Hazus User Guide

Hazus 7.0

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U.S. DEPARTMENT OF HOMELAND SECURITY

FEMA

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
AAL	Average Annualized Losses
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GUI	Graphical User Interface
HURREVAC	Hurricane Evacuation
NHP	National Hurricane Program
SLTT	State, Local, Tribal and Territorial government
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Section 1. Introduction to Hazus 7.0

Welcome to the Hazus 7.0 User Guide. This guide is the primary resource for how to use the Hazus software – from opening the application through running an analysis and interpreting results – comprised of screenshots and explanations of the buttons and processes within Hazus. It is designed to help users navigate Hazus, and does not provide the technical and scientific methods underpinning Hazus, software changes due to updates from the previous versions of Hazus, guidance on advanced modeling procedures, or Hazus use cases; that information is found in other documents located on the Hazus website and we highly encourage users to view those documents as part of their Hazus familiarization. By following this User Guide, any user is able to define the study area of interest, set the parameters for the analysis, run the analysis for the desired hazard event, and view results.

FEMA has released Hazus 7.0, the first release in ArcGIS Pro, marking a major milestone for the natural hazard risk assessment software. Hazus 7.0 is the first of several updates to bring users the key features of Hazus with the enhanced capabilities of ArcGIS Pro. The transition from ArcMap to ArcGIS Pro improves user experience by simplifying workflows and making analyses more efficient. Users will be able to move through the modeling steps conveniently and efficiently with ArcGIS Pro's streamlined interface, intuitive ribbons, and helpful tooltips. Hazus 7.0 features functionality for modeling hurricane wind using HURREVAC and modeling flood impacts from a single event or an Average Annualized Loss (AAL) analysis. Earthquake and tsunami modeling are not yet available in Hazus 7.0, but users can continue to use Hazus 6.1 for these capabilities until these models are transitioned into the ArcGIS Pro version. Users can also find pre-run results in the Hazus Loss Library (HLL). For a comprehensive overview of new features, functionality and enhancements please refer to the Hazus 7.0 Release Notes (November 2024).

1.1 Background

Hazus is a decision support tool designed to help state, local, tribal, and territorial (SLTT) officials, as well as other stakeholders, estimate potential losses from natural hazards. This capability allows users to forecast the impact of hazard events and develop strategies to mitigate risks in their communities. Using Geographic Information Systems (GIS), Hazus enables users with different levels of technical expertise to examine and analyze diverse geographic areas.

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

- Anticipating the possible nature and scope of the emergency response needed to cope with an event.
- Developing plans for recovery and reconstruction following an event.
- Mitigating the possible consequences of the current Hazus-supported hazards, flood and hurricane wind.

The use of this standardized methodology provides nationally comparable estimates that allow the federal government to plan response and guide the allocation of resources to stimulate risk mitigation efforts. Currently, Hazus 7.0 focuses on Flood and hurricane hazard scenarios in this initial release. Future updates will expand the range of hazards and enhancing functionalities.

1.2 Tips for Conducting a Risk Assessment

Hazus allows its users to conduct a natural hazard risk assessment that is predicated on three specific elements – inventory information, hazard data, and damage functions – in order to model potential impacts of natural hazard events (Figure 1-1).

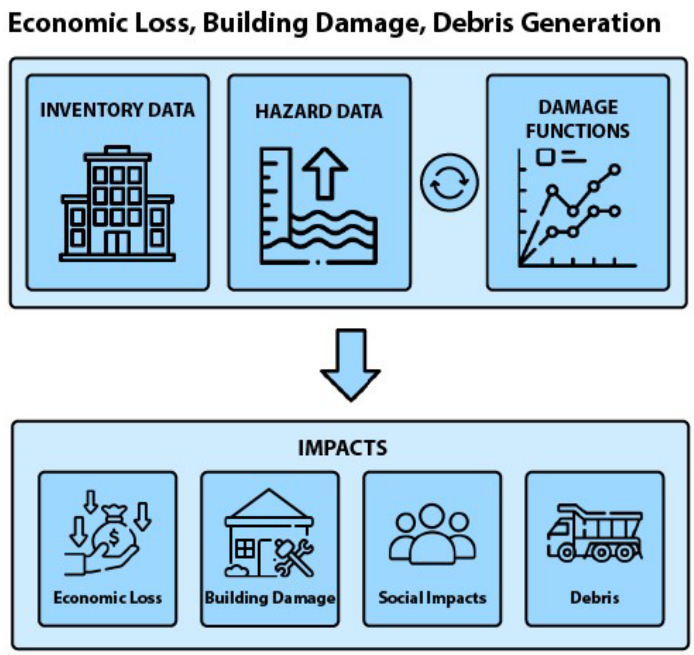


Figure 1-1: Conducting a Risk Assessment

Inventory data are data on structures, buildings, and facilities in a location that Hazus will use to represent that area's exposure, or potential loss. This is intersected with the hazard data, which define the extent, severity, or nature of the hazard being modeled. This intersection results in a calculation of the affected structures within the Study Area. Hazus then references a library of hazard-specific damage functions to calculate the potential impacts. These potential impacts are subdivided into four categories:

- Economic loss – the building losses, content losses, and inventory losses sustained by inventory within the Study Area.
- Building damage – the percent damage to structures within the Study Area.

- Social impacts – the displaced households, shelter needs, and loss of use by transportation and utility facilities.
- Debris – the resulting debris generated by fallen structures, trees, or other sources within the Study Area.

Hazus is able to conduct a natural hazard risk analysis that provides all of these impacts using its baseline data. However, as these data are from nationwide or generic datasets, the resulting potential impacts can be considered “basic” because they may not accurately reflect the real inventory, geographical, or other Study Area characteristics. To create a more “advanced” assessment, users are encouraged to import more detailed inventory and hazard data.

1.3 Hazus Uses and Applications

Hazus is a standardized risk modeling tool that can be used to estimate potential damages, economic losses, and social impacts from flood, and hurricane hazards. These estimates can be used by a variety of individuals for a variety of purposes, such as disaster management and risk assessment. An SLTT government official may be interested in the costs and benefits of specific mitigation strategies and 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 specific hazards. Emergency response teams may use the results of 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 operation centers, and police stations. Emergency planners may want estimates of temporary shelter requirements for different hazard scenario type. Federal and state government officials may conduct a loss analysis to obtain quick estimates of impacts immediately following a hazard event to best direct resources to the disaster area. Insurance companies may be interested in the estimated monetary losses so they can determine asset vulnerability.

Hazus 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 are able to determine how to use it to best suit their needs, and how to appropriately interpret the analysis results.

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

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

- Development of preparedness (contingency) planning measures for hazard preparedness and education seminars.
- Anticipation of the nature and scope of response and recovery efforts including the identification of alternative housing and the location, availability, and scope of required medical or response services, and the establishment of a priority ranking for restoration of essential facilities.

Examples of post-event applications of the outputs are:

- 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, rapid identification and treatment of casualties, 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.

1.4 Terminology Changes

Please note that some terms and concepts have been updated as part of the development process and user interface enhancement for Hazus 7.0. There may be new terminology or changes in the definitions often compared to Hazus 6.1 and earlier versions. These updates aim to make our terminology clearer and more representative of what the term defines.

Terminology changes are present throughout the GUI (Graphical User Interface) and the accompanying Hazus 7.0 documentation – while most changes are straightforward and intuitive, we would like to highlight one significant update in terminology change: The General Building Stock, commonly known as the GBS, will now be referred to as the Aggregated Baseline Inventory. This change does not affect what the term represents.

1.5 Assumed User Expertise

Hazus users can be divided into two groups: those who *perform the analysis* and those who *use the analysis results*; for some cases, these two groups will consist of the same people. The more interaction that occurs between these two groups, the better the analysis will be, and 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. Depending on the hazard and nature of analysis, a team could consist of the following:

- Emergency planners
- Policy makers
- GIS specialists
- Floodplain managers
- Meteorologists/Wind engineers
- Structural engineers
- Geologists/Geotechnical engineers
- Architects
- Economists
- Social scientists

The individuals needed to perform the analysis can all provide valuable insight into the risk assessment process and will depend on the desired detail of analysis results. In addition to subject matter involvement, at least one GIS specialist should participate on the team.

If an 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.

1.6 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, 2024).

If the loss estimation team does not include individuals with expertise in the areas described in Section 1.5, 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 subject matter expert may be needed to provide deterministic or probabilistic scenario data or review the software 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.

1.7 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 constructed over a range of years under diverse 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 may not be sufficient data from past hazard events or laboratory experiments to determine precise estimates of damage based on known hazard impacts, even for specific buildings and other structures. To deal with this complexity and lack of data, buildings and components of systems are grouped into categories based on key characteristics. The relationships between key features of hazard impacts and the average degree of damage with associated losses for each building category are based on current data and available theories.

The results of an 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 quality of inventory data and the hazard parameters. This is particularly true in areas where hazard events are infrequent or where recorded data are scarce.

1.8 Technical Support

Technical Support contact information is provided in the Hazus application at **Learning Resources**; technical assistance is available via the Hazus Help Desk by email at FEMA-Hazus-support@fema.dhs.gov, or the FEMA Hazus website also provides information on the software and training resources.

The application's **Learning Resources** also references the help files for ArcGIS Pro. Because Hazus was built as an extension to ArcGIS Pro functionality, knowing how to use the ArcGIS Pro Learning Resources will help Hazus users.

Section 2. Hazard Methodology Overview

This section provides a brief overview of the Hazus hazard methodologies that are used to estimate impacts of real or scenario based hazard events for an area of interest. For a deeper explanation of the methodology, please refer to the appropriate Technical Manual, as these contain comprehensive overviews of the scientific, mathematical, and relational foundations for Hazus loss estimations. There are two hazards currently represented in the Hazus application:

- Flood Model: Estimates potential physical damage and economic loss from coastal and riverine flooding.
- Hurricane Wind Model: Analyzes wind speeds, storm surges, and potential impacts from hurricanes.

The resulting "loss estimate" of these models will generally describe the scale and extent of damage and disruption that may result from the modeled hazard event. The following information can be obtained:

- *Quantitative estimates of losses* in terms of direct costs for repair and replacement of damaged buildings both structural and system components, direct costs associated with loss of function (e.g., loss of business revenue, relocation costs), casualties, people displaced from residences, quantity of debris, and regional economic impacts. Not all types of losses are estimated for all hazard models.
- *Functionality losses* in terms of loss-of-function and restoration times for critical facilities such as hospitals and components of transportation and utility systems, and simplified analyses of loss-of-system function for electrical distribution and potable water systems.
- *Extent of induced hazards* in terms of exposed population and building value due to potential flooding and fire following earthquake scenario.
- *Estimates of social and infrastructure impacts* in terms of economic effects on the community.

To generate this information, the methodology includes:

- Classification systems used in assembling inventory and compiling information on the buildings comprising the area, components of transportation and utility systems, and demographic and economic data.
- Standard calculations for estimating type and extent of damage and for summarizing losses.
- National and regional databases containing information for use as baseline (built-in) data in the absence of user-supplied data, and useable in the calculation of losses.

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.

2.1 Basic and Advanced Hazus Analyses

Hazus risk analyses are categorized as Basic or Advanced, depending on the level of effort and expertise required by the user. Advanced Hazus analyses incorporate more detailed local data about a community's population and assets to generate more accurate and applicable loss estimates.

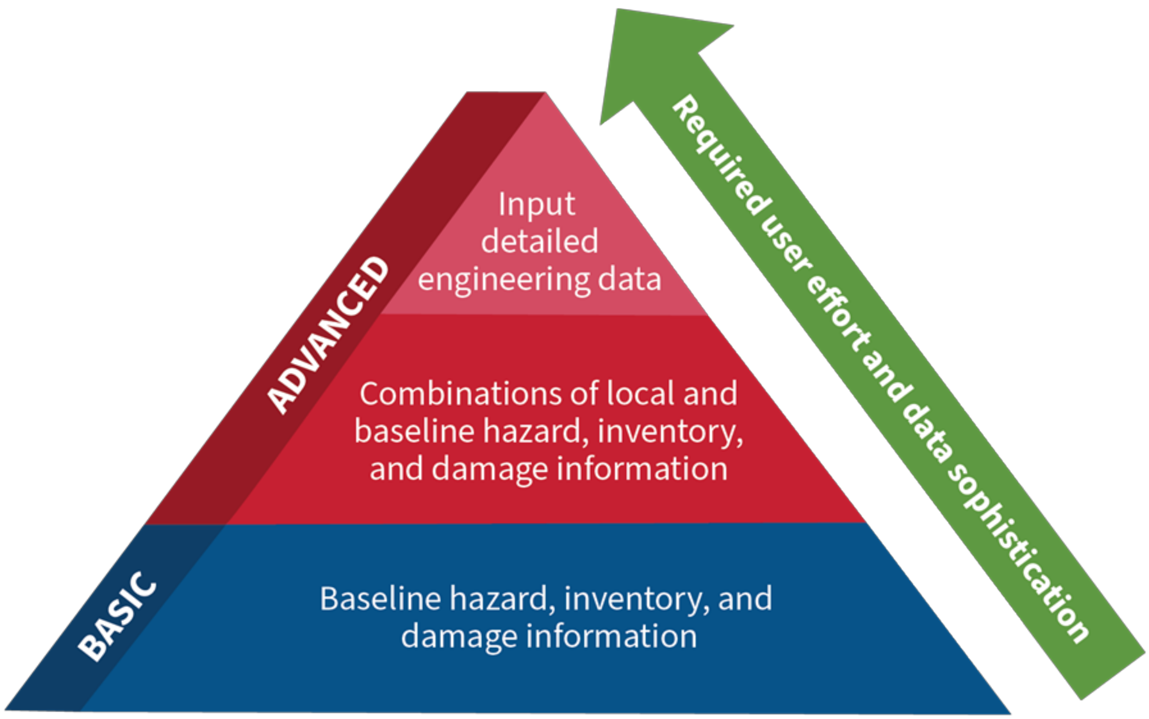


Figure 2-1: Levels of Hazus Analysis

2.1.1 Basic: Analysis with Baseline Information

A Basic Hazus analysis produces initial estimates of flood or hurricane wind losses based on the generalized national databases and best available information included in Hazus software: building square footage and value, population characteristics, costs of building repair, and certain basic economic data. In a basic analysis, environmental data like tree inventory, surface roughness, or average soil conditions are similarly generalized, sometimes assuming a single value throughout the entire Study Area. Direct economic and social losses associated with essential facilities and transportation and utility systems are computed in a Basic analysis; however, there is a significant level of uncertainty pertaining to the estimates.

Other than defining the Study Area, selecting the scenario, and making decisions concerning the extent and format of the output, an analysis based on baseline data requires minimal effort from the user. This level of analysis is suitable primarily for preliminary evaluations and identifying potential mitigation actions within a community, which could be useful if evaluating funding priority for projects.

2.1.2 Advanced: Analysis with User Supplied Data

An Advanced Hazus analysis produces more accurate loss estimates by including information on local hazard conditions and replacing generalized national data with more accurate local inventories of buildings, essential facilities, and infrastructure. Improved results are highly dependent on the quality and quantity of these data, which are collectively referred to as “User Supplied Data” in the Hazus community. The significance of the improved results also relies on the user’s analysis priorities. The following are examples of User Supplied Data that will impact the accuracy of Advanced analysis results:

- Development of maps of terrain-related conditions, such as soil conditions affecting ground shaking (liquefaction and landslide potential), surface roughness, or tree inventory. These maps, if available, are used for evaluating the effects of these local conditions on damage and losses.
- Use of locally available data or estimates of the square footage of buildings in different occupancy classes.
- Use of local expertise to modify the mapping scheme databases that determine the percentages of specific building types associated with different occupancy classes.
- Use of locally available data concerning construction costs or other economic parameters.
- Preparation of a detailed inventory of all essential facilities and infrastructure.

Section 3. Using Tooltips

Hazus 7.0 includes in-application support through Tooltips. These tooltips provide guidance within the application and specific to the process, dialog box, or decision that the user is interacting with. This section provides an overview of the resources – how it will appear, what information it provides, and how users can best use these resources while completing their analyses.

3.1 Tooltips in Hazus 7.0

In Hazus 7.0, tooltips offer interactive help and information as users navigate through the software. These tooltips provide short descriptions to explain Hazus features or guide data input requirements. Tooltips have been customized for each item that they reference and are intended to provide quick, actionable context to the user in instances where there are multiple options available for the user to select between, uncertainty in what a selected process will accomplish, or clarification on what data inputs are being requested at that time.

To view a tooltip, simply hover the mouse cursor over buttons, icons, or the "i" symbol next to the empty input fields. After a short delay, a pop-up will appear with a brief description or instructions (Figure 3-1).

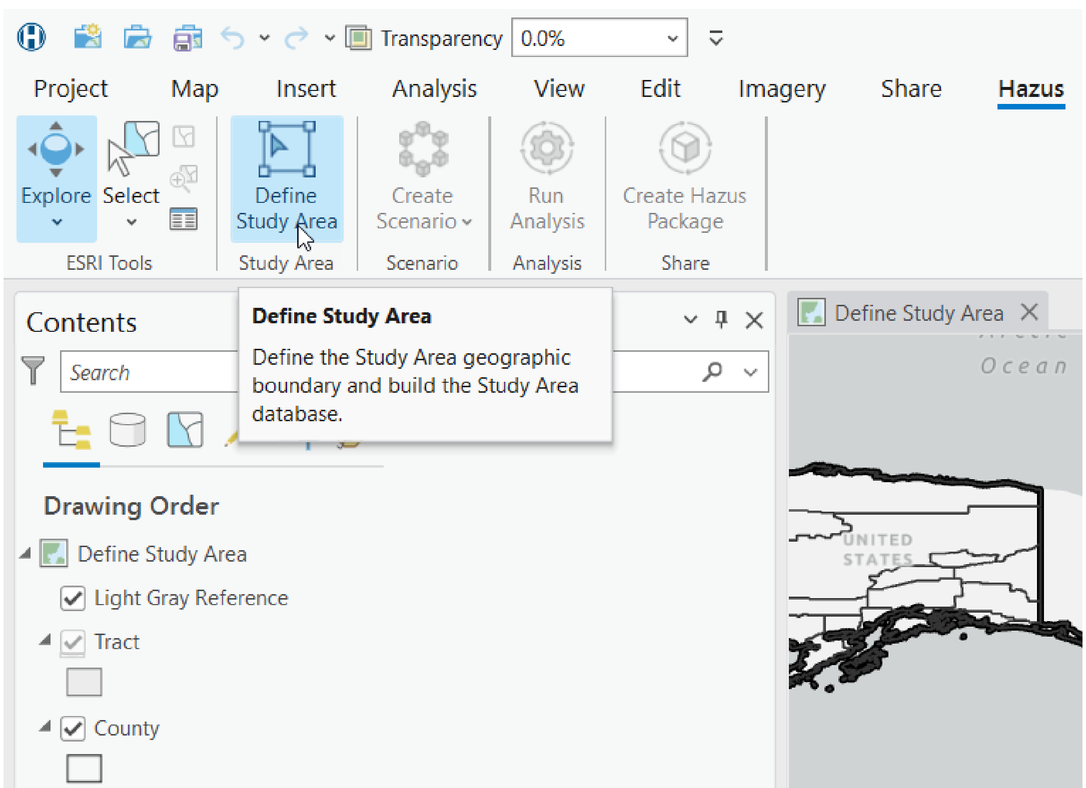


Figure 3-1: Example Ribbon Button Tooltip

Tooltips can also be accessed by hovering on the information symbol when it appears next to certain, more complex items.

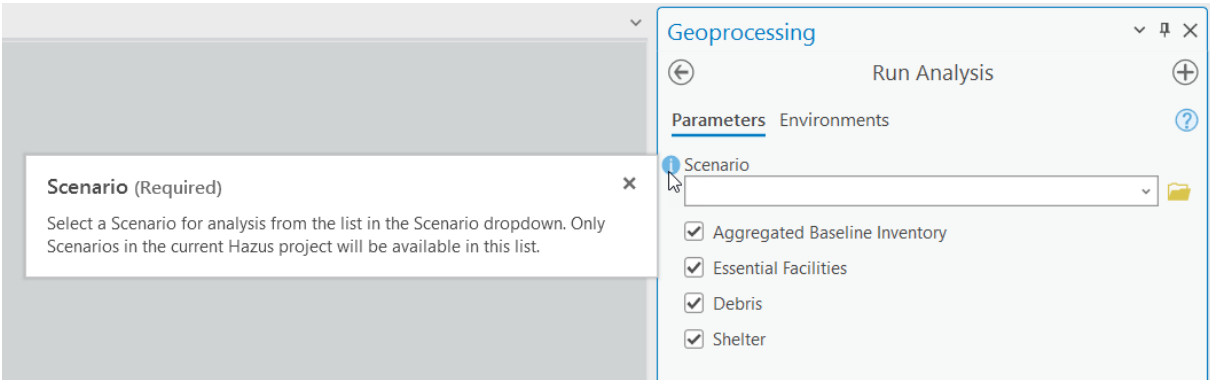


Figure 3-2: Tooltip Accessed via the Information Symbol

To close out of a tooltip, click the **x** in the upper right-hand corner. Tooltips can be opened and closed as many times as needed.

Section 4. Hazus Startup Screen

4.1 Hazus Startup

Launching Hazus will open the **Hazus Startup** screen within ArcGIS Pro, where users can create a new Hazus Project, Import a Hazus Project Package, view or delete recent Hazus Projects, and access Learning Resources.

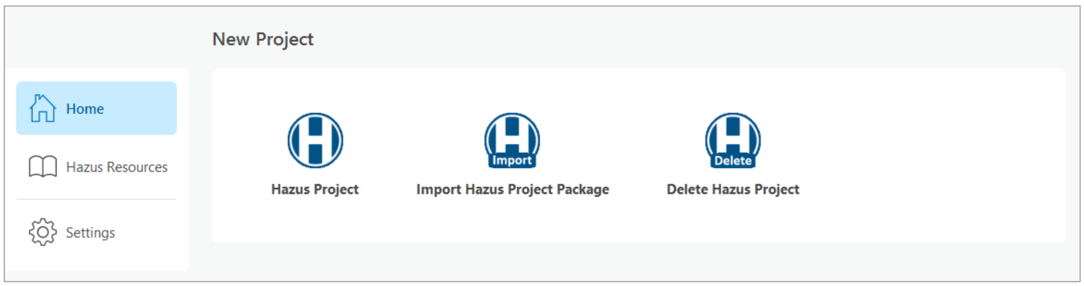


Figure 4-1: Hazus Startup Screen

4.1.1 New Hazus Project

From the **Hazus Startup** screen, Hazus Projects can be created and accessed. Click the **Hazus Project** button in the New Project ribbon to create a brand new Hazus Project. Once you set up a Hazus Project, you are able to define the study area, create the hazard scenario, set analysis parameters, and run the analysis.

1. Double clicking the **Hazus Project** button will open the **Create a New Project** dialog box.

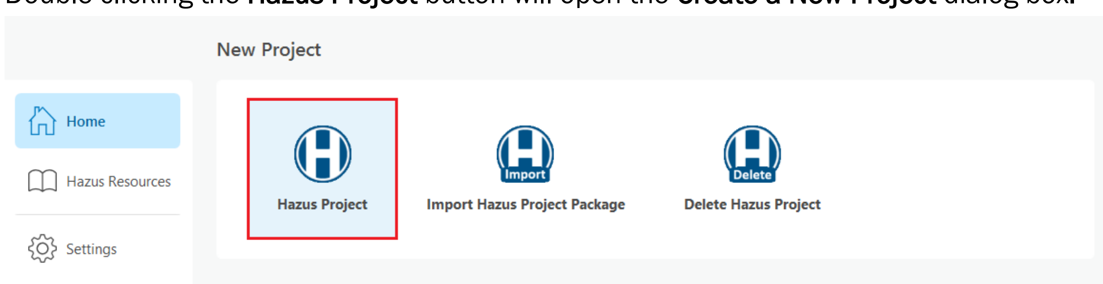


Figure 4-2: Create a New Hazus Project

2. Enter a name for the Hazus Project and select the location where the project will be saved. Click **OK** to create the Hazus project.

Figure 4-3: Create a New Project Dialog Box.

3. This opens the main ArcGIS Pro interface, providing access to the **Hazus** tab in the upper ribbon. The Hazus project is now active, which allows the user to define the geographic extent of the analysis, determine hazard type, and run an analysis. The map view is labeled as Define Study Area. It is essential that users have an active internet connection so that Hazus can create the Study Area (Figure 4-4).

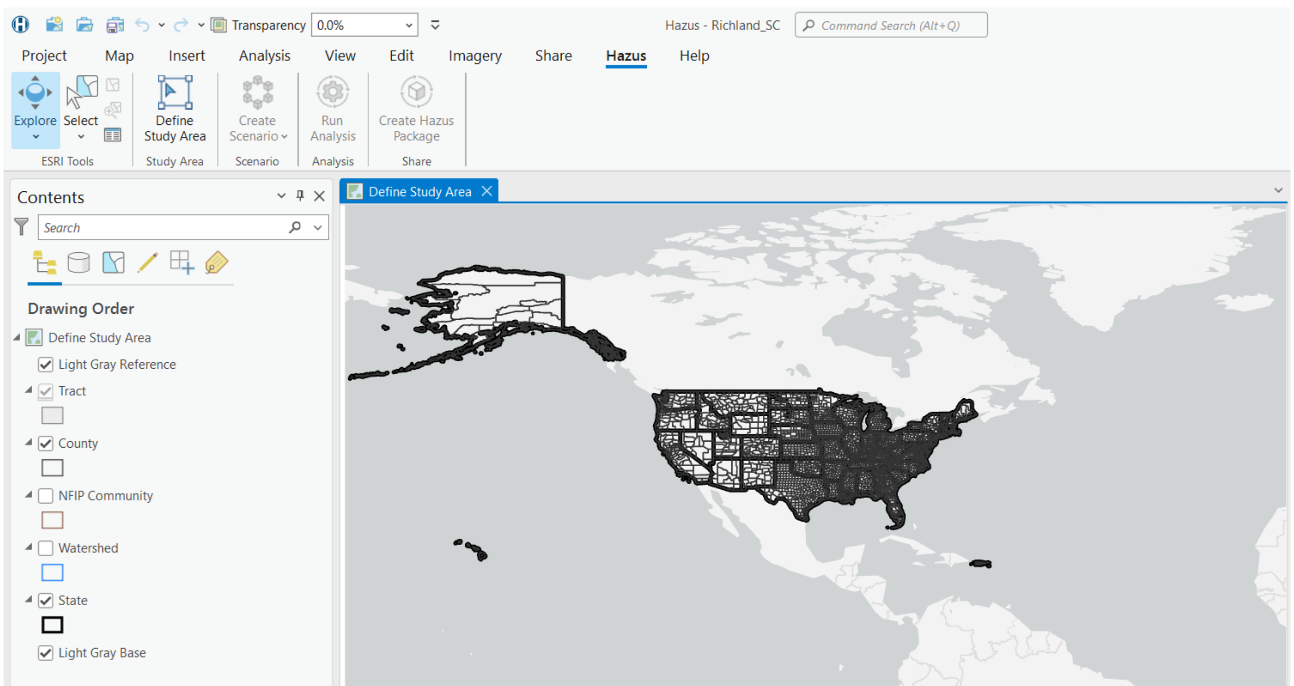


Figure 4-4: A New Hazus Project

4. Proceed to **Section 5** to continue with the next step of the process: Define Study Area.

4.1.2 Import Hazus Project Package

In addition to creating a brand new Hazus Project, an exported Hazus Project can be accessed through the **Import Hazus Project Package** menu option (Figure 4-5). The supported file format is PPKX, which is an ArcGIS Pro Project package file. This format functions similarly to a zipped version of an ArcGIS Pro project, and contains all components, including maps, data, symbology, settings, layouts, and more. Importing a PPKX file allows users to access the study area, hazard event, analysis parameters, and results created in another Hazus project.

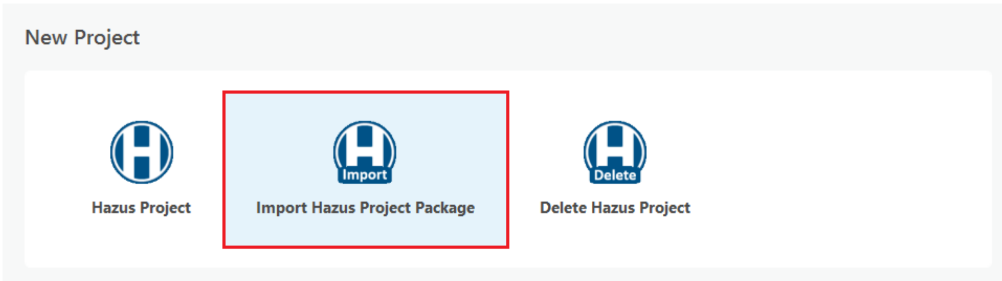


Figure 4-5: Import Hazus Project Package on the Startup Screen

Note that these Hazus Project Packages are NOT synonymous with the HPR files used in previous versions of Hazus (Hazus 6.1 and earlier) and users can NOT import HPRs into Hazus 7.0.

1. To import a PPKX file, click on the **Import Hazus Project Package** icon on the startup screen. A new window will appear (Figure 4-6).

2. Click on the folder icon and navigate to the location of the existing PPKX file (Figure 4-6).

3. Enter a project name in the blank filed next to **Name,** then click OK.

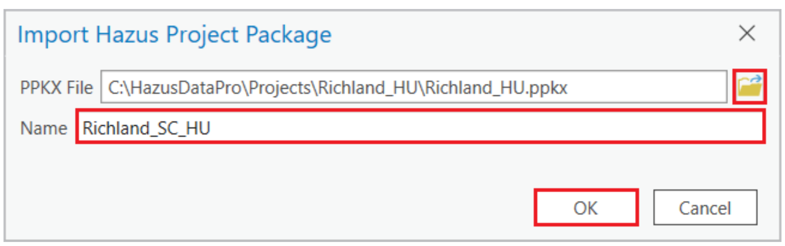


Figure 4-6: Import Hazus Project Package Window

4. A line of red text will appear at the bottom of the window, indicating that the import is in progress. Once the process is completed, a new ArcGIS Pro project with the previously entered name will be opened.

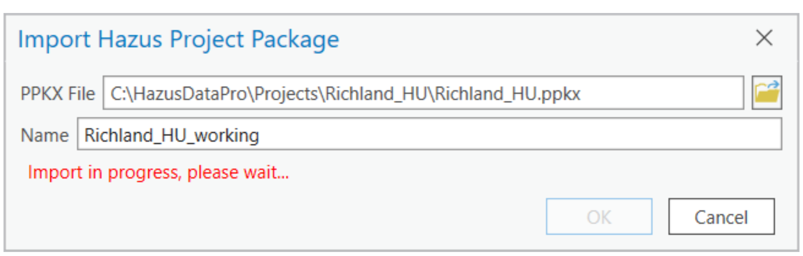


Figure 4-7: Import Hazus Project Package In Progress

4.1.3 Delete Hazus Project

Users can delete unwanted Hazus projects directly from the startup screen. This feature offers a more efficient and intuitive way to manage Hazus projects. Below are steps to delete a Hazus project:

1. Navigate to the startup screen and click on **Delete Hazus project.**

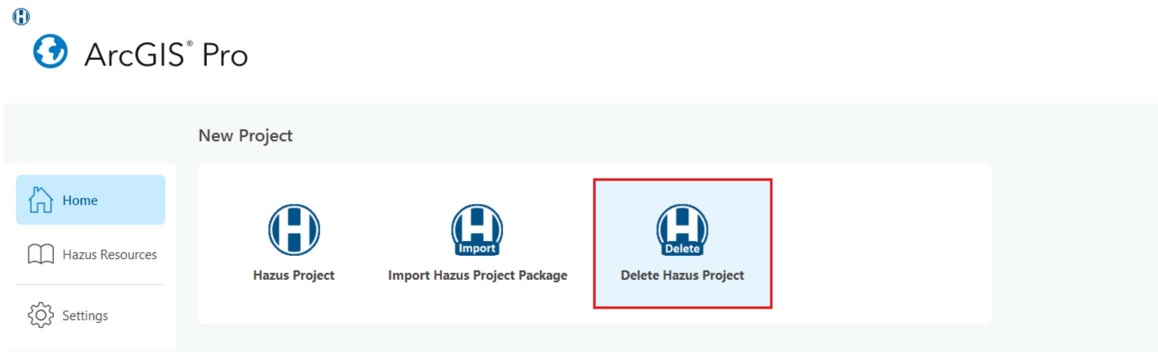


Figure 4-8: Delete Hazus Project on the Startup Screen

2. A new window will appear, displaying a list of Hazus projects. Select the project to delete and click **OK**.

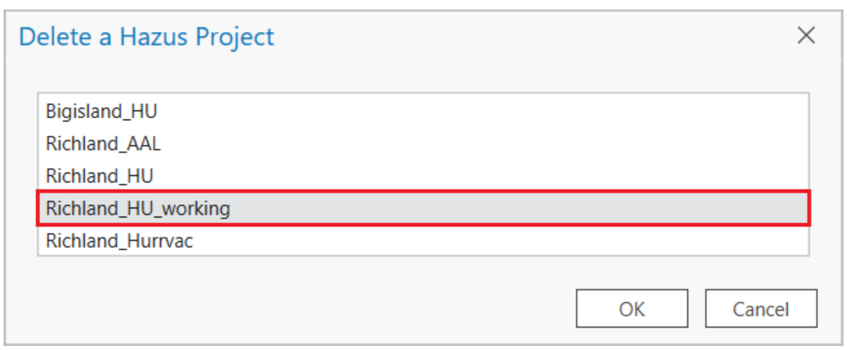


Figure 4-9: Highlight the Hazus Project to Delete

3. A confirmation window will appear, notifying that the selected Hazus project has been successfully deleted.

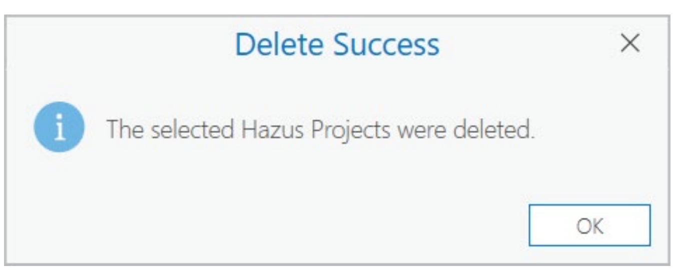


Figure 4-10: Delete Success Dialog

4. After a Hazus project is deleted, it will remain in the **Recent Project** list in the startup screen. Users can manually remove it from the list by clicking on the three dots in the lower-right corner of the project box, as illustrated in Figure 4-11.

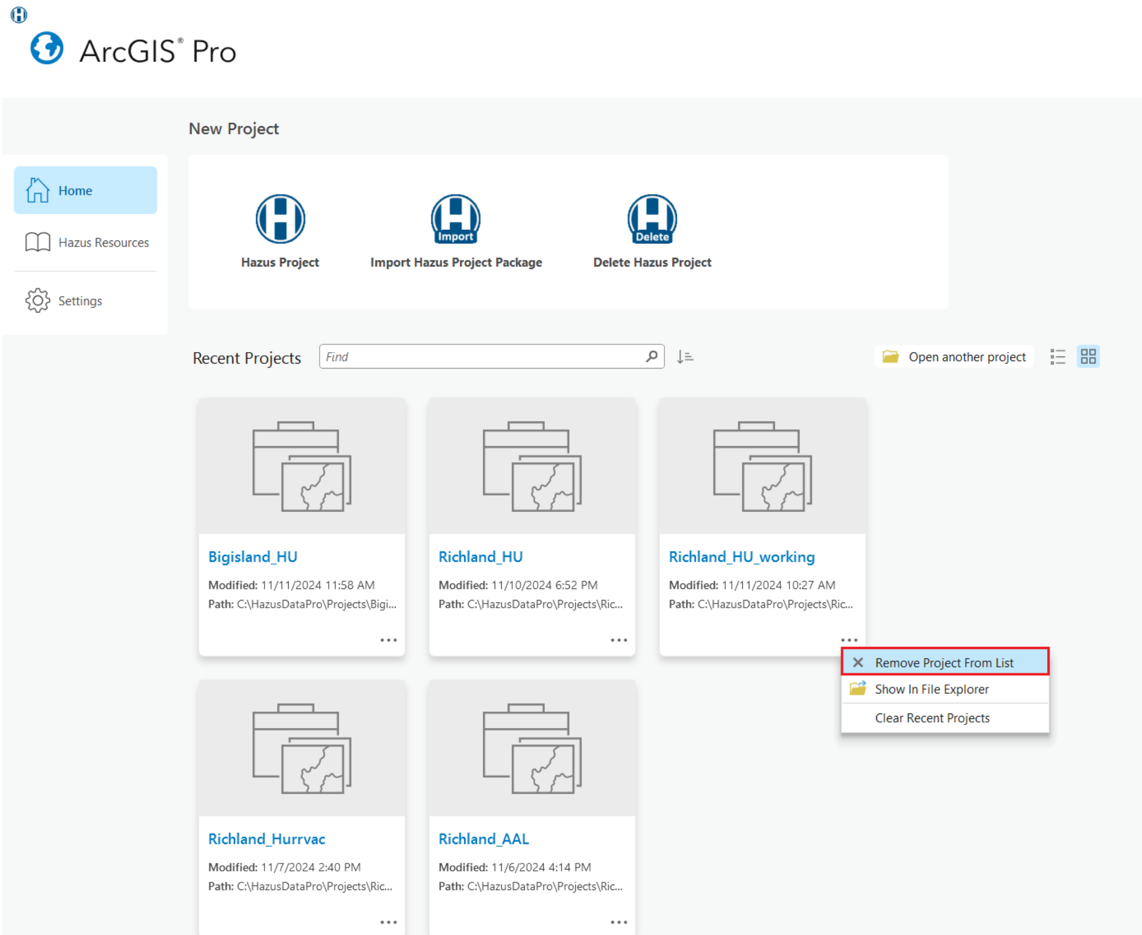


Figure 4-11: Remove a Project

4.2 Hazus Resources

Additional Hazus-related materials can be accessed by selecting the **Hazus Resources** element on the left sidebar of the Hazus startup screen.

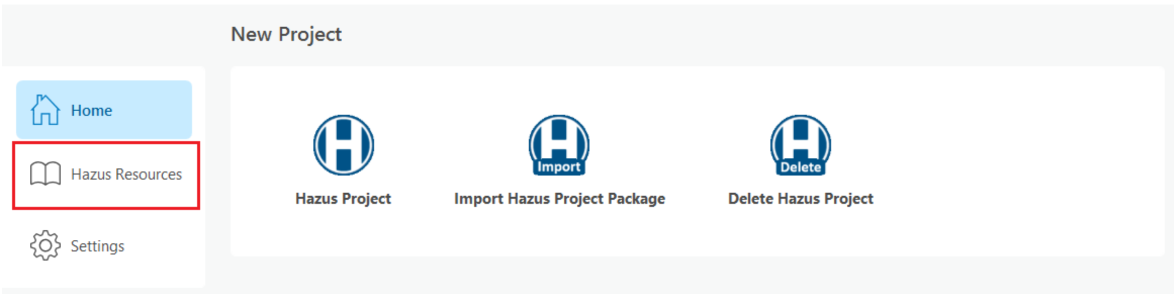


Figure 4-12: Hazus Resources Selection

Here users are able to sign up for the Hazus email list, contact the Hazus help desk, and view Hazus Resources.

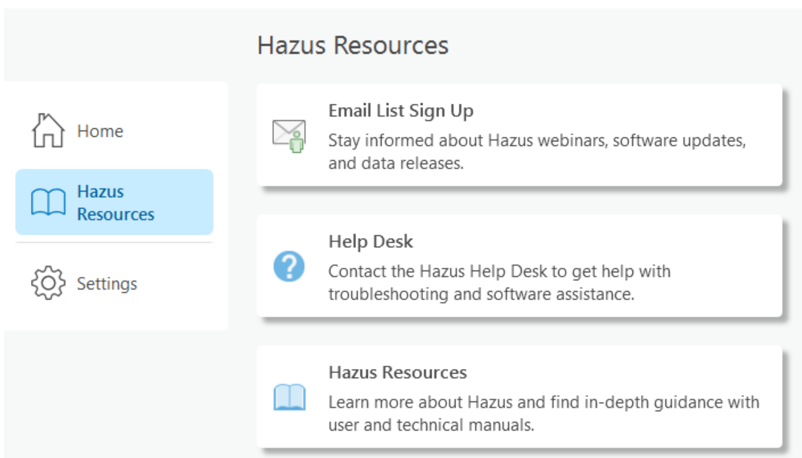


Figure 4-13: Hazus Resources Page

Section 5. Study Area Ribbon Button

Once a Hazus Project is created, select the **Hazus** tab in the upper ribbon. There are several buttons and galleries within the ribbon – Study Area, Scenario, Analysis, and Share – that each have one-to-several buttons that activate different processes or capabilities of Hazus. Icons that are grayed out will become active as processes progress. This section outlines the **Study Area** Ribbon Button, which allows for defining the study area, accessing information about baseline inventory data, creating a hazard scenario, running an analysis and generating a Hazus package.

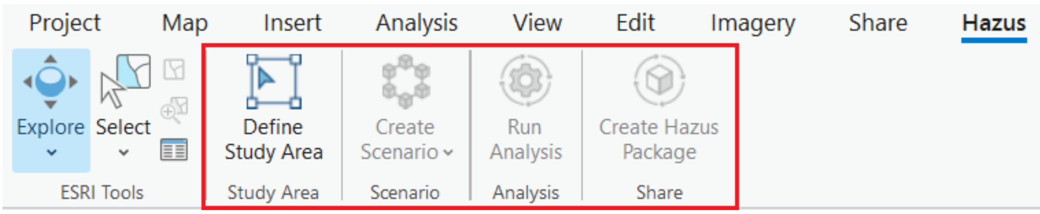


Figure 5-1: Define Study Area and the Hazus Ribbon

Defining the Study Area establishes the geographic limits of the Hazus analysis. Hazus uses this information to compile the associated baseline inventory data against which the hazard event scenario will be applied to estimate losses.

Note that unlike previous versions, Hazus 7.0 does NOT require selecting the type of hazard (Flood or Hurricane) before defining the Study Area. The process of Defining the Study Area in order to collect the necessary inventory data is no longer dependent on the type of hazard event to be model in the analysis.

5.1 Define Study Area

The **Define Study Area** button starts the process to define the geographic extent of the Hazus analysis. Clicking the button will open the Define Study Area Geoprocessing tool on the right side of the screen (Figure 5-2).

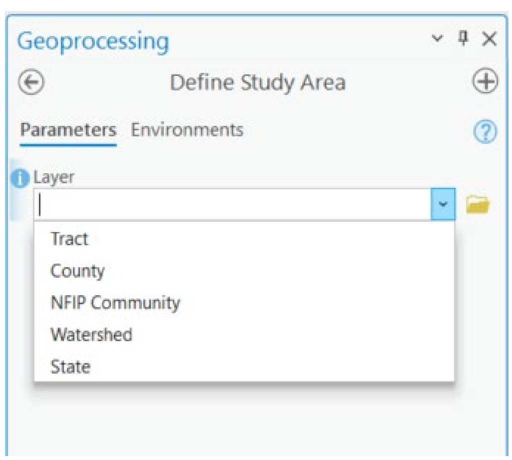


Figure 5-2: The Define Study Area Geoprocessing Tool

1. Choose the geographic unit to define the area of the study (ex: Census tract, County, NFIP Community, Watershed or State) and the extent of the study area. For example, choosing “Tract” from the dropdown menu will allows for the selection of specific Census tracts to include in the Study Area (Figure 5-3); choosing “County” will allows the selection of Counties to include in the Study Area (Figure 5-4).

Figure 5-3: Define Study Area by Census Tract

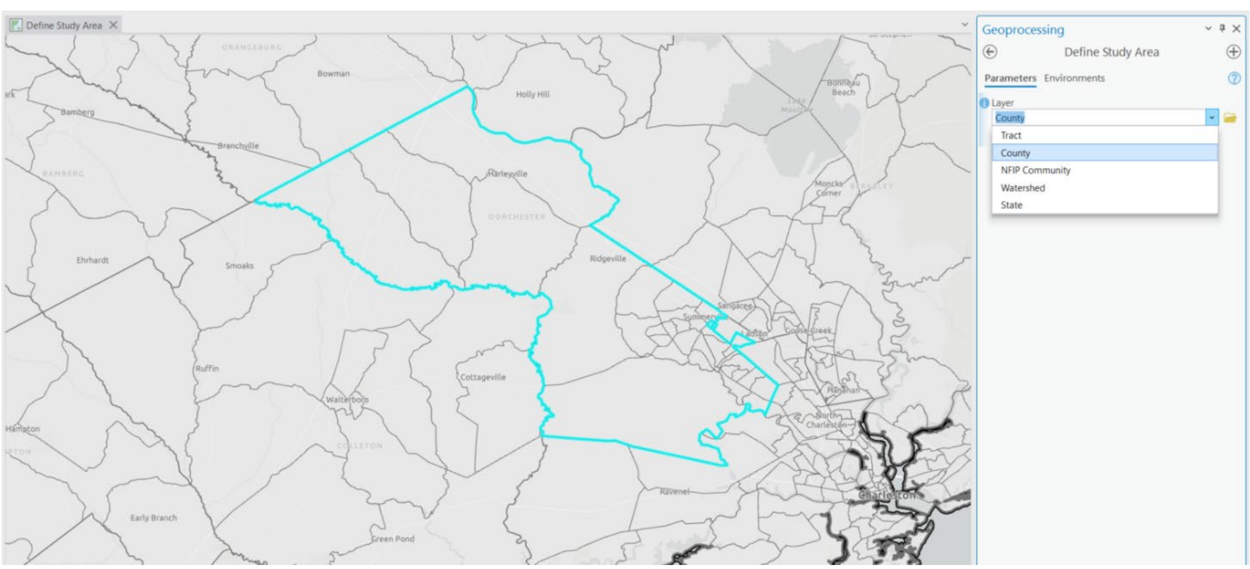


Figure 5-4: Define Study Area by County

2. Go to the Hazus ribbon and click the **Select** tool, then click on the desired areas on the map to include in the Study Area. The borders of the selected areas will turn cyan to indicate that they will be included in the Study Area (Figure 5-5).

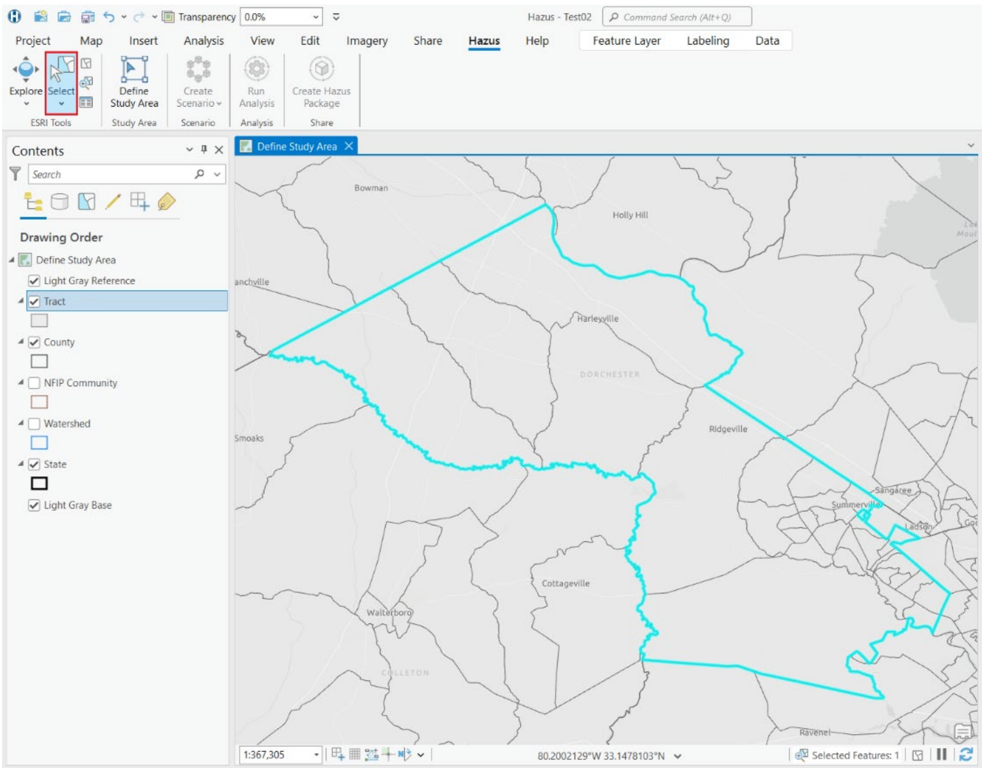


Figure 5-5: Selecting Geographies for a Study Area

3. Once the desired geographies are selected, the description "Use the selected record:" displays the number of records selected in the map viewer. The switch will turn blue to indicate that the study area has been selected. Click the **Run** button in the bottom of the Define Study Area Geoprocessing tool (Figure 5-6).

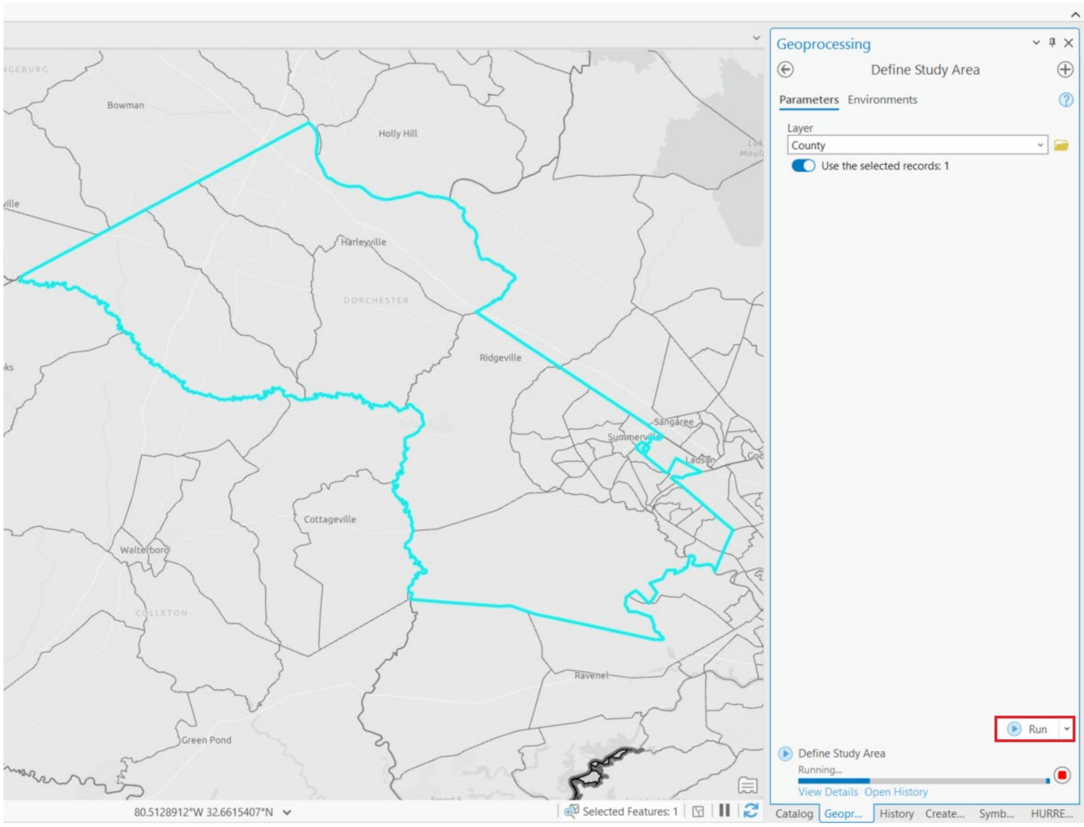


Figure 5-6: Run the Define Study Area Geoprocessing Tool

4. The tool will compile the inventory data associated with the selected study area and processing time will vary according to the size of the study area. Once the geoprocessing tool run is complete, a green checkmark will appear at the bottom of the Define Study Area Geoprocessing tool. Additionally, new layers will be visible in the contents pane on the left side of the screen with the map view name updated to Overview (Figure 5-7).

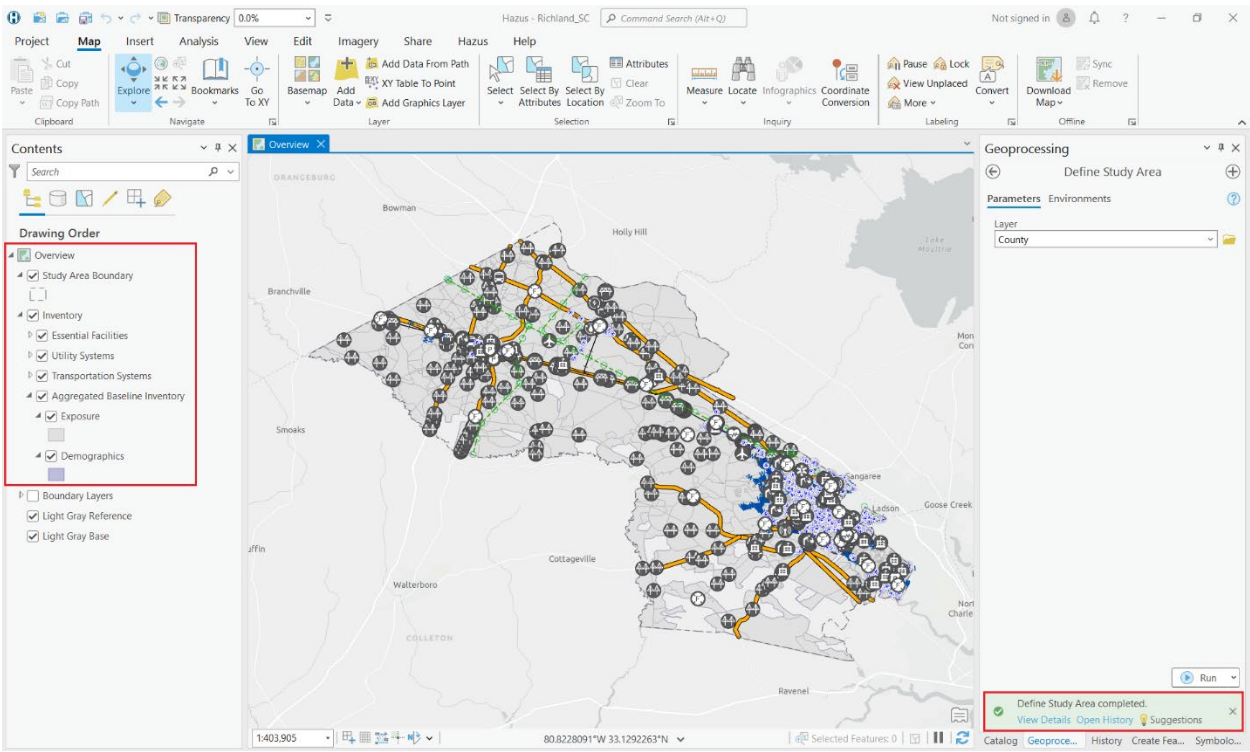


Figure 5-7: Define Study Area Complete

5. The Study Area is now compiled and ready for use. Proceed to create the hazard scenario (Section 6).

Section 6. Scenario Ribbon Button

Once the Study Area has been defined and inventory data updated, access the **Create Scenario** button to create the desired hazard events for analysis. Unlike previous versions of Hazus, users do not need to enable a specific hazard during study area creation in order to create scenarios of that hazard type.

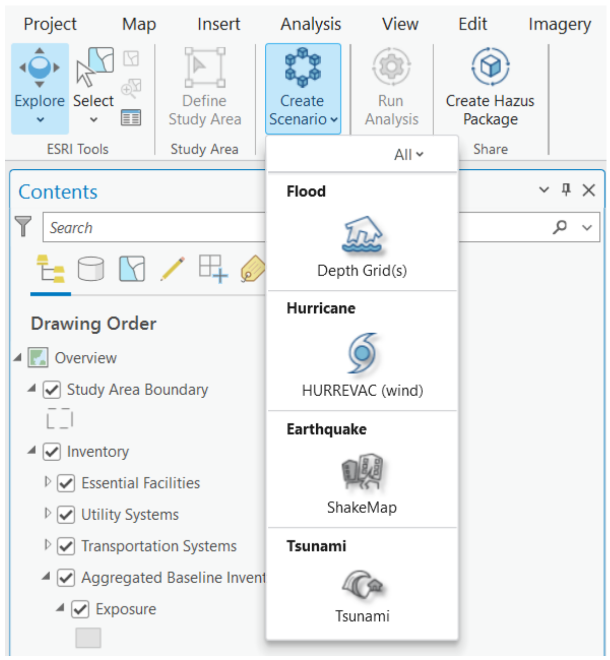


Figure 6-1: Create Scenario Ribbon Button and the Hazus Ribbon

The **Create Scenario** ribbon button is where users choose the type of hazard scenario to apply to the Study Area. Clicking on the button will expand a gallery of hazard-specific buttons to select from. Currently, the Earthquake and Tsunami functions are grayed out, as they are not available in Hazus 7.0, but will be included in a future release.

The **Flood** scenario enables the selection of Single Event or Average Annualize Loss (AAL) calculations for analysis (see Section 6.1.1).

The **HURREVAC** scenario enables users to access real-time hurricane tracking and prediction data provided from HURREVAC, allowing for active and historic hurricane risk assessments directly with Hazus (see Section 6.1.2).

To filter by a specific hazard scenario, click the down arrow next to **All** at the top of the dropdown and choose a scenario. The dropdown will then display only the selected hazard scenario.

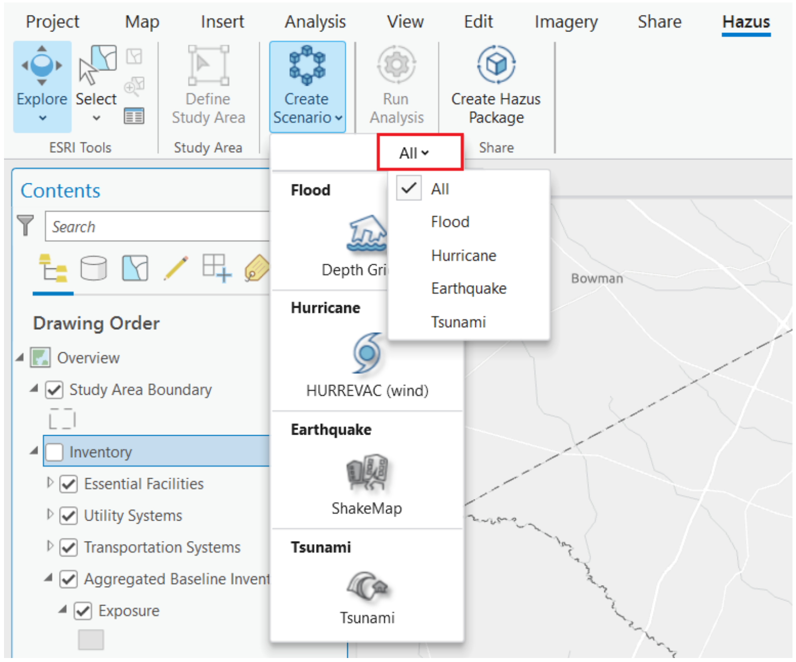


Figure 6-2: Hazard Scenario Dropdown Menu

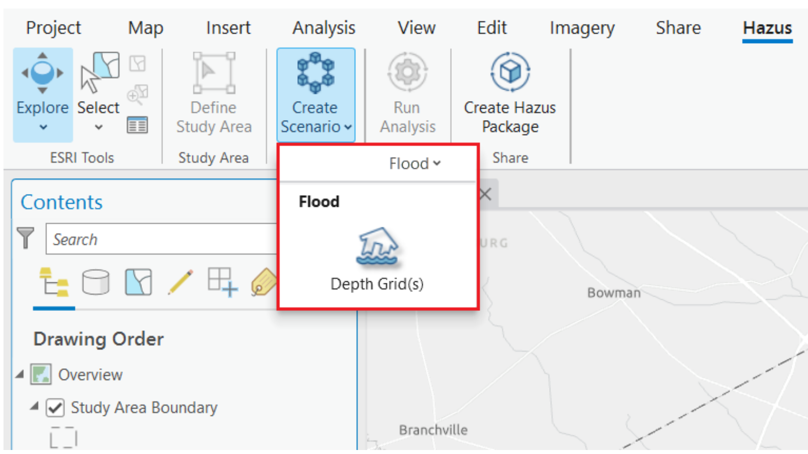


Figure 6-3: Filtering Hazard Scenario

Note that a single Study Area may be able to support multiple types of hazard scenarios depending on its geographic location. A recommended best practice is to analyze hazards only in areas that are susceptible to that/those hazards. For example, a study area may only be suitable for flood scenario if it is not prone to hurricanes, as it would lack the relevant storm data needed for analysis.

Different menu options, processes, and capabilities are available depending on the chosen hazard type for the scenario. Each of the hazards is given its own subsection in this guide to outline the full process of creating a scenario for that hazard.

6.1 Create the Scenario

Once the study area is defined and completed, the next step is to create a scenario based on the hazard to be analyzed. Options are available to select from various scenarios based on the type of hazard under consideration.

6.1.1 Flood

The process for creating a flood scenario can be accessed by clicking on the **Flood** sub-button within the **Create Scenario** gallery (Figure 6-4).

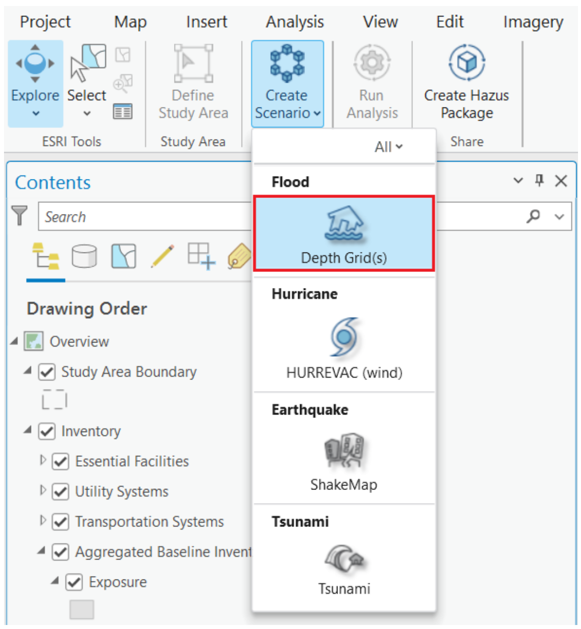


Figure 6-4: Create a Flood Scenario

This will launch the **Create Flood Scenario** Geoprocessing tool on the right side of the screen (Figure 6-5).

6.1.1.1 Create a Flood Scenario

The **Create Flood Scenario** Geoprocessing tool should be open to input all necessary information for setting up the food scenario, as shown in Figure 6-5.

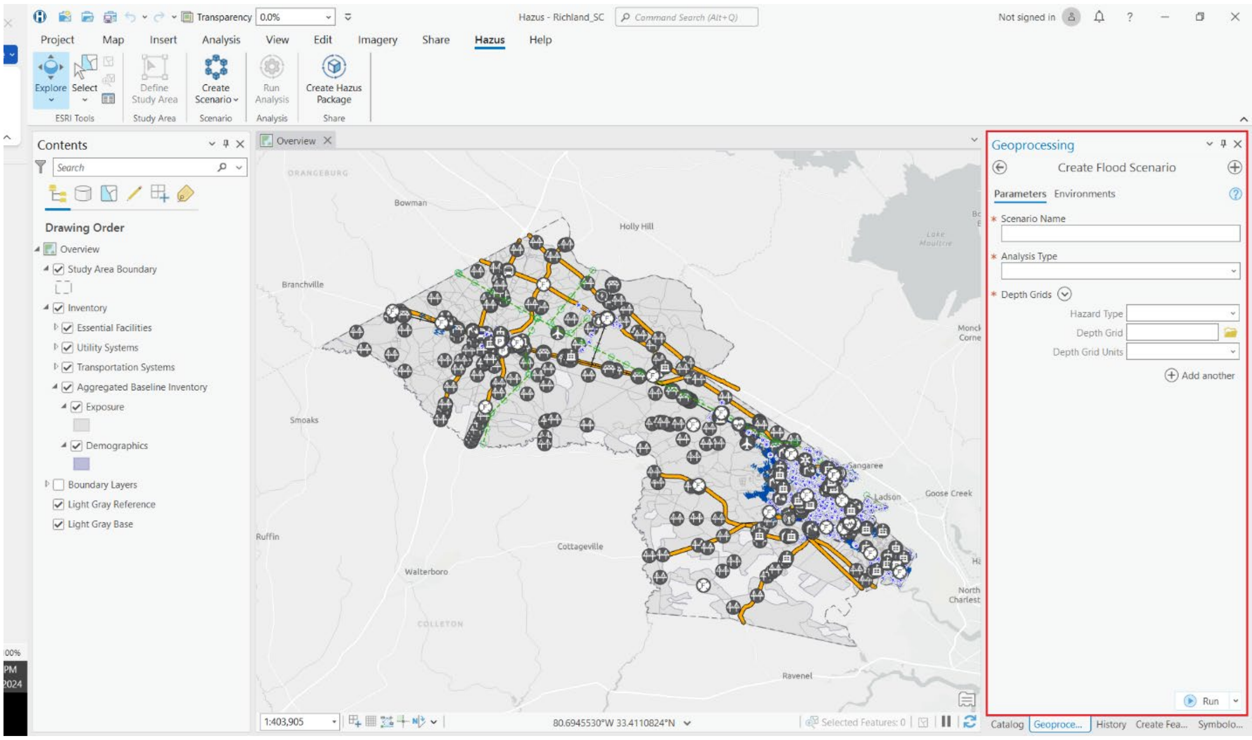


Figure 6-5: Flood Scenario in ArcGIS Pro

1. Enter a **Scenario Name** that uniquely identifies it within the Study Area (Figure 6-6).

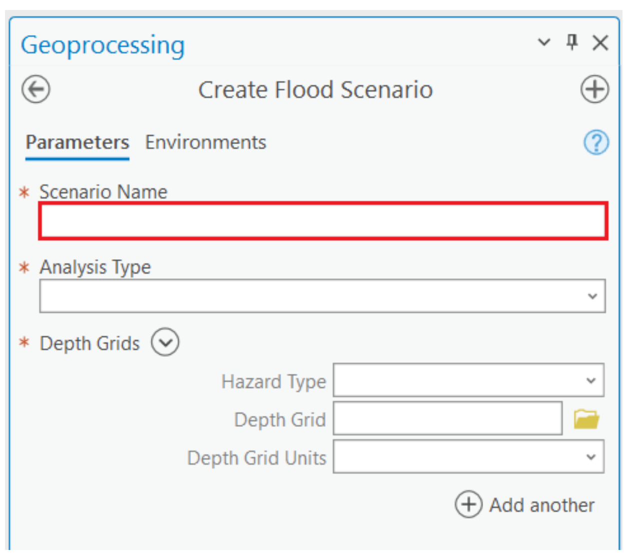


Figure 6-6: Flood Scenario Name

2. Open the **Analysis Type** dropdown menu to select between Single Event and Average Annualized Loss (Figure 6-7). If **Average Annualized Loss** is selected, it replaces the current Depth Grids input as this selection adds the parameter for three return periods and requires three depth grids for input. See Section 6.1.1.2 for an Average Annualized Loss specific walkthrough.

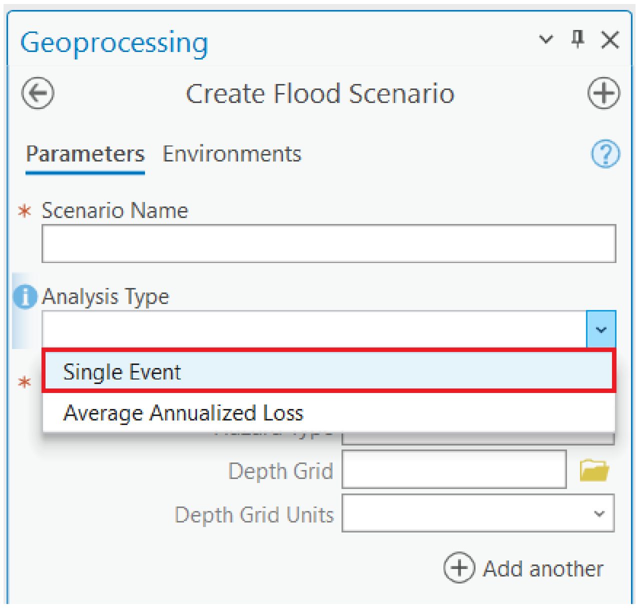


Figure 6-7: Flood Analysis Type

3. Under the Depth Grids section, select between Riverine and Coastal for the **Hazard Type** (Figure 6-8).

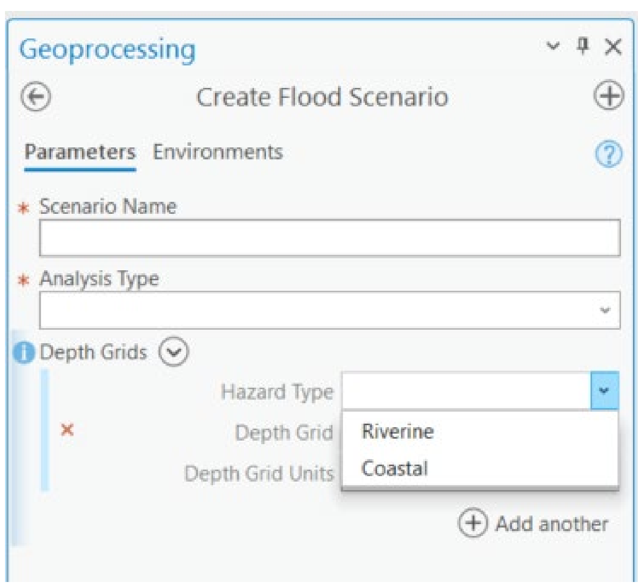


Figure 6-8: Select Hazard Type

4. Next, locate the **Depth Grid** file to be imported for use in the scenario (Figure 6-9). Note**:** Users can import any ESRI-supported raster filetype; Hazus will NOT create a depth grid.

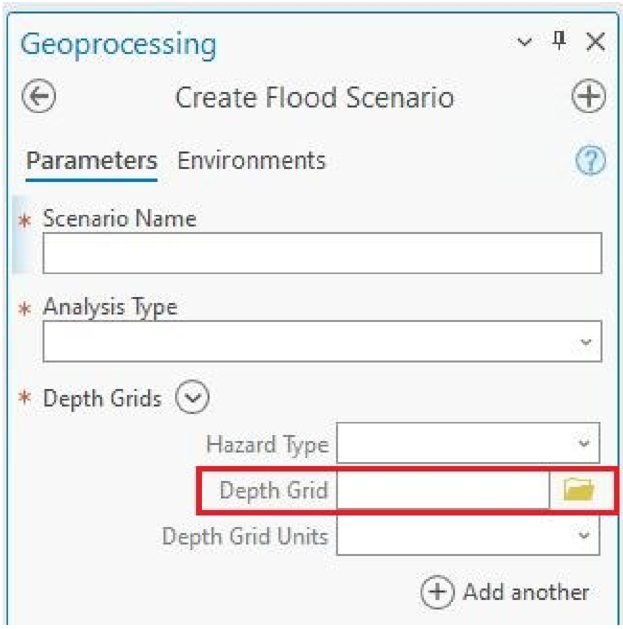


Figure 6-9: Flood Scenario Depth Grid Selection

5. Then specify if the imported Depth Grid values are in feet or meters (Figure 6-10).

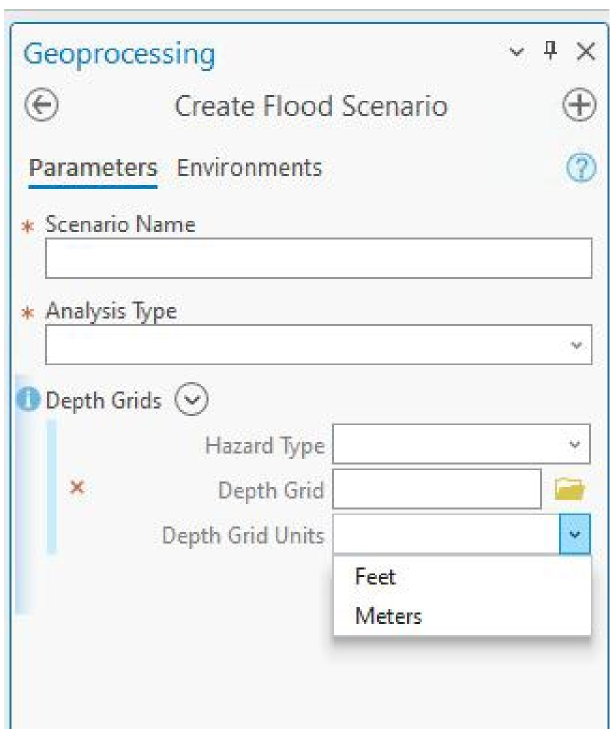


Figure 6-10: Depth Grid Units Selection

6. Once all fields are completed, the icon next to **Depth Grid** will change to a warning symbol. This indicates that the input depth grid is not projected to WGS84, and Hazus will automatically reproject to the appropriate coordinate system.

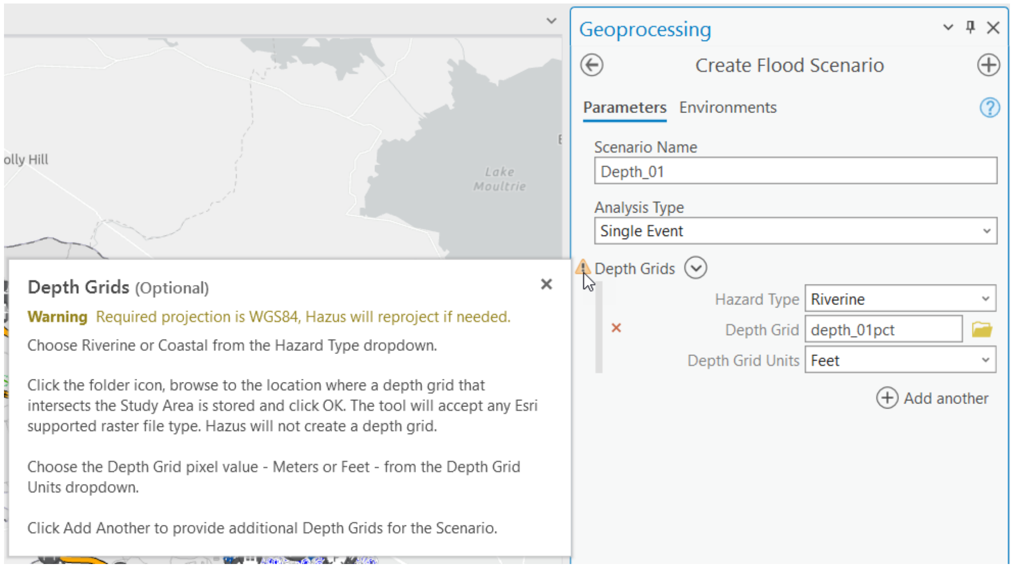


Figure 6-11: Depth Grid Warning Symbol

7. Click **Run** after all input data are populated and Hazus will create the scenario (Figure 6-12).

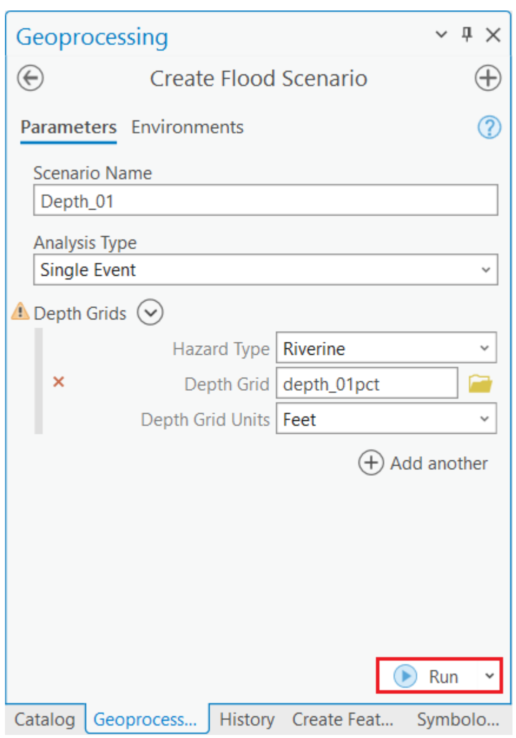


Figure 6-12: Run the Completed Flood Scenario

8. Once the scenario has been created, a green checkmark will appear at the bottom of the Geoprocessing tool (Figure 6-13). A new map view window will also appear, named after the **Scenario Name** specified in the geoprocessing tool.

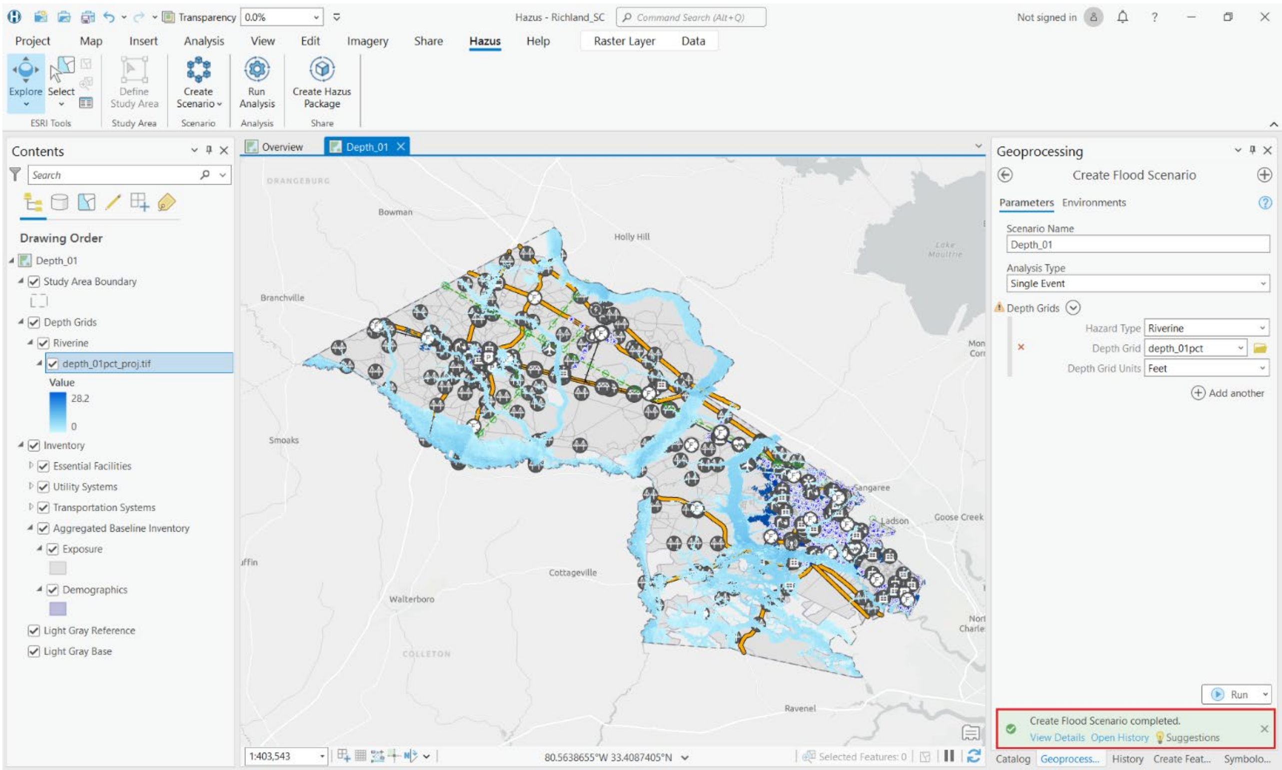


Figure 6-13: Completed Flood Scenario

9. The Flood scenario is now active and ready for analysis (see Section 7.1).

6.1.1.2 Average Annualized Loss Scenario

The **Average Annualized Loss** (AAL) represents the expected annual loss due to flood hazards. To perform the analysis, users will need a minimum of three depth grids with various return periods.

1. In the **Create Flood Scenario** geoprocessing tool, select **Average Annualization Loss** in the **Analysis Type** dropdown menu.

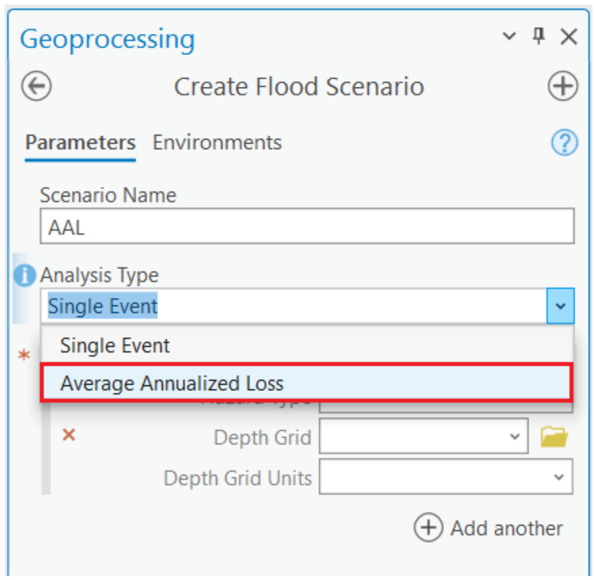


Figure 6-14: Select Average Annualized Loss in the Dropdown Menu

2. Navigate to each **Depth Grid** location being imported and complete the required information in the provided fields, then click **Run** at the bottom of the Geoprocessing tool. Please note that the AAL process may take some time to complete depending on the study area and the need to analyze multiple return periods.

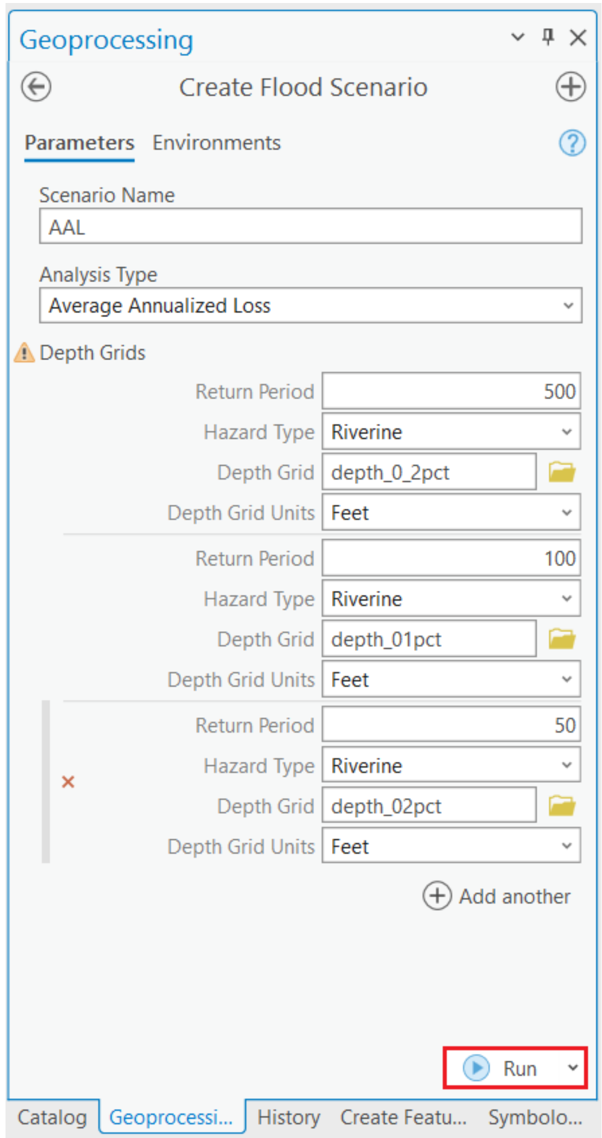


Figure 6-15: AAL Depth Grid Selection

3. To delete depth grids that have already been input into the **Create Flood Scenario** geoprocessing tool, click the "x" next to the depth grid to remove as shown in Figure 6-14.

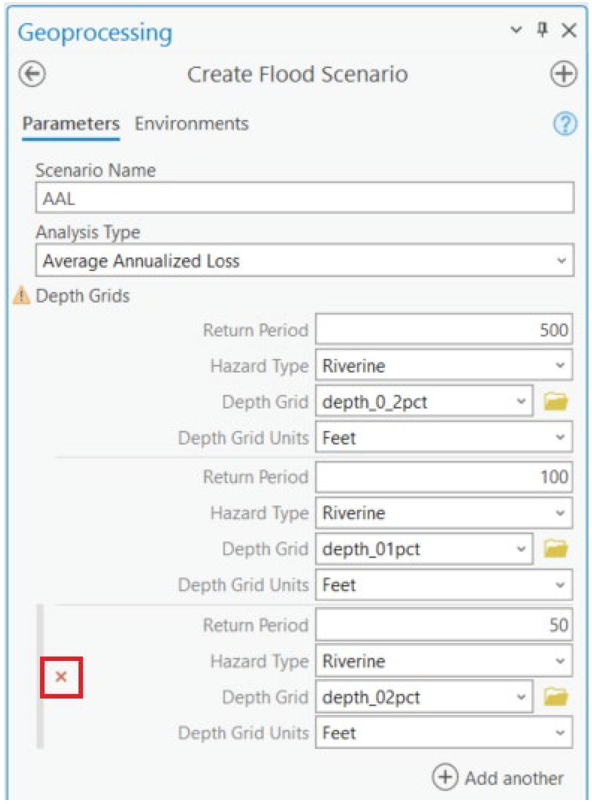


Figure 6-16: Remove Selected Depth Grid

4. To add multiple depth grids in the geoprocessing tool, click **Add Another** or the plus symbol as shown in Figure 6-15.

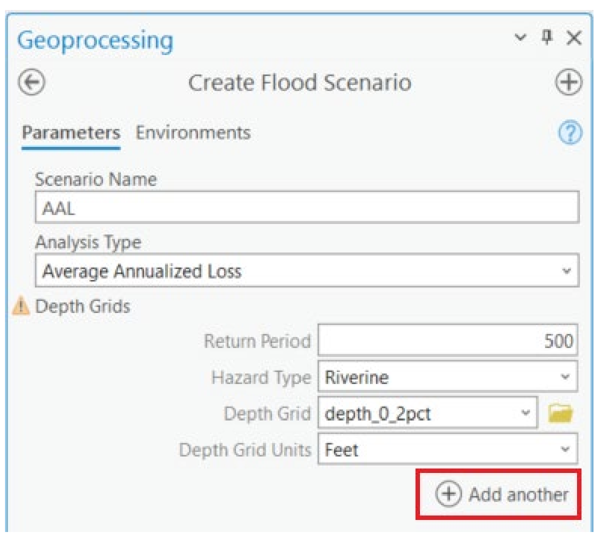


Figure 6-17: Add Depth Grid

5. Once the process is complete, a new map view with the **Scenario Name** specified in the previous step will appear next to the Overview map view as illustrated in Figure 6-16.

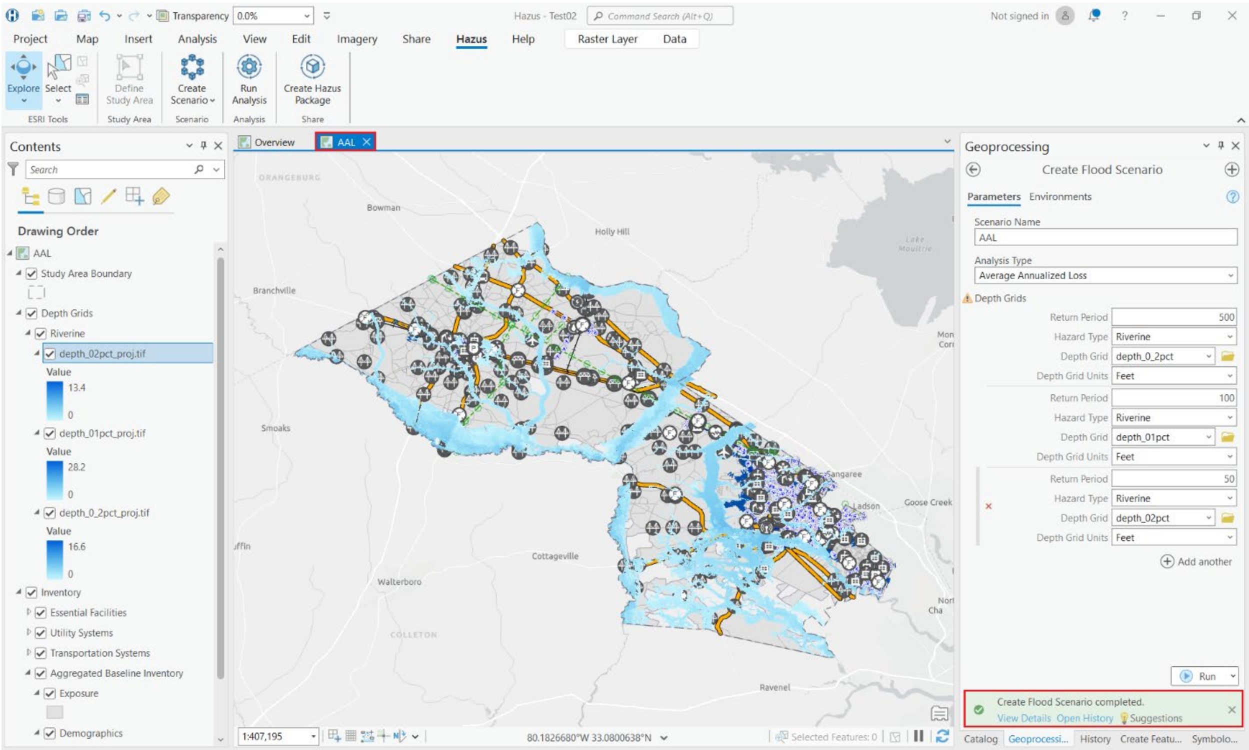


Figure 6-18: Create Flood Scenario Completed

6. The AAL scenario is now active and ready for analysis (see Section 7.1).

6.1.2 HURREVAC

HURREVAC utilizes data from the National Hurricane Program (NHP), integrating both real-time and historical information to predict impacts and potential damages. However, Hazus 7.0 is only compatible with HVX files from HURREVAC, limiting access to historical storm data to records from 2005 and later.

There are two wind risk assessment options:

1. **Active storms** – This is the probabilistic scenario. Hazus will access current storm data in real-time, providing tracking information on current active storms.
2. **Historical storms** – This provides archived storm data of the final HURREVAC advisory for each historic storm from 2005 to present day. This helps in understanding storm behavior and potential impacts.

6.1.2.1 Create a HURREVAC Scenario

1. The process for creating a flood scenario can be accessed by clicking on the **HURREVAC** sub-button within the **Create Scenario** ribbon button.

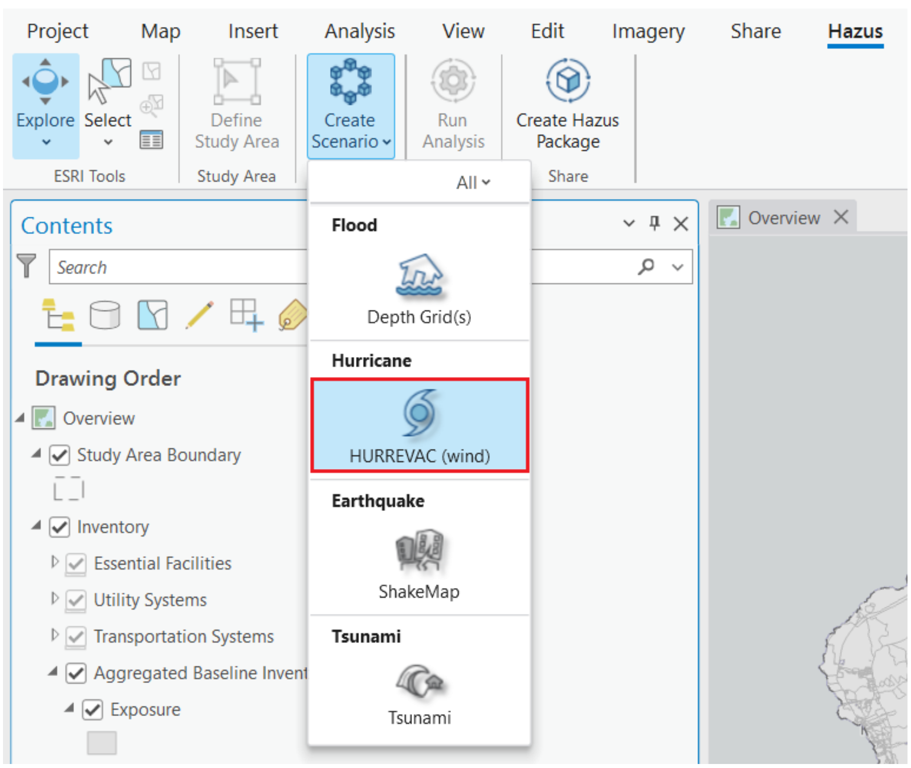


Figure 6-19: HURREVAC Scenario Button

1. The **HURREVAC Scenario** Geoprocessing tool will launch on the right side of the screen, with the Storm Type set to “Active” and the Basin set to “Atlantic” by default.

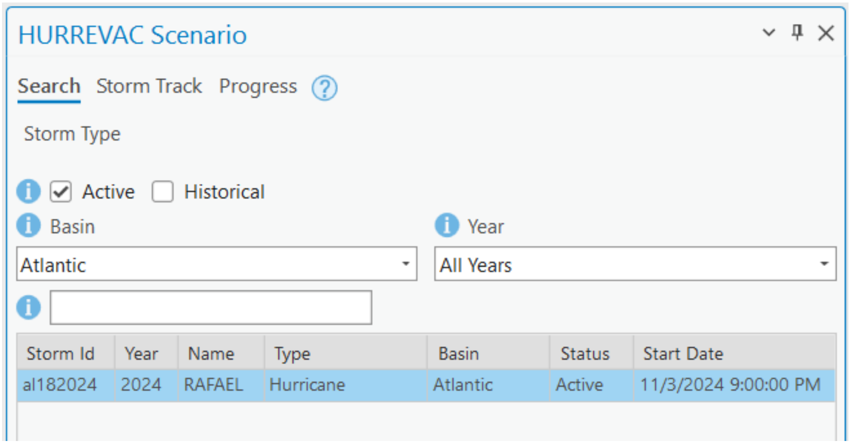


Figure 6-20: HURREVAC Scenario Geoprocessing Tool

2. In the **HURREVAC Scenario** Geoprocessing tool, check the box next to “Historical” and select the appropriate Basin. Next, scroll through the table to find the storm to analyze, then click "Continue" to allow Hazus to validate the storm track data.

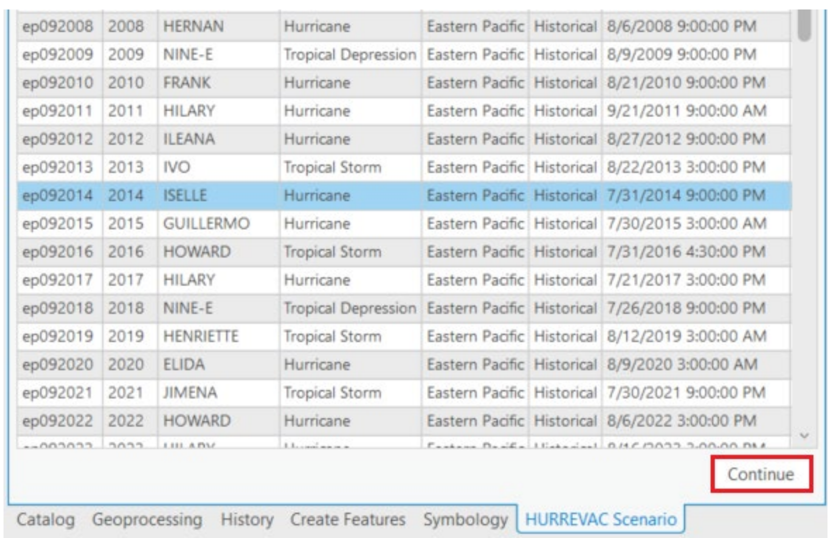


Figure 6-21: Run the HURREVAC Scenario

3. Once validation is complete, the geoprocessing tool will be directed to the **Storm Track** tab in the **HURREVAC Scenario**. After reviewing the data, click **Create** to proceed. A new map view will appear next to the **Overview**, along with Inventory group layers in the Table of Contents pane.

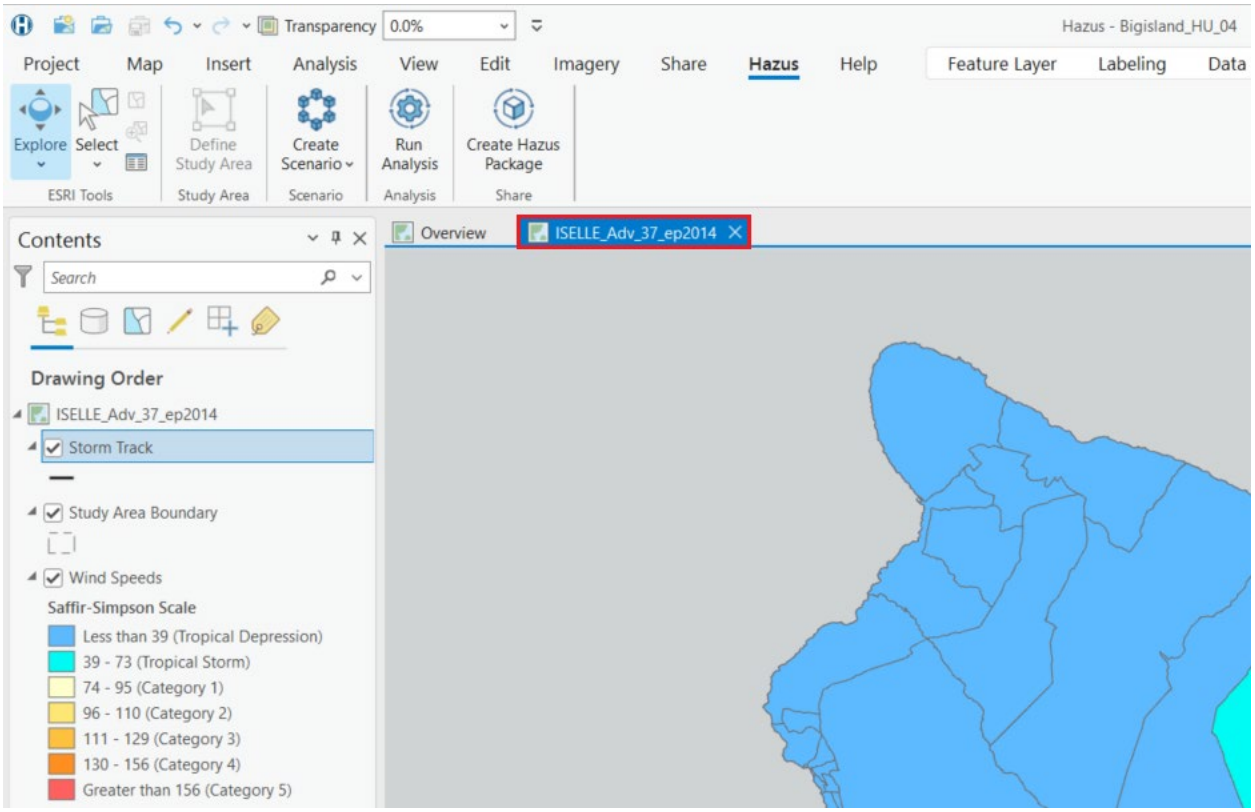


Figure 6-22: Updated Map View

6.1.2.1.1 Active Storms

By selecting the **Active** scenario, Hazus will display any storms that are currently being monitored using real-time data from meteorological sources. This data is then utilized to project the storm's future path and its potential impact areas.

Check the box next to **Active** under **Storm Type** to activate the analysis.

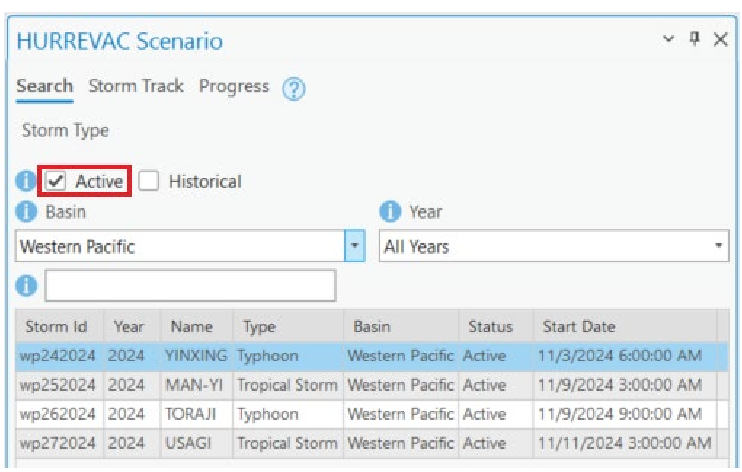


Figure 6-23: Selecting Active Storm Type

6.1.2.1.2 Historical Storms

The historical storm will display data on the past tropical storms, cyclones and hurricanes. To activate this, check the box next to **Historical** under **Storm Type**.

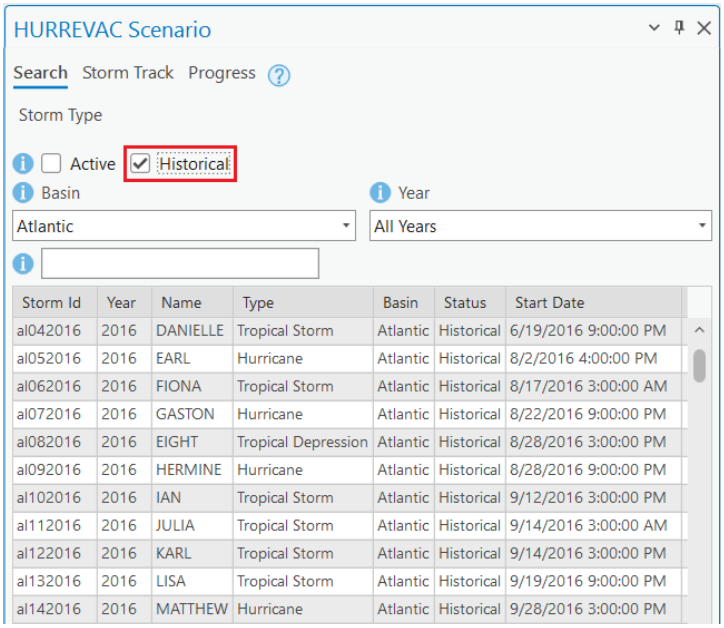


Figure 6-24: Select Historical Storm in the HURREVAC Scenario Window

6.1.2.1.3 Search for a Storm

To locate a storm, use the **Search** tab at the top of the geoprocessing tool window, which provides various options for identifying specific storms.

1. Select the affected **Basin** and **Year** from the dropdown menus.

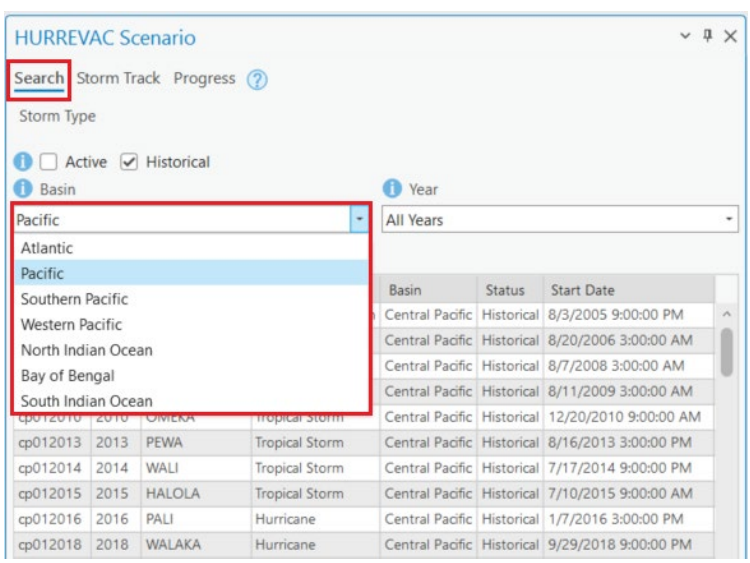


Figure 6-25: Select Basin from the Dropdown Menu

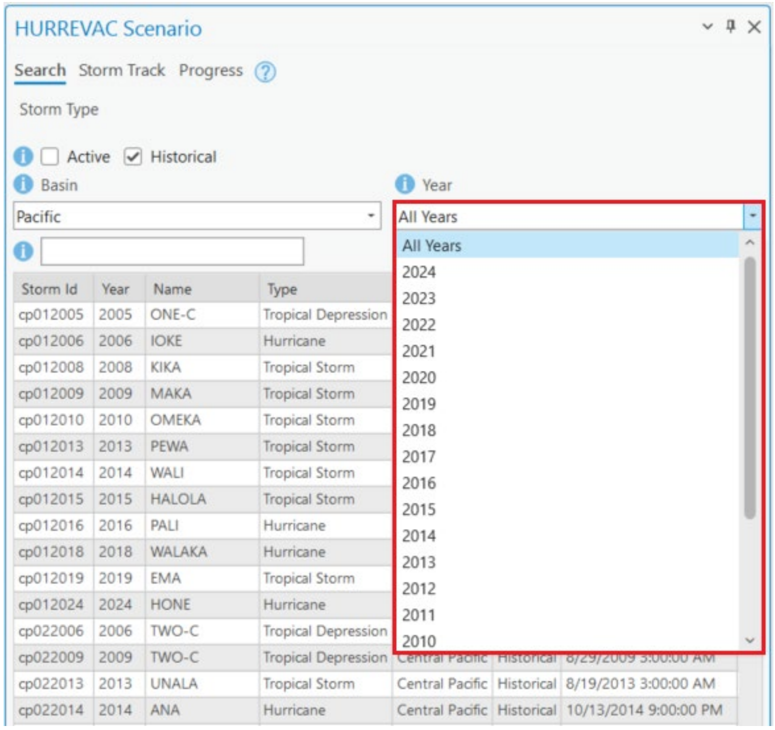


Figure 6-26: Select Year in Dropdown Menu

2. Scroll down to locate the storm or use the **sort** function on the column headings to arrange the columns in ascending or descending order. For storms that share the same name, refer to the **Start Date** or **Storm Id**, which indicates the reported time the storm made landfall in the region.

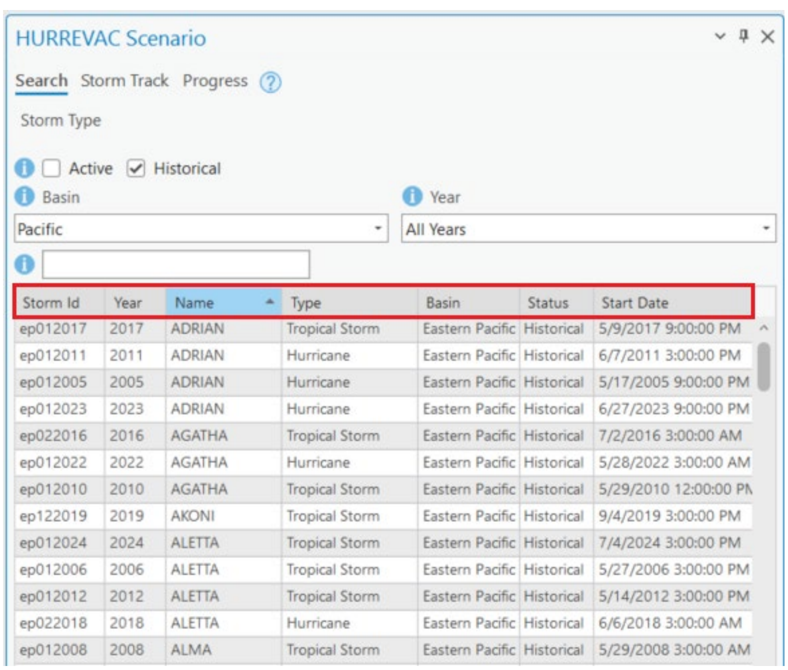


Figure 6-27: Use the Sort Function to Organize Columns

3. A storm can also be found using the search box located directly below the Basin selection. This search tool accepts either the **Storm Id** or the storm name, and it is not case-sensitive.

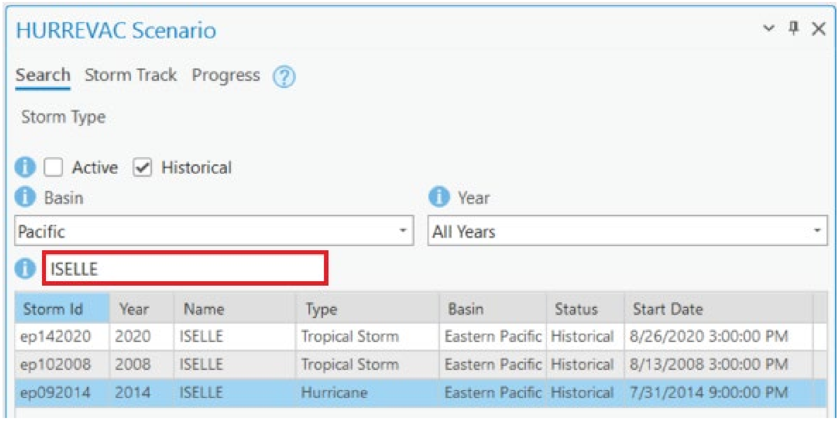


Figure 6-28: Storm Search Box

4. Highlight the desired row to select the storm.

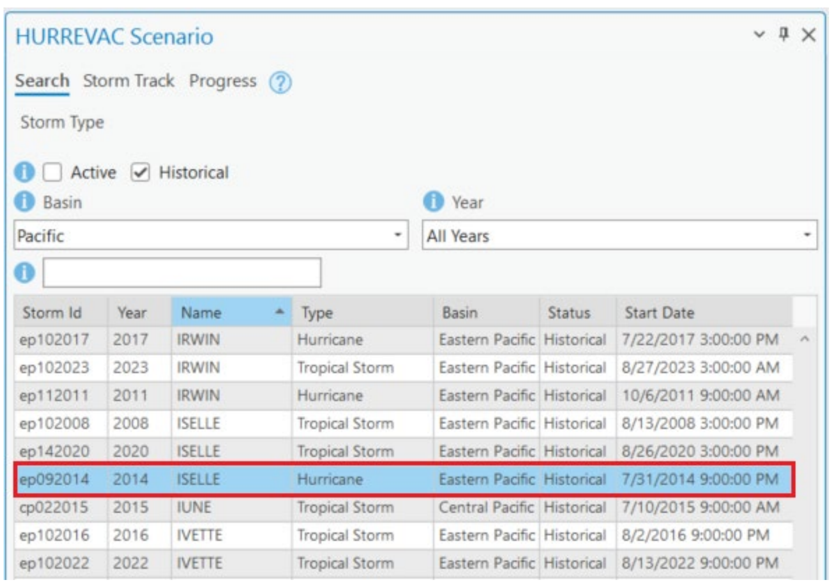


Figure 6-29: Highlight the Row to Select the Storm

5. Once the storm is selected, click **Continue** at the bottom right corner of the window to proceed to the **Storm Track** tab.

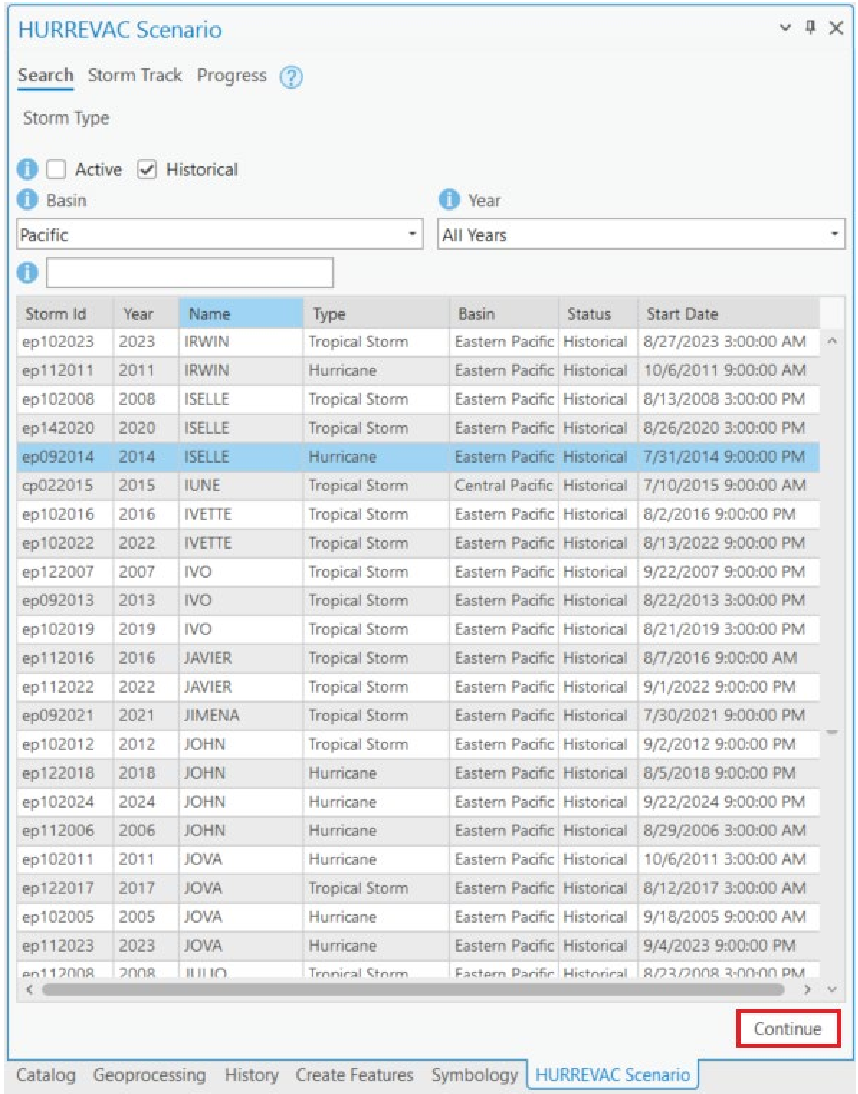
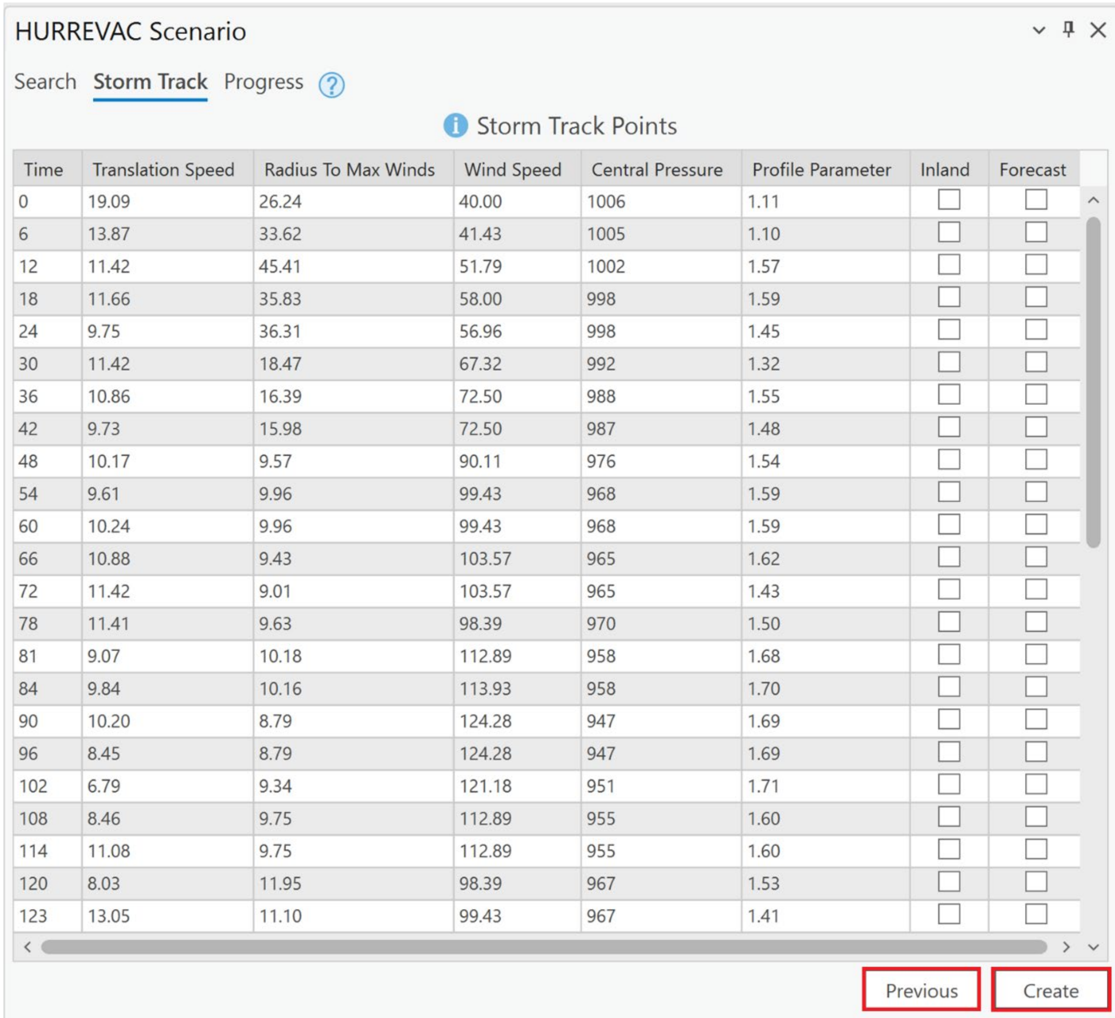


Figure 6-30: Click Continue to Proceed to the next tab

6.1.2.1.4 Displaying Storm Track

1. The **Storm Track** table provides data on a storm system's path, including movement of the storm, direction, wind speed, pressure, and impacted areas (Figure 6-31). Storm track data is available only if the selected storm has impacted the defined study area. Users can also click the **Previous** button to return to the Search tab or click **Create** to proceed with scenario creation.



Time	Translation Speed	Radius To Max Winds	Wind Speed	Central Pressure	Profile Parameter	Inland	Forecast
0	19.09	26.24	40.00	1006	1.11	☐	☐
6	13.87	33.62	41.43	1005	1.10	☐	☐
12	11.42	45.41	51.79	1002	1.57	☐	☐
18	11.66	35.83	58.00	998	1.59	☐	☐
24	9.75	36.31	56.96	998	1.45	☐	☐
30	11.42	18.47	67.32	992	1.32	☐	☐
36	10.86	16.39	72.50	988	1.55	☐	☐
42	9.73	15.98	72.50	987	1.48	☐	☐
48	10.17	9.57	90.11	976	1.54	☐	☐
54	9.61	9.96	99.43	968	1.59	☐	☐
60	10.24	9.96	99.43	968	1.59	☐	☐
66	10.88	9.43	103.57	965	1.62	☐	☐
72	11.42	9.01	103.57	965	1.43	☐	☐
78	11.41	9.63	98.39	970	1.50	☐	☐
81	9.07	10.18	112.89	958	1.68	☐	☐
84	9.84	10.16	113.93	958	1.70	☐	☐
90	10.20	8.79	124.28	947	1.69	☐	☐
96	8.45	8.79	124.28	947	1.69	☐	☐
102	6.79	9.34	121.18	951	1.71	☐	☐
108	8.46	9.75	112.89	955	1.60	☐	☐
114	11.08	9.75	112.89	955	1.60	☐	☐
120	8.03	11.95	98.39	967	1.53	☐	☐
123	13.05	11.10	99.43	967	1.41	☐	☐

Figure 6-31: Storm Track Data

2. If the storm did not impact the study area, a message box will appear, indicating that wind speed calculations are zero for the selected storm (Figure 6-32).

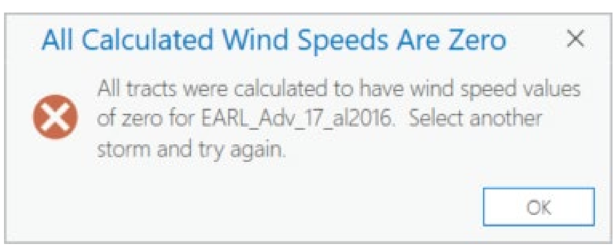


Figure 6-32: Window Message Indicating Calculated Wind Speeds at Zero

3. Once **Create** is selected, the HURREVAC Scenario window will transition to the Progress tab, where the status of the process will be displayed.

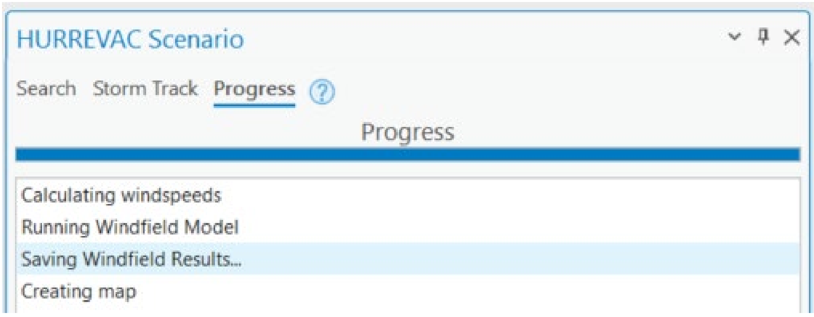


Figure 6-33: HURREVAC Scenario Progress Tab

4. The HURREVAC scenario is now active and ready for analysis (see Section 7.1).

Section 7. Analysis Ribbon Button

Once a scenario is created for the Study Area, access the **Analysis** ribbon button to run the Hazus project's analysis.

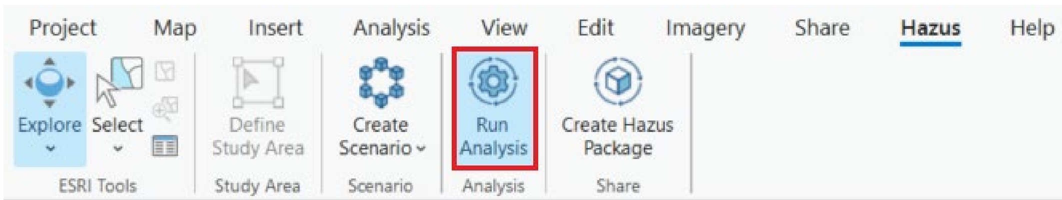


Figure 7-1: Analysis Ribbon Button and the Hazus Ribbon

7.1 Run Analysis

Clicking the **Run Analysis** ribbon button will open the Run Analysis Geoprocessing tool on the right of the screen.

1. Select the desired scenario from the **Scenario** dropdown within the Run Analysis Geoprocessing tool.

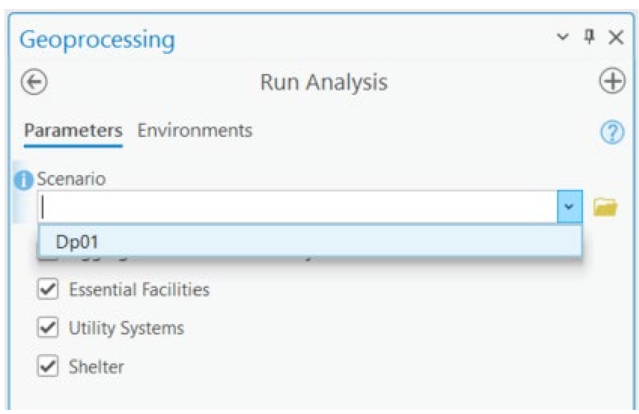


Figure 7-2: Select a Flood Scenario to Run

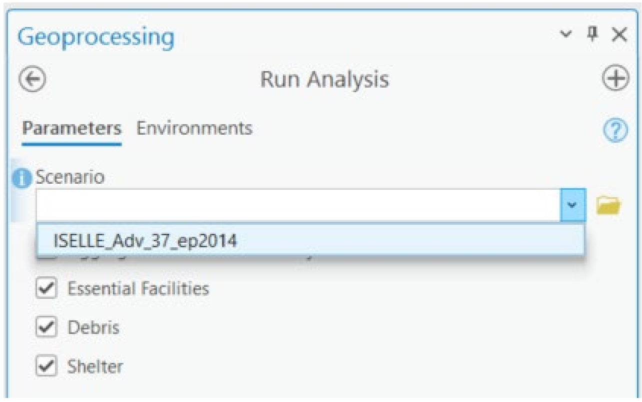


Figure 7-3: Select a HURREVAC Scenario to Run Analysis

The parameter selections in the **Run Analysis** Geoprocessing tool are identical for both the flood or hurricane scenarios. The following is a list of available parameters for both Flood and Hurricane scenarios:

- **Aggregated Baseline Inventory** is a collection of building attributes and model parameters used to assess the impact of natural hazards on a specific study area. The Aggregated Baseline Inventory includes a wide range of building types, such as residential, commercial, industrial, and public service.
- **Essential Facilities** are critical assets that play vital role in disaster response and recovery. This category includes medical care facilities, emergency response facilities, and schools. Schools are included because they often serve as public shelters and housing for displaced individuals during a disaster.
- **Debris** (Hurricane only) provides estimates of potential debris generated by each Hazard Scenario Type. The results include various categories of debris volumes at different geographic levels based on selected scenario.
- **Shelter** estimates of potential shelter needs at the Census Tract level, including the number of people displaced and those seeking shelter. The analysis relies on demographic data and requires evaluation of the Aggregated Baseline Inventory in conjunction with Shelter.

2. Select or deselect the analysis components to be included in the analysis by using the checkboxes next to the name of each analysis component (Figure 7-4).

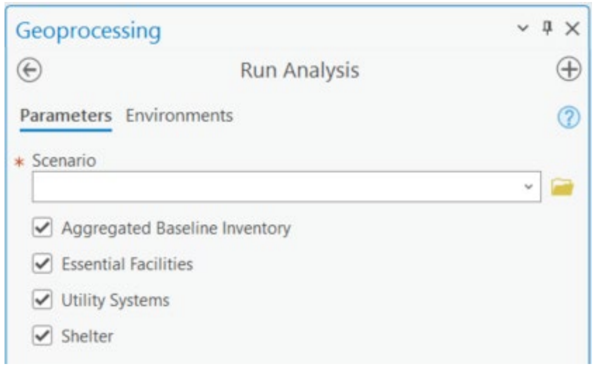


Figure 7-4: All Components Selected for Flood Analysis

3. Click the **Run** button at the bottom of the Geoprocessing tool to run the analysis. The time required to produce results will vary depending on the size of the Study Area, amount of enhanced data imported, and the hazard scenario created.

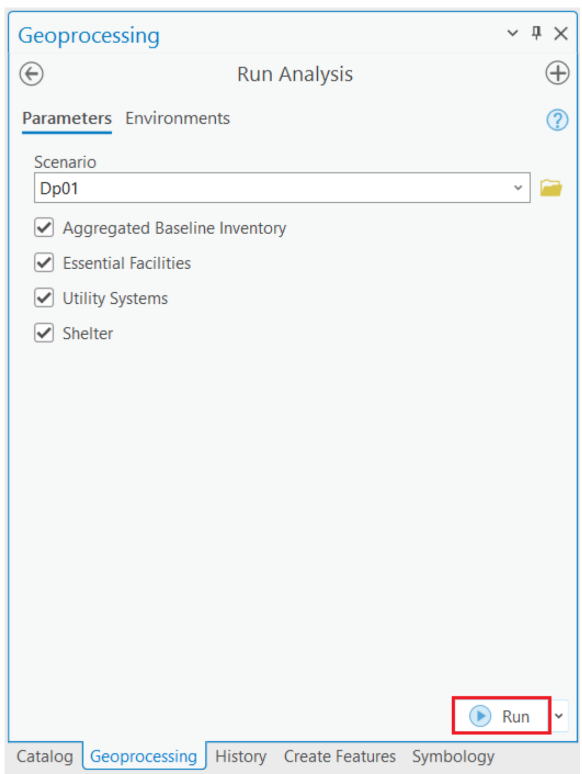


Figure 7-5: Run Analysis

4. When running an AAL scenario for Flood, a new option labeled **Average Annualized Loss (AAL)** will appear at the bottom when proceeding to **Run Analysis.** Be sure to select this option if performing the AAL analysis.

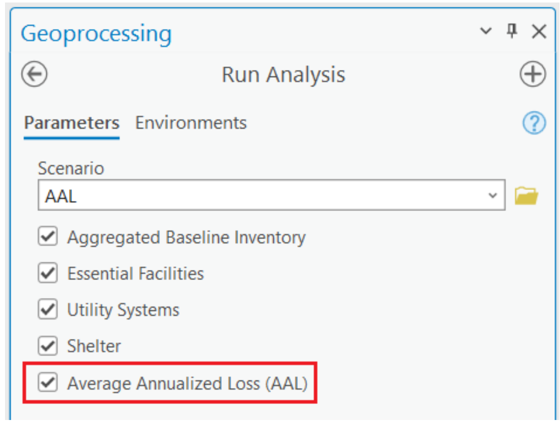


Figure 7-6: Run Analysis For AAL

5. Once the analysis is complete, a green checkmark will appear at the bottom of the Geoprocessing tool.

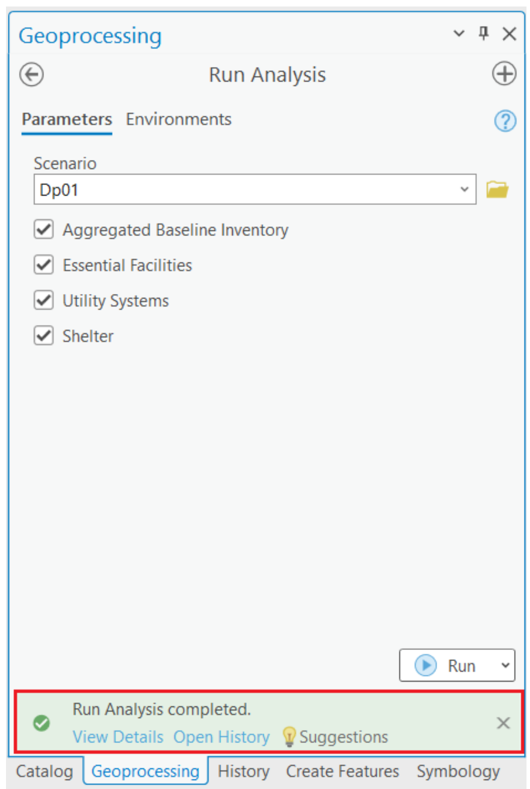


Figure 7-7: Completed Flood Analysis

6. A new map view is created once the analysis has run successfully. This map view will be named after the **Scenario** name entered at the top of the Geoprocessing tool.

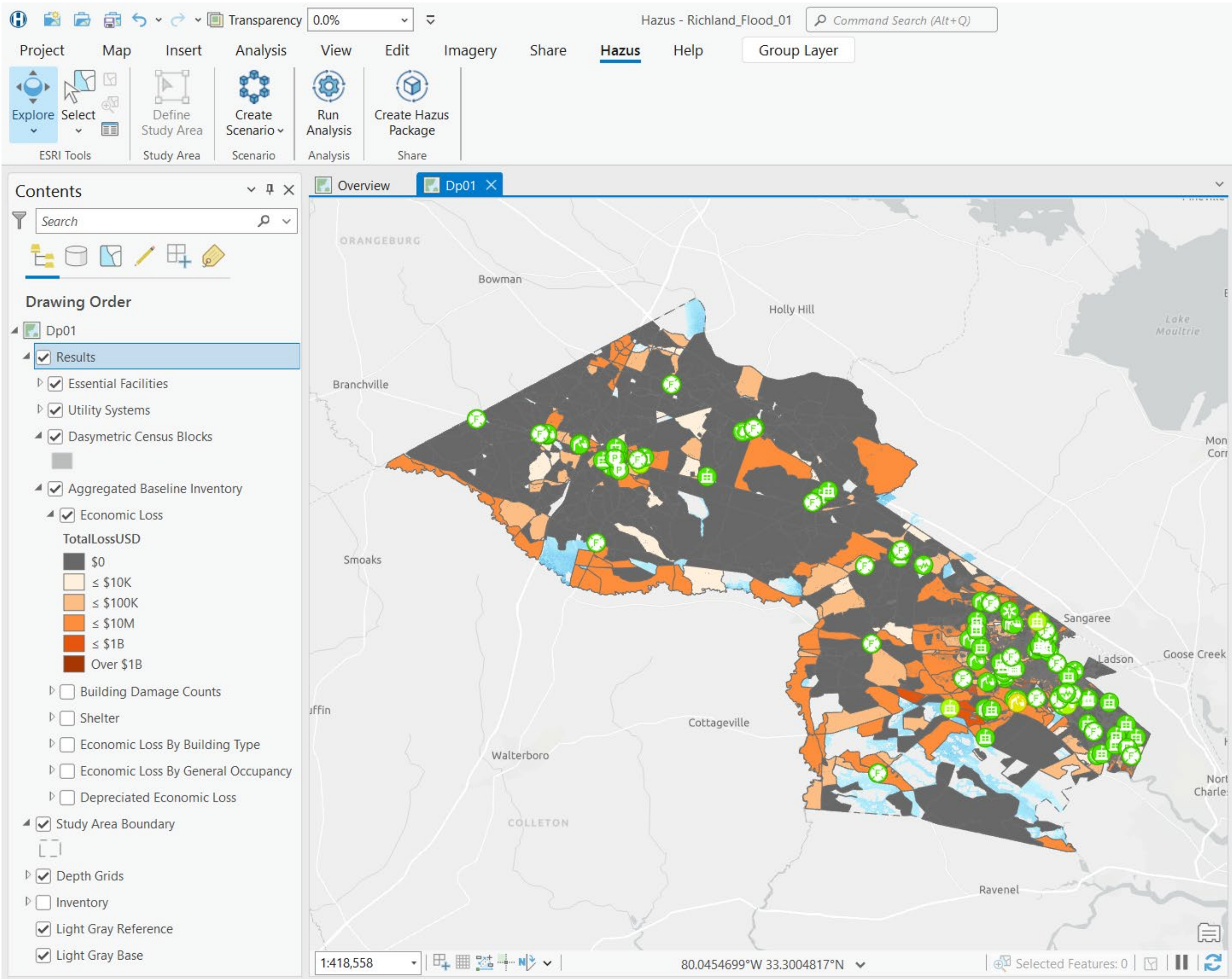


Figure 7-8: Completed Flood Analysis Map View

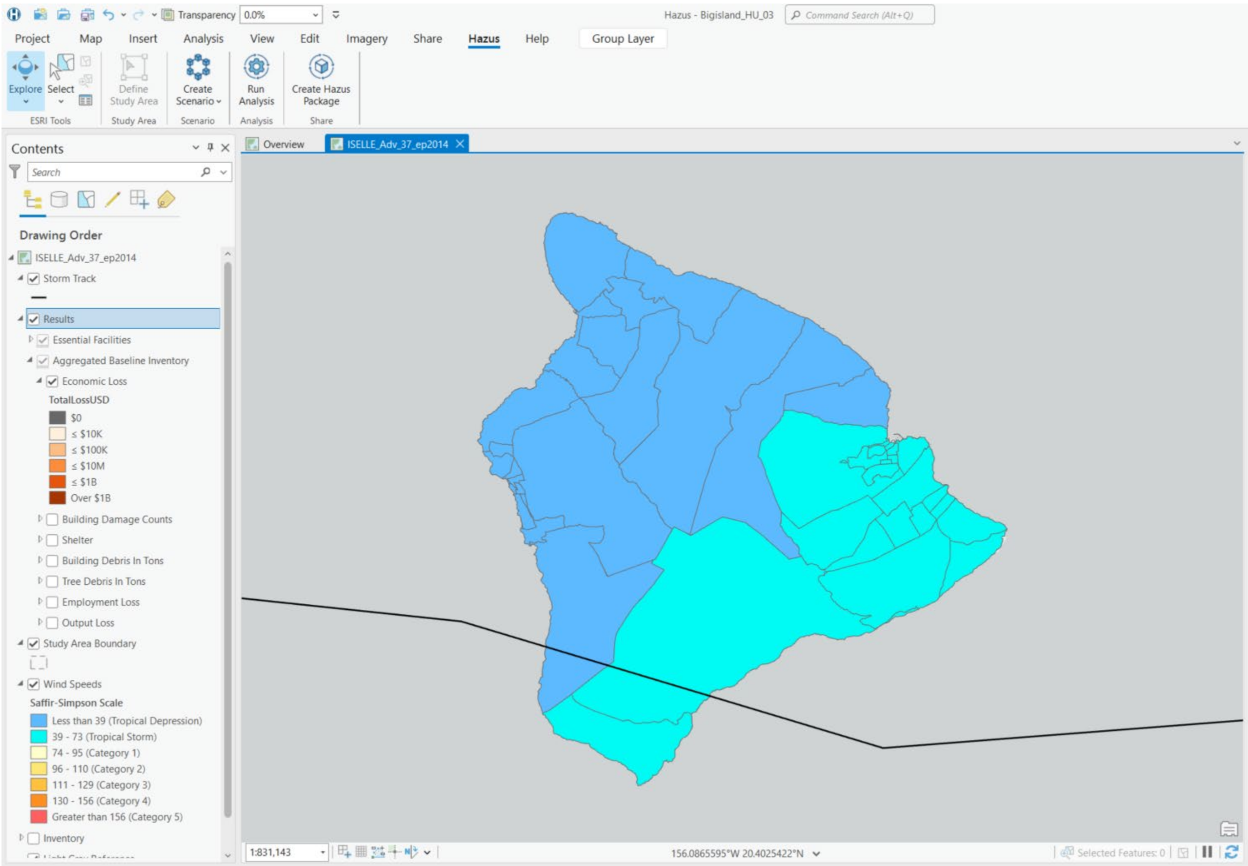


Figure 7-9: Completed HURREVAC Analysis Map View

7. The analysis is now complete. The results can be viewed in the Table of Contents on the left side of the screen. For details on how to interpret the analysis, please refer to Section 9 in the User Guide.

Section 8. Results

Once the Analysis is completed for either a Flood or Hurricane Wind scenario, the results can be viewed directly from the Contents windowpane on the left side of the screen. The results are grouped under their respective **Scenario Name** and displayed as layers that can be accessed and shown within the map viewer (Figure 8-1).

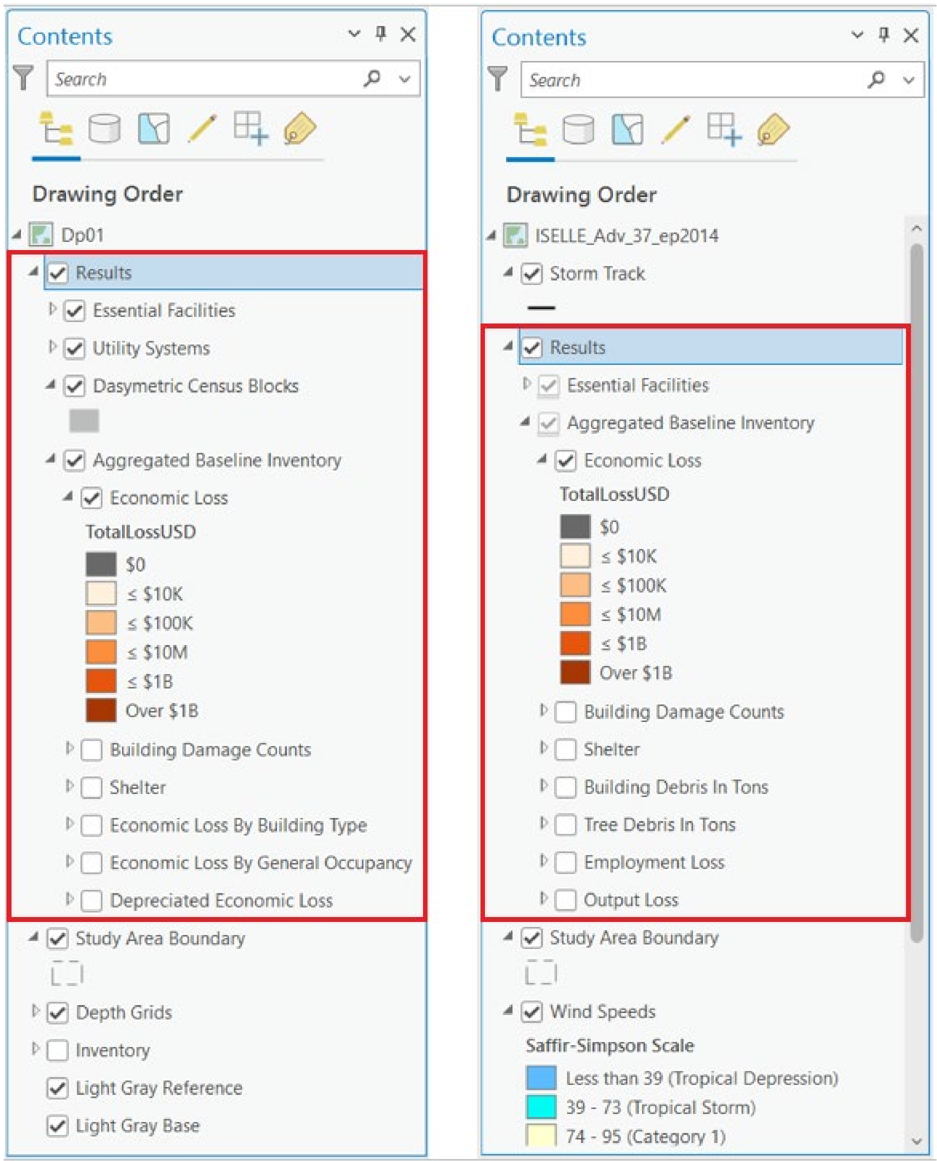


Figure 8-1: Flood and HURREVAC Scenario Results Layers in TOC

1. To view the results, select and expand one of the layers. This will visualize the layer on the map view and open an attribute table to interact with the data (Figure 8-2).

2. Each result layer is represented with unique point symbols and color ramps to enhance organization of the output. These symbols are visible only at scales larger than 1:500,000.

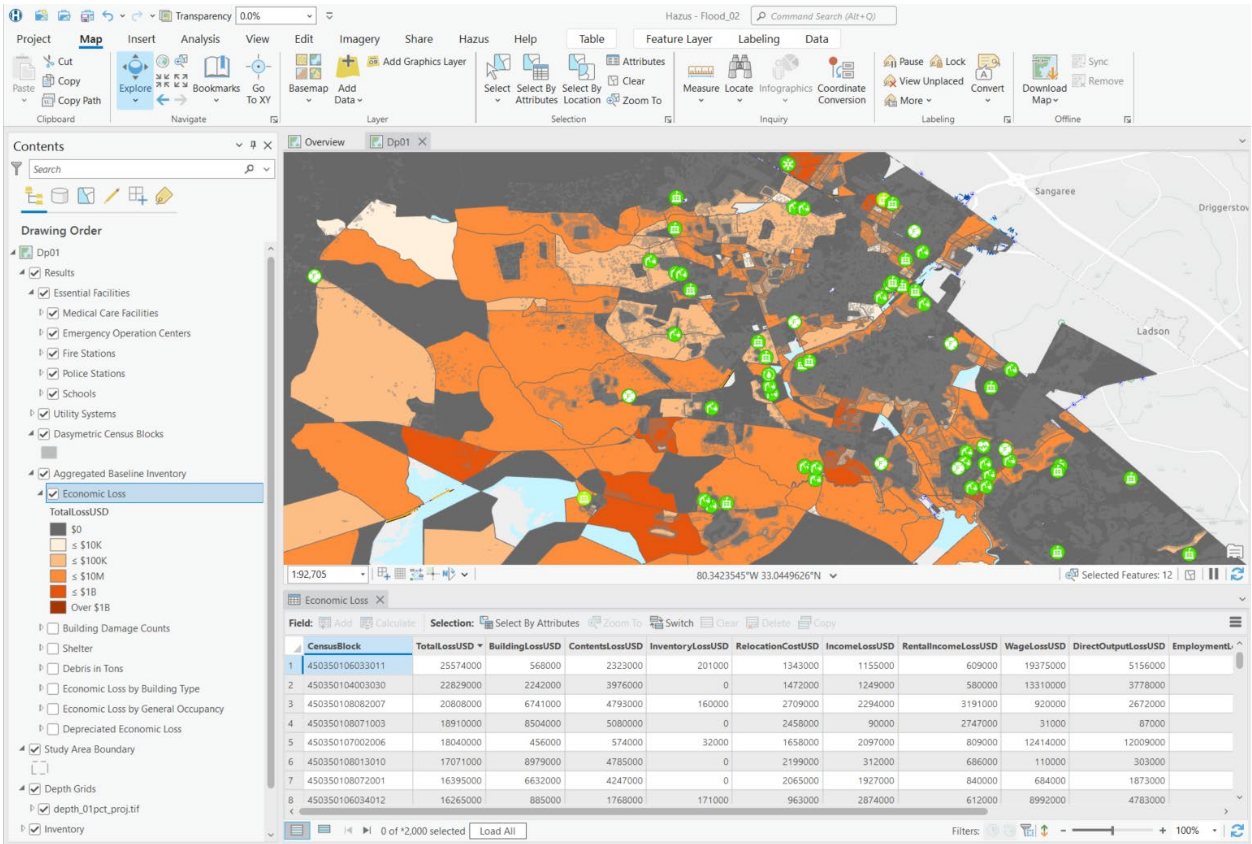


Figure 8-2: Viewing a Single Result Layer

2. Different geographies can be selected separately, or several geographies can be chosen at once within the Study Area to view those specific results. Additionally, result layers can be exported to an individual shapefile for further analysis.

3. To modify data visualizations or maps, Hazus 7.0 uses the default capabilities of ArcGIS Pro for adjusting colors, symbols, and other elements. For more information on these abilities, please refer to the Esri Learning Resources and support.

4. The Hazus project can be exported and shared using the **Create Hazus Package** tool found in the ribbon. For detailed instructions, see Section 10.

8.1 Inventory Data

Inventory and Aggregated Baseline Inventory data can be accessed from the overview and result map views within Hazus project. The inventory data layers will appear in the TOC on the left pane. This data includes information about various types of buildings, essential facilities, and infrastructure such as roads, bridges and utilities. The inventory typically encompasses population, geospatial location and attributes such as occupancy types, construction materials, and replacement costs.

8.1.1 Attribute Table

The attribute tables are a crucial component of Hazus. Users can access the attribute tables for both inventory and results layers in the TOC on the left pane. These tables include various data categories, such as damage percentage, dollar losses, displaced households, loss of functions, and more. To access a table, simply select the desired layer and right-click to open the attribute table.

Section 9. Interpreting Results

As mentioned earlier in this guide, Hazus provides *estimates* of losses for its results and these should not be treated as definitive figures of dollars or casualties. The nature of representative nationwide inventory datasets, variation in hazard event definition, and multitude of adjustable analysis parameters are each factors in how Hazus-modeled impacts may differ from real-world events. Because of this, it is important to interpret results and convey their meaning appropriately to different audiences.

9.1 Guidance for Disseminating Hazus Loss Outputs

There is no single format that is most appropriate for the presentation of loss study results to non-Hazus users. The optimal format will depend on the use of the results and the intended audience. Audiences can vary from the general public to technical experts. Decision-makers such as city council members, county commissioners, local and state emergency management staff, and other government officials may require only summaries of losses for a region. Emergency managers or response planners may want to see the geographical distribution of all losses and damage for several different loss scenarios. Hazus provides a great deal of flexibility in presenting results in either a tabular or map form, and which maps or tables are selected for reports will depend on the intended use of the results. As a best practice, the users of the results should be involved from the beginning in determining the types and formats of the results that best suit their needs.

Reports should focus on describing results in non-technical language that is easily understood by the intended audience, using the following recommendations:

- Reports should serve to **clarify the meaning** of the loss estimates. For example, the reporting of economic loss should indicate whether direct losses are included in the estimates. The report should indicate whether losses are due only to structural and nonstructural damage or whether they also include monetary losses resulting from loss of function. Casualty reports should indicate that casualties include only those that result from building damage and bridge collapse and do not include injuries and deaths from fires, hazardous material releases, or other secondary impacts. It should be clarified that in most cases, losses are not calculated for specific buildings or facilities but instead are based on the performances of entire classes of buildings and systems. These are just a few examples of the types of clarifications that should appear in reports citing Hazus outputs.

- Reports should also **clarify the assumptions** that were made in developing the scenario and inventory and in calculating losses. For example, were losses based on baseline inventories or were baseline inventories augmented? Were baseline repair costs and repair times used? If not, what values were used? Were detailed hazard event maps provided or were results based on a baseline assumption, such as a uniform soil type in an earthquake event? What assumptions were made in selecting the event scenario? Is it based on a historical event? Is it based on a specified probability of occurrence (e.g., 10% chance in 200 years)? What types of assumptions were made about design and construction quality of structures in the Study Area?

Some users may note that Hazus produces single values for its output, rather than ranges of possible values with confidence intervals. While this methodology does not explicitly include a technique for carrying the uncertainty of each variable through the entire set of calculations, sensitivity analyses are useful for providing bounds on loss estimates. At a minimum, reports citing Hazus outputs should make some statement about the uncertainty of the input values, depending on analysis style and audience preference.

Section 10. Create a Hazus Project Package

Once the Hazus Project is complete, it can be shared with another individual or saved to another location for future reference. This function can be accessed through the **Share** Ribbon Button in the Hazus menu shown Figure 10-1.

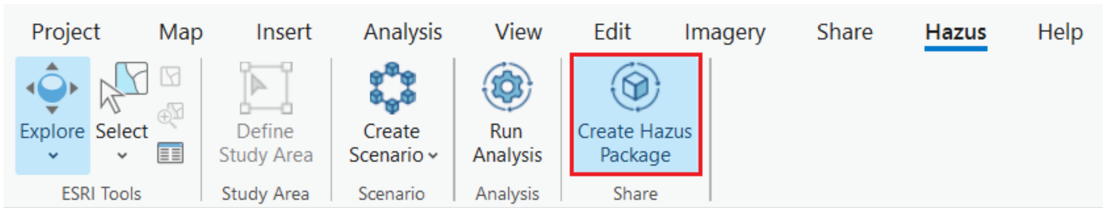


Figure 10-1: Create Hazus Package and the Hazus Ribbon

1. The **Create Hazus Package** ribbon button initiates the process of packaging the Hazus Analysis and map. Clicking this ribbon button will open the Geoprocessing tool on the right side of the screen.

2. The Output File will automatically populate with the current project's name and a save location. Click **Run** to begin the packaging process (Figure 10-2).

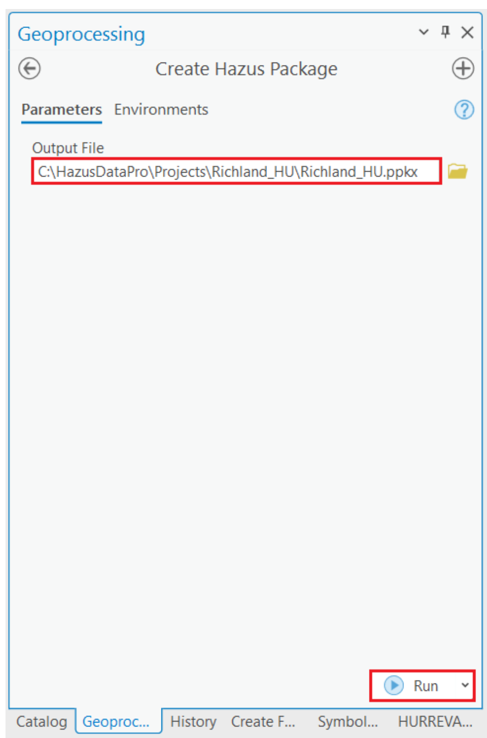


Figure 10-2: Create Hazus Package Geoprocessing Tool

3. The Hazus Package is now ready to share with other users.