E0170: Hazus for Hurricanes

Student Manual

Date Released: 08/2020

FEMA

Contents

Handouts: Reference Materials

Handouts Outline

The table below contains the type, number, and description of each handout. The data needed column identifies major datasets required to complete the activity. The data provided column identifies if that dataset is provided in the zip folder E0170_ActivityData for download.

Type	Number	Description	Data Needed	Data Provided?
Exercise	1.2	Build a hurricane study region.	TX	No
Activity	2.1	Explore the Comprehensive Data Management System (CDMS).	FL	No
Exercise	2.2	Update state database using CDMS and create a new study region.	FL; GBS.mdb,MedicalCareFacilities.mdb	No; Yes
Activity	3.2	Explore the Hazus inventory.	N/A	N/A
Exercise	4.1	Create multiple historic storm scenarios and review the results.	1916-6.pdf, 1919-2.pdf, harvey2017.pdf	Yes
Activity	4.2	Import Hurricane Harvey data using HURREVAC.	N/A	N/A
Exercise	4.3	Create a	Harvey_Winfield_HazusReady.dat	Yes

Type	Number	Description	Data Needed	Data Provided?
		scenario with .dat data.		
Activity	4.4	Import Hurricane Irma data using a .bin file.	FL; IrmaLandfallTrack.bin	No; Yes
Activity	5.2	Run a probabilistic scenario.	Probabilistic.hpr	Yes
Demonstration	6.1	Review and discuss curve viewers.	Irma_Hurricane.hpr	Yes
Exercise	6.2	Modify the surface roughness parameters in order to see the effect on the damages and losses.	N/A	N/A
Demonstration	7.1	View results and reports from a hurricane analysis.	Irma_ResultsReport.hpr	Yes
Exercise	7.2	Learn methods for displaying hurricane results.	HurricaneMichael.hpr, TotalExposure.mdb	Yes
Exercise	8.2	Run a historic scenario and modify the economic loss parameters.	FL; case1.pdf, case2.pdf, case3.pdf, case4.pdf, case5.pdf, case6.pdf	No; Yes

Type	Number	Description	Data Needed	Data Provided?
Demonstration	9.1	Show how to view shelter and tree parameters	HurricaneMichael.hpr	Yes
Exercise	9.2	Explore the impact of altering tree and sheltering parameters	N/A	N/A
Activity	10.2	Create a combined Flood/Hurricane study region.	FL	No
Exercise	10.3	Explore the Surge menu items in the hurricane model and flood model. Discuss the reports and tables from the combined losses.	Irma_Surge.hpr	Yes
Discussion	11.1	Discuss mitigation options.	N/A	N/A
Exercise	11.2	Run various mitigation scenarios. Compare and contrast the results.	FL	No
Demonstration	12.1	Discuss and demonstrate Forecast	Demo12.1_Forecast39.hpr, Demo12.1_Forecast44.hpr	Yes

Type	Number	Description	Data Needed	Data Provided?
		Advisory Uncertainties.		
Exercise	12.2	Run various user-defined scenarios. Compare the results.	TX; forecast advisory 21 global summary report.pdf, Harve Forecast Advisory 21.pdf, Harvey_Windfield_HazusReady.dat, hurrevac gloval summary report.pdf, hwind global summary report.pdf	No; Yes
Exercise	13.1	Modify uncertain and sensitive variables in Hazus. Run multiple scenarios. Compare the results.	FL; IrmaLandfallTrack.bin	No; Yes

Data Dictionary

The table below contains the type, number, and data file name for each exercise. The data provided can be found in the zip folder E0170_ActivityData for download.

Type	Number	Data Folder Name	Data Provided
Exercise	1.2	N/A	N/A
Activity	2.1	Activity_2.1	N/A
Exercise	2.2	Exercise_2.2	GBS.mdb, MedicalCareFacilities.mdb

Type	Number	Data Folder Name	Data Provided
Activity	3.2	N/A	N/A
Exercise	4.1	Exercise_4.1/Results	1916-6.pdf, 1919-2.pdf, harvey2017.pdf
Activity	4.2	N/A	N/A
Exercise	4.3	Exercise_4.3	Harvey_Winfield_HazusReady.dat
Activity	4.4	Activity_4.4	IrmaLandfallTrack.bin
Activity	5.2	Activity_5.2	Probabilistic.hpr
Demonstration	6.1	Demonstration_6.1	Irma_Hurricane.hpr
Activity	6.2	N/A	N/A
Demonstration	7.1	Demonstration_7.1	Irma_ResultsReport.hpr
Exercise	7.2	Exercise_7.2	HurricaneMichael.hpr, TotalExposure.mdb
Exercise	8.2	Exercise_8.2/Results	case1.pdf, case2.pdf, case3.pdf, case4.pdf, case5.pdf, case6.pdf
Demonstration	9.1	Demonstration_9.1	HurricaneMichael.hpr
Exercise	9.2	N/A	N/A

Type	Number	Data Folder Name	Data Provided
Activity	10.2	N/A	N/A
Exercise	10.3	Exercise_10.3	Irma_Surge.hpr
Discussion	11.1	N/A	N/A
Exercise	11.2	Exercise_11.2	N/A
Demonstration	12.1	Demonstration_12.1	Demo12.1_Forecast39.hpr, Demo12.1_Forecast44.hpr
Exercise	12.2	Exercise_12.2	forecast advisory 21 global summary report.pdf, Harve Forecast Advisory 21.pdf, Harvey_Windfield_HazusReady.dat, hurrevac gloval summary report.pdf, hwind global summary report.pdf
Exercise	13.1	Exercise_13.1	IrmaLandfallTrack.bin

A Note on Understanding Images

Please note that many of these documents contain images that assist in the completion of the activities. These images are explained both by the surrounding text and by the alt text provided with the image. For individuals accessing the course with the relevant technology, please read the surrounding text and the alt text to gain a full understanding of the image.

Lesson 1: Hazus for Hurricanes

Visual 1: Lesson 1: Introductions and Overview

Visual 2: Let's Get Acquainted!

- Participant introductions
  - Name
  - Organization
  - Role in organization
  - Hazus, GIS, and hazard analysis experience
  - Goals and expectations for this class
- Instructor introduction

Visual 3: Course Agenda

Day One:

- Lesson 1: Introduction and Overview
- Lesson 2: Hazus Inventory
- Lesson 3: Hurricane Wind Model
- Lesson 4: Deterministic Scenarios
- Lesson 5: Probabilistic Scenarios

Day Two:

- Lesson 6: Damage Models
- Lesson 7: Hurricane Model Results
- Lesson 8: Economic Loss Methodology

Visual 4: Course Agenda

Day Three:

- Lesson 9: Hurricane Surge Model
- Lesson 10: Shelter and Debris Models
- Lesson 11: Mitigation Analysis
- Lesson 12: Hazus Response and Recovery Applications

Day Four:

- Lesson 13: Uncertainty and Sensitivity
- Lesson 14: Capstone Exercise
- Lesson 15: Course Wrap Up

Visual 5: Course Prerequisites

- Have a broad understanding of the goals of loss estimation and hurricane hazards
  - This course will provide an introduction to assessing risks associated with natural hazards and orients participants to Hazus capabilities
  - This course will focus on Basic and Intermediate analyses
- Have familiarity with ArcGIS
- Have successfully completed E0313: Basic Hazus

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Course Prerequisites

Information from National Preparedness Course Catalog Website.
(https://www.firstrespondertraining.gov/frt/npccatalog/EMI#anc-search-results)

Visual 6: Course Tasks

- Lecture
- Discussion
- Demonstration: Instructor-Only
  - Students observe instructor completing task
- Activity: Instructor-Led
  - Guided Practice
  - Students follow along and complete task with Instructor
- Exercise: Student-Led
  - Individual or Small Group Practice
  - Hands-on
  - Shows how to apply material from this course to an actual incident

Visual 7: Hints for Success

Ask LOTS of questions! There are NO "silly" questions.

Share your experiences with the rest of the class - they will learn from you and you from them.

Try to apply the concepts presented in class to your own needs. If you don't see applicability, ask for an example.

Practice the skills that you learn in class right away.

- In class (exercises and activities)
- After class (use it or lose it)

Visual 8: Lesson 1: Goal and Objectives

Goal: To provide an overview of Hazus and review the Hazus Hurricane Model.

After completing this lesson you will be able to:

- Describe Hazus and the various hazards it supports.
- Differentiate between the Hazus Hurricane Model and Surge Model.
- Explain the differences in Hazus analysis levels as they pertain to the hurricane model.

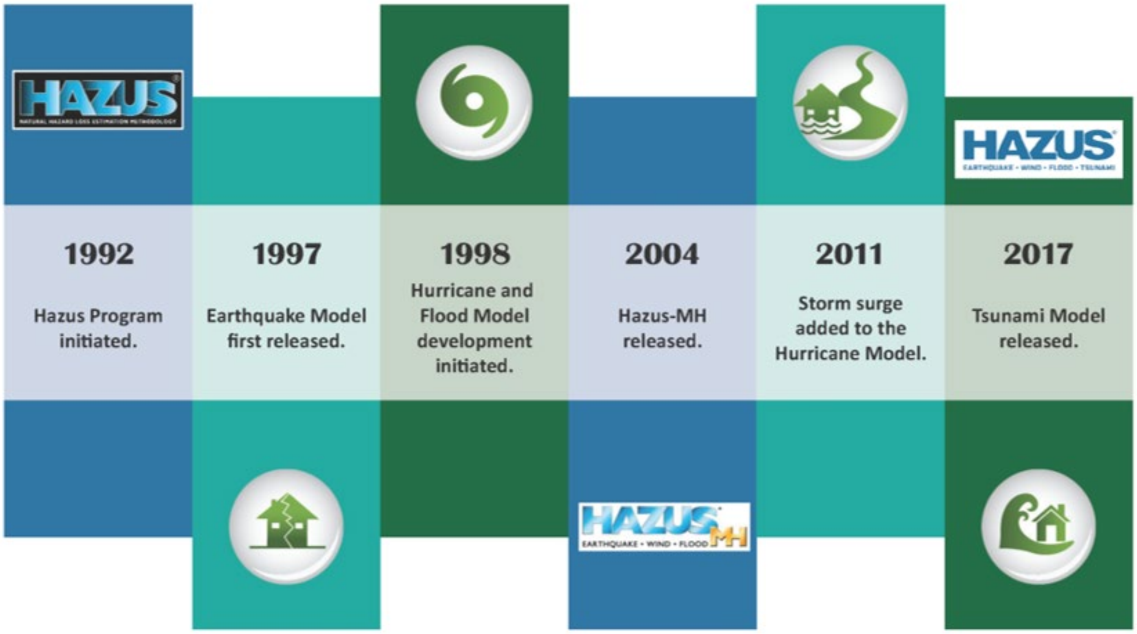
Visual 9: What is Hazus?

- A package of software tools and support system designed by FEMA for the purpose of providing communities with the means to identify and reduce risk from natural hazards
- Used by a variety of communities and organizations
- Available from FEMA free of charge (requires ArcGIS license with Spatial Analyst extension)

Visual 10: Supported Hazards

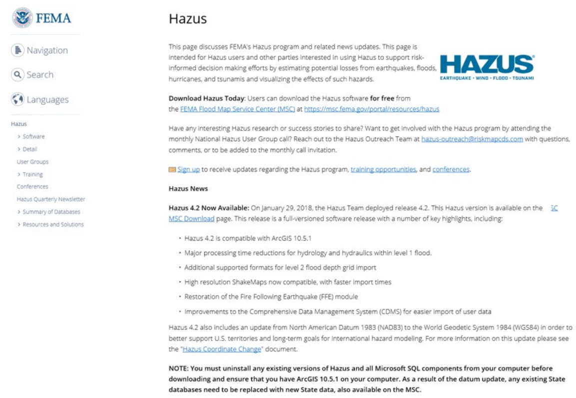
- **Hurricane Wind and Storm Surge**
- **Riverine and Coastal Flooding**
- **Earthquake**
- **Tsunami**

Visual 11: History



Visual 12: FEMA Hazus Website

Primary FEMA resource for updated information related to Hazus: FEMA Hazus Website (www.fema.gov/hazus)



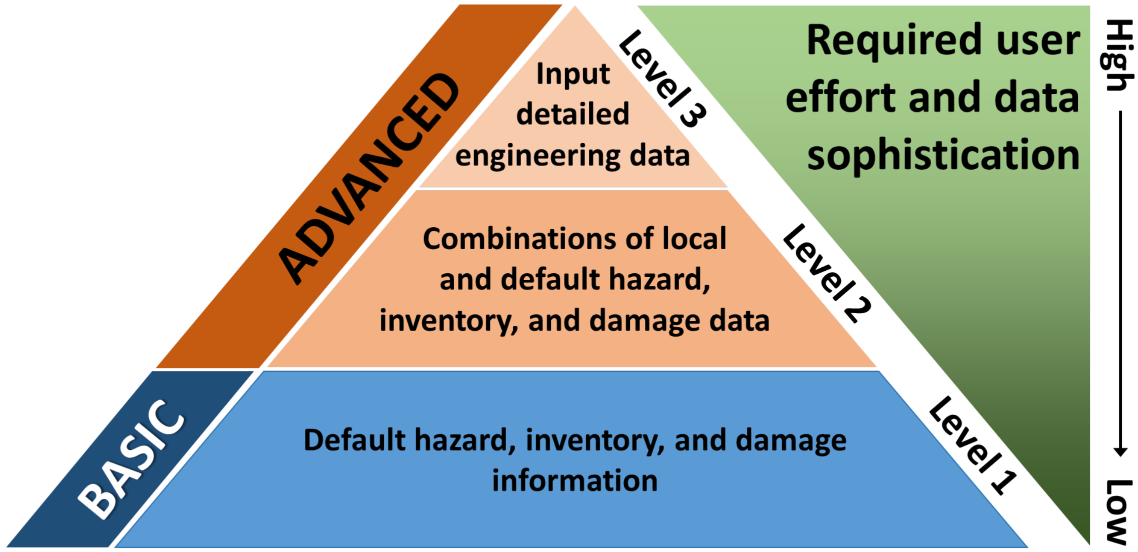
Visual 13: Using Hazus to Support Emergency Management

- Identify vulnerable areas
- Estimate potential impacts of hazards
- Inform resource allocation
- Prioritize mitigation measures
- Assess level of readiness and preparedness
- Inform response and post-disaster recovery efforts

Visual 14: Who is a Hazus User?

- Hazus is used by a variety of communities and organizations across the United States:
  - Local and State Government
  - Federal Agencies
  - Educational Institutions
  - Private Industry
  - Others
- Considerable international interest

Visual 15: User Levels



Visual 16: Hurricane Levels of Analysis

- Level 1: Analysis Based on Default Information
  - Default general building stock and essential facility databases
  - Default database of surface roughness and tree coverage
- Level 2: Analysis with User-Supplied Inventory
  - Modify the general building stock and essential facility databases based on local expertise
  - Develop maps of tree coverage
  - Use local data concerning direct economic analysis parameters
- Level 3: Analysis with Advanced Data
  - Supply local terrain (surface roughness data)

Visual 17: Inventory (Exposure)

General building types and occupancies

- Lifelines
- Replacement costs
- Demographics

Hazard-specific

- Specific building types
- First floor elevations
- Building configurations

Visual 18: Loss Estimation Process

- Identify hazard
- Identify physical landscape
- Consider what is at risk
- Produce maps, tables, and reports
- Analyze social and economic impacts

Visual 19: Integrating User-Provided Data

Non-Hazard Data Integration Tools

- Comprehensive Data Management System (CDMS) enables integration of locally developed non-hazard data
- CDMS validates that user data are compliant with Hazus requirements

Hazard Data Integration

- ShakeMap (for EQ) and Hurrevac (for HU) hazard data integration
- Each model includes tools for integrating user-provided hazard data

Techniques for integrating user-provided data are covered in other courses

Visual 20: Hazus 4.2 Capabilities

Hazus 4.2 Capabilities	Earthquake	Flood	Hurricane	Tsunami
Inputs	**Ground Shaking** **Ground Failure**	**Frequency |Depth** **Riverine |Coastal Surge**	**Wind** **Surge**	**Depth |Momentum Flux** **Runup |Velocity**
Historic	x	x	x	
Deterministic	x	x	x	x
Probabilistic	x	x	x	
User-supplied	x	x	x	x
Other supported inputs	Real-time & scenario USGS ShakeMaps	Risk MAP, User-supplied depth grids (ArcGRID, GeoTIFF, IMAGINE), HEC-RAS (.FLT)	Hurrevac, User-supplied wind files (.dat)	NOAA PMEL SIFT, State models

Visual 21: Hardware and Software Requirements

- Memory: 4 GB or higher
- Disk space: 10GB for one multi-hazard large urban study region, plus inventory data size (varies by state), or 70 GB to store entire U.S. inventory data
- Graphics Adaptor: 24-bit capable video card with at least 128 MB of video memory, resolution of 1078 x 768 or higher
- Operating Systems: Windows 10 Pro and Enterprise, Windows 8.1*, and Windows 7 Pro* (64-bit); only U.S. English version are supported for use**
- Supporting Software: Appropriate version of Esri ArcGIS for Desktop and the Spatial Analyst extension for the flood and tsunami models

*Hazus is no longer supported but still operates on these platforms

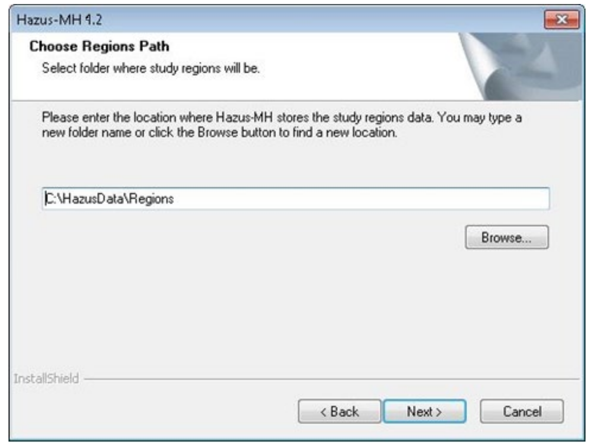
**Hazus can be installed on other windows operating systems/service packs, but Hazus may not operate as expected with those operating systems/service packs.

Visual 22: Installation

- Log in with a full Administrator account
- Download Hazus from the Map Service Center website. (msc.fema.gov/portal/resources/hazus)
- Unzip the downloaded file
- Right-click on setup.exe file and select “Run as Administrator” option
- “Administrator Rights” can vary - consult the “Getting Started.pdf” document to ensure a proper installation

Visual 23: Study Region Location

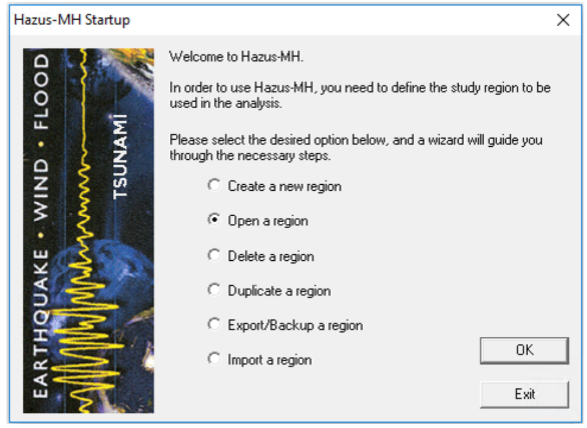
- All study regions will be created in the folder specified in this window
- All data related to the Study Region will be stored in this location
- Default location is C:\HazusData\Regions



Visual 24: Study Region Size

- Size limit of 10 GB per database for SQL Server 2014 Express
- The success of a Hazus analysis will depend on the available system resources of the PC
- Large flood (riverine or coastal) and combined flood/wind analyses require large amounts of system resources even for small geographic areas (e.g., a single county)

Visual 25: Study Region Options

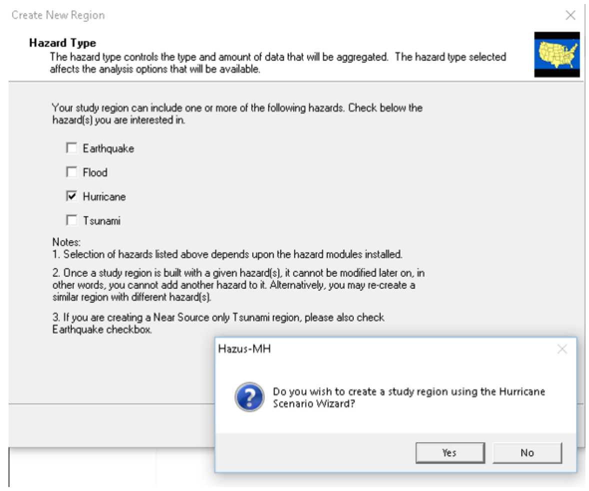


Hazus Startup Dialog

- Create a new region
- Open a region
- Delete a region
- Duplicate a region
- Export/Backup a region
- Import a region

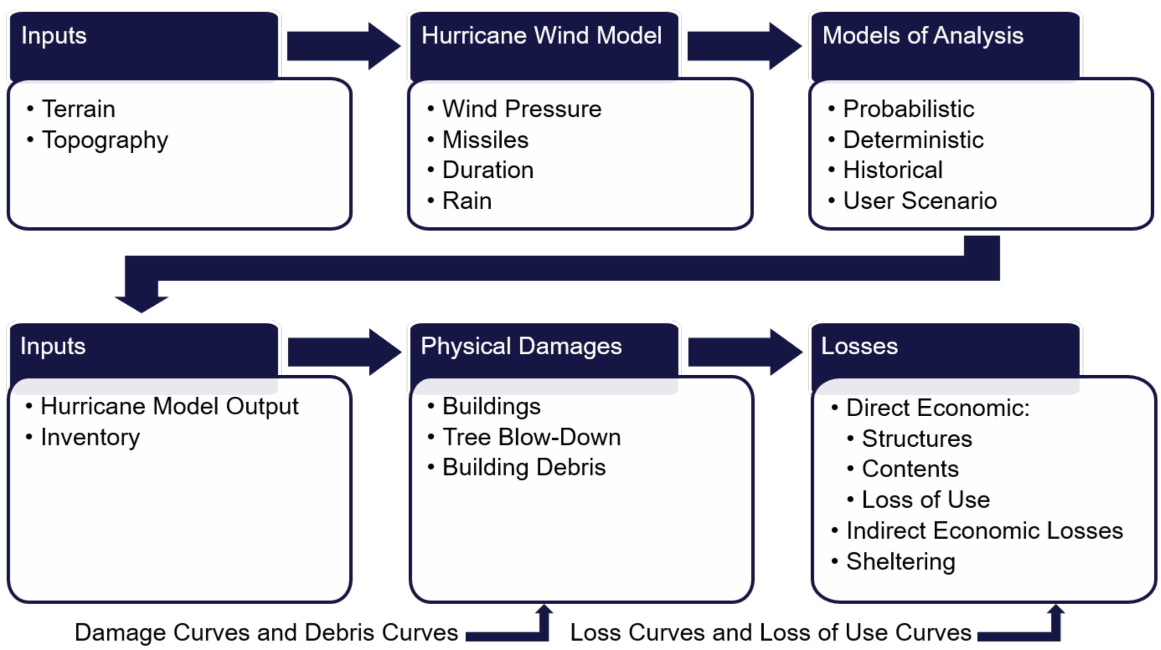
Visual 26: Study Region Creation by Scenario

- Unique to a hurricane-only study region
- When a user creates a hurricane-only study region, it can be defined by a scenario (historic, user-defined, etc.).
- The counties that would experience damage by intersecting with hurricane windspeeds are included in the region.



NOTE: After clicking "Yes" the screen takes you to the scenario wizard.

Visual 27: Components of Hazus Hurricane Wind Model



Visual 28: Hazus Combined Hurricane Wind and Storm Surge Model

- User works in Hurricane Wind model then runs the surge using the Flood model
- Utilizes industry standard models:
    - SLOSH - Sea, Lake, and Overland Surges from Hurricanes; National Weather Service's Meteorological Development Laboratory.
    - SWAN - Simulating Waves Nearshore; Delft University of Technology
- Modified WHAFIS - to propagate waves inland from the shoreline
- Allows for estimation of combined economic losses to general building stock for hurricane scenarios on coastal flood regions
- Avoids double counting of flood and wind losses
- Service Pack 3 allows users to import and run a combined wind/surge with user-defined surge products*

*for user-defined flood hazard information, please reach out to the help desk at hazus-support@riskmapcds.com

Visual 29: Discussion 1.1: Hazus Applications

Goal: Identify two ways that you would like to apply the information that Hazus generates in support of one or more of the following emergency management activities:

- Mitigation
- Preparedness
- Response
- Recovery

Groups: 3 to 6 people

Time: 10 minutes

Discussion 1.1: Hazus Applications

Goal: Identify two ways that you would like to apply the information that Hazus generates in support of one or more of the following emergency management activities:

- Mitigation
- Preparedness
- Response
- Recovery

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Groups: 3 to 6 people

Time: 10 minutes

Discussion Steps:

1. Listen to the instructor's directions.
2. Ask questions if they need directions clarified.
3. Discuss the questions with your group.
4. Designate a group member to share your answers with the class.

Visual 30: Exercise 1.2: Hurricane Study Region

Goal: Build a hurricane study region.

Time: 15 minutes

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Exercise 1.2: Hurricane Study Region

Goal: Build a hurricane study region.

Time: 15 minutes

Exercise Steps:

1. Listen to the instructor's directions.
2. Ask questions if clarification is needed.
3. Work individually on the goal.
4. Ask questions to the instructor if needed.
5. Complete the assigned goal.
6. Be prepared to share your answers/results.
7. Ask any final questions.

Visual 31: Exercise 1.2: Tasks

Task 1: Create a New Study Region.

Task 2: Select Areas Affected by Hurricane Harvey.

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Exercise 1.2: Tasks

- Refer to Activities Document “01.2_Exercise_Hurricane Study Region.”

Exercise 1.2: Hurricane Study Region

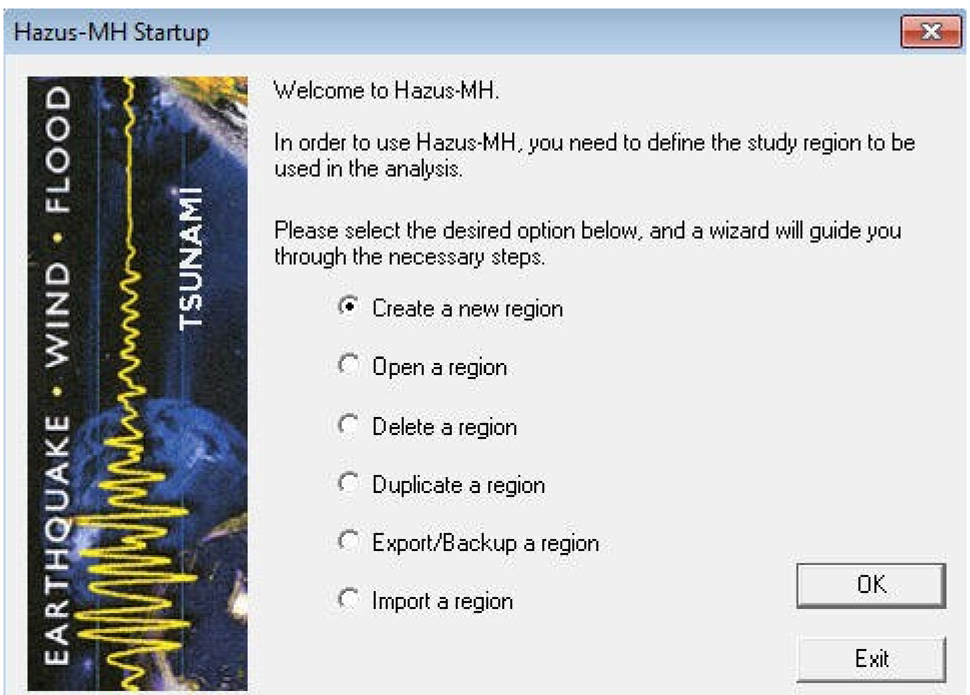
Type: Instructor-Led Exercise

Time: 15 minutes

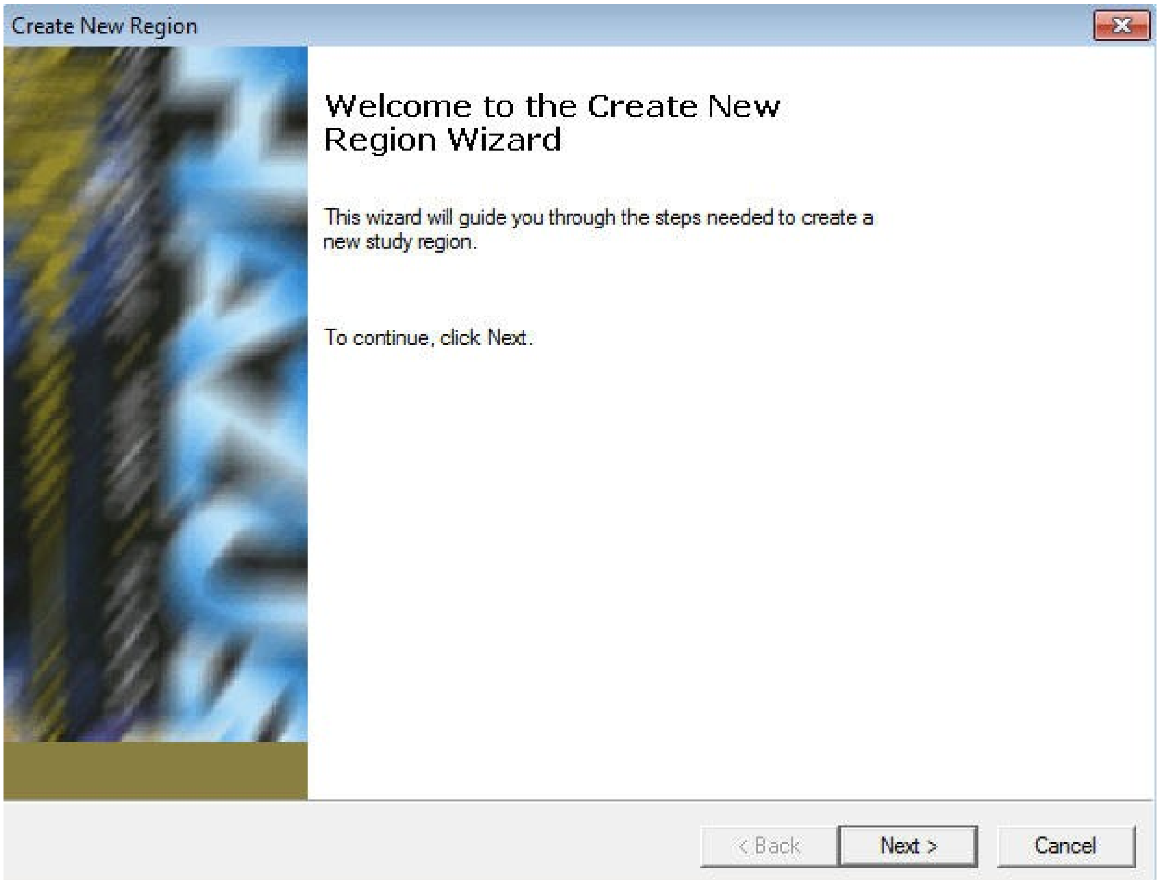
Goals: Build a hurricane study region.

Task 1: Create a New Study Region.

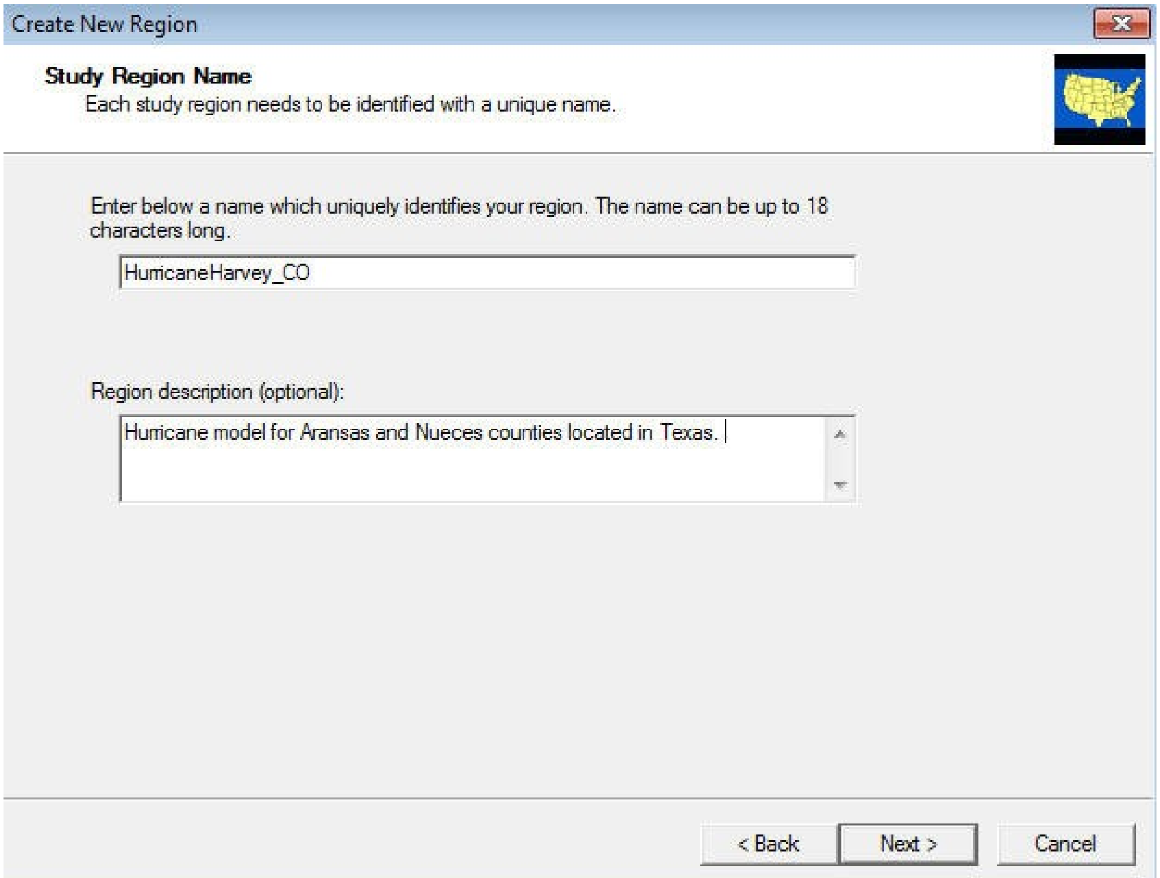
1. Open Hazus from your desktop and select “Create a new region.”
2. Click “OK.”



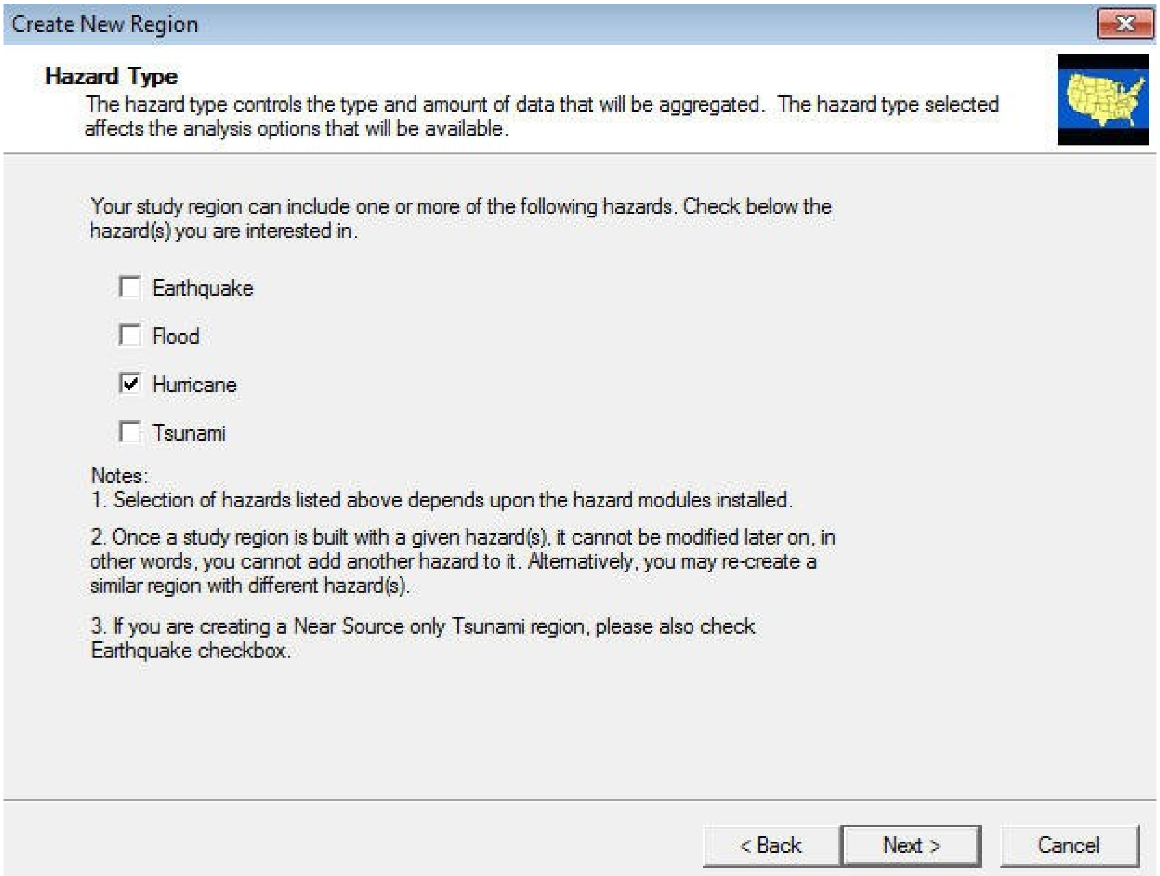
3. Click “Next” on the Create New Scenario Wizard.



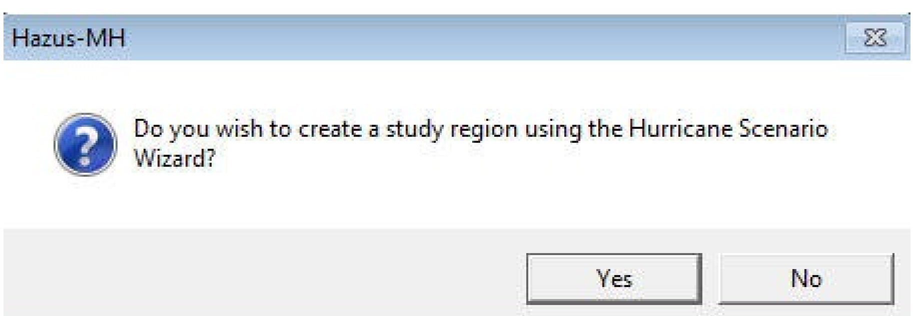
4. Enter a name and a brief description (optional) for your study region. Click "Next."



5. Select "Hurricane" as the Hazard type. Click "Next."

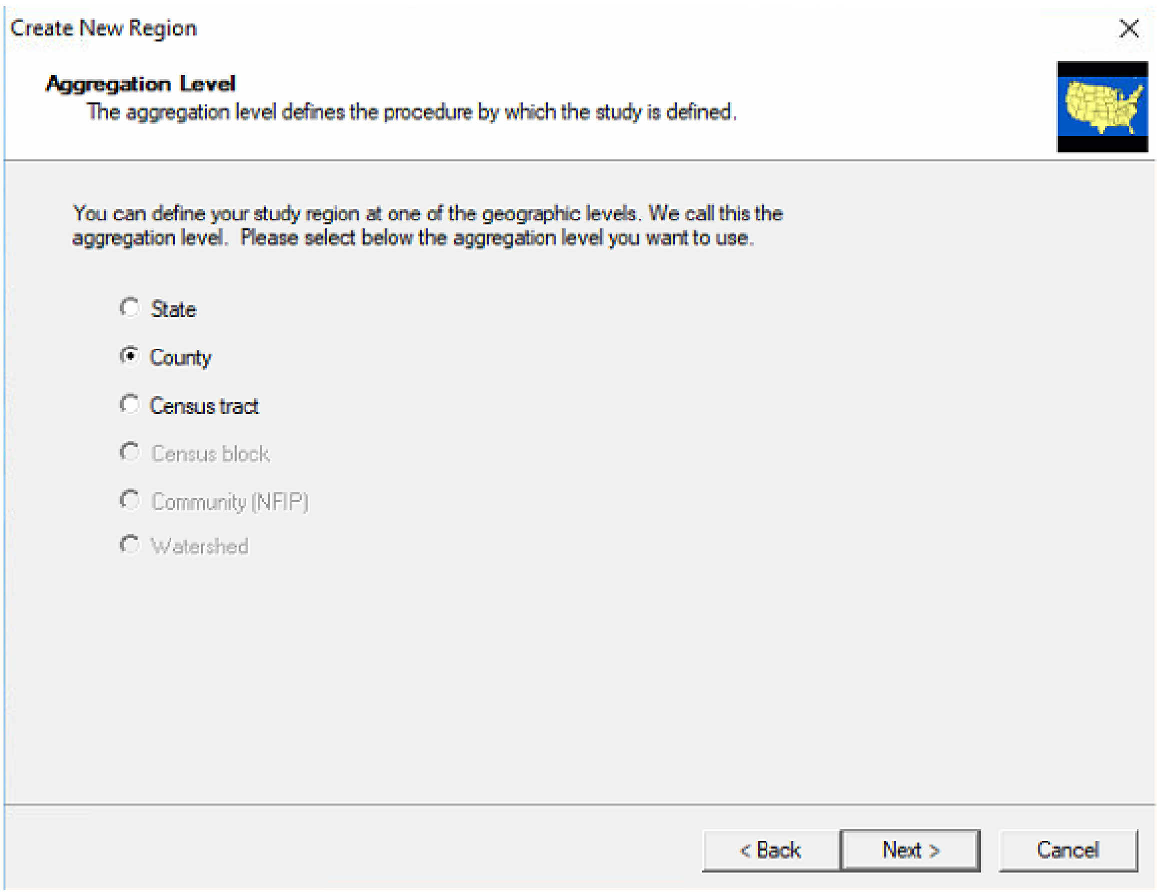


6. Select "No" when prompted to create the study region using the Hurricane Scenario Wizard. By continuing to create the study region only, you will be able to use the study region for multiple scenarios later. If you create a study region using the Hurricane Scenario Wizard, the study region will be used for ONLY that scenario.

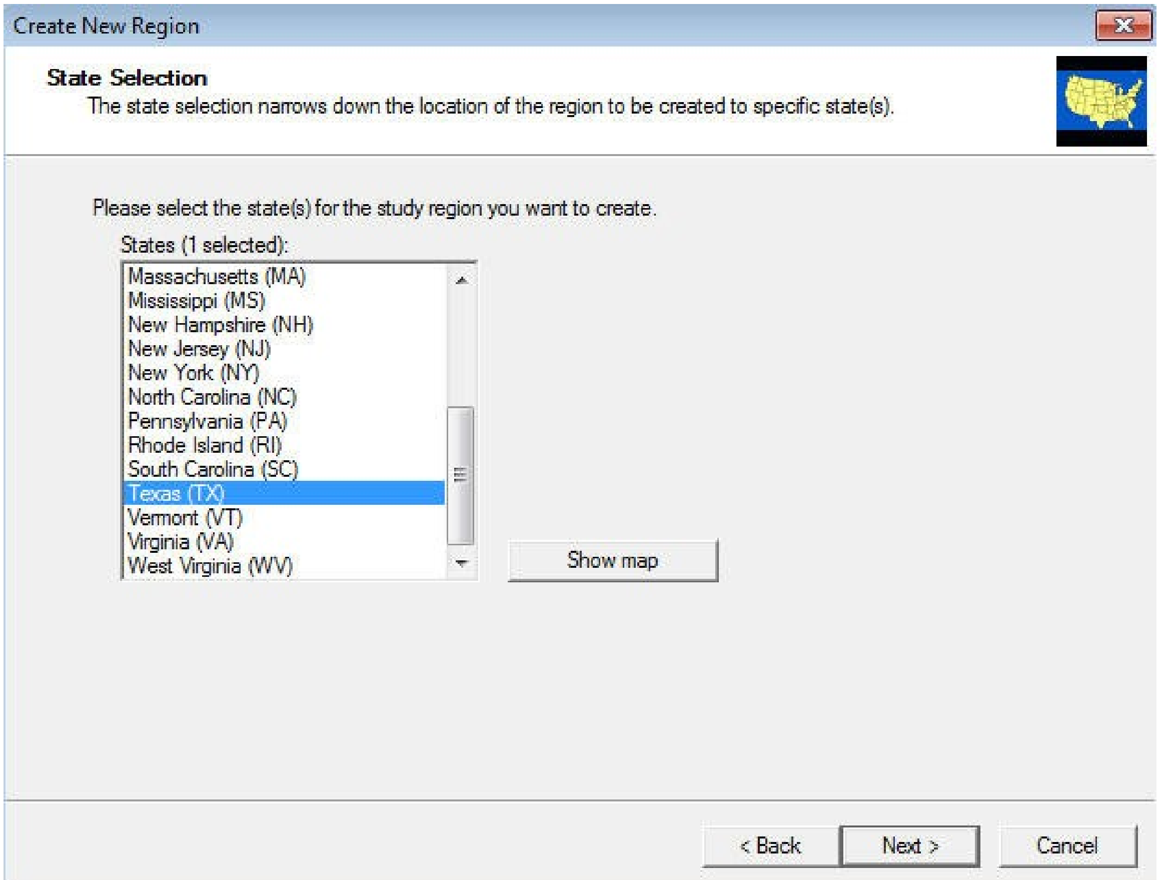


Task 2: Select Areas Affected by Hurricane Harvey.

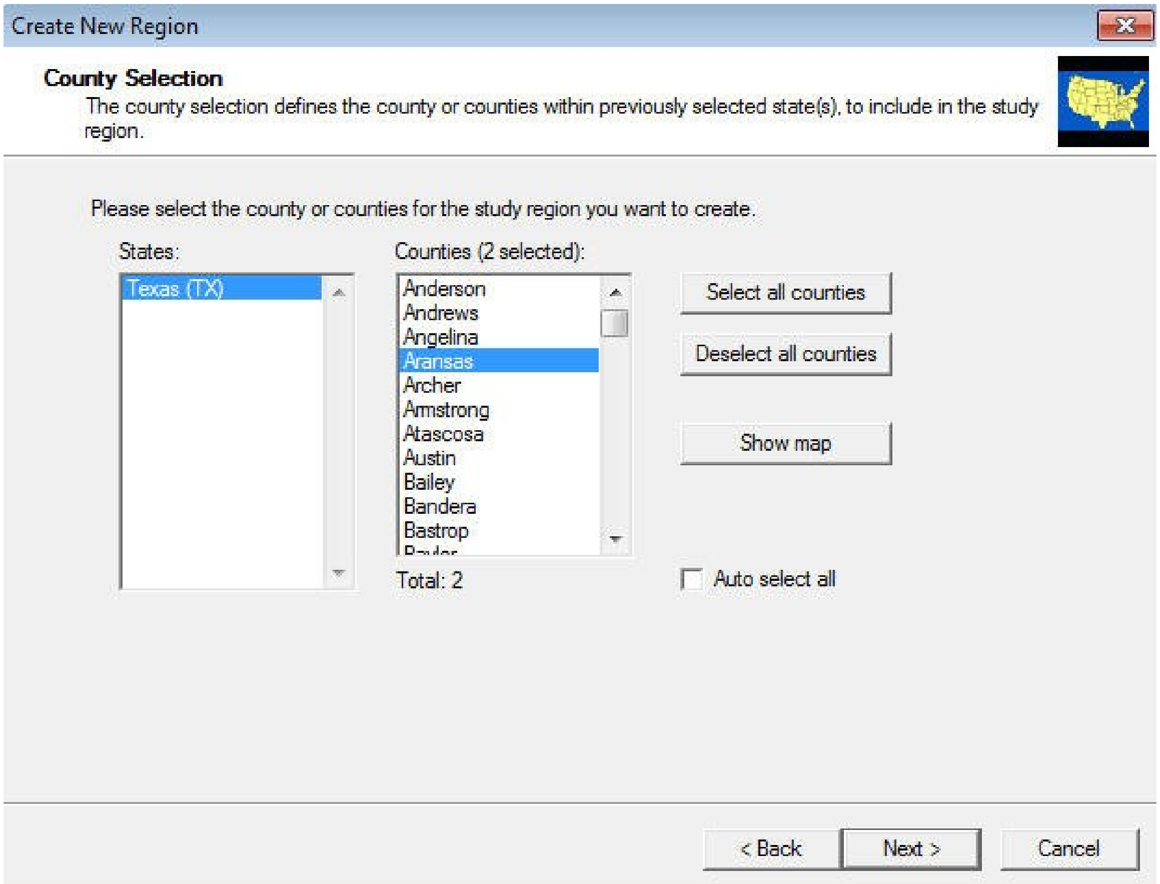
1. Select "County" as the aggregation level.
2. Click "Next."



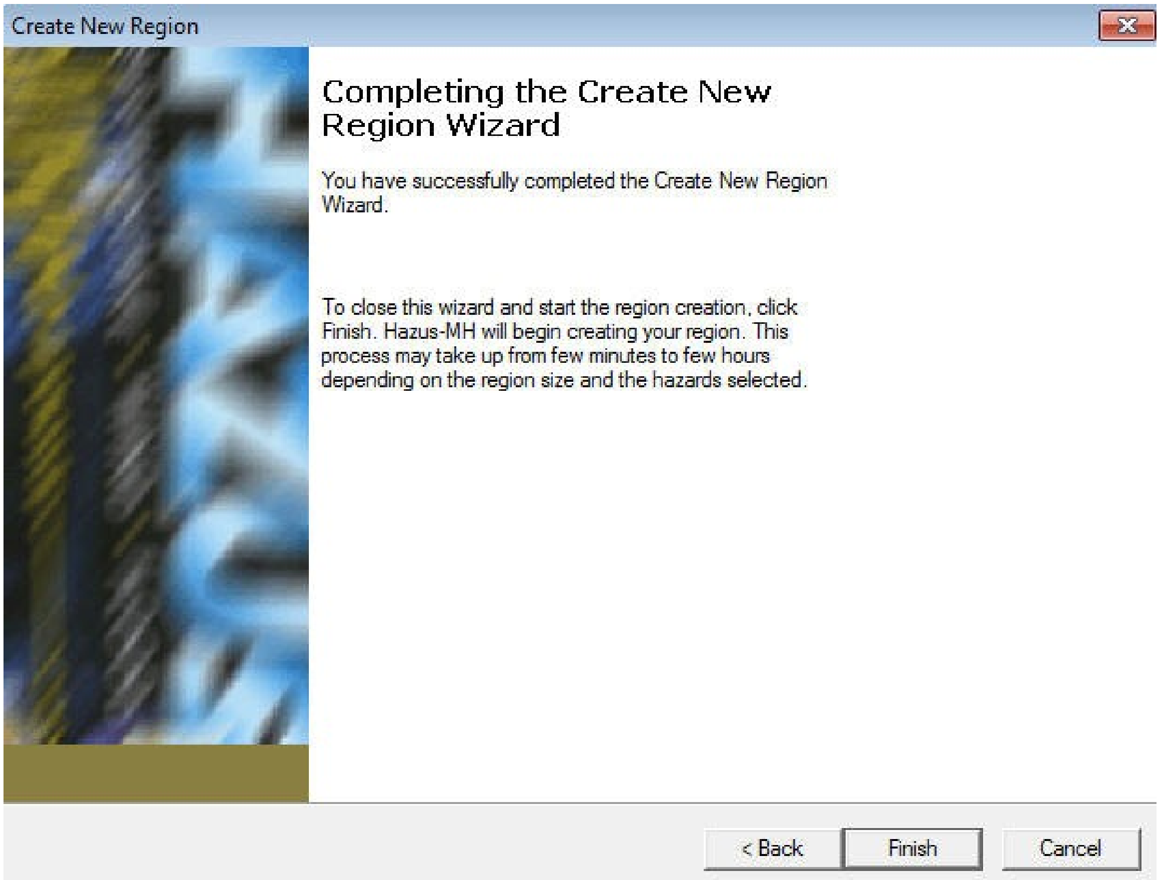
3. Select "Texas" from the list of states.
4. Click "Next."



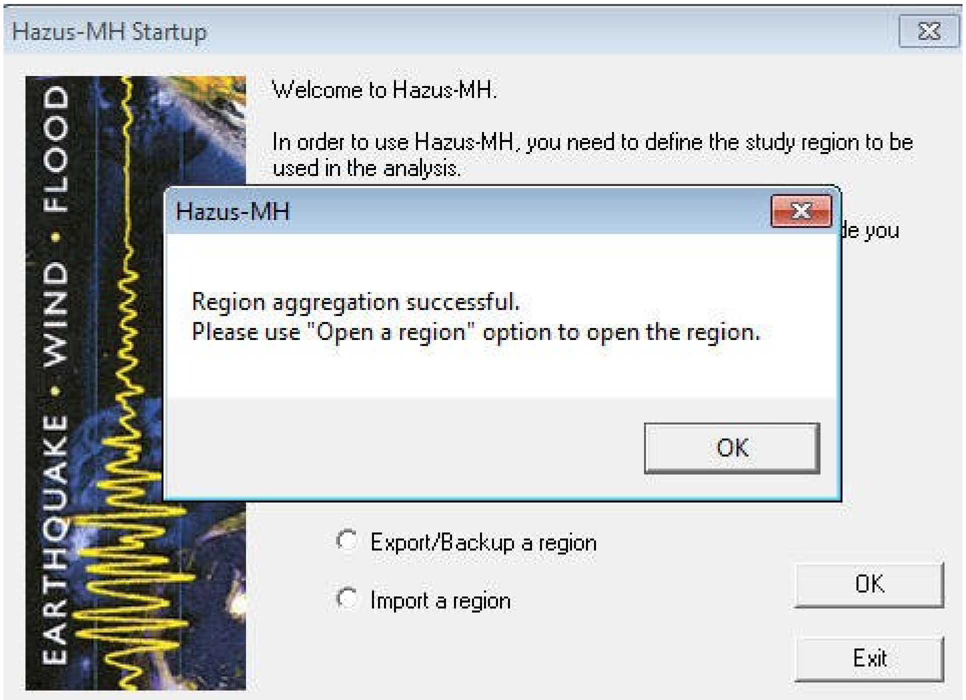
5. Select “Aransas” and “Nueces” from the list of counties and click “Next.”



6. Click “Finish” to complete the Create New Region Wizard.



7. After a few minutes, a dialog box will appear indicating that your region was aggregated successfully. Click “OK.”


Hazus-MH Startup
EARTHQUAKE • WIND • FLOOD
Welcome to Hazus-MH.
In order to use Hazus-MH, you need to define the study region to be used in the analysis.
de you
Hazus-MH
Region aggregation successful.
Please use "Open a region" option to open the region.
OK
Export/Backup a region
Import a region
OK
Exit

Visual 32: Lesson 1: Review

1. What is Hazus?
2. What are the four hazards supported by Hazus?
3. Explain the Hazus Hurricane Model. Then, explain The Surge Model.
4. Provide an example of a basic and advanced analysis using the Hazus hurricane model.

Visual 33: Capstone Exercise Preview

Goal: Use Hazus to help a county assess hurricane risk in order to develop hurricane mitigation OR response and recovery strategies.

Planning:

- Day 2 afternoon
- Day 3 afternoon
- Day 4 morning

Presentation:

- Day 4 afternoon

Visual 34: Capstone Exercise Preview

- There is no written final exam for this course
- Participants will be evaluated based on:
    - Completeness of the final presentation
    - Use of the ideas learned in this class

Visual 35: Capstone Exercise Explanation

- The county planning board has hired your team to give a 20-minute PowerPoint presentation at its next public meeting on the severity of hurricane hazards in the county and the possible methods for mitigating or responding to future hurricane damage in that county.
- You, as the consultants and Hazus experts, have decided to use Hazus to analyze the county's hurricane risk.
- The results of your study will be presented at the monthly commissioners meeting.
    - Each group will present while the remaining participants assume the role of the commissioners.

Visual 36: Capstone Exercise Explanation

Required issues to be addressed:

- Which major hurricane(s) have impacted this region in the past?
- What damage would the worst of these storms produce if it happened again today?
- What is the approximate return period for the worst historic winds?
- Summarize the number and value of buildings at risk to hurricanes.
- Provide a map of essential facilities, high potential loss facilities, and any additional features you deem important for risk communication.
- What are potential benefits of mandating shutters on all new single-family dwellings? Summarize the assumptions made in your benefit analysis.

Visual 37: Capstone Exercise Explanation

Presentation Guidelines:

- Prepare using PowerPoint.
- Include maps, tables, or other media you deem appropriate and helpful for conveying your message.
- Information should be primarily derived from Hazus, but may be supplemented by other sources.
- 10-15 minutes in length, allowing 5 minutes for questions

Commissioner Guidelines:

- Class will assume the role of commissioners.
- Commissioners may ask questions related to the presentation.

Visual 38: Capstone Exercise Preparation

- Capstone Exercise Strategy
- Past Presentation Examples
- Preparation
  - Discuss strategies.
  - Select a state to use for the analysis.

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Capstone Exercise Preparation

- Capstone Exercise Strategy
  - Everyone needs a role and to work with Hazus.
  - Make sure goals are achievable within the time frame.

Visual 39: Questions?

Lesson 2: Hazus Inventory

Visual 1: Lesson 2: Hazus Inventory

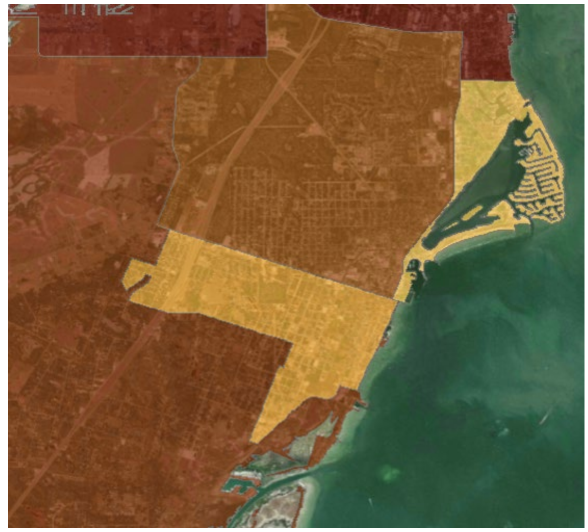
Visual 2: Lesson 2: Goals and Objectives

Goal: To provide an overview of the data included with Hazus, emphasizing hurricane-specific inventory, and of the tools and processes to update the data.

After completing this lesson you will be able to:

- Describe the types of aggregate and point inventory supported by the Hazus hurricane model.
- List the options that Hazus provides for updating inventory.

Visual 3: Inventory Components: Aggregate Inventory

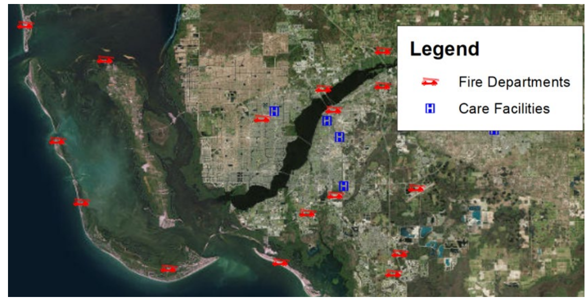


Aggregate Inventory

- Demographics
- General Building Stock broken down by type (how constructed) and occupancy (how used)

Hazard-Specific Inventory (both aggregate and site-specific)

Visual 4: Inventory Components: Site Specific Inventory



Site-Specific Inventory

Hazard-Specific Inventory (both aggregate and site-specific)

Visual 5: Inventory Update Tools

State and Study Region Updates

- Comprehensive Data Management System (CDMS)

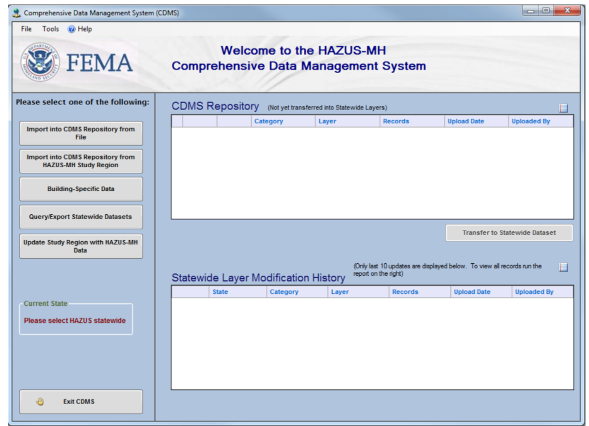
Study Region Only Updates

- Access databases - use import tools in Hazus
- ArcGIS editing tools

NOTE: E0317: CDMS provides considerably more detail about inventory updates.

Visual 6: Comprehensive Data Management System

- System for integrating user provided site-specific and aggregate data into the Hazus state databases.
- CDMS supported data includes:
  - Site-specific / Aggregate
  - Data Types
    - xls
    - shp
    - mdb



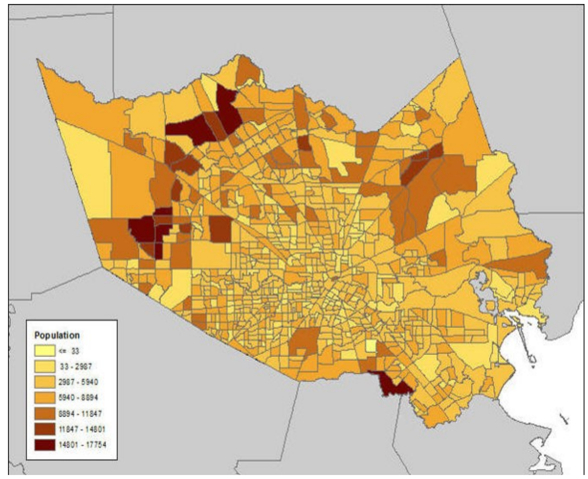
Visual 7: Comprehensive Data Management System

Functions:

- Validates user provided data
- Parses data into appropriate Hazus tables
- Provides historical tracking of database updates
- Can import/export data from/to a variety of formats

Visual 8: Demographic Data

- Aggregated at census tract (hurricane and earthquake) level
- Detailed by:
  - Age
  - Income
  - Ethnicity
  - Ownership
  - Gender



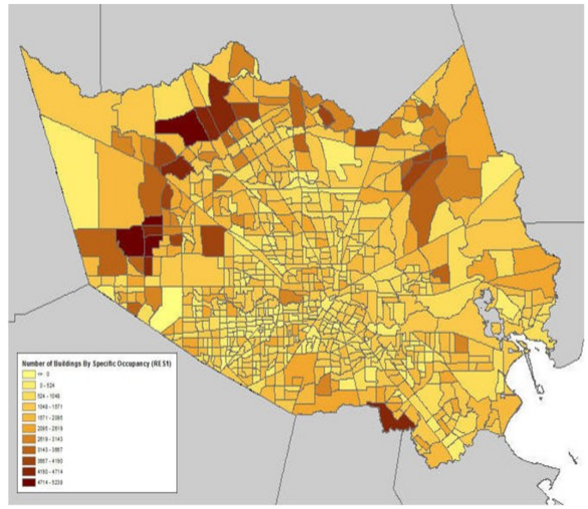
Visual 9: What is the General Building Stock?

An engineering based estimation of buildings for the US represented by:

- Floor area (Sq Ft)
- Value ($)
- Count of all structures by occupancy type

Data Sources:

- Residential: from US Census Data
- Commercial / Industrial: from Dun & Bradstreet



Visual 10: Aggregate Inventory: General Building Stock

Specific Occupancy Categories

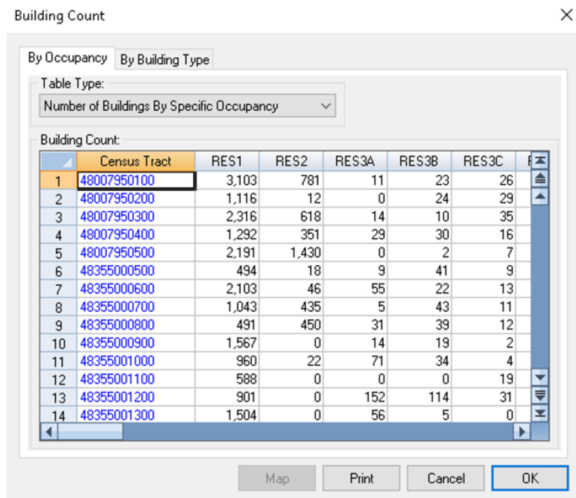
- 33 Specific Occupancy Types
- You can view the categories from the Inventory menu

Specific Occupancy	General Occupancy	Description
AGR1	Agriculture	Agriculture
COM1	Commercial	Trade
COM2	Commercial	Wholesale Trade
COM3	Commercial	Personal and Repair Service
COM4	Commercial	Professional/Technical Service
COM5	Commercial	Banks
COM6	Commercial	Hospital

Visual 11: GBS: Building Count

Square Footage Factors

- Average square footage for each specific occupancy determined during model development
- Building counts computed by dividing floor area by average square footage



	Census Tract	RES1	RES2	RES3A	RES3B	RES3C
1	48007950100	3,103	781	11	23	26
2	48007950200	1,116	12	0	24	29
3	48007950300	2,316	618	14	10	35
4	48007950400	1,292	351	29	30	16
5	48007950500	2,191	1,430	0	2	7
6	48355000500	494	18	9	41	9
7	48355000600	2,103	46	55	22	13
8	48355000700	1,043	435	5	43	11
9	48355000800	491	450	31	39	12
10	48355000900	1,567	0	14	19	2
11	48355001000	960	22	71	34	4
12	48355001100	588	0	0	0	19
13	48355001200	901	0	152	114	31
14	48355001300	1,504	0	56	5	0

NOTE: RES1 (single family homes) and RES2 (manufactured housing) are derived from census housing unit counts.

Visual 12: Activity 2.1: Comprehensive Data Management System

Goal: Explore the Comprehensive Data Management System.

Time: 30 minutes

Visual 13: Activity 2.1: Tasks

Task 1: How to Use CDMS to Update Inventory.

Activity 2.1: Comprehensive Data Management System

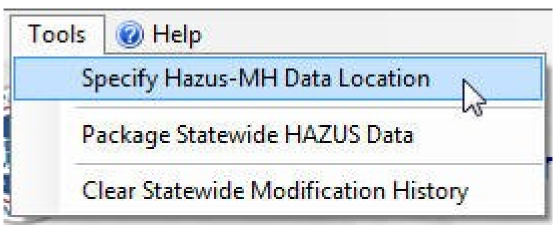
Type: Student Activity

Time: 30 minutes

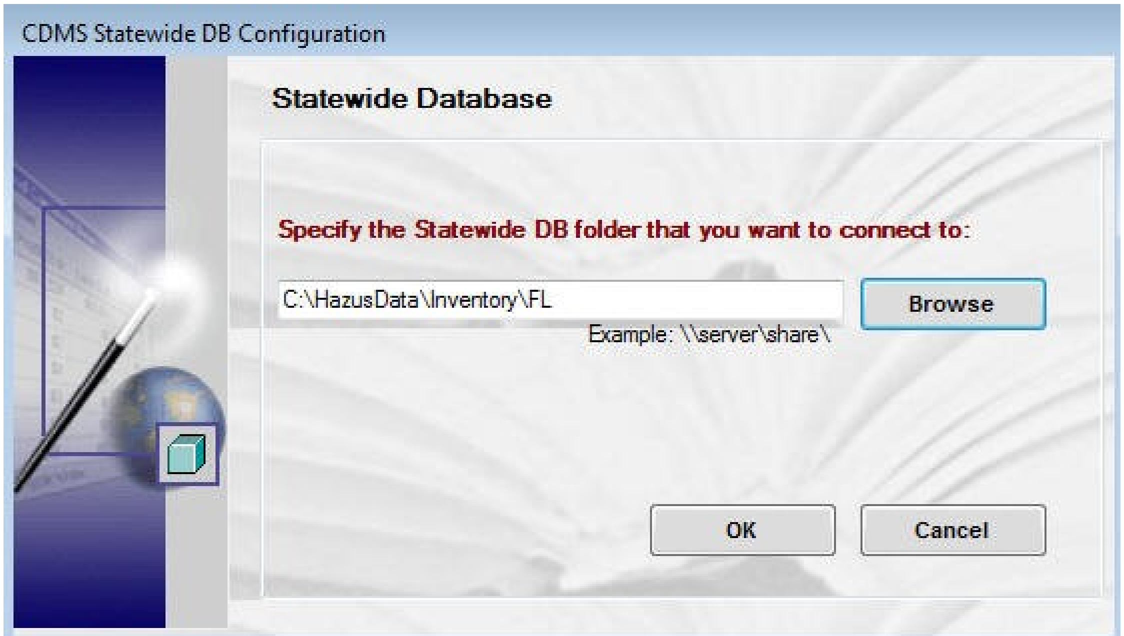
Goal: Explore the Comprehensive Data Management System.

Task 1: How to Use CDMS to Update Inventory.

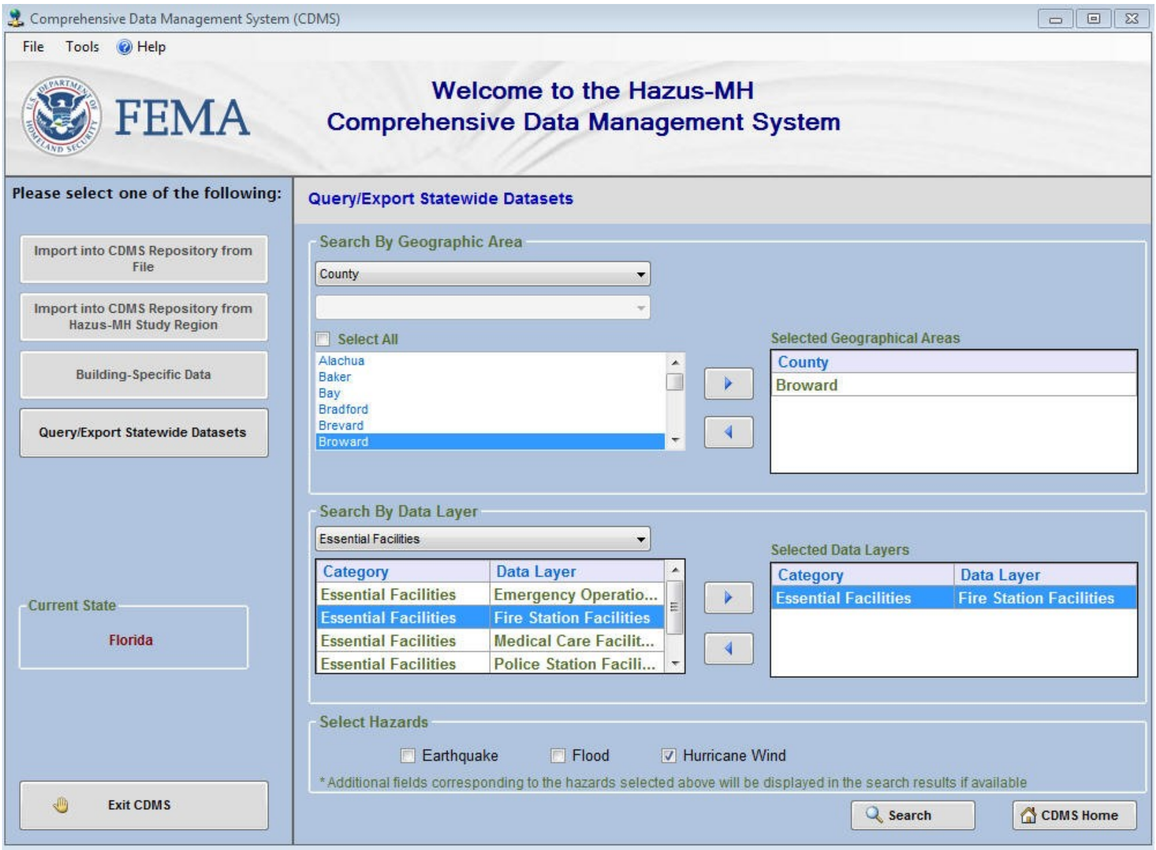
1. Double click the CDMS icon on the desktop to start CDMS.
2. Navigate to Tools and then select "Specify Hazus Data Location".



3. Click "Browse" and navigate to C:\HazusData\Inventory\FL to set the Hazus State Data location to "Florida".



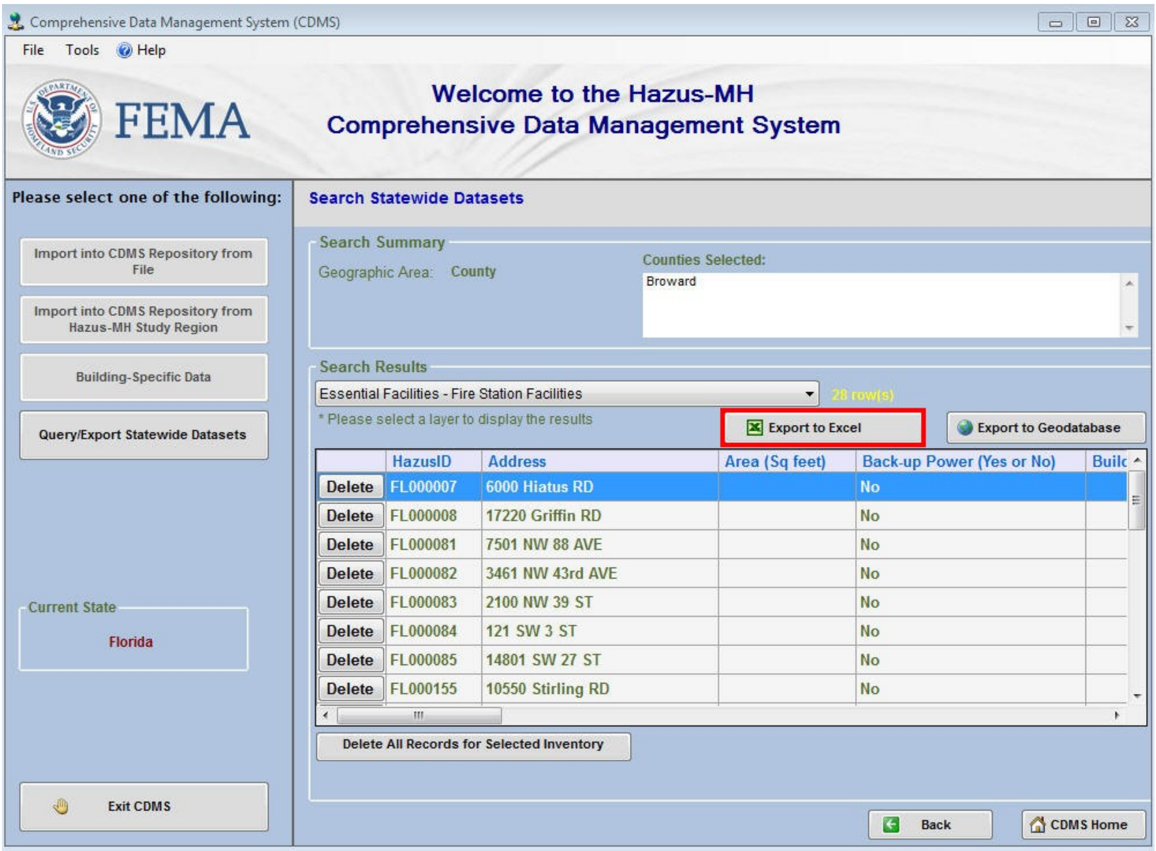
4. Click OK.
5. Click "Query/Export Statewide Datasets".
6. Under Search By Geographic Area, select "County" from the drop down selection.
7. Click to highlight Broward county and select the right arrow to move it to the selected list.
8. Choose "Essential Facilities" from the drop down under Search by Data Layer.
9. Click to highlight the Fire Station Facilities and select the right arrow to move it to the selected list.
10. Click the checkbox next to Hurricane Wind for this exercise.
11. The CDMS screen should appear as below:



12. Click “Search” at the bottom of the screen to find all of the fire stations in the county.

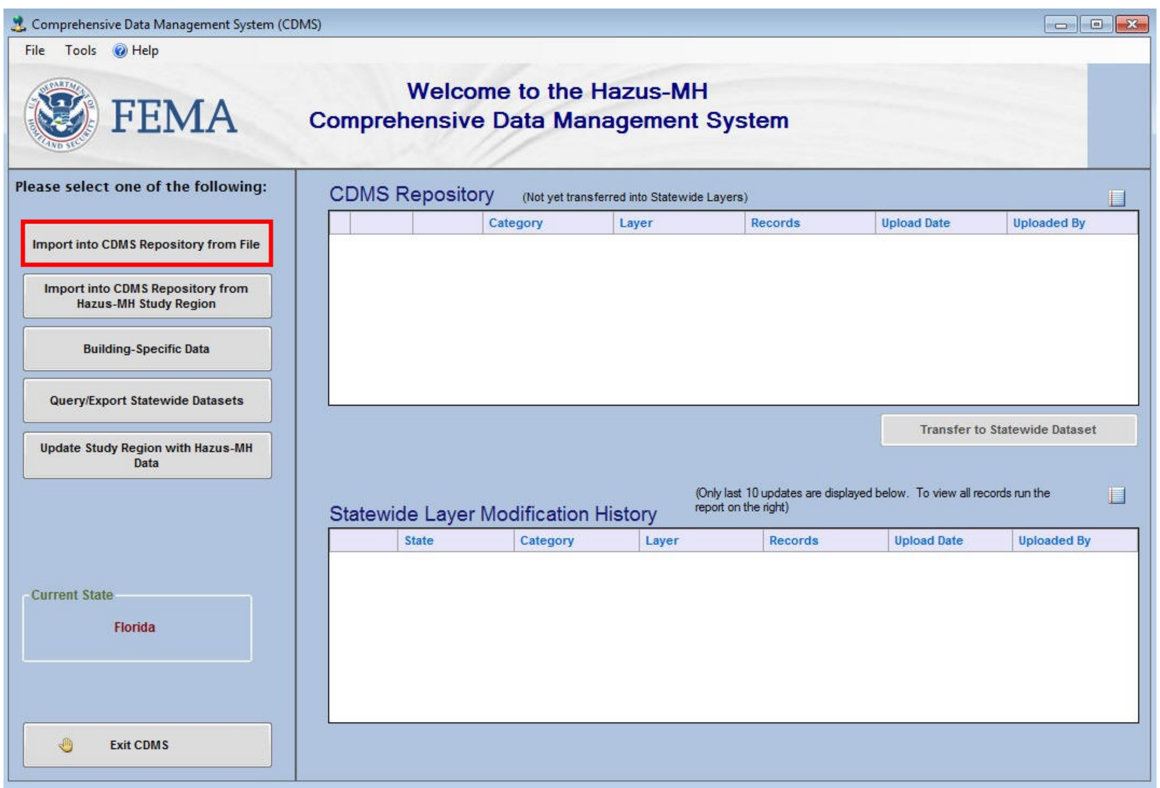
13. Click “Export to Excel” to export the fire stations to an Excel file.

Note: If you are unable to export to Excel, export to a geodatabase first. Then, convert it to an .xls. The .xls can be edited and imported back into CDMS.

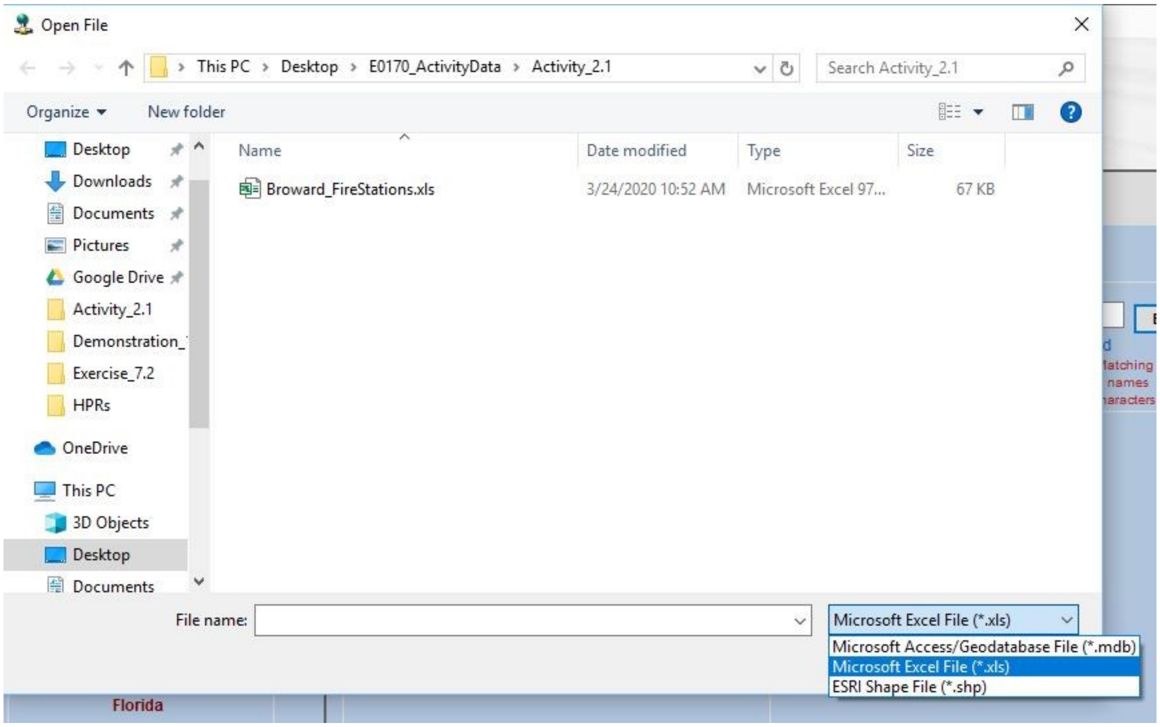


14. Choose the radio button next to "Export currently selected layer" and click Submit.

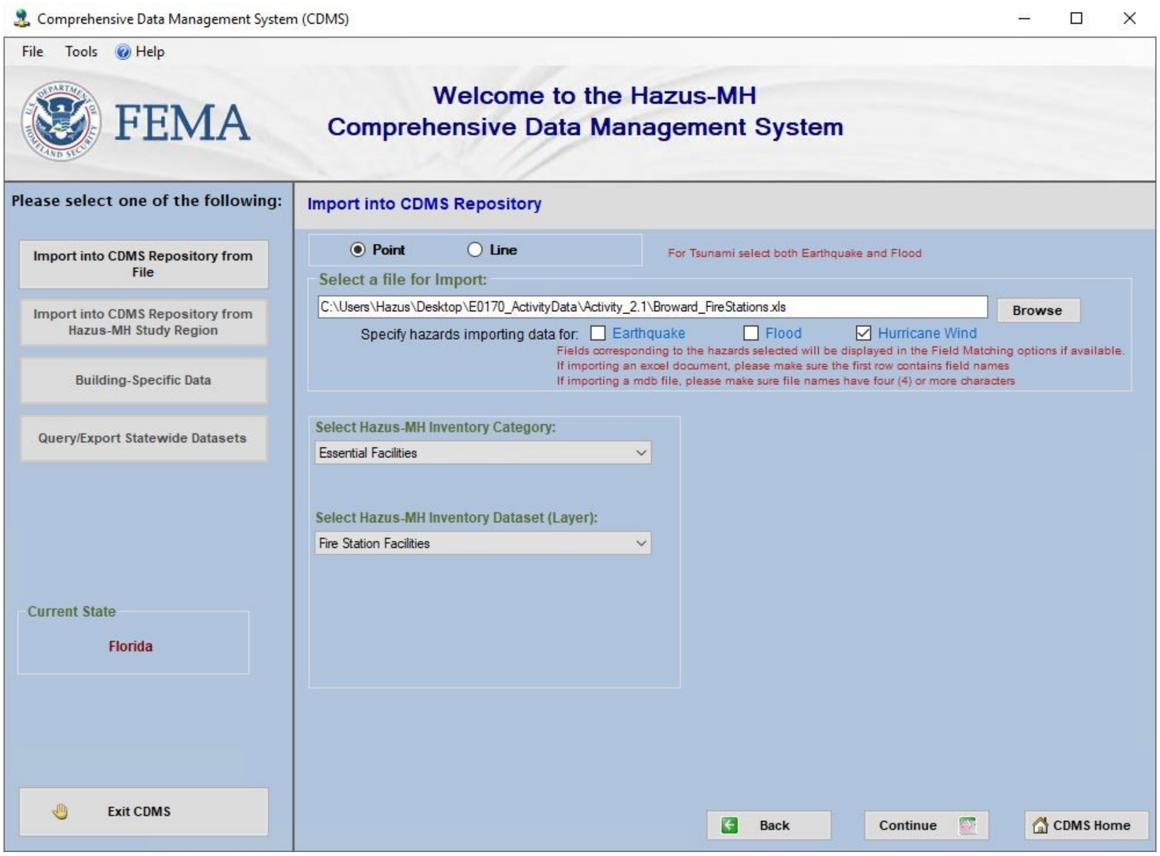
15. Navigate to the C:\E0170_ActivityData\Activity_2.1 folder and name the folder "Broward_FireStations" and click "Save".
16. Click OK once complete.
17. Click Delete All Records for Selected Inventory to delete all of the fire stations for the county.
18. Click "Yes" on the warning that it cannot be undone.
19. Minimize CDMS.
20. Open the Excel file saved to C:\E0170_ActivityData\Activity_2.1 and change the address of the first fire station.
21. Save the changes to the Excel table (be sure not to save to the Office 2007 format) and close Excel.
22. Maximize CDMS and click CDMS Home.
23. Click Import into CDMS Repository from File to import the edited Excel file.



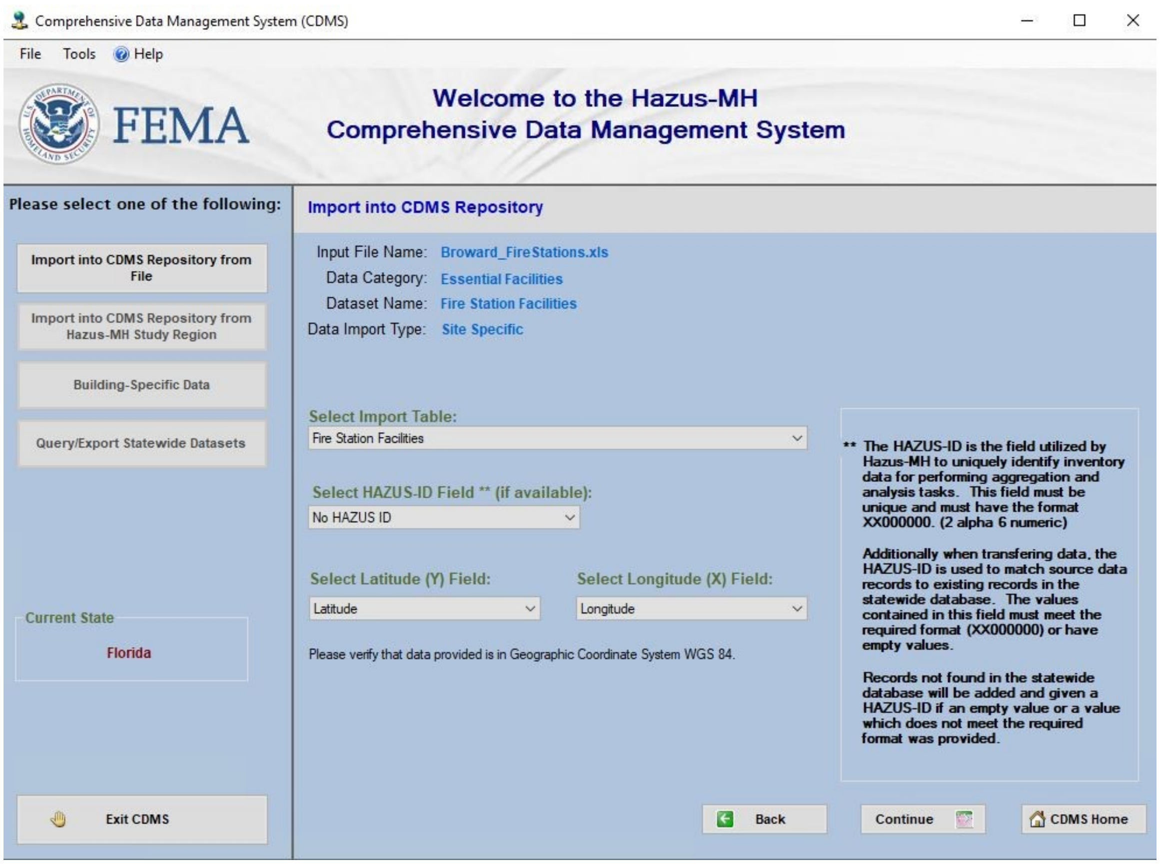
24. Select "Browse" and navigate to C:\E0170_ActivityData\Activity_2.1 to import the edited Excel file. You may need to change the file type at the bottom of the screen to Microsoft Excel File (*.xls) in order for the file to appear.



25. Uncheck the boxes next to Earthquake and Flood.
26. From the Inventory Category drop down, select “Essential Facilities”.
27. From the Inventory Dataset (Layer) select “Fire Stations”.



28. Click “Continue”.
29. Change the Import table to "Fire Station Facilities.”
30. From the drop down menu under Select Hazus ID-Field select No HAZUS ID.
31. Select “Latitude” from the Latitude (Y) Field drop down menu and select “Longitude” from the Longitude (X) Field drop down menu.

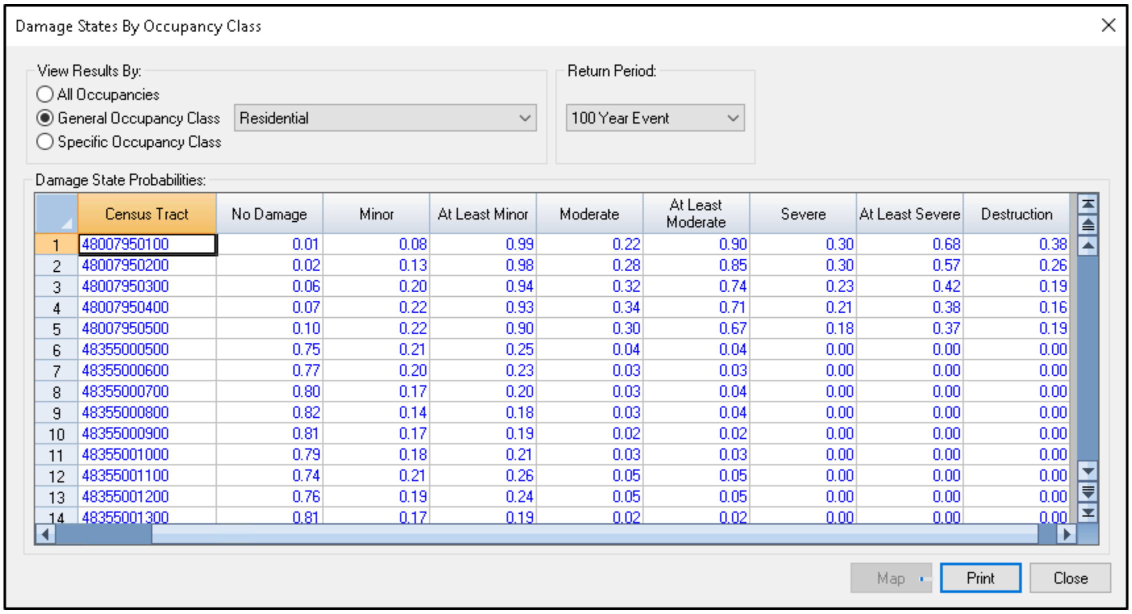


32. Click “Continue”.
33. Click OK to Categorize Fields. These data values are already matched to the proper Hazus fields since they were exported from Hazus.
34. Click continue on the following screens until the import is successfully completed.
35. Click OK on the message stating the import was successful.
36. In the CDMS Repository click on the View/Edit button.
37. Notice that the address of the first record reflects the changes you made in Excel.
38. Click Close.
39. Click Transfer to Statewide Dataset.
40. Select the radio button next to the Append/Update option and click Submit.
41. Query the county for which you imported the fire stations and look for the updated
42. Click Yes to confirm you want to transfer the layer.
43. Close CDMS.

Visual 14: GBS: Damage States

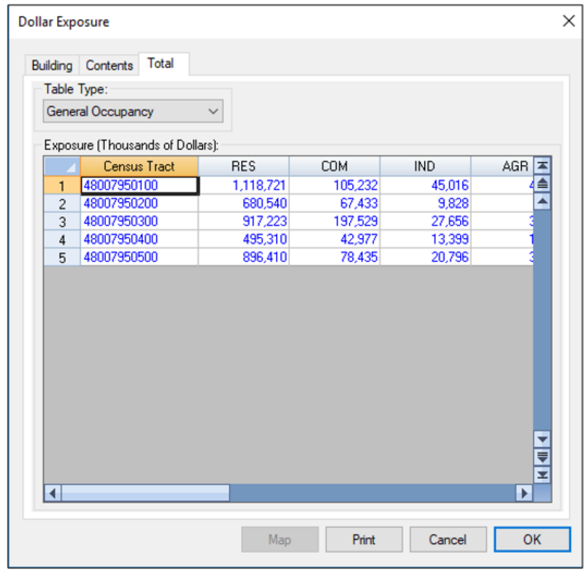
GBS results for damage can be mapped by occupancy and building type

- Damage represented by damage states (moderate, severe, etc.)
- Damage state values represent the expected fraction of building square footage in each damage state



	Census Tract	No Damage	Minor	At Least Minor	Moderate	At Least Moderate	Severe	At Least Severe	Destruction
1	48007950100	0.01	0.08	0.99	0.22	0.90	0.30	0.68	0.38
2	48007950200	0.02	0.13	0.98	0.28	0.85	0.30	0.57	0.26
3	48007950300	0.06	0.20	0.94	0.32	0.74	0.23	0.42	0.19
4	48007950400	0.07	0.22	0.93	0.34	0.71	0.21	0.38	0.16
5	48007950500	0.10	0.22	0.90	0.30	0.67	0.18	0.37	0.19
6	48355000500	0.75	0.21	0.25	0.04	0.04	0.00	0.00	0.00
7	48355000600	0.77	0.20	0.23	0.03	0.03	0.00	0.00	0.00
8	48355000700	0.80	0.17	0.20	0.03	0.04	0.00	0.00	0.00
9	48355000800	0.82	0.14	0.18	0.03	0.04	0.00	0.00	0.00
10	48355000900	0.81	0.17	0.19	0.02	0.02	0.00	0.00	0.00
11	48355001000	0.79	0.18	0.21	0.03	0.03	0.00	0.00	0.00
12	48355001100	0.74	0.21	0.26	0.05	0.05	0.00	0.00	0.00
13	48355001200	0.76	0.19	0.24	0.05	0.05	0.00	0.00	0.00
14	48355001300	0.81	0.17	0.19	0.02	0.02	0.00	0.00	0.00

Visual 15: General Occupancy Categories



Seven general occupancy classes:

- Majority of Building Stock
  1. Residential
  2. Commercial
  3. Industrial
- Others
  4. Agriculture
  5. Religion
  6. Government
  7. Education

Visual 16: Specific Occupancy Categories

33 Specific Occupancy Types:

- 11 Residential Classes
- 10 Commercial Classes
- 6 Industrial Classes
- 2 Government Classes
- 2 Education Classes
- 1 Agriculture Class
- 1 Religious Class

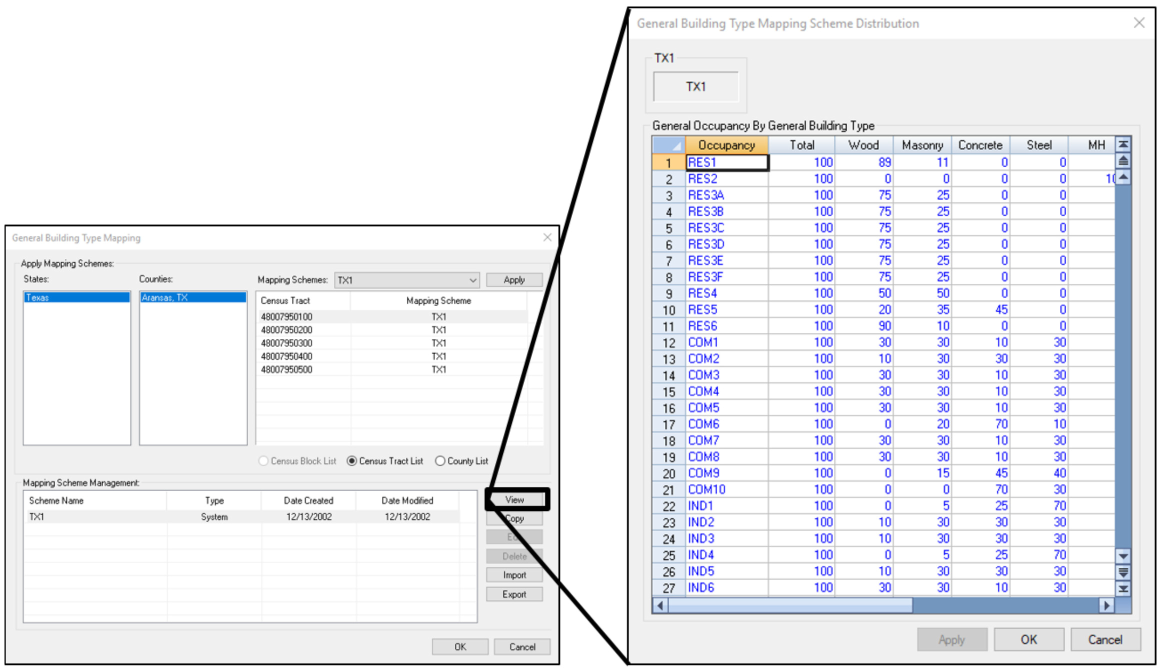
Visual 17: General Building Types

Five General Building Types:

1. Wood
2. Steel
3. Concrete
4. Masonry
5. Manufactured Housing (Mobile Home)

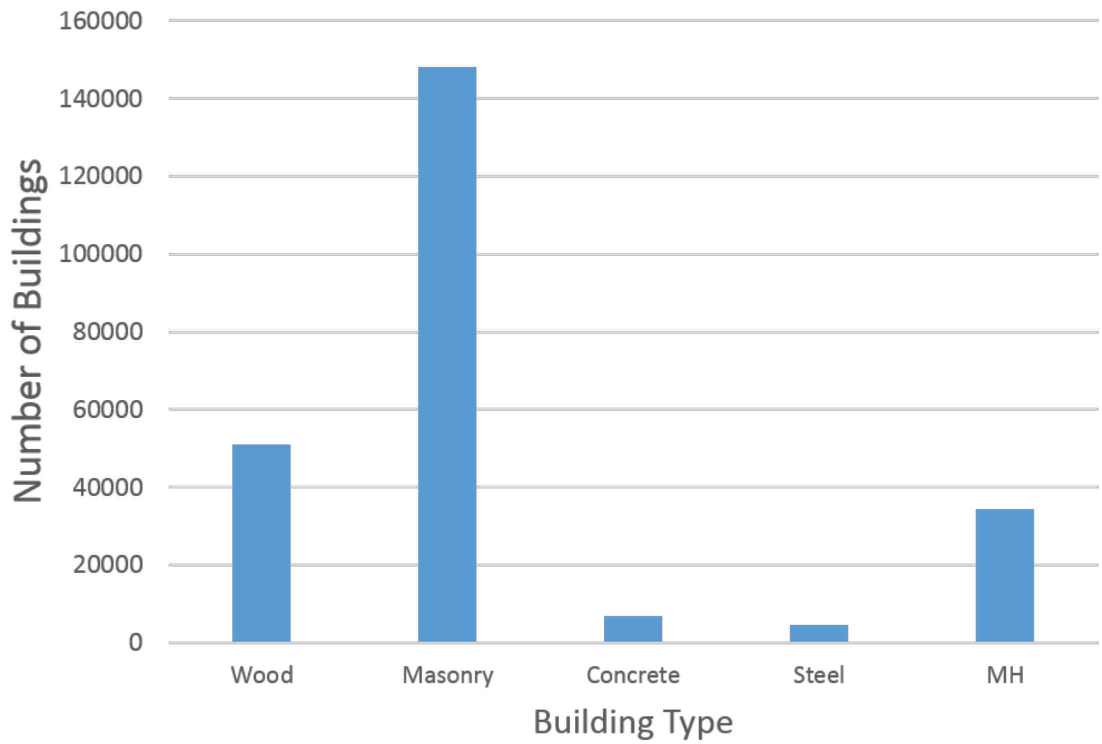
Visual 18: General Building Type Mapping

- Mapping Scheme Management:
  - View
  - Copy
  - Edit
  - Delete
  - Import
  - Export



Visual 19: Aggregated Building Stock

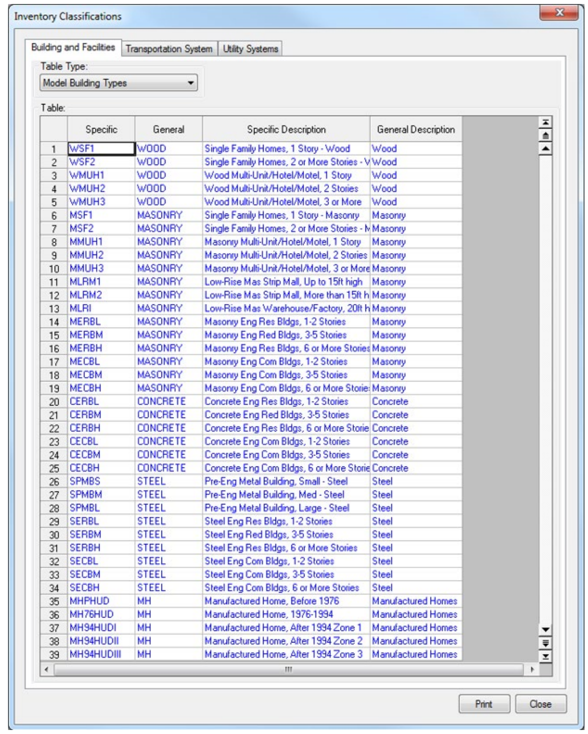
Building Count: By building type



Visual 20: Specific Building Types (SBT)

Thirty-nine Specific Building Types:

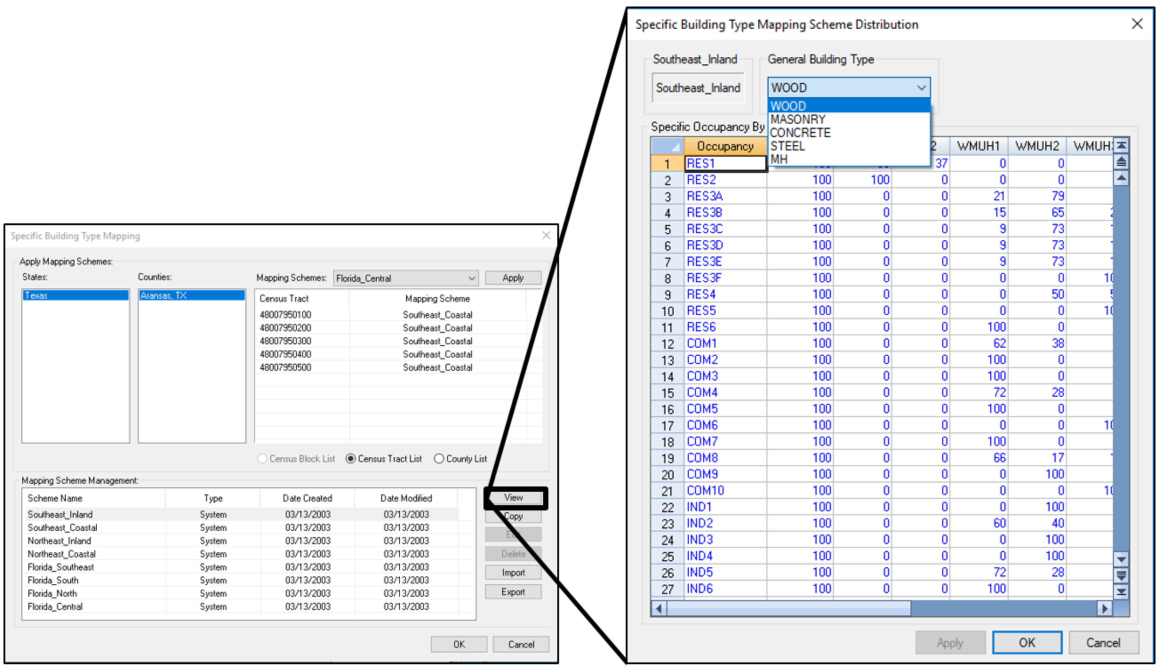
- 5 Wood
- 9 Steel
- 6 Concrete
- 14 Masonry
- 5 Manufactured Housing (Mobile Home)



	Specific	General	Specific Description	General Description
1	WSF1	WOOD	Single Family Homes, 1 Story - Wood	Wood
2	WSF2	WOOD	Single Family Homes, 2 or More Stories - V	Wood
3	WMUH1	WOOD	Wood Multi-Unit/Hotel/Motel, 1 Story	Wood
4	WMUH2	WOOD	Wood Multi-Unit/Hotel/Motel, 2 Stories	Wood
5	WMUH3	WOOD	Wood Multi-Unit/Hotel/Motel, 3 or More	Wood
6	MSF1	MASONRY	Single Family Homes, 1 Story - Masonry	Masonry
7	MSF2	MASONRY	Single Family Homes, 2 or More Stories - M	Masonry
8	MMUH1	MASONRY	Masonry Multi-Unit/Hotel/Motel, 1 Story	Masonry
9	MMUH2	MASONRY	Masonry Multi-Unit/Hotel/Motel, 2 Stories	Masonry
10	MMUH3	MASONRY	Masonry Multi-Unit/Hotel/Motel, 3 or More	Masonry
11	MLRM1	MASONRY	Low-Rise Mas Strip Mall, Up to 15ft high	Masonry
12	MLRM2	MASONRY	Low-Rise Mas Strip Mall, More than 15ft h	Masonry
13	MLRI	MASONRY	Low-Rise Mas Warehouse/Factory, 20ft h	Masonry
14	MERBL	MASONRY	Masonry Eng Res Bldgs, 1-2 Stories	Masonry
15	MERBM	MASONRY	Masonry Eng Red Bldgs, 3-5 Stories	Masonry
16	MERBH	MASONRY	Masonry Eng Res Bldgs, 6 or More Stories	Masonry
17	MECBL	MASONRY	Masonry Eng Com Bldgs, 1-2 Stories	Masonry
18	MECBM	MASONRY	Masonry Eng Com Bldgs, 3-5 Stories	Masonry
19	MECBH	MASONRY	Masonry Eng Com Bldgs, 6 or More Storie	Masonry
20	CERBL	CONCRETE	Concrete Eng Res Bldgs, 1-2 Stories	Concrete
21	CERBM	CONCRETE	Concrete Eng Red Bldgs, 3-5 Stories	Concrete
22	CERBH	CONCRETE	Concrete Eng Res Bldgs, 6 or More Storie	Concrete
23	CECBL	CONCRETE	Concrete Eng Com Bldgs, 1-2 Stories	Concrete
24	CECBM	CONCRETE	Concrete Eng Com Bldgs, 3-5 Stories	Concrete
25	CECBH	CONCRETE	Concrete Eng Com Bldgs, 6 or More Storie	Concrete
26	SPMBS	STEEL	Pre-Eng Metal Building, Small - Steel	Steel
27	SPMBM	STEEL	Pre-Eng Metal Building, Med - Steel	Steel
28	SPMBL	STEEL	Pre-Eng Metal Building, Large - Steel	Steel
29	SERBL	STEEL	Steel Eng Res Bldgs, 1-2 Stories	Steel
30	SERBM	STEEL	Steel Eng Red Bldgs, 3-5 Stories	Steel
31	SERBH	STEEL	Steel Eng Res Bldgs, 6 or More Stories	Steel
32	SECBL	STEEL	Steel Eng Com Bldgs, 1-2 Stories	Steel
33	SECBM	STEEL	Steel Eng Com Bldgs, 3-5 Stories	Steel
34	SECBH	STEEL	Steel Eng Com Bldgs, 6 or More Stories	Steel
35	MHPHUD	MH	Manufactured Home, Before 1976	Manufactured Homes
36	MH76HUD	MH	Manufactured Home, 1976-1994	Manufactured Homes
37	MH94HUDI	MH	Manufactured Home, After 1994 Zone 1	Manufactured Homes
38	MH94HUDII	MH	Manufactured Home, After 1994 Zone 2	Manufactured Homes
39	MH94HUDIII	MH	Manufactured Home, After 1994 Zone 3	Manufactured Homes

Visual 21: Specific Building Type Mapping

- Mapping Scheme Management:
  - View
  - Copy
  - Edit
  - Delete
  - Import
  - Export



Visual 22: Hurricane-Specific Inventory

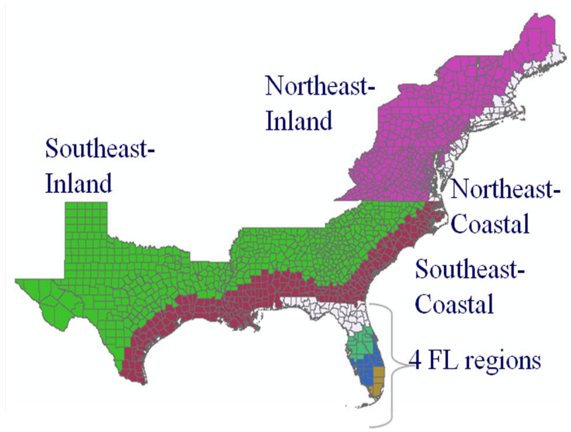
Wind-Building Mapping Schemes

Florida: 4 Regions

Hawaii: 4 Regions

Other States: 4 Regions

1. Northeast Inland
2. Northeast Coastal
3. Southeast Inland
4. Southeast Coastal



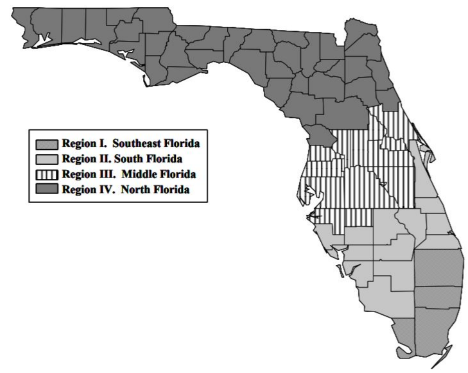
A map of the different Wind-Building Mapping Schemes for the "Other" states and Florida.

Visual 23: Hurricane-Specific Inventory

Wind-Building Mapping Schemes

Florida building stock regions

- Different building codes
  - Southeast Florida has historically stronger wind provisions for past decade
- Different building practices
  - More wood frame in northern portion of Florida than southern Florida



Key Points

Student Manual

Florida is divided into 4 regions.

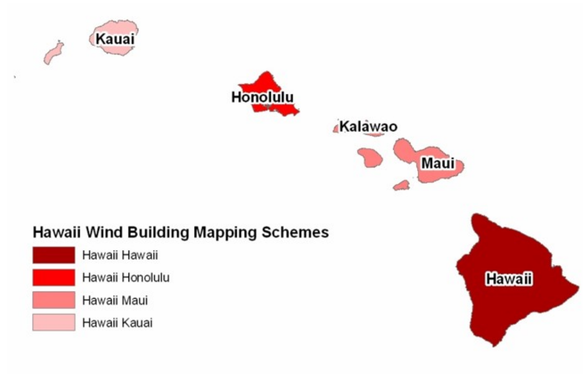
- Southeast Florida
- South Florida
- Middle Florida
- North Florida

Visual 24: Hurricane-Specific Inventory

Wind-Building Mapping Schemes

Hawaii Building Stock Regions

- Different wall construction type
  - Single wall vs. double wall
- Different roof deck construction
  - Metal roof deck
- Different foundation type
- Applies only to single-family models
- All other SBT models are identical to mainland US.



Student Manual

Key Points

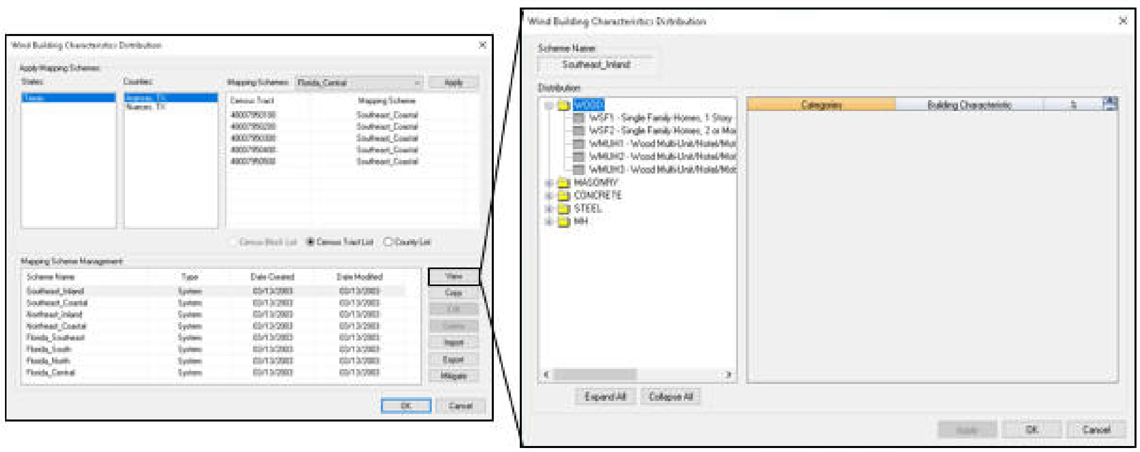
Hawaii is divided into 4 regions:

- Hawaii Hawaii - Island of Hawaii
- Hawaii Honolulu - Island of Oahu
- Hawaii Maui - Islands of Maui, Kaho'olawe, Lanai, and Molokai
- Hawaii Kauai - Islands of Kauai and Ni'ihau

Hawaii has different construction types, therefore different building mapping schemes were developed.

Visual 25: Hurricane-Specific Inventory: Wind-Building Mapping Schemes

- Eight Mapping Schemes
- Consider:
    - Roof type
    - Secondary water resistance
    - Roof deck attachment
    - Roof wall connection
    - Shuttering



Visual 26: Pre-FIRM Sub-Assembly Replacement Values

Reference your manual for the table of Pre-FIRM Sub-Assembly Replacement Values

Sub-Assembly Replacement Values

Pre-FIRM Sub-Assembly Replacement Values

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
RES1: Single	6%	2%	13%	5%	5%	20%	49%	100%
RES2: MH	6%	2%	10%	3%	5%	20%	54%	100%
RES3A: Duplex	6%	2%	13%	5%	5%	20%	49%	100%
RES3B: 3-4 units	6%	2%	13%	5%	5%	20%	49%	100%
RES3C: 5-9 units	5%	1%	10%	2%	3%	10%	69%	100%
RES3D: 10-19 units	5%	1%	10%	2%	3%	10%	69%	100%
RES3E: 20-49 units	5%	1%	13%	1%	3%	10%	67%	100%
RES3F: 50+ units	3%	0%	13%	1%	1%	13%	69%	100%
RES4: Temp. Lodging	3%	1%	9%	1%	2%	10%	74%	100%

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
RES5: Institutional Dormitory	4%	0%	14%	1%	3%	14%	64%	100%
RES6: Nursing Home	5%	0%	10%	3%	2%	13%	67%	100%
COM1: Retail	6%	1%	10%	5%	5%	10%	63%	100%
COM2: Wholesale	20%	1%	7%	9%	7%	11%	45%	100%
COM3: Personal & repair services	10%	1%	8%	7%	3%	10%	61%	100%
COM4: Professional/Business	4%	1%	11%	1%	3%	17%	63%	100%
COM5: Banks	6%	0%	10%	4%	9%	8%	63%	100%
COM6: Hospital	2%	0%	7%	1%	4%	7%	79%	100%
COM7: Medical	5%	1%	5%	3%	2%	12%	72%	100%

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
Office								
COM8: Entertainment	9%	1%	10%	4%	3%	8%	65%	100%
COM9: Theaters	6%	1%	10%	5%	6%	10%	62%	100%
COM10: Parking	12%	0%	40%	0%	10%	9%	29%	100%
IND1: Heavy	14%	1%	3%	7%	3%	10%	62%	100%
IND2: Light	15%	1%	4%	9%	7%	11%	53%	100%
IND3: Food/Chemical	11%	1%	4%	8%	6%	11%	59%	100%
IND4: Metals/ Mineral Processing	7%	0%	25%	2%	6%	8%	52%	100%
IND5: High Technology	11%	0%	5%	4%	4%	4%	72%	100%
IND6:	20%	1%	7%	9%	7%	11%	45%	100%

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
Construction								
AGR1: Agriculture	26%	0%	8%	9%	9%	12%	36%	100%
REL1: Church	10%	1%	12%	4%	17%	10%	46%	100%
GOV1: General Services	10%	1%	12%	6%	4%	8%	59%	100%
GOV2: Emergency Response	6%	0%	15%	2%	2%	12%	63%	100%
EDU1: School	4%	1%	12%	3%	6%	10%	64%	100%
EDU2: College	4%	1%	10%	2%	3%	8%	72%	100%
Wood	6%	1%	13%	4%	4%	16%	56%	100%
Steel	4%	0%	12%	1%	2%	15%	66%	100%
Masonry	7%	1%	14%	3%	3%	18%	54%	100%
Concrete	4%	0%	12%	1%	2%	15%	66%	100%

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
MH	6%	2%	10%	3%	5%	20%	54%	100%

Visual 27: Post-FIRM Sub-Assembly Replacement Values

Reference your manual for the table of Post-FIRM Sub-Assembly Replacement Values

Sub-Assembly Replacement Values

Post-FIRM Sub-Assembly Replacement Values

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
RES1: Single	11%	3%	10%	5%	5%	19%	47%	100%
RES2: MH	8%	2%	10%	3%	5%	20%	52%	100%
RES3A: Duplex	11%	3%	10%	5%	5%	19%	47%	100%
RES3B: 3-4 units	11%	3%	10%	5%	5%	19%	47%	100%
RES3C: 5-9 units	10%	1%	9%	2%	3%	9%	66%	100%
RES3D: 10-19 units	10%	1%	9%	2%	3%	9%	66%	100%
RES3E: 20-49 units	10%	1%	12%	1%	3%	10%	63%	100%
RES3F: 50+ units	8%	0%	12%	1%	1%	12%	66%	100%
RES4: Temp. Lodging	8%	1%	8%	1%	2%	9%	71%	100%

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
RES5: Institutional Dormitory	9%	0%	13%	1%	3%	13%	61%	100%
RES6: Nursing Home	10%	1%	9%	3%	2%	12%	63%	100%
COM1: Retail	11%	1%	9%	5%	5%	9%	60%	100%
COM2: Wholesale	25%	1%	6%	9%	7%	10%	42%	100%
COM3: Personal & repair services	15%	1%	7%	7%	3%	9%	58%	100%
COM4: Professional/Business	9%	1%	10%	1%	3%	16%	58%	100%
COM5: Banks	11%	0%	9%	4%	9%	7%	60%	100%
COM6: Hospital	7%	0%	6%	1%	4%	6%	76%	100%
COM7: Medical	10%	1%	4%	3%	2%	11%	69%	100%

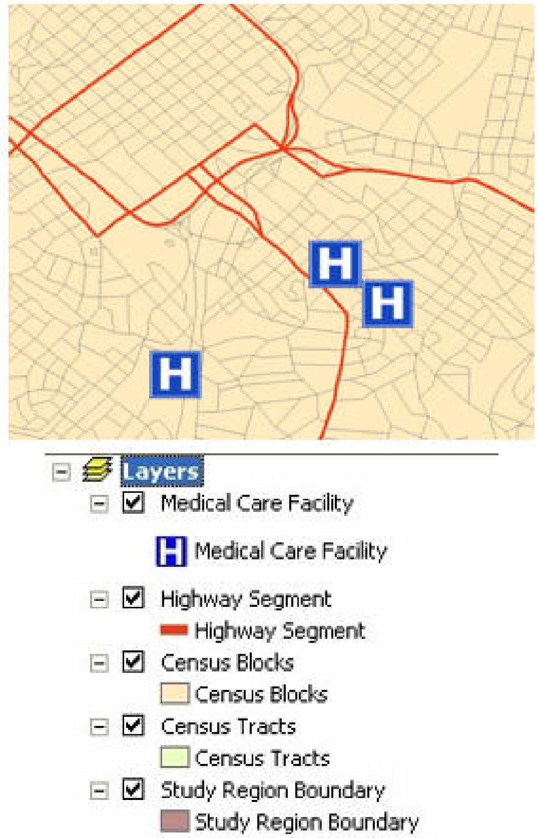
Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
Office								
COM8: Entertainment	14%	1%	9%	4%	3%	7%	62%	100%
COM9: Theaters	11%	1%	9%	5%	6%	9%	59%	100%
COM10: Parking	17%	0%	39%	0%	10%	8%	26%	100%
IND1: Heavy	19%	1%	2%	7%	3%	9%	59%	100%
IND2: Light	20%	1%	3%	9%	7%	10%	50%	100%
IND3: Food/Chemical	16%	1%	3%	8%	6%	10%	56%	100%
IND4: Metals/ Mineral Processing	12%	0%	24%	2%	6%	7%	49%	100%
IND5: High Technology	16%	0%	4%	4%	4%	3%	69%	100%
IND6:	25%	1%	6%	9%	7%	10%	42%	100%

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
Construction								
AGR1: Agriculture	31%	0%	7%	9%	9%	11%	33%	100%
REL1: Church	15%	1%	11%	4%	17%	9%	43%	100%
GOV1: General Services	15%	1%	11%	6%	4%	7%	56%	100%
GOV2: Emergency Response	11%	0%	14%	2%	2%	11%	60%	100%
EDU1: School	9%	1%	11%	3%	6%	9%	61%	100%
EDU2: College	9%	1%	9%	2%	3%	7%	69%	100%
Wood	11%	1%	12%	4%	4%	15%	53%	100%
Steel	9%	0%	11%	1%	2%	14%	63%	100%
Masonry	12%	1%	13%	3%	3%	17%	51%	100%
Concrete	11%	0%	11%	3%	2%	11%	62%	100%

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
MH	8%	2%	10%	3%	5%	20%	52%	100%

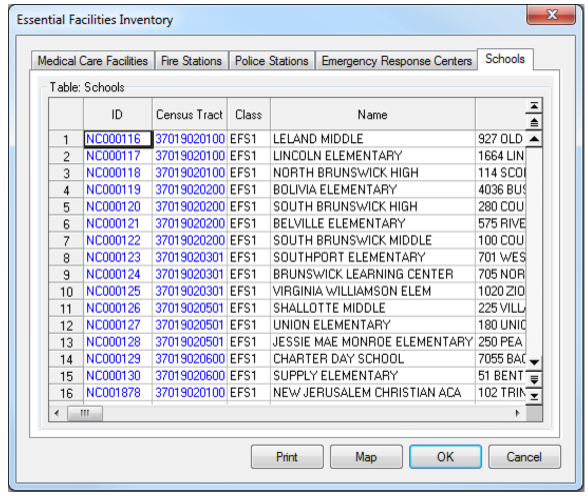
Visual 28: Site-Specific Inventory

- Includes essential facilities, high potential loss facilities, user-defined facilities, transportation systems, utility systems, hazardous material sites
- Represents discrete points of facilities and systems of inventory
- Provides site-to-site results versus an aggregated table of damages and losses



Visual 29: Essential Facilities

- Fire Stations
- Police Stations
- Schools
- Emergency Operations Centers (EOC)
- Medical Care Facilities



Visual 30: Essential Facility Classes

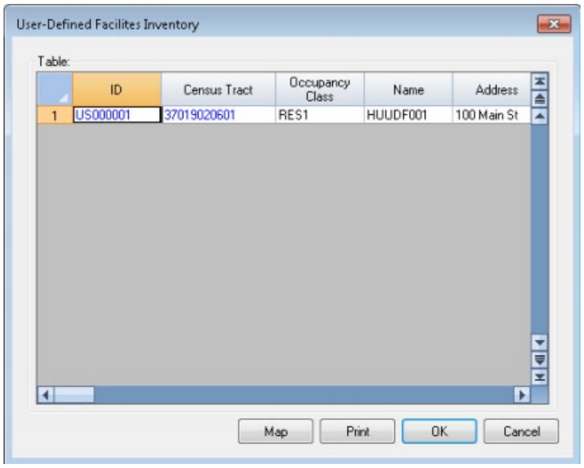
Class	Category	Description	Occupancy
MDFLT	DEFAULT	Default for Medical	COM6
EFHL	Medical Care	Large Hospital (greater than 150 beds)	COM6
EFHM	Medical Care	Medium Hospital (50 to 150 Beds)	COM6
EFHS	Medical Care	Small Hospital (less than 50 Beds)	COM6
EFMC	Medical Care	Medical Clinics and Labs	COM7
PDFLT	DEFAULT	Default for Police	GOV2
EFPS	Emergency Response	Police Station	GOV2
FDFLT	DEFAULT	Default for Fire Station	GOV2
EFFS	Emergency Response	Fire Station	GOV2
EDFLT	DEFAULT	Default for Emergency Response Facility	GOV2
EFEO	Emergency Response	Emergency Operation Centers	GOV2
SDFLT	DEFAULT	Default for School	EDU1
EFS1	School	Grade Schools (Primary/High Schools)	EDU1

Class	Category	Description	Occupancy
EFS2	School	Colleges/Universities	EDU2

Note the links between site-specific and GBS

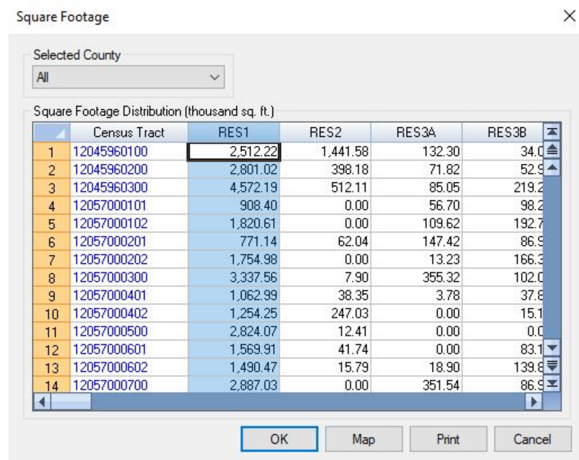
Visual 31: User-Defined Facilities

- Used to perform site-specific analysis of types of buildings found in the General Building Stock
- Required fields for hurricane:
    - ID
    - Census Tract
    - Occupancy
    - Wind Building Type
    - Wind Building Scheme Name
    - Location

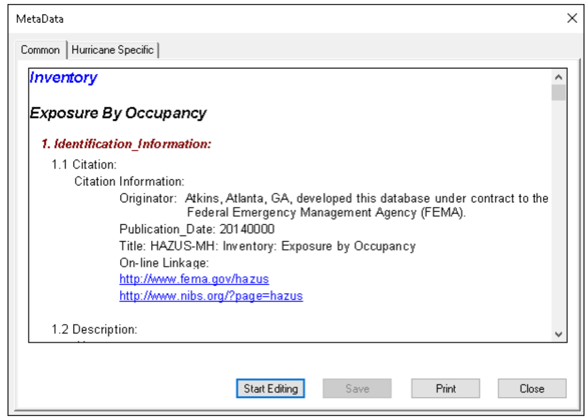


Visual 32: Other Inventory Table Options

- Metadata
- Data Dictionary
- Export
- Map



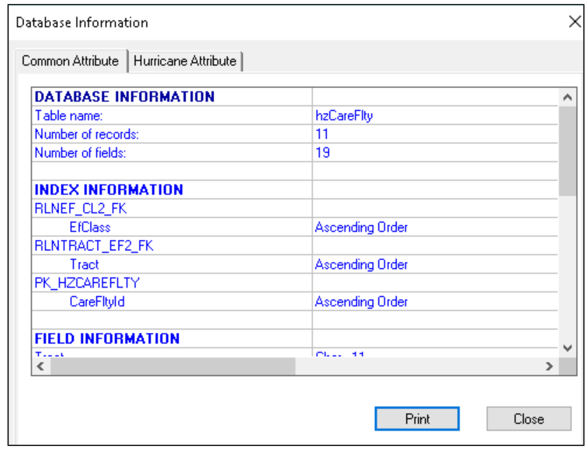
Visual 33: Inventory Table Features: Metadata



- Metadata can be accessed through context menu.
- Metadata is essentially reference information.
  - Includes description, source, spatial reference, etc.

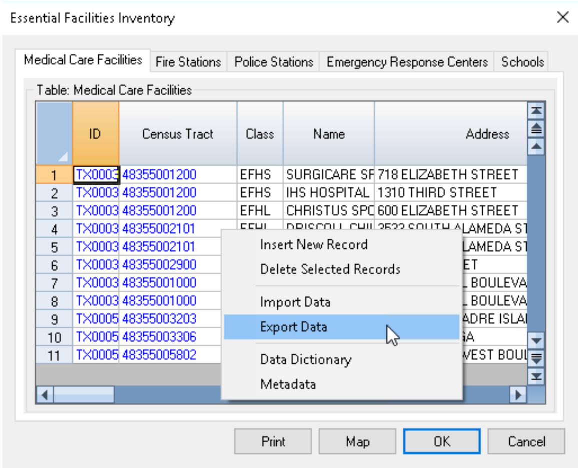
Visual 34: Inventory Table Features: Data Dictionary

- The data dictionary can be accessed through the context menu.
- The data dictionary describes the table (name, field definitions, etc.)
- Also used to build a table for import.



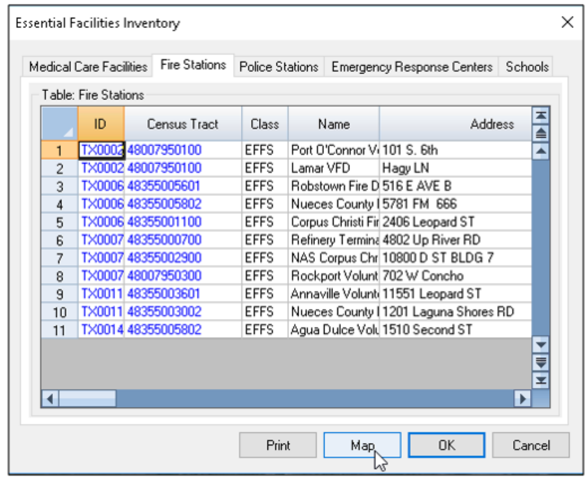
Visual 35: Inventory Table Features: Export

- The option to export can be accessed through the inventory menu.
- Inventory can be exported to two file formats: txt and csv.
  - Used to manipulate data outside of Hazus.



Visual 36: Inventory Table Features: Map

- Click on the column heading to select the field you wish to map.
- Click "Map."
- Inventory item map layer is created and symbology is automatically populated.



Visual 37: Exercise 2.2: Comprehensive Data Management System

Goals:

- Update state database using CDMS.
- Create a new study region.

Time: 35 minutes

Visual 38: Exercise 2.2: Tasks

Part 1: Update State Database

Task 1: Start CDMS and Set State Database to be Updated.

Task 2: Delete Existing Medical Care Facilities in State Database.

Task 3: Import New Medical Care Facilities into CDMS Repository.

Task 4: Transfer Medical Care Facilities to Statewide Database.

Part II: Update the Aggregate Inventory:

Task 1: Import the assessor’s data into the CDMS repository.

Exercise 2.2: Comprehensive Data Management System

Type: Student-Led Exercise

Time: 35 minutes

Goals:

- Update state database using CDMS.
- Create a new study region.

Background:

Hazus provides a vast amount of information that can be used to complete a Level 1 analysis. However, this information is compiled based upon best available national data sources and frequently is not complete. This exercise will introduce you to some of the tools Hazus provides for improving the inventory data with your own data. The exercise is not intended to serve as a detailed exploration of inventory update tools and processes, but rather an overview. In addition, note that the inventory data used in this exercise, while very similar to actual data, has been modified explicitly for this course and should not be considered representative of actual conditions in the community used in the examples.

Part I: Update State Database

Use the Comprehensive Data Management System (CDMS) to update two types of inventory data in the state databases from which Hazus study regions are derived.

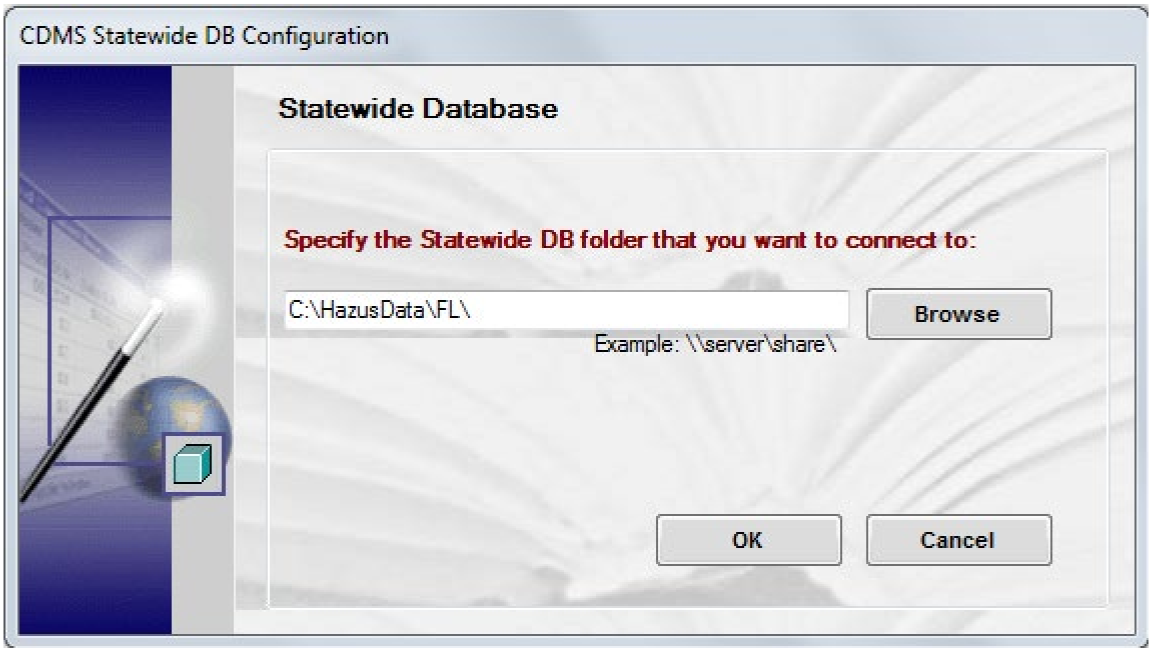
Task 1: Start CDMS and Set State Database to be Updated

1. Double-click the CDMS icon on your desktop to start CDMS. You can also choose “All Programs > FEMA RISK Assessment System > CDMS” from the Start menu.

2. From the Tools menu, choose “Specify Hazus Data Location.” This specifies to CDMS which state data you are updating. You can only update data for one state at a time.

3. Click “Browse” and navigate to the C:\HazusData\Inventory\FL folder. This folder contains the state data for Florida. You may elect to store your state data elsewhere for your own purposes.

4. Click “OK” once you have selected the appropriate folder.

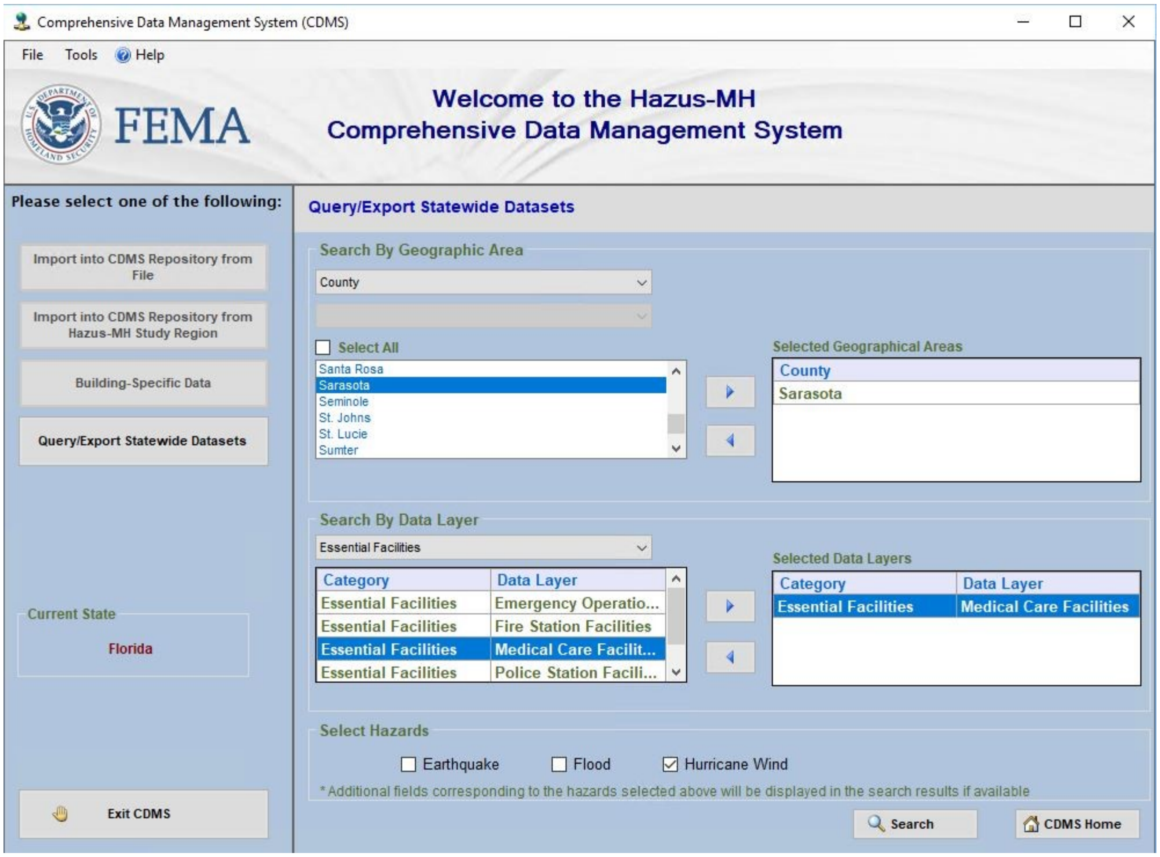


5. Click “OK” to close the CDMS Statewide DB Configuration window.

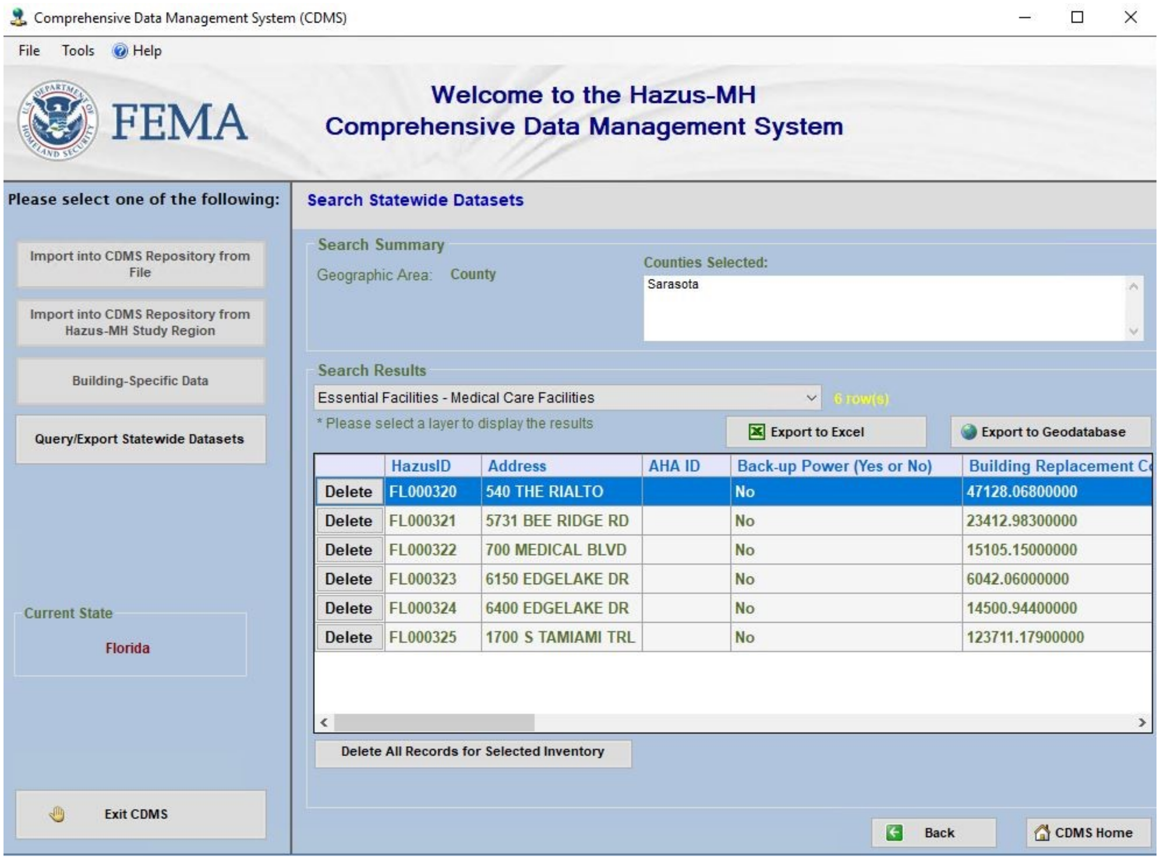
Task 2: Delete Existing Medical Care Facilities in State Database

Note: There are several approaches available for updating inventory data. This exercise will lead you through replacing the entire set of existing medical care facilities in Sarasota County, FL with a new set of medical care facilities. You also could add new medical care facilities or remove only medical care facilities that have been

1. Click “Query/Export Statewide Datasets.”
2. Select “County” as the Geographic Area option.
3. Scroll through the list of counties, highlight “Sarasota” and then click the right arrow to move it to the Selected Geographic Areas list.
4. Select “Essential Facilities” from the list of options under the Search By Data Layer label. It is possible to select more than one type of inventory at a time.
5. Click on the “Medical Care Facilities” category and then click the right arrow to move it to the Selected Data Layers list.
6. Select the “Hurricane Wind” hazards.



7. Click “Search.” CDMS will take just a moment to find the 6 medical care facilities.



8. Click “Delete All Records for Selected Inventory” and click “Yes” when prompted to indicate that you recognize that you are deleting all of the selected records. It may take a few moments to complete the process. When the process is complete the window will show No Records Found. Please try another layer.

9. Click “CDMS Home.”

Task 3: Import New Medical Care Facilities into CDMS Repository

1. Click “Import into CDMS Repository from File” to view the Import into CDMS Repository options.

2. Click “Browse” on the right side of the screen. Browse to the C:\E0170_ActivityData\Exercise_2.2 folder, double-click the “MedialCareFacilities.mdb” and click “Open.”

Note: This database contains updated medical care facility records for Sarasota County, Florida. The replacement costs have been increased by 10% to reflect an increase in materials costs over 5 years (created solely for the purposes of this course). The structure that this database must follow to be Hazus compliant is discussed in detail in the Compensive Hazus-Data Management course.

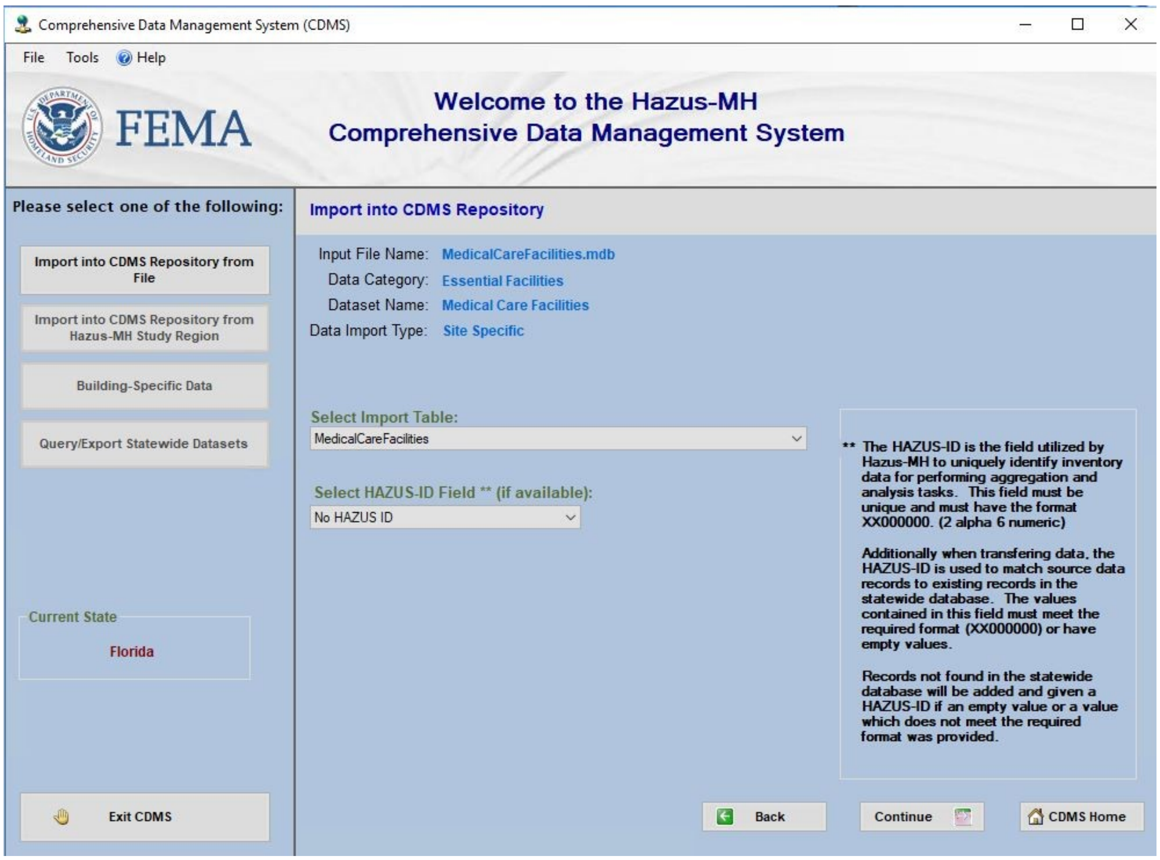
3. Select “Essential Facilities” from the Select Hazus Inventory Category list.

4. Select “Medical Care Facilities” from the Select Hazus Inventory Dataset (Layer) list.

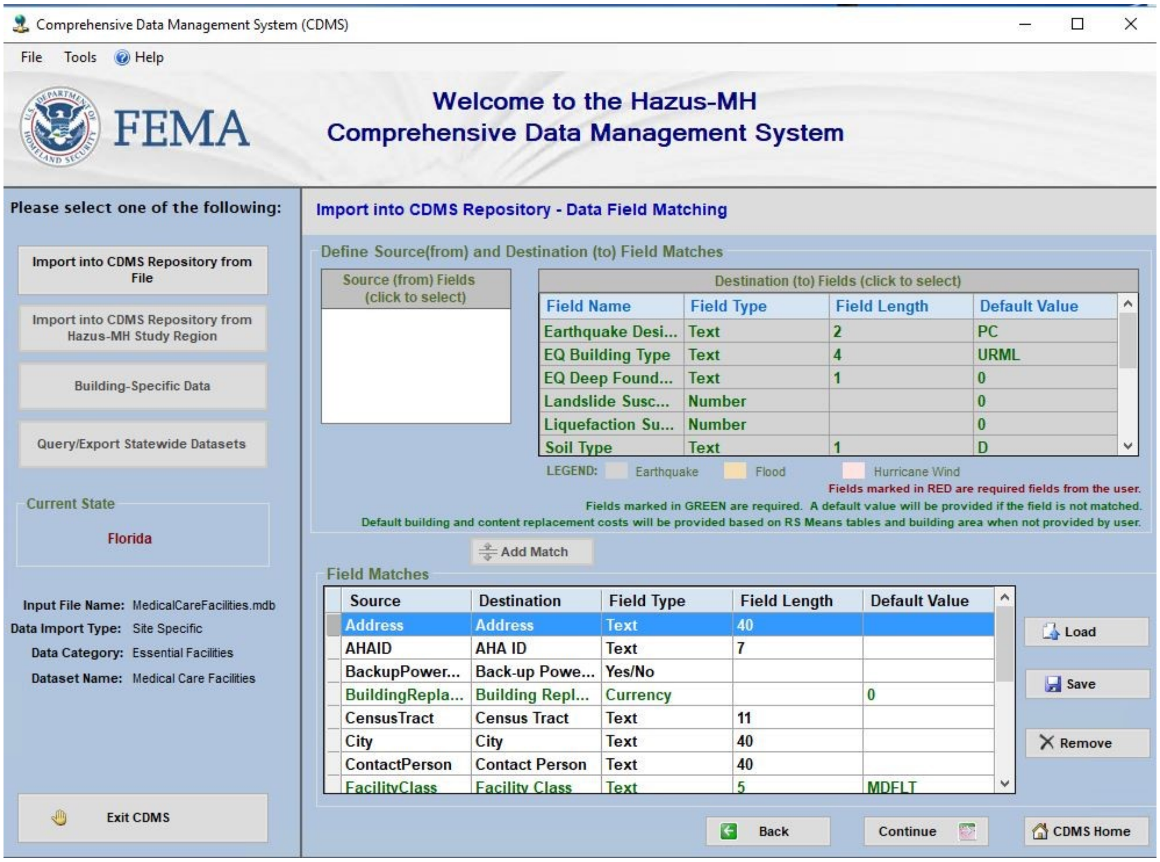
5. Click “Continue” in the lower right corner of the CDMS window.

6. Verify that “MedicalCareFacilities” is identified as the Select Import table. The MedicalCareFacilities table automatically appears since it is the only table in the database.

7. Select “No Hazus ID” for the Select Hazus-ID field option. All site-specific inventory records must have a unique identifier. This can either be created by Hazus or it can be provided by the user if it is in a Hazus compliant format.



8. Click “Continue” to view the Data Field Mapping window:

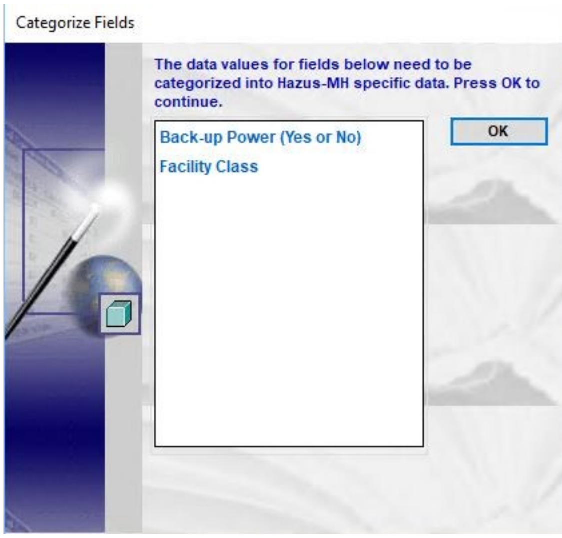


Note: Field matching is the process of telling CDMS how the fields in your table match up to those required by Hazus. CDMS will attempt to match fields that are similar in name. You can then manually match any fields that do not auto-match or you can un-match fields that are incorrectly matched. Observe there are several fields in the top half of the window that are shaded green. These are required fields, but CDMS will populate these with a default value if you do not provide a field in your table that contains the required information.

9. Click “Continue.”

10. CDMS will produce a window that states that default values will be used for the fields not matched. Click “Yes” to accept the default values.

11. The Categorize fields window will appear showing the fields that need to be categorized. Categorizing is a process that involves telling CDMS how the values in your table related to the Hazus required values.



12. Click “OK” to move to the Back-up Power category value matching window.
13. Back-up Power (Yes or No) was automatically matched to the correct value in the destination field by CDMS. Click “Continue”.
14. EFHL and EFHM were already automatically matched to the correct value in the destination field by CDMS. Click “Continue” to move to the Facility Class category value matching window.
15. Click “OK” when the window appears reporting Data was imported into CDMS Repository.
16. When the process has completed, the CDMS Repository window will appear listing the essential facilities medical care facilities table that you just imported.
17. Click “View/Edit” to open a window that shows each of the medical care facilities that you imported. From this window you can remove individual medical care facilities that you do not want to import into the state database.

		HazusID	Address	AHA ID	Back-up Power (Yes or No)	Building Replacement Cost (thous. $)	Census Tract	City	Contact Pers
Remove	Edit	CD000001	540 THE RIALTO		No	51840.8748	12115002401	VENICE	
Remove	Edit	CD000002	5731 BEE RIDGE RD		No	25754.2813	12115001505	SARASOTA	
Remove	Edit	CD000003	700 MEDICAL BLVD		No	16615.6650	12115002718	ENGLEWOOD	
Remove	Edit	CD000004	6150 EDGELAKE DR		No	6646.2660	12115001401	SARASOTA	
Remove	Edit	CD000005	6400 EDGELAKE DR		No	15951.0384	12115001401	SARASOTA	
Remove	Edit	CD000006	1700 S TAMIAMI TRL		No	136082.2969	12115000501	SARASOTA	

18. Click “Close” to close the CDMS Detail Information window.

Task 4: Transfer Medical Care Facilities to Statewide Database

1. Click “Transfer to Statewide Dataset” to view Statewide Data Transfer Options. There are two options at this point: The “Append/Update Data” option adds new data to the statewide database. The “Replace data” option replaces everything in the statewide database with the new information that you select.

2. Select the “Append/Update Data” option and then click “Submit.”

3. Click “Yes” when prompted to indicate that you are sure you want to transfer this layer to the Statewide Datasets. It may take a minute or two to complete the update process.

4. Click “OK” when prompted to acknowledge that the Statewide Data Transfer is complete.

Note: The medical care facilities have now been moved from the CDMS Repository window to the Statewide Layer Modification History window. You can query the medical care facilities again to verify. You could also build a study region that includes the updated inventory at this point. However, you will use CDMS to update an aggregate inventory database prior to doing so.

Part II: Update the Aggregate Inventory:

In this part of the exercise we will update the general building stock inventory in the state database inventory using information about individual structures that could be acquired from a local assessor’s office or some other source. The goal is to introduce you to the tools that Hazus provides for managing this type of inventory. However, the detailed steps that you would need to prepare your own data for importing in this fashion are covered in the Comprehensive Data Management course.

Task 1: Import the assessor's data into the CDMS repository

1. Click "Import into CDMS Repository from File."

2. Click "Browse" on the right side of the screen.

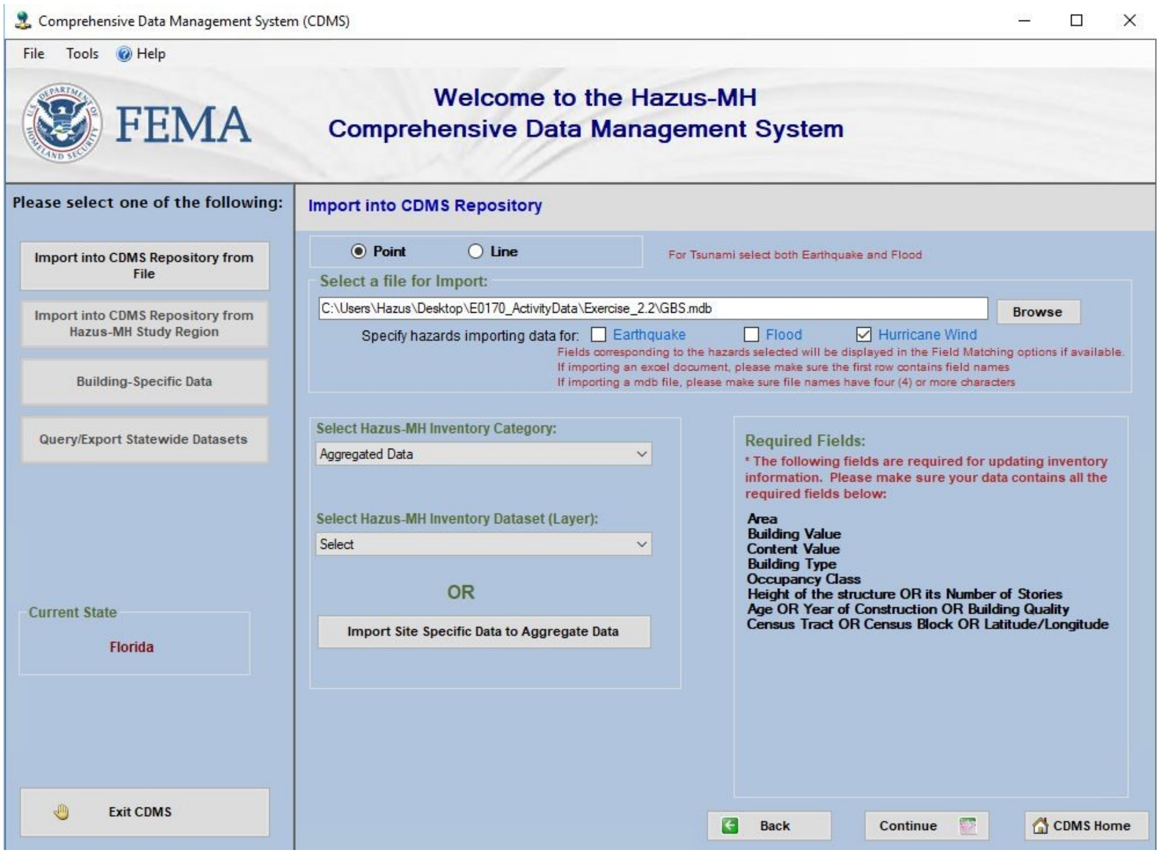
3. Browse to the C:\E0170_ActivityData\Exercise_2.2 folder and double-click the "GBS.mdb" geodatabase.

Note: As noted above, this database was prepared specifically for this exercise. Keep in mind that creating a Hazus compliant database can be a time-consuming process. The detailed steps for completing this process are discussed in the Comprehensive Data Management course.

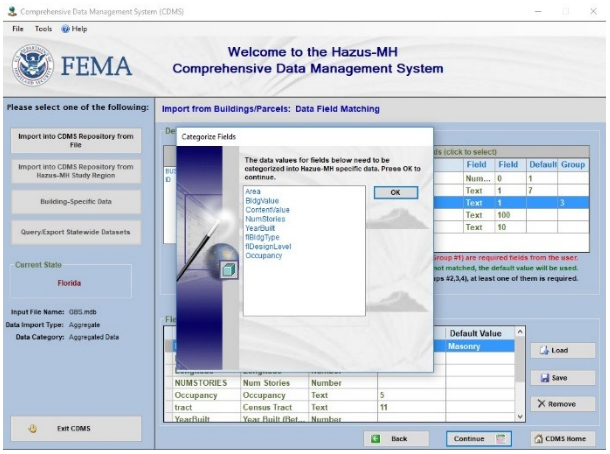
4. Uncheck the "Earthquake" and "Flood" hazard importing option. Since you are only running a hurricane model analysis in this course it is not necessary to import information unique to the earthquake hazard.

5. Select "Aggregated Data" from the Select Hazus Inventory Category drop-down list.

6. Select "Import Site Specific Data to Aggregate Data."



7. Click “Yes” to acknowledge updating the aggregate layers in the CDMS repository.
8. Select the GBS table from the input table section drop-down menu and click “OK.”
9. Select “BldgRepCost” in the Source from Fields box and find and highlight the matching field in the Destination box which should be called “Building Replacement Cost”. Click “Add Match”.
10. Select “ContentRplcCost” in the Source from Fields box and find and highlight the matching field in the Destination box which should be called “Content Replacement Cost”. Click “Add Match”.
11. Click “Continue”.
12. Click “OK” to categorize the fields that require categorization:



13. Click “OK” for the Area Field Type categorization.

Note: This value was already in thousands of square feet in the GBS file. It is important to know what the units of your data are in before you enter the categorization process. If you enter in the wrong value, CDMS will not know and you imported data will be incorrect.

14. Click “OK” for the Building Value Field Type categorization.

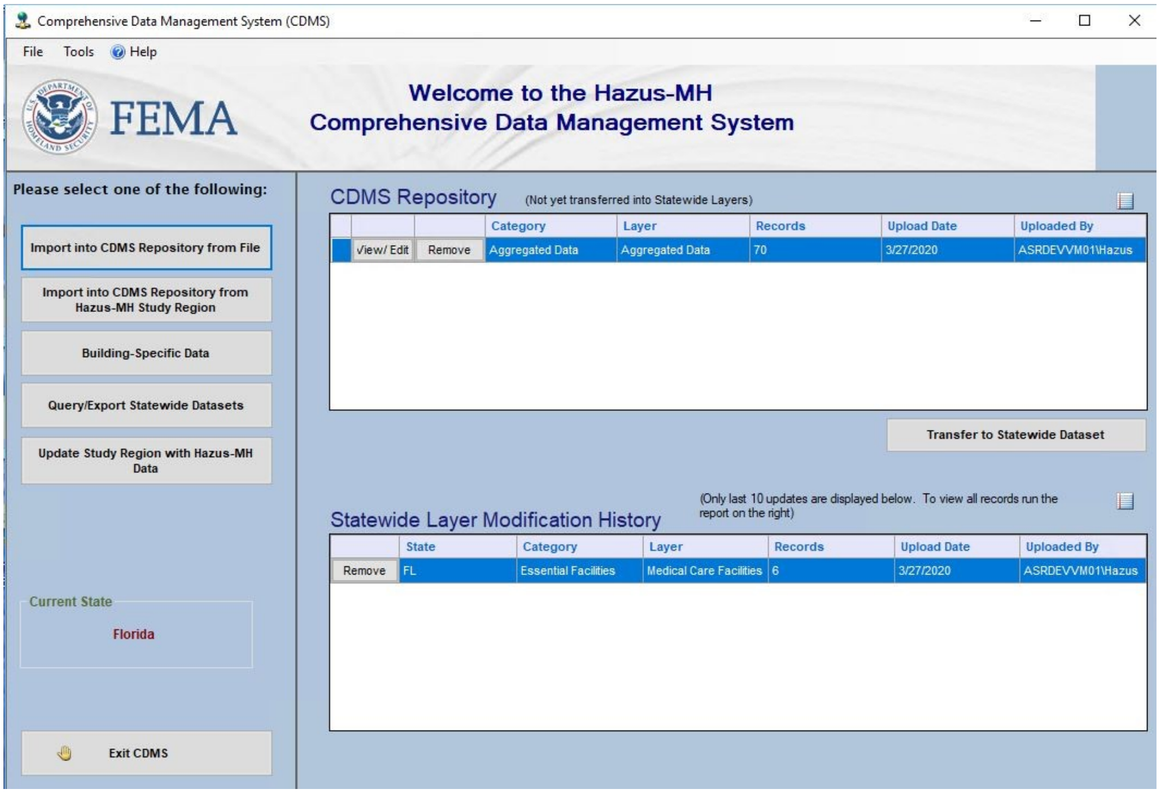
15. Click “OK” for the Content Value Field Type categorization.

16. Click “OK” for the Number of Stories Value Field Type to indicate “Field is numeric. Use as is.”

17. Click the radio button next to “Year is in 4-digit format (e.g. 1995)” for the Year Built Field Type and then click “OK.”

18. Click “Continue”. You do not have to match any fields in the next step. CDMS recognizes the value and has automatically matched it.

19. Click “OK” to acknowledge the data was imported into the CDMS repository to return to the CDMS Repository window. Aggregated data now appears as an entry under the CDMS Repository heading.



20. Click “View” to view the Aggregate Data Results. The data that you imported is organized by census block and tract. The number of records reflects the number of census blocks and tracts that you are updating in the state database.

21. Click “Close.”

22. Click “Transfer to Statewide Dataset” and click “Yes” when prompted to indicate that you understand that your action cannot be undone. This process will take approximately one minute to complete.

23. In order to update the entire aggregated inventory, click “Select All” on the Transfer Aggregated Data to Statewide Databases window.

24. Click “Process only imported tracts/blocks” and check the box to “Update General Building Mapping Schemes.”

25. When finished click “OK.”

26. The first selection updates all of the blocks you are updating (69). The second step updates all of the blocks in the county you are updated. In blocks where you are not importing data, they will keep the default inventory.

27. Click the radio button next to “Replace all occupancies for this statewide transfer.” Click “Continue.” This assumes that for the blocks you are updating you have accounted for every building and have classified it correctly.

28. When the Statewide Data Transfer process is complete, click “OK” to move the Aggregated data entry to the Statewide Layer Modification History. This process may take a minute or two to complete.

29. Exit CDMS.

Visual 39: Lesson 2: Review

1. What is the purpose of the wind building characteristics distribution mapping scheme?
2. What two states have their own set of mapping schemes?
3. What types of buildings are considered by Hazus to be essential facilities?
4. What is the tool provided by Hazus for updating the state databases?
5. What are the only two site-specific dataset groups that are analyzed by the hurricane model?

Visual 40: Questions?

Lesson 3: Hurricane Wind Model

Visual 1: Lesson 3: Hurricane Wind Model

Visual 2: Lesson 3: Goal and Objectives

Goal: To provide an overview of the hurricane wind model within Hazus.

After completing this lesson you will be able to:

- List the key components of hurricane development.
- Describe the areas of the U.S. mainland that have the highest risk to major hurricanes.
- Provide four scenario types that a user can select to run the hurricane model.
- Understand two databases unique to the hurricane model.

Visual 3: Hurricane Basics

- Rotate counter-clockwise in the Northern Hemisphere
- Require ocean temperatures around 80° F or 27° C or above
- Occurs between 5°N and 40°N in the Atlantic Ocean
- Hurricane season: June 1 through November 30 (Atlantic Basin)

Visual 4: Tropical System Basics

Type of Tropical Cyclone	Maximum Sustained Winds
Tropical Depression	38 mph (33 knots) or less
Tropical Storm	39-73 mph (34-63 knots)
Hurricane Category 1	74-95 mph (64-82 knots)
Hurricane Category 2	96-110 mph (83-95 knots)
Hurricane Category 3	111-129 mph (96-112 knots)
Hurricane Category 4	130-156 mph (113-136 knots)
Hurricane Category 5	157 mph (137) knots or greater
Tropical Cyclone Category 1	77 mph (67 knots) or less
Tropical Cyclone Category 2	78-102 mph (68-89 knots)
Tropical Cyclone Category 3	103-139 mph (90-121 knots)
Tropical Cyclone Category 4	140-173 mph (122-150 knots)
Tropical Cyclone Category 5	174 mph (151 knots) or greater
Super Typhoon	150 mph (130 knots) or greater

Visual 5: Hurricane Intensity

Saffir-Simpson Hurricane Wind Scale for the Continental United States

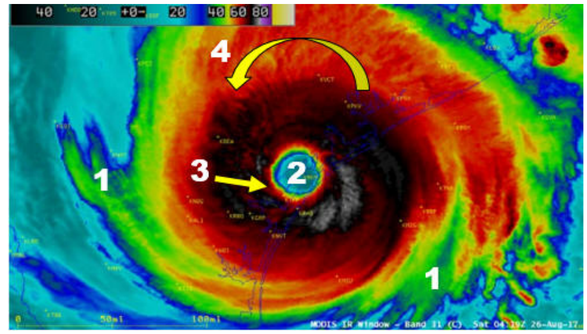
Scale Number (Category)	Sustained Winds (MPH)	Typical of Damage Due to Hurricane Winds	Hurricanes
1	74-95	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.	Florence (2018), near Wilmington, North Carolina
2	96-110	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.	Frances (2004) in coastal Port St. Lucie, Florida
3	111-129	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.	Irma (2017) second landfall near Marco Island, Florida
4	130-156	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.	Harvey (2017) near Aransas, Texas
5	>157	**Catastrophic damage will occur:** A high	Andrew (1992)

Scale Number (Category)	Sustained Winds (MPH)	Typical of Damage Due to Hurricane Winds	Hurricanes
		percentage of framed homes will be destroyed with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.	in coastal parts of Cutler Ridge, Florida

http://www.weather.govfos/hurricane/resources/TropicalCyclones11.pdf

Visual 6: Hurricane Anatomy

1. Rain bands or “feeder bands”
2. Eye
3. Eye wall
4. Counterclockwise rotation



Hurricane Harvey. Source: NOAA

*NOTE: A second outer eye wall may develop, but it can be difficult to differentiate from the inner eye wall.

Visual 7: Hurricane Anatomy: Symmetry

- Each quadrant is symmetric
- Strongest winds and highest surge (without coastline effects) occur in the right-front quadrant of hurricane
- Forward speed of the hurricane + Rotational winds of the hurricane = highest wind speeds

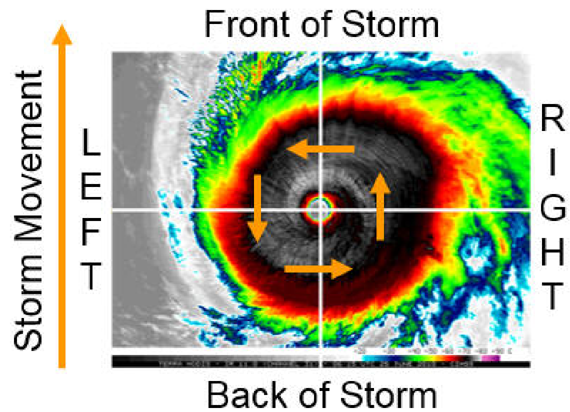
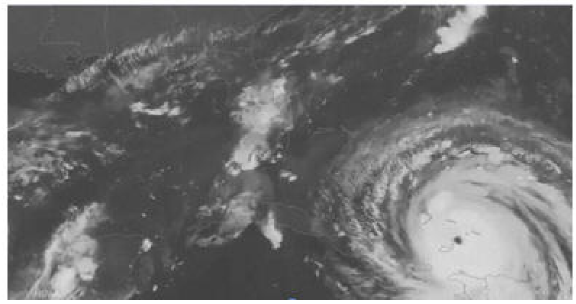
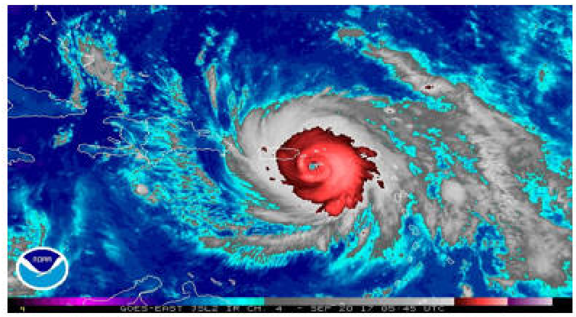


Image: Satellite image of Celia (2010) Cooperative Institute for Meteorological Studies (CIMSS), University of Wisconsin

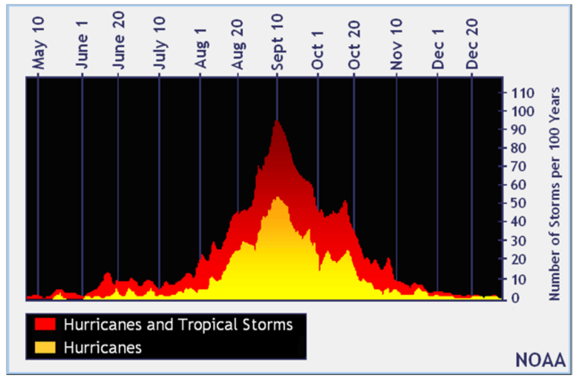
Visual 8: Hurricane Irma, Maria, and Michael

- Hurricane Irma, 2017
    - Approaching the coast of Florida
- Hurricane Maria, 2017
    - At its strongest point, approaching Puerto Rico.
- Hurricane Michael, 2018
    - Making landfall in Florida's Panhandle.





Visual 9: Hurricane Climatology



NOAA, National Hurricane Center (NHC)

Atlantic Hurricane Season:

June 1st – November 30th

Peak of the hurricane season

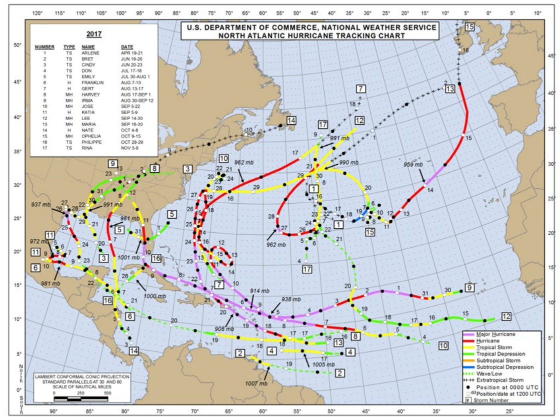
- Peak September 10th
- Second peak approx. October 15th

Peaks are related to:

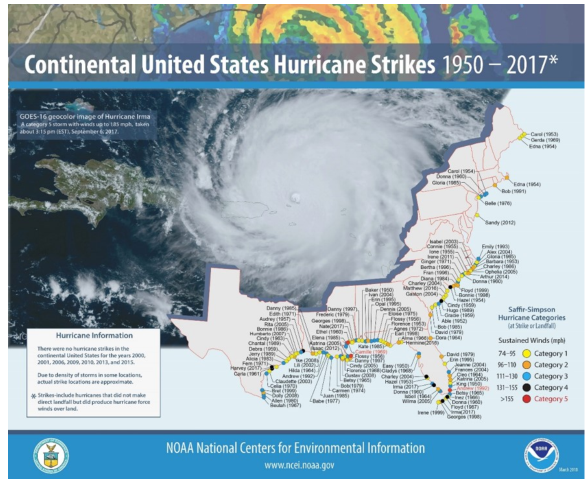
- Peak ocean temperatures
- Peak of ideal weather patterns

Visual 10: Hurricane Geography

- Hurricanes impacting the US mainland often follow one of two general paths:
  - Staying in the Atlantic and tracking up the East Coast
  - Tracking west of Florida and entering the Gulf of Mexico



Visual 11: Hurricane Geography



Major hurricane U.S. strikes:

- Florida has the greatest number
- North Carolina, Louisiana, Mississippi, Alabama, and Texas are also high frequency areas

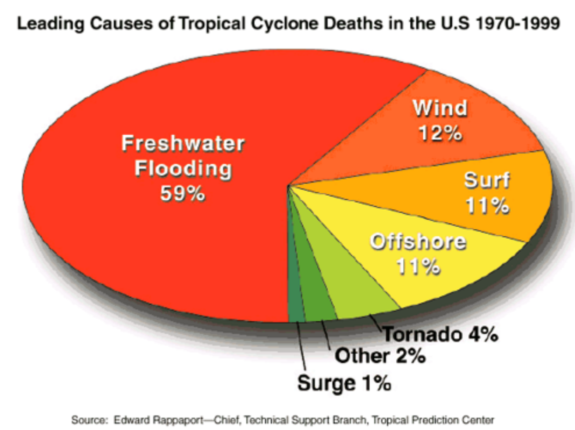
Visual 12: Hurricane Damages and Losses

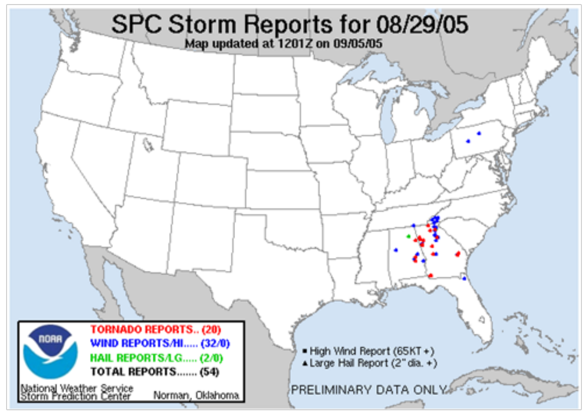
Possible hurricane effects:

- Hurricane Winds*
- Hurricane Storm Surge*
- Rainfall / Inland Riverine Flooding*
- Tornadoes
- Rip Currents and High Waves

Hurricane and Tropical Storms winds can extend far inland from the coast.

* Modeled by Hazus

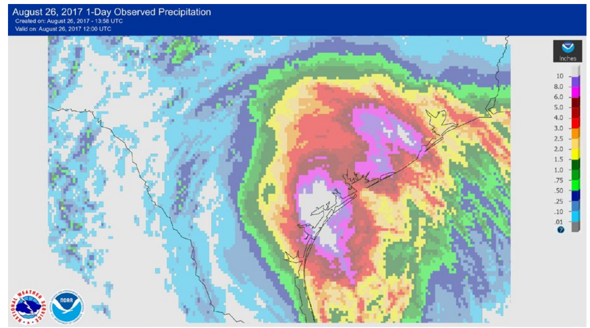




NOAA, National Hurricane Center (NHC), Storms Prediction Center (SPC)

Visual 13: Additional Hazards

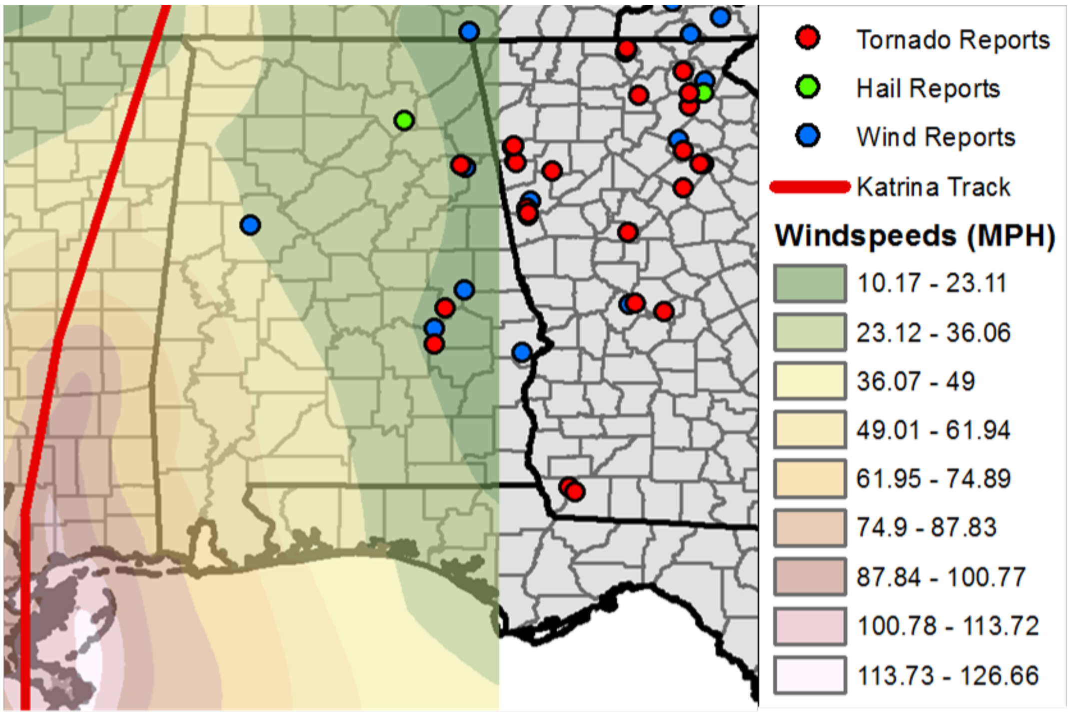
- Tornadoes and severe thunderstorms are common for tropical systems.
- Heavy rainfall produces additional riverine and coastal flooding.
- Hurricane effects are felt much further inland.



Hurricane Harvey (2017) Rainfall

Visual 14: Additional Hazards

Katrina: approximately 53 tornadoes in 6 states



Storm Reports and Hurricane Winds

Visual 15: Discussion 3.1: Hurricane Hazard

Goal: Review the Hurricane Hazard and the Hazus Hurricane Model.

Groups: 3-5

Time: 15 minutes

Visual 16: Discussion 3.1: Hurricane Hazard

Questions:

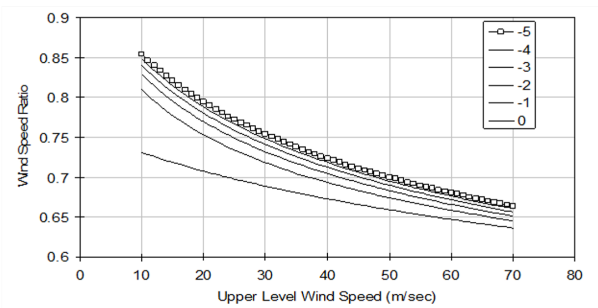
1. What are the implications of not modeling some of the hazards not traditionally generated by a hurricane, such as tornadoes, severe thunderstorms, rip currents?

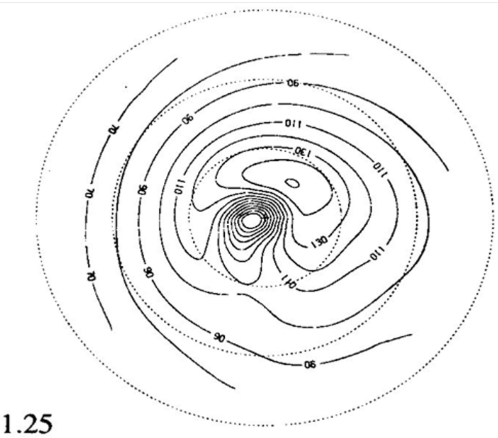
2. Given what we have seen in the previous slide, where (geographically) in relationship to the hurricane path are communities at greatest risk of a landfalling hurricane?

Visual 17: Wind Field Model

Solves full non-linear equations of motion for translating hurricane; then establishes parameters for fast running simulation

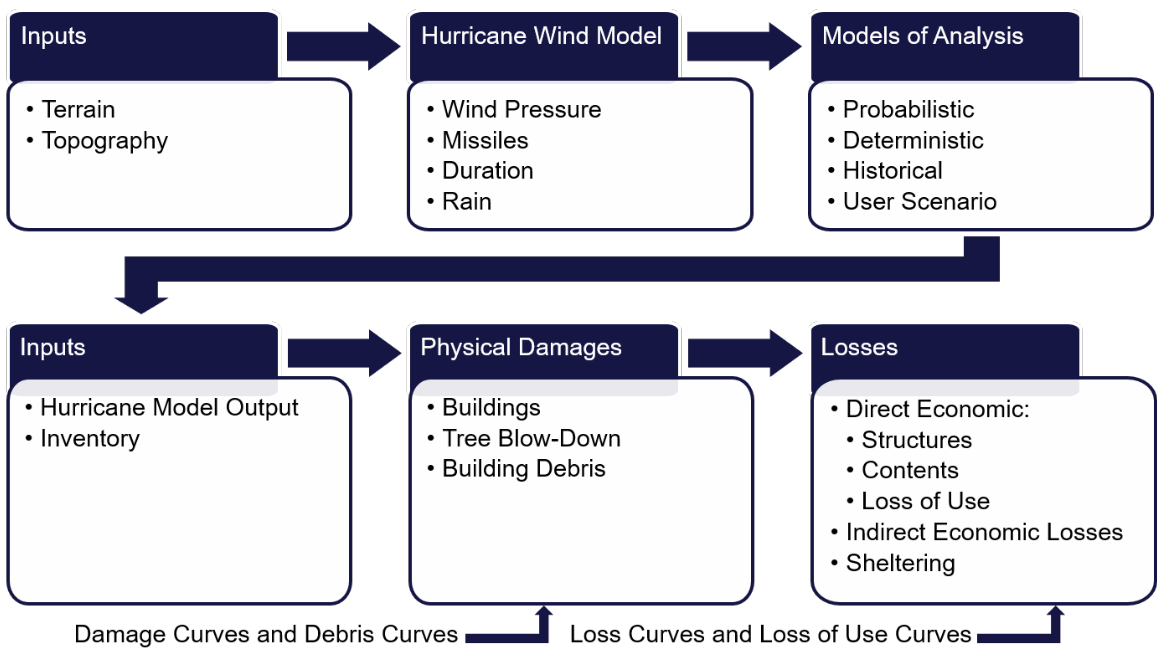
- Storm asymmetries
- Changing sea-surface roughness
- Air-sea temperature difference



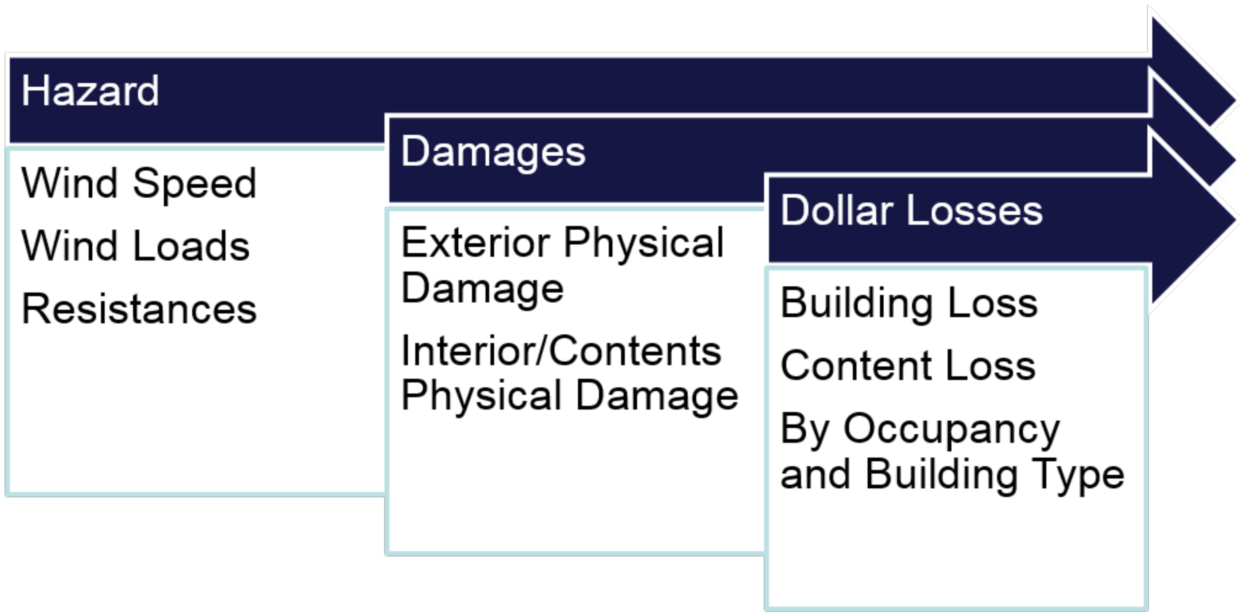


b = 1.25
Maximum Gust Windspeed = 151.4 mph

Visual 18: Components of Hazus Hurricane Wind Model



Visual 19: Building Damage and Loss Methodology



Visual 20: Hurricane Model States

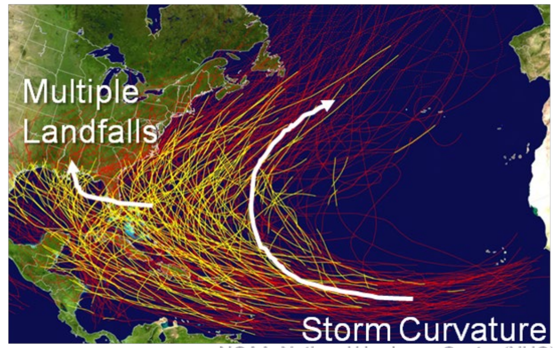
- Hurricane model only applies to 23 coastal states
- These are the only states which can be modeled by the Hurricane Wind model AND surge model
- Puerto Rico and US Virgin Islands wind model is in development and may be provided in a future update.

Visual 21: Components of Hurricane Model

- Hurricane Database/Model
- Inventory with Wind-Specific Features
- Surface Roughness (Terrain) Database*
- Tree Database*
- Damage/Loss/Debris Functions
- Shelter Model

*NOTE: The surface roughness (terrain) and tree databases are unique to the Hurricane model.

Visual 22: Hurricane Wind Hazard Model: Track



Track Model

- Affecting Gulf Coast, Atlantic Coast, or Hawaii
- Storm curvature
- Multiple landfalls
- Changes in intensity

Visual 23: Hurricane Wind Hazard Model

Wind Field Model

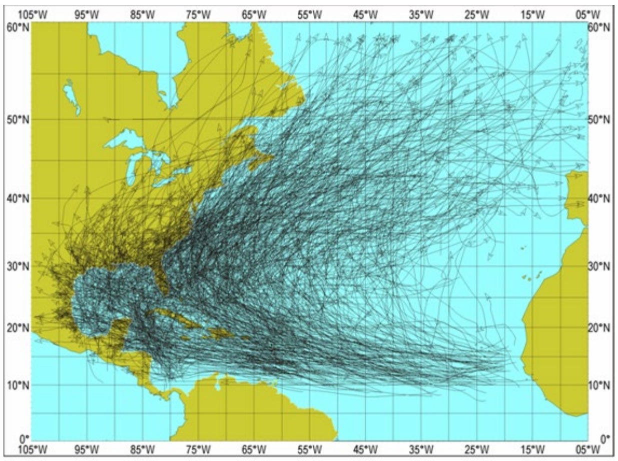
- Updated version of model used for design wind speeds in ASCE-7-98
- Used in International Building Code Series
- Allows for asymmetries (or unevenly distributed wind fields)

Asymmetric Hurricane Irene - 2011, NOAA

Visual 24: Hurricane Wind Model Scenarios

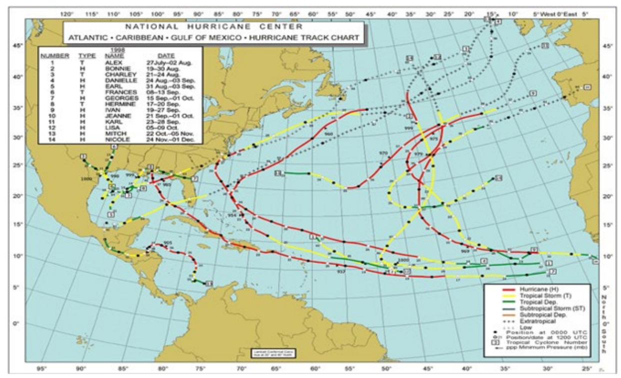
Probabilistic wind speed database:

- 100,000 years of simulated storms



Deterministic

- Historical
- Forecast/Advisory
- User-defined



Visual 25: Damage and Loss Modeling

Damage includes effects of

- Wind pressures
- Wind-borne debris
- Tree blow-down
- Rainfall
- Storm duration

Models damage explicitly to

- Roof cover
- Roof deck
- Whole roof failures
- Window and door failures
- Wall damage

Hurricane Irene (2011) damage in Washington, NC

Visual 26: Damage and Loss Modeling

Loss model based on:

- Insurance loss data
- Correlation of financial damage with water infiltration and building damage

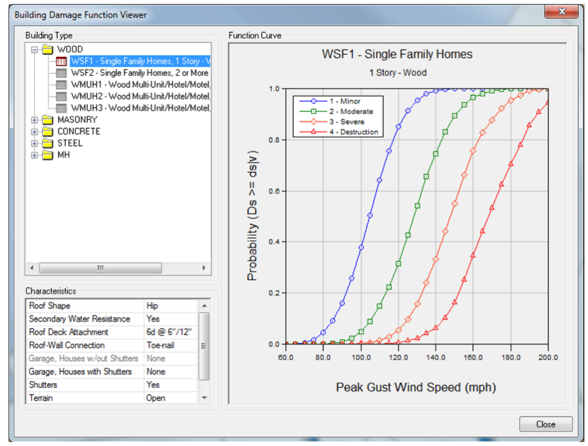
Current model now includes storm surge:

- Hurricane wind and flooding analysis is coupled

Debris from Hurricane Irma in Marathon, Florida has been scheduled for removal to clear waterway in this canal, which is surrounded by a full time commercial trailer park.

Visual 27: Fast-Running Damage & Loss Functions

- Includes 1,884 unique building models
- 45 damage/loss functions for each building model
- Total of ~240,000 unique damage/loss curves



Visual 28: Mitigation of Buildings

- Hazus:
  - Uses a load and resistance approach to estimate damage and ensuing loss
  - Is able to model effects of mitigation
- Hurricane model includes mitigation options for all building types
- Mitigation methods include:
  - Addition of hurricane straps
  - Application of window protection
  - Effects of re-nailing roof sheathing on damage/loss
  - Application of secondary water resistance
  - Combinations of the above

Visual 29: Hurricane Wind Simulation

Why Hurricane Categories Make a Difference: https://www.youtube.com/watch?v=lqfExHpvLRY

Why Hurricane Categories Make a Difference – The Weather Channel

Visual 30: Hurricane Damage Simulation

Student Manual

Hurricane Damage Simulation

- The video demonstrates the benefits of mitigation by showing how hurricane winds interact with a house un-protected by mitigation efforts vs. a house that has mitigation efforts.
- The animation shows:
  - A house situated along the coast that is subjected to a hurricane that produces roughly the design wind speed.
  - Not long after the winds begin, damage to the roof cover begins to accumulate.
  - Next, a piece of wind borne debris breaches a window.
  - The rapid build-up of pressure inside the house quickly causes additional windows and doors to fail.
  - Now, the roof panels are beginning to fail.
  - As the wind shifts directions, the loads on the roof change and more panels fail.
  - Finally, the entire roof frame collapses, and the house is a total loss. As the video pans over to an identical, but mitigated house exposed to the same winds, we see only roof cover damage.
    - This damage can be easily repaired at only a small fraction of the total replacement value of the house.

Visual 31: Terrain Database

- Surface Roughness = Terrain
  - Higher Roughness = Lower Damage (generally)
- Hazus terrain database
  - Derived from Land Use Data
    - National Land Cover Data (NLCD) database
    - Florida Water Management District (FWMD) data
- Roughness parameters averaged for each census tract

Visual 32: Tree Database

Trees:

- Increases roughness but also increases damage
- Building/content loss
- Debris removal

Tree Coverage Database is derived from:

- MRLC land use coverage database
- Forest Inventory Analysis Database

Visual 33: Shelter Models

Two estimates for each census tract

- Number of displaced households
- Number of people requiring short-term public shelter
    - Function of income class, ethnic class, ownership class, population age class

Similar to model used for earthquake model

- Uses building loss ratios instead of building damage states to estimate proportion of uninhabitable housing units

Visual 34: Hurricane Loss Estimation Outputs

Building damage state probabilities

- General Building Stock
- Essential facilities
- User-defined facilities

Capital-related loss ($)

- Building
- Contents

Income-related losses ($)

- Relocation
- Business Income
- Rental Income
- Wages

Social losses

- Displaced households
- Short-term shelter requirements

Debris (tons)

- Building debris
- Tree debris

Summary reports

- Inventory
- Damage
- Loss

Visual 35: Activity 3.2: Explore the Inventory

Goals:

- Explore Inventory

Time: 15 minutes

Visual 36: Activity 3.2 – Explore the Inventory

Task 1: Explore the General Building Stock (GBS) inventory.

Activity 3.2 – Explore the Inventory

Type: Instructor-Led Activity

Time: 15 minutes

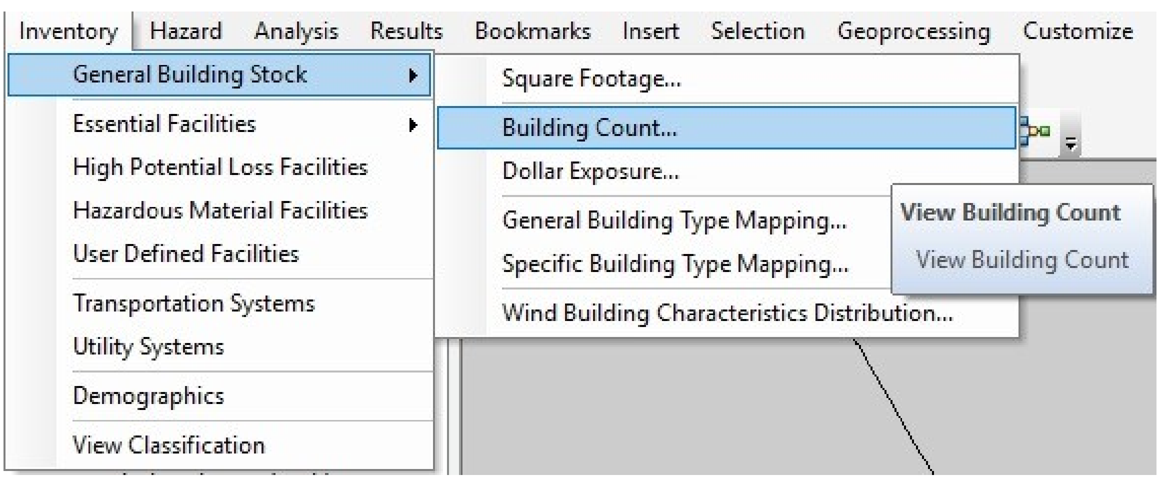
Goals: Explore Inventory

Background:

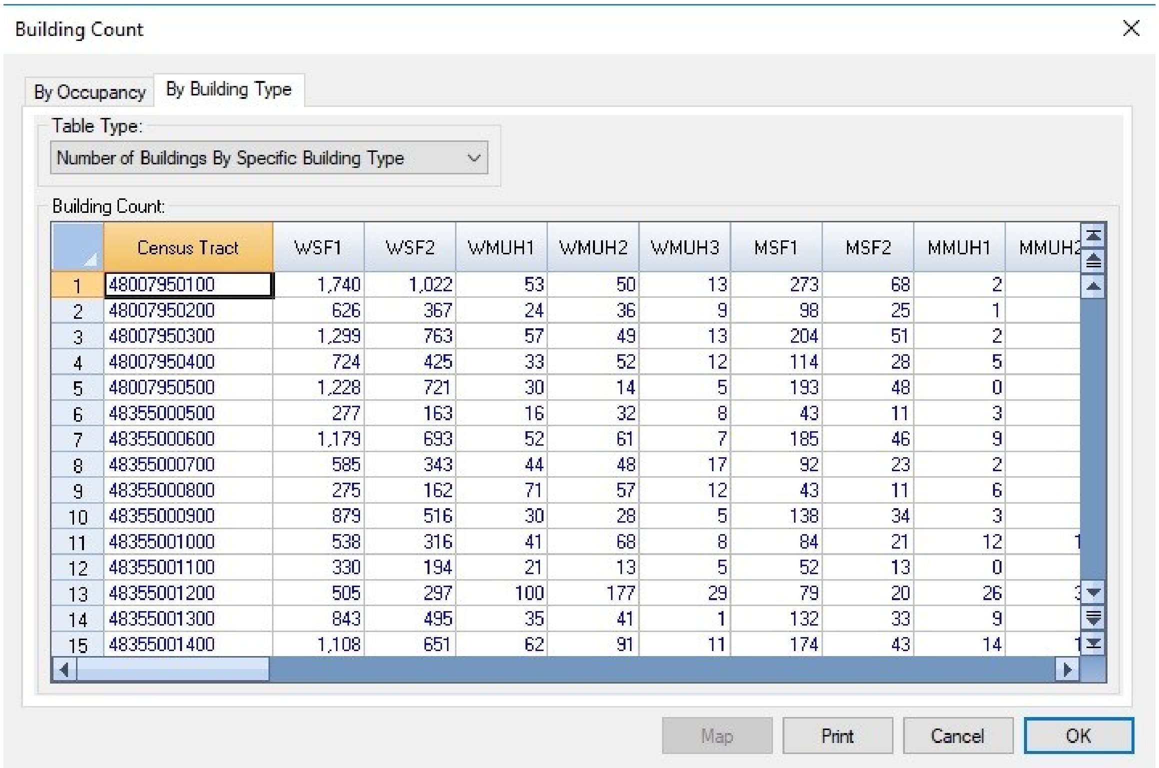
Hazard-specific inventory is inventory that is specific to one of the models. For instance, the hurricane-specific building types are specific to the hurricane model. There is aggregate inventory (demographics and General Building Stock (GBS)), Site-specific inventory and Hazard-specific inventory. In this activity, we will look at aggregate and Site-specific inventory.

Task 1: Explore the General Building Stock (GBS) inventory

1. Start Hazus and open the "HurricaneHarvey_CO" study region created in Exercise 1.2.
2. From the Inventory menu click on General Building Stock > Building Count:



3. On the Building Count window, note that you can show data by Building Type or By Occupancy. Data is shown at Census tract level by default. Note you can display by specific or general building types.

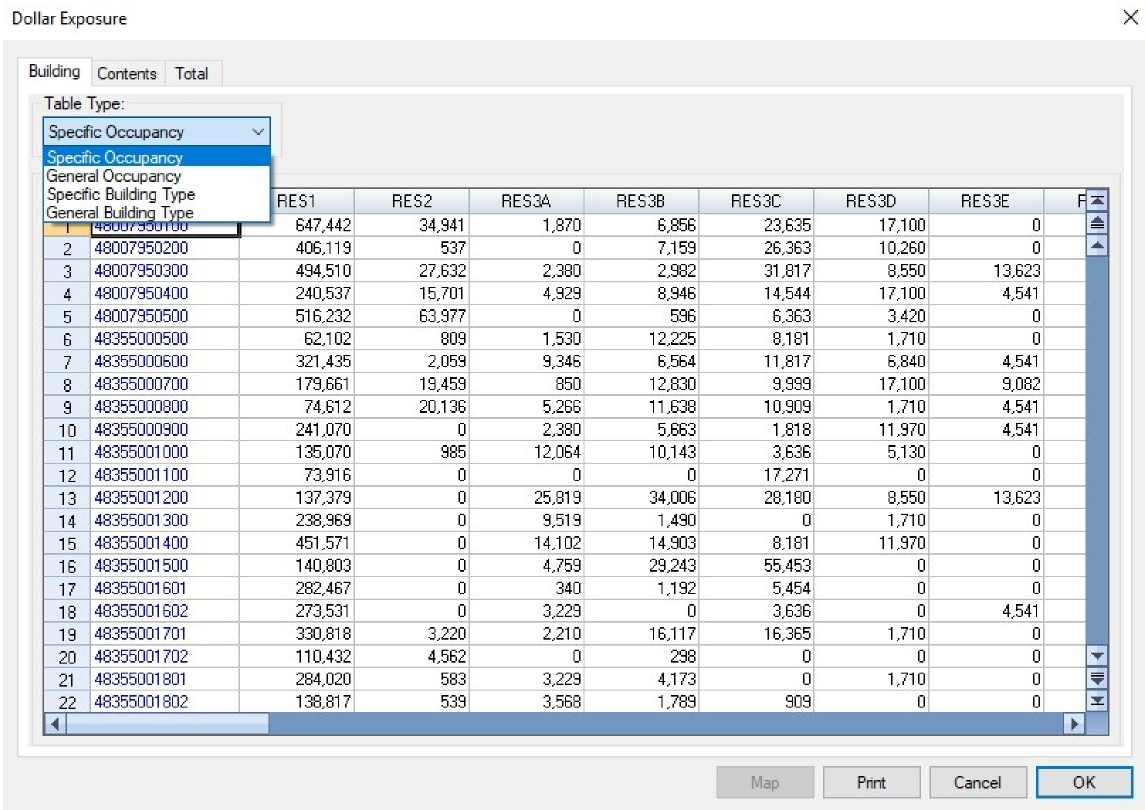


	Census Tract	WSF1	WSF2	WMUH1	WMUH2	WMUH3	MSF1	MSF2	MMUH1	MMUH2
1	48007950100	1,740	1,022	53	50	13	273	68	2	
2	48007950200	626	367	24	36	9	98	25	1	
3	48007950300	1,299	763	57	49	13	204	51	2	
4	48007950400	724	425	33	52	12	114	28	5	
5	48007950500	1,228	721	30	14	5	193	48	0	
6	48355000500	277	163	16	32	8	43	11	3	
7	48355000600	1,179	693	52	61	7	185	46	9	
8	48355000700	585	343	44	48	17	92	23	2	
9	48355000800	275	162	71	57	12	43	11	6	
10	48355000900	879	516	30	28	5	138	34	3	
11	48355001000	538	316	41	68	8	84	21	12	1
12	48355001100	330	194	21	13	5	52	13	0	
13	48355001200	505	297	100	177	29	79	20	26	3
14	48355001300	843	495	35	41	1	132	33	9	
15	48355001400	1,108	651	62	91	11	174	43	14	1

4. Click “OK” when done.

5. From the Inventory menu click on General Building Stock>Dollar Exposure.

6. On the Dollar Exposure window, note the tabs to display the data by building, contents, and the totals by occupancy or building type.

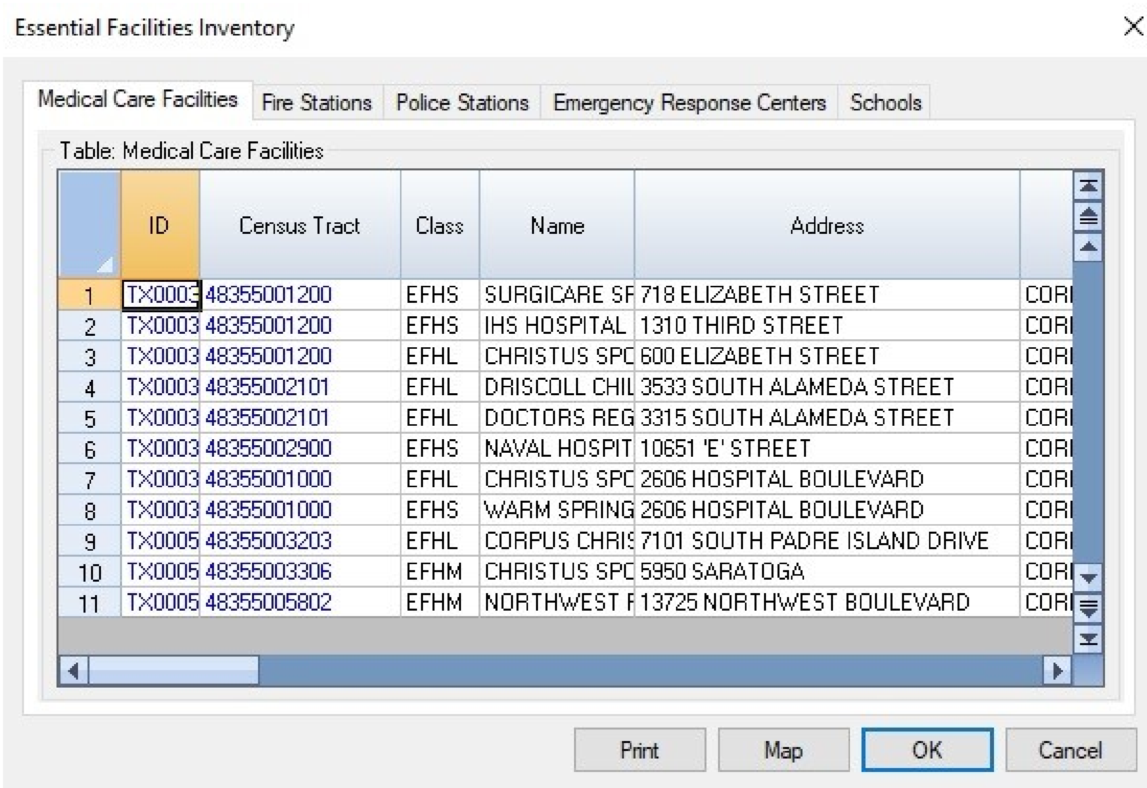


		RES1	RES2	RES3A	RES3B	RES3C	RES3D	RES3E
1	48007950100	647,442	34,941	1,870	6,856	23,635	17,100	0
2	48007950200	406,119	537	0	7,159	26,363	10,260	0
3	48007950300	494,510	27,632	2,380	2,982	31,817	8,550	13,623
4	48007950400	240,537	15,701	4,929	8,946	14,544	17,100	4,541
5	48007950500	516,232	63,977	0	596	6,363	3,420	0
6	48355000500	62,102	809	1,530	12,225	8,181	1,710	0
7	48355000600	321,435	2,059	9,346	6,564	11,817	6,840	4,541
8	48355000700	179,661	19,459	850	12,830	9,999	17,100	9,082
9	48355000800	74,612	20,136	5,266	11,638	10,909	1,710	4,541
10	48355000900	241,070	0	2,380	5,663	1,818	11,970	4,541
11	48355001000	135,070	985	12,064	10,143	3,636	5,130	0
12	48355001100	73,916	0	0	0	17,271	0	0
13	48355001200	137,379	0	25,819	34,006	28,180	8,550	13,623
14	48355001300	238,969	0	9,519	1,490	0	1,710	0
15	48355001400	451,571	0	14,102	14,903	8,181	11,970	0
16	48355001500	140,803	0	4,759	29,243	55,453	0	0
17	48355001601	282,467	0	340	1,192	5,454	0	0
18	48355001602	273,531	0	3,229	0	3,636	0	4,541
19	48355001701	330,818	3,220	2,210	16,117	16,365	1,710	0
20	48355001702	110,432	4,562	0	298	0	0	0
21	48355001801	284,020	583	3,229	4,173	0	1,710	0
22	48355001802	138,817	539	3,568	1,789	909	0	0

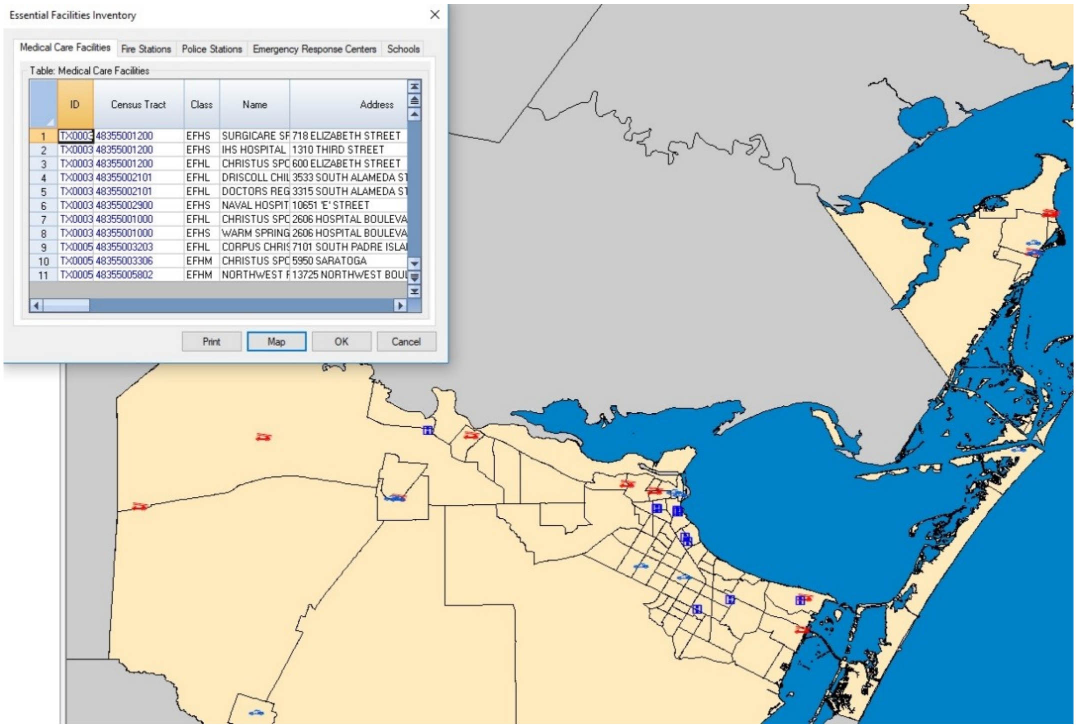
7. Click “OK” when done.

8. From the Inventory menu click on Essential Facilities > Inventory.

9. On the Essential Facilities window, note there are multiple tabs to view the different inventories: Medical Care Facilities, Fire Stations, Police Stations, etc.. Scroll through the table and note the fields that list each facility’s attribute information.



Note: You can click on “Map” and the facilities/inventory you are viewing will display on the map. This feature is available for most inventory categories.

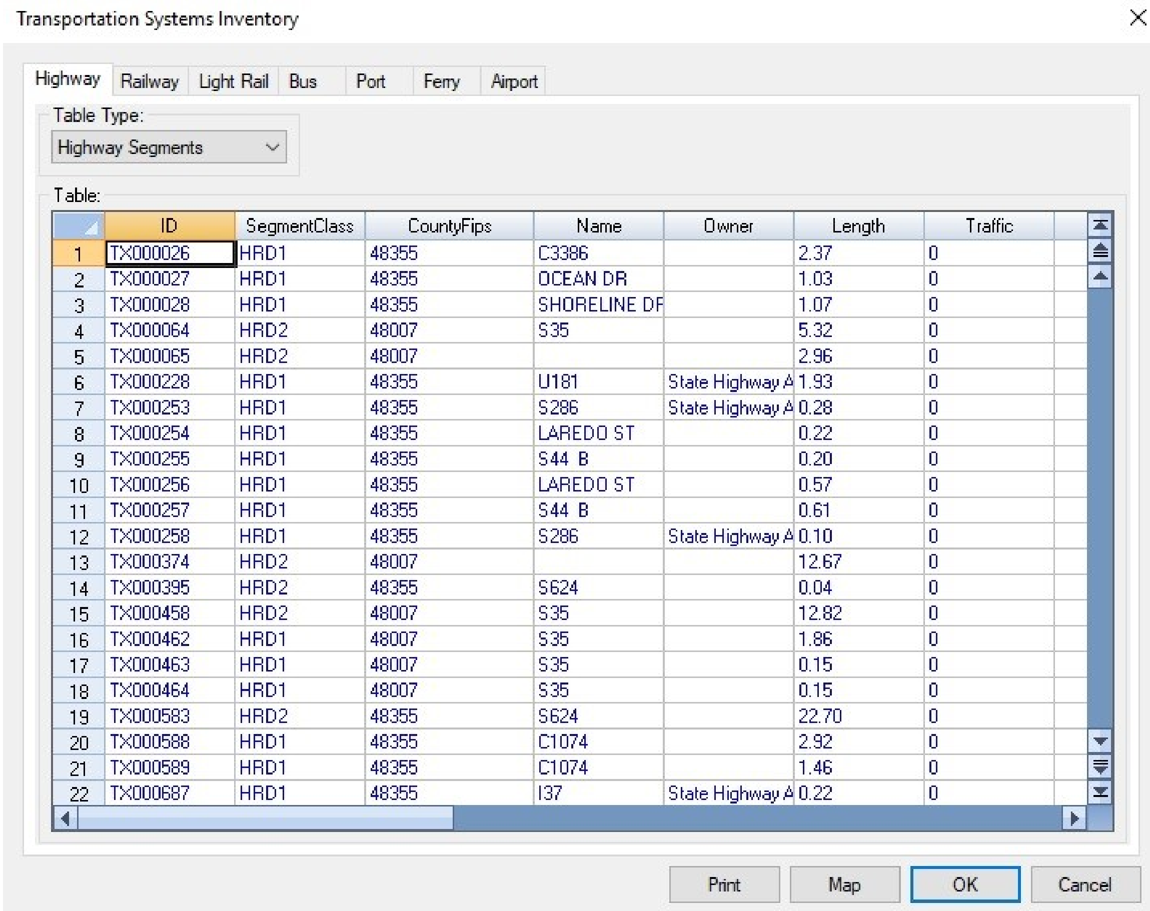


10. Click “OK” when done.

11. From the Inventory menu click on Transportation Systems.

12. On the Transportation Systems Inventory window, note there are multiple tabs to view the different types: Highway, Railway, Bus, etc.

13. Scroll through the table and note the fields that list each facility’s attribute information.



	ID	SegmentClass	CountyFips	Name	Owner	Length	Traffic
1	TX000026	HRD1	48355	C3386		2.37	0
2	TX000027	HRD1	48355	OCEAN DR		1.03	0
3	TX000028	HRD1	48355	SHORELINE DF		1.07	0
4	TX000064	HRD2	48007	S35		5.32	0
5	TX000065	HRD2	48007			2.96	0
6	TX000228	HRD1	48355	U181	State Highway A	1.93	0
7	TX000253	HRD1	48355	S286	State Highway A	0.28	0
8	TX000254	HRD1	48355	LAREDO ST		0.22	0
9	TX000255	HRD1	48355	S44 B		0.20	0
10	TX000256	HRD1	48355	LAREDO ST		0.57	0
11	TX000257	HRD1	48355	S44 B		0.61	0
12	TX000258	HRD1	48355	S286	State Highway A	0.10	0
13	TX000374	HRD2	48007			12.67	0
14	TX000395	HRD2	48355	S624		0.04	0
15	TX000458	HRD2	48007	S35		12.82	0
16	TX000462	HRD1	48007	S35		1.86	0
17	TX000463	HRD1	48007	S35		0.15	0
18	TX000464	HRD1	48007	S35		0.15	0
19	TX000583	HRD2	48355	S624		22.70	0
20	TX000588	HRD1	48355	C1074		2.92	0
21	TX000589	HRD1	48355	C1074		1.46	0
22	TX000687	HRD1	48355	I37	State Highway A	0.22	0

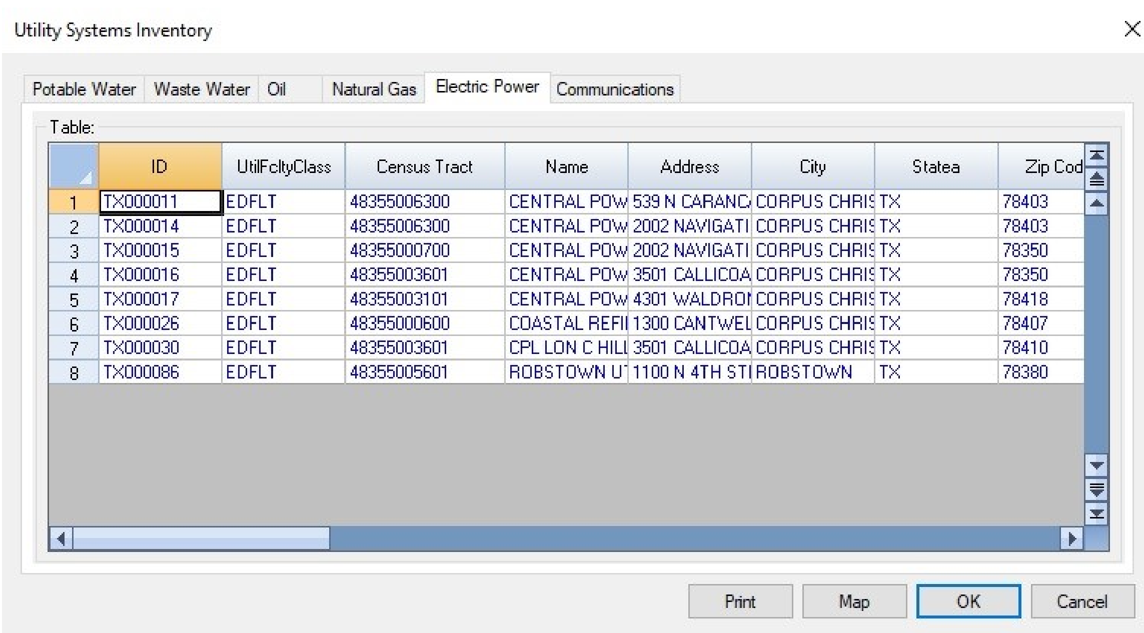
14. Click “OK” when done.

15. From the Inventory menu click on Utility Systems.

16. On the Utility Systems Inventory window, note there are multiple tabs to view the different types: Potable Water, Oil, Electric Power, etc.

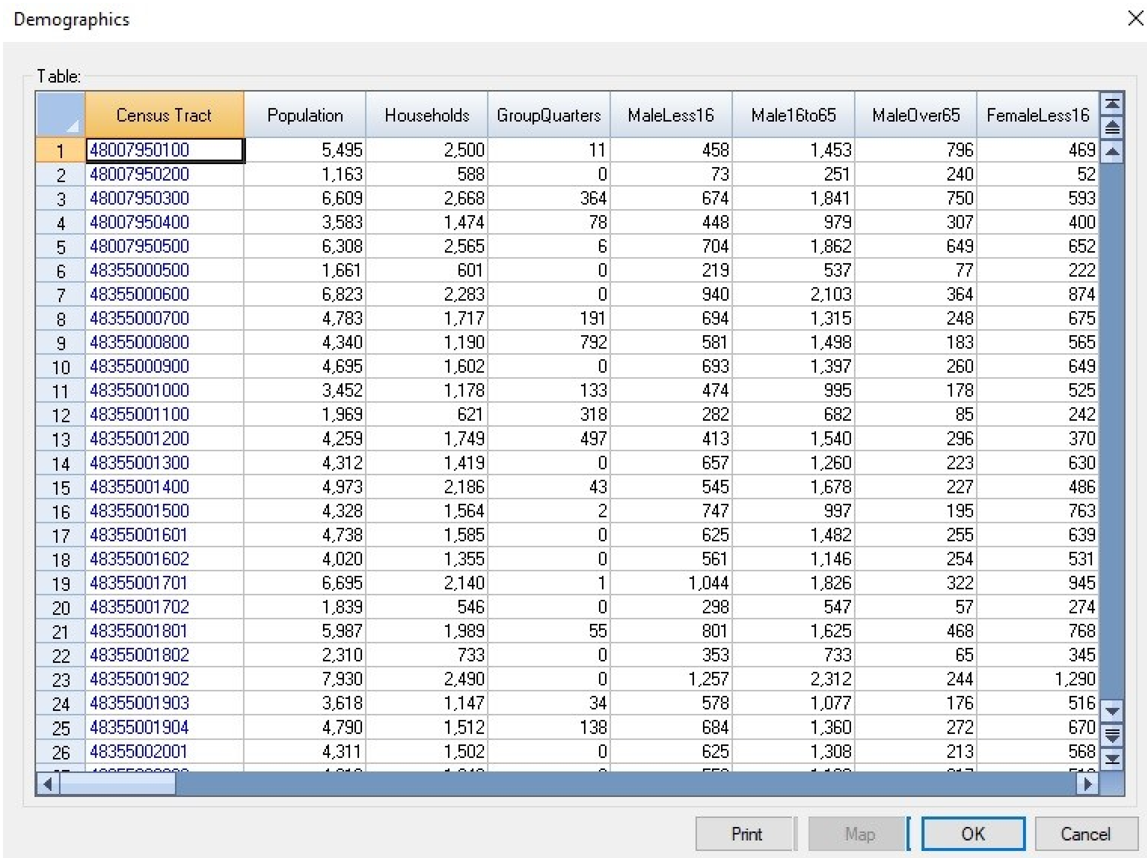
17. Scroll through the table and note the fields that list each facility’s attribute information.

Note: The Potable Water facilities, Potable Water Pipelines, and Waste Water pipeline tables are empty because there are no records in the state data to aggregate for these inventory categories.



	ID	UtilFcltyClass	Census Tract	Name	Address	City	Statea	Zip Cod
1	TX000011	EDFLT	48355006300	CENTRAL POW	539 N CARANC	CORPUS CHRIS	TX	78403
2	TX000014	EDFLT	48355006300	CENTRAL POW	2002 NAVIGATI	CORPUS CHRIS	TX	78403
3	TX000015	EDFLT	48355000700	CENTRAL POW	2002 NAVIGATI	CORPUS CHRIS	TX	78350
4	TX000016	EDFLT	48355003601	CENTRAL POW	3501 CALLICOA	CORPUS CHRIS	TX	78350
5	TX000017	EDFLT	48355003101	CENTRAL POW	4301 WALDROI	CORPUS CHRIS	TX	78418
6	TX000026	EDFLT	48355000600	COASTAL REFII	1300 CANTWEL	CORPUS CHRIS	TX	78407
7	TX000030	EDFLT	48355003601	CPL LON C HILI	3501 CALLICOA	CORPUS CHRIS	TX	78410
8	TX000086	EDFLT	48355005601	ROBSTOWN U	1100 N 4TH STI	ROBSTOWN	TX	78380

18. Click “OK” when done.
19. From the Inventory menu click on Demographics.
20. On the Demographics window, note there are multiple tabs to view the population attributes by the selected aggregate level.
21. Scroll through the table to view the available data breakdowns.



	Census Tract	Population	Households	GroupQuarters	MaleLess16	Male16to65	MaleOver65	FemaleLess16
1	48007950100	5,495	2,500	11	458	1,453	796	469
2	48007950200	1,163	588	0	73	251	240	52
3	48007950300	6,609	2,668	364	674	1,841	750	593
4	48007950400	3,583	1,474	78	448	979	307	400
5	48007950500	6,308	2,565	6	704	1,862	649	652
6	48355000500	1,661	601	0	219	537	77	222
7	48355000600	6,823	2,283	0	940	2,103	364	874
8	48355000700	4,783	1,717	191	694	1,315	248	675
9	48355000800	4,340	1,190	792	581	1,498	183	565
10	48355000900	4,695	1,602	0	693	1,397	260	649
11	48355001000	3,452	1,178	133	474	995	178	525
12	48355001100	1,969	621	318	282	682	85	242
13	48355001200	4,259	1,749	497	413	1,540	296	370
14	48355001300	4,312	1,419	0	657	1,260	223	630
15	48355001400	4,973	2,186	43	545	1,678	227	486
16	48355001500	4,328	1,564	2	747	997	195	763
17	48355001601	4,738	1,585	0	625	1,482	255	639
18	48355001602	4,020	1,355	0	561	1,146	254	531
19	48355001701	6,695	2,140	1	1,044	1,826	322	945
20	48355001702	1,839	546	0	298	547	57	274
21	48355001801	5,987	1,989	55	801	1,625	468	768
22	48355001802	2,310	733	0	353	733	65	345
23	48355001902	7,930	2,490	0	1,257	2,312	244	1,290
24	48355001903	3,618	1,147	34	578	1,077	176	516
25	48355001904	4,790	1,512	138	684	1,360	272	670
26	48355002001	4,311	1,502	0	625	1,308	213	568

22. Click “OK” when done.
23. Save the map document and exit Hazus.

Visual 37: Lesson 3: Review

1. What are the key components for hurricane development?
2. What areas of the US mainland have the highest risk to major hurricanes?
3. List four scenario types that a user can select to run the hurricane model.
4. Which two databases are unique to the hurricane model?

Visual 38: Questions?

Lesson 4: Deterministic Storm Parameters

Visual 1: Lesson 4: Deterministic Storm Parameters

HAZUS®

EARTHQUAKE • WIND • FLOOD • TSUNAMI

Visual 2: Goal and Objectives

Goal: To provide an overview of the set of storm scenarios available to users in Hazus.

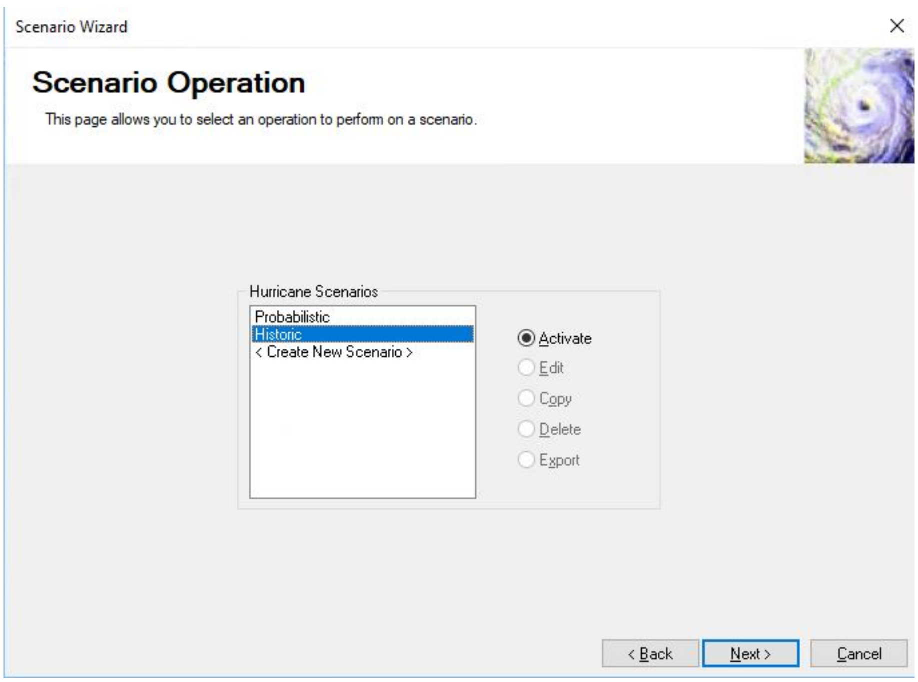
After completing this lesson, you will be able to:

- Describe the Historical Scenario options.
- Understand the process for creating a user-defined scenario in Hazus.
- Discuss the differences in the probabilistic analyses in Hazus.

Visual 3: Scenario Operations

Hazus has six choices for defining hurricane scenarios:

- Historic
- Probabilistic
- Create New:
    - Define Storm Track Manually
    - Import from Exported File (storm created in previous Hazus Study Region)
    - Import Census Tract Data File
    - Import a Hurrevac Storm Advisory



Visual 4: Hurricane Scenario Definition Options

- X Probabilistic
- ✓ Historic
- X .dat Import

Historic or Observed Wind Fields

- ✓ User-Defined
- ✓ HurrEvac Import
- ✓ Hazus Import

Wind Fields Computed from Hurricane Track Parameters

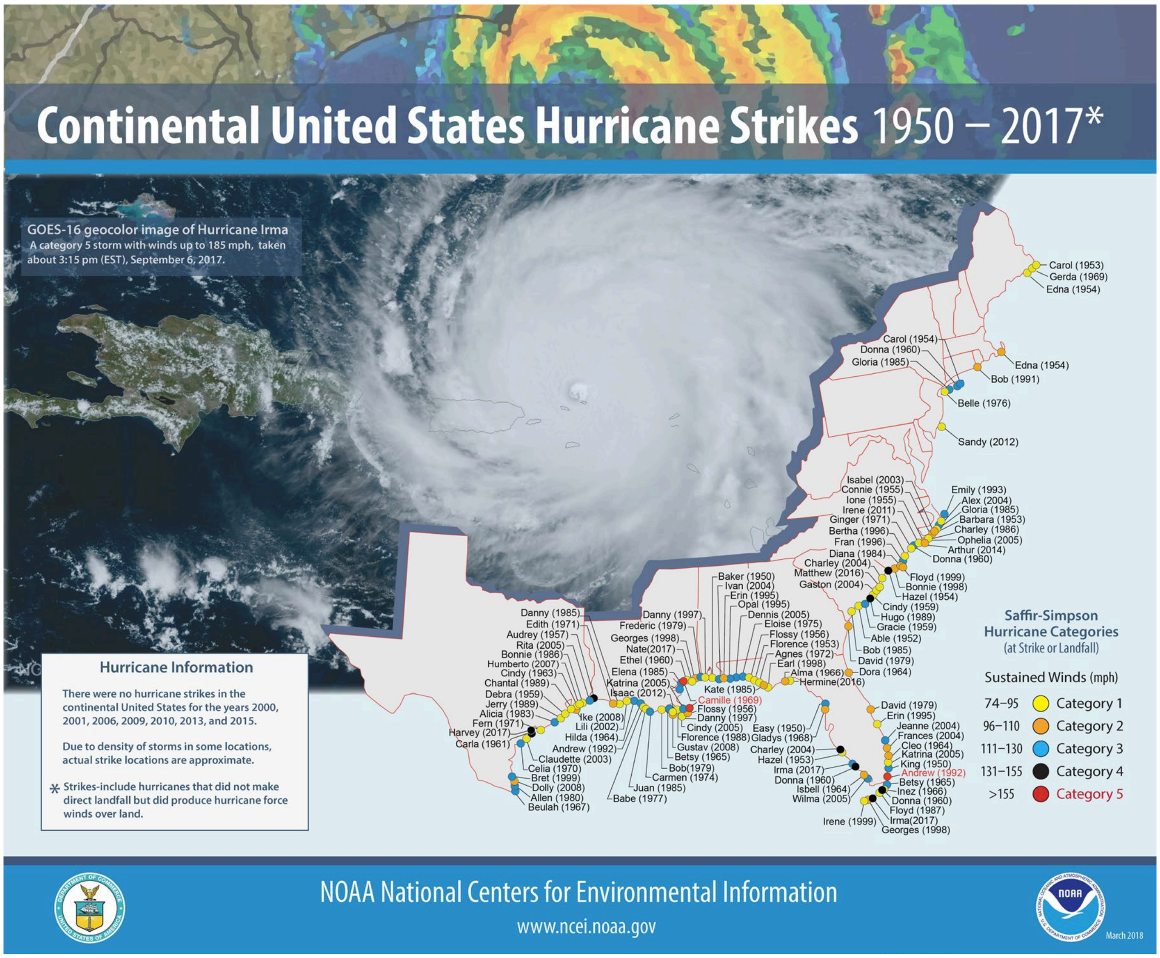
✓ = Coastal surge analysis allowed
X = Coastal surge not supported

Visual 5: Determining Risk

Typically the risk of hazard occurrence is translated into a probabilistic recurrence interval (e.g., 1% annual change or 100-year event).

Two approaches:

- Historic record
- Modeling methods



Visual 6: Using the Historic Record for Risk

Recurrence Interval = (n+1)/m

- n: number of years on record
- m: rank of the event being considered

When a good historical record exists, the Recurrence Interval and its annual chance probability can be computed.

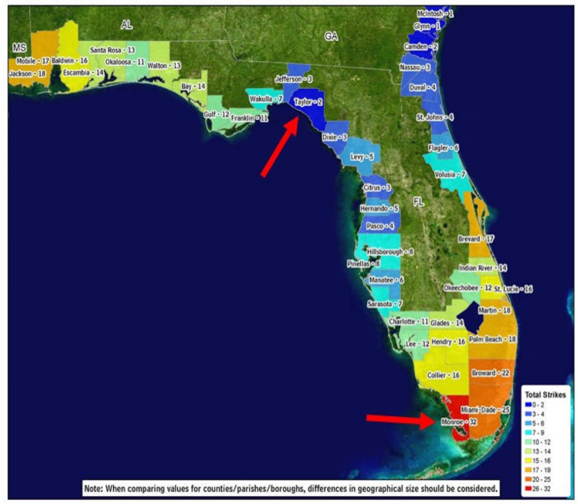
Year	Maximum Winds (kt)	Rank	Recurrence Interval
1989	120	3	7.00
1991	90	8	2.63
1992	145	1	21.00
1993	100	6	3.50
1995	100	6	3.50
1996	100	6	3.50
1997	70	12	1.75
1998	95	7	3.00
1999	100	6	3.50
2002	80	10	2.10
2003	90	8	2.63
2004	130	2	10.50
2005	110	5	4.20
2007	80	10	2.10
2008	95	7	3.00
2011	75	11	1.91

2012	70	12	1.75
2014	85	9	2.33
2016	75	11	1.91
2017	115	4	5.25

Visual 7: Using the Historic Record for Risk

Potential Problems:

- The historic record has a short timescale (e.g. Atlantic hurricane records collected from 1851-2019 and Northeast and North Central Pacific hurricane records collected from 1949-2019).
  - This map shows the total number of hurricane strikes by county from 1900-2010.
- Some hazards have wide geographic variations.
  - EX: County X has been missed by landfalling hurricanes since 1900, but adjacent County Y has had 14.



Total number of hurricane strikes by counties/parishes/boroughs, 1900-2010

Data from NWS NHC 46: Hurricane Experience Levels of Coastal County Populations from Texas to Maine. Jerry D. Jarrell, Paul J. Hebert, and Max Mayfield. August, 1992, with updates.

Student Manual

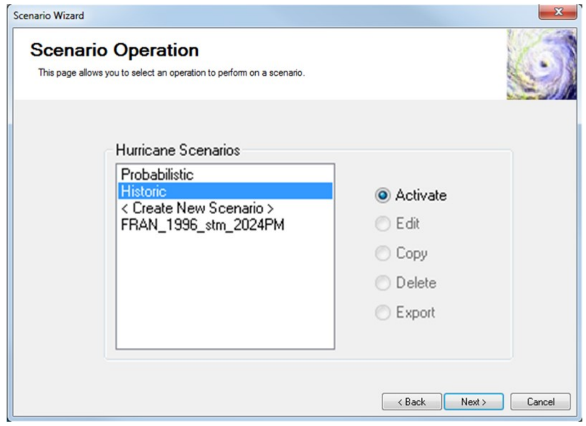
Using the Historic Record for Risk

- This image illustrates the total number of hurricane strikes by county (1900-2010).
  - Some areas have had a high number of landfalling hurricanes others have had few landfalls.
    - The upper arrow points to Taylor County which has had 2 landfalls.
    - The lower arrow points to Monroe County which has had 32 landfalls.

Visual 8: Historic Storm Scenario

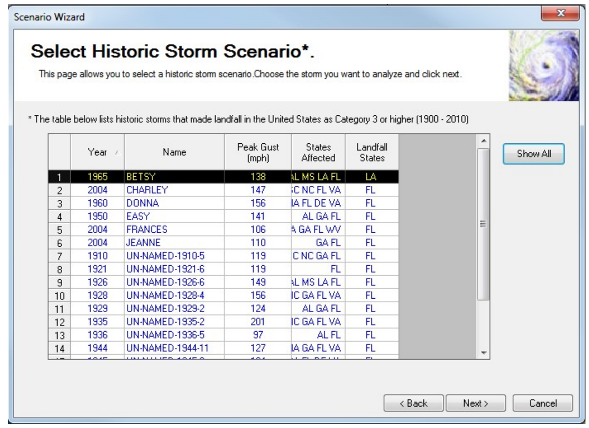
Potential Problems:

- Pre-computed wind fields and storm tracks
- Only storms that affected the study region can be selected



Visual 9: Historic Storm Region Filter

- Region Filter button: Filters to select only the storms in which the storm track intersects the study region.
- Peak Gust: Largest modeled gust speed over land anywhere in US.



Visual 10: Exercise 4.1: Historic Scenarios

Goal:

- Create multiple historic storm scenarios
- Review the results

Time: 45 minutes

Student Manual

Exercise 4.1: Historic Scenario

Goal:

- Create multiple historic storm scenarios
- Review the results

Time: 45 minutes

Exercise Steps:

1. Refer to Activities Document “04.1_Exercise_Historic Scenario.”
2. Listen to instructor’s directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share your answers/results.
8. Ask any final questions.

Visual 11: Exercise 4.1: Tasks

Task 1: Open the Region and Define a Historic Scenario.

Task 2: Run the Analysis.

Task 3: View the Results.

Student Manual

Exercise 4.1: Historic Scenario

- Refer to Activities Document "04.1_Exercise_Historic Scenario."

Exercise 4.1: Historic Scenario

Type: Student-Led Activity

Time: 45 minutes

Goals:

- Create multiple historic storm scenarios
- Review the results

Background:

Hazus comes with a substantial library of historical storms. You can use the tracks and other characteristics of storms that occurred in the past to understand what the impact would be on a community if a storm of the past were to occur today given the way that buildings are constructed, how they are used, and where they are located. This exercise will help you explore the process of defining a historic storm scenario, and it will also help you explore the study region inventory to provide a context for understanding the impact of the hurricane on the exposed buildings and population.

Task 1: Open the Region and Define a Historic Scenario

1. Start Hazus and open the "HurricaneHarvey_CO" study region.
2. From the Hazard menu, choose "Scenario" to open the Scenario wizard.
3. Click "Next" to move past the initial window of the wizard.
4. Verify that this Historic option is highlighted and the Activate radiobox is checked.
5. Click "Next". A list of historical storms that are in the Hazus database will appear.
6. Click "Region Filter" to search only for the storms that impacted the area in which your study region is located.
7. Select the UN-NAMED-1916-6 scenario.
8. Click "Next" on the remaining windows of the wizard until you reach the last screen of the wizard where you should click "Finish". This will activate the selected historic storm.

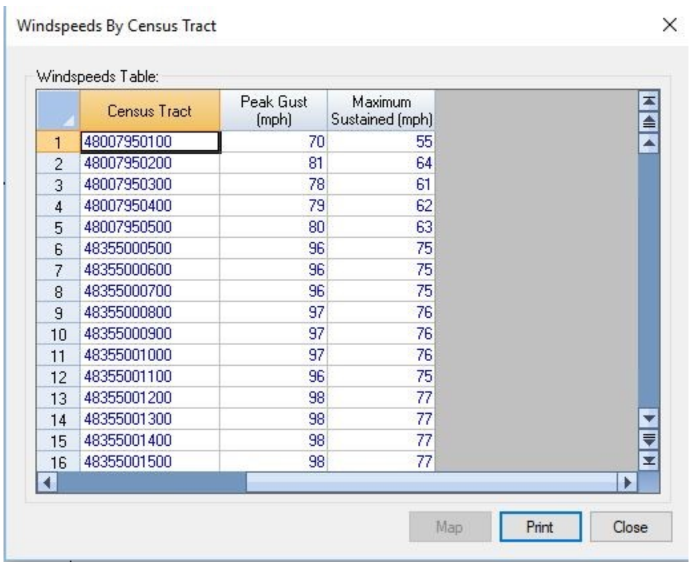
Task 2: Run the Analysis

1. From the Analysis menu choose "Run" to open the Analysis Options window.
2. Choose "Select all" but uncheck the box for "Automated Output Options".
3. Click "Run Analysis" to begin the analysis.
4. The analysis should take around 2-3 minutes.
5. After the analysis is complete, the application will display the Analysis Completed message box.
6. Click "OK" to close the box.

Task 3: View the Results

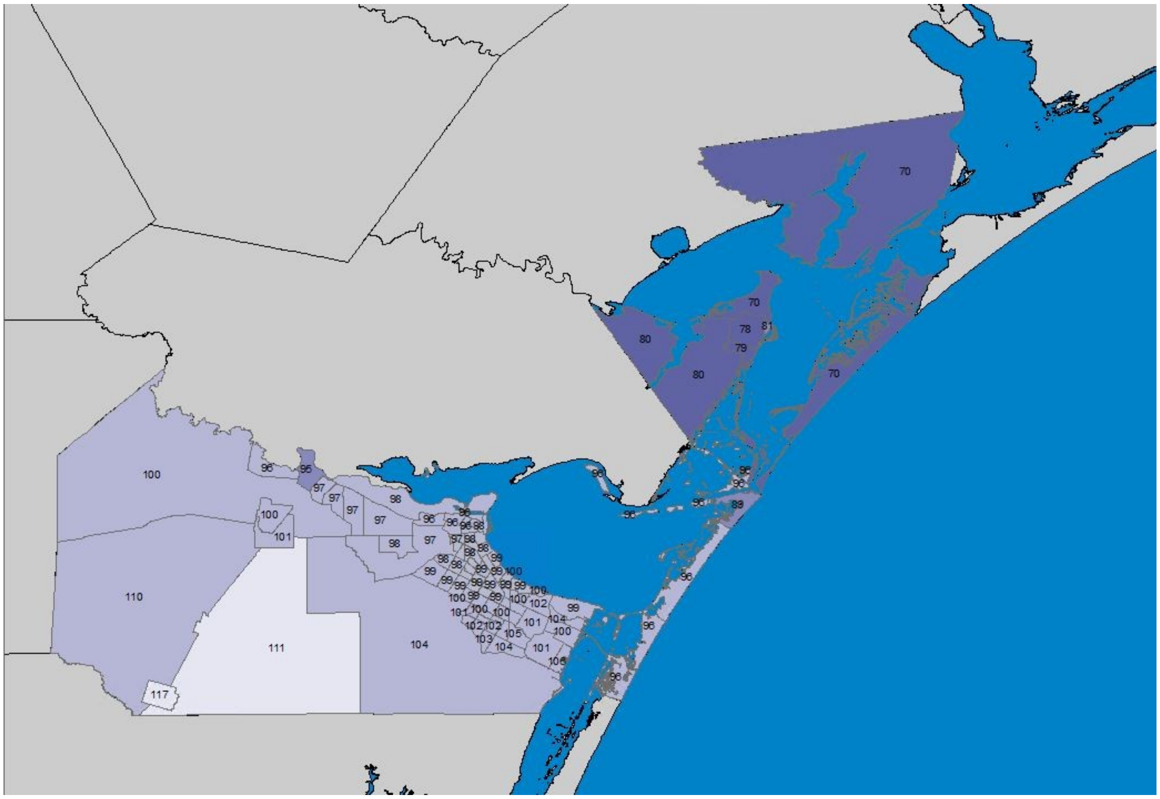
You will explore some of the analysis output in the following steps and continue your exploration of the results in the next exercise.

1. When the analysis is complete, navigate to the Results menu and choose "Wind Speeds."



	Census Tract	Peak Gust (mph)	Maximum Sustained (mph)
1	48007950100	70	55
2	48007950200	81	64
3	48007950300	78	61
4	48007950400	79	62
5	48007950500	80	63
6	48355000500	96	75
7	48355000600	96	75
8	48355000700	96	75
9	48355000800	97	76
10	48355000900	97	76
11	48355001000	97	76
12	48355001100	96	75
13	48355001200	98	77
14	48355001300	98	77
15	48355001400	98	77
16	48355001500	98	77

2. Click the “Peak Gust (mph)” column and then click “Map” to add the 1916-6 historic storm path and windspeeds as a map layer. The “Wind Speeds – Peak Gust (mph)” layer should be added to the map.



3. Click Close.
4. Right click on the "Wind Speeds – Peak Gust (mph)" layer and open the attribute table.
5. Use the attribute table to answer Questions A through C in the table at the end of this exercise.
6. Close the Wind Speeds attribute table window.
7. Refer to the map and describe the location of the highest windspeeds in relationship to the coastline and to the storm path.
8. Click on the Results menu and then Summary Reports.
9. Click on the Other Reports tab, select "Global Summary Report", and then click "View". This will take a few minutes to create.
10. Use this report to answer Questions D – I in the table at the end of this exercise.

Task 4: Complete Additional Scenarios

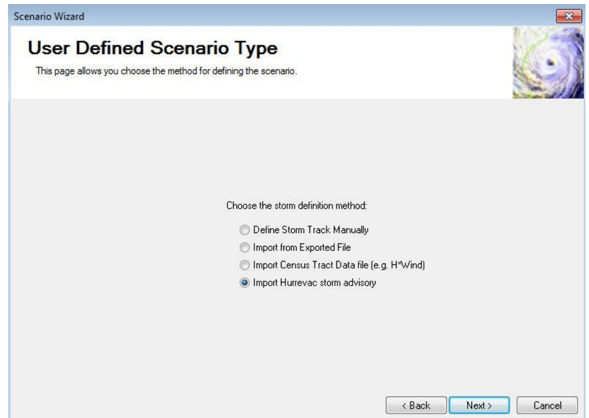
1. Follow the steps you completed earlier in Tasks 1-3 (without opening the study region) for historic storm UN-NAMED-1916-6 for the following storms: UN-NAMED-1919-2 and Hurricane Harvey.
2. Complete the table below and answer the question that follows.

Question	UN-NAMED 1916-6	UN-NAMED 1919-2	Hurricane Harvey 2017
a. What is the highest peak wind gust in the study region?			
b. What is the highest sustained wind in the region?			
c. Based on the highest sustained wind in the region, what is the Saffir-Simpson Category?			
d. How many buildings will be at least moderately damaged?			
e. How many residential buildings will be at least moderately damaged?			
f. How many households will be displaced?			
g. What is the total economic loss?			
h. What is the building related residential economic loss? (Property Damage)			

Question: UN-NAMED-1919-2 and UN-NAMED-1916-6 had similar peak gust windspeeds and the same category storm but had different results. Why did this occur?

Answer:

Visual 12: User-Defined Scenario



- Import from
  - Hurrevac
  - .dat file
  - Exported file (other Hazus users)
- Define manually*

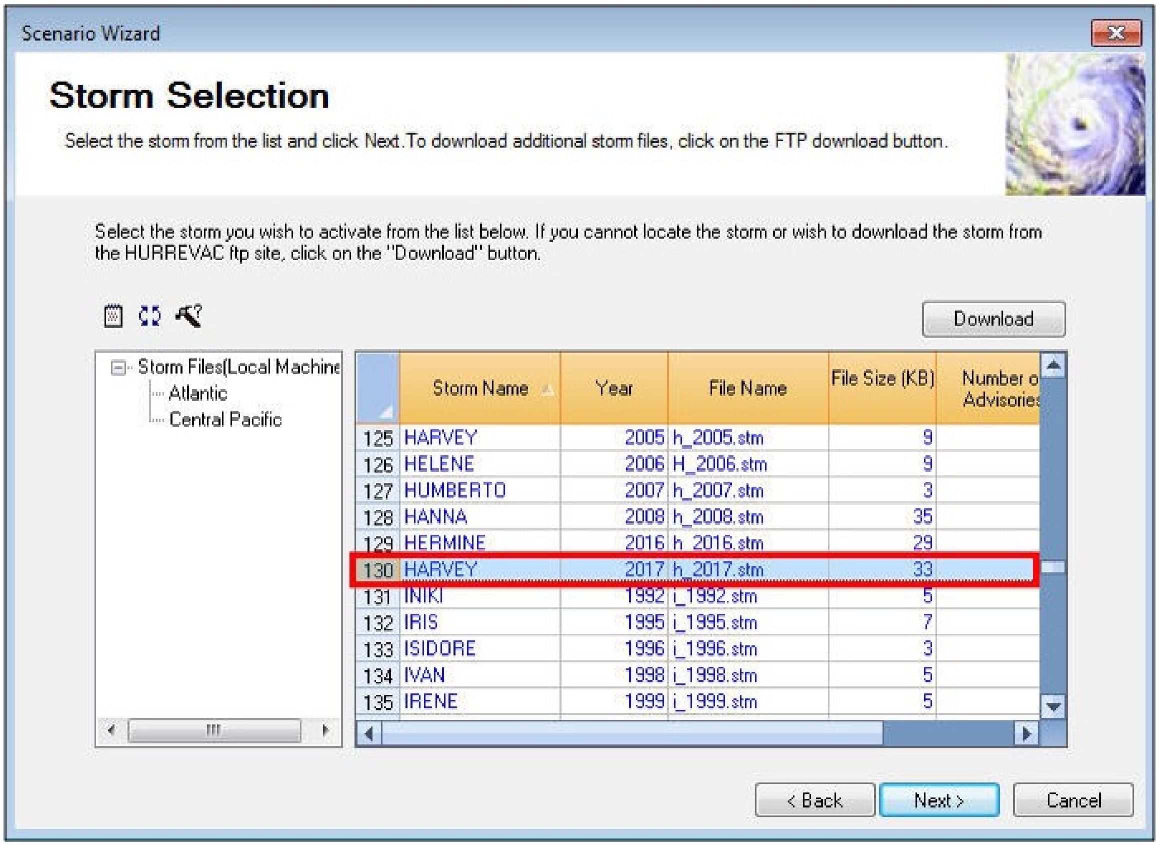
*Define manually should only be used if data are not available anywhere else, including Hurrevac.

Visual 13: Hurricane Data Sources: Hurrevac

- HURRicane EVACuation – storm tracking and decision support tool developed off Hurricane Evacuation Studies and NHC data.
- Translates forecast track and wind extent information from NHC text-based products into interactive maps and produces storm files.
- Best available data for Hurricane Wind Loss estimation prior to landfall and until observed wind fields are developed.
- Direct dynamic link within Hazus
- Hurrevac can be used to create exercise scenarios

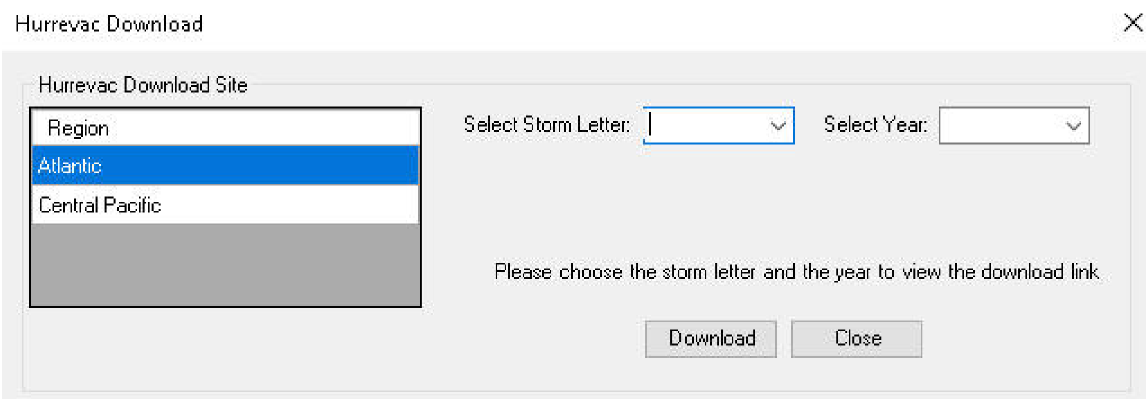
Visual 14: Hurrevac Import

- Hurrevac data is integrated into the Hazus interface
- Click on the hurricane of interest and click "Next"



Visual 15: Hurrevac Download

- Hazus is dynamically linked to Hurrevac FTP site to provide real-time data availability
- Advisories are available in Hazus as they become available in Hurrevac
- Searching for the year and first letter of the storm's name will provide download options
- Continuous update of advisories is crucial during response phase
- Make sure to click the refresh button before selecting the updated Hurrevac advisory for an active storm



Visual 16: Activity 4.2: HURREVAC Scenario – Hurricane Harvey

Goals:

- Import Hurricane Harvey data using HURREVAC.

Time: 10 minutes

Student Manual

Activity 4.2: HURREVAC Scenario – Hurricane Harvey

Goals:

- Import Hurricane Harvey data using HURREVAC.

Time: 10 minutes

Exercise Steps:

1. Refer to Activities Document "04.2_Activity_HURREVAC Scenario – Hurricane Harvey."
2. Listen to instructor's directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share your answers/results.
8. Ask any final questions.

Visual 17: Activity 4.2: Tasks

Task 1: Import the HURREVAC file.

Student Manual

Exercise 4.2: Tasks

- Refer to Activities Document "04.2_Activity_HURREVAC Scenario – Hurricane Harvey."

Activity 4.2: HURREVAC Scenario – Hurricane Harvey

Type: Instructor-Led Activity

Time: 10 minutes

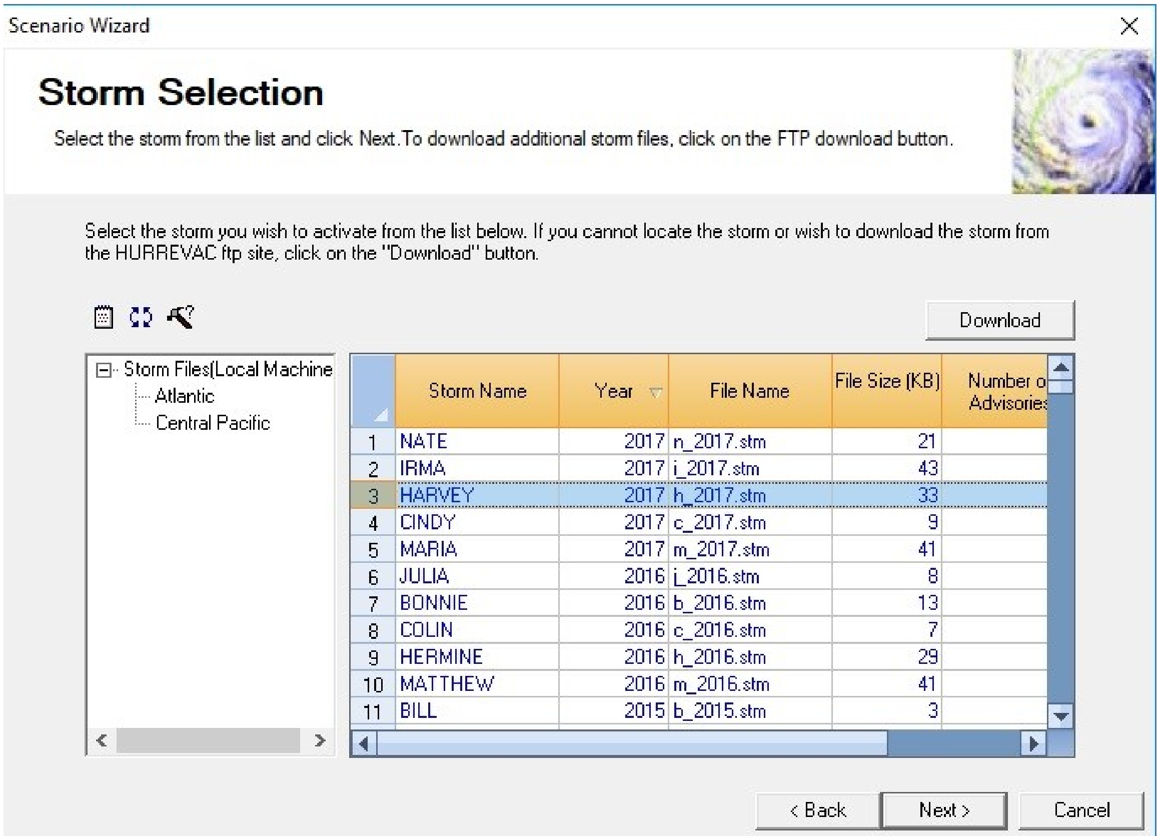
Goals: Import Hurricane Harvey data using HURREVAC.

Background:

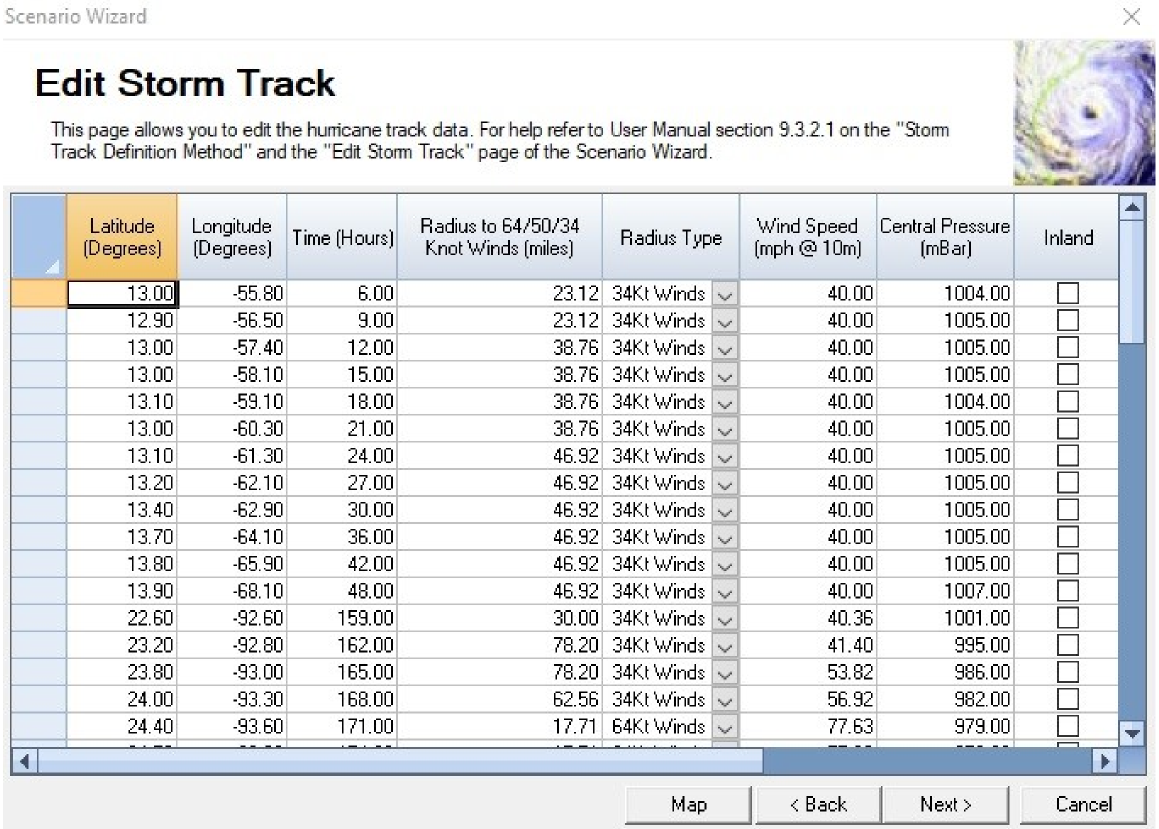
This exercise will help you learn to import Hurrevac to create a user defined storm. In this exercise we will import the final Hurricane Harvey track. During hurricane season, the forecast advisories for current storms will be pre-processed and you can import them into Hazus without having to enter values from the advisories. This can be a particularly useful capability at times when you are trying to determine the potential impact of an oncoming storm, or when you are considering what impact a past storm might have based on currently exposed inventory. In this exercise we will import the final Hurricane Harvey track.

Task 1: Import the HURREVAC file.

1. Open the HurricaneHarvey_CO study region.
2. From the Hazard menu choose Scenario to open the scenario wizard.
3. Click “Next” to advance to the scenario operation window.
4. Click on Create New Scenario and click “Next”.
5. Click Import Hurrevac storm advisory and click “Next”.
6. Click on Atlantic in the Storm Files Window.



7. Scroll through the list and select HARVEY with the date of 2017.
8. Click “Next” to move to the Edit Storm Track window.



9. Click "Next" again to move to the Windfield Calculation window. Validating the storm track may take up to 10 minutes to complete.

10. Once it completes, hit "Next" four times and then "Finish".

11. Save your map document and keep Hazus open for the next activity.

Visual 18: Import Census Tract Data File

- User-defined scenario option.
- Import a hurricane wind data file in the .dat format with information at the census tract level.
- Storm track data table will not populate because wind speeds are assigned to census tracts directly.
- Also known as H*Wind.

Visual 19: Exercise 4.3: Harvey .dat Model

Goals:

- Create a scenario with .dat data.

Time: 15 minutes

Student Manual

Exercise 4.3: Harvey .dat Model

Goals:

- Create a scenario with .dat data.

Time: 15 minutes

Exercise Steps:

1. Refer to Activities Document "04.3_Exercise_Harvey (.dat) Model."
2. Listen to instructor's directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share your answers/results.
8. Ask any final questions.

Visual 20: Exercise 4.3: Tasks

Task 1: Create a scenario from a .dat file.

Student Manual

Exercise 4.3: Tasks

- Refer to Activities Document "04.3_Exercise_Harvey (.dat) Model."

Exercise 4.3: Harvey .dat Model

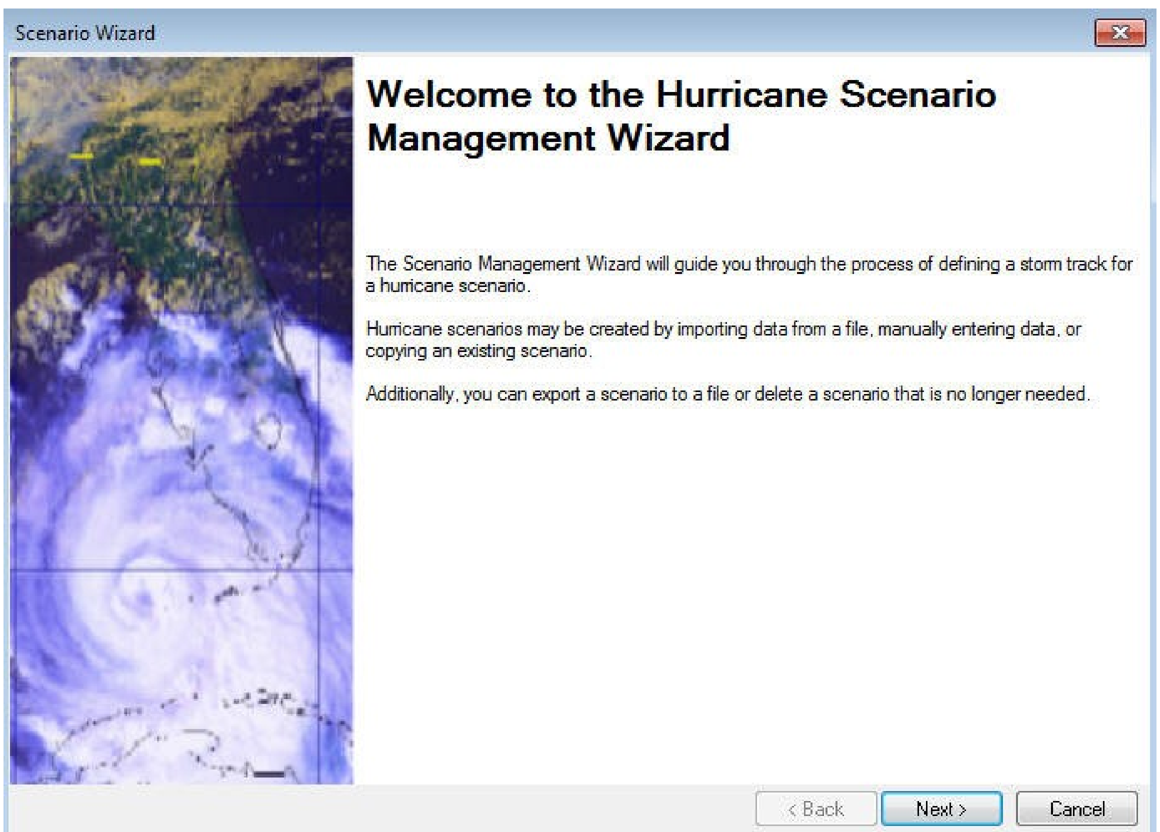
Type: Student-Led Activity

Time: 15 minutes

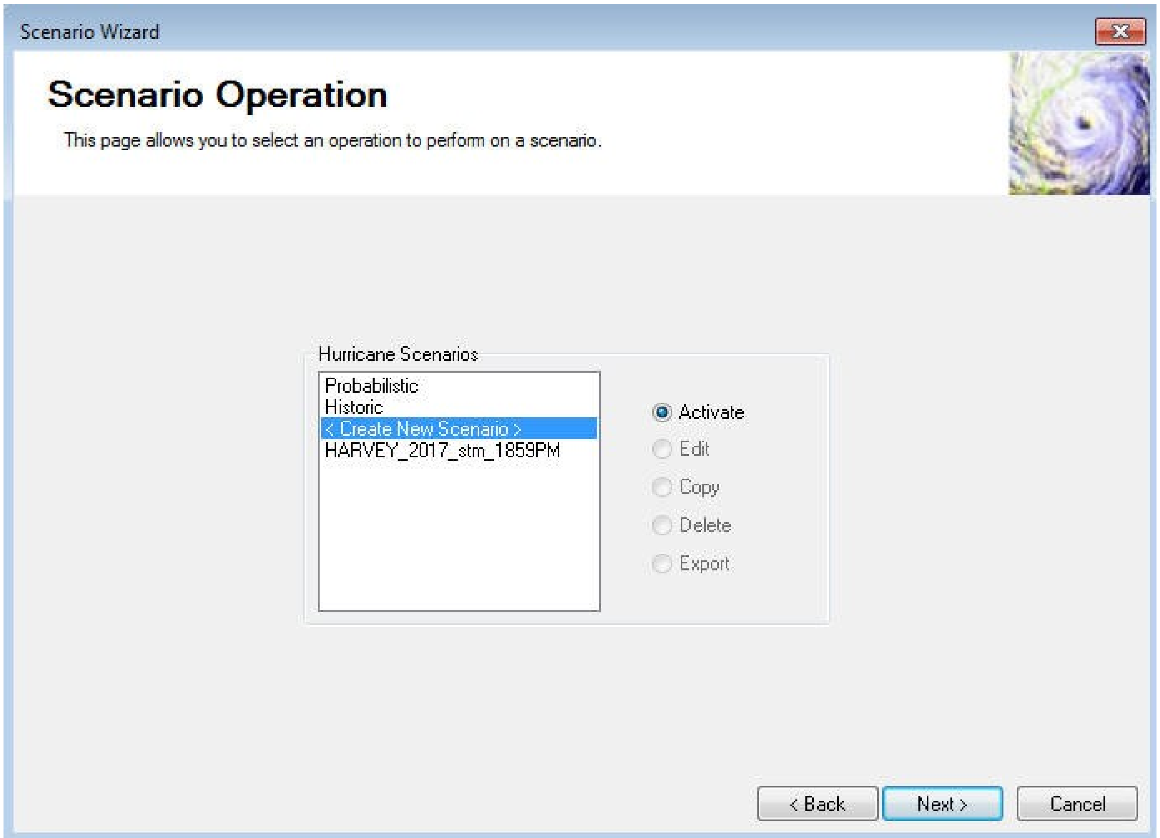
Goals: Create a scenario with .dat data.

Task 1: Create a scenario from a .dat file.

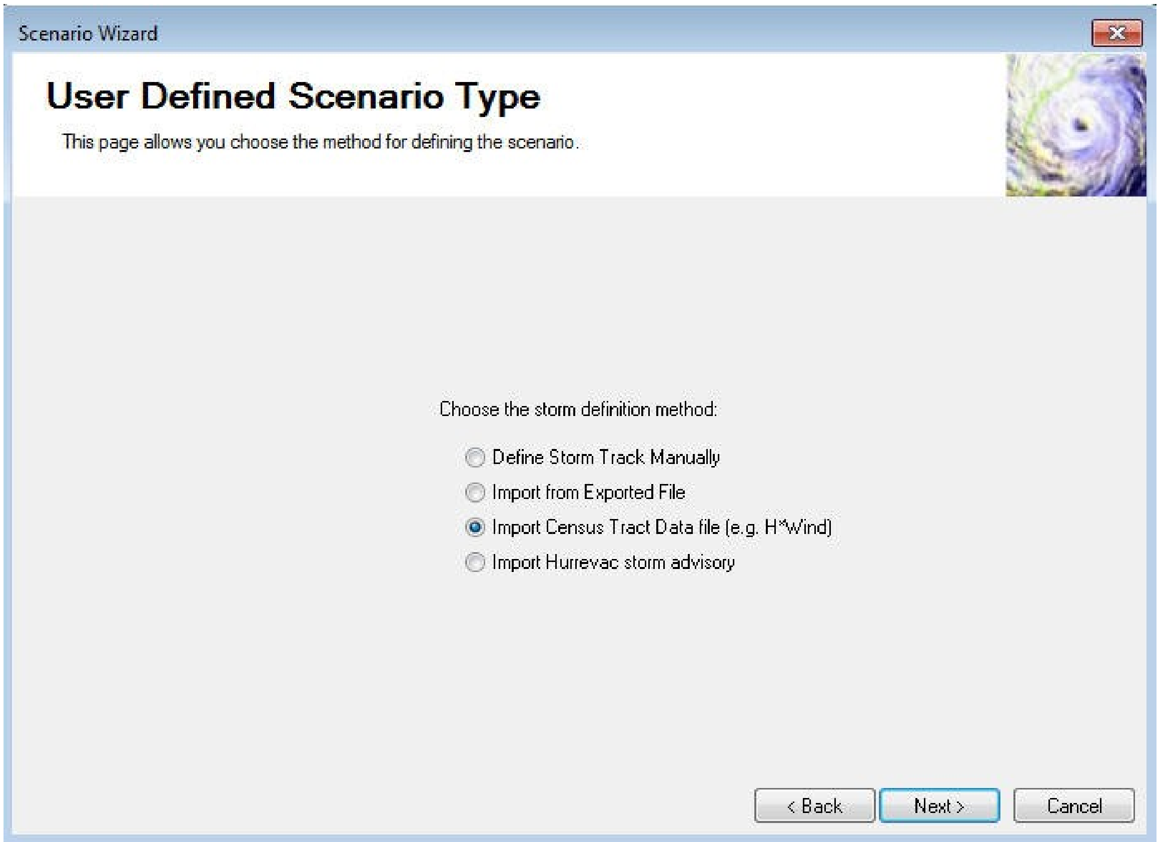
1. Return to the HurricaneHarvey_CO study region, it should already be open from the previous activity.
2. In the top menu, navigate to “Hazard > Scenario.” This prompts the Hurricane Management Window to open.
3. Click “Next” on the welcome screen.



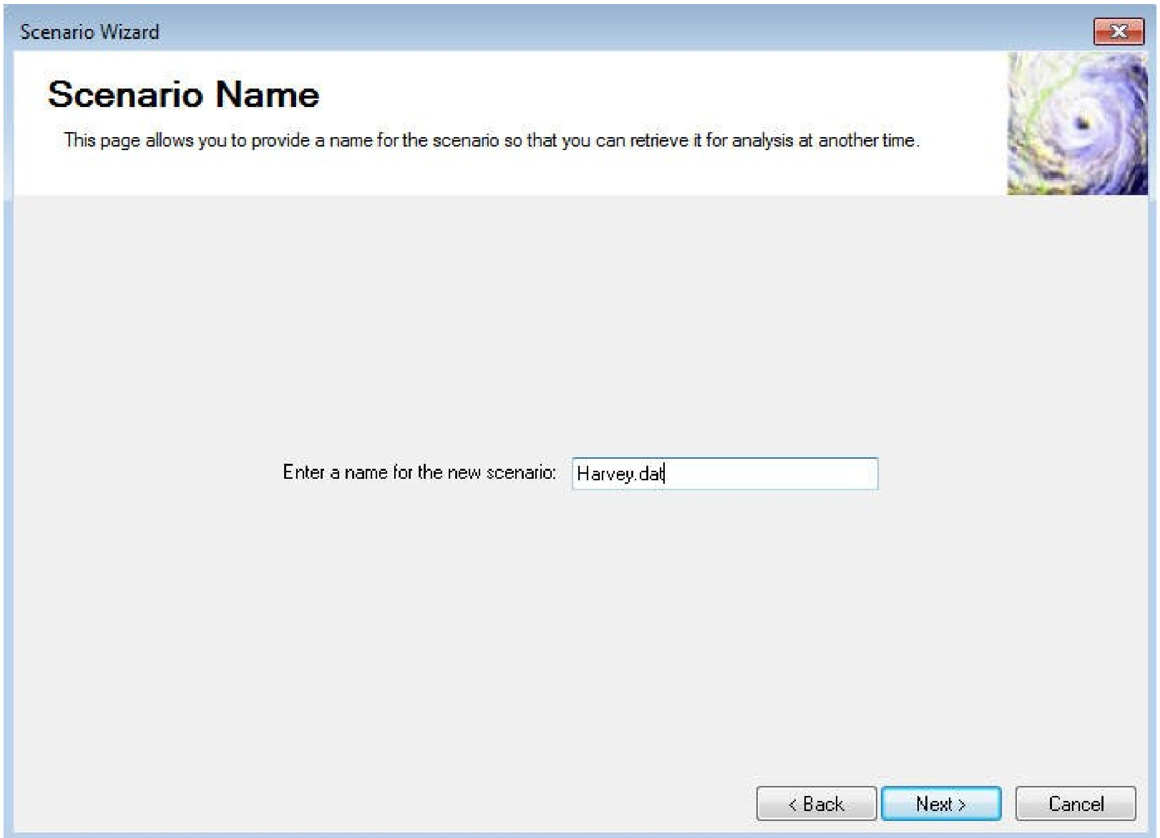
4. Select “Create a New Scenario.” Click “Next.”



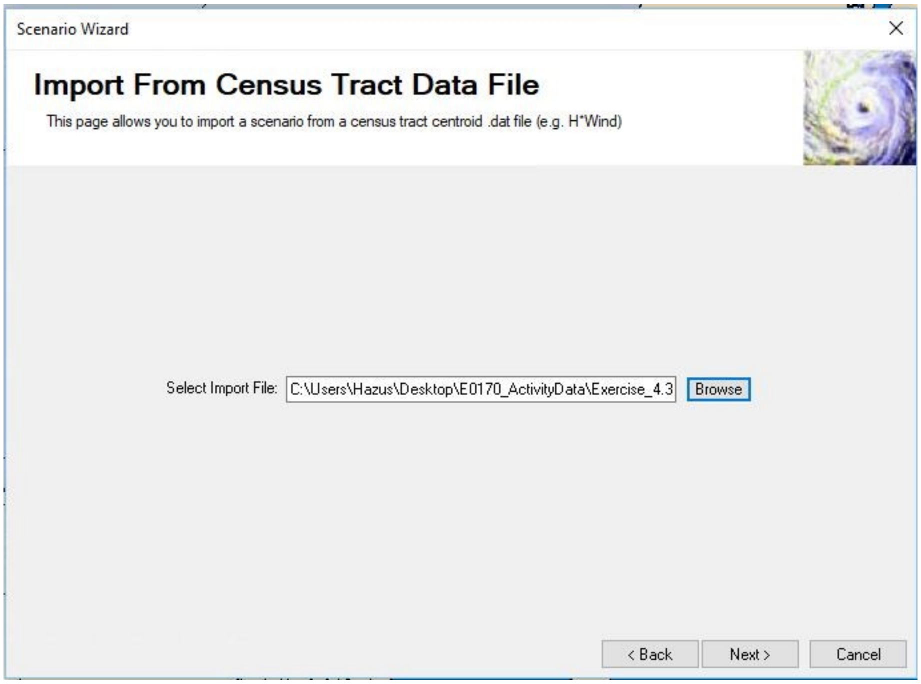
5. In the User Defined Scenario Type, select “Import Census Tract Data file (e.g. H*Wind).” Click “Next.”



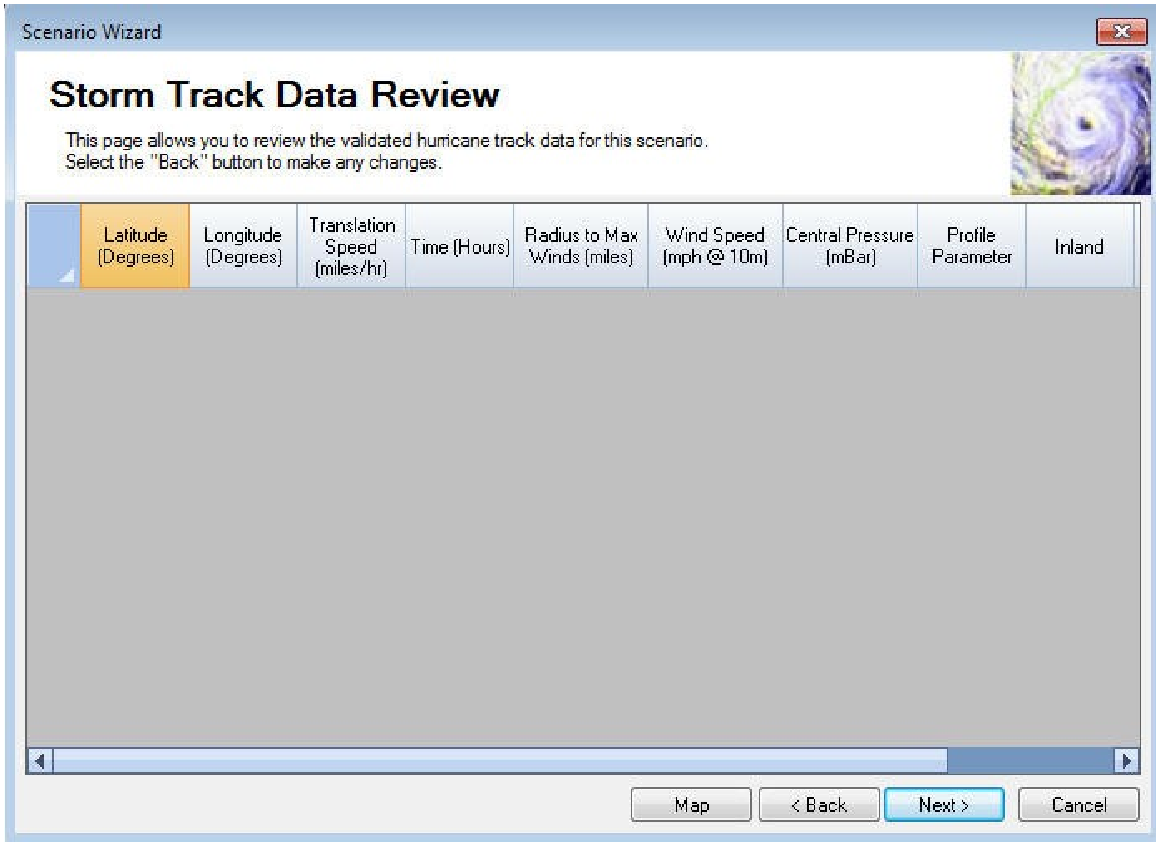
6. Enter a name for the new scenario.



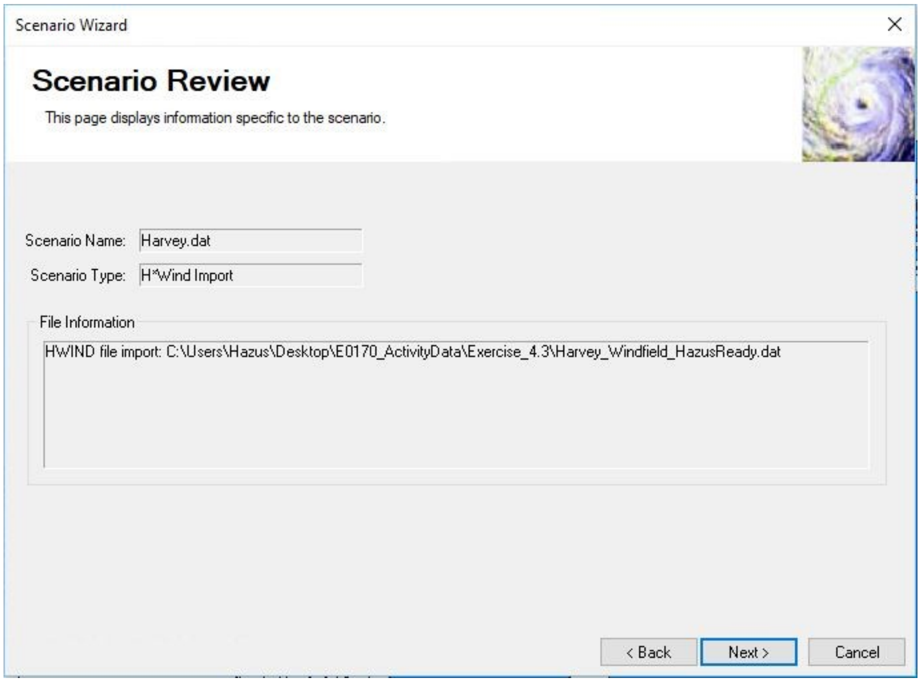
7. Click “Browse” to navigate to and select the “Harvey_Windfield_HazusReady.dat” file saved in the C:\E0170_ActivityData\Exercise_4.3 folder.



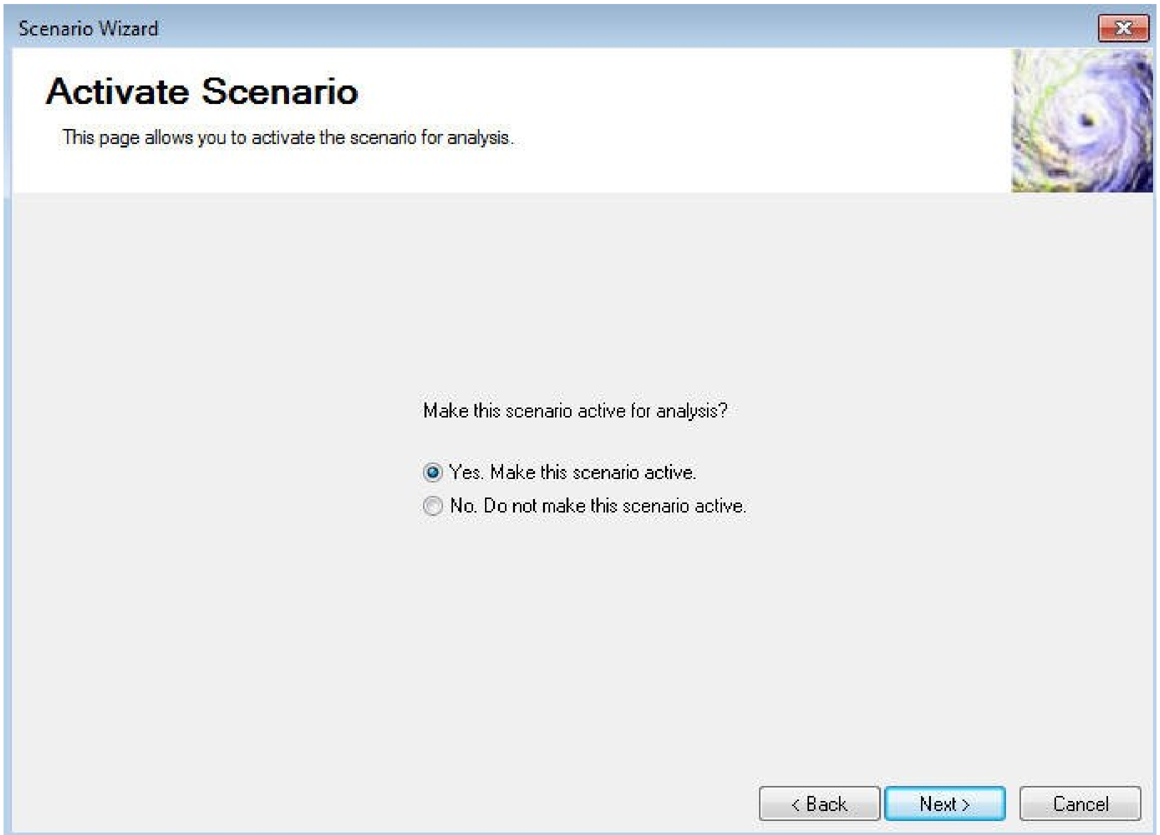
8. Click "Next."
9. Click "Next" on the Storm Track Data Review.



10. Click “Next” on the Scenario Review.



11. Select "Yes. Make this scenario active". Click "Next."



12. Click “Finish” to exit the Hurricane Scenario Management Wizard.
13. Save your map document and exit Hazus.

Visual 21: Import from Exported File

- User-defined scenario type
- Previously saved file from prior Hazus run
- Default name will be the date of import but scenario can be renamed
- Storm track input
- Wind field calculation will run before activating the scenario

Visual 22: Exercise 4.4: Importing .bin Files

Goal:

- Import Hurricane Irma data using a .bin file.

Time: 10 minutes

Student Manual

Exercise 4.4: Importing .bin Files

Goal:

- Import Hurricane Irma data using a .bin file.

Time: 10 minutes

Exercise Steps:

1. Refer to Activities Document "04.4_Exercise_Importing .bin Files."
2. Listen to instructor's directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share your answers/results.
8. Ask any final questions.

Visual 23: Exercise 4.4: Tasks

Task 1: Create the Study Region.

Task 2: Import the .bin File.

Student Manual

Exercise 4.4: Tasks

- Refer to Activities Document "04.4_Exercise_Importing .bin Files."

Exercise 4.4 – Importing .bin Files

Type: Instructor-Led Activity

Time: 10 minutes

Goals: Import Hurricane Irma data using a .bin file.

Background:

This exercise will help you learn to import .bin files to create a user defined storm. This can be a particularly useful capability at times when you are trying to ascertain the potential impact of an oncoming storm, or when you are considering what impact a past storm might have based on currently exposed inventory.

Task 1: Create the Study Region.

1. Start Hazus and select Create a New Region.
2. Click OK.
3. Name the study region “Irma_Hurricane” and click Next.
4. Check the boxes next to the hazards for Flood and Hurricane and click Next.
5. Select County and click Next.
6. Select Florida and click Next.
7. Choose the following counties to create the study region: Hillsborough, Manatee, Pinellas, and Sarasota. Remember to hold the “Ctrl” key down while clicking on the county names to select multiple counties.
8. Click Next when all four counties are highlighted.
9. Click Finish.
10. Once the aggregation is successful, click OK.
11. Select Open a region and click OK.
12. Click Next.
13. Select Irma_Hurricane and click Next.
14. Choose the radio button next to Hurricane and click Next.
15. Click Finish.

Task 2: Import the .BIN File

1. From the Hazard menu choose Scenario.
2. Click “Next” to advance the scenario wizard.
3. Select Create New Scenario and click the “Next” button.
4. Select Import from Exported File and click the “Next” button.

5. Name the new scenario Irma Landfall Track.

6. Click the Next button.
7. Click on the Browse button and navigate to the C:\E0170_ActivityData\Activity_4.4 folder.
8. Select the import file named IrmaLandfallTrack.bin and click the "Open" button.
9. Click the "Next" button to complete the import process and to perform the wind field calculation.
10. Click "Next" after the application has finished computing the wind speeds.
11. Click "Next" to move beyond the Storm Track Data window and "Next" to move through the Scenario Review.
12. Continue to click "Next" again and then "Finish".
13. Save your map document and exit Hazus.

Visual 24: Define Storm Track Manually

How fast is the storm moving?

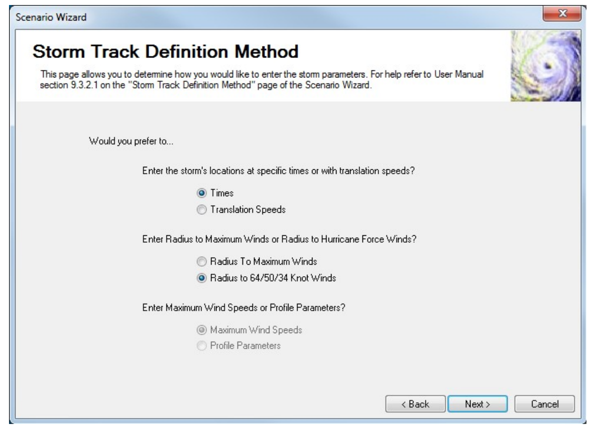
- Elapsed time for each point along the storm track
- Forward translation speed of the storm at each point

What is the size of the storm?

- Radius to maximum winds
- Radius to hurricane force (64kt, 50kt, or 34kt winds)

What is the intensity of the storm?

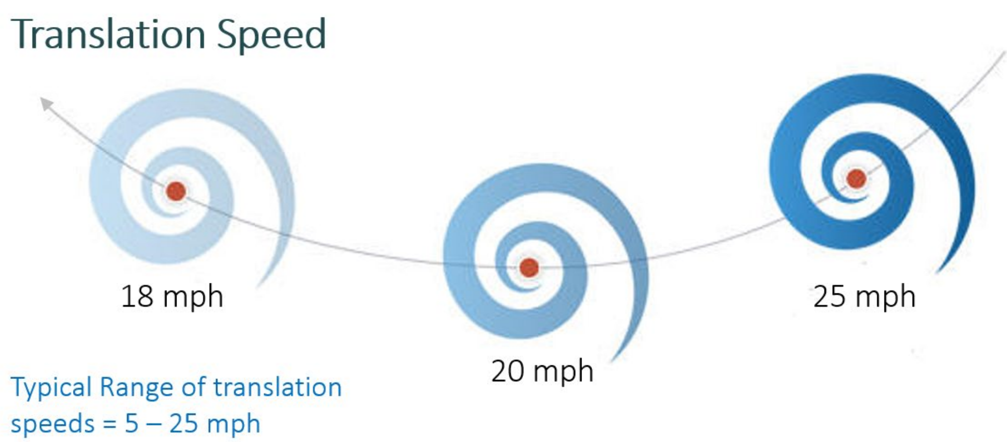
- Maximum wind speed
- A Holland B profile parameter



NOTE: Answers to these questions will depend on the format of the information you have.

Visual 25: Parameters - Translation Speed

How fast is the storm moving?

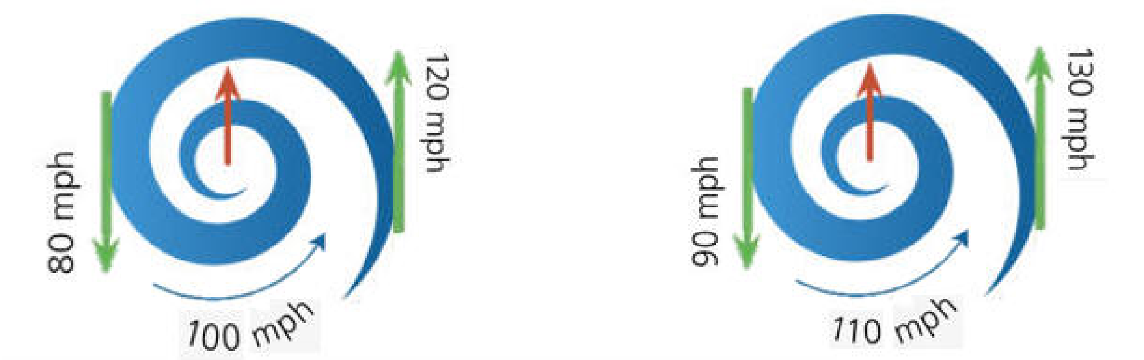


Visual 26: Translation and Rotation Speeds

Increase in rotation speed means different % increase on right and left side of storms.

For example below:

- 10 mph increase in rotation speed (100 to 110 mph)
- 8% increase in windspeed on right side of storm (120 to 130 mph)
- 12% increase in windspeed on left side of storm (80 to 90 mph)



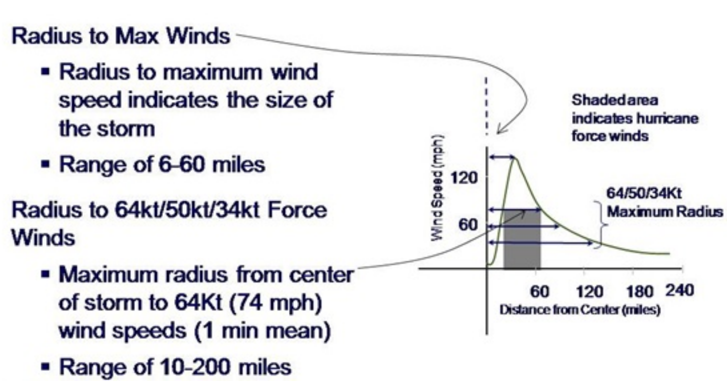
Visual 27: Converted Wind Speeds

Typical Storm Parameters

Saffir Simpson Scale	1 Min Mean (mph)	3 sec Gust (mph)	Min Central Pressure (mb)
1	74-95	90-116	980 and up
2	96-110	117-134	965-979
3	111-129	135-159	945-964
4	130-156	160-189	920-944
5	157+	189+	920 and below

1 min mean = Hazus Input Windspeeds
3 sec gust = Hazus Output Windspeeds

Visual 28: Parameters: Storm Size



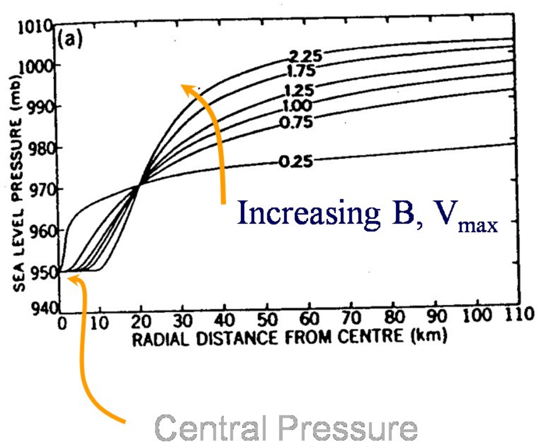
Radius to max winds and radii can be adjusted in the settings.xml

Visual 29: Parameters: Storm Intensity

Maximum Wind Speed

Profile Parameter (B)

- Parameter that describes the rate of pressure drop in the storm
- Pressure drop determines the maximum wind speed

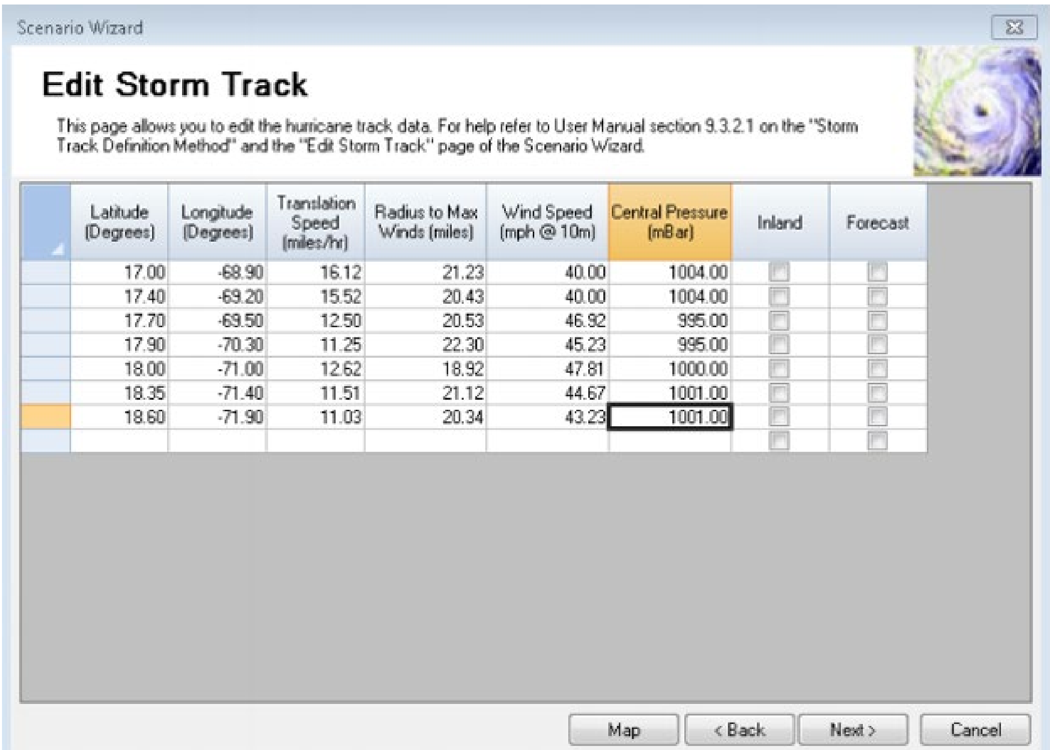


Visual 30: Typical Storm Parameters

Hurricane and Station	Measured Peak Gust at 10m (m/sec)	Anemometer Height (m)	Wind Speed Averaging Time (sec) Mean	Wind Speed Averaging Time (sec) Gust	Holland's B Parameter	Radius to Maximum Winds (km)
Fran (1996), FPSN7	48.3, 37.7	44.2	600	5	.95	85
Fran (1996), DSLN7	29.6	46.6	600	5	.95	85
Bertha (1993), FPSN7	45.1	44.2	600	5	1.2	70
Emily (1993) DSLN7	51.0, 56.7	46.6	600	5	1.7	39
Andrew (1992), NGW LMS	58.6	13.7	120	5	1.6	19
Bob (1991), 41001	30.6	5.0	600	5	1.4	35
Hugo (1989), FPSN7	31.7	42.2	600	5	1.0	40

Visual 31: Storm Track Definition

- Manually enter storm parameters



Visual 32: Hurricane Data Sources: Hurdat

- Good to manually define storm track

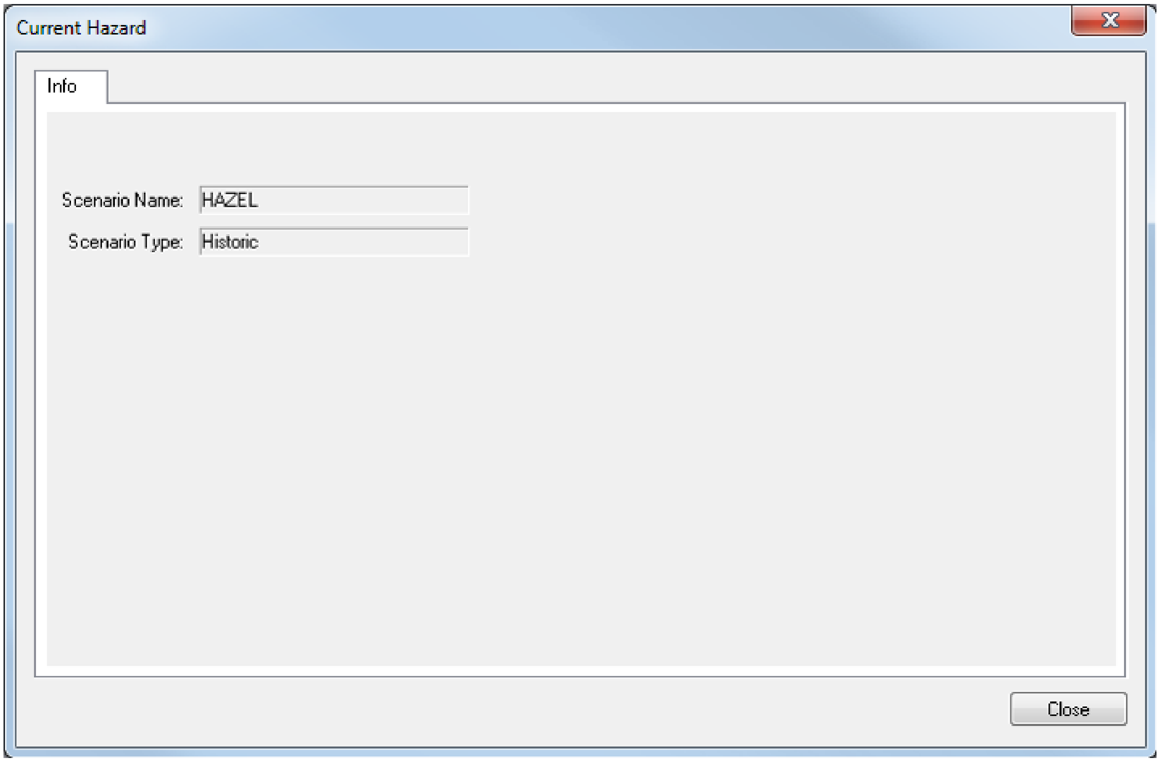
National Hurricane Center’s HURricane DATabase: https://www.nhc.noaa.gov/data/#hurdat

  - Enhanced collection of historical meteorological data

- HURDAT2: Best Track Data
  - Atlantic and Pacific
  - Comma-delimited, text format
  - Six-hourly information on location, maximum winds, central pressure, and size of all known tropical and subtropical cyclones

Visual 33: Show Current Scenario

Select Hazard > Show Current



Visual 34: Lesson 4: Review

1. What are the deterministic options for hurricane scenarios in Hazus?
2. Where (geographically within a hurricane) are the greatest hurricane windspeeds located and why?

Visual 35: Questions?

Lesson 5: Probabilistic Storm Parameters

Visual 1: Lesson 5: Probabilistic Storm Parameters

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Visual 2: Goal and Objectives

Goal: To provide an overview of the set of probabilistic storm scenarios available to users in Hazus.

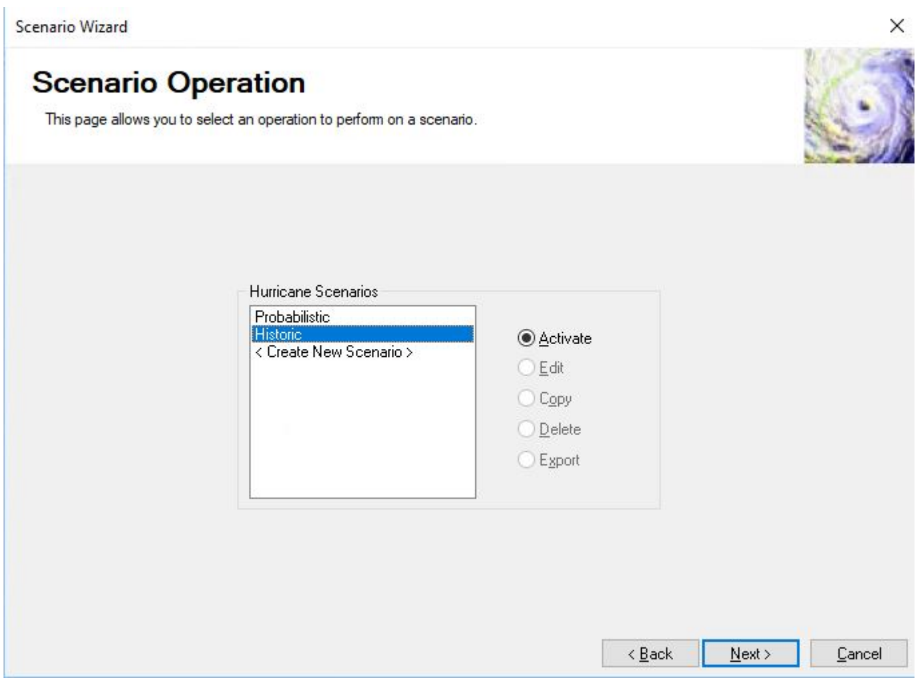
After completing this lesson, you will be able to:

- Discuss the differences in the probabilistic analyses in Hazus

Visual 3: Scenario Operations

Hazus has six choices for defining hurricane scenarios:

- Historic
- Probabilistic
- Create New:
    - Define Storm Track Manually
    - Import from Exported File (storm created in previous Hazus Study Region)
    - Import Census Tract Data File
    - Import a Hurrevac Storm Advisory



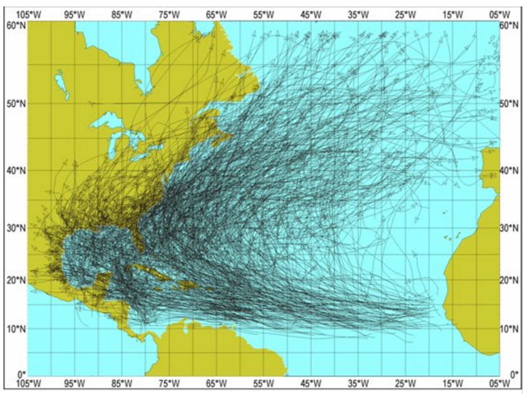
Visual 4: Probabilistic vs. Deterministic

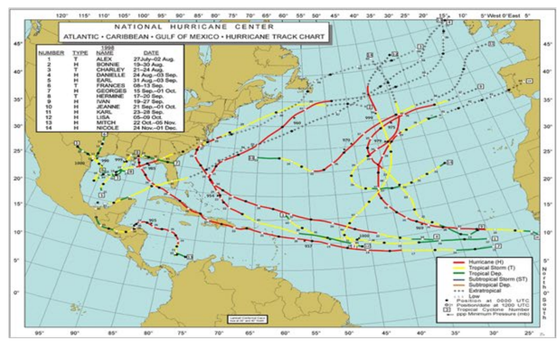
Probabilistic wind speed database (Left)

- 100,000 years of simulated storms

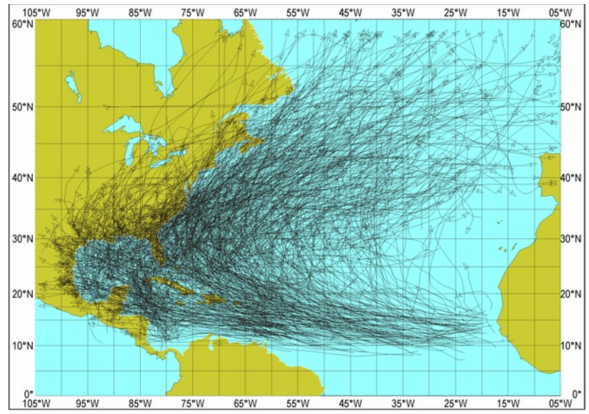
Individual Storms (Right)

- Historical
- Forecast/Advisory
- User-defined





Visual 5: Modeling Risk



- The hurricane wind model was run to simulate 100,000 hurricane seasons.
  - Storms can vary in size, strength, speed, direction
- Provides objective way to compare risk of different areas

Visual 6: Probabilistic Windspeeds

- The probabilistic windspeeds in the Table of Contents window (next slide) show the overall wind risk to the US and are the same windspeeds as in Figure 4.28
- These layers were created from the 100,000 years worth of simulated storms.
- Windspeeds were ranked for each tract and recurrence intervals were determined.

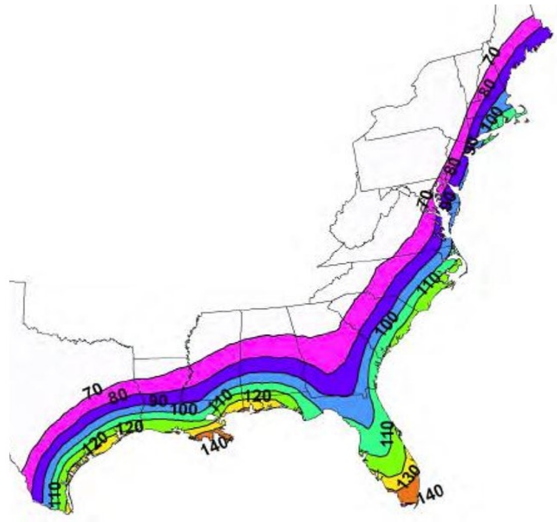
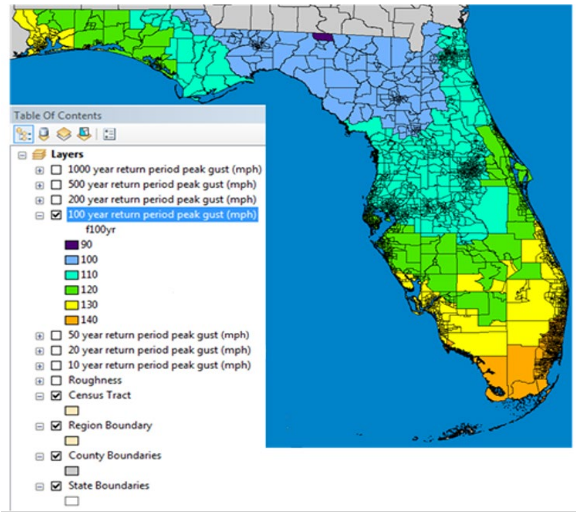


Figure 4.28 in Hurricane Technical Manual

Visual 7: Probabilistic Windspeeds (Cont'd.)

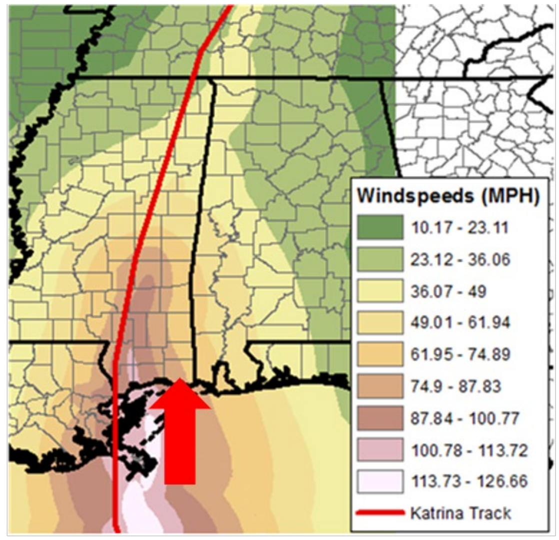


These layers answer the question:

- What is the windspeed for this tract that equates to a given recurrence interval?
- For example, 115 MPH winds for tract 12103024901 for the 1% annual chance

Visual 8: Probabilistic Windspeeds

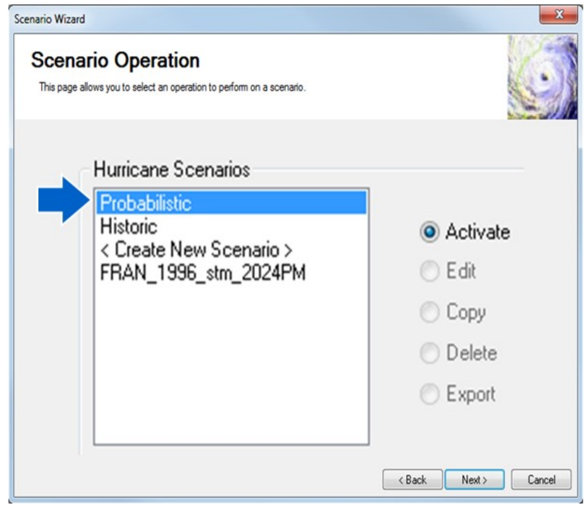
- For an actual hurricane:
  - Windspeeds are not uniform across the storm.
  - Windspeeds are higher at eyewall and lower farther away.
- Using these layers:
  - Assume the recurrence interval (100 year) at every location in the study region
  - Good for building codes, but may not be best for planning



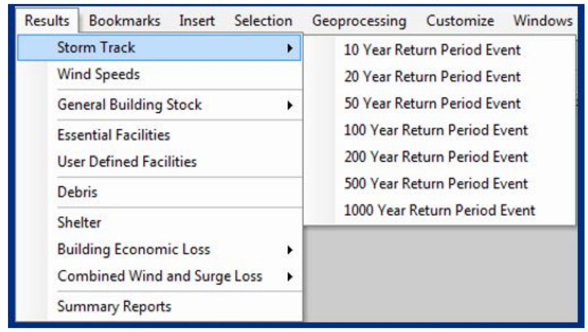
For a given county the windspeeds will vary geographically across the region during an actual hurricane event.

Visual 9: Probabilistic Scenario: Scenario Driven

- Table of Contents windspeed probabilities should not be confused with the probabilistic scenario.
- Table of Contents layers:
    - Provide communities with the recurrence interval windspeed for each tract.
- Probabilistic scenario:
    - Provide communities with a representative recurrence interval event based on loss for the study region.
    - Losses are representative of the specific event, not the recurrence interval windspeeds.



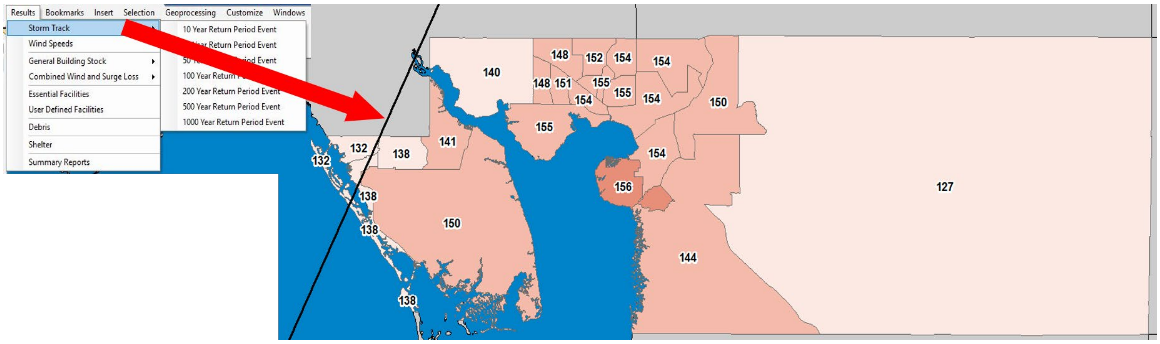
Visual 10: Probabilistic Scenario: Scenario Driven



For planning purposes:

- A community needs to understand damages and losses from an actual hurricane for each recurrence interval.
- This method answers questions such as "What would the damages and losses be for our community from a return period (e.g. 100-year) hurricane event?"

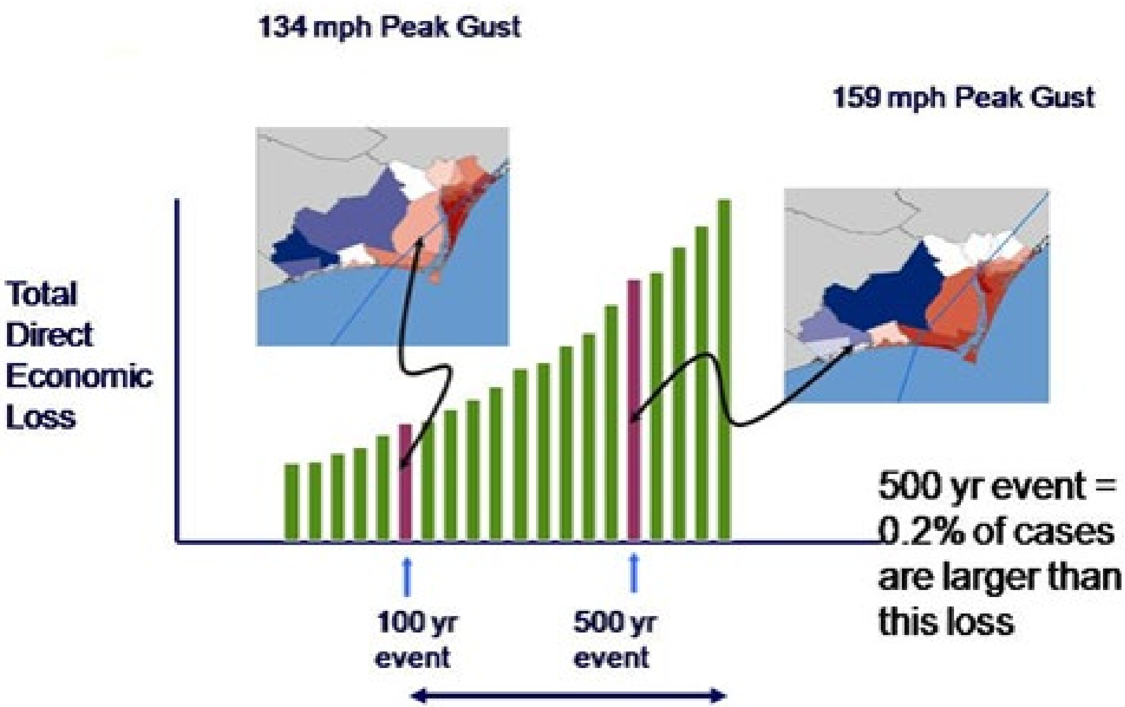
Visual 11: Probabilistic Scenario: Scenario Driven



- Hazus searches through 100,000 year simulated database for all storms that intersect the study region.
- The total losses for the region based on each storm are ranked.
- Loss is selected, then the hurricane event is used to generate damages and losses.

Visual 12: Seven Return Period Events

Events Sorted by Total Loss for the study region

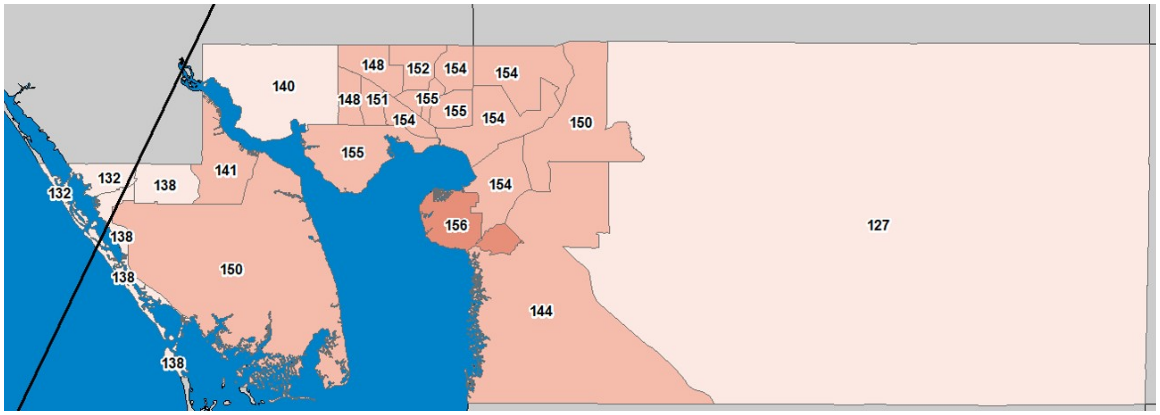


Visual 13: Discussion 5.1: 500-Year Event

Goal: Discuss the windspeed distribution for this 500 year event.

Time: 5 minutes

Visual 14: Discussion 5.1: 500-Year Event



Discuss the windspeed distribution for this 500 year event.

- Where do you expect the highest and lowest losses?
- Is every Census tract experiencing a 500 year event (individually)?

Visual 15: Outputs: Return Period Event

Seven Return Period Events

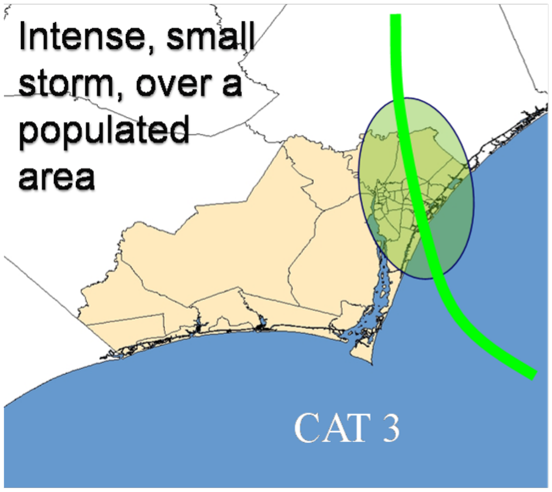
- Seven single storm scenarios from 100,000 year storm database
- Representation of the return period losses for study region: 10, 20, 50, 100, 200, 500, 1,000 years
- Return periods are based on total direct economic loss for entire study region

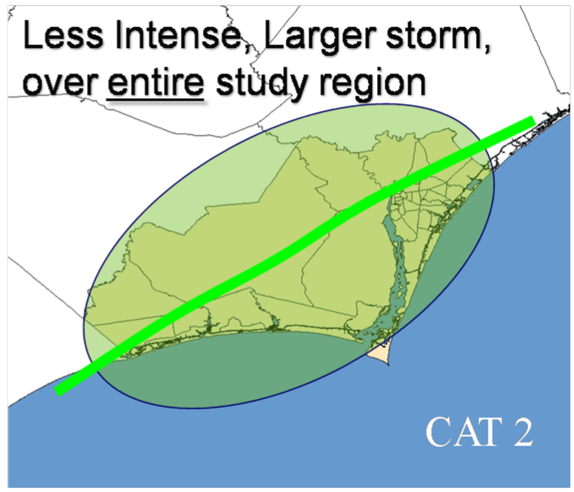
Full set of results provided

- Damage, debris, shelter, etc.
- Dollar losses

Visual 16: Study Region Characteristics & Losses

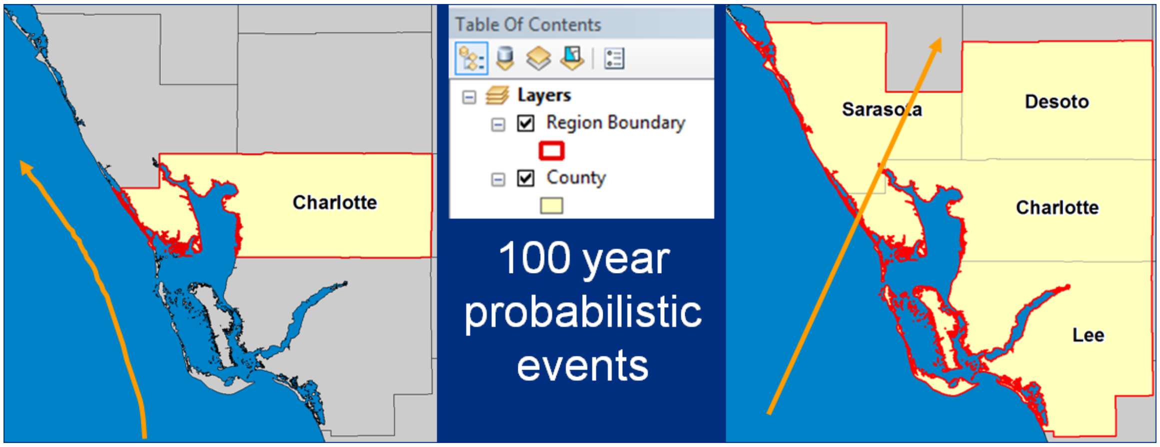
There are many different ways to produce a 100-year loss for a given study region.





*These very different storms can produce identical dollar losses for the same study region.

Visual 17: Study Region Characteristics & Losses



Even though both of these study regions contain Charlotte County, Florida, they will have very **different** probabilistic scenarios because the events are selected by finding all probabilistic events that intersect the study region and ranked based upon the losses to the **study region**.

Visual 18: Uses of Probabilistic Layers

Wind speed Maps in Table of Contents window

- Mitigation plan: identifies the windspeed each location individually plans for with respect to each probabilistic interval (10 yr, 100 yr, etc.)
- Construction design: identifies the windspeed buildings should be able to withstand

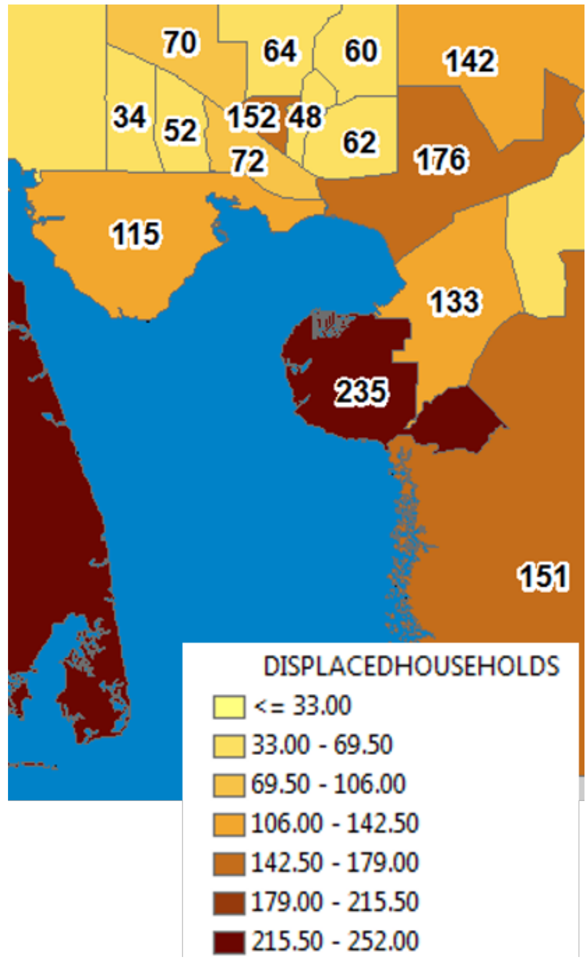
NOTE: Wind building characteristics distributions can model changes in construction wind resistance.

Categories	Building Characteristic	%
Roof Shape	Hip	5
	Gable	95
	Total	100
Secondary Water Resistance	Yes	0
	No	100
	Total	100
Roof Deck Attachment	6d @ 6"/12"	44
	8d @ 6"/12"	34
	6d/8d Mix @ 6"/6"	0
	8D @ 6"/6"	22
	Total	100
Roof-Wall Connection	Toe-nail	37
	Strap	63
	Total	100
Garage, Houses w/out Shutters	None	48
	Weak	26
	Standard	26
	Total	100

Visual 19: Uses of Probabilistic Layers

Probabilistic Event Scenarios

- Layers used in mitigation and planning situations to understand overall losses to the jurisdiction for each recurrence interval event.
- Demonstrate the damages and losses if an actual hurricane affected the area
- Example: debris planning, sheltering planning, and response and recovery exercises



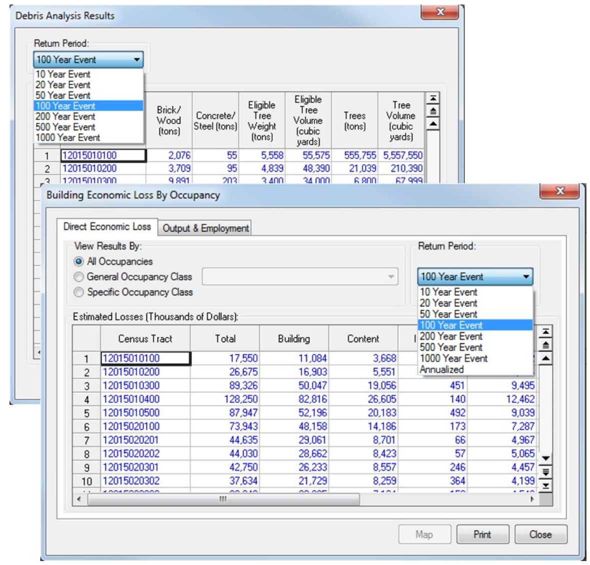
Visual 20: Probabilistic Losses

Building Economic Losses

- Seven Return Period Events
- Annualized: the estimated long-term value of losses to the general building stock averaged on an annual basis for a specific hazard type

All other results

- Seven Return Period Events



Visual 21: Exercise 5.2: Probabilistic Scenario

Goal: Run a Probabilistic Scenario.

Time: 45 Minutes

Student Manual

Exercise 5.2: Probabilistic Scenario

Goal:

- Run a Probabilistic Scenario

Time: 45 minutes

Exercise Steps:

1. Refer to Activities Document "05.2_Exercise_Probabilistic Scenario."
2. Listen to instructor's directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share your answers/results.
8. Ask any final questions.

Visual 22: Exercise 5.2: Tasks

Task 1: Open the Region and Define a Probabilistic Scenario.

Task 2: Run the Analysis.

Task 3: View the Results.

Student Manual

Exercise 5.2: Tasks

- Refer to Activities Document "05.2_Exercise_Probabilistic Scenario."

Activity 5.2: Probabilistic Scenarios

Type: Student-Led Activity

Time: 45 minutes

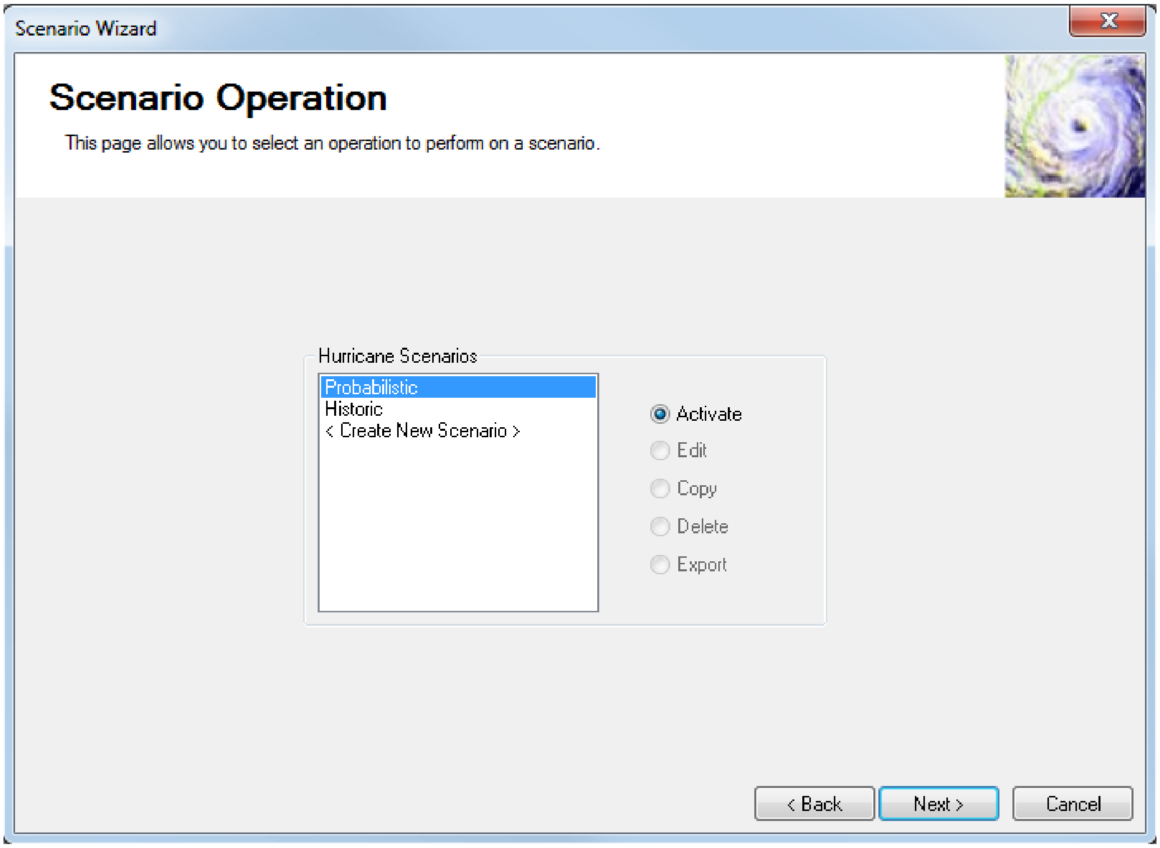
Goal: Run probabilistic scenario.

Background:

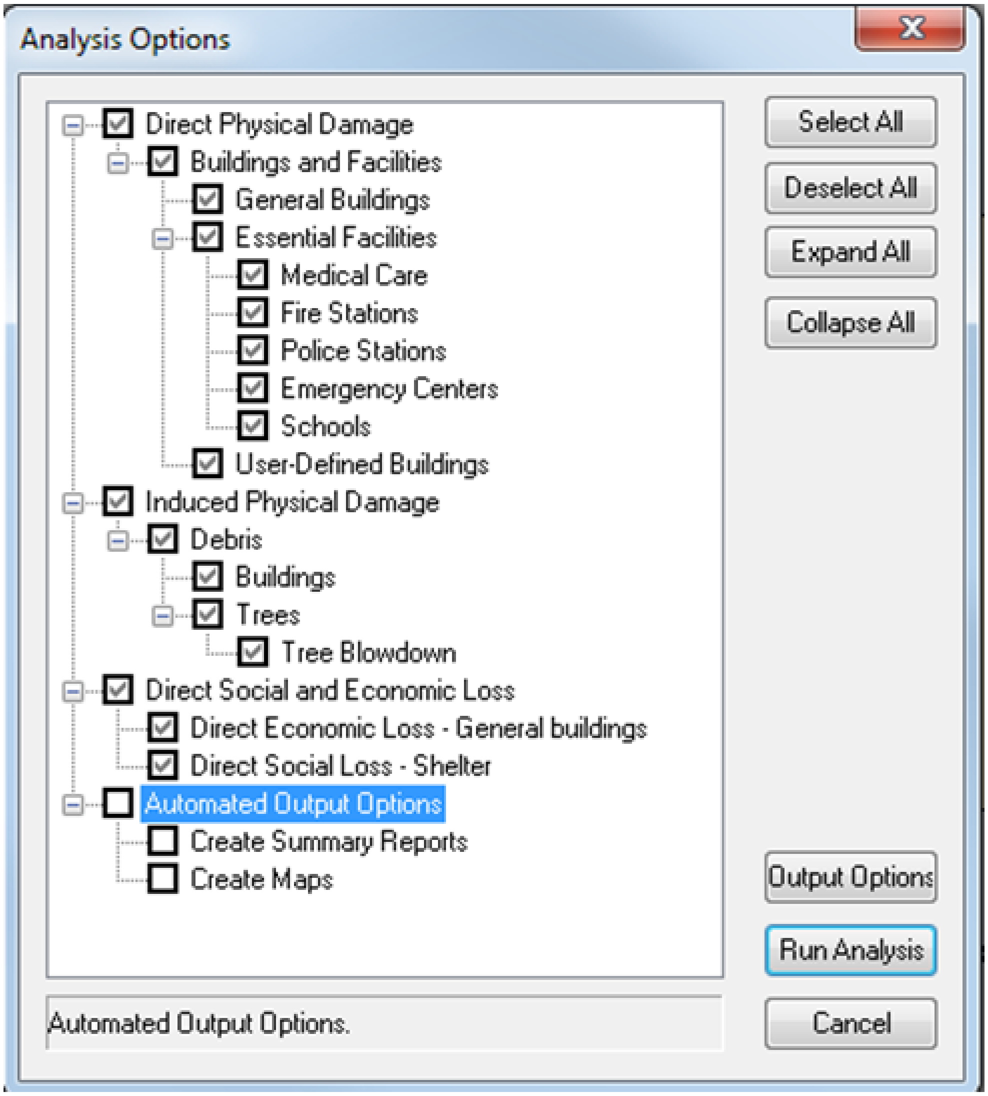
Hazus comes with a substantial library of historical storms. You can use the tracks and other characteristics of storms that occurred in the past to understand what the impact would be on a community of a similar storm were to occur today given the way that buildings are constructed, how they are used, and where they are located. This exercise will help you explore the process of defining a probabilistic storm scenario and it will also help you explore the study region inventory to provide a context for understanding the impact of the hurricane on the exposed buildings and population.

Task 1: Run the Probabilistic Analysis.

1. Start Hazus and select “Import a region”. Import the “Probabilistic” HPR from the C:\E0170_ActivityData\Activity_5.2 folder.
2. Name the imported region, “Probabilistic_HU”
3. Once complete, select Open a Region from the Hazus startup menu and select the “Probabilistic_HU” region.
4. From the Hazard menu choose “Scenario” to open the Scenario wizard.
5. Click Next to move past the initial window of the wizard.
6. Select Probabilistic and click “Next”.



7. Click “Next” to make the scenario active and then click Finish.
8. From the Analysis menu choose “Run” to open the Analysis Options window.
9. Uncheck the Automated Output Option radio boxes and click “Run Analysis”.



10. When the analysis is complete, click OK.

11. From the Results menu, choose “Wind Speeds”.

12. Find the 200 Year Event Peak Gust (mph) column. Question: What is the highest peak wind gust? Answer: Peak Wind Gust: 135

13. Click on the 200 Year Event Peak Gust (mph) column and then “Map” to add the probabilistic storm path and windspeeds as map layers.

14. “Close” this window.

15. Right-click on the StormTrack - 200 year return period event layer in the Table of Contents window on the left and choose Zoom to Layer.

16. View the probabilistic storm being used to create the 200 year event for the study region. The storm’s winds are modeled for each tract of the study region based on the speed, size, and

intensity of the probabilistic hurricane. Based on the peak wind gusts for each tract, damage and losses are calculated within each tract.

17. Right-click on the Wind Speeds-200 Year Event Peak Gust (mph) layer and choose Zoom to Layer.

Question: What is the geographic distribution of windspeeds for the probabilistic event of this study region?

Answer:

Question: Explain why this pattern exists.

Answer:

18. Click the check box next to the StormTrack - 200 year return period event and Wind Speeds - 200 Year Event Peak Gust (mph) to turn off each layer.

19. Click the box next to the 200 year return period peak gust (mph) layer which was created and populated when the study region was created, to turn it on.

Note: Notice there is no storm track associated with this layer. This is because it was not created from a hurricane event.

20. Right-click on the 200 year return period peak gust (mph) layer and select Label Features.

21. Answer the following questions:

Question: What is the peak wind gust for this probabilistic layer?

Answer:

Question: What is the geographic distribution of windspeeds for this probabilistic layer for this study region?

Answer:

Question: Explain why this pattern exists.

Answer:

Question: What are the major differences between the two windspeed layers?

Answer:

22. Right-click on the Wind Speeds - 200 Year Event Peak Gust (mph) layer and choose Open Attribute Table.

23. Find tracts 48355003001 and 48355005802. (The wRtnP5 column contains the 200-year gusts.)

Question: What are the peak wind gusts for these two tracts?

Answer:

Task 2: View and Compare the Results.

You just completed an analysis of the impact to the study region from the perspective of individual census tracts. At the beginning of this exercise you ran the probabilistic event analysis where you generated seven return period events. We looked at the 200-year event, which was selected from the 100,000-year probabilistic storm database located in Hazus. The storm will affect each individual census tract in the study region differently depending on the characteristics (size, speed, intensity) and the proximity to the storm path of each tract.

- Scenario 1: If you lived in tract **48355003001** and this probabilistic event actually occurred, you would experience a 200-year event. This is determined by opening the attribute tables of the seven different return period layers, locating the census tract records, and determining which column the peak wind gust falls into. The peak wind gust for this tract is 123 mph and this falls into the "f200yr" column for this census tract record in each of the attribute tables of the return period layers.
- Scenario 2: If you lived in census tract **48355005802**, you would experience a 500-year event. In this scenario, the peak wind gust in the tract is 119 mph and this value falls into the "f500yr" column in each of the attribute tables of the seven return period layers.

Question: As a county emergency manager, how would you explain the event the county as a whole is experiencing?

Answer:

2. Locate tract 48355003001.

Question: What are the peak wind gusts for each return period?

Answer:

- **wRtnP1 (10 year):**
- **wRtnP2 (20 year):**
- **wRtnP3 (50 year):**
- **wRtnP4 (100 year):**
- **wRtnP5 (200 year):**
- **wRtnP6 (500 year):**
- **wRtnP7 (1000 year):**

3. Close the attribute table.

4. Answer the following questions:

Question: Why doesn't the winsdpeed steadily increase as the return periods get longer?

Answer:

Question: What might you expect for the damages and losses for this tract as the return periods increase? What about for the study region?

Answer:

5. From the Results menu select "Summary Reports".

6. Select the "Direct Losses" tab.

7. Click to highlight the "Direct Economic Losses for Buildings" report.

8. Click View to view the report.

9. Reports for every return period are listed. Note: To view other return period reports you can click the arrows in the top left of the report window.

10. In the table below, record the Cost Building Damage for each return period:

Results Table

Return Period	Cost Building Damage
Annualized	
10	
20	
50	
100	
200	
500	
1000	

Visual 23: Annualized Hurricane Loss (AHL)

- The expected value of future losses averaged on an annual basis
- Formula expression
  - *m* = events
  - *n* = years
- Formula description
  - Sum of expected loss for each event, divided by number of years in simulation (n= 100,000 years)
- Uses
  - Fundamental measure of the risk for mitigation strategy
  - Unbiased basis for relative ranking and resource allocation
  - Benefit-cost analysis of mitigation options

$$\mathrm{AHL} = \frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{m} L_{i,j}$$

Visual 24: Annualized Hurricane Loss (AHL)

Annualized Hurricane Losses are provided for

- Building Economic losses ($)
- Output and Employment losses ($)

Not provided for

- Damage
- Debris
- Shelter

Called "Annualized" in direct economic results tables

Visual 25: Probabilistic Return Intervals vs. AHL

- Probabilistic scenarios work inherently different from event based AHL estimates
  - Probabilistic scenarios look at a specific return interval
  - AHL looks at all potential events and is a combined value of events and years
  - Probabilistic scenarios are not calculating the impact of an event in all regions; it is specific to whatever is defined

Visual 26: Review

1. Where can you find the two different types of probabilistic datasets?
2. What return periods are used in probabilistic hurricane scenarios in Hazus?

Visual 27: Questions?

Lesson 6: Damage Models

Visual 1: Economic Loss Methodology

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Visual 2: Lesson 6: Goal and Objectives

Goal: To provide an overview of the damage and loss methodology for hurricane wind models in Hazus.

After completing this lesson you will be able to:

- Discuss the wind damage and loss methodology in Hazus.

Visual 3: The Building Envelope

- Damages and losses begin with the building envelope performance, the amount of resistance to hurricane force winds.
  - Walls
  - Roofing
  - Windows
  - Doors
- Failures to these components lead to more extensive damage.

Mitigation Assessment Team Report: Hurricane Ivan in Alabama and Florida (FEMA 489)

Visual 4: Sub-Assembly Inventory Wind Model

- Sub-assembly cost ratios separate the individual building components.
- Represents the percentage of the replacement cost for each component
  - EX: if Hazus modeled a roof 100% damaged on a $100,000 one story residential structure, the total loss would be $3,000.

Table of Default Residential Subassembly Cost Ratios

Subassembly	1 Story	2 Story	3 Story
Site Work	1%	1%	1%
Foundation	13%	8%	5%
Framing	13%	11%	14%
Exterior Wall	22%	25%	26%
Roofing	3%	2%	1%
Interiors	32%	38%	39%
Specialties	4%	4%	4%
Mechanical	9%	8%	7%
Electrical	3%	3%	3%
Total	100%	100%	100%

Hurricane winds do not affect all components equally, and therefore individual components must be modeled

Visual 5: Sub-Assembly Inventory Flood Model

- Sub-assembly cost ratios were created for the surge model for combined losses.
- 5 categories were created, but they are different than the hurricane model.
- Therefore the hurricane sub-assemblies were aggregated into the same 5 categories, which prevents double counting of losses.

Pre-FIRM

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
RES1: Single	6%	2%	13%	5%	5%	20%	49%	100%
RES2: MH	6%	2%	10%	3%	5%	20%	54%	100%
RES3A: Duplex	6%	2%	13%	5%	5%	20%	49%	100%
RES3B: 3-4 Units	6%	2%	13%	5%	5%	20%	49%	100%
RES3C: 5-9 Units	5%	1%	10%	2%	3%	10%	69%	100%

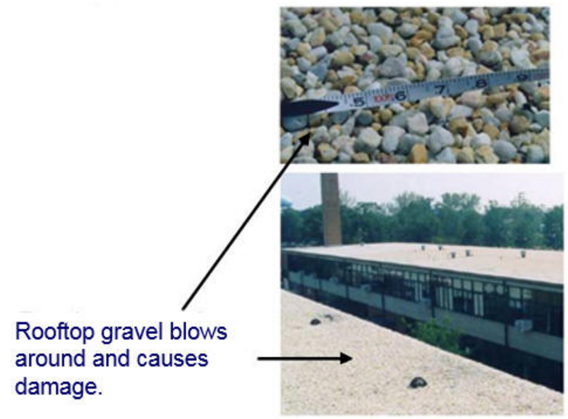
Visual 6: Sub-Assembly Inventory Flood Model

Post-FIRM

Specific Occupancy or General Building Type	Foundation	Below First Floor	Structure Frame	Roof Covering	Roof Framing	Exterior Wall	Interiors	Total
RES1: Single	11%	3%	10%	5%	5%	19%	47%	100%
RES2: MH	8%	2%	10%	3%	5%	20%	52%	100%
RES3A: Duplex	11%	3%	10%	5%	5%	19%	47%	100%
RES3B: 3-4 Units	11%	3%	10%	5%	5%	19%	47%	100%
RES3C: 5-9 Units	10%	1%	9%	2%	3%	9%	66%	100%

Visual 7: Damages from Hurricane Winds

- Wind pressure: the effect of the force of the wind on a building
- Windborne Debris (Missiles): damage caused by building debris being airborne and damaging other structures
- Roof types are referred to as "ballasted."

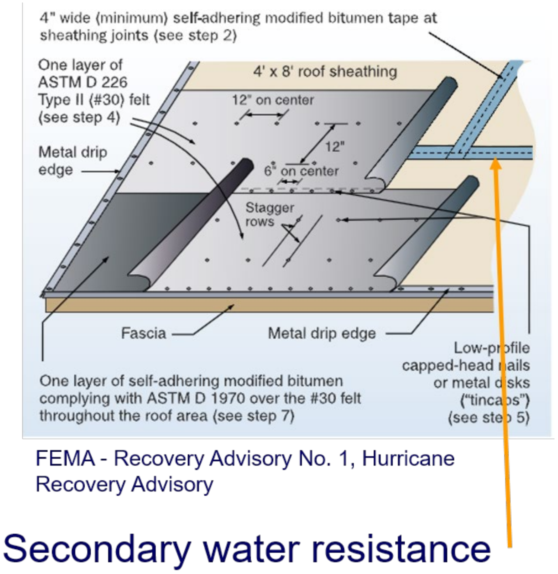


Visual 8: Damages from Hurricane Winds

Duration: longer durations (more damage) vs. shorter durations (less damage) of hurricanes when the windspeeds are equal

Rainfall: after roofing materials or openings fail, water can damage the inside of a structure

Atmospheric pressure: difference in atmospheric pressure causing damage



FEMA - Recovery Advisory No. 1, Hurricane Recovery Advisory

Visual 9: Damage States

Damage State 1

Damage results are reported by average percentage of buildings in each damage state:

- None
- Minor
- Moderate
- Severe
- Destruction

Damage state:

- Function of amount of damage to key components

Visual 10: Damage States

- Different damage state definitions for each building type
- See the Hazus Hurricane Model Technical Manual

Damage State	Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
0	**No Damage or Very Minor Damage** Little or no visible damage from the outside. No or very limited water penetration.	Less than or equal to 2%	No	No	No	No	No
1	**Minor Damage** Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring	**Greater than 2% and less than or equal to 15%**	**One window, door, or garage door failure**	No	<5 Impacts	No	No

Damage State	Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
	painting or patching for repair						

Damage States for Residential Construction Classes

Visual 11: Damage States

- Different damage state definitions for each building type
- See the Hazus Hurricane Model Technical Manual

Damage State	Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
2	**No Damage or Very Minor Damage** Little or no visible damage from the outside. No or very limited water penetration.	**>15% and less than or equal to 50%**	**Greater than 1 and less than or equal to the larger of "20%" and "3"**	**1 to 3 panels**	Typically 5 to 10 impacts	No	No
3	**Severe Damage** Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	**>50%**	**greater than the larger of "20%" and "3" and less than or equal to 50%**	**>3 panels and Less than or equal to 25%**	Typically 10 to 20 impacts	No	No

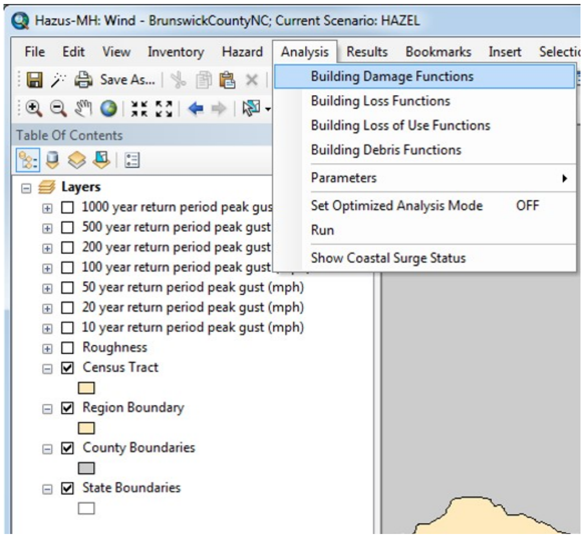
Damage State	Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
4	**<u>Destruction</u>** Complete roof failure and/or failure of wall frame. Loss of more than 50% of roof sheathing.	Typically > 50%	**>50%**	**>25%**	Typically >20 impacts	**Yes**	**Yes**

Damage States for Residential Construction Classes

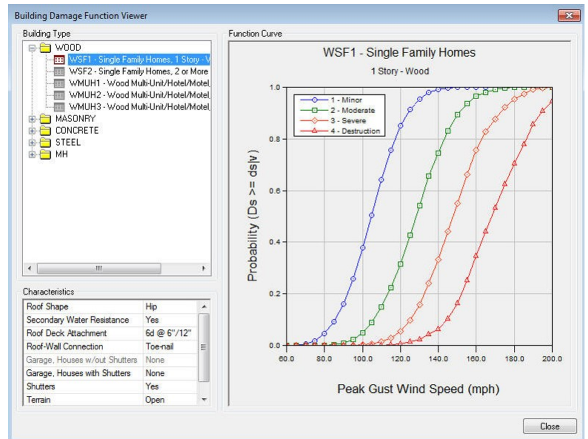
Visual 12: Examining Damage and Loss Curves

Analysis Menu

- Damage
- Loss
- Loss of use
- Debris



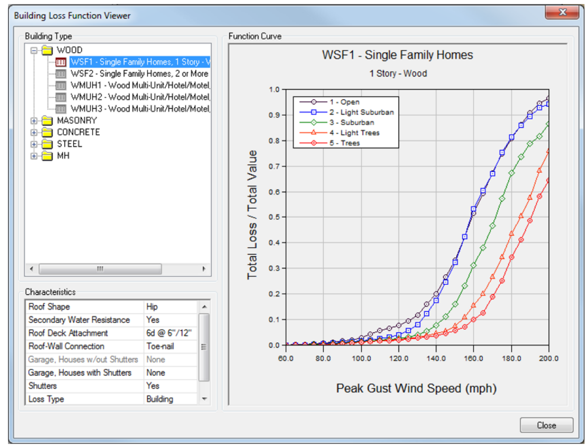
Visual 13: Damage Curve Viewer



- Select a Building Type
- Click to Select different parameters
- For 140 mph speed, there is a 35 percent chance that the building will have at least severe damage

Visual 14: Four Curve Viewers

- Building Damage
- Building Loss
- Building Loss of Use
- Debris



Loss curves for variety of terrains

Visual 15: Demonstration 6.1: Curve Viewers

Goal: Review and discuss curve viewers

Time: 10 minutes

Demonstration 6.1: Curve Viewers

Type: Instructor-Led Activity

Time: 10 minutes

Goal: Review and discuss curve viewers

Background:

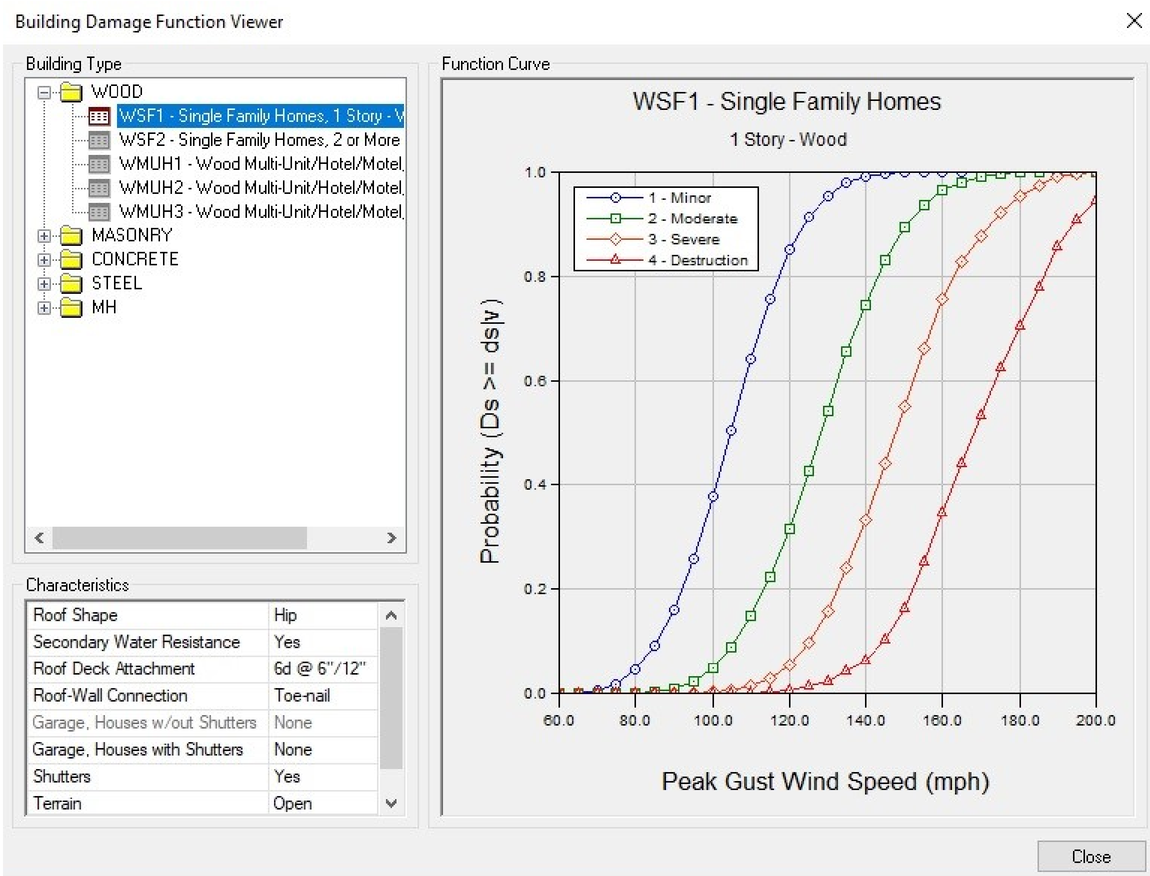
In order to show the losses from hurricane winds and storm surge, the sub-assembly losses were created. Sub-assembly loss curves for flooding were developed. After the damages to these components have been calculated, the % damage is then applied to the % of the replacement cost from the cost ratios. The losses for each component are totaled to get a total loss.

Task 1: Show Damage and Loss Curve viewers

1. For this demonstration, open the "Irma_Hurricane" study region created in Exercise 4.4.

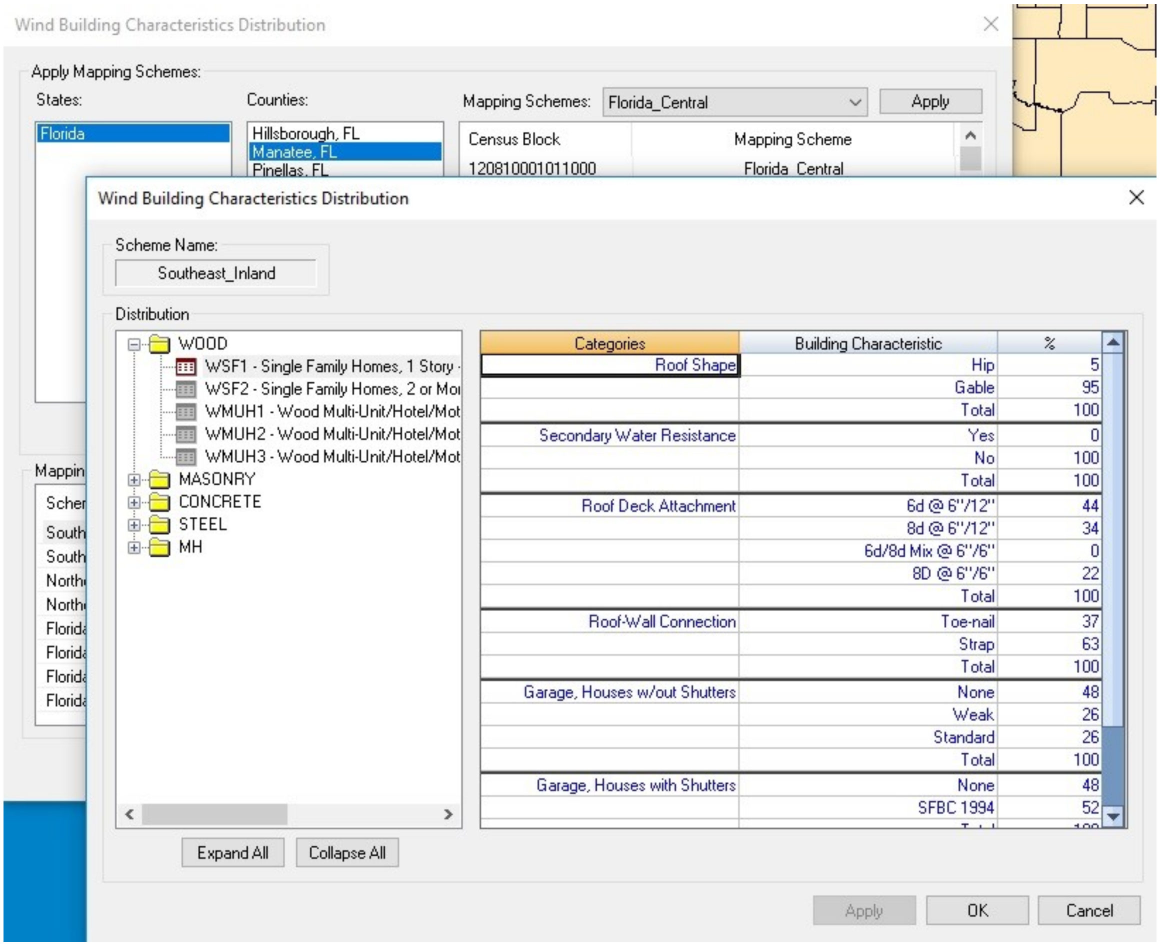
Note: If you did not create this study region, the HPR is provided in the C:\E0170_ActivityData\Demonstration_6.1 folder.

2. Choose the Hurricane hazard.
3. To view the damage and loss curves click on Analysis.
4. Then click on each loss, damage and debris viewers and discuss how the GUIs work.

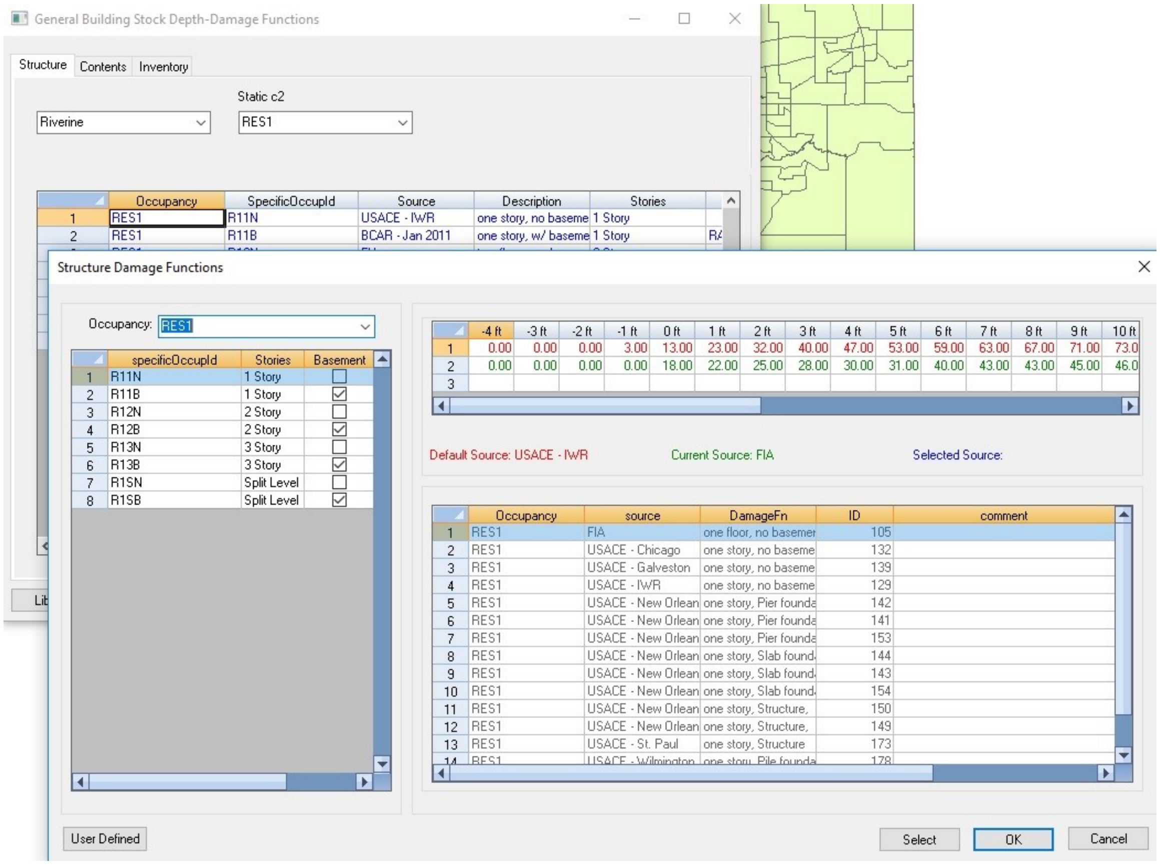


Task 2: Discuss Damage and Loss Curve modification examples

1. Provide some examples of changing the wind building characteristics and how the curves change.



2. Switch the hazard to the Flood model.
3. Go to Analysis > Damage Functions > Buildings.
4. In the bottom left corner click Library.
5. View the depth damage curves for RES1 structures.



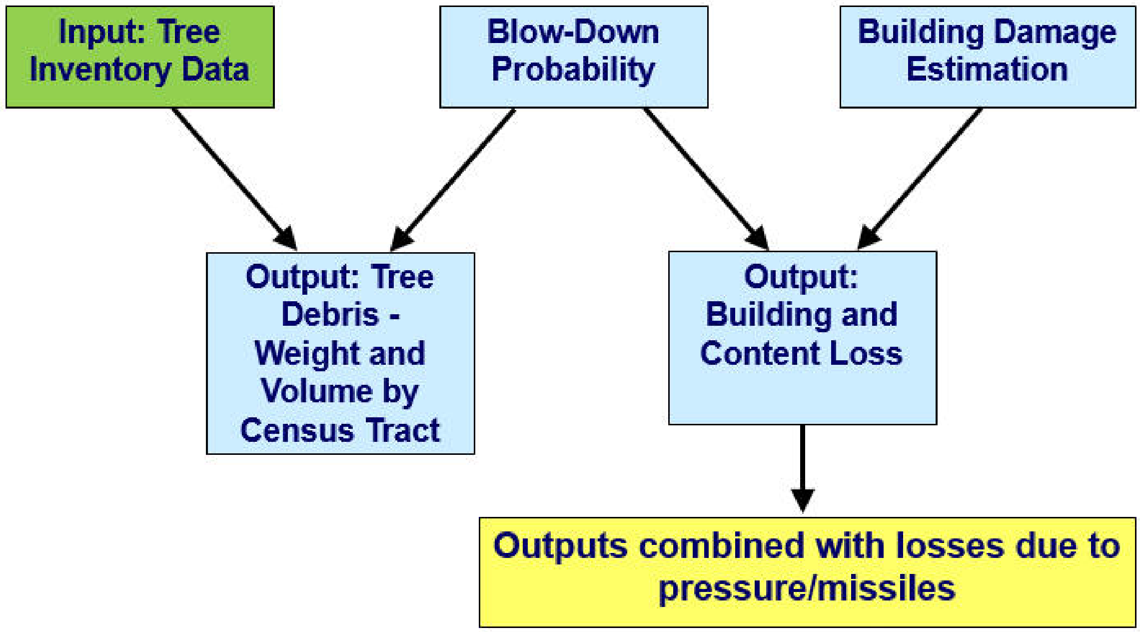
6. Discuss how these curves change with water depth.
7. Exit Hazus.

Visual 16: Tree Blow-Down Model

Tree effects during wind storms:

- Positive
  - Provide shelter to structures
  - Reduces wind pressure
- Negative
  - Falling trees produce strike hazard to structure
  - Fallen trees add to amount of debris to dispose of after storm

Visual 17: Tree Model



Visual 18: Hazus Tree Coverage Database

- Tree Inventory Database is derived from:
  - Multi-Restoration Land Consortium (MRLC) land use coverage database
    - Same data used for terrain database
- Forest Inventory Analysis (FIA) Database
  - Developed by U.S. Forest Service (USFS)
  - Updated every 5 years
  - Nationwide inventory by species
  - Field survey and statistical analysis
  - Contains tree count and tree diameter distribution

Visual 19: Tree Database in Hazus

Tree types

- Deciduous
- Coniferous
- Mixed Tree Density (stems per acre)

Tree height

- Distribution between 3 broad categories:
  - 30 - 40 ft
  - 40 - 60 ft
  - 60 + ft

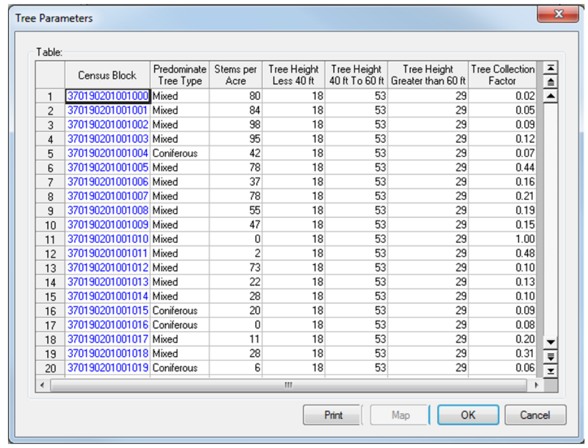

Tree Parameters

Table:

	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	370190201001000	Mixed	80	18	53	29	0.02
2	370190201001001	Mixed	84	18	53	29	0.05
3	370190201001002	Mixed	98	18	53	29	0.09
4	370190201001003	Mixed	95	18	53	29	0.12
5	370190201001004	Coniferous	42	18	53	29	0.07
6	370190201001005	Mixed	78	18	53	29	0.44
7	370190201001006	Mixed	37	18	53	29	0.16
8	370190201001007	Mixed	78	18	53	29	0.21
9	370190201001008	Mixed	55	18	53	29	0.19
10	370190201001009	Mixed	47	18	53	29	0.15
11	370190201001010	Mixed	0	18	53	29	1.00
12	370190201001011	Mixed	2	18	53	29	0.48
13	370190201001012	Mixed	73	18	53	29	0.10
14	370190201001013	Mixed	22	18	53	29	0.13
15	370190201001014	Mixed	28	18	53	29	0.10
16	370190201001015	Coniferous	20	18	53	29	0.09
17	370190201001016	Coniferous	0	18	53	29	0.08
18	370190201001017	Mixed	11	18	53	29	0.20
19	370190201001018	Mixed	28	18	53	29	0.31
20	370190201001019	Coniferous	6	18	53	29	0.06

Residential = 10-50 stems per acre
Forest = approx. 100 stems per acre

Visual 20: Damage Resulting from Trees

Simulations of amount of damage:

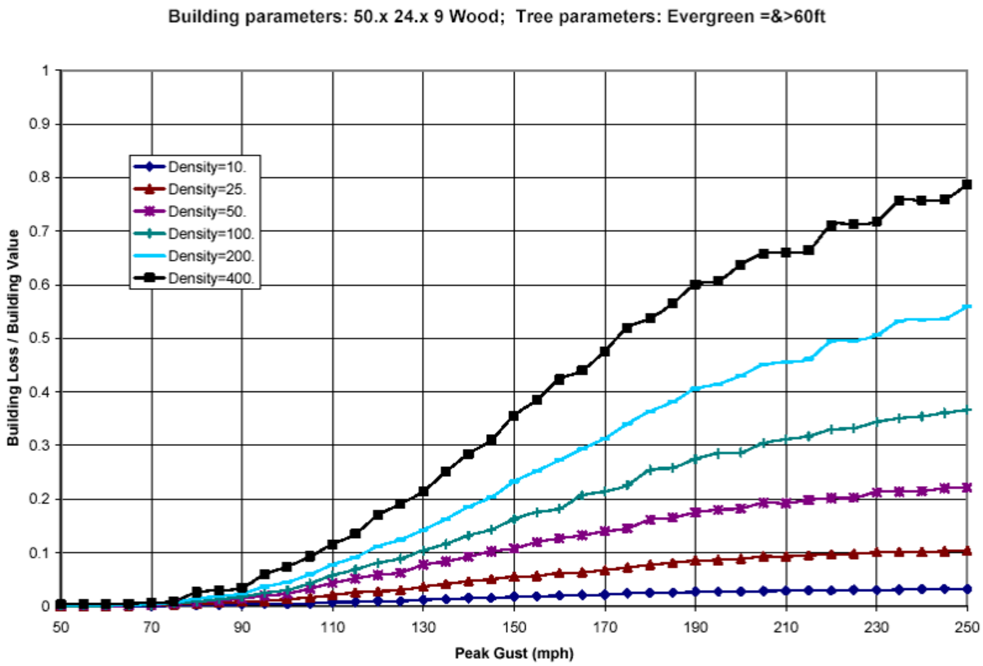
- Tree drop tests at Clemson University
- Derived relationship of impact energy and damage severity
- Cost estimated using data from RSMeans 2018

Visual 21: Tree Damage from Hurricane Irma (2017)

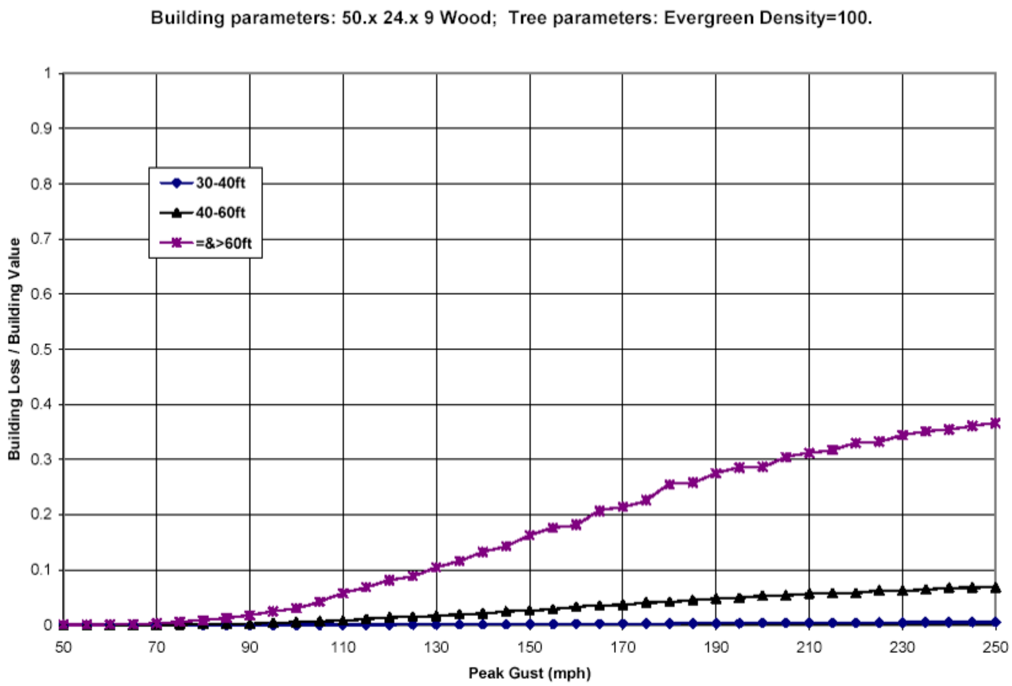
Hazus tree model accounts for different types of tree damage that may occur.

Photo taken in Gospel Island, FL after Hurricane Irma, September 2017

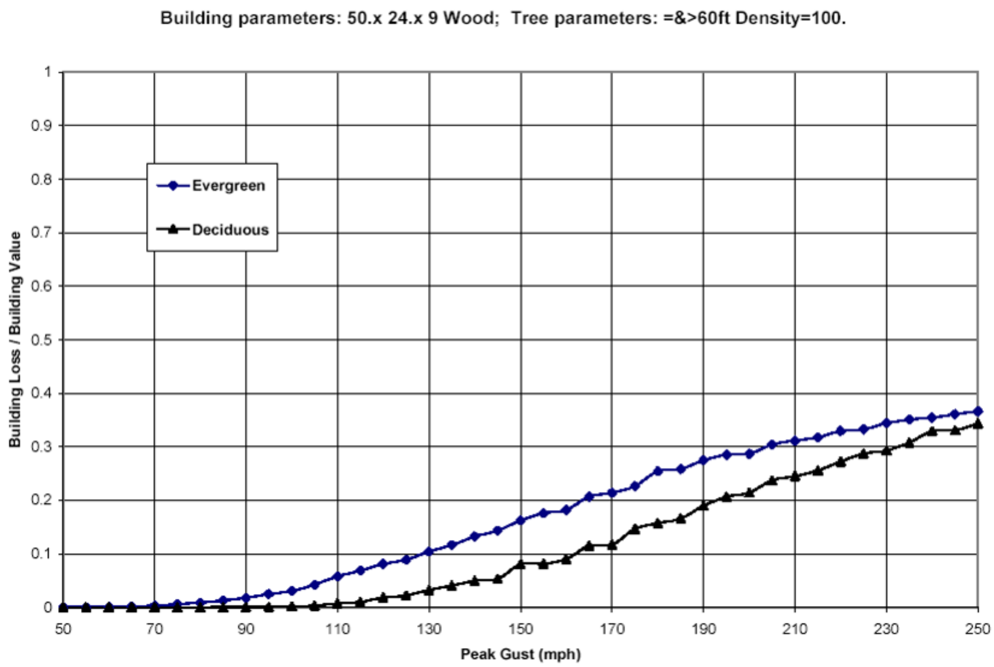
Visual 22: Loss Curves as Function of Tree Density



Visual 23: Loss Curves as Function of Tree Height



Visual 24: Loss Curves as Function of Tree Type



Visual 25: Exercise 6.2: Surface Roughness

Goal:

- Modify the surface roughness parameters in order to see the effect on the damages and losses.

Time: 30 minutes

Visual 26: Exercise 6.2: Tasks

Task 1: Define the default scenario.

Task 2: Adjust the Surface Roughness to a Rural setting.

Task 3: Adjust the Surface Roughness to an Urban setting.

Task 4: View and Compare Results.

Task 5: Restore the Census Tract to the default setting.

Exercise 6.2: Surface Roughness

Type: Student-Led Activity

Time: 30 minutes

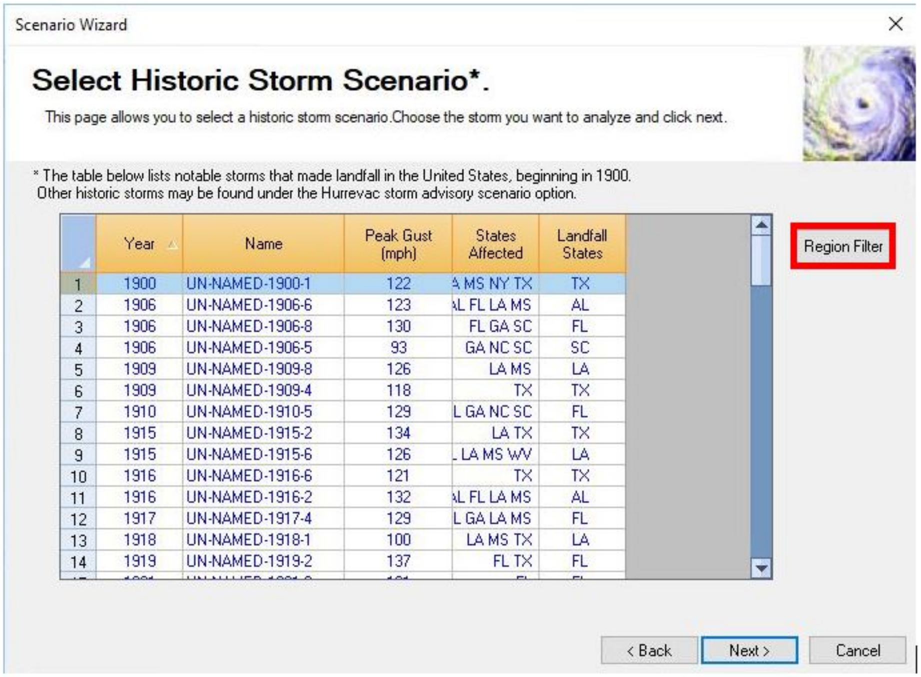
Goal: Modify the surface roughness parameters in order to see the effect on the damages and losses.

Background:

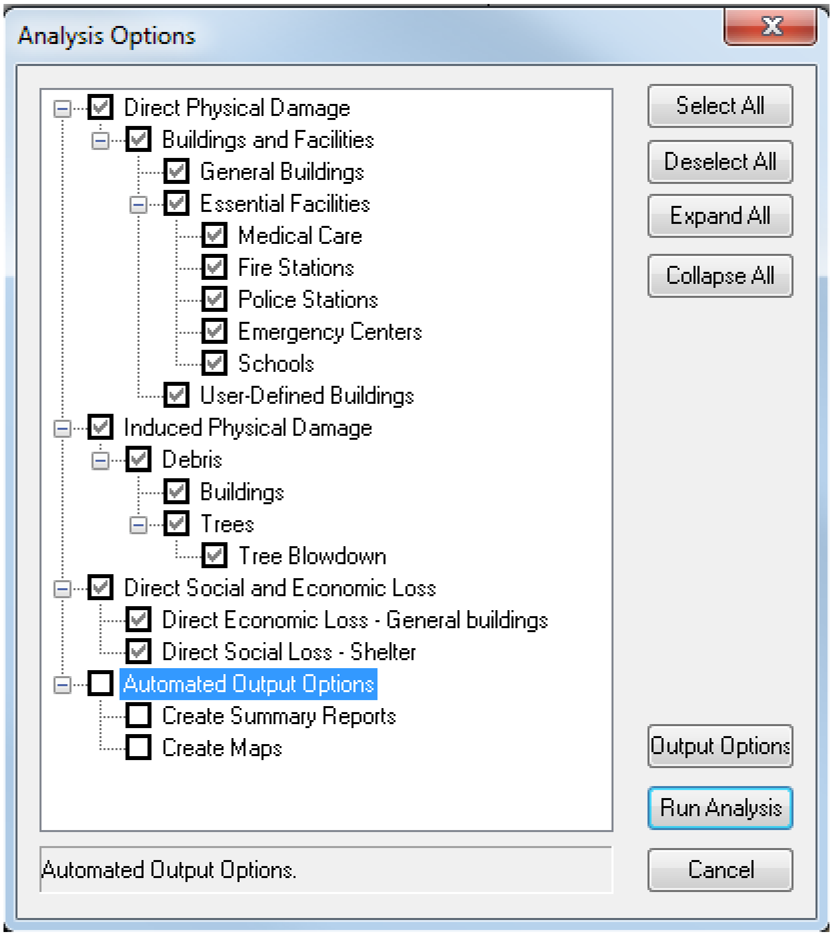
Hazus comes with a substantial library of damage functions. Many of these functions depend on surface roughness. In areas with high surface roughness the damages from winds decrease because of the easing of the winds as a result of friction. In the areas with lower surface roughness, damages are generally greater because there is less friction. In this short exercise you will explore the impact of the surface roughness values by altering those values and then recording the changes in the damages.

Task 1: Define the default scenario

1. Start Hazus and select Open a region, click Next.
2. Select HurricaneHarvey_CO and click Next.
3. Click Finish.
4. Once the study region is open in Hazus, navigate to Hazard and then Scenario.
5. Click Next on the Scenario Wizard.
6. Select Historic and then click Next.
7. Click the Region Filter box to limit the historic storm options to only those that intersected the study region.



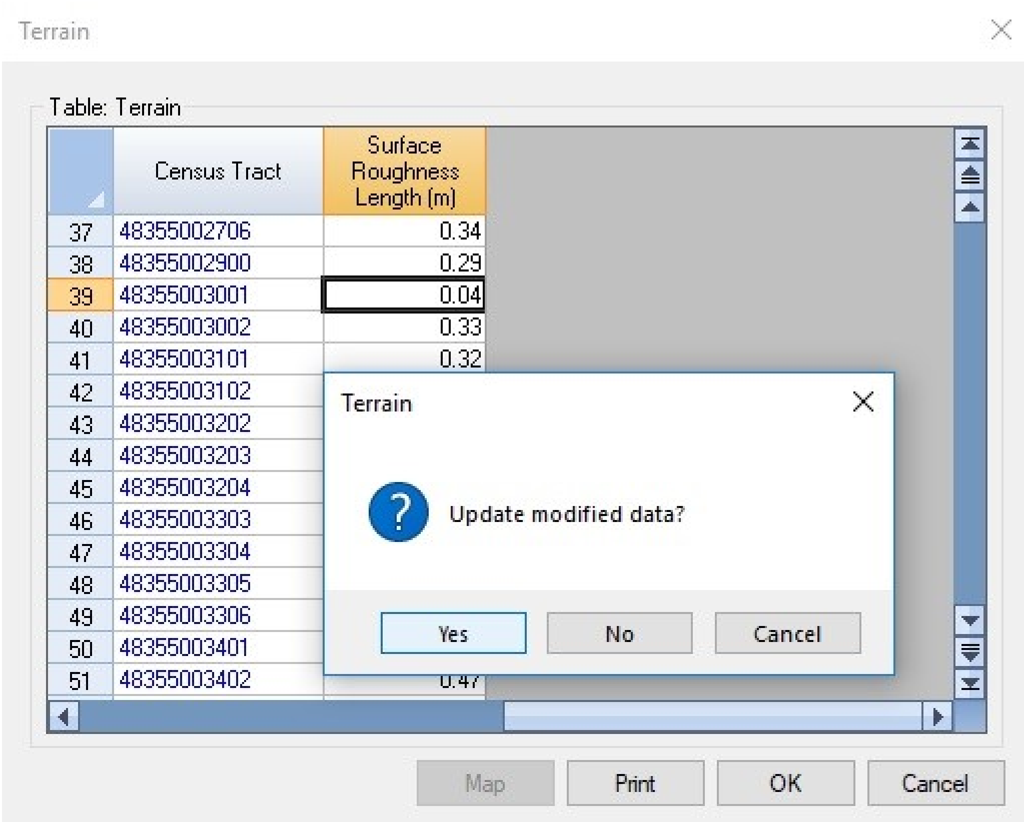
8. Select the 2017 Hurricane Harvey – Observed FEMA storm and click Next.
9. Click next on the scenario review window.
10. Click next to make the scenario active.
11. Click Finish.
12. Select “Analysis > Run” to open the Analysis Options window.
13. Uncheck the Automated Output Options radio box.



14. Click “Run Analysis”.
15. Click “OK” when the analysis completes.
16. From the Results menu click Wind Speeds.
17. Click on the column header for Peak Gust (mph) and then click “Map”.
18. In the table under the Peak Gust (mph) column find census tract 48355003001.
19. In the table located at the end of this exercise, record the Peak Wind Gust in the row for Scenario 1.
20. Close the Wind Speeds by Census Tract window.
21. Navigate to Results and Summary Reports.
22. Click on the Direct Losses tab and view the Direct Economic Loss for Buildings report.
23. Record the Total Direct Economic Loss in the row for Scenario 1 in the table at the end of the exercise.
24. Close the Summary Reports window.

Task 2: Adjust the Surface Roughness to a Rural Setting

1. From the Analysis menu choose “Parameters” then “Terrain”.
2. Find census tract 48355003001 and change the surface roughness from 0.34 to 0.04. This value (0.04) simulates an agricultural setting.
3. Click OK.
4. Click “Yes” you want to update modified data.



5. From the Analysis menu choose “Run” to open the Analysis Options window.
6. Uncheck the Automated Output Options and then “Run analysis”.
7. Click “OK” when the analysis completes.
8. From the Results menu click Wind Speeds and “Map” the Peak Wind Gusts.
9. In the attribute table of the Wind Speeds – Peak Gust (mph) layer, find census tract 48355003001.
10. In the table at the end of this exercise, record the Peak Wind Gust in the row for Scenario 2.
11. Close the Wind Speeds by Census Tract window.

12. Navigate to Results and Summary Reports.
13. Click on the Direct Losses tab and view the Direct Economic Loss for Buildings report.
14. Record the Total Direct Economic Loss in the row for Scenario 2 in the table at the end of the exercise.
15. Close the Summary Reports window.

Task 3: Adjust the Surface Roughness to an Urban Setting.

1. From the Analysis menu choose “Parameters” then “Terrain”.
2. Find census tract 48355003001 and change the surface roughness to 0.70. This is to simulate a highly urban landscape.
3. Click “OK” and indicate “Yes” you want to update your modified data.
4. Go to “Analysis” then “Run”.
5. Uncheck the Automated Output Options and “Run analysis”.
6. Click “OK” when the analysis completes.
7. From the Results menu click Wind Speeds and “Map” the Peak Wind Gusts.
8. In the attribute table of the Wind Speeds – Peak Gust (mph) layer find census tract 48355003001.
9. In the table at the end of this exercise, record the Peak Wind Gust in the row for Scenario 3.
10. Close the Wind Speeds by Census Tract window.
11. Navigate to Results and Summary Reports.
12. Click on the Direct Losses tab and view the Direct Economic Loss for Buildings report.
13. Record the Total Direct Economic Loss in the row for Scenario 3 in the table at the end of the exercise.
14. Close the Summary Reports window.

Task 4: View and Compare Results

Results Table for Census Tract 48355003001

Scenario	Peak Gust	Total Direct Economic Loss
1. Default Surface Roughness: 0.34		
2. Surface Roughness: 0.04		
3. Surface Roughness: 0.70		

Task 5: Restore the Census Tract to the default setting

1. To return the census tract's surface roughness to the default value click on the Analysis menu.
2. Choose "Parameters" then "Terrain".
3. Find census tract 48355003001 and change the surface roughness back to 0.34.
4. Click "OK" and indicate "Yes" you want to update your modified data.
5. Save your map document and exit Hazus.

Visual 27: Lesson 6: Review

1. What parameters define the Hazus wind damage models?
2. How does Hazus display damage curves?

Visual 28: Questions?

Lesson 7: Hurricane Model Results

Visual 1: Lesson 7: Hurricane Model Results

Visual 2: Goal and Objectives

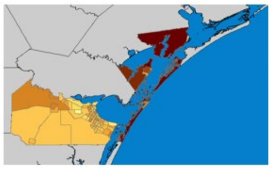
Goal: To provide an overview of the set of results and how they can be viewed in Hazus.

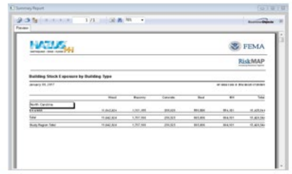
After completing this lesson, you will be able to:

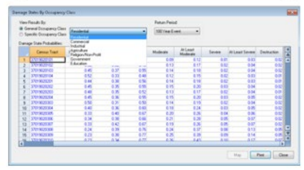
- Understand the damage and loss outputs.
- Interpret the meaning of the results.

Visual 3: Results Formats

- Tables
- Maps
- Reports

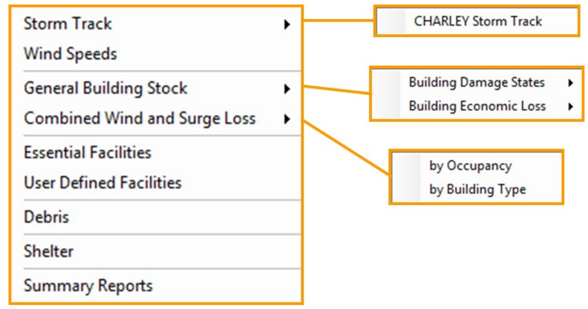




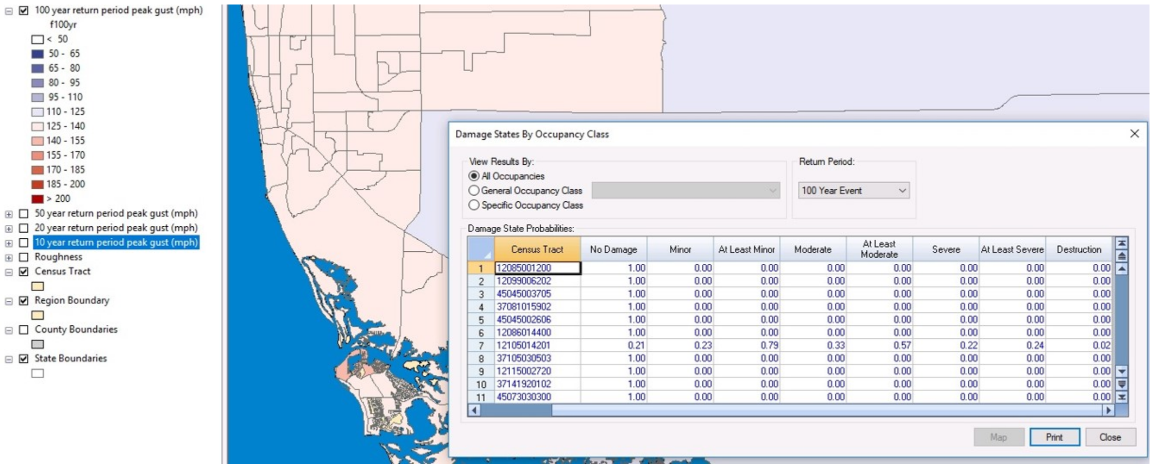


Visual 4: Viewing Results

- Results menus are enabled once a hurricane scenario has been run and “Analysis > Run” has been selected.

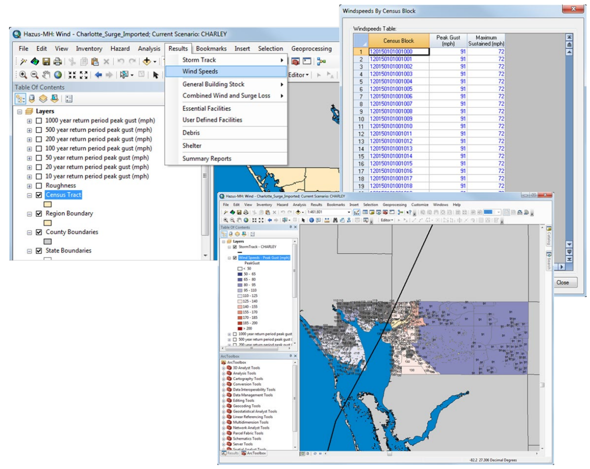


Visual 5: Tables



- Results align with inventory and analysis.
- Tables populate only for damaged inventory / tracts.
- Fields can be thematically mapped.

Visual 6: Hazard Maps



- To show the hazard map choose “Results > Wind Speeds.”
- Click on the column you wish to map.
- Click “Map.”

Visual 7: Windspeed Results

Peak wind gust: 3 second gust speeds

- Hazus damages and losses are given as a function of the gust speed.

Sustained winds: one minute average

- Used for hurricane category determination

NOTE: In study regions that have hurricane and flood hazards, the windspeeds are displayed on the block level; however, windspeeds are only calculated at the tract level and every block in each tract is assigned the same value.

Visual 8: Demonstration 7.1: Viewing Results & Reports

Goal:

- View results and reports from a hurricane analysis.

Time: 40 Minutes

Student Manual

Demonstration 7.1: Viewing Results & Reports

Goal: View results and reports from a hurricane analysis.

Time: 40 minutes

Exercise Steps:

1. Listen to instructor's directions.
2. Ask questions if clarification is needed.
3. Watch the instructor's demonstration.
4. Ask any final questions.

Visual 9: Demonstration 7.1: Tasks

Task 1: Import HPR

Task 2: View General Building Stock Damage

Task 3: View Essential Facilities Losses

Task 4: View Debris

Task 5: View Shelter Needs

Task 6: Overview of Viewing Reports

Task 7: Toolbar

Task 8: Inventory Reports

Task 9: Building Reports

Task 10: Induced Losses

Task 11: Direct Losses Reports

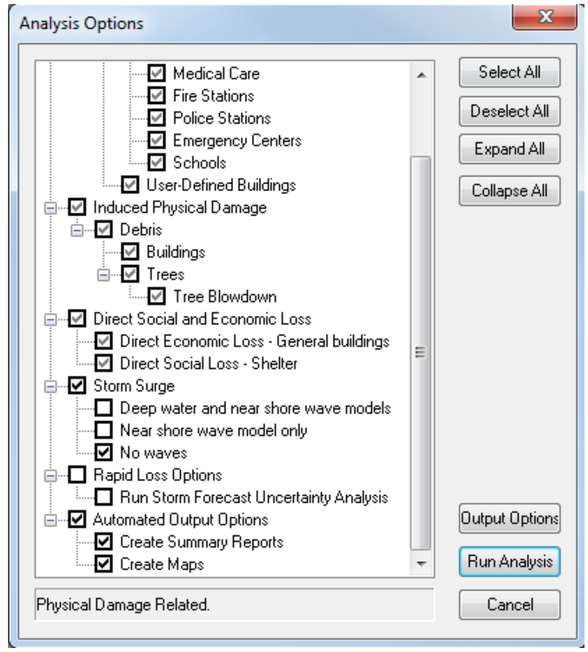
Task 12: Other Report Options

Student Manual

Demonstration 7.1: Tasks

- Refer to Activities Document "Demonstration07.1_Viewing Results & Reports."

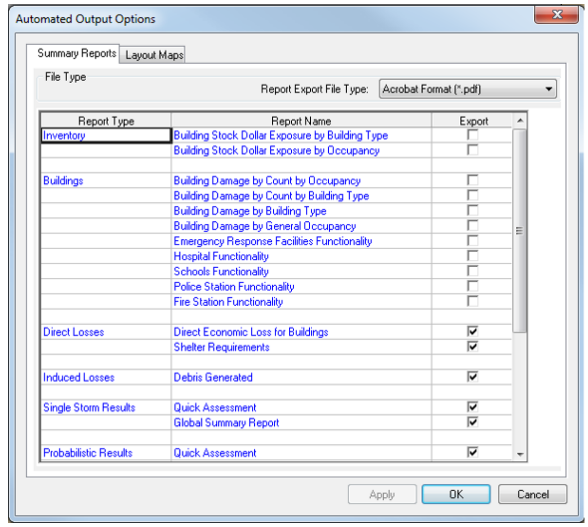
Visual 10: Automated Output Options



- Automatically saves reports
- Creates thematic maps of results
- Drawback: Increases analysis processing time (up to an hour increase in some cases)

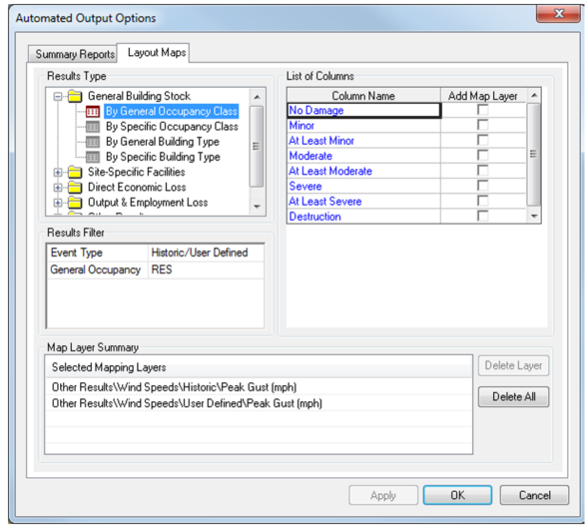
Visual 11: Automated Output Options

- Output reports are automatically saved in the study region folder.
- Four different output formats:
  - PDF
  - Word
  - Excel
  - HTML

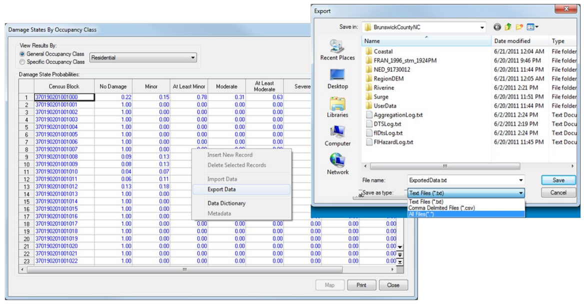


Visual 12: Automated Output Options

- Select Results: When the analysis is complete a thematic map is automatically created.
- Layer(s): automatically appears in the table of contents window.



Visual 13: Results Table: Export

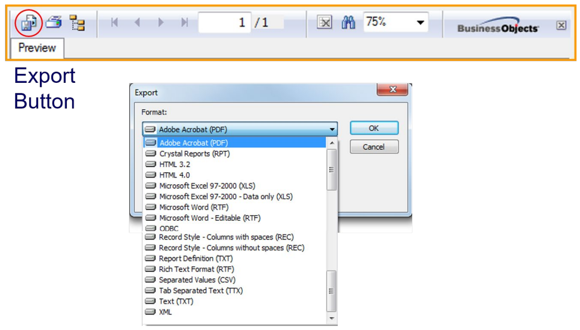


Formats

- TXT
- CSV

Visual 14: Summary Report: Export

- PDF
- RTF
- DOC
- XLS
- CSV
- TXT
- XML
- Etc.



Visual 15: Exercise 7.2: Hurricane Results

Goal:

- Learn methods for displaying hurricane results.

Time: 30 minutes

Student Manual

Hurricane Results

Goal: Learn methods for displaying hurricane results.

Time: 30 minutes

Exercise Steps:

1. Refer to Activities Document “07.2_Exercise_Hurricane Results”
2. Listen to instructor’s directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share their answers/results.
8. Ask any final questions.

Visual 16: Exercise 7.2: Tasks

Task 1: Import the Hurricane Michael HPR.

Task 2: Open the Scenario.

Task 3: Prepare the Results in the Map.

Task 4: Visualize Building Damage and Dollar Losses.

Student Manual

Exercise 7.2: Tasks

- Refer to Activities Document “07.2_Exercise_Hurricane Results”

Exercise 7.2: Hurricane Results

Type: Student-Led Activity

Time: 30 minutes

Goal: Learn methods for displaying hurricane results.

Background:

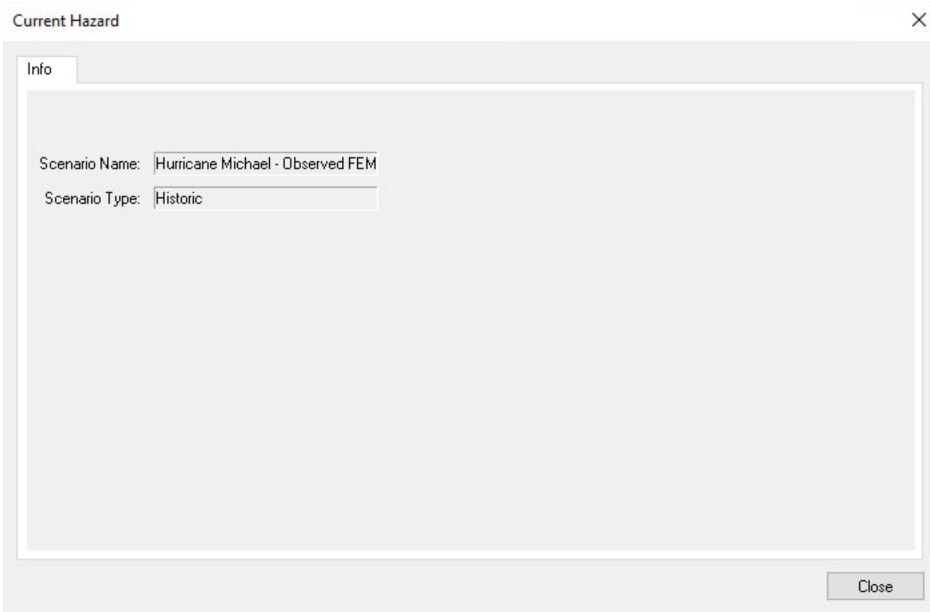
Understanding, interpreting, and communicating the results in Hazus is vital. This exercise will examine results in Hazus to allow you to become more familiar with where they are stored. Additionally, this exercise will help you focus on how to interpret the information that Hazus generates.

Task 1: Import the Hurricane Michael HPR.

1. Start Hazus and import the HurricaneMichael HPR from the C:\E0170_ActivityData\Exercise_7.2 folder.
2. Name the region Hurricane_Michael.
3. Once the import is complete, click Open a Study region, select the study region name and click Next.
4. Click Finish.

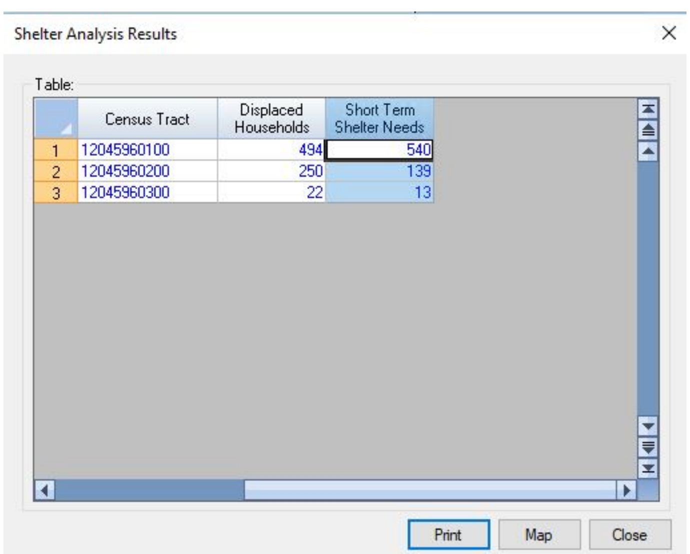
Task 2: Open the Scenario.

1. Navigate to the Hazard menu and then click Show Current to ensure the historic Michael scenario is the active scenario.

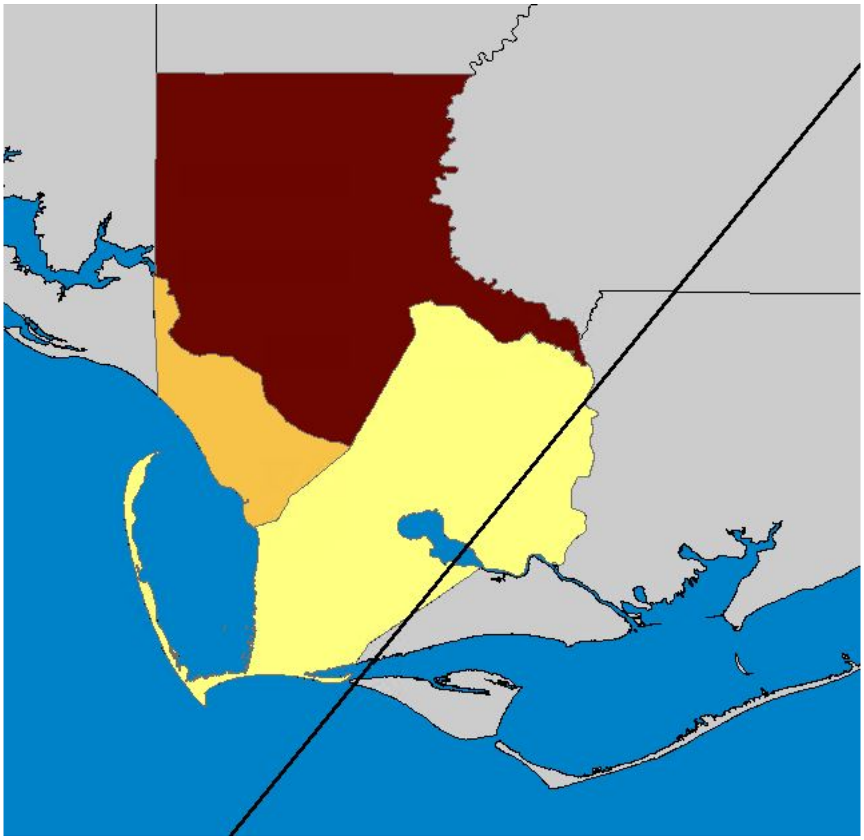


Task 3: Prepare the Results in the Map.

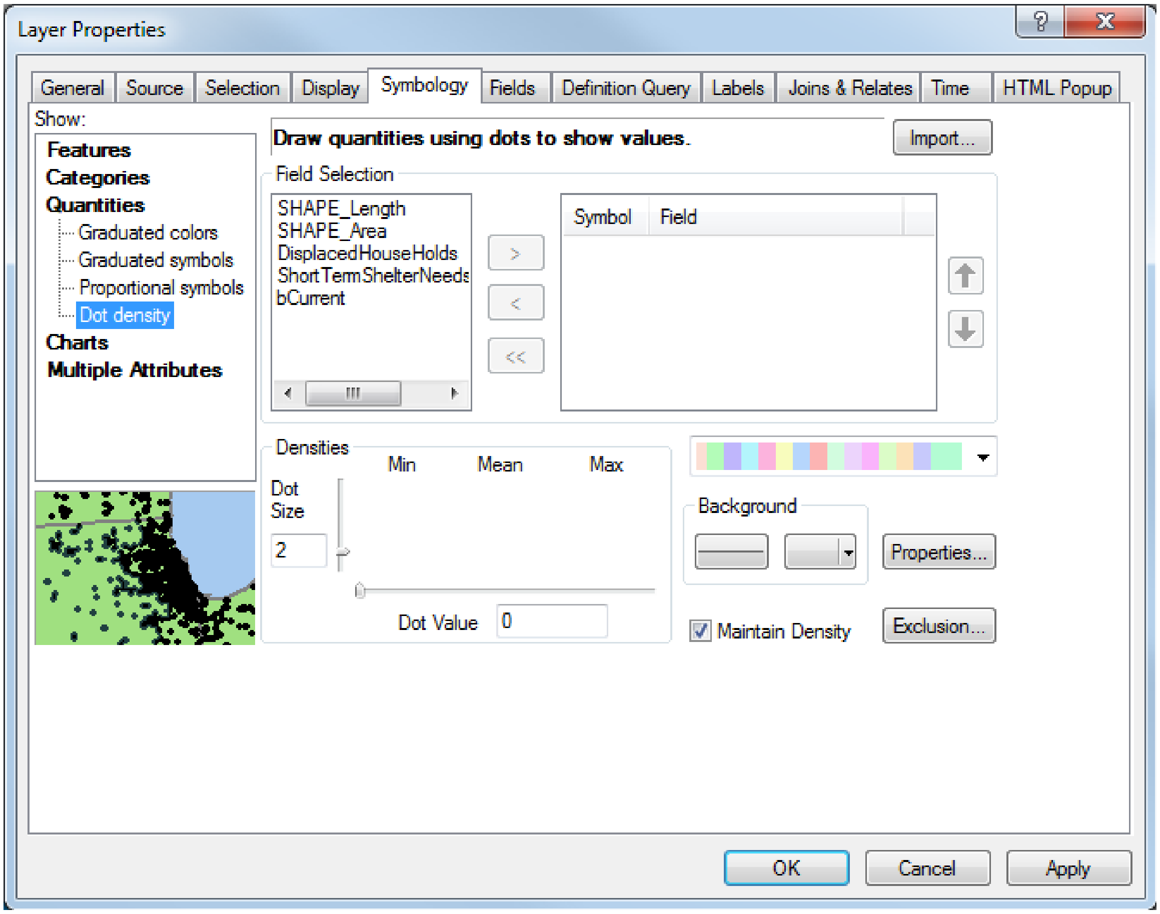
1. From the Results menu choose “Shelter” to open the Shelter Analysis Results.
2. Click on the Short Term Shelter Needs column and click “Map”.



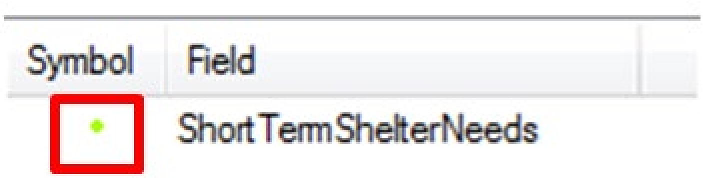
3. Click “Close” to close the Shelter Analysis Results.



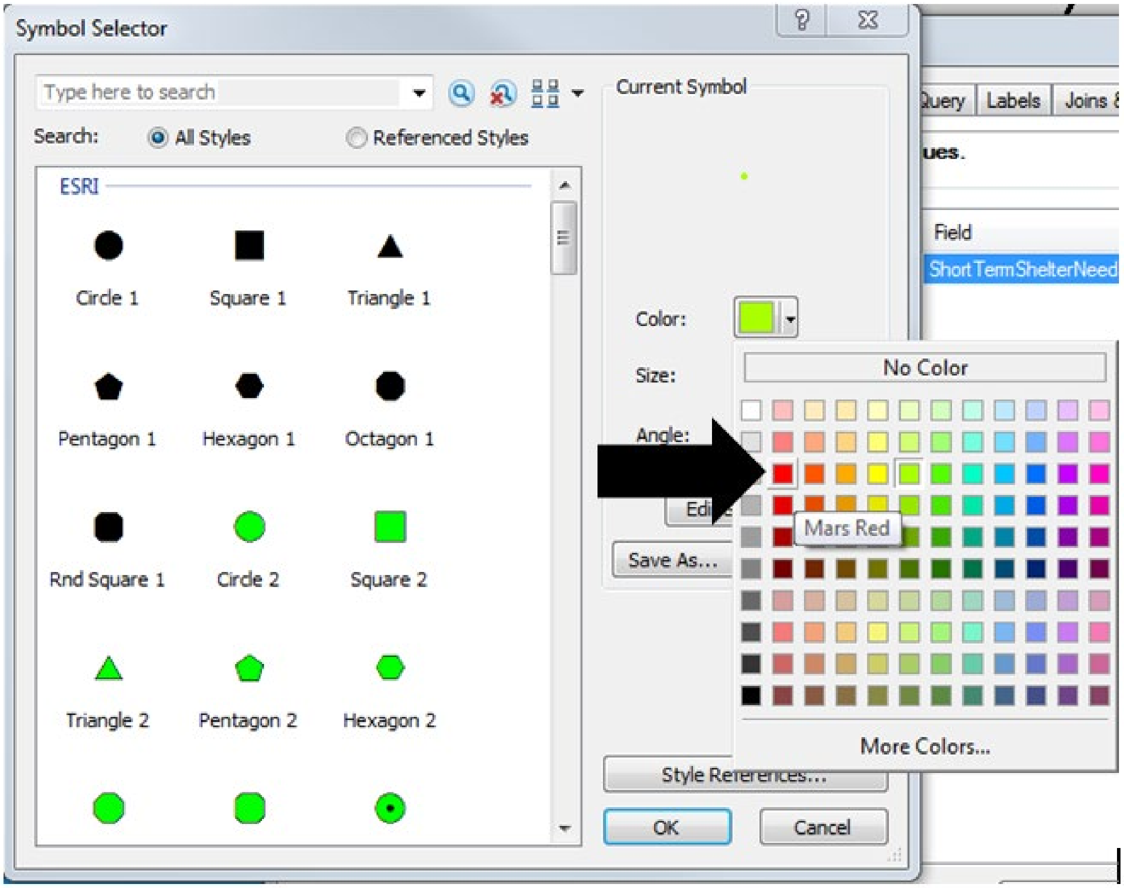
4. Right-click on the Shelter - Short Term Shelter Needs layer and select Properties.
5. Select the Symbology tab.
6. In the Show window on the left side of the Layer Properties window, select Quantities.
7. Under Quantities select “Dot density”.



8. In the Field Selection window choose ShortTermShelterNeeds and then click the right arrow.
9. Double-click on the Circle symbol to the left of ShortTermShelterNeeds.

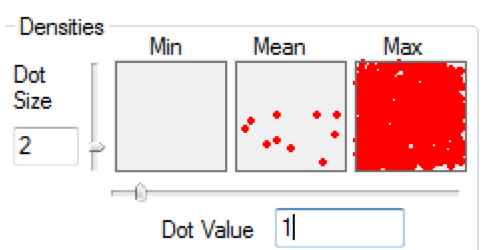


10. Click on the down arrow next to the color and select Mars Red.

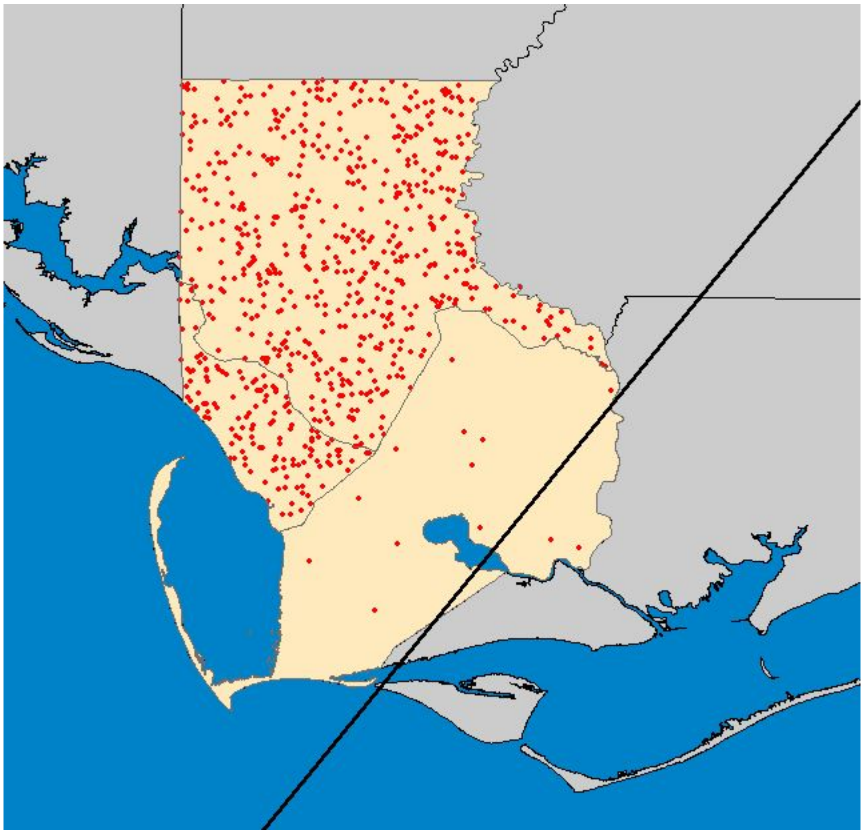


11. Click “OK”.

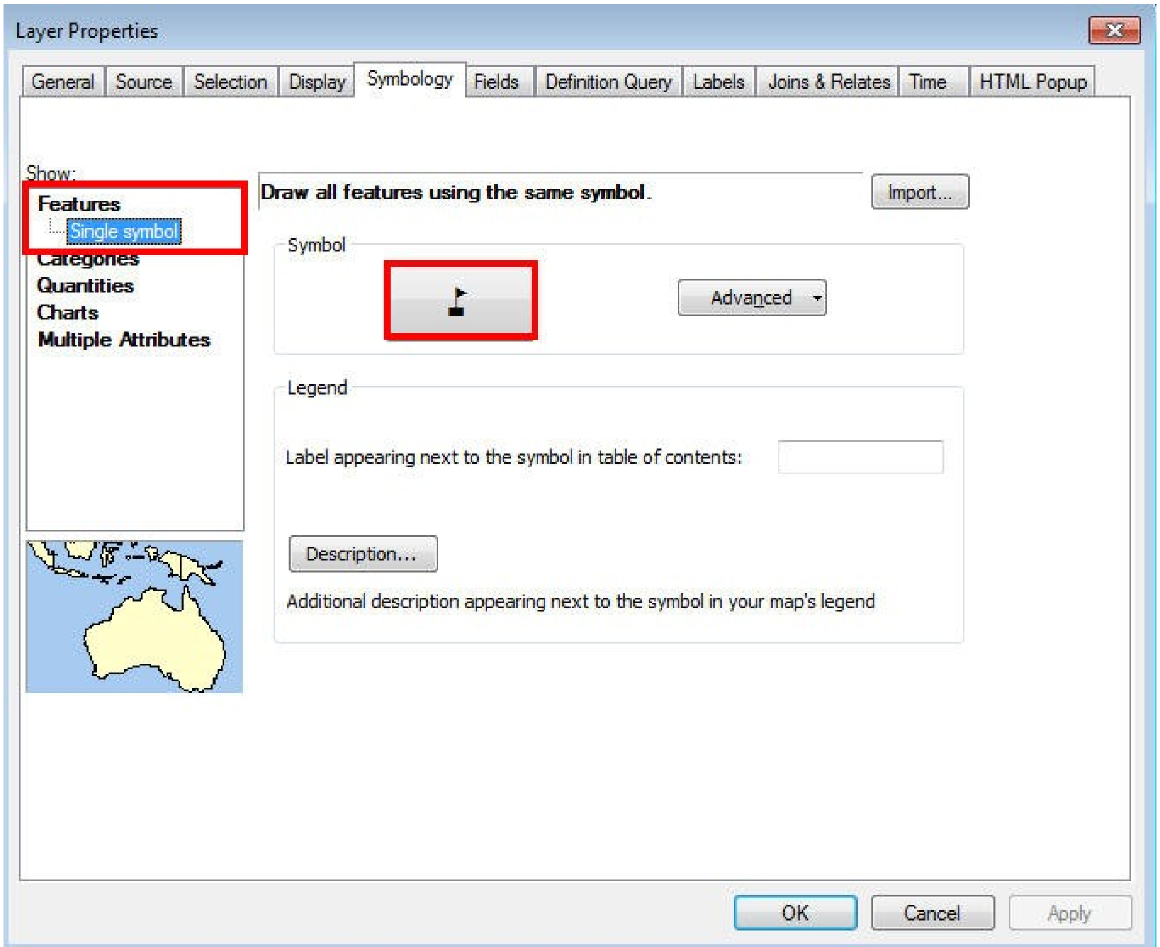
12. Change the Dot Value to “1”.



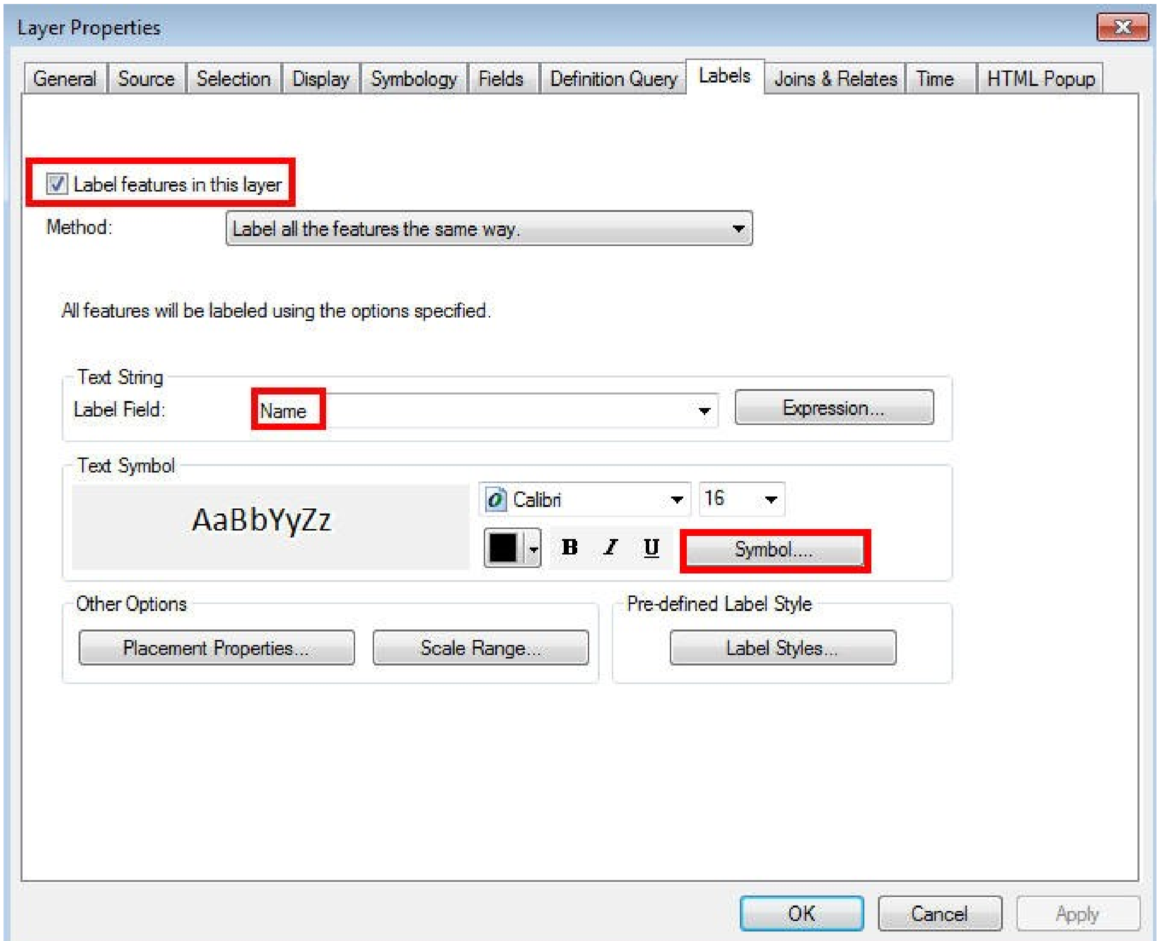
13. Click “OK”. The dot density map provides a slightly different view of the results. This helps find clusters with the data and identifying areas of the greatest concern.



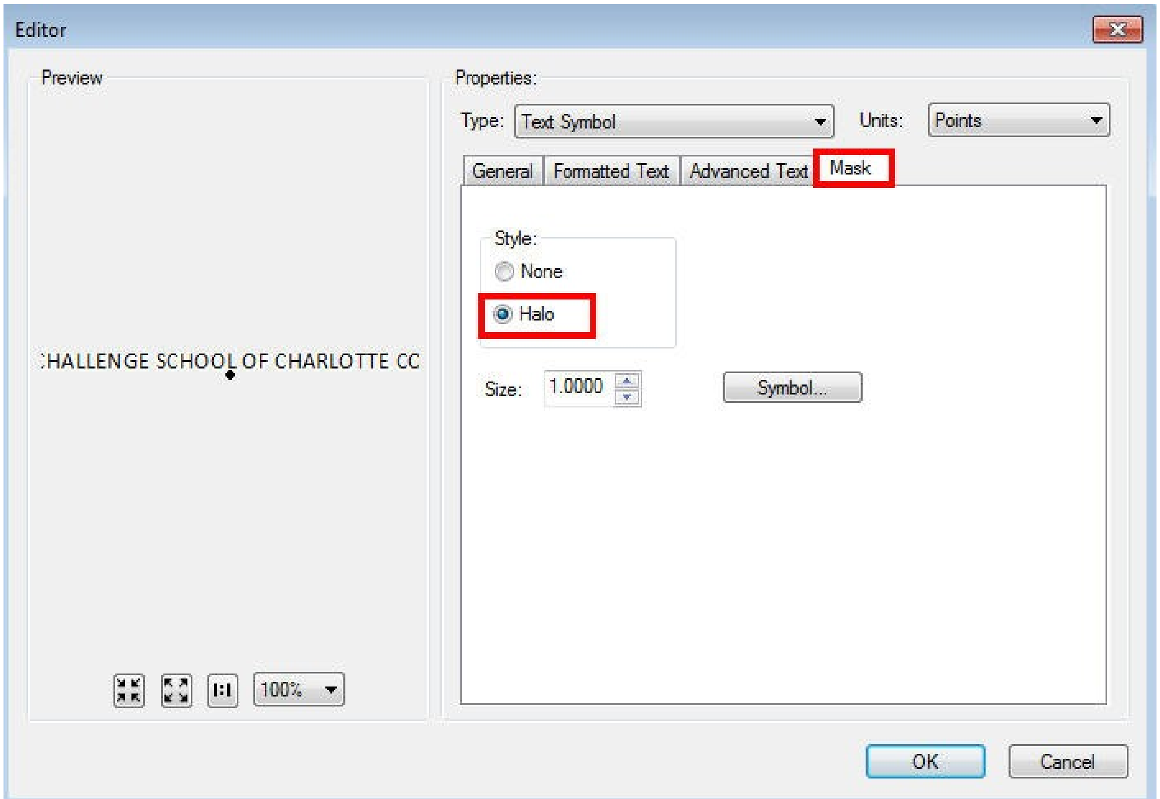
14. From the Results menu choose Essential Facilities.
15. Click on the Schools tab and map the schools with minor damage.
16. Close the Essential Facilities window.
17. Right click on the Schools – Minor Damage in the Table of Contents and click Properties.
18. Click on the Symbology tab and choose Features: Single Symbol.
19. Click on the Symbol to activate the symbol selector and search for "School".



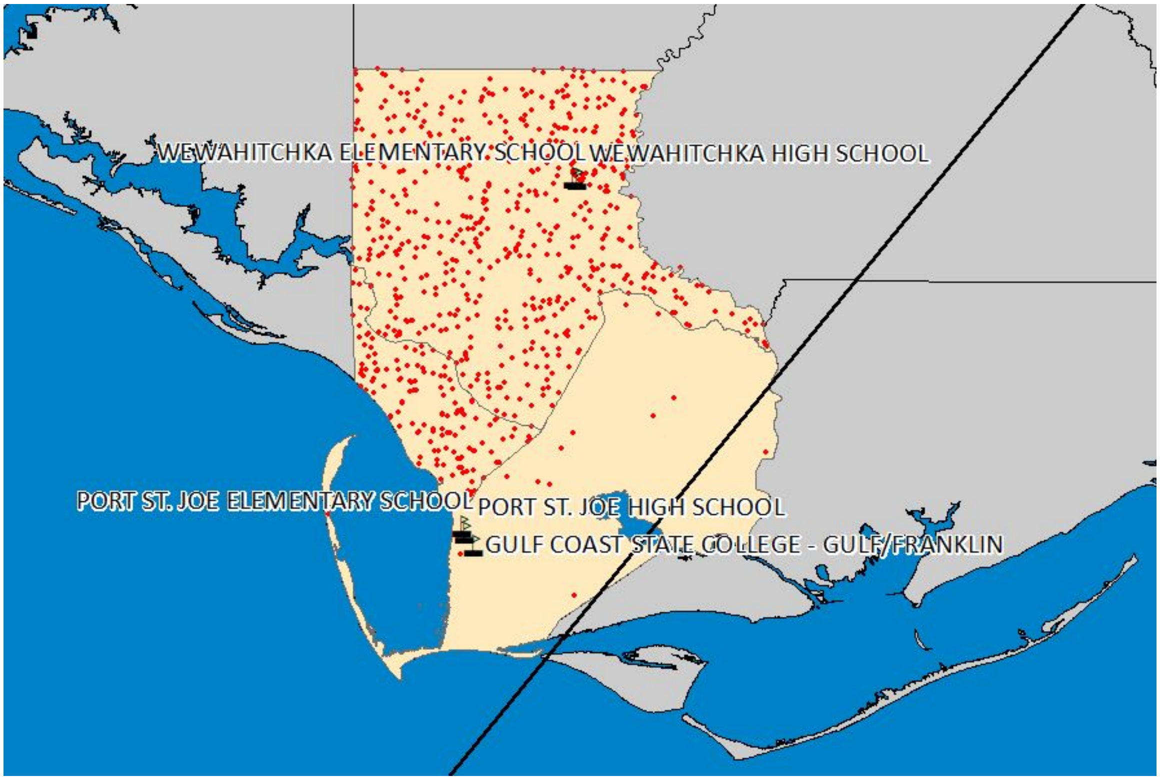
20. Click on the Labels tab and check the box next to Label features in this layer.
21. Change the label field to Name.
22. Change the font to Calibri and size 16.
23. Click the "Symbol..." button under Text Symbol.



24. Click the "Edit Symbol" button.
25. Choose the Mask tab and then the radio button next to Halo.
26. Change the Size to 1.



27. Click "OK" through the next three screens to display the schools with labels on the map.



28. Answer the following question.

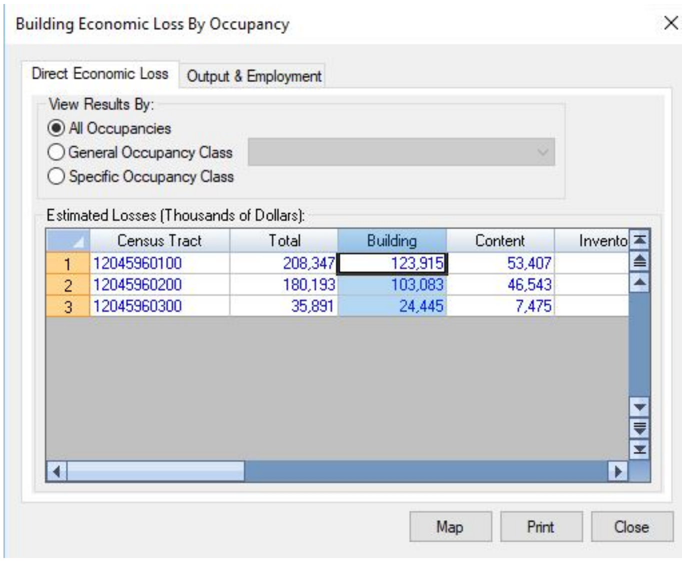
Question: How could this information be used?

Task 4: Visualize Building Damage and Dollar Losses.

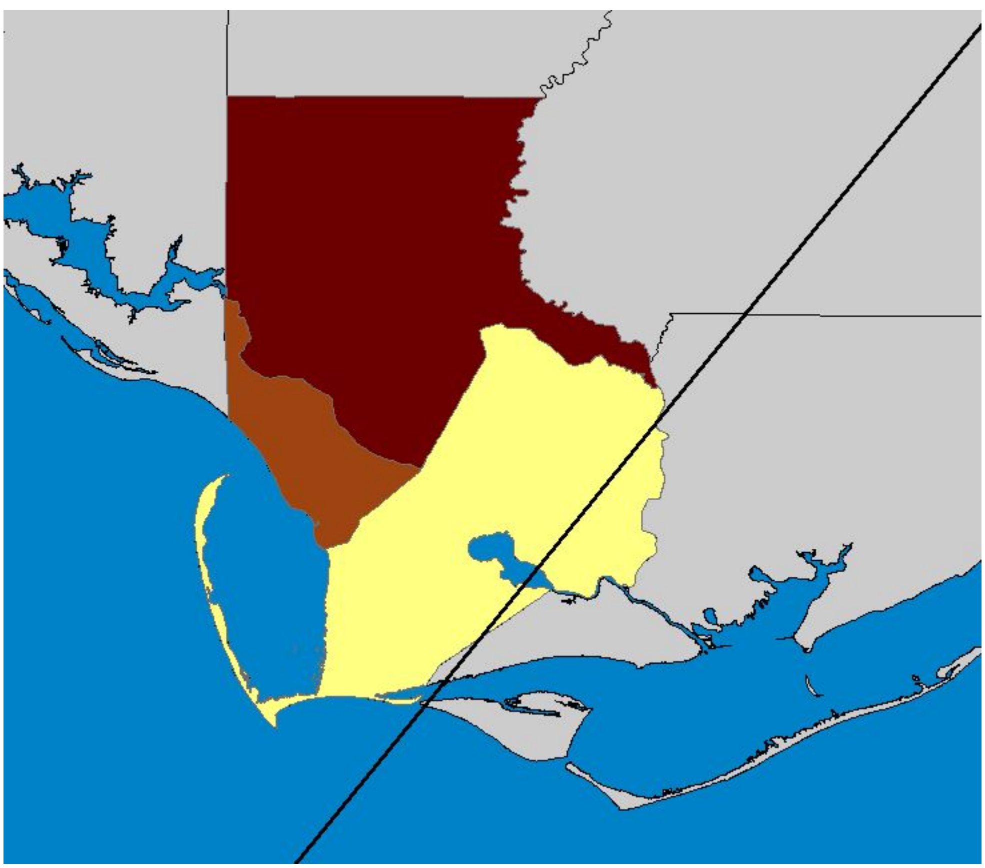
1. Turn off or remove the Shelter - Short Term Shelter Needs and the Schools-Minor Damage layers.

2. From the Results Menu, choose General Building Stock > Building Economic Loss > By Occupancy.

3. Click on the All Occupancies radio button under View Results By and then select the Building column and click “Map”.

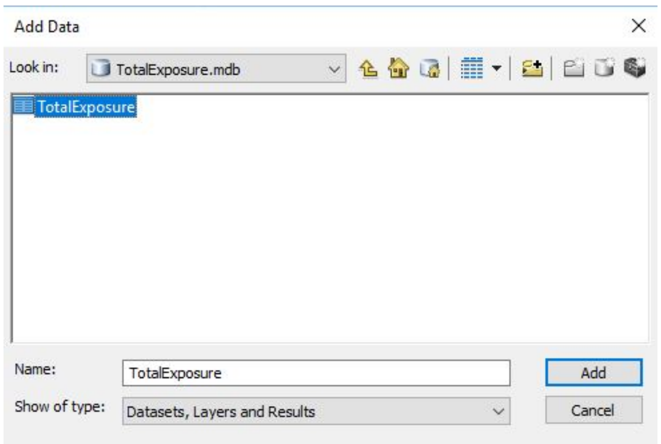


4. Once finished click “Close”.



5. Click the “Add Data” button, navigate to C:\E0170_ActivityData\Exercise_7.2 folder and double click on the TotalExposure.mdb. This database was prepared for this activity by exporting the Total Exposure values from the General Building Stock inventory in Hazus.

6. Click to highlight the TotalExposure table and click Add.



7. Click on the “List by Drawing Order” button at the top of the table of contents window.

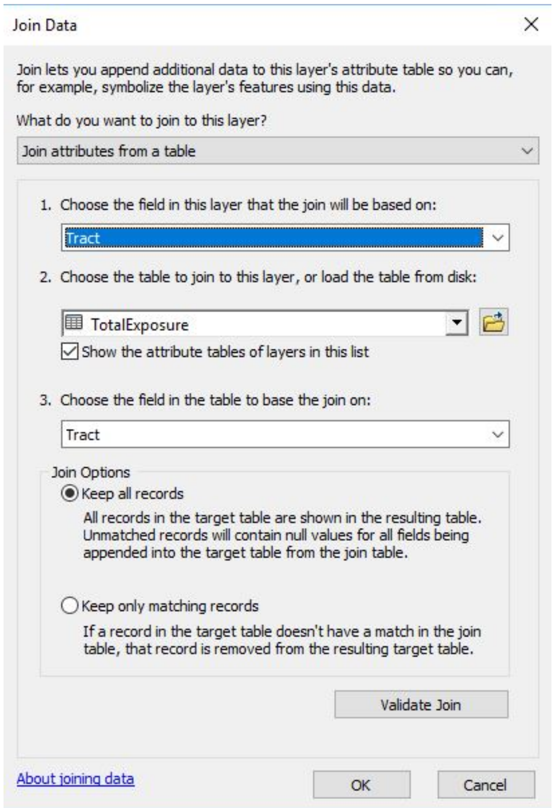
8. Right-click on the Building Loss - All ($K) layer and select Joins and Relates > Join.

9. Select “Join Attributes” from a table from the “What do you want to join to this layer” option.

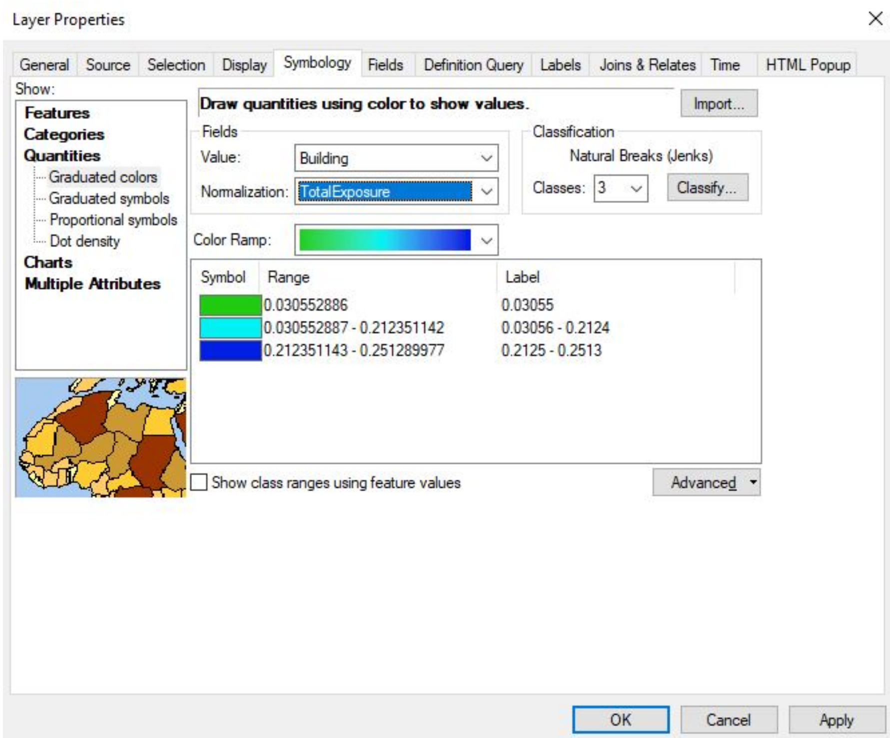
10. Under Option 2 select TotalExposure using the drop down arrow.

11. Select Tract from the drop down arrow in Option 1 and Tract in Option 3.

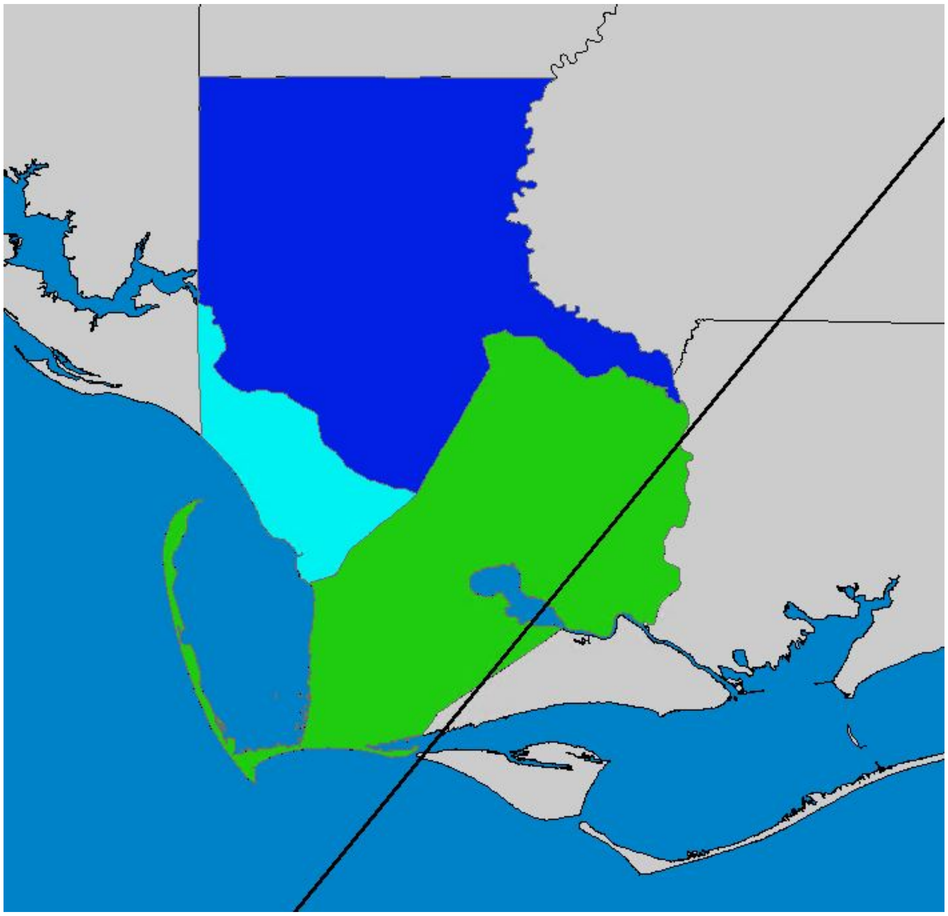
12. Select “Keep all records”.



13. Click “OK” when finished and select “Yes” if asked if you want to index the table.
14. Right-click on the Building Loss - All ($K) layer and select Properties.
15. Select the Symbology tab, if it is not already selected, and then select Quantities > Graduated colors, if not already selected.
16. Under Value select Building.
17. Under Normalization select TotalExposure.



18. Click “OK”. The layer you have created is Total Building Loss over Total Building Exposure for each tract. This is a building loss ratio map.



19. You have just created a building loss ratio layer. This represents the percentage of the total building exposure that is damaged for each census block. Answer the following:

Question: What are some uses for this layer?

20. Save your map and exit Hazus when you are finished.

Visual 17: Lesson 7: Review

1. How are the general building stock damages reported?
2. What is the Rapid Loss Assessment?
3. What are the three main formats a user can use to display his/her results?

Visual 18: Questions?

Lesson 8: Economic Loss Methodology

Visual 1: Lesson 8: Economic Loss Methodology

Visual 2: Lesson 8: Goal and Objectives

Goal: To provide an overview of the economic loss methodology in the hurricane wind model.

After completing this lesson you will be able to:

- Discuss the economic loss outputs.
- Understand the parameters associated with this methodology.
- Describe the appropriate use of these outputs.

Visual 3: Direct Economic Loss Outputs

- Building Loss
- Contents Loss
- Business Inventory Loss
- Relocation Expense
- Loss of Income
- Rental Income
- Wage Income
- Output Loss
- Employment Loss

Visual 4: Building/Content Loss Model: Development

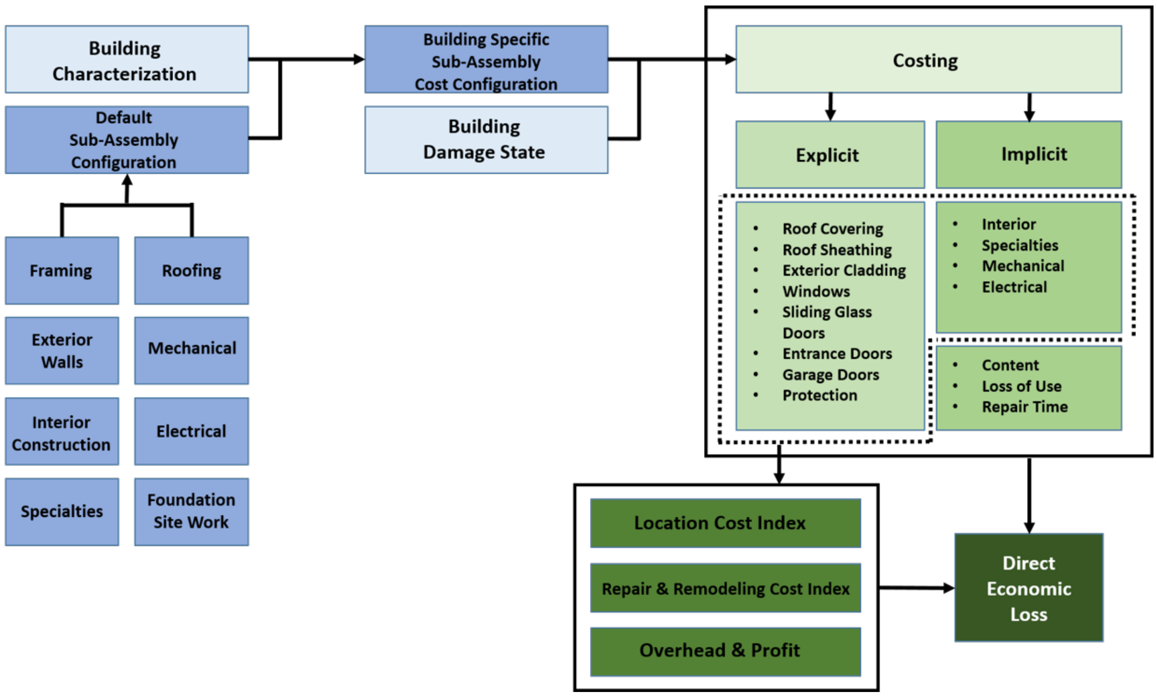
- Physically-based damage-to-loss model
- Computes direct economic losses using
    - Explicit costing
        - Windows, doors, sheathing, roof cover, etc.
    - Implicit costing
        - Estimates of volume of water entering through failed windows, doors, etc.
- Details of loss models found in Section 8 of the Hurricane Technical Manual

Visual 5: Loss Model

Hazus loss models are based upon building types:

- Residential
  - Exterior vs. interior losses
- Manufactured homes
  - Includes damage to foundation and frame
  - Includes serviceability replacements (85% of ultimate capacity)
- Commercial buildings
  - Total cost distributed differently
  - Sub-assembly costs used instead of unit costs

Visual 6: Residential Damage-to-Loss Methodology



Visual 7: Loss of Use

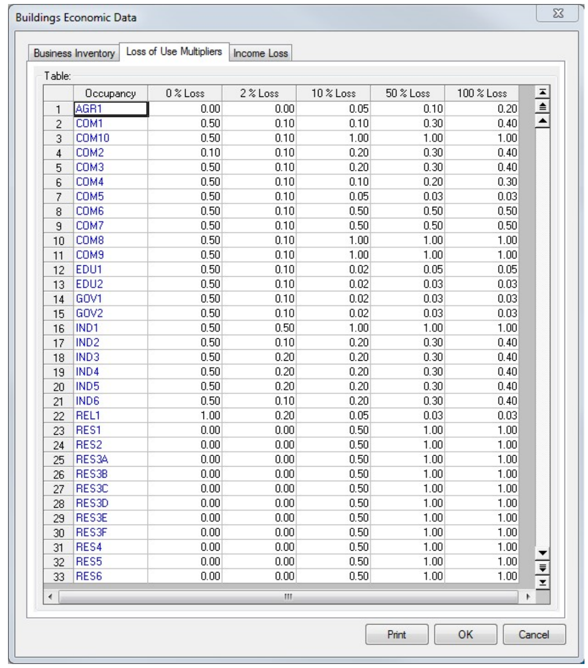
- Building Loss Ratio: Loss to the building divided by the replacement cost of the building.
- Building loss ratio is used as an indicator of reconstruction time.
- A multiplier is applied to the total reconstruction time to determine the loss of use to a structure.

Occupancy	0% Building Loss Ratio	2% Building Loss Ratio	10% Building Loss Ratio	50% Building Loss Ratio	100% Building Loss Ratio
RES1	0	0	0.5	1	1
COM1	0.05	0.1	0.1	0.3	0.4

Visual 8: Loss of Use

Loss of Use Multiplier

- Reflects ability of business to relocate and thus minimize impact on income loss
- At low levels of loss, business continues to operate in existing facility
- At high levels of loss, business will decide to relocate and resume operation


Buildings Economic Data

Business Inventory | Loss of Use Multipliers | Income Loss

Table:

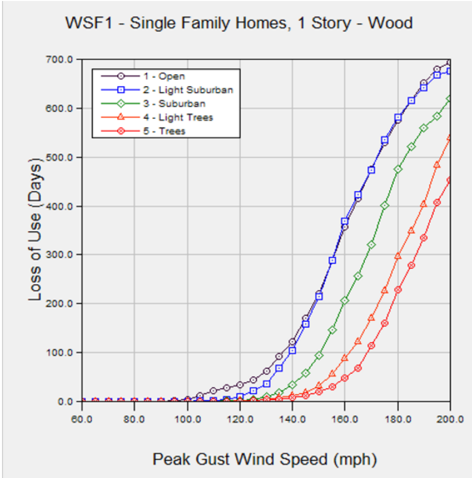
	Occupancy	0 % Loss	2 % Loss	10 % Loss	50 % Loss	100 % Loss
1	AGR1	0.00	0.00	0.05	0.10	0.20
2	COM1	0.50	0.10	0.10	0.30	0.40
3	COM10	0.50	0.10	1.00	1.00	1.00
4	COM2	0.10	0.10	0.20	0.30	0.40
5	COM3	0.50	0.10	0.20	0.30	0.40
6	COM4	0.50	0.10	0.10	0.20	0.30
7	COM5	0.50	0.10	0.05	0.03	0.03
8	COM6	0.50	0.10	0.50	0.50	0.50
9	COM7	0.50	0.10	0.50	0.50	0.50
10	COM8	0.50	0.10	1.00	1.00	1.00
11	COM9	0.50	0.10	1.00	1.00	1.00
12	EDU1	0.50	0.10	0.02	0.05	0.05
13	EDU2	0.50	0.10	0.02	0.03	0.03
14	GOV1	0.50	0.10	0.02	0.03	0.03
15	GOV2	0.50	0.10	0.02	0.03	0.03
16	IND1	0.50	0.50	1.00	1.00	1.00
17	IND2	0.50	0.10	0.20	0.30	0.40
18	IND3	0.50	0.20	0.20	0.30	0.40
19	IND4	0.50	0.20	0.20	0.30	0.40
20	IND5	0.50	0.20	0.20	0.30	0.40
21	IND6	0.50	0.10	0.20	0.30	0.40
22	REL1	1.00	0.20	0.05	0.03	0.03
23	RES1	0.00	0.00	0.50	1.00	1.00
24	RES2	0.00	0.00	0.50	1.00	1.00
25	RES3A	0.00	0.00	0.50	1.00	1.00
26	RES3B	0.00	0.00	0.50	1.00	1.00
27	RES3C	0.00	0.00	0.50	1.00	1.00
28	RES3D	0.00	0.00	0.50	1.00	1.00
29	RES3E	0.00	0.00	0.50	1.00	1.00
30	RES3F	0.00	0.00	0.50	1.00	1.00
31	RES4	0.00	0.00	0.50	1.00	1.00
32	RES5	0.00	0.00	0.50	1.00	1.00
33	RES6	0.00	0.00	0.50	1.00	1.00

Print | OK | Cancel

Visual 9: Loss of Use Model

Loss Ratio	Occupancy	
	RES1	IND1
0%	0	0
2%	5	10
10%	120	90
50%	360	240
100%	720	360

Loss of Use or Recovery Time (days)



Visual 10: Business Inventory Losses

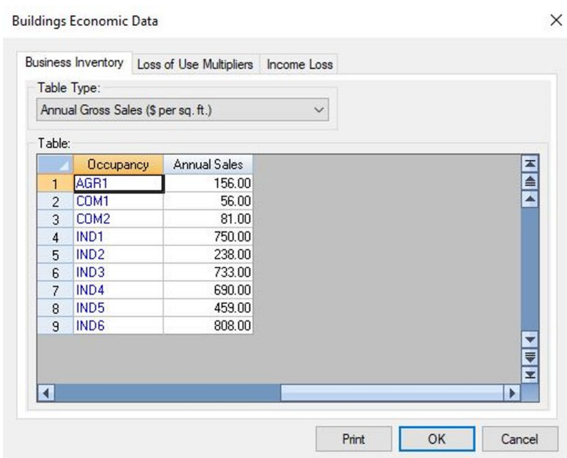
- Function of contents loss ratio and square footage
- Estimated for following occupancies:
  - COM1: Retail Trade
  - COM2: Wholesale Trade
  - IND1: Heavy
  - IND2: Light
  - IND3: Food/Drugs/Chemicals
  - IND4: Metals/Minerals Processing
  - IND5: High Technology
  - IND6: Construction
  - AGR1: Agriculture

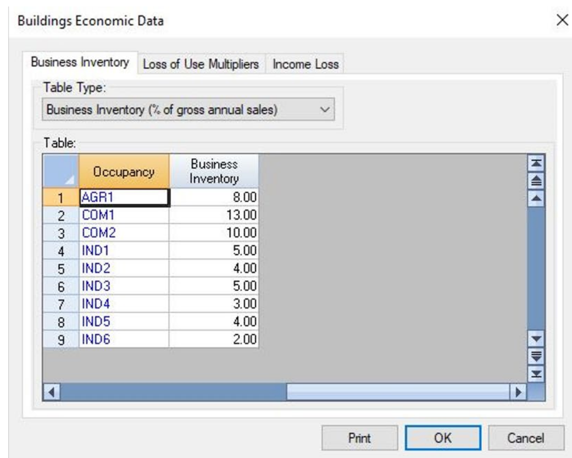
INV = FA x SALES x BI x CL

- FA: Floor Area
- SALES: Annual gross sales per square foot
- BI: Business Inventory %
- CL: Content Loss Ration (0-1)

Visual 11: Business Inventory Losses

- National Averages
  - May not apply to your community
  - Updates can be obtained from U.S. Department of Commerce's Bureau of Economic Analysis or local state.





Visual 12: Discussion 8.1: Loss Estimates

Goal: Participate in a class discussion about loss estimates.

Time: 10 minutes

Questions:

1. How are loss of use estimates and business inventory losses used in mitigation planning or response and recovery planning?
2. Where are potential sources from which we might obtain credible values to put in the analysis tables?

Visual 13: Rental Income Loss

Addresses the remainder of population in census tract that is not owner-occupied.

$RY_i = FA_i \times (1\text{-}00\%_i) \times RENT_i \times LOU_i$

FA_i = Floor Area
$1\text{-}00\%_i$ = % of Renter-Occupied
$RENT_i$ = RENT (sq.ft/day)
LOU_i = Loss of Use in Days

Visual 14: Relocation Loss

Costs associated with moving out of an unusable building:

- Disruption costs: cost of shifting business to new facility
- Rental costs: cost of renting new facility while old facility is repaired

Assumptions:

- Building owners incur expense of moving tenants
- Renter has no new rental expenses
- The following occupancies will not relocate
  - COM8: Entertainment & Recreation
  - COM9: Theaters
  - COM10: Parking
  - IND1: Heavy Industry

Visual 15: Relocation Loss

$REL_i = FA_i \times DC_i \times p_i(\text{damage} > \text{Minor}) + FA_i \times 00\%_i \times RENT_i \times LOU_i$

FA_i = Floor Area
DC_i = Disruption cost per square foot
p_i(damage > Minor) = Fractino of buildings with damage state of at least moderate
$00\%_i$ = % of Owner-Occupied
$RENT_i$ = RENT (sq.ft/day)
LOU_i = Loss of Use in Days

Visual 16: Loss of Income

- Business income (profit) loss occurs when building damage disrupts economic activity.
- Data is based on IMPLAN system from U.S. Department of Commerce Bureau of Analysis.

$YLOS_i = (1-RF_i) \times FA_i \times INC_i \times LOU_i \times MOD_i$

RF_i = Recapture Factor
FA_i = Floor Area
INC_i = Income per day (per sq. ft.)
LOU_i = Loss in Use in Days
MOD_i = Loss of Use Multiplier

Visual 17: Loss of Income

Occupancy	Description	Recapture Factor
RES1 -3	Private Residences	0
RES4 -6	Hotel/Motel Institutions	0.6
COM1 -2	Retail/Wholesale Trade	0.87
COM3	Personal & Repair Service	0.51
COM4 -5	Financial	0.9
COM6 -10	Hospital, Entertainment, Parking	0.6
IND1 -6	Industrial	0.98
AGR1	Agricultural	0.75
EDU1	Education	0.6
EDU2	College/university	0.6
GOV1	General Service	0.8
GOV2	Emergency Response	0
REL1	Churches	0.6

Visual 18: Wage, Employment, and Output Losses

Same as business income loss:

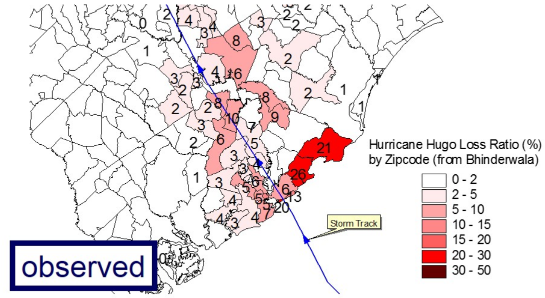
$LOSS_{i,n} = (1\text{-}RF_i) \times FA_i \times INC_i \times LOU_i \times MOD_i$

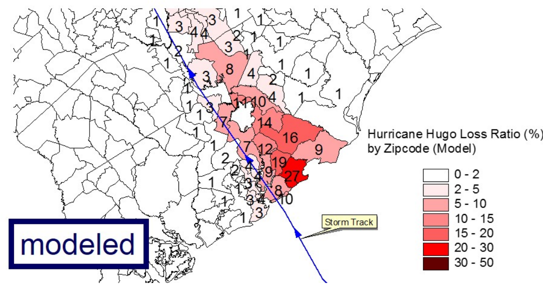
Replace INCi with:

Wage Losses: $WAGE_i$ = $/SF/day
Employment Losses: $EMPLOY_i$ = work day/SF/day
Output Losses: $OUTPUT_i$ = $/SF/day

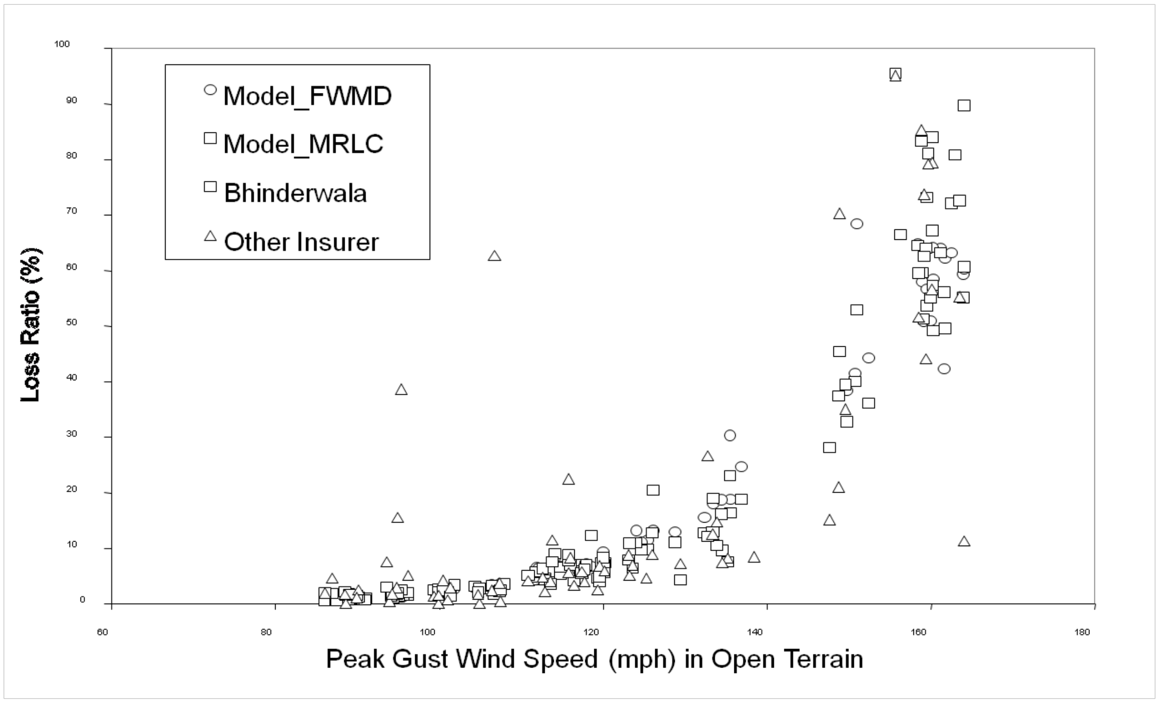
Visual 19: Loss Model Validation

- Comparison to insurance claim data
- Five sets of insurance loss data from three insurance companies
    - Bhinderwala (1995)
    - Two proprietary data sets





Visual 20: Loss Model Validation



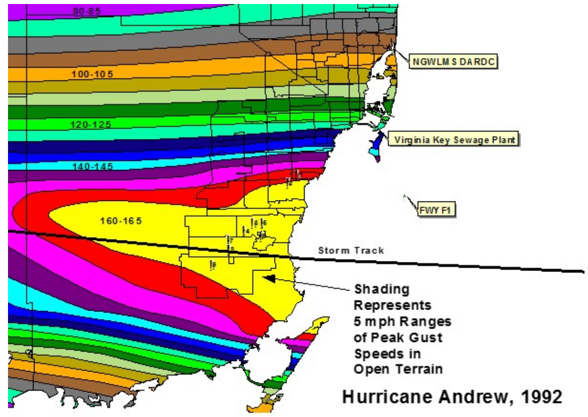
Visual 21: Loss Model Validation: Comparison

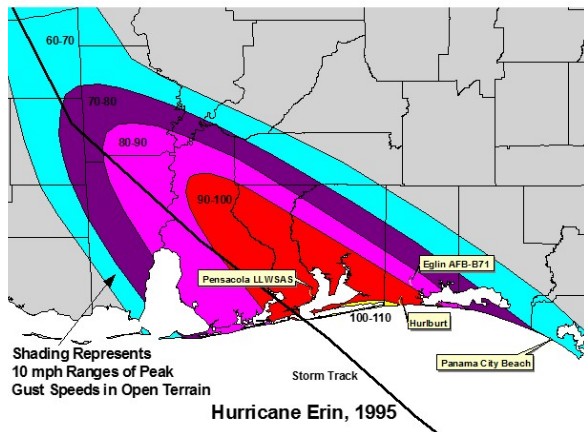
Validation completed by performing analysis of specific storms:

- Hurricane Andrew
- Hurricane Hugo
- Hurricane Erin
- Hurricane Opal

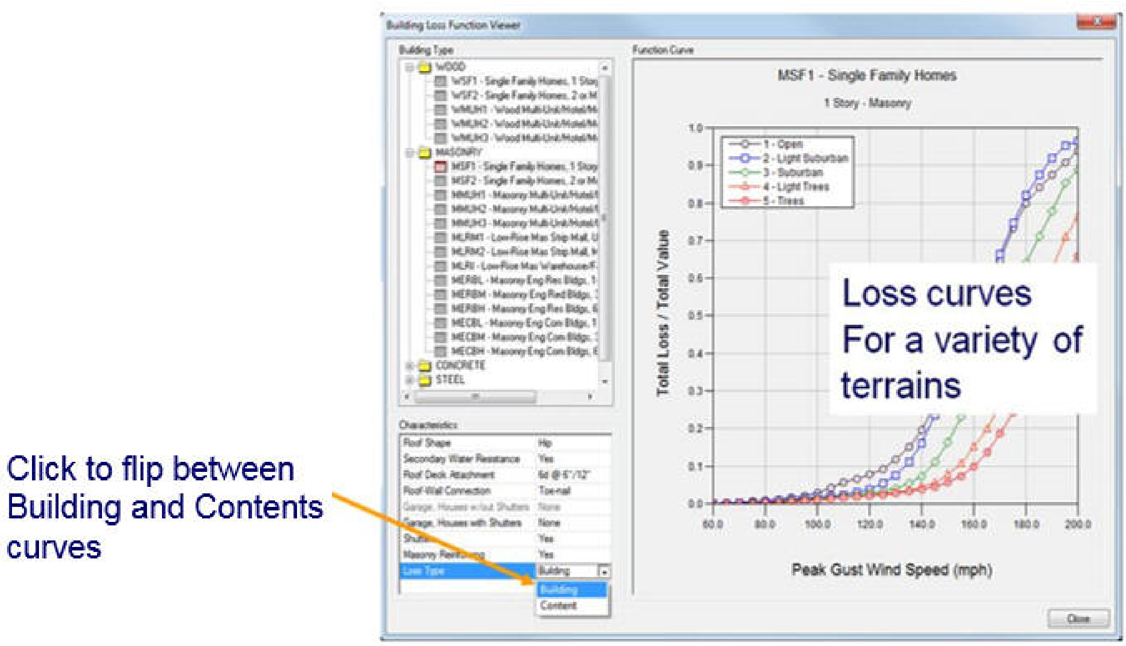
Simulation:

- Wind field and wind loads
- Terrain model
- Damage, loss models
- Inventory





Visual 22: Loss Function Viewer



Visual 23: Exercise 8.2: Economic Loss Parameter

Goals:

- Run a historical scenario.
- Modify the economic loss parameters.

Time: 60 minutes

Visual 24: Exercise 8.2: Tasks

Task 1: Run the default Historic Hurricane Michael Scenario.

Task 2: Modify Annual Gross Sales Parameter.

Task 3: Modify the Business Inventory Parameter.

Task 4: Modify the Rental and Disruption Costs Parameter.

Task 5: Modify the Percent Owner Occupied Parameter.

Task 6: Modify the Wages and Capital Related Income Parameter.

Task 7: Compare the Results of Modifying the Economic Loss Parameters.

Exercise 8.2: Economic Loss Parameter

Type: Student-Led Activity

Time: 60 minutes

Goals:

- Run a historical scenario.
- Modify the economic loss parameters.

Background:

In this exercise you are going to use current values to update the parameters responsible for calculating economic losses. Many of the default values in Hazus are out-of-date and the values are based on national averages. If you are interested in the economic outputs from Hazus, it is important you update the appropriate inputs. In this exercise you will update the economic loss parameters.

Note: If you have trouble generating any of the Global Summary Reports for the six cases, the reports are provided in the C:\E0170_ActivityData\Exercise_8.3\Results folder.

Task 1: Run the default Historic Hurricane Michael Scenario.

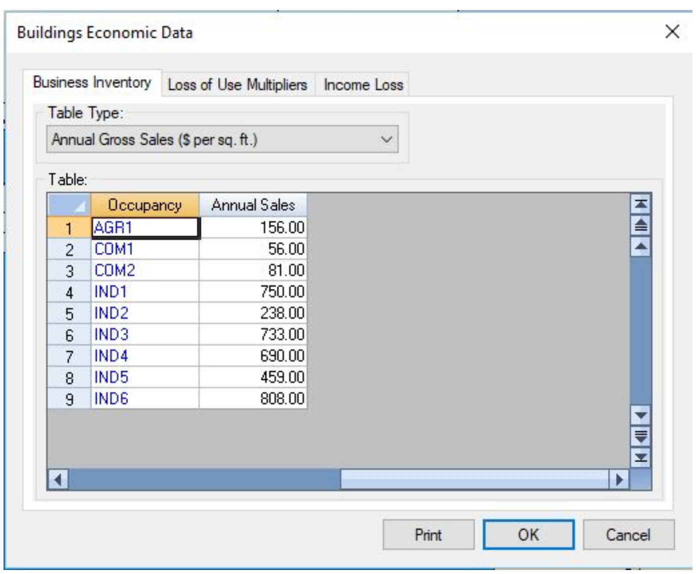
1. Open Hazus.
2. Create a new region with the following paramenters:
   - Name: Economic_Parameter
   - Hazard: Hurricane
   - Aggregation level: County
   - State: Florida
   - Counties: Bay and Gulf
3. Open the region.
4. From the Hazard menu choose Senario.
5. Click Next.
6. Choose Historic and click Next.
7. Click Region Filter.
8. Select “2018 Hurricane Michael – Observed FEMA” and click Next.
9. Click Next.
10. Click Next to make the scenario active.
11. Click Finish.
12. From the Analysis menu select “Run”.
13. Choose Select All except for “Automated Output Options”
14. Click “Run Analysis”.
15. When the analysis has finished, click “OK” to close the window.

16. From the Results menu click on “Summary Reports”.
17. Select the Other tab, and click to highlight the “Global Summary Report” .
18. Click View to view the report.
19. Use the Global Summary report to fill out the table at the end of this exercise for Case 1.

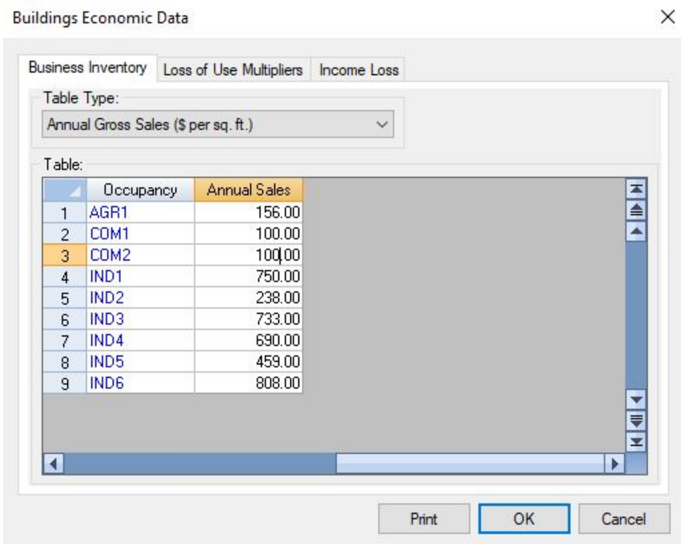
Task 2: Modify Annual Gross Sales Parameter

The parameters in the Building Economic Data table were created many years ago and are out of date. Furthermore, many of the values are based upon national averages. To get accurate results for the economic loss parameters you must update these tables. State workforce development, trade agencies, and labor statistics offices may provide you with more up-to-date information. As is the case with most input data in Hazus, the more local the economic information you acquire, the more precise your results will be.

1. From the Analysis menu choose “Parameters” > “Building Economic”.
2. Select the Business Inventory tab. Make sure Annual Gross Sales ($ per sq. ft.) is selected from the drop-down menu.



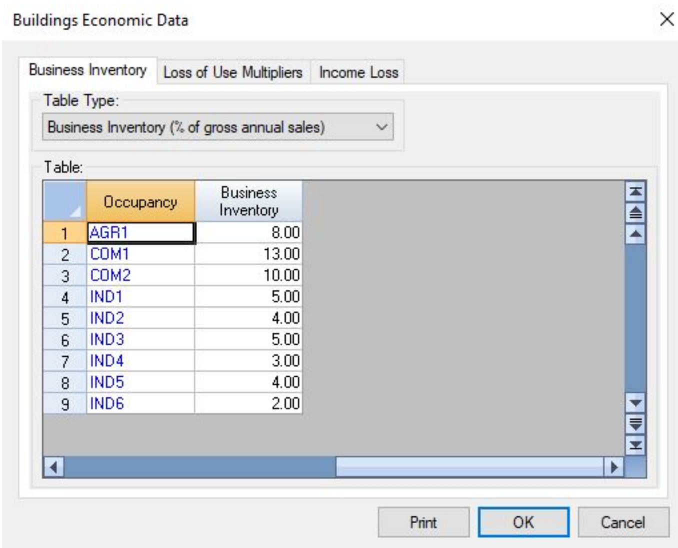
3. Change the values of COM1 and COM2 to “100”. Based on national averages, the default Hazus values are too low. The values you will enter represent bottom end values for national averages today.



4. Click “OK” and then “Yes” to save your changes.
5. From the Analysis menu select “Run”.
6. Choose Select All except “Automated Output Options”.
7. Click “Run Analysis”.
8. When the analysis has finished, click “OK” to close the window.
9. From the Results menu click on “Summary Reports”.
10. Select the Other tab, and open the “Global Summary Report” .
11. Click View to view the report.
12. Use the report to fill out the table at the end of this exercise for Case 2.

Task 3: Modify the Business Inventory Parameter

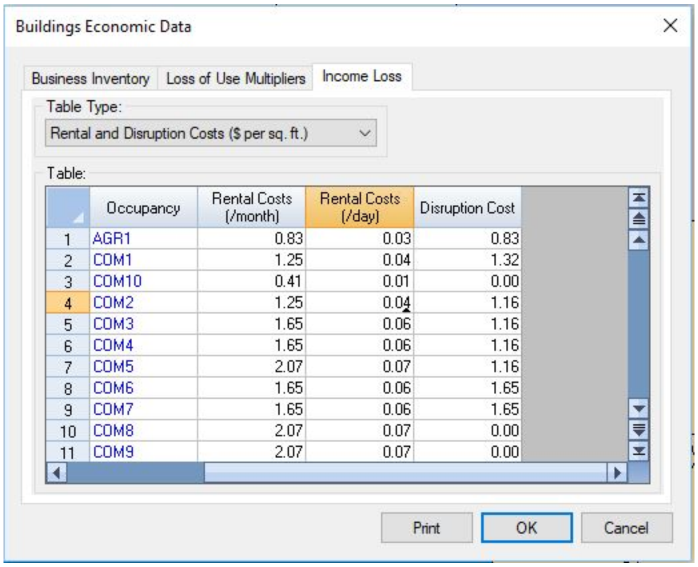
1. From the Analysis menu choose “Parameters” > “Building Economic”.
2. Select the Business Inventory tab.
3. Select Business Inventory (% of gross annual sales) from the Table Type drop-down menu.
4. Based on national averages, the default Hazus values appear to be too low. The % of gross annual sales for retail and whole sale trade is nearly all of these industries total sales in today’s market



5. Change the values of COM1 and COM2 to "90".
6. Click "OK" and then "Yes" to save your changes.
7. From the Analysis menu select "Run".
8. Choose Select All except for "Automated Output Options"
9. Click "Run Analysis".
10. When the analysis has finished, click "OK" to close the window.
11. From the Results menu click on "Summary Reports".
12. Select the Other tab, and open the "Global Summary Report".
13. Click View to view the report.
14. Use the report to fill out the table at the end of this exercise for Case 3.

Task 4: Modify the Rental and Disruption Costs Parameter

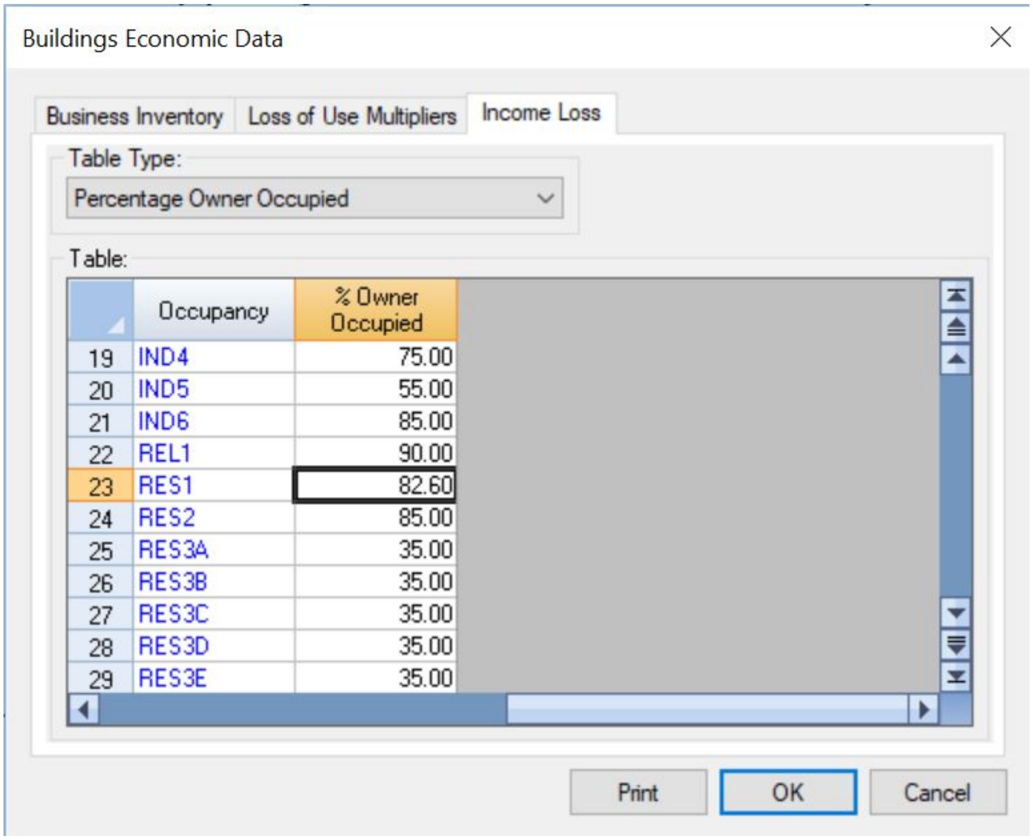
1. From the Analysis menu choose "Parameters" > "Building Economic".
2. Select the Income Loss tab and "Rental and Disruption Costs ($ per sq ft): from the Table Type drop-down menu.
3. Change the values of COM1 and COM2 to "1.25" for Rental Costs/month and "0.04" for Rental Costs/day.



4. Click “OK” and then “Yes” to save your changes.
5. From the Analysis menu select “Run”.
6. Choose Select All except for “Automated Output Options”
7. Click “Run Analysis”.
8. When the analysis has finished, click “OK” to close the window.
9. From the Results menu click on Summary Reports.
10. Select the Other tab, and open the “Global Summary Report”.
11. Click View to view the report.
12. Use the report to fill out the table at the end of this exercise for Case 4.

Task 5: Modify the Percent Owner Occupied Parameter

1. From the “Analysis” menu choose “Parameters > Building Economic”.
2. Select the Income Loss tab and “Percentage Owner Occupied” from the Table Type drop-down menu.
3. Scroll down and change the values of RES1 to “82.6” for % Owner Occupied. This is an opportunity for you or other local officials to integrate more detailed data.



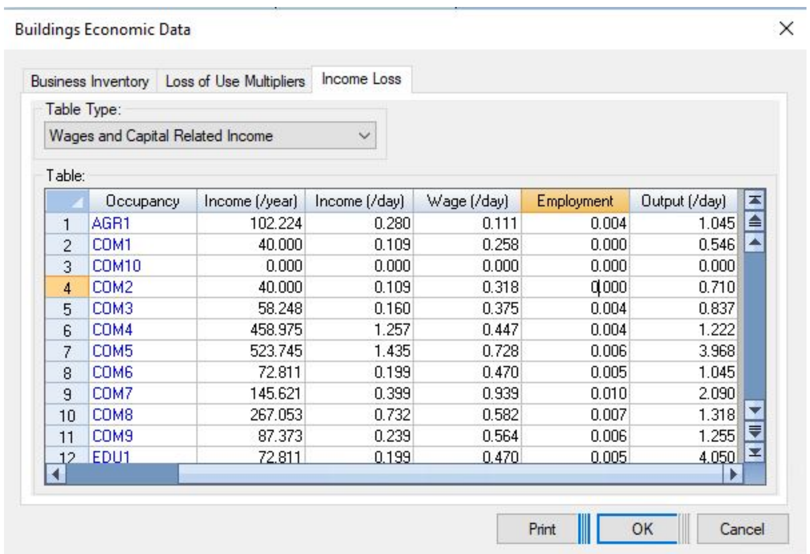
4. Click "OK" and then "Yes" to save your change.
5. From the Analysis menu select "Run".
6. Choose Select All except for "Automated Output Options".
7. Click "Run Analysis".
8. When the analysis has finished, click "OK" to close the window.
9. From the Results menu click on" Summary Reports".
10. Select the Other tab, and open the "Global Summary Report".
11. Click View to view the report.
12. Use the report to fill out the table at the end of this exercise for Case 5.

Task 6: Modify the Wages and Capital Related Income Parameter

1. From the Analysis menu choose "Parameters" > "Building Economic".
2. Select the Income Loss tab and "(Wages and Capital Related Income)" from the Table Type drop-down menu.
3. Change the values of COM1 and COM2 to the following:

- Income/year to 40.000

- Income/day to 0.109
- Employment to 0.000



4. Click “OK” and then “Yes” to save your changes.
5. From the Analysis menu select “Run”.
6. Choose Select All except for “Automated Output Options”.
7. Click “Run Analysis”.
8. When the analysis has finished, click “OK” to close the window.
9. From the Results menu click on” Summary Reports”.
10. Select the Other tab, and open the “Global Summary Report”.
11. Click View to view the report.
12. Use the report to fill out the table at the end of this exercise for Case 6.
13. When you are finished filling out the table and answering the questions below, save your map document and exit Hazus.

Task 7: Compare the Results of Modifying the Economic Loss Parameters.

Case	Scenario Description	Inventory Losses	Income Losses	Relocation Losses	Rental Losses	Wage Losses

Case	Scenario Description	Inventory Losses	Income Losses	Relocation Losses	Rental Losses	Wage Losses
1	Hazus Default Building Economics					
2	Set COM1 and COM2 Sales/SQFT to 100					
3	Set COM1 and COM2 business inventory to 90.					
4	Set COM1 and rental costs to $1.25/SQFT/Month					
5	Set Owner Occupied to 82.6%					
6	Set Income(40, 0.109) and Employment (0.000)					

Questions

Use the technical manuals or presentation slides to answer the following questions

1. Why did the Rental Losses decrease when the Owner Occupied values were increased to 82.6%?
2. Why didn't the Wage Losses ever change?
3. Why did the relocation loss results change?

Visual 25: Lesson 8: Review

1. Why are the Building Loss of Use results important for planning?
2. Where can you find the input parameters that determine the economic loss results?
3. What confidence should you place on results that use the default inputs for economic losses? Why?

Visual 26: Questions?

Lesson 9: Shelter and Debris Models

Visual 1: Lesson 9: Shelter and Debris Models

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Visual 2: Lesson 9: Goal and Objectives

Goal: To describe the shelter and debris models.

After completing this lesson, you will be able to:

- Understand the shelter and debris parameters.
- Demonstrate how to modify the parameters.

Visual 3: Shelter Model

Follows model used for earthquake hazard.

- Uses building loss ratios instead of building damage states to estimate proportion of uninhabitable housing units

Two estimates for each census tract

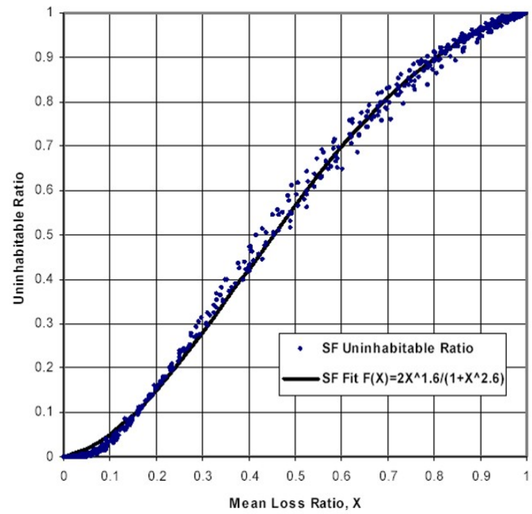
- Number of displaced households
- Number of people requiring short-term public shelter
    - Function of income class, ethnic class, ownership class, population age class

NOTE: Discussed in Technical Manual (Chapter 11)

Visual 4: Shelter Model Methodology

Step 1: Estimate number of uninhabitable households resulting from wind damage.

- Mean loss ratio (loss/building value) used to predict fraction of uninhabitable units
- Function derived from simulations of damage and loss for single-family and multi-family buildings
- Analyzed for each census tract



Visual 5: Shelter Model Methodology

Step 2: Calculate number of displaced households.

- Add displaced houses from previous step
- Multiply by occupancy rate
    - Estimated from census data

Step 3: Repeat for each census tract.

Visual 6: Shelter Model Methodology

Step 4: Estimate number of people in shelters.

- Based on fraction of displaced households

$$N = D\frac{P}{H}\sum_{i=1}^{5}\sum_{j=1}^{5}\sum_{k=1}^{5}\sum_{l=1}^{5}(\alpha_{ijkl} \cdot I_i E_j O_k A_l)$$

D: Displaced Households

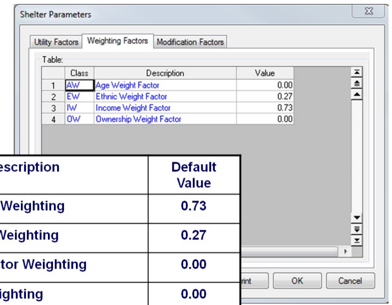
$\frac{P}{H}$: Number of People per Household (census data)

$ijkl$: Weighting Factors

IEOA: Proportion of population in certain categories of: Income (I), Ethnicity (E), Ownership (O), Age (A)

Visual 7: Shelter Estimates: Weighting Factors

- Same factors as earthquake model
- Defaults to only income and ethnicity affecting shelter estimates



Symbol	Description	Default Value
w_I	Income Factor Weighting	0.73
w_E	Ethnic Factor Weighting	0.27
w_O	Ownership Factor Weighting	0.00
w_A	Age Factor Weighting	0.00
	Total	1.00

Visual 8: Shelter Estimates: Income Weighting Factors

Proportion of people in a given class that will go to a public shelter:

Excerpt of Table 11.2-2 for Household Income weighting factors

Symbol	Description	Default Value
(Fi)1	Income < \$10000	0.62
(Fi)2	\$10000 < Income < \$15000	0.42
(Fi)3	\$15000 < Income < \$25000	0.29
(Fi)4	\$25000 < Income < \$35000	0.22
(Fi)5	\$35000 < Income	0.13

Visual 9: Shelter Estimates: Ethnicity Weighting Factors

Excerpt of Table 11.2-2 for Ethnicity weighting factors

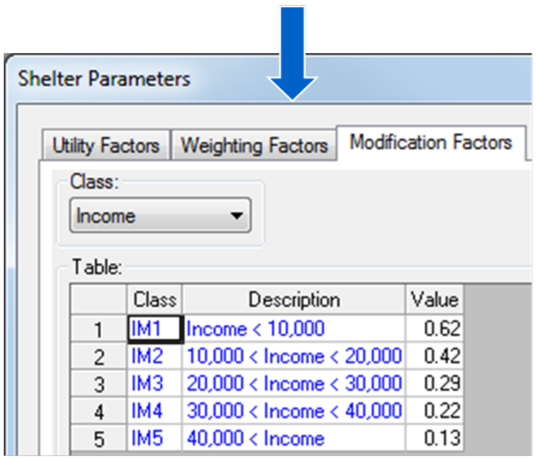
Symbol	Description	Default Value
(Fe)1	White	0.24
(Fe)2	Black	0.48
(Fe)3	Hispanic	0.47
(Fe)4	Asian	0.26
(Fe)5	Native American	0.26

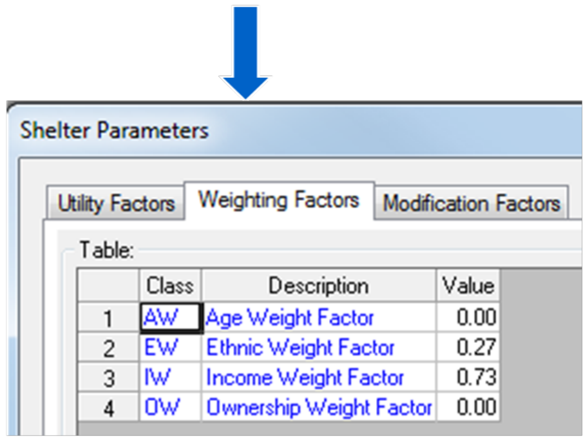
Visual 10: Shelter Estimates: Weighting Factors

Weight factor is a product of two sets of factors

- Weighting Factors
- Modification Factors

$$\alpha_{ijkl} = w_I(F_I)_i + w_E(F_E)_j + w_O(F_O)_k + w_A(F_A)_l$$





Visual 11: Debris Model

Eleven categories of debris resulting from wind events (Public Assistance Program and Policy Guide, 2018):

- Vegetative Debris
- Construction and Demolition Debris
- Hazardous Waste
- Household Hazardous Waste
- White Goods
- Electronic Waste
- Soil, Mud, and Sand
- Vehicles and Vessels
- Putrescent Debris
- Infectious Waste
- Chemical, Biological, and Nuclear – Contaminated Debris

NOTE: Chapters 10 and 12 in the Hurricane Model Technical Manual

Visual 12: Building Debris Model

Development of debris curves

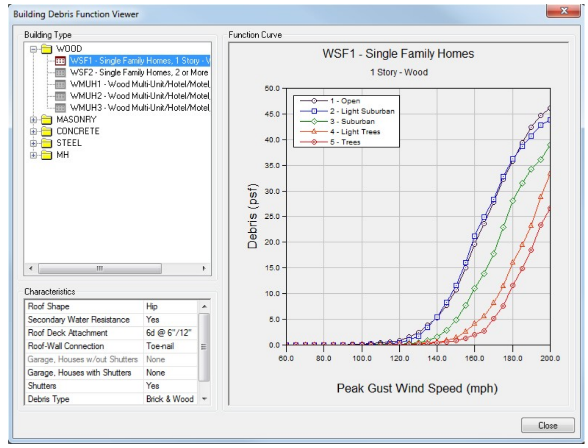
- Based on load-resistance damage states
- Component unit weights
- Typical density of debris type
- Debris type distribution of damaged components

Visual 13: Component Unit Weight

- Exterior building components: Weights from RS Means 2018
- Interior building components: Weights from RS Means 2018
- Contents: Estimated based on sustained live loads from ASCE 7-98

Visual 14: Viewing Building Debris Curves

- Each specific building type has a set of debris functions related to terrain.
- Rougher terrains: Less building debris



Visual 15: Debris Model: Validation

Storm	Region	Actual Weight (tons)	Actual Volume (cubic yards)	Modeled Weight (tons)	Modeled Volume (cubic yards)	Model/Actual Weight	Model/Actual Volume
Hugo	South Carolina	-	15,500,000	951,009	9,130,843	-	0.59
Hugo	USACE Admin. Region	-	4,589,559	782,480	7,366,394	-	1.61
Andrew	Dade County	2,900,000	40,000,000	3,396,991	35,323,080	1.17	0.88

- Statistics reported in published papers
- Limitations of comparisons
  - Hugo South Carolina comparison region may be larger than assumed from paper
- Hazus debris model = ~ +/- 30%

Visual 16: Tree Debris Model

- Estimates based on
  - Tree coverage database
  - Tree blow-down model
- Expected green weight of tree stems for trees greater than 30 ft. tall
- Eligible tree debris
  - Debris estimates made for all areas.
  - Unpopulated areas may not be collected.
- Volume based on 10 cubic yards / ton.

Visual 17: Demonstration 9.1 – Shelter and Tree Parameters

Goal:

- Show how to view shelter and tree parameters

Time: 10 Minutes

Student Manual

Demonstration 9.1: Shelter and Debris Parameters

Goal: Show how to view shelter and tree parameters

Time: 10 Minutes

Demonstration Steps:

1. Listen to instructor's directions.
2. Ask questions if clarification is needed.
3. Watch the instructor's demonstration.
4. Ask any final questions.

Demonstration 9.1 – Shelter and Tree Parameters

Type: Instructor-Led Demonstration

Time: 10 minutes

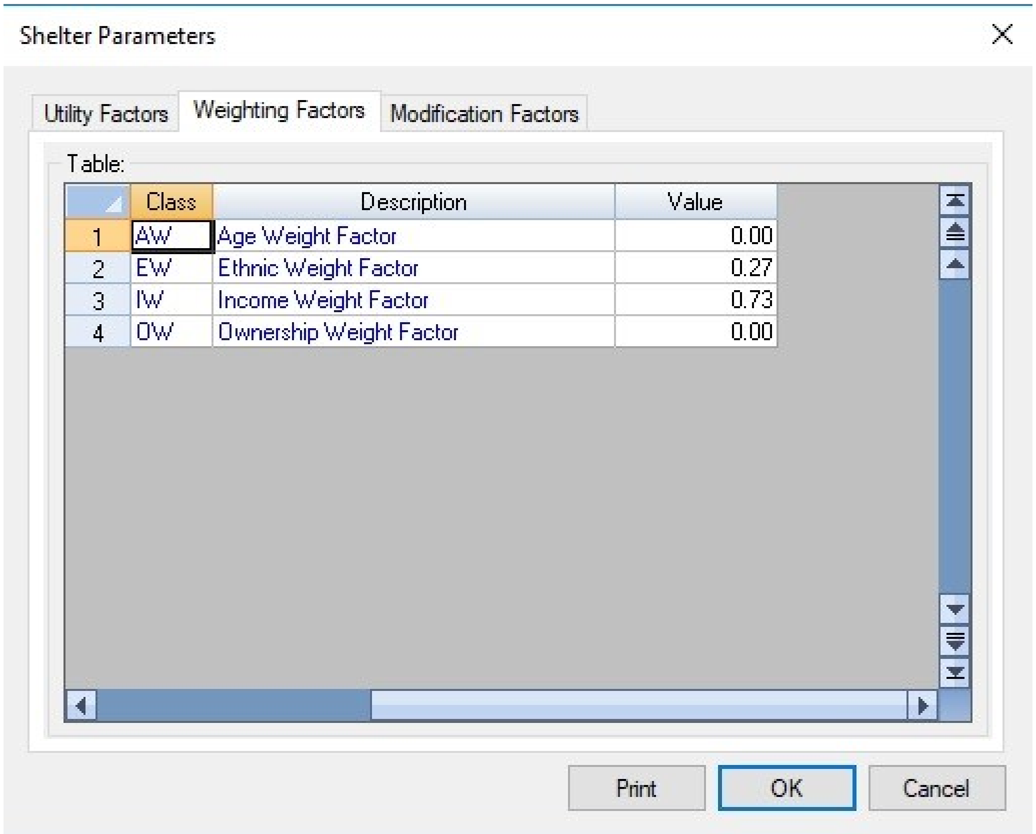
Goal: Show how to view shelter and tree parameters

Background:

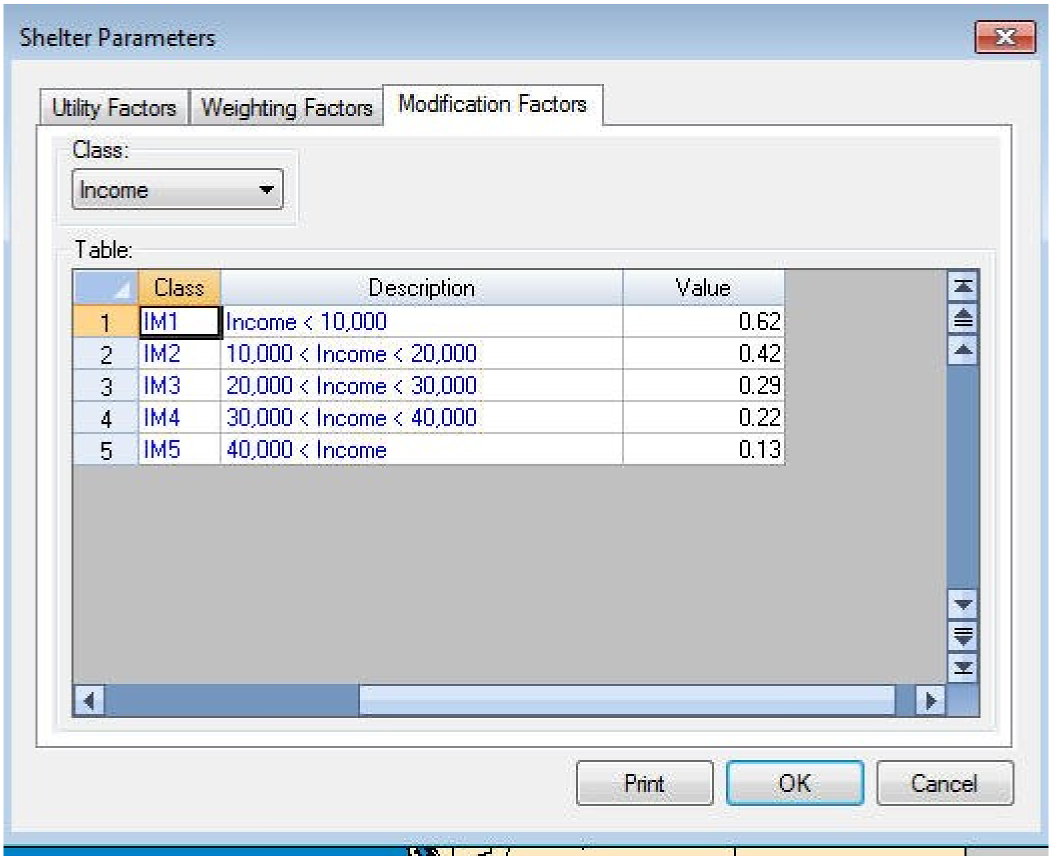
In this demonstration you will explore the shelter and tree parameters. The default values for the sheltering parameters are based upon national assumptions. In this exercise you will investigate the role these parameters play in the calculations of the sheltering results. Tree parameters are also based upon national datasets and you will modify the tree parameters to explore the changes to the results.

Task 1: Review Shelter Parameters

1. Navigate to the C:\E0170_ActivityData\Demonstration_9.1 folder and import the HurricaneMichael HPR.
2. Name the study region “ShelterTree”.
3. Open the study region and go to Analysis > Parameters > Shelter
4. Discuss the Weighting Factors (Age, Ethnic, Income, Ownership) and their values.



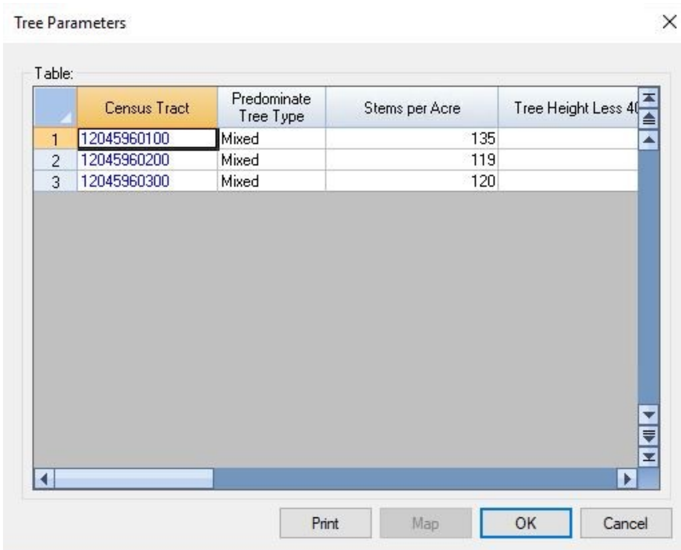
5. Discuss the Modification Factor classes (Income, Ethnicity, Ownership, Age) and the values associated with each of the factors.



6. Demonstrate that you can modify these values.

Task 2: Review Tree Parameters

1. Go to Analysis > Parameters > Trees.



2. Discuss tree parameters including predominant tree type, stems per acre, tree height, and tree collection factor.

3. Demonstrate that you can modify these values.

Question for the participants: Where can you as a user obtain information that can improve the shelter parameter?

Visual 18: Exercise 9.2: Tree and Sheltering Parameters

Goal:

- Explore the impact of altering tree and sheltering parameters.

Time: 45 Minutes

Student Manual

Exercise 9.2: Tree and Sheltering Parameters

Goal: Explore the impact of altering tree and sheltering parameters.

Time: 45 Minutes

1. Refer to Activities Document “09.2_Exercise_Tree and Sheltering Parameters.”
2. Listen to instructor’s directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share your answers/results.
8. Ask any final questions.

Visual 19: Exercise 9.2: Tasks

Task 1: Open the Study Region

Task 2: Explore Sensitivity to Shelter Parameters.

Task 3: Compare Shelter Parameter Modification Results.

Task 4: Explore Sensitivity of Debris to Tree Damage.

Task 5: Compare Tree Density Modification Results.

Student Manual

Exercise 9.2: Tasks

- Refer to Activities Document “09.2_Exercise_Tree and Sheltering Parameters.”

Exercise 9.2: Tree and Sheltering Parameter

Type: Student-Led Activity

Time: 45 minutes

Goals: Explore the impact of altering tree and sheltering parameters.

Background:

In this exercise you will explore the sheltering and tree parameters in Hazus. The default values for the sheltering parameters are based upon national assumptions. In this exercise you will investigate the role these parameters play in the calculations of the sheltering results. Tree parameters are also based upon national datasets and you will modify the tree parameters to explore the changes to the results.

Task 1: Open the Study Region

1. Open Hazus.
2. Select Open a region and click OK.
3. Click Next.
4. Select the Economic_Parameter study region (created in Exercise 8.2) and click Next.
5. Click Finish.
6. From the Hazard menu choose Show Current.
7. The Historic Hurricane Michael should be the active scenario.

8. Click “Close”.

Task 2: Explore Sensitivity to Shelter Parameters

In this section of the exercise you will explore the impacts that the shelter parameters have on estimation of shelter needs. As you explore these impacts, you will fill in the table named Shelter Parameters Comparison which is found at the end of the exercise. The first row of this table, which shows the results of the Hurricane Michael scenario using default shelter estimation parameters, has been filled in for you.

1. From the Inventory menu choose “Demographics” to open the demographics table.

2. Click on the FemaleOver65 field name and then click “Map”.

3. Click on the MaleOver65 field name and then click “Map”.

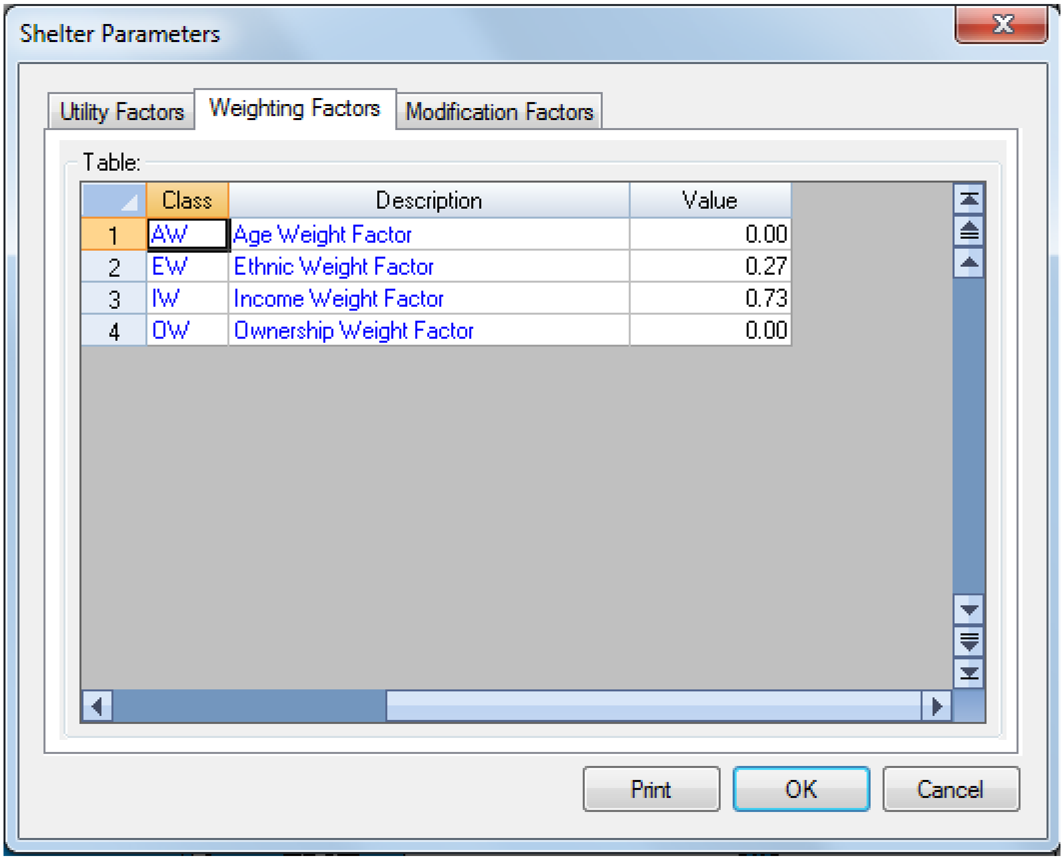
4. Click “OK” to exit the demographics window.

5. Toggle between the Demographics – MaleOver65 and Demographics – FemaleOver65 layers, and in the space below describe where the over 65 populations reside in this study region.

Answer:

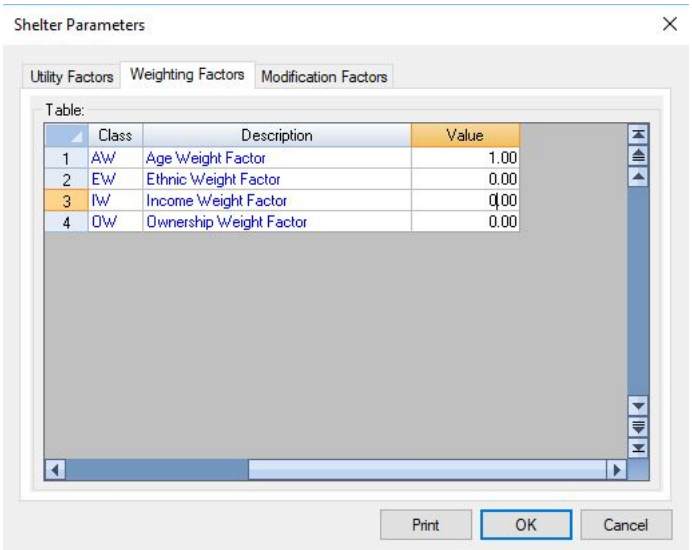
6. From the Analysis menu choose “Parameters” > “Shelter” to open the Shelter Parameters window.

7. Click the Weighting Factors tab. The default values show no consideration is given to either age or home ownership. Also notice that income is the most important factor by default.



8. Change the value for the Age weight factor to 1.0.

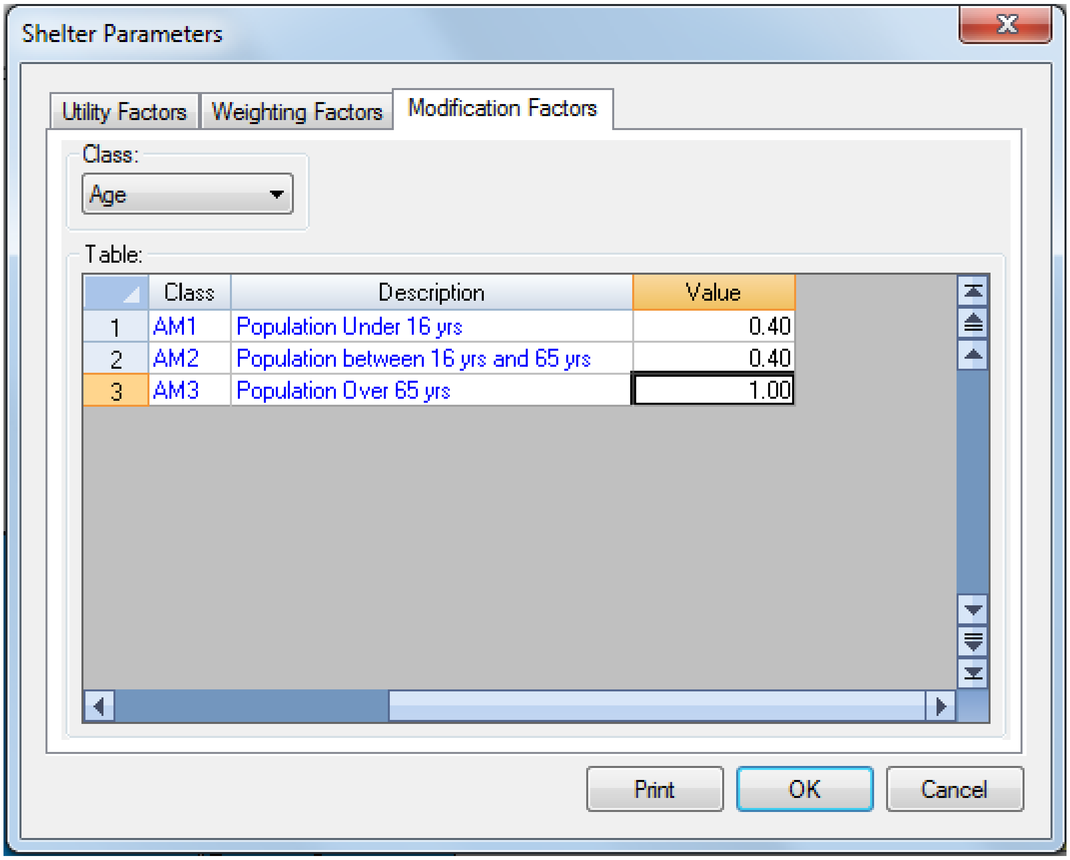
9. Change all other weighting factors to zero. This will make the age the only factor considered for sheltering.



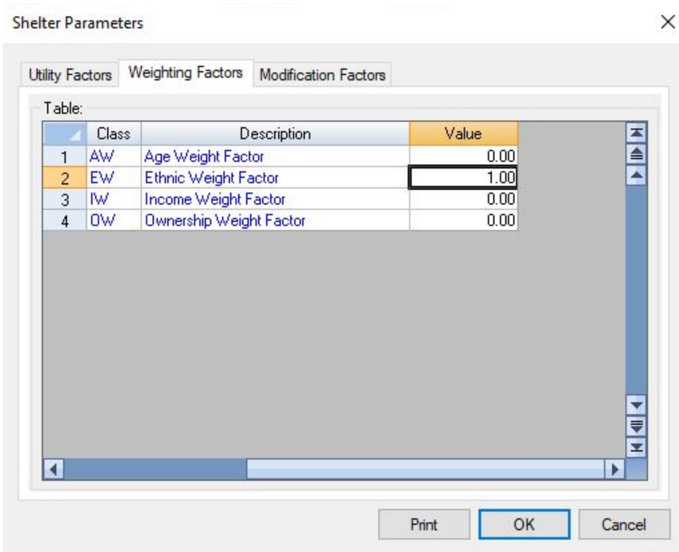
10. Click “OK” on the Shelter Parameters window.
11. Click “Yes” to indicate you want to save the changes.
12. From the Analysis menu choose “Run”.
13. Choose Select All.
14. Uncheck the Automated Output Options.
15. Click “Run Analysis”.
16. When the analysis has finished, click “OK” to close the window.
17. From the Results menu click on Shelter.
18. Click on the Short Term Shelter Needs column, click “Map.
19. Close the Shelter Results window.
20. Label the map to show the number of people requiring shelter.
21. Write down which census tract has the most people requiring shelter.

Answer:

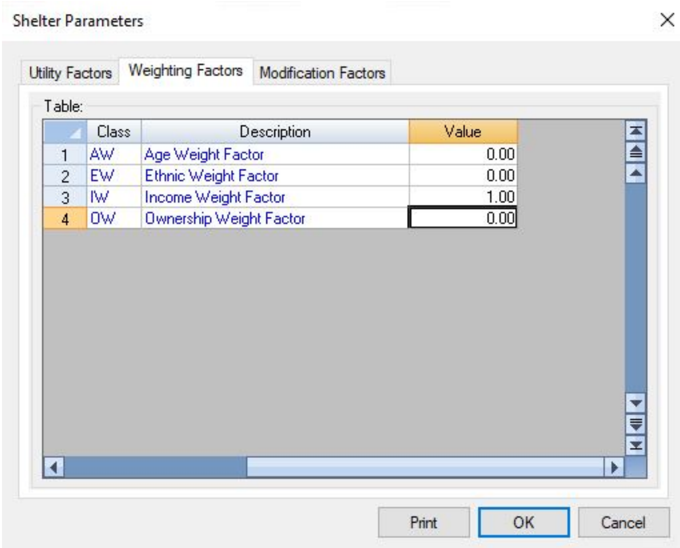
22. Record the number of displaced households and the number of people requiring shelter in the row labeled Case 2 of the Shelter Parameters Comparison table at the end of the exercise.
23. From the Analysis menu choose “Parameters” > “Shelter” to open the Shelter Parameters window.
24. Click the Modification Factors tab.
25. Select Age from the Class drop down menu.
26. Change the value for Population Over 65 yrs to 1.00. This will mean that 100% of this age group that is displaced from the hurricane will require shelter.
27. Do not alter the other factors.



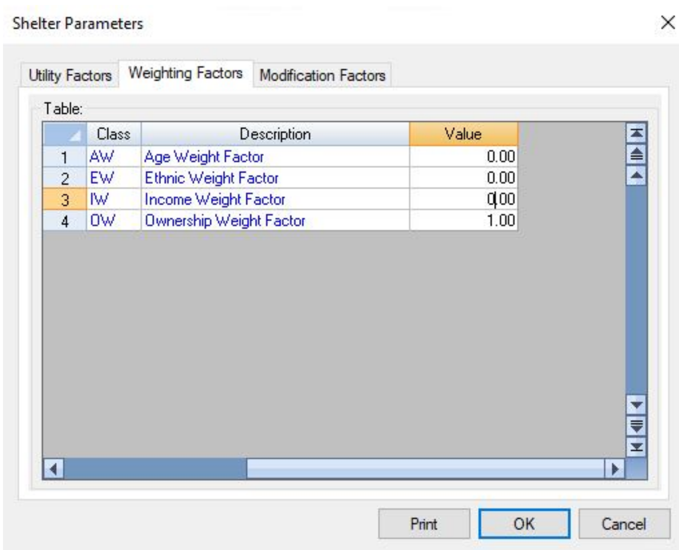
28. Click the “OK” button and then “Yes” when prompted to save your changes.
29. From the Analysis menu choose “Run”.
30. Select all of the outputs except the Automated Output Options.
31. Click “Run Analysis”.
32. When the analysis is done click OK.
33. Record the number of displaced households and the number of people requiring shelter in the row labeled Case 3 of the Shelter Parameters Comparison table.
34. Open the Shelter Parameters Weighting Factors table and change the value for the Ethnicity weight factor to 1.0.
35. Change all other weighting factors to zero.



36. Click "OK" and then "Yes" when prompted to indicate whether you want to save your changes.
37. From the Analysis menu choose Run.
38. Select all of the outputs except the Automated Output Options.
39. Click "Run analysis".
40. Record the number of displaced households and the number of people requiring shelter in the row labeled Case 4 of the Shelter Parameters Comparison table at the end of the exercise.
41. Open the Shelter Parameters Weighting Factors table and change the value for the Income weight factor to 1.0.
42. Change all other weighting factors to zero.



43. Click the “OK” button and then “Yes” when prompted to save your changes.
44. From the Analysis menu choose “Run”.
45. Select all of the outputs except the Automated Output Options.
46. Click “Run analysis”.
47. Record the number of displaced households and the number of people requiring shelter in the row labeled Case 5 of the Shelter Parameters Comparison table at the end of the exercise.
48. Open the Shelter Parameters Weighting Factors table and change the value for the Ownership weight factor to 1.0.
49. Change all other weighting factors to zero.



50. Click “OK” and then “Yes” when prompted to save your changes.

51. Run the analysis and record the number of displaced households and the number of people requiring shelter in the row labeled Case 6 of the Shelter Parameters Comparison table at the end of the exercise.

Task 3: Compare Shelter Parameter Modification Results.

1. Review the results of modifying the different weighting factors. Consider how modifying these factors might help you better represent the impacts of a hurricane in your community.

Task 4: View and Compare Results

Shelter Parameters Comparison

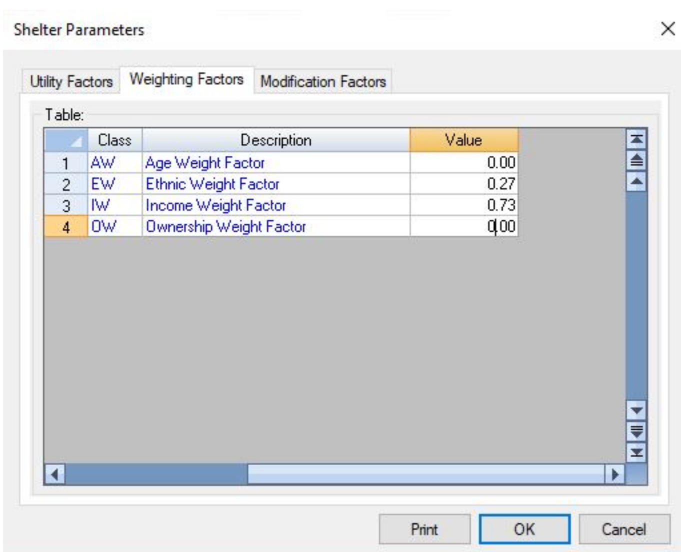
Case	Shelter Parameters	Displaced Households	People in Shelter
1	Hurricane Celia Hazus Default	8,018	4,816
2	Set Age Weight Factor to 1.0 and all others to 0		
3	Set the Over 65 Age Modification Factor to 1.00		
4	Set Ethnic Weight Factor to 1.0 and all others to 0		

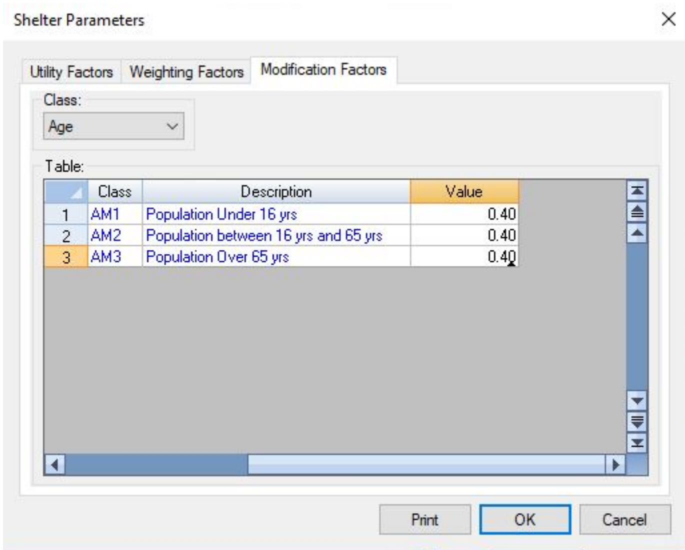
Case	Shelter Parameters	Displaced Households	People in Shelter
5	Set Income Weight Factor to 1.0 and all others to 0		
6	Set Ownership Weight Factor to 1.0 and all others to 0		

Questions

1. Which weighting factor(s) change had the greatest impact on the shelter results.
2. Why didn't the displaced households values change in any case?
3. Why did Case 2 and Case 6 have the exact same sheltering result?
4. Why did the income weight make little difference in this study region?

2. Once you are finished, replace the values with the Original Sheltering Parameters. Use the following graphics as a guide. You have made changes to only the Weighting factors table and the Age Modification Factors table.



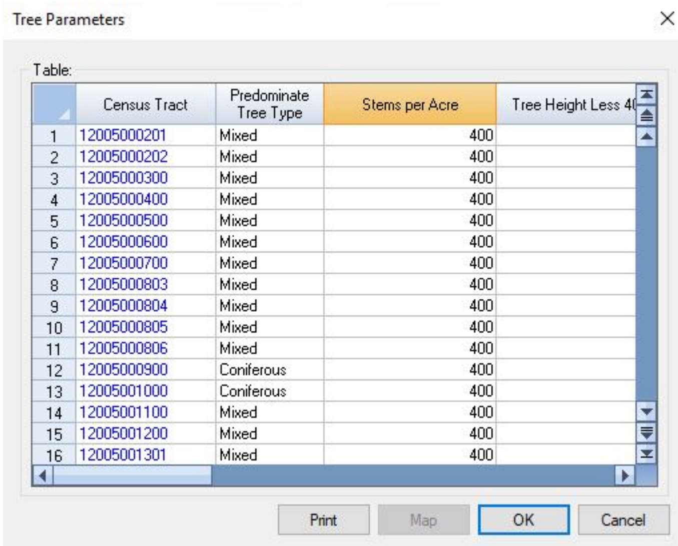


Task 4: Explore Sensitivity of Debris to Tree Damage.

In this section of the exercise you will explore the impact that changing input parameters has on estimation of tree debris. As you explore these impacts, you will fill in the table named Tree Density Parameters Comparison which is found at the end of the exercise. The first column of this table, which shows the results of the Hurricane Michael scenario using default parameters, has been filled in for you.

1. From the Analysis menu choose “Parameters” > “Trees” to open the Tree Parameters window.

2. Change all of the values in the Stems per Acre column to 400. • Note: You can copy (CTRL + C) and paste (CTRL + V) values to save time.



	Census Tract	Predominate Tree Type	Stems per Acre	Tree Height Less 4(
1	12005000201	Mixed	400	
2	12005000202	Mixed	400	
3	12005000300	Mixed	400	
4	12005000400	Mixed	400	
5	12005000500	Mixed	400	
6	12005000600	Mixed	400	
7	12005000700	Mixed	400	
8	12005000803	Mixed	400	
9	12005000804	Mixed	400	
10	12005000805	Mixed	400	
11	12005000806	Mixed	400	
12	12005000900	Coniferous	400	
13	12005001000	Coniferous	400	
14	12005001100	Mixed	400	
15	12005001200	Mixed	400	
16	12005001301	Mixed	400	

3. This change will illustrate an example where the default tree inventory has been severely underestimated.

4. Click "OK" to close the Tree Parameters window and click "Yes" when asked if you want to update the modified data.

5. From the Analysis menu choose "Run".

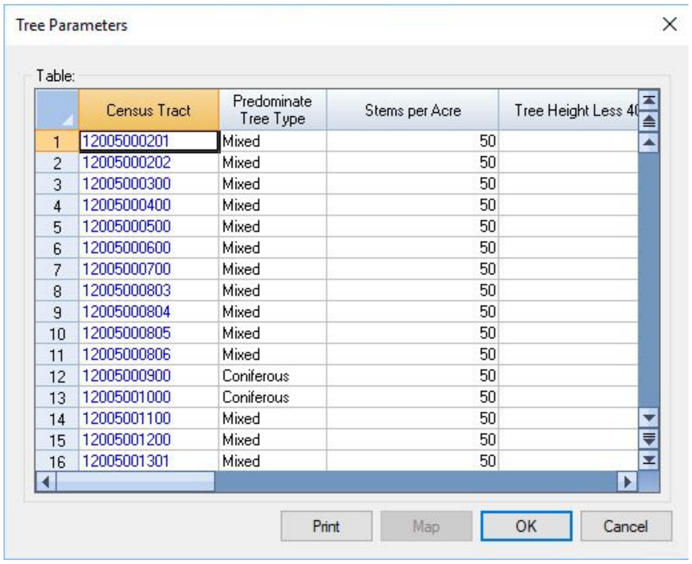
6. Select all of the outputs except the Automated Output Options

7. Click Run Analysis.

8. Explore the results and fill in the column labeled 400 Stems Per Acre of the Tree Density Parameters Comparison table located at the end of the exercise.

9. Change all of the values in the Stems per Acre column of the Tree Parameters table to 50.

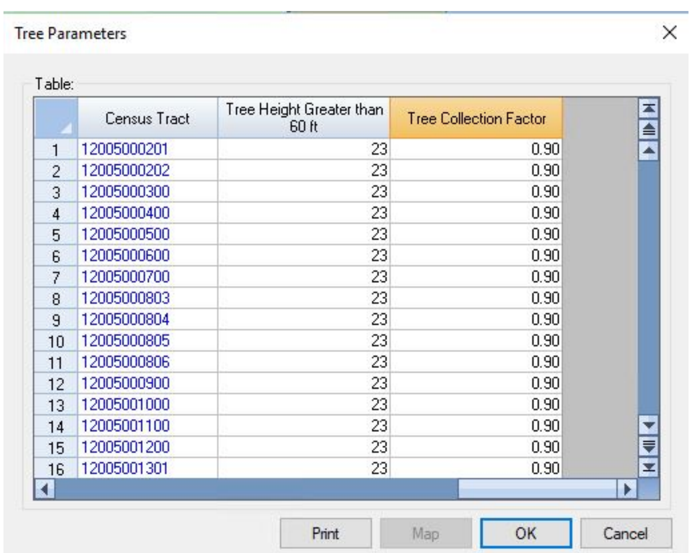
10. This change will illustrate an example where the default tree inventory has been slightly underestimated.



	Census Tract	Predominate Tree Type	Stems per Acre	Tree Height Less 4(
1	12005000201	Mixed	50	
2	12005000202	Mixed	50	
3	12005000300	Mixed	50	
4	12005000400	Mixed	50	
5	12005000500	Mixed	50	
6	12005000600	Mixed	50	
7	12005000700	Mixed	50	
8	12005000803	Mixed	50	
9	12005000804	Mixed	50	
10	12005000805	Mixed	50	
11	12005000806	Mixed	50	
12	12005000900	Coniferous	50	
13	12005001000	Coniferous	50	
14	12005001100	Mixed	50	
15	12005001200	Mixed	50	
16	12005001301	Mixed	50	

11. Run the analysis and use the results to fill in the 50 stems per acre column of the Tree Density Parameters Comparison table.

12. Change all of the values in the Tree Collection Factor column of the Tree Parameters table to 0.90.



	Census Tract	Tree Height Greater than 60 ft	Tree Collection Factor
1	12005000201	23	0.90
2	12005000202	23	0.90
3	12005000300	23	0.90
4	12005000400	23	0.90
5	12005000500	23	0.90
6	12005000600	23	0.90
7	12005000700	23	0.90
8	12005000803	23	0.90
9	12005000804	23	0.90
10	12005000805	23	0.90
11	12005000806	23	0.90
12	12005000900	23	0.90
13	12005001000	23	0.90
14	12005001100	23	0.90
15	12005001200	23	0.90
16	12005001301	23	0.90

13. Run the analysis and fill in the Tree Collection Factor 0.90 column of the Tree Density Parameters Comparison table. Since you didn't change the inventory to the default amounts, you can only compare the results from this step with the ones from the previous step (50 stems per acre).

14. When the exercise is complete, save your map document and exit Hazus.

Task 5: Compare Tree Density Modification Results.

Parameter	Hurricane Michael Hazus Default	400 Stems per Acre	50 Stems per Acre	Tree Collection Factor 0.90
Displaced Households	8,018			
Residential Property Damage Total	$3.2 B			
Debris: Trees (tons)	2,774,289			
Debris: Eligible Tree Debris (tons)	29,446			

Questions

1. Why was there a change to the number of displaced households due to changes in the stems per acre?

Answer:

2. Why did the amount of Tree Debris decrease from the 50 steps per acre analysis to the Tree Collection Factor analysis?

Answer:

Visual 20: Lesson 9: Review

1. What are the four factors modeled in Hazus that impact sheltering estimates?
2. What are the only types of debris modeled in the Hazus Hurricane Model?

Visual 21: Questions?

Lesson 10: Hurricane Surge Model

Visual 1: Lesson 10: Hurricane Surge Model

HAZUS®

EARTHQUAKE • WIND • FLOOD • TSUNAMI

Visual 2: Lesson 10: Goal and Objectives

Goal: To provide an overview of the storm surge model within Hazus.

After completing this lesson, you will be able to:

- Discuss the causes for storm surge.
- Describe the Hazus surge model components.
- Understand the procedure for running a hurricane surge in Hazus.

Visual 3: Hurricane Scenario Definition Options

- X Probabilistic
- ✓ Historic
- X .dat Import

Historic or Observed Wind Fields

- ✓ User-Defined
- ✓ HurrEvac Import
- ✓ Hazus Import

Wind Fields Computed from Hurricane Track Parameters

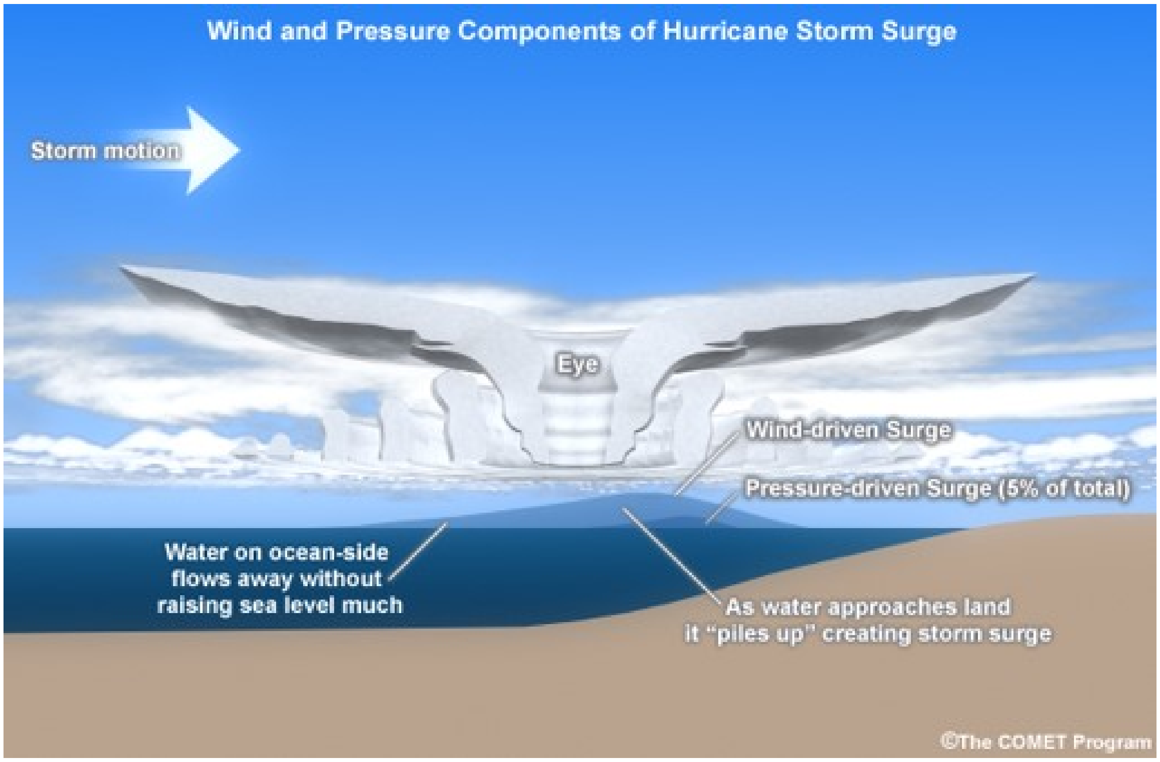
✓ = Coastal surge analysis allowed
X = Coastal surge not supported

Visual 4: Sources of Storm Surge

1. Hurricanes (i.e. Hurricane Katrina)
2. Extratropical Cyclones and Nor'easters
   - Edmund Fitzgerald (1975): 15-20 foot waves in Great Lakes
   - Storm of the Century (1993): 12 foot waves in Atlantic
3. Subtropical Storms

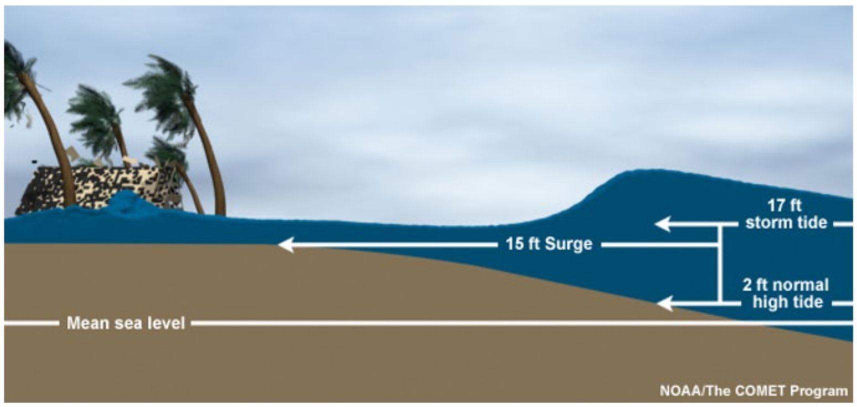
https://earthobservatory.nasa.gov/IOTD/view.php?id=46662

Visual 5: What Causes a Storm Surge?



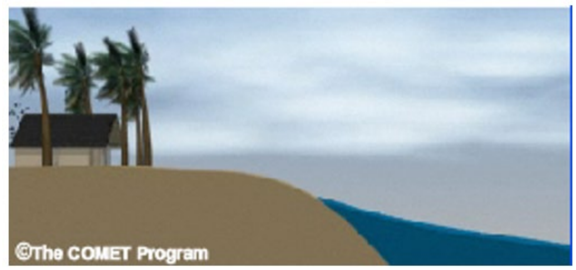
Visual 6: Factors Influencing a Surge's Size

- Storm surge: abnormal rise of water generated by a storm, over and above the predicted astronomical tides
- Storm tide: water level rise due to the combination of storm surge and the astronomical tide



Visual 7: Factors Influencing a Surge's Size

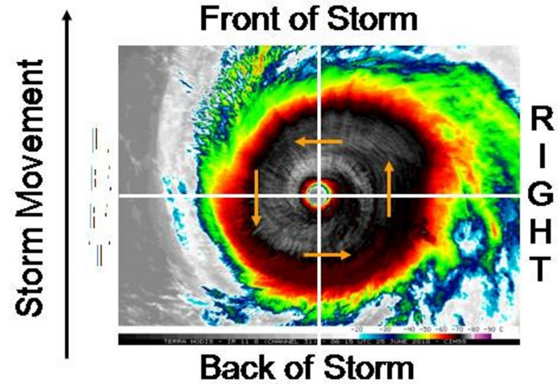
- Wave breaking can increase the height of the surge and is dependent on the continental shelf.



Visual 8: Factors Influencing a Surge's Size

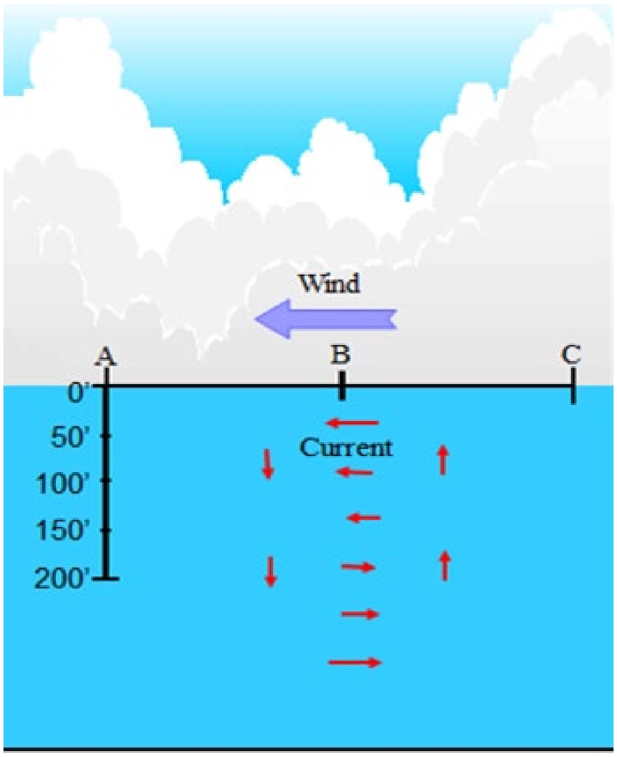
Wind and Storm Motion

- Strongest winds and thus highest surge (without coastline effects) occur in the right - front quadrant of hurricane
- Here the forward speed of the hurricane is added to the rotational winds of the hurricane to achieve the highest wind speeds

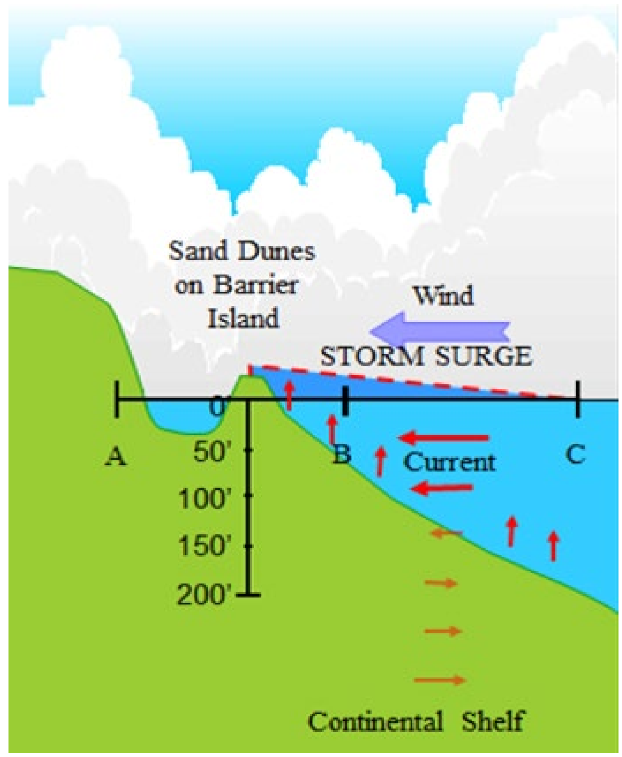


Satellite image of Celia (2010)
Cooperative Institute for Meteorological Studies (CIMSS), University of Wisconsin

Visual 9: Storm Surge Dynamics



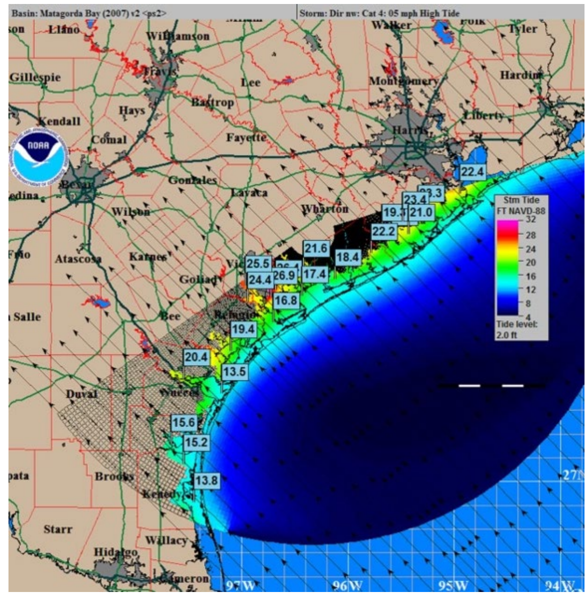
The hurricane's surface winds push against the water, and water from below moves upward to replace the displaced water.



The bulge of water and current slam into the continental shelf and are forced upward and inward.

Visual 10: Coastline Effects and Surge Size

- Orientation of the hurricane with respect to the coastline can influence the surge magnitude.
- Water can ‘pile up’ with favorable orientations. If hurricane winds are pushing against the coastline, water is caught along the coast.
- Water can also be trapped in bays.



Visual 11: Surge Demonstration

Hurricane Dennis Surge:
https://www.nhc.noaa.gov/surge/HistoricalRuns/?large&parm=2005_dennis#contents

Hurricane Dennis (2005)

Visual 12: Discussion 10.1: Storm Surge

Goal: Discuss the previous animation and answer the questions.

Time: 10 Minutes

Questions:

1. How does the orientation of the coastline effect the storm surge depth?
2. Where are the highest storm surges?
3. How can a surge affect an area (geographically) that is not in close proximity to the hurricane path?

Student Manual

Discussion 10.1: Storm Surge

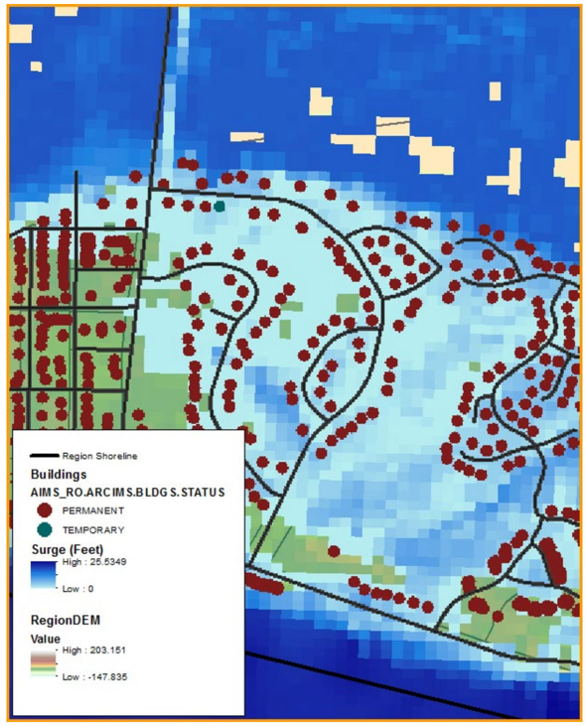
Goal: Discuss the previous animation and answer the questions.

Time: 10 minutes

Discussion Steps:

1. Listen to instructor's directions.
2. Ask questions if they need directions clarified.
3. Discuss the questions with your group.
4. Designate a group member to share your answers with the class.

Visual 13: Hurricane Storm Surge Overview



Hurricane Model

- Windspeed and direction

Surge Model

- SLOSH (sea, land, ocean)
- SWAN (near shore)

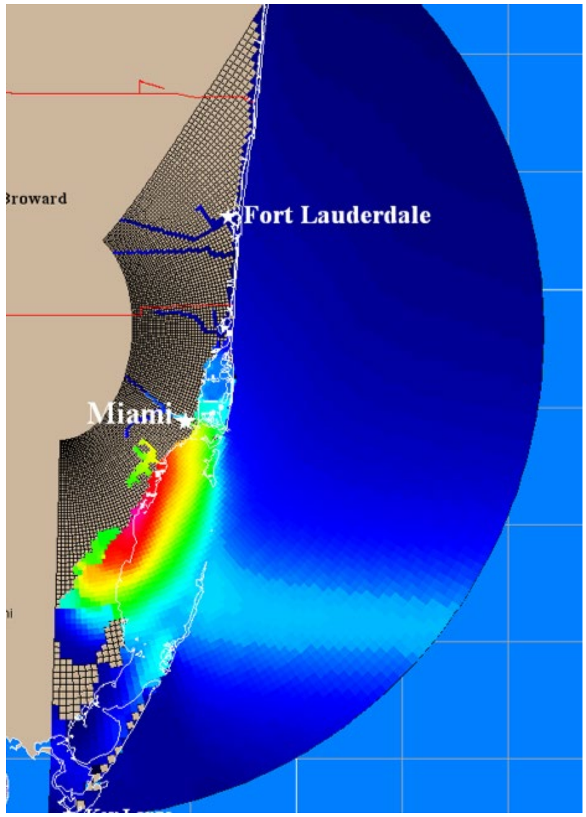
Wind and Surge are combined for aggregate inventory damages and losses only.

Visual 14: SLOSH

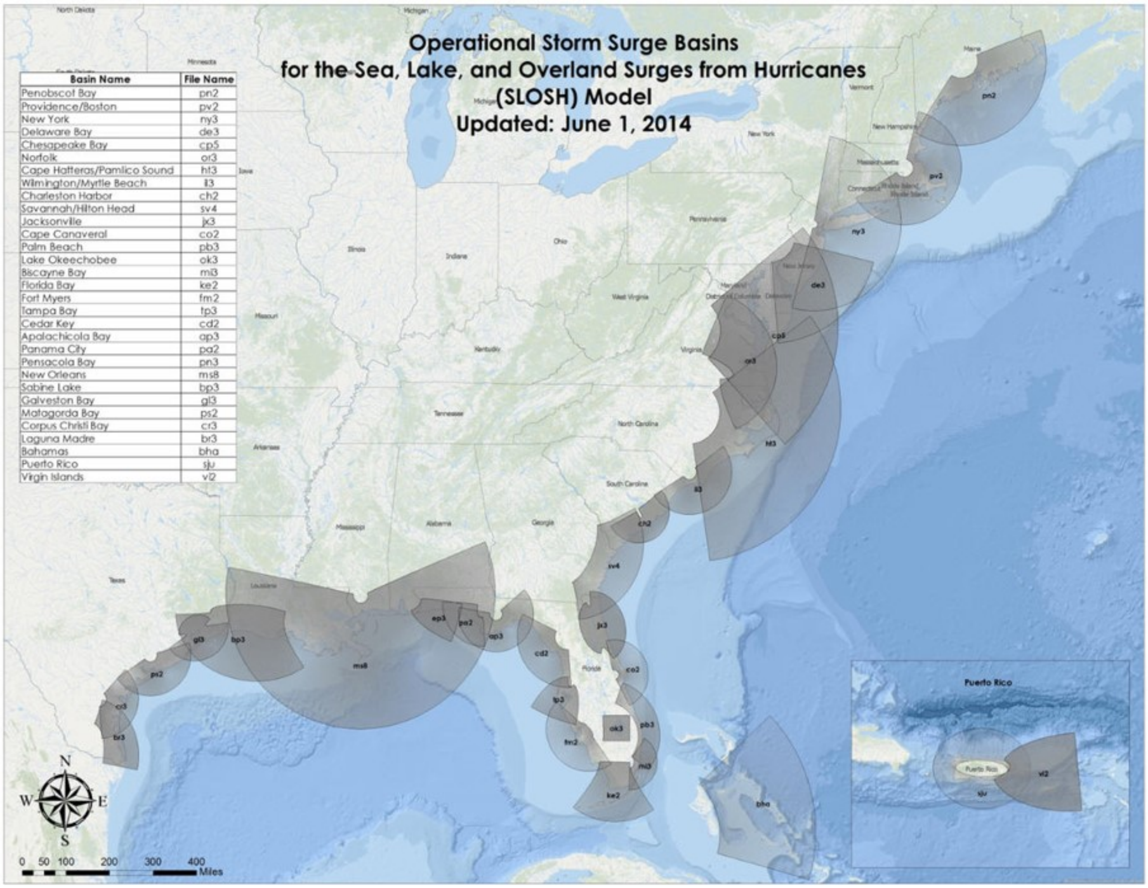
- SLOSH = Sea, Lake, and Overland Surge from Hurricanes
- Numeric Model initialized on a grid that requires the following inputs:
    - Basin selection: SLOSH is packaged with pre-defined basins that have bathymetry (NGDC) and elevation information (USGS) for each grid cell.
    - Hurricane characteristics: direction of movement, radius to maximum winds, pressure, location, direction, and speed

Visual 15: SLOSH

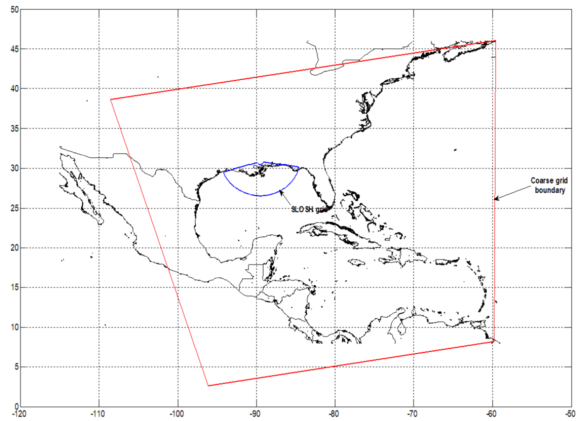
- Produces reasonably accurate estimates of surge and runs quickly
- Emergency management community is familiar and comfortable with using this model.
- Does not explicitly model tide.
  - Tide is generalized by treating it as a fixed increase or decrease in initial water level based on predicted tide at time of landfall in the absence of storm surge and waves.



Visual 16: SLOSH Basins



Visual 17: Domains in SWAN Runs

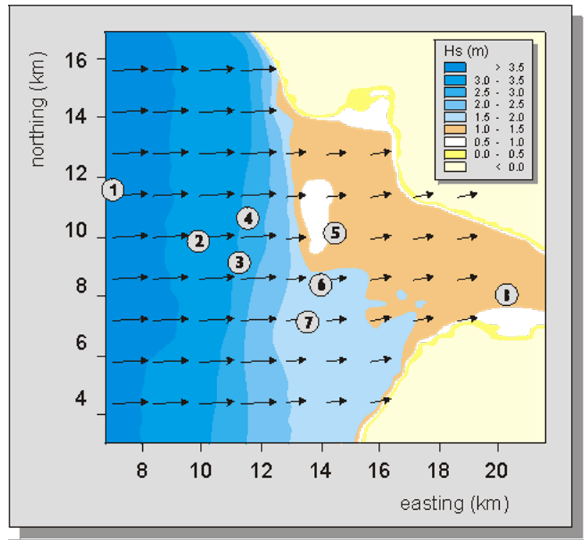


<u>Domains</u>

- Deep Water: Red
- Near Shore: Blue

Visual 18: SWAN

- Simulating Waves Nearshore
- Created by Delft University of Technology
- Models:
  - Wave propagation
  - Wave generation from wind
  - Wave interactions, dissipation, transmission, and diffraction
  - Others



http://www.wldelft.nl/soft/swan/

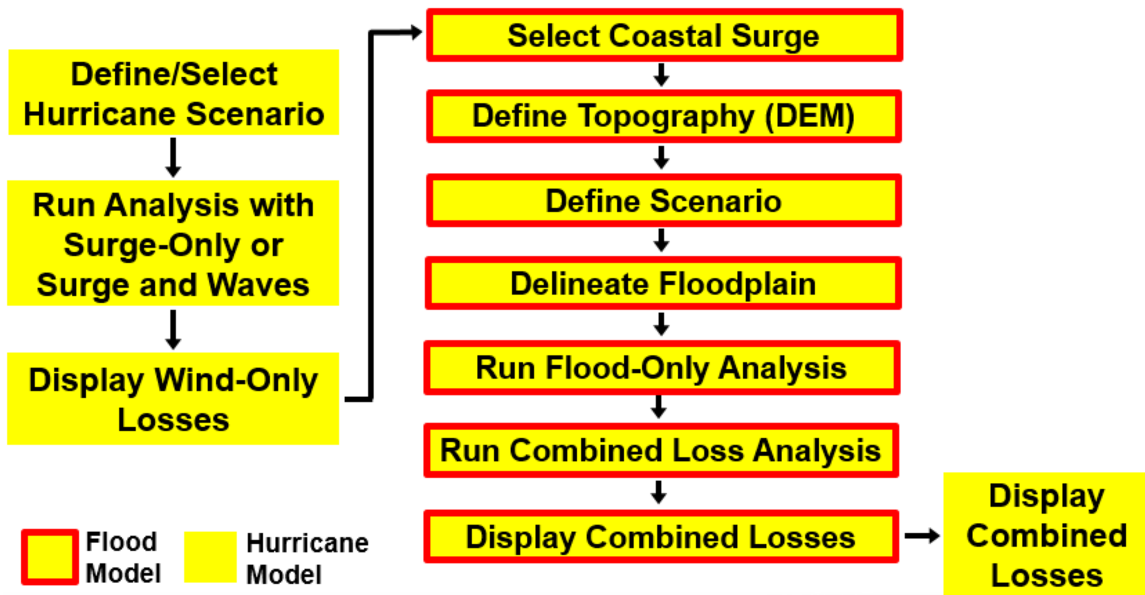
Visual 19: Coupled Surge and Wave Modeling

- SLOSH and SWAN codes have been coupled together.
- Methodology bridges gap between existing Hazus Hurricane Wind and Hazus Coastal Flood models
- SLOSH is run first to update water elevations.
  - SWAN uses water elevations produced by SLOSH.
  - Result is larger modeled wave heights in areas where waves are depth-limited.
- SWAN is run to update wave stresses.
  - Wave stresses are added to wind stress in SLOSH.
  - Increases modeled storm surge due to wave setup

Visual 20: Overland Waves

- Model uses 1-D transects and simplified WHAFIS-like methodology to propagate waves inland from the shoreline.
- Where each transect intersects the coastline, use the modeled significant wave height from SWAN to estimate the controlling wave height, Hc = min(0.78 ds, 1.6 Hs) where ds = still water depth at the coast line.
- Wave crest elevation = SWEL + 0.7 Hc
    - Neglect wave regeneration and wave dissipation
    - Neglect wave run-up and dune erosion
- Use V-zone damage functions where Hc $\geq$ 1.5 ft

Visual 21: User Work Flow



Visual 22: Activity 10.2: Hurricane Storm Surge

Goal:

- Create a combined Flood/Hurricane study region.

Time: 10 minutes

Student Manual

Storm Surge

Goal: Create a combined Flood/Hurricane Study Region

Time: 10 minutes

Exercise Steps:

1. Refer to Activities Document "10.2_Activity_Hurricane Storm Surge"
2. Listen to instructor's directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share their answers/results.
8. Ask any final questions.

Visual 23: Exercise 10.2: Tasks

Task 1: Create a Surge Study Region

Task 2: Create a Surge Scenario

Task 3: Run a Surge Analysis

Student Manual

Activity 10.2: Tasks

- Refer to Activities Document “10.2_Activity_Hurricane Storm Surge”

Activity 10.2 – Hurricane Storm Surge

Type: Instructor-Led Activity

Time: 10 minutes

Goals: Create a combined Flood/Hurricane study region

Background:

The storm surge model is a powerful application that allows users to understand the combined losses from hurricane winds and storm surge. This application provides a more realistic set of losses than can be produced by separately analyzing flood and wind losses. By using this approach, mitigators and planners can have a more comprehensive look at what to expect and prepare for in their community.

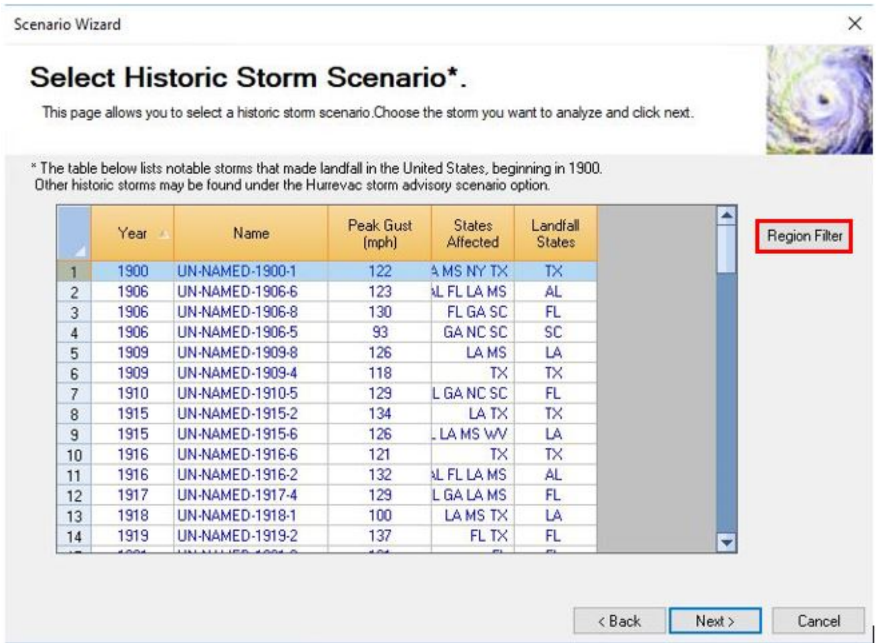
In this exercise you will build a study region for Pinellas, Florida. You will go through the steps of running the analysis based on the Hurricane Irma historical scenario. In your next activity, you will then import a study region for which the storm surge analysis has already completed in which you will move to the flood model, run the analysis, and view the results.

Task 1: Create a new Surge scenario

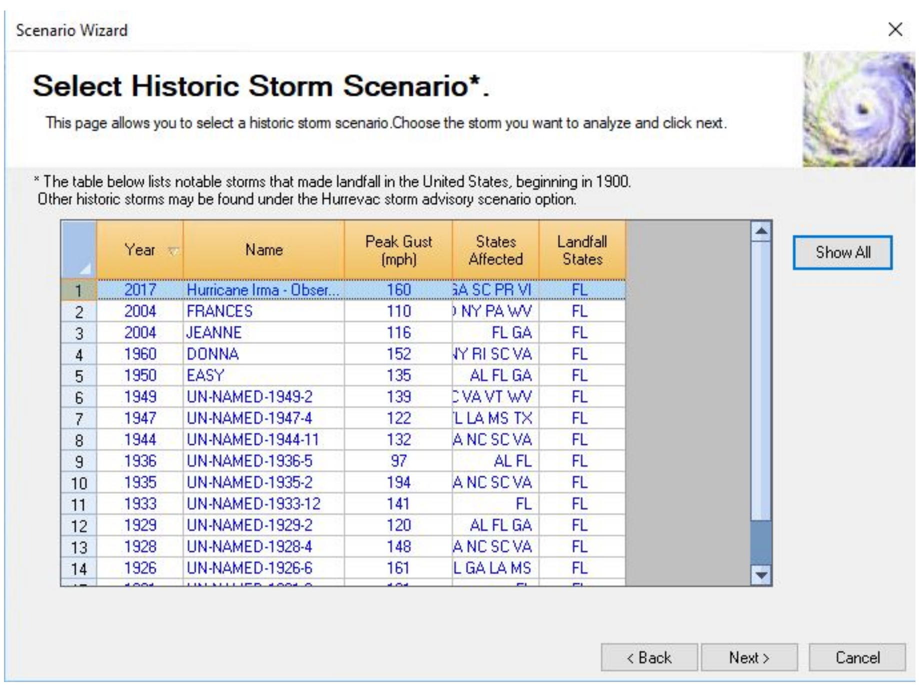
1. Create a new study region based on the following parameters:
    - Study Region Name: IrmaStormSurge
    - Hazard Type: Hurricane and Flood
    - State: Florida
    - County: Pinellas
2. Open the "IrmaStormSurge" study region
3. Select the radio button next to the hurricane hazard and click Next.
4. Click Finish.

Task 2: Create a Surge Scenario

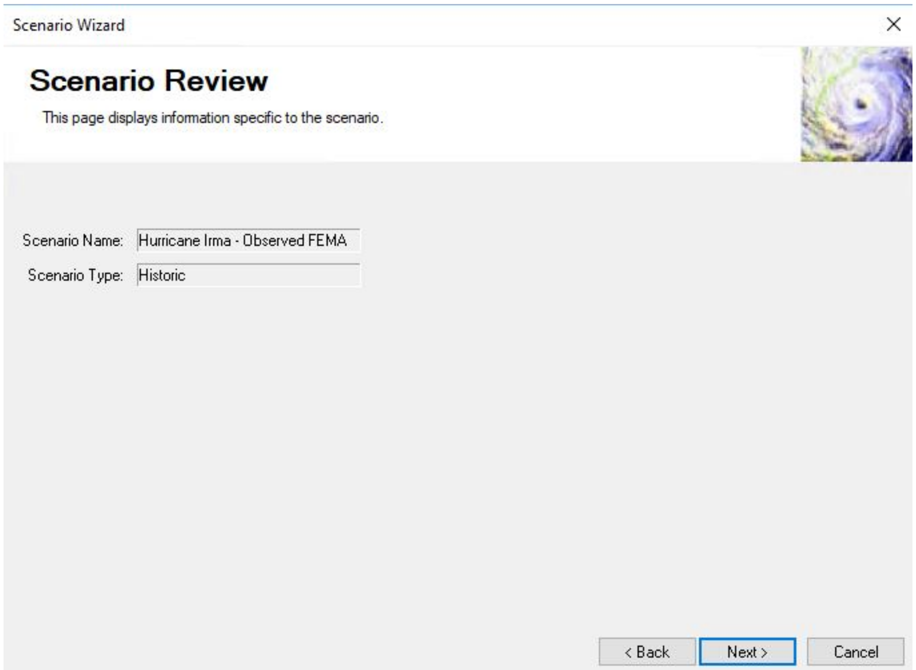
1. From the Hazard menu select Scenario to open the scenario wizard.
2. Click "Next" to advance beyond the welcome screen.
3. Select "Historic" from the Hurricane Scenario options and make sure the radio button is selected next to "Activate".
4. Click "Next" to advance the wizard.
5. Click on the Region Filter button. This will only list the hurricanes that affected your study region.



6. Select “Hurricane Irma – Observed FEMA” and click “Next”.



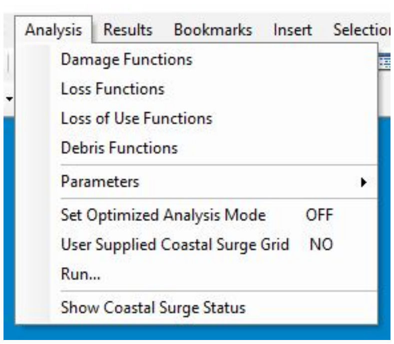
7. On the scenario review screen make sure you have selected the correct storm and then click “Next”.



8. Select "Yes. Make this scenario active" and then click "Next".
9. Exit the wizard by clicking "Finish" on the final screen.

Task 3: Run a Surge Analysis

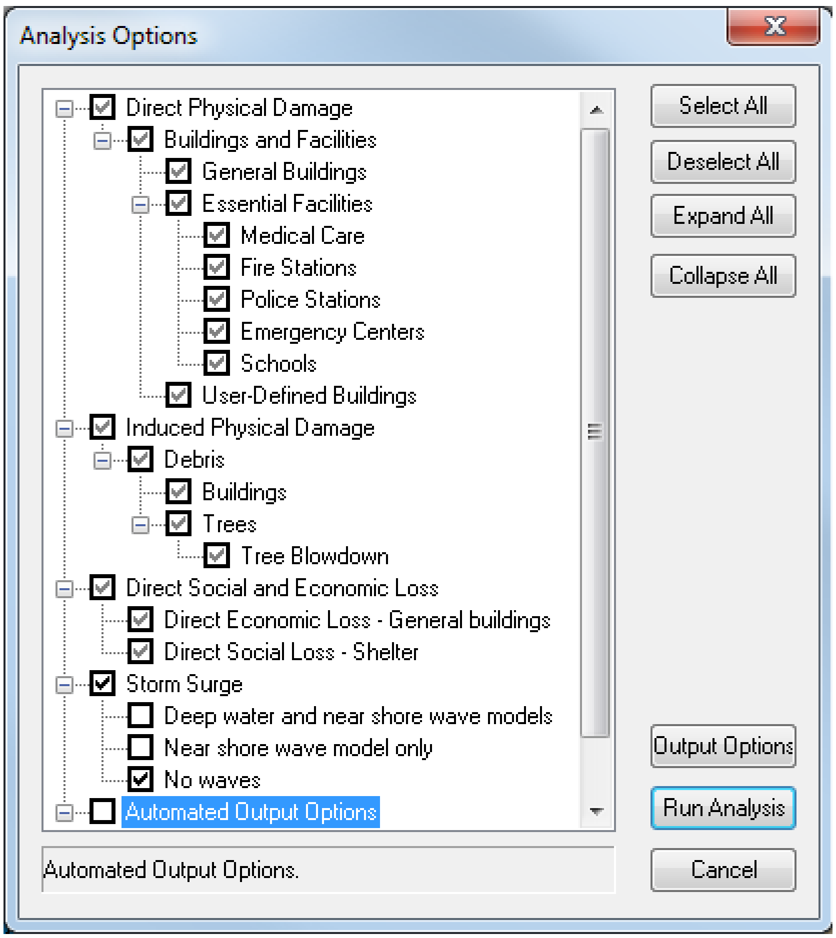
1. From the Analysis menu make sure the "Set Optimized Analysis Mode" is set to OFF.



2. When set to ON Hazus will calculate the wind hazard on the tract level. Since we are running the storm surge model, we want this set to OFF so it will run on the block level to combine block level wind results with block level flood results.

3. Open the Analysis menu by choosing “Analysis > Run”. This is the step that you would take to begin the damage and loss calculations for the Hurricane Wilma scenario.

4. Click Select All and then uncheck Automated Output Options. Make sure to select “No Waves” for Storm Surge.



5. Click on “Run Analysis”.

6. The Initial Water Level window will appear. For this activity we estimated 2 feet. Instead of entering a value and running the analysis, click cancel on this window.

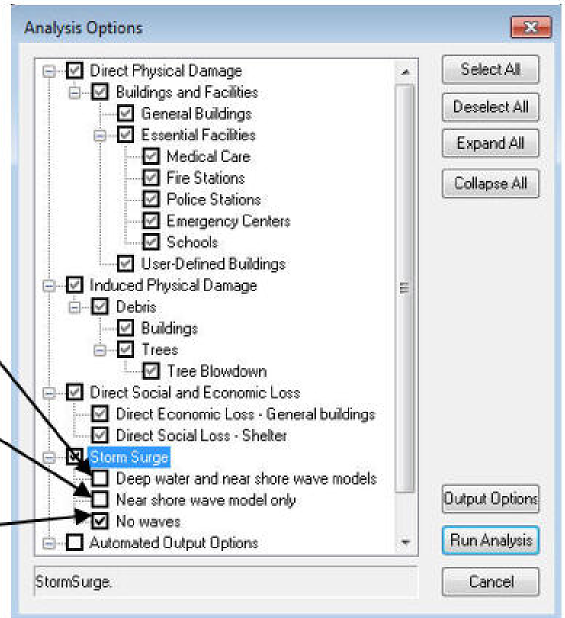
7. Click “Cancel” on the analysis options window.

8. Running the storm surge model can take > 1 hour to complete. Instead we will exit this region and import one that has completed already. The only step you are missing by not running the analysis is watching the status bars progress as the surge model completes.

9. Exit Hazus.

Visual 24: Coastal Surge Hazard Modeling Options

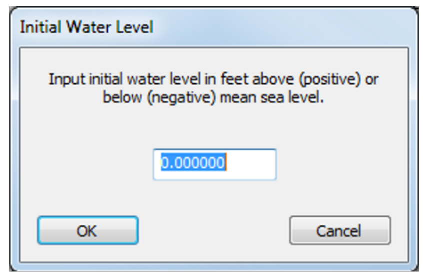
- **Surge with coupled deep water and near shore waves (SLOSH+SWAN)**
- **Surge with coupled near shore waves (SLOSH+SWAN)**
- **Surge only (SLOSH)**

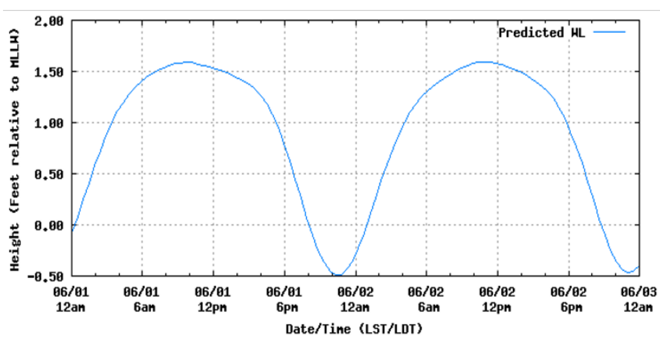


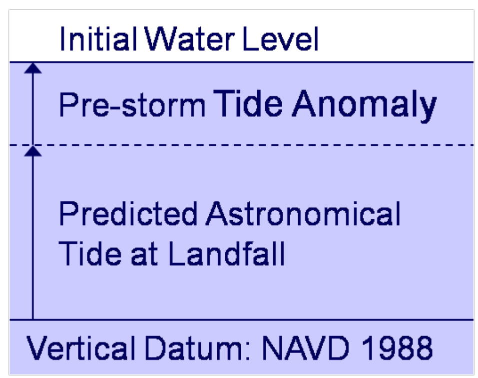
Visual 25: Initial Water Level

Pre-storm tide anomaly is the difference between:

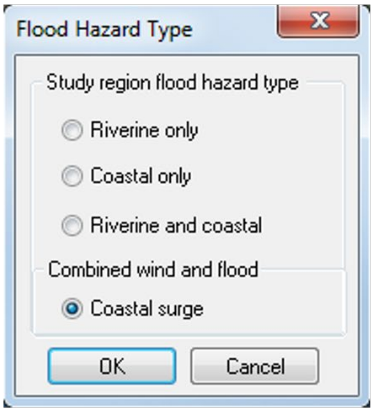
- The observed tide
- The predicted tide approximately two days before landfall (i.e., before the effects of storm surge or waves reach the study region)

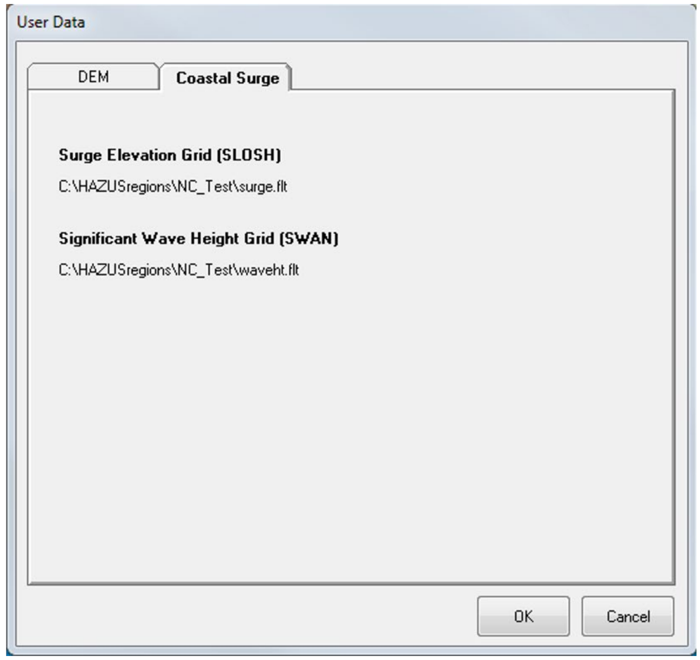






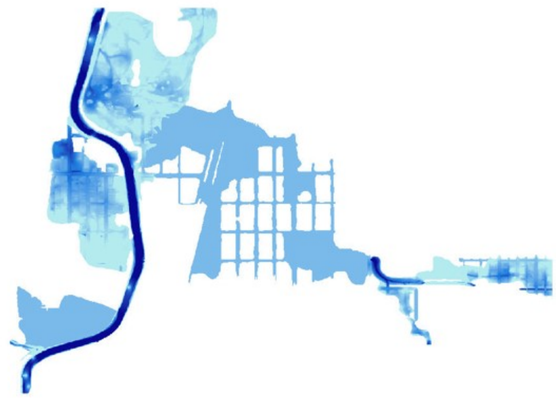
Visual 26: Flood Hazard Type and User Data





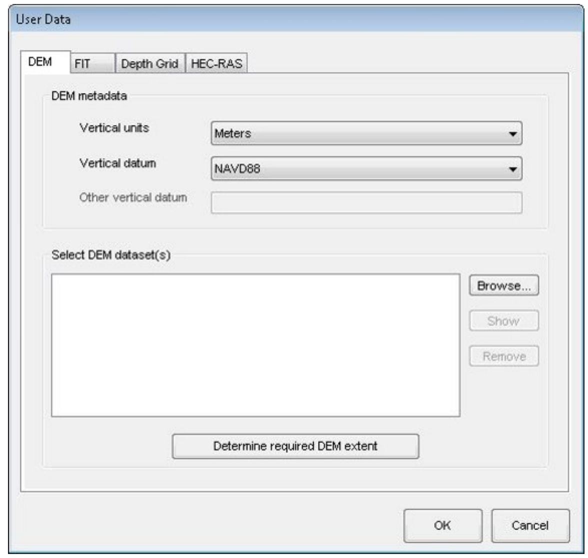
Visual 27: Depth Grids

- Depict variable flood depths throughout the determined flood extent for an event
- May be produced for a range of flood events
    - Most commonly the 0.2-percent, 1-percent, 2-percent, 4-percent, and 10-percent annual chance flood events
- Many are available for download from FEMA MSC
- Can be created from raw data



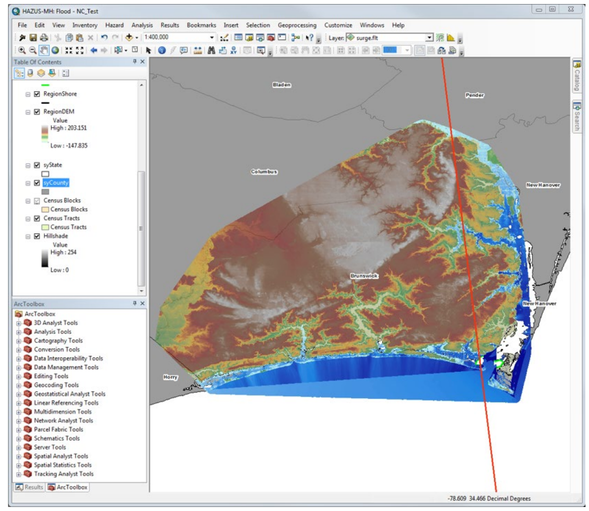
Visual 28: Defining Topography

- Required DEM extents automatically determined by Hazus
- You can use USGS national map DEM or provide your own more detailed DEM
- Terrain Data in Esri GRID format (Ex. High resolution community/county specific LiDAR, NED 10m or NED 30m)



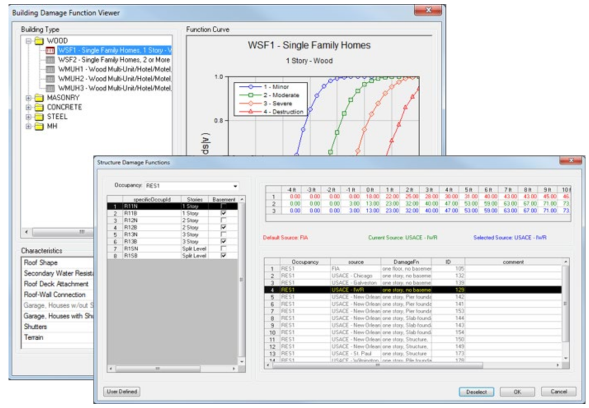
Visual 29: Delineate Floodplain

- Inundation limits
- Transects
  - Depth-limited wave heights
- Zone determination
  - A-zone
  - Coastal A-zone
  - V-zone



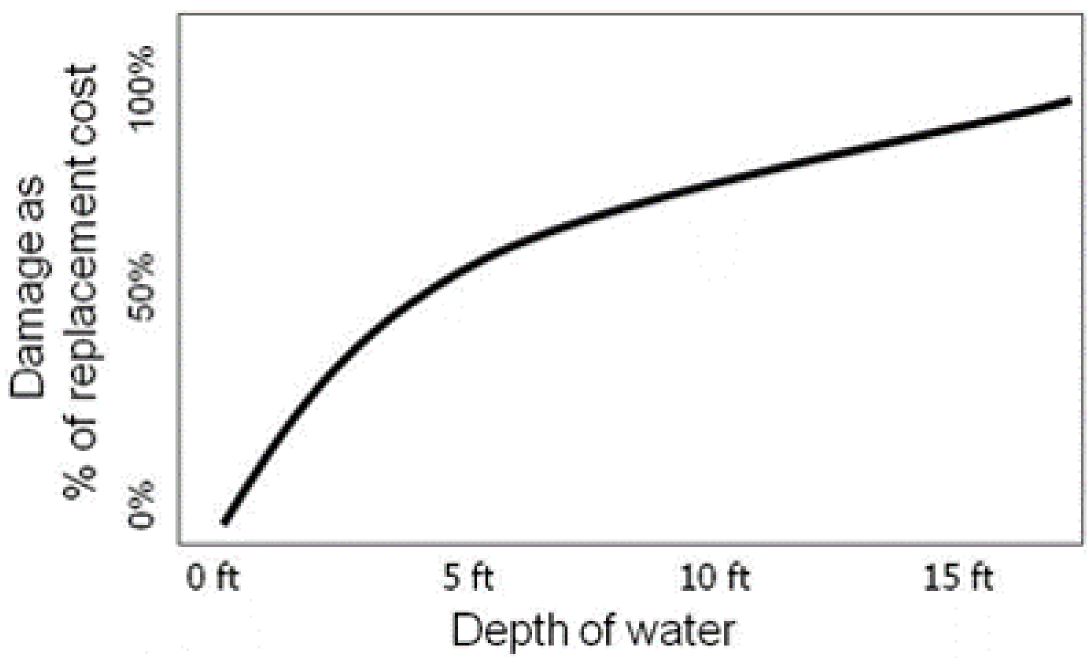
Visual 30: Surge Model

- Wind losses created first in the hurricane model.
- Storm surge depths are input into the flood model.
- Flood (surge) damages and losses utilize the flood depth damage curves.
- The combined analysis utilizes a new set of curves that combine the flood and wind losses.



Visual 31: Flood Depth-Damage Curves

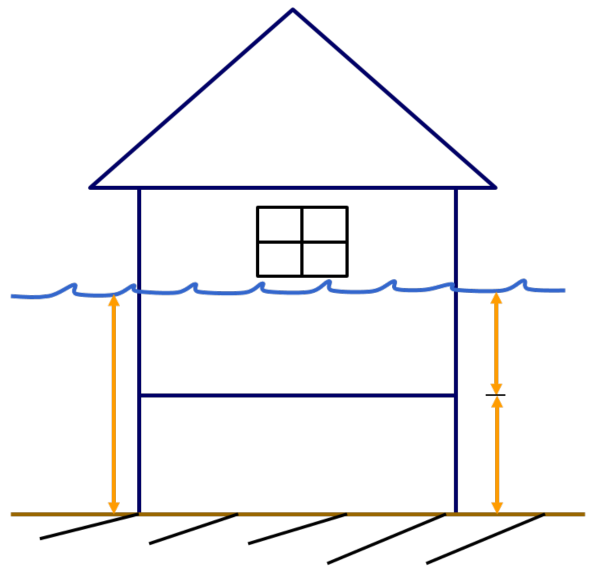
Damage to buildings and infrastructure is estimated using depth-damage curves.



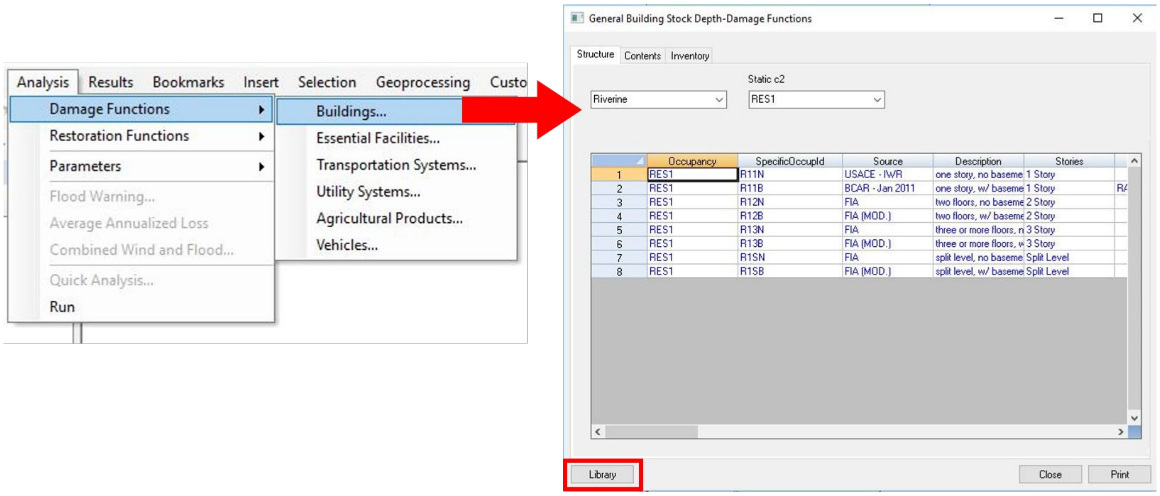
Visual 32: Depth-Damage Functions

Depth-damage functions are applied to relevant depth.

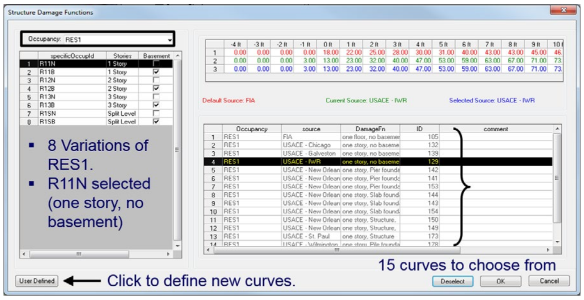
- Buildings: first-floor height
- Coastal Buildings: Bottom of first finished floor
- Equipment: height above first floor



Visual 33: Viewing Depth Damage Curves



Visual 34: Viewing Depth Damage Curves



Visual 35: FEMA Flood Zone A

The Special Flood Hazard Area (except coastal V Zones) shown on a community's Flood Insurance Rate Map. There are five types of A Zones:

Zone	Description
A	SFHA where no base flood elevation is provided.
A#	Numbered A Zones (e.g., A7 or A14), SFHA where the FIRM shows a base flood elevation in relation to NGVD.
AE	SFHA where base flood elevations are provided. AE Zone delineations are now used on new FIRMs instead of A# Zones.
AO	SFHA with sheet flow, ponding, or shallow flooding. Base flood depths (feet above grade) are provided.
AH	Shallow flooding SFHA. Base flood elevations in relation to NGVD are provided.

Visual 36: FEMA Flood Zone V

The Special Flood Hazard Area subject to coastal high hazard flooding.

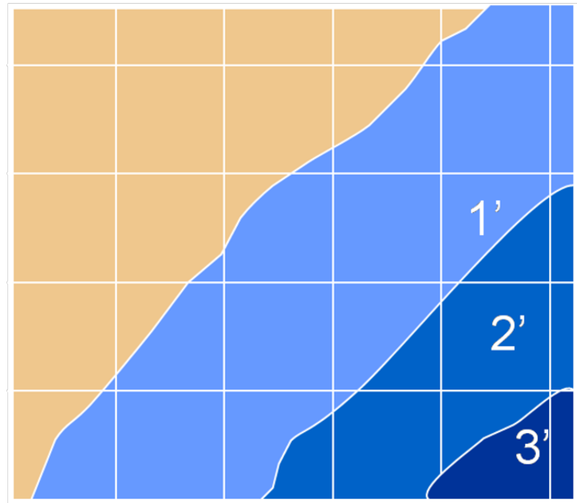
There are three types of V Zones:

Zone	Description
V	SFHA where no base flood elevation is provided.
V#	Numbered V Zones (e.g., V7 or V14), SFHA where the FIRM shows a base flood elevation in relation to NGVD.
VE	SFHA where base flood elevations are provided. VE Zone delineations are now used on new FIRMs instead of V# Zones.

Visual 37: FEMA Flood Zone C

- Area of minimal flood hazard.
- Usually depicted on Flood Insurance Rate Maps as above the 500-year flood level.
- B and C Zones may have flooding that does not meet the criteria to be mapped as a Special Flood Hazard Area.
    - Especially ponding and local drainage problems.

Visual 38: GBS Flood Loss Estimation

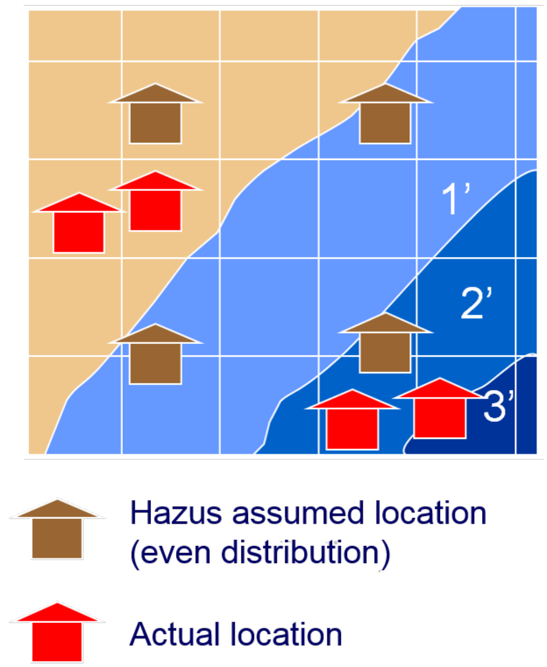


Hazus performs an area weighted assessment of damage for aggregate inventory.

- Number of grid cells at a given depth is counted and then divided by total number of cells within census block.
- Result is used to "weight" damage at that flood depth for each occupancy.
- This approach is most appropriate for large areas.

Visual 39: GBS Loss Estimation Methodology

- Assumes that inventory is evenly distributed across each census block.
  - EX: If 25% of the block has 2 feet of water, it is assumed that 25% of the 4 single family dwellings in the block are in 2 feet of water.
- Losses reported as totals for each occupancy and building type rather than for each building.



Visual 40: Combined Flood and Wind Losses

Table 8.132 in the Hurricane Technical Manual

Sub-Assembly	Pre-FIRM Foundation A Zone Conditions	Pre-FIRM Foundation CA/V Zone Conditions
Foundation	Start damaging foundation at 80% (first non-zero value is at 90%) damage and max damage at 50% Pre-FIRM value (e.g. 3% if foundation represents 6% of the structure value)	Start damaging foundation at 50% damage (first non-zero value is at 60%) and max at 80% Pre-FIRM value (e.g. 5% if foundation represents 6% of the structure value)
Below First Floor	Start damaging BFF at 0% damage (first non-zero value is 10%) and achieve 100% pre-FIRM value by 40% building damage	Start damaging BFF at 0% damage (first non-zero value is 10%) and achieve 100% pre-FIRM value at 20% building damage
Structure Frame	Start damaging structure frame at 70% damage (first non-zero value is 80%) and achieve 100% Pre-FIRM value at 100% building damage	Start damaging structure frame at 10% damage (first non-zero value is 20%) and achieve 100% Pre-FIRM value at 90% building damage
Roof Cover	Same as Structure	Same as Structure
Roof Frame	Same as Structure	Same as Structure
Exterior Walls	Start damaging exterior walls at 0% damage (first non-zero value at 10%) and reach maximum (100%) at 100% building damage. Ensure that exterior is always below interior.	Start damaging exterior walls at 10% damage (first non-zero value is 20%) and reach maximum (100%) pre-FIRM value at 90% building damage.
Interiors	Start damaging interior at 0% damage (first non-zero value at 10%) and reach maximum Pre-FIRM value (100%) at	Start damaging interiors at 0% damage (first non-zero value at 10%) and reach maximum Pre-FIRM value (100%) at

Sub-Assembly	Pre-FIRM Foundation A Zone Conditions	Pre-FIRM Foundation CA/V Zone Conditions
	80% building damage.	80% building damage.

Visual 41: Combined Flood and Wind Losses

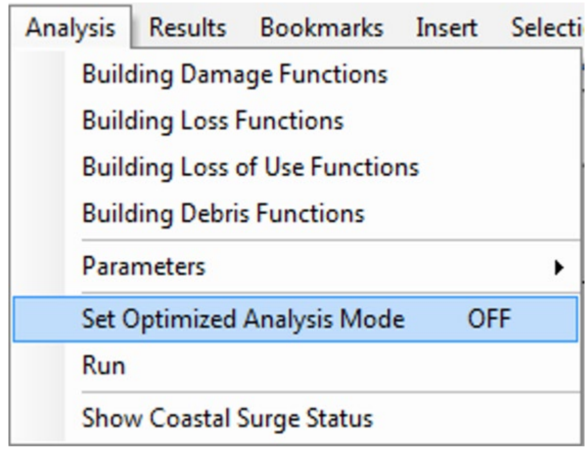
- Losses from wind and surge are combined using the combined losses tables.
  - EX: When wind losses are 50% and flood losses are 20%, the combined loss is 62.5%.

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
0%	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
10%	10%	19.5%	28.7%	37.9%	47.1%	56.2%	65.3%	74.5%	84.4%	94.3%	100%
20%	20%	29.1%	37.5%	45.9%	54.3%	62.5%	70.9%	79.4%	89.1%	98.9%	100%
30%	30%	38.8%	46.7%	54.5%	62.3%	70.0%	77.8%	85.7%	95.0%	100.0%	100%
40%	40%	48.4%	55.7%	62.8%	69.9%	76.9%	84.0%	91.2%	100.0%	100.0%	100%
50%	50%	58.0%	62.6%	71.1%	77.5%	83.8%	90.3%	96.9%	100.0%	100.0%	100%
60%	60%	67.6%	73.5%	79.3%	85.0%	90.6%	96.4%	100.0%	100.0%	100.0%	100%
70%	70%	77.2%	82.4%	87.5%	92.5%	97.3%	100.0%	100.0%	100.0%	100.0%	100%
80%	80%	86.8%	91.4%	95.7%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100%
90%	90%	96.4%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100%
100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Column Headers represent Wind-Only Building Loss percentages, Row Labels represent Flood-Only Building Loss percentages.

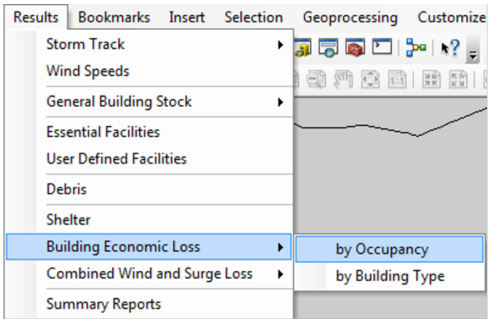
Visual 42: Combined Flood and Wind Losses

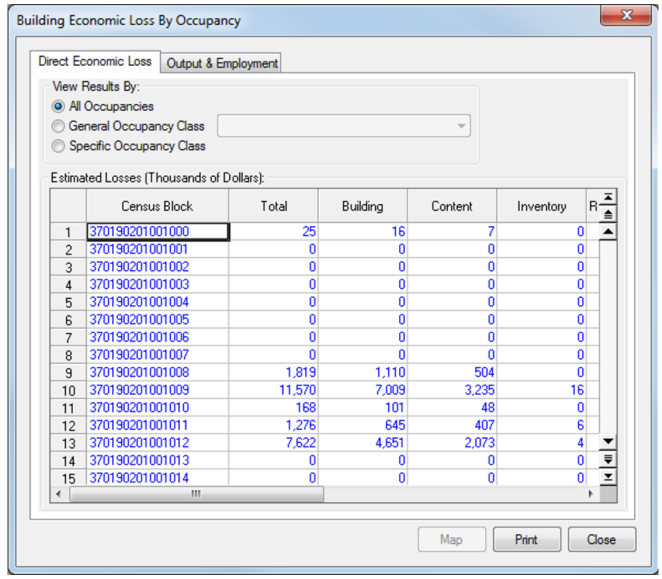
- The flood model (surge) calculates losses on the census block level: in a combined hurricane/flood model the hurricane wind model will calculate losses on the block level.
- Combined losses can only be calculated on the GBS inventory: user-defined facilities and site-specific facilities cannot be analyzed using the combined analysis.



NOTE: The Set Optimization option is only available in flood/hurricane regions. If you are not interested in combined surge/wind, select this to run the hurricane model at the tract level (faster).

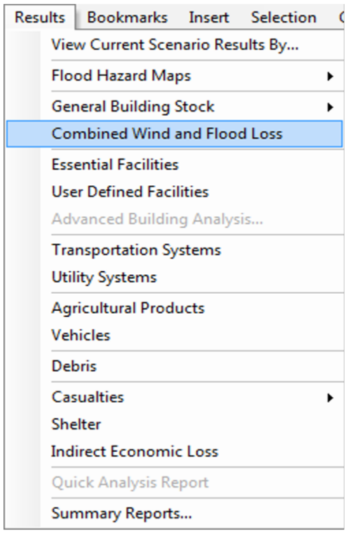
Visual 43: Wind-Only Economic Loss Table



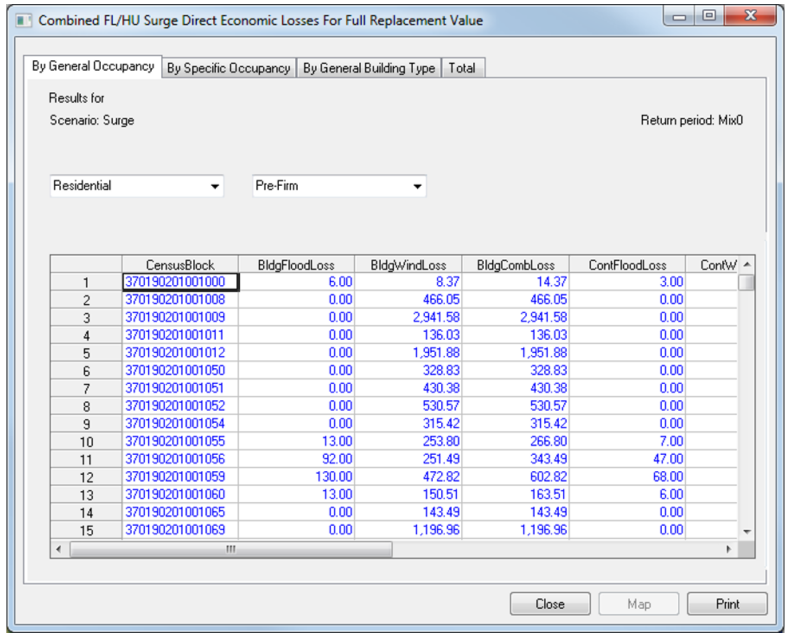


	Census Block	Total	Building	Content	Inventory	R
1	370190201001000	25	16	7	0	
2	370190201001001	0	0	0	0	
3	370190201001002	0	0	0	0	
4	370190201001003	0	0	0	0	
5	370190201001004	0	0	0	0	
6	370190201001005	0	0	0	0	
7	370190201001006	0	0	0	0	
8	370190201001007	0	0	0	0	
9	370190201001008	1,819	1,110	504	0	
10	370190201001009	11,570	7,009	3,235	16	
11	370190201001010	168	101	48	0	
12	370190201001011	1,276	645	407	6	
13	370190201001012	7,622	4,651	2,073	4	
14	370190201001013	0	0	0	0	
15	370190201001014	0	0	0	0	

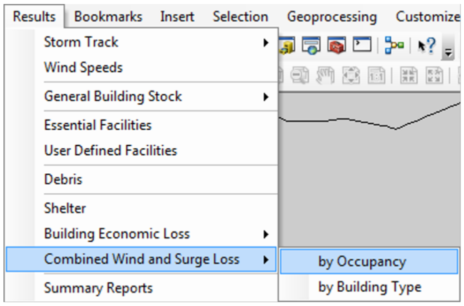
Visual 44: Combined Wind & Flood Loss Table

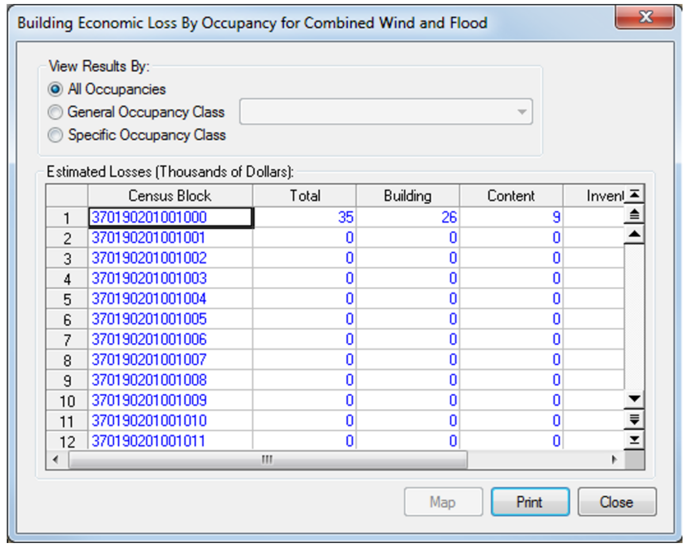


Flood Model



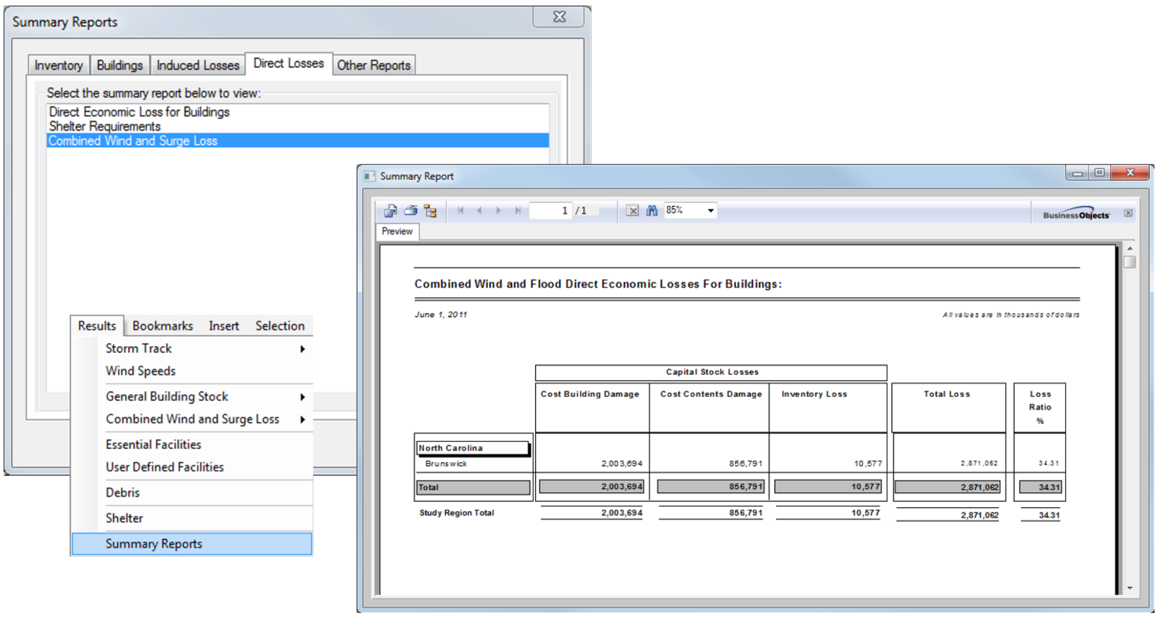
Visual 45: Combined Wind & Flood Loss Table





Hurricane Model

Visual 46: Combined Loss Summary Report



Visual 47: Exercise 10.3: Surge Menu

Goals:

- Explore the Surge menu items in the hurricane model and flood model. Discuss the reports and tables from the combined losses.

Time: 45 Minutes

Student Manual

Exercise 10.3: Surge Menu

Goals:

- Explore the Surge menu items in the hurricane model and flood model.
- Discuss the reports and tables from the combined losses.

Time: 45 minutes

1. Refer to Activities Document “10.3_Exercise_Surge Menu.”
2. Listen to instructor’s directions.
3. Ask questions if clarification is needed.
4. Follow along to complete the task with the instructor.
5. Complete the goal assigned.
6. Ask any final questions.

Visual 48: Exercise 10.3: Tasks

Task 1: Define User Data

Task 2: Create a New Scenario

Task 3: Run the Surge Analysis

Task 4: View Reports and Discuss Map Options

Activity 10.3: Surge Menu

Type: Instructor-Led Activity

Time: 45 minutes

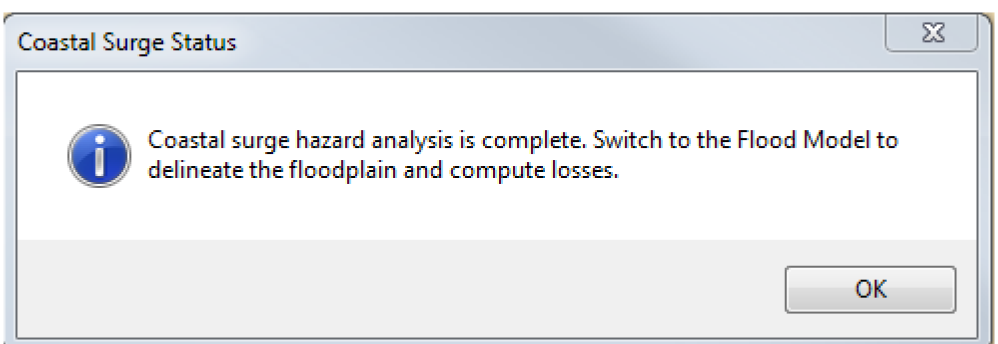
Goal: Explore the Surge menu items in the hurricane model and flood model. Discuss the reports and tables from the combined losses.

Background:

This activity is a continuation of the previous activity in which you created a combined Flood/Hurricane study region and defined your analysis. This activity begins as if the analysis had just finished. Using an imported study region, you will move to the flood model, run the analysis, and view the results in table and report forms.

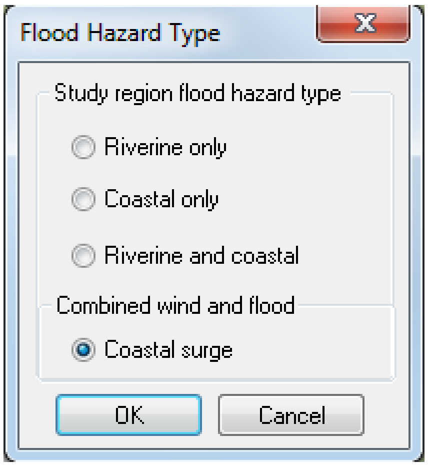
Task 1: Define User Data

1. Open Hazus.
2. Select Import a region and then click OK.
3. Navigate to C:\E0170_ActivityData\Activity_10.3 folder and select the Irma_Surge.hpr and click "Open".
4. Name the imported region "Irma_Surge". **If you receive a duplicate log file error for "Irma_Surge" name this study region "Irma_Surge_HUFL".**
5. Click "OK".
6. When the import finishes, "Open" the region and when prompted, indicate that you wish to open the Hurricane hazard.
7. From the Analysis menu select "Show Coastal Surge Status".

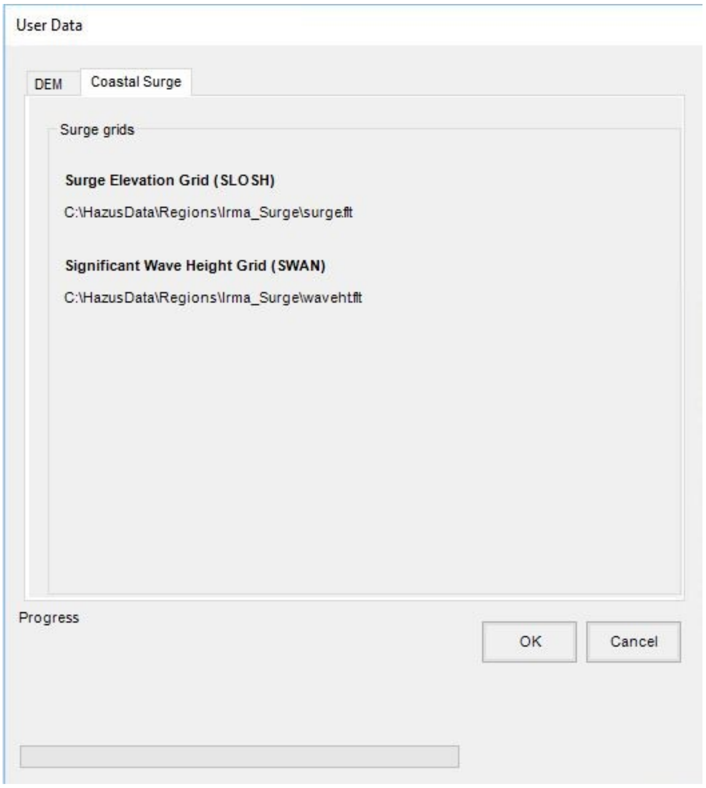


8. Click "OK".
9. Click the Switch Hazard button and change the hazard to Flood. You can also find the switch hazard option in the File menu.

10. Click “Yes” if you are asked to save changes to HazusHu.mxd.
11. Open the Hazard menu to choose Flood Hazard Type.
12. Select “Coastal Surge” and click “OK”.



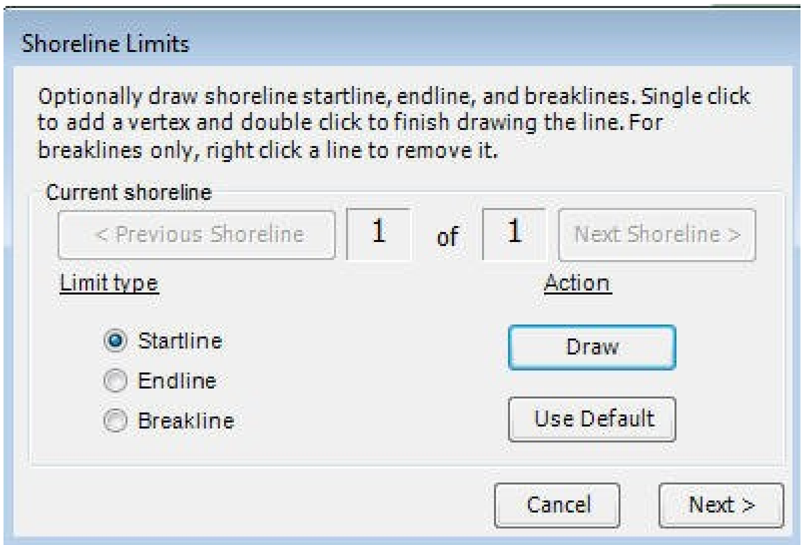
13. From the Hazard menu choose User Data and select the DEM tab.
14. Click Determine required DEM extent.
15. Once complete, click Download and Unzip All.
16. Click OK when complete.
17. Click Yes to incorporate the DEM data into the study region.
18. Click OK.
19. Click Yes on the Process window. This should take less than a minute.
20. Click OK when complete.
21. Navigate to the Hazard menu and choose User Data again.
22. Click the Coastal Surge tab.
23. This window specifies the location of the surge grids that will be used in the analysis. You can view these datasets in ArcGIS. Note that the location of your data may be different than the example shown below if your software was installed to point to a different location for study regions.



24. Click “OK” to process the DEM and click “Yes” to acknowledge you want to proceed. This will take less than a minute to complete.
25. Click “OK” once the DEM processing is complete.

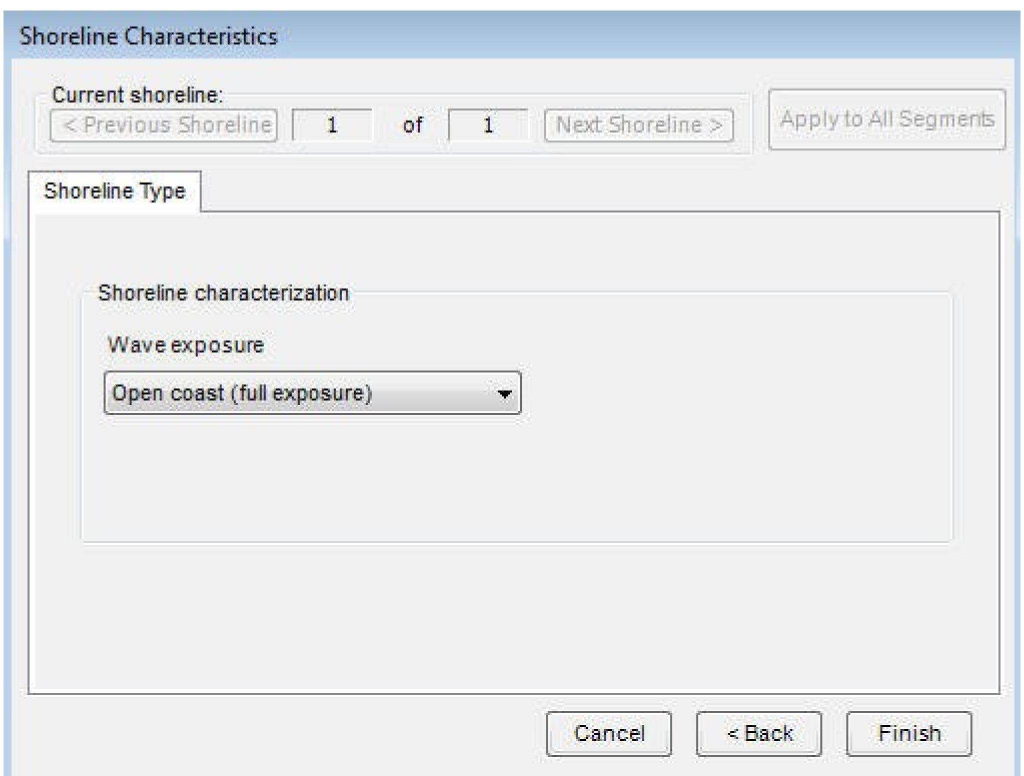
Task 2: Create a New Scenario.

1. From the Hazard menu choose “Scenario > New”.
2. Name the scenario Irma_Surge and click OK. This prompts the shoreline wizard to populate.



3. Accept the default shoreline limits by clicking "Next". We will use the default assumptions for the shoreline.

4. Choose "Open Coast (full exposure)" for the Wave exposure. We are choosing this for speed. Many of the shorelines are actually protected from wave exposure.



5. Click “Finish”.

6. From the Hazard menu choose “Coastal > Delineate Floodplain”. This will take approximately 5 minutes to complete.

7. Once completed, click “OK”. You should now see the storm surge flood depth grid appear on the map.

Task 3: Run the Surge Analysis

1. From the Analysis menu choose “Run”.

2. Click Select All and then unselect the “What-If” option. If you do not unselect the What-If option the combined losses may not populate.

3. Click “OK” to start the analysis. This will take approximately 10 minutes to complete. If you have not taken a break, this is a good time for a short break.

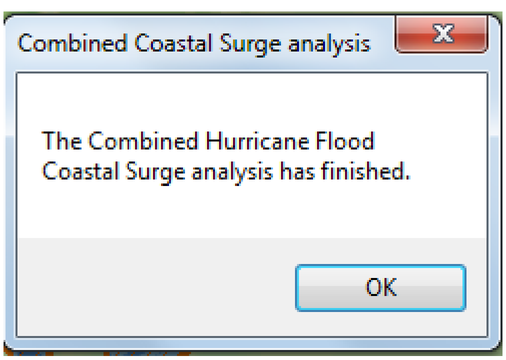
4. When prompted enter September 12 as the flood date and click “OK”.

5. Click “OK” once the flood analysis has completed.

6. From the Analysis menu choose Combined Wind and Flood…This initializes the combined hurricane wind and surge analysis.

7. Click OK to begin the analysis.

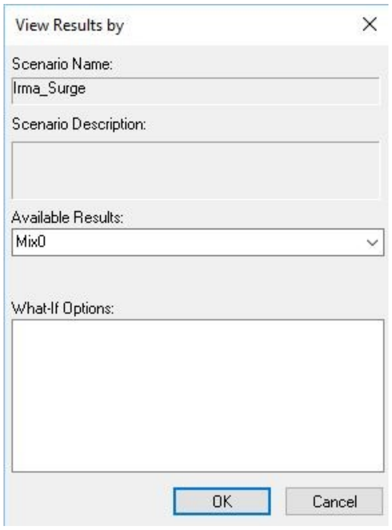
8. Click “OK” when you are informed that the combined analysis has completed.



Task 4: View Reports and Discuss Map Options

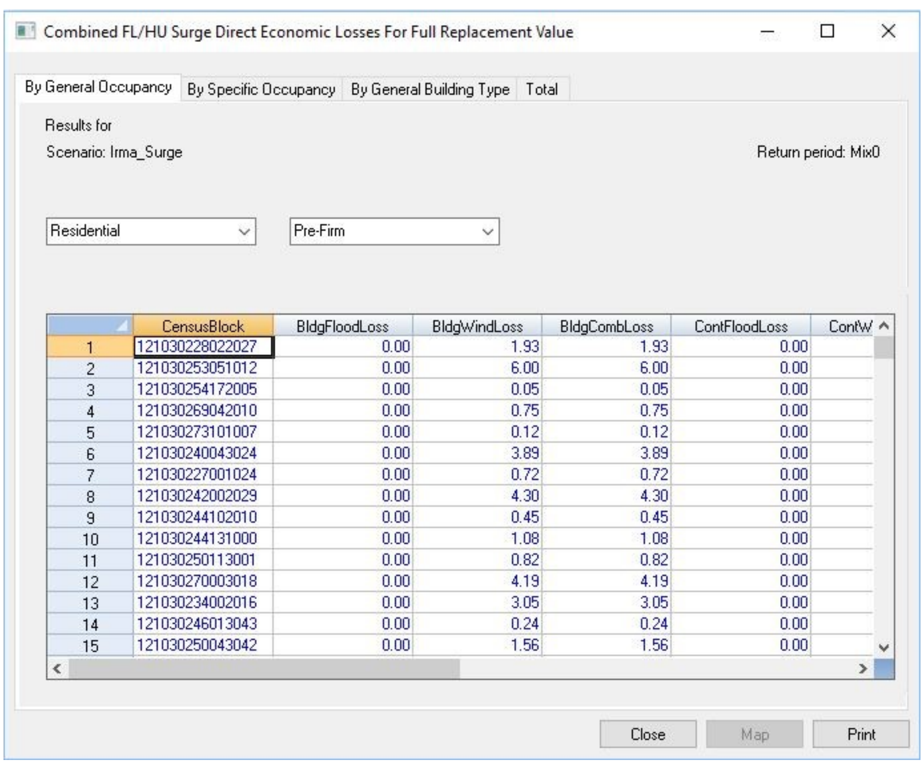
1. From the Results menu choose View Current Scenario Results By…

2. Under Available Results choose “Mix0”.



3. Click “OK”.

4. From the Results menu choose Combined Wind and Flood Loss. This table contains the flood only, wind only, and combined losses for each census block.



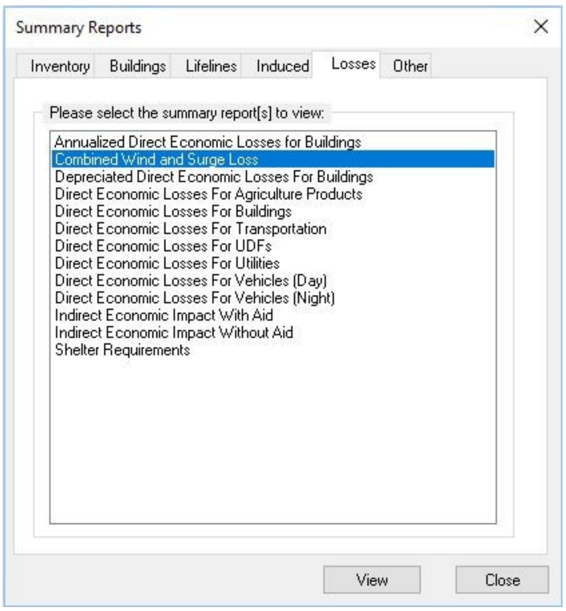
	CensusBlock	BldgFloodLoss	BldgWindLoss	BldgCombLoss	ContFloodLoss	ContW
1	121030228022027	0.00	1.93	1.93	0.00	
2	121030253051012	0.00	6.00	6.00	0.00	
3	121030254172005	0.00	0.05	0.05	0.00	
4	121030269042010	0.00	0.75	0.75	0.00	
5	121030273101007	0.00	0.12	0.12	0.00	
6	121030240043024	0.00	3.89	3.89	0.00	
7	121030227001024	0.00	0.72	0.72	0.00	
8	121030242002029	0.00	4.30	4.30	0.00	
9	121030244102010	0.00	0.45	0.45	0.00	
10	121030244131000	0.00	1.08	1.08	0.00	
11	121030250113001	0.00	0.82	0.82	0.00	
12	121030270003018	0.00	4.19	4.19	0.00	
13	121030234002016	0.00	3.05	3.05	0.00	
14	121030246013043	0.00	0.24	0.24	0.00	
15	121030250043042	0.00	1.56	1.56	0.00	

5. Close the Combined FL/HU Surge Direct Economic Losses For Full Replacement Value window.

6. From the Results menu choose Summary Reports.

7. Click on the Losses tab.

8. Click on the “Combined Wind and Surge Loss” report and then click “View”. This is the combined losses report.



9. “Close” the report.

10. Click the Switch Hazard button and go back to the Hurricane hazard.

11. When prompted, click “Yes” to save your changes.

12. Under the Results menu choose Combined Wind and Surge Loss > By Occupancy.

13. The table shows the combined losses. “Close” the window when you have viewed the layout.

14. From the Results menu choose Summary Reports.

15. Click on the Direct Losses tab.

16. Click on the Combined Wind and Surge Loss report and then click “View". Notice that the losses reported in this report are identical to the report that you viewed in the flood model. This report is provided in both the hurricane and flood models for the user’s convenience.

17. Close the Summary Report.

18. When you are finished click “Save”.

19. Exit Hazus.

Visual 49: Lesson 10: Review

1. What are the causes of a storm surge?
2. What are the Hazus surge model components?
3. What is the procedure for running a hurricane surge in Hazus?
4. How do the hurricane and flood model damage and loss analyses differ (not combined)?

Visual 50: Questions?

Lesson 11: Mitigation Analysis

Visual 1: Lesson 11: Mitigation Analysis

Visual 2: Lesson 11: Goal and Objectives

Goal: To provide an overview of the mitigation analysis provided in Hazus.

After completing this lesson you will be able to:

- Understand the common mitigation practices for hurricanes.
- Explain how mitigation is modeled in Hazus.

Visual 3: Applying Mitigation

- In Hazus: Modifying wind building mapping scheme
- Can be applied:
  - One technique at a time
  - Many techniques at once
- Can be applied geographically:
  - Entire region
  - Specific census tracts
- Applies to all building classes

Visual 4: Possible Uses of Mitigation Options

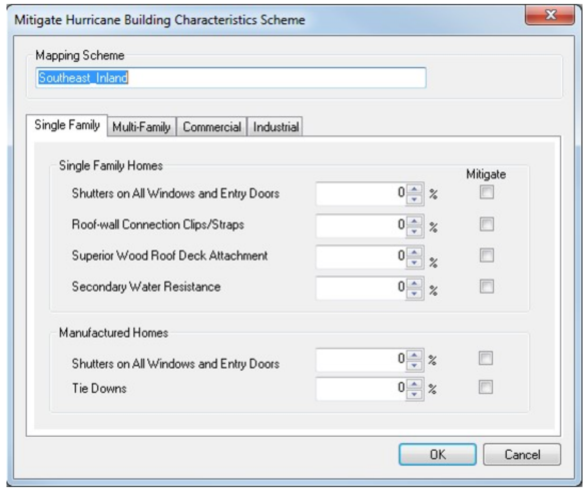
Identify mitigation options with best return on investment.

- Answers depend on local hurricane climatology and building stock
- Additional information required: mitigation cost data

Predict impact of building stock changes:

- New building codes
- New construction trends

Visual 5: Mitigation of Damage: Options for...



Single-Family or Multi-Family Residential:

- Roof covering
- Secondary water resistance
- Roof sheathing attachment
- Roof framing attachment
- Opening protection

Manufactured Homes:

- Tie-downs
- Opening protection

Visual 6: Mitigation of Damage: Options for...

Commercial buildings (low-rise strip mall buildings):

- Shutters on all windows and entry doors
- Roof-wall connection clips/straps
- Superior wood roof deck attachment
- Superior metal roof deck attachment

Commercially engineered buildings, low rise industrial buildings, and pre-engineered metal buildings:

- Superior metal roof deck attachment
- Opening protection

Visual 7: Roof Covering

- Best solution to mitigate loss of roof cover:
  - Replacement of inferior products with superior ones
- Consider life span of roof:
  - Shingles: 10-25 years
  - Tiles: 50+ years
- Consider cost of replacement:
  - Shingles: Approx. $3,000-5,000 (relatively cheap)
  - Tiles: Approx. $20,000 (relatively expensive)
- Hazus model does not include models for concrete tiles or metal roofs (except Hawaii)

Visual 8: Shingle Roof Covering Standards

Testing Standards:

- ASTM D7158 (modified to 115 mph)
- SFBC PA 107 or PA 108: Dade County test for wind resistance of shingles
- UL 997 modified to 110 mph: Make sure it is high wind version of test

Visual 9: Secondary Water Resistance (SWR)

Applied on all plywood joints

Visual 10: Secondary Water Resistance (SWR)

- Roof cover loss is likely.
- SWR serves as backup in event of roof covering losses.
    - Self-adhering waterproof underlayment
    - Meets ASTM D 1970
    - Apply at time of normal re-roofing

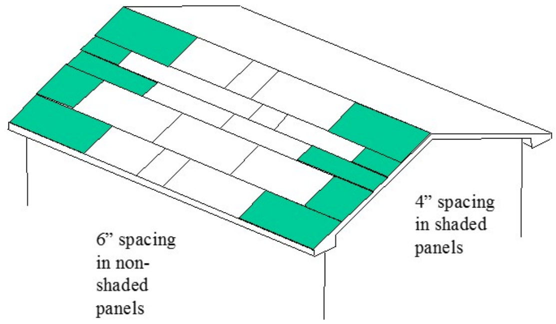
Visual 11: Roof Sheathing Attachment

Re-nail with tighter nail spacing:

- SSTD 10-99: Latest code requirements are 6”x6” spacing in high wind areas
- Re-nail during re-roofing option

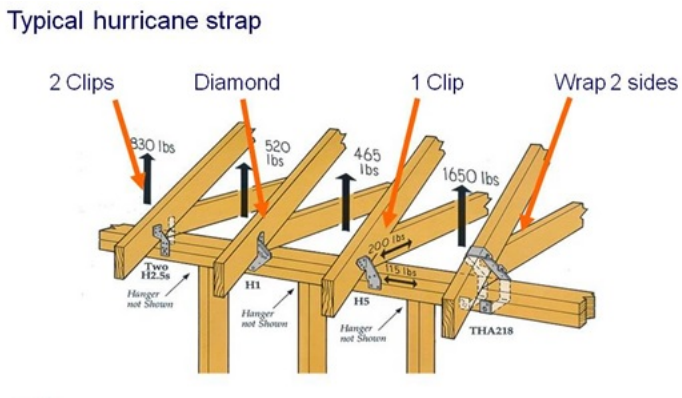
Re-nail with stronger fasteners:

- Larger nails
- Ring shank nails
- Screws



Not a good option for expensive roof coverings such as tile or slate

Visual 12: Roof Framing Attachment



Visual 13: Opening Protection

Openings include:

- Windows
- Doors (including patio and French doors)
- Sliding glass doors
- Garage doors
- Skylights

Protection takes two forms:

- Replace existing fenestration with one that is impact-resistant
- Install external protection devices that are impact-resistant

Visual 14: Opening Protection

Large Missile Impact Test:

- Firing a 2x4 at approximately 50ft/s at product
- Product passes if it remains operable after resisting impacts

Four Dominant Impact Standards:

- ASTM E 1996 - 9lm missile
- SBCCISSTD 12-97
- Dade County South Florida Building Code PA 201
- Florida Building Code TAS 201

Small Missile Impact Test:

- Approx. 20 pieces of gravel are fired with a cannon at the product

NOTE: These tests also include a pressure cycling component

Visual 15: Opening Protection

Student Manual

Opening Protection

- Transcript of the video:
    - 00:01 "Ready"
    - 00:03 "Fire"
- The video demonstrates a large missile impact test where a 9lb 2x4 is shot from an air cannon at a shutter specimen. The shutter withstands the impact of the missile.

Visual 16: External Protection Devices (Shutters)

Bahama

Accordion

Panels

Roll-Up

Visual 17: Shutters vs. Impact Resistant

Replacement of doors/windows vs. external protection devices

Exceptions:

- Garage doors: Large spans make shuttering difficult
- Entry doors: One entry door to the building is replaced with an impact resistant product to allow for egress regulations in building code
- Skylights: Very few external protection devices exist

Visual 18: Replacement Garage Door

Impact door features:

- Ribs to reinforce panel
- Heavy track

Alternative retrofit:

- Post system

Visual 19: Other Information

Fortified for Safer Living:

- By Institute for Business and Home Safety
- For more information visit: disastersafety.org

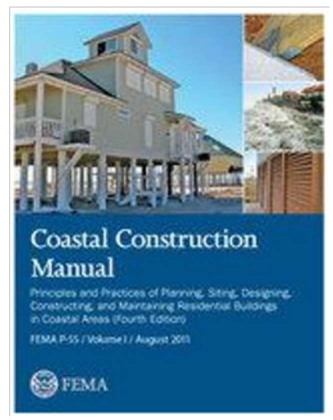
Blueprint for Safety:

- By Federal Alliance for Safe Homes

For more information visit: www.flash.org

Coastal Construction Manual:

- Principles and Practices of … Residential Buildings in Coastal Areas
- FEMA P-55, 4th Edition (2011)
- For more information visit: https://www.fema.gov/media-library/assets/documents/3293



Visual 20: Mitigation Benefits (SE Florida)

Single-Family Homes	**Reduction in Annualized Hurricane Losses (AHL)**
Install Shutters	17% to 46%
Upgrade Roof	3% to 49%
Add Secondary Water Resistance	3% to 35%
Upgrade Roof and Add SWR	4% to 57%
Install Shutters and Upgrade Roof	46% to 71%
Shutters, Upgrade Roof and SWR	51% to 85%
Manufactured Homes	**Reduction in AHL**
Foundation Tie-Down	9% to 25%

Visual 21: Discussion 11.1: Mitigation Options

Goal:

- Discuss mitigation options.

Time: 10 minutes

Visual 22: Exercise 11.2: Mitigation Actions

Goals:

- Run various mitigation scenarios.
- Compare and contrast the results.

Time: 45 minutes

Visual 23: Exercise 11.2: Tasks

Task 1: Create a Study Region

Task 2: View the Pre-Mitigation Annualized Loss Estimates.

Task 3: Create and Apply a Mitigation Mapping Scheme.

Task 4: View the Post-Mitigation Annualized Loss Estimates.

Task 5: Compare the Estimated Losses

Exercise 11.2: Mitigation Actions

Type: Student-Led Activity

Time: 45 minutes

Goals:

- Run various mitigation scenarios.
- Compare and contrast the results.

Background:

This exercise illustrates the type of strategies you can pursue for evaluating the risk posed by hurricanes. To examine this risk, you will import a completed probabilistic analysis, examine its losses, implement mitigation strategies to the building stock, and examine the reduction in annualized losses from the hurricane. This type of approach is often useful when developing mitigation strategies since communities work with limited resources and they must use the best information available, often prepared with tools such as Hazus, to apply those resources in the most effective manner possible.

Task 1: Create a Study Region.

1. Double-click the Hazus icon on your desktop.
2. Click Create a New Region and click OK.
3. Click Next.
4. Enter Michael_Mitigation as the study region name.
5. Check the box next to the Hurricane hazard.
6. Click Next.
7. Click No to using the Hurricane Scenario Wizard to create the study region.
8. Select County and click Next.
9. Choose Florida and then click Next.
10. Select Gulf county and then click Next.
11. Click Finish and open the region

Task 2: View the Pre-Mitigation Annualized Loss Estimates.

1. From the Hazard menu choose Scenario.
2. Click Next.
3. Choose Probabilistic and make sure radio button next to Activate is filled.
4. Click Next.
5. Click Next on the Activate Scenario window.
6. Click Finish.

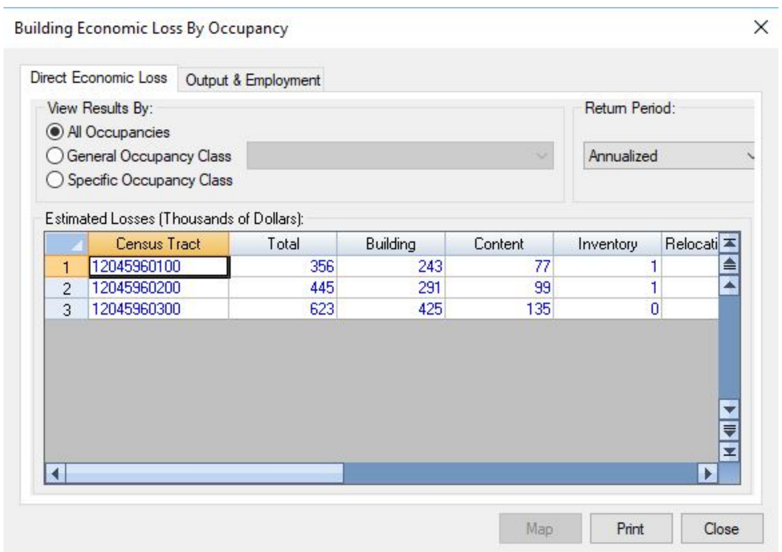
7. Go to Analysis and then Run.

8. Select all except for the Automated Output Options and click Run Analysis.

9. From the Results choose General Building Stock > Building Economic Loss > by Occupancy to open the Building Economic Loss by Occupancy window.

10. Click the Direct Economic Loss tab and verify that View Results by All Occupancies is selected.

11. Change the Return Period to “Annualized”.



12. Select the Total column and click the “Map” button. This will add the layer “Total Loss - All - Annualized ($K)” to the map.

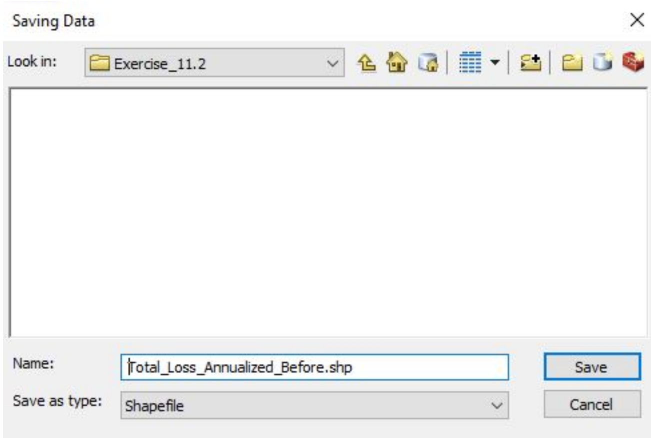
13. Click “Close” to close the Building Economic Loss by Occupancy window.

14. Right-click the Total Loss - All Annualized ($K) layer and choose “Data” > “Export Data” to open the Export Data window. Note: This layer will be used to compare the pre-mitigation losses with the post mitigation losses to calculate the savings associated with applying the mitigation actions.

15. In the Export Data window click on the “Browse” folder icon.

16. Navigate to C:\E0170_ActivityData\Exercise_11.2 and name the file “Total_Loss_Annualized_Before”.

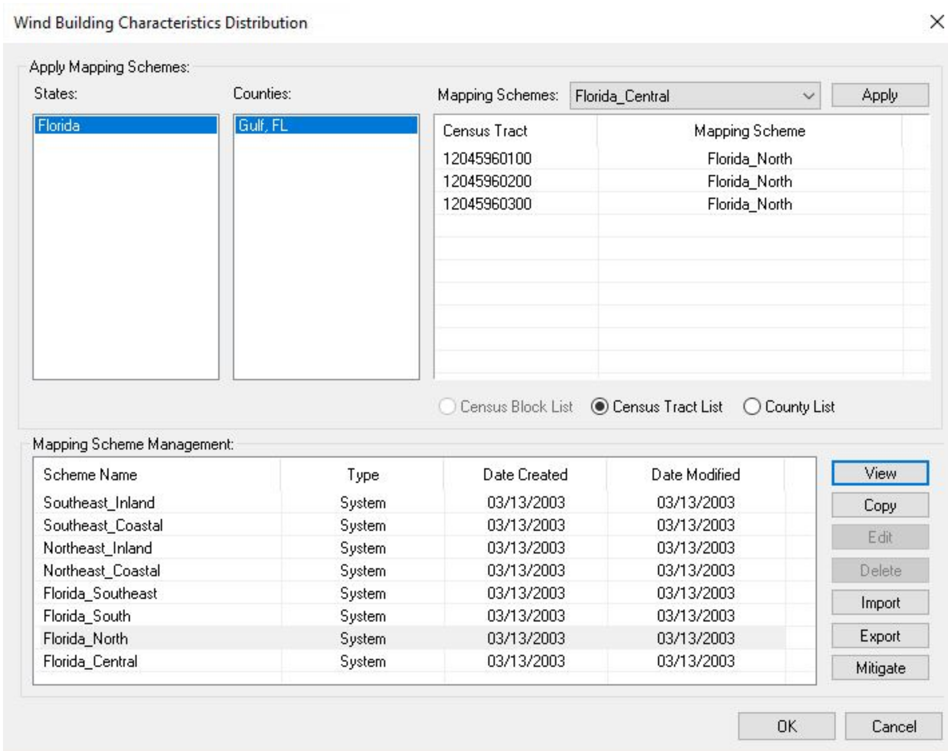
17. Change the Save as type drop-down menu to “Shapefile”.



18. Click “Save” to close the Saving Data window.
19. Click “OK” to close the Export Data window.
20. Answer “Yes” to add the exported data to the map as a layer.

Task 3: Create and Apply a Mitigation Mapping Scheme.

1. From the Inventory menu choose General Building Stock > Wind Building Characteristics Distribution to open the Wind Building Characteristics Distribution window.
2. At the bottom of the window click on Florida_North and then click “View”.
3. Double-click on the Wood folder and then click on WSF1 – Single Family Homes, 1 Story – Wood.
4. Scroll down to the Shutters Category. Note: The percentage of homes with shutters (8%) and the percentage without (92%). We will apply a mitigation scheme that will increase this percentage later.
5. Click “OK” to close the Wind Building Characteristics Distribution Window.
6. Click on “Gulf, FL” from the Counties selection box. Notice all of the census tracts in Gulf, FL are assigned the Florida_North mapping scheme.

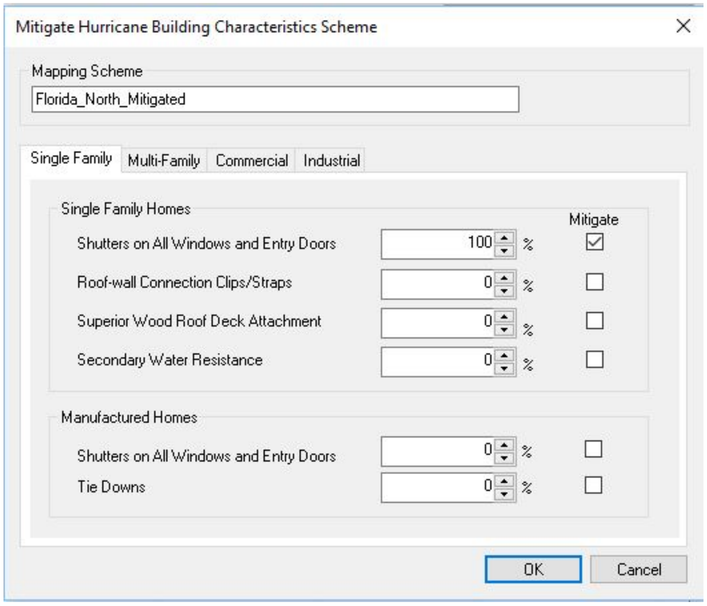


7. Select the Florida_North mapping scheme on the bottom half of the window and indicate that you want to create a new Mapping scheme by clicking "Mitigate".

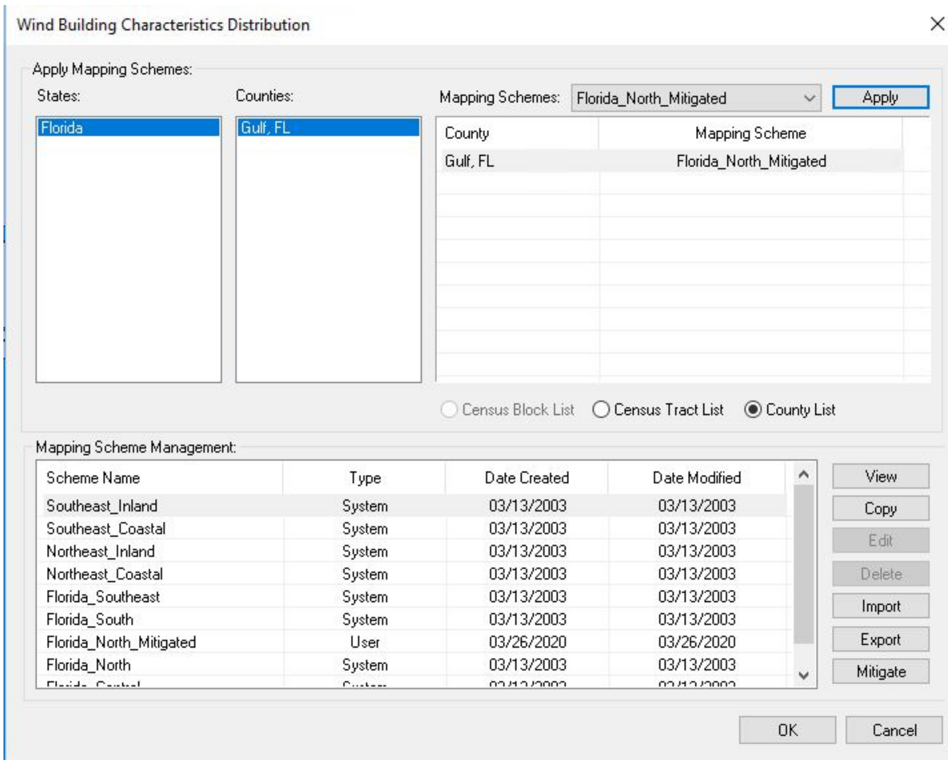
8. Name the new Mapping Scheme Florida_North_Mitigated and change the percentage of Shutters on All Windows and Entry Doors for Single Family Homes to 100%.

Note: This will simulate a program that would provide incentives to existing residential housing to shutter and require all new housing to be constructed with shutters.

9. Click the check box to Mitigate next to the 100% increase.



10. Click “OK” to close the Mitigate Hurricane Building Characteristics Scheme window. In the next few steps you will apply the new mitigated mapping scheme to the whole study region.
11. Select Gulf, FL from the counties in the middle box. Select the County List radio button.
12. Under the County column in the window to the far right select Gulf, FL.
13. Choose Florida_North_Mitigated from the Mapping Schemes drop-down box.
14. Click “Apply” to ensure the mitigation options are applied.



15. Click “OK” to close the Wind Building Characteristics Distribution window.

16. Navigate to the Analysis menu and click on “Analysis > Run”. Select all of the options except the Automated Output Options and then click “Run Analysis”.

17. Once the analysis has finished click “OK”.

Task 4: View the Post-Mitigation Annualized Loss Estimates.

1. From the Inventory menu choose General Building Stock > Wind Building Characteristics Distribution to open the Wind Building Characteristics Distribution window.

2. At the bottom of the window click on Florida_North_Mitigated and then “View.”

3. Double-click on the Wood folder and click on WSF1 – Single Family Homes, 1 Story – Wood.

4. Scroll down to the Shutters Category. The percentage of shutters should have increased to 100%.

5. Click “OK” to close the Florida_North_Mitigation mapping scheme.

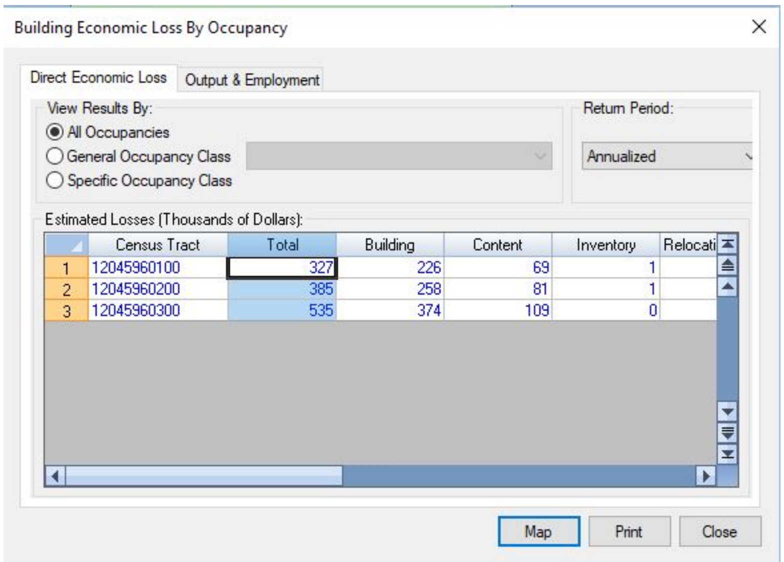
6. Click “OK” to close the Wind Building Characteristics Distribution window.

7. From the Results menu choose General Building Stock > Building Economic Loss > By Occupancy to open the Building Economic Loss by Occupancy window.

8. Click the Direct Economic Loss tab and verify that View Results by All Occupancies is selected.

9. Click Annualized from the Return Period drop down selection.

10. Select the Total column and click on “Map”. This will add the layer “Total Loss - All - Annualized ($K)” to the map.



11. Click “Close” to close the Building Economic Loss by Occupancy window.

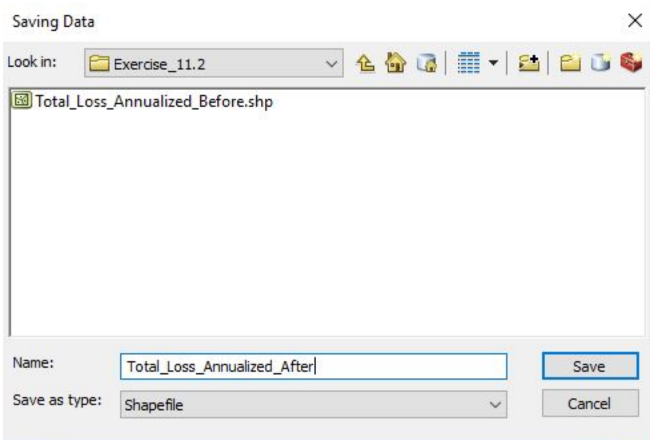
12. Right-click the Total Loss - All - Annualized ($K) layer and choose Data > Export Data from the layer context menu to open the Saving Data window.

13. In the Saving Data window click on “Browse”.

14. Navigate to C:\E0170_ActivityData\Exercise_11.2 and name the file Total_Loss_Annualized_After.shp

15. Select Shapefile from the Save as type drop-down menu.

16. Click “Save” to close the Saving Data window.



17. Click “OK” to close the Export Data window.
18. Answer “Yes” to add the exported data to the map as a layer.

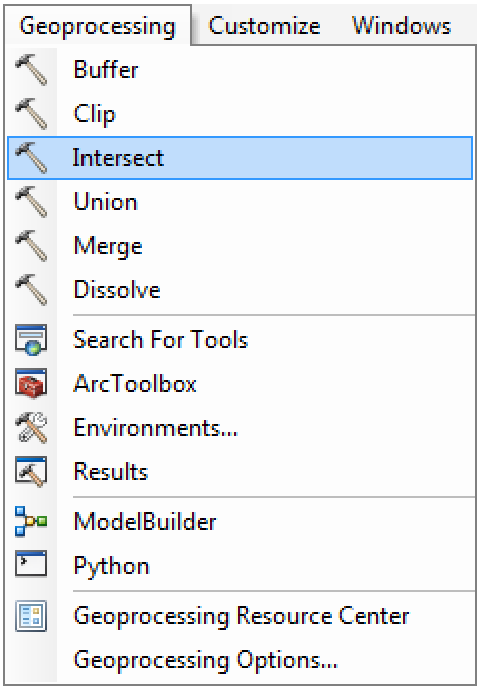
Task 5: Compare the Estimated Losses

In the following section you will be using ArcGIS tools to compare the total annualized losses pre and post mitigation. You should have exported two layers:

- Total annualized losses calculated by Hazus without mitigation options applied
- A layer of total annualized losses calculated by Hazus with all of the mitigation options applied.

The Intersect tool in the ArcToolbox will be used to combine the results into one layer. Once this layer has been created you will then calculate the differences in losses within each census tract.

1. From the Geoprocesssing menu choose “Intersect”.

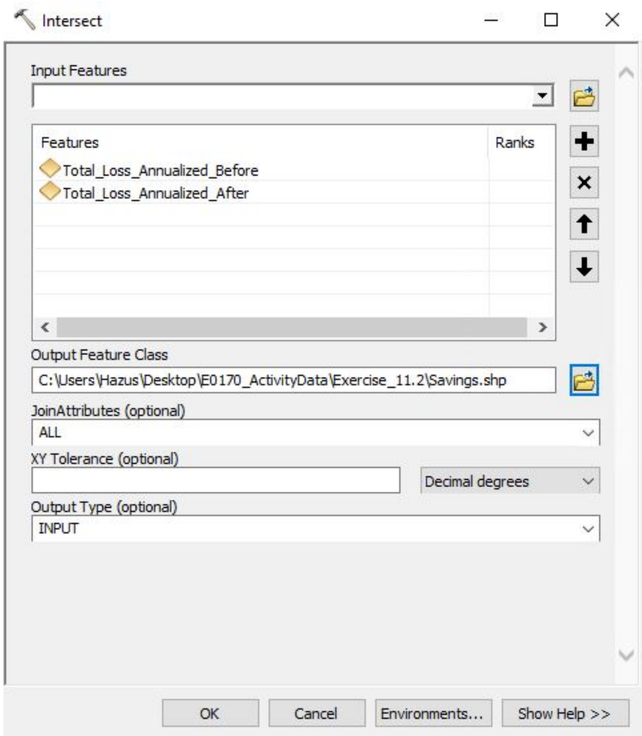


2. For Input feature class select both the Total_Loss_Annualized_After layer and the Total_Loss_Annualized_Before layer.

3. For Output feature class, click “Browse” and navigate to the C:\E0170_ActivityData\Exercise_11.2 folder and enter “Savings”.

4. Click “Save”. Leave all of the other default settings as they are.

Note: If necessary, use the arrows to move the position of the before and after layers. They must be in the order shown for the process to work correctly. The Intersect window should appear as shown below.



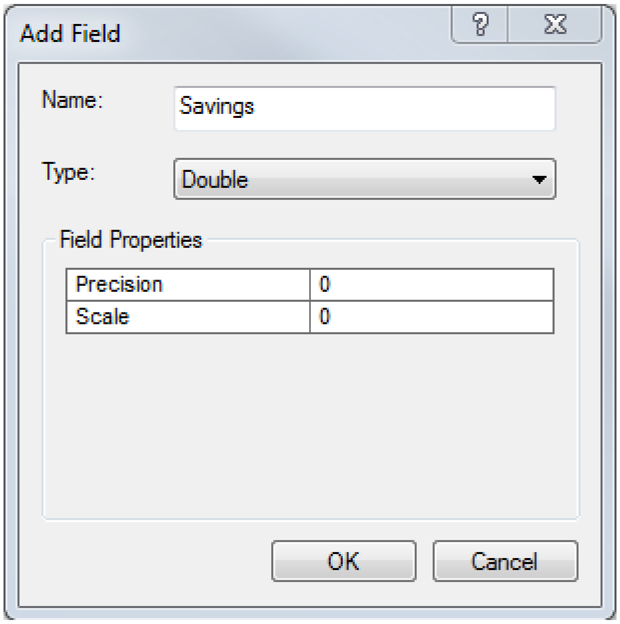
5. Click "OK" to complete the intersect process.

6. Right-click on the Savings layer (which should have appeared at the top of the table of contents) and choose "Open Attribute Table" to view the attributes of the data.

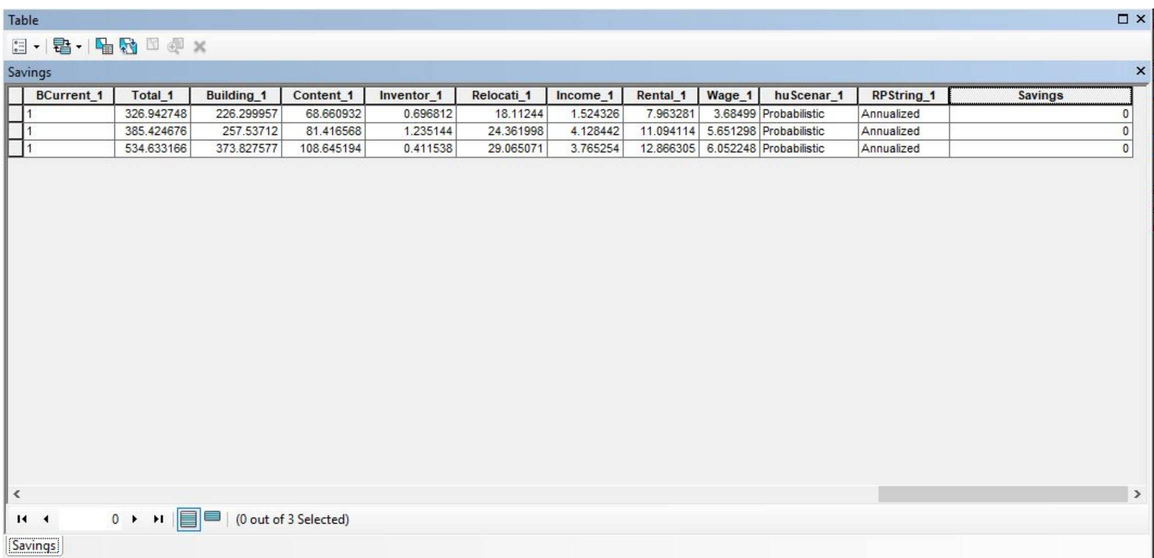
Tip: If the Savings layer does not appear in the Table of Contents window, use the Add Data button and add it to the table of contents window.

7. Click Table Options in the Savings table and select "Add Field".

8. Enter "Savings" as the field name and select "Double" as the field type.



9. Click “OK” to add the new field which should appear at the end of the table.

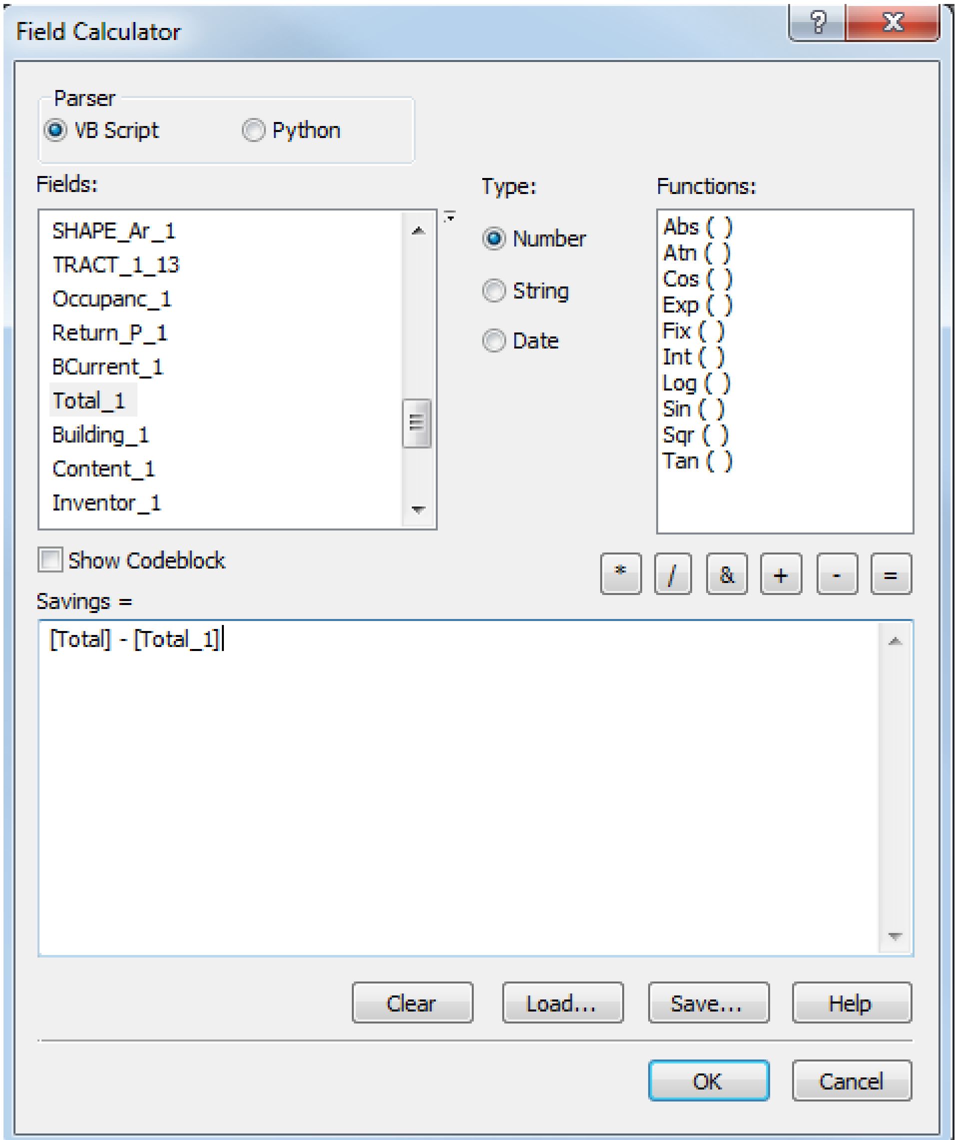


BCurrent_1	Total_1	Building_1	Content_1	Inventor_1	Relocati_1	Income_1	Rental_1	Wage_1	huScenar_1	RPString_1	Savings
1	326.942748	226.299957	68.660932	0.696812	18.11244	1.524326	7.963281	3.68499	Probabilistic	Annualized	0
1	385.424676	257.53712	81.416568	1.235144	24.361998	4.128442	11.094114	5.651298	Probabilistic	Annualized	0
1	534.633166	373.827577	108.645194	0.411538	29.065071	3.765254	12.866305	6.052248	Probabilistic	Annualized	0

10. Right-click on the Savings field and select “Field Calculator”.

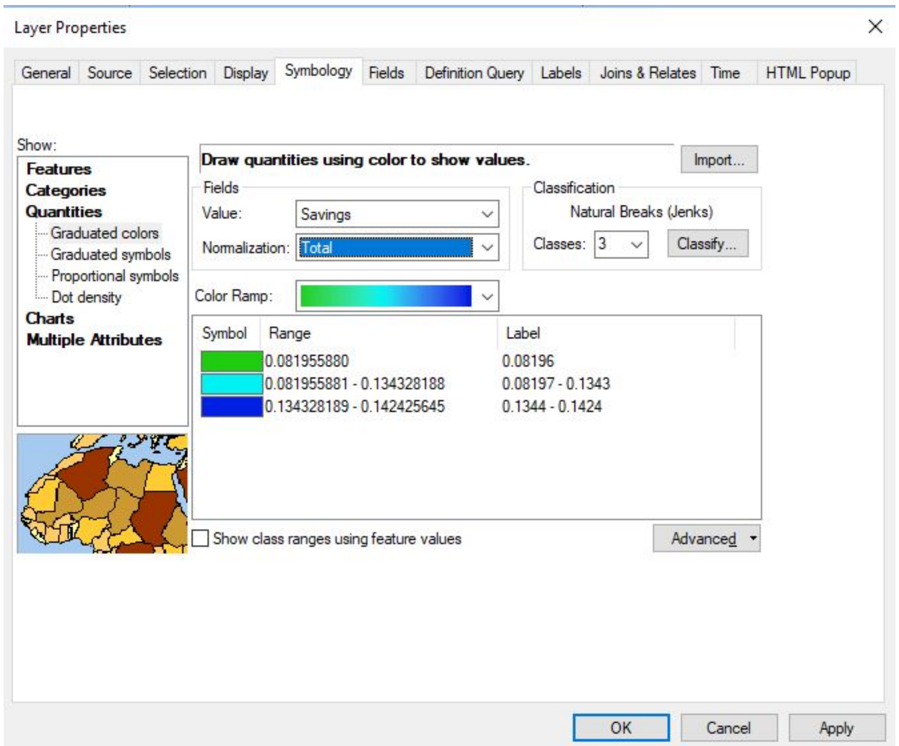
Tip: If asked, click “Yes” when prompted to indicate that you know that your edits cannot be undone. The field calculator allows calculations on fields in the attribute table.

11. Create an expression that says [Total] - [Total_1] as shown below. This expression produces an output that reflects the savings resulting from your mitigation action.

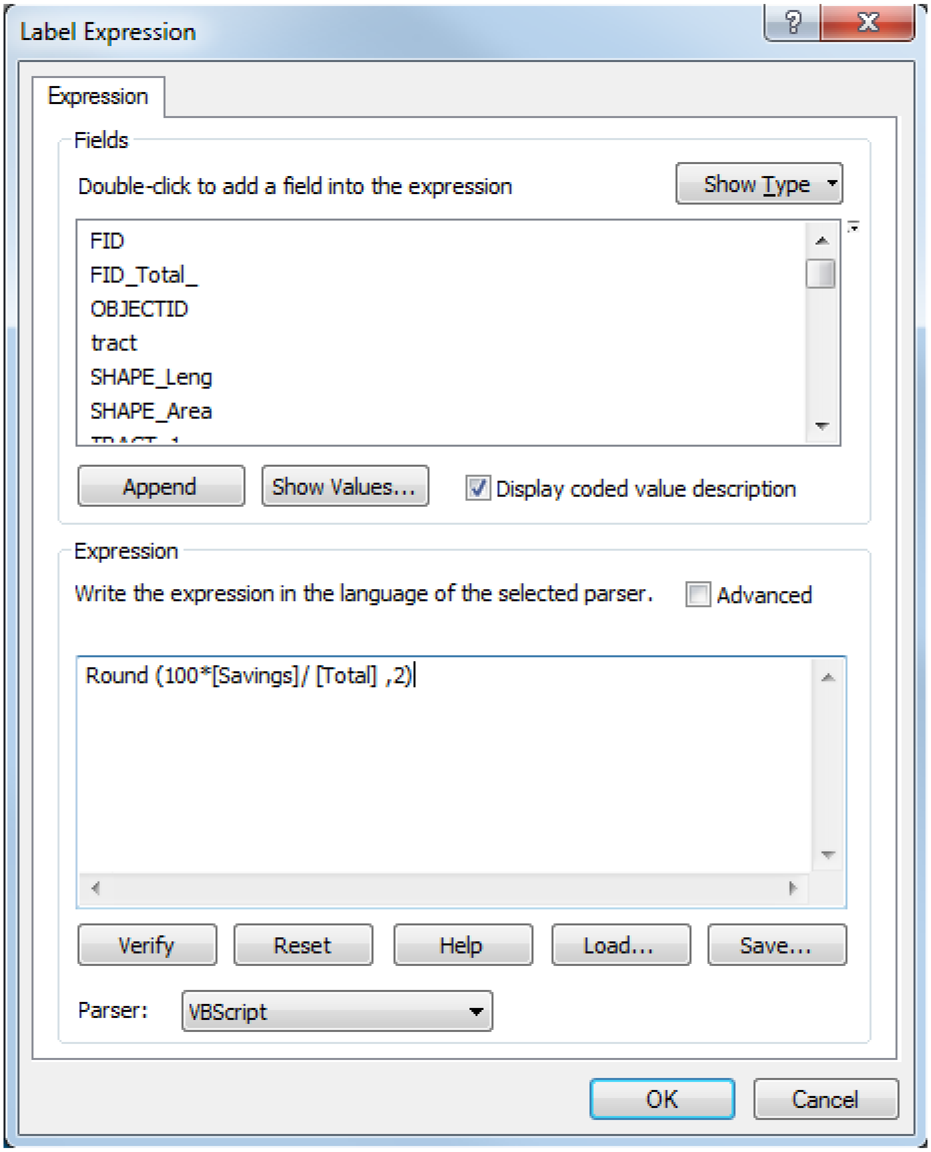


12. Click “OK” to run the calculation and to update the Savings field.
13. Close the Savings table by clicking Close in the upper right corner of the table window.
14. Right-click on the Savings layer and choose “Properties” to open the Layer Properties window.
15. Click the Symbology tab to view the Symbology options.
16. Select the Graduated colors option under the Quantities menu.
17. Select “Savings” as the value field.
18. Select “Total” as the field by which to normalize.

Note: Normalizing data is very important since it establishes a foundation by which to compare values. For instance, population totals are often normalized by the area in which the population is located, thus creating a population density.



19. Click on the Labels tab.
20. Click in the check box next to Label features in this layer to turn the labeling on in this layer.
21. Click Expression to open the Label Expression window and enter “Round (100*[Savings]/[Total] ,2)” as the label expression. This expression produces a label that shows the percentage of savings and rounds the value to two decimal places.



22. Click “OK” to close the Label Expression window and then “OK” to close the Layer Properties window and to update the map. The values shown on the map represent percentage reduction of total losses that were achieved through the mitigation measures that you imposed on the region. Notice the spatial differences in these reductions.

23. Use the layer to answer the following questions:

This exercise demonstrates what the overall reduction in annual losses would be for only Single Family Residential homes if every home in the community had shutters or an increase of 92% of shuttering (8% was already assumed to have shuttering).

Question	Answer

Question	Answer
What is the minimum percentage of savings after mitigating the study region?	
What is the maximum percentage of savings after mitigating the study region?	
What was the total savings (in dollars)?	

24. Exit Hazus and select “Yes” when prompted to indicate whether you wish to save your changes.

Visual 24: Lesson 11: Review

1. What are the four occupancy types that can be mitigated in Hazus?
2. What are two types of opening protection?
3. What is the potential reduction in loss from shuttering a structure?

Visual 25: Questions?

Lesson 12: Hazus for Response and Recovery

Visual 1: Lesson 12: Hazus for Response and Recovery

HAZUS®

EARTHQUAKE • WIND • FLOOD • TSUNAMI

Visual 2: Lesson 12: Goal and Objectives

Goal: To provide an overview of how to set up Hazus for response and recovery operations.

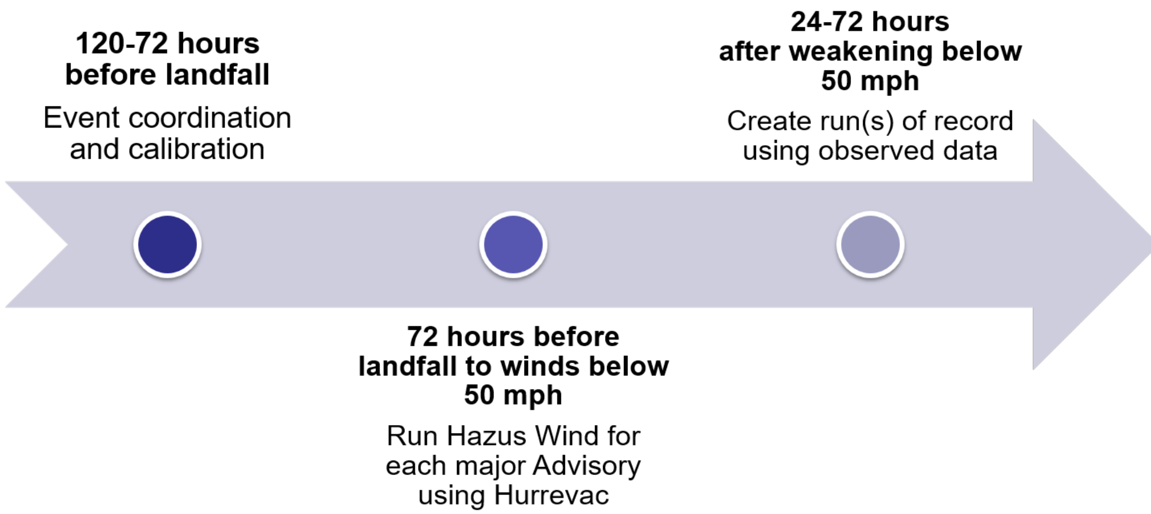
After completing this lesson, you will be able to:

- Read and understand a Tropical Forecast Advisory.
- Understand how to input a Tropical Forecast Advisory into Hazus.

Visual 3: Hazus for Response and Recovery

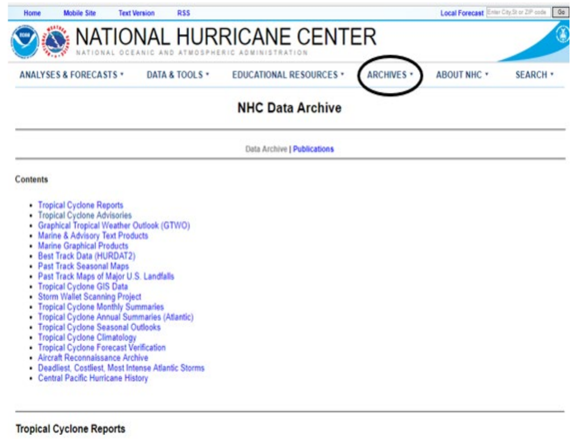
- Predicting effects of hurricanes: Warning time of hurricanes is typically 3-5 days
- During hurricane season: Advisories are issued every six hours for all tropical storms with intermediate advisories for landfalling for rapidly changing storms
- Current position/strength and predicted position/strength can be used to make estimates of likely damage.

Visual 4: When to Start Running Hazus

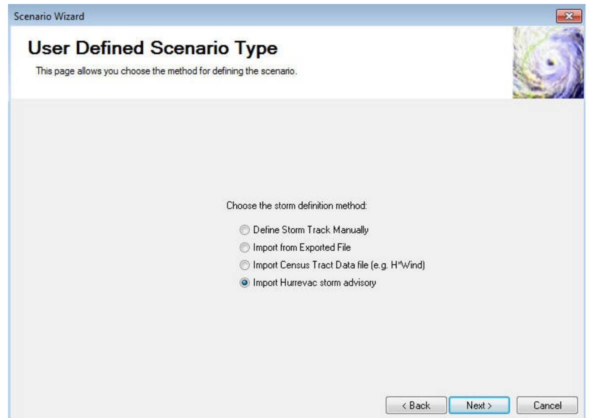


Visual 5: Obtaining Storm Data

- Tools for manual entry of storm data:
  - Designed to allow users to run analysis in Hazus based on forecast advisories.
  - National Hurricane Center of the National Weather Service offers several products.
  - Forecast advisories contain all information needed for Hazus.



Visual 6: User Defined (Single Storm) Scenario



- User-Defined Scenario Type offers four options for data
- Hurrevac or Census tract data file should be used for recovery once observed data are available

Visual 7: Typical Storm Parameters

Typical Storm Parameters

Saffir Simpson Scale	1 Min Mean (mph)	3 sec Gust (mph)	Min Central Pressure (mb)
1	74-95	90-116	980 and greater
2	96-110	117-134	965-979
3	111-129	135-159	945-964
4	130-156	160-189	920-944
5	157+	189+	920 and below

1 min mean = Hazus Input Windspeeds
3 sec gust = Hazus Output Windspeeds

Visual 8: Using Forecast Advisories

- Forecast advisories: Text files that are available for download.
- Contain storm data:
  - Lat/Long
  - Central pressure
  - Radius to hurricane winds
  - Translation speed of storm
- Units:
  - Times - UTC.
  - Distances - nautical miles.
  - Wind speeds - knots.

```
ZCZC MIATCMAT2 ALL
TTAA00 KNHC DDHHMM
HURRICANE KATRINA FORECAST/ADVISORY NUMBER  25
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL   AL122005
0300Z MON AUG 29 2005

A HURRICANE WARNING IS IN EFFECT FOR THE NORTH CENTRAL GULF COAST
FROM MORGAN CITY LOUISIANA EASTWARD TO THE ALABAMA/FLORIDA
BORDER...INCLUDING THE CITY OF NEW ORLEANS AND LAKE PONTCHARTRAIN.
PREPARATIONS TO PROTECT LIFE AND PROPERTY SHOULD BE RUSHED TO
COMPLETION.

A TROPICAL STORM WARNING AND A HURRICANE WATCH ARE IN EFFECT FROM
EAST OF THE ALABAMA/FLORIDA BORDER TO DESTIN FLORIDA...AND FROM
WEST OF MORGAN CITY TO INTRACOASTAL CITY LOUISIANA.

A TROPICAL STORM WARNING IS ALSO IN EFFECT FROM DESTIN FLORIDA
EASTWARD TO INDIAN PASS FLORIDA...AND FROM INTRACOASTAL CITY
LOUISIANA WESTWARD TO CAMERON LOUISIANA.

HURRICANE CENTER LOCATED NEAR 27.6N  89.4W AT 29/0300Z
POSITION ACCURATE WITHIN  10 NM

PRESENT MOVEMENT TOWARD THE NORTH-NORTHWEST OR 335 DEGREES AT   9 KT

ESTIMATED MINIMUM CENTRAL PRESSURE  904 MB
MAX SUSTAINED WINDS 140 KT WITH GUSTS TO 170 KT.
64 KT....... 90NE  90SE  50SW  80NW.
50 KT.......110NE 100SE  75SW 100NW.
34 KT.......200NE 200SE 150SW 180NW.
12 FT SEAS..325NE 250SE 250SW 225NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.

REPEAT...CENTER LOCATED NEAR 27.6N  89.4W AT 29/0300Z
AT 29/0000Z CENTER WAS LOCATED NEAR 27.2N  89.1W

FORECAST VALID 29/1200Z 29.2N  89.7W
MAX WIND 135 KT...GUSTS 165 KT.
64 KT... 90NE  90SE  50SW  60NW.
50 KT...110NE 110SE  75SW  75NW.
34 KT...200NE 200SE 150SW 150NW.
```

Visual 9: Using Forecast Advisories

To run the uncertainty analysis, user must enter the times in standard advisory format (0 , 9, 21, 33, 45, 69).

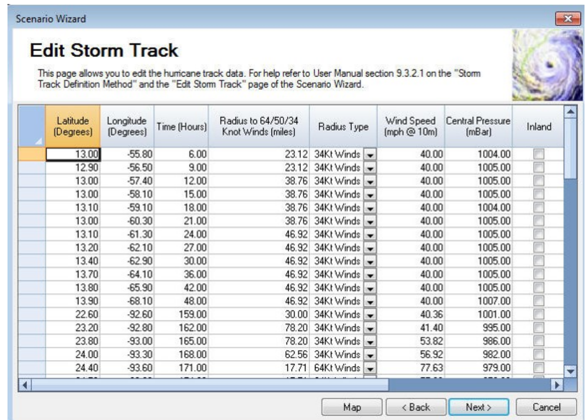
```
HURRICANE CENTER LOCATED NEAR 27.6N  89.4W AT 29/0300Z
POSITION ACCURATE WITHIN  10 NM

PRESENT MOVEMENT TOWARD THE NORTH-NORTHWEST OR 335 DEGREES AT   9 KT

ESTIMATED MINIMUM CENTRAL PRESSURE  904 MB
MAX SUSTAINED WINDS 140 KT WITH GUSTS TO 170 KT.
64 KT....... 90NE  90SE  50SW  80NW.
50 KT.......110NE 100SE  75SW 100NW.
34 KT.......200NE 200SE 150SW 180NW.
12 FT SEAS..325NE 250SE 250SW 225NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.

REPEAT...CENTER LOCATED NEAR 27.6N  89.4W AT 29/0300Z
AT 29/0000Z CENTER WAS LOCATED NEAR 27.2N  89.1W

FORECAST VALID 29/1200Z 29.2N  89.7W
MAX WIND 135 KT...GUSTS 165 KT.
64 KT... 90NE  90SE  50SW  60NW.
50 KT...110NE 110SE  75SW  75NW.
34 KT...200NE 200SE 150SW 150NW.

FORECAST VALID 30/0000Z 31.8N  89.5W...INLAND
MAX WIND  85 KT...GUSTS 105 KT.
64 KT... 50NE  50SE  30SW  50NW.
50 KT... 75NE  75SE  50SW  75NW.
34 KT...125NE 175SE  75SW 100NW.

FORECAST VALID 30/1200Z 34.8N  88.1W...INLAND
MAX WIND  45 KT...GUSTS  55 KT.
34 KT... 75NE  75SE  25SW  50NW.

FORECAST VALID 31/0000Z 37.7N  85.9W...INLAND
MAX WIND  30 KT...GUSTS  40 KT.

FORECAST VALID 01/0000Z 43.5N  78.5W...INLAND
MAX WIND  25 KT...GUSTS  35 KT.
```

Times in Standard Advisory Format	Day of Current Month	Forecast Time
0 hours Start Time	29	0300Z

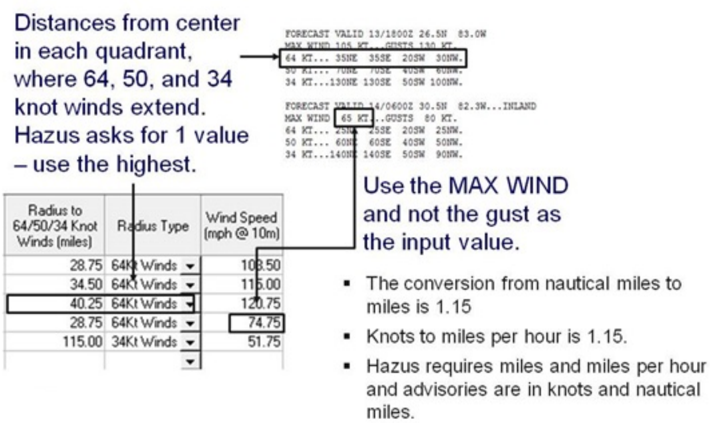
Times in Standard Advisory Format	Day of Current Month	Forecast Time
9 hours from Start Time	29	1200Z
21 hours from Start Time	30	0000Z
33 hours from Start Time	30	1200Z
45 hours from Start Time	31	0000Z
69 hours from Start Time	01	0000Z

Visual 10: Editing Storm Information

- Delete rows by right-clicking on header.
- Make sure there is only one blank row at bottom before clicking “Next.”
- “Time (hours)” format needed for Uncertainty Analysis.
- “Central Pressure (mbar)” and “Inland” taken from Advisory.



Visual 11: Entering in Forecast Advisories



Visual 12: Using NHC Advisories

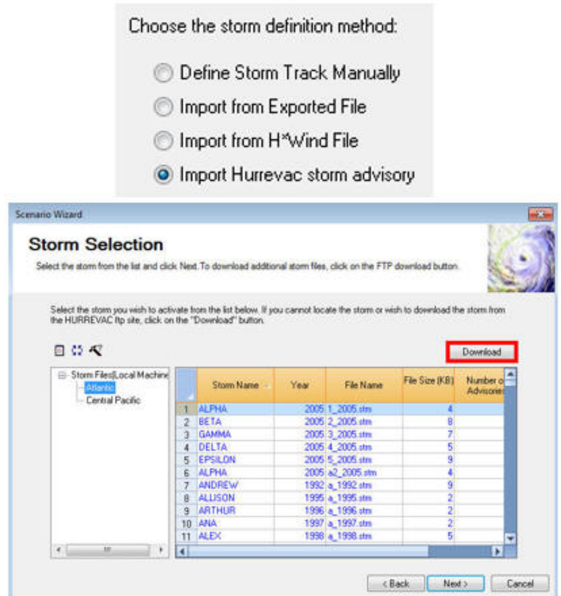
Forecast advisories:

- Conservative estimates
- Don't update central pressure
- Don't update radius to wind speeds realistically

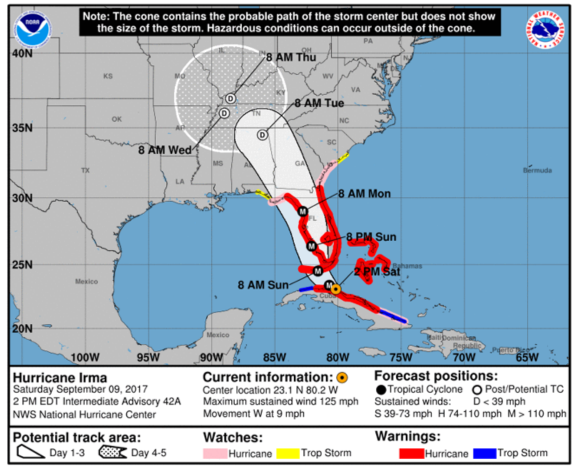
Hazus model enforces a realistic relationship between radius, central pressure, and wind speeds.

Visual 13: Hurrevac

- HURRicane EVACuation
- Taken from NHC advisory information
- Historical storms database
- Eliminates entering information from the text-based advisories



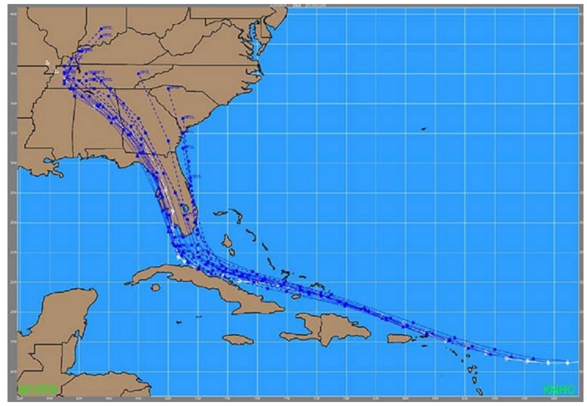
Visual 14: Response and Recovery Points



- There are uncertainties within Hazus.
- Forecasts are subject to changes in track and intensity.
  - Causes changes in damage and loss estimations.
- Damages and losses are based on windspeeds.
  - If these change, damage and loss calculations also change.

Visual 15: Track Comparison

- Changes in position of a hurricane track can make significant changes to results.
- Discussed further in the next section

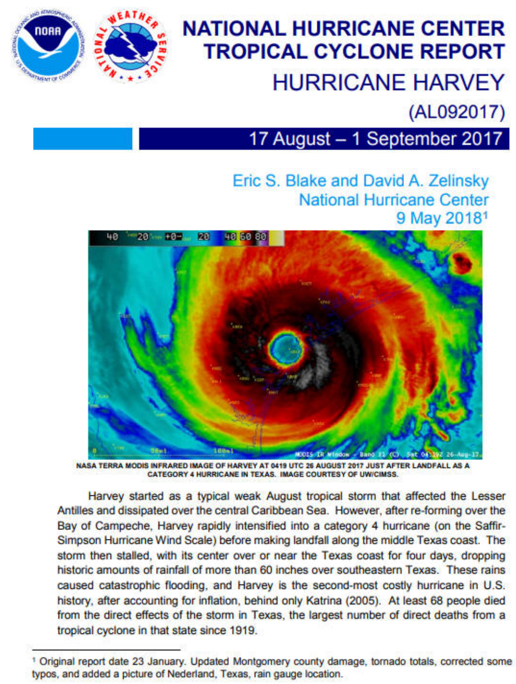


NHC official track forecasts (dashed blue lines) for Hurricane Irma from 0000 UTC 5 September 2017 to 0000 UTC 12 September 2017. The best track is given by the white line with positions given at 6 hour intervals.

Visual 16: Errors in Forecasts

"Official forecast intensity errors were above the mean official errors for the previous 5-year period through 48 hours, then considerably lower than average after that through 5 days. A homogenous comparison of the official intensity errors with selected guidance models is given in Table 7b. The NHC intensity forecast performed better than all of the intensity model guidance at 12, 96, and 120 hours, but was worse than all of guidance at 36 and 48 hours. This unusual dichotomy appears to be due to the cyclone weakening faster than expected over land at 36 and 48 hours, but NHC correctly forecasting Harvey to stay a weak cyclone at long range, with almost every forecast point verifying over land."

NHC Tropical Cyclone Report - Hurricane Harvey, May 2018



NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT
HURRICANE HARVEY
(AL092017)
17 August – 1 September 2017

Eric S. Blake and David A. Zelinsky
National Hurricane Center
9 May 2018[1]

NASA TERRA MODIS INFRARED IMAGE OF HARVEY AT 0419 UTC 26 AUGUST 2017 JUST AFTER LANDFALL AS A CATEGORY 4 HURRICANE IN TEXAS. IMAGE COURTESY OF UW/CIMSS.

Harvey started as a typical weak August tropical storm that affected the Lesser Antilles and dissipated over the central Caribbean Sea. However, after re-forming over the Bay of Campeche, Harvey rapidly intensified into a category 4 hurricane (on the Saffir-Simpson Hurricane Wind Scale) before making landfall along the middle Texas coast. The storm then stalled, with its center over or near the Texas coast for four days, dropping historic amounts of rainfall of more than 60 inches over southeastern Texas. These rains caused catastrophic flooding, and Harvey is the second-most costly hurricane in U.S. history, after accounting for inflation, behind only Katrina (2005). At least 68 people died from the direct effects of the storm in Texas, the largest number of direct deaths from a tropical cyclone in that state since 1919.

[1] Original report date 23 January. Updated Montgomery county damage, tornado totals, corrected some typos, and added a picture of Nederland, Texas, rain gauge location.

NHC Tropical Cyclone Report – Hurricane Harvey, May 2018
https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf

Visual 17: Demonstration 12.1: Forecast Advisory Uncertainties

Goal: Discuss and demonstrate Forecast Advisory uncertainties.

Time: 45 Minutes

Student Manual

Demonstration 12.1: Forecast Advisory Uncertainties

Goal: Discuss and demonstrate Forecast Advisory uncertainties

Time: 45 minutes

Exercise Steps:

1. Listen to instructor’s directions.
2. Ask questions if clarification is needed.
3. Watch the instructor's demonstration.
4. Ask any final questions.

Visual 18: Exercise 12.2 Forecast Advisory

Goals:

- Run various user-defined scenarios.
- Compare the results.

Time: 30 Minutes

Exercise 12.2: Forecast Advisory

Student Manual

Goals:

- Run various user-defined scenarios.
- Compare the results.

Time: 30 minutes

1. Refer to Activities Document "12.2_Exercise_Forecast Advisory."
2. Listen to instructor's directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share your answers/results.
8. Ask any final questions.

Visual 19: Exercise 12.2: Tasks

Task 1: Investigate Hurricane Harvey Scenarios.

Task 2: Import the Final Track using HURREVAC.

Task 3: Explore the use of H*Wind files.

Task 4: Compare the results.

Exercise 12.2 - Forecast Advisory

Type: Student-Led Activity

Time: 30 minutes

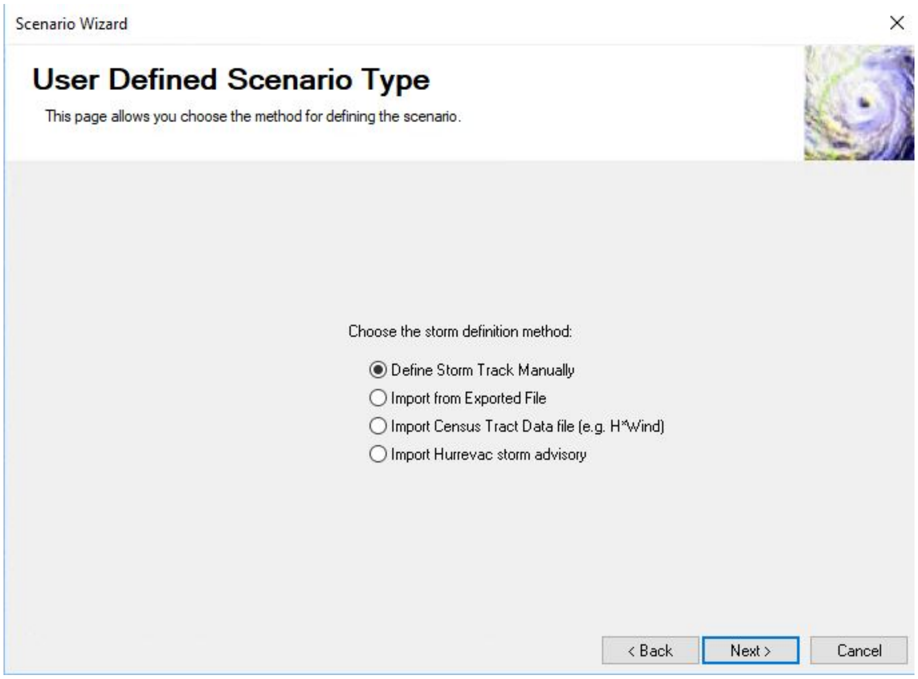
Goals:

- Run various user-defined scenarios
- Compare the results

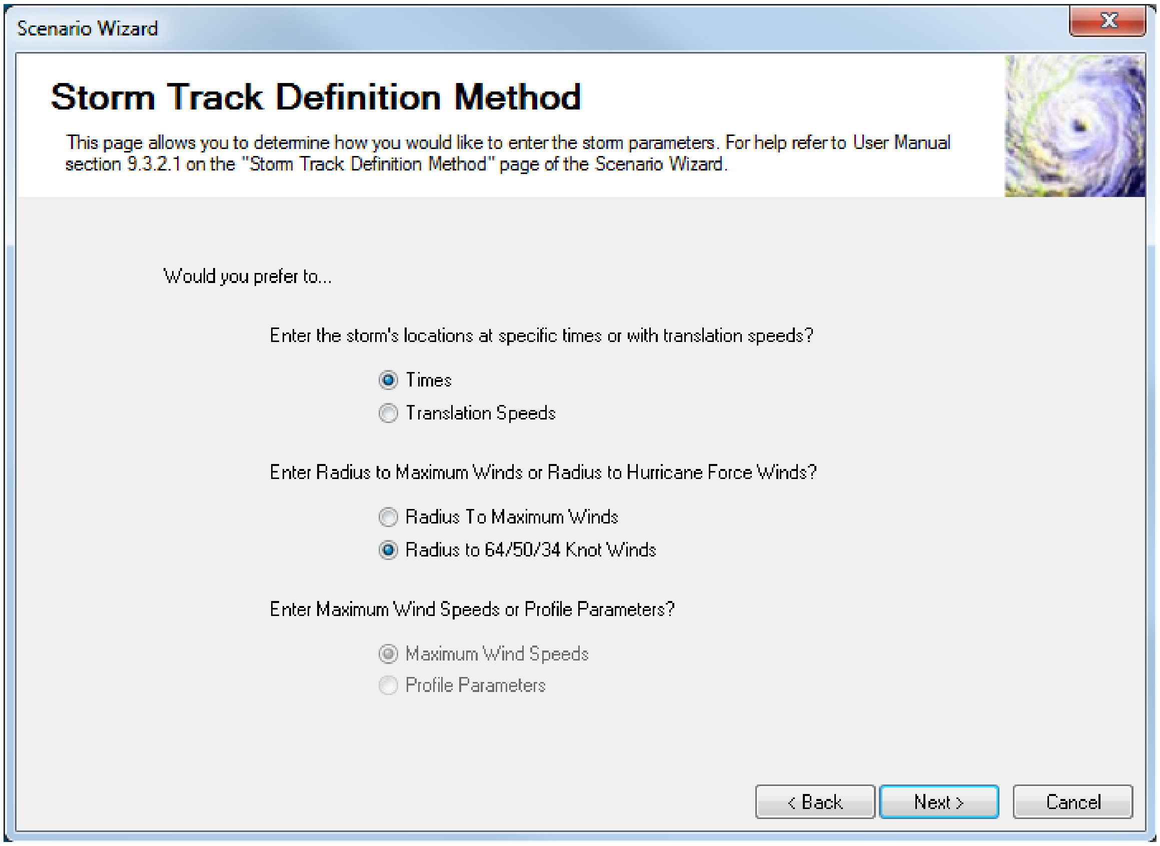
Background: This exercise will help you learn to use forecasts and advisories available from the National Weather Service to create a user defined storm. This can be a particularly useful capability at times when you are trying to ascertain the potential impact of an oncoming storm, or when you are considering what impact a past storm might have based on currently exposed inventory.

Task 1: Investigate Hurricane Harvey Scenarios

1. Start Hazus.
2. Create a study region with the following parameters:
   - Name: Harvey_Forecast
   - Hazard: Hurricane
   - County Level • State: Texas
   - Counties: Aransas and Nueces
3. Open the Study region, and from the Hazard menu choose Scenario.
4. Click Next to advance the scenario wizard.
5. Select Create New Scenario and then Next.
6. Select Define Storm Track Manually and click Next.



7. Name the new scenario ForecastAdvisory21 and click Next. This forecast is for Hurricane Harvey Forecast Advisory 21.
8. Select the values shown below (Times and Radius to 64/50/34 Knot Winds).



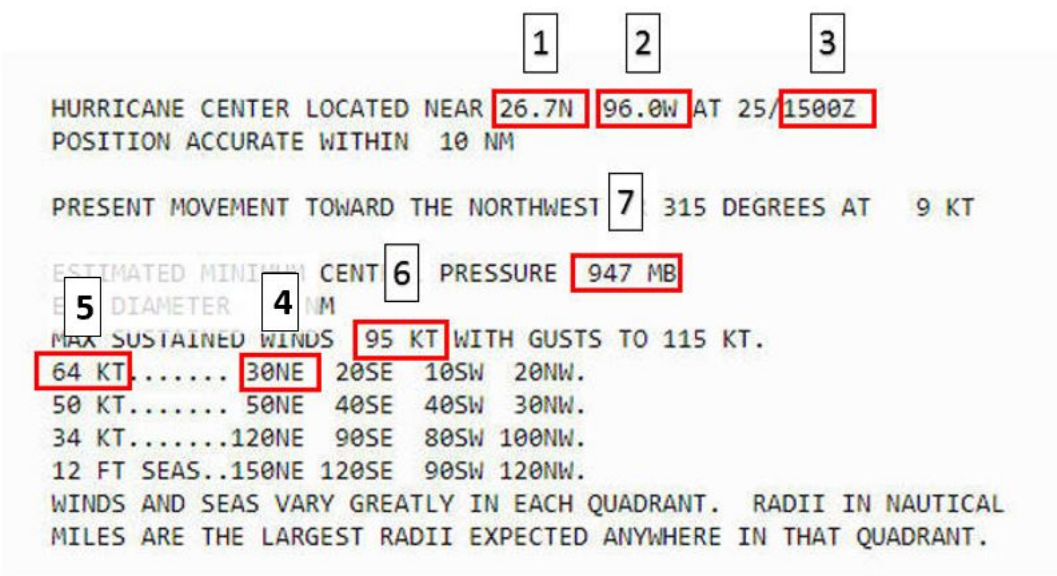
9. Click Next to view the Interactive Storm Track Definition window.

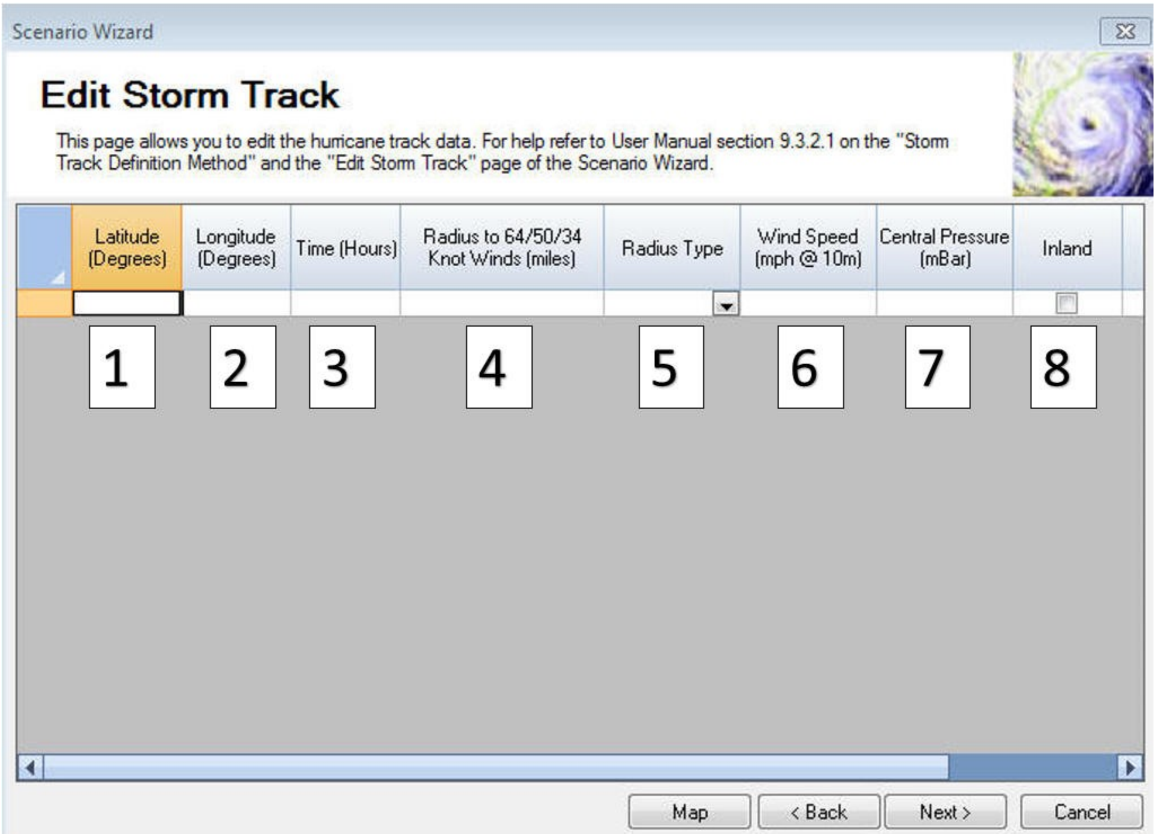
10. The first portion of Forecast Advisory 21 is on the next page. You can view the full advisory as a PDF located at C:\E0170_ActivityData\Exercise¬_12.2\Harvey Forecast Advisory 21.pdf.

11. The beginning of the advisory contains descriptive information about the hurricane as well as the current location. Review this information. Try to interpret the information in the forecast on your own. Compare your results with the graphic after the advisory. Ensure that your values match those in the graphic.

```
HURRICANE CENTER LOCATED NEAR 26.7N  96.0W AT 25/1500Z
POSITION ACCURATE WITHIN  10 NM

PRESENT MOVEMENT TOWARD THE NORTHWEST OR 315 DEGREES AT   9 KT

ESTIMATED MINIMUM CENTRAL PRESSURE  947 MB
EYE DIAMETER  15 NM
MAX SUSTAINED WINDS  95 KT WITH GUSTS TO 115 KT.
64 KT....... 30NE  20SE  10SW  20NW.
50 KT....... 50NE  40SE  40SW  30NW.
34 KT.......120NE  90SE  80SW 100NW.
12 FT SEAS..150NE 120SE  90SW 120NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.
```

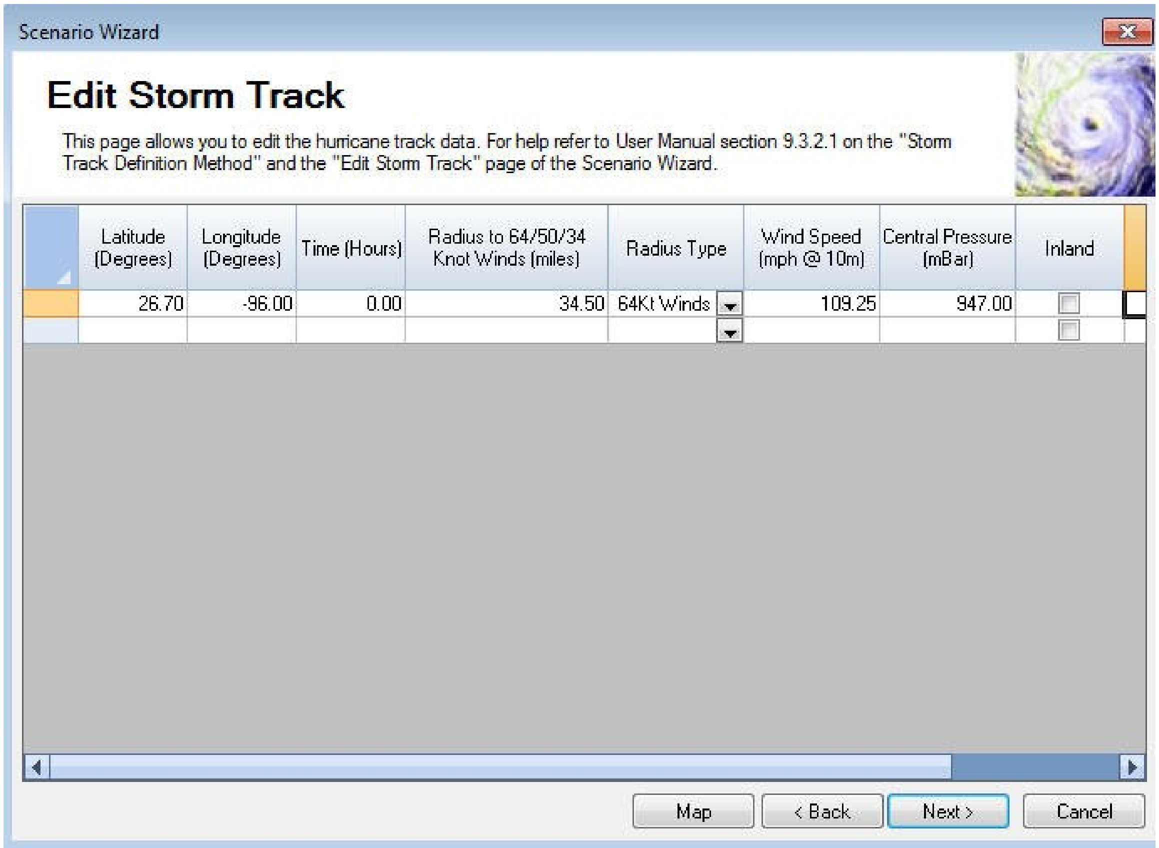
12. Numbers have been added to the Forecast Advisory and the Edit Storm Track window to show where you can find the information required in the Hazus Edit Storm Track window.





- Note the longitude should include a negative sign
- The radius must be converted from nautical miles to miles (*1.15)
- The wind speed must be converted from knots to miles per hour (*1.15).
- If the storm is inland, the words INLAND will appear on the advisory.

13. Note the following key points:
    - Longitude should include a negative sign.
    - The radius must be converted from nautical miles to miles (multiply number in forecast by 1.15).
    - The wind speed must be converted from knots to miles per hour (multiply number in forecast by 1.15).
    - If the storm is inland, the words INLAND will appear on the advisory.
14. Enter these values into the Edit Storm Track window.
15. When completed, the Edit Storm Track window should look like the graphic below.



16. For the Central Pressure parameter, only the initial pressure is provided in the forecast advisory. You can create a reasonable central pressure number for the following advisories by using the table below.

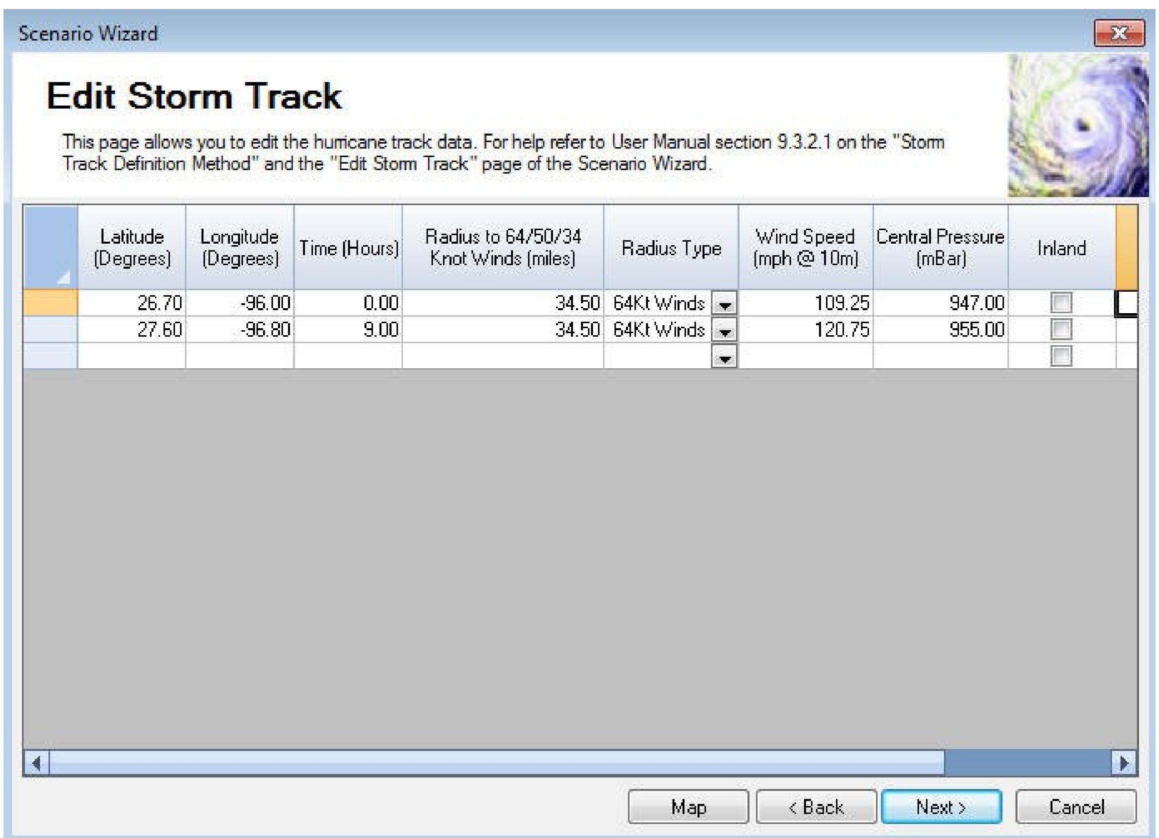
Saffir-Simpson Category	Minimum Central Pressure mb	Maximum Sustained Wind Speed (Over water) m/s	Maximum Sustained Wind Speed (Over water) mph
1	>= 980	33.1-42.0	74-94
2	979-965	42.0-49.6	94-110
3	964-945	49.6-58.1	110-130
4	944-920	58.1-69.3	130-155
5	<920	>69.3	>155

17. Use the following portion of the Forecast Advisory to complete the next line of the storm track.

```
FORECAST VALID 26/0000Z 27.6N  96.8W
MAX WIND 105 KT...GUSTS 130 KT.
64 KT... 30NE  25SE  15SW  20NW.
50 KT... 60NE  50SE  40SW  40NW.
34 KT...120NE 100SE  90SW 100NW.
```

18. The Edit Storm Track window should now look like the following graphic.

- The forecast box has been checked since this is a forecasted location of the hurricane.
- Time indicates 9 hours. This is derived by counting the number of hours from the time of the first forecast point of the hurricane (1500Z) to the current time of the forecast point (0000Z) using a 24 hour scale.



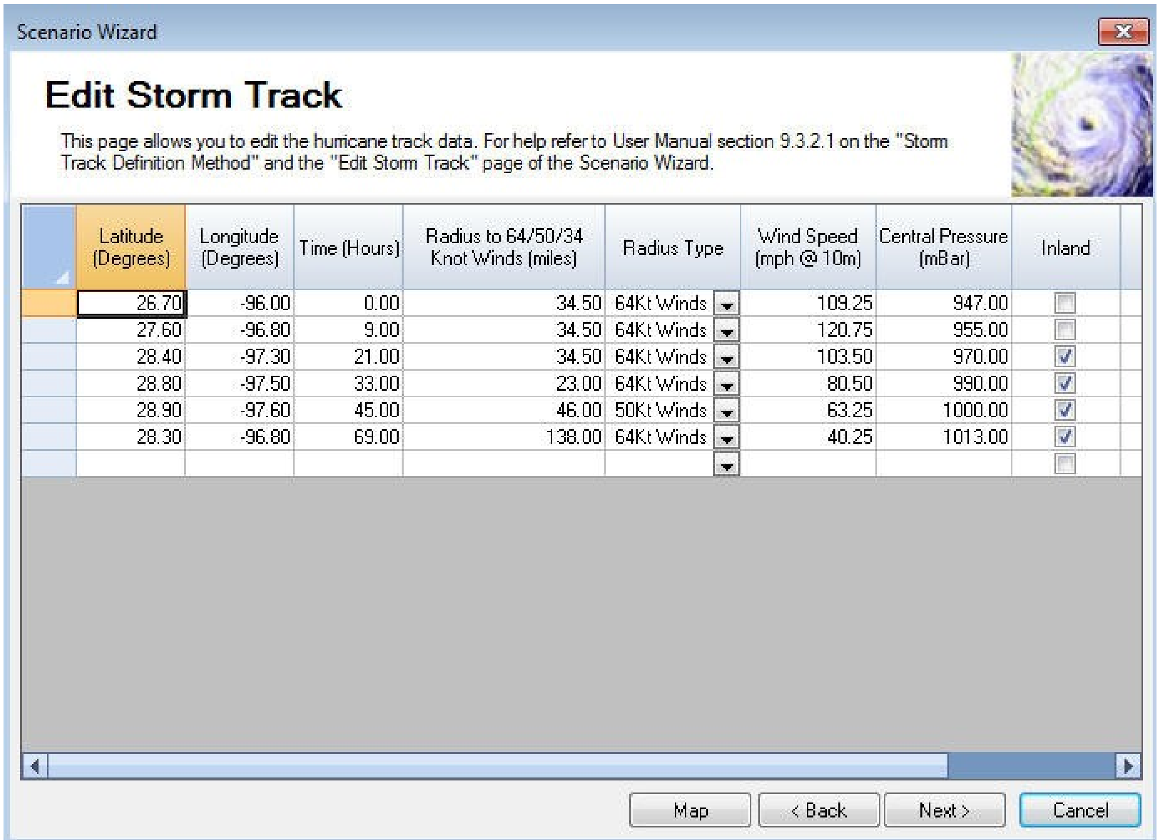
19. Continue to add the rows to the storm track window using the rest of the forecast advisory below.

17. Continue to add the rows to the storm track window using the rest of the forecast advisory below.

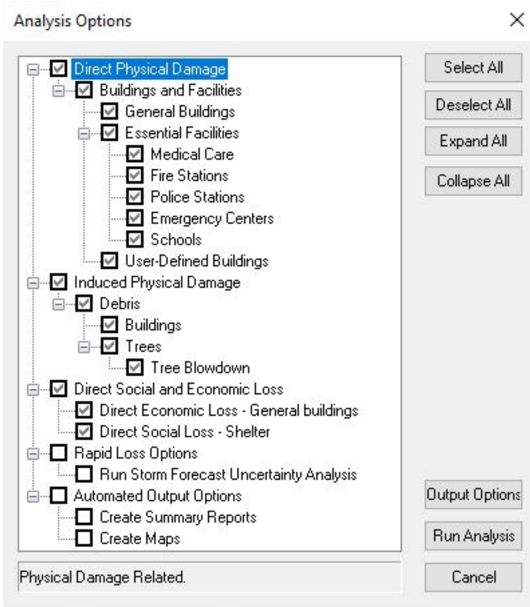
```
FORECAST VALID 26/1200Z 28.4N  97.3W...INLAND
MAX WIND  90 KT...GUSTS 110 KT.
64 KT... 30NE  30SE  20SW  20NW.
50 KT... 60NE  50SE  40SW  40NW.
34 KT...120NE 120SE 100SW 100NW.

FORECAST VALID 27/0000Z 28.8N  97.5W...INLAND
MAX WIND  70 KT...GUSTS  85 KT.
64 KT... 20NE  20SE   0SW   0NW.
50 KT... 50NE  50SE  40SW  30NW.
34 KT...100NE 120SE  90SW  80NW.

FORECAST VALID 27/1200Z 28.9N  97.6W...INLAND
MAX WIND  55 KT...GUSTS  65 KT.
50 KT... 40NE  40SE  30SW  20NW.
34 KT...100NE 110SE  80SW  50NW.

FORECAST VALID 28/1200Z 28.3N  96.8W...INLAND
MAX WIND  35 KT...GUSTS  45 KT.
34 KT...120NE  70SE  50SW   0NW.
```

20. Your final Edit Storm Track window should look the same as the one below.

18. Your final Edit Storm Track window should look the same as the one below.



21. Click Next to move to the windfield calculations window.
22. Click Next until prompted to indicate you would like to make this the active scenario.
23. Click Next and then Finish to complete the wizard.
24. From the Analysis menu select Run to open the Analysis Options menu.
25. Click Select All to choose all of the analysis options except the Rapid Loss Options and the Automated Output Options.

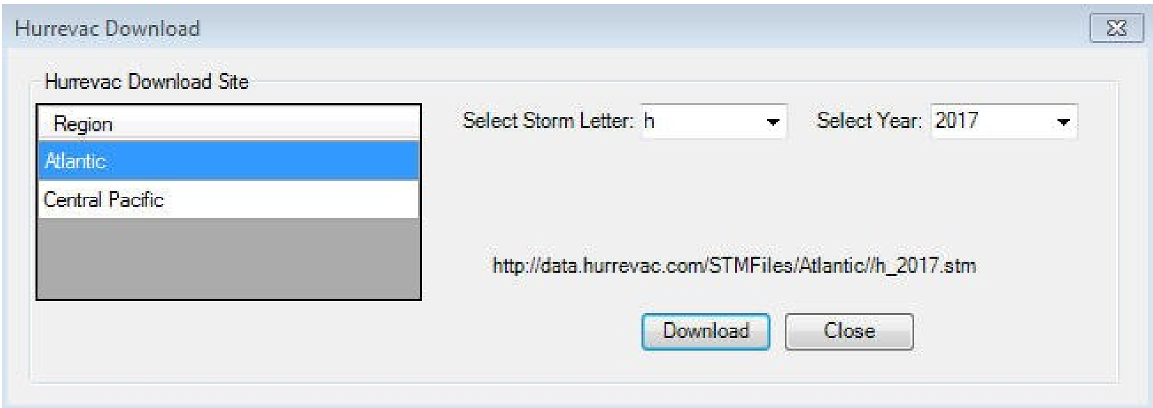


26. Click Run Analysis to begin the analysis.
27. Click OK when prompted to acknowledge that the analysis has completed.
28. Open the Global Summary Report. This report is also provided in the folder C:\E0170_ActivityData\Exercise_12.2\Forecast Advisory 21 Global Summary Report.pdf.
29. Use the report to complete the questions for the Forecast Advisory column in the table found at the end of the exercise.
30. When you have completed the questions, close the Summary Reports window.

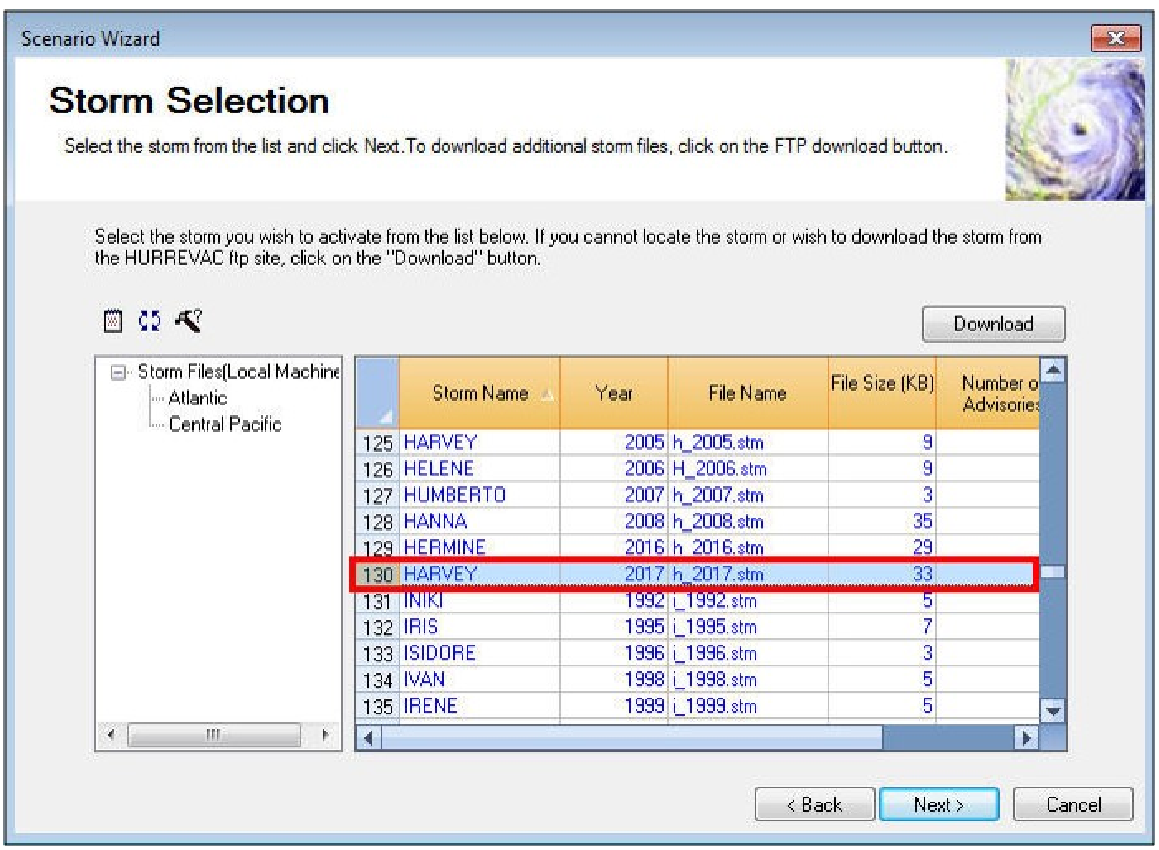
Task 2: Import the Final Track using HURREVAC.

In the next portion of the exercise you will import the final track for the same storm but this time using input generated from Hurrevac. The intent of this step is to demonstrate the difference between using a forecast advisory and a final storm track. The final storm track represents the actual track of the storm, whereas the forecast track is a projection of where the storm is forecasted to go.

1. From the Hazard menu choose Scenario to open the scenario wizard.
2. Click Next to advance to the scenario operation window.
3. Click on Create New Scenario and click Next.
4. Click Import Hurrevac storm advisory and click Next.
5. Click the Download button.
6. From the dropdown menu for Select Storm Letter, choose “H”. For the year select “2017”.



7. Click Download.
8. When downloaded successfully click OK and then Close.
9. Scroll through the list and select HARVEY with the date of 2017.
   - There are multiple Harvey entries, make sure you select the one from 2017.



10. Click Next to move to the Edit Storm Track window.
11. Click Next again to move to the Windfield Calculation window.
12. Once it completes hit Next four times and then Finish. Validating the storm track may take up to 2 minutes to complete.
13. Run the analysis with all options selected except the Rapid Loss Options and the Automated Output Options.
14. From the Results menu choose Summary Reports.
15. Click the Other Reports tab, view the Global Summary Report. This report is also provided in the folder C:\E0170_ActivityData\Exercise_12.2\Hurrevac Global Summary Report.pdf.
16. Use the report to complete the questions for Hurrevac Import in the table found at the end of the exercise.
17. When you have completed the questions, close the Summary Reports window.

Task 3: Explore the use of H*Wind files

H*Wind files formatted for Hazus are special products and not widely circulated. They are produced by the Hurricane Research Division. This is a great dataset because it provides observational data recorded during the hurricane's movement over land. This analysis compares track data with windfield computed by Hazus to observational data of actual winds measured from the hurricane.

1. From the Hazard menu choose Scenario to open the scenario wizard.
2. Click Next to advance to the scenario operation window.
3. Click on Create New Scenario and click Next.
4. Click Import from H*Wind File and click Next.
5. Name the scenario Harvey_Hwind and click Next.
6. Click browse and navigate to the C:\E0170_ActivityData\Exercise_12.2 folder.
7. Select Harvey_Windfield_HazusReady.dat.
8. Click Open and Next until you can click Finish.
9. Run the analysis with all options selected except the Rapid Loss Options and the Automated Output Options.
10. From the Results menu choose Summary Reports.
11. Click the Other Reports tab, view the Global Summary Report. This report is also provided in the C:\E0170_ActivityData\Exercise_12.2\Hwind Global Summary Report.pdf.
12. Use the report to complete the questions for H*Wind Import in the table found at the end of the exercise.
13. Click Save and then close Hazus.

Task 4: Compare the results.

Observe the difference in the results obtained by using updated forecast advisories. Due to the complex nature of hurricanes it is important that you consider early forecast advisories as general approximations of what may happen if a hurricane retains its current path and if it follows predictions exactly as they are defined in the forecast. However, due to the possibility of significant changes that might occur during the course of a hurricane's evolution, information produced from early forecast advisories should be carefully used and distributed with caution.

Question	Forecast Advisory	Hurrevac Import	H*Wind Import
What is the peak wind gust (mph) for the study region?			
How many Residential Buildings have been damaged? (minor, moderate, severe, and destroyed)			
What is the total estimated economic loss?			
How many people will require short term shelter?			
What is the total amount of debris generated?			

Visual 20: Hurricane Recovery Timeline

Length of recovery operations:

- Days (Short-term): Resource Allocation
- Weeks/Months (Intermediate): Clean up operations
- Months/Years (Long-term): Rebuilding
- Recovery groups: Economic, Health and Social Services, Housing, Natural and Cultural Resources

Visual 21: Lesson 12: Review

1. How many hours are between the current location of a hurricane and the first forecast point?
2. What is the elapsed time sequence required to run the uncertainty analysis when entering values into Hazus from a forecast advisory?
3. What is the conversion factor from nautical miles to miles?

Visual 22: Questions?

Lesson 13: Considerations When Reviewing Results

Visual 1: Lesson 13: Considerations When Reviewing Results

Visual 2: Lesson 13: Goal and Objectives

Goal: To provide an overview of considerations when reviewing results in the Hazus wind model.

After completing this lesson you will be able to:

- Understand forecast errors for landfalling hurricanes.

Visual 3: Sources of Uncertainty

Wind Speed Estimates	Only 116 years of storm data Incomplete/noisy observations
Rainfall Model	Simplified model based on limited data
Terrain Roughness	Land use is used to calculate surface roughness. Changes in land use Direction and transition effects.
Load & Resistance Model	Pressure coefficients Missile debris sources & transport Fatigue effects not modeled

Visual 4: Sources of Uncertainty

Damage-to-Loss Model	Limited validation of implicit loss models	
Building Stock Distribution	Model building types Incomplete or incorrect inventory data	
Fast-Running Loss Functions	Average loss as function of peak gust	
Business Interruption	Analysis parameters based on national averages	

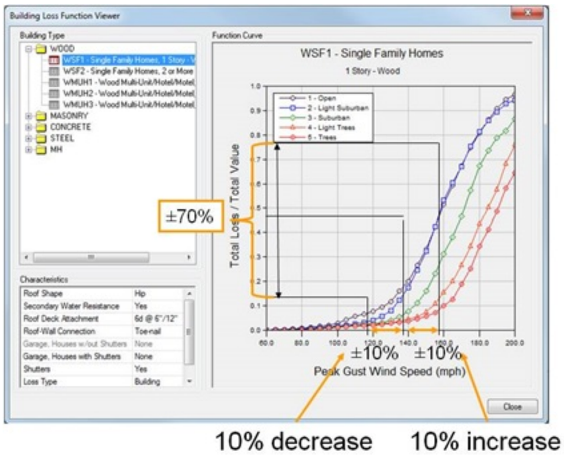
Visual 5: Treatment of Uncertainties

- Hazus produces "best estimate results," but there is no explicit treatment or estimation of uncertainty.
- Potential impact of uncertainties can be assessed through multiple sensitivity analyses.
  - Intensity, size, speed, and track of scenario storms
  - Distributions of construction characteristics
  - Building valuation
  - Terrain and tree coverage
  - Economic and shelter model parameters

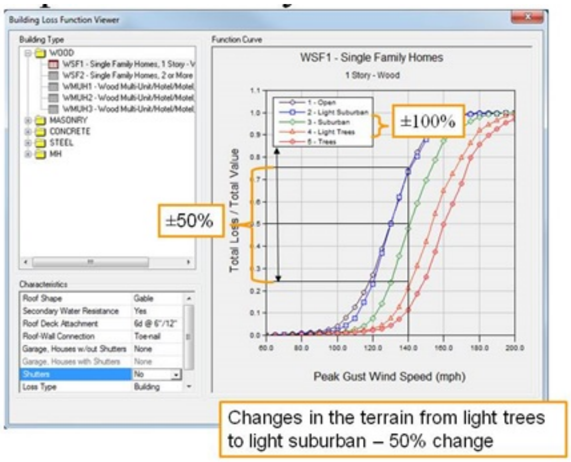
Visual 6: Uncertainty in Hazus

- As a hurricane approaches landfall, the amount of uncertainty on its landfalling location decreases.
- In Hazus, as you import forecast advisory information (Hurrevac or from NHC) over time in the days before a hurricane landfall, the uncertainty ranges will narrow, indicating it is too close for the hurricane to miss the study region.

Visual 7: Example: Sensitivity to Wind Speed



Visual 8: Example: Sensitivity to Terrain



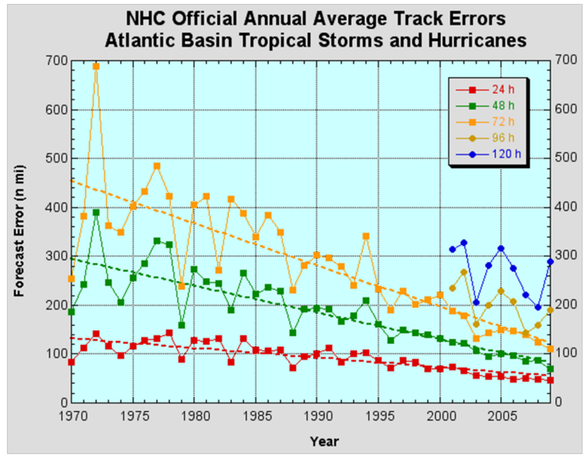
Visual 9: Ranking of Uncertainties

Smaller storms and/or smaller study regions will generally have greater uncertainties.

- Individual building / single storm
- Regional loss / single storm
- Regional return period losses / probabilistic
- Regional annualized losses / probabilistic

(Ranked from most to least uncertain)

Visual 10: Real-Time Hurricane Modeling



National Hurricane Center (NHC)
http://www.nhc.noaa.gov/verification/verify5.shtml

While hurricane forecasts are improving, errors still exist.

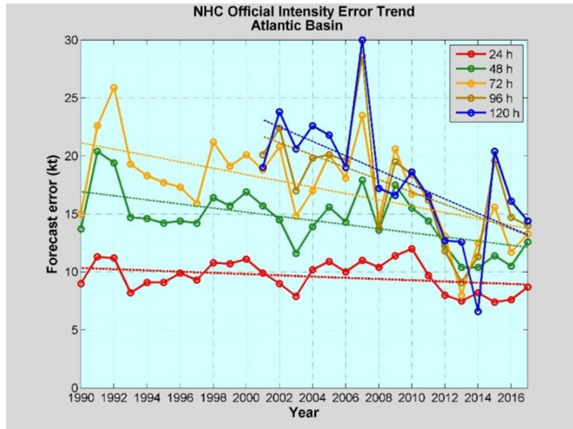
- 24 hour forecasts have a positional error of approximately 40 miles.
- When compared to a city or county, this can have major consequences for damage and loss modeling.

https://www.nhc.noaa.gov/verification/verify5.shtml

Visual 11: Real-Time Hurricane Modeling

Intensity forecasts also have errors: 24 hour forecasts (10 mph)

- 120 to 130 mph
  - 10 mph increase, 8% increase
  - WSF1 goes from 10% loss to 25%
- 130 to 140 mph
  - Changes from 25% to 50% loss
  - See Building Loss Function Viewer



While the positional forecasts have improved considerably, the intensity forecasts have remained nearly the same.

Visual 12: Recommendations

- Understand dependency of modules and analysis parameters.
- Enhance inventory data:
    - Building value, square footage, count
    - Occupancy mapping schemes
    - Wind building characteristics
- Enhance terrain modeling using recent remote sensing data and/or local land use databases.
- Develop local estimates for economic and shelter parameters.
- Run sensitivity cases to see range of results.
- Present results with appropriate caveats.

Visual 13: Exercise 13.1: Sensitivity of Hurricane Storm Parameters

Goal:

- Modify uncertain and sensitive variables in Hazus.
- Run multiple scenarios.
- Compare the results.

Time: 45 minutes

Exercise 13.1: Sensitivity of Hurricane Storm Parameters

Goal:

- Modify uncertain and sensitive variables in Hazus.
- Run multiple scenarios.
- Compare the results.

Time: 45 Minutes

Student Manual

1. Refer to Activities Document "13.1_Exercise_Sensitivity of Hurricane Storm Parameters."
2. Listen to instructor's directions.
3. Ask questions if clarification is needed.
4. Work individually on the goal.
5. Ask questions to the instructor if needed.
6. Complete the assigned goal.
7. Be prepared to share your answers/results.
8. Ask any final questions.

Visual 14: Exercise 13.1: Tasks

Task 1: Create an Irma Study Region

Task 2: Run the default landfall track scenario

Task 3: Run the scenario with a modified speed.

Task 4: Run the scenario with a modified size.

Task 5: Run the scenario with a modified intensity.

Student Manual

Exercise 13.1 - Tasks

- Refer to Activities Document “13.1_Exercise_Sensitivity of Hurricane Storm Parameters.”

Exercise 13.1: Sensitivity of Hurricane Storm Parameters

Type: Student-Led Activity

Time: 45 minutes

Goals:

- Modify uncertain and sensitive variables in Hazus.
- Run multiple scenarios.
- Compare the results.

Background:

This exercise will explore the impact of changing various parameters that define the course, speed, and strength of a hurricane. It is very important that you are aware of the differences that these types of inputs can produce with respect to predicted damages. This exercise only alters the hurricane parameters just slightly and illustrates the impact on the damage and loss estimates.

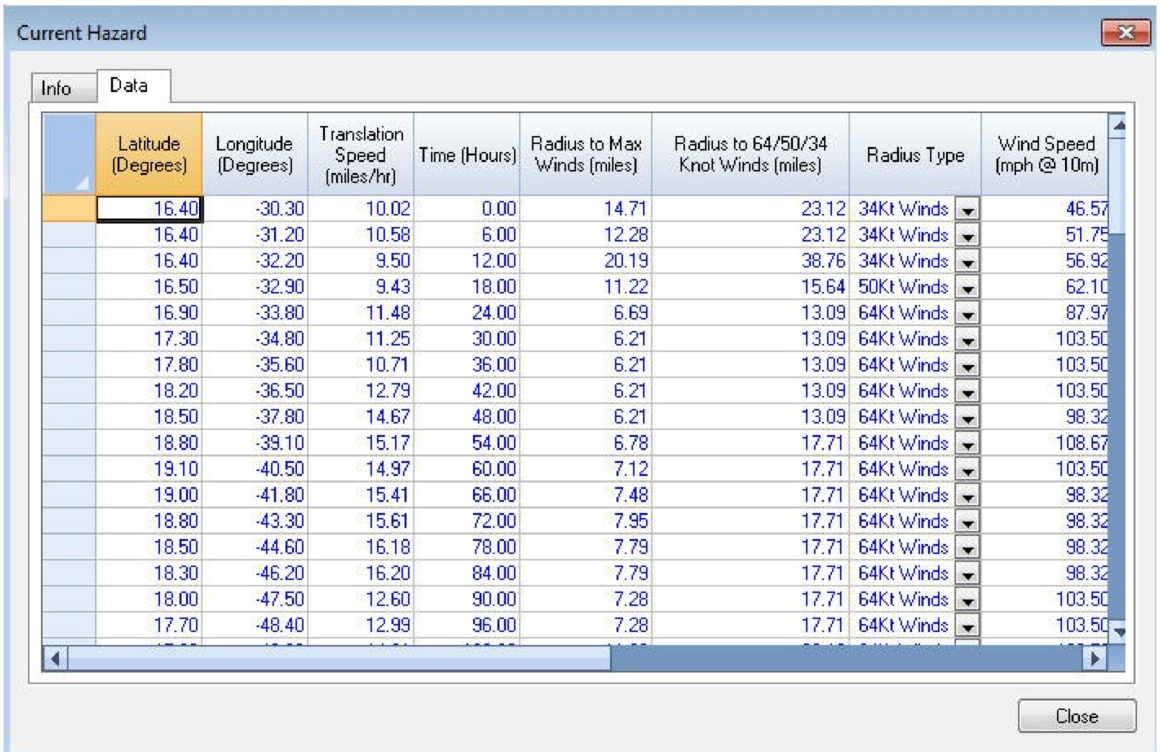
Task 1: Create an Irma Study Region

1. Start Hazus
2. Create a new study region with the following parameters:
   - Name: Irma_Landfall
   - Aggregation level: County
   - State: Florida
   - Counties: Hillsborough and Pinellas
   - Hazard type: Hurricane

Task 2: Run the default landfall track scenario

1. From the Hazard menu choose “Scenario”.
2. Click “Next” to advance the Scenario wizard.
3. Select Create New Scenario and click “Next”.
4. Select Import from Exported File and click “Next”.
5. Name the new scenario Irma Landfall Track. This storm was created by entering latitude, longitude, wind speed, and central pressure information from forecast advisory information.

6. Click "Next".
7. Click on Browse and navigate to the C:\E0170_ActivityData\Exercise_13.1 folder.
8. Select the import file named IrmaLandfallTrack.bin and click "Open".
9. Click "Next" to complete the import process and to perform the wind field calculation.
10. Click "Next" after the application has finished computing the wind speeds.
11. Click "Next" to move beyond the Storm Track Data window.
12. Click "Next" to move through the Scenario Review.
13. Click "Next" again
14. Click Finish.
15. From the Hazard menu choose Show Current.
16. Click the Data tab. The data tab of the Current Hazard box should show the following information.

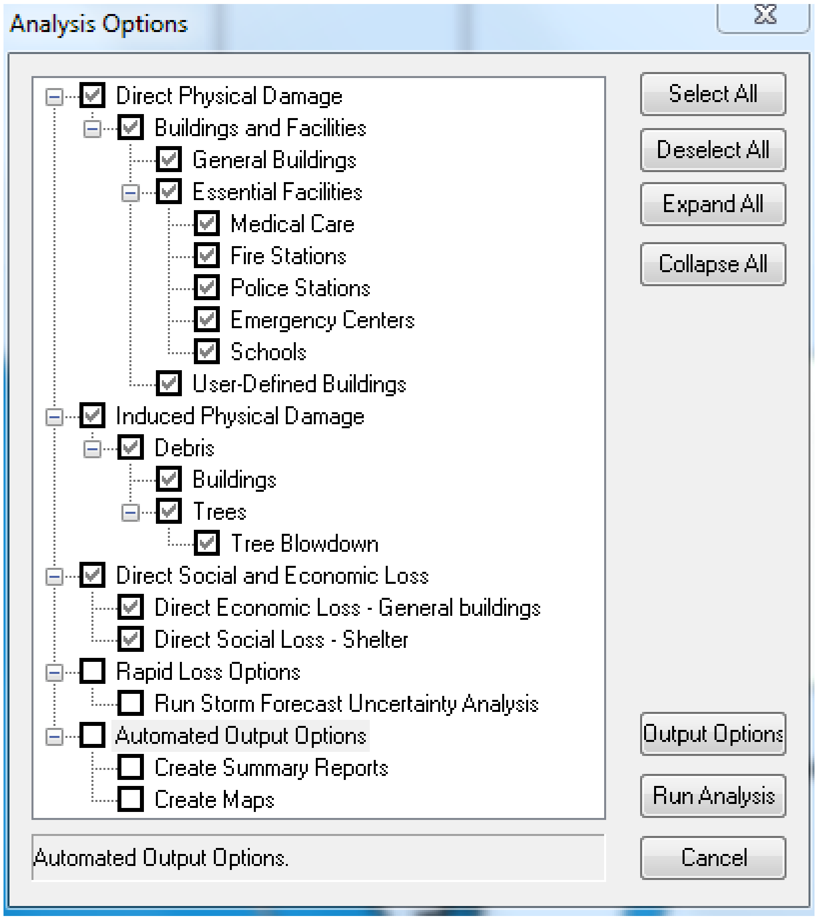

Current Hazard

Info | Data

Latitude (Degrees)	Longitude (Degrees)	Translation Speed (miles/hr)	Time (Hours)	Radius to Max Winds (miles)	Radius to 64/50/34 Knot Winds (miles)	Radius Type	Wind Speed (mph @ 10m)
16.40	-30.30	10.02	0.00	14.71	23.12	34Kt Winds	46.57
16.40	-31.20	10.58	6.00	12.28	23.12	34Kt Winds	51.75
16.40	-32.20	9.50	12.00	20.19	38.76	34Kt Winds	56.92
16.50	-32.90	9.43	18.00	11.22	15.64	50Kt Winds	62.10
16.90	-33.80	11.48	24.00	6.69	13.09	64Kt Winds	87.97
17.30	-34.80	11.25	30.00	6.21	13.09	64Kt Winds	103.50
17.80	-35.60	10.71	36.00	6.21	13.09	64Kt Winds	103.50
18.20	-36.50	12.79	42.00	6.21	13.09	64Kt Winds	103.50
18.50	-37.80	14.67	48.00	6.21	13.09	64Kt Winds	98.32
18.80	-39.10	15.17	54.00	6.78	17.71	64Kt Winds	108.67
19.10	-40.50	14.97	60.00	7.12	17.71	64Kt Winds	103.50
19.00	-41.80	15.41	66.00	7.48	17.71	64Kt Winds	98.32
18.80	-43.30	15.61	72.00	7.95	17.71	64Kt Winds	98.32
18.50	-44.60	16.18	78.00	7.79	17.71	64Kt Winds	98.32
18.30	-46.20	16.20	84.00	7.79	17.71	64Kt Winds	98.32
18.00	-47.50	12.60	90.00	7.28	17.71	64Kt Winds	103.50
17.70	-48.40	12.99	96.00	7.28	17.71	64Kt Winds	103.50

Close

17. Click “Close” to close the Current Hazard window.
18. From the Analysis select “Run” to open the Analysis Options menu.
19. Select all of the options except the Rapid Loss Options and the Automated Output Options.



20. Click “Run Analysis” to begin the analysis. The analysis will take a few moments to complete.

21. Click “OK” when prompted to acknowledge that the analysis has completed.

22. Answer the questions for the column titled Irma Landfall Track found in the Results Table located at the end of the exercise.

Note: Hints for answering these types of questions can be found in earlier exercises. You can also ask your instructor for assistance.

Task 3: Run the scenario with a modified speed.

In this task of you will copy the Irma Landfall Track scenario and modify the parameters to explore the impact of changing the speed of the storm.

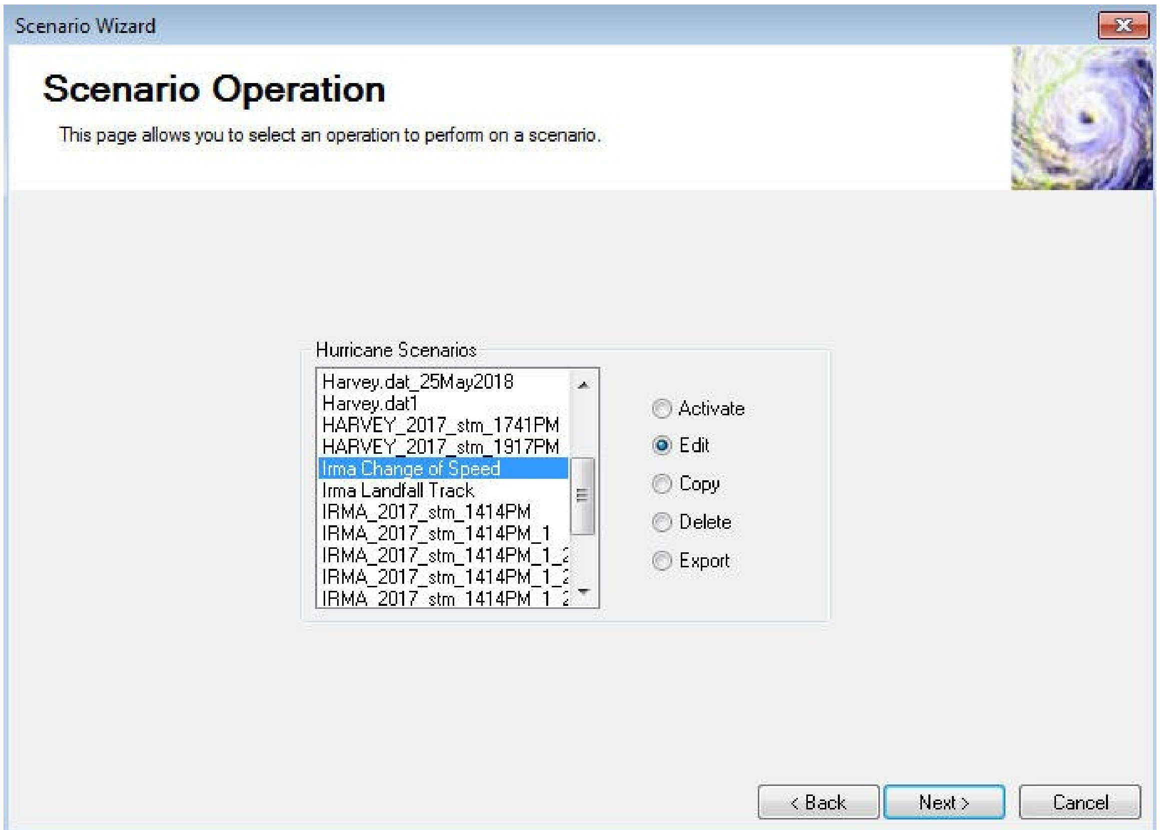
1. From the Hazard menu choose Scenario to start the Scenario Wizard.

2. Click “Next”.

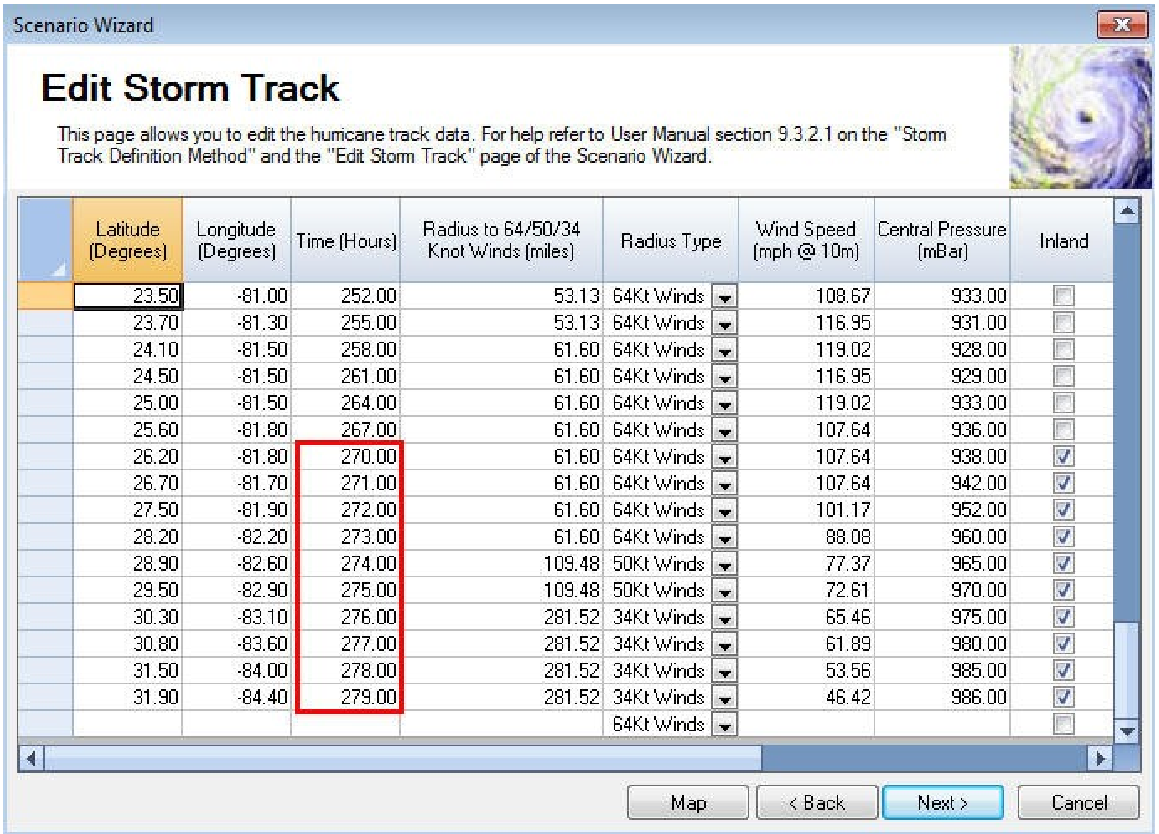
3. Select the Irma Landfall Track scenario and select “Copy”.

4. Click “Next”.

5. Name the new scenario Irma Change of Speed.
6. Click “Next”.
7. Edit the new scenario by selecting the Irma Change of Speed scenario, selecting “Edit”.
8. Click “Next”.



9. Click next until you reach the Edit Storm Track table.
10. Scroll down to the bottom of the table where the boxes are checked in the Inland column.
11. Edit the Time (Hours) column in the data table by increasing the times as shown below. This shows a faster moving hurricane than the previously modeled hurricane.



Latitude (Degrees)	Longitude (Degrees)	Time (Hours)	Radius to 64/50/34 Knot Winds (miles)	Radius Type	Wind Speed (mph @ 10m)	Central Pressure (mBar)	Inland
23.50	-81.00	252.00	53.13	64Kt Winds	108.67	933.00	☐
23.70	-81.30	255.00	53.13	64Kt Winds	116.95	931.00	☐
24.10	-81.50	258.00	61.60	64Kt Winds	119.02	928.00	☐
24.50	-81.50	261.00	61.60	64Kt Winds	116.95	929.00	☐
25.00	-81.50	264.00	61.60	64Kt Winds	119.02	933.00	☐
25.60	-81.80	267.00	61.60	64Kt Winds	107.64	936.00	☐
26.20	-81.80	270.00	61.60	64Kt Winds	107.64	938.00	☑
26.70	-81.70	271.00	61.60	64Kt Winds	107.64	942.00	☑
27.50	-81.90	272.00	61.60	64Kt Winds	101.17	952.00	☑
28.20	-82.20	273.00	61.60	64Kt Winds	88.08	960.00	☑
28.90	-82.60	274.00	109.48	50Kt Winds	77.37	965.00	☑
29.50	-82.90	275.00	109.48	50Kt Winds	72.61	970.00	☑
30.30	-83.10	276.00	281.52	34Kt Winds	65.46	975.00	☑
30.80	-83.60	277.00	281.52	34Kt Winds	61.89	980.00	☑
31.50	-84.00	278.00	281.52	34Kt Winds	53.56	985.00	☑
31.90	-84.40	279.00	281.52	34Kt Winds	46.42	986.00	☑
				64Kt Winds			☐

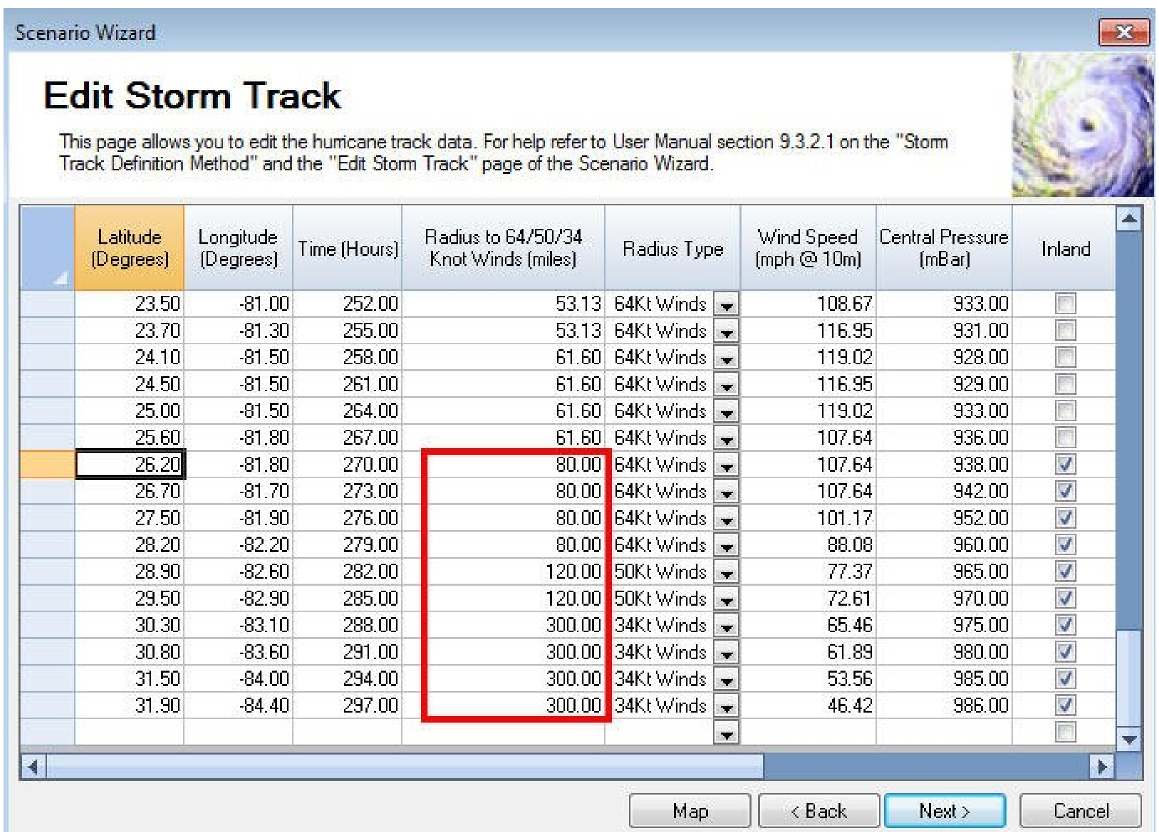
11. Complete the scenario wizard. Make the scenario active.
12. Navigate to the Analysis menu and click "Run." Select all of the options except the Rapid Loss Options and the Automated Output Options.
13. Answer the questions in the **Results Table** at the end of this exercise in the column entitled Irma Change of Speed.
14. Return to this page and continue with the exercise after you have filled in the Irma Change of Speed column.

12. Complete the scenario wizard and make the scenario active.
13. Navigate to the Analysis menu and then click Run.
14. Select all of the options except the Rapid Loss Options and the Automated Output Options.
15. When the analysis is complete, click OK.
16. Answer the questions in the Results Table at the end of this exercise in the column titled "Irma Change Speed".
17. Return to this page and continue with the exercise after you have filled in the Irma Change of Speed column.

Task 4: Run the scenario with a modified size.

In this part of the exercise you will copy the Irma Landfall Track scenario and modify the parameters to explore the impact of changing the size of the storm.

1. From the Hazard menu choose Scenario to start the scenario wizard.
2. Click “Next”.
3. Select the Irma Landfall Track scenario and “Copy”. Then click “Next”.
4. Name the new scenario Irma Change of Size and click “Next”.
5. Edit the new scenario by selecting the Irma Change of Size scenario, selecting “Edit”, and then clicking “Next” until you get to the data table.
6. Scroll down to the bottom of the table where the boxes are checked in the Inland column.
7. Edit the Radius to 64/50/34 Knot Winds (miles) column in the data table by increasing the miles as shown below. This shows a larger hurricane than the previously modeled hurricane.



Latitude (Degrees)	Longitude (Degrees)	Time (Hours)	Radius to 64/50/34 Knot Winds (miles)	Radius Type	Wind Speed (mph @ 10m)	Central Pressure (mBar)	Inland
23.50	-81.00	252.00	53.13	64Kt Winds	108.67	933.00	☐
23.70	-81.30	255.00	53.13	64Kt Winds	116.95	931.00	☐
24.10	-81.50	258.00	61.60	64Kt Winds	119.02	928.00	☐
24.50	-81.50	261.00	61.60	64Kt Winds	116.95	929.00	☐
25.00	-81.50	264.00	61.60	64Kt Winds	119.02	933.00	☐
25.60	-81.80	267.00	61.60	64Kt Winds	107.64	936.00	☐
26.20	-81.80	270.00	80.00	64Kt Winds	107.64	938.00	☑
26.70	-81.70	273.00	80.00	64Kt Winds	107.64	942.00	☑
27.50	-81.90	276.00	80.00	64Kt Winds	101.17	952.00	☑
28.20	-82.20	279.00	80.00	64Kt Winds	88.08	960.00	☑
28.90	-82.60	282.00	120.00	50Kt Winds	77.37	965.00	☑
29.50	-82.90	285.00	120.00	50Kt Winds	72.61	970.00	☑
30.30	-83.10	288.00	300.00	34Kt Winds	65.46	975.00	☑
30.80	-83.60	291.00	300.00	34Kt Winds	61.89	980.00	☑
31.50	-84.00	294.00	300.00	34Kt Winds	53.56	985.00	☑
31.90	-84.40	297.00	300.00	34Kt Winds	46.42	986.00	☑
							☐

8. Complete the Scenario wizard and make the scenario active.
9. Navigate to the Analysis menu and then click Run. Select all of the options except the Rapid Loss Options and the Automated Output Options.
10. Answer the questions in the Results Table at the end of this exercise in the column titled

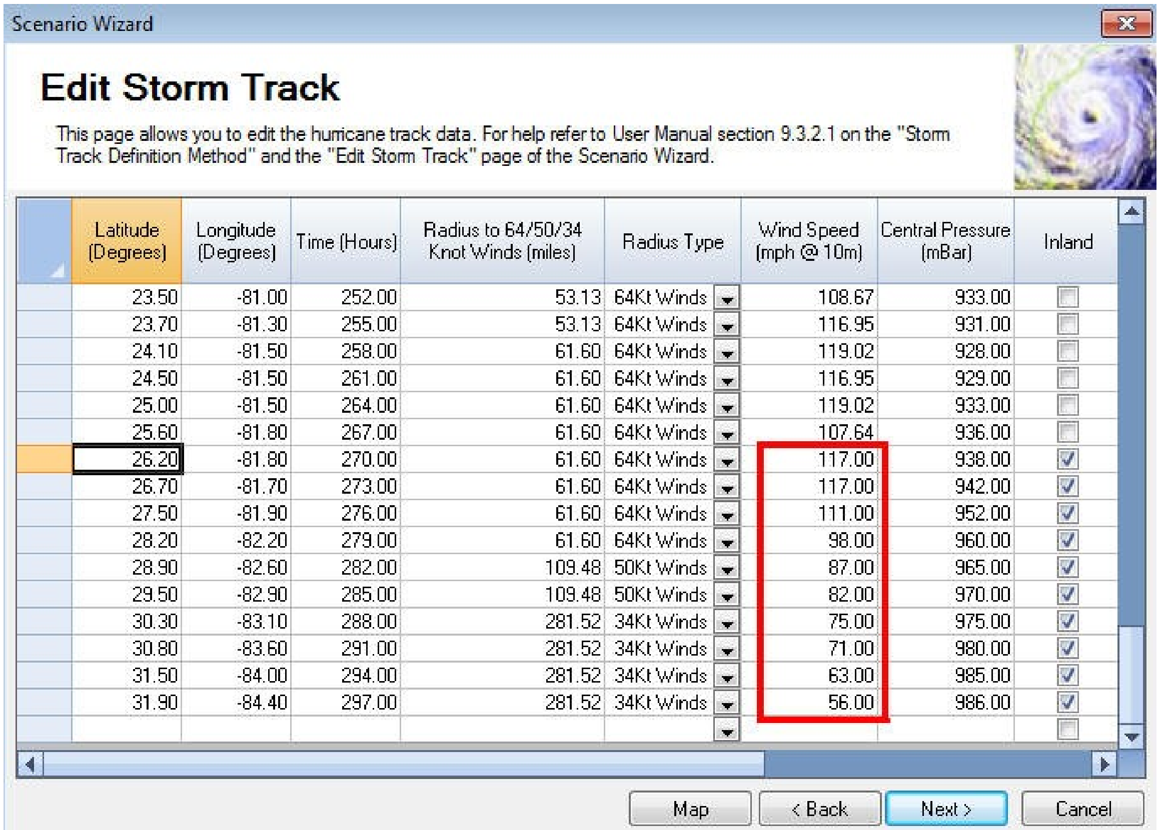
"Irma Change Size".

8. Complete the Scenario wizard and make the scenario active.
9. Navigate to the Analysis menu and then click Run.
10. Select all of the options except the Rapid Loss Options and the Automated Output Options.
11. Answer the questions in the Results Table at the end of this exercise in the column titled "Irma Change Size".

Task 5: Run the scenario with a modified intensity.

In the final portion of the exercise you will copy the Irma Landfall Track scenario and modify the parameters to explore the impact of changing the intensity of the storm.

1. From the Hazard menu choose Scenario to start the Scenario Wizard. Click "Next".
2. Select the Irma Landfall Track scenario and select Copy. Then click "Next".
3. Name the new scenario Irma Change of Intensity and click "Next".
4. Edit the new scenario by selecting the Irma Change of Intensity scenario, selecting "Edit", and then clicking "Next" until you get to the data table.
5. Scroll down to the bottom of the table where the boxes are checked in the Inland column.
6. Edit the Wind Speed column in the data table by increasing the wind speeds, by approximately 10 mph, as shown below. This shows a stronger hurricane than the previously modeled hurricane.



7. Complete the Scenario wizard. Make the scenario active.

8. Navigate to the Analysis menu and then click Run. Select all of the options except the Rapid Loss Options and the Automated Output Options.

9. Answer the questions in the Results Table at the end of this exercise in the column titled “Irma Change Intensity”.

Results Table

Question	Irma Landfall Track	Irma Change Speed	Irma Change Size	Irma Change Intensity
a) What is the maximum peak gust wind speed on land in the study area?				
b) How many Residential Buildings have been damaged? (minor, moderate, severe, destroyed)				

Question	Irma Landfall Track	Irma Change Speed	Irma Change Size	Irma Change Intensity
c) What is the Total Direct Economic Loss for the region?				
d) How many expected displaced households are there in the region?				
e) What is the total estimated debris in tons?				

Observe the difference in the results that you can obtain by using altered forecast advisories. Due to the complex nature of hurricanes, you must consider early forecast advisories as general approximations of what may happen if a hurricane retains its current path and if it follows predictions exactly as they are defined in the forecast. However, due to the possibility of significant changes that might occur during the course of a hurricanes evolution, information produced from early forecast advisories should be carefully used and distributed with extreme caution.

10. Save your map document and exit Hazus.

Visual 15: Lesson 13: Review

1. What are two types of forecast errors for landfalling hurricanes?

Visual 16: Questions?

Lesson 14: Capstone Exercise

Visual 1: Lesson 14: Capstone Exercise

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Visual 2: Lesson 14: Goal and Objectives

Goal: To complete and present the Capstone Exercise

Objectives:

- Develop hurricane mitigation plan for chosen county OR
- Develop hurricane response and recovery plan for chosen county.
- Create PowerPoint presentation
- Present to class in groups of 3-4

Visual 3: Capstone Exercise Explanation

- The county planning board has hired your team to give a 20-minute PowerPoint presentation at its next public meeting on the severity of hurricane hazards in the county and the possible methods for mitigating or responding to future hurricane damage in that county.
- You, as the consultant and a Hazus expert, have decided to use Hazus to analyze the county's hurricane risk.
- The results of your study will be presented at the monthly commissioners meeting.
    - Each group will present while the remaining participants assume the role of the commissioners.

Visual 4: Capstone Exercise Explanation

Required issues to be addressed:

- Which major hurricane(s) have impacted this region in the past?
- What damage would the worst of these storms produce if it happened again today?
- What is the approximate return period for the worst historic storm?
- Summarize the number and value of buildings at risk to hurricanes.
- Provide a map of essential facilities, high potential loss facilities, and any additional features you deem important for risk communication.
- What are potential benefits of mandating shutters on all new single-family dwellings?
- Summarize the assumptions made in your benefit analysis.

Visual 5: Capstone Exercise Explanation

Presenter Guidelines:

- Prepare using PowerPoint
- Include maps, tables, or other media you deem appropriate
- Information should be primarily derived from Hazus, but may be supplemented by other sources
- 10-15 minutes in length

Commissioner Guidelines

- Class will assume the role of commissioners
- Commissioners may ask questions related to the presentation

Visual 6: Capstone Exercise

- Allow groups time to work on their presentation.
- Break as needed.
- Additional work time will be provided after lunch.
- Presentations will begin at 2:30pm.

Lesson 15: Course Wrap-Up

Visual 1: Lesson 15: Course Wrap Up

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Visual 2: Lesson 15: Goal and Objectives

Goal: To review the major themes of the course and discuss opportunities for learning more about Hazus.

After completing this lesson you will be able to:

- Identify courses and other opportunities for training available to enhance your Hazus skills.
- Identify additional resources available to explore to enhance your Hazus experience.

Visual 3: Hazus Training

Courses to Consider:

- E0190: ArcGIS for Emergency Managers
- E0172: Hazus for Floods
- E0174: Hazus for Earthquake and Tsunami
- E0317: Comprehensive Data Management for Hazus
- E0177: Advanced Hazus Applications
- E0179: Application of Hazus for Disaster Operations

Visual 4: Become A Hazus Expert!

Hazus Trained User

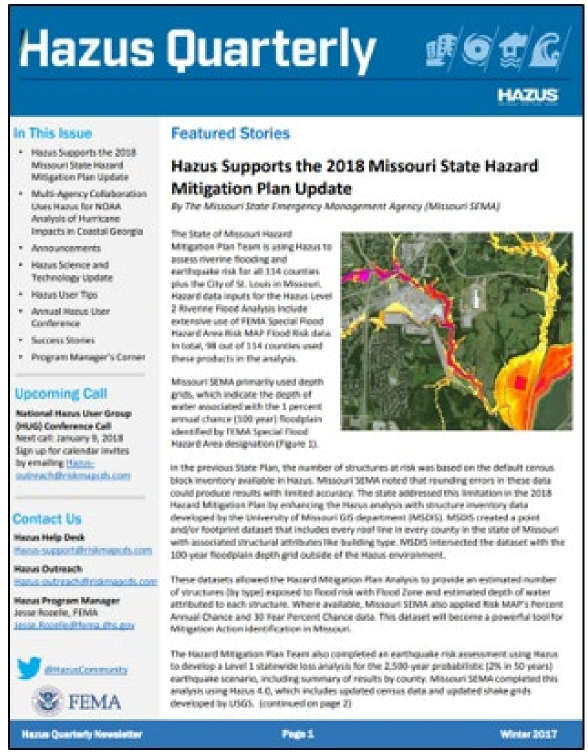
- E0190 ArcGIS for Emergency Managers (or prior GIS experience may substitute)
- E0313 Basic Hazus
- E0317 Comprehensive Data Management (CDMS)
- Minimum of two of the following:
  - E0170 Hazus for Hurricanes
  - E0172 Hazus for Floods
  - E0174 Hazus for Earthquakes and Tsunami

Hazus Practitioner

- E0190 ArcGIS for Emergency Managers (or prior GIS experience may substitute)
- E0313 Basic Hazus
- E0317 Comprehensive Data Management (CDMS)
- Minimum of two of the following:
  - E0170 Hazus for Hurricanes
  - E0172 Hazus for Floods
  - E0174 Hazus for Earthquakes and Tsunami
- E0179 Application of Hazus for Disaster Operations
- E0177 Advanced Hazus Applications

Visual 5: Hazus Community Participation

- Hazus User Conference
- Quarterly Newsletter
- National Hazus User Group calls
- Local Hazus User Groups
- Hazus Outreach Email: hazus-outreach@riskmapcds.com



Hazus Quarterly

HAZUS

In This Issue

- Hazus Supports the 2018 Missouri State Hazard Mitigation Plan Update
- Multi-Agency Collaboration Uses Hazus for NOAA Analysis of Hurricane Impacts in Coastal Georgia
- Announcements
- Hazus Science and Technology Update
- Hazus User Tips
- Annual Hazus User Conference
- Success Stories
- Program Manager's Corner

Upcoming Call

National Hazus User Group (HUG) Conference Call
Next call: January 9, 2018
Sign up for calendar invites by emailing Hazus-outreach@riskmapcds.com

Contact Us

Hazus Help Desk
Hazus-support@riskmapcds.com

Hazus Outreach
Hazus-outreach@riskmapcds.com

Hazus Program Manager
Jesse Rozelle, FEMA
Jesse.Rozelle@fema.dhs.gov

@HazusCommunity

FEMA

Featured Stories

Hazus Supports the 2018 Missouri State Hazard Mitigation Plan Update

By The Missouri State Emergency Management Agency (Missouri SEMA)

The State of Missouri Hazard Mitigation Plan Team is using Hazus to assess riverine flooding and earthquake risk for all 114 counties plus the City of St. Louis in Missouri. Hazard data inputs for the Hazus Level 2 Riverine Flood Analysis include extensive use of FEMA Special Flood Hazard Area Risk MAP Flood Risk data. In total, 98 out of 114 counties used these products in the analysis.

Missouri SEMA primarily used depth grids, which indicate the depth of water associated with the 1 percent annual chance (100 year) floodplain identified by FEMA Special Flood Hazard Area designation (Figure 1).

In the previous State Plan, the number of structures at risk was based on the default census block inventory available in Hazus. Missouri SEMA noted that rounding errors in these data could produce results with limited accuracy. The state addressed this limitation in the 2018 Hazard Mitigation Plan by enhancing the Hazus analysis with structure inventory data developed by the University of Missouri GIS department (MSDIS). MSDIS created a point and/or footprint dataset that includes every roof line in every county in the state of Missouri with associated structural attributes like building type. MSDIS intersected the dataset with the 100 year floodplain depth grid outside of the Hazus environment.

These datasets allowed the Hazard Mitigation Plan Analysis to provide an estimated number of structures (by type) exposed to flood risk with Flood Zone and estimated depth of water attributed to each structure. Where available, Missouri SEMA also applied Risk MAP's Percent Annual Chance and 30 Year Percent Chance data. This dataset will become a powerful tool for Mitigation Action identification in Missouri.

The Hazard Mitigation Plan Team also completed an earthquake risk assessment using Hazus to develop a Level 1 statewide loss analysis for the 2,500-year probabilistic (2% in 50 years) earthquake scenario, including summary of results by county. Missouri SEMA completed this analysis using Hazus 4.0, which includes updated census data and updated shake grids developed by USGS. (continued on page 2)

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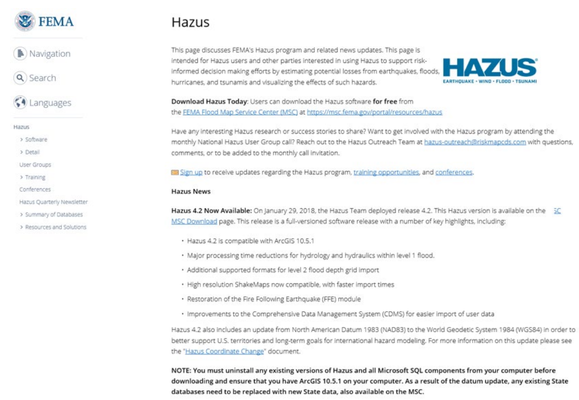
Visual 6: FEMA Hazus Website

Primary FEMA resource for updated Hazus information:
[FEMA Hazus Website](https://www.fema.gov/hazus):
https://www.fema.gov/hazus



Visual 7: Additional Resources

Hazus YouTube Videos – http://bit.ly/HAZUS

- 21 short (3-7 min) tutorials on all parts of Hazus.

Hazus GitHub - https://github.com/nhrap-hazus

- Site of published Hazus Open Source tools, such as Hazus FAST.

- Hazus Training Data and Student Guides - Site TBD

New Natural Hazards Risk Assessment Program website - https://www.fema.gov/nhrap

- Document Container of methods and research applications - https://www.fema.gov/media-library/assets/documents/180915

Visual 8: Getting Help

- Email Hazus Help Desk
    - hazus-support@riskmapcds.com
- Consult the User Manuals and Technical Manuals

https://www.fema.gov/hazus-mh-user-technical-manuals

Visual 9: Questions?

Appendix: Activity Data Zip File Hurricane

E0170 Activity Data