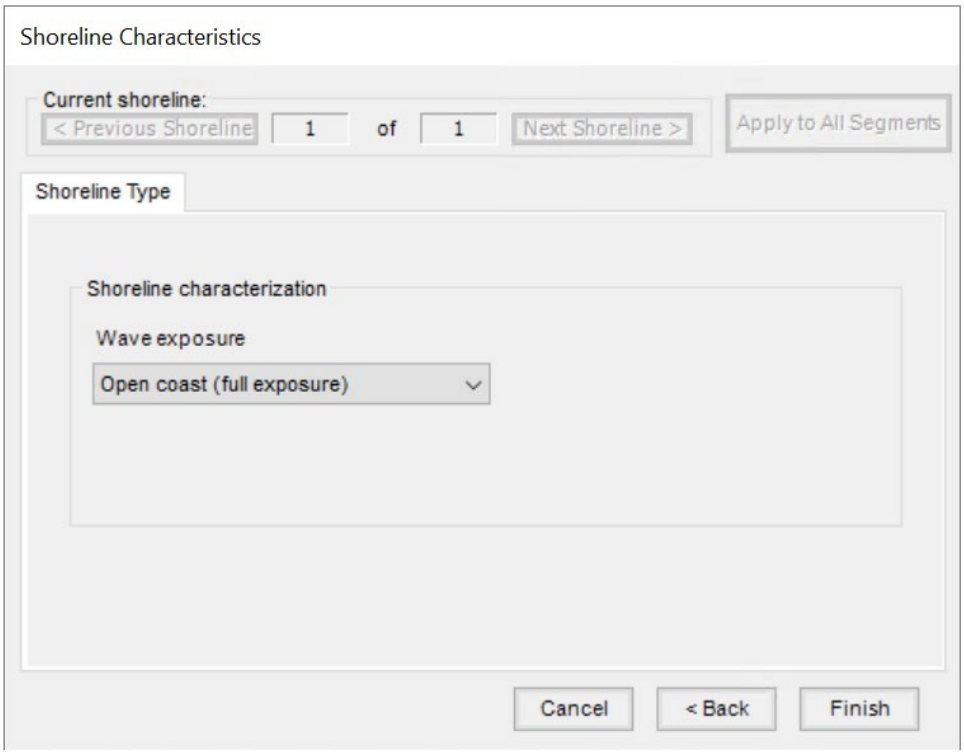


Figure 11-22 Select Shoreline Characteristics

The options for the wave exposure include:

- Open coast (full exposure): Any shoreline where the storm surge and waves come directly off open waters without the benefit of barrier islands or other land mass protection. Think in terms of lines of waves marching directly onto the shoreline uninterrupted. Full exposure is the Hazus default.

- Moderate exposure: Best represented by a shoreline that is slightly protected from the storm surge and associated waves. Moderate exposure might be a shoreline that has small islands or a low-lying sandbar that help break the direct force of the waves on the shoreline. A shoreline with moderate exposure might be angled to the direct line of the waves and will therefore receive a portion of the wave front.

- Minimal exposure: Best represented by a shoreline that is not in direct line with the storm surge or the waves. Minimal exposure might include an exposed shoreline that is running close to parallel to the storm surge and is therefore not bearing the brunt of the wave fronts.

- Sheltered: Best represented by the shoreline within a bay or protected by a larger barrier island. Sheltered could also be a shoreline along a large river inlet. The shoreline is sheltered from the wave front and is most likely subjected to stillwater flooding.

The default parameter is open coast (full exposure). At the top of the screen, the user can switch from one shoreline segment (if more than one) to another and back. If there are multiple segments and most have a single characteristic and a few have unique characteristics, the user can save time and effort by applying the common characteristic to all segments by pressing “Apply to All Segments” and then editing the unique segments.

After selections, click **Finish**.

Proceed to Delineate Floodplain by going to the Hazus Menu and selecting Coastal (Figure 11-23). When it is finished, the completion window will be shown as in Figure 11-24.

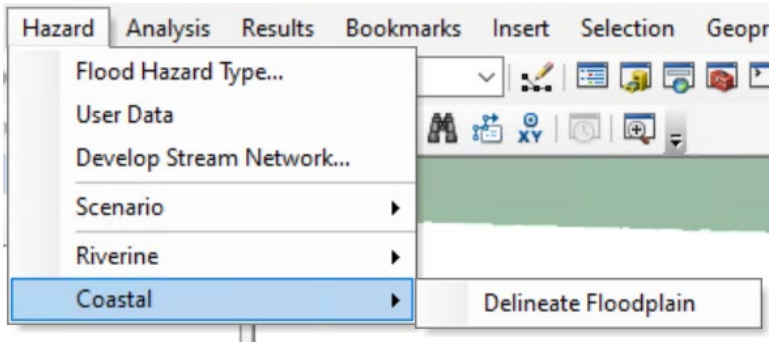


Figure 11-23 Select Coastal to Delineate Floodplain

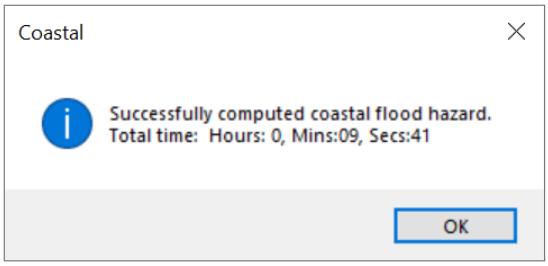


Figure 11-24 Delineate Floodplain Completion Status Window

Figure 11-25 displays the completed hazard portion of a storm surge model. The storm surge model outputs a flood depth grid named "Mix0_c" to the map, which comprises SLOSH and wave height grids.

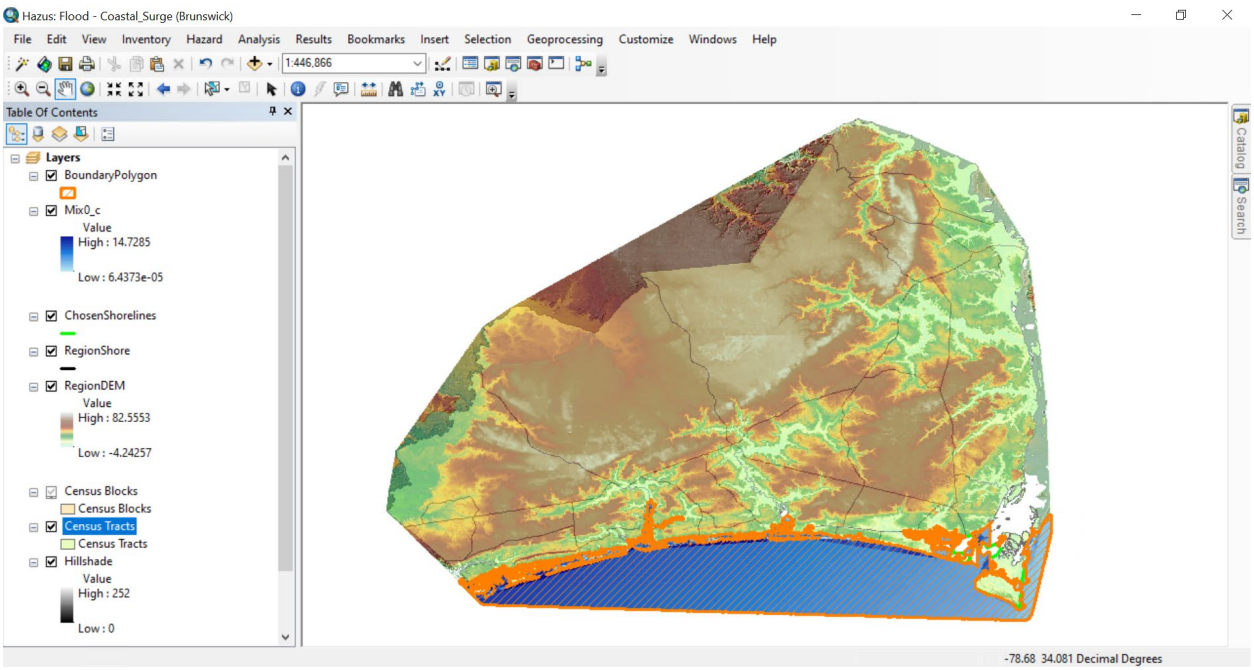


Figure 11-25 Example – Storm Surge Floodplain Delineation

The next step to complete the analysis is by using the Analysis Menu and choose **Run** (Figure 11-26). Next, check the **General Building Stock Damage and Loss** option and click **OK** (Figure 11-27).

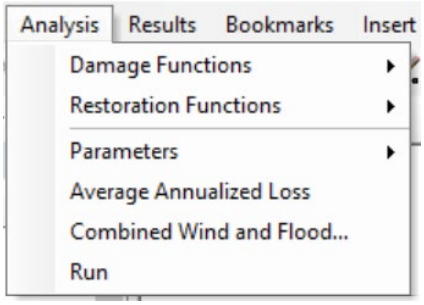


Figure 11-26 Select Run in Analysis Menu

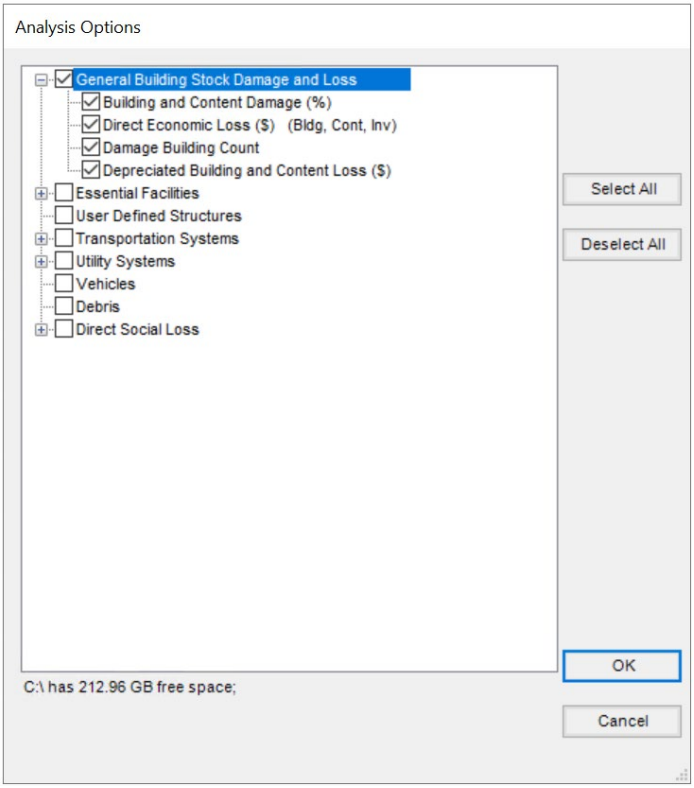


Figure 11-27 Select Preferred Analysis Options

The final step of a storm surge analysis is to calculate the combined hurricane wind and coastal storm surge losses, using the Analysis Menu and selecting **Combined Wind and Flood ...** (Figure 11-28). When the combined losses are completed, click **OK** to the message box (Figure 11-29).

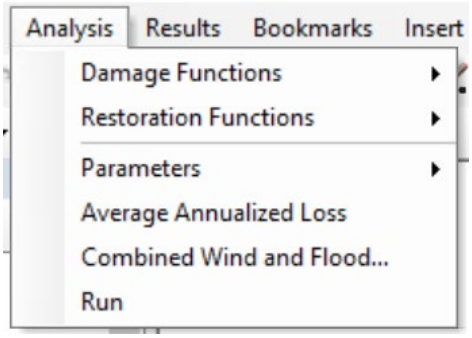


Figure 11-28 Select Combined Wind and Flood to Calculate Losses

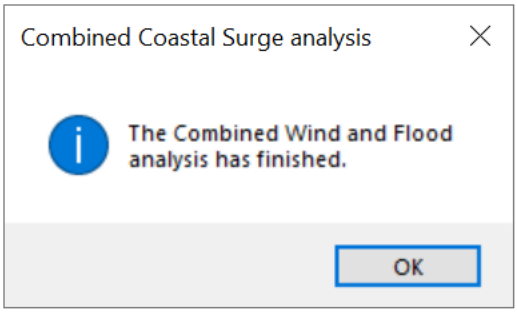


Figure 11-29 Combined Coastal Surge Status Window

When the analysis options have finished running, use the **Results Menu** (Figure 11-30) to **View Current Scenario Results By...**, select the scenario in the drop-down, and click **OK,** as shown in Figure 11-31.

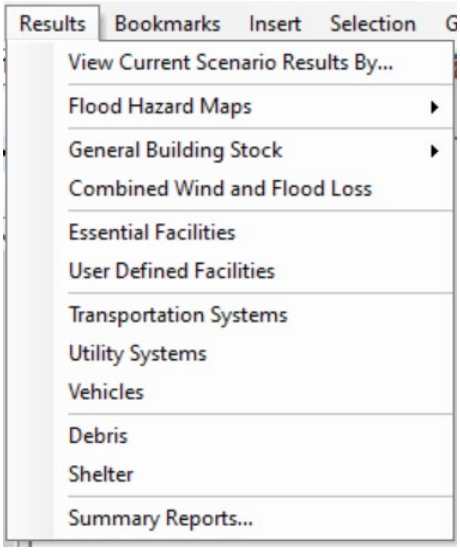


Figure 11-30 Select View Current Scenario Results

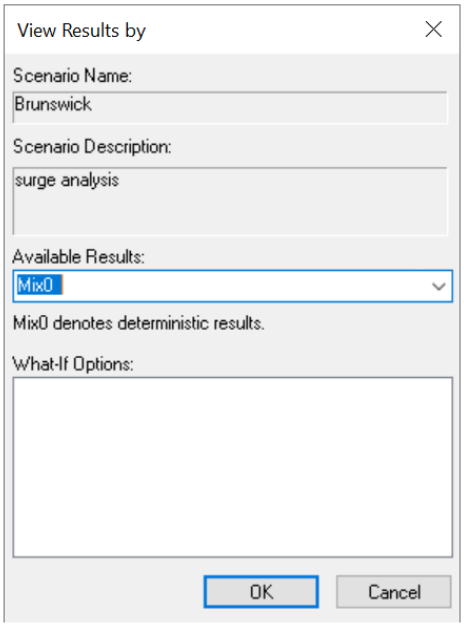


Figure 11-31 Select Available Results for Surge Analysis

The combined losses can be viewed either in the Flood Model or in the Hurricane Model using either the Results > Combined Wind and Surge Loss menu (Figure 11-32 and Figure 11-33) or the Results > Summary Reports > Direct Losses > Combined Wind and Surge Loss summary report. An example results table is shown in Figure 11-33.

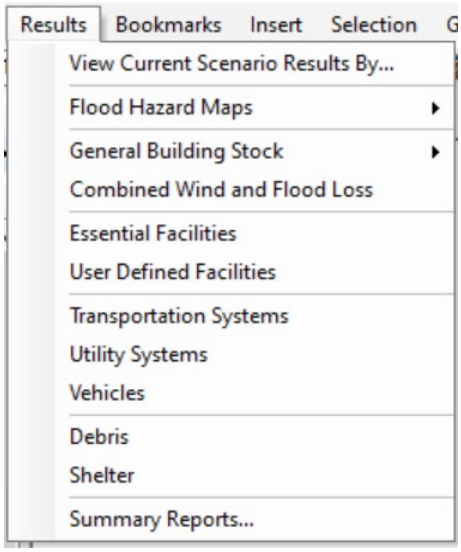


Figure 11-32 Select Combined Wind and Flood Loss Results

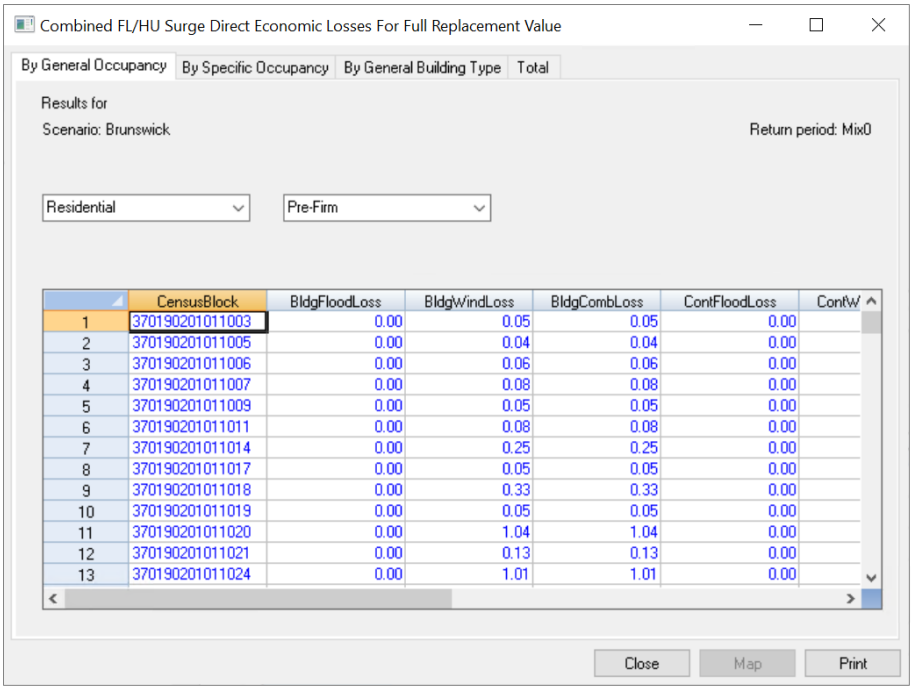


Figure 11-33 Example – Combined Surge Result Table

Note that combined wind and surge results are available for building, content, and inventory losses but not for relocation, income, rental, or wage losses. The radio buttons and drop-down boxes allow the user to filter the losses by occupancy or building type.

Hazus has a limit of one scenario for the Storm Surge flood hazard type. If the user already completed the storm surge model in a Study Region and decides to re-run the Hurricane Model, the user must delete the previous flood scenario and re-input the DEM in the User Data dialog in the Flood Model.

11.4 User-supplied Storm Surge Depth Grid Analysis

The user also has the option of importing their own coastal surge grid created outside of Hazus. To do this, from the **Analysis** menu in the Hurricane Model ensure **User Supplied Coastal Surge Grid** is set to "**YES**" (Figure 11-34), then run a hurricane wind analysis for the Study Region. Once the run hurricane analysis has completed, reopen the Study Region in the Flood Model.

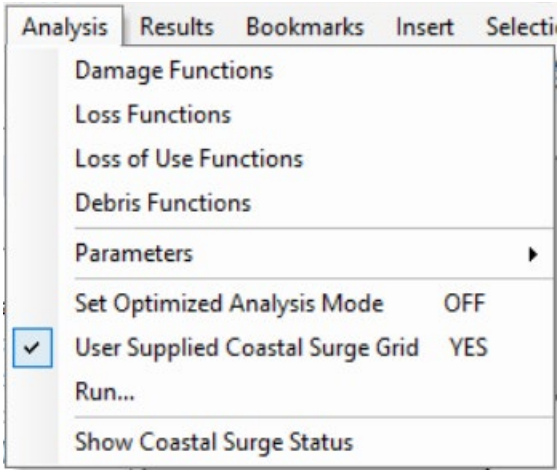


Figure 11-34 User Supplied Coastal Surge Grid Set to YES

With the Study Region Flood Model open go to **Hazard > Flood Hazard Type** and select **Storm surge** (Figure 11-35). Click **OK**.

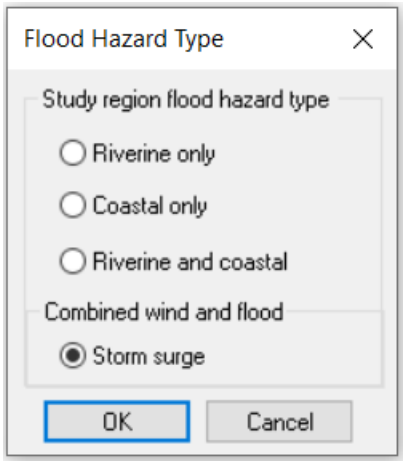


Figure 11-35 Flood Hazard Type Storm Surge

Next go to the **Hazard > User Data** menu and the **User Data > Storm Surge** dialog box will open as shown in Figure 11-36. Click **Browse** to navigate to your user-supplied storm surge grid and click **OK**.

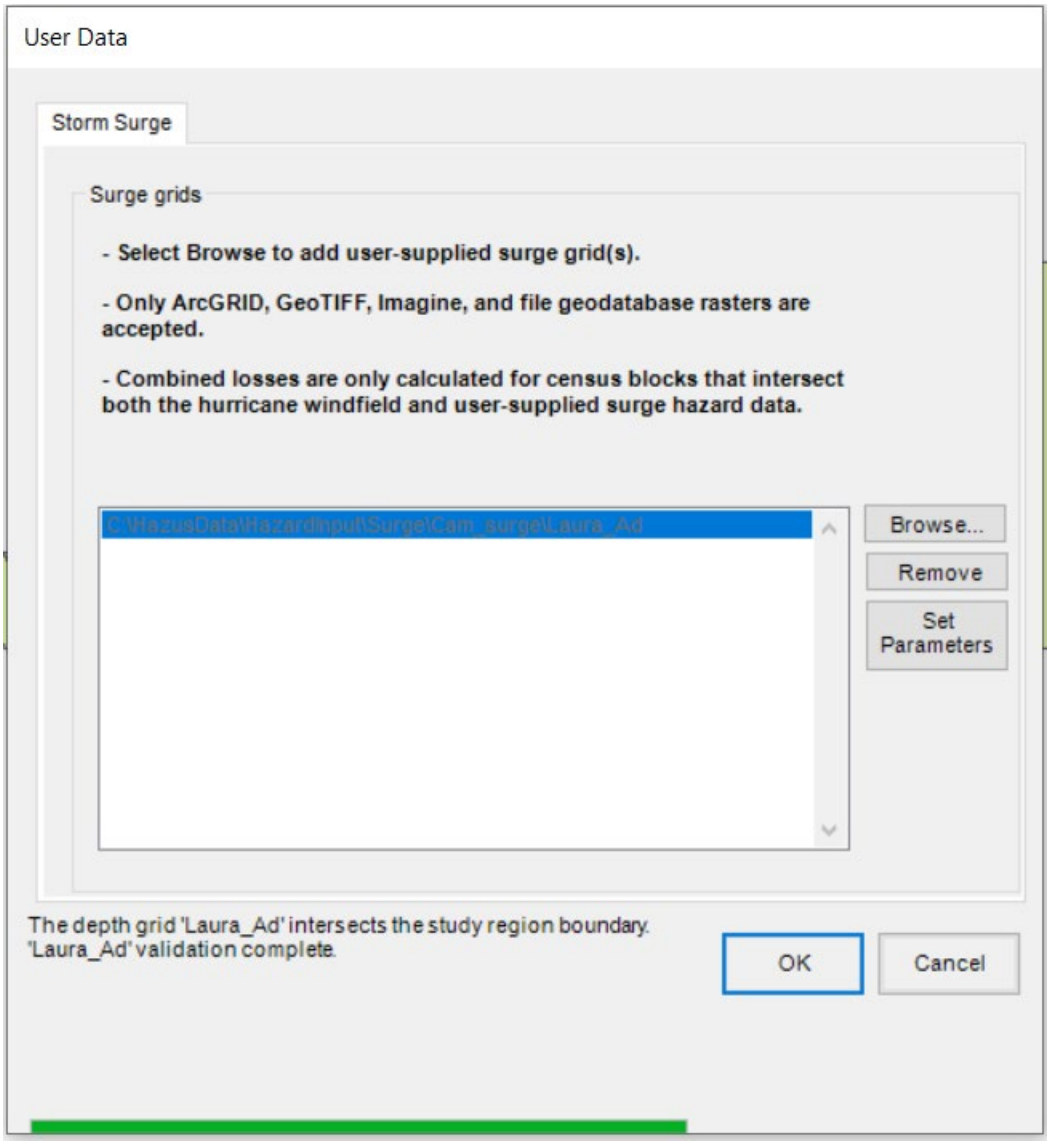


Figure 11-36 Storm Surge Data Import Dialog Box

Click **Yes** to Overwrite and Process your storm surge data (Figure 11-37). The storm surge data is now ready to be brought into a **New Scenario** and processed in the Coastal Flood Model.

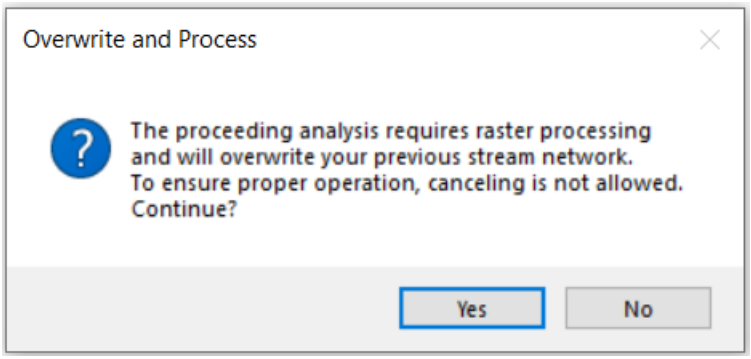


Figure 11-37 Overwrite and Process User-Supplied Storm Surge Data

Go to **Hazard > Scenario > New...** and name your **New Scenario**. The **New Scenario** window will open as shown in Figure 11-38. Click the **Plus** button and with the mouse drag a box around the coastal surge grid. Then click the **Save** button and click **OK**.

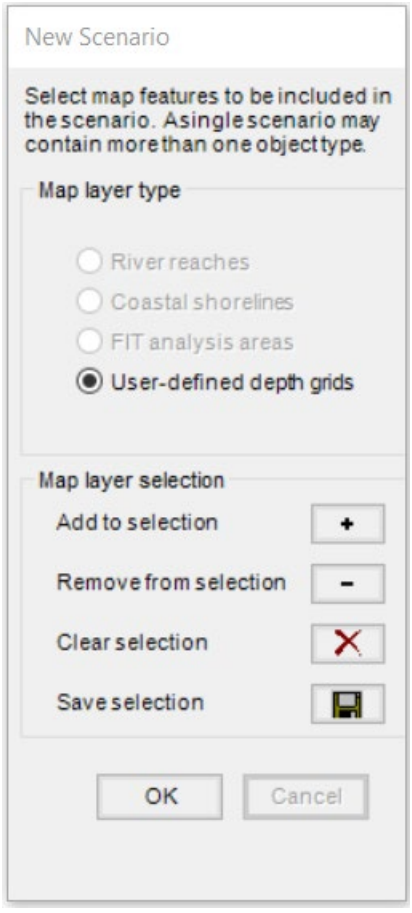


Figure 11-38 New Scenario Window

Next go to **Hazard > Coastal > Delineate Floodplain** (Figure 11-39). Click **OK** (Figure 11-40) and click **Yes** on the next screen (Figure 11-41). Processing will take a few minutes. Click **OK** on the Successfully Completed Coastal Flood Hazard dialog box (Figure 11-42).

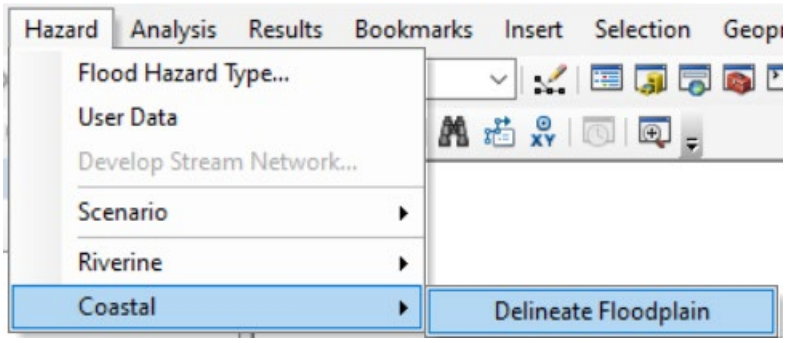


Figure 11-39 Delineate Floodplain

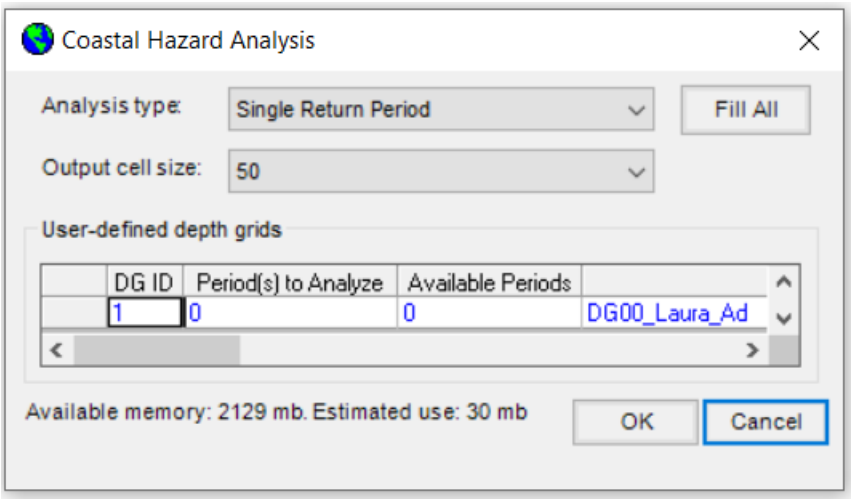


Figure 11-40 Coastal Hazard Analysis

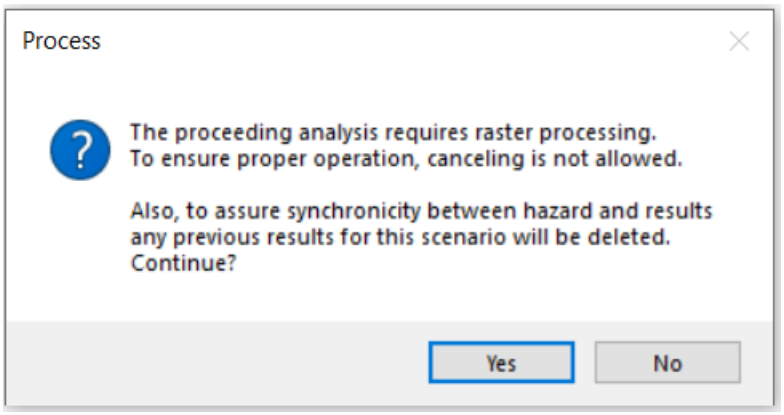


Figure 11-41 Process Coastal Hazard

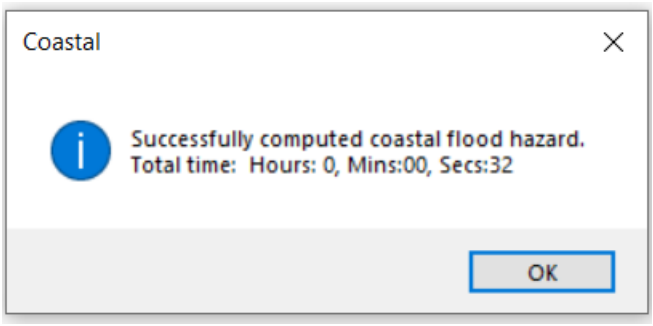


Figure 11-42 Successfully Completed Coastal Flood Hazard

Now the user can **Run > Analysis** to produce losses. It is critical to run the storm surge flood-only losses first, before running storm surge flood and hurricane combined losses.

Section 12. Advanced Hazus Analysis: Modifying Analysis Parameters

Users can modify Hazus default parameters used to calculate losses and associated results, such as shelter estimates. Many of the parameters can be accessed in the **Analysis** Menu.

After selecting **Analysis**, users can select **Parameters** to define tree coverage, terrain data, shelter information, and parameters related to building economics, as shown in Figure 12-1.

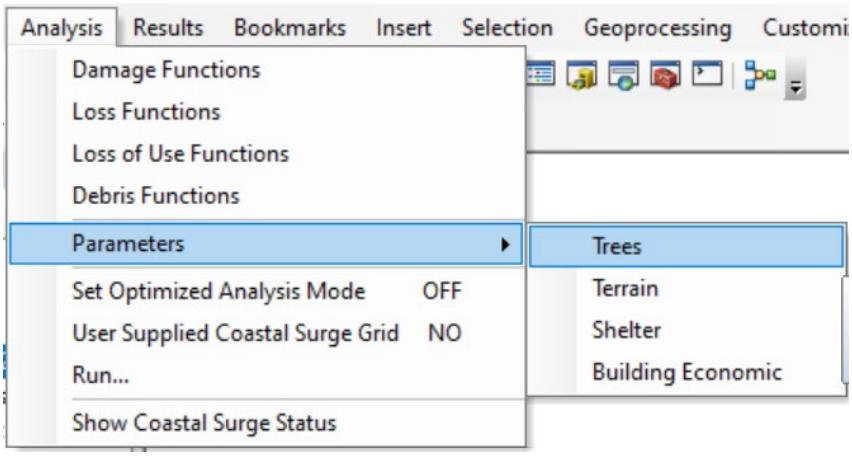


Figure 12-1 Analysis > Parameters Menu

12.1 Tree Coverage

Select **Trees** to view, map, and edit the type, density, and height distribution of trees, as shown in Figure 12-2. The available tree types are:

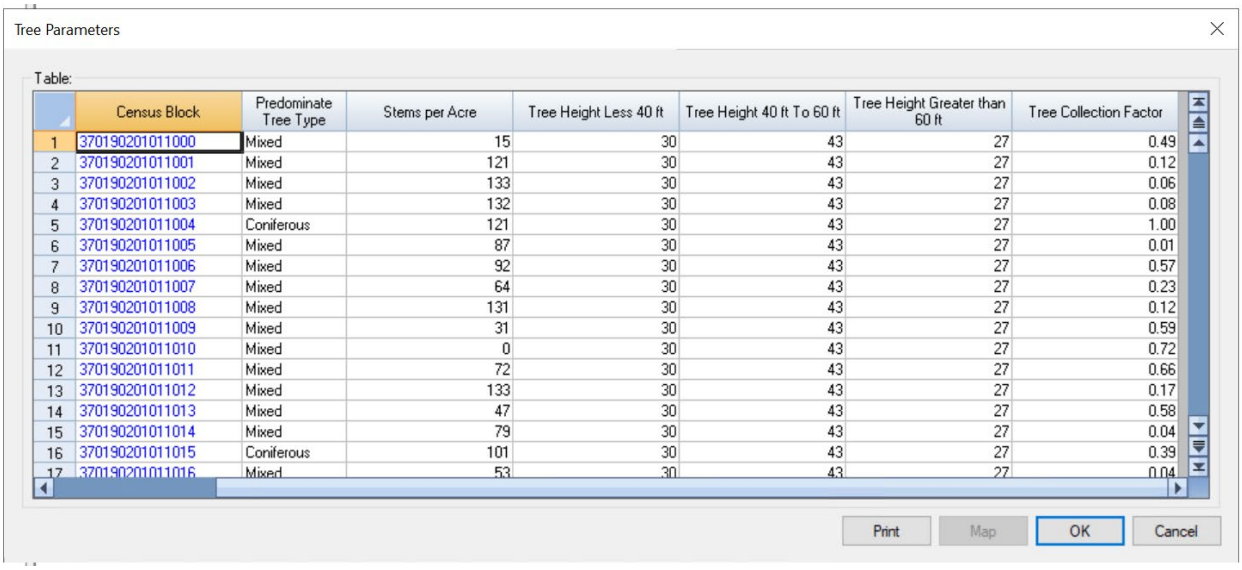
- Coniferous (>75% evergreens)
- Deciduous (>75% deciduous)
- Mixed

Using the entered information, the model calculates tree blowdown, called the Tree Collection Factor on the table, to estimate a tree debris collection factor for each Census tract. The tree blowdown model only considers trees over 30 feet tall. The estimated tree debris factor is added as a loss for single-family housing to account for tree damage.

The Tree Collection Factor is a number between zero and one that represents the fraction of downed trees that would likely be collected and disposed at public expense:

- In sparsely developed Census tracts, the tree collection factor should be near zero

- In heavily developed Census tracts, the tree collection factor will be closer to one



	Census Block	Predominate Tree Type	Stems per Acre	Tree Height Less 40 ft	Tree Height 40 ft To 60 ft	Tree Height Greater than 60 ft	Tree Collection Factor
1	370190201011000	Mixed	15	30	43	27	0.49
2	370190201011001	Mixed	121	30	43	27	0.12
3	370190201011002	Mixed	133	30	43	27	0.06
4	370190201011003	Mixed	132	30	43	27	0.08
5	370190201011004	Coniferous	121	30	43	27	1.00
6	370190201011005	Mixed	87	30	43	27	0.01
7	370190201011006	Mixed	92	30	43	27	0.57
8	370190201011007	Mixed	64	30	43	27	0.23
9	370190201011008	Mixed	131	30	43	27	0.12
10	370190201011009	Mixed	31	30	43	27	0.59
11	370190201011010	Mixed	0	30	43	27	0.72
12	370190201011011	Mixed	72	30	43	27	0.66
13	370190201011012	Mixed	133	30	43	27	0.17
14	370190201011013	Mixed	47	30	43	27	0.58
15	370190201011014	Mixed	79	30	43	27	0.04
16	370190201011015	Coniferous	101	30	43	27	0.39
17	370190201011016	Mixed	53	30	43	27	0.04

Figure 12-2 Select Tree Parameters

12.2 Terrain Data

Hazus has default terrain data that is automatically imported based on Census tract location. Select **Terrain** to view, map, and edit the surface roughness values for each Census tract, as shown in Figure 12-3. Before modifying the default terrain data or importing substitute terrain data, however, it is strongly recommended that users consult with a wind engineer.

Local terrain (i.e., surface roughness) has a significant effect on the magnitude of the actual surface level wind speeds applied to buildings. Surface roughness lengths depend on vegetation height and density, building heights and densities, and other obstructions upwind from the point of interest.

The default surface roughness lengths provided with the Hurricane Model are derived from state and national land-use databases and have been validated through extensive comparisons with aerial photography. However, land-use conditions change over time and locations with the same land-use category may, in fact, have substantially different surface roughness.

It is important to recognize that the surface roughness values in the Hurricane Model are averaged over each Census tract and are assumed to be independent of wind direction.

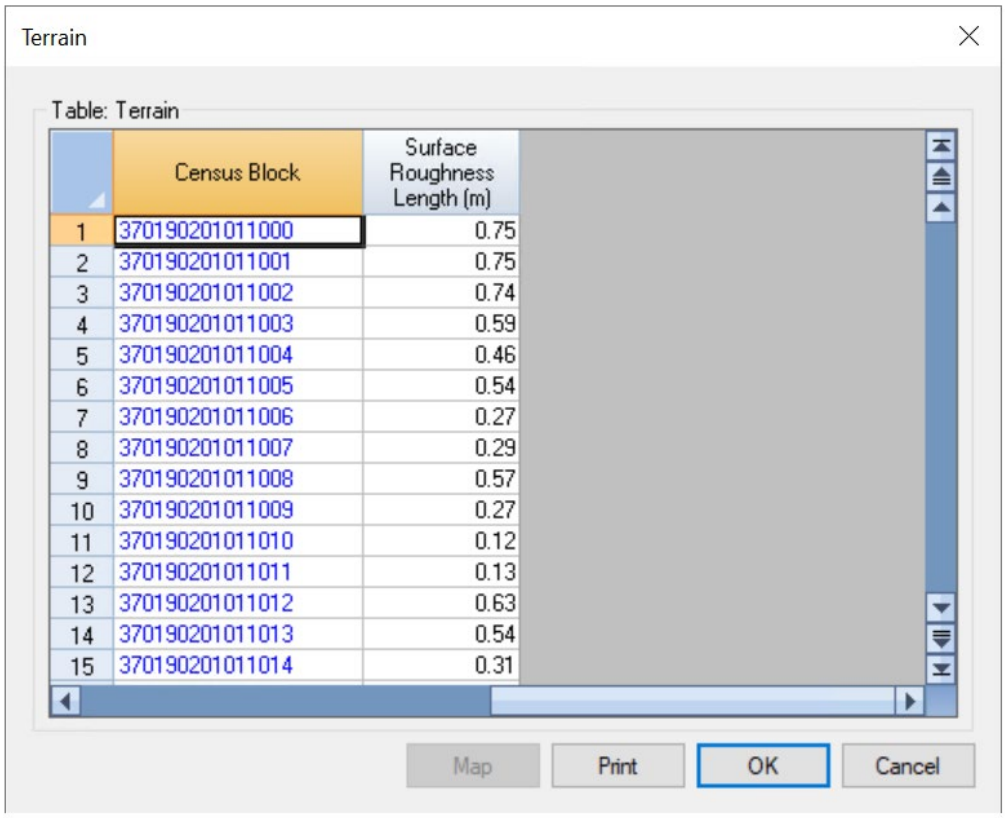


Figure 12-3 Select Terrain Parameters

12.3 Shelter Information

Emergency response organizations and local governments often need to have an estimate of the number of people seeking short-term public housing and long-term alternative housing. While the number of people seeking short-term public shelter is of great concern to emergency response organizations, the longer-term impacts on the housing stock are of great concern to local governments. The need for long-term alternative housing can occur in situations where repairs take longer than a few weeks. Long-term alternative housing needs can be met by importing mobile homes, building on vacant units, net emigration from the affected area, and eventually by the repair or reconstruction of new public and private housing.

Hazus provides two estimates related to sheltering:

- The number of people requiring short-term shelter
- The methodology for calculating short-term shelter requirements recognizes that only a portion of those displaced from their homes will seek short-term public shelter, and some will seek shelter even though their residence may have little, if any, damage.
- The total number of displaced households (due to loss of habitability)

- Loss of habitability is calculated directly from damage to the residential occupancy inventory and from loss of water and power.

From **Shelter Parameters**, users can select **Utility Factors**, **Weighting Factors**, and **Modification Factors**. The **Utility Factors** for the percentage of household affected by utility outages, the **Weighting Factors** for age, ethnicity, income, and ownership, and **Modification Factors** for income can be modified in the Shelter Parameters window (Figure 12-4).

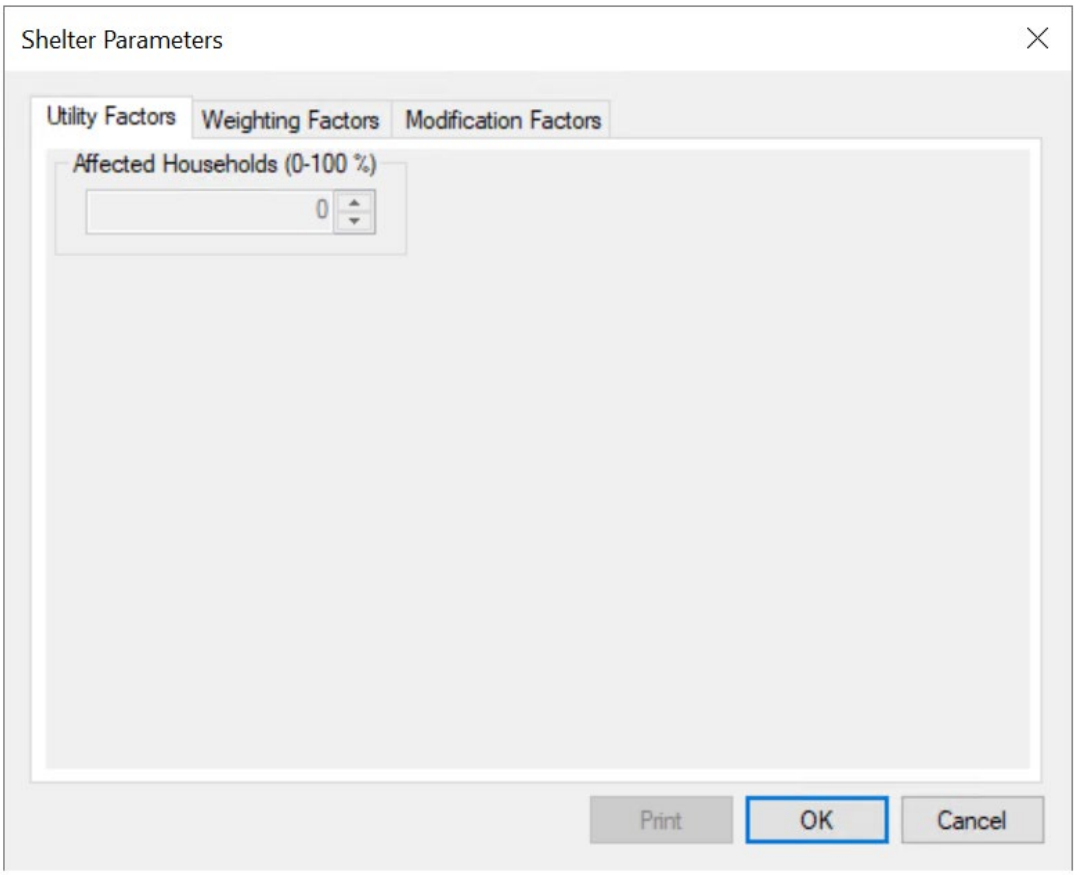


Figure 12-4 Select Shelter Parameters

The **Weighting Factors** and **Modification Factors** are automatically populated using information provided in the default Census database. The default Census database can be viewed, modified, and mapped in the inventory module (Figure 12-5), as shown in Figure 12-6.

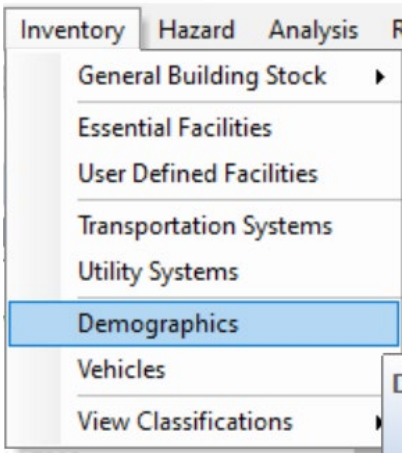
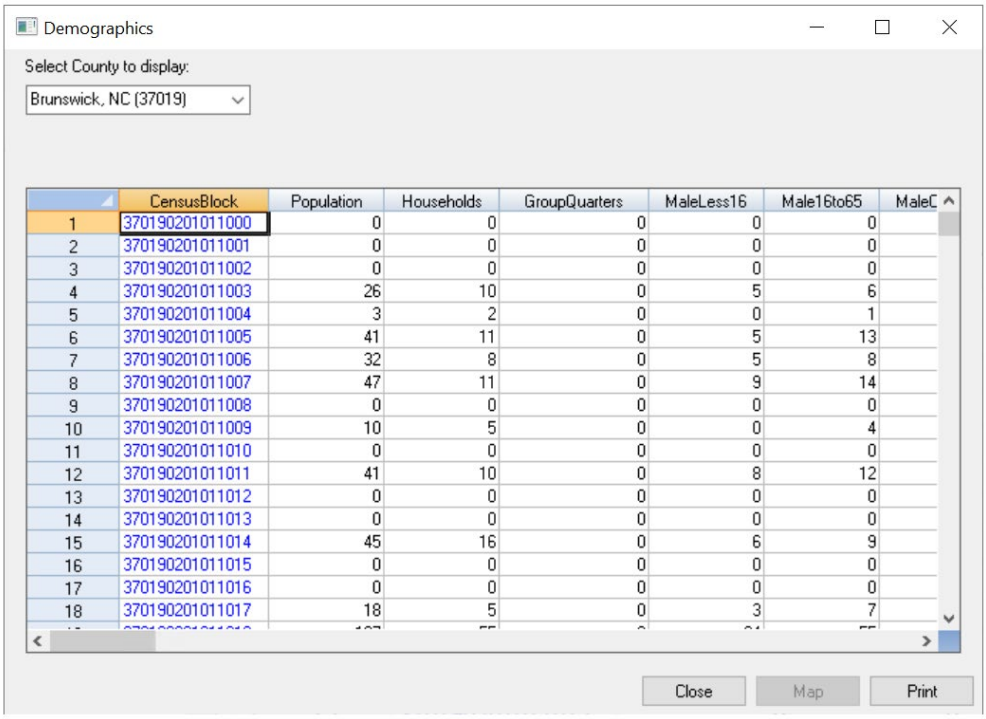


Figure 12-5 Inventory > Demographics Menu



	CensusBlock	Population	Households	GroupQuarters	MaleLess16	Male16to65	MaleO
1	370190201011000	0	0	0	0	0	
2	370190201011001	0	0	0	0	0	
3	370190201011002	0	0	0	0	0	
4	370190201011003	26	10	0	5	6	
5	370190201011004	3	2	0	0	1	
6	370190201011005	41	11	0	5	13	
7	370190201011006	32	8	0	5	8	
8	370190201011007	47	11	0	9	14	
9	370190201011008	0	0	0	0	0	
10	370190201011009	10	5	0	0	4	
11	370190201011010	0	0	0	0	0	
12	370190201011011	41	10	0	8	12	
13	370190201011012	0	0	0	0	0	
14	370190201011013	0	0	0	0	0	
15	370190201011014	45	16	0	6	9	
16	370190201011015	0	0	0	0	0	
17	370190201011016	0	0	0	0	0	
18	370190201011017	18	5	0	3	7	

Figure 12-6 Example – Inventory Demographics Data Supplied in Hazus

Modifying the **Weighting Factors** - Users have the option to weight the importance of the four factors that affect the fraction of households seeking short-term public shelter: income, ethnicity, ownership, and age. The importance factors must sum to one. Default values are shown in Table 12-1 and Figure 12-7.

Table 12-1 Hazus Default Values for Fraction of Households Likely to Seek Public Shelter If Dwelling Becomes Uninhabitable

Category	Description	Default
Income	Household Income < $10,000	0.62
	$10,000 < Household Income < $20,000	0.42
	$20,000 < Household Income < $30,000	0.29
	$30,000 < Household Income < $40,000	0.22
	$40,000 < Household Income	0.13
Ethnicity	White	0.24
	Black	0.48
	Hispanic	0.47
	Asian	0.26
	Native American	0.26
Ownership	Own Dwelling Unit	0.40
	Rent Dwelling Unit	0.40
Age	Population Under 16 Years Old	0.40
	Population Between 16 and 65 Years Old	0.40
	Population Over 65 Years Old	0.40

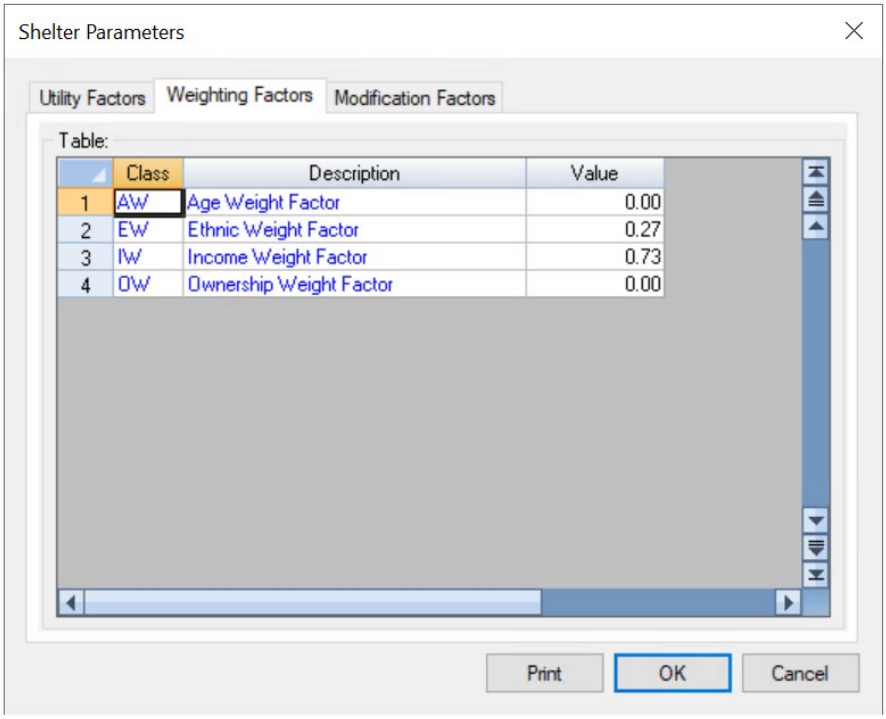


Figure 12-7 Hazus Default Weighting Factors for Fraction of Households Likely to Seek Public Shelter If Dwelling Becomes Uninhabitable

Modifying the **Modification Factors** - Users have the option of changing each of the four weighting factors that govern how the demographic distribution for the Study Region is used to calculate that factor. For example, Figure 12-8 shows the default weights for ranges of incomes; the income weights can be adjusted from 0 to 1.0 to represent the likelihood that income level will influence the decision to seek shelter.

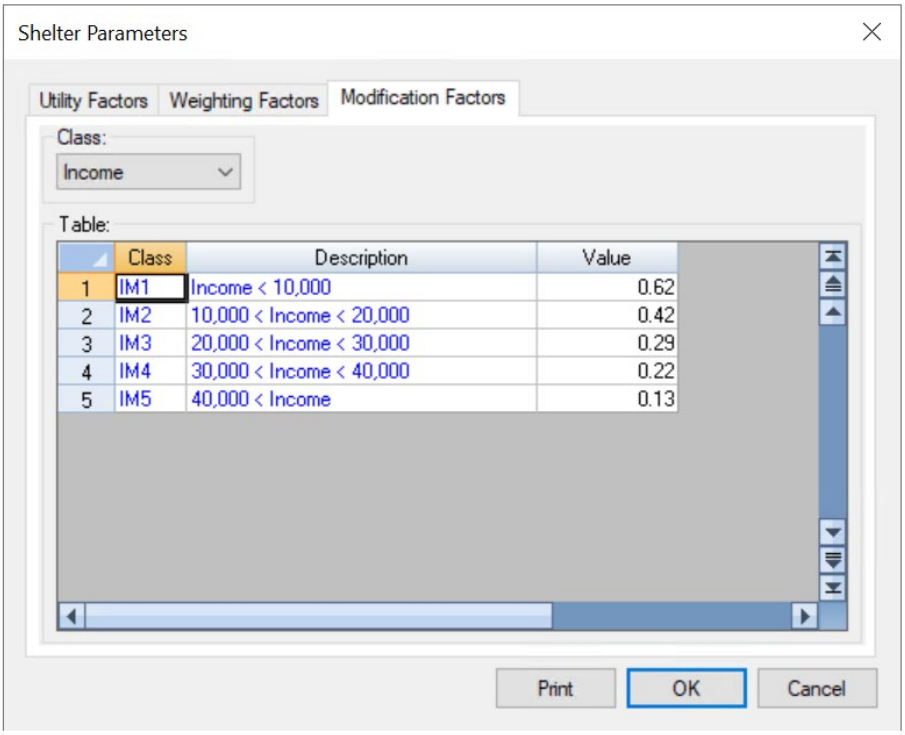


Figure 12-8 Default Weighting Factors for Demographic Distribution > Income

12.4 Building Economics

In addition to parameters that can be modified in the **Analysis** Menu, there are also Hazus parameters that can be adjusted in the **Inventory** Menu related to the cost of hurricane damages. The model converts estimates of damage to the built environment to dollar loss.

Losses that are directly derived from building damage are:

- Cost of repair and replacement of damaged and destroyed buildings
- Costs of damage to building contents
- Losses of building inventory (contents related to business activities)

Losses that are related to the length of time the facility is non-operational (or the immediate economic consequences of damage):

- Relocation expenses (for businesses and institutions)
- Capital-related income losses (a measure of the loss of productivity, services or sales)
- Wage losses (consistent with income loss)
- Rental income losses (to building owners)

The default economic data can be viewed and modified from within the **Inventory** menu (Figure 12-9). Select **Dollar Exposure** (Replacement Value) to view **Building**, **Contents**, and **Total**, shown in Figure 12-10. To modify the data, the Table Type must be set to "Specific Occupancy." The Dollar Exposure data cannot be modified when viewed by general occupancy, general building type, or specific building type. Default values are provided for contents (by occupancy) as a percentage of the replacement value of the facility.

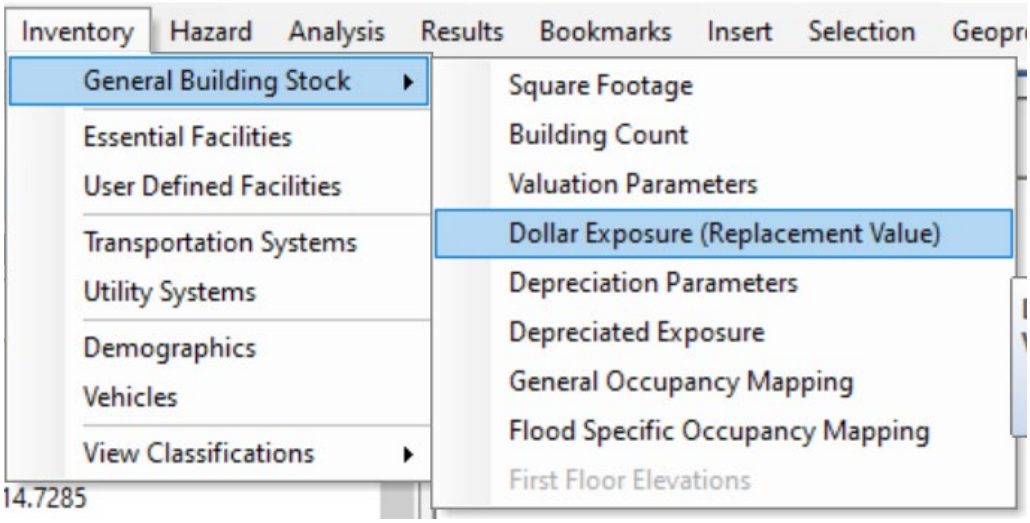
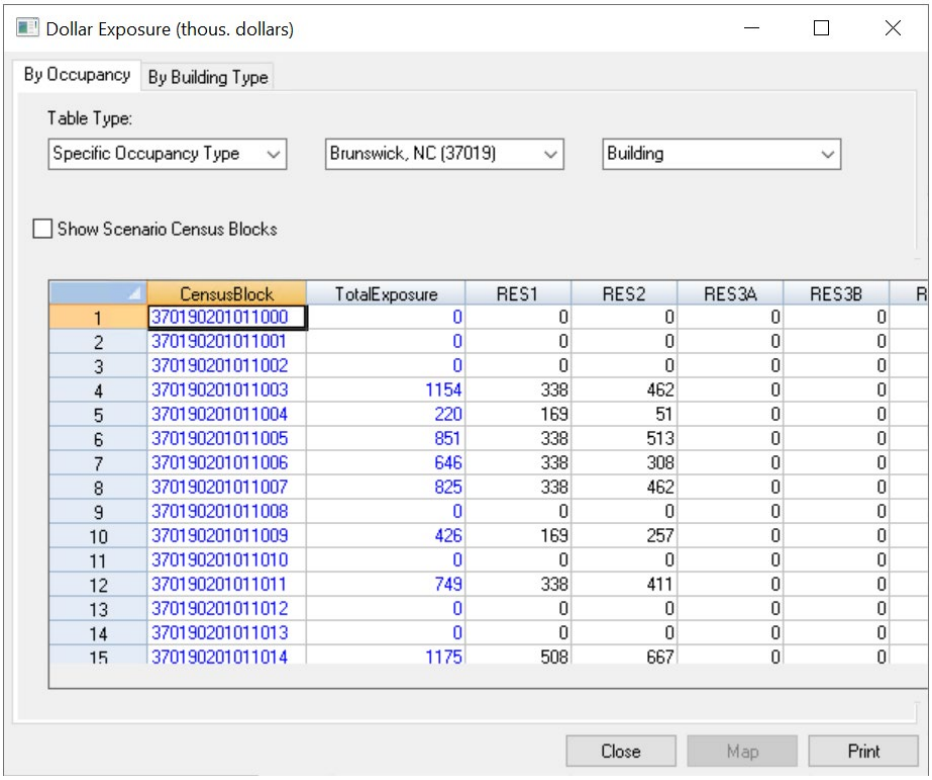


Figure 12-9 Select Dollar Exposure



	CensusBlock	TotalExposure	RES1	RES2	RES3A	RES3B	R
1	370190201011000	0	0	0	0	0	
2	370190201011001	0	0	0	0	0	
3	370190201011002	0	0	0	0	0	
4	370190201011003	1154	338	462	0	0	
5	370190201011004	220	169	51	0	0	
6	370190201011005	851	338	513	0	0	
7	370190201011006	646	338	308	0	0	
8	370190201011007	825	338	462	0	0	
9	370190201011008	0	0	0	0	0	
10	370190201011009	426	169	257	0	0	
11	370190201011010	0	0	0	0	0	
12	370190201011011	749	338	411	0	0	
13	370190201011012	0	0	0	0	0	
14	370190201011013	0	0	0	0	0	
15	370190201011014	1175	508	667	0	0	

Figure 12-10 View and Modify Hazus Default Economic Data

The Building Economic data can be viewed and modified from within Hazus Inventory Menu, as shown in Figure 12-11. The window that is used to view and modify the other economic default data parameters is shown in Figure 12-12.

The default values of business inventory for this model are derived from annual gross sales by assuming that business inventory is some percentage of annual gross sales. These default values are based on judgment.

Building repair and clean-up estimates are provided with Hazus. These values include both the time to do the actual construction or repair and the additional delays which may include clean-up time, and time to obtain financing, permits and complete a design. All these factors are built into the Building Loss of Use functions described previously.

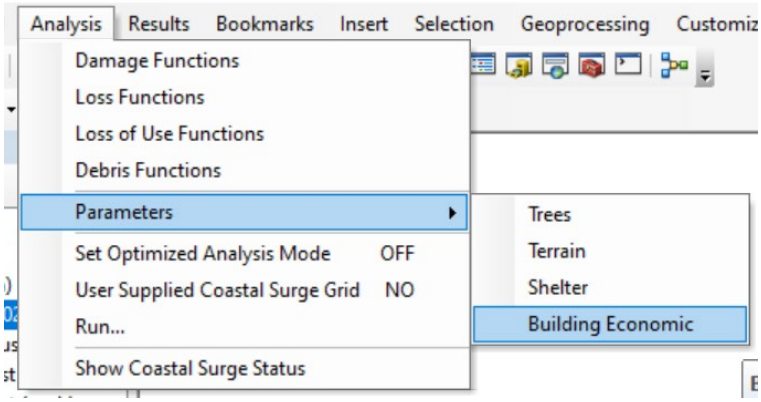


Figure 12-11 Building Economic Menu

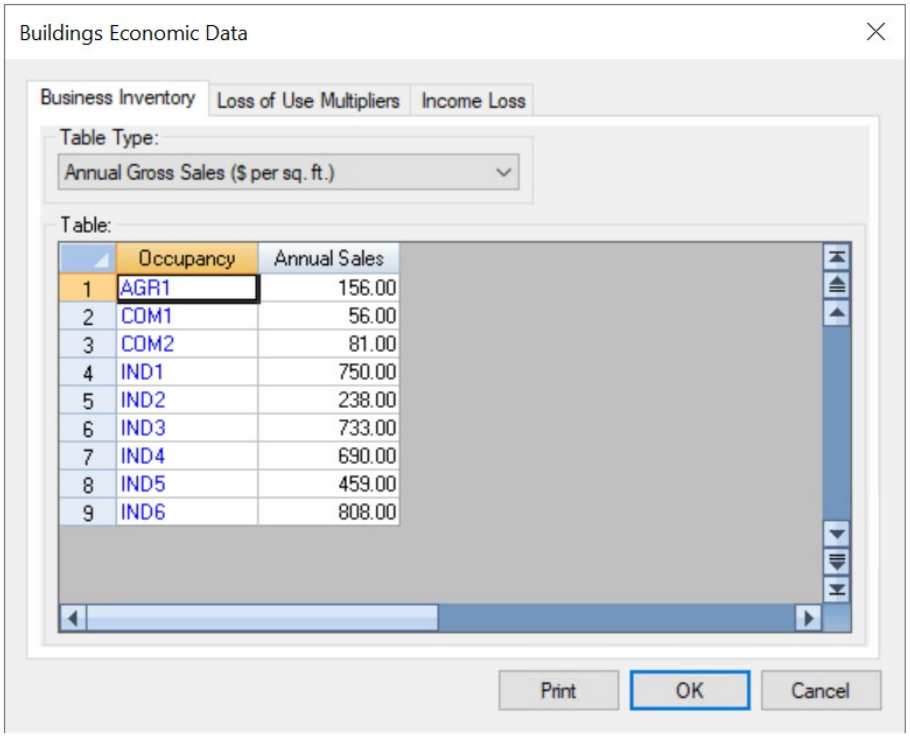


Figure 12-12 View and Modify Economic Data for Estimating Business Inventory Losses, Lost Income and Relocation Costs

12.4.1 Loss of Use Multipliers

Repair time does not translate directly into business or service interruption. For some businesses, building repair time is largely irrelevant, because these businesses can rent alternative space or use spare industrial/commercial capacity elsewhere. Therefore, Building Repair Time Multipliers have been developed to arrive at estimates of business interruption for economic purposes. These values are multiplied by the building cleanup and repair times. Building Repair Time Multipliers can be viewed using the window shown in Figure 12-13.

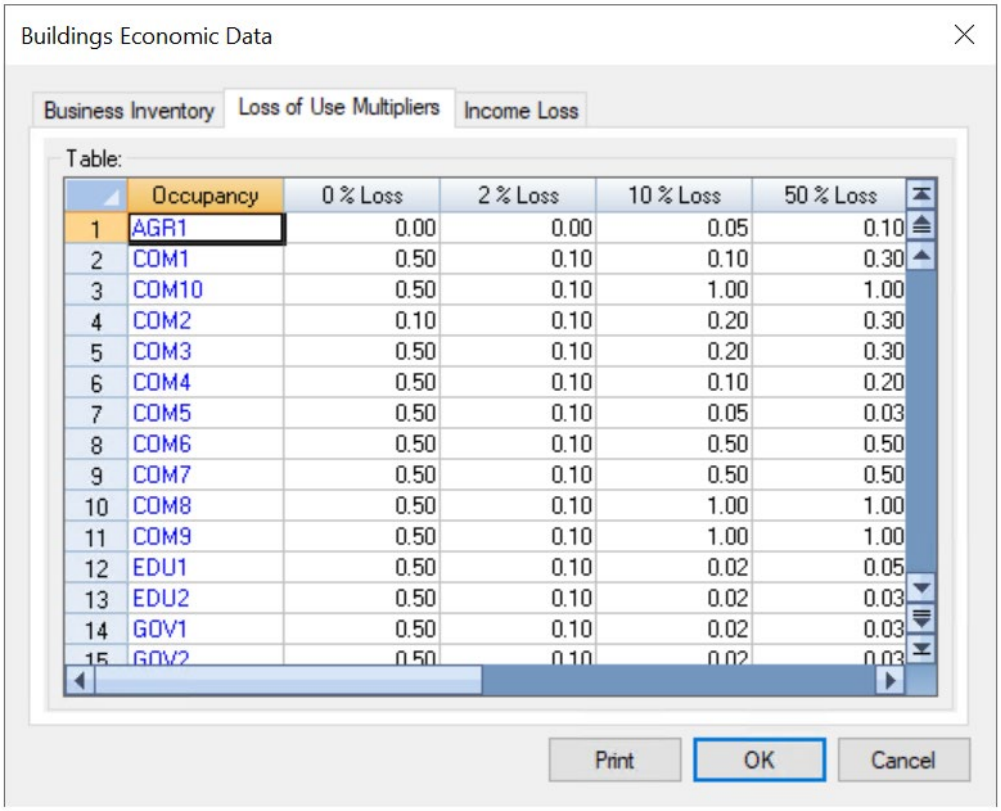


Figure 12-13 View Default Building Repair Time Multipliers

12.4.2 Income Loss

Figure 12-14 shows the last tab where Income Loss is calculated. This includes Rental and Disruption Costs, Percentage Owner Occupied, Wages and Capital Related Income and Recapture Factors.

Hazus only considers disruption costs that may include the cost of shifting and transferring and the rental of temporary space. Relocation expenses are assumed to be incurred only by building owners and measured in $ per square foot per month. Relocation expenses are then a function of the floor area, rental costs per day per square foot, disruption costs, and the expected days of loss of function for each damage state.

Capital-related income is a measure of the profitability of a commercial enterprise. Income losses occur when building damage disrupts commercial activity. Income losses are the product of floor area, income realized per square foot and the expected days of loss of function for each damage state. The U.S. Department of Commerce's Bureau of Economic Analysis reports regional estimates of capital-related income by economic sector. Capital-related income per square foot of floor space can then be derived by dividing income by the floor space occupied by a specific sector. Income will vary considerably depending on regional economic conditions. Therefore, default values need to be adjusted for local conditions.

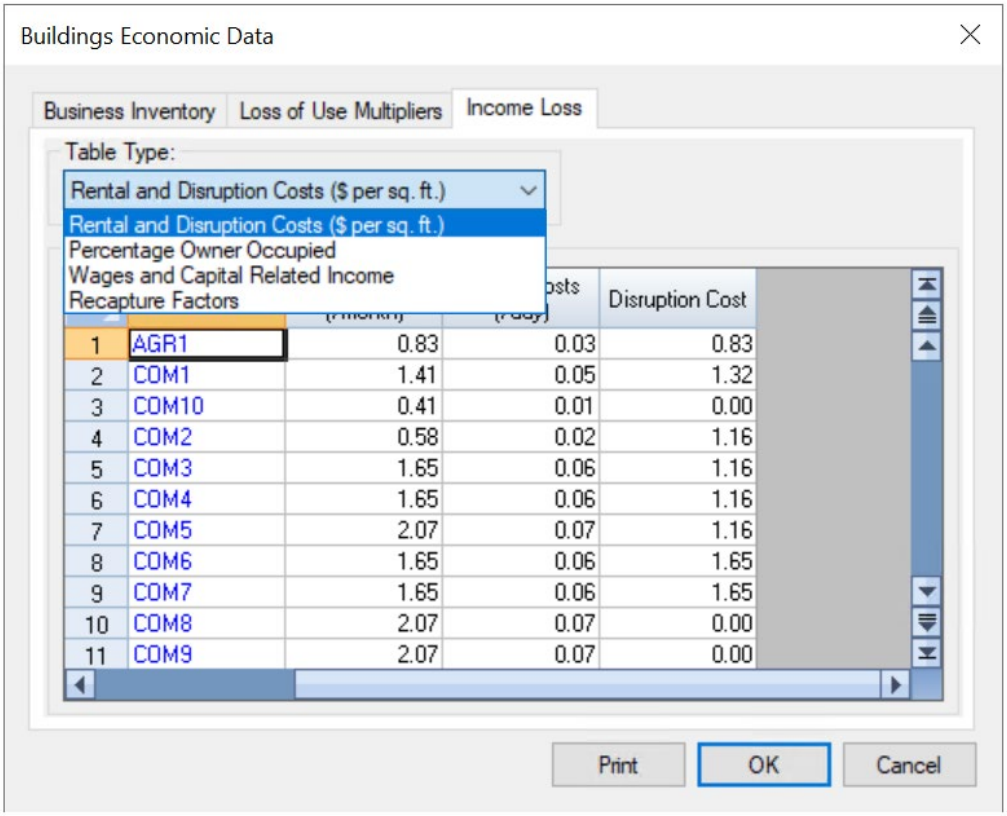


Figure 12-14 Income Loss Table