E0179: Application of Hazus for Disaster Operations

Student Manual

Date Released: 03/2019

Contents

Lesson 1: Introductions and Overview

Visual 1: Lesson 1: Introductions and Overview

HAZUS®

EARTHQUAKE • WIND • FLOOD • TSUNAMI

Visual 2: Let's Get Acquainted!

Participant introductions

- Name
- Organization
- Role in organization
- GIS and hazard analysis experience
- Goals and expectations for this class

Instructor introduction

Visual 3: Course Agenda

- **Day One:** Introduction and Overview, Review of Disaster Operations, Basic Hurricane, Hurricane Response, and Hurricane Recovery
- **Day Two:** CDMS, Site-Specific Data/UDF, Basic Flood, and Flood Response
- **Day Three:** Flood Recovery, Basic Earthquake, Earthquake Response, and Earthquake Recovery
- **Day Four:** Basic Tsunami, Tsunami Response and Recovery, Earthquake and Tsunami Combined Analysis, Hazus Products and Communication, and Course Wrap-up

Visual 4: Course Prerequisites

Completed the ArcGIS for Emergency Managers course and Basic Hazus

- General understanding of GIS capabilities and the goals of disaster operations.
- Recommended:
  - E0170: Hazus for Hurricane
  - E0172: Hazus for Flood
  - E0174: Hazus for Earthquake & Tsunami
  - E0317: Comprehensive Data Management System for Hazus

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Course Prerequisites

- Completed the ArcGIS for Emergency Managers course and Basic Hazus.
- General understanding of GIS capabilities and the goals of disaster operations.
- Recommended:
  - E0172: Hazus Flood or E0174: Hazus Earthquake or
  - E0170: Hazus Hurricane
  - E0317: Comprehensive Data Management System for Hazus
  - Participants should have a general understanding of GIS capabilities and the goals of disaster operations.
- Information from National Preparedness Course Catalog Website. (https://www.firstrespondertraining.gov/frt/npccatalog/EMI#anc-search-results)

Visual 5: 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 "experiments")
- After class (use it or lose it)

Visual 6: Course Tasks

- Lecture
- Discussion
- Demonstration: Instructor-Led
    - 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: Lesson 1: Goal and Objectives

Goal: To provide an overview of Hazus.

After completing this lesson you will be able to:

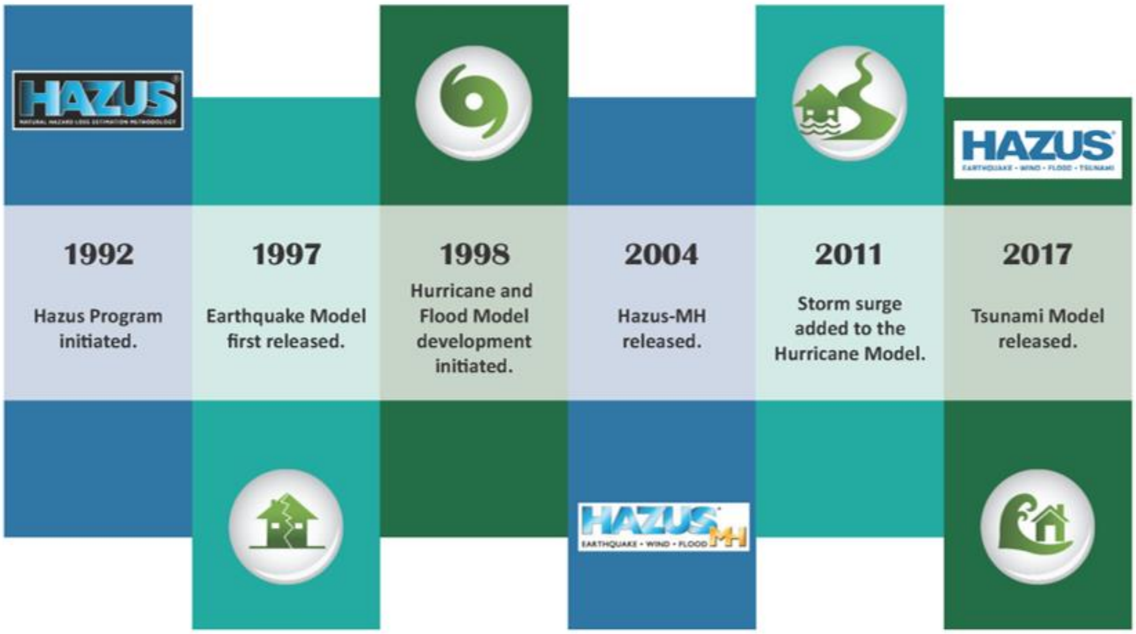
- Summarize the purpose of Hazus.
- List the hazards supported by Hazus.
- Describe how Hazus supports emergency management.
- Explain how data is integrated into Hazus.

Visual 8: What is Hazus?

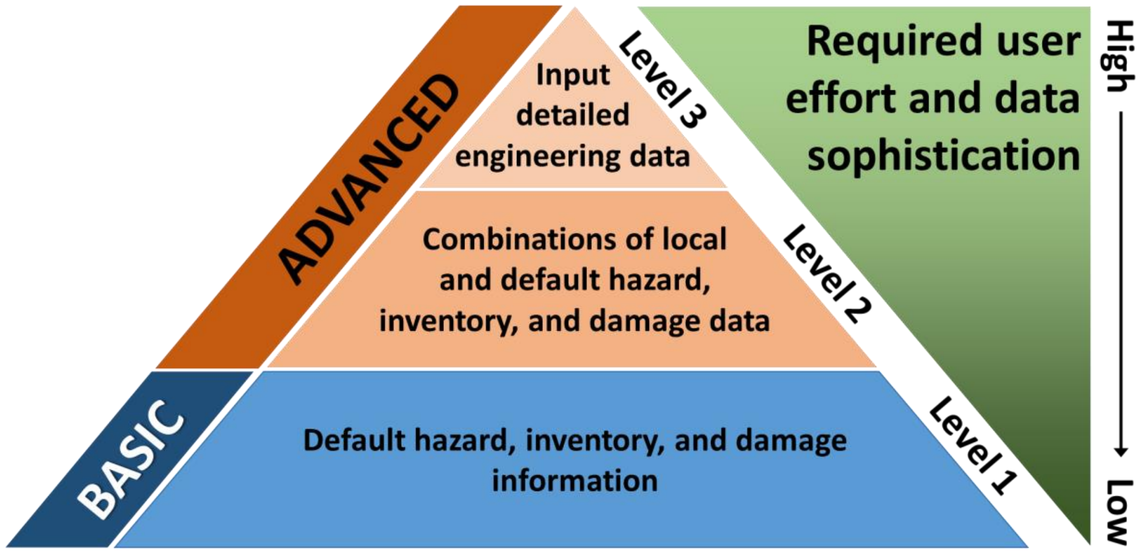
- Software tools and support system designed by FEMA for the purpose of providing communities with the means to identify and reduce risk from natural hazards
- Used by a variety of communities and organizations
- Available from FEMA free of charge (requires ArcGIS license with Spatial Analyst extension)

Visual 9: Supported Hazards

Visual 10: History



Visual 11: User Levels



Visual 12: Supporting Emergency Management

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

Visual 13: Loss Estimation Process

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

Direct Damages

Visual 14: Inventory (Exposure)

General building types and occupancies

- Lifelines
- Replacement costs
- Demographics

Hazard-specific

- Specific building types
- First floor elevations
- Building configurations

Visual 15: 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 and Hurrevac 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 16: Hazus 4.2 Capabilities

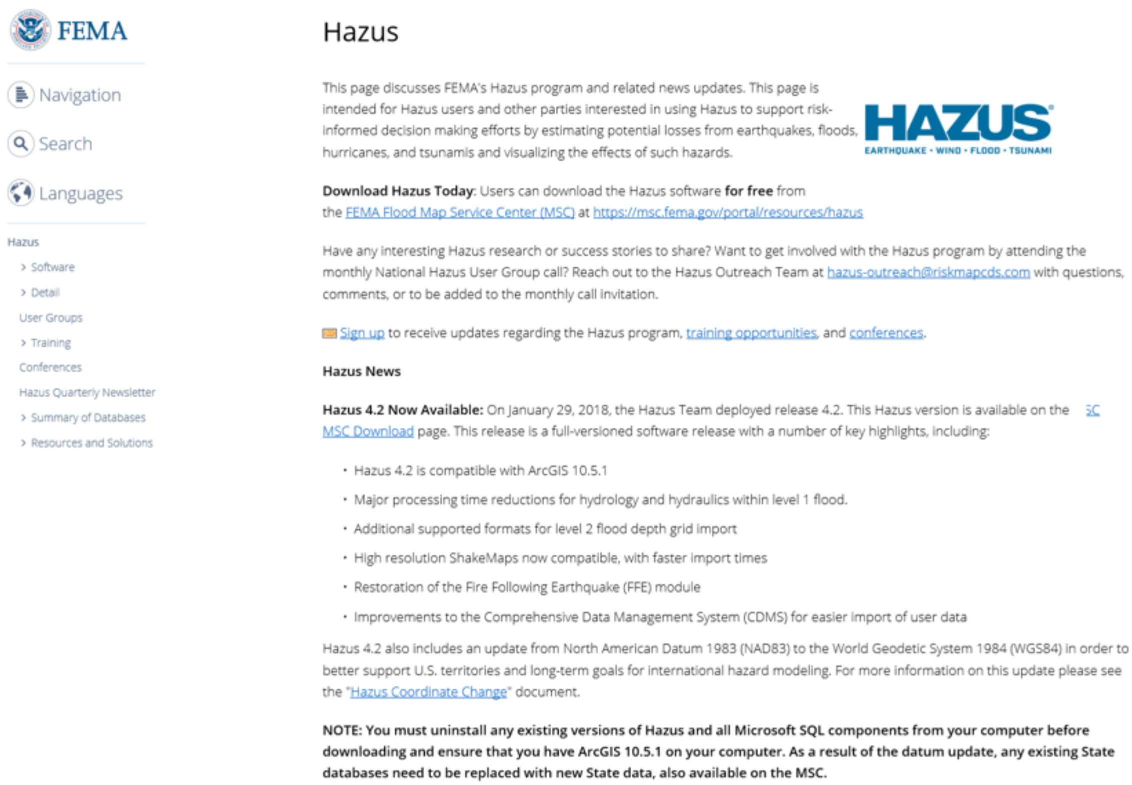
Hazus 4.2 Capabilities: Inputs	Earthquake	Flood	Hurricane	Tsunami
	Ground Shaking **Ground Failure**	**Frequency | Depth** **Riverine | Coastal Surge**	**Wind** **Surge**	**Depth | Momentum Flux** **Runup | Velocity**
Historic	✓	□	✓	
Deterministic	✓	✓	✓	✓
Probabilistic	✓	✓	✓	
User-supplied	✓	✓	✓	✓
Other 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 17: 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: 64-bit versions of Windows 10 Professional and Enterprise, Windows 8.1, and Windows 7 Professional
- Supporting Software: Appropriate version of Esri ArcGIS and the Spatial Analyst extension for the flood model

Visual 18: FEMA Hazus Website

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


FEMA

Navigation

Search

Languages

Hazus
- Software
- Detail

User Groups
- Training

Conferences

Hazus Quarterly Newsletter
- Summary of Databases
- Resources and Solutions

Hazus

This page discusses FEMA's Hazus program and related news updates. This page is intended for Hazus users and other parties interested in using Hazus to support risk-informed decision making efforts by estimating potential losses from earthquakes, floods, hurricanes, and tsunamis and visualizing the effects of such hazards.

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Download Hazus Today: Users can download the Hazus software **for free** from the FEMA Flood Map Service Center (MSC) at https://msc.fema.gov/portal/resources/hazus

Have any interesting Hazus research or success stories to share? Want to get involved with the Hazus program by attending the monthly National Hazus User Group call? Reach out to the Hazus Outreach Team at hazus-outreach@riskmapcds.com with questions, comments, or to be added to the monthly call invitation.

Sign up to receive updates regarding the Hazus program, training opportunities, and conferences.

Hazus News

Hazus 4.2 Now Available: On January 29, 2018, the Hazus Team deployed release 4.2. This Hazus version is available on the MSC MSC Download page. This release is a full-versioned software release with a number of key highlights, including:

- Hazus 4.2 is compatible with ArcGIS 10.5.1
- Major processing time reductions for hydrology and hydraulics within level 1 flood.
- Additional supported formats for level 2 flood depth grid import
- High resolution ShakeMaps now compatible, with faster import times
- Restoration of the Fire Following Earthquake (FFE) module
- Improvements to the Comprehensive Data Management System (CDMS) for easier import of user data

Hazus 4.2 also includes an update from North American Datum 1983 (NAD83) to the World Geodetic System 1984 (WGS84) in order to better support U.S. territories and long-term goals for international hazard modeling. For more information on this update please see the "Hazus Coordinate Change" document.

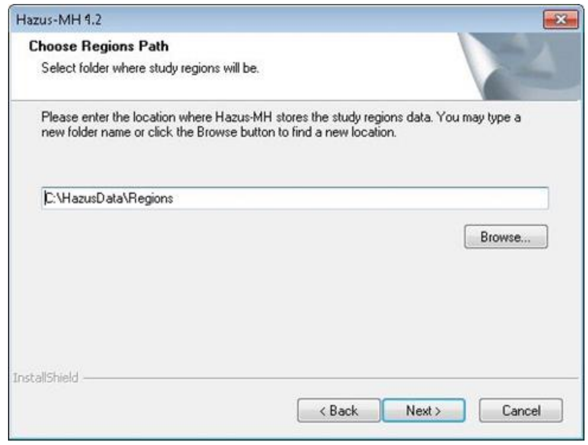
NOTE: You must uninstall any existing versions of Hazus and all Microsoft SQL components from your computer before downloading and ensure that you have ArcGIS 10.5.1 on your computer. As a result of the datum update, any existing State databases need to be replaced with new State data, also available on the MSC.

Visual 19: Installation

- Log in with a full Administrator account
- Download Hazus from the Map Service Center's 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

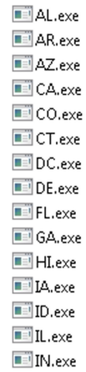
Visual 20: Study Region Location

- 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



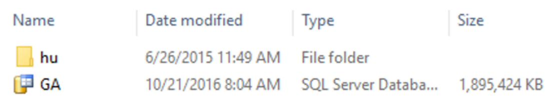
Visual 21: State Inventory Data

- Download Hazus provided data (aggregated by each state) at the FEMA Hazus Download site: msc.fema.gov/portal/resources/hazus
- Each State dataset is wrapped into a .exe file
- Extract state(s) files of interest to Data Path folder by double-clicking the .exe file and selecting the data path folder
- C:\HazusData\Inventory



Download each State's .exe file through the Map Service Center website

Each State's .exe will extract the State databases



Name	Date modified	Type	Size
hu	6/26/2015 11:49 AM	File folder	
GA	10/21/2016 8:04 AM	SQL Server Databa...	1,895,424 KB

Visual 22: What is a Study Region?

The area for which you are conducting a loss estimation study.

Can be defined by state, county, or census tract. Flood only or flood-tsunami regions can also be defined by census block, community, or watershed.

Questions to consider:

- What type of hazard(s) are you studying?
- What area(s) is the hazard likely to impact?
- Do you need to understand impacts outside your immediate jurisdiction?

No damage is assessed outside the study region - even if it exists!

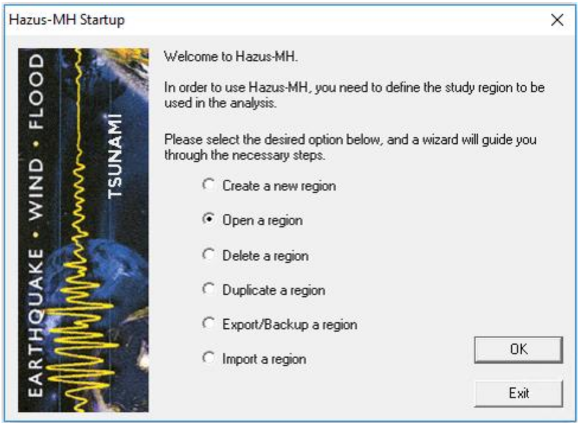
Visual 23: Study Region Size

- 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 24: Study Region Options

Hazus Startup Window

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



Visual 25: Discussion 1.1: Capabilities of Hazus

Question: What is the role of Hazus in modeling…

- dam breaks?
- levee breaks?
- pluvial flooding?
- category 5 hurricanes?
- minimal tropical storms?
- an 11.5 magnitude earthquake?

Group: 3-6 people

Time: 15 minutes

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Discussion 1.1: Capabilities of Hazus

Question: What is the role of Hazus in modeling…

- dam breaks?
- levee breaks?
- pluvial flooding?
- category 5 hurricanes?
- minimal tropical storms?
- an 11.5 magnitude earthquake?

Time: 15 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 26: Lesson 1: Review

1. What is the purpose of Hazus?
2. What are the four hazards supported by Hazus?
3. How does Hazus support emergency management?
4. How is data integrated into Hazus?

Visual 27: Capstone Exercise Preview

Goal: Understand the role of Hazus in assisting GIS analysts in a tabletop exercise.*

Planning:

- Day 1 (briefly)
- Day 4 morning

Presentation:

- Day 4 afternoon

*The exercise and your supporting materials will be presented to the leadership team.

Visual 28: 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 29: Capstone Exercise Explanation

- Scenario: Disaster Operations Response and Recovery agencies are enacting a tabletop exercise modeling their response to a natural disaster.
  - You, as Hazus experts will act as the GIS analysts using Hazus to support the tabletop exercise.
  - The type of tabletop exercise is up to you.
  - Create maps and other Hazus products to facilitate the exercise.
- Each group will present while the remaining participants assume the role of the leadership team.
  - Present and explain the type of tabletop exercise you are supporting.
  - Present and explain the materials you produced and why you produced those specifically.

Visual 30: Capstone Exercise Explanation

Presentation Guidelines:

- Should be prepared 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.

Leadership Team Guidelines:

- Class and instructor will assume the role of the leadership team.
- Leadership team may ask questions related to the presentation.

Visual 31: Capstone Exercise Preparation

Goals:

- Divide into 4 groups
- Start discussing roles, strategies, and the type of tabletop exercise you are supporting.

Time: 20 minutes

Visual 32: Questions

Lesson 2: Review of Disaster Operations Management

Visual 1: Lesson 2: Review of Disaster Operations Management

Visual 2: Lesson 2: Goal and Objectives

Goal: To review the field of disaster operations and provide an understanding of emergency management.

After completing this lesson you will be able to:

- Describe the effects of disasters.
- Summarize the emergency management cycle.
- Explain incident management activities during the response phase and recovery phase.

Visual 3: Disaster Effects

Disasters typically result in the following types of damage:

- Physical
- Social
- Economic
- Special concerns (environmental, historic properties, etc.)

What are some ideas of how Hazus can assist Emergency Management prior to and following a major disaster?

Visual 4: Disaster Effects: Physical Impacts

- Damage to community infrastructure assets
  - Roads, bridges, utilities
- Damage or destroyed community facilities
  - Hospitals, government offices, etc.
- Damage or destroyed homes and contents
- Damage or destroyed commercial buildings

What types of information can Hazus provide decision-makers?

Visual 5: Disaster Effects: Social Impacts

- Casualties
- Shelter needs
- Special Populations:
  - Elderly, disabled, children, transient populations, single parents
- Cultural Effects:
  - Education, literacy, household size
- Social Capital:
  - Public trust, social dependence, crime

Why is this information critical for preparedness operations?

Visual 6: Disaster Effects: Economic Impacts

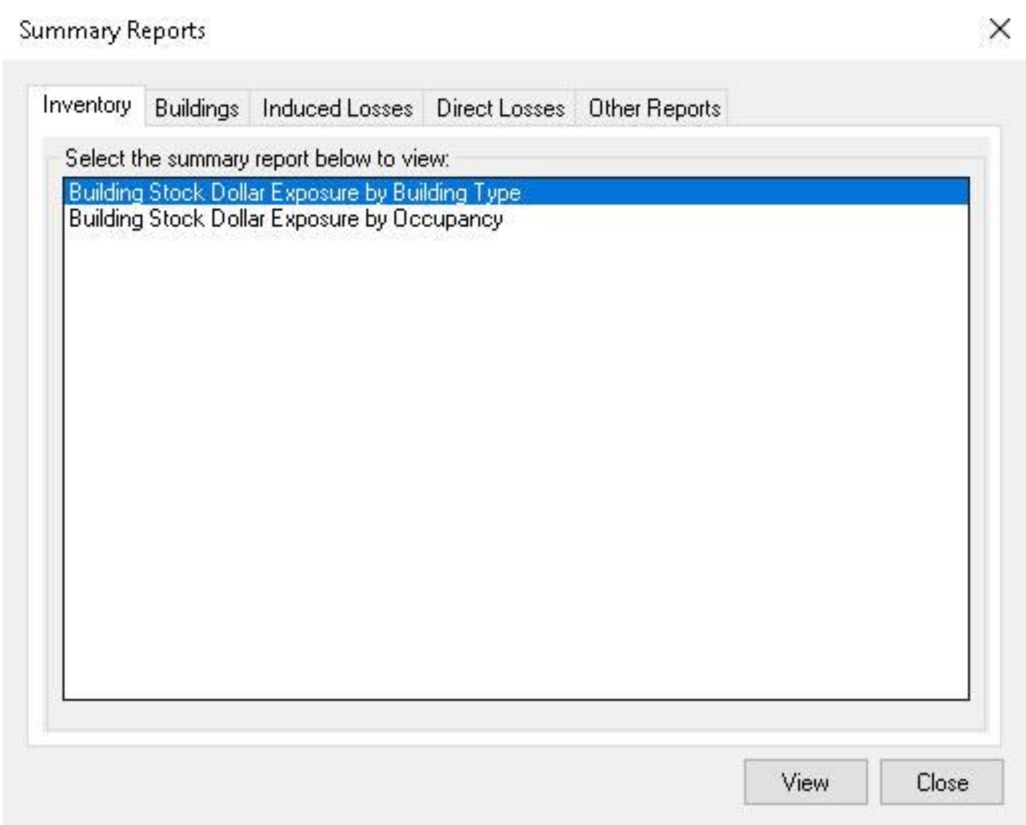
- Business interruption or closure
- Job losses
- Loss of Public Revenues:
    - Utilities, taxes, etc.
- Long-run growth of the local economy suffers

Visual 7: Disaster Effects: Special Concerns

- Environmental impacts
- Special Properties:
  - Historic places, coastal zone management, etc.
- Insurance
- Operational Considerations:
  - Evacuations, sheltering, private-public partnerships, etc.

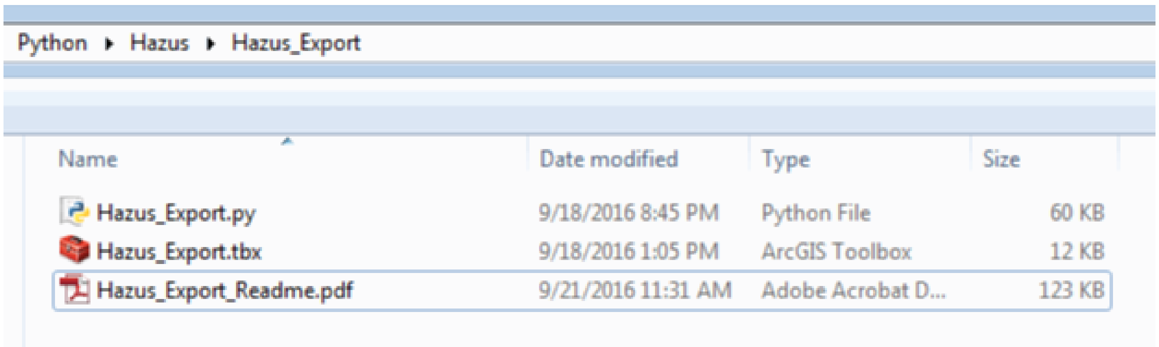
Visual 8: Hazus Summary Reports

- Various summary reports are available for viewing and printing in the Results menu
- Reports vary for each hazard
- Common summary report categories: inventory, building, losses, other
    - "Other" may include summary reports specific to the hazard, such as evacuation time for tsunami



Visual 9: Hazus Export Tool

- Hazus export toolbox is downloaded with Hazus installation
- Add Hazus export toolbox to Arc toolbox
- Run the export script to create a new geodatabase for your study region
- The tool exports results from the latest run in your study region



Visual 10: Principles of Emergency Management

- Comprehensive: taking into account all hazards, all stakeholders, all impacts
- Progressive: take preventative measures to build disaster-resistant communities
- Risk Driven: use sound risk management principles
- Integrated: ensure unity of effort among all levels of government
- Collaborative: create and sustain trust among peers, build consensus
- Coordinated: organize resources to achieve a common goal
- Professional: knowledge-based, ethical, continuous improvement

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Principles of Emergency Management

- Comprehensive: taking into account all hazards, all stakeholders, all impacts
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- Collaborative: create and sustain trust among peers, build consensus
- Coordinated: organize resources to achieve a common goal
- Professional: knowledge-based, ethical, continuous improvement
- Information from the Emergency Management Institute website: http://training.fema.gov/EMIWeb/edu/emprinciples.asp

Visual 11: Disaster Declaration Process

Types of Disaster Declarations

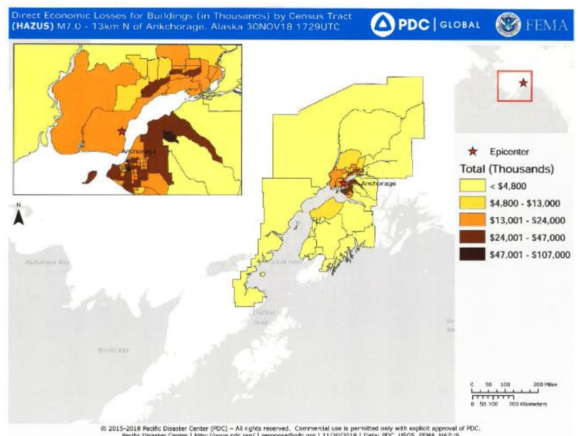
- Declared Emergencies
- Declared Major Disasters

Visual 12: Post-Earthquake Applications - PDA

Hazus was deployed to support response to the M7.0 Alaskan Earthquake that struck near Anchorage on November 30, 2018.

Hazus analysis was incorporated into Alaskan Governor Dunleavy's Official Request to the White House for a Presidential Disaster Declaration.

FEMA IA leadership confirmed: "Hazus estimates of building damage for the event (Hazus = Destroyed 5; Major 250) are a reasonable estimate of what is being found in the Preliminary Damage Assessments (PDA = 46 destroyed, 643 major) submitted by the State."



Visual 13: Incident Management Actions: Phases of Emergency Management

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Incident Management Actions: Phases of Emergency Management

- Preparedness: Pre-Incident, Incident, Post-Incident
- Prevention: Pre-Incident, Incident, Post-Incident
- Response: Pre-Incident, Incident
- Recovery: Incident, Post-Incident
- Mitigation: Pre-Incident, Incident, Post-Incident

Visual 14: Preparedness

- Preparing to handle an emergency
- Includes plans or preparations made to save lives and to help response and rescue operations
- Evacuation plans and stocking food and water are both examples of preparedness
- Preparedness activities take place before, during, and after an emergency occurs
- Hazus results can be used to help create community plans in case of future disasters
- Results may support creation of injects for exercises

Visual 15: Response

- Responding safely to an emergency and putting your preparedness plans into action.
- Includes actions taken to save lives and prevent further property damage in an emergency situation.
- Response activities take place pre-incident and during an emergency.
- Includes incident management
- Seeking shelter from a tornado or turning off gas valves in an earthquake are both response activities.

Visual 16: Recovery

- Responding safely to an emergency
- Includes actions taken to return to a normal or an even safer situation following an emergency or disaster.
- Recovery includes getting financial assistance to help pay for the repairs.
- Recovery activities can begin during an incident and continue to take place after an emergency.

Visual 17: Mitigation

- The effort to reduce loss of life and property by lessening the impact of disasters.
- Achieved through risk analysis, which provides the foundation for mitigation activities that reduce risk.
- Hazus provides opportunity for detailed risk assessment useful for mitigation applications.

Hazard Mitigation Grant Program (HMGP):

- Provides grants to states/local governments to implement long-term hazard mitigation measures after a Major Disaster Declaration.
- Enacts mitigation measures that reduce the risk of loss of life and property from future disasters.

Visual 18: Data Sources for Response Modeling

- National, state, and local agencies
  - Floodplain boundary, Critical Infrastructure and Key Resources (CIKR), and community infrastructure
- United States Geological Survey (USGS)
  - User supplied data maps for liquefaction, landslide, water depth, ShakeMap, and PAGER
- National Hurricane Center (NHC)
  - Historical hurricane tracks, windspeeds, projected tracts
- Pacific Marine Environmental Laboratory (PMEL)
  - Tsunami wave heights, inundation and depths, and momentum flux
- FEMA Flood Map Service Center (MSC)
  - Depth grid, DFIRM
- Provide your own data
  - Depth grid, user-defined facilities

Visual 19: Activity 2.1: Data Availability

Goal: Explore the data available through the United States Geological Survey (USGS), the National Hurricane Center (NHC), the Pacific Marine Environmental Laboratory (PMEL), and the Map Service Center (MSC).

Time: 10 minutes

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Activity 2.1: Data Availability

Goal: Explore the data available through the United States Geological Survey (USGS), the National Hurricane Center (NHC), the Pacific Marine Environmental Laboratory (PMEL), and the Map Service Center (MSC).

Time: 10 minutes

Activity Steps:

1. Refer to Activities Document “02.1_Activity_Data Availability.”
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 20: Demonstration 2.2: ArcGIS Online

Goal: Review ArcGIS Online and other online platforms.

Time: 5 minutes

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Demonstration 2.2: ArcGIS Online

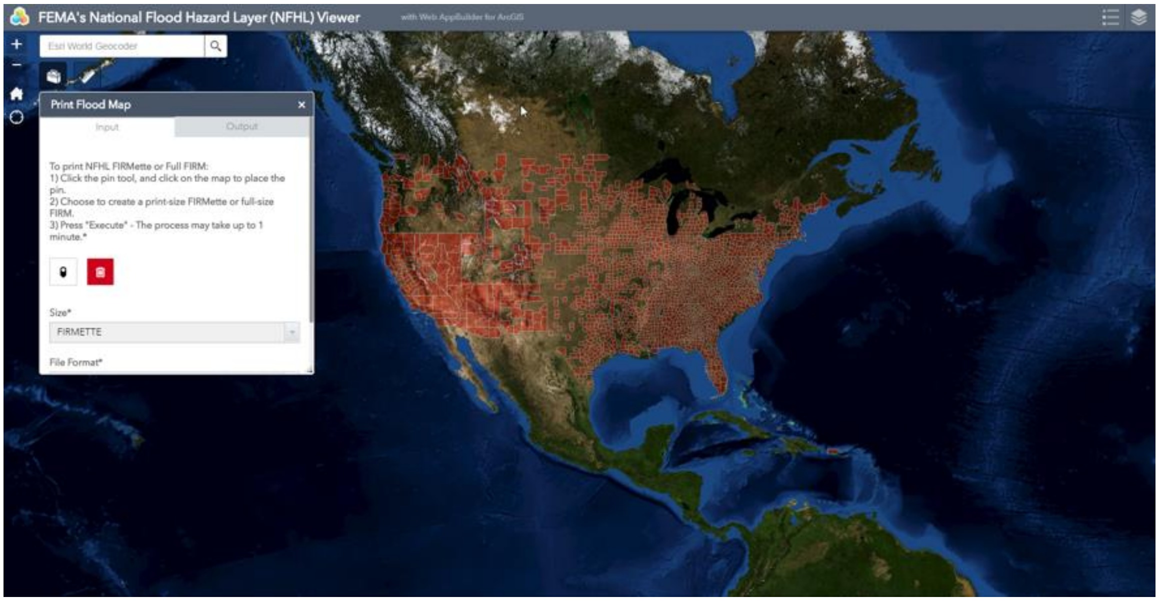
Goal: Review ArcGIS Online and other online platforms.

Time: 5 minutes

Activity Steps:

1. Refer to Activities Document “02.2_Demonstration_ArcGIS Online.”
2. Listen to instructor’s directions.
3. Ask questions if clarification is needed.
4. Watch the instructor's demonstration.
5. Ask any final questions.

Visual 21: National Flood Hazard Layer



Visual 22: Lesson 2: Review

1. What are some examples of disasters that occur?
2. What are the four typical effects of damage that result from disasters?
3. Explain the emergency management cycle.
4. What are examples of incident management activities during the response phase? The recovery phase?

Visual 23: Questions

Lesson 3: Basic Hurricane

Visual 1: Lesson 3: Basic Hurricane

Visual 2: Lesson 3: Goal and Objectives

Goal: To provide a review of the hurricane wind and storm surge model within Hazus.

After completing this lesson you will be able to:

- Review conditions for hurricane development and the parts of a hurricane.
- 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.
- List databases used in the hurricane model.
- Explain damage and loss modeling.

Visual 3: Hurricane Basics

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

Visual 4: Converted Wind Speeds

Typical Storm Parameters

Hazus Input Wind Speeds = 1 Min Mean

Hazus Output Wind Speeds = 3 Sec Gust

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	921-944
5	157+	189+	920 and below

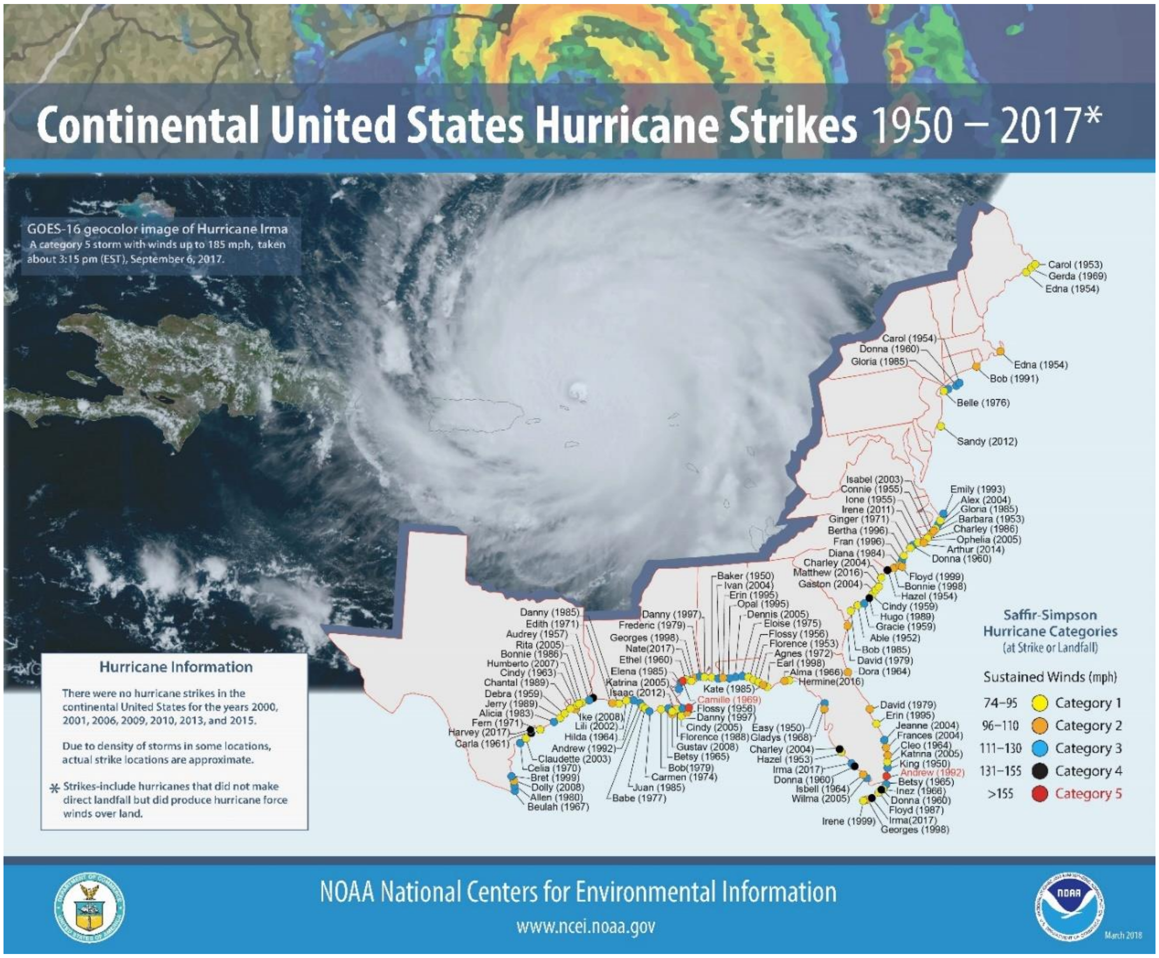
Visual 5: Hurricane Geography

Hurricanes impact the US often follow one of two general paths

- Staying in the Atlantic and tracking up the East Coast
- Tracking the West Coast of Florida and entering the Gulf of Mexico

Major hurricane U.S. strikes:

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



Visual 6: Hurricane Impacts

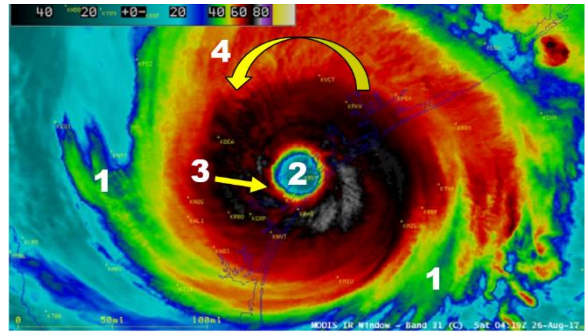
- Hurricane risks and impacts are dependent on the geography
- Different states and regions will have different needs for response, recovery, and mitigation
- The three storms in 2017 affected diverse geographic areas of varying size and population density

	Texas	Florida/Puerto Rico/ U.S. Virgin Islands	Puerto Rico/ U.S. Virgin Islands
	Harvey Category 4	Irma Category 5	Maria Category 4
Major Area Affected			
Sq miles	*Texas 268,597 mi²*	*Florida 65,755 mi²* *Puerto Rico 3,515 mi²* *USVI 133.73 mi²*	*Puerto Rico 3,515 mi²* *USVI 133.73 mi²*
State & Territory population	25.2 Million	22.7 Million	3.8 Million
% of population affected	30%	85%	100%

Visual 7: Hurricane Anatomy

1. Rain bands
2. Eye
3. Eye wall*
4. Counterclockwise rotation

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

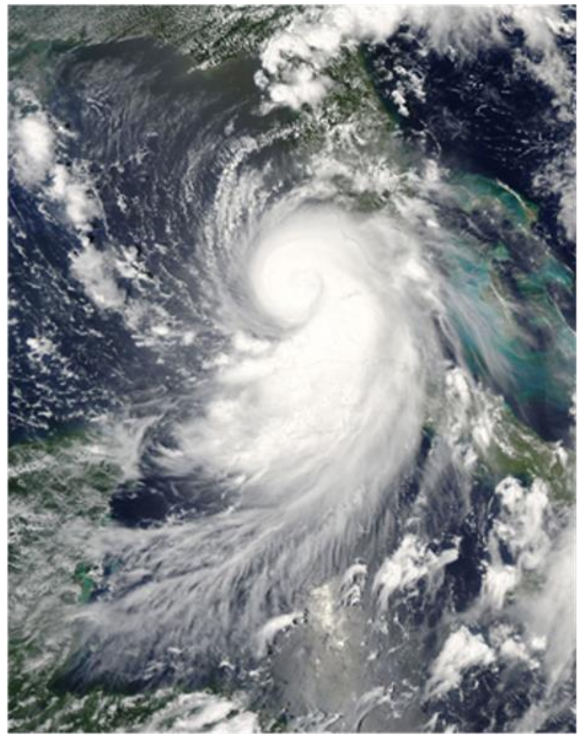


Hurricane Harvey. Source: NOAA

Visual 8: Hurricane Wind Hazard Model: Wind Field

Wind Field Model:

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

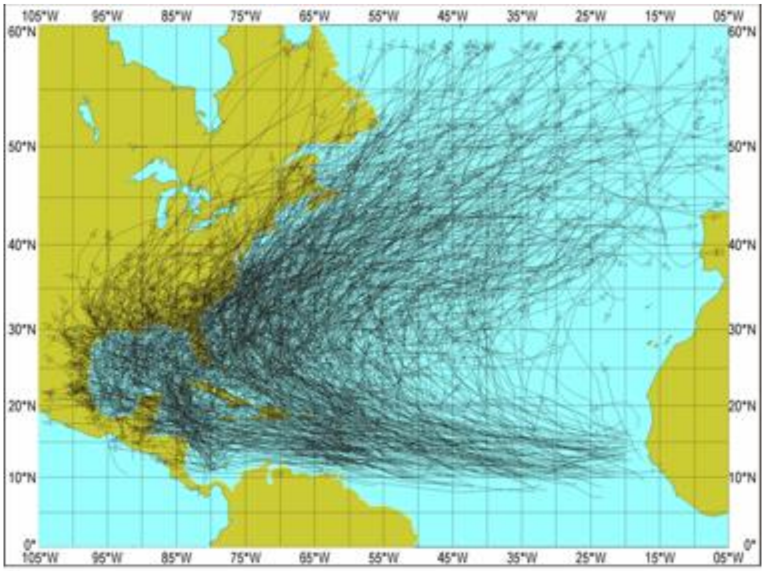


Asymmetric Katrina (2005). Cooperative Institute for Meteorological Studies (CIMSS). University of Wisconsin.

Visual 9: Hurricane Wind Model Scenarios

Probabilistic wind speed database:

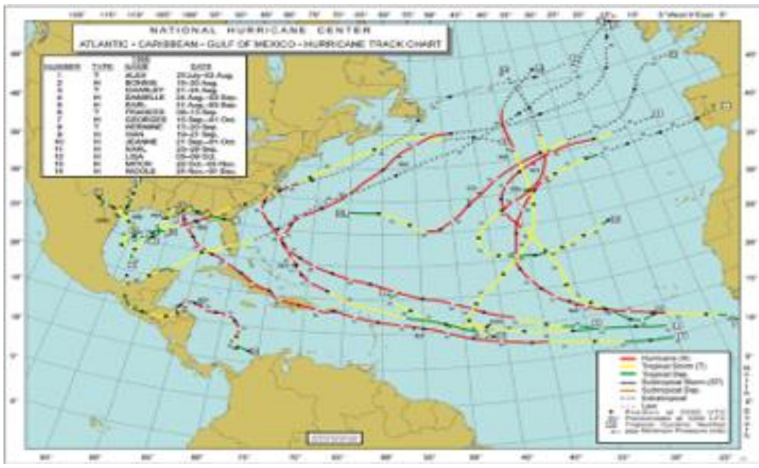
- 100,000 years of simulated storms



Visual 10: Hurricane Wind Model Scenarios

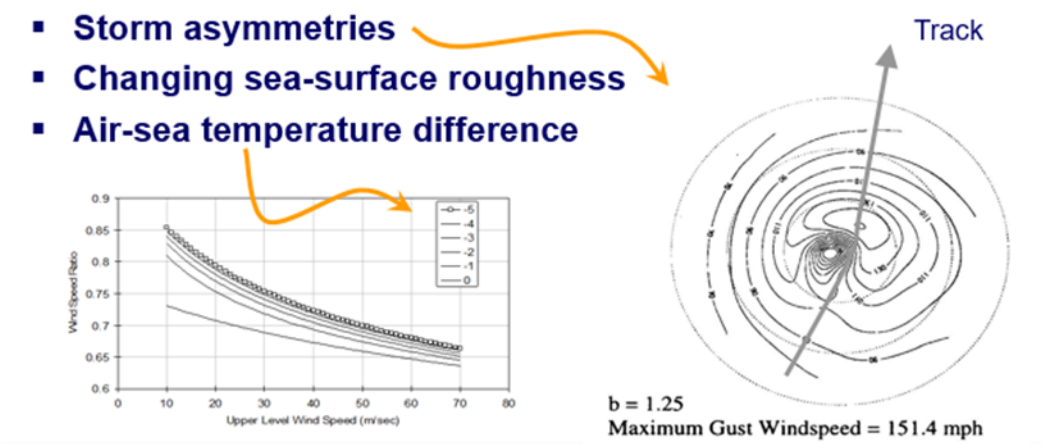
Deterministic:

- Historical
- Forecast/Advisory
- User-defined



Visual 11: Wind Field Model

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



Visual 12: Hurricane Wind and Surge Analysis Options

- Wind: losses created first in hurricane model
- Surge: depths are input into the flood model
- Combined flood and wind losses: sub-assembly loss tables

		Wind-Only Building Loss										
		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Flood-Only Building Loss	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%	64.6%	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%

Visual 13: Hurricane-Specific Inventory

4 regions in Florida and 4 Regions in Hawaii have Hurricane-Specific Inventory and 4 regions for other states

Based on:

- Review of building codes
- Census data
- Aerial photos review
- MLS and tax data samples

Florida/Hawaii building stock regions:

- Different building codes
- Different building practices

Visual 14: Hurricane Inventory

- Terrain Database: surface roughness
- State-Specific:
    - Land-Use: Florida Water Management District
    - Elevation: Hawaii Statewide GIS Program
- Historic and Deterministic Storm Models:
    - HURDAT or Historic Database
    - Hurrevac
- Tree Database: types, height, density
- Hurricane Surge Model: flood depth damage curves

Visual 15: 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

Jacksonville, FL, December 5, 2017 Pockets of debris from Hurricane Irma can still be seen all over the state. Counties are working hard to remove all hurricane related debris as quickly as possible.

Visual 16: Damage and Loss Modeling

Loss model based on:

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

Current model now includes storm surge:

- Hurricane 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 17: Exercise 3.1: Hurricane Study Region

Goal: Build a hurricane study region for Hurricane Harvey (2017).

Time: 10 minutes

Student Manual

Exercise 3.1: Hurricane Study Region

Goal: Build a hurricane study region for Hurricane Harvey (2017).

Time: 10 minutes

Exercise Steps:

1. Refer to Activities Document “03.1_Exercise_Hurricane Study Region.”
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 18: Exercise 3.1: Tasks

Task 1: Create a New Hurricane Study Region.

Task 2: Select Areas Affected (Aransas County) by Hurricane Harvey.

Student Manual

Exercise 3.1: Tasks

Refer to Activities Document "03.1_Exercise_Hurricane Study Region."

Visual 19: Lesson 3: Review

1. Explain hurricane basics (components needed for development and four parts of a hurricane).
2. What areas of the U.S. mainland have the highest risk to major hurricanes?
3. Which four scenario types can a user select to run the hurricane model?
4. Which databases are used in the hurricane model?
5. Explain damage and loss modeling.

Visual 20: Questions

Lesson 4: Hazus Hurricane for Response

Visual 1: Lesson 4: Hazus Hurricane for Response

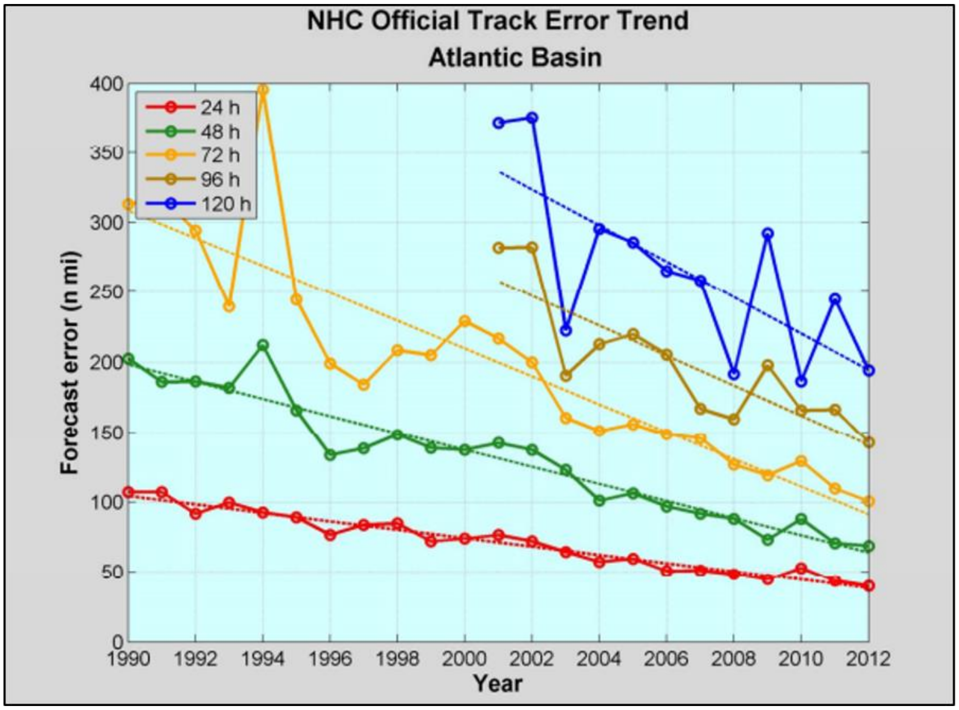
Visual 2: Lesson 4: Goal and Objectives

Goal: To understand how Hazus can aid situational awareness and generate useful products during hurricane response.

After completing this lesson you will be able to:

- Summarize situational awareness.
- Identify when and when not to use Hazus for hurricanes.
- Demonstrate how to run models with Hurrevac.

Visual 3: Hurricane Forecasting



Error Reduction since 1990

72 h: 67%

48 h: 65%

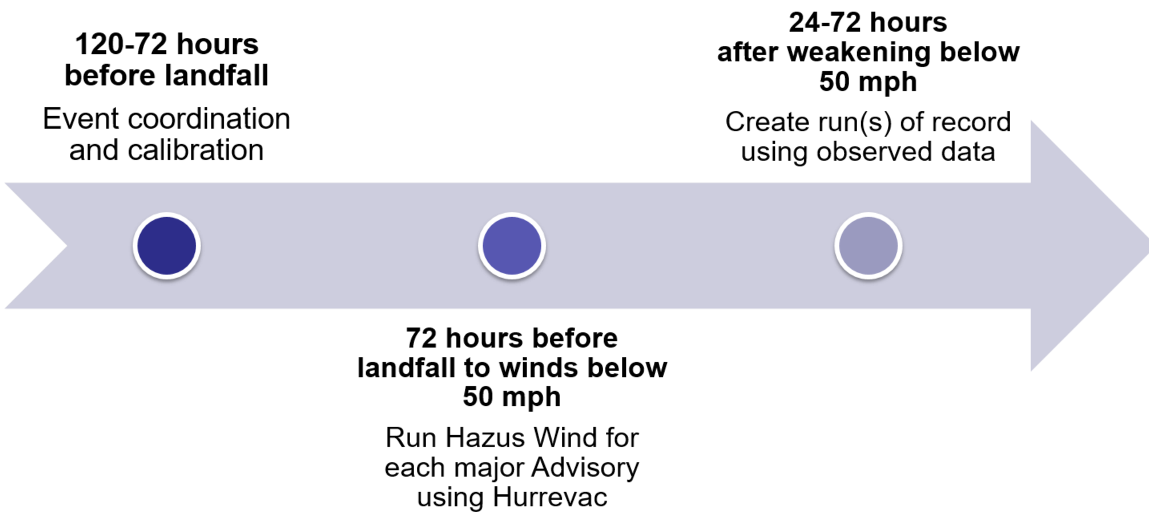
24 h: 58%

Student Manual

Hurricane Response Timeline and Coordination

- NOAA uses a variety of tools to track and predict hurricane paths and possible landfall locations
- These tools:
  - Include some level of uncertainty associated with the predictions
  - Uncertainty is realized through errors
  - Track errors have been reducing over time as technology and methodologies have improved.

Visual 4: When to Start Running Hazus



Visual 5: Situational Awareness

Hazus results can identify:

- Areas of high losses
- Shelter needs and displaced populations
- Impacts to Critical Infrastructure and Key Resources (CIKR)
    - Power grids and water filtration plants
    - National monuments and government facilities
    - Telecommunications and transportation systems
    - Chemical facilities
- Where disproportionate losses may occur
    - Vulnerable populations
    - Urban and rural areas

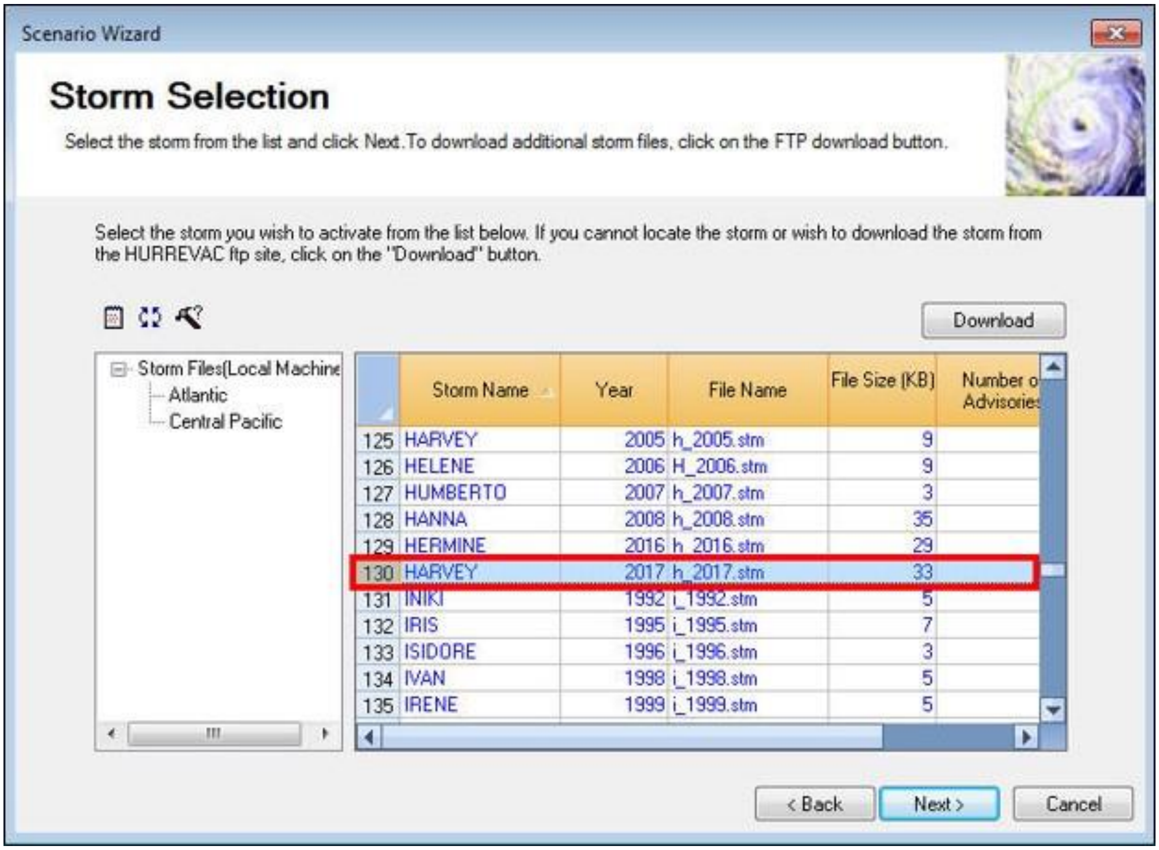
Visual 6: Applications of Hazus for Hurricanes

- Forecasting hurricane impacts on communities with Hurrevac data
- Creating models of hurricanes with HURDAT data to explore scenarios around historical storms
- Assess the combined losses of wind and storm surge
- Modeling impacts on trees, debris, sheltering, and economic loss in hurricane forecast
- Estimating losses from previous events
- Not for long-term projections of hurricane size or track

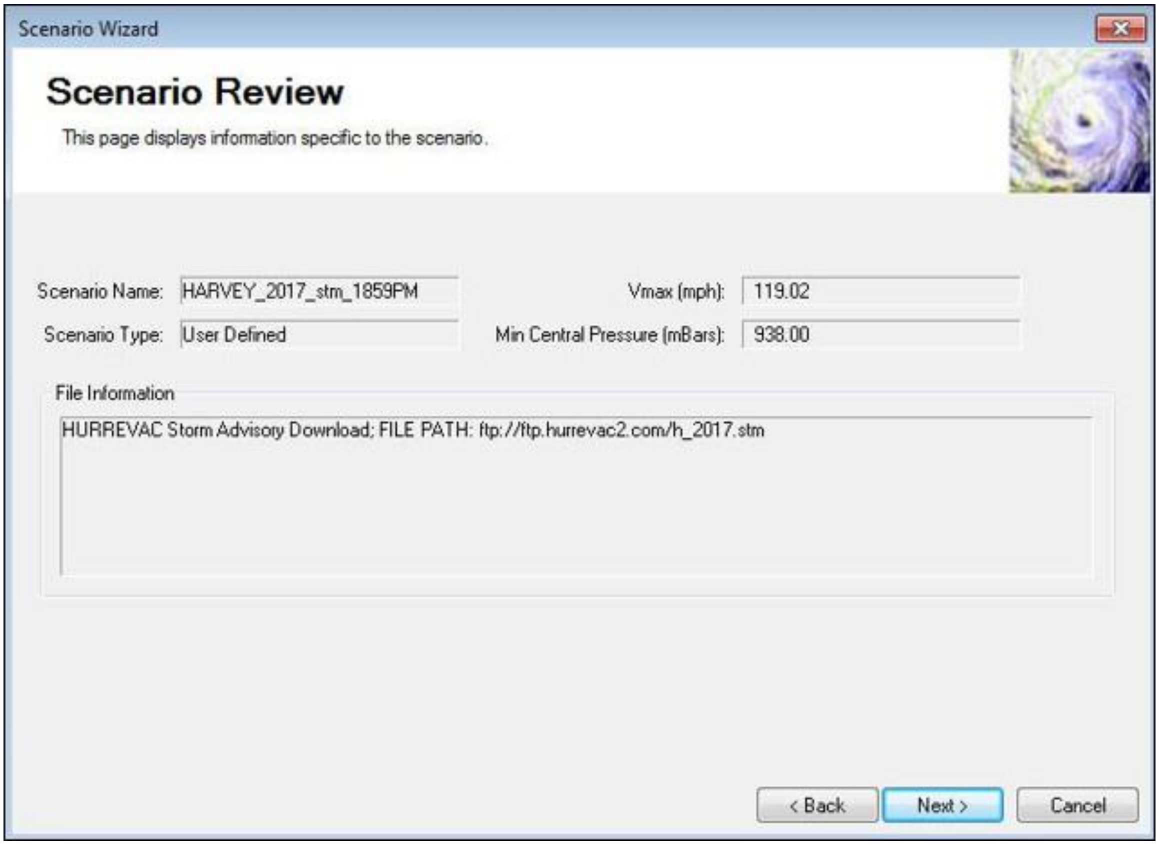
Visual 7: Hurricane Data Sources: Hurrevac

- HURRicane EVACuation
- Taken from National Hurricane Center advisory information
- Useful for pre-event estimations
- Post-event, use Hurrevac until observed wind fields are available
- Great for creating hurricane exercise track information
- If interested, consider taking E0170: Hazus for Hurricanes
- Recent hurricane files (.stm) ship with Hazus and all are available via Hurrevac download button

Visual 8: Hurrevac Import



Visual 9: Hurrevac Import



Visual 10: Exercise 4.1: Harvey Hurrevac Model

Goals:

- Run Model with Hurrevac.
- Develop a map of your choice: winds (by category), displaced population, economic loss, or tree debris.
- View results.
- Choose the same study region you created in Exercise 3.1.

Time: 45 minutes

Student Manual

Exercise 4.1: Harvey Hurrevac Model

Goals:

- Run Model with Hurrevac.
- Develop a map of your choice: winds (by category), displaced population, economic loss, or tree debris.
- View results.
- Choose the same study region you created in Exercise 3.1.

Time: 45 minutes

Exercise Steps:

1. Refer to Activities Document “04.1_Exercise_Harvey Hurrevac 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 11: Exercise 4.1: Tasks

Task 1: Open the Study Region.

Task 2: Create a New Scenario.

Task 3: Run the Analysis.

Task 4: View and Record the Results.

Student Manual	***Exercise 4.1: Tasks*** Refer to Activities Document “04.1_Exercise_Harvey Hurrevac Model.”

Visual 12: Discussion 4.2: Hurricane Harvey

Questions:

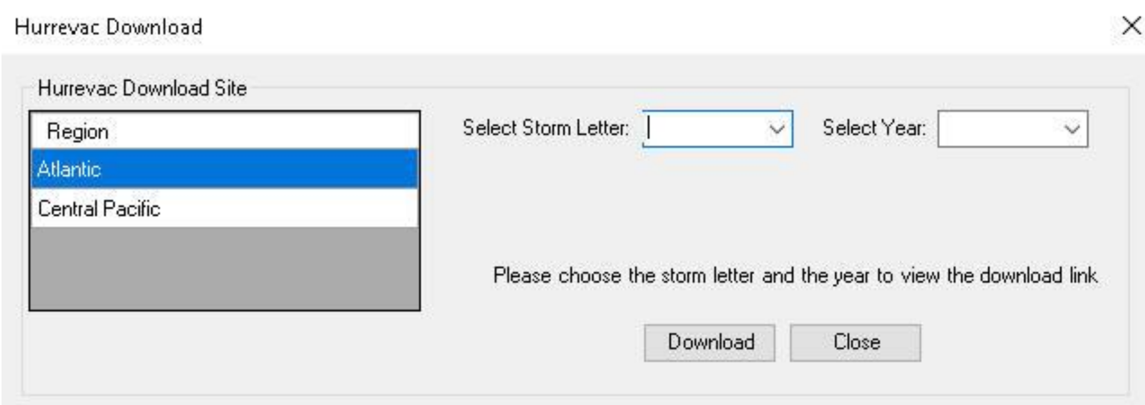
- Did you choose to make a map of winds (by category), displaced population, economic loss, or tree debris?
- How is your map applicable to response leadership?
- What platforms exist to share this data?

Time: 15 minutes

Student Manual	***Discussion 4.2: Hurricane Harvey*** Questions: • Did you choose to make a map of winds (by category), displaced population, economic loss, or tree debris? • How is your map applicable to response leadership? • What platforms exist to share this data? Time: 15 minutes Discussion Steps: 1. Listen to instructor's directions. 2. Ask questions if they need directions clarified. 3. Answer the following questions and present your map to the class.

Visual 13: Dynamic Hurrevac Link

- 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



Visual 14: Standard Products

- Maps of wind hazards by category
- Hazus summary reports: inventory, damage, loss
    - General Building Stock (GBS) damages and losses
    - Essential facilities damages and losses
    - Building and tree debris
    - Social losses, including displacements and shelter requirements
- Identification of the locations of:
    - Critical Infrastructure and Key Resources (CIKR)

Visual 15: Products During Response

- Communicate products during response through daily video-teleconference with leadership across departments and agencies
- Pre-landfall:
  - Shelter needs and points of distribution planning
  - Debris: trees, brick and wood, concrete and steel
  - Evacuation planning and transportation needs
- Landfall: Disaster declarations
  - Allocate assets: storm surge and rapid deployment gauges, which support water-level measurements
  - Hurricane Model Outputs: debris, damage probabilities, high potential loss facilities, etc.

Visual 16: Lesson 4: Review

1. Summarize situational awareness.
2. When should Hazus for Hurricanes be used? When should it not be used?
3. How does Hurrevac work with Hazus?

Visual 17: Questions

Lesson 5: Hazus Hurricane for Recovery

Visual 1: Lesson 5: Hazus Hurricane for Recovery

Visual 2: Lesson 5: Goal and Objectives

Goal: To understand the use of Hazus and FEMA assistance in hurricane recovery.

After completing this lesson you will be able to:

- Understand the recovery timeline for hurricanes.
- Explain the components of the FEMA Public Assistance Program.
- Differentiate between Hurricane Wind and Surge Analysis option and Wind Field Model.
- Utilize Hazus for response and recovery for pre and post hurricane.

Visual 3: Hurricane Recovery Timeline

Length of recovery operations:

- Days (Short-term): Resource Allocation
- Weeks/Months (Intermediate): Clean up operations and local, state, & federal agency coordination
- Months/Years (Long-term): Rebuilding
- Recovery groups: Economic, Health and Social Services, Housing, Natural and Cultural Resources

Visual 4: FEMA Public Assistance Program

- FEMA's PA Program provides assistance to:
  - Local, State, Tribal, and Private Non-Profit
  - Communities can quickly respond to and recover from major disasters or emergencies declared by the president
- What assistance can be received under the PA Program?
  - Emergency Work (Debris removal, Emergency Protective Measures)
  - Permanent Work (Restoration of disaster-damage permanent work to pre-disaster conditions)
  - 406 mitigation
- What costs are eligible?
  - Labor, equipment, materials, contracts, administrative
- How can Hazus support the program?
  - Informing hazard mitigation proposals or plans
  - Evaluating damages and recovery capabilities
  - Supporting project formulation

FEMA Public Assistance Program Website: https://www.fema.gov/hazard-mitigation-grant-program

Visual 5: FEMA Mitigation Grant Program

- Section 406 (presidential declared affected areas)
  - Up to 75/25 cost coverage with work completed within 12 months
  - Must be in a "declared disaster" county
- Template for requesting assistance through FEMA
  1. Identify potential or actual impact areas
  2. Complete an Eligibility Analysis of any related damages
  3. Develop scope and costs of improvements/repairs
  4. Obligate damages for funding

To learn more about FEMA's PA Program, please visit: https://www.fema.gov/public-assistance-local-state-tribal-and-non-profit

Visual 6: Hurricane Data in Hazus

- Some historic hurricane data is included with Hazus
- Hurrevac track data pre-loaded through 2017 storms
- Only historical storms that affected the study region created can be selected as a scenario
- Information includes:
  - Year
  - Name
  - Peak gust
  - States affected
  - Landfall states

Visual 7: Hurricane Data (Hurdat) Sources

- Hurdat is modeled for historic data
- National Hurricane Center: https://www.nhc.noaa.gov/data/#hurdat
- 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 8: Hurricane Data (.dat) Sources

- A census tract file that has observed maximum sustained winds and peak wind gusts tied to census tract centroids
- A method to bring maximum windspeeds based upon observations into Hazus
- .dat files must already be available and created using the format established originally by the NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML) Hurricane Research Division (HDR) for their retired H*wind Program
- These are generally available within a few days after the storm makes landfall for all major hurricanes
- They are often updated over time as more observations come and are finalized

Visual 9: Exercise 5.1: Harvey .dat Model

Goals:

- Run Model with .dat data.
- Develop a map of your choice: winds (by category), displaced population, economic loss, or tree debris.
- View Results.
- Choose the same study region you created in Exercise 3.1 and topic in Exercise 4.1.

Time: 45 minutes

Student Manual

Exercise 5.1: Harvey .dat Model

Goals:

- Run Model with .dat data.
- Develop a map of your choice: winds (by category), displaced population, economic loss, or tree debris.
- View Results.
- Choose the same study region you created in Exercise 3.1 and topic you chose in Exercise 4.1.

Time: 45 minutes

Exercise Steps:

1. Refer to Activities Document “05.1_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 10: Exercise 5.1: Tasks

Task 1: Open the Study Region.

Task 2: Create a New Scenario.

Task 3: Run the Analysis.

Task 4: View and Record the Results.

Student Manual

Exercise 5.1: Tasks

Refer to Activities Document “05.1_Exercise_Harvey (.dat) Model.”

Visual 11: Exercise 5.2: Compare the Outputs

Goal: Compare the Hurrevac and .dat results for Hurricane Harvey.

Time: 15 minutes

Student Manual

Exercise 5.2: Compare the Outputs

Goal: Compare the Hurrevac and .dat results for Hurricane Harvey.

Time: 15 minutes

Exercise Steps:

1. Refer to Activities Document “05.2_Exercise_Compare the Outputs.”
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 12: Exercise 5.2: Tasks

Task 1: View the Results from the Hurrevac Output (previous lesson).

Task 2: View the Results from the .dat Output (earlier this lesson).

Task 3: Compare the Results and Identify Differences.

Student Manual

Exercise 5.2: Tasks

Refer to Activities Document “05.2_Exercise_Compare the Outputs.”

Visual 13: Discussion 5.3: Hurricane Modeling

Questions:

- How do the results compare with one another?
- How can this be used for Recovery and Mitigation?
- How does Hazus Hurricane fit into the JFO cycle?

Time: 15 minutes

Student Manual

Discussion 5.3: Hurricane Modeling

Questions:

- How do the results compare with one another?
- How can this be used for Recovery and Mitigation?
- How does Hazus Hurricane fit into the JFO cycle?

Time: 15 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 14: Hazus for Hurricane Review

Pre-event applications of outputs:

- Development of mitigation strategies that outline policies/programs for:
    - Reducing hurricane losses/disruptions indicated in initial loss estimation study
    - Strategies can involve upgrading existing buildings (e.g., shutters) and the adoption of new building codes
- Anticipation of the nature and scope of response and recovery efforts including:
    - Identifying short-term shelter requirements
    - Debris management requirements
    - Evacuation Planning and Transportation needs
- Preposition of assets for response

For more information, consider taking E0170: Hazus for Hurricanes

Visual 15: Hazus for Response and Recovery: Post-Event

Post-event applications of the outputs:

- Projection of immediate economic impact assessments including:
  - Supporting the declaration of a state and/or federal disaster
  - Calculating direct economic impact on public and private resources, local governments, and functionality of the area
- Activation of immediate emergency recovery efforts including:
  - Providing emergency housing shelters
  - Initiating debris clean-up efforts
  - Initiating evacuation and transportation needs
- Application of long-term reconstruction plans including:
  - Identifying long-term reconstruction goals
  - Instituting appropriate wide-range economic development plans for the entire area
  - Allocating permanent housing needs, and the application of land use planning principles and practices

Visual 16: Lesson 5: Review

1. Who is eligible for the FEMA Public Assistance Program?
2. What assistance can be received under the Public Assistance Program?
3. How is Hazus utilized pre-hurricane? Post-hurricane?

Visual 17: Questions

Lesson 6: CDMS

Visual 1: Lesson 6: Comprehensive Data Management System

Visual 2: Lesson 6: Goal and Objectives

Goal: To gain familiarity with use of CDMS to update and import/export data.

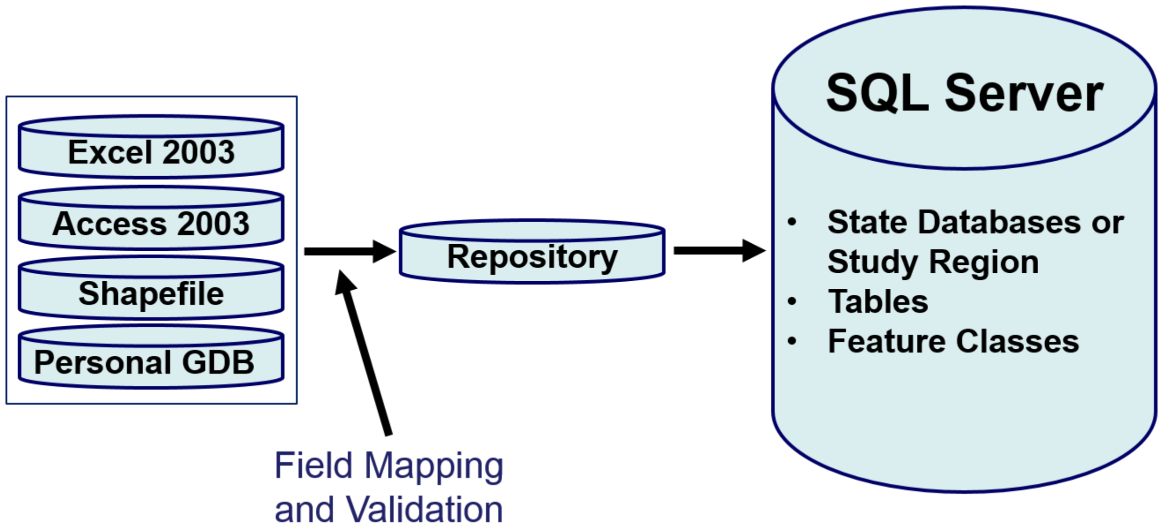
After completing this lesson you will be able to:

- Explain CDMS.
- Identify what data sources feed in and out of CDMS.

Visual 3: What is CDMS?

- A system for integrating user-provided site-specific and aggregate data into the Hazus state databases.
- CDMS supported data includes:
  - Site-specific
  - Aggregate
  - Building-specific
- Functions:
  - Validates user-provided data
  - Parses data into appropriate Hazus tables
  - Provides historical tracking of database updates
  - Can import/export data to/from a variety of formats

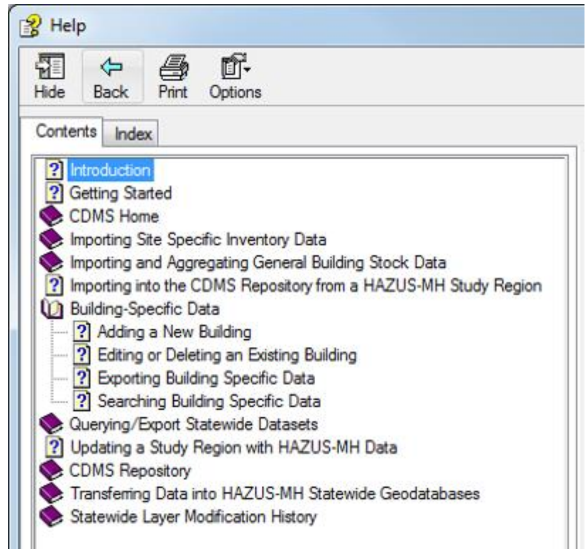
Visual 4: Comprehensive Data Management System



Student Manual	***Comprehensive Data Management System*** Excel and Access 2003, Shapefile, Personal GDB > Repository > SQL Server • SQL Server = State Database or Study Region, Tables, Feature Classes

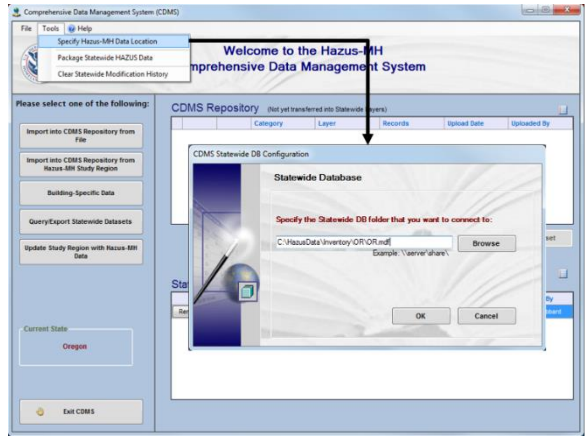
Visual 5: CDMS Help File

- A compiled CDMS Help File is provided.
- Useful for reviewing concepts and definitions:
  - Getting Started Instructions
  - Searchable
  - Importing, Querying, and Exporting step-by-step instructions



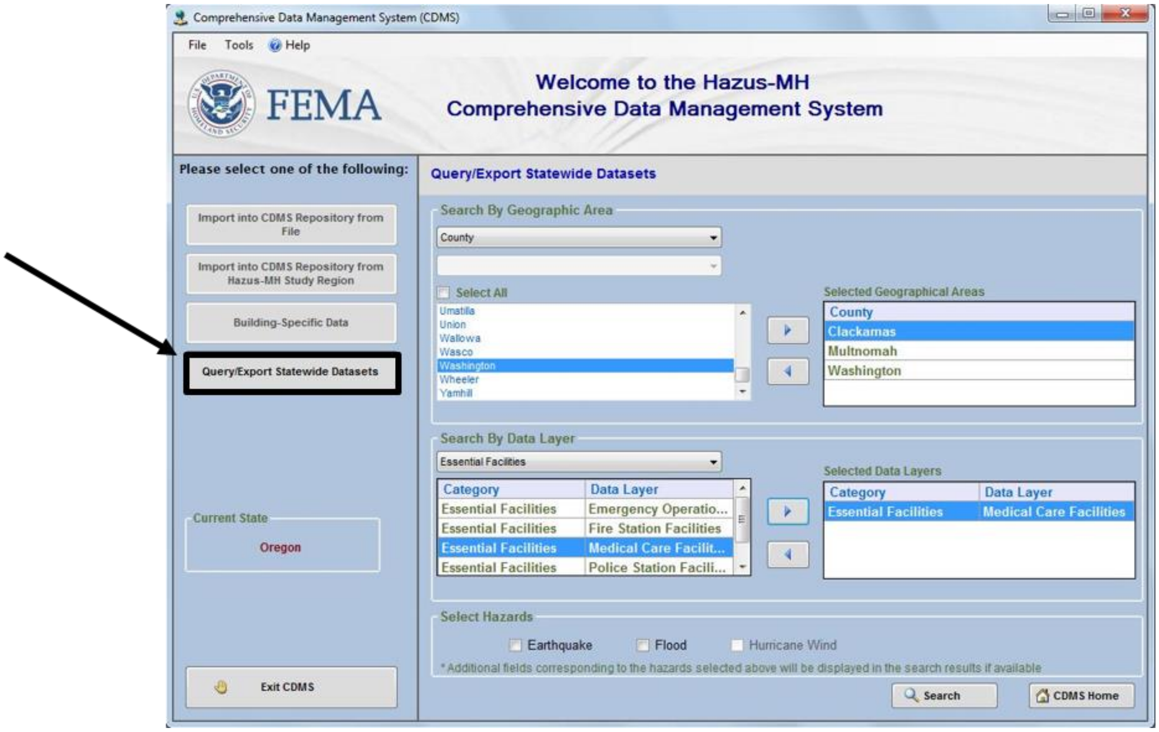
Visual 6: Default State Database

- The first time CDMS runs, you must specify a default statewide database location on a local drive.
- Be sure to verify that you have read/write access to the data.



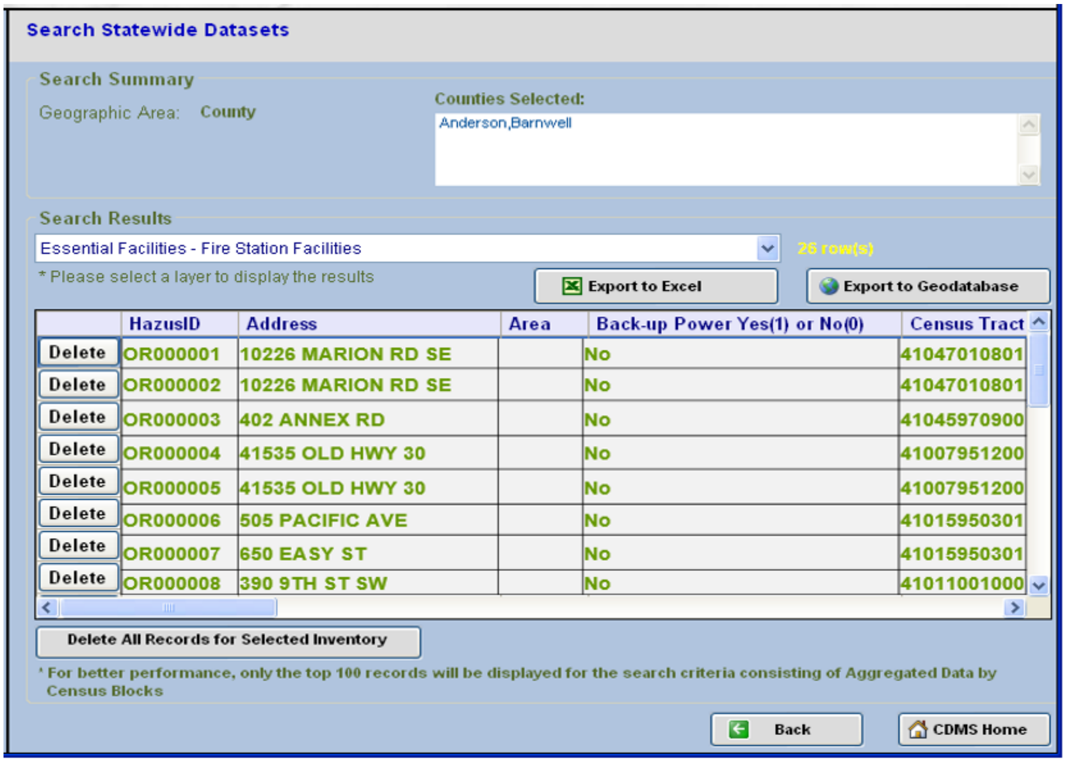
Visual 7: Querying Statewide Datasets

CDMS allows you to query existing state data by State, County, Census Tract, or Census Block.



Visual 8: Export Options

- Delete one or more records; often a useful step prior to updating the inventory.
- Export results to Excel or personal Geodatabase.



Visual 9: Options for Updating GBS Inventory

- Import user-supplied pre-aggregated data
- Import user-supplied site-specific data
- Import user-supplied building specific data

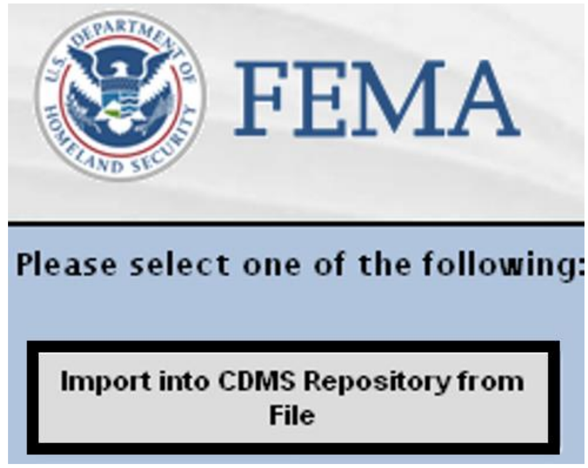
Visual 10: Updating From Pre-Aggregated Data

GBS tables can be updated from pre-aggregated data:

- Building counts by Census Block/Tract
- Demographics by Census Block/Tract
- Building area by Census Block/Tract
- Building exposure value by Census Block/Tract
- Content exposure value by Census Block/Tract

Visual 11: Aggregation Process

1. Select the source file to import.
2. Specify the destination category and table to update.
3. Specify the table to import.
4. Field matching. Validation.
5. View Results.
6. Transfer to state database.

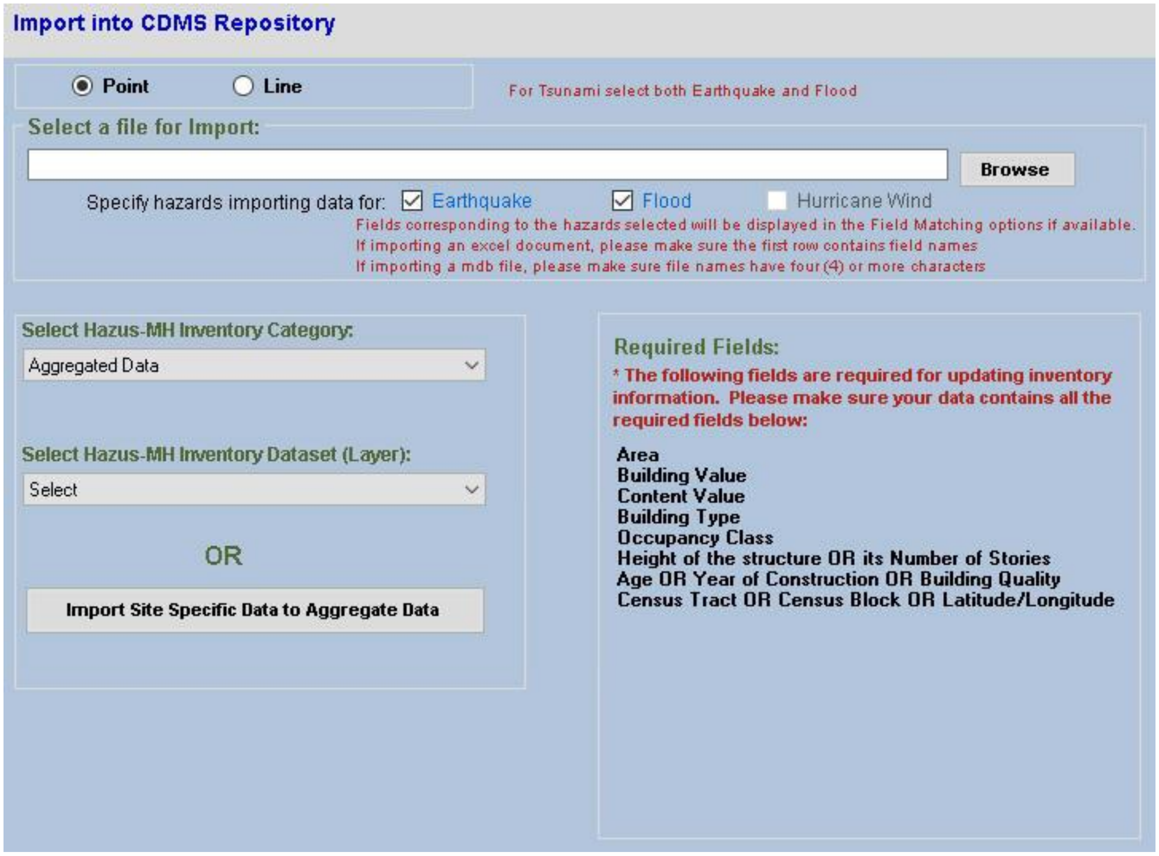


NOTE: This option is ideal for users that already maintain data at an aggregate level.

Visual 12: Source to Destination Dataset

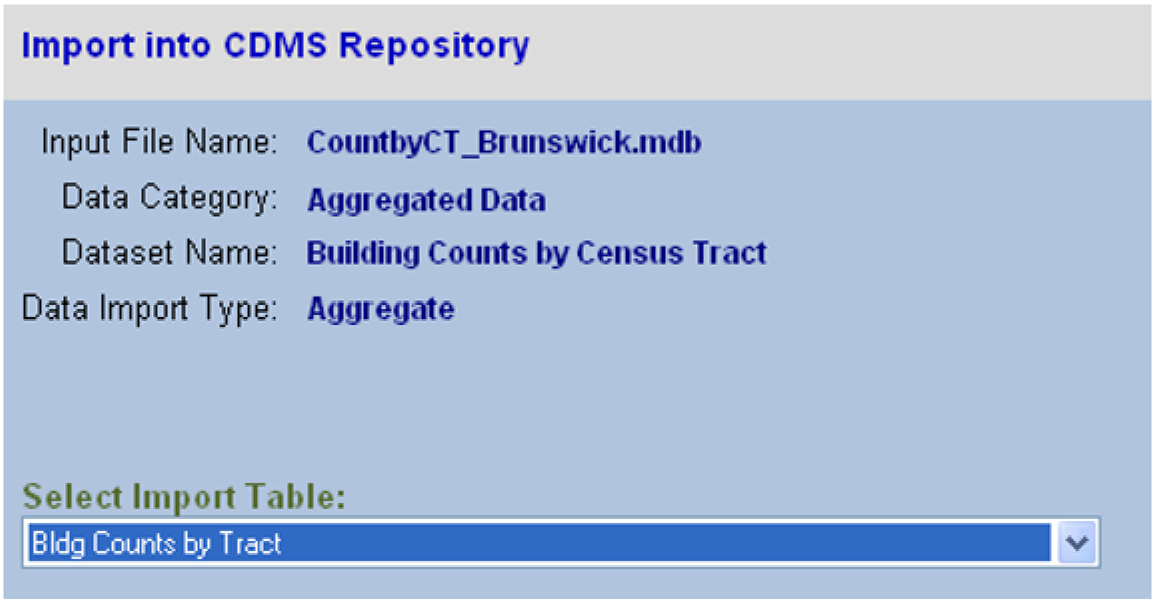
Imported table must conform to the structure of the state database you are updating.

1. Select aggregated data for category.
2. Select an inventory dataset.



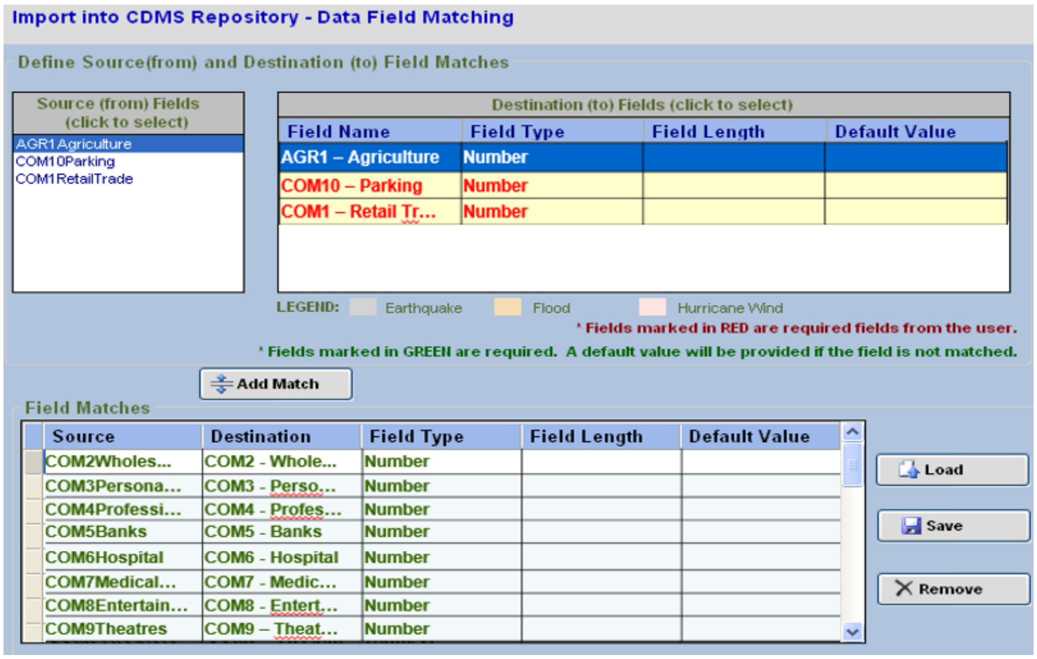
Visual 13: Import Table or Worksheet

- If the import is from a Shapefile, the import table is automatically selected.
- If the import is an MS Access or MS Excel file, the user has to specify the table or worksheet that contains the data.



Visual 14: Field Matching

- Fields with the same name/characteristics are auto-matched.
- Other fields must be manually matched.



Visual 15: Exercise 6.1: GBS Data

Goal: Identify and export data from a state dataset.

Time: 15 minutes

Student Manual

Exercise 6.1: GBS Data

Goal: Identify and export data from a state dataset.

Time: 15 minutes

Exercise Steps:

1. Refer to Activities Document “06.1_Exercise_GBS Data.”
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 16: Exercise 6.1: Tasks

Task 1: Open CDMS and change State Databases.

Task 2: Query County for Specific Buildings.

Task 3: Export Query to Excel.

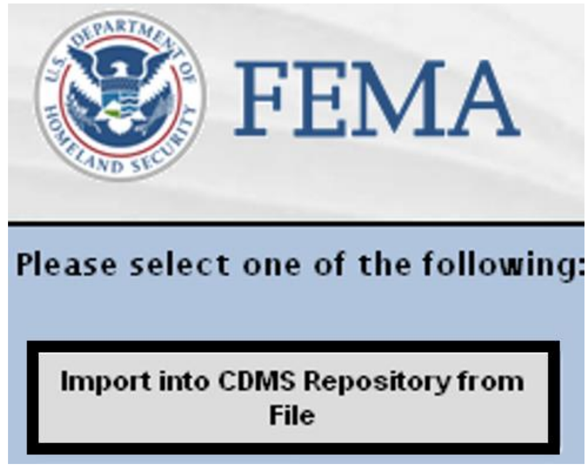
Student Manual

Exercise 6.1: Tasks

Refer to Activities Document “06.1_Exercise_GBS Data.”

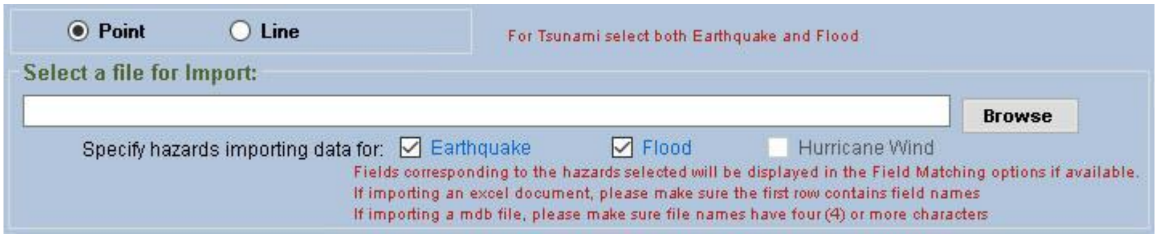
Visual 17: Site-Specific Update Process

1. Select source data file and destination category.
2. Define source data parameters.
3. Match fields.
4. Categorize data.
5. Validation.
6. Review results in CDMS repository.
7. Transfer to state database.



Visual 18: Source Category and Dataset

- File name and location, category and inventory dataset

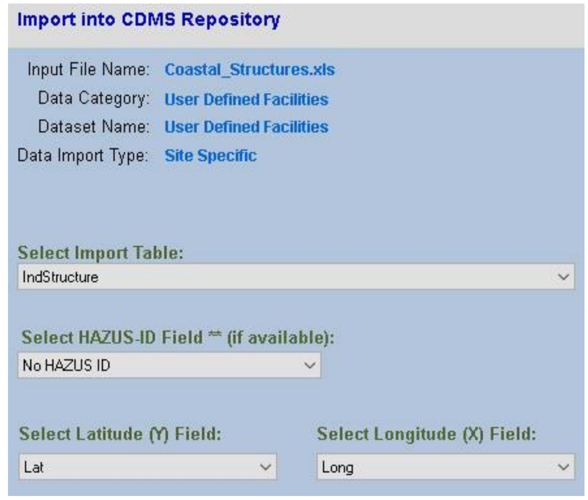


Note: Specify a hazard if you plan to modify or import hazard-specific information.

Visual 19: Source Data Parameters

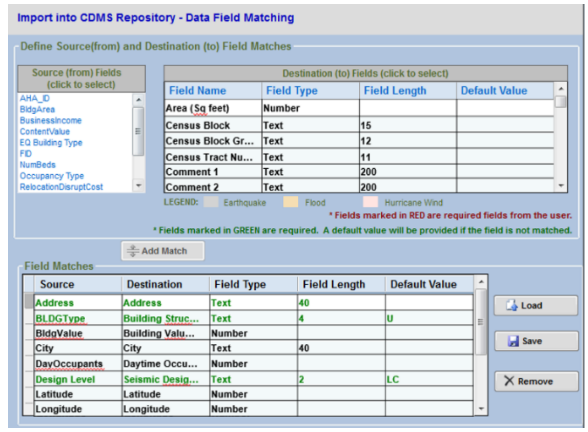
Specifies:

- Table containing data
- Hazus-ID field
- Coordinate fields (dependent on data type)

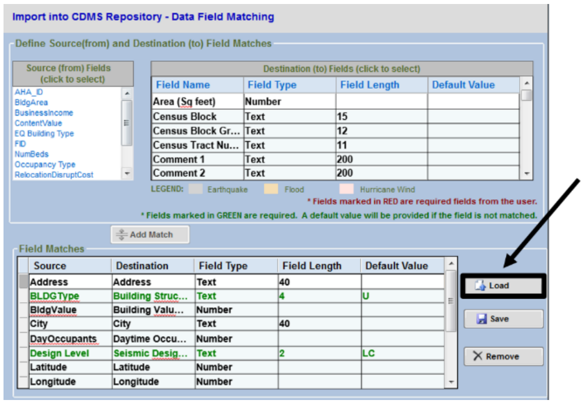


Visual 20: Field Matching

- Specifies how fields in the input table are related to fields in the Hazus inventory.
- CDMS auto-matches fields with the same name and characteristics.
- Colors indicate which fields are required or can have defaults auto-assigned.



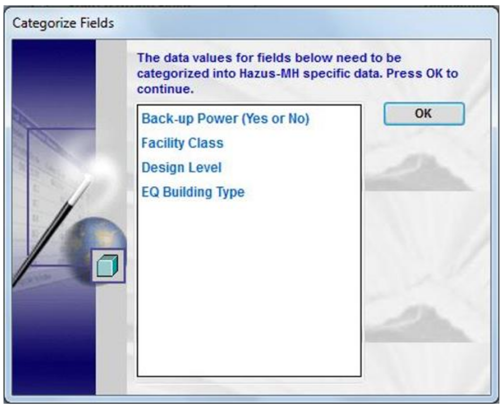
Visual 21: Field Matching

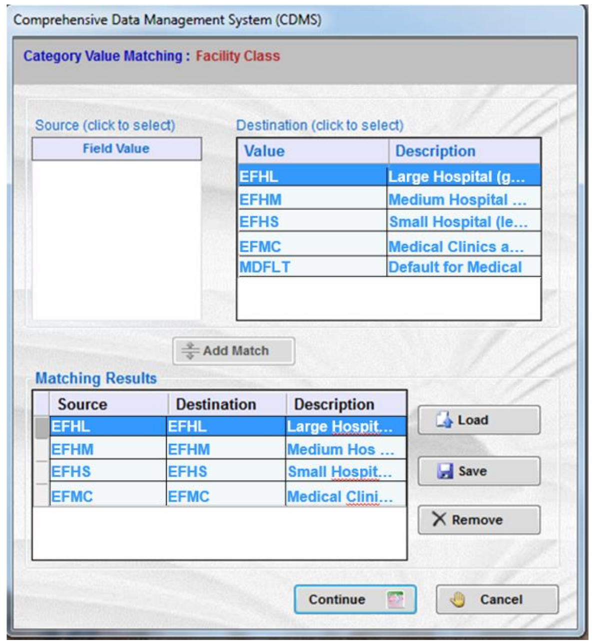


NOTE: Templates save on setup time in cases where you will be importing data on a recurring basis.

Visual 22: Categorizing Data

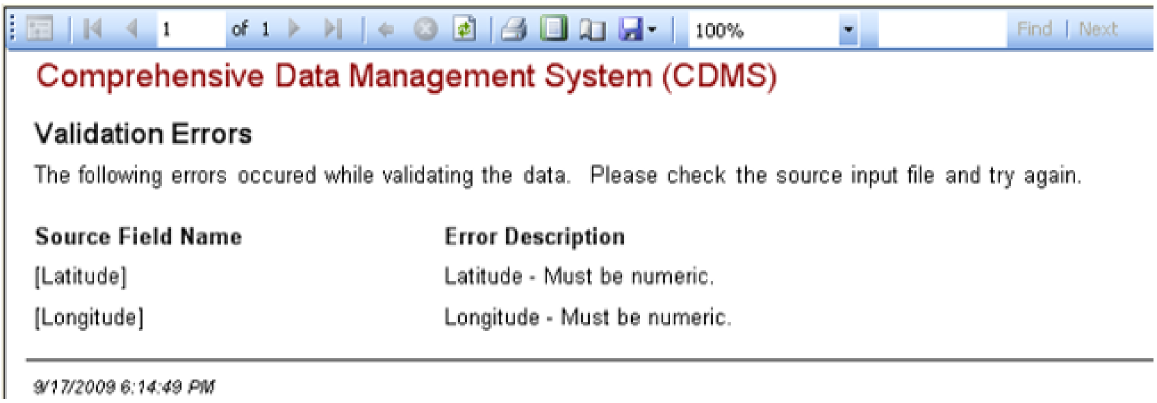
Category matching specifies how individual values in a field relate to Hazus required values.





Visual 23: Validation

- CDMS will identify situations where the data being imported does not match Hazus requirements.
- The solution is to fix the data, and then attempt the import process again.
- Familiarity with the Hazus data requirements is vital for troubleshooting validation errors.



Comprehensive Data Management System (CDMS)

Validation Errors

The following errors occured while validating the data. Please check the source input file and try again.

Source Field Name	Error Description
[Latitude]	Latitude - Must be numeric.
[Longitude]	Longitude - Must be numeric.

9/17/2009 6:14:49 PM

Visual 24: Exercise 6.2: Site-Specific Data

Goal: Use CDMS to update existing inventory.

Time: 30 minutes

Student Manual

Exercise 6.2: Site-Specific Data

Goal: Use CDMS to update existing inventory.

Time: 30 minutes

Exercise Steps:

1. Refer to Activities Document “06.2_Exercise_Site-Specific Data.”
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 25: Exercise 6.2: Tasks

Task 1: Query Hospitals in Salt Lake and Delete Existing Inventory.

Task 2: Import Medical Facilities Data Set into CDMS.

Task 3: Match Source and Destination Fields.

Task 4: Update State Database and Query for Confirmation.

Student Manual

Exercise 6.2: Tasks

Refer to Activities Document "06.2_Exercise_Site-Specific Data."

Visual 26: Lesson 6: Review

1. What are the functions of CDMS?
2. What data sources feed in and out of CDMS?

Visual 27: Questions

Lesson 7: Site-Specific/UDF

Visual 1: Lesson 7: Site-Specific Data and User-Defined Facilities

Visual 2: Lesson 7: Goal and Objectives

Goal: To explore datasets that effectively support disaster operations.

After completing this lesson you will be able to:

- Explain the differences between GBS and UDF.
- Identify what data is required to complete an assessment.
- Differentiate between the different hazard's analysis data.

Visual 3: Difference Between GBS and UDF

General Building Stock: an engineering based estimation of structures by occupancy

- Aggregate data by Census geography according to hazard type
- Reported by square footage, dollar exposure, building count
- Linked during development, but not in software

User-Defined Facilities: building or structure specific data

- Must be imported through CDMS by the user
- Provides actual locations of buildings
- Replacement value rather than appraisal value of buildings

Site-Specific Data: building or structure specific data

- Some data included in Hazus inventory, such as hospitals, fire stations, and schools
- May include user-defined, AEBM, high potential loss, essential, transportation and utility facilities
- Damages assessed on an individual building basis

Visual 4: UDF Data

- Produces results and loss estimates at the structure level
- Can often help facilitate risk discussions with individual homeowners or business owners in a community
- Provides valuable information to help pre-screen properties and projects before going through a more in-depth Benefit-Cost Analysis (BCA)
- Generally the best and most accurate approach to analyzing and communicating risk

Visual 5: Site-Specific Inventory

- Provides “actual” locations of buildings rather than aggregated General Building Stock tables (site-specific GBS data are referred to as user-defined facilities)
- Sources vary by inventory type:
  - Essential Facilities: medical, fire, police, schools, etc.
  - High Potential Loss Facilities: dams, nuclear, military
  - Transportation Systems: bridges, highways, rail, airports, etc.
  - Utility Systems: water, oil, gas, electric, etc.
  - Hazardous Material Sites
  - User-Defined Facility

Visual 6: Hazard-Specific Data: Debris Analysis

To complete an assessment of situation, the following data is needed:

- Hazard areas of impact
- Demographics (# of households/density/land use)
- Vegetation coverage
- Critical infrastructure/assets

Visual 7: Assessor Data

- Data can often be downloaded from county or city governments.
  - May be free or require payment
  - Will require pre-processing for import to Hazus
- Converting assessor data to user-defined facilities:
  - Build appropriate study region
  - Create building footprint centroids feature class

Visual 8: Demonstration 7.1: Tax Assessor Data

Goal: Explore Tax Assessor Data.

Time: 10 minutes

Student Manual

Demonstration 7.1: Tax Assessor Data

Goal: Explore Tax Assessor Data.

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.

Visual 9: Hazard-Specific Data: Hurricane Analysis

- Trees: U.S. Forestry Service, LiDAR-derived tree locations, State Department of Natural Resources
- Terrain: Land cover datasets obtained from State Departments of Natural Resources, USGS, or locally derived
- Shelter: Red Cross National Shelter System, State Homeland Security and local shelter personnel. Examine a historic disaster and the sheltering demographics and adjust the parameters
- Economic Loss: U.S. Dept. of Commerce's Bureau of Economic Analysis

Visual 10: Hazard-Specific Data: Flood Analysis

- Debris Weight (no vegetative): R.S. Means
- Shelter: State Homeland Security and local shelter personnel.
- Economic Loss: U.S. Dept. of Commerce’s Bureau of Economic Analysis
- Agriculture products: damage functions from the U.S. Army Corps of Engineers
- Vehicles: count based on building occupancies in each census block

Visual 11: Hazard-Specific Data: Earthquake Analysis

- Debris Weight (no vegetative): R.S. Means
- Shelter: State Homeland Security and local shelter personnel.
- Economic Loss: U.S. Dept. of Commerce's Bureau of Economic Analysis
- Fire Following: Local fire departments, universities (geology and earthquake hazard research)
- Transportation Economic Loss: Regional and local planning agencies
- Utility Economic Loss: Utility companies (private and local)

Visual 12: Hazard-Specific Data: Tsunami Analysis

- General Building Stock: US Army Corps of Engineers National Structure (NSI) point data
- Essential User-Defined Facilities
- Casualty analysis: hazard boundary and fatality boundary
- Pedestrian evacuation: travel and warning times
- Community preparedness level (evacuation): FEMA rating of good, fair, or poor
- Traffic factor (evacuation): travel speed and road networks

Visual 13: Exercise 7.2: UDF Database

Goal: Load UDF into Hazus through CDMS.

Time: 20 minutes

Student Manual

Exercise 7.2: UDF Database

Goal: Load UDF into Hazus through CDMS.

Time: 20 minutes

Exercise Steps:

1. Refer to Activities Document “07.2_Exercise_UDF Database.”
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 7.2: Tasks

Task 1: Open CDMS and confirm or change State Database.

Task 2: Import the UDF data with CDMS and set Import Parameters.

Task 3: Complete Data Field Mapping.

Task 4: View Table and Import into State Geodatabase.

Student Manual	***Exercise 7.2: Tasks*** Refer to Activities Document “07.2_Exercise_UDF Database.”

Visual 15: Lesson 7: Review

1. What is the difference between GBS and UDF?
2. What data is required to complete an assessment?
3. Describe the different analysis data for the various hazards.

Visual 16: Questions

Lesson 8: Basic Flood

Visual 1: Lesson 8: Basic Flood

Visual 2: Lesson 8: Goal and Objectives

Goal: To provide a review of the flood model within Hazus.

After completing this lesson you will be able to:

- List the inputs of Flood Hazard.
- Describe the Depth Damage Functions (DDFs).
- Identify the factors that influence flood damage to buildings.
- Explain dasymetric inventory.

Visual 3: Flood Basics

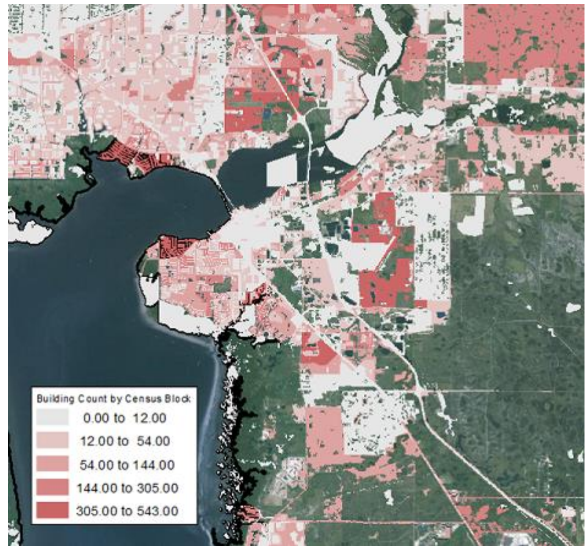
Flood Hazard Inputs:

- User-Defined analysis options (Quick Look and Enhanced Quick Look)
- User-Defined depth grid
- Digital Flood Insurance Rate Map (DFIRM)
- High Water Mark Data
- HEC-RAS

Visual 4: Flood-Specific Inventory

Dasymetric Inventory:

- Flood Model only
- Assumes building exposure only exists within areas which satellite and land-use data confirm there exists a built environment
- Based upon the 2011 National Land Cover Dataset (NLCD)



Visual 5: Flood-Specific Inventory

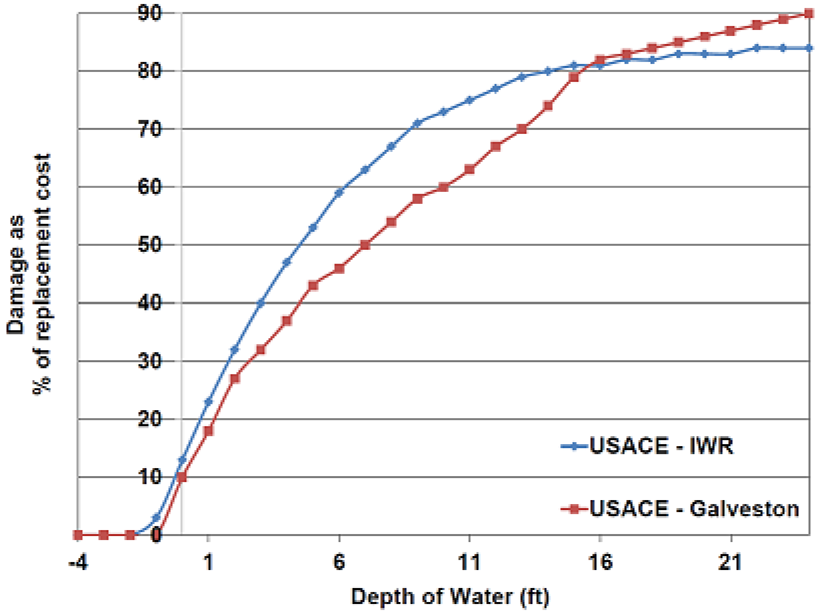
General Building Stock:

- Depreciated Replacement Costs
    - Estimates depreciated value of structures (used for insurance purposes)
- Distribution of foundation types and first-floor heights
- Estimates the first floor height based upon the foundation type

Models differ for riverine, coastal, and Great Lakes census blocks, as well as for Pre-FIRM and Post-FIRM structures

Visual 6: Depth-Damage Functions

Default depth-damage functions are assigned based on building characteristics



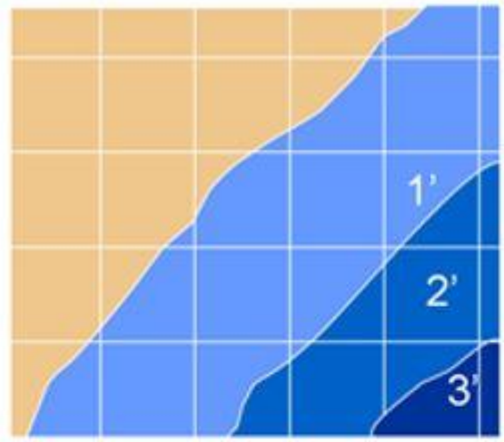
Visual 7: Depth-Damage Functions (DDFs)

- Assigned based on building characteristics
- Factors influencing flood damage to buildings:
  - Water (most important)
  - Duration
  - Velocity
  - Salinity
- Applied to relevant depth
  - Buildings: first-floor height
  - Equipment: Height above first floor
- NOTE:
  - Low water depths: steep slopes
  - High water depths: flatter sections

Visual 8: GBS Loss Estimation Methodology

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



DEM Grid points

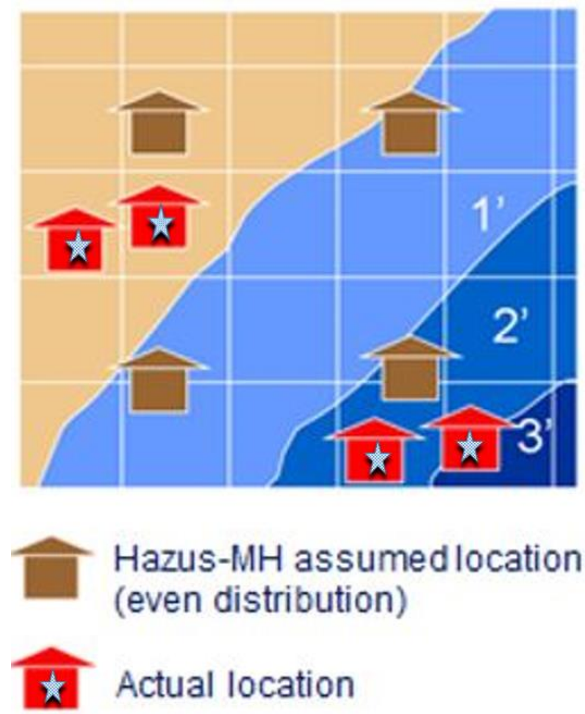
This approach is most appropriate for large areas.

Visual 9: GBS Loss Estimation Methodology (Cont'd.)

Assumes that inventory is evenly distributed across each census block.

Example: If 25% of the block has 2 ft. of water, it is assumed that 25% of the four single-family dwellings in the block are in 2 ft. of water.

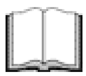
Losses are reported as totals for each occupancy and building type rather than for each building.



Visual 10: Exercise 8.1: Depth Grid

Goals: Import a 100-year depth grid.

Time: 25 minutes



Student Manual

Exercise 8.1: Depth Grid

Goals: Import a 100-year depth grid.

Time: 25 minutes

Exercise Steps:

1. Refer to Activities Document “08.1_Exercise_Depth Grid.”
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 8.1: Tasks

Task 1: Create a new Salt Lake City Study Region.

Task 2: Open Salt Lake City Study Region.

Task 3: Use Hazus Interface to Define a DFIRM.

Task 4: View Results.

Student Manual

Exercise 8.1: Tasks

Refer to Activities Document “08.1_Exercise_Depth Grid.”

Visual 12: Lesson 8: Review

1. What are the inputs of the Flood Hazard?
2. What are the Depth Damage Functions (DDFs) based on?
3. What factors influence flood damage to buildings?
4. What is dasymetric inventory?

Visual 13: Questions

Lesson 9: Hazus Flood for Response

Visual 1: Lesson 9: Hazus Flood for Response

Visual 2: Lesson 9: Goal and Objectives

Goal: To review the applications of Hazus in flood response.

After completing this lesson you will be able to:

- Understand the flood response timeline.
- Identify when and when not to use Hazus for flood.
- Describe a flood depth grid.

Visual 3: Flood Response Timeline and Coordination

Preparation for Flooding:

- Identify jurisdiction's susceptibility to floods
- Estimating vulnerable zones
- Flood fighting
- NWS issues flood warnings

Once Flooding Occurs:

- Search and Rescue
- Continuity of Operations
- Inspection and Condemnation

Visual 4: When to Use Hazus for Floods

Use Hazus to create:

- Identify areas with differential impacts
- Create user-defined scenarios
- Utilize depth grids for damage and loss estimations

Visual 5: When Not to Use Hazus for Floods

- Regulated Streams:
  - Not computed in Hazus unless gage available
  - Must use user-defined hazard input
- Hydrologic analysis is NOT necessary if you are providing results from another flood study, such as:
  - Entering discharges
  - Quick Look: drawing a polygon having a constant flood depth
  - Enhanced Quick Look: providing a flood plain boundary and DEM
  - Providing a flood depth grid
  - HEC-RAS input
- Dam Failures - Hazus does not model dam failures
- Creating the flood hazard or anything that is not loss estimation
- Level 1 hydraulic and hydrologic modeling should not be used during response

Visual 6: Hazus Flood Data Sources

- National Oceanic and Atmospheric Administration (NOAA)
- Federal Emergency Management Agency (FEMA)
- Map Service Center (MSC)
- Flood Insurance Studies
- Risk MAP non-regulatory products
- HEC-RAS (US Army Corps of Engineers)
- National Elevation Dataset (US Geological Survey)
  - Bare earth digital elevation models (DEM)
  - Source lidar point clouds
  - Ifsar digital source models (DSM)
- User-defined depth grids
- Shapefiles, rasters, depth grids, and imagery from state and local governments

Visual 7: Depth Grid

- Raster surface with depth value for each pixel
- Interpolates elevation between cross-sections
- Creates a flood elevation surface
- Flood Depth Grid = Flood Surface – Ground Elevation
- Sources may include digital flood insurance rate maps, high water mark data, and many are available for download from FEMA MSC

Depth grid derived from DFIRM data for Denver, Colorado. Darker shaded areas designate deeper water. For example, the areas adjacent to the river stream. Lighter shaded areas designate shallow water. For example, urban street grids further away from river stream.

Visual 8: Exercise 9.1: DFIRM Depth Grid

Goals:

- Create a depth grid based off the DFIRM dataset and the Esri ArcMap Spatial Analyst toolset.
- Keep track of the name of the files generated.

Time: 30 minutes

Student Manual

Exercise 9.1: DFIRM Depth Grid

Goals:

- Create a depth grid based off the DFIRM dataset and the Esri ArcMap Spatial Analyst toolset.
- Keep track of the name of the files generated.

Time: 30 minutes

Exercise Steps:

1. Refer to Activities Document “09.1_Exercise_DFIRM Depth Grid.”
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 9: Exercise 9.1: Tasks

Task 1: Prepare the Data in ArcMap.

Task 2: Interpolate the Water Surface.

Task 3: Prepare the Depth Grid.

Task 4: Understand the DFIRM Database.

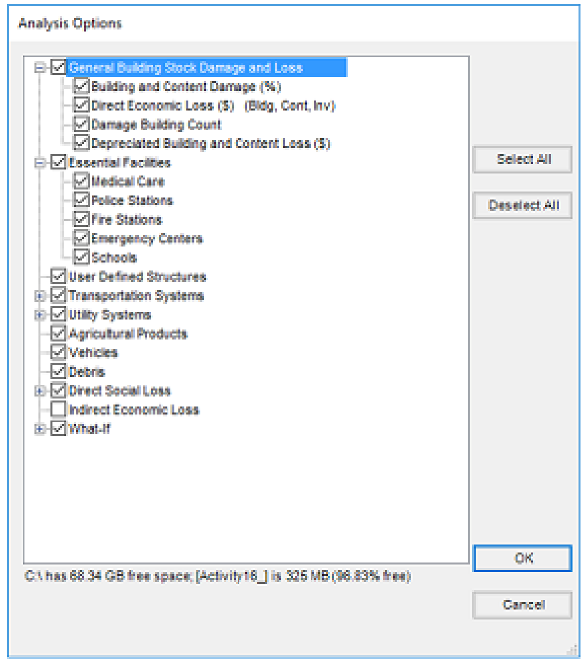
Student Manual

Exercise 9.1: Tasks

Refer to Activities Document “09.1_Exercise_DFIRM Depth Grid.”

Visual 10: Running the Analysis

- User selects desired analysis lessons to run
- Lessons can be re-run as needed
- Hint: Select only the analysis you need (speeds up processing time)

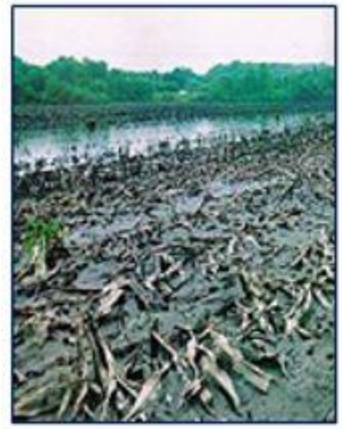


Visual 11: Viewing Depth-Damage Functions

Instructor Demonstration

- Open the Depth-Damage Functions viewer for buildings
- Change default damage functions
- View the library
- Demonstrate creating a new damage function

Visual 12: Agriculture Products



User must input a calendar date (e.g., May 25 that is converted to Julian Calendar (1 to 365) to define relation to crop cycle.

Damage is not flood-depth dependent.

- Area of impacted crop is determined.

No duration estimate is calculated.

- Flood Model estimates flood damage if duration is 0 days, 3 days, 7 days, or 14 days.

Based on USACE's AGDAM method.

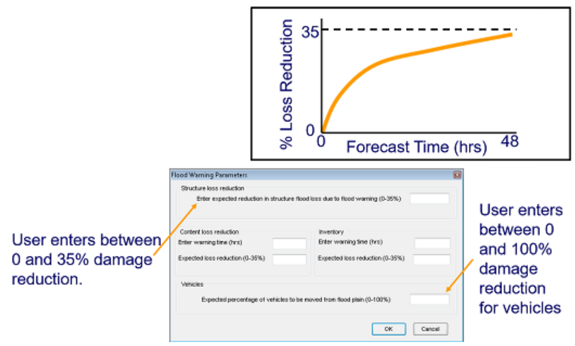
Visual 13: Vehicles

- Damages are based on type of vehicle and depth of water relative to critical vehicle components
- Hazus developed damage functions are based on expert opinion and historical damage data

VehicleType	VehicleID	Description	VehicleHeight	0 ft	0.5 ft	1 ft	1.5 ft	2 ft	2.5 ft
Car	Passenger Car	Damage to car from inundation only	1.5	0	7.5	15	20	40	60
LtTrk	Light Truck	Damage to light truck from inundation only	2.7	0	3	6	9	12	15
HvTrk	Heavy Truck	Damage to heavy truck from inundation only	7	0	1.9	3	5	7	8.3

Visual 14: Flood Warning

- Warning of imminent flooding can reduce damage up to 35% (The Day Curve)
- Hazus will reduce losses by user-defined percentage



Visual 15: Debris Parameters

Debris analysis can be modified to account for

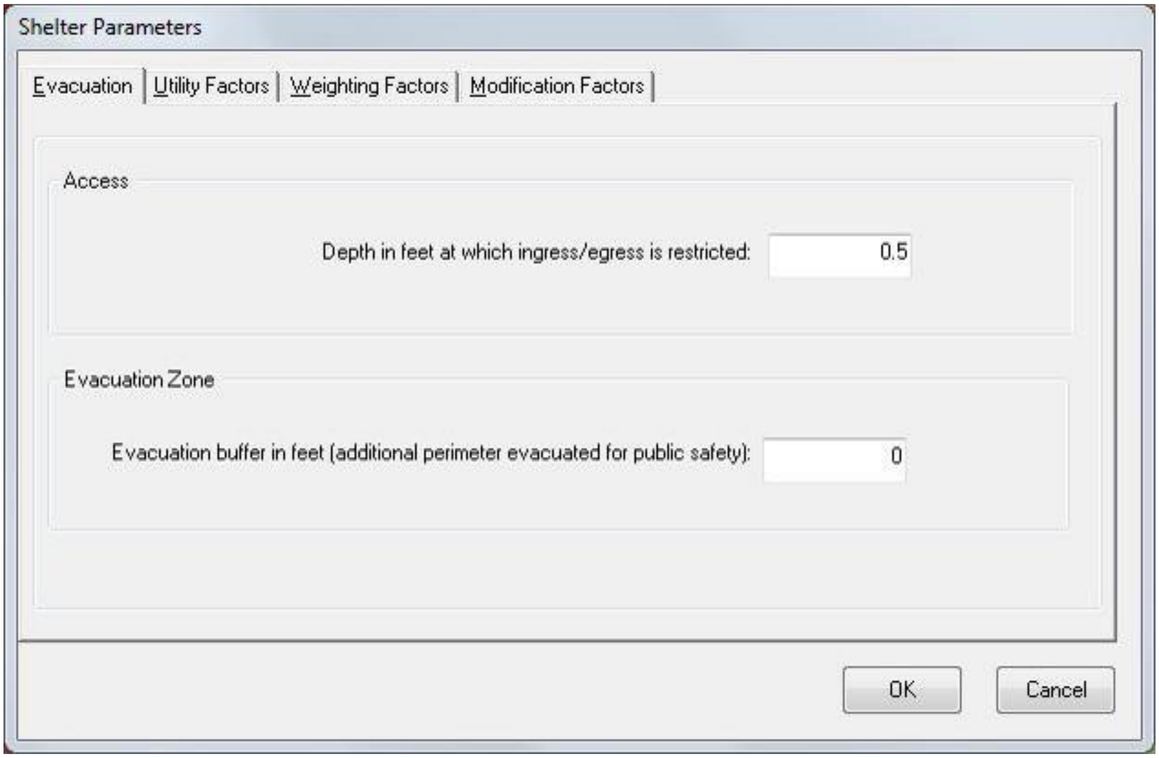
- Occupancy and Foundation Type
- Finish, Structure, and Foundation Weight

Specific Occupancy	Foundation Type	Minimum Depth	Maximum Depth	Finish Weight Per Thous Sq Ft	Structure Weight Per Thous Sq Ft	Foundation Weight Per Thous Sq Ft
RES1	Slab	0	4	4.1	0	0
RES1	Slab	4	8	6.8	0	0
RES1	Slab	8	25	6.8	6.5	25

Visual 16: Shelter

Parameters

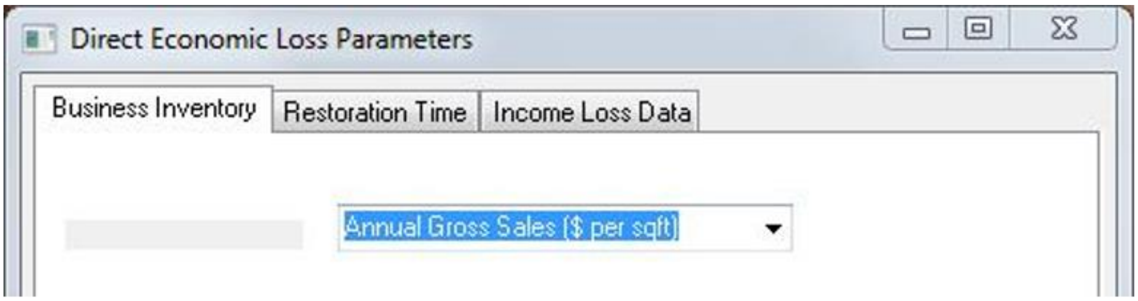
- Evacuation buffer
- Income
- Age



Visual 17: Direct Economic Losses

Parameters:

- Annual Gross Sales
- Restoration Time
- Income and Wage Losses
- Inventory Value



Specific Occupancy	Annual Gross Sales Per SqFt
COM1	53
COM2	77
IND1	713
IND2	226
IND3	697
IND4	656
IND5	437
IND6	768
AGR1	148

Example values for Annual Gross Sales ($ per sqft)

***Many locations nationally have the same default values.

Visual 18: Lesson 9: Review

1. Summarize the flood response timeline.
2. When should Hazus for Flood be used? When should it not be used?
3. What is a flood depth grid and how is it created?

Visual 19: Questions

Lesson 10: Hazus Flood for Recovery

Visual 1: Lesson 10: Hazus Flood for Recovery

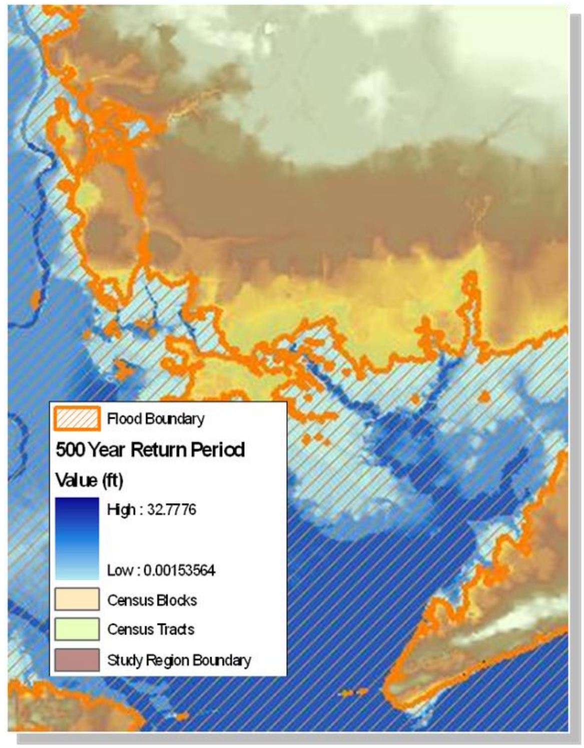
Visual 2: Lesson 10: Goal and Objectives

Goal: To review the applications of Hazus for flood recovery.

After completing this lesson you will be able to:

- Explain the ways that FEMA provides help according to the Individual Assistance Program.
- List the components of site-specific flood inventory.
- Determine the minimal construction design characteristics required by Hazus.

Visual 3: Flood Results: Results (1 of 4)



00 Year Flood Map Explained:

- Dark border lines (here in orange) designates the flood boundaries.
- The shaded areas adjacent to the flood boundary line, which tends to be packed closer together in terms of their hidden contour lines, are unflooded areas at a higher elevation such as slopes, hills, mountains, and ideal population settlements.
- For example, the northern and central areas of the map and the southeast area of the map.
- The shaded areas (here in light to dark blue), which tends to be spread out or flatter in terms of their hidden contour lines, are flooded areas of the map.
- For example, the southern and central areas of the map.
- The lighter blue (shaded) areas that are closer to the flood boundary and higher ground depicts less than 1 foot of flooding. In contrast are the darker blue (shaded) areas further away from the flood boundary representing a decreasing slope in elevation resulting in a high of 32.776 feet of flooding above the ground elevation.

Visual 4: Flood Results

- GBS: by amount of damage and by dollar losses
- Essential facilities: building and content losses, functionality assessment, and restoration time
- Lifeline losses: losses to structures, functionality assessment
- Vehicle losses: day and night, by car or truck
- Agriculture losses (Not reimbursed under FEMA PA)
- Shelter requirements: displaced households and short-term needs

Visual 5: Individual Assistance Program

Provides:

- Immediate Assistance (partners with other organizations)
- FEMA help
  - Home/Primary Residence
  - Business/Secondary Home
  - Other (medical, dental, child care, storage, etc.)
- Additional Assistance
  - Small Business Administration Application
  - Home Inspection
  - After the Inspection

Visual 6: Final High Water Marks (HWM)

- A measure of the event water surface elevation
- Collected by either USGS or local governments
- During periods of flooding, HWM elevations may be collected at the peak elevation using high-resolution GPS systems.
- Values represent the most accurate depiction of the flood event.
- Represent the highest extent of riverine flood or coastal storm surge inundation.
- Represents the elevation of the water during the flood event and ‘fills in’ the gaps where water marks are not present
- HWMs can be interpolated into depth grids for loss estimation

Visual 7: Exercise 10.1: HWM Depth Grid

Goal: Create a high water mark depth grid.

Time: 30 minutes

Student Manual

Exercise 10.1: HWM Depth Grid

Goals: Create a high water mark depth grid.

Time: 30 minutes

Activity Steps:

1. Refer to Activities Document “10.1_Exercise_HWM Depth Grid.”
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 8: Exercise 10.1: Tasks

Task 1: Insert Interpolation of the Water Surface; Create Depth Grid.

Task 2: Subtract Water Surface Grid from the DEM.

Task 3: Remove Negative Values.

Task 4: Create the Flood Boundary.

Student Manual

Exercise 10.1: Tasks

Refer to Activities Document “10.1_Exercise_HWM Depth Grid.”

Visual 9: Site-Specific Flood Inventory

- Essential Facilities
- Transportation Infrastructure: All inventory can be entered, but only bridges are analyzed
- Utilities: Additional classifications include control vaults and control stations
- User-Defined Facilities: Used to perform a more refined site-specific analysis of inventory found in the GBS

Visual 10: User-Defined Facilities

Hazus requires minimal construction design characteristics to select the correct damage curve for damage and loss analysis for each facility:

- Foundation type
- Number of stories
- First floor elevation
- Specific occupancy
- Building and contents valuations

Applications: Explore

- Explore Impact of fewer homes in floodplain
- Outcome of elevating at-risk homes

Visual 11: Lesson 10: Review

1. What are some of the ways that FEMA provides help according to the Individual Assistance Program?
2. What components are used for a site-specific flood inventory?
3. What are the minimal construction design characteristics required by Hazus?

Visual 12: Questions

Lesson 11: Basic Earthquake

Visual 1: Lesson 11: Basic Earthquake

Visual 2: Lesson 11: Goal and Objectives

Goal: To provide a review of the earthquake model within Hazus.

After completing this lesson you will be able to:

- Explain earthquake basics and inventory parameters.
- Describe the function and necessities of ShakeMap.
- Differentiate between Fragility and Capacity Curves.

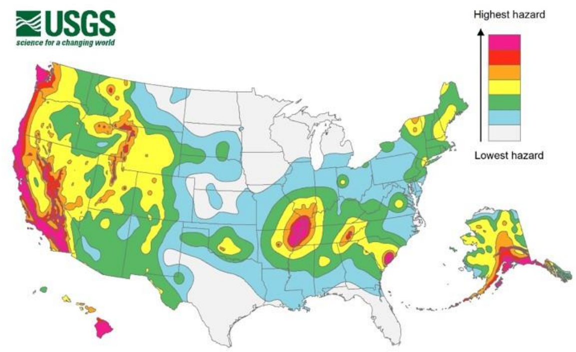
Visual 3: Where Do Earthquakes Happen?

Most of world's active faults are located along or near boundaries between shifting plates

- Plate Boundary earthquakes

Other active faults are not associated with plate boundaries and are inside plates

- Intra-plate earthquakes



Visual 4: GBS for Earthquakes

- In addition to standard inventory, the GBS has attributes particular to the earthquake hazard
- 37 unique building types based on frame and height
  - Steel, concrete, masonry, wood, mobile homes
  - Low-rise, mid-rise, high-rise
- Seven different design levels

Visual 5: Earthquake Data Sources

- National Earthquake Information Center (NEIC)
- USCG: ShakeMaps for actual and scenario events
- Regional earthquake consortia
    - CUSEC: soils and liquefaction susceptibility maps
- State geologists
- Local universities

Student Manual

Earthquake Data Sources

- National Earthquake Information Center (NEIC)
- USGS: ShakeMaps for actual and scenario events
    - Recent Events map: https://earthquake.usgs.gov/earthquakes/map/
    - Historic Event search: https://earthquake.usgs.gov/earthquakes/search/
    - Scenario Catalog: https://earthquake.usgs.gov/scenarios/catalog/
- Regional earthquake consortia
    - CUSEC: soils and liquefaction susceptibility maps cusec.org/earthquake-maps-data/
- State geologists
- Local universities

Visual 6: Hazus Earthquake Basics

- Catastrophic Response Planning
- Annualized Earthquake Loss Study (FEMA P.-366)
- Earthquake results are sensitive to categories of inventory parameters
  - Location
  - Classification to earthquake vulnerability
  - Valuation
  - Societal

Visual 7: Hazus Approach

Evaluates ground motion parameters

- At the location for site-specific inventory
- At the centroid of the census tract for aggregate inventory

Ground shaking characterized in terms of

- Location-specific shaking
- Spectral response
- Peak ground values
- Regional attenuation functions
- Site-soil effects

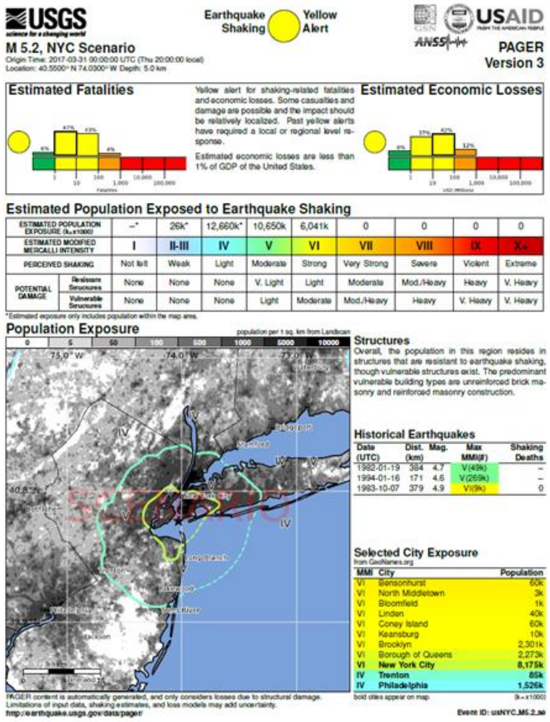
Visual 8: Hazus Approach (Cont'd.)

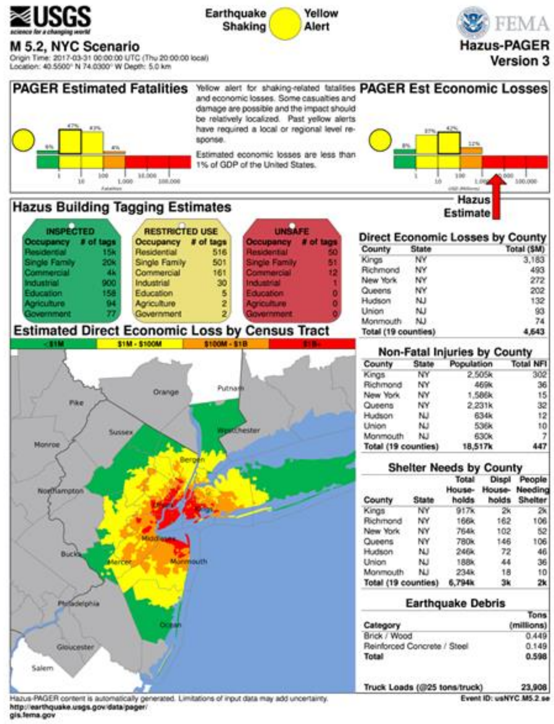
Ground Failure shaking is characterized in terms of amount of ground failure due to liquefaction and landslide.

Visual 9: USGS PAGER

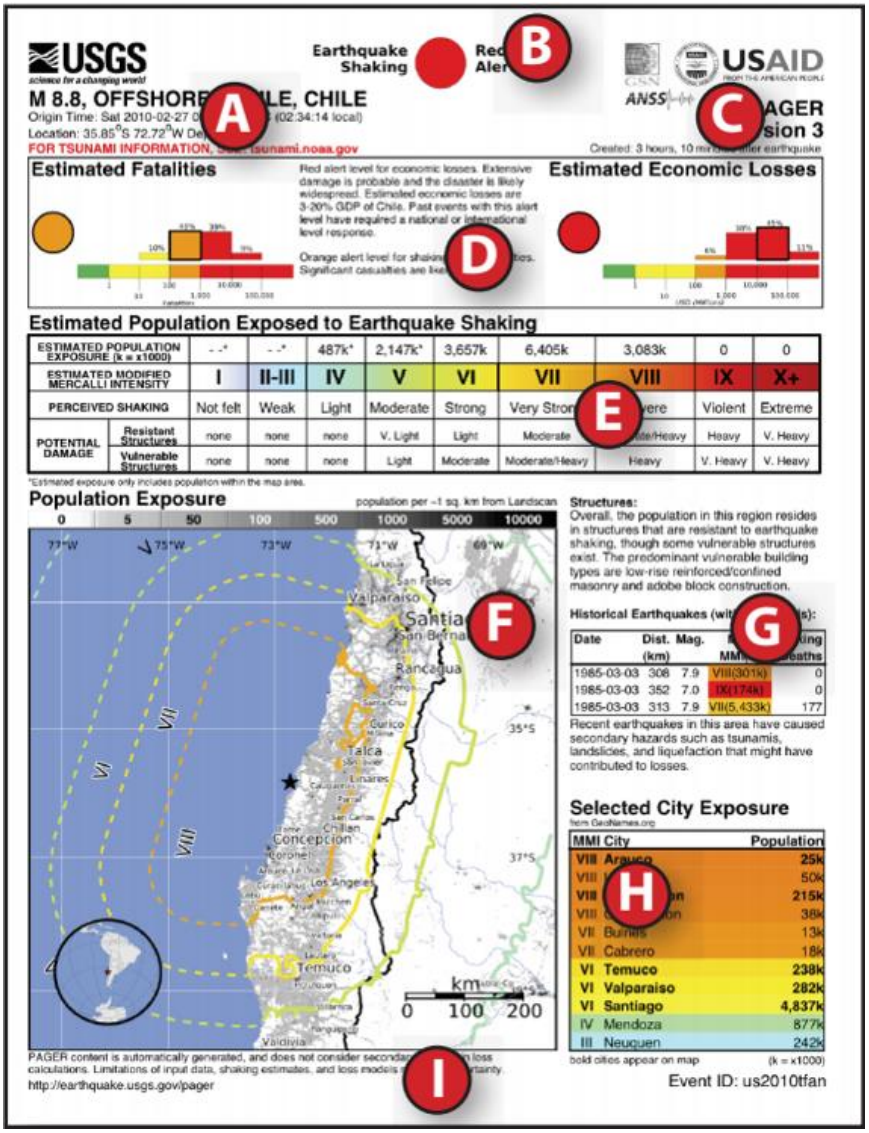
- Prompt Assessment of Global Earthquakes for Response
- Provides fatality and economic loss impact estimates following significant earthquakes worldwide.
- onePAGER: concise, printable version of the rapid assessment of estimated fatalities and economic losses delivered online and via email
- NOTE: There is currently a joint USGS-FEMA effort underway to develop a PAGER 2nd page, providing Hazus results for significant US earthquakes.

Visual 10: USGS PAGER Comparison

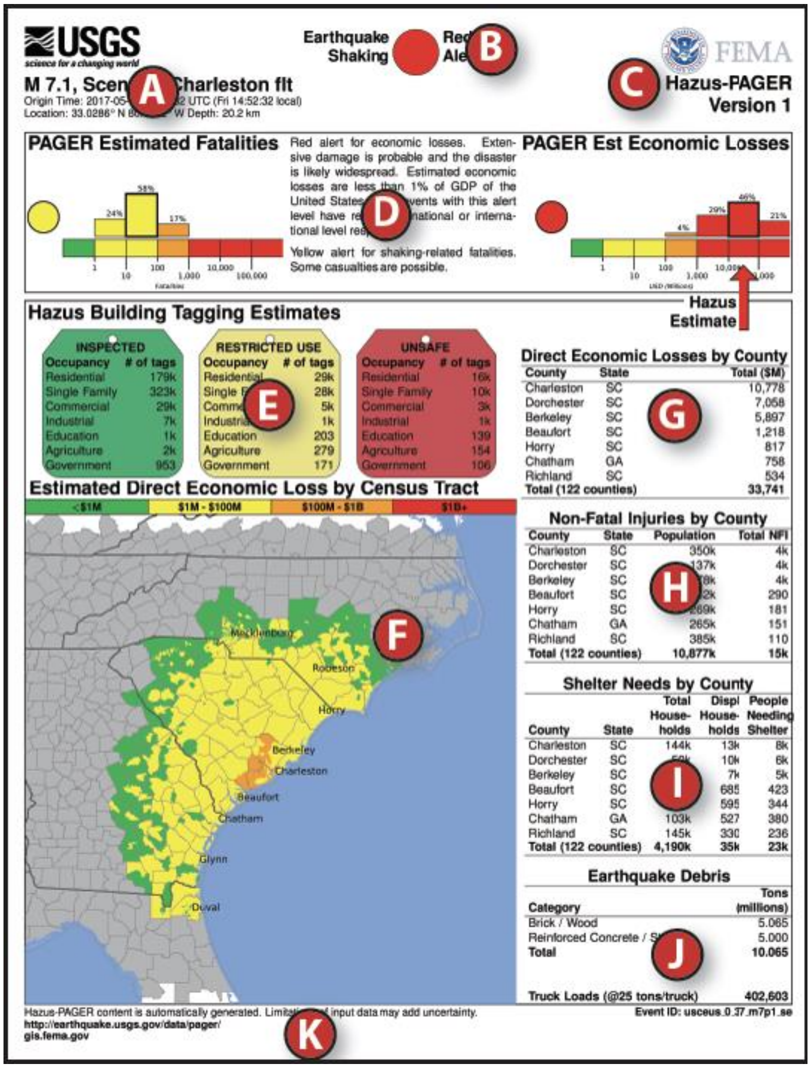




Visual 11: USGS onePAGER Review



Visual 12: USGS twoPAGER Review



Visual 13: PAGER vs. Hazus

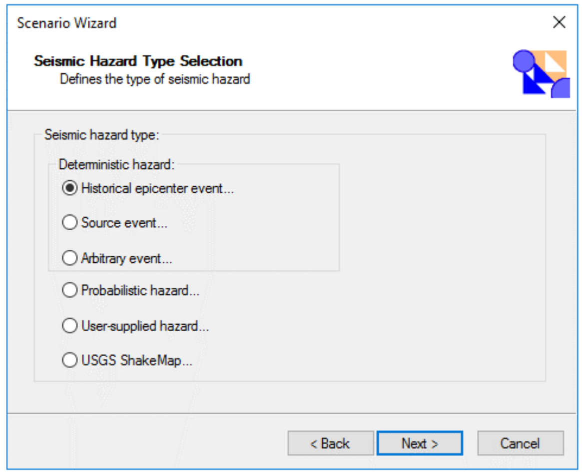
PAGER: Exposure Model

- Shaking intensity, population exposure, and loss estimates
- Ground shaking impacts
- Fatality and economic loss estimates given the exposure
- Estimated results only

Hazus: Loss Estimation Model

- Ground shaking, fault rupture, liquefaction, land sliding, and tsunami impacts
- Considers building density and composition
- Site-specific and user-defined capabilities
- Results options:
    - Quantitative estimates of direct and indirect losses
    - Functionality losses
    - Extent of induced hazards

Visual 14: Defining a New Earthquake Scenario



Deterministic

- USGS ShakeMap*
- Historical epicenter event
- Source event
- Arbitrary event

Probabilistic

User-Supplied

*Preferred method

Visual 15: ShakeMap

ShakeMap is a product of the USGS Earthquake Hazards Program

- Provide near-real-time maps of ground motion and shaking intensity following earthquakes
- Used by federal, state, and local organizations (private and public) for:
  - Post-earthquake response and recover
  - Public and scientific information
  - Preparedness exercises
  - Disaster planning
- Provides maps on intensity, acceleration, velocity, and uncertainty of earthquakes
- ShakeMap data download options include: XML grids, rock grid, uncertainty grid, text ASCII grids, KML, KMZ, Shapefiles, general-purpose GIS files, ESRI raster files, text metadata, and other supplementary maps and images

Visual 16: ShakeMap

ShakeMaps for Hazus must include a file with the following parameters:

- Peak Ground Acceleration (PGA)
- Peak Ground Velocity (PGV)
- Spectral Acceleration at 1 second (psa10)
- Spectral Acceleration at 0.3 seconds (psa03)

Visual 17: Demonstration 11.1: ShakeMap

Goal: Use the Hazus interface to find a ShakeMap.

Time: 25 minutes

Student Manual

Demonstration 11.1: ShakeMap

Goal: Use the Hazus Interface to find a ShakeMap

Time: 25 minutes

Demonstration Steps:

1. Refer to Activities Document “11.1_Demonstration_ShakeMap.”
2. Listen to instructor’s directions.
3. Ask questions if clarification is needed.
4. Watch the instructor’s demonstration.
5. Ask any final questions.

Visual 18: Demonstration 11.1: Tasks

Task 1: Create a New Salt Lake City Study Region.

Task 2: Open Salt Lake City Study Region.

Task 3: Use Hazus Interface to Define USGS ShakeMap.

Task 4: View Direct Economic Loss.

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Demonstration 11.1: Tasks

Refer to Activities Document “11.1_Demonstration_ShakeMap.”

Visual 19: Using Hazard Maps

Simplified hazard maps are automatically generated during the creation of the study region. These approximate hazard maps are based on default soil maps and the census tract boundaries.

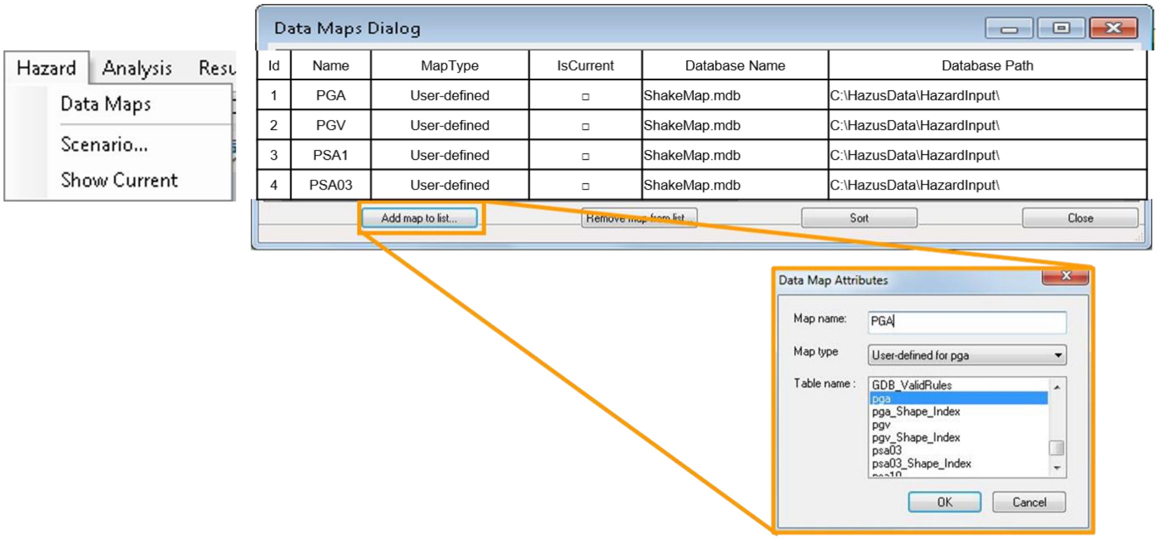
Users can modify and enhance soils, liquefaction, landslide and water depth if spatial data is available from experts or other agencies.

If available, these expert-generated maps should be used to replace the simplified maps.

Hazard maps should be used when default data may not represent actual conditions or to model historical scenarios. If improved hazard maps are not available, the site class of each hazard for the study region can be changed.

Note: Soil hazard maps should not be used with ShakeMaps.

Visual 20: Importing Hazard Maps

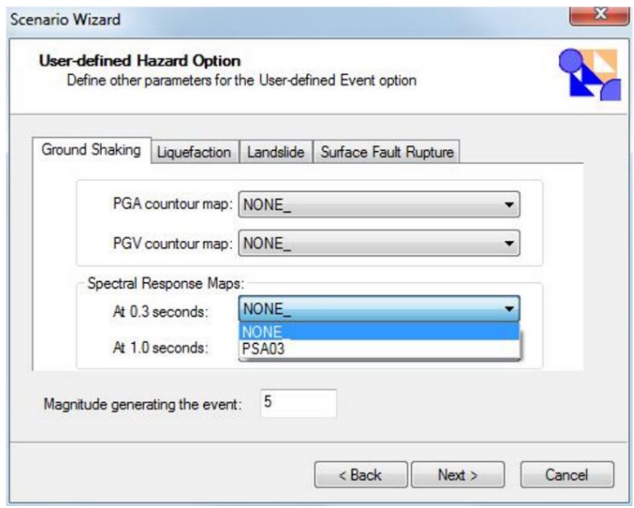


- Import user-defined maps to create more detailed analysis
- Expertly generated ground motion and soils maps can enhance the quality of your results.

Visual 21: Define Hazard Maps Option

Hazard map options:

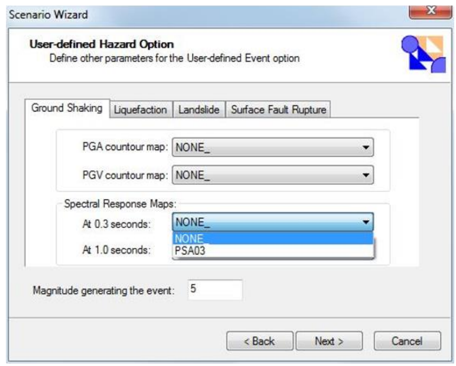
- Apply same value to the entire region
- Import hazard maps so that Hazus can generate more accurate ground motion data



Visual 22: User-Defined Hazard Option

These data can be brought into Hazus in order to generate more accurate loss estimations

Allows you to import hazard maps created outside of Hazus that are related to a specific event



Visual 23: Exercise 11.2: Source Event

Goals:

- Create a Source Event Scenario.
- Create a map of economic loss.

Time: 25 minutes

Student Manual

Exercise 11.2: Source Event

Goals:

- Create a Source Event Scenario.
- Create a map of economic loss.

Time: 25 minutes

Exercise Steps:

1. Refer to Activities Document “11.2_Exercise_Source Event.”
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 24: Exercise 11.2: Tasks

Task 1: Open Study Region Salt_Lake_City_EQ.

Task 2: Define the Scenario.

Task 3: Add a Soil Map and Define the Data.

Task 4: Run Analysis.

Task 5: View Direct Economic Loss Results.

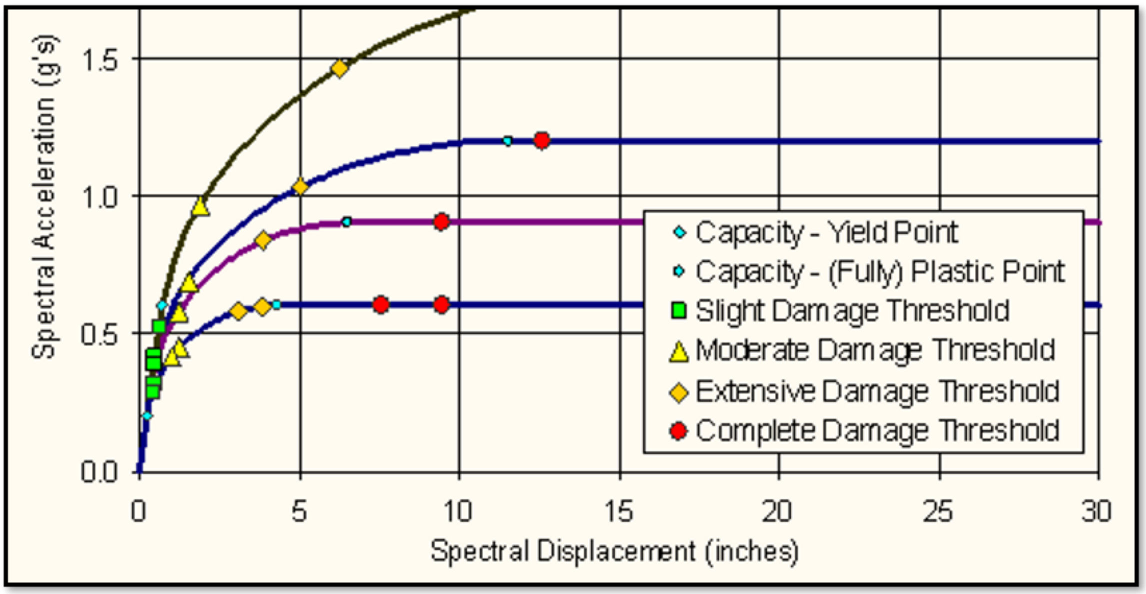
Student Manual

Exercise 11.2: Tasks

Refer to Activities Document “11.2_Exercise_Source Event.”

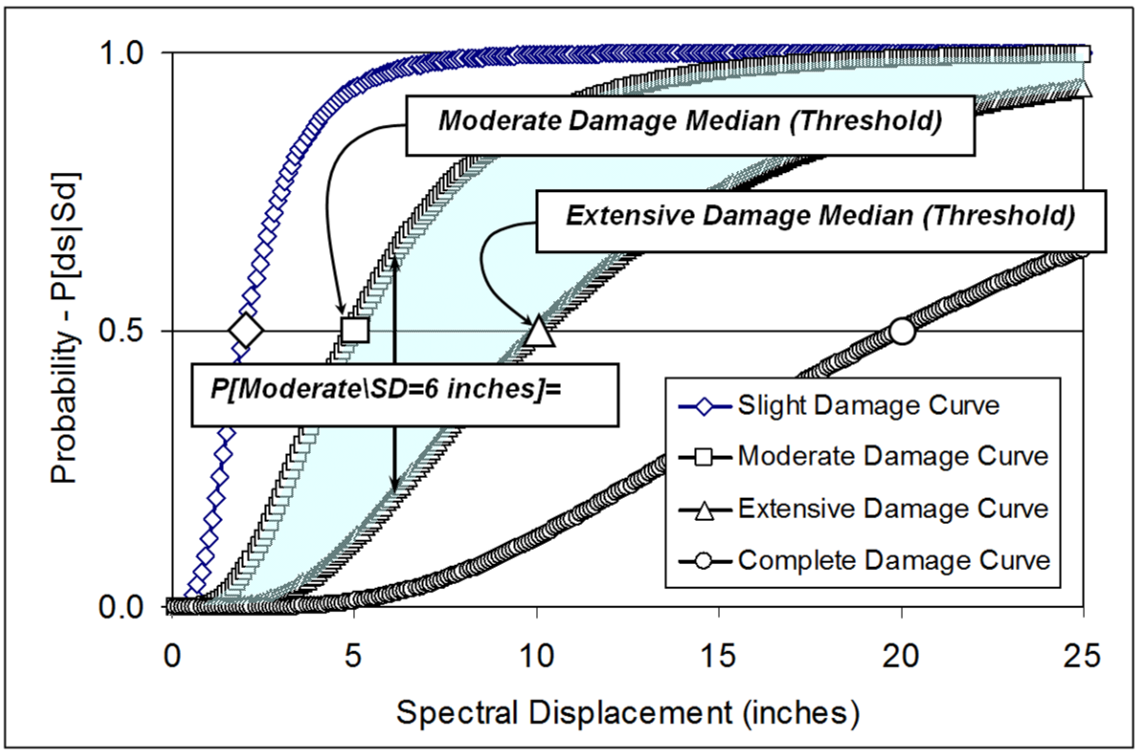
Visual 25: Capacity Curves

- Characterize building response (e.g. displacement) resulting from input ground motion
- Lognormal distribution of being in or exceeding damage state
- Estimated displacement is used with the Fragility Curve to determine damage state probabilities
- Capacity curves are described by:
    - Design capacity – strength of a building
    - Yield capacity – point where a building experiences damage
    - Ultimate capacity – point where a building is completely destroyed



Visual 26: Fragility Curves

- Damage functions for earthquakes
- Lognormal distribution of being in or exceeding damage state
- Considers variability of damage state due to:
  - Uncertainty of damage state threshold
  - Variability in building capacity
  - Spatial variability of ground motion
- Depending on the level of earthquake forces, damage to building can range from no damage to complete damage
  - Uncertainty



Visual 27: Lesson 11: Review

1. List four categories of inventory parameters that earthquake results are sensitive to.
2. What is a ShakeMap and what types of data does it use?
3. What parameters must be included in ShakeMap for Hazus?
4. What is the difference between a Fragility Curve and a Capacity Curve?

Visual 28: Questions

Lesson 12: Hazus Earthquake for Response

Visual 1: Lesson 12: Hazus Earthquake for Response

Visual 2: Lesson 12: Goal and Objectives

Goal: To understand basics of modeling earthquakes for response in Hazus.

After completing this lesson you will be able to:

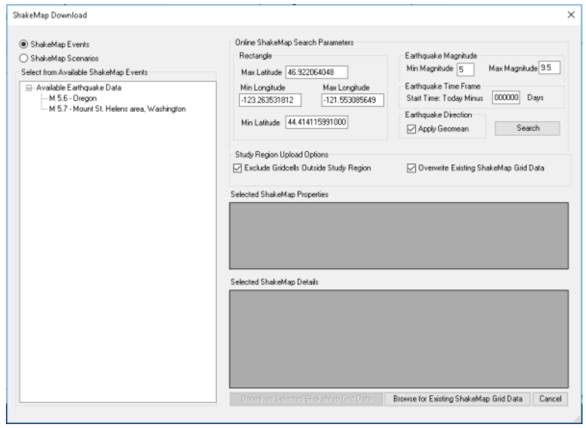
- Describe the earthquake response timeline.
- Summarize the quantification of the hazards for an earthquake.
- Explain the characteristics of ground shaking.
- List the data sources used for Hazus for Earthquakes.

Visual 3: Federal Response

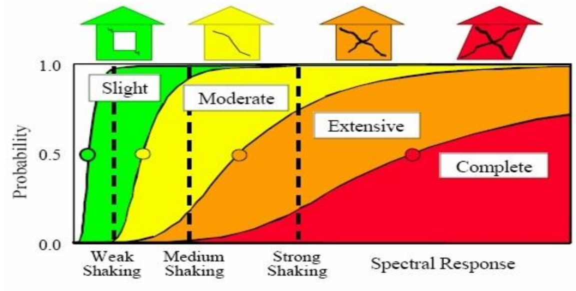
- USGS Earthquake Notification Service (ENS)
  - Free email notification service
  - Default magnitude of 6.0 in U.S. (can be user modified)
- PAGER Yellow Alert: regional impact and response
- PAGER Orange Alert: national-scale impact and response
  - Support efforts of state and local governments
- FEMA’s Natural Hazards Risk Assessment program will contain loss data scenarios beginning 2019
  - Based on ShakeMaps, Hazus Loss results, PAGER (page 1) and PAGER (page 2)
- Earthquake Notification Service: earthquake.usgs.gov/ens/userhome_map

Visual 4: USGS ShakeMap

- ShakeMaps provide near-real-time maps of ground motion and shaking intensity following significant earthquakes
- ShakeMaps also contain archives of previous earthquakes
- Will show earthquakes in the last 90 days by default - to add historic or scenario events, make selection and expand search parameters.



Visual 5: Direct Physical Damage



Hazus assesses the maximum displacement that a building will undergo and the damages that would result

Damages vary according to

- Uncertainty of damage state threshold
- Variations in building capacity
- Geographic variations of ground motion

Analyzes both structural and non-structural elements

Visual 6: Direct Physical Damage

- Essential Facilities
  - Fire Stations, Police Stations, Hospitals and Clinics, Schools, Emergency Operations Centers

What can Hazus provide the community/State decision-makers?

- Parameters
  - Facility Damage
  - Restoration Time
  - Based on ground shaking and ground failure

Why is this data critical for emergency planning?

Visual 7: Direct Physical Damage

Transportation:

- Highway, Railway, Light Rail, Bus, Port, Ferry, Airport

Parameters

- Facility Damage
- Time to Restore Facility
- Economic Loss Estimations

When and in what form should this be provided to leadership?

Cypress viaduct of Interstate Highway 880, Loma Prieta, 1989 (USGS)

Oakland Bay Bridge, Loma Prieta, 1989 (USGS)

Visual 8: Direct Physical Damage

Utilities:

- Potable Water, Waste Water, Oil Systems, Natural Gas, Electric Power and Communication

Parameters

- Facility Damage
- Time to Restore Facility
- Economic Loss Estimations

Following an earthquake, how can Hazus facilitate recovery operations?

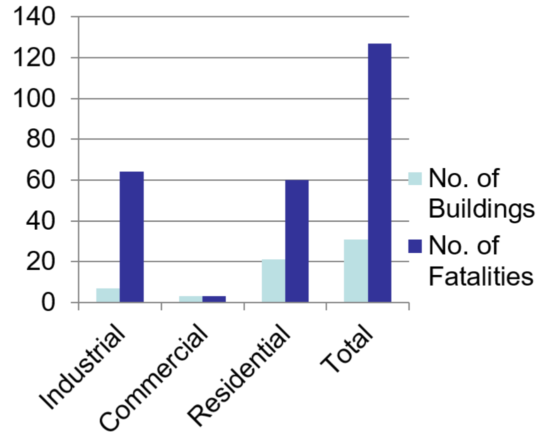
Broken utilities, Watsonville Area, Loma Prieta, 1989 (USGS)

Visual 9: Social Losses - Casualties

Calculates multiple levels of casualties based on severity and time of day

Parameters

- Damage to various Building Types
- Bridge Damage Contribution
- Time Dependent



Spence and So. 2009. “Estimating Shaking-Induced Casualties and Building Damage for Global Earthquake Events"

Visual 10: Social Losses - Shelter

Calculates need for public shelters

Parameters

- Age
- Ethnicity
- Income
- Home Ownership
- Damage states of different types of buildings

What information and recommendations can Hazus provide leadership?

Red Cross shelter; Minot, ND; June 24, 2011

Visual 11: Debris

Parameters

- Weight of structural and nonstructural model building types
- Probabilities of damage states for structural and nonstructural elements by census tract

Why is this information critical for recovery operations?

Damage in the Old Town historical district, City of Salinas, Loma Prieta, 1989 (USGS).

Visual 12: Direct Economic Loss

Parameters

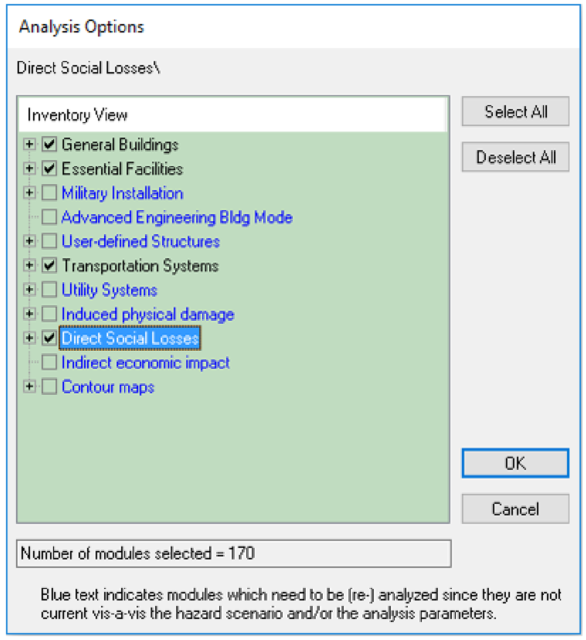
- Annual Gross Sales
- Restoration Time
- Income and Wage Losses

Visual 13: Running the Analysis

User picks modules they wish to run

Modules can be re-run as needed

Only select the analysis you need (speeds up processing time)



Visual 14: Exercise 12.1: ShakeMap

Goals:

- Import a ShakeMap.
- Create a map of economic loss.

Time: 25 minutes

Student Manual

Exercise 12.1: ShakeMap

Goals:

- Import a ShakeMap.
- Create a map of economic loss.

Time: 25 minutes

Exercise Steps:

1. Refer to Activities Document “12.1_Exercise_ShakeMap.”
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 15: Exercise 12.1: Tasks

Task 1: Open study region Salt_Lake_City_EQ.

Task 2: Define the Scenario.

Task 3: Run Analysis.

Task 4: View Direct Economic Loss Results.

Student Manual

Exercise 12.1: Tasks

Refer to Activities Document “12.1_Exercise_ShakeMap.”

Visual 16: Lesson 12: Review

1. How is the hazard of an earthquake quantified?
2. How is ground shaking characterized?
3. What are the data sources used for Hazus for Earthquake

Visual 17: Questions

Lesson 13: Hazus Earthquake for Recovery

Visual 1: Lesson 13: Hazus Earthquake for Recovery

Visual 2: Lesson 13: Goal and Objectives

Goal: To understand the applications of the Hazus Earthquake Loss Estimation Model for recovery operations.

After completing this lesson you will be able to:

- Identify sources of data.
- Interpret loss estimations for recovery operations.

Visual 3: Collecting Local Data

- State, county, and city governments
- Earth science experts and universities
- Recommend updating inputs such as:
    - Ground shaking maps: region-wide ground motion contour maps
    - Soil conditions
    - Critical Infrastructure and Key Resources (CIKR)
    - Local traffic models, including roads and bridges

Visual 4: Recovery Activities

- Actions taken to return to or exceed pre-earthquake levels of activity and productivity
- Short-term and long-term activities
- Restoring, repairing, and reconstructing lifelines and buildings
- Undertaking measures to overcome economic downturns
- Providing financial assistance to compensate for losses

Visual 5: Long-Term Efforts

- Reconstruct and restore the earthquake-stricken area
- Deal with the disruption that the disaster has caused
- Mitigate future hazards

Visual 6: Mitigation

- Can impact a community's ability to recover
- Example: earthquake insurance
  - Lessens financial burden on individuals and governments to replace damaged property
  - Frees up resources that can be applied to other recovery efforts
- Hazard Mitigation Grant Program (HMGP) supports state and local government planning.

Visual 7: Exercise 13.1: ShakeMap with UDF

Goals:

- Run a ShakeMap Analysis with UDF Results.
- Create a map of economic loss.
- Time: 35 minutes

Student Manual

Exercise 13.1: ShakeMap with UDF

Goals:

- Run a ShakeMap Analysis with UDF Results.
- Create a map of economic loss.

Time: 35 minutes

Exercise Steps:

1. Refer to Activities Document "13.1_Exercise_ShakeMap with UDF."
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 8: Exercise 13.1: Tasks

Task 1: Create a New Study Region.

Task 2: Open Salt Lake City Study Region.

Task 3: Add a ShakeMap.

Task 4: Run an Earthquake Analysis.

Task 5: View Direct Economic Loss Results.

Student Manual

Exercise 13.1: Tasks

Refer to Activities Document “13.1_Exercise_ShakeMap with UDF.”

Visual 9: Discussion 13.2: ShakeMap

Question: How did including UDF change the earthquake run?

Time: 10 minutes

Student Manual

Discussion 13.2: ShakeMap

Question: How did including UDF change the earthquake run?

Time: 10 minutes

Discussion Steps:

1. Listen to instructor’s directions.
2. Ask questions if they need directions clarified.
3. Discuss the questions with the class.

Visual 10: Lesson 13: Review

1. What are some potential sources of updated input data for Hazus?
2. What are some examples of recovery activities?
3. What are the general steps involved in viewing direct economic loss results from an earthquake?

Visual 11: Questions

Lesson 14: Basic Tsunami

Visual 1: Lesson 14: Basic Tsunami

HAZUS®

EARTHQUAKE • WIND • FLOOD • TSUNAMI

Visual 2: Lesson 14: Goal and Objectives

Goal: To provide a review of the tsunami model within Hazus

After completing this lesson you will be able to:

- Define tsunami.
- Differentiate between near and distant source tsunamis.
- Understand tsunami-specific inventory.

Visual 3: Tsunami Overview

A series of long-period waves that are usually generated by an impulsive disturbance that displaces massive amounts of water

- Travels at speeds of > 450 mph across the ocean, slowing as it approaches shallower water
- A series of waves with minutes to hours between – the first wave may not be the largest
- Encompass the entire water column in open ocean, with an average surface height of 0.5 m

Visual 4: Tsunami Overview

Tsunamis can be triggered by

- earthquakes
- volcanic activity
- submarine landslides
- onshore landslides in which large volumes of debris fall into the water

All of these triggers can occur in the United States

Most of the tsunamis (88%) in the Global Historical Tsunami Database were generated by earthquakes or landslides caused by earthquakes

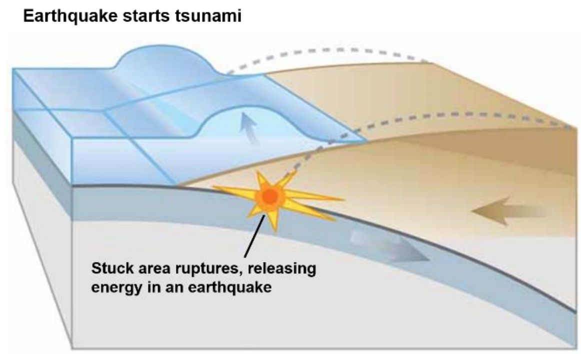
Visual 5: Hazus Tsunami Model

- Loss estimation model that provides state-of-the-art decision support software for estimating potential losses from tsunamis.
- Available for 5 Very High-risk states (AK, WA, OR, CA, HI) and the 5 High Risk U.S. territories
- Combined Earthquake/Tsunami analysis functionality available for the 5 states and PR

Visual 6: Tsunami - Near vs Distant Source

Near Source (local source)

- Those generated within 100 km of a locality of interest
- Earthquake ground shaking precedes the tsunami
- Earthquake damage possible
- Subsidence (lowering) of coastal area possible
- Lead time – a few minutes to an hour

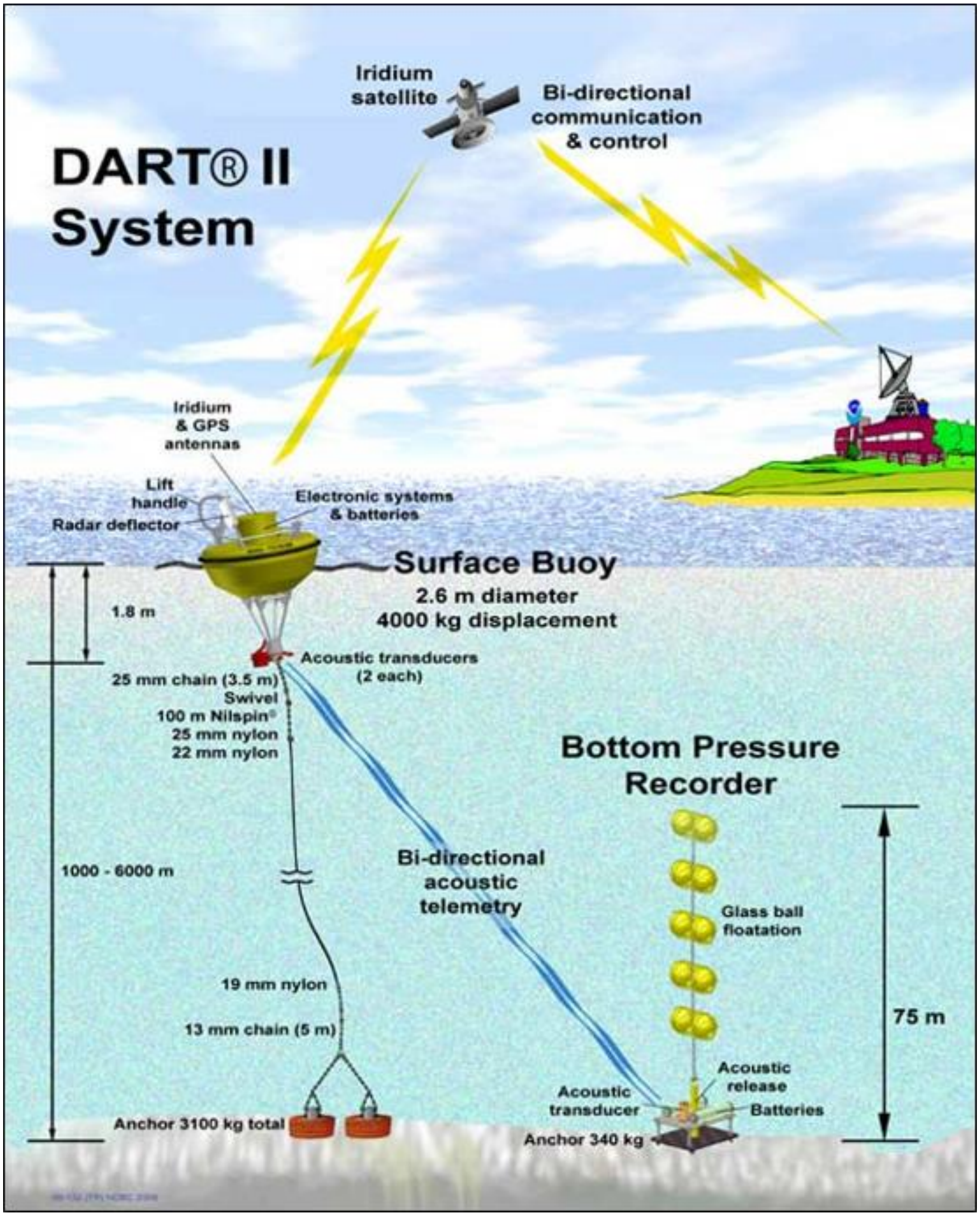


Credit: USGS

Visual 7: Tsunami - Near vs Distant Source

Distant Source

- Those generated far away (>1,000 km from a locality)
- No ground shaking precedes the tsunami
- Lead time – few to several hours



Visual 8: Available Data

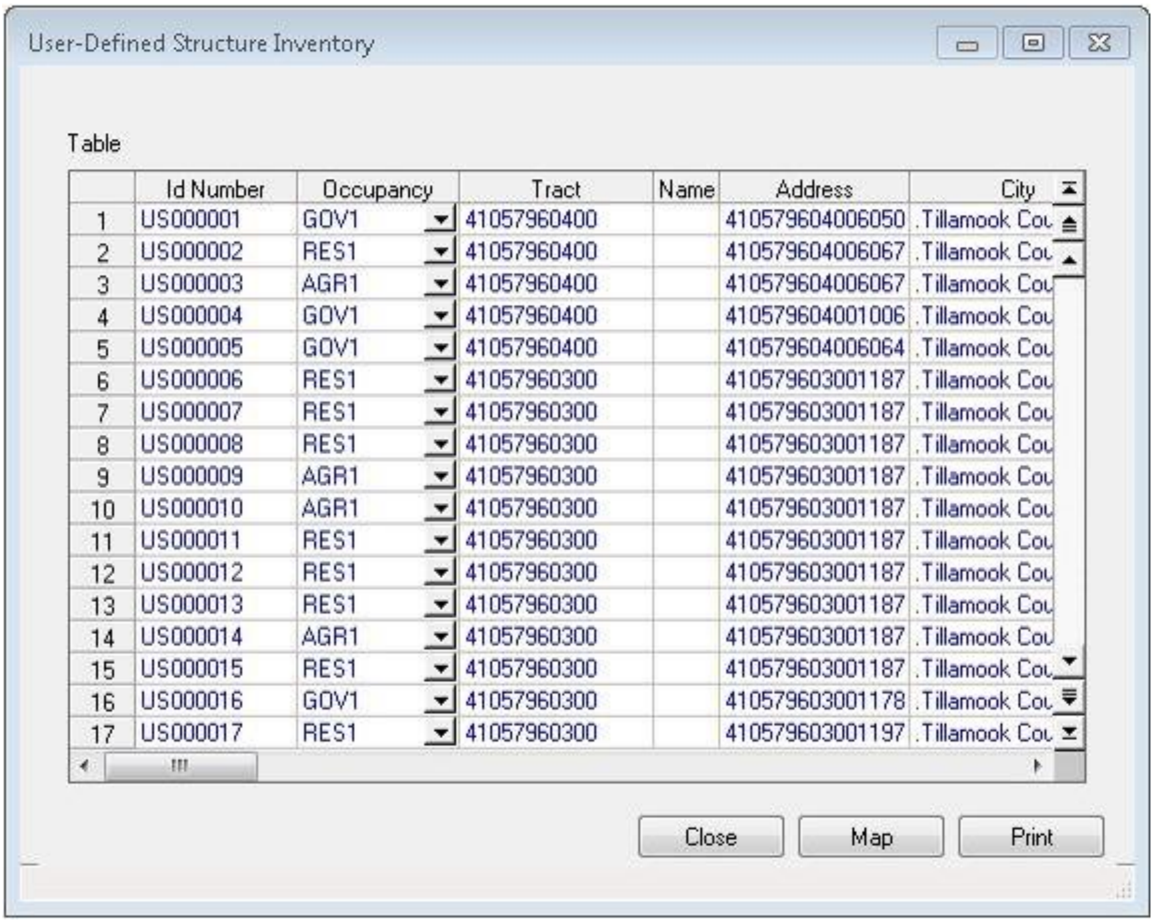
- Census Bureau: road networks
- NOAA
  - National Center for Environmental Information: tsunami events, runups, deposits
  - Bathymetry, seismic activity, real-time data
- State governments
  - Hawaii: tsunami zones, evacuation zones, wave heights, parcels, terrestrial
- US Tsunami Warning System

Visual 9: National Structure Inventory (NSI)

- U.S. Army Corp of Engineers' National Structural Inventory point data. Developed with FEMA.
- Creates notional structures, or 'points,' in the developed portion of each census block to represent the numbers and types of buildings that occur based on size, occupancy type, construction materials, etc.

Visual 10: <u>User Defined Facilities</u>

- Enables user specific datasets to be analyzed through the Hazus methodologies providing more accurate results
- User populated table using Hazus CDMS
- Attributes include:
  - Occupancy type
  - Earthquake building type
  - Design level
  - First floor height
  - Building replacement cost
  - Content replacement cost
  - Location of structure

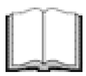


	Id Number	Occupancy	Tract	Name	Address	City
1	US000001	GOV1	41057960400		410579604006050	Tillamook Cou
2	US000002	RES1	41057960400		410579604006067	Tillamook Cou
3	US000003	AGR1	41057960400		410579604006067	Tillamook Cou
4	US000004	GOV1	41057960400		410579604001006	Tillamook Cou
5	US000005	GOV1	41057960400		410579604006064	Tillamook Cou
6	US000006	RES1	41057960300		410579603001187	Tillamook Cou
7	US000007	RES1	41057960300		410579603001187	Tillamook Cou
8	US000008	RES1	41057960300		410579603001187	Tillamook Cou
9	US000009	AGR1	41057960300		410579603001187	Tillamook Cou
10	US000010	AGR1	41057960300		410579603001187	Tillamook Cou
11	US000011	RES1	41057960300		410579603001187	Tillamook Cou
12	US000012	RES1	41057960300		410579603001187	Tillamook Cou
13	US000013	RES1	41057960300		410579603001187	Tillamook Cou
14	US000014	AGR1	41057960300		410579603001187	Tillamook Cou
15	US000015	RES1	41057960300		410579603001187	Tillamook Cou
16	US000016	GOV1	41057960300		410579603001178	Tillamook Cou
17	US000017	RES1	41057960300		410579603001197	Tillamook Cou

Visual 11: Exercise 14.1: Tsunami Study Region

Goal: Build a tsunami study region.

Time: 15 minutes



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Exercise 14.1: Tsunami Study Region

Goal: Build a study region for Tsunami.

Time: 15 minutes

Exercise Steps:

1. Refer to Activities Document “14.1_Exercise_Tsunami Study Region.”
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 12: Exercise 14.1: Tasks

Task 1: Build a Tsunami Study Region.

Task 2: Open the Region and Input Tsunami User Data.

Student Manual

Exercise 14.1: Tasks

Refer to Activities Document “14.1_Exercise_Tsunami Study Region.”

Visual 13: Lesson 14: Review

1. What are the characteristics of a tsunami?
2. List the incidents that can trigger a tsunami.
3. What is the differences between a tsunami approaching the coast and tsunamis occurring near the coast?
4. How does the National Structure Inventory work with Hazus?

Visual 14: Questions

Lesson 15: Hazus Tsunami for Response and Recovery

Visual 1: Lesson 15: Hazus Tsunami for Response and Recovery

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Visual 2: Lesson 15: Goal and Objectives

Goal: To describe the levels of analysis and applications for estimating losses and casualties.

After completing this lesson you will be able to:

- List the steps for estimating tsunami losses.
- Describe the steps for estimating tsunami casualties.

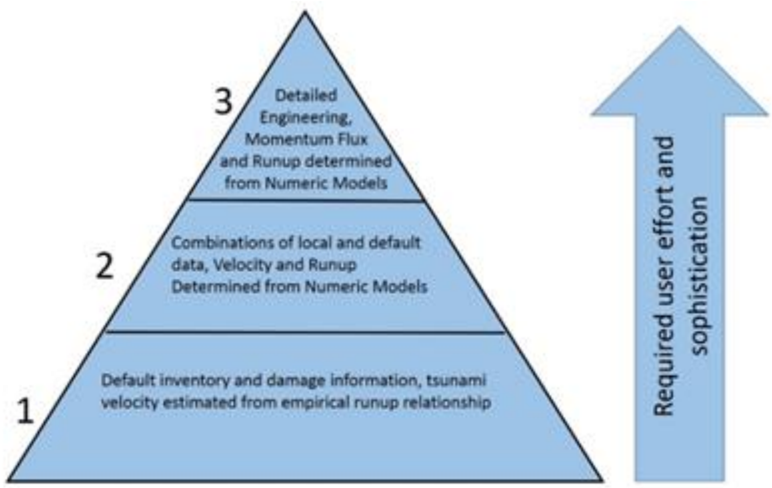
Visual 3: Levels of Tsunami Analysis

Basic (Level 1)

- Out-of-the-box default infrastructure
- Basic user input

Advanced (Level 2/3)

- User-provided data - more accurate to the region
- Data provided by third-party studies/hazard models



Levels of Analysis

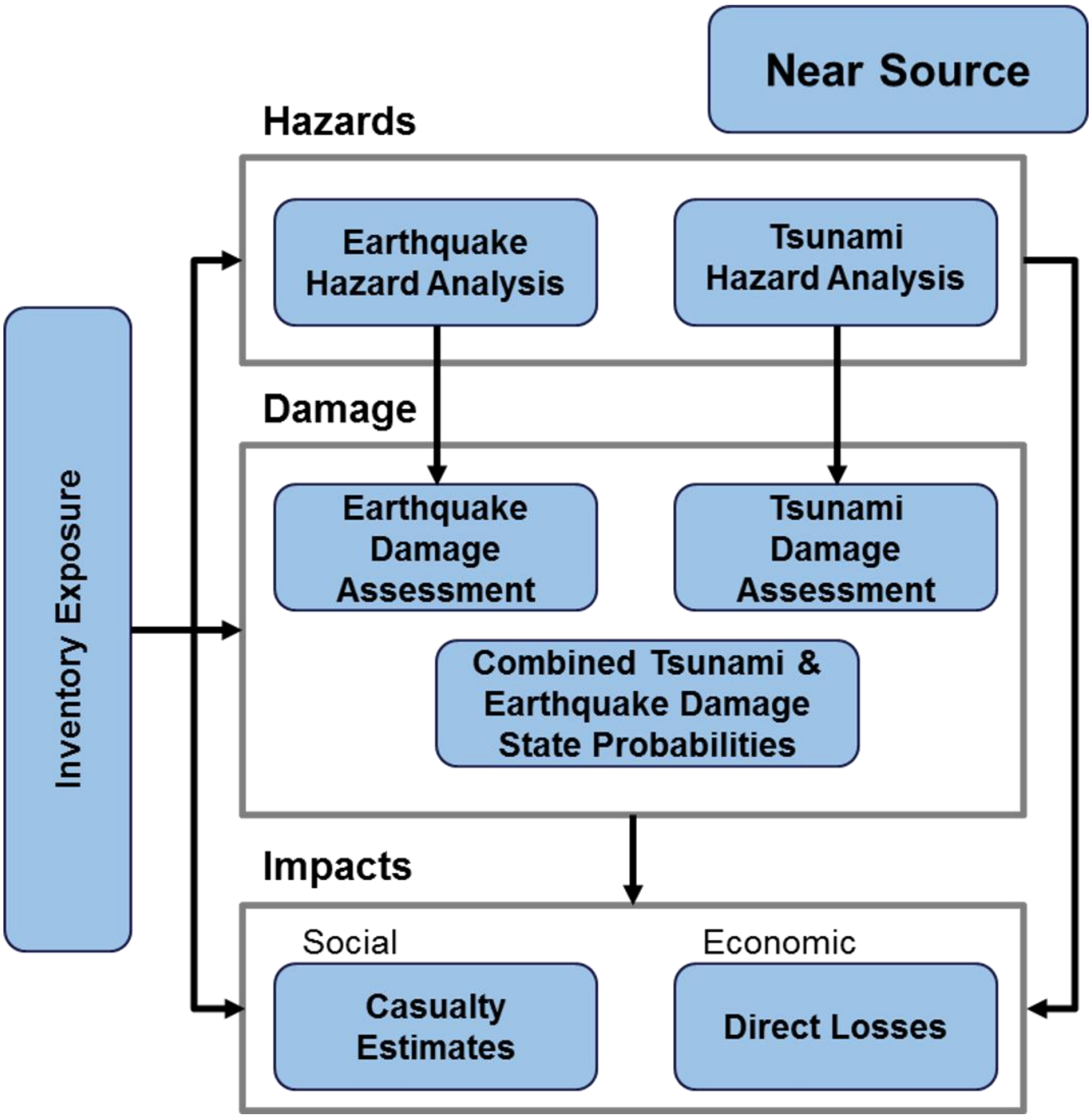
Visual 4: Hazus Analysis Components

Hazard Input

- Tsunami inundation depth
- Velocity or momentum flux
- Topography
- Run-up Height

Infrastructure

- NSI data (point location – aggregated)
- User defined structures



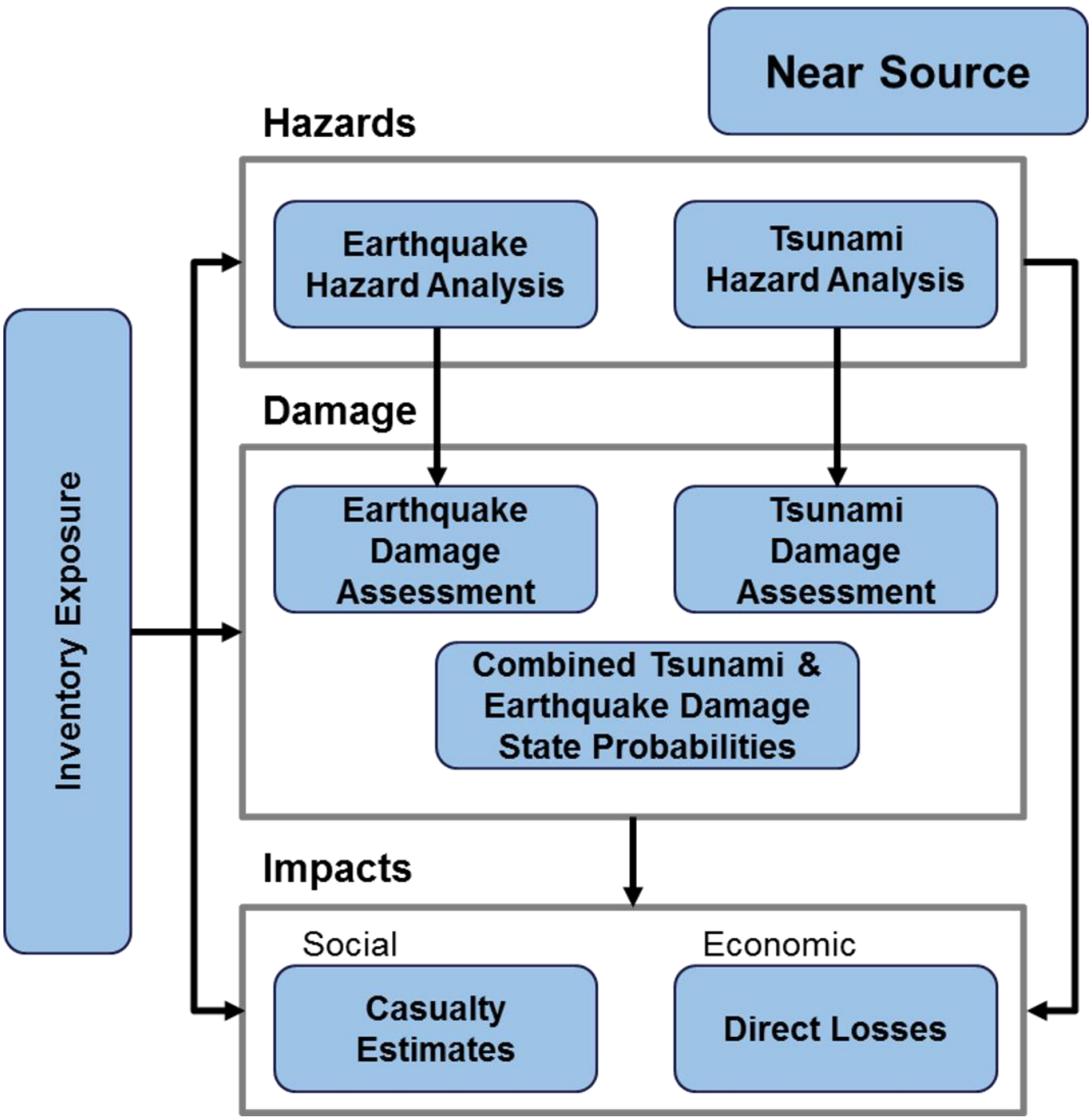
Visual 5: Hazus Analysis Components

Damage and Losses

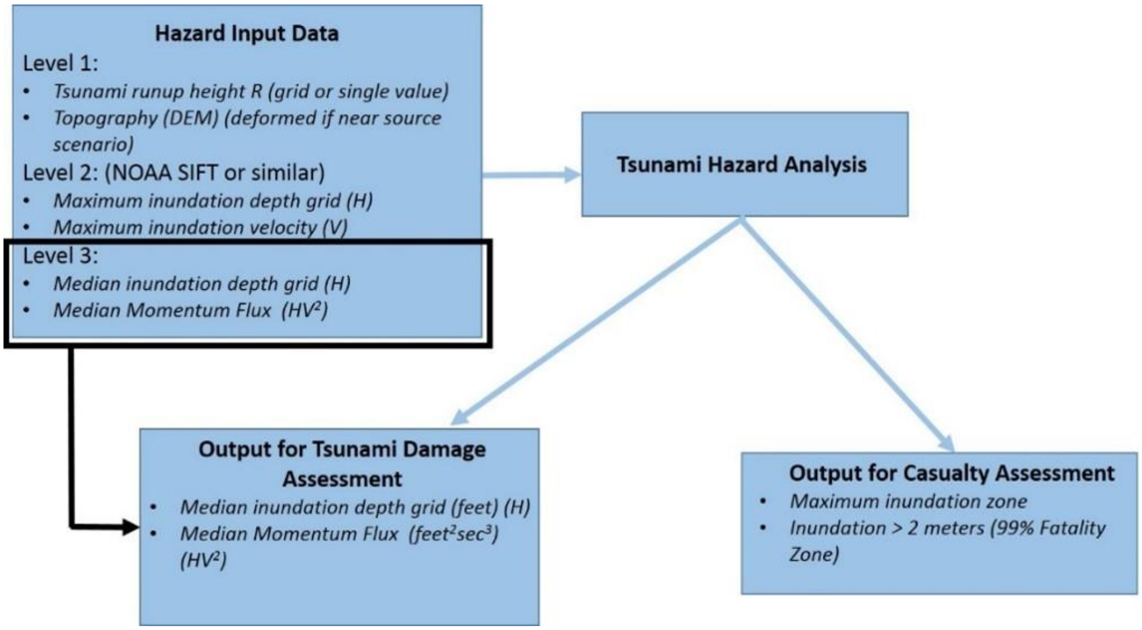
- Direct damage to structures, contents and nonstructural elements
- Direct economic losses

Casualties

- Evacuation times
- Injury/Fatality estimates
    - Age, time of day, community preparedness

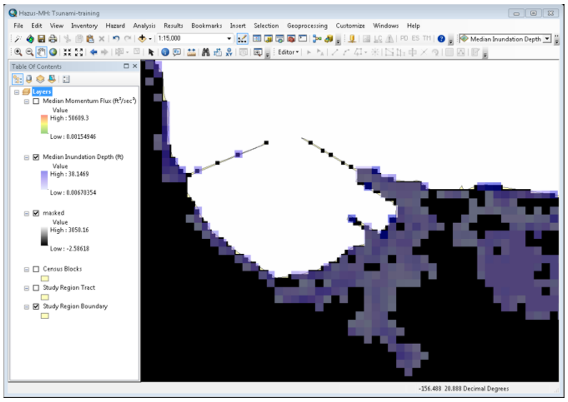


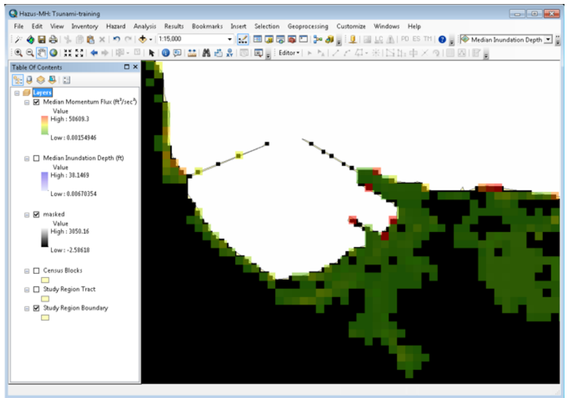
Visual 6: Hazard Analysis - User Input



Visual 7: Level 1 Analysis

- Requires user input data
- Level 1 outputs are the inputs needed for levels 2 and 3 analysis
- Runup Only-Mean Sea Level (MSL) and Quick Look-Single Maximum Runup outputs:
    - Median Inundation Depth (ft)
    - Median Momentum Flux (ft3/sec2)





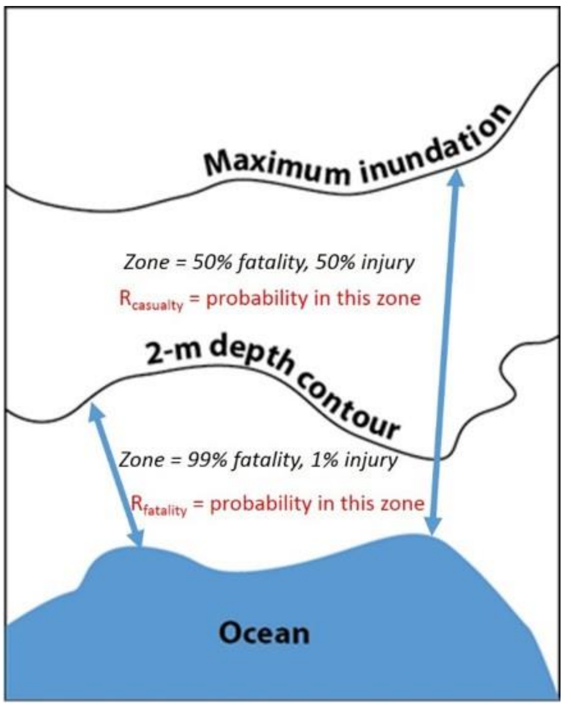
Visual 8: Casualty Scenario

Level 1 - Input:

- Fatality Boundary (depth > 2m)
- Hazard Boundary (depth > 0)
- Road Network Data
- Topography (DEM)
- Estimated time of tsunami arrival and maximum runup

Level 2 - Input:

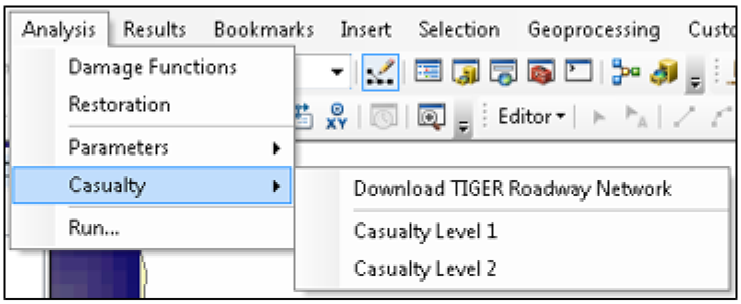
- Output travel time results provided by the USGS Pedestrian Evacuation Analyst Tool



Visual 9: Road Network Data

Casualty Level 1 assumes a 'roads only' analysis, in that the population will follow the road network to safety

- The Census TIGER road networks data may be downloaded through the Hazus Tsunami model from the Analysis Menu, under Casualty
- Or directly from the Census website at: 2016 TIGER/Line Shapefiles: Roads (https://www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2016&layergroup=Roads)



Visual 10: Casualty Assessment Results

- Estimates pedestrian evacuation, and warning times to evaluate potential loss of life and injuries
- Two levels of analysis: Basic and Advanced
- Results:
  - Evacuation Travel Time (Age – Under/Over 65)
  - Day/Night population exposure
  - Day/Night probability of casualties
  - Casualties based on Community Preparedness Level (good, fair, poor)

Visual 11: Exercise 15.1: Tsunami

Goal: Run a Tsunami Level-1 analysis.

Time: 30 minutes

Student Manual

Exercise 15.1: Tsunami

Goal: Run a Tsunami Level-1 analysis.

Time: 30 minutes

Exercise Steps:

1. Refer to Activities Document “15.1_Exercise_Tsunami Analysis.”
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 12: Exercise 15.1: Tsunami

Task 1: Open the Study Region.

Task 2: Run a Level 1 Analysis: Runup Only-Mean Sea Level.

Task 3: Run a Level 1 Casualty Analysis.

Student Manual

Exercise 15.1: Tasks

Refer to Activities Document “15.1_Exercise_Tsunami Analysis.”

Visual 13: Lesson 15: Review

1. What are the steps for estimating tsunami losses?
2. How does Hazus estimate tsunami casualties?

Visual 14: Questions

Lesson 16: Hazus Earthquake and Tsunami Combined Analysis

Visual 1: Lesson 16: Hazus Earthquake and Tsunami Combined Analysis

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Visual 2: Lesson 16: Goal and Objectives

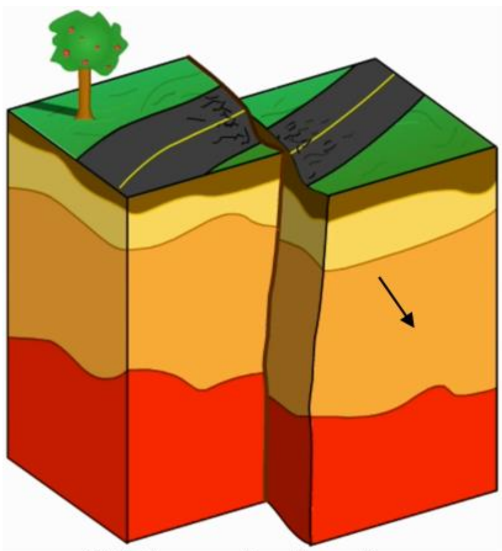
Goal: To understand the interrelationships between earthquakes and tsunamis in Hazus modeling.

After completing this lesson you will be able to:

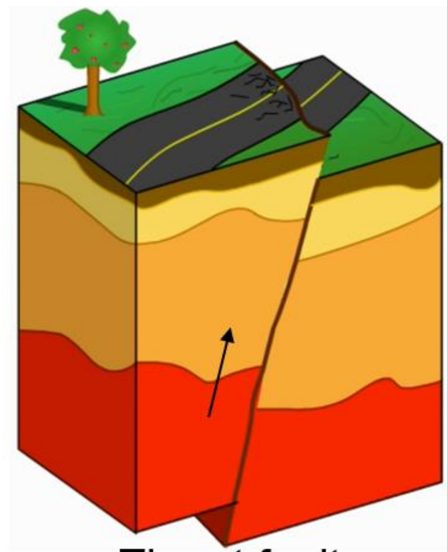
- Explain the relationship between earthquakes and tsunamis.
- Identify the factors necessary for a combined analysis.

Visual 3: Earthquake and Tsunami Basics

- Near source scenarios: earthquake starts the tsunami
- Strike-slip fault: vertical fractures where the blocks have mostly moved horizontally
- Thrust fault: reverse fault with a dip of 45° degrees or less



Strike-slip fault



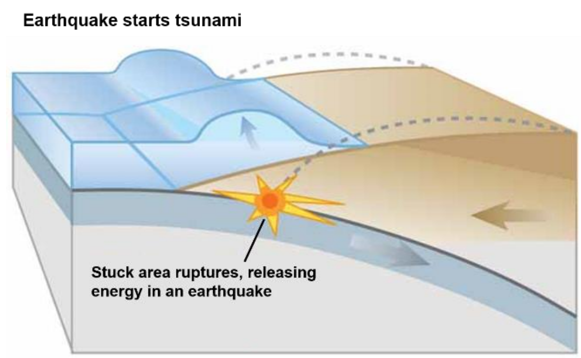
Thrust fault

Visual 4: Earthquake Strength

Magnitude	Effect
< 6.5	Earthquakes of this magnitude are very unlikely to trigger a tsunami.
6.5 - 7.5	Earthquakes of this size do not usually produce destructive tsunamis. However, small sea level changes may be observed in the vicinity of the epicenter. Tsunamis capable of producing damage or casualties are rare in this magnitude range but have occurred due to secondary effects such as landslides or submarine slumps.
7.6 - 7.8	Earthquakes of this size may produce destructive tsunamis especially near the epicenter; at greater distances small sea level changes may be observed. Tsunamis capable of producing damage at great distances are rare in this magnitude range.
> 7.8	Destructive local tsunamis are possible near the epicenter, and significant sea level changes and damage may occur in a broader region. Note that with a magnitude 9.0 earthquake, the probability of an aftershock with a magnitude exceeding 7.5 is not negligible.

Visual 5: Near Source – Deformed DEM

- Post-earthquake event deformed topography should be used in the case of a near source scenario
- Earthquake could result in several meters of ground deformation, which may substantially change the inundation area and affect potential losses resulting from a tsunami



Visual 6: Analysis Options

Earthquake

- General buildings
- Essential facilities
- Military installation: Advanced Engineering Building Module (AEBM)
- User-defined structures
- Utility systems
- Induced physical damage
- Direct social losses
- Indirect economic impact

Tsunami

- General Building Stock
- User-defined facilities
- Direct damages
- Functionality and economic loss

Visual 7: Combined Analysis Options

- Combined General Building Stock
  - Direct damages (by count and by square footage)
  - Direct economic loss
- Combined User-Defined Facilities
  - Direct damages (damage state)
  - Functionality
  - Economic loss

Visual 8: Exercise 16.1: Combined Earthquake and Tsunami

Goal: Run a combined near source earthquake and tsunami analysis.

Time: 60 minutes

Student Manual

Exercise 16.1: Combined Earthquake and Tsunami

Goal: Run a combined near source earthquake and tsunami analysis.

Time: 60 minutes

Exercise Steps:

1. Refer to Activities Document “16.1_Exercise_Combined Earthquake and Tsunami.”
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 9: Exercise 16.1: Combined Earthquake and Tsunami

Task 1: Open your Tsunami Study Region.

Task 2: Download Near Source Earthquake ShakeMap.

Task 3: Open ShakeMap in Hazus and Run an Analysis.

Task 4: Explore Earthquake Results.

Task 5: Run a Tsunami Analysis.

Task 6: Run the Combined Analysis.

Task 7: Download the Roadways and Run a Level 1 Casualty Analysis.

Task 8: Explore Tsunami and Combined Analysis Results.

Student Manual

Exercise 16.1: Tasks

Refer to Activities Document “16.1_Exercise_Combined Earthquake and Tsunami.”

Visual 10: Lesson 16: Review

1. How are earthquakes and tsunamis related?
2. What type of model is most appropriate for a combined analysis?
3. What are the analysis options for a combined tsunami and earthquake scenario?

Visual 11: Questions

Lesson 17: Hazus Products and Communication

Visual 1: Lesson 17: Hazus Products and Communication

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Visual 2: Lesson 17: Goal and Objectives

Goal: To understand how Hazus can be used to generate meaningful communication products.

After completing this lesson you will be able to:

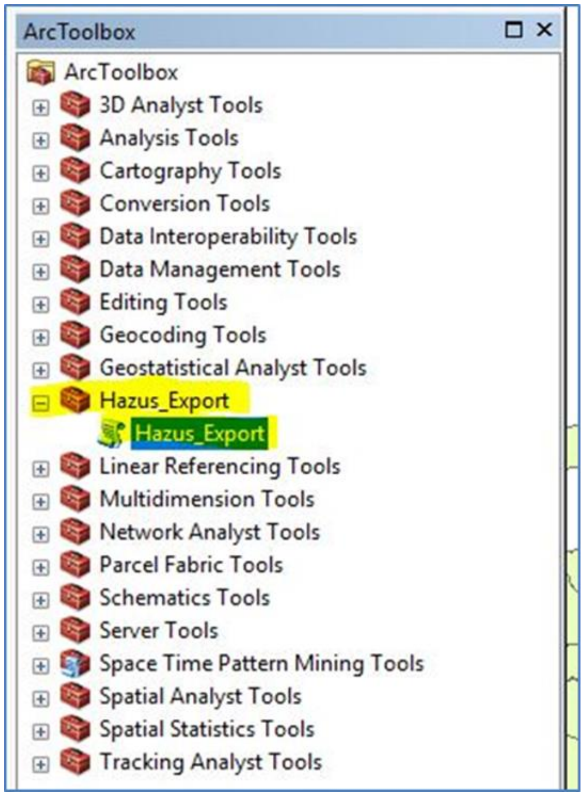
- List various examples of online mapping platforms.
- Explain the benefits of online communications.
- Describe the benefits of static maps.

Visual 3: Packaging Data

- Any mapped layer can be exported as a shapefile or geodatabase feature class.
- Output file types: feature class, table, database, shapefile, raster
- Geodatabases: store multiple feature classes
- Shapefiles must be zipped before sending
- HPRs: include SQL tables and hazard datasets
    - If you do not have Hazus, you can still view HPRs in ArcMap
    - Change HPR to zip file and connect to SQL

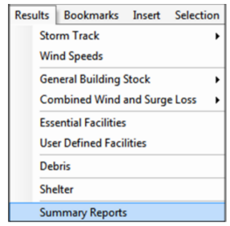
Visual 4: Hazus Export Tool

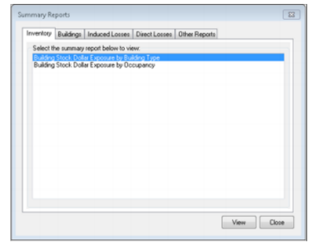
- Script that exports results from Hazus study regions
- C:\Program Files (x86)\Hazus-MH\BIN\Tools
- Creates a geodatabase



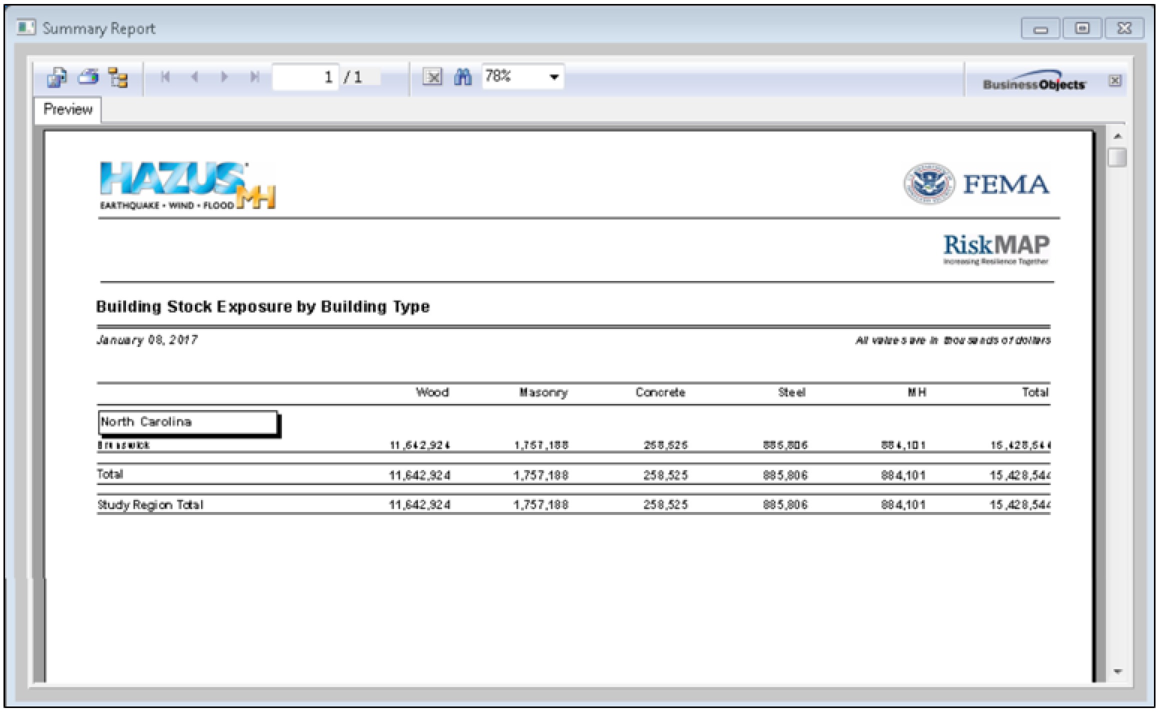
Visual 5: Hazus Reports

- Consolidate data and provide summary findings
- Valuable tools in communicating to decision makers
- Options vary for different hazards





Visual 6: Hazus Reports



Building Stock Exposure by Building Type

January 08, 2017

All values are in thousands of dollars

	Wood	Masonry	Concrete	Steel	MH	Total
North Carolina						
[illegible]	11,642,924	1,757,188	258,525	885,806	884,101	15,428,544
Total	11,642,924	1,757,188	258,525	885,806	884,101	15,428,544
Study Region Total	11,642,924	1,757,188	258,525	885,806	884,101	15,428,544

Visual 7: Activity 17.1: Packaging Data

Goals:

- Export UDF shapefile.
- Export HAZUS HPR file.

Time: 15 minutes

Student Manual

Activity 17.1: Packaging Data

Goals:

- Export UDF shapefile.
- Export HAZUS HPR file.

Time: 15 minutes

Activity Steps:

1. Refer to Activities Document “17.1_Activity_Packaging Data.”
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 8: Activity 17.1: Tasks

Task 1: Open a Study Region.

Task 2: Export the UDF Data.

Task 3: Export Hazus HPR.

Student Manual

Activity 17.1: Tasks

Refer to Activities Document “17.1_Activity_Packaging Data.”

Visual 9: Secure File Transfer Protocol (sFTP)

- Push to sFTP for distribution.
  - FEMA Cloud GIS Infrastructure Production Site: https://data.femadata.com/
  - Esri Site: https://mft.esri.com/
- Often a predetermined life span of the data.

Visual 10: Demonstration 17.2: sFTP Distribution

Goal: Explore WinSCP in accessing FEMA data repository.

Time: 10 minutes

Student Manual

Demonstration 17.2: sFTP Distribution

Goal: Explore WinSCP in accessing FEMA data repository.

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.

Visual 11: Demonstration 17.2: Tasks

Task 1: Open WinSCP and Log-in.

Task 2: Navigate to Desired Destination Folder.

Task 3: Upload File(s).

Task 4: View Online Destination.

Visual 12: GIS Online

- Esri products: ArcGIS Online
  - Map Viewer
  - Story Maps
  - Dashboards
- CartoDB
- Tableau
- Government GeoPlatform

Visual 13: Activity 17.3: ArcGIS Online

Goal: Explore ArcGIS Online as an online option for creating maps and communication information.

Time: 20 minutes

Student Manual

Activity 17.3: ArcGIS Online

Goal: Explore ArcGIS Online as an online option for creating maps and communication information.

Time: 20 minutes

Activity Steps:

1. Refer to Activities Document “17.3_Exercise_ArcGISOline.”
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 14: Activity 17.3: Tasks

Task 1: Go to ESRI's site to access ArcGIS Online.

Task 2: Load data of your choice.

Task 3: View online map.

Task 4: View geoplatform.gov

Student Manual

Activity 17.3: Tasks

Refer to Activities Document “17.3_Exercise_ArcGISOnline.”

Visual 15: Static Maps

- Standalone images that do not require a mapping library or API
- Easy option for printing maps or embedding maps on a webpage.
- May be created through:
  - Screenshots of interactive maps
  - Export from mapping platform

Visual 16: Activity 17.4: Static Maps

Goal: Create a static map from the results of one of the activities you completed in this course.

Time: 10 minutes

Student Manual

Activity 17.4: Static Maps

Goal: Create a static map from the results of one of the activities you completed in this course.

Time: 10 minutes

Activity Steps:

1. Refer to Activities Document “17.4_Activity_Static Maps.”
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 17: Activity 17.4: Tasks

Task 1: Open Region and Scenario of Your Choice.

Task 2: Define Resolution (default 300 dpi) and Output Image Quality.

Student Manual	***Activity 17.4: Tasks*** Refer to Activities Document "17.4_Activity_Static Maps."

Visual 18: Communication of Data

- Cartographic design
- Spatial and temporal elements
- Uncertainty and error
- Embedding disclaimers into maps

Visual 19: Lesson 17: Review

1. What are some examples of online mapping platforms?
2. What are the benefits of online communications?
3. What are the benefits of static maps?

Visual 20: Questions

Lesson 18: Capstone Exercise

Visual 1: Lesson 18: Capstone Exercise

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Visual 2: Lesson 18: Goal and Objectives

Goal: To complete and present the Capstone Exercise

Objectives:

- Develop Tabletop Exercise Materials
- Formulate PowerPoint presentation
- Present to class

Visual 3: Capstone Exercise Explanation

- Scenario: Disaster Operations Response and Recovery agencies are enacting a tabletop exercise modeling their response to a natural disaster.
  - You, as Hazus experts will act as the GIS analysts using Hazus to support the tabletop exercise.
  - The type of tabletop exercise is up to you.
  - Create maps and other Hazus products to facilitate the exercise.
- Each group will present while the remaining participants assume the role of the leadership team.
  - Present and explain the type of tabletop exercise you are supporting.
  - Present and explain the materials you produced and why you produced those specifically.

Visual 4: Capstone Exercise Explanation

Presentation Guidelines:

- Should be prepared 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.

Leadership Team Guidelines:

- Class and instructor will assume the role of the leadership team.
- Leadership team may ask questions related to the presentation.

Visual 5: Capstone Exercise Preparation

- Time allowed to work on presentations
- Break as needed

Visual 6: Questions

Lesson 19: Course Wrap-Up

Visual 1: Lesson 19: Wrap-Up

Visual 2: Lesson 19: 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 training opportunities available to enhance your Hazus skills.
- Identify additional resources available to explore to enhance your Hazus experience.

Visual 3: Additional Training

Classroom Courses:

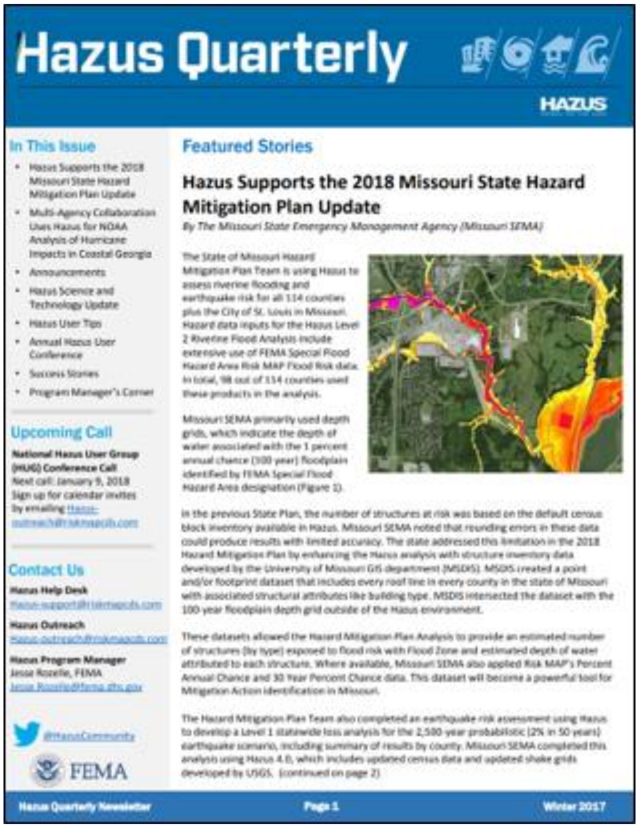
- E0170: Hazus for Hurricanes
- E0172: Hazus for Floods
- E0174: Hazus for Earthquake and Tsunami
- E0177: Advanced Hazus Applications *(coming soon)*
- E0190: ArcGIS for Emergency Managers
- E0313: Basic Hazus
- E0317: Comprehensive Data Management for Hazus

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 follow:
    - 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 follow:
    - E0170 Hazus for Hurricanes
    - E0172 Hazus for Floods
    - E0174 Hazus for Earthquakes and Tsunami
  - E0177 Advanced Hazus Applications
  - E0179 Hazus for Disaster Operations

Visual 5: Hazus Community Participation

- Annual Hazus User Conference Hazus
- 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

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@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)

Hazus Quarterly Newsletter Page 1 Winter 2017

Visual 6: Getting Help

Hazus Help Desk - email

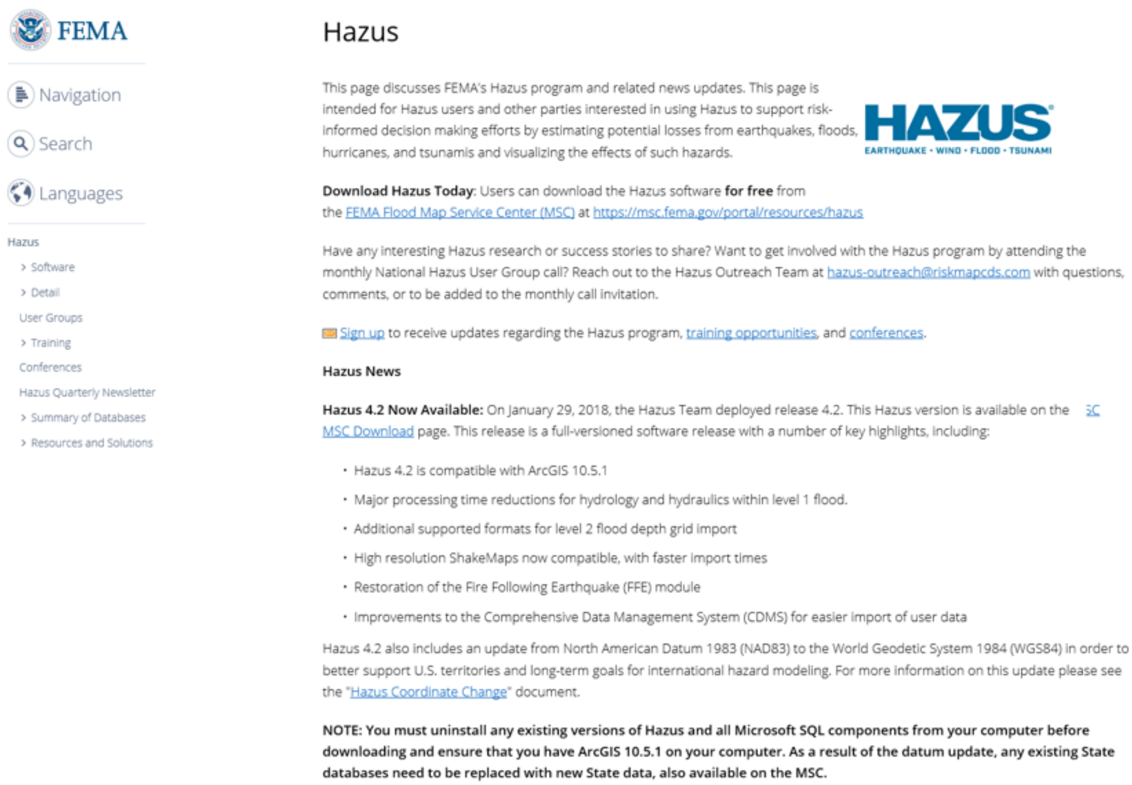
hazus-support@riskmapcds.com

Consult the User Manuals and Technical Manuals

https://www.fema.gov/hazus-mh-user-technical-manuals

Visual 7: FEMA Hazus Website

Primary FEMA resource for updated Hazus information:
FEMA Hazus Website: https://www.fema.gov/hazus



FEMA

Navigation

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- Detail

User Groups
- Training

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Hazus Quarterly Newsletter
- Summary of Databases
- Resources and Solutions

Hazus

This page discusses FEMA's Hazus program and related news updates. This page is intended for Hazus users and other parties interested in using Hazus to support risk-informed decision making efforts by estimating potential losses from earthquakes, floods, hurricanes, and tsunamis and visualizing the effects of such hazards.

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Download Hazus Today: Users can download the Hazus software **for free** from the FEMA Flood Map Service Center (MSC) at https://msc.fema.gov/portal/resources/hazus

Have any interesting Hazus research or success stories to share? Want to get involved with the Hazus program by attending the monthly National Hazus User Group call? Reach out to the Hazus Outreach Team at hazus-outreach@riskmapcds.com with questions, comments, or to be added to the monthly call invitation.

Sign up to receive updates regarding the Hazus program, training opportunities, and conferences.

Hazus News

Hazus 4.2 Now Available: On January 29, 2018, the Hazus Team deployed release 4.2. This Hazus version is available on the MSC MSC Download page. This release is a full-versioned software release with a number of key highlights, including:

- Hazus 4.2 is compatible with ArcGIS 10.5.1
- Major processing time reductions for hydrology and hydraulics within level 1 flood.
- Additional supported formats for level 2 flood depth grid import
- High resolution ShakeMaps now compatible, with faster import times
- Restoration of the Fire Following Earthquake (FFE) module
- Improvements to the Comprehensive Data Management System (CDMS) for easier import of user data

Hazus 4.2 also includes an update from North American Datum 1983 (NAD83) to the World Geodetic System 1984 (WGS84) in order to better support U.S. territories and long-term goals for international hazard modeling. For more information on this update please see the "Hazus Coordinate Change" document.

NOTE: You must uninstall any existing versions of Hazus and all Microsoft SQL components from your computer before downloading and ensure that you have ArcGIS 10.5.1 on your computer. As a result of the datum update, any existing State databases need to be replaced with new State data, also available on the MSC.

Visual 8: So in closing...

What is Hazus and why should you use it?

Visual 9: Questions

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 E0179_ActivityData for download.

Type	Number	Description	Data Needed	Data Provided?
Activity	2.1	Explore data available from various online sources	None	N/A
Demonstration	2.2	Explore and review online GIS platforms for gathering data	None	N/A
Exercise	3.1	Build a hurricane study region for Hurricane Harvey	TX state dataset	No
Exercise	4.1	Run a Hurrevac scenario for Hurricane Harvey region using interactive Hurrevac download	Hurrevac data	No
Exercise	5.1	Run a .dat scenario for Hurricane Harvey region	.dat wind field	Yes
Exercise	5.2	Compare results of Hurrevac and .dat runs	Results from previous activities	No

Type	Number	Description	Data Needed	Data Provided?
Exercise	6.1	Export data in CDMS	Utah state dataset	No
Exercise	6.2	Query and update data in CDMS	Medical Facilities data	Yes
Demonstration	7.1	Explore tax assessor data for Salt Lake County	None	N/A
Exercise	7.2	Import UDF data using CDMS	Sample UDF data	Yes
Exercise	8.1	Import a depth grid and run analysis	Depth grid	Yes
Exercise	9.1	Create a depth grid from DFIRM data	DFIRM data	Yes
Exercise	10.1	Create a depth grid from HWM data	HWM data	Yes
Demonstration	11.1	Review finding ShakeMaps from within Hazus	None	N/A
Exercise	11.2	Run a source event earthquake scenario	Data Map Attributes	Yes
Exercise	12.1	Run a ShakeMap scenario	Data Map Attributes, ShakeMap	Yes

Type	Number	Description	Data Needed	Data Provided?
Exercise	13.1	Run a ShakeMap scenario with UDF	ShakeMap grid XML	Yes
Exercise	14.1	Build a tsunami study region	Oregon state dataset	No
Exercise	15.1	Run tsunami analysis and casualty analysis	Sample data	Yes
Exercise	16.1	Run a combined earthquake and tsunami analysis	Sample data	Yes
Activity	17.1	Export data as a shapefile and export an HPR	Results from previous activities	No
Demonstration	17.2	Explore WinSCP and femadata	None	N/A
Activity	17.3	Explore ArcGIS Online and create a map	Results from previous activities	No
Activity	17.4	Create a static map	Results from previous activities	No

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 E0179_ActivityData for download.

Type	Number	Data File(s) Provided	Folder Location
Exercise	5.1	Harvey_Windfield_HazusReady.dat	E0179_ActivityData
Exercise	6.1	Utah_MedicalFacilities.xls	E0179_ActivityData
Exercise	6.2	Utah_MedicalFacilities_Edit.xls	E0179_ActivityData
Exercise	7.2	UDF_Sampled.xls	E0179_ActivityData
Exercise	8.1	dg_100	E0179_ActivityData\SaltLake\DG
Exercise	9.1	SLC_AOI; S_FLD_HAZ_AR;dem_ft;S_BFE	E0179_ActivityData\SaltLake\DFIRM
Exercise	10.1	SLC_AOI;dem_ft;SLC_HWM	E0179_ActivityData\SaltLake\HWM
Exercise	11.2	ModelBuilderShakeMap.mdb	E0179_ActivityData
Exercise	12.1	ModelBuilderShakeMap.mdb; ShakeMapMag5.xml	E0179_ActivityData
Exercise	13.1	grid_7.0Scenario.xml	E0179_ActivityData
Exercise	14.1	gar_maxR_ft;gar_dem_ft	E0179_ActivityData\MSC_HazardSampleData\Garibaldi\Level1.gdb
Exercise	15.1	gar_dem_ft	E0179_ActivityData\MSC_HazardSampl

Type	Number	Data File(s) Provided	Folder Location
			eData\Garibaldi\Level1.gdb
Exercise	16.1	gar_maxR_ft;gar_dem_ft	E0179_ActivityData\MSC_HazardSampleData\Garibaldi\Level1.gdb

Activity 2.1 - Data Availability

Type: Instructor-Led Activity

Time: 10 minutes

Goal: Explore the data available through the United States Geological Survey (USGS), the National Hurricane Center (NHC), the Pacific Marine Environmental Laboratory (PMEL), and the Map Service Center (MSC).

- Guide the class through the following websites to illustrate data availability for applications in disaster operations.
- Go to the United States Geological Survey website https://www.usgs.gov/. The United States Geological Survey can supply data to Hazus for floods and earthquakes.
  - View the USGS Earthquake Data and Products website for data on earthquakes, https://earthquake.usgs.gov/data/.
    - NOTE: Hazus users are encouraged to use ShakeMap for earthquake runs in Hazus. ShakeMaps will be reviewed in detail later in the course.
    - Browse the data for a significant event and identify the files Hazus requires – PGA, PGV, Sa(0.3), and Sa(1.0).
  - View the National Water Information System website https://waterdata.usgs.gov/nwis for data on floods. Browse to a specific stream gauge and identify peak flow results.
- Go to the National Hurricane Center website https://www.nhc.noaa.gov/. The National Hurricane Center is a part of the National Oceanic and Atmospheric Administration.
  - Click between the Pacific and Atlantic coasts to see how data is released separately for the different coasts. If there are storms available, click on them to receive additional, forecasted information.
  - Best Track Data or HURDAT, can be downloaded through the NHC data website https://www.nhc.noaa.gov/data/ and integrated into Hazus. HURDAT is a historical record for Pacific and Atlantic hurricane data. Click on the advisory archive and select a storm of interest. Click on a forecasted advisory and identify the storm location, pressure, size, and speed.
- Go to the Pacific Marine Environmental Laboratory website https://www.pmel.noaa.gov/. The Pacific Marine Environmental Laboratory is a part of the National Oceanic and Atmospheric Administration (NOAA).
  - The PMEL data website https://www.pmel.noaa.gov/public/pmel/globe/ has options for a variety of hazards and environmental factors. Click on the NCTR box to see the areas where NOAA has researched tsunami propagation. The National Center for Tsunami Research https://nctr.pmel.noaa.gov/ provides additional information on tsunami forecasting and mapping.

- Go to the Map Service Center website https://msc.fema.gov/portal. The Map Service Center (MSC) is a part of the Federal Emergency Management Agency (FEMA).
    - The MSC publishes information through FEMA’s website https://www.fema.gov/national-flood-hazard-layer-nfhl on the National Flood Hazard Layer (NFHL). From here, click on the NFHL viewer link to view the data through the FEMA account on the ArcGIS Online website.
    - View the data products available by searching on all products and identifying a county. Discuss the GIS data available as well as the Flood Insurance Studies (FIS).

Exercise 3.1 - Hurricane Study Region

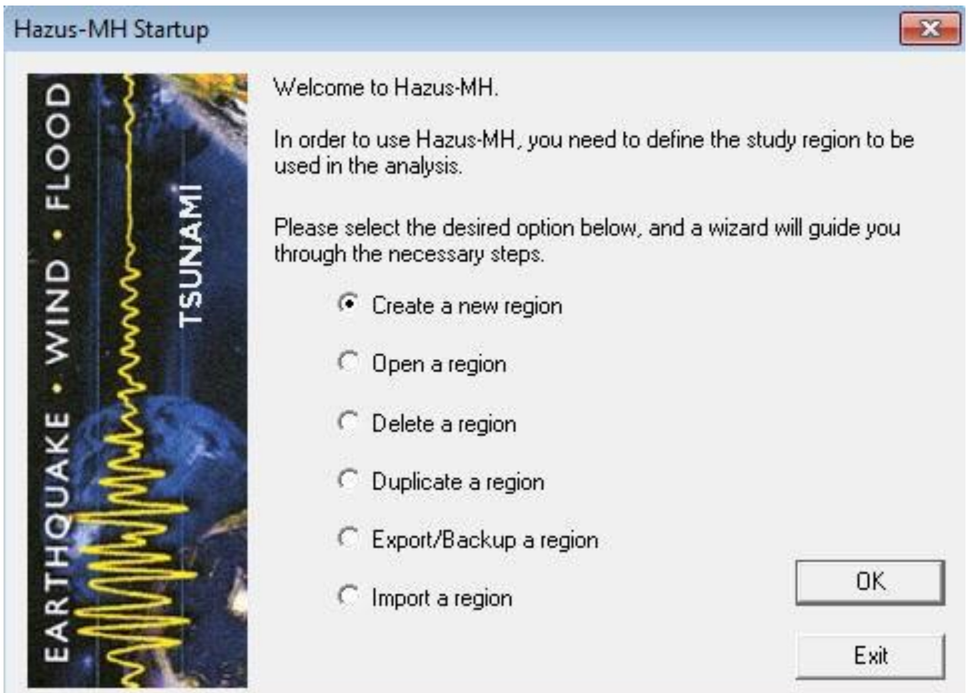
Type: Student-Led Activity

Time: 10 minutes

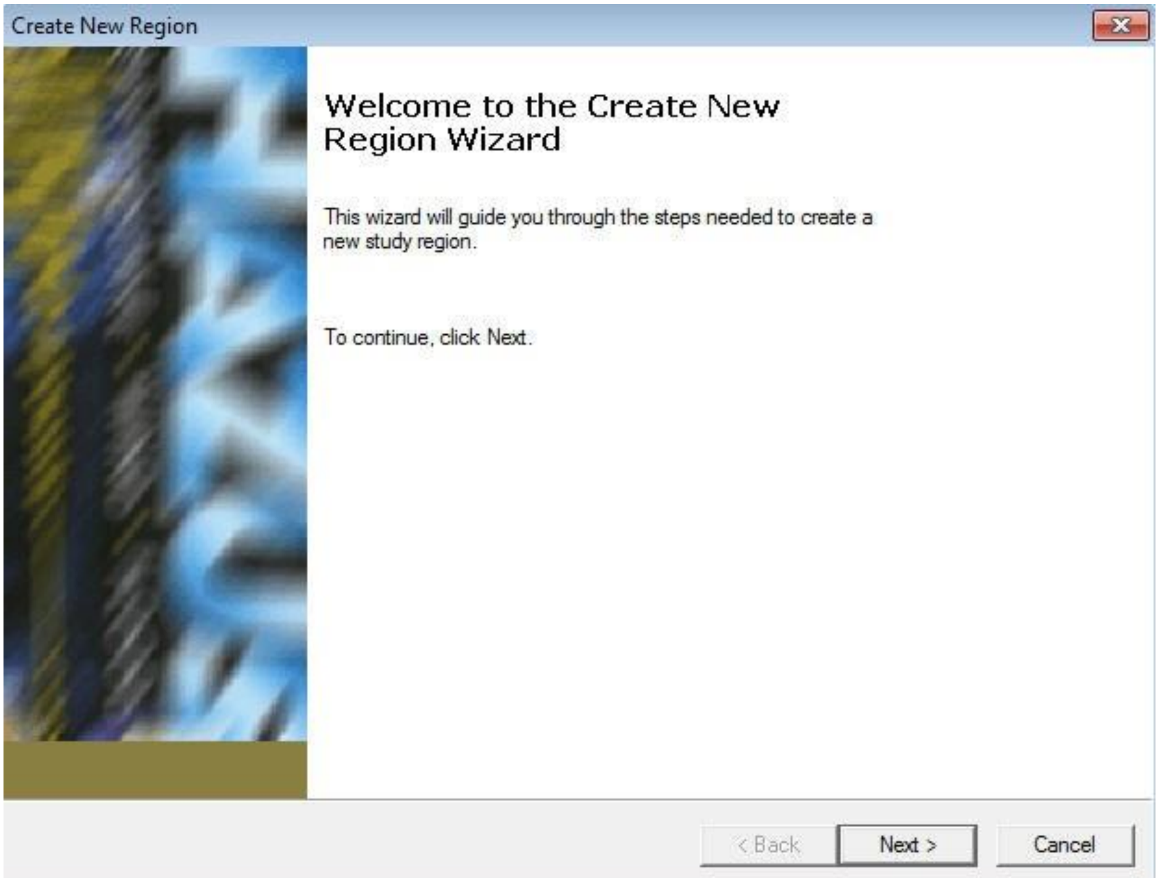
Goal: Build a hurricane study region for Hurricane Harvey (2017).

Task 1: Create a New Study Region

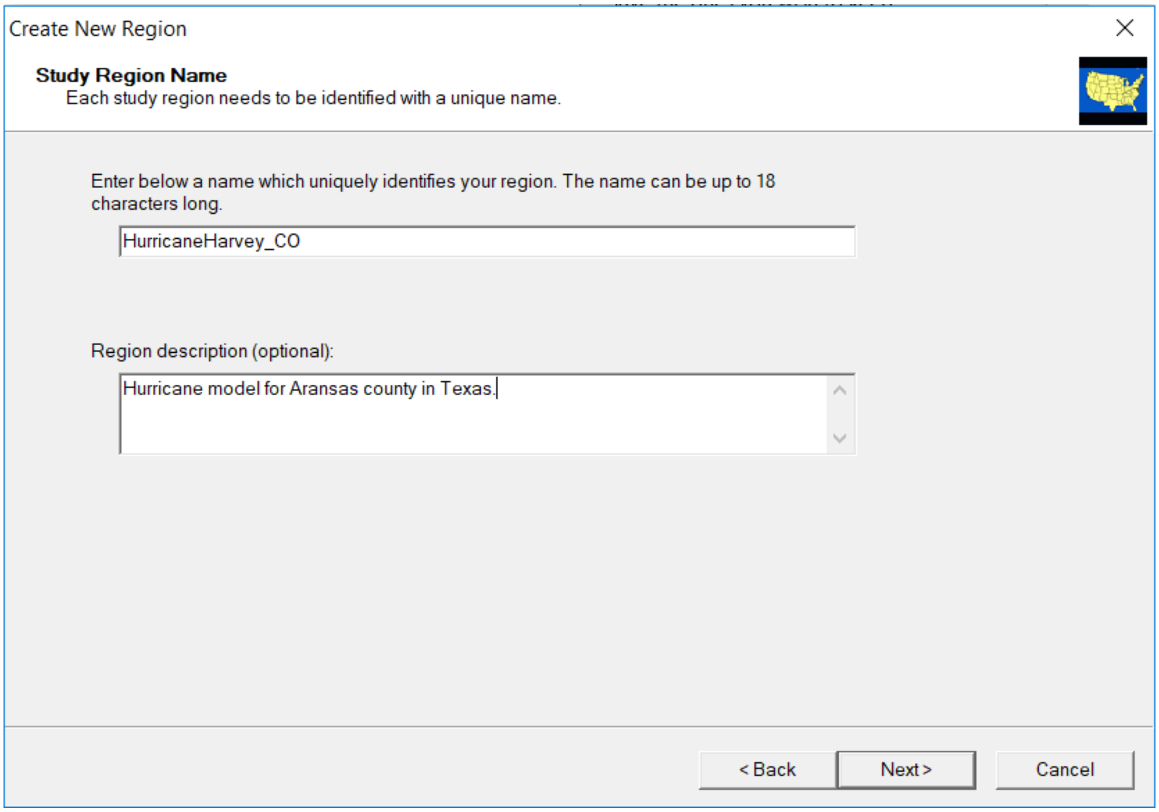
- Open Hazus from your desktop and select “Create a new region.” Click “OK.”



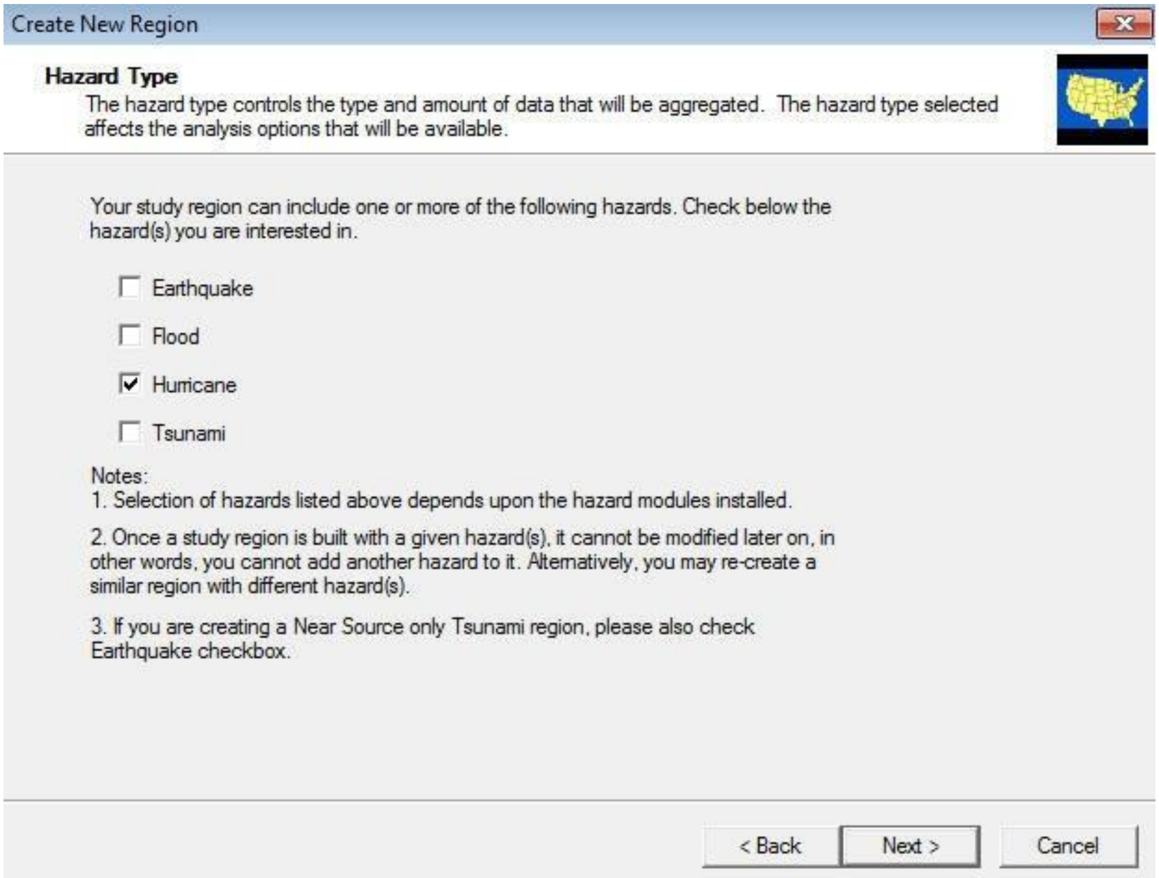
- Click “Next” on the Create New Scenario Wizard.



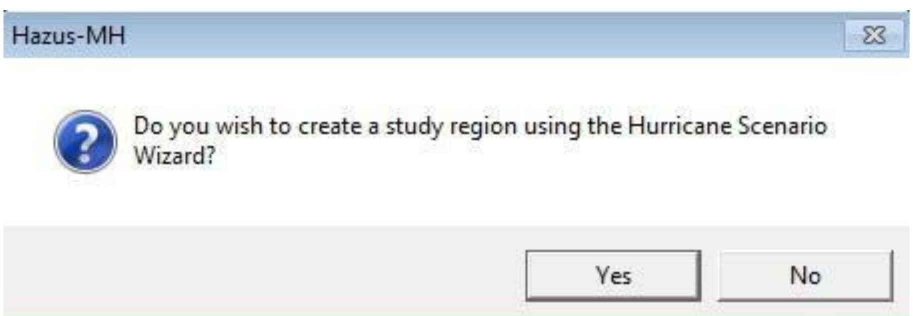
- Enter a name and a brief description (optional) for your study region. Click "Next."



- Select “Hurricane” as the Hazard type. Click “Next.”

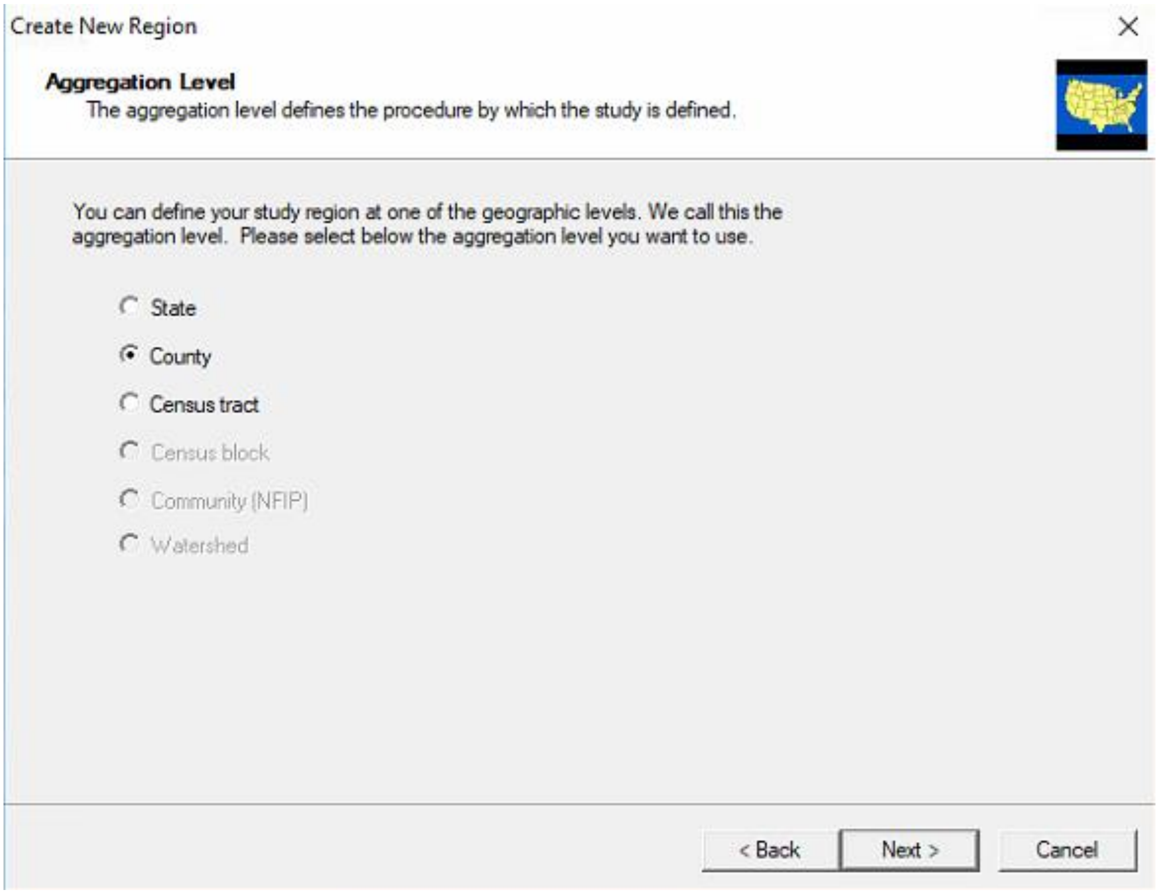


- When prompted to create the study region using the Hurricane Scenario Wizard, select "No."

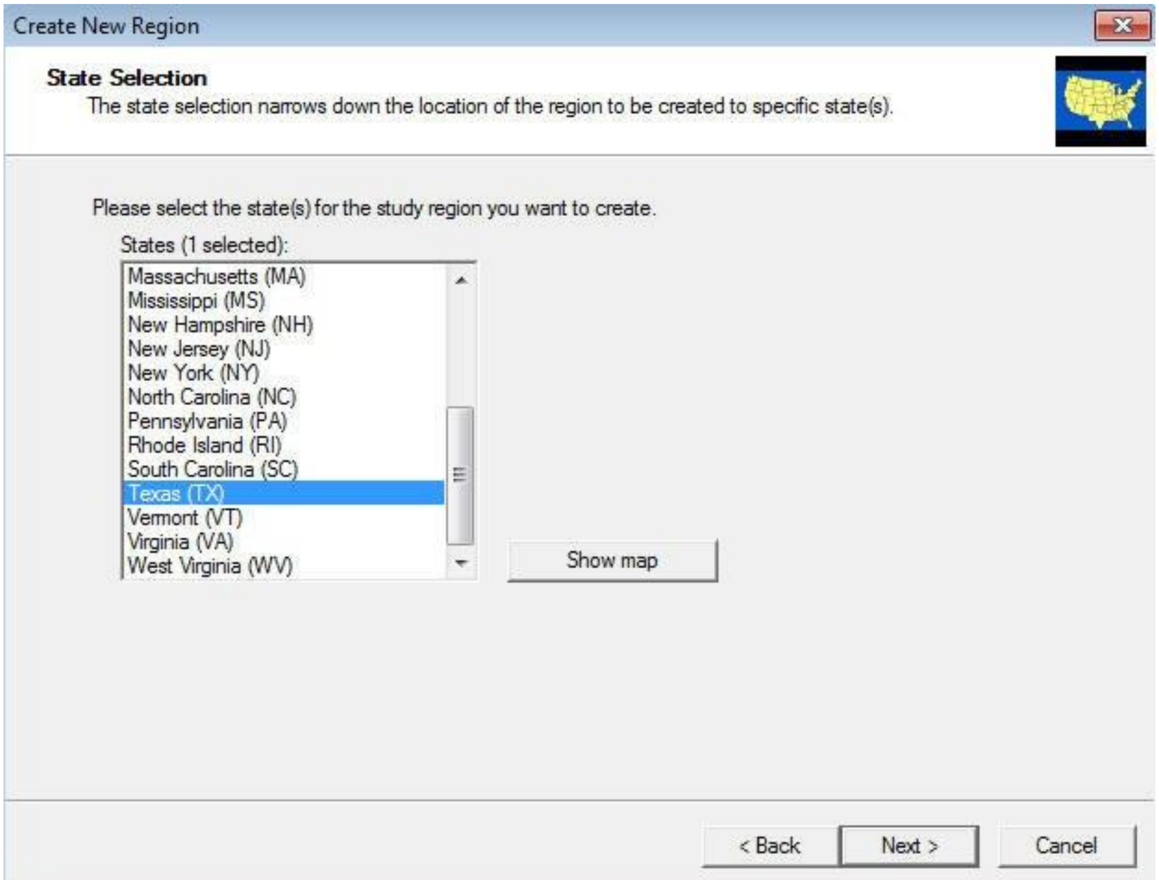


Task 2: Select Areas Affected by Hurricane Harvey

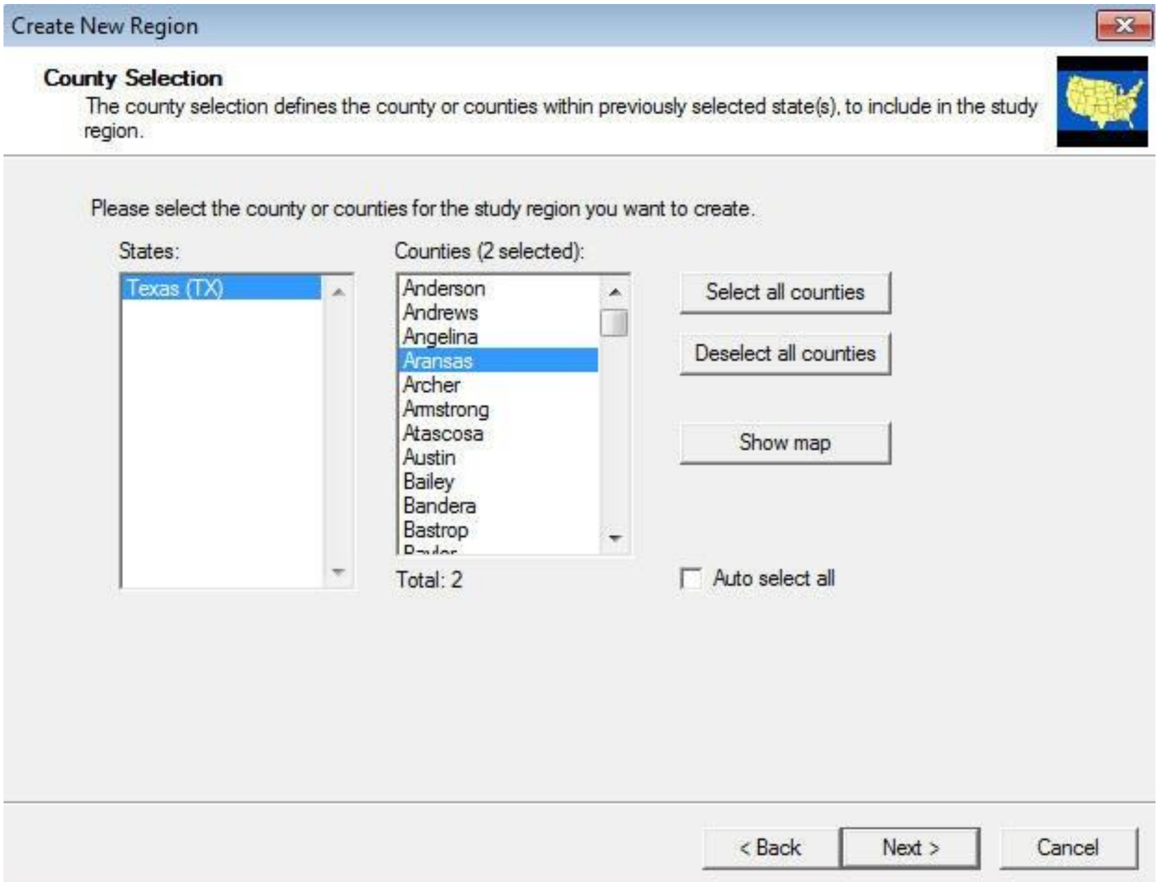
- Select "County" as the aggregation level. Click "Next."



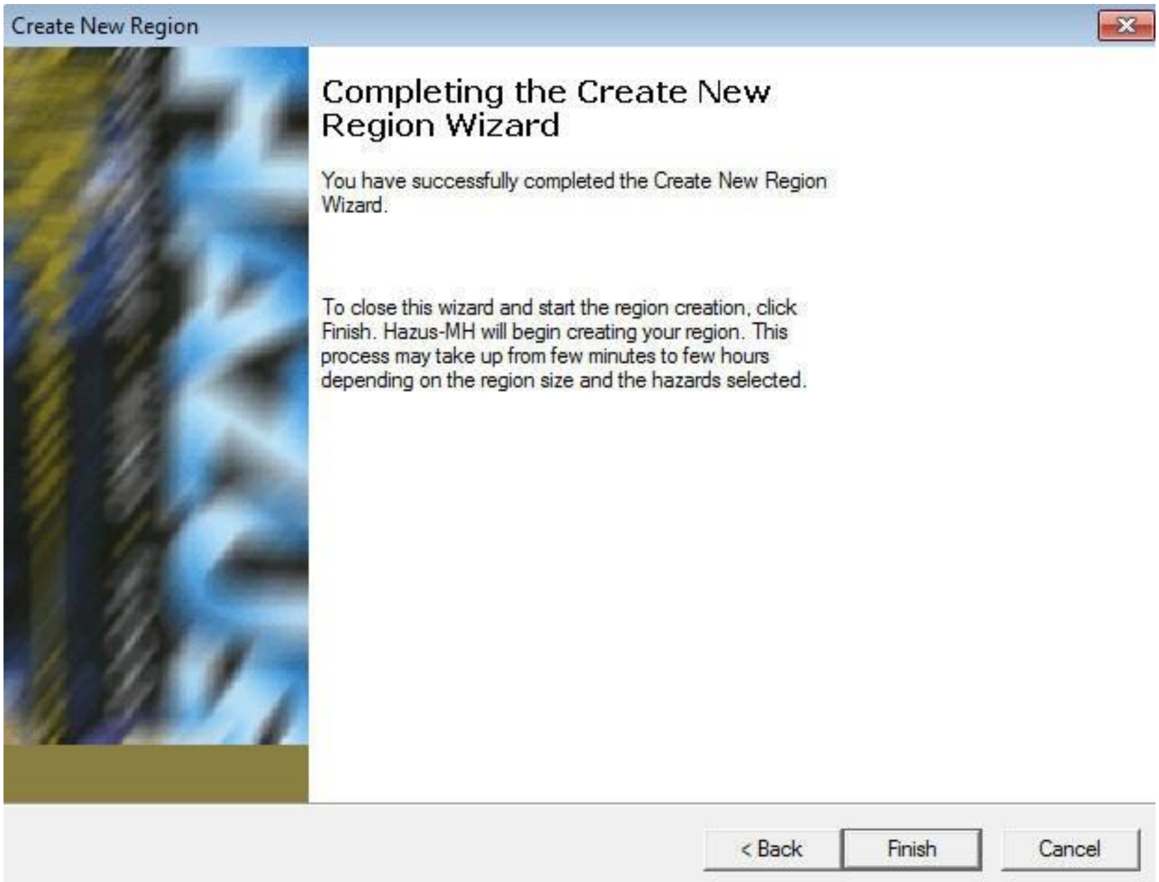
- Select “Texas” from the list of states. Click “Next.”



- Select “Aransas” from the list of counties. Click “Next.”



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



- A dialog box will appear (after a few minutes) indicating that the 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

Exercise 4.1: Harvey Hurrevac Model

Type: Student-Led Activity

Time: 45 minutes

Goals:

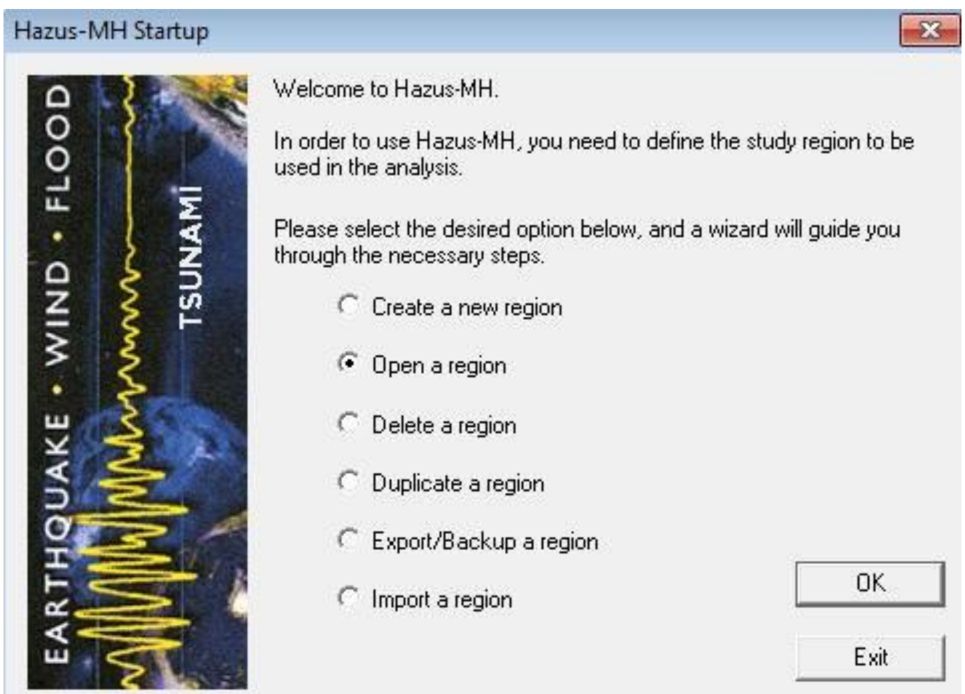
- Run Model with Hurrevac.
- Develop a map of your choice: the winds (by category), displaced population, economic loss, or tree debris.
- View results.
- Choose the same study region created in Exercise 3.1.

Note: These instructions will guide making a map for building debris, but you can choose different results if you wish to create your map and view results.

Task 1: Open the Study Region

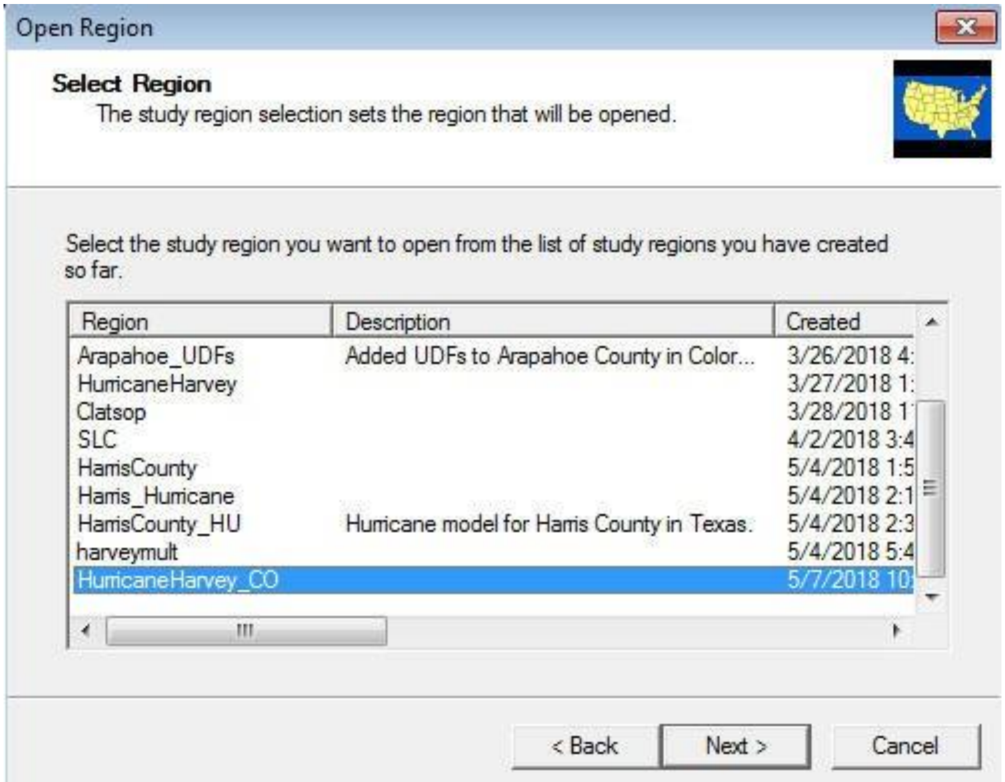
This exercise will use the previously created study region for Aransas county in Texas.

- Open Hazus and select "Open a region."

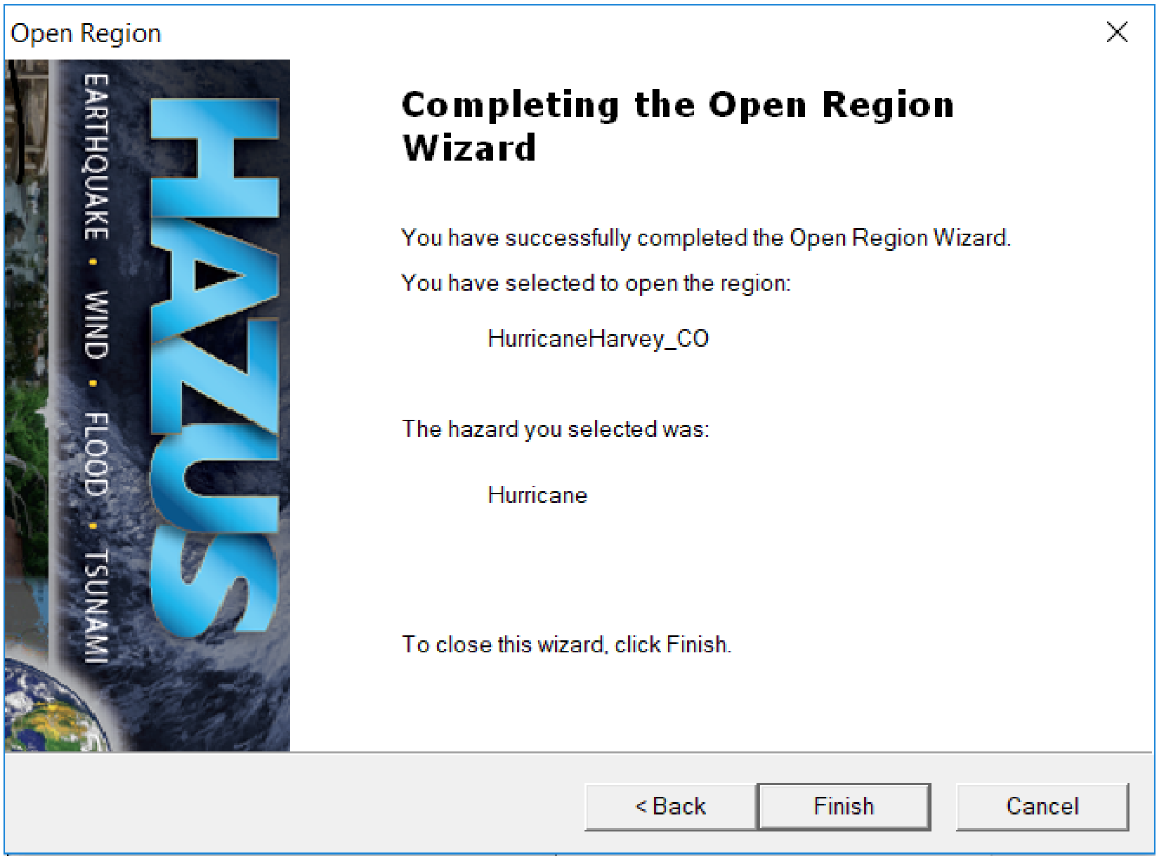


- Click "Next" on the Open Region Wizard.

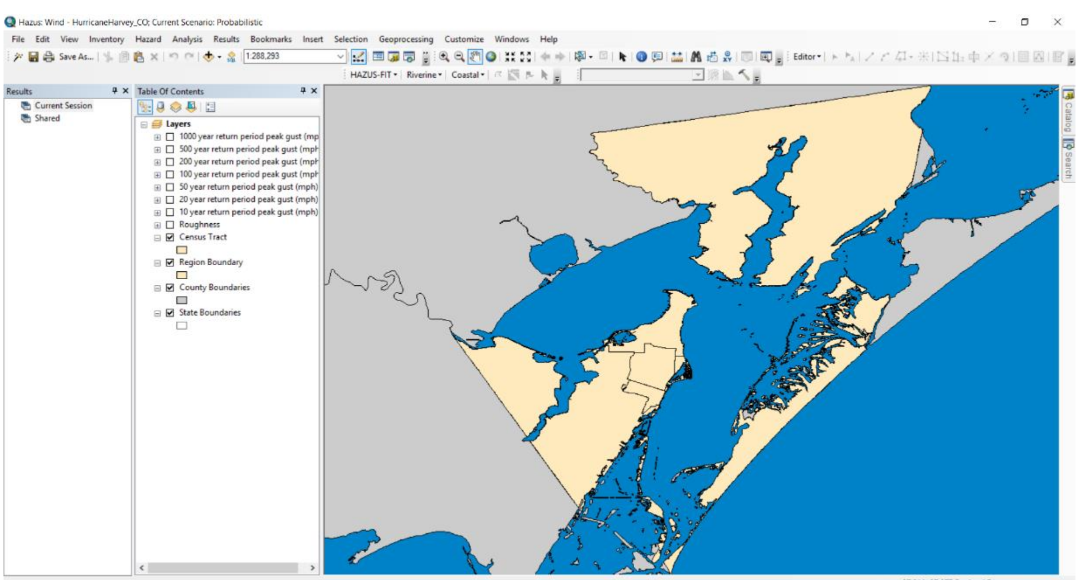
- Select a study region to open. For this activity, select “HurricaneHarvey_CO” and click “Next.”



- Click “Finish” to complete the Open Region Wizard.

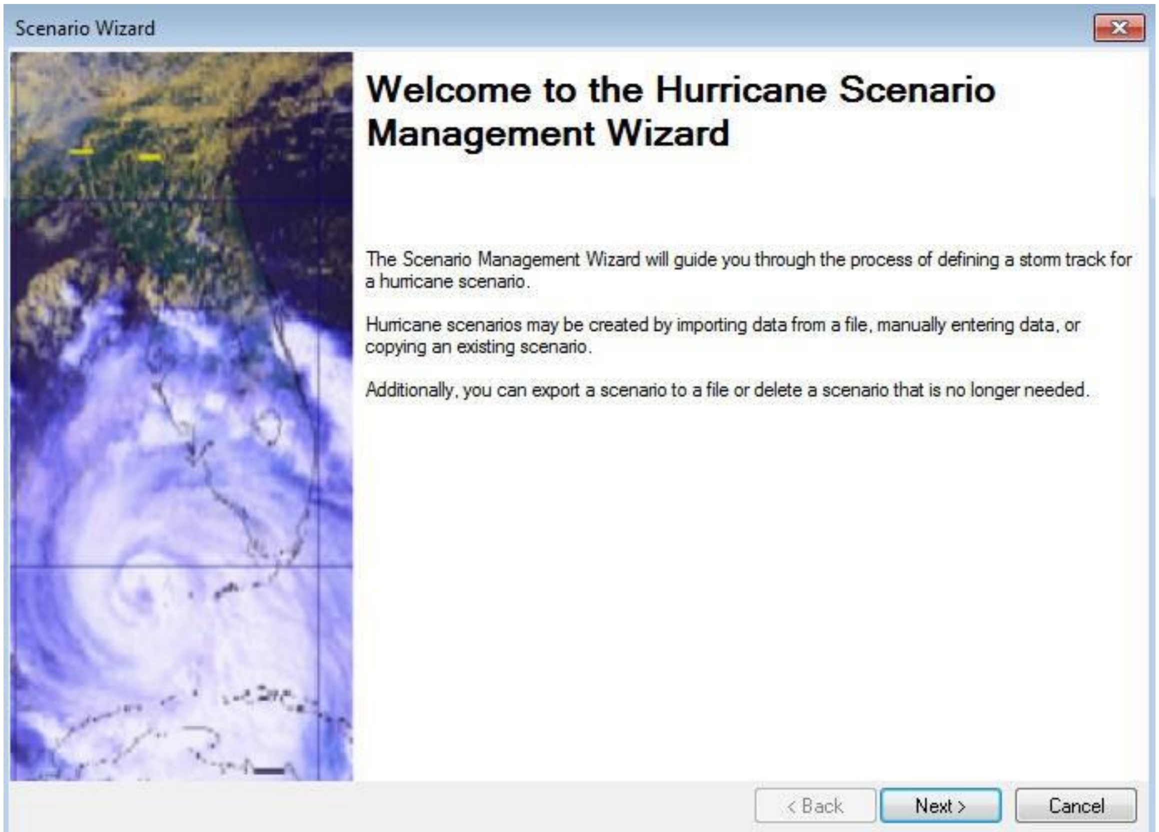


- Hazus will open in ArcMap (after a few minutes), displaying a map of Aransas county.

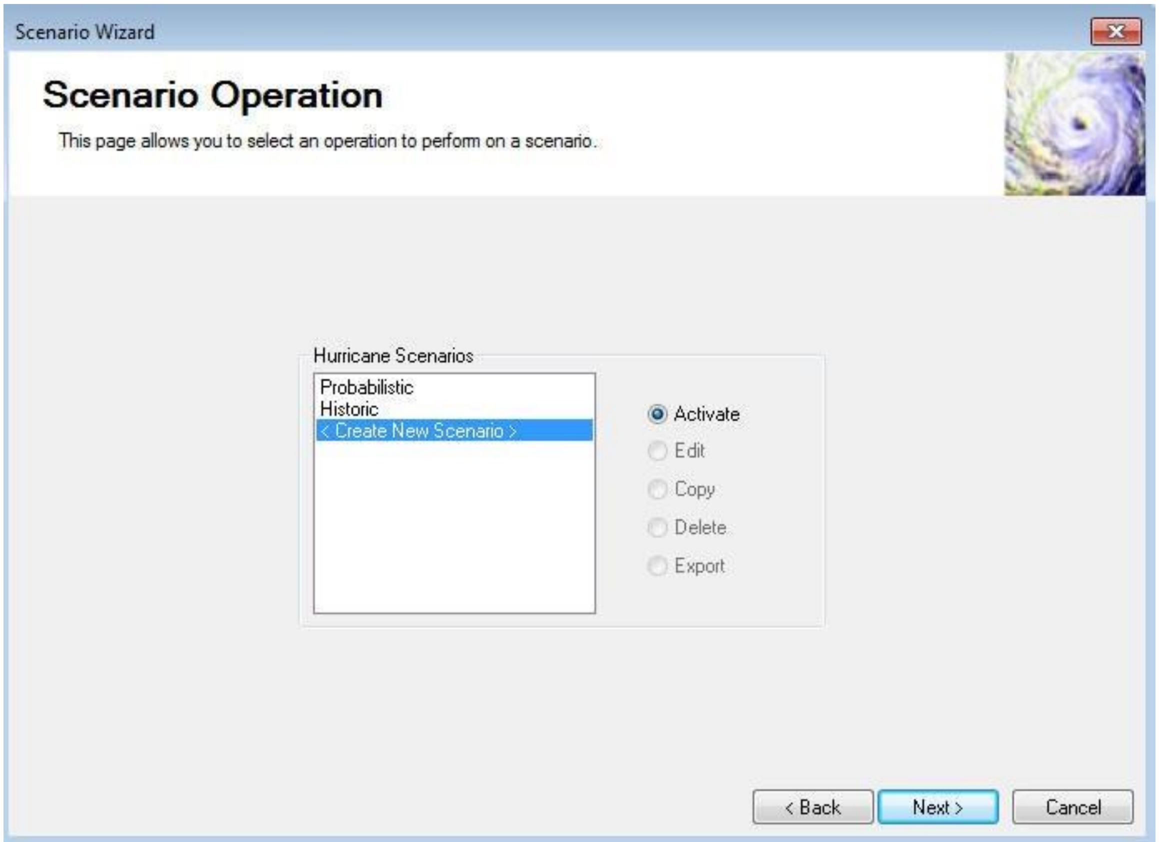


Task 2: Create a New Scenario

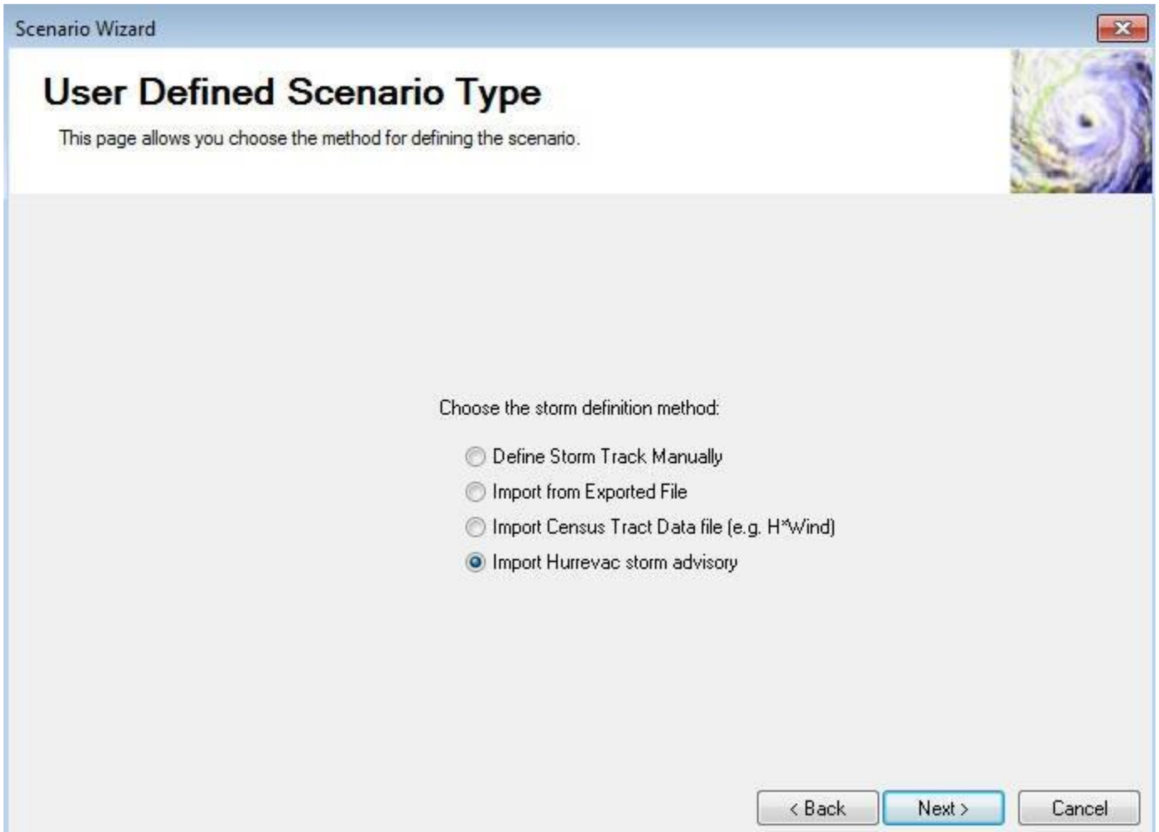
- In the top ribbon, navigate to “Hazard > Scenario.”
- This prompts the Hurricane Scenario Management Window to open. Click “Next” on the welcome screen.



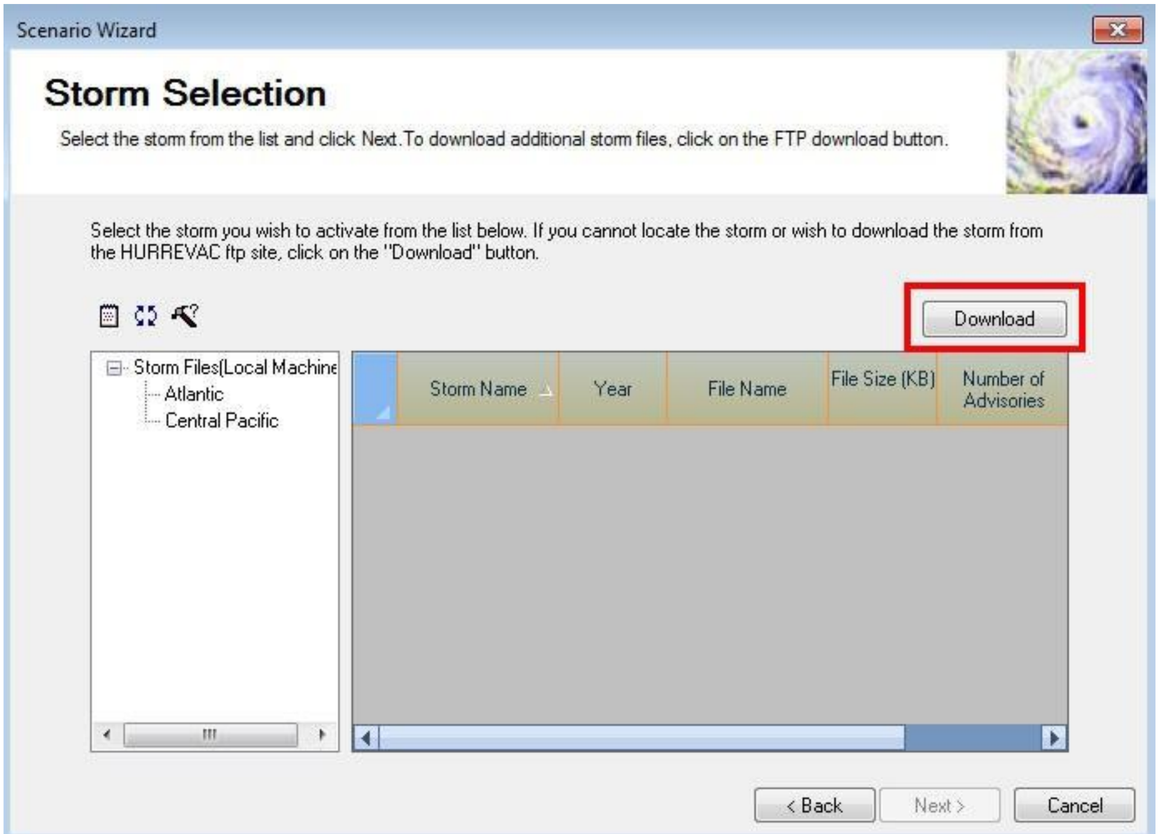
- Select “Create a New Scenario.” Click “Next.”



- In the “User Defined Scenario Type” window, select “Import Hurrevac storm advisory.” Click “Next.”



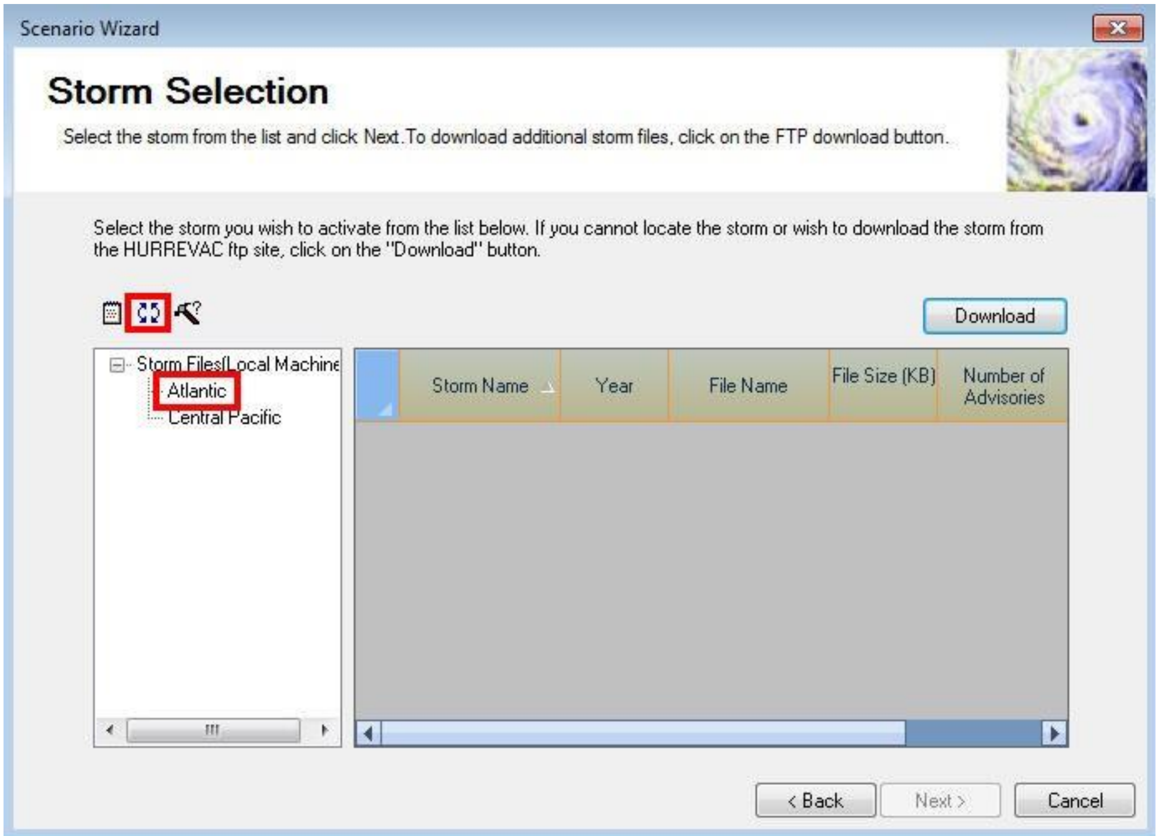
- Click “Download” to download the storm from the HURREVAC ftp site.



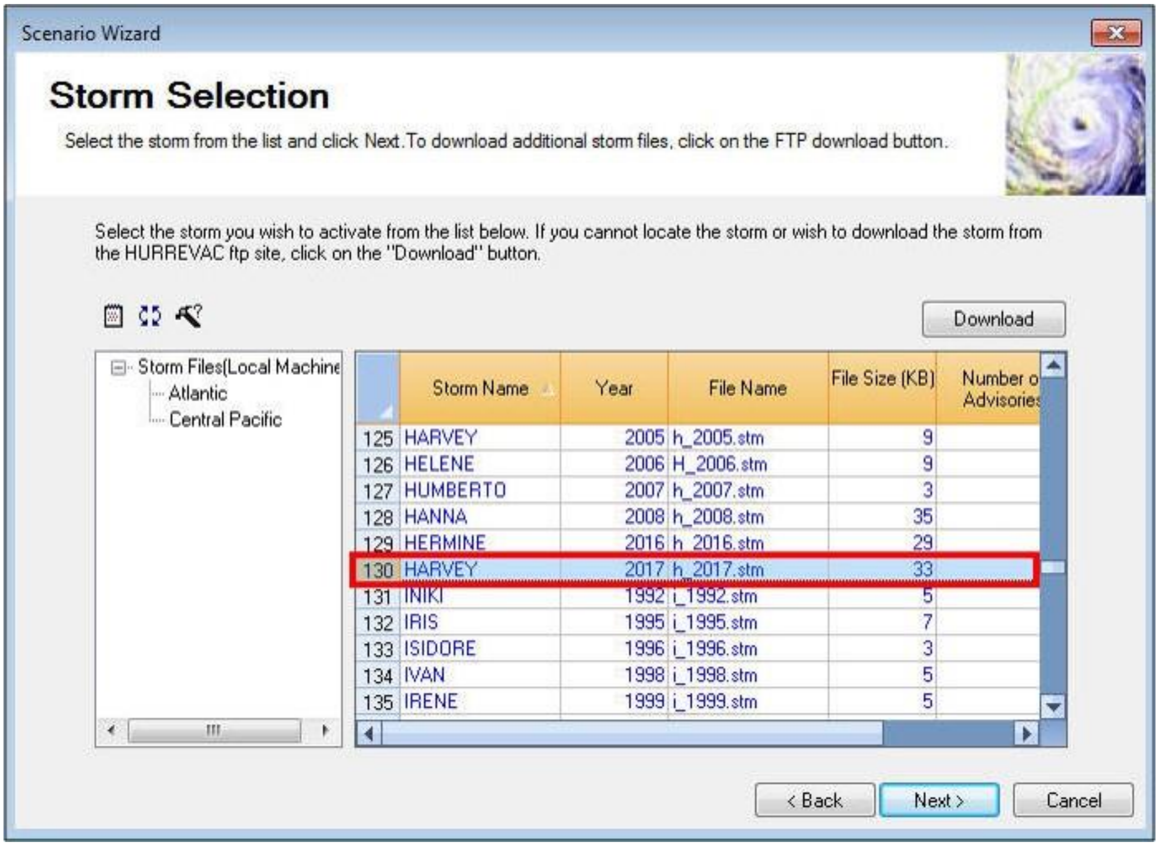
- Highlight the “Atlantic” region, select “H” from the Storm Letter drop-down and “2017” for the year. Click “Download.”

- Click “OK” when the data has successfully downloaded.

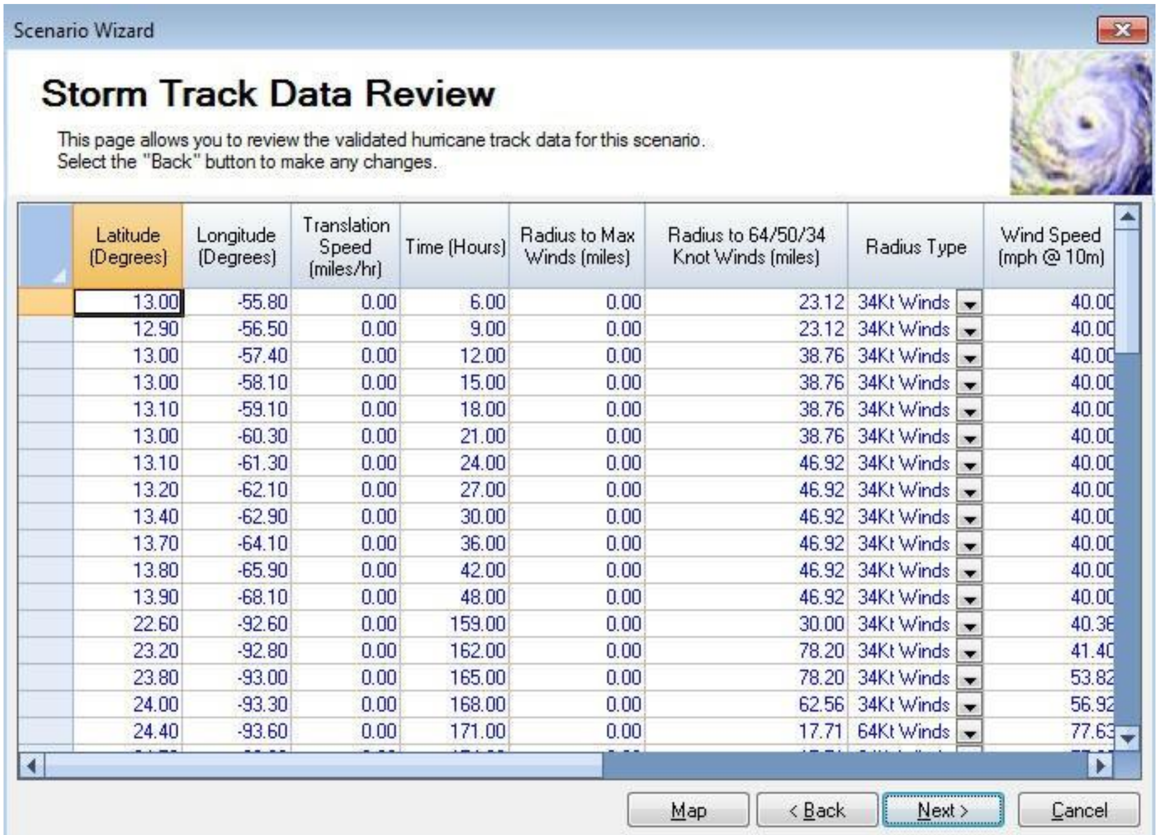
- Click “Close” to close the Hurrevac Download dialog box.
- Click the refresh icon to refresh the list of storms with the downloaded data. Then select the “Atlantic” region to populate the list of storms.



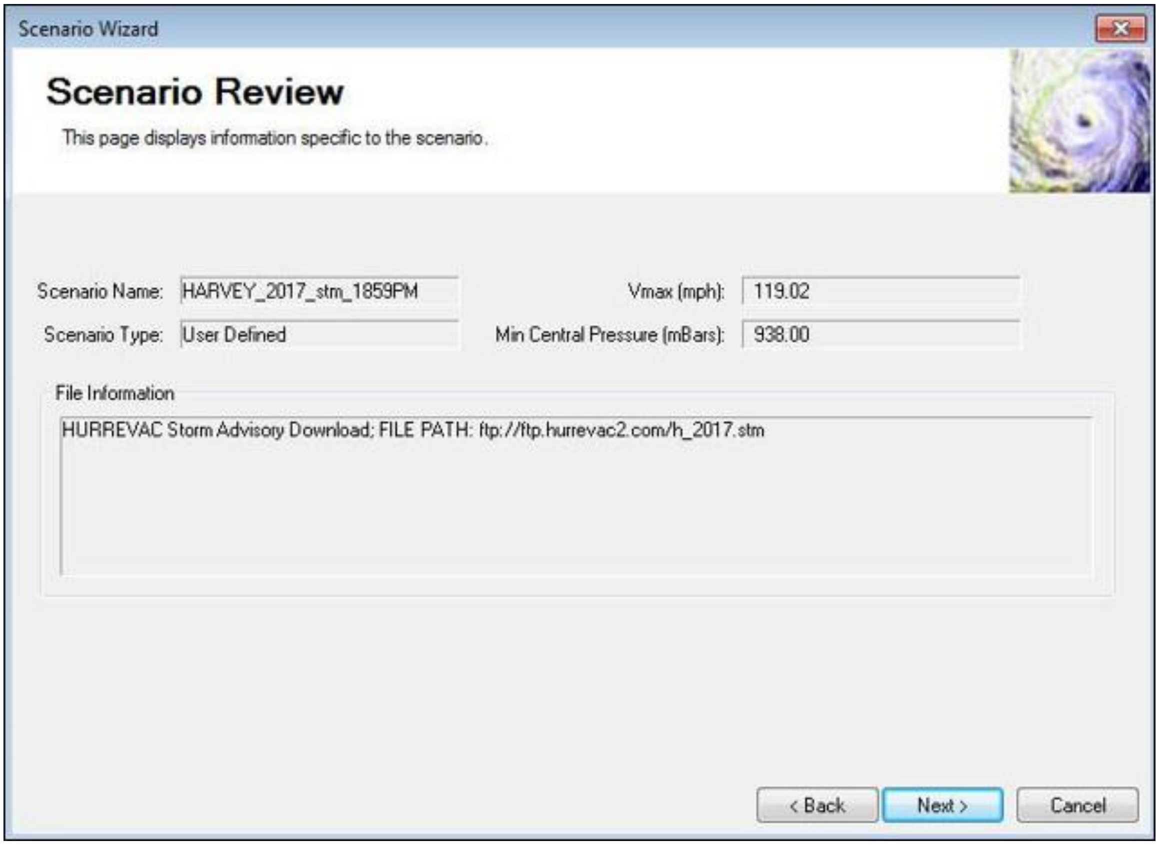
- Navigate to the Harvey 2017 storm and click on the row to highlight and select it. Click “Next.”



- Click “Next” on the Edit Storm Track window to continue. It will take a couple minutes to validate the storm track and perform calculations for the scenario. When the Windfield Calculation is complete, click “Next.”
- Click “Next” on the Storm Track Data Review.



- Click “Next” on the Scenario Review.

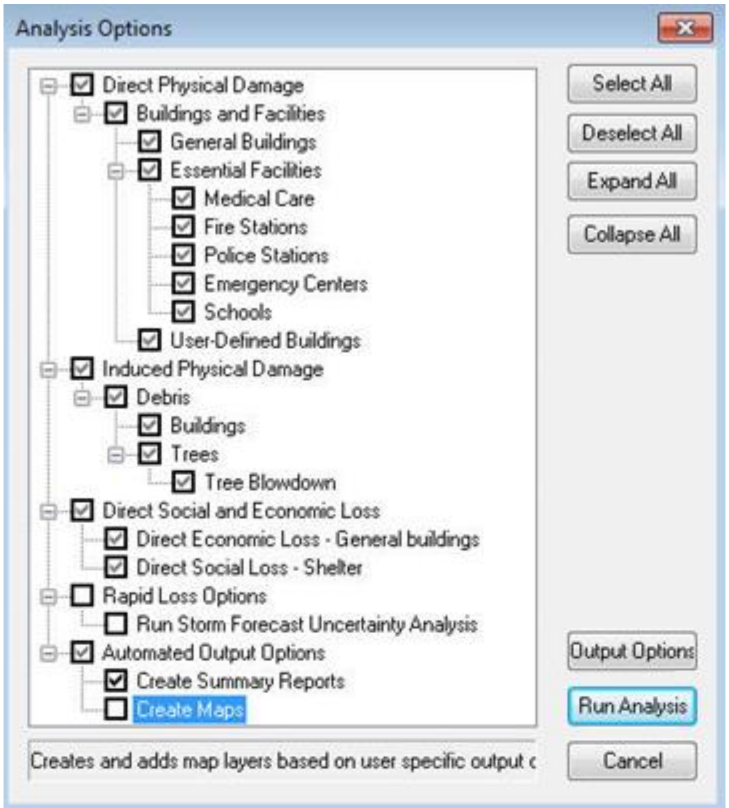


- Select “Yes. Make this scenario active.” Click “Next.”
- Click “Finish” to exit the Hurricane Scenario Management Wizard.

Task 3: Run the Analysis

- Navigate to “Analysis > Run” to begin the damage and loss calculations for the Hurricane Harvey scenario.
- Under “Automated Output Options” unselect “Create Maps,” then click “Run Analysis.” This will take a few minutes to complete.

  Note: The create maps option generates one or more standardized maps that you can define. This is a useful feature if you tend to create the same maps for your study region on a frequent basis. However, for this exercise that functionality serves no useful purpose.

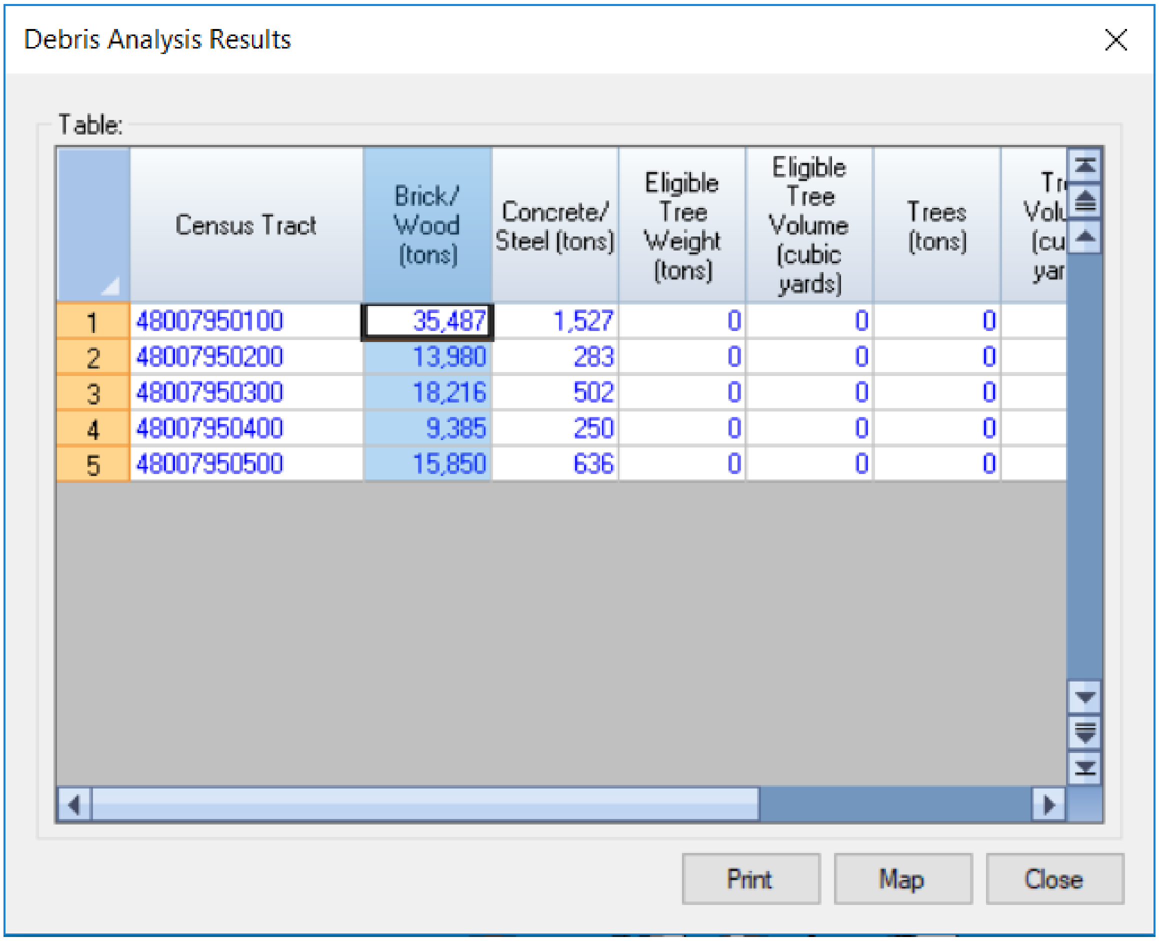


- Click “OK” once the analysis has finished.

Task 4: View and Record the Results

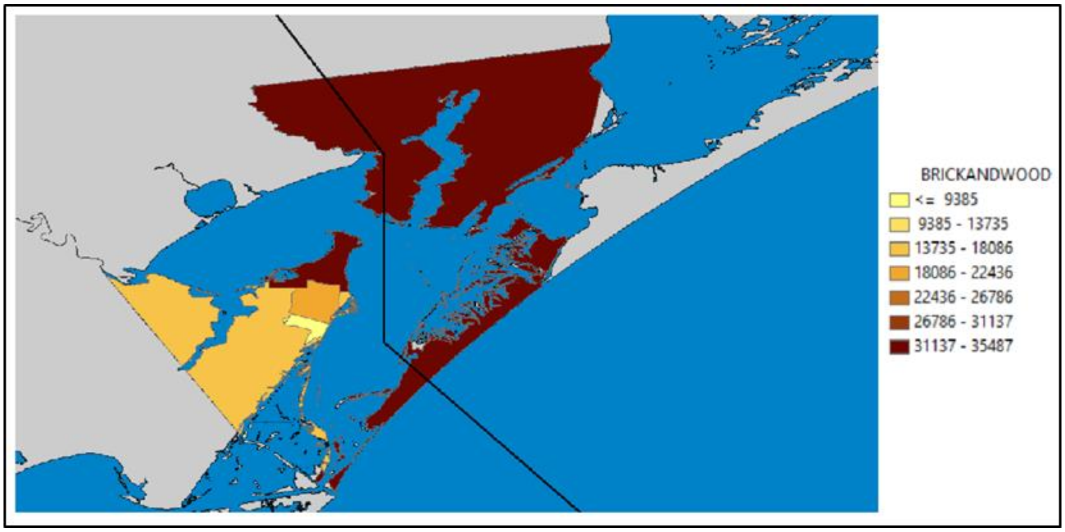
Note: These steps outline viewing and mapping Brick/Wood debris. You should develop a map of your choice: winds (by category), displaced population, economic loss, or tree debris.

- Navigate to “Results > Debris.”
- Click on the column “Brick/Wood (tons)” and then click “Map.” Then click “Close.”



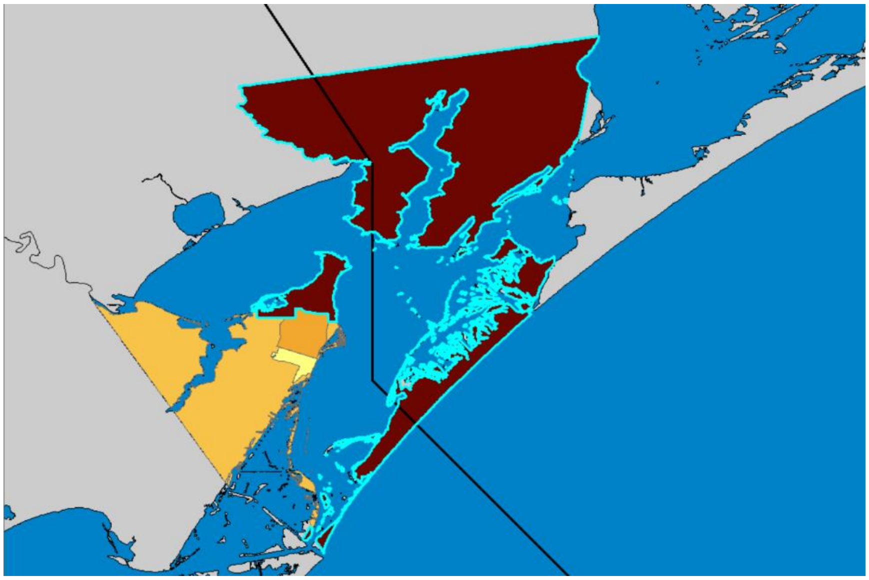
	Census Tract	Brick/ Wood (tons)	Concrete/ Steel (tons)	Eligible Tree Weight (tons)	Eligible Tree Volume (cubic yards)	Trees (tons)	Tr Volu (cu yar
1	48007950100	35,487	1,527	0	0	0	
2	48007950200	13,980	283	0	0	0	
3	48007950300	18,216	502	0	0	0	
4	48007950400	9,385	250	0	0	0	
5	48007950500	15,850	636	0	0	0	

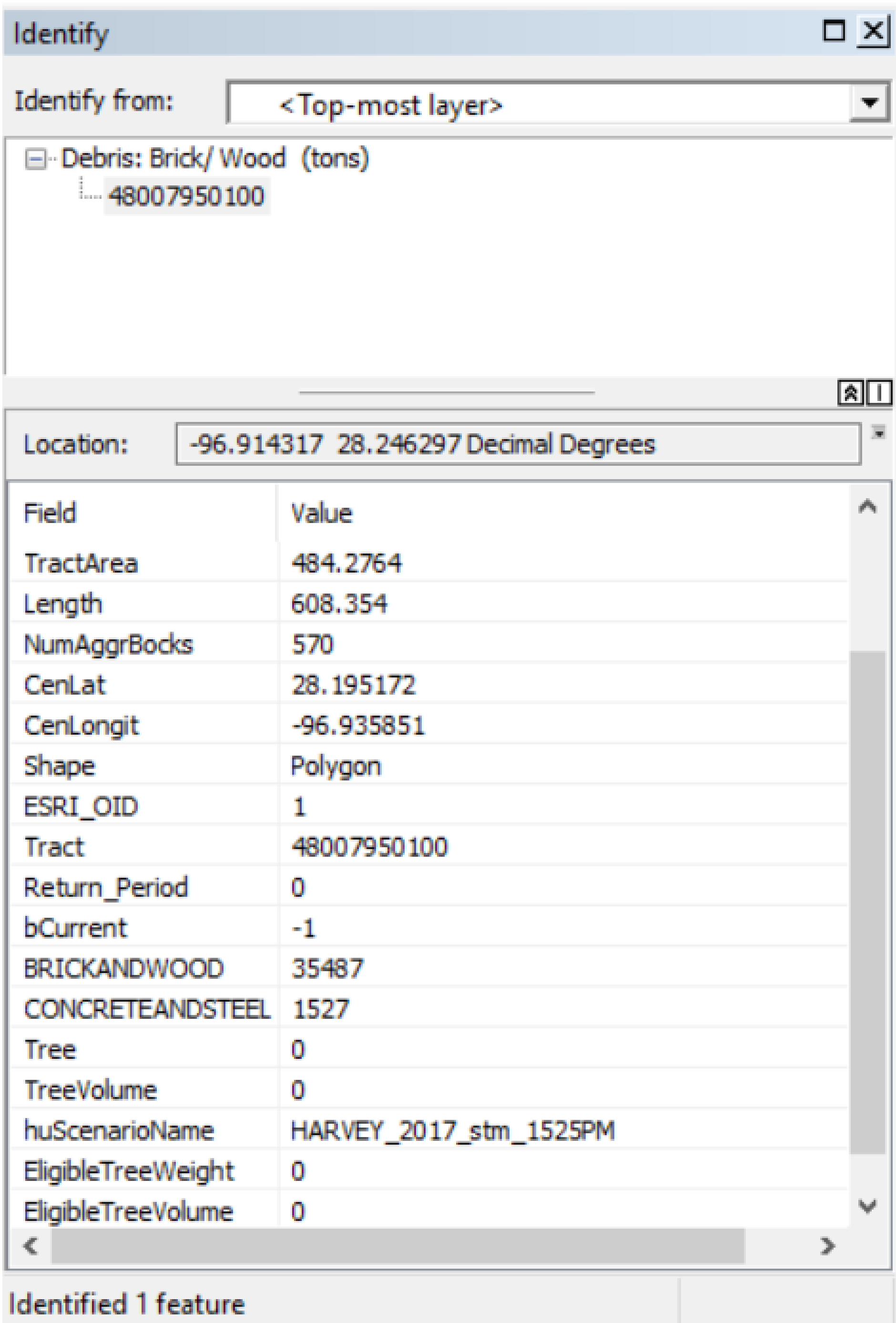
- The census tracts that experienced losses from brick and wood debris will be categorically displayed on the map.



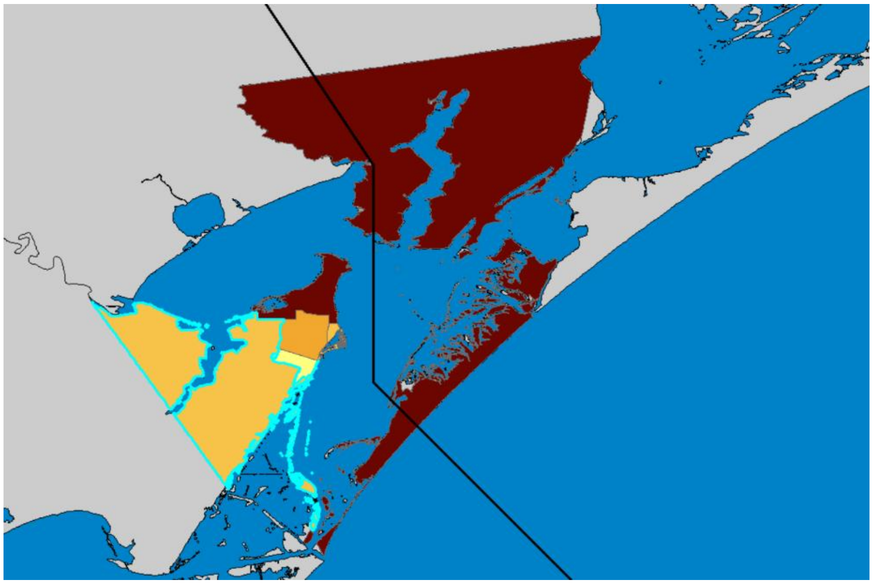
- Select the “Identify” tool.

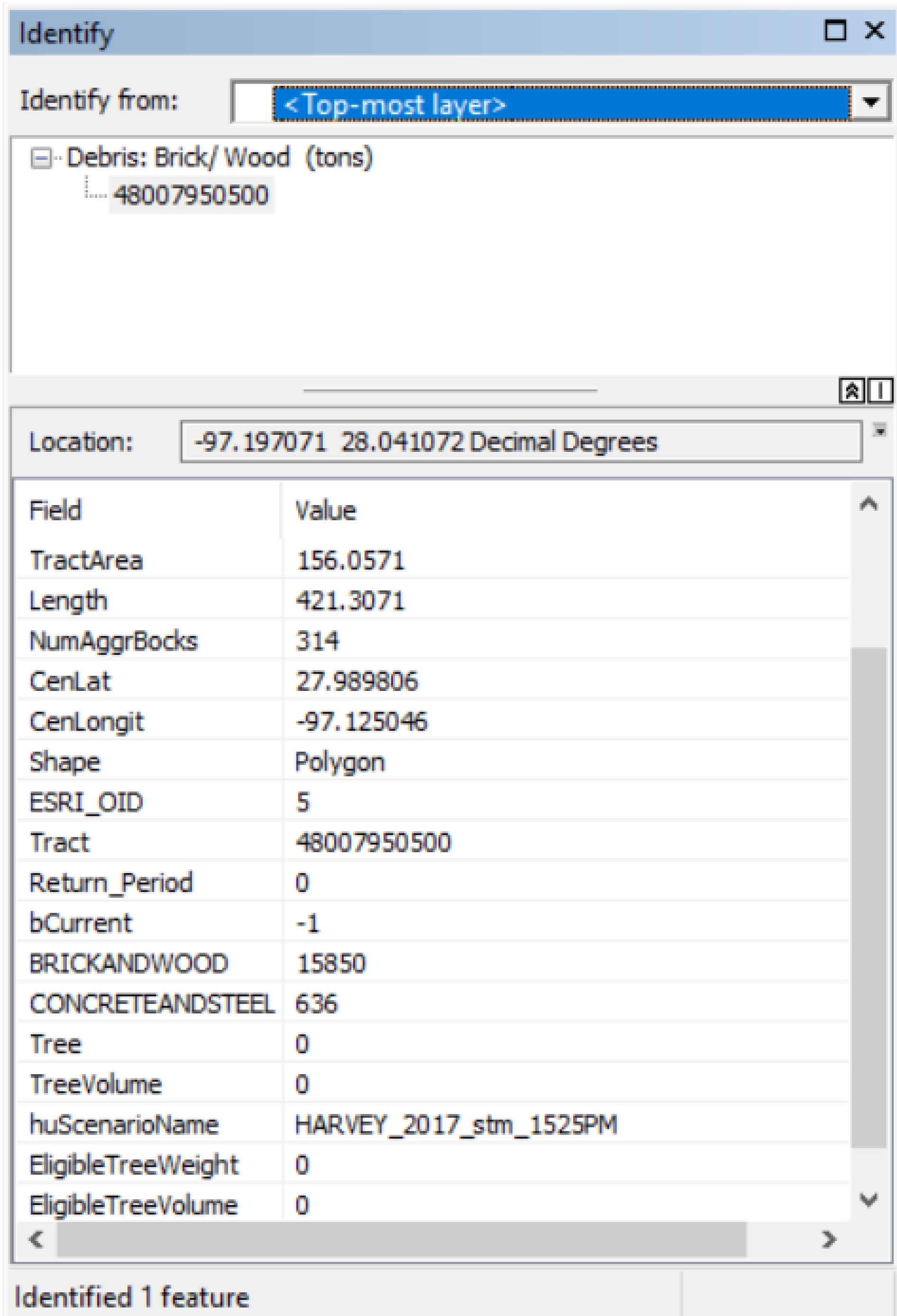
- Click on the highlighted census tract and record its “BRICKANDWOOD” value in the table at the end of this exercise.



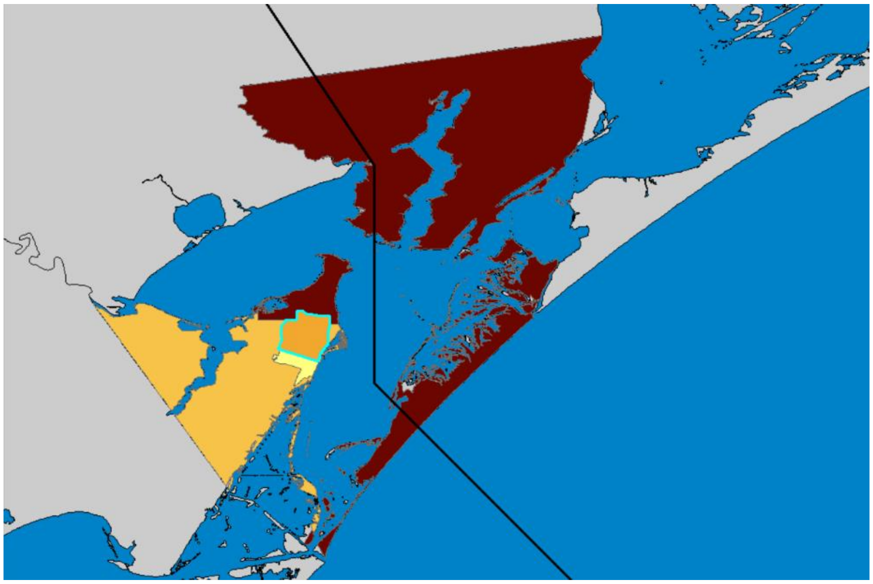


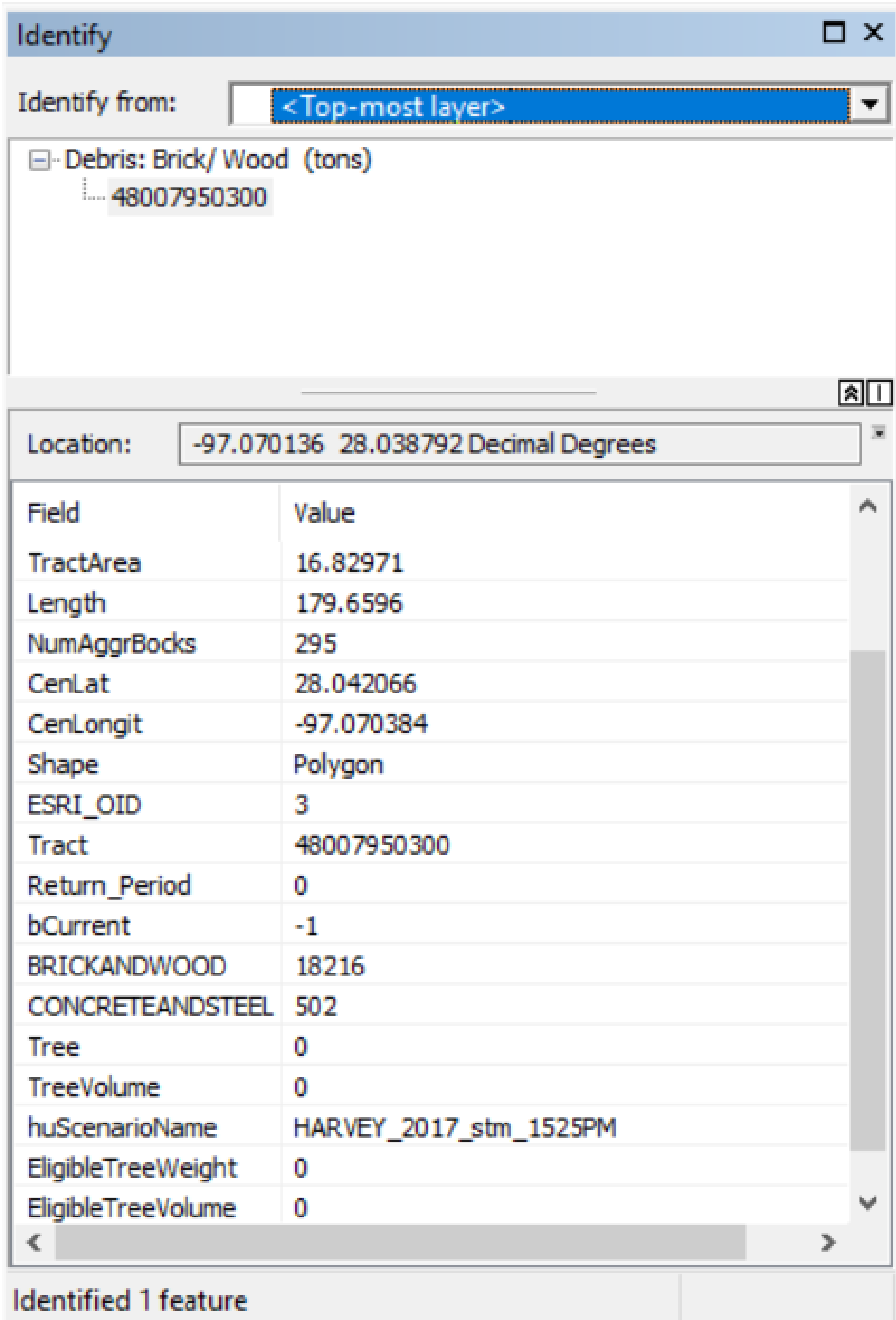
- Click on the highlighted census tract and record its “BRICKANDWOOD” value.





- Click on the highlighted census tract and record its “BRICKANDWOOD” value.





- Enter the BRICKANDWOOD values in the table below.

Census Tract	Hurrevac
48007950100	

Census Tract	Hurrevac
48007950500	
48007950300	

- Save your map document and close the scenario.

Exercise 5.1: Harvey .dat Model

Type: Student-Led Activity

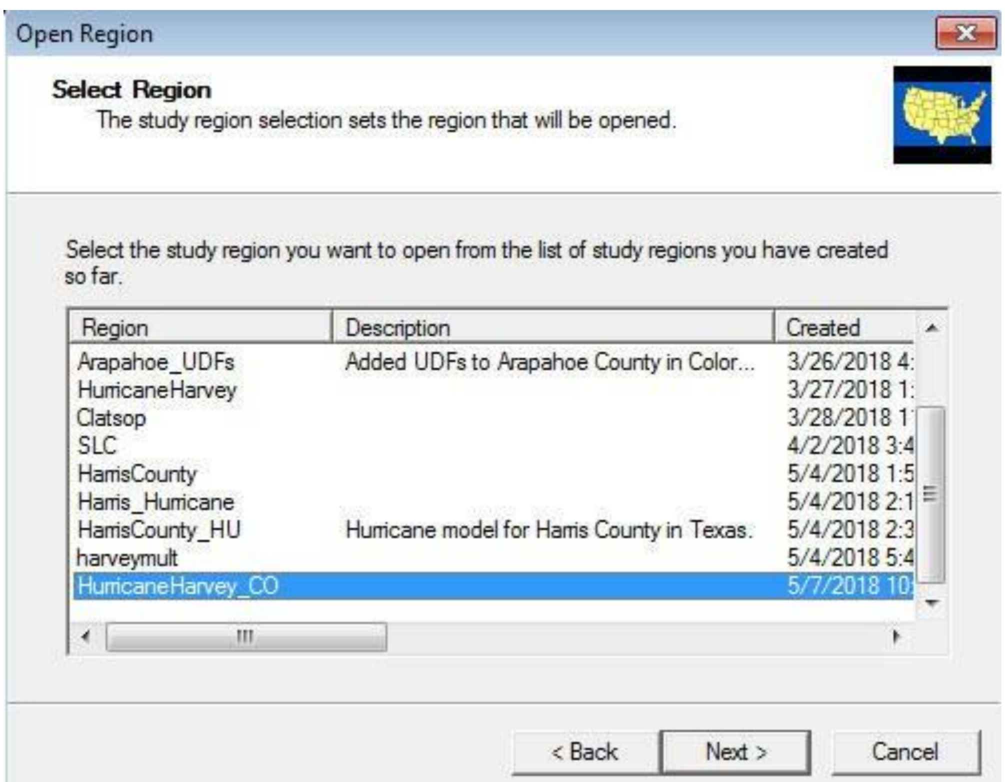
Time: 45 minutes

Goals:

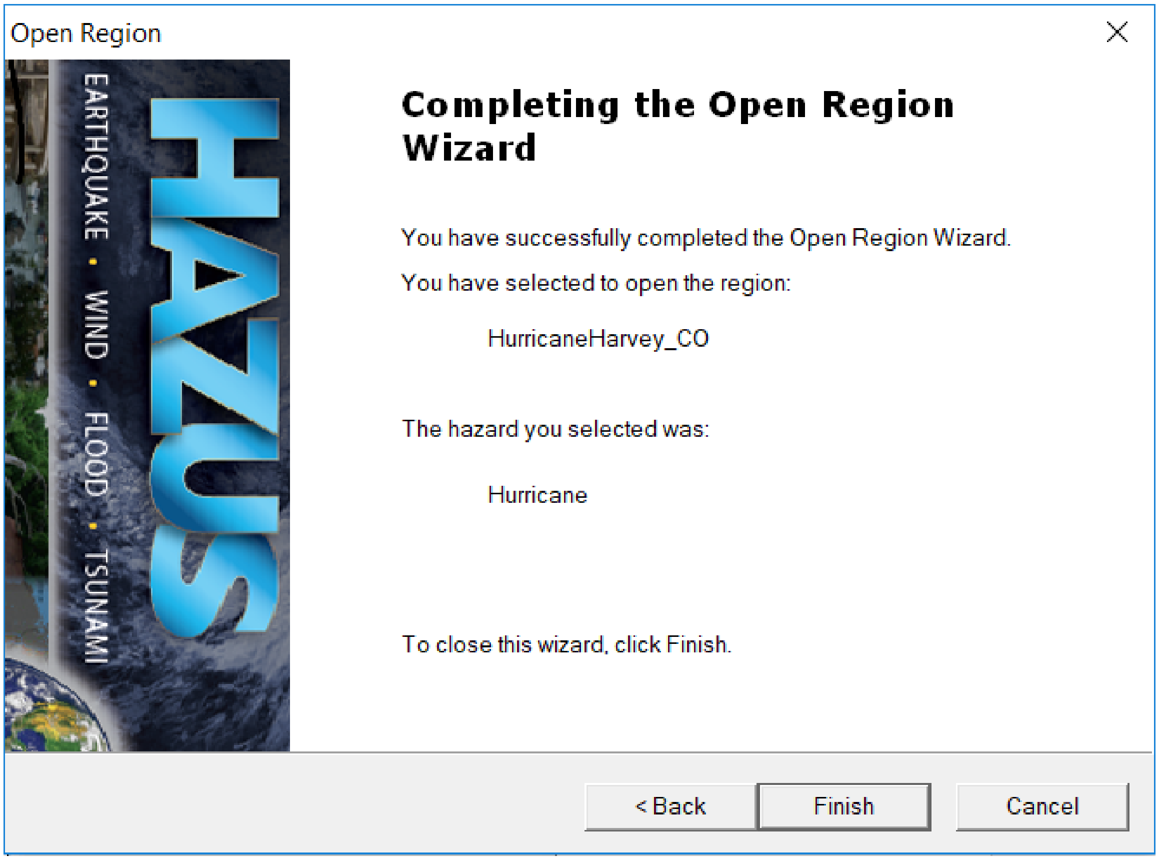
- Run Model with .dat data.
- Develop a map of the winds (by category), displaced population, economic loss, or tree debris.
- View Results.
- Choose the same study region you created in Exercise 3.1.

Task 1: Open the Study Region

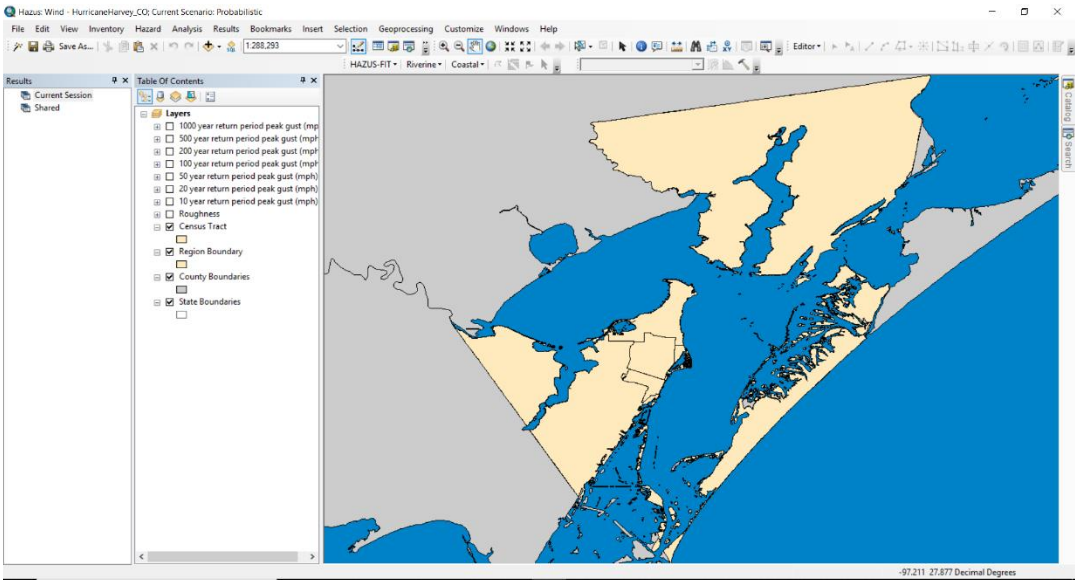
- Open Hazus and select "Open a region." We will open the previously created study region for Aransas county in Texas.
- Click "Next" on the Open Region Wizard.
- Select the study region you wish to open. For this activity, open "HurricaneHarvey_CO."



- Click “Finish” to complete the Open Region Wizard.

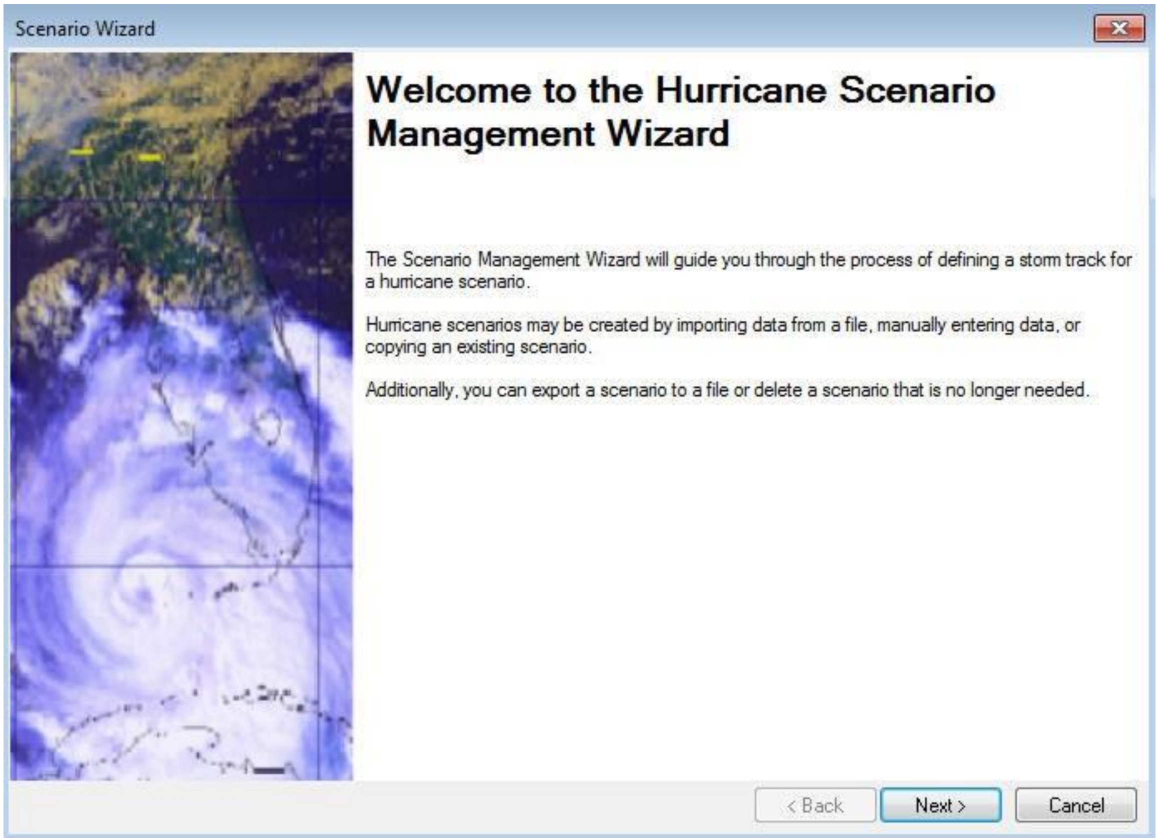


- After a few minutes, Hazus will open in ArcMap displaying a map of Aransas county.

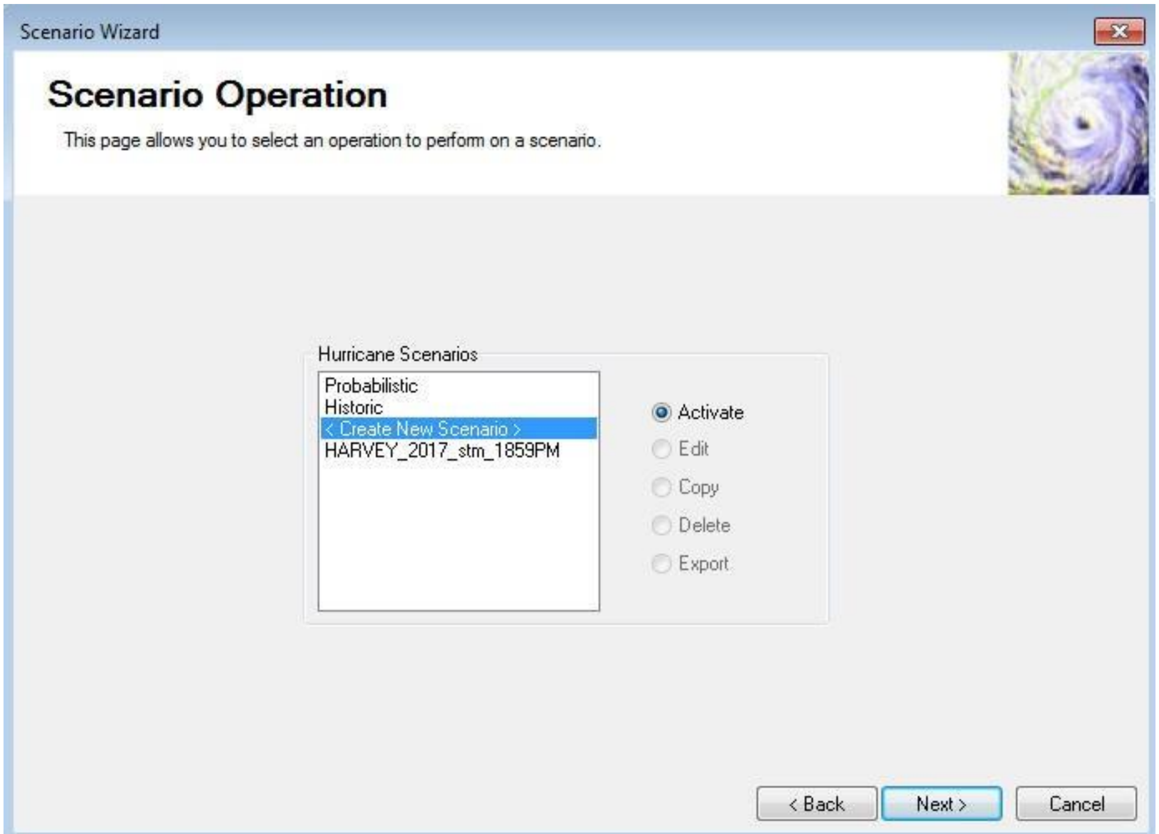


Task 2: Create a New Scenario

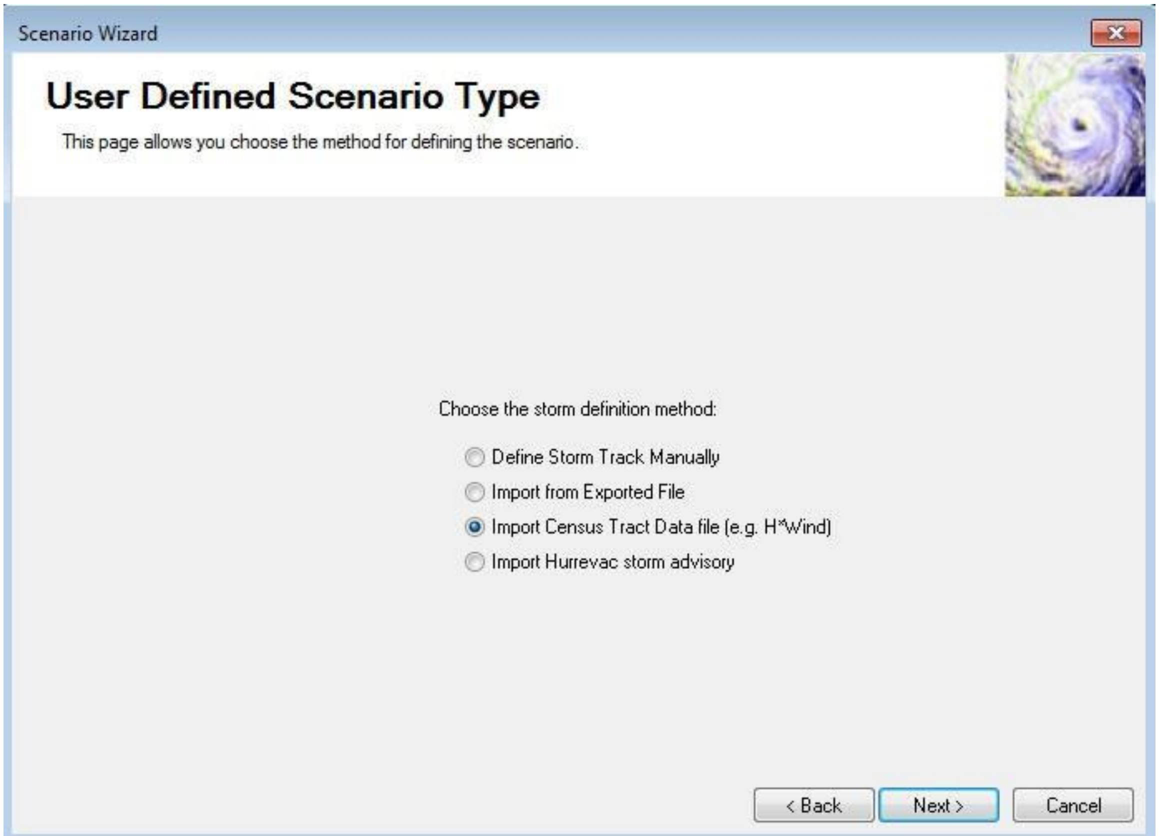
- In the top ribbon, navigate to “Hazard > Scenario.” This prompts the Hurricane Management Window to open.
- Click “Next” on the welcome screen.



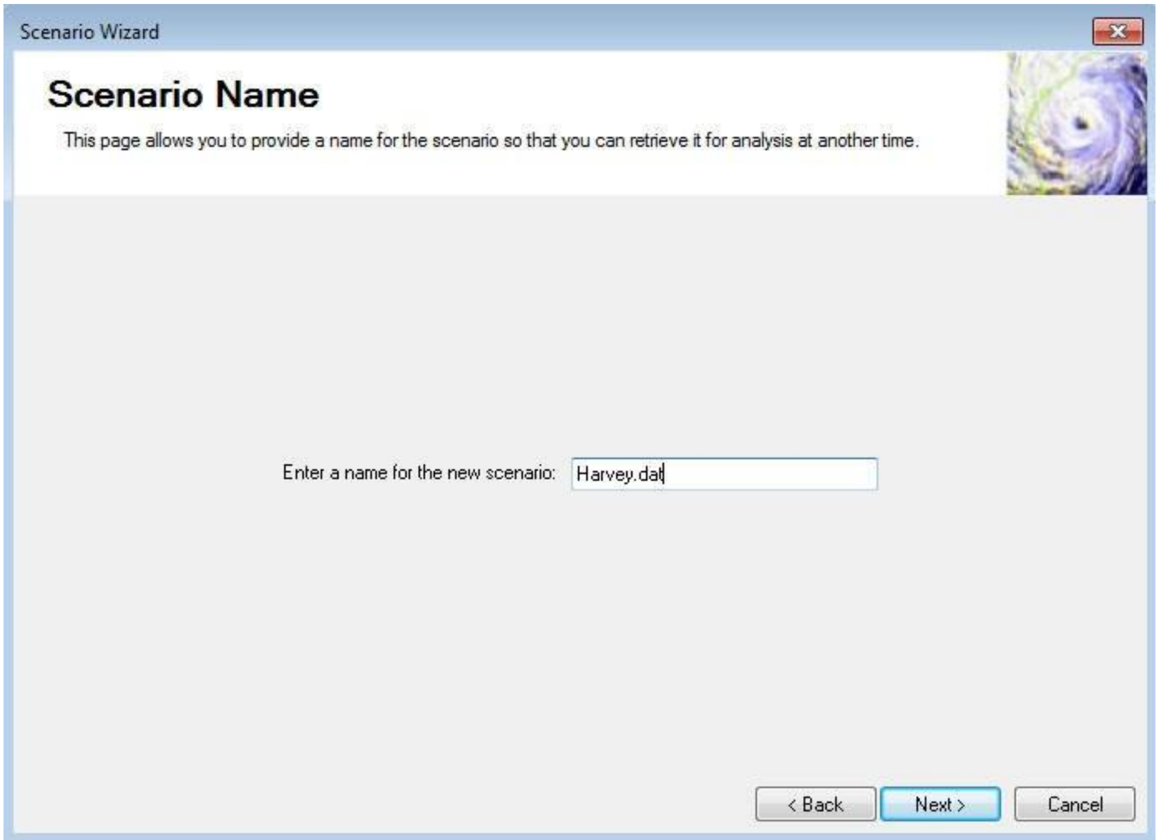
- Select “Create a New Scenario.” Click “Next.”



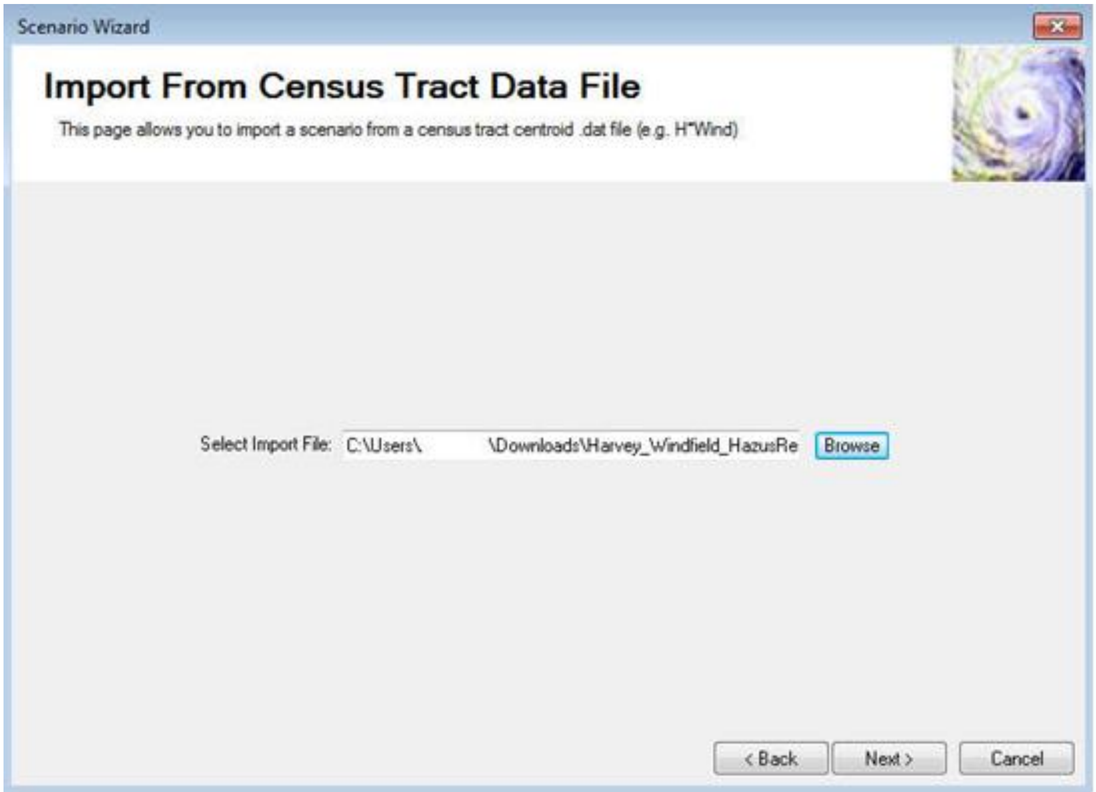
- In the User Defined Scenario Type, select “Import Census Tract Data file (e.g. H*Wind).” Click “Next.”



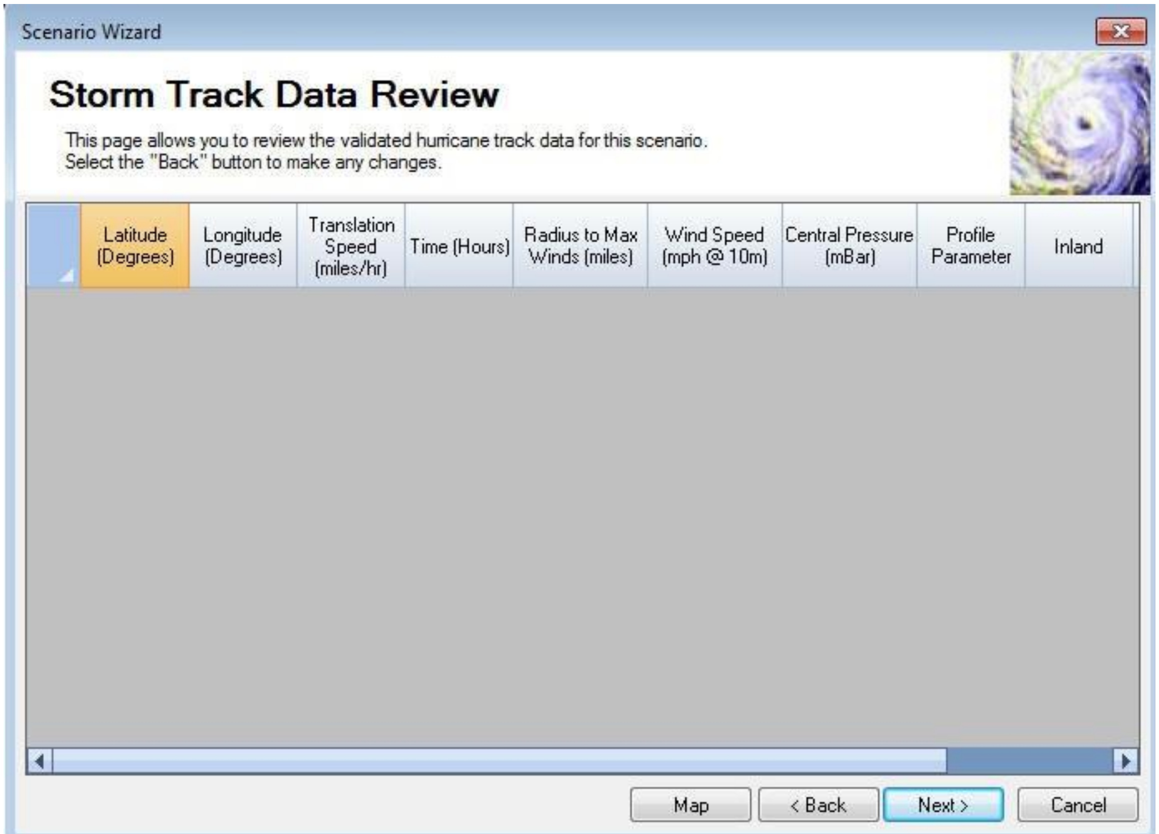
- Enter a name for the new scenario.



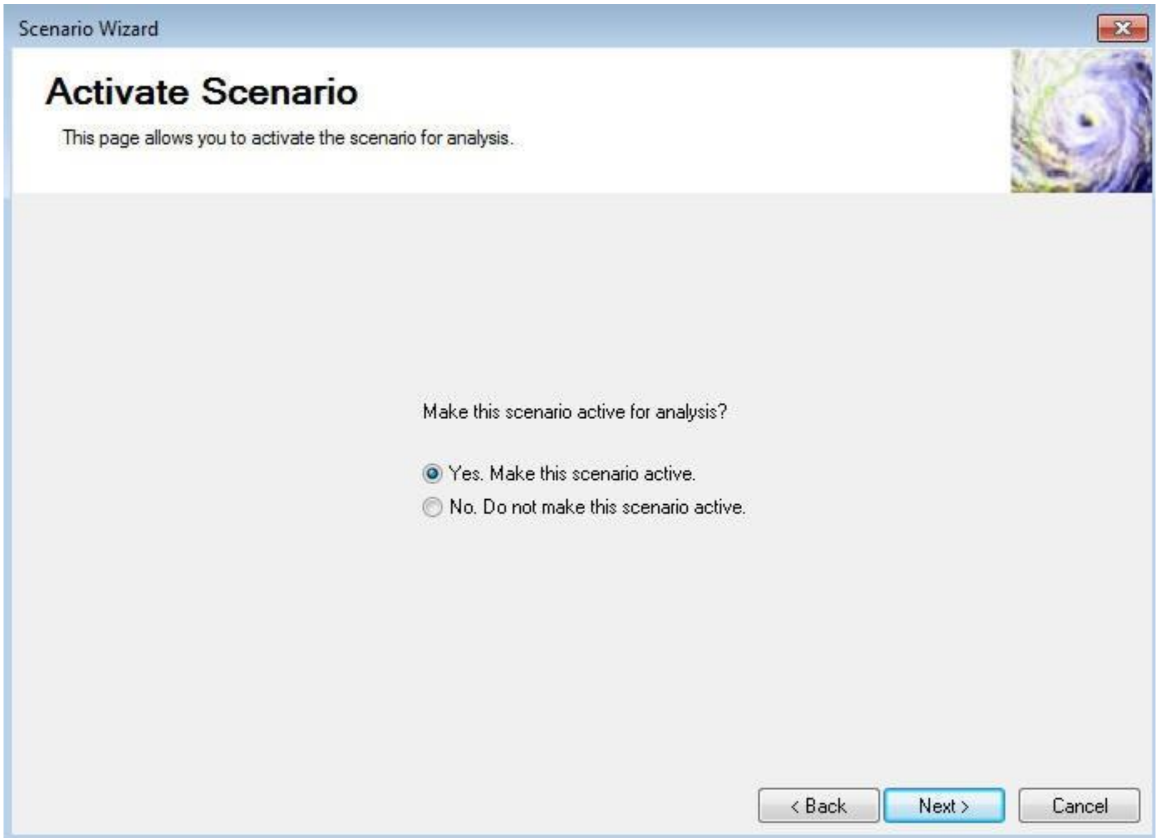
- Click “Browse” to navigate to and select the “Harvey_Windfield_HazusReady.dat” file saved on the computer. Click “Next.”



- Click “Next” on the Storm Track Data Review.



- Click "Next" on the Scenario Review.
- Select "Yes. Make this scenario active." Click "Next."

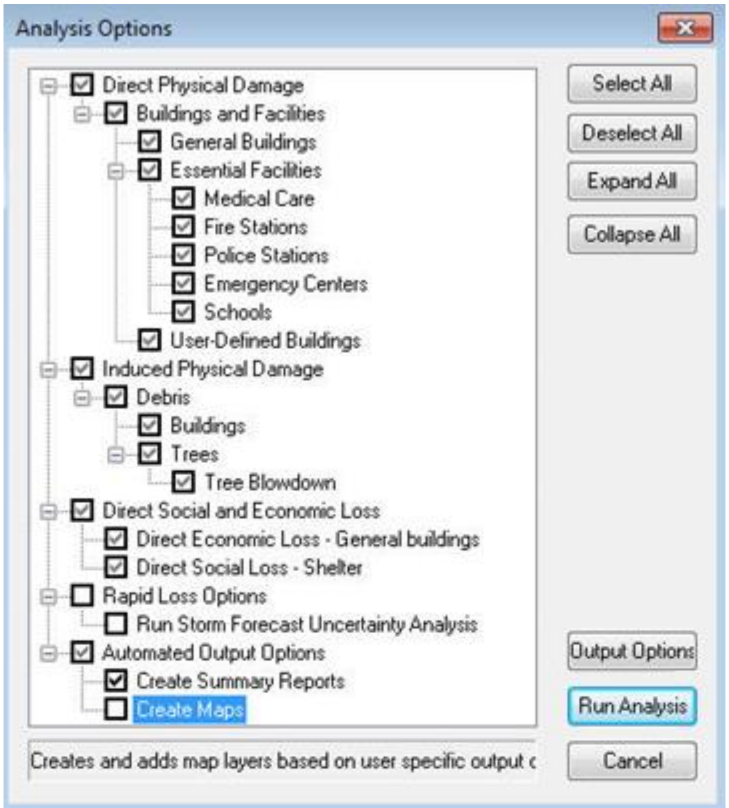


- Click “Finish” to exit the Hurricane Scenario Management Wizard.

Task 3: Run the Analysis

- Navigate to “Analysis > Run” to begin the damage and loss calculations for the Hurricane Harvey scenario.
- Under Automated Output Options unselect “Create Maps,” then click “Run Analysis.” This will take a few minutes to complete.

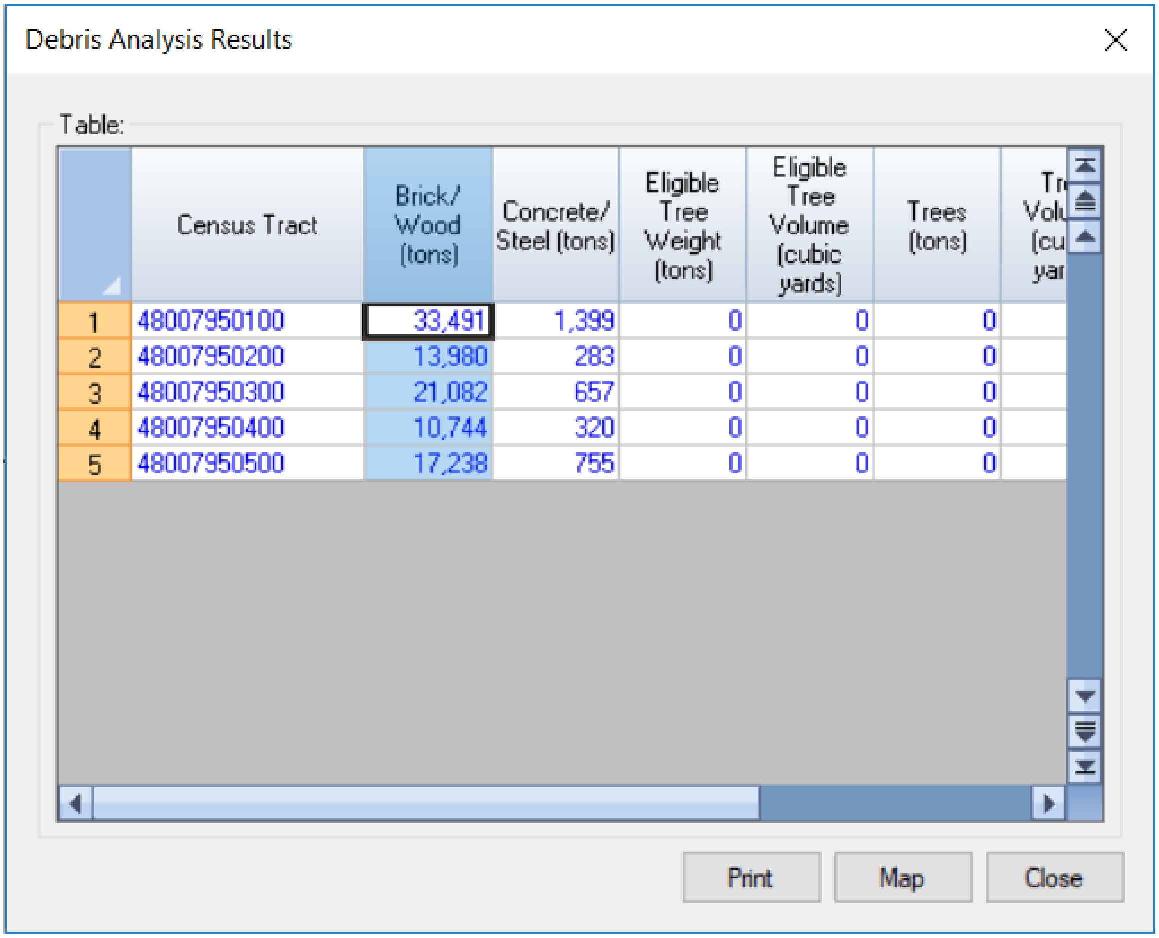
  Note: The create maps option generates one or more standardized maps that you can define. This is a useful feature if you tend to create the same maps for your study region on a frequent basis. However, for this exercise that functionality serves no useful purpose.



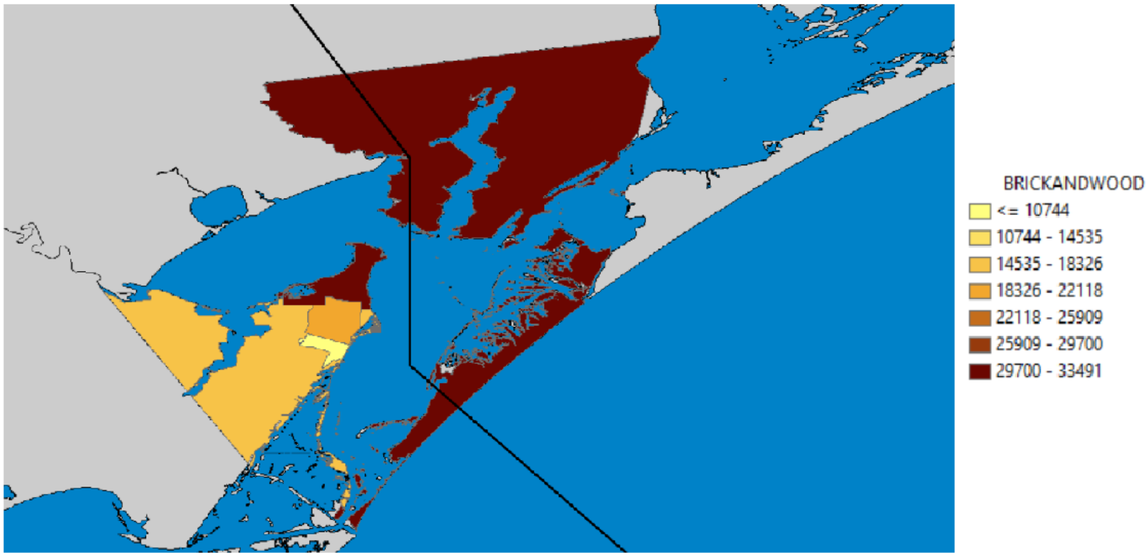
- Once the analysis is complete, click “OK”.

Task 4: View and Record the Results

- Navigate to “Results > Debris.”
- Click on the column for “Brick/Wood (tons)” and then click “Map.”

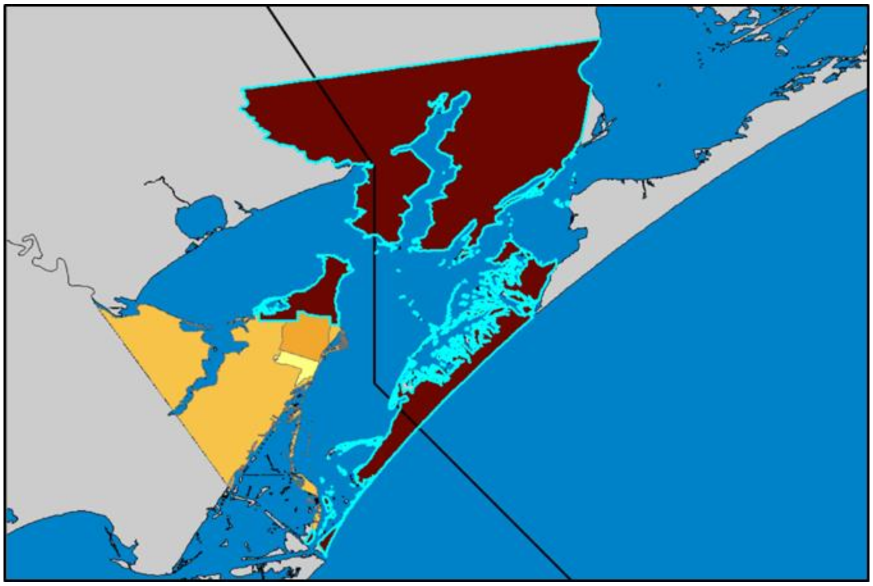


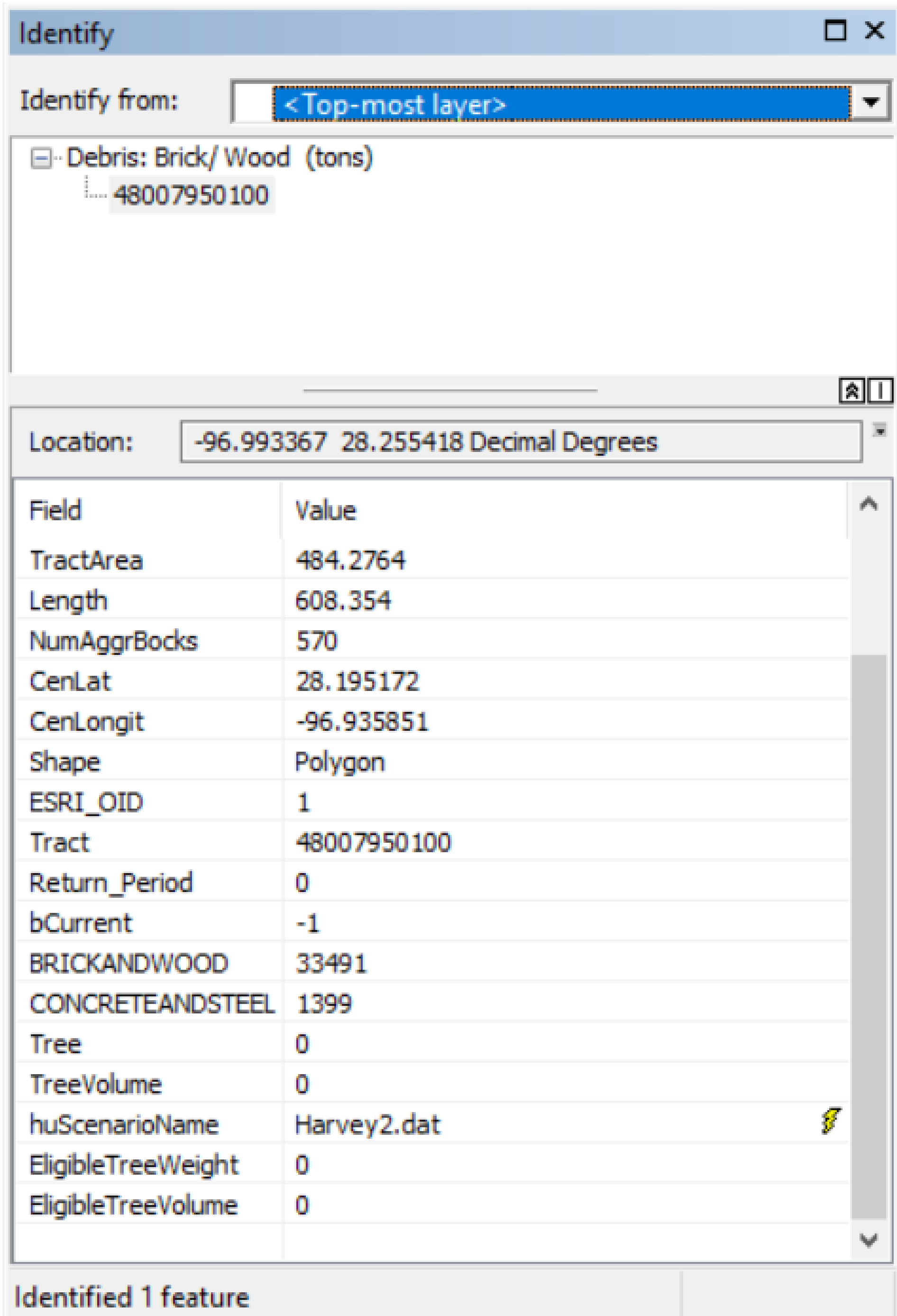
- The census tracts that experienced losses from brick and wood debris will be categorically displayed on the map.



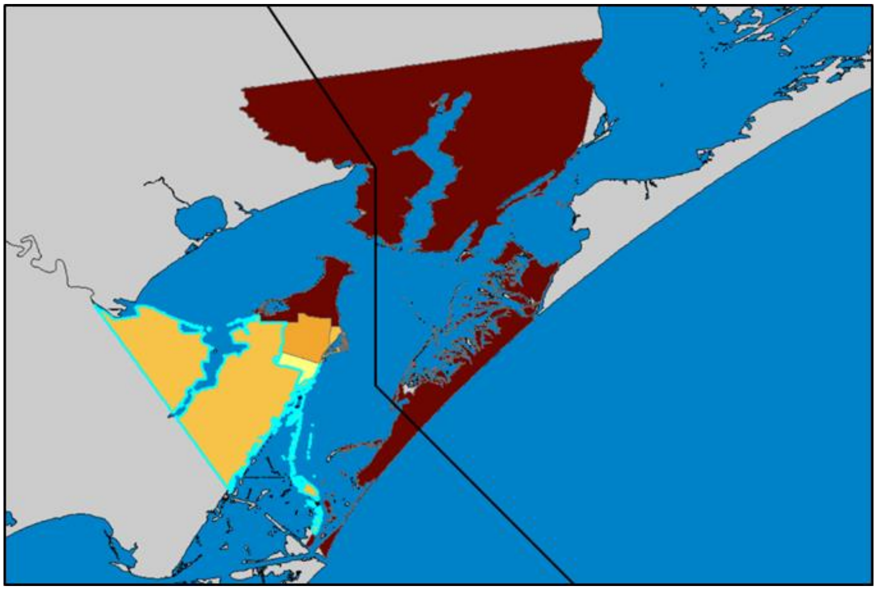
- Select the “Identify” tool.

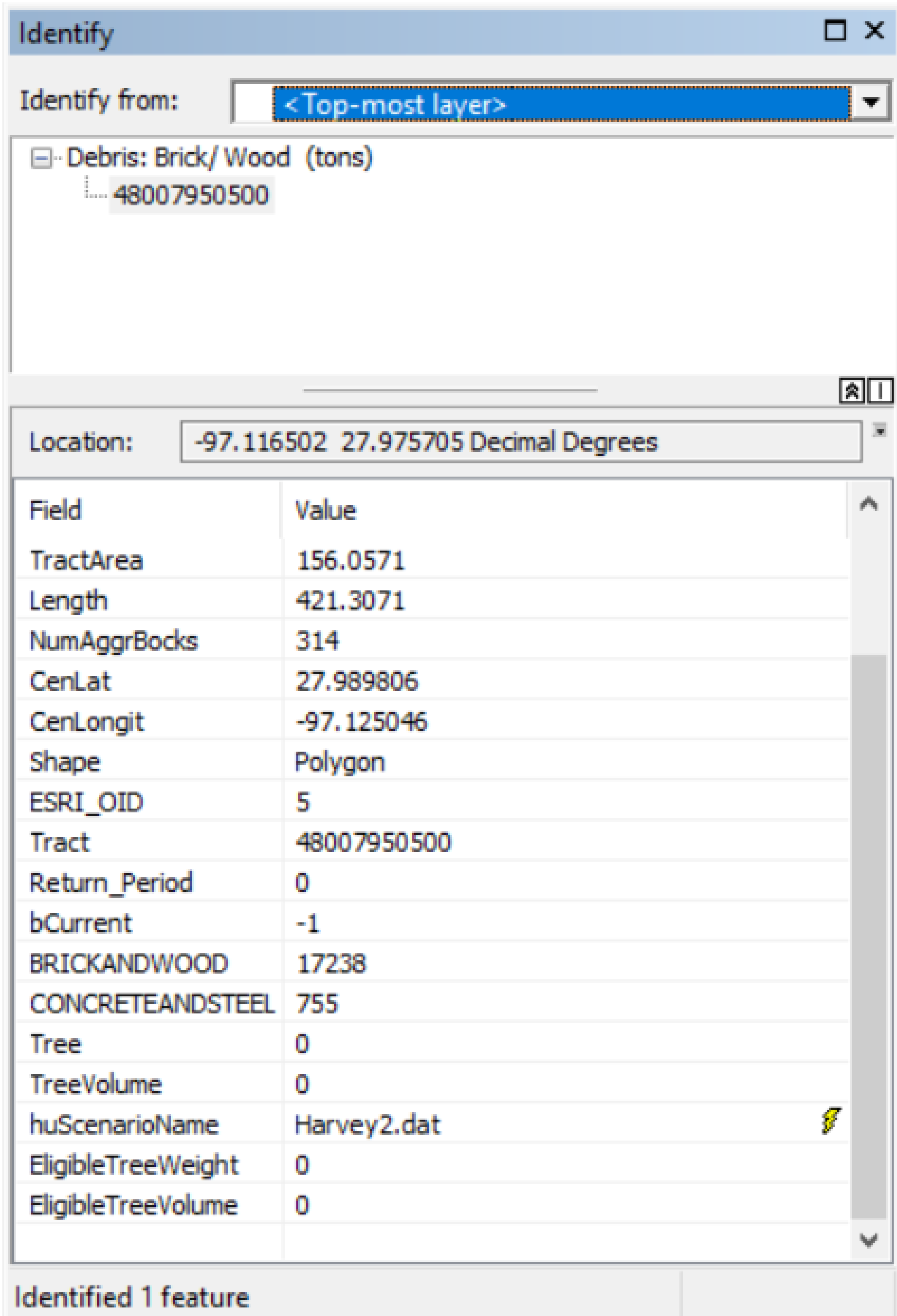
- Click on the highlighted census tract and record its “BRICKANDWOOD” value.



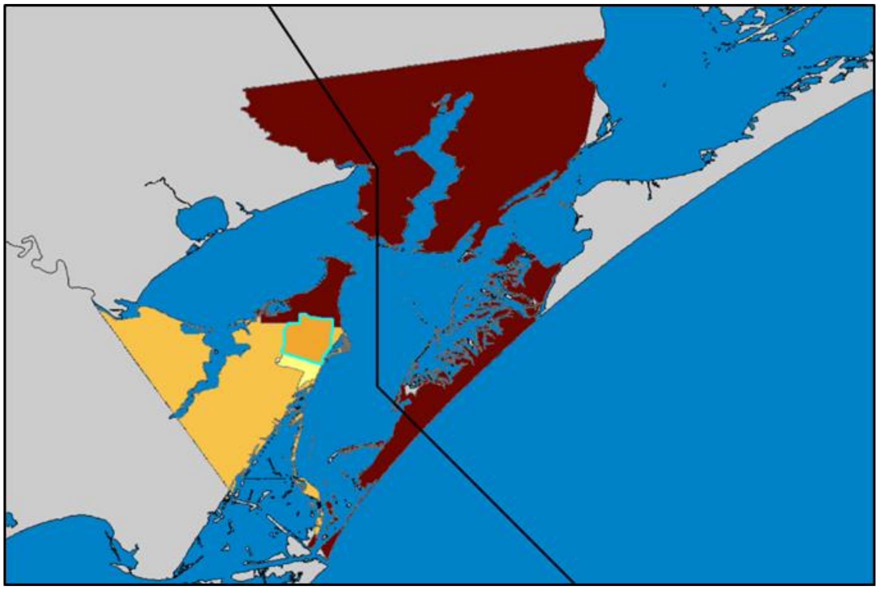


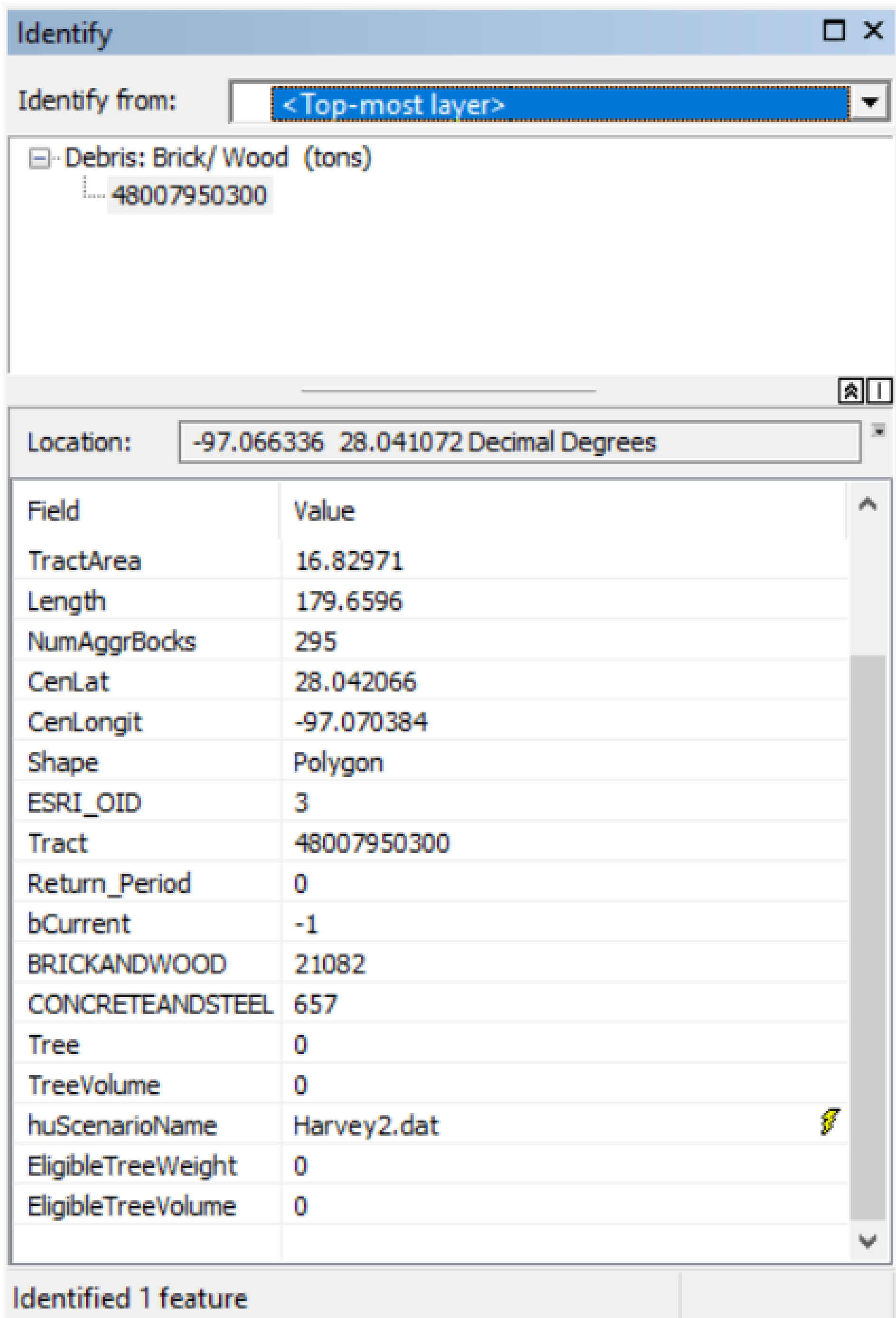
- Click on the highlighted census tract and records its “BRICKANDWOOD” value.





- Click on the highlighted census tract and records its “BRICKANDWOOD” value.





- Save your map document and close the scenario.

- Enter the BRICKANDWOOD values in the table below.

Census Tract	.dat

Census Tract	.dat
48007950100	
48007950500	
48007950300	

- Save your map document and close the scenario.

Exercise 5.2: Compare the Outputs

Type: Student-Led Activity

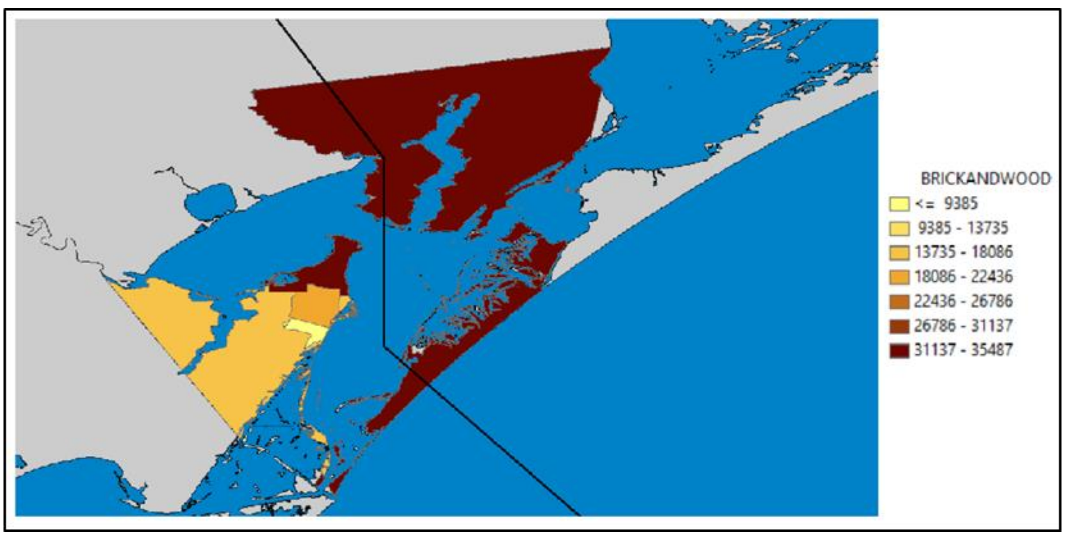
Time: 15 minutes

Goal: Compare the Hurrevac and .dat results for Hurricane Harvey.

Background: As a disaster operations manager, you may be responsible for assessing damages both as a planning measure and during recovery efforts. As you move through this exercise, consider how you would use this information during various operational phases. For example, if preparing a report on damages and resources needed to rebuild a community, what data source and results type would you want to use?

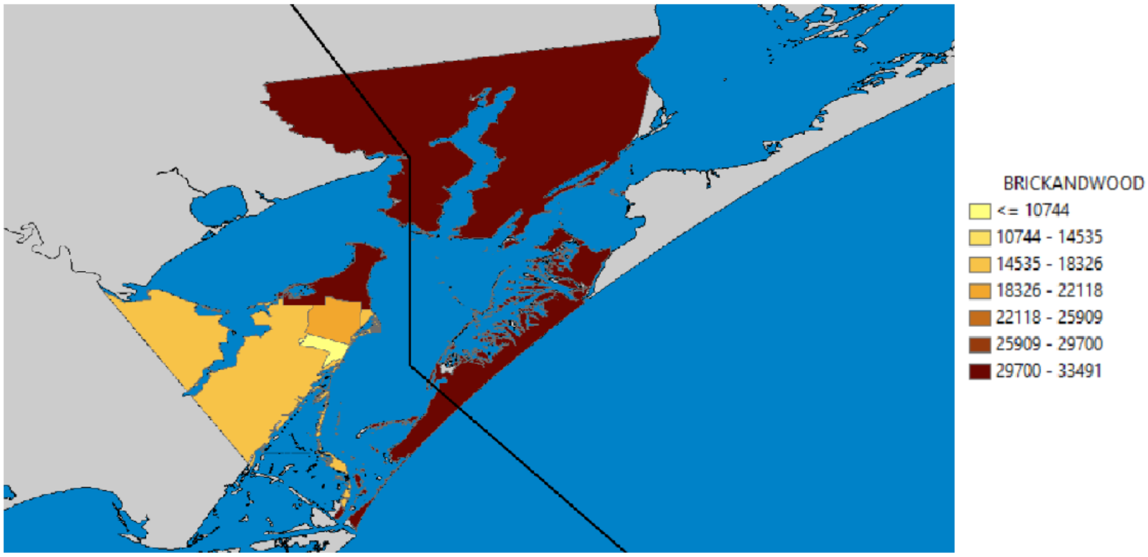
Task 1: View the Results from the Hurrevac Output (previous lesson)

- Open the map document and refer to the debris damages noted earlier in the previous lesson (Exercise 4.1).



Task 2: View the Results from the .dat Output (earlier this lesson)

- Open the map document and refer to the debris damages noted earlier in this lesson (Exercise 5.1).



Task 3: Compare the Results and Identify Differences

- Identify differences in values, range, distribution, display, or other aspects of the maps and data.

Census Tract	Hurrevac	.dat

You can populate this table based on the results from Exercises 4.1 and 5.1.

Results Questions

1. What differences do you observe between the results from Hurrevac and the results from .dat?
2. What is the Hurrevac data based upon?
3. What is the .dat data based upon?
4. What could be the reason behind the differences in the results?

Exercise 6.1: GBS (General Building Stock) Data

Type: Student-Led Activity

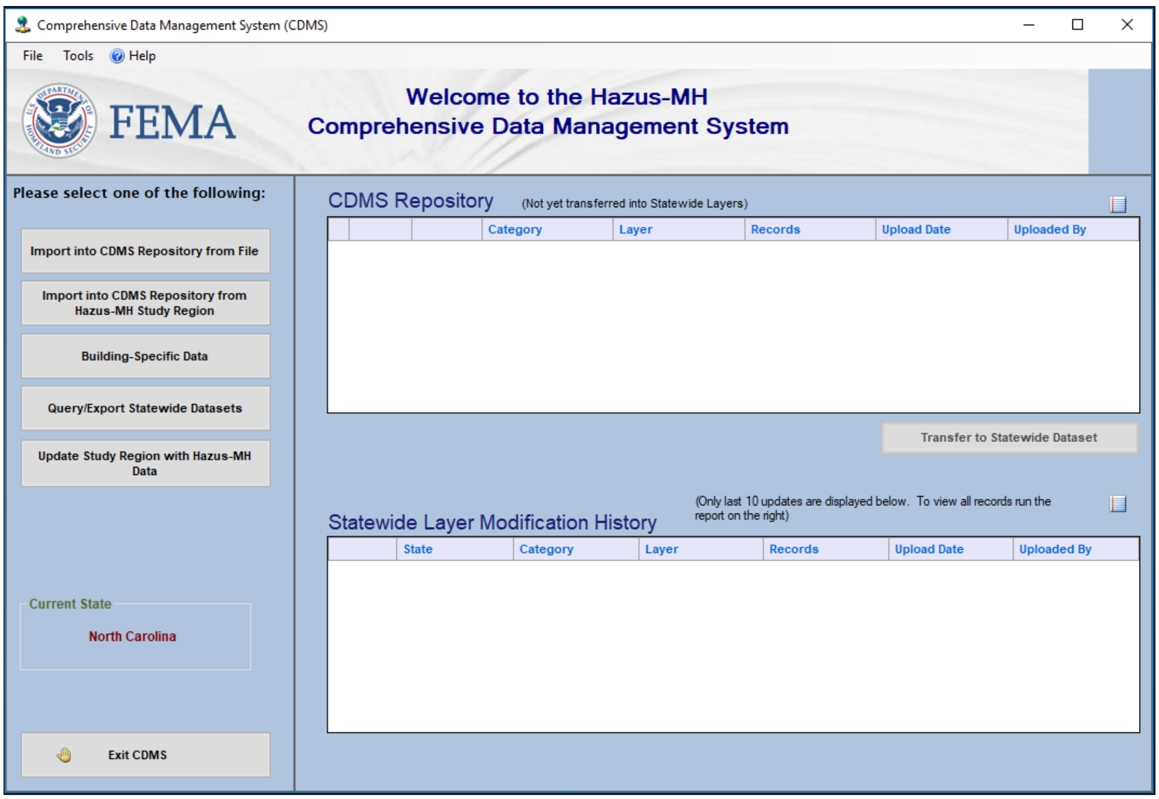
Time: 15 minutes

Goal: Identify and export data from a state dataset.

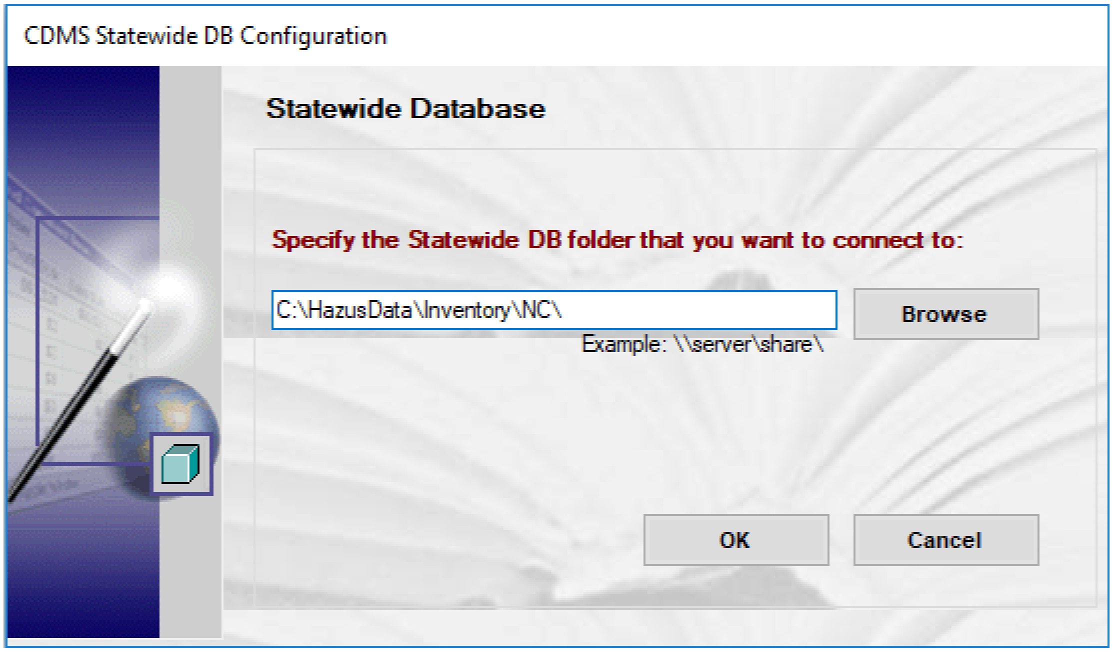
Background: This document describes how to use CDMS (Comprehensive Data Management System) to export data from a Statewide database to manipulate.

Task 1: Open CDMS and Change State Databases

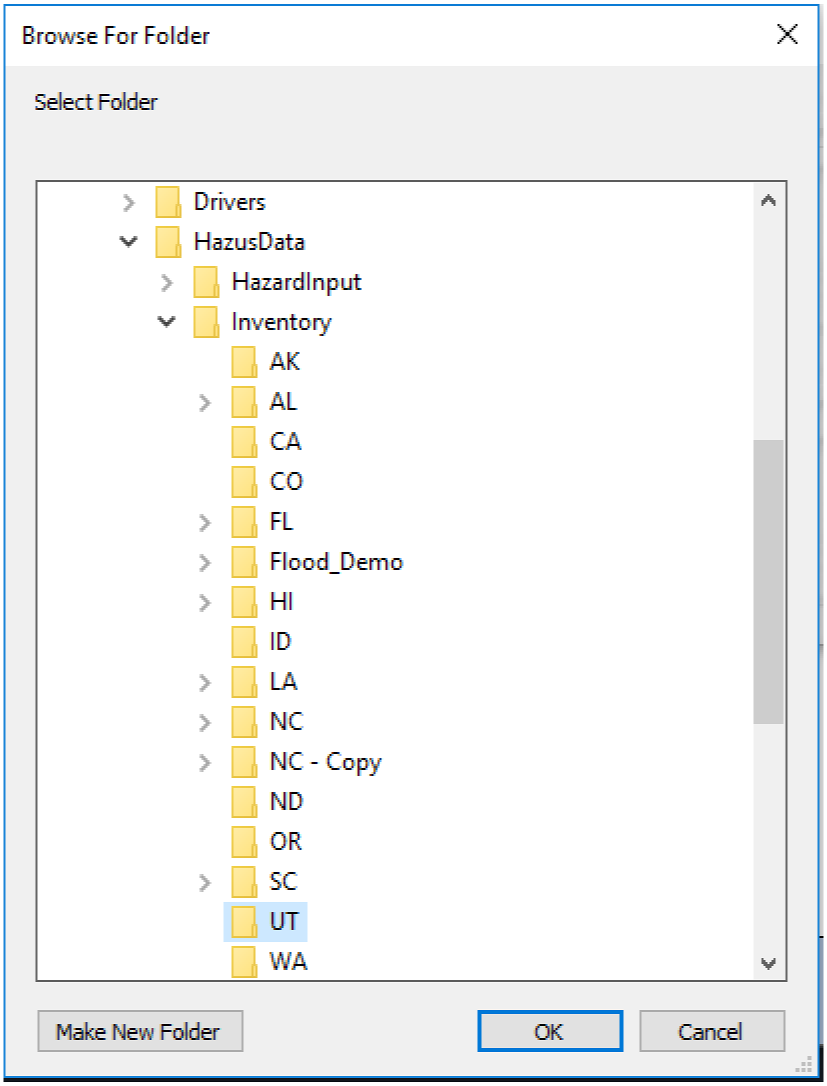
- Open CDMS.



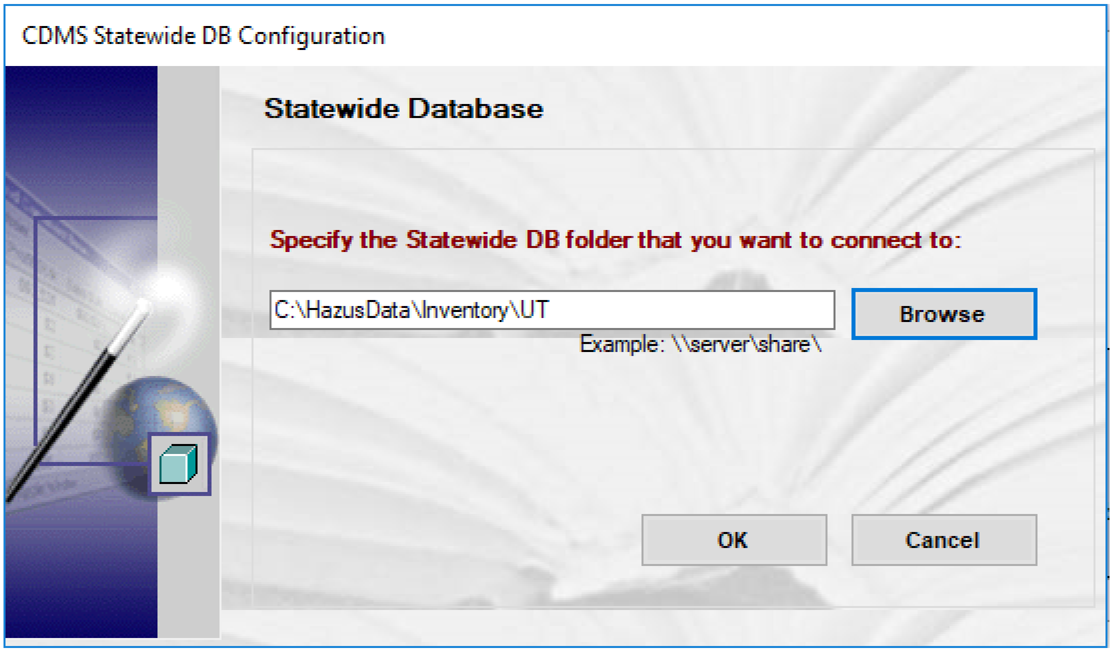
- Navigate to “Tools > Specify Hazus-MH Data Location.”
- The CDMS Statewide DB Configuration window will appear. Click “Browse” and navigate to C:\HazusData\Inventory\UT\.



- Select “UT” and click “OK.”

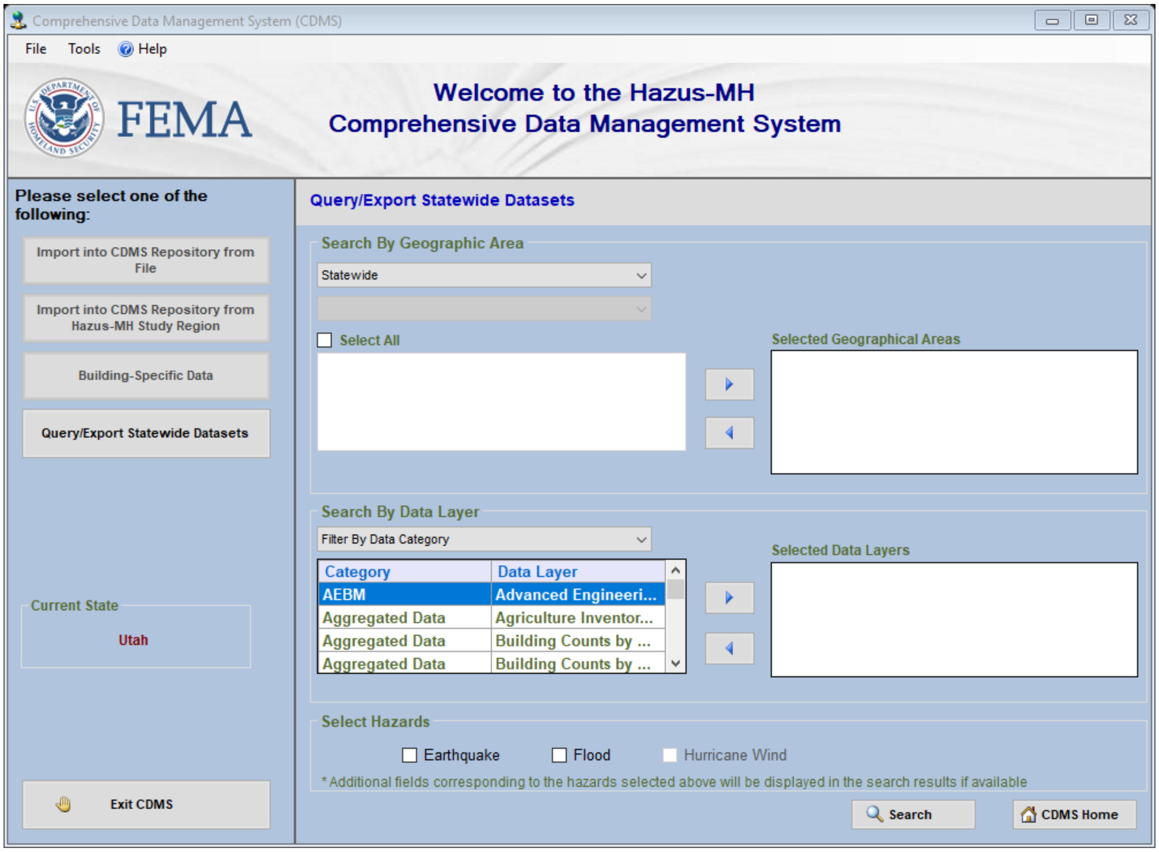


- Click “OK” and the current state will be changed to Utah.

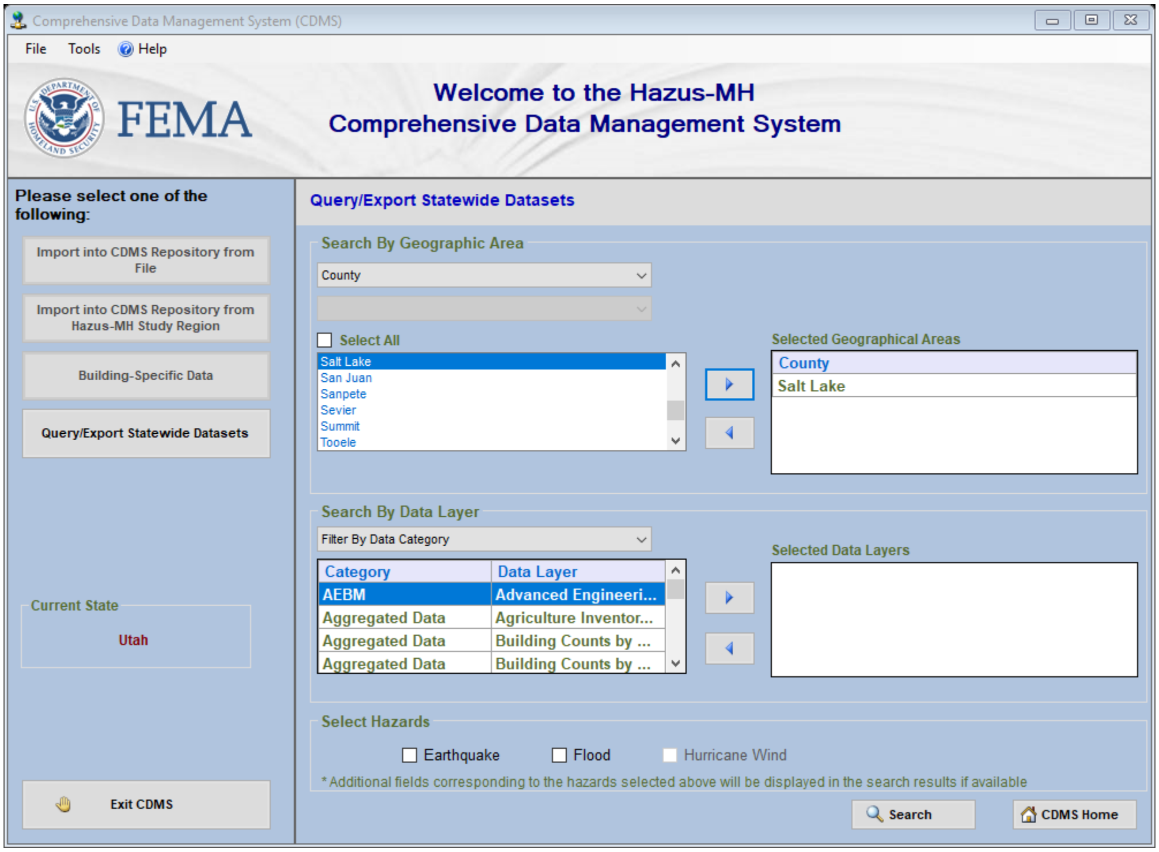


Task 2: Query County for Specific Buildings

- From the main CDMS page, click “Query/Export Statewide Datasets.” Click the drop-down under “Search By Geographic Area” and select “County.”

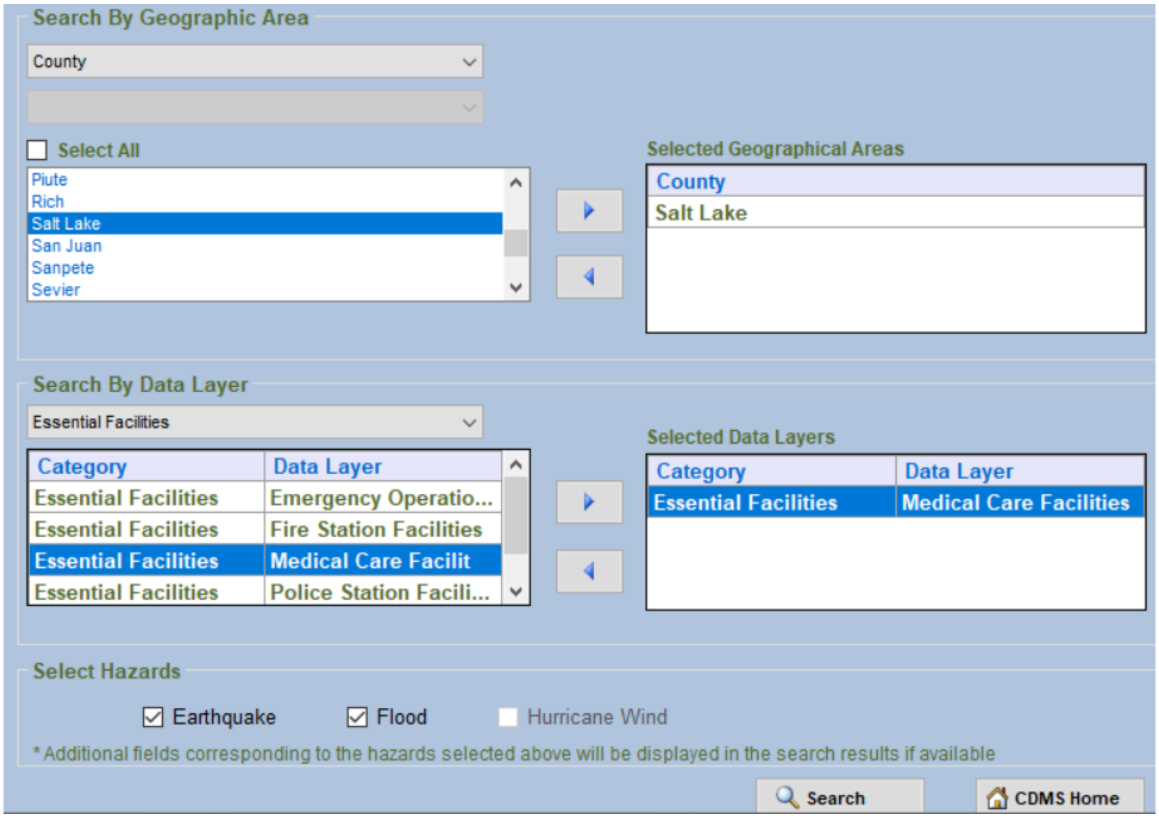


- A list of counties will appear in the box.
- For this exercise, we will be reviewing hospitals in Salt Lake City. Select “Salt Lake” as your county and move it over to the “Selected Geographical Areas” using the right arrow.



- Select “Essential Facilities,” in the Filter By Data Category drop-down menu. Click on “Medical Care Facilities” and use the right arrow to move it over to Selected Data Layers.

    Note: This drop-down can be used to filter through the various categories. If you do not want to filter, you can always simply scroll and select the desired data categories.

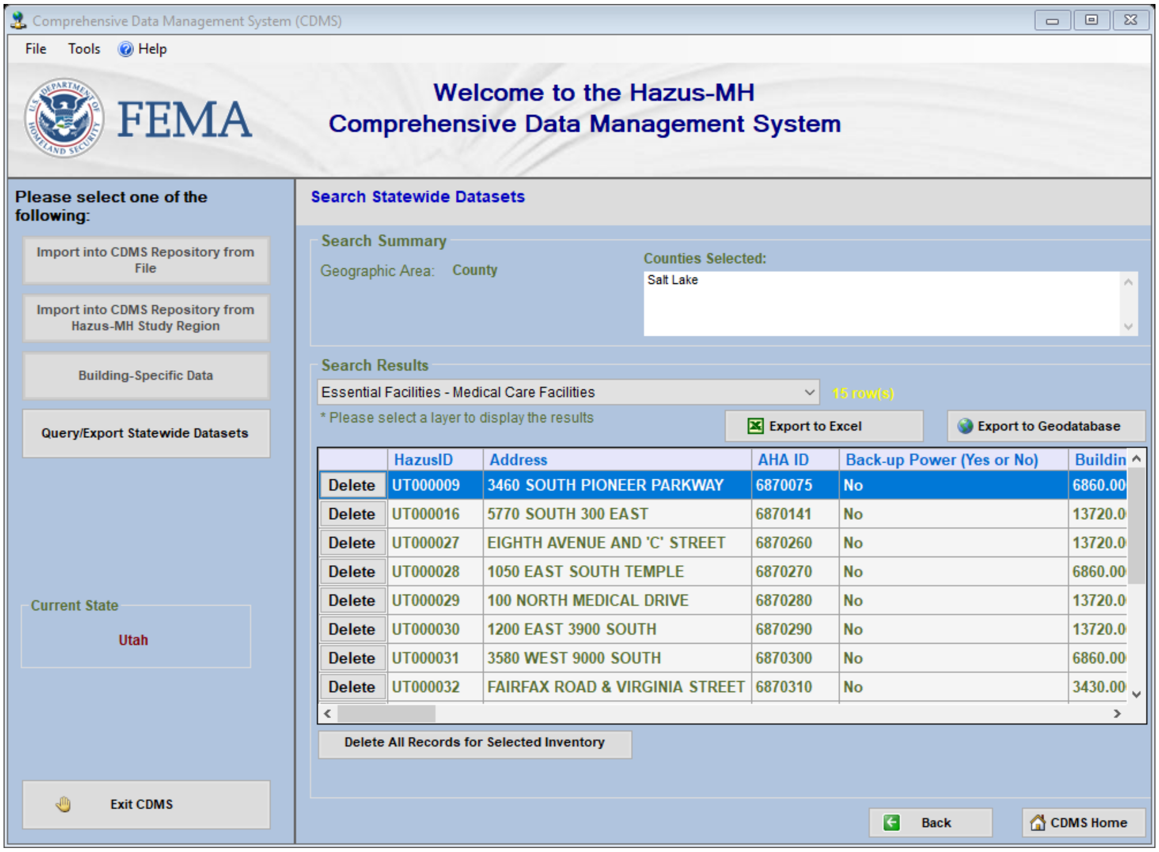


- Check off the hazards you wish to pull data for. For this exercise, check both "Earthquake" and "Flood."
- Click "Search." Depending on how many items CDMS has to pull, this can take a few minutes. For this exercise, it should take less than a minute.

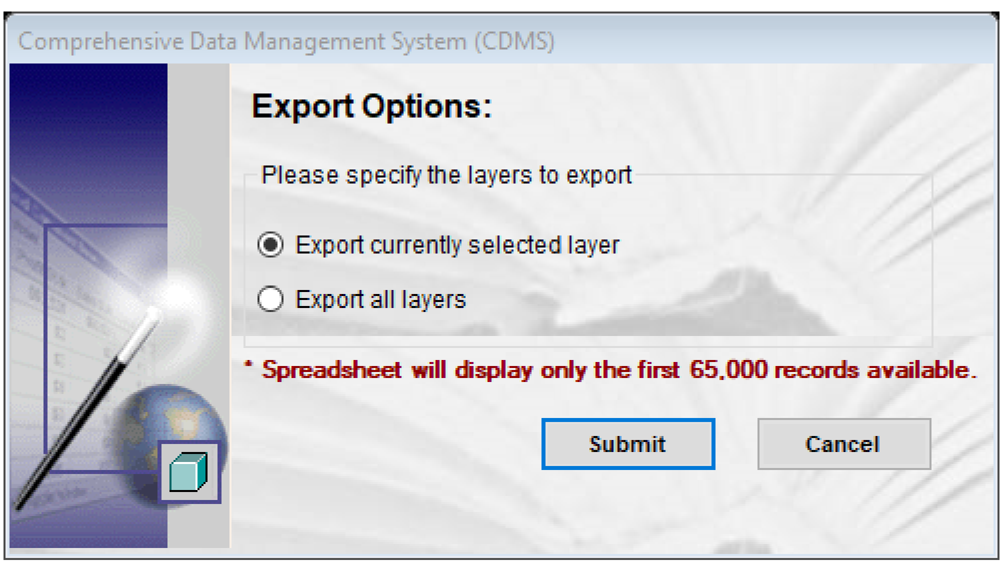
Task 3: Export Query to Excel

- The screen now displays all the Medical Care Facilities within Salt Lake County. They are organized by their HazusID. Select "Export to Excel."

  Note: If you wanted to make changes to the medical facilities, you would want to first back up your state database (found in //HazusData/Inventory).

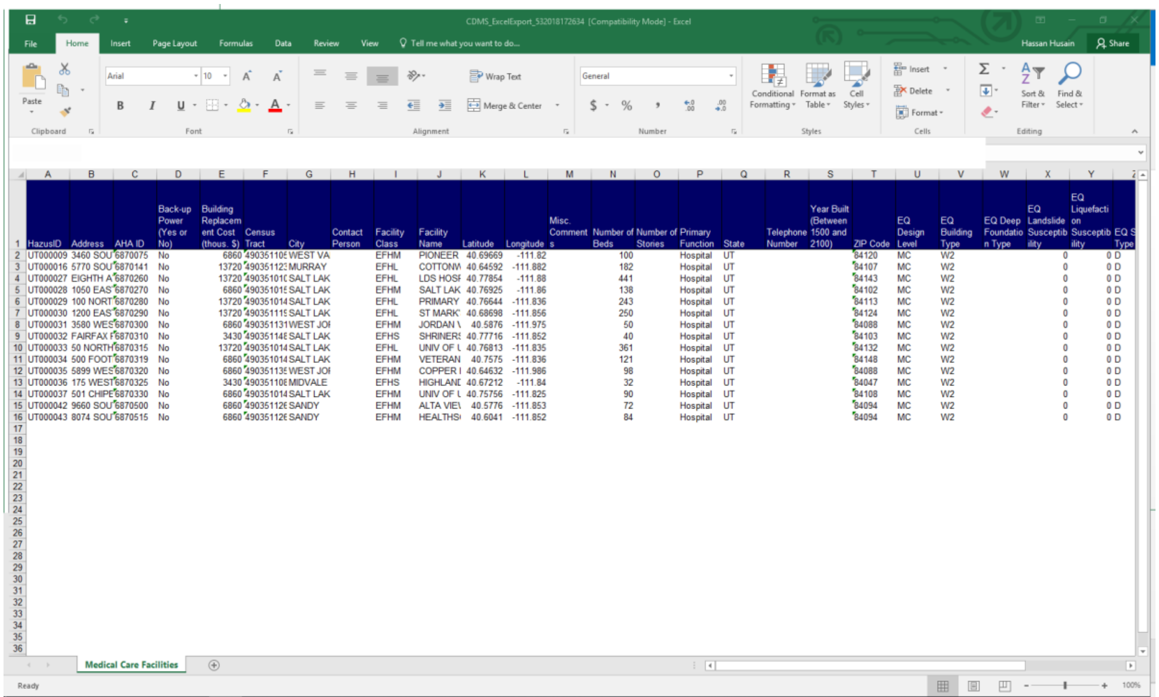


- Select “Export currently selected layer,” and click “Submit.”



- Name and save the exported file “Utah_MedicalFacilities.xls” in the Downloads folder. If a Downloads folder doesn’t exist, create one.
- Navigate to the location of the exported file and open it. You will see that the first row contains the various parameters Hazus uses for buildings. These are the fields Hazus can accept in order to add Medical Facilities to a database. Not all of these fields are required.

  Note: This represents the Hazus format of how Hazus looks at data. In subsequent exercises, we will go through how to add/update data for a Hazus database to use.



- Keep CDMS open for the next activity.

Exercise 6.2: Site-Specific Data

Type: Student-Led Activity

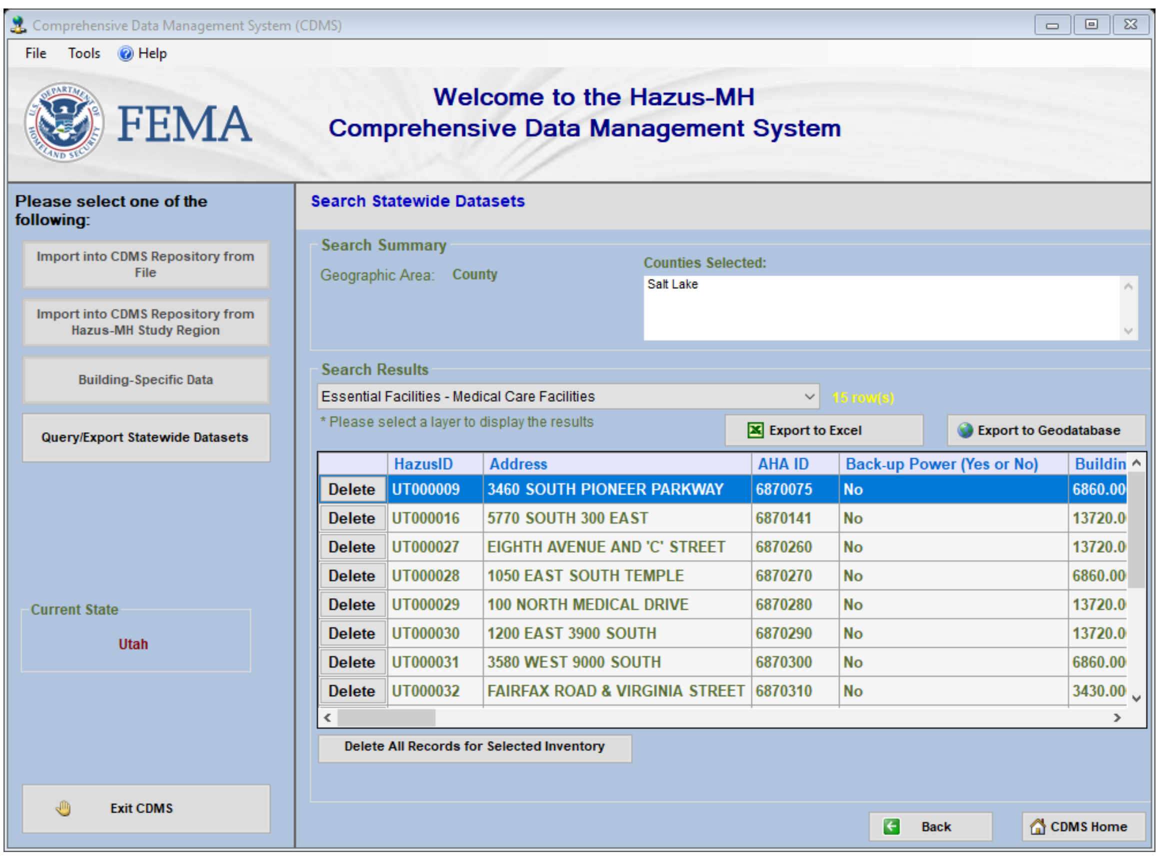
Time: 30 minutes

Goal: Use CDMS to update existing inventory.

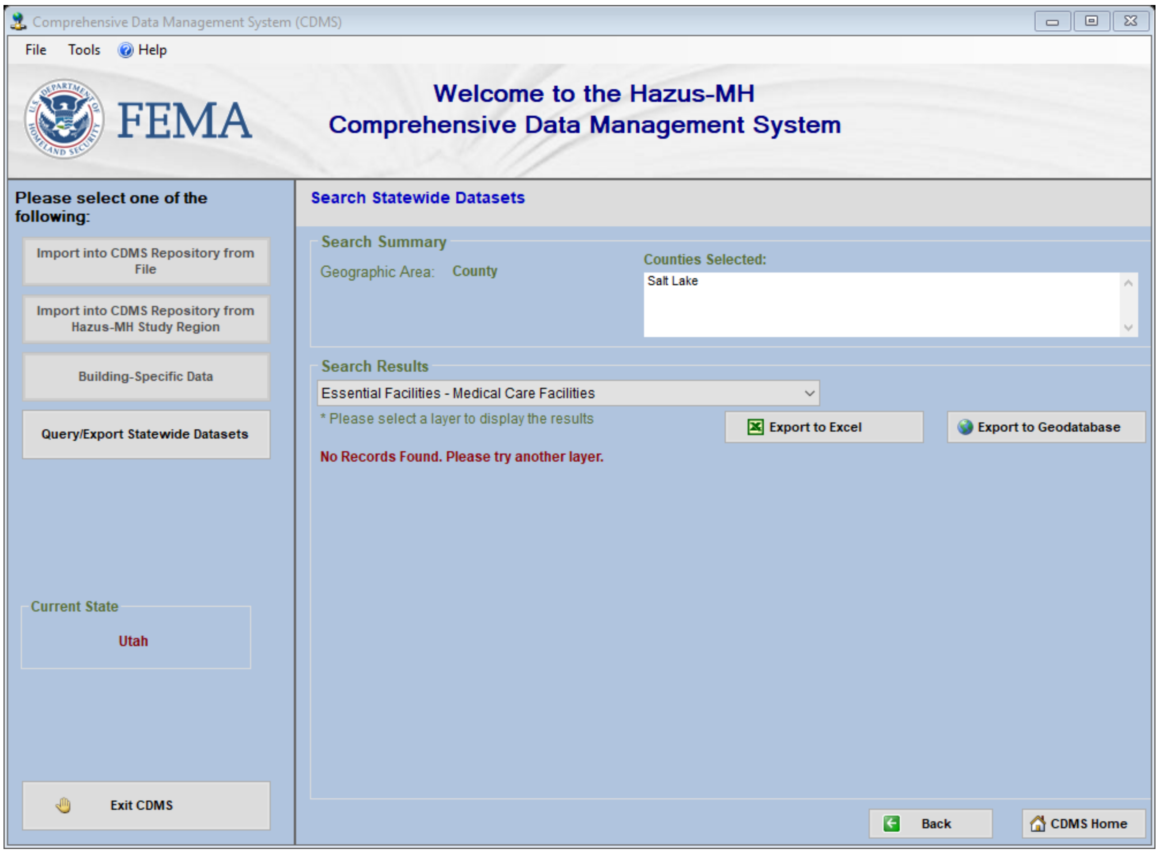
Background: This document describes how to use CDMS (Comprehensive Data Management System) to import data into a statewide database. For this exercise, you will use the data you exported from the last activity. If you were unable to complete the last activity, use the provided Utah_MedicalFacilities.xls file. Before beginning this exercise, it is recommended to back-up your Utah state database as this exercise may alter previous changes. In general, when making major updates and changes to a statewide dataset, it is a good idea to back up your latest working version.

Task 1: Query Hospitals in Salt Lake and Delete Existing Inventory

- This screen displays all the Medical Care Facilities within Salt Lake County organized by their HazusID.



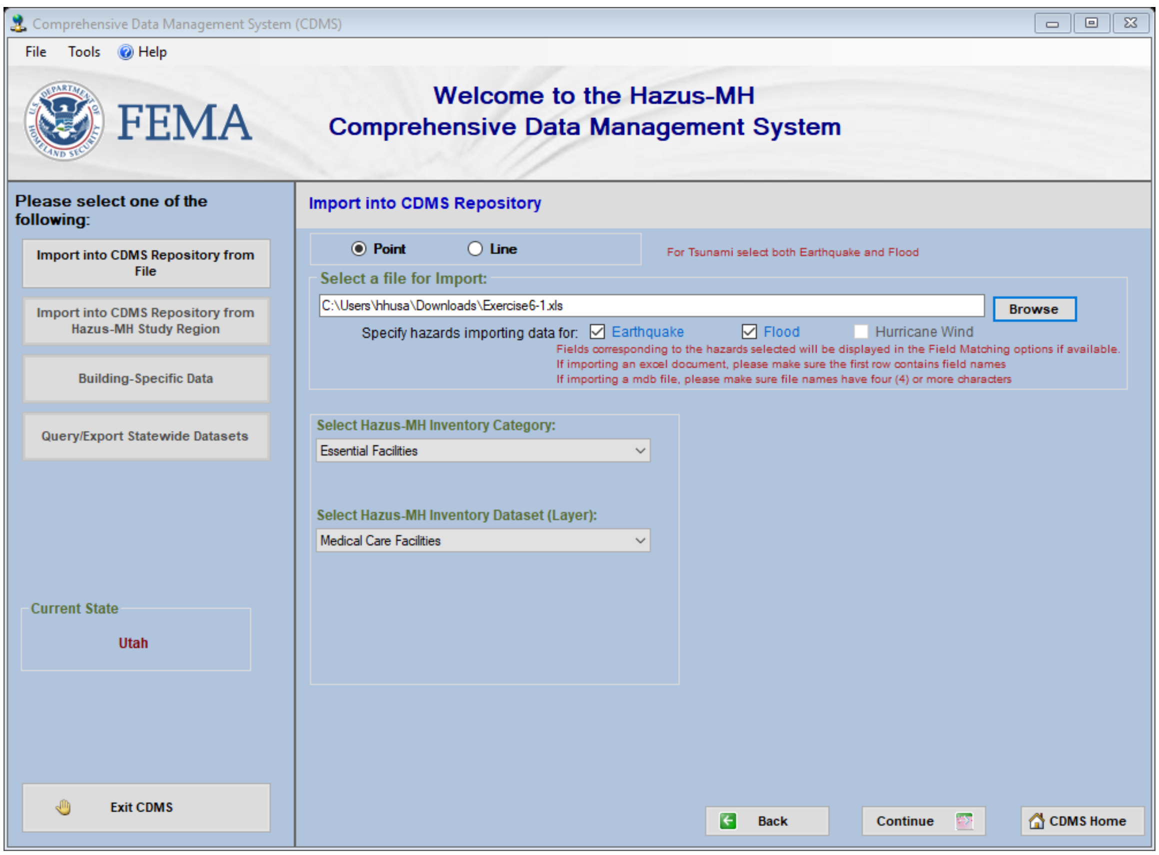
- In the previous exercise, this information was exported. For the purpose of this exercise, click on the first entry, hit “Ctrl + A” on your keyboard to select all entries, and then click “Delete All Records for Selected Inventory.” Click “Yes” when asked to confirm deletion.



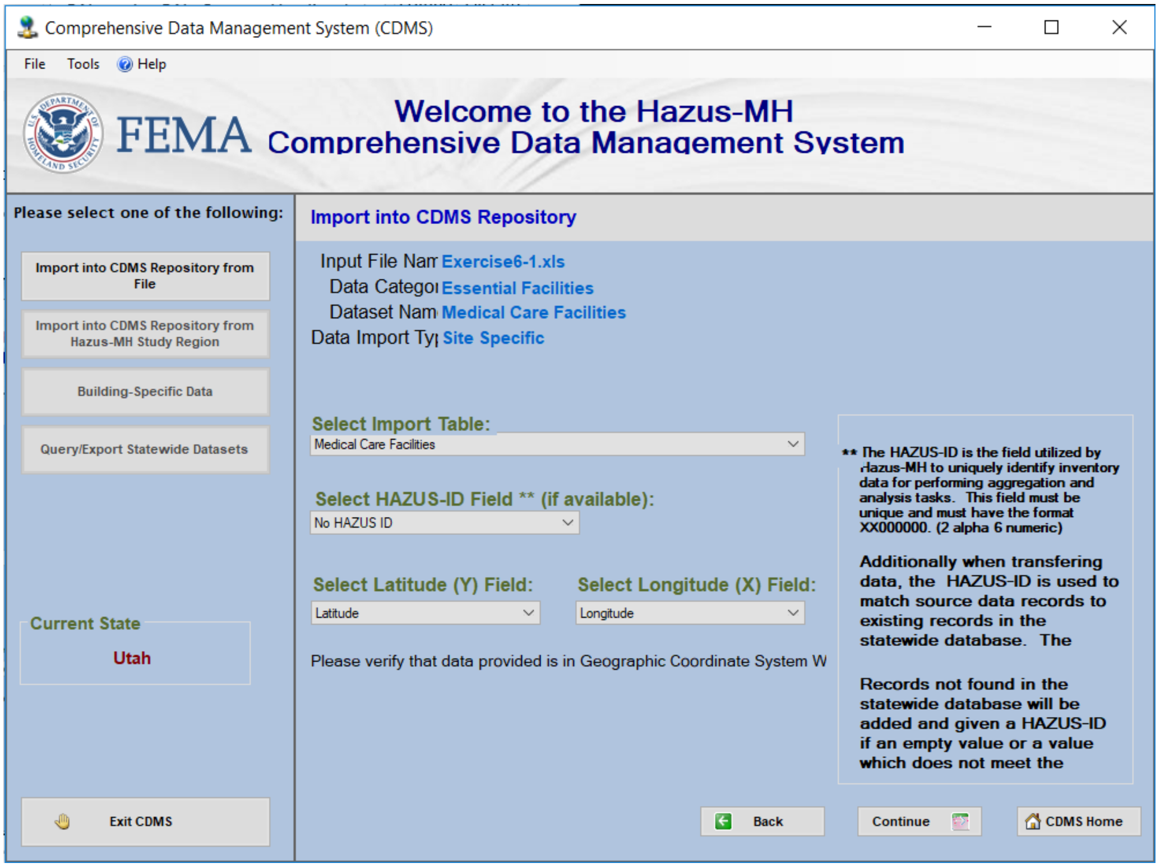
- You should now see zero entries for Medical Facilities. When updating data points for facilities, it is necessary to delete the previous entry. This ensures all the fields for that building are overwritten. In this case, all new entries will be added because the entire county is being updated.
- Open the Utah_MedicalFacilities.xls file from the last activity.
- Delete the first column, HazusID.
- Save the new file as Utah_MedicalFacilities_Edit.xls

Task 2: Import Medical Facilities Dataset into CDMS

- Click "CDMS Home."
- Select "Import into CDMS Repository from File."
- In the Select a file for Import dialogue, click "Browse" and change the file type to "Microsoft Excel (*.xls)." Navigate to the Utah_MedicalFacilities_Edit file in the downloads folder and click "Open."
- For "Specify hazards importing data for", select "Earthquake" and "Flood."
- For Select Inventory Category, select "Essential Facilities."
- For Select Inventory Dataset (Layer), select "Medical Care Facilities." Click "Continue."



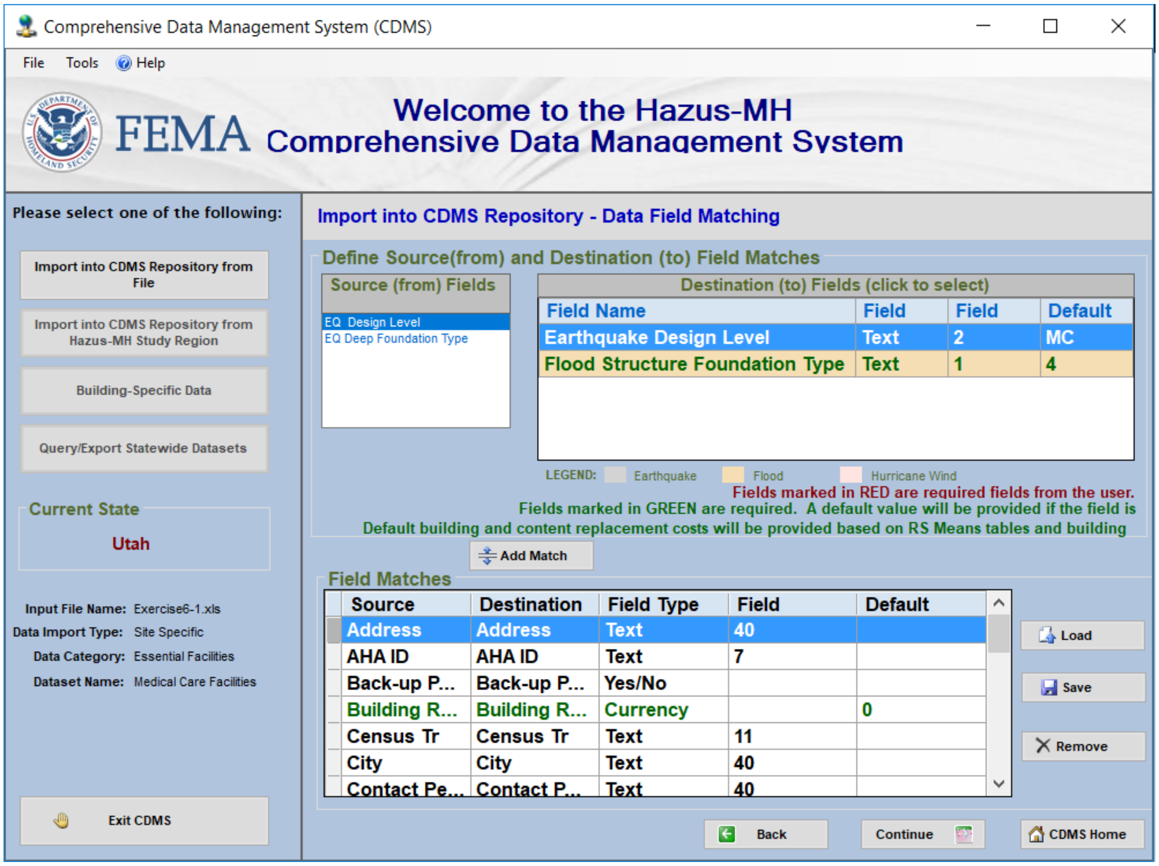
- Leave "Select Import Table" as the default.
- Change "Select HAZUS-ID Field" drop-down to "No HAZUS ID".
- For the "Latitude" drop-down, select "Latitude" and for the "Longitude" drop-down, select "Longitude."



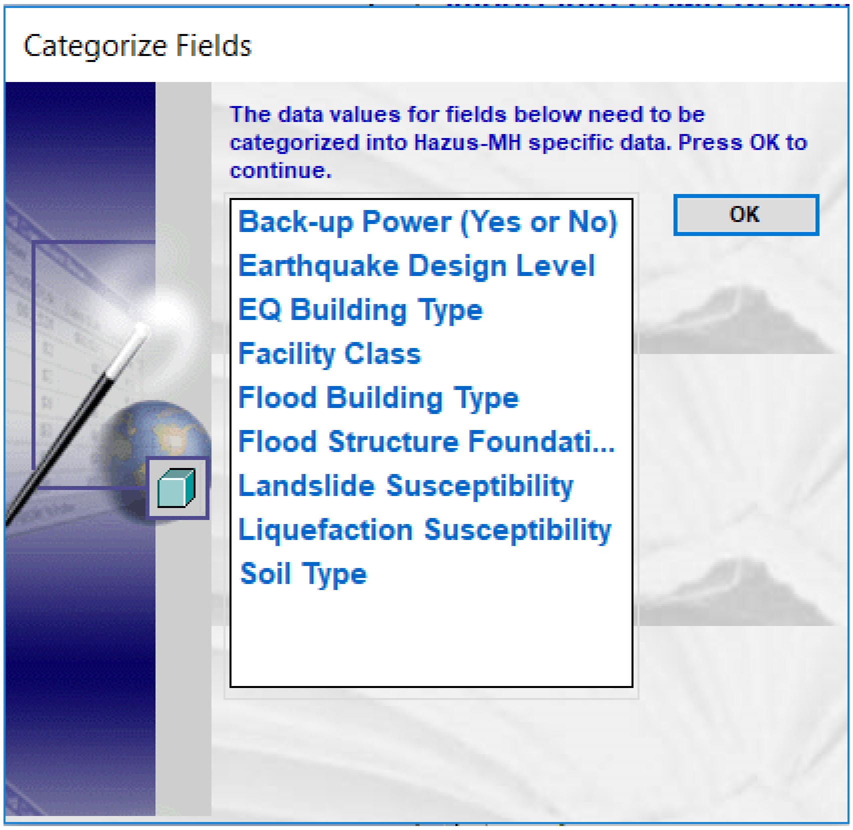
- Click “Continue.”

Task 3: Match Source and Destination Fields

- This screen will display data field matching. In a real situation, it would take effort to prepare the data to make sure it is compatible with what Hazus is looking for.
- Click “Add” from the “Source Fields” and make sure “Address” is selected from the Destination Fields. Then click “Add Match.”



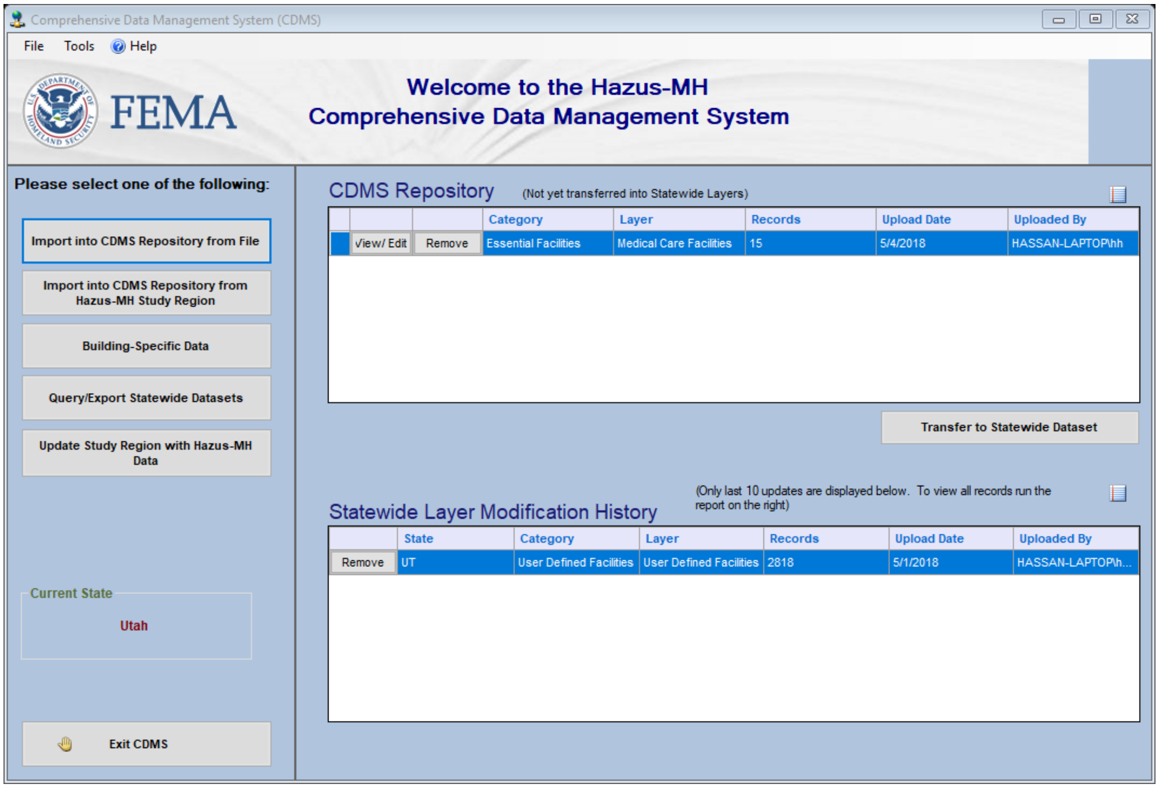
- Continue matching for the following items until you have one entry remaining in the “Source Fields” (EQ Deep Foundation Type) and one entry in the “Destination Fields.” (Flood Structure Foundation Type), which do not match. CDMS should match most of the Source and Destination columns naturally because it looks for similar naming conventions, however, it may miss some.
- Click “Continue.” A window will appear to inform you that default values will be put in for those where no matches were provided. Click “Yes.”
- CDMS will now ask you to categorize specific data. Click “OK.”



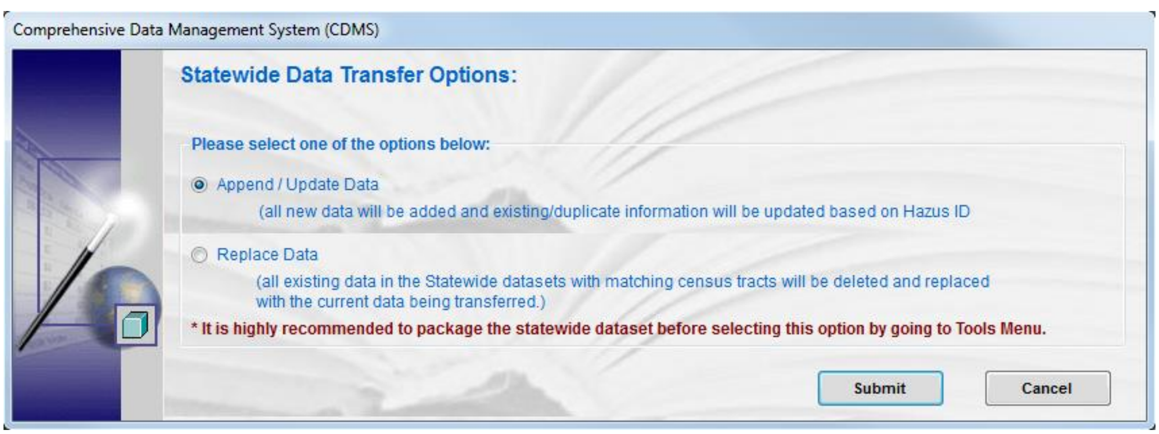
- On the next few screens, you will need to verify that the entry in Matching Results matches with an entry in the Destination box. For this exercise, they should all match up. In a real situation, there may be instances where you have to match the value in the Source field with the Destination field. Click "Continue" as they match up.
- CDMS will now process the information. This will take approximately one minute. Once the data is imported, a window will appear signifying the import was successful. Click "OK." Maintaining the most accurate data possible in CDMS will improve the accuracy of damage estimates and other Hazus results. When identifying medical facilities, for example, accurate building data may assist in identifying the hospitals that are still functional after a hazard strikes an area. The identification of functional and damage hospitals can support resource allocation, evacuation route planning, movement of at-risk populations, and other recovery efforts.

Task 4: Update State Database and Query for Confirmation

- Click "Transfer to Statewide Dataset."



- A Statewide Data Transfer Options window will appear. Since we already deleted previous entries, select "Append/Update Data."



- You will be asked to confirm this action. Click "Yes." This will take a few minutes to process.

- Once CDMS has added the new data to your Utah dataset, run the query exercise again to confirm the Medical Facilities have been added.

Exercise 7.2: User-Defined Facilities (UDF) Database

Type: Student-Led Activity

Time: 20 minutes

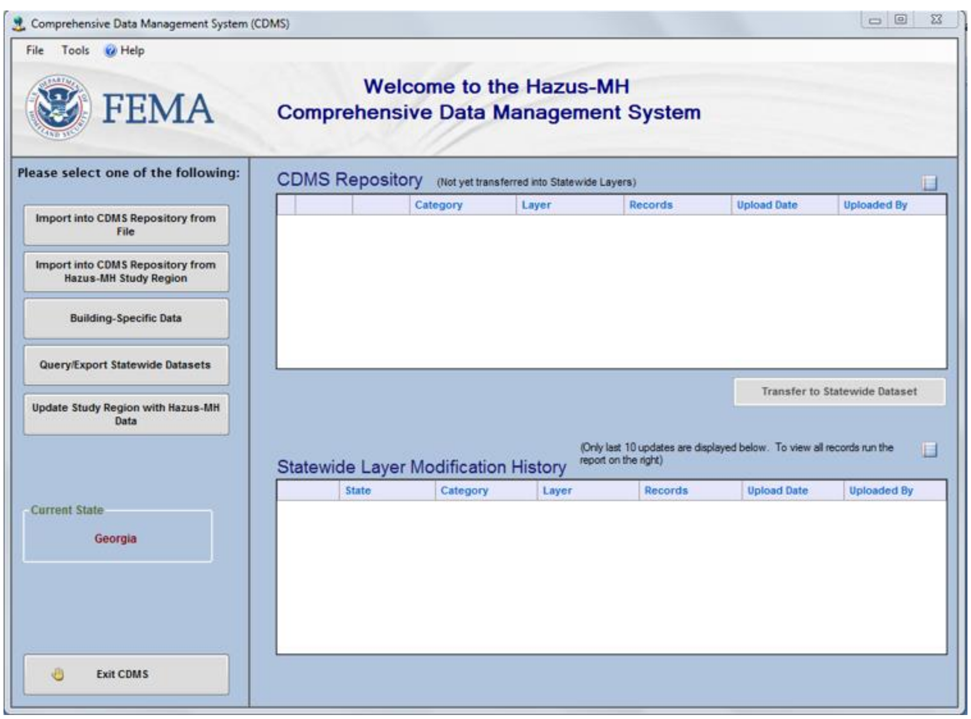
Goal: Load UDF into Hazus through CDMS.

Background: This document describes how to use CDMS (Comprehensive Data Management System) to add a dataset of User Defined Facilities (UDFs) to the Salt Lake City study region. You may need to extract the data found in the Activities data folder.

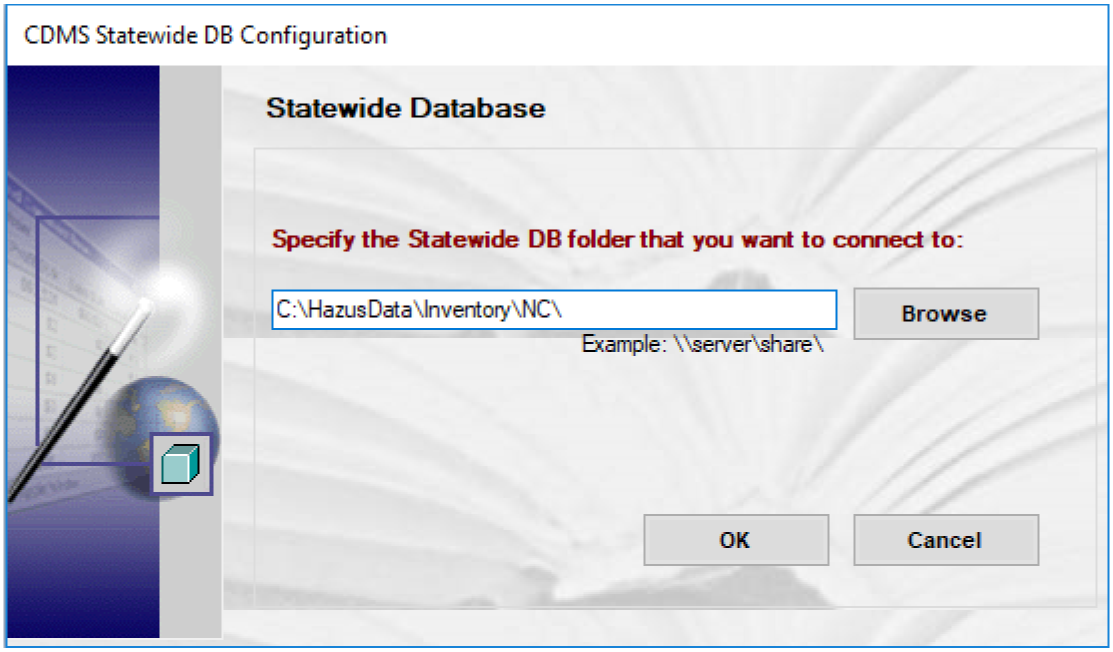
Note: Once you change a State Database you must create a new study region with the updated State Database. Old study regions are not updated with new inventory information from the state database after they are first formed.

Task 1: Open CDMS and confirm or change State Databases

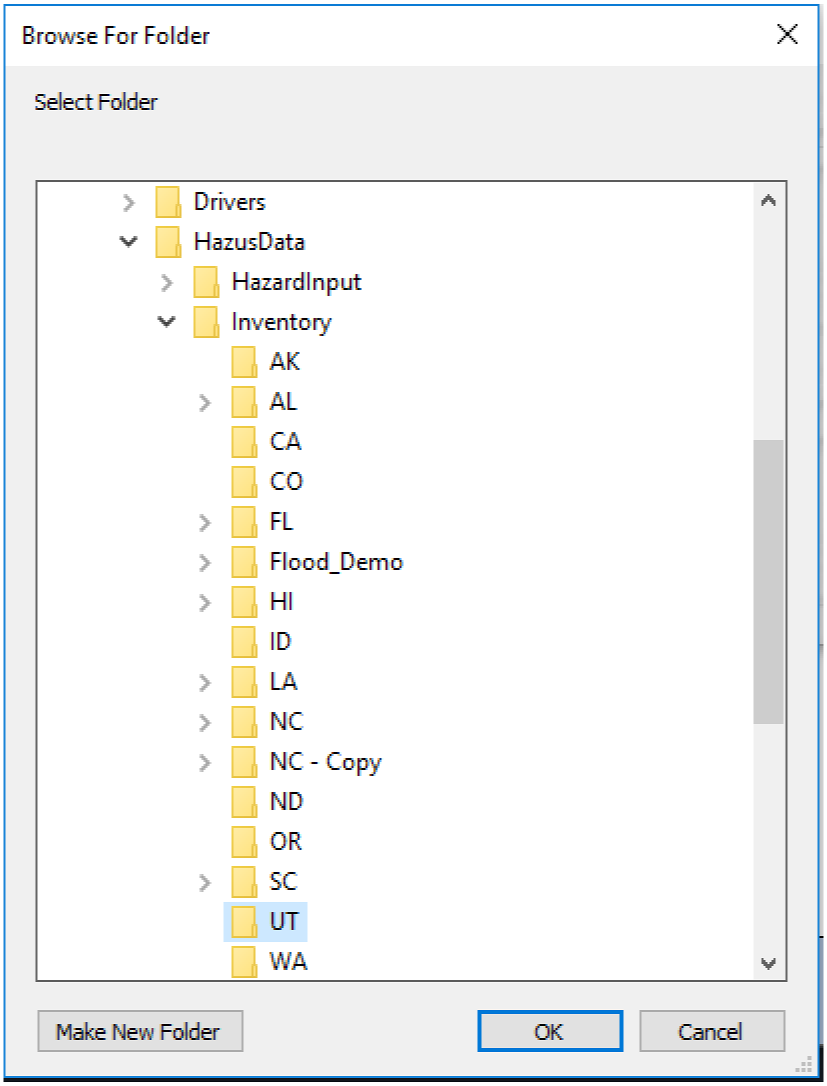
- Open CDMS. If the current state database is Utah (from previous exercises) you can skip to Task 2.



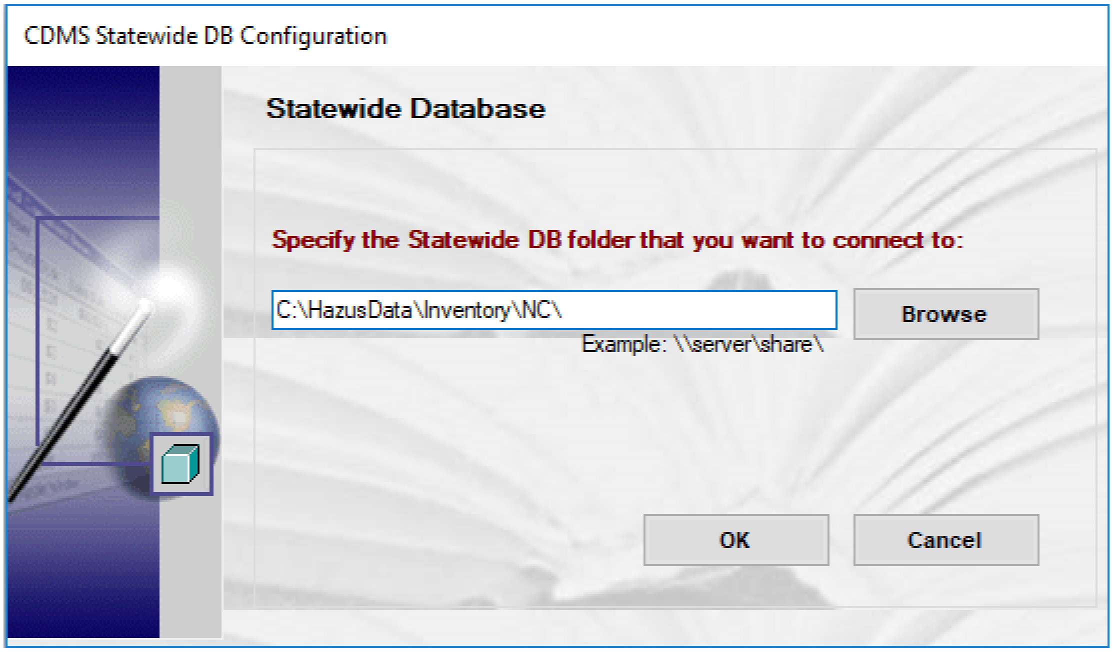
- Go to “Tools > Specify Hazus-MH Data Location.”
- The CDMS Statewide DB Configuration window will appear.



- Click “Browse” and navigate to C:\HazusData\Inventory\UT\.

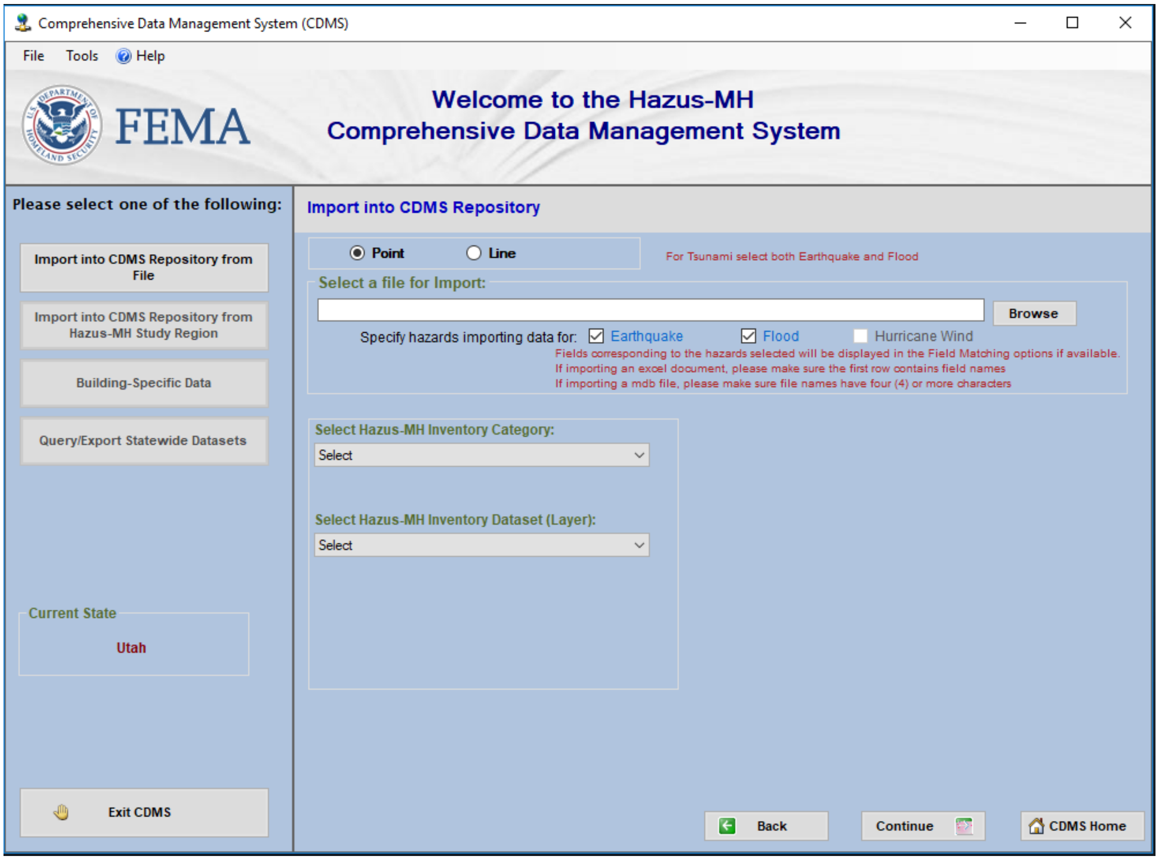


- Select UT and click “OK.” Click “OK” again and the current state will be changed to Utah.

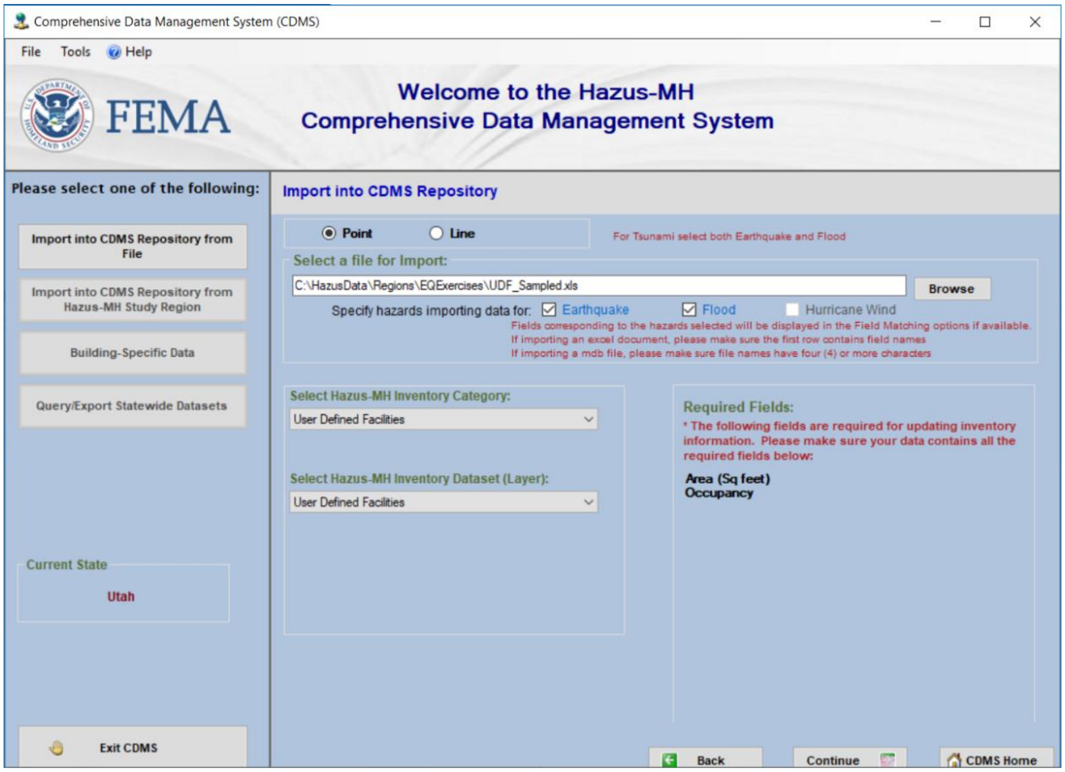


Task 2: Import the UDF data with CDMS and Set Import Parameters

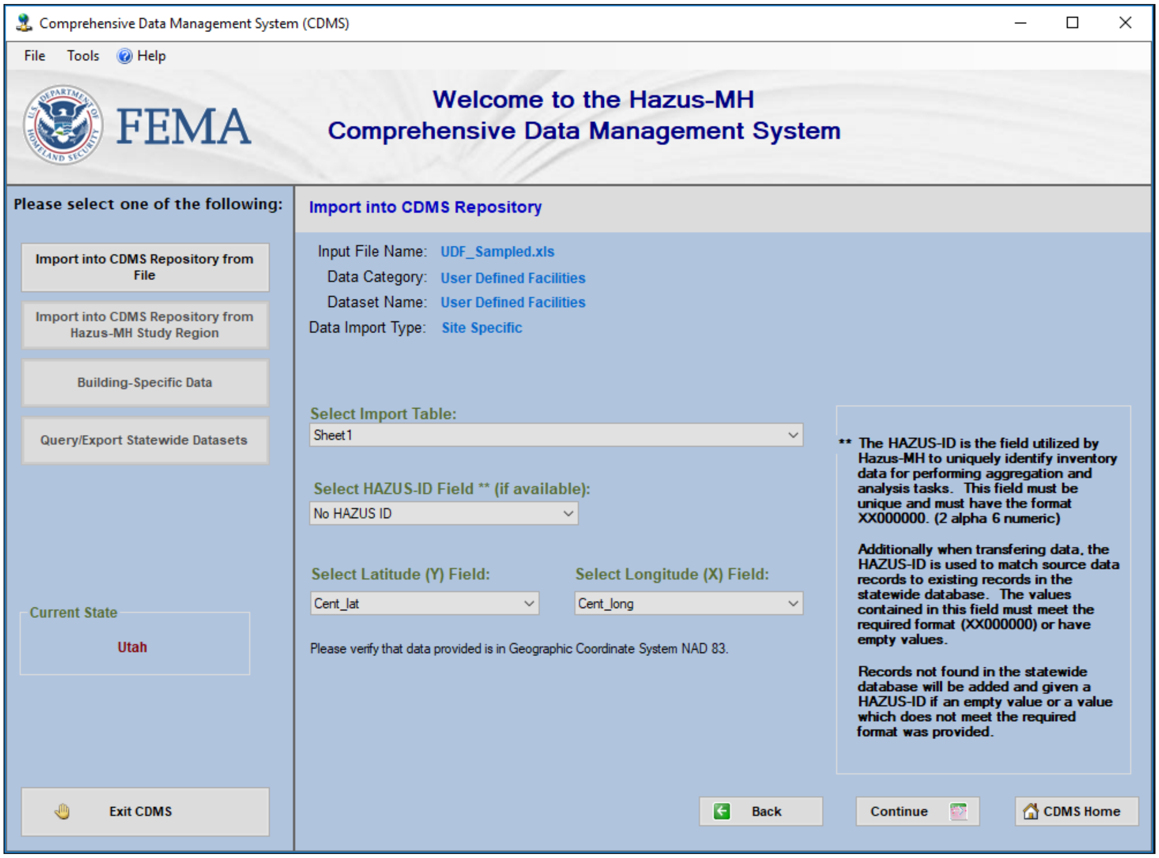
- Click “Import into CDMS Repository from File.”



- Click “Browse” and navigate to the Activities folder.
- Change the file type to find “Microsoft Excel File (*.xls).”
- Choose “UDF_Sampled.xls.”
- For “Specify hazard importing data for”, select “Earthquake” and “Flood.”
- Select “User Defined Facilities” from the drop-down menu for both Select Hazus Inventory Category and Select Hazus Inventory Dataset (Layer).



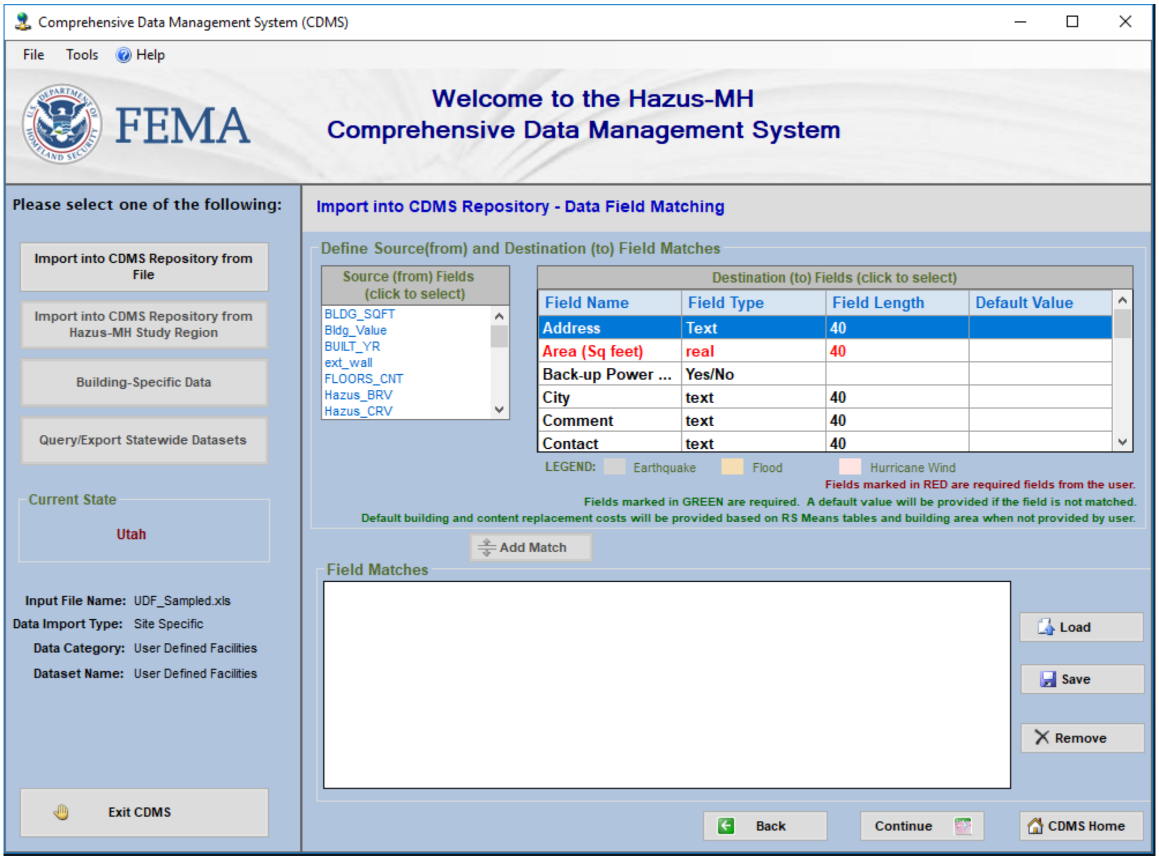
- Click “Continue.”
- “Sheet1” will be selected for the import table automatically.
  - It is the only sheet in the workbook.
  - If there were multiple sheets, the user would have to choose the table they wanted to import into CDMS.
- Select “No HAZUS ID” from the Select HAZUS ID Field ** (if available) drop-down menu.
- Select “Cent_lat” from the Select Latitude (Y) Field drop-down menu.
- Select “Cent_long” from the Select Longitude (X) Field drop-down menu.



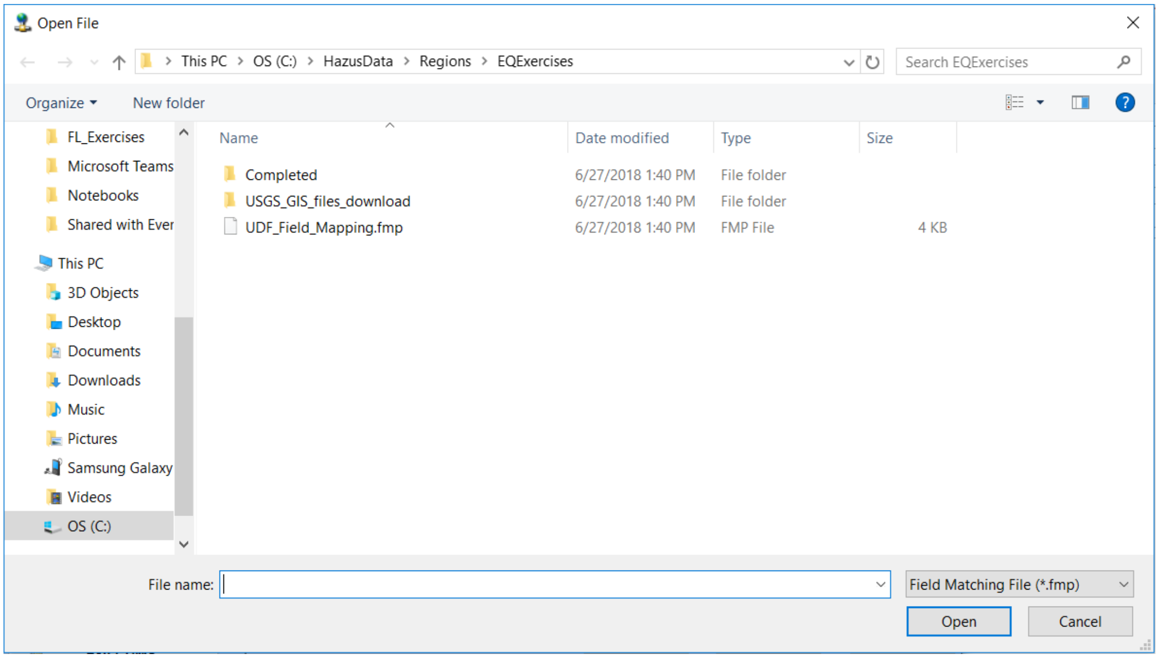
- Click “Continue.”

Task 3: Complete Data Field Mapping

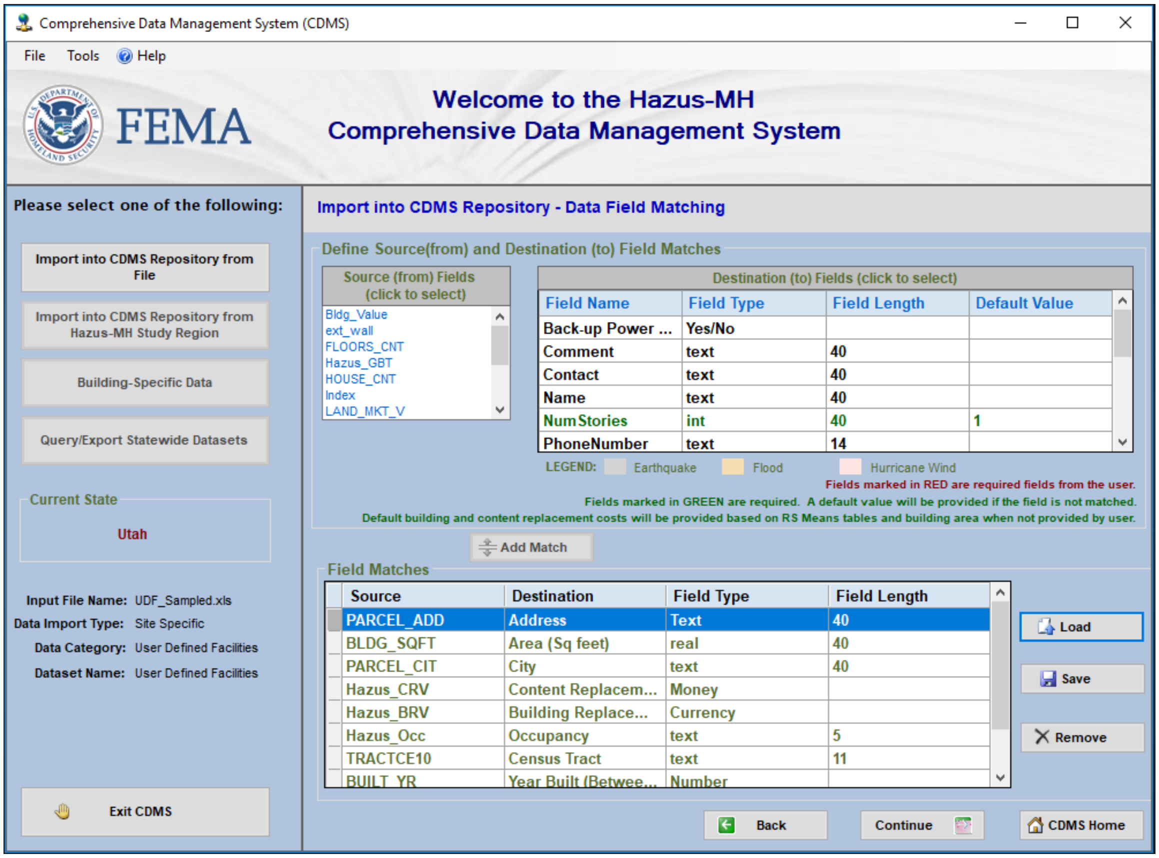
- Data Field Matching has already been done for you.
  - If needed, you can do it manually by selecting the source field, the destination field, and clicking “Add Match.”
- Click “Load.”



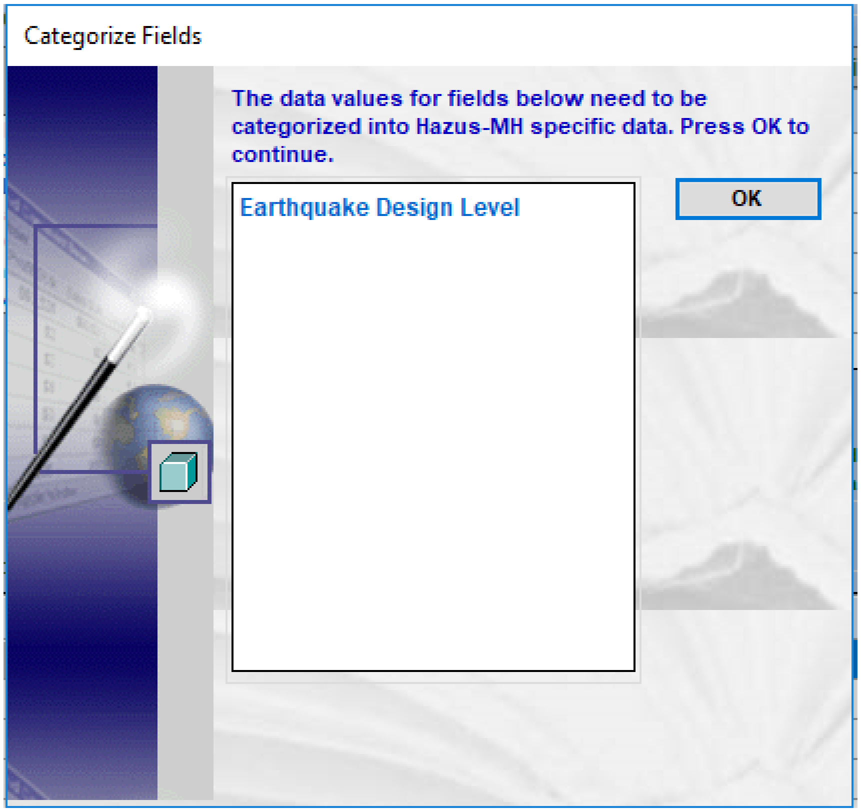
- Browse to the Activities folder and select the “UDF_Field_Mapping.fmp” file. Click “Open.”



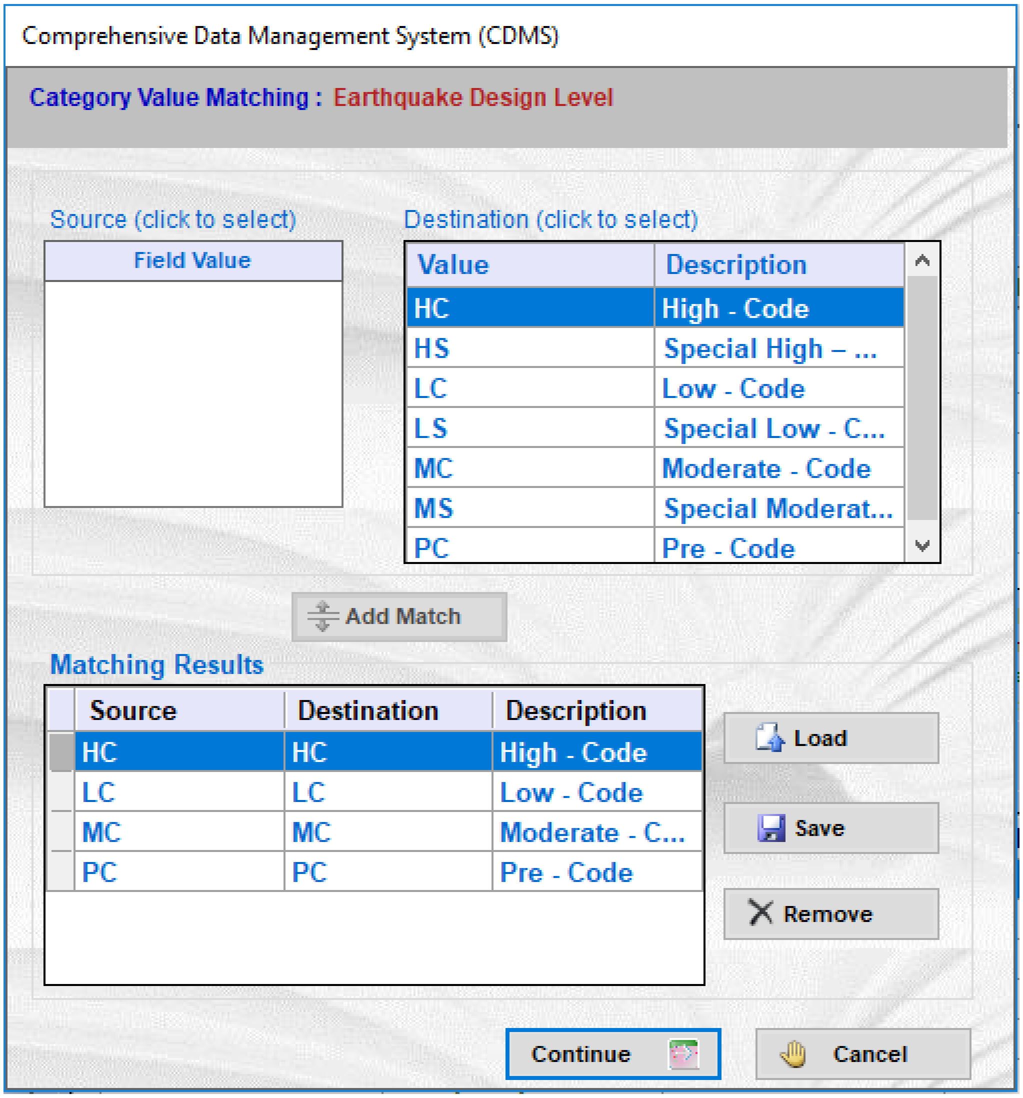
- The fields will automatically be mapped.



- Click “Continue.”
- CDMS will ask if the Hazus defaults are ok for the rest of the fields. Click “Yes”
- CDMS will ask you to categorize the “Earthquake Design Level.” Click “OK.”



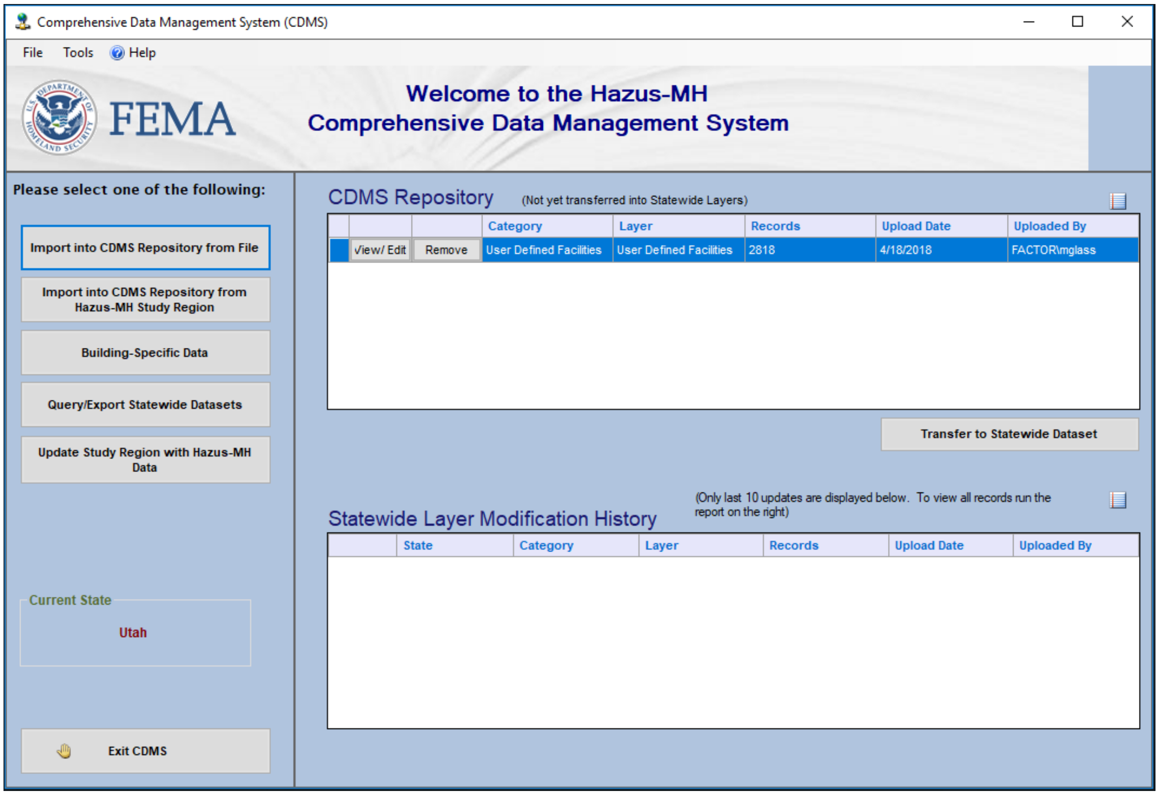
- All the values have been properly mapped. Click "Continue."



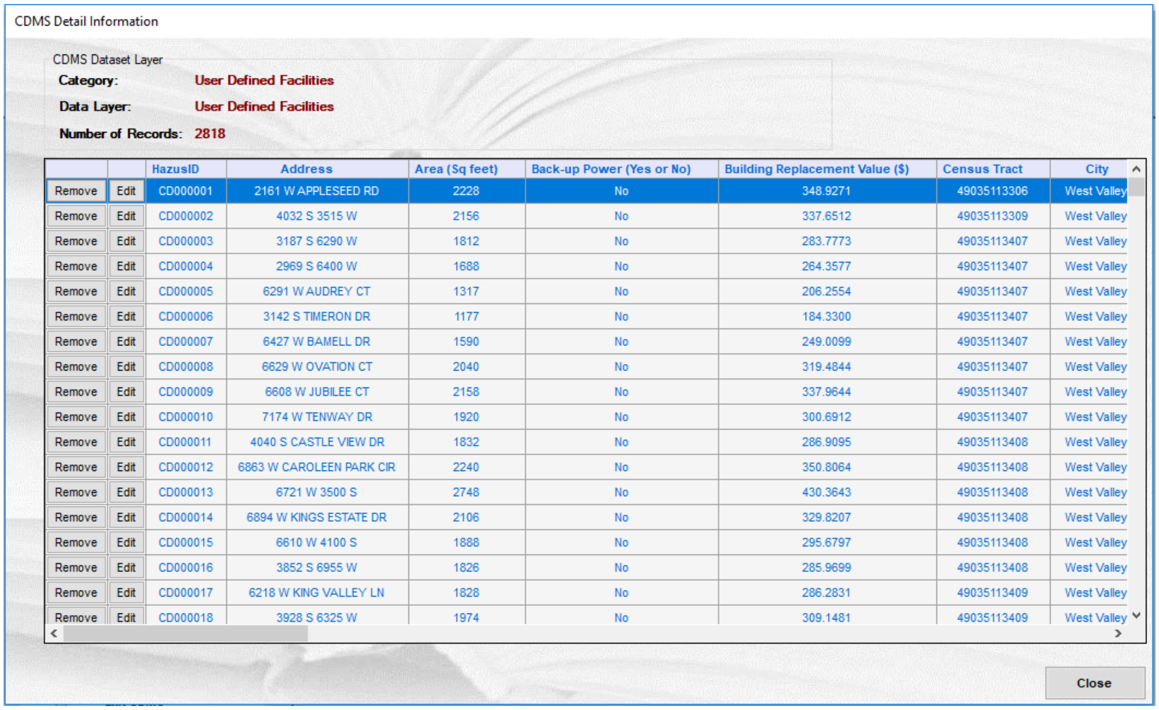
- CDMS will now run this request. This will take approximately 3 to 4 minutes. When the confirmation box appears, click “OK.”

Task 4: View Table and Import into State Geodatabase

- Click “View/Edit.”



- A UDF table will appear that will be used by Hazus. Explore it at your leisure.


CDMS Detail Information

CDMS Dataset Layer

Category: User Defined Facilities

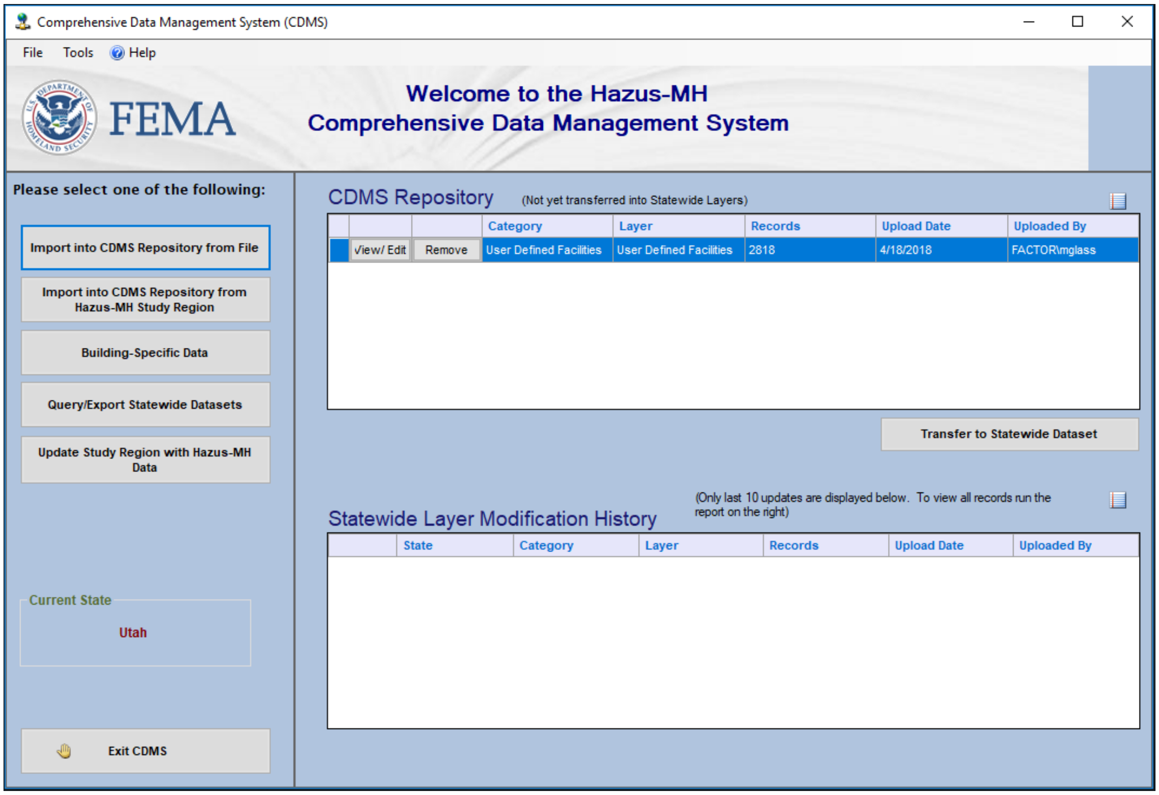
Data Layer: User Defined Facilities

Number of Records: 2818

		HazusID	Address	Area (Sq feet)	Back-up Power (Yes or No)	Building Replacement Value ($)	Census Tract	City
Remove	Edit	CD000001	2161 W APPLESEED RD	2228	No	348.9271	49035113306	West Valley
Remove	Edit	CD000002	4032 S 3515 W	2156	No	337.6512	49035113309	West Valley
Remove	Edit	CD000003	3187 S 6290 W	1812	No	283.7773	49035113407	West Valley
Remove	Edit	CD000004	2969 S 6400 W	1688	No	264.3577	49035113407	West Valley
Remove	Edit	CD000005	6291 W AUDREY CT	1317	No	206.2554	49035113407	West Valley
Remove	Edit	CD000006	3142 S TIMERON DR	1177	No	184.3300	49035113407	West Valley
Remove	Edit	CD000007	6427 W BAMELL DR	1590	No	249.0099	49035113407	West Valley
Remove	Edit	CD000008	6629 W OVATION CT	2040	No	319.4844	49035113407	West Valley
Remove	Edit	CD000009	6608 W JUBILEE CT	2158	No	337.9644	49035113407	West Valley
Remove	Edit	CD000010	7174 W TENWAY DR	1920	No	300.6912	49035113407	West Valley
Remove	Edit	CD000011	4040 S CASTLE VIEW DR	1832	No	286.9095	49035113408	West Valley
Remove	Edit	CD000012	6863 W CAROLEEN PARK CIR	2240	No	350.8064	49035113408	West Valley
Remove	Edit	CD000013	6721 W 3500 S	2748	No	430.3643	49035113408	West Valley
Remove	Edit	CD000014	6894 W KINGS ESTATE DR	2106	No	329.8207	49035113408	West Valley
Remove	Edit	CD000015	6610 W 4100 S	1888	No	295.6797	49035113408	West Valley
Remove	Edit	CD000016	3852 S 6955 W	1826	No	285.9699	49035113408	West Valley
Remove	Edit	CD000017	6218 W KING VALLEY LN	1828	No	286.2831	49035113409	West Valley
Remove	Edit	CD000018	3928 S 6325 W	1974	No	309.1481	49035113409	West Valley

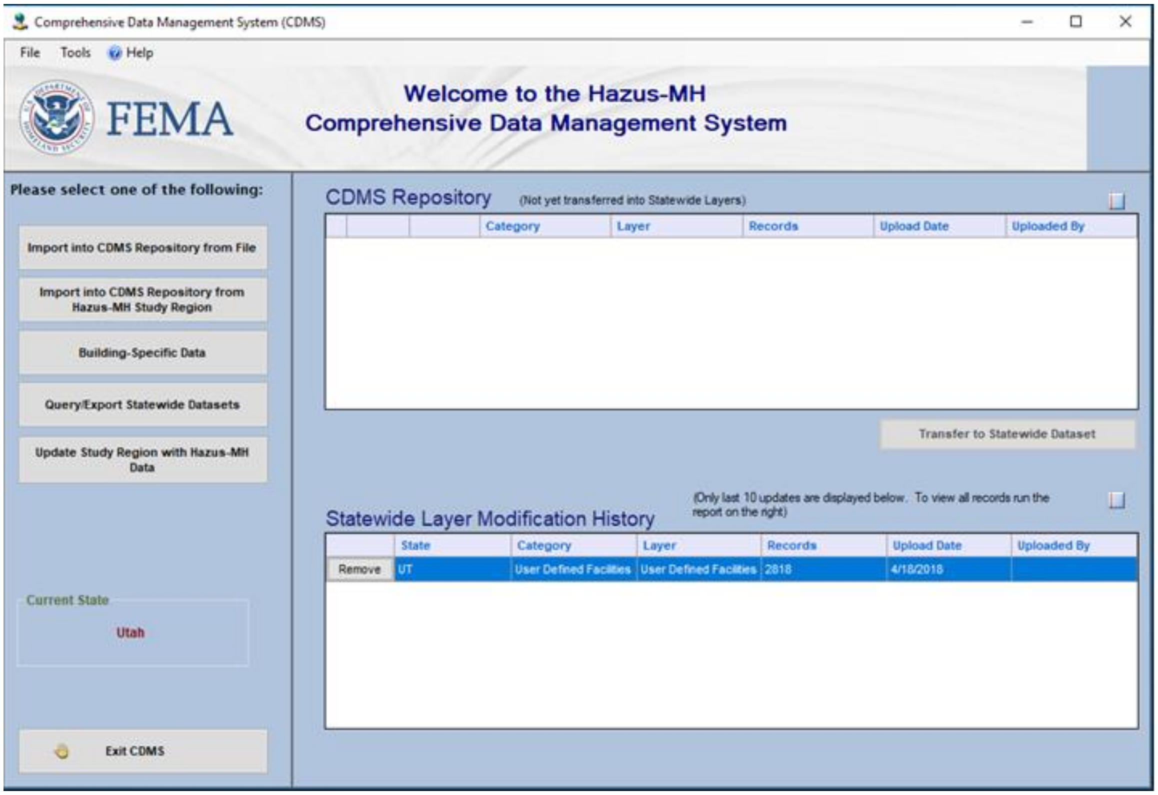
Close

- Click “Close.”
- Click “Transfer to Statewide Dataset.”



- Click “Append/Update Data” and then “Submit.”

- CDMS will ask for confirmation. Click “Yes.” This will take about 1 minute.
- The window will then show that the UDF dataset has been moved to the State database folder.


Comprehensive Data Management System (CDMS)
File Tools Help
FEMA
Welcome to the Hazus-MH
Comprehensive Data Management System
Please select one of the following:
Import into CDMS Repository from File
Import into CDMS Repository from Hazus-MH Study Region
Building-Specific Data
Query/Export Statewide Datasets
Update Study Region with Hazus-MH Data
Current State
Utah
Exit CDMS
CDMS Repository
(Not yet transferred into Statewide Layers)
Category
Layer
Records
Upload Date
Uploaded By
Transfer to Statewide Dataset
(Only last 10 updates are displayed below. To view all records run the report on the right)
Statewide Layer Modification History
State
Category
Layer
Records
Upload Date
Uploaded By
Remove
UT
User Defined Facilities
User Defined Facilities
2818
4/18/2018

Exercise 8.1: Depth Grid

Type: Student-Led Activity

Time: 25 minutes

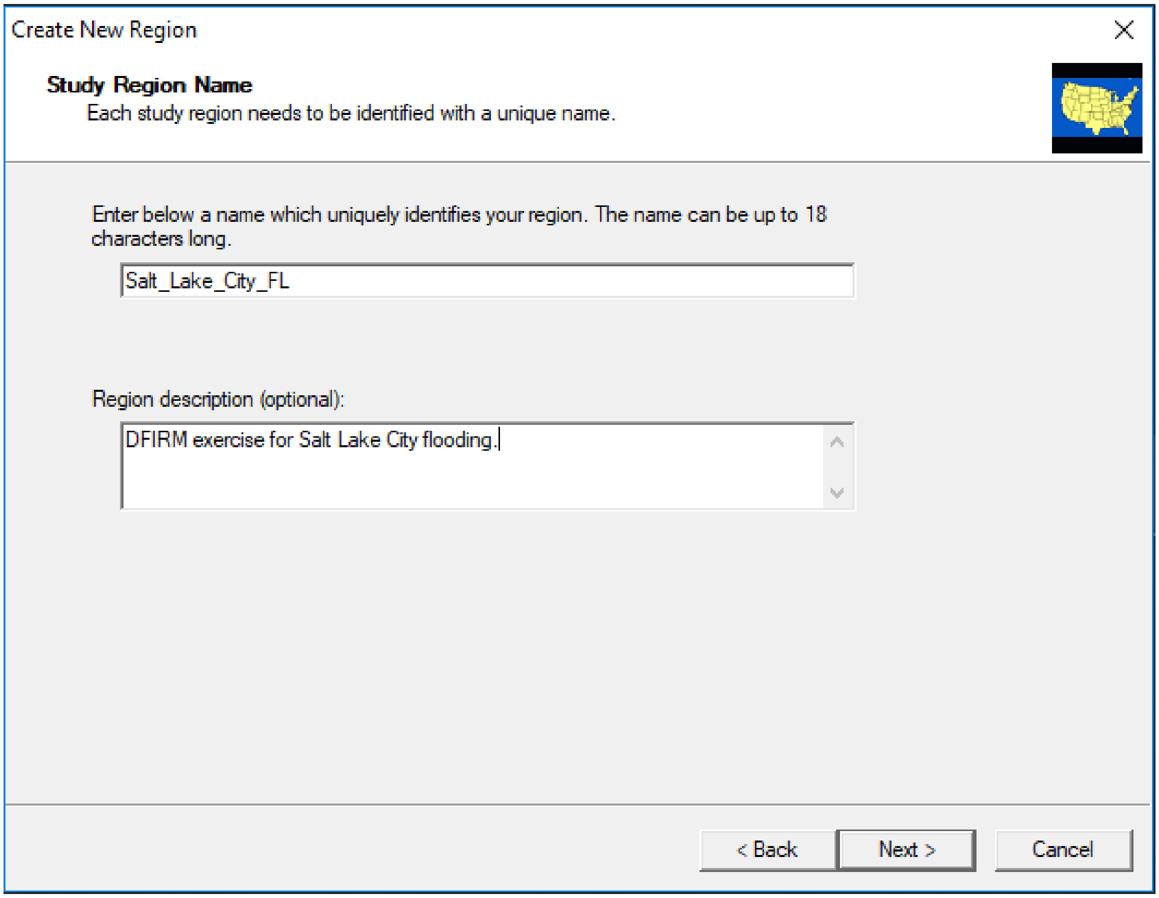
Goal: Import a 100-year depth grid.

File Preparation:

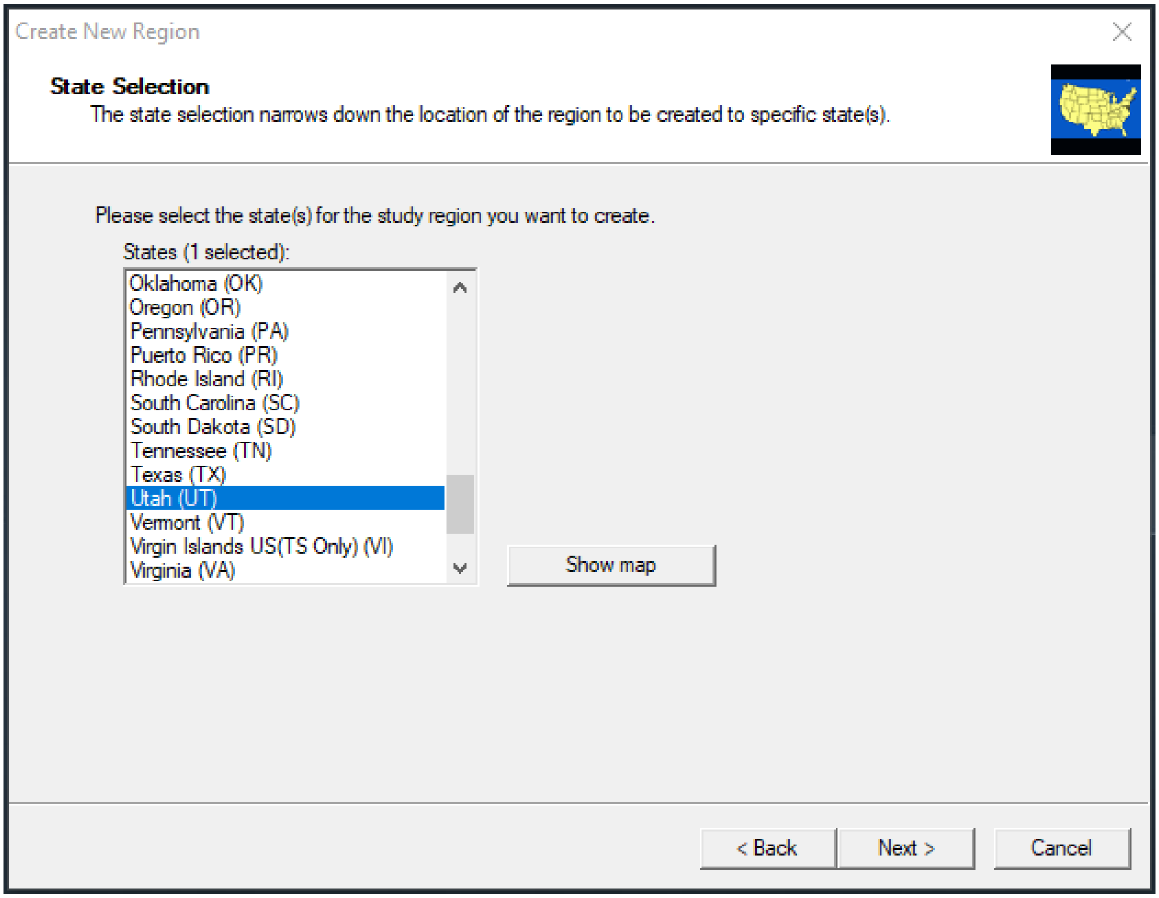
- You should have Utah state data already on your computer. If not, download the "Utah" State Folder from https://msc.fema.gov/portal/resources/hazus
- Move the file to the "\HazusData\Inventory\" folder and unzip the folder onto the hard drive of the computer on which the analysis is being conducted (for this example, C:\HazusData\Inventory).
  - To unzip the folder, double-click the UT file and it will extract itself to the correct location.
- Your instructor will provide data in the Activities folder. Unzip the SaltLake.zip folder so you can access it throughout the exercise.
- Place this folder in the "\HazusData\Regions\" on the hard drive of the computer.

Task 1: Create a New Salt Lake City Study Region

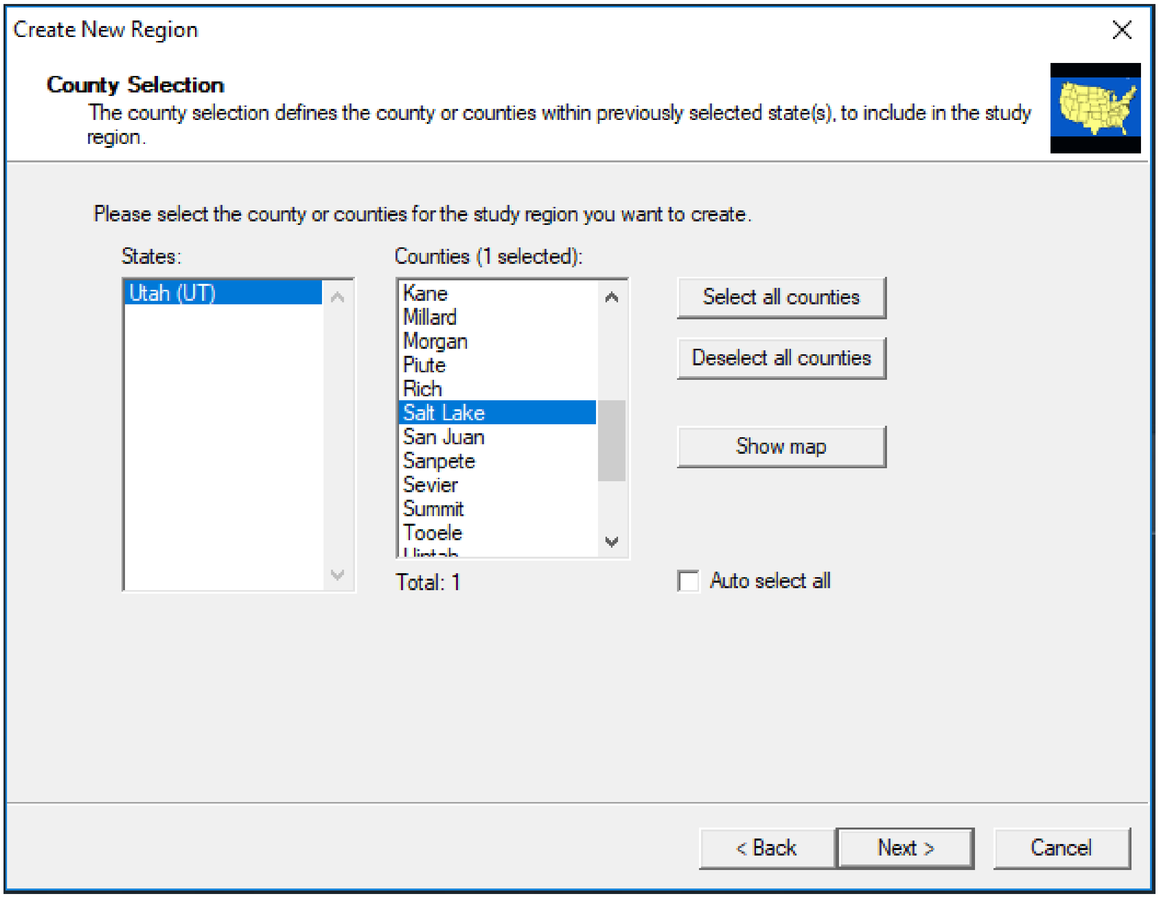
- Open Hazus 4.2.
- Click "Create a new study region" and "OK."
- The Create New Region window will appear. Click "Next."
- Name the study region "Salt_Lake_City_FL" and enter a brief description, such as "DFIRM exercise for Salt Lake City flooding."
- Click "Next."



- Check the box “Flood” and click “Next.”
- Click “County” and then “Next.”
- Select “Utah” and click “Next.”



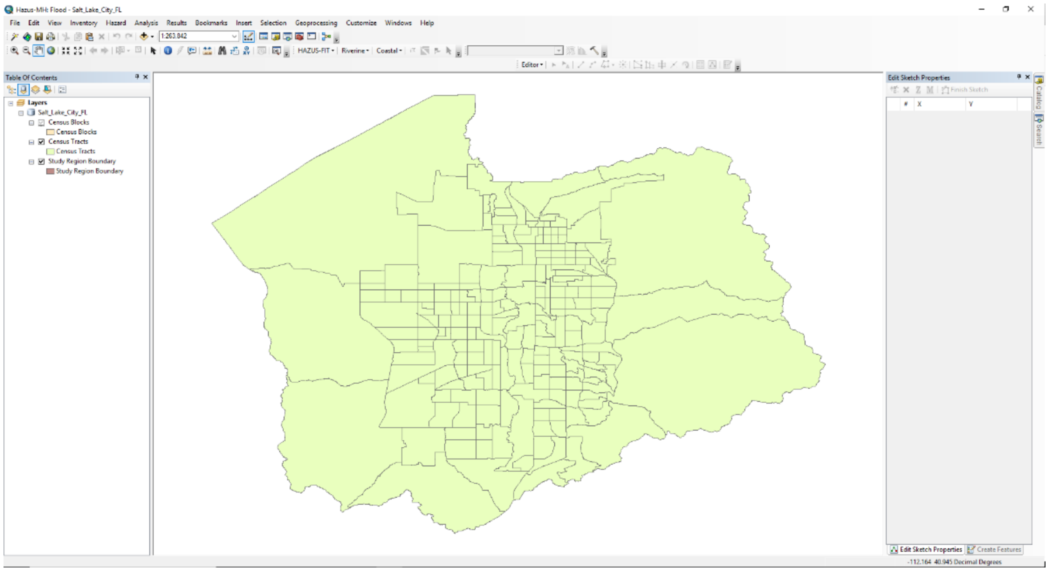
- Select “Salt Lake” County and click “Next.”



- Click "Finish."

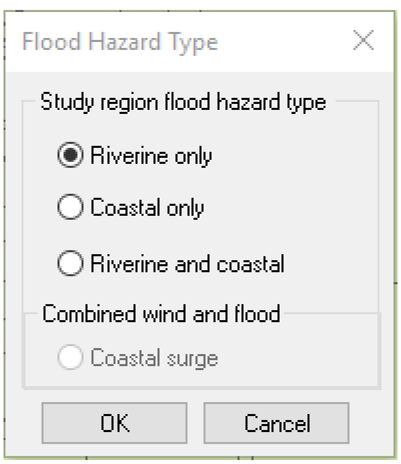
Task 2: Open Salt Lake City Study Region

- Click "Open a region" and then "OK." The Open Region window will appear.
- Click "Next."
- Select "Salt_Lake_City_FL" and click "Next."
- Click "Finish." ArcMap will open your Salt Lake City region.

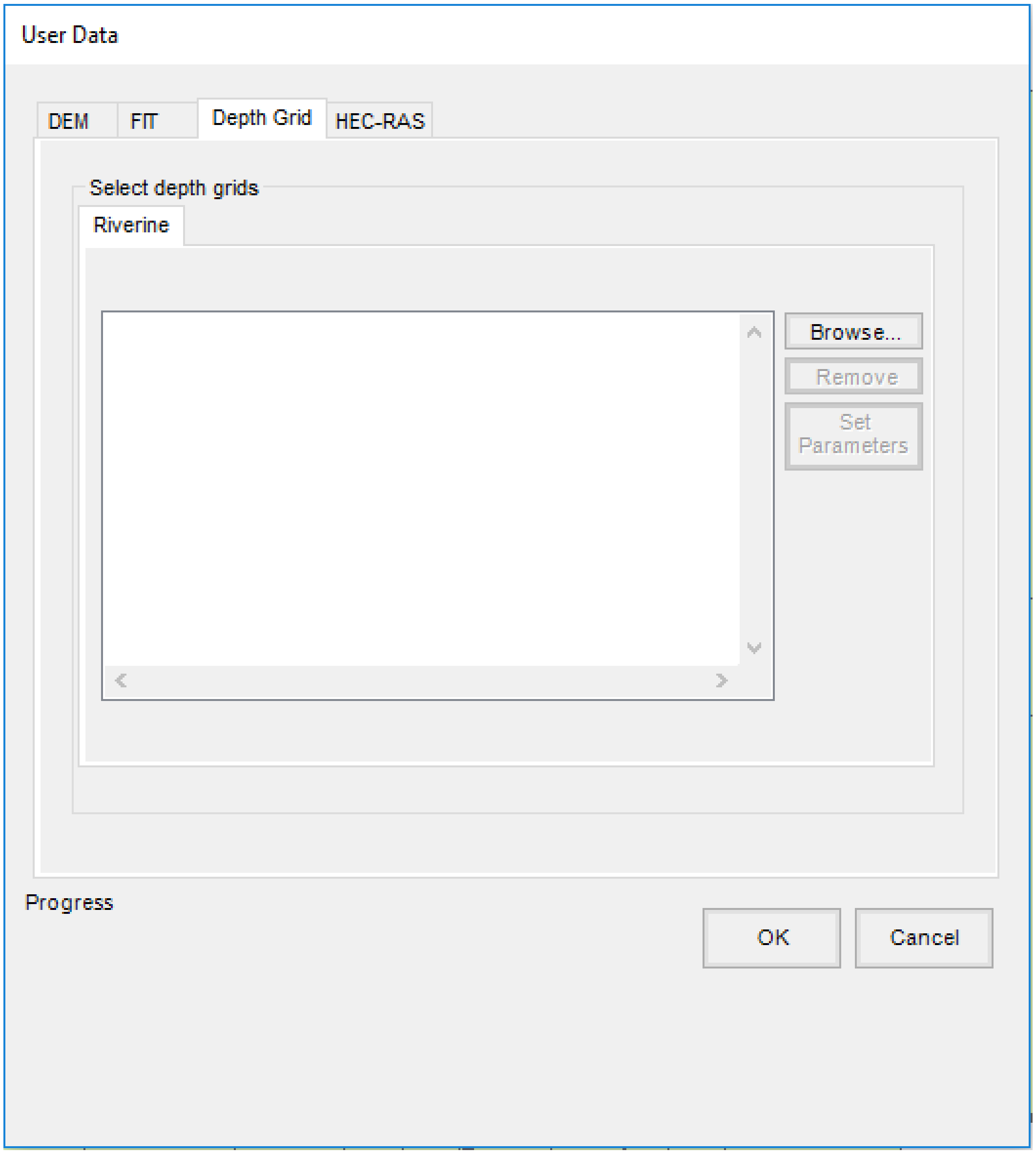


Task 3: Use the Hazus Interface to Define a DFIRM

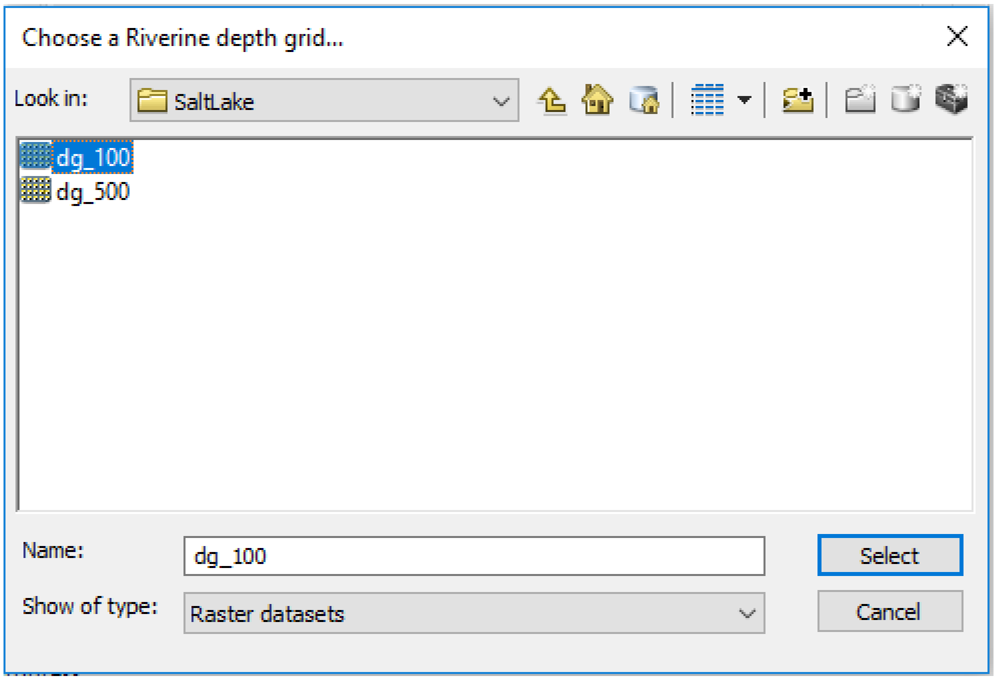
- Click “Hazard > Flood Hazard Type…,” located in the top ribbon.
- Select “Riverine Only” and click “OK.”



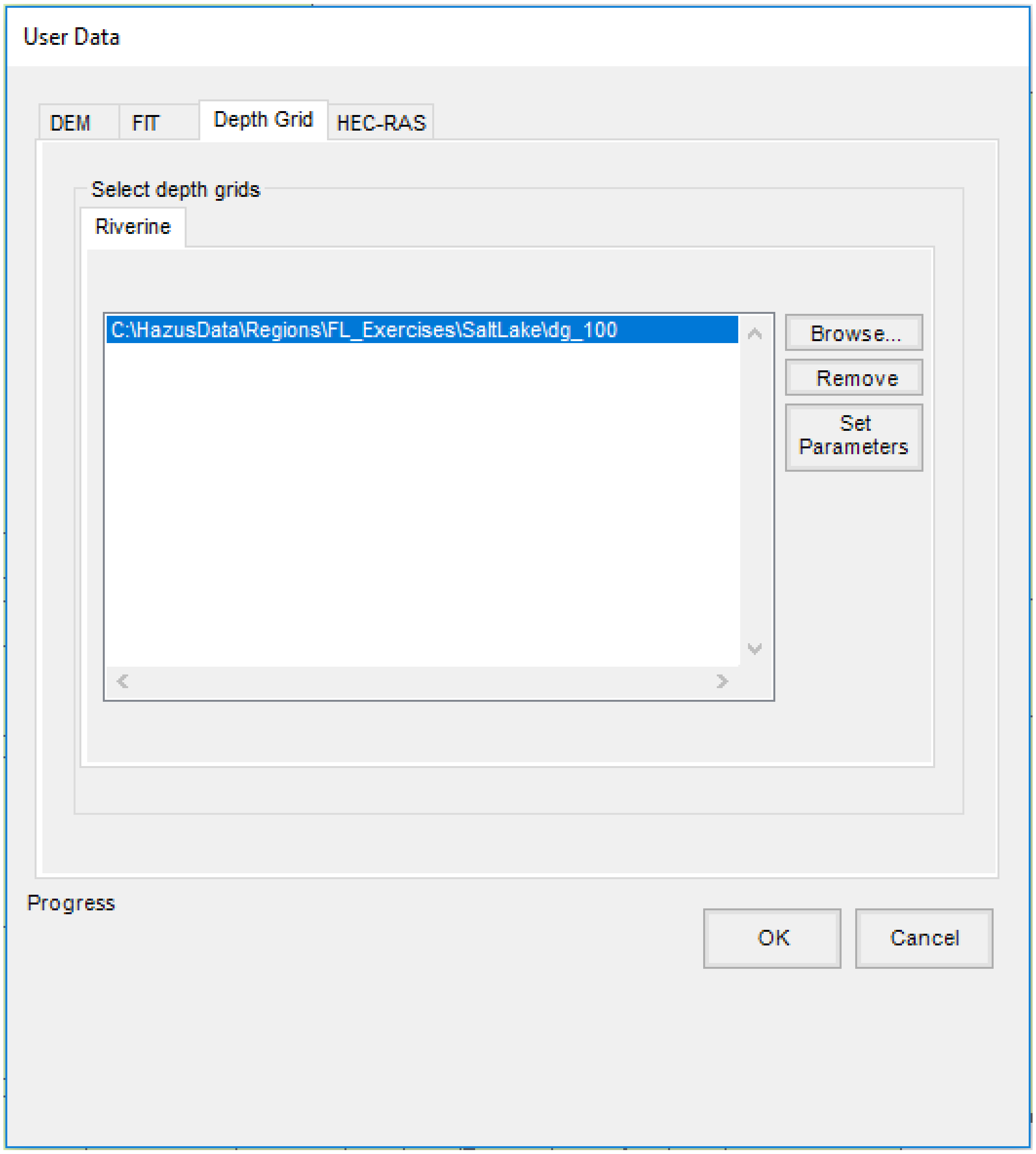
- Click “Hazard > User Data” in the top ribbon.
- Navigate to the “Depth Grid” tab and click “Browse…”



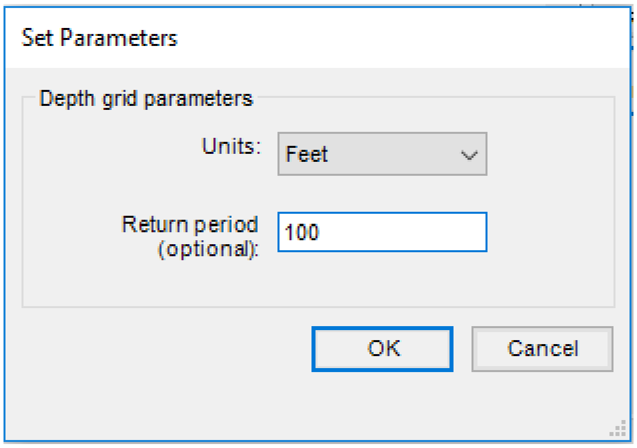
- Browse to the provided data located in the Regions folder and select “dg_100.” Click “Select.”



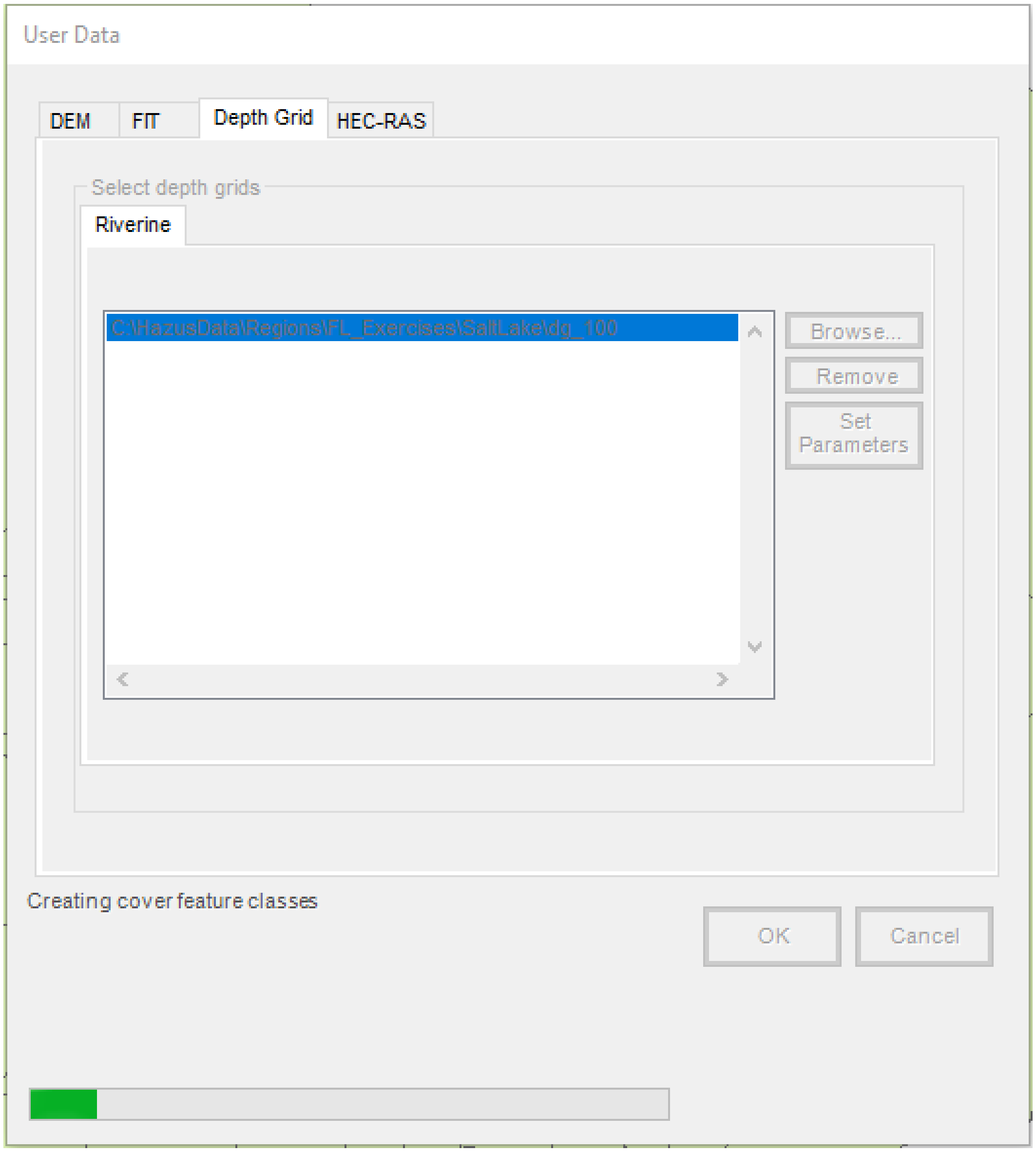
- Click “Set Parameters.”



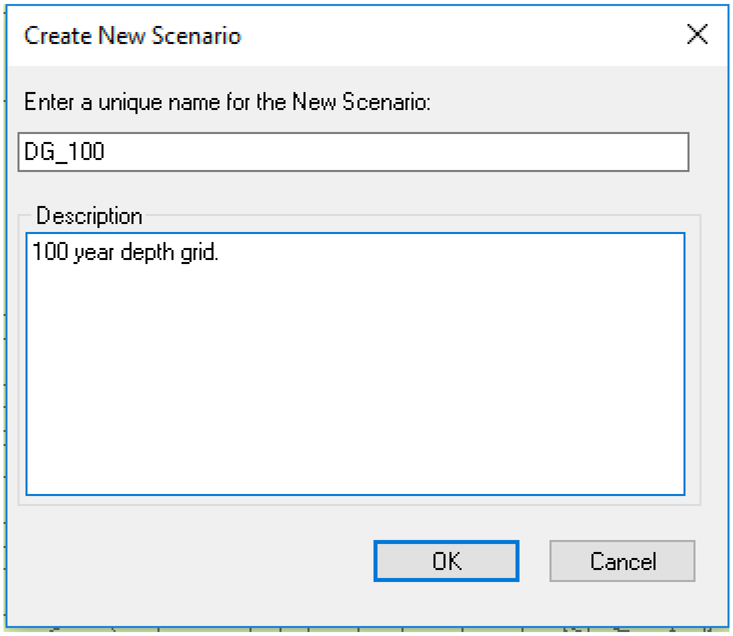
- Input a Return Period of “100” and click “OK.”



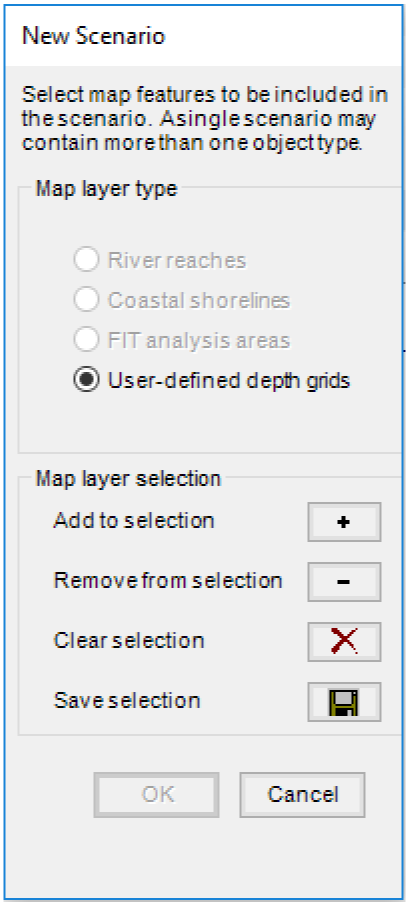
- Click “OK” again and a progress bar will appear.



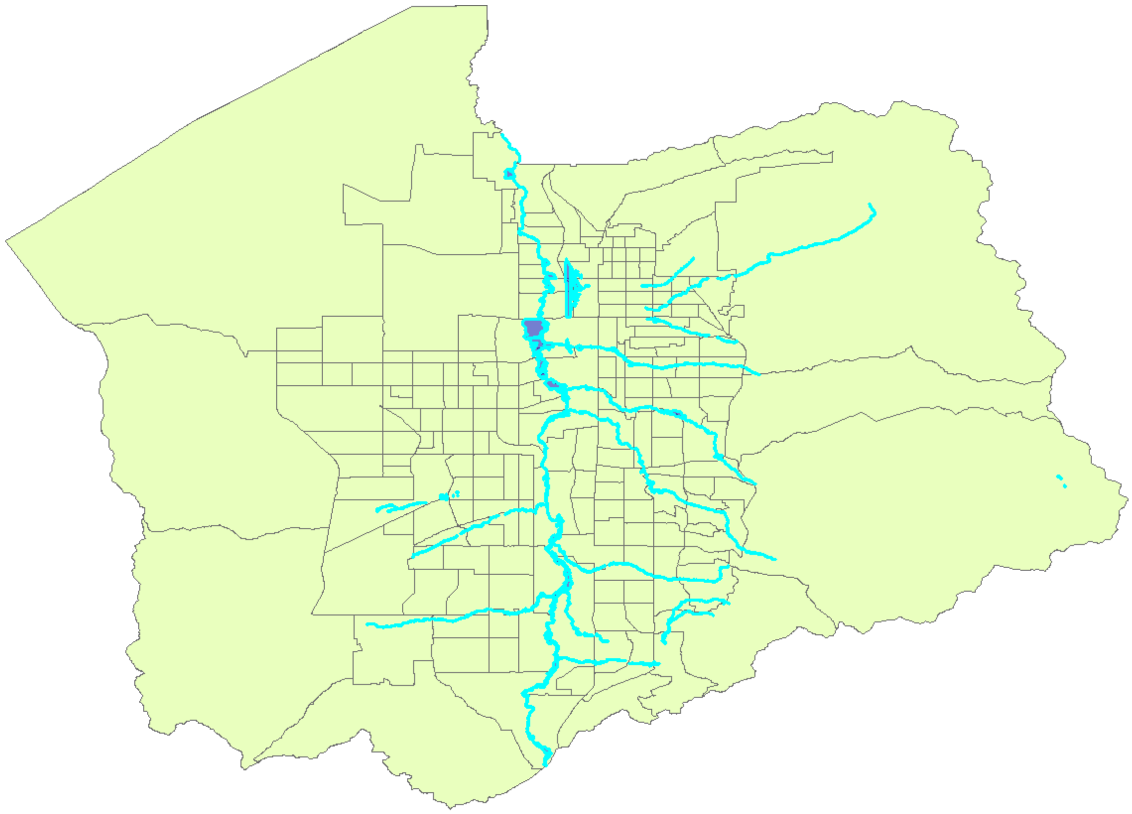
- Navigate to “Hazard > Scenario > New…,” located in the top ribbon.
- Name the scenario “DG_100” and enter a brief description “100 year depth grid.”



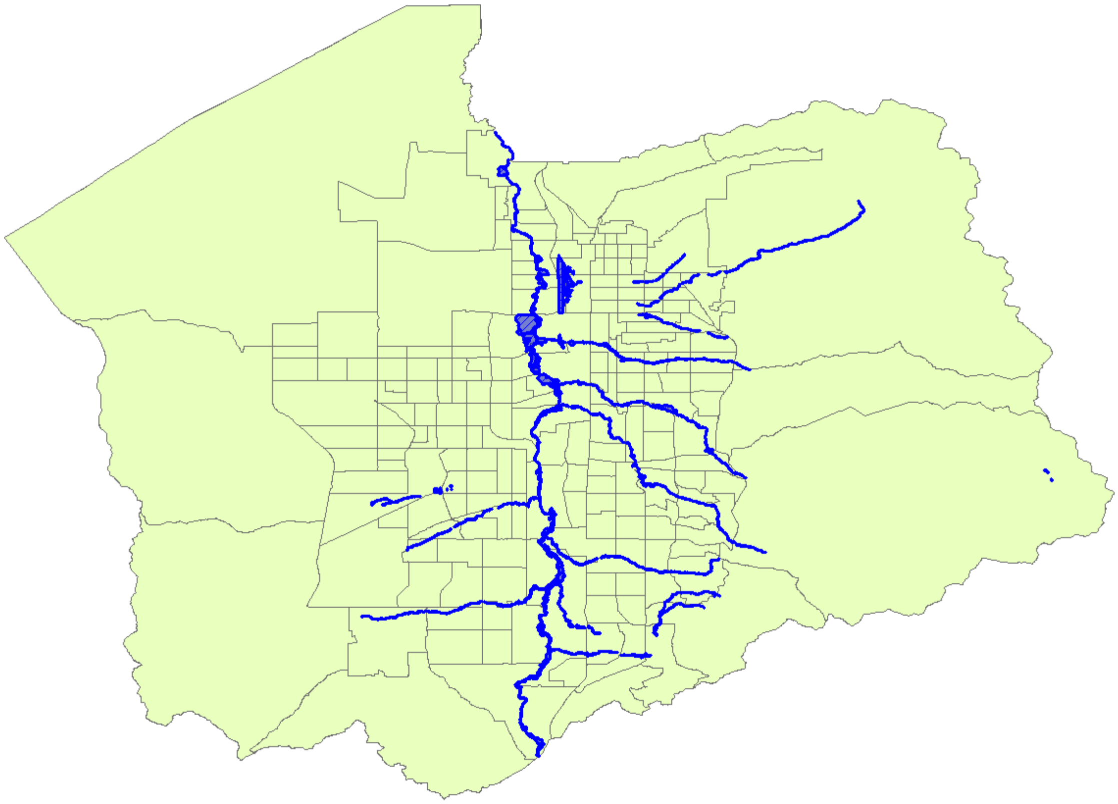
- Click “OK” and the outline of the depth grid will appear on the map with the layer Depth Grid in the table of contents.
- Click the plus button next to “Add to selection” and draw a box around one of the outlined areas.



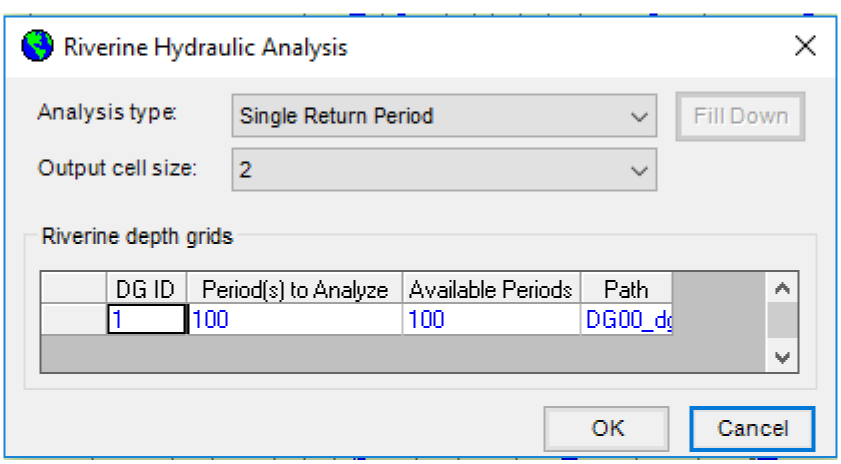
- The depth grid outline will be highlighted. Click the save button next to "Save selection."



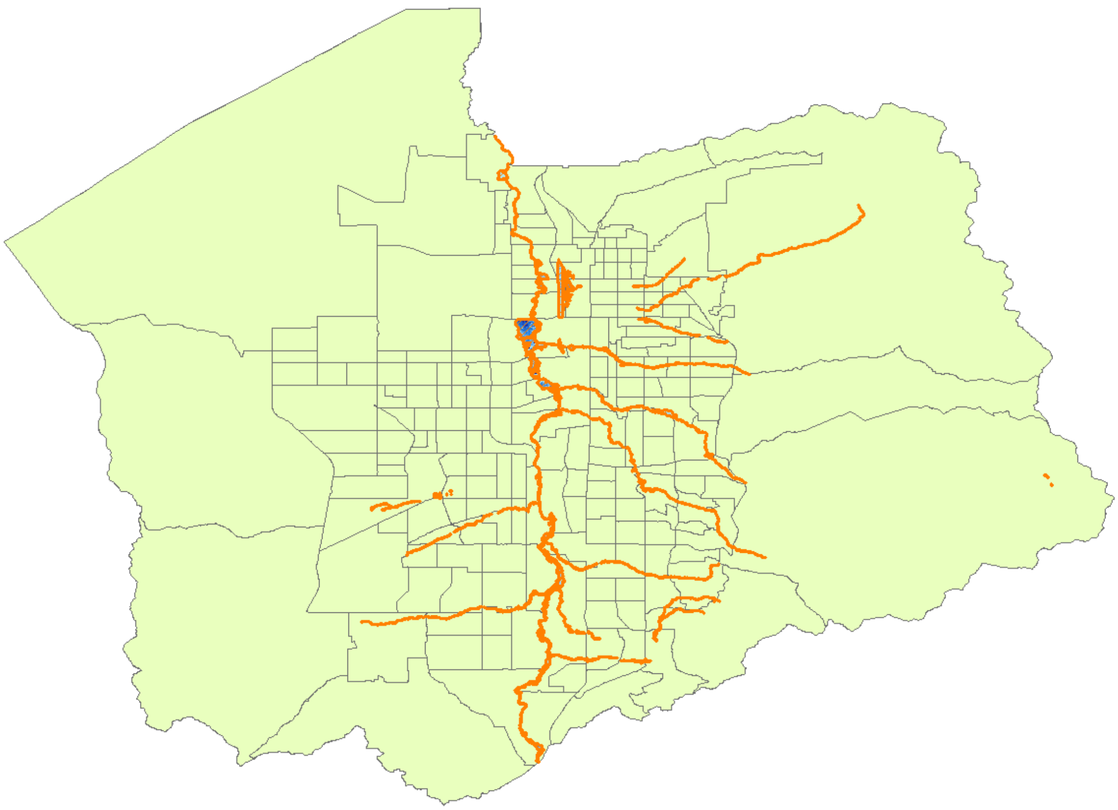
- The selection will change to a dark blue and a “DGRiv” layer will appear in the table of contents.



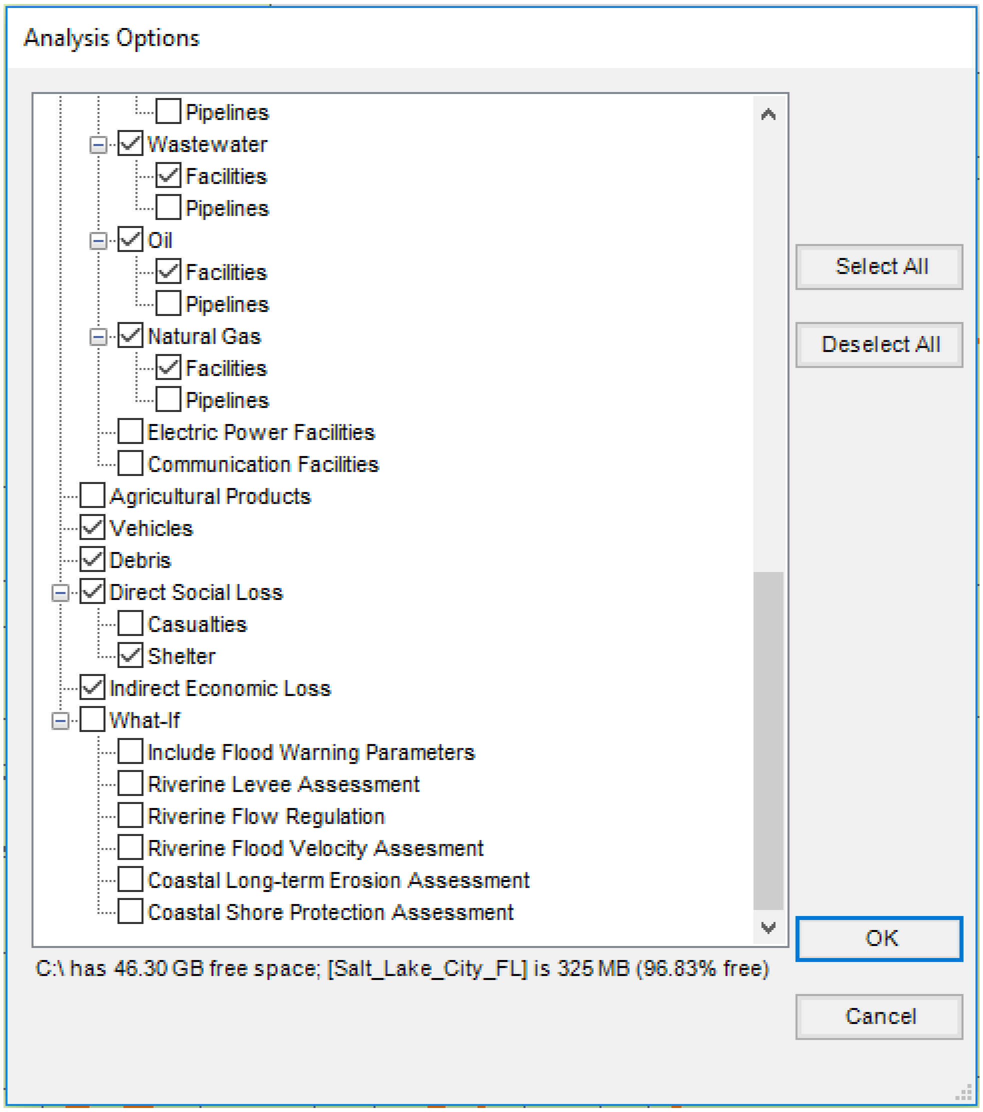
- Click “OK.”
- Navigate to “Hazard > Riverine > Delineate Floodplain,” located in the top ribbon.
- Click “OK”



- Click “Yes” to indicate that raster processing may occur.
    - The user cannot stop this process once it starts.
    - This will take approximately 1 minute.
- Click “OK” on the successful run time window. A “RPD100_r” and a “BoundaryPolygon” layer will appear in the table of contents and the map will update.



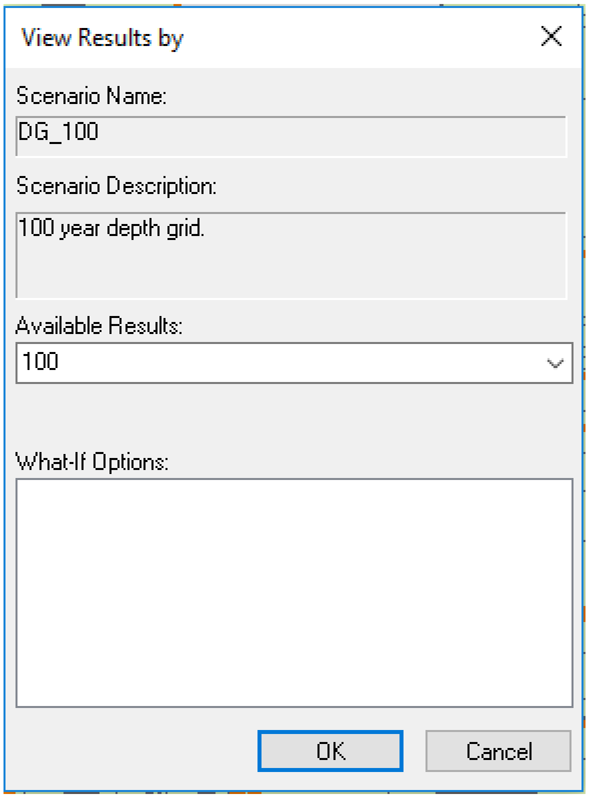
- Navigate to “Analysis > Run,” located in the top ribbon.
- Click “Select All” and deselect “Agricultural Products” and “What-if” in the Analysis Options window.



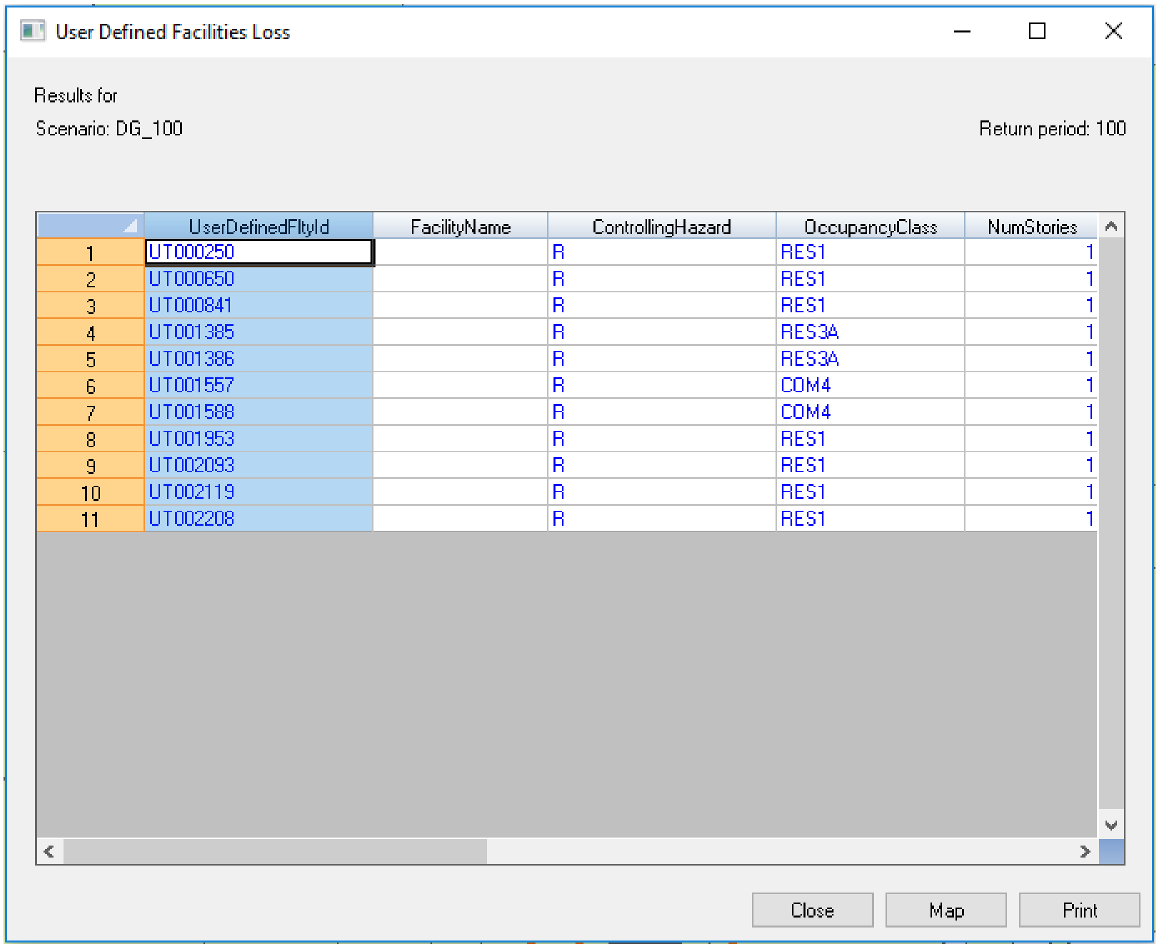
- Click “OK.” This will run for about 15 minutes.
- Click “OK” on the successful run time window.

Task 4: View Results

- Navigate to "Results > View Current Scenario Results By..."
- Click “OK” to view the 100 year return period results.

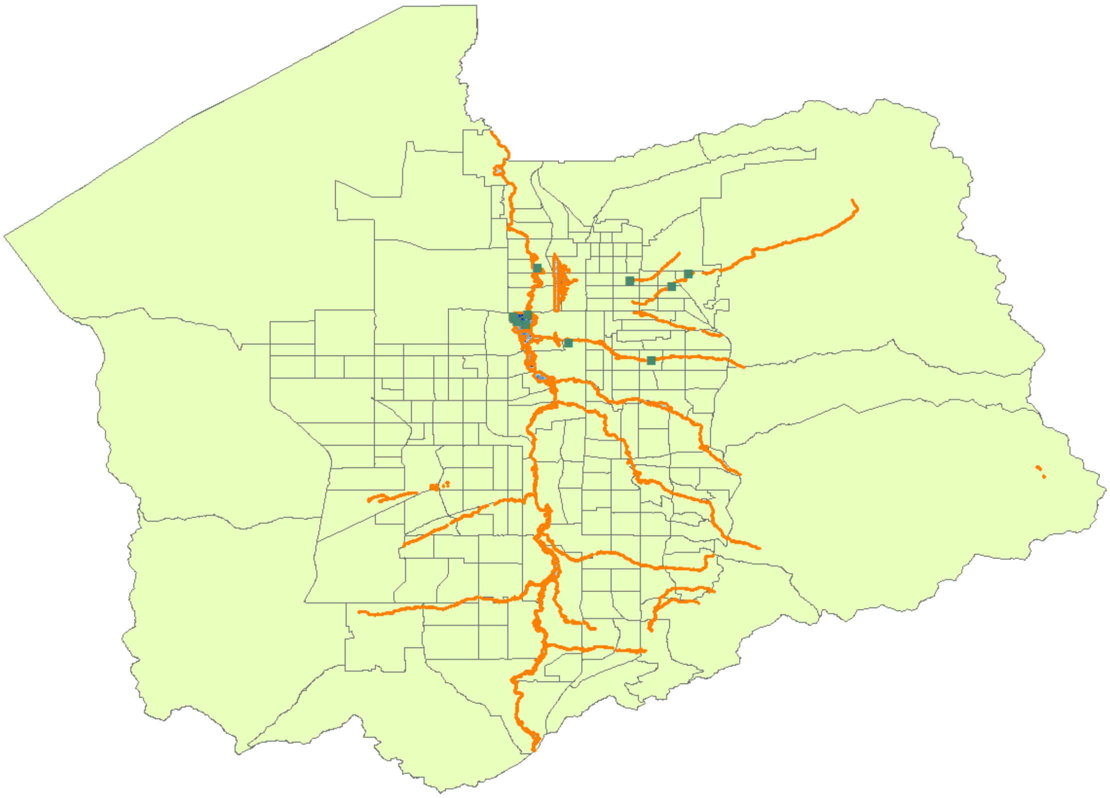


- Navigate to “Results > User-Defined Facilities.”
- Click a column header and click “Map.” We will have to specifically select symbology to map a particular field.



	UserDefinedFltyId	FacilityName	ControllingHazard	OccupancyClass	NumStories
1	UT000250		R	RES1	1
2	UT000650		R	RES1	1
3	UT000841		R	RES1	1
4	UT001385		R	RES3A	1
5	UT001386		R	RES3A	1
6	UT001557		R	COM4	1
7	UT001588		R	COM4	1
8	UT001953		R	RES1	1
9	UT002093		R	RES1	1
10	UT002119		R	RES1	1
11	UT002208		R	RES1	1

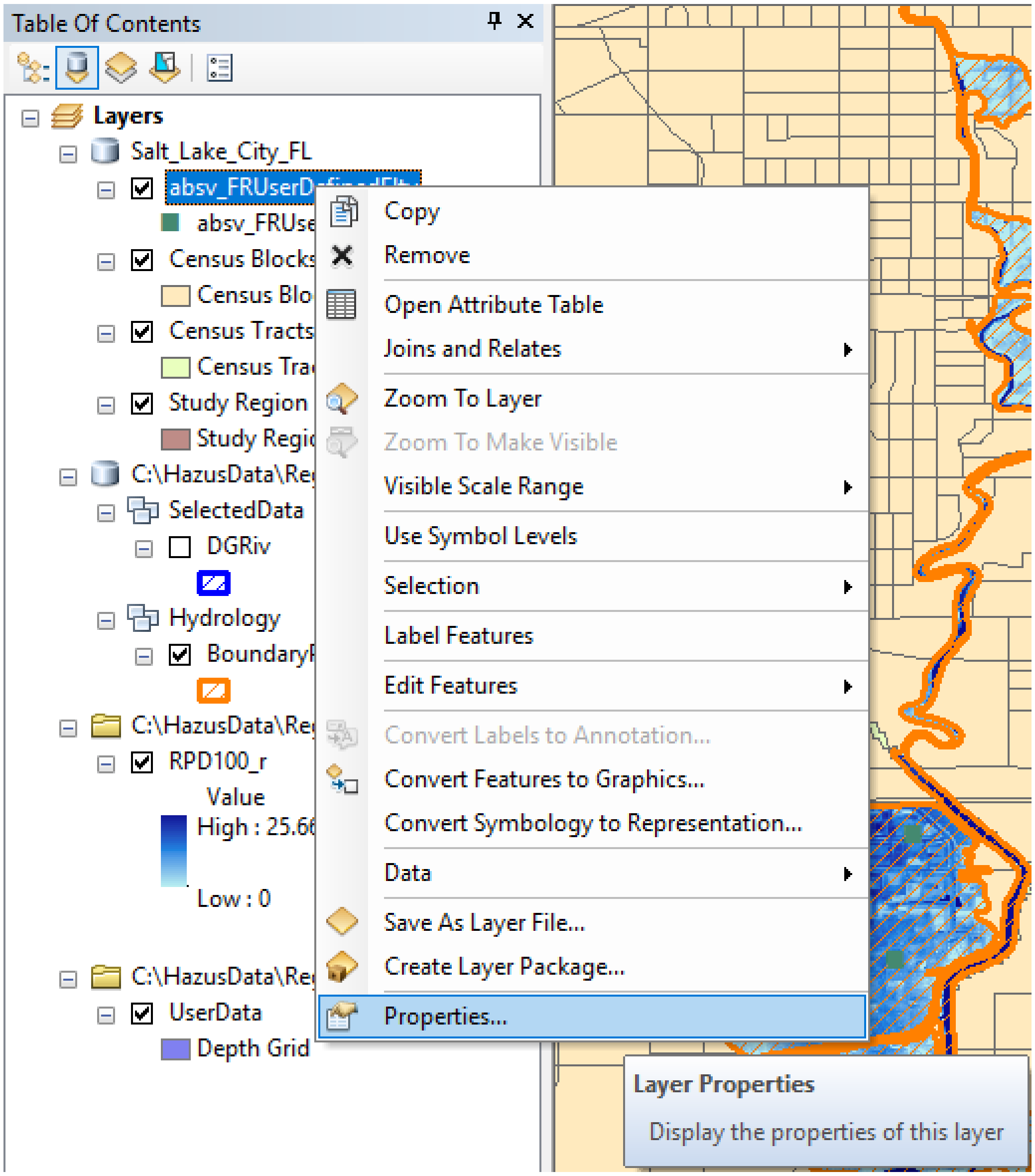
- Click “Close” and notice the green boxes that appeared on the map.



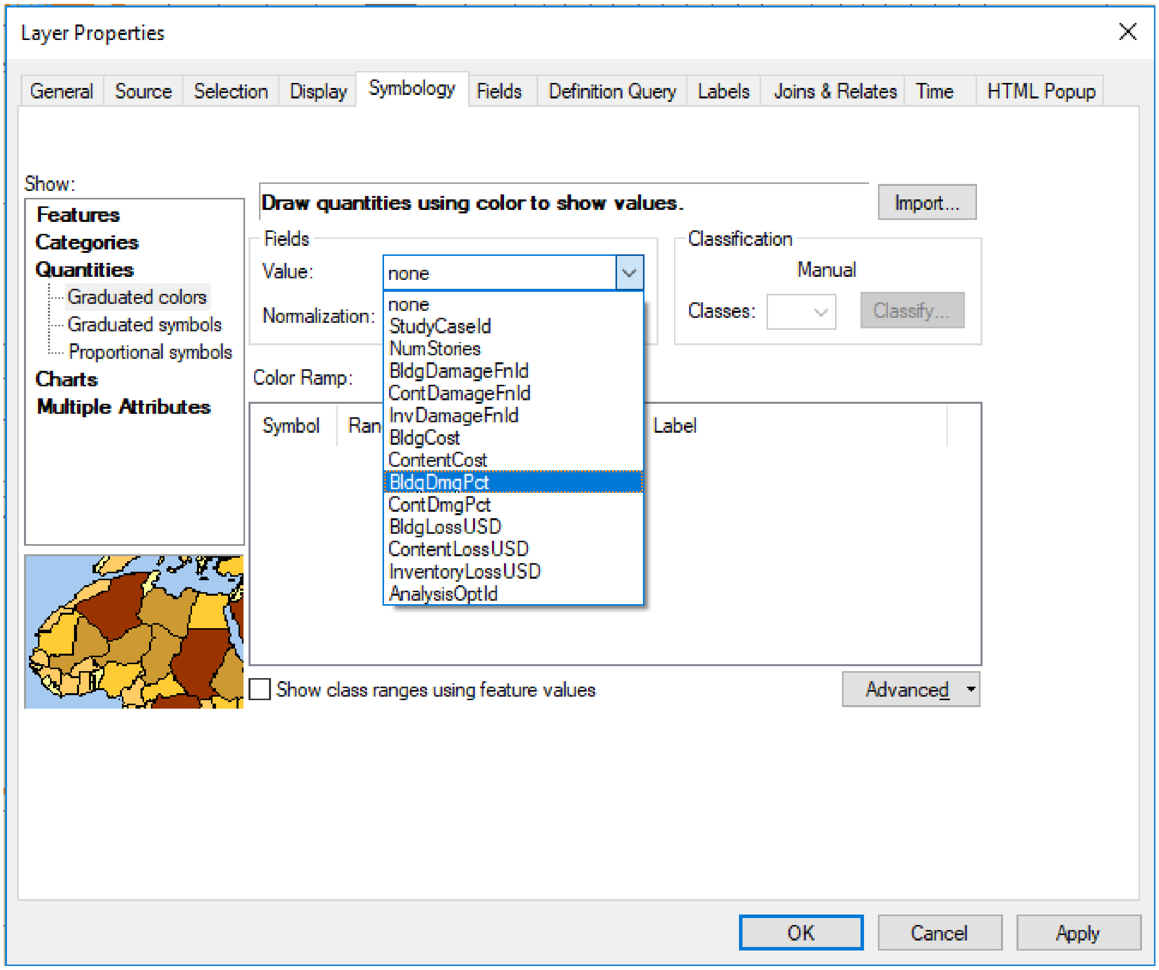
- Use the zoom button to zoom into the green boxes.

  Note: The dasymetric census blocks will appear when zoomed in.

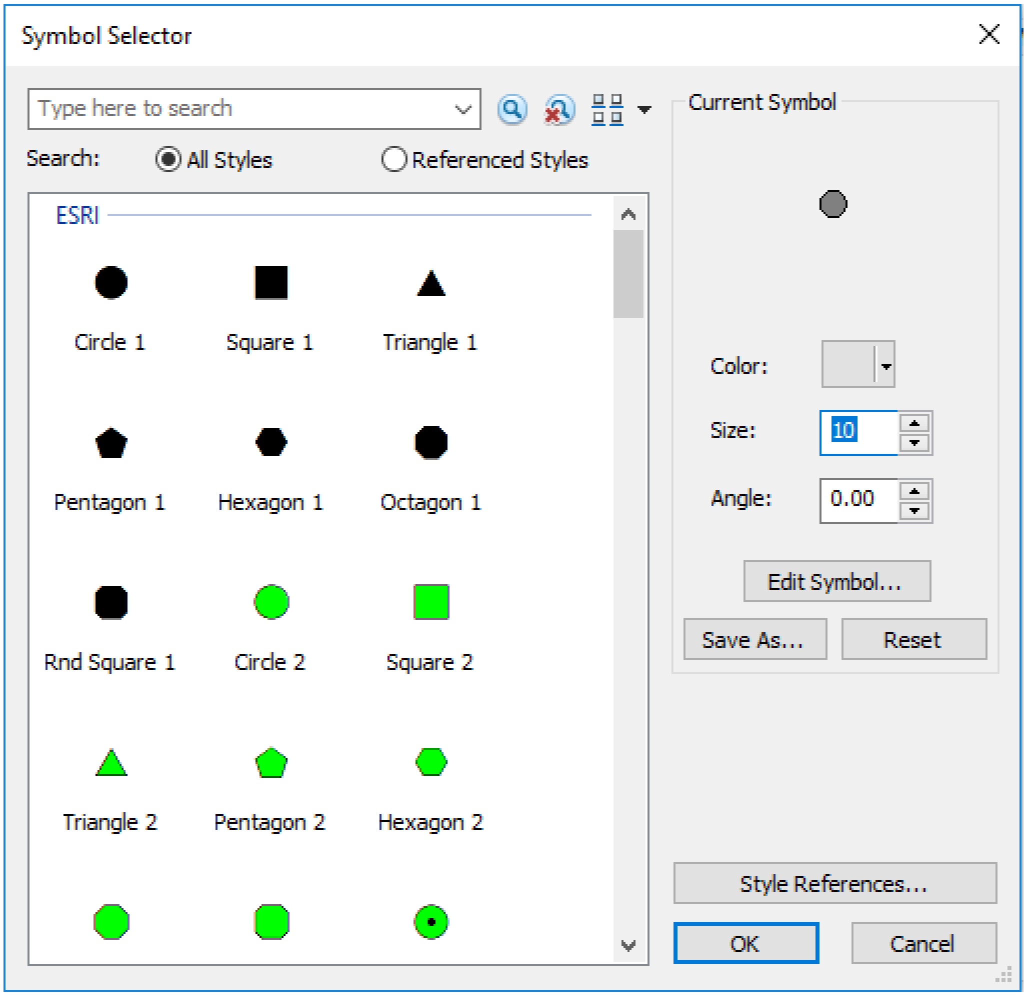
- Right-click on the “User-Defined Facilities Layer” in the table of contents and go to Properties.



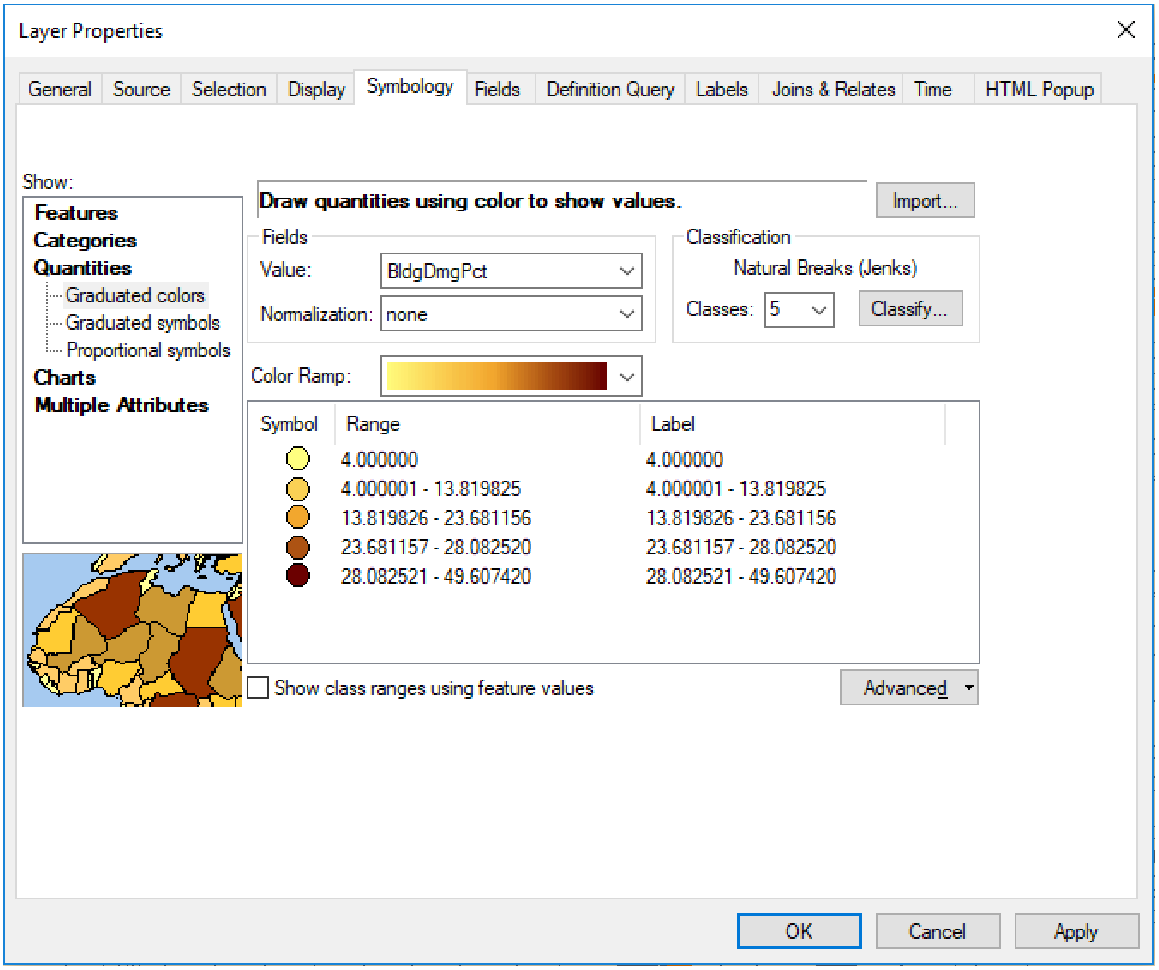
- In the symbology tab, locate “Quantities” on the left.
- Click the “Value” drop-down menu and select “BldgDmgPct."

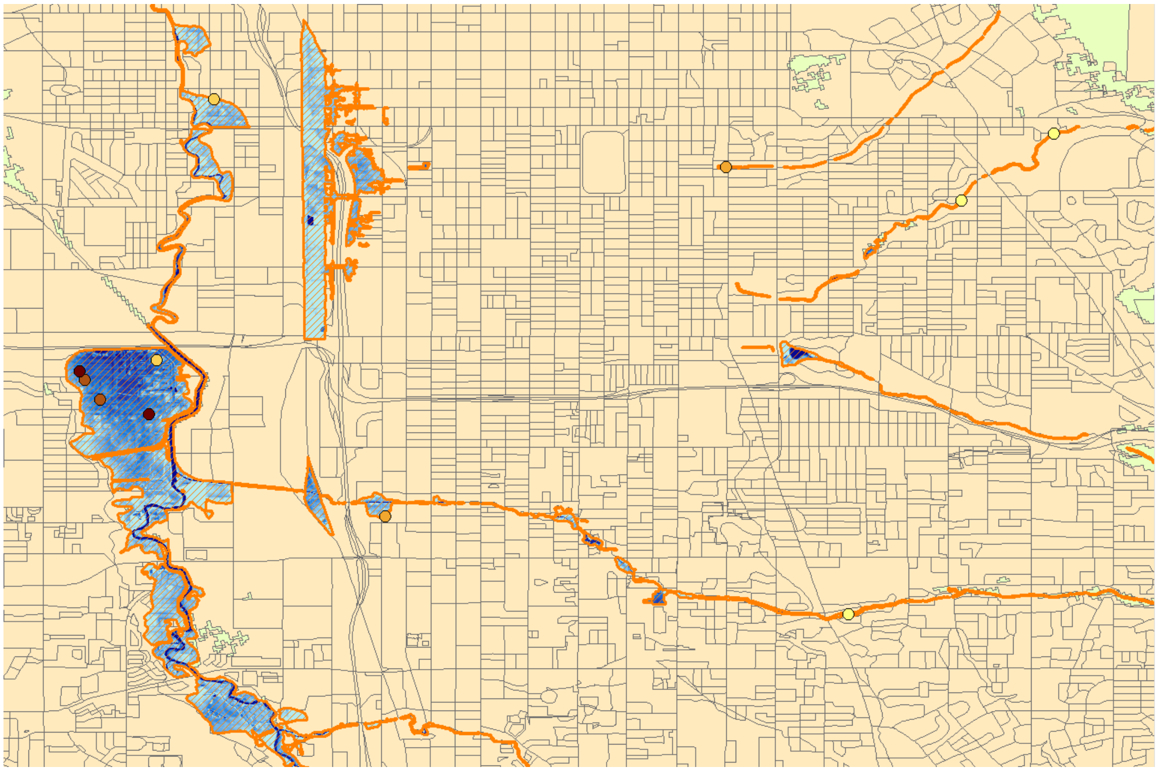


- Change the symbol properties, making all the symbols size 10, for ease of viewing. Click “OK.”

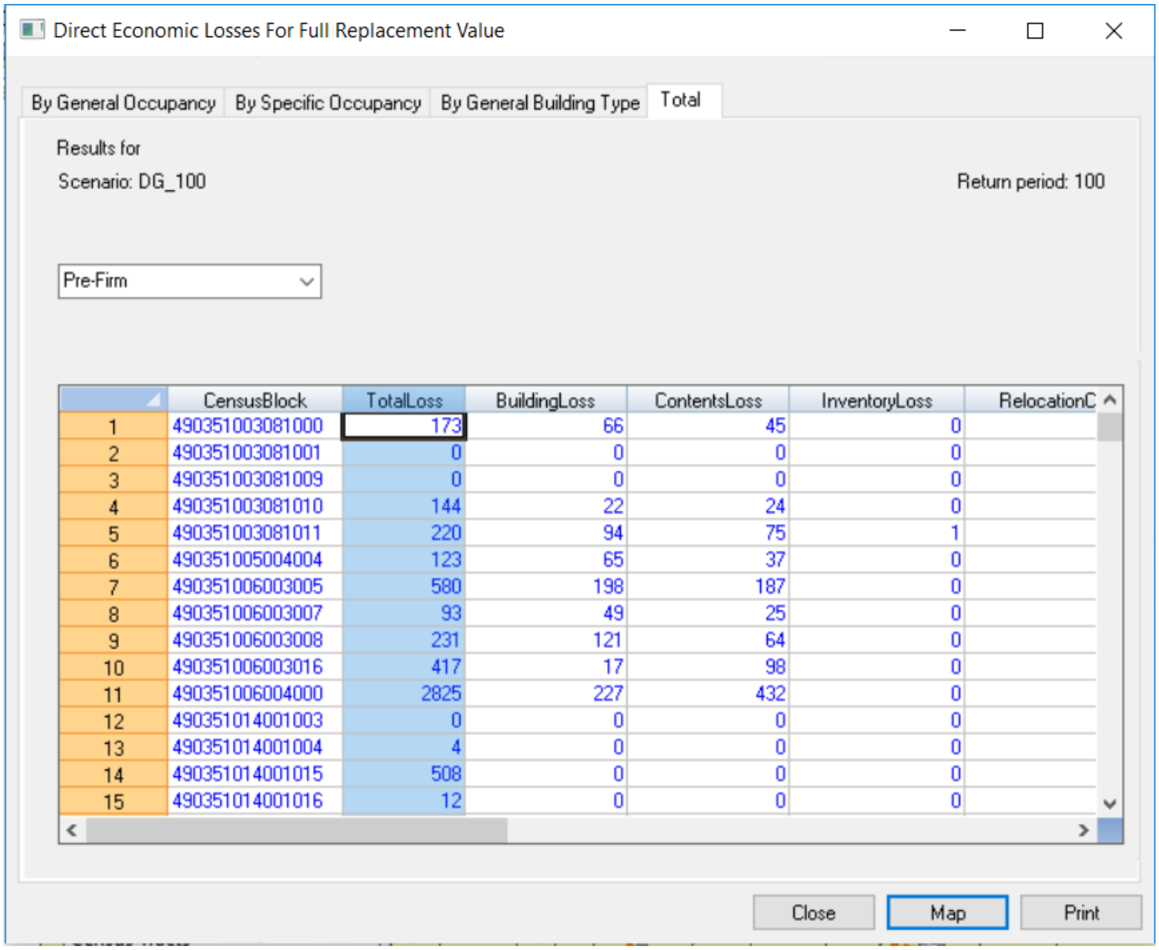


- Click “OK.“ The markers are now colored by damage percent.


Layer Properties
General
Source
Selection
Display
Symbology
Fields
Definition Query
Labels
Joins & Relates
Time
HTML Popup
Show:
Features
Categories
Quantities
Graduated colors
Graduated symbols
Proportional symbols
Charts
Multiple Attributes
Draw quantities using color to show values.
Import...
Fields
Value: BldgDmgPct
Normalization: none
Classification
Natural Breaks (Jenks)
Classes: 5
Classify...
Color Ramp:
Symbol
Range
Label
4.000000 4.000000
4.000001 - 13.819825 4.000001 - 13.819825
13.819826 - 23.681156 13.819826 - 23.681156
23.681157 - 28.082520 23.681157 - 28.082520
28.082521 - 49.607420 28.082521 - 49.607420
Show class ranges using feature values
Advanced
OK
Cancel
Apply

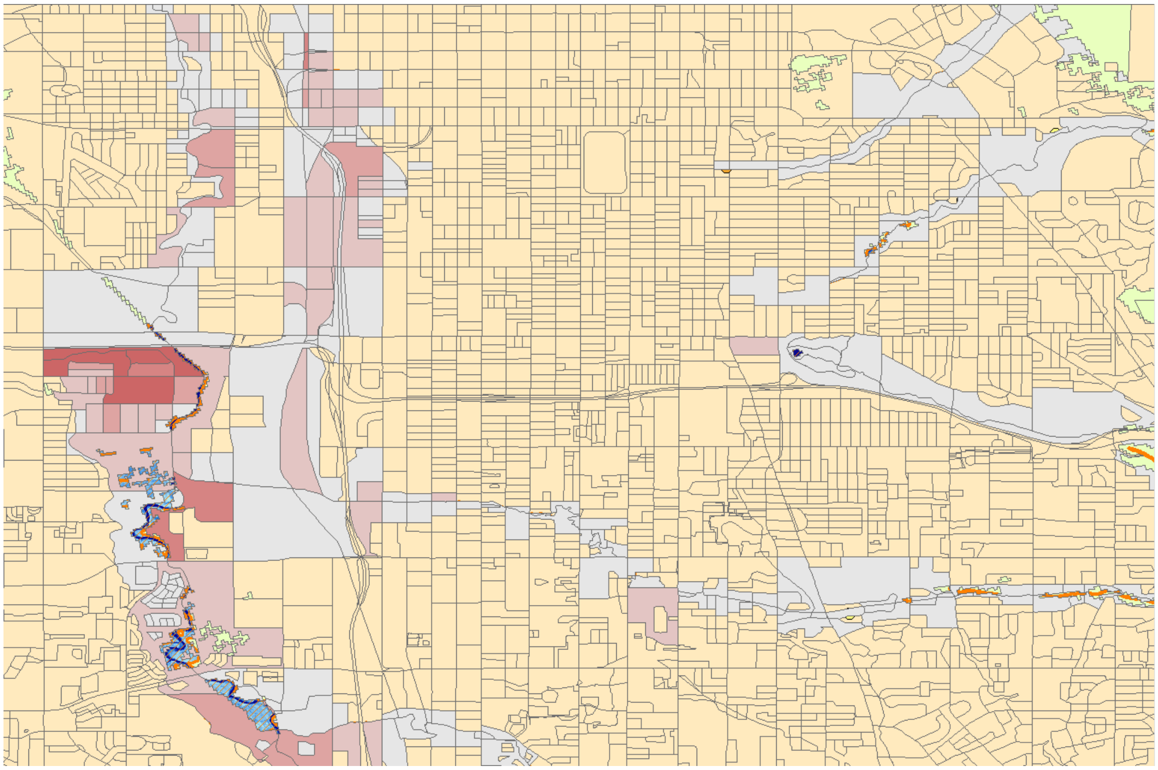


- Take a minute to explore the mapped facilities and identify parts of the study region that may require targeted response activities. This identification and staging area location is an important part of response planning. Think about what other information you might need to develop and to conduct disaster operations management given this scenario. Discuss with your neighbors what additional data would be helpful and if Hazus may have it.
- Navigate to “Results > General Building Stock > Economic Loss > By Full Replacement.”
- Click the “Total” tab. Change the drop down from “Pre-Firm” to “Total”. Click the “TotalLoss” header and then “Map.”



	CensusBlock	TotalLoss	BuildingLoss	ContentsLoss	InventoryLoss	RelocationC
1	490351003081000	173	66	45	0	
2	490351003081001	0	0	0	0	
3	490351003081009	0	0	0	0	
4	490351003081010	144	22	24	0	
5	490351003081011	220	94	75	1	
6	490351005004004	123	65	37	0	
7	490351006003005	580	198	187	0	
8	490351006003007	93	49	25	0	
9	490351006003008	231	121	64	0	
10	490351006003016	417	17	98	0	
11	490351006004000	2825	227	432	0	
12	490351014001003	0	0	0	0	
13	490351014001004	4	0	0	0	
14	490351014001015	508	0	0	0	
15	490351014001016	12	0	0	0	

- Click “Close.”



Exercise 9.1: DFIRM (Digital Flood Insurance Rate Map) Depth

Type: Student-Led Activity

Time: 30 minutes

Goal:

- Create a depth grid based off a DFIRM dataset and the Esri ArcMap Spatial Analyst toolset.
- Keep track of the name of the files generated.

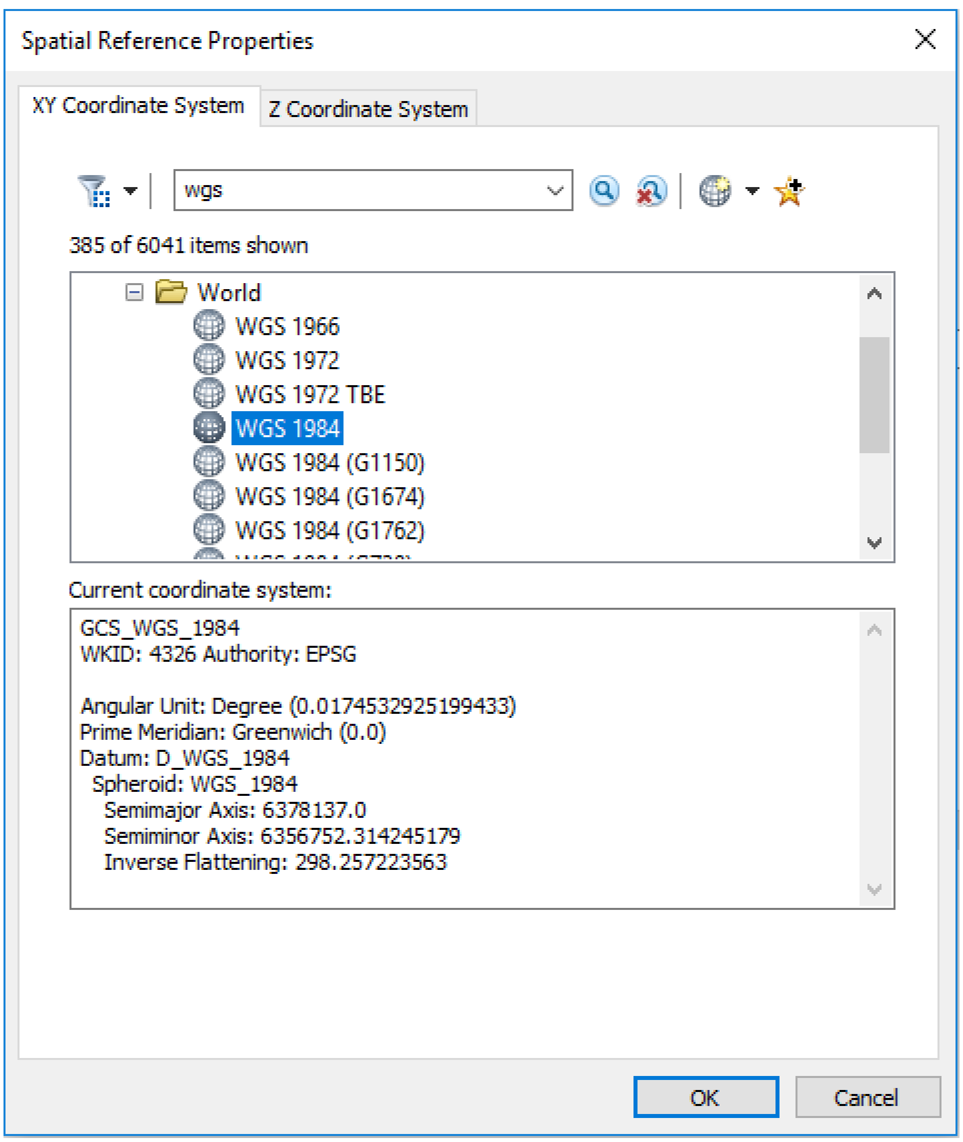
Background: The purpose of this activity is to demonstrate the geoprocessing steps to create a depth grid (DG) utilizing DFIRM data and the Esri ArcMap spatial analyst toolset. DFIRM is often the only source of depth data available for communities, so understanding this process is crucial for being able to use Hazus in disaster operations around flooding hazards.

- Required Geographic Data:
    - Digital Flood Insurance Rate Map (DFIRM)
        - DFIRM: digital version of a Flood Insurance Rate Map (FIRM)
        - Shows a community's base flood elevations, flood zones, and floodplain boundaries for the 1% and 0.2% annual chance flood hazard zones
        - All data used to produce the FIRM are stored in the DFIRM Database.
        - A portion of the DFIRM Database is packaged as the National Flood Hazard Layer (NFHL); available from the FEMA Map Service Center (MSC) (http://msc.fema.gov/portal).
        - For this activity, we will be using several features found in the DFIRM Database for Salt Lake County, UT (NFHL_49035C; Last Study Effective Date: 08/02/2012).
    - Terrain Data (DEM)
        - For this activity, we will be using 1/3 arc second DEM.
        - Time and level of analysis detail are prime factors in determining the resolution of terrain data to be used in your analysis.
    - Area of Interest (AOI)
        - To ensure everyone is able to complete the exercise in a reasonable time frame, an Area of Interest (AOI) polygon has been provided.
        - This file is named SLC_AOI and is stored in the DFIRM folder in the SaltLake folder used in the last exercise.

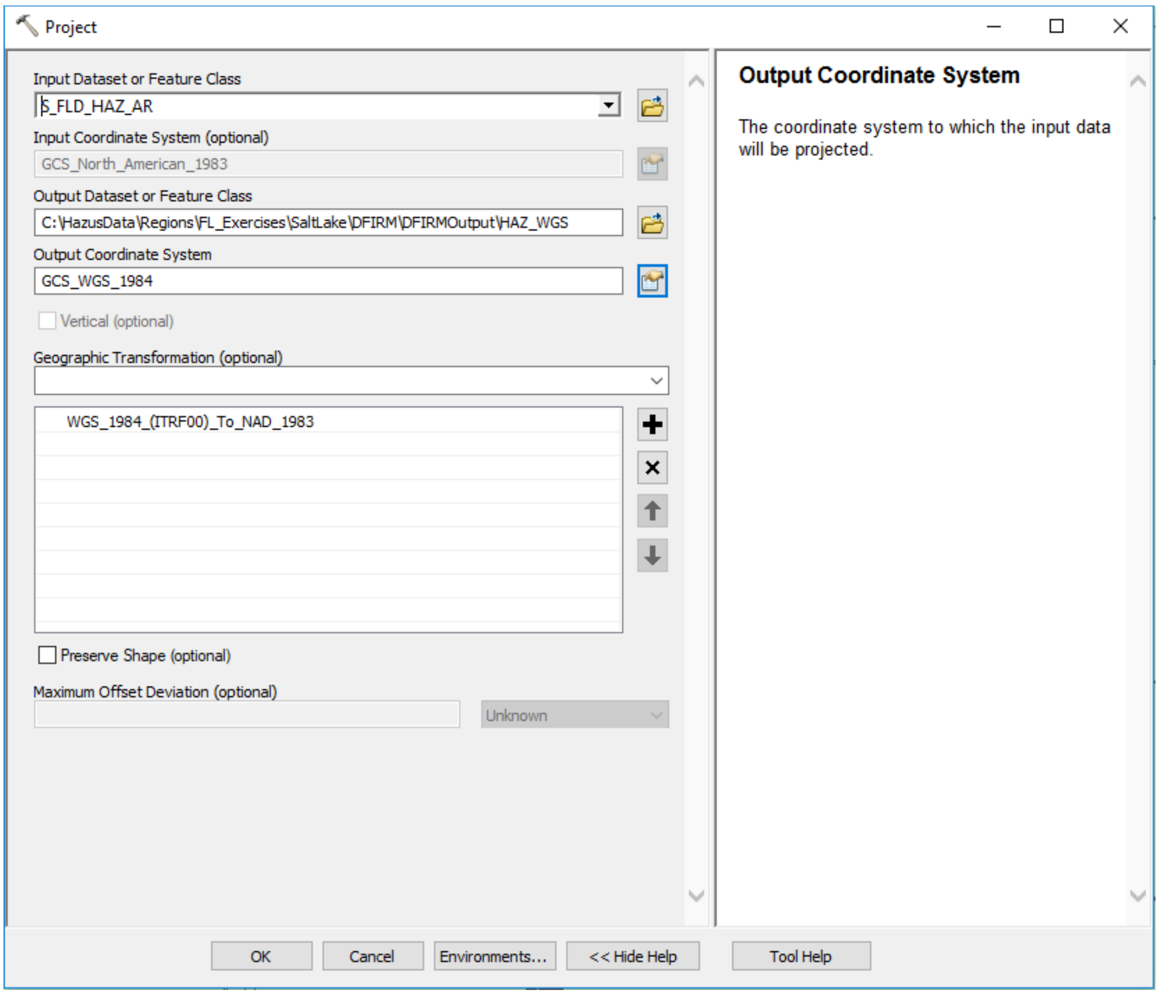
Note: Only the major steps have been provided. Be sure to keep track of the name of the files that you generate.

Task 1: Prepare the Data in ArcMap

- Open ArcMap and start a new map.
- In your new Blank Map add the “SLC_AOI” feature class from the SaltLake\DFIRM\ folder. This file represents your area of interest.
- In your new Blank Map add the “S_FLD_HAZ_AR” feature class from the SaltLake\DFIRM\ folder. You may receive a Geographic Coordinate Systems Warning. Click “Close.” This file represents your special flood hazard area.
- Add the “dem_ft” dataset from the SaltLake\DFIRM\ folder. This file represents your digital elevation model.
- Using the Data Management tools in the Projections and Transformations Toolbox, project the S_FLD_HAZ_AR feature class to WGS_1984.

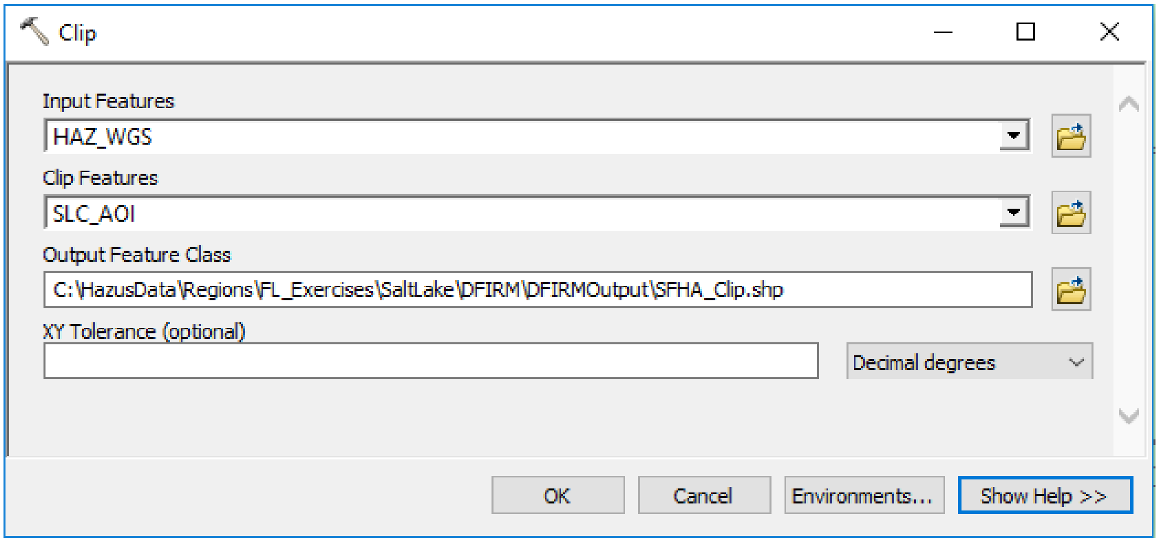


- Set the following parameters:
  - Input Dataset: S_FLD_HAZ_AR
  - Output Dataset: HAZ_WGS SaltLake\DFIRM\DFIRMOutput\ folder
  - Output Coordinate System: WGS 1984

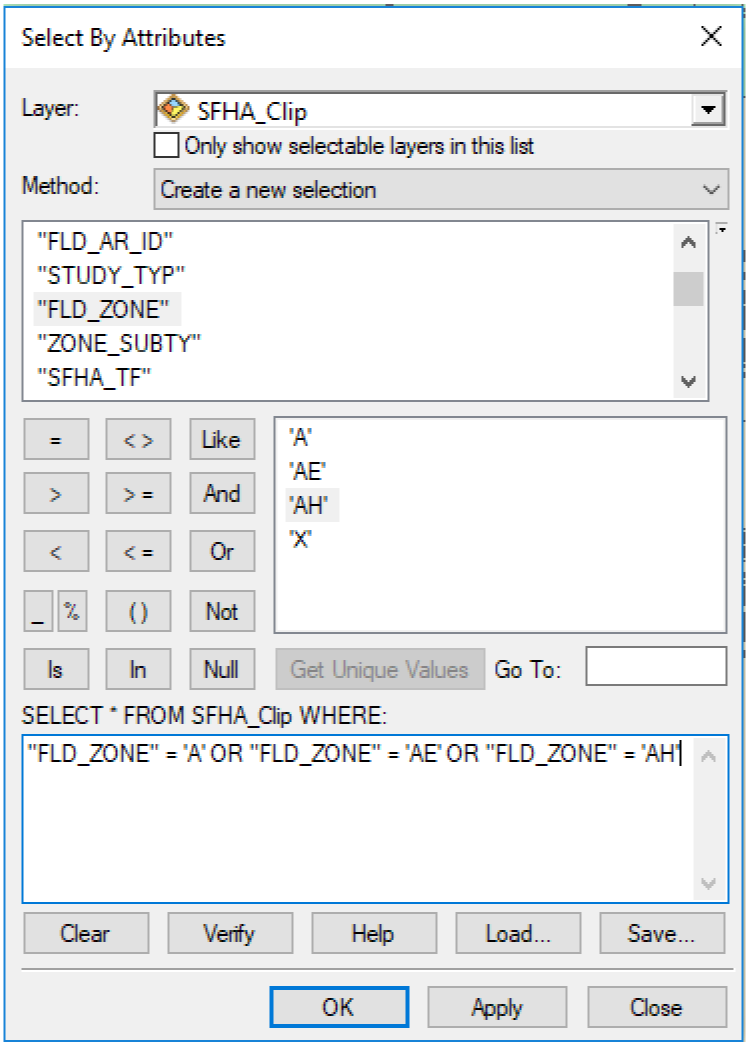


- Click “OK.”
- Remove the “S_FLD_HAZ_AR” layer or turn it off.
- From the Geoprocessing menu, choose “Clip.” Set the following parameters.
  - Input Features: HAZ_WGS
  - Clip Features: SLC_AOI
  - Name the output “SFHA_Clip.”

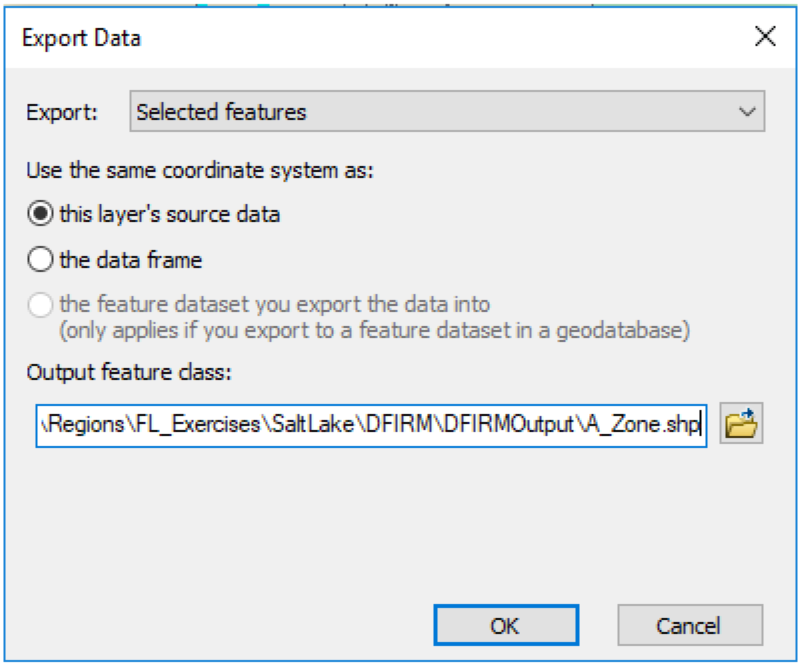
- Save it to the SaltLake\DFIRM\DFIRMOutput\ folder.



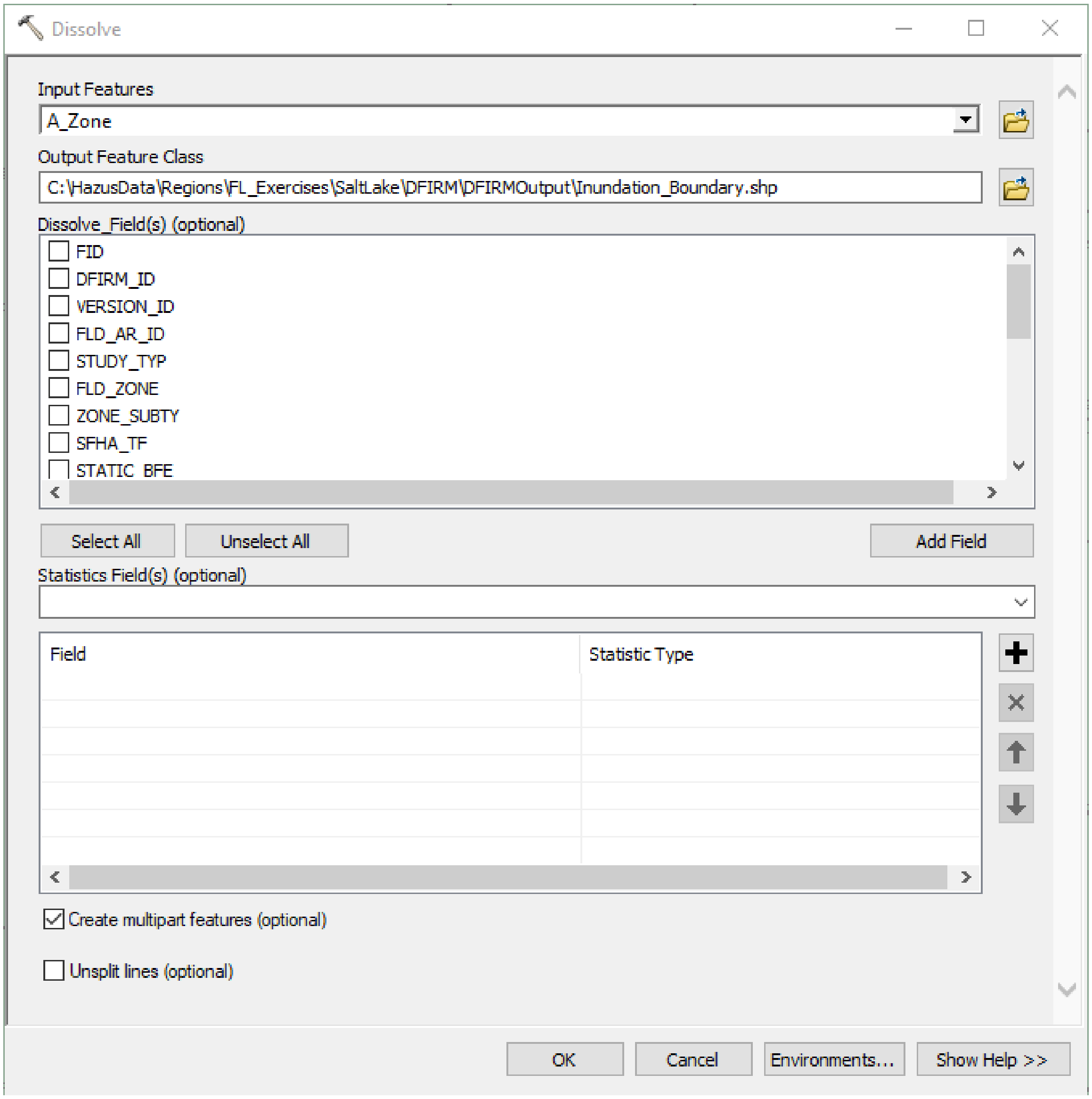
- Click “OK.”
- Remove the “HAZ_WGS” layer or turn it off.
- From the File Menu choose “Selection > Select by Attributes.”
  - Choose “SFHA_Clip” as the Layer.
  - Type one of the following in the Query text box toward the bottom of the window. This query includes all flooding A-zones.
    - "FLD_ZONE" = 'A'
    - "FLD_ZONE" = 'AE'
    - "FLD_ZONE" = 'AH’



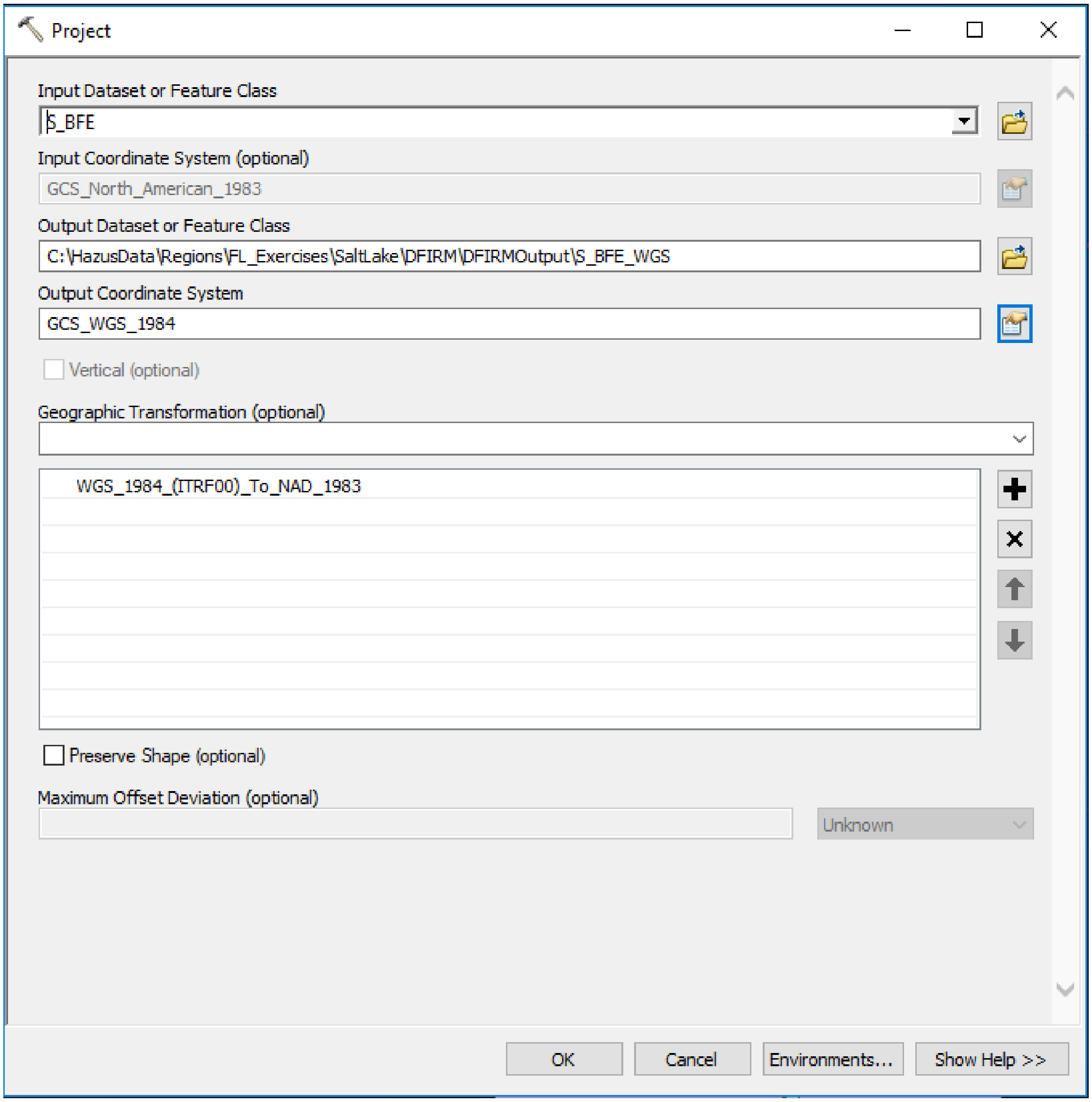
- Click “OK.”
- Right-click on the “SFHA_Clip” layer and choose “Data > Export Data.”
- Save the selected features to a new feature class named “A_Zone” in the SaltLake\DFIRM\DFIRMOutput\ folder.



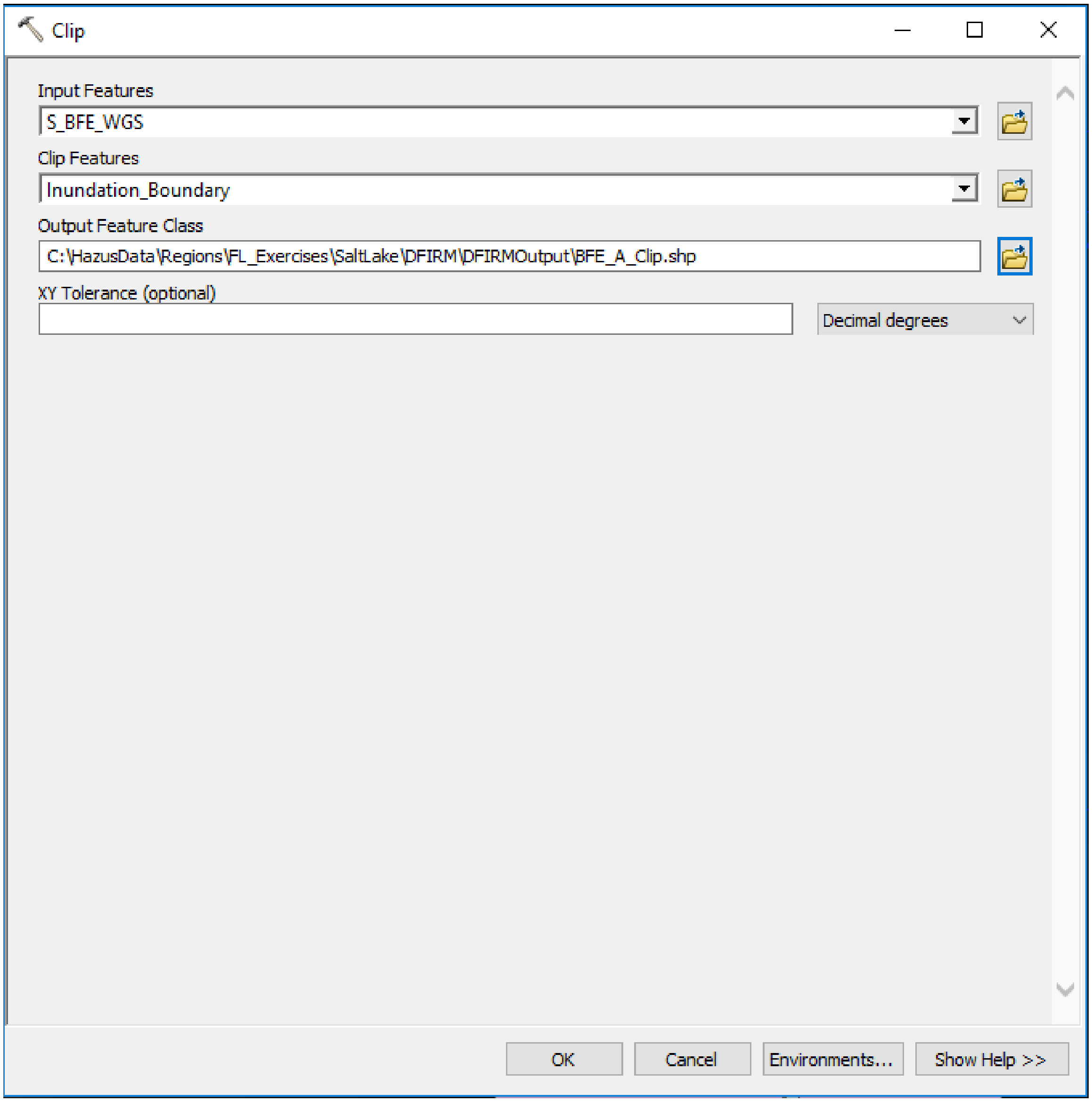
- Click “OK.”
- Select “Yes” to add the layer to the map.
- From the Geoprocessing menu choose “Dissolve.”
    - Choose “A_Zone” as the Input Features.
    - Name the Output Feature Class “Inundation_Boundary” in the SaltLake\DFIRM\DFIRMOutput\ folder.



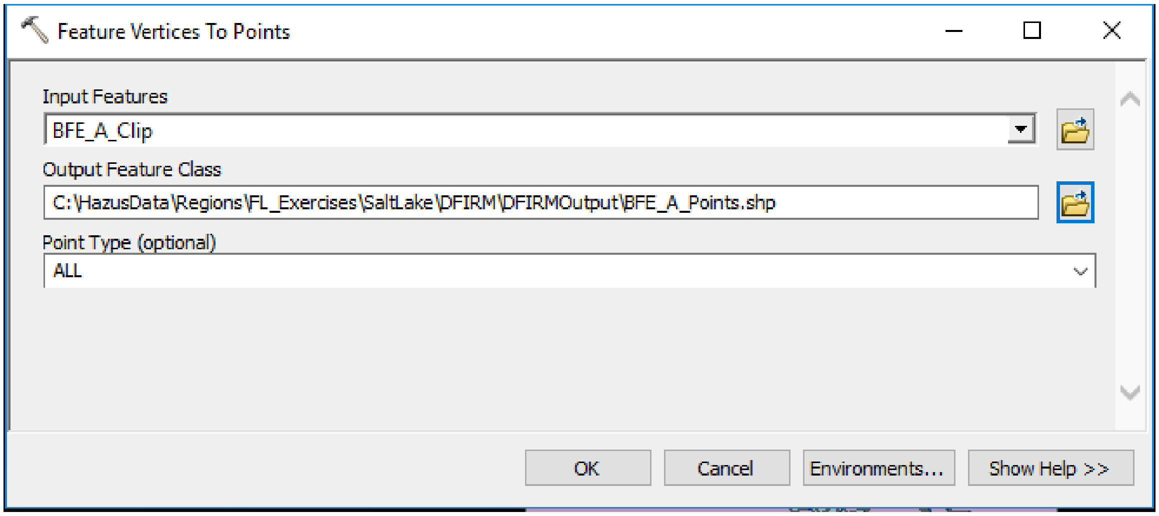
- Be sure “Create multipart features” is checked. Click “OK.”
- Remove or turn off the “A_Zone” and “SFHA_Clip” Layers.
- Add the “S_BFE” shapefile in the the SaltLake\DFIRM\DFIRMOutput\ folder to the map. This file contains the cross sections. You may receive a Geographic Coordinate Systems Warning. Click “Close.”
- Using the Data Management tools in the Projections and Transformations Toolbox, project the “S_BFE” feature class to WGS_1984.
    - Input Dataset: S_BFE
    - Output Dataset: S_BFE_WGS in \SaltLake\DFIRM\DFIRMOutput\ folder
    - Output Coordinate System: WGS 1984



- Click "OK."
- Turn off or remove the "S_BFE layer."
- From the Geoprocessing menu choose "Clip." Set the following parameters.
    - Input Features: S_BFE_WGS
    - Clip Features: Inundation_Boundary
    - Name the new feature class "BFE_A_Clip"
    - Save it in the FL_Exercises\SaltLake\DFIRM\DFIRMOutput\ folder.

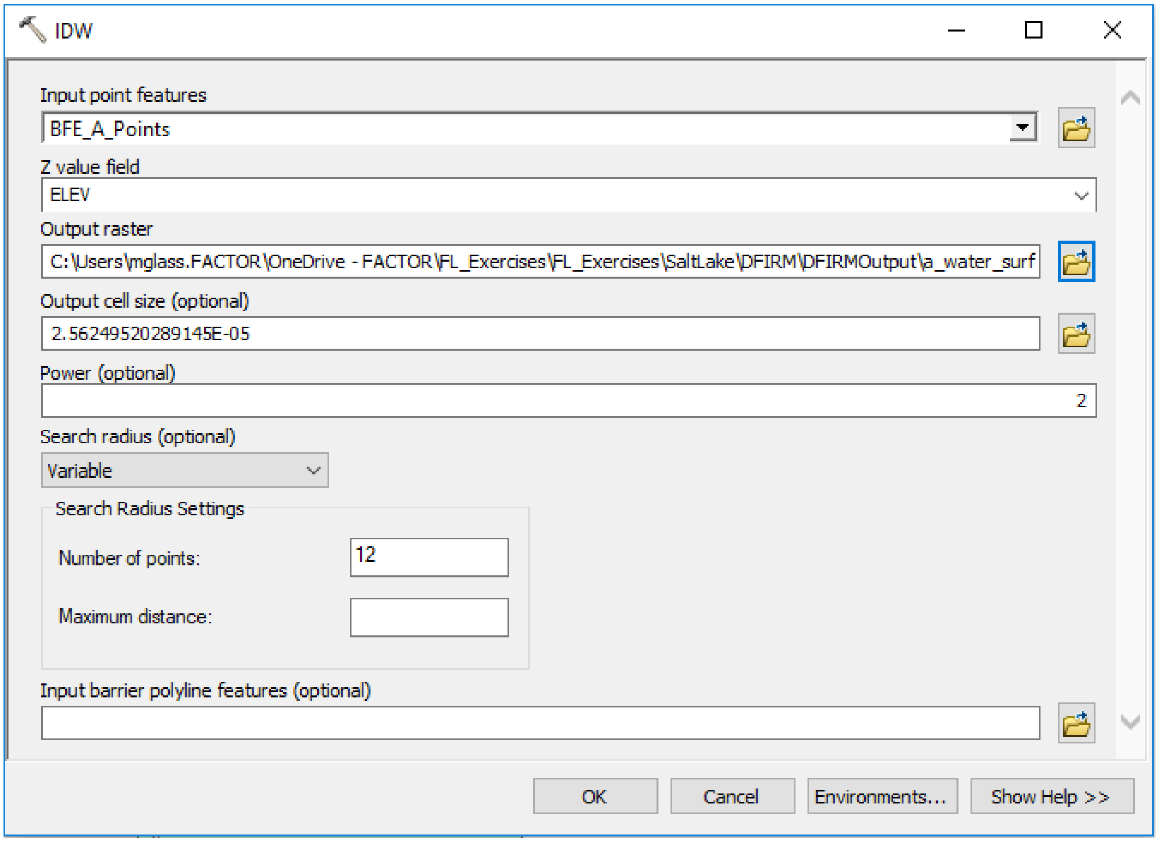


- Click "OK."
- Turn off or remove the "S_BFE_WGS layer."
- In ArcToolbox open the "Feature Vertices to Points" tool located in the "Data Management Tools > Features" folder.
- Set the Input features to "BFE_A_Clip."
- Save the output feature class as "BFE_A_Points" in the FL_Exercises\SaltLake\DFIRM\DFIRMOutput\ folder.
- Click "OK."



Task 2: Interpolate the Water Surface

- In ArcToolbox open the IDW tool found under the “Spatial Analyst Tools > Interpolation” folder. Set the following parameters:
  - Input point features: BFE_A_Points
  - Z value field: ELEV
  - Output raster: “A_Water_Surf” in the SaltLake\DFIRM\DFIRMOutput\ folder.
  - Output cell size: 2.56249520289145E-05.

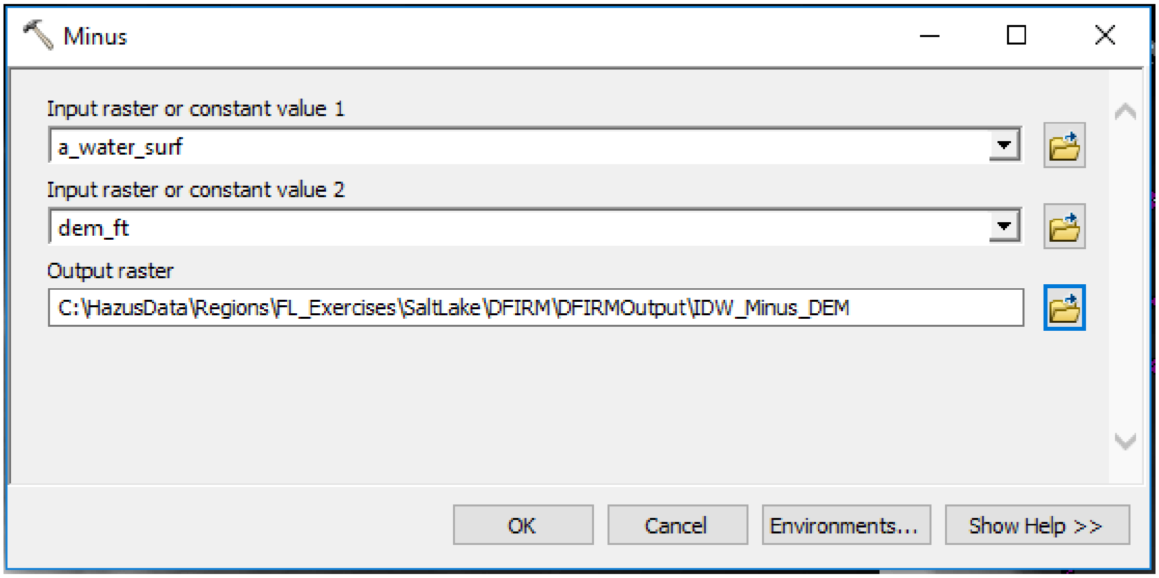


- Click “Environments.”
    - From the Processing Extent area under the “Extent” drop-down menu, choose “Same as layer SLC_AOI.” The fields should read as:
        - Top: 40.804658
        - Right: -111.874235
        - Bottom: 40.675088
        - Left: -111.974413
    - From the Raster Analysis area under the “Mask” drop-down menu, choose “SLC_AOI.” Click “OK.” 3. Click “OK” to create the A Water Surface.

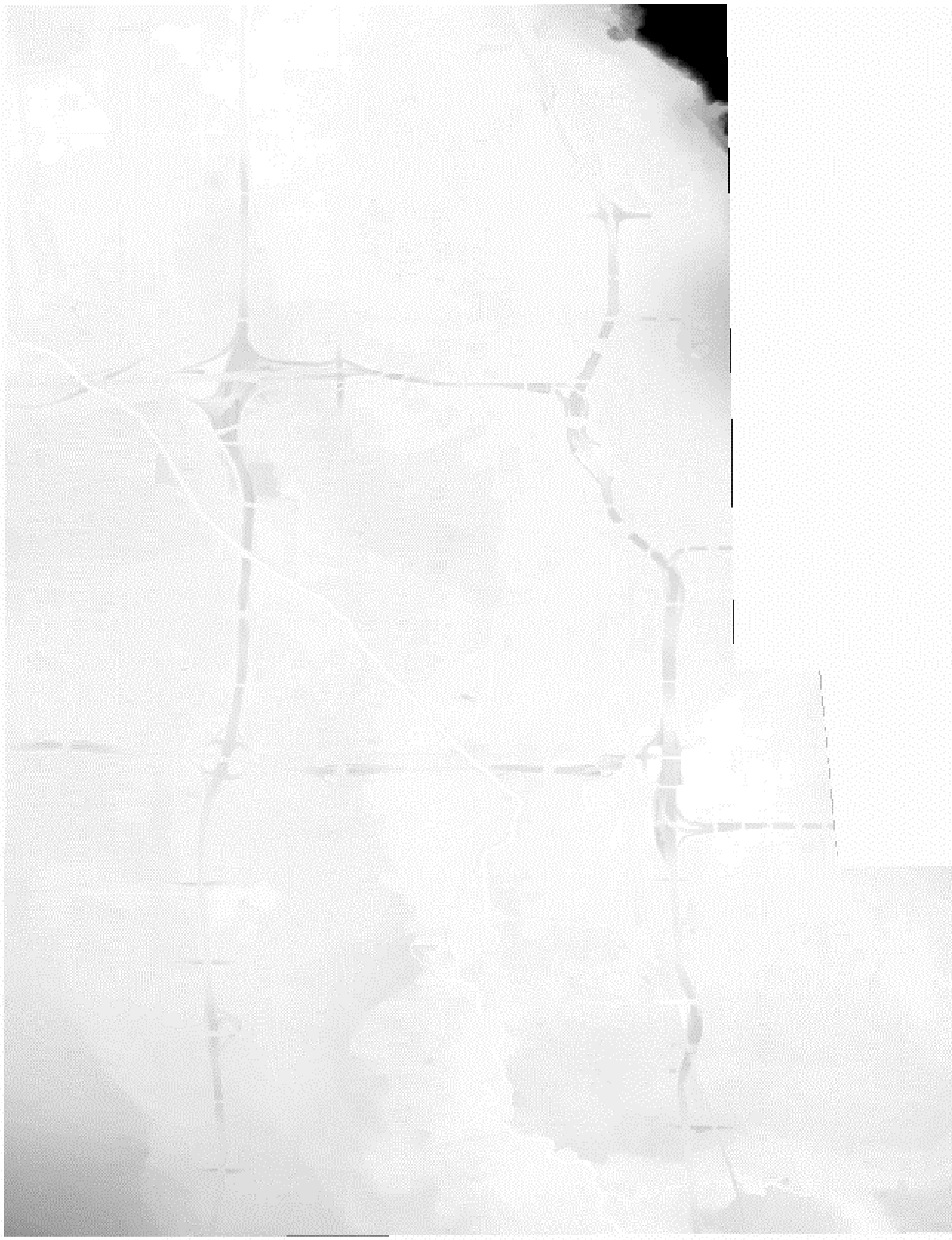
Task 3: Prepare the Depth Grid

- In ArcToolbox, open the “Spatial Analyst Tools > Math” toolbox.
- Double-click the Minus tool and fill in the parameters as shown below to subtract the water surface from the ground surface.
    - Input raster or constant value 1: A_Water_Surf
    - Input raster or constant value 2: dem_ft
    - Output raster = IDW_Minus_DEM in the DFIRMOutput folder.

- By subtracting the water surface from the DEM you will get those areas where the water is at a higher elevation than the ground or, more specifically, the depth of water.

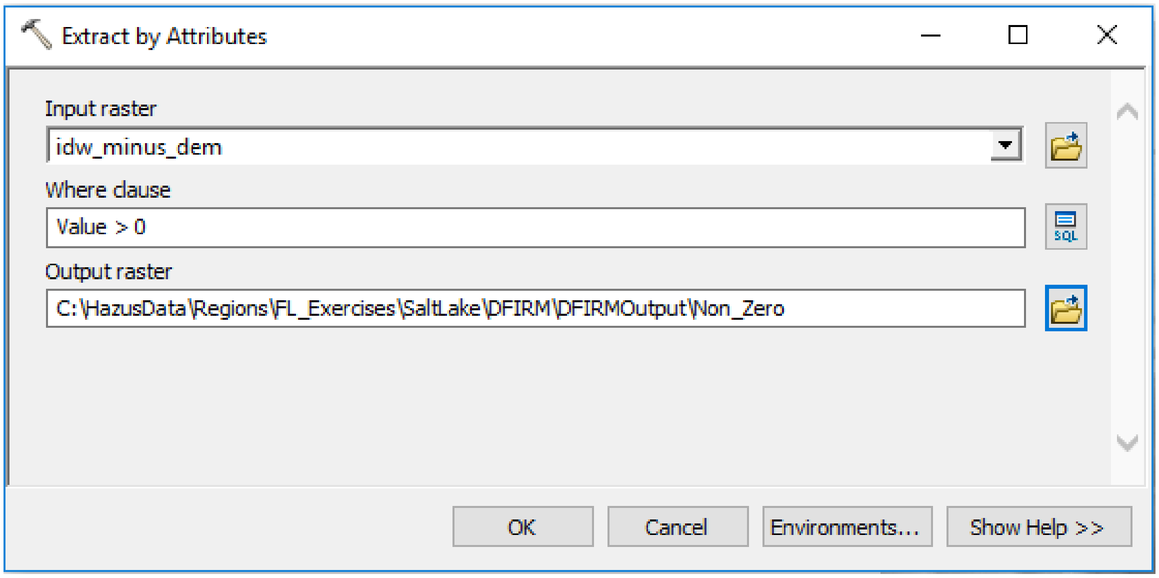


- Click “OK” to complete the process. The new layer should appear as follows.

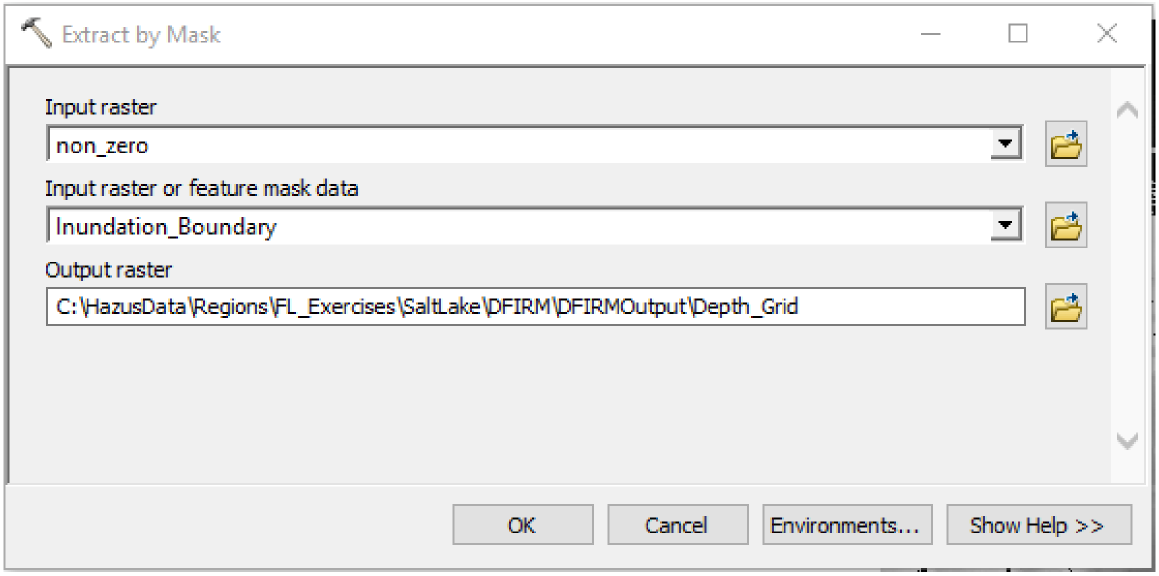


- In ArcToolbox, open the “Spatial Analyst Tools > Extraction” toolbox.
- Open the “Extract by Attributes” tool. Set the following parameters:

- Input Raster: IDW_Minus_DEM.
- Where clause: Value > 0
- Save the output raster as Non_Zero in the DFIRMOutput folder.
- When subtracting the water surface from the DEM there are places where the DEM is at a greater elevation than the water surface, indicating there is no water depth. Removing the negative values leaves only the depth of flooding.

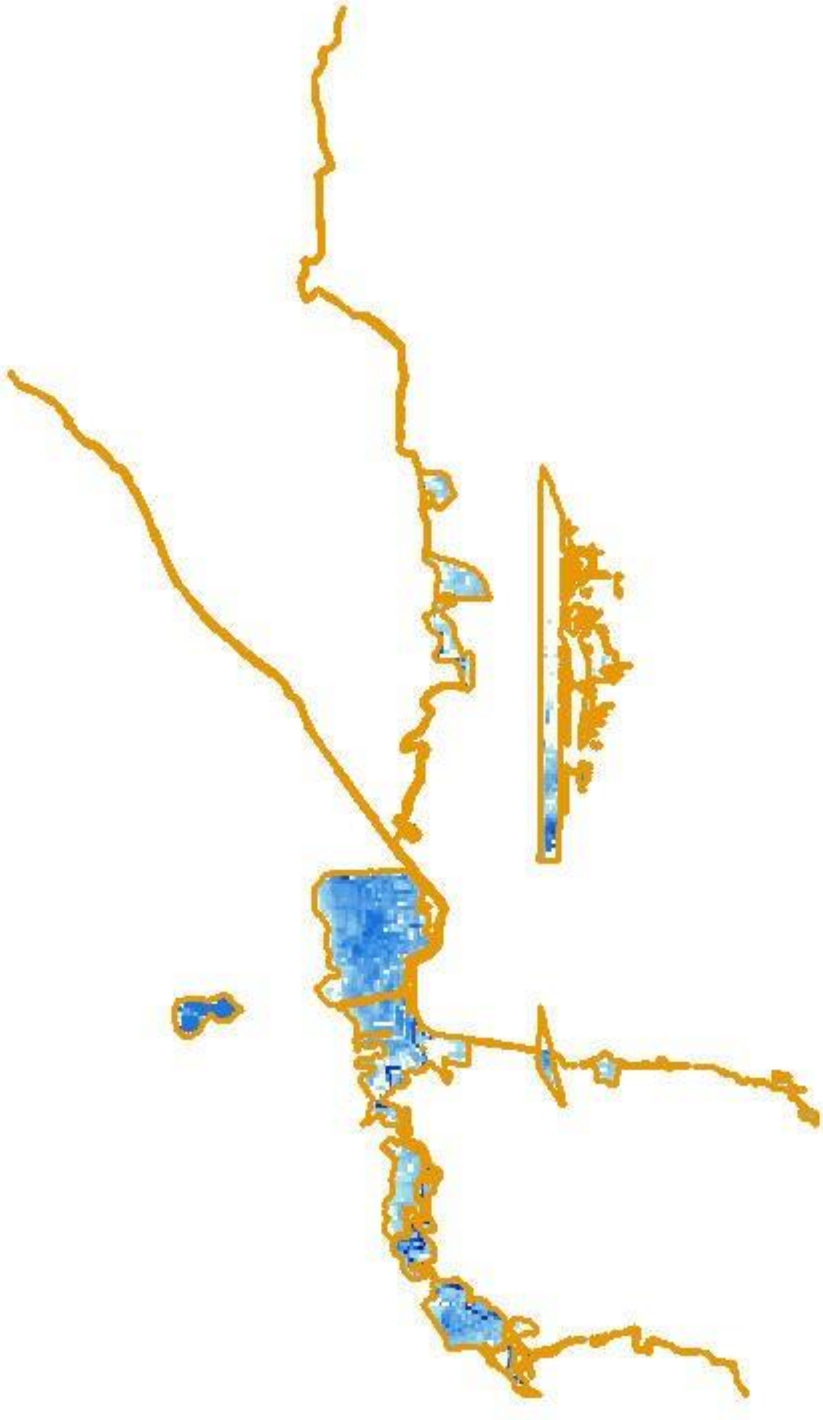


- Click “OK.”
- From the Spatial Analyst Toolbox choose “Extraction > Extract by Mask.” Set the following parameters:
  - Input Raster: Non_Zero
  - Feature mask data: Inundation Boundary (from earlier in the exercise)
  - Save the output raster as Depth_Grid in the DFIRMOutput\ folder.



- Click “OK.”

Note: When your Depth Grid has finished, the grid and boundary (Inundation Boundary) should look similar to the following image. You may have to re-arrange or turn off layers to view the new dataset.



Task 4: Understand the DFIRM Database

- The National Flood Hazard Layer (NFHL) data incorporates all Flood Insurance Rate Map (FIRM) databases published by the Federal Emergency Management Agency

(FEMA), and any Letters of Map Revision (LOMRs) that have been issued against those databases since their publication date. It is updated on a monthly basis. The FIRM Database is the digital, geospatial version of the flood hazard information shown on the published paper FIRMs.

- The FIRM Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1-percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The FIRM Database is derived from Flood Insurance Studies (FISs), previously published FIRMs, flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data, where available. The FISs and FIRMs are published by FEMA.
- The NFHL is available as State or US Territory data sets. Each State or Territory data set consists of all FIRM Databases and corresponding LOMRs available on the publication date of the data set.
- The specification for the horizontal control of FIRM Databases is consistent with those required for mapping at a scale of 1:12,000. This file is georeferenced to the earth's surface using the Geographic Coordinate System (GCS) and North American Datum of 1983.
- Data included (bold features are the most often used for depth grid creation):
    - L_COMM_INFO.dbf: Information about each community on the FIRM.
    - L_SOURCE_CIT.dbf: Listing and description of the sources of information used in the FIRM or referenced in the FIS report bibliography.
    - L_XS_ELEV.dbf: Information about the hydrologic model at each mapped cross section and those cross sections referenced in the FIS report Floodway Data Tables. This table is used to generate the Floodway Data Tables and contains lettered cross sections.
    - S_BFE: Shapefile with the location and attributes for Base Flood Elevations (BFEs) shown on FIRM.
    - S_FIRM_PAN: Shapefile with location and attributes for FIRM hardcopy map panels.
    - S_FLD_HAZ_AR: Shapefile with the location and attributes for flood insurance risk zones on the FIRM.
    - S_FLD_HAZ_LN: Shapefile with the location and attributes for the boundaries of flood insurance risk zone on the FIRM.
    - S_GEN_STRUCT: Shapefile with the location and attributes for flood control structures shown on the flood profile and FIRM.
    - S_LEVEE: Shapefile with the location of levee centerlines, floodwalls, and closure structures protecting accredited and provisionally accredited levees.
    - S_LOMR: Shapefile with the location and attributes for Letter of Map Revisions (LOMRs) not yet incorporated on the FIRM. Used only as part of the national Flood Hazard Layer (NFHL).
    - S_PLSS_AR: Shapefile with the location and attributes of sections, townships, and ranges on the FIRM
    - S_POL_AR: Shapefile with the location and attributes for political jurisdictions shown on the FIRM.

- S_PROFIL_BASLN: Shapefile with the location and attributes for profile baseline and stream centerline features for the flood risk project area.
- S_WTR_LN: Shapefile with the location and attributes for hydrography features shown on FIRM as lines
- S_XS: Shapefile with the location and attributes for cross section lines in the area covered by the FIRM. This layer must contain all cross sections in a model, not just the lettered cross sections.
- STUDY_INFO.dfb: General information about the FRIM

Exercise 10.1 - High Water Marks (HWM) Depth Grid

Type: Student-Led Activity

Time: 30 minutes

Goal: Create a high water mark depth grid.

Background: There are a variety of tools and resources from which you might acquire depth grids. The availability of data, along with your skills as a GIS analyst, will determine how effectively you can use these resources. This activity demonstrates one process for creating a Hazus compliant depth grid using field collected and verified High Water Marks (HWM) and the Esri ArcMap Spatial Analyst toolset. FEMA recently laughed the High Water Mark (HWM) Initiative, which is a community-based awareness program that increases local communities' awareness of flood risk and encourages action to mitigate that risk. HWM signs may be posted in prominent places to encourage greater understanding of how floods may affect communities and provide greater awareness of how that data can be used to complete mitigation actions and build resilience against future flooding.

A few data considerations to keep in mind while working through the geoprocessing steps to creating a depth grid:

- Make sure that all of your data conforms to the same projection. If requisite datasets are projected differently, you will encounter errors in your geoprocessing procedure. It is recommended that all datasets be projected into World Geodetic System 1984 (WGS 84).
- What vertical units is your terrain data displayed (Feet, Meters, etc.)?
  - If the terrain data is in meters, use the Raster Calculator to convert the terrain dataset to feet if the intention is to use the final depth grid in Hazus.
- What vertical datum are the HWM’s (NAVD88, NGVD29, etc.)?
  - The vertical datum of your terrain data and HWM data need to match. Most data will be delivered in NAVD88. In the rare case HWM data is collected and delivered in NGVD29, you will need to convert the data. You can use the VDATUM converter or another tool of your choice for this purpose.

Required Geographic Data

- High Water Marks (HWM):
  - Point data collected using high resolution GPS systems. HWM points represent the highest extent of riverine flood or coastal storm surge inundation. These points are used as the foundation for interpolating maximum flood or surge extent for the final processed Depth Grid.
  - For this activity, an example of HWM in Salt Lake City (SLC), Utah, will be used. This data is stored as a feature class named SLC_HWM. You can review the dataset at SaltLake\HWM\.

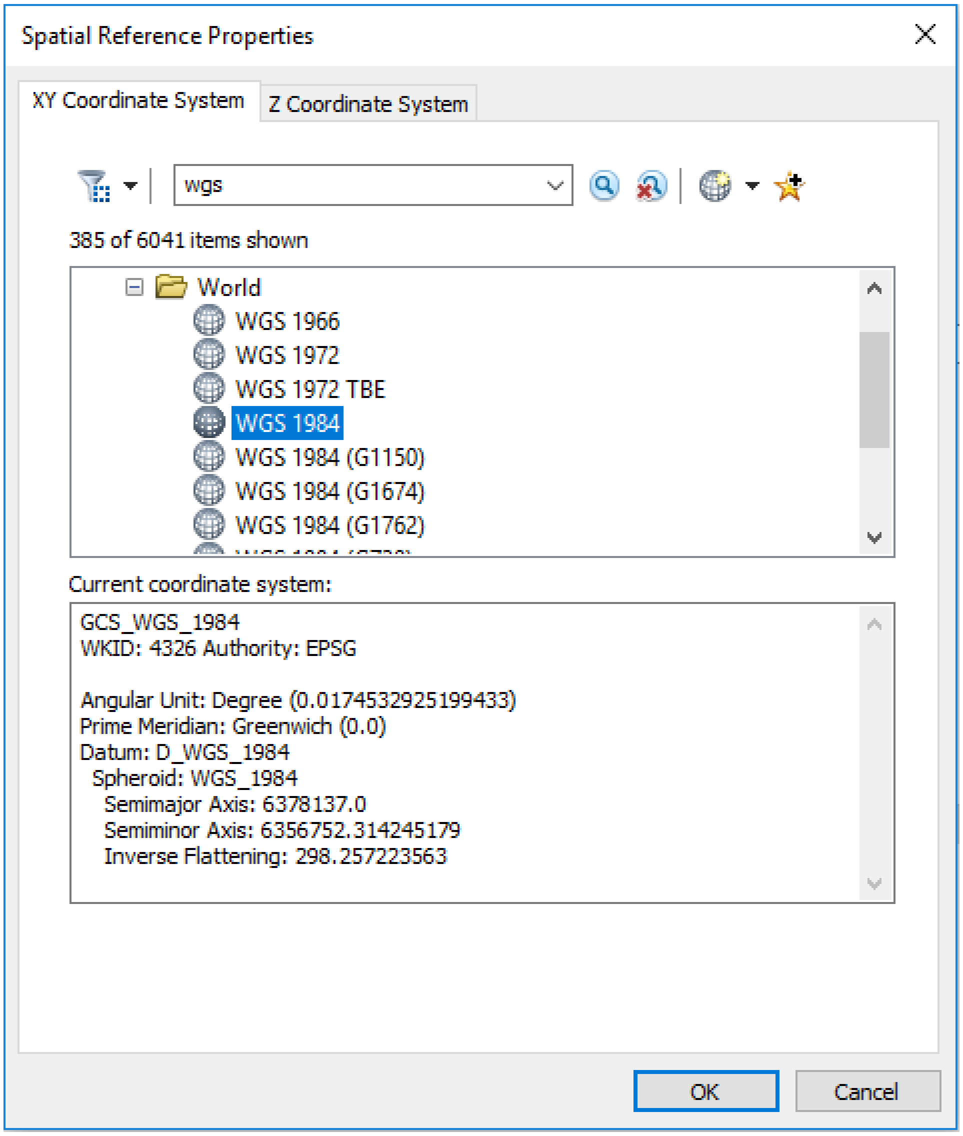
- Terrain Data:
  - Can be acquired from many sources. The most common venue for obtaining elevation datasets is through the USGS National Map Viewer. The National Elevation Dataset (NED) is available nationally at resolutions of 1 arc-second (about 30 meters), 1/3 arc second (about 10 meters), and in 1/9 arc-second (about 3 meters).
  - In addition, high resolution LiDAR (Light Detection and Ranging) data terrain data (1-3 meter resolution) may be available through local municipalities within your project area. The US Interagency Elevation Inventory is good source of information on local LiDAR collections.
  - For this exercise, 1/3 arc second NED will be used. Time and level of analysis detail are prime factors in determining the resolution of terrain data to be used in your analysis. The raster dataset, “dem_ft”, is saved as a Grid.

Task 1: Interpolate the Water Surface and Create Depth Grid

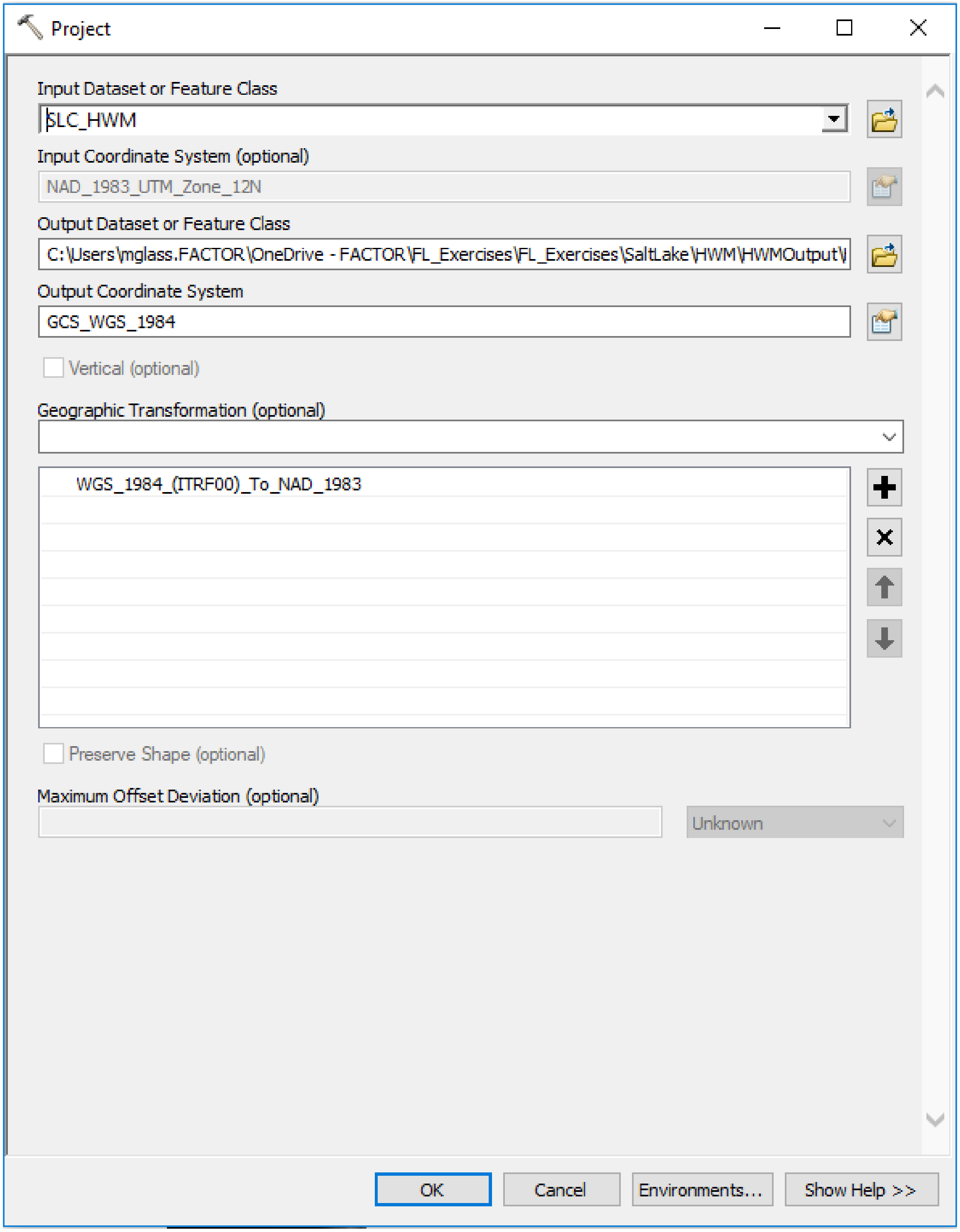
- Start ArcMap.

  Note: Verify that the Spatial Analyst Extension is activated. You will need tools in this activity that are provided as part of this extension.

- Add the following shapefiles to your map. All data is found in the \SaltLake\HWM\ folder.
  - SLC_AOI
  - dem_ft
  - SLC_HWM (You may receive a Geographic Coordinate Systems Warning. Click “Close.”)
- Project the Salt Lake City High Water Marks.
- In ArcToolbox open the Data Management Tools > Projections and Transformations folder.
- Open the Project tool.
- Complete the Project tool parameters as shown below:
  - Input point features: SLC_HWM
  - Output raster: \SaltLake\HWM\HWMOutput\HWM_WGS
  - Output Coordinate System: WGS 1984

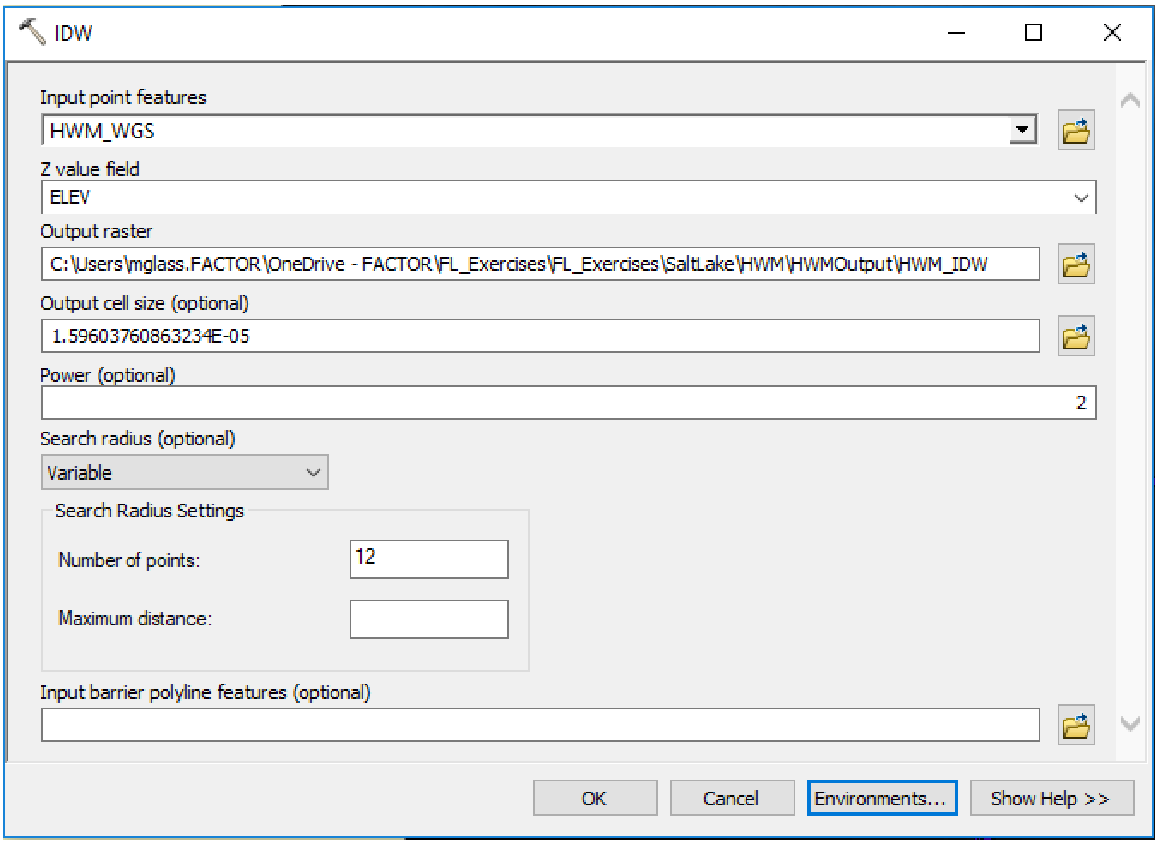

Spatial Reference Properties
XY Coordinate System
Z Coordinate System
wgs
385 of 6041 items shown
World
WGS 1966
WGS 1972
WGS 1972 TBE
WGS 1984
WGS 1984 (G1150)
WGS 1984 (G1674)
WGS 1984 (G1762)
Current coordinate system:
GCS_WGS_1984
WKID: 4326 Authority: EPSG
Angular Unit: Degree (0.0174532925199433)
Prime Meridian: Greenwich (0.0)
Datum: D_WGS_1984
Spheroid: WGS_1984
Semimajor Axis: 6378137.0
Semiminor Axis: 6356752.314245179
Inverse Flattening: 298.257223563
OK
Cancel

- Click “OK.”

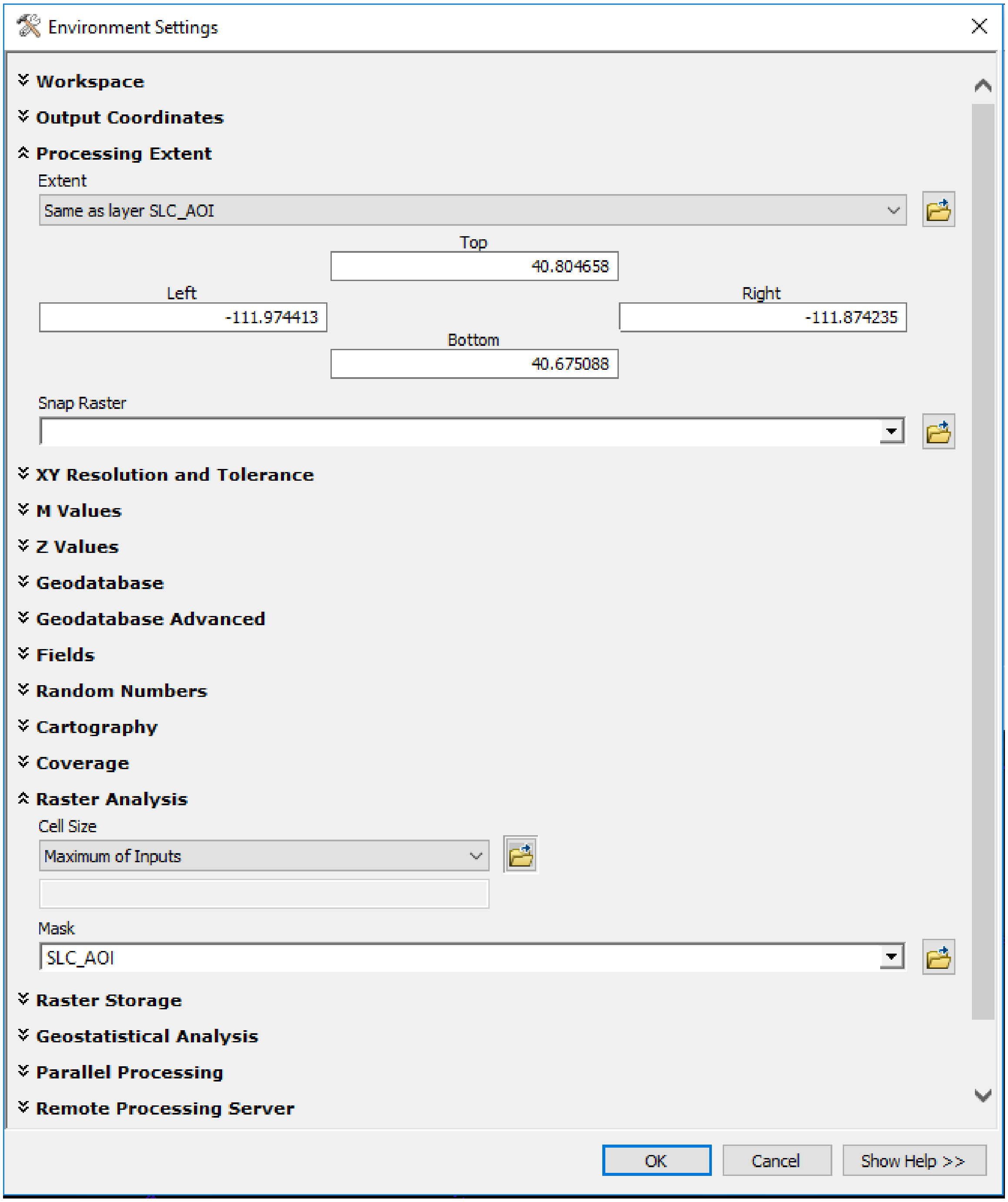


- In ArcToolbox open the Spatial Analyst Tools > Interpolation folder.
- Open the Inverse Distance Weighted (IDW) tool.
- Complete the IDW tool parameters as shown below:

- Input point features: HWM_WGS
- Z value field: ELEV
- Output raster: \SaltLake\HWM\HWMOutput\HWM_IDW
- Output cell size: 1.59603760863234E-05



- Click “Environments.”
  - From the Processing Extent area under the “Extent” drop-down menu, choose “Same as layer SLC_AOI.”
  - From the Raster Analysis area under the “Mask” drop-down menu, choose “SLC_AOI.” Click “OK.”

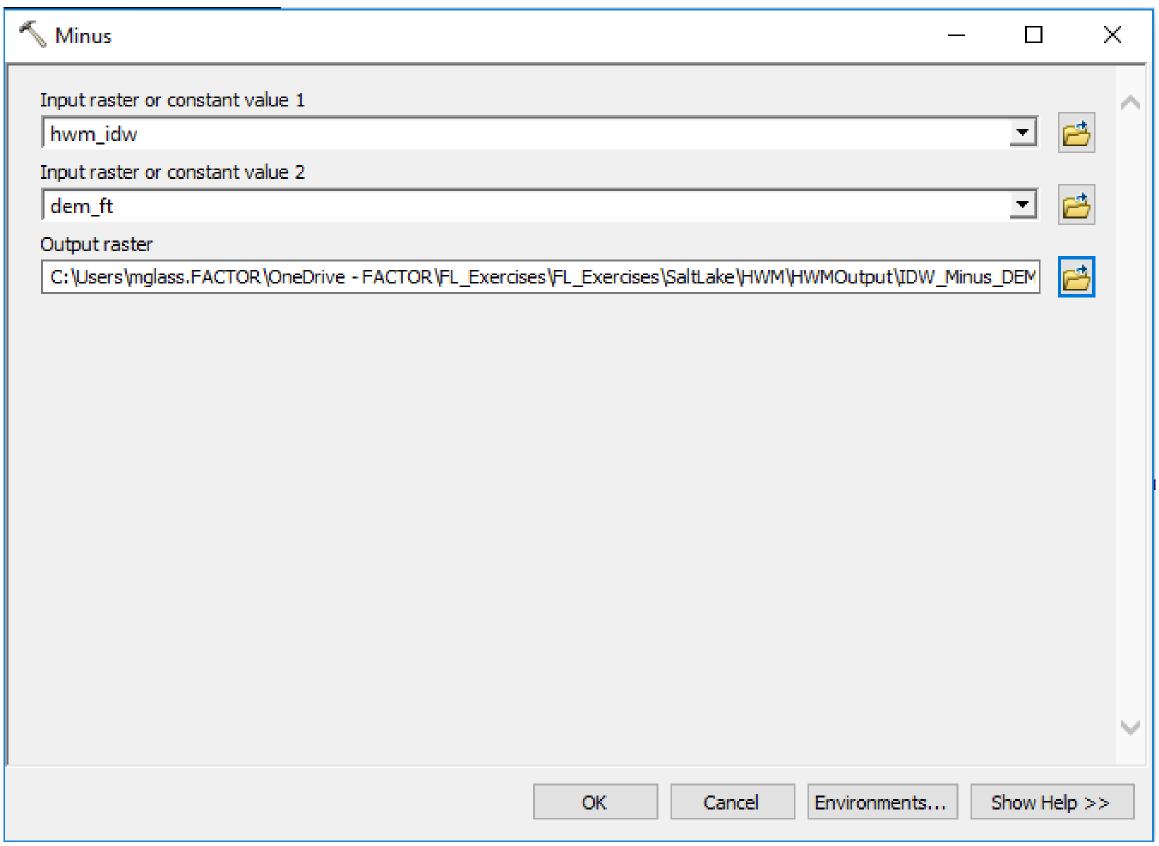


- Click “OK” to complete the process. This will take approximately 3 minutes to complete.

Task 2: Subtract Water Surface Grid from the DEM

- In ArcToolbox, open the Spatial Analyst Tools > Math folder.

- Double-click the Minus tool and fill in the parameters as shown below to subtract the water surface from the ground surface.
  - Input raster or constant value 1: HWM_IDW
  - Input raster or constant value 2: dem_ft
  - Output raster: \SaltLake\HWM\HWMOutput\ IDW_Minus_DEM
  - By subtracting the water surface from the DEM, you will get the areas where the water is at a higher elevation than the ground or, more specifically, the depth of water.

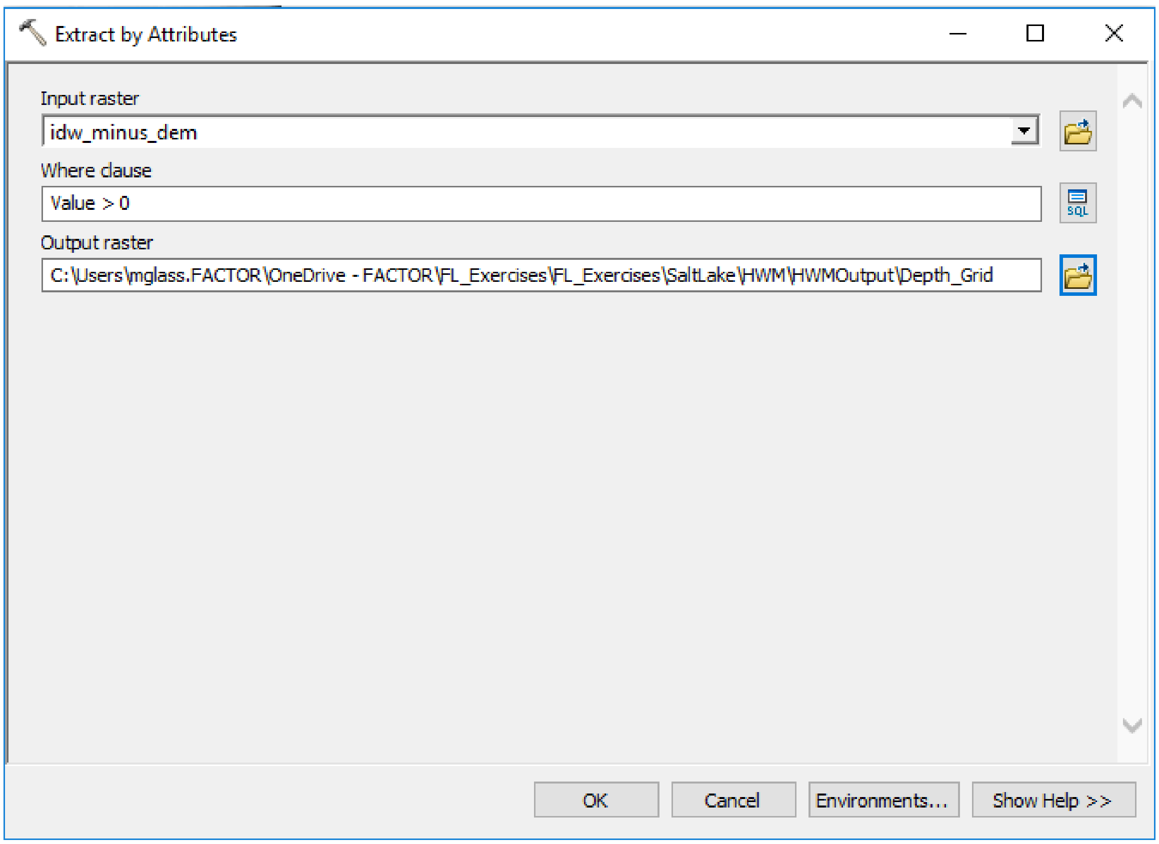


- Click “OK” to complete the process. The new layer should appear as shown below:

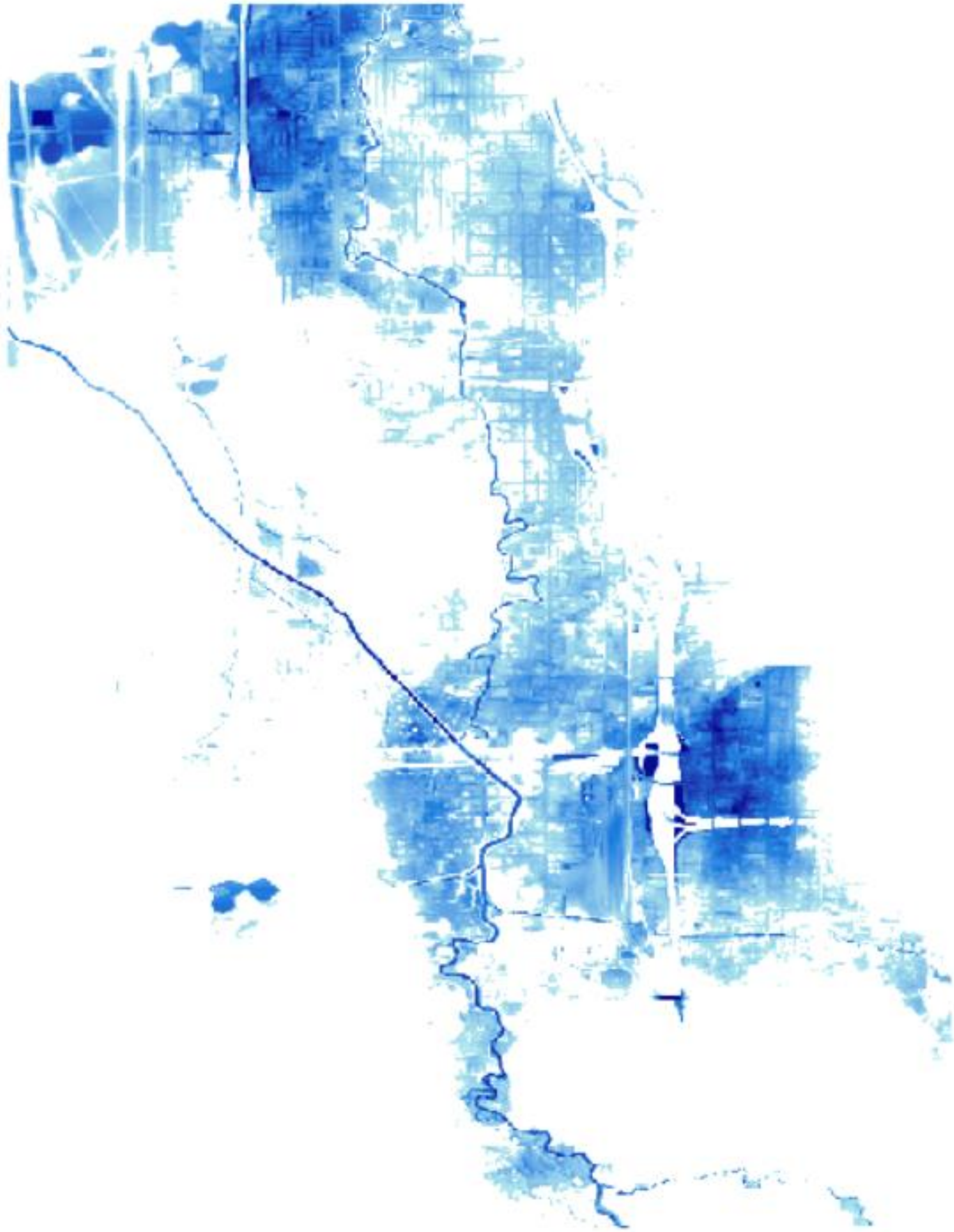
Task 3: Remove Negative Values

- In ArcToolbox, open the Spatial Analyst Tools > Extraction folder.

- Open the Extract by Attributes tool.
- Fill in the parameters as shown:
  - Input Raster: IDW_Minus_DEM
  - Where clause: Value > 0
  - Output Raster: \SaltLake\HWM\HWMOutput\Depth_Grid
  - When subtracting the water surface from the DEM, there are places where the DEM is at a greater elevation than the water surface. This indicates there is no water depth. Removing the negative values leaves only the depth of flooding.



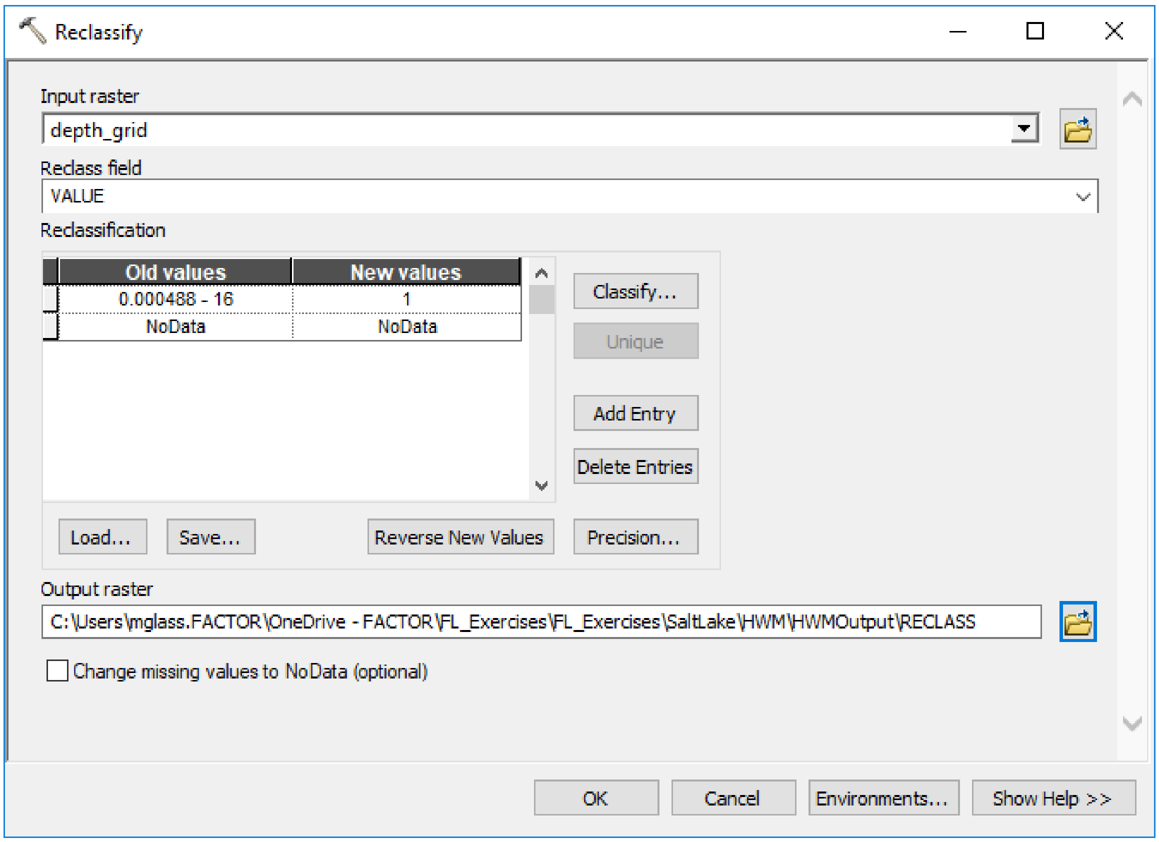
- Click “OK.” Your map should appear as follows:



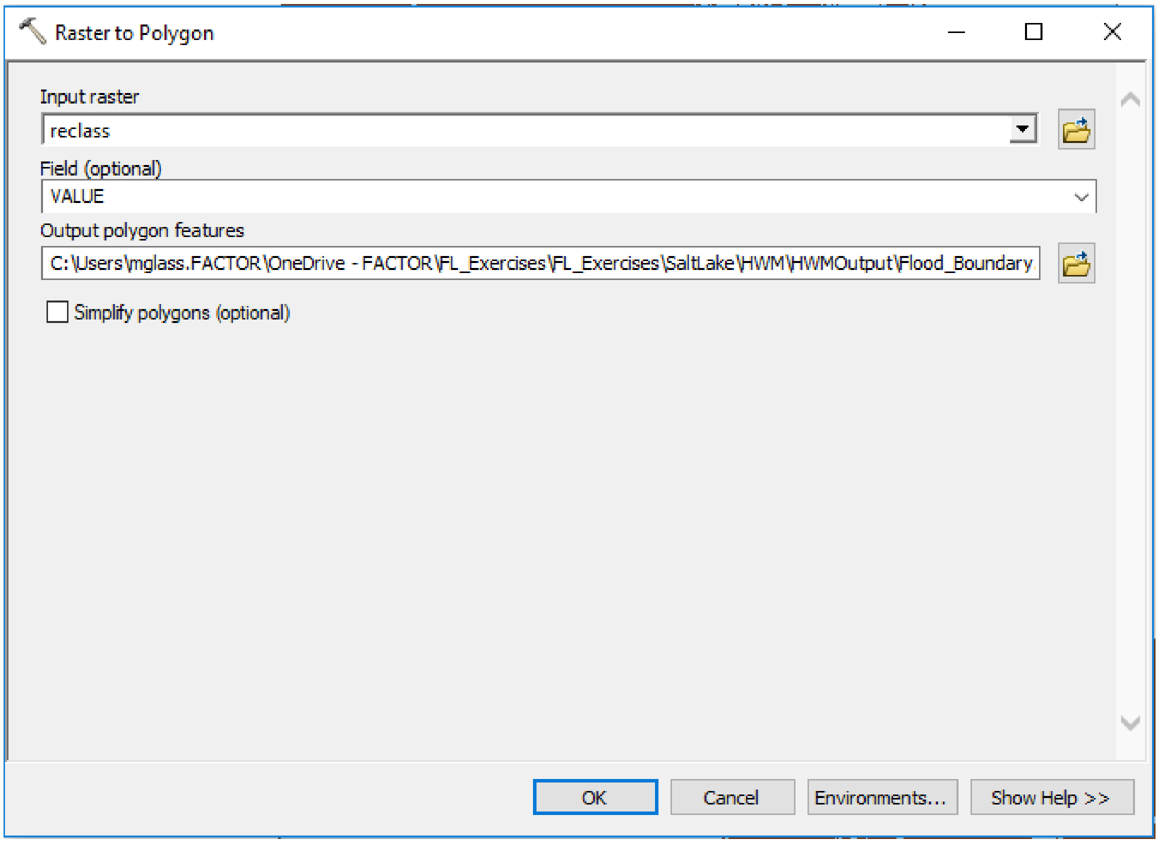
Task 4: Create a Flood Boundary

- In ArcToolbox, open the Reclass toolset in the Spatial Analyst Tools.
- Select the Reclassify tool.

- Set the following parameters:
  - Input Raster: Depth_Grid
  - Reclass Field: VALUE
- Click “Load…”
- Navigate to “\SaltLake\HWM\” and choose the “hwmreclass.info” file.
- Set the Output Raster as “\SaltLake\HWM\HWMOutput\RECLASS.”

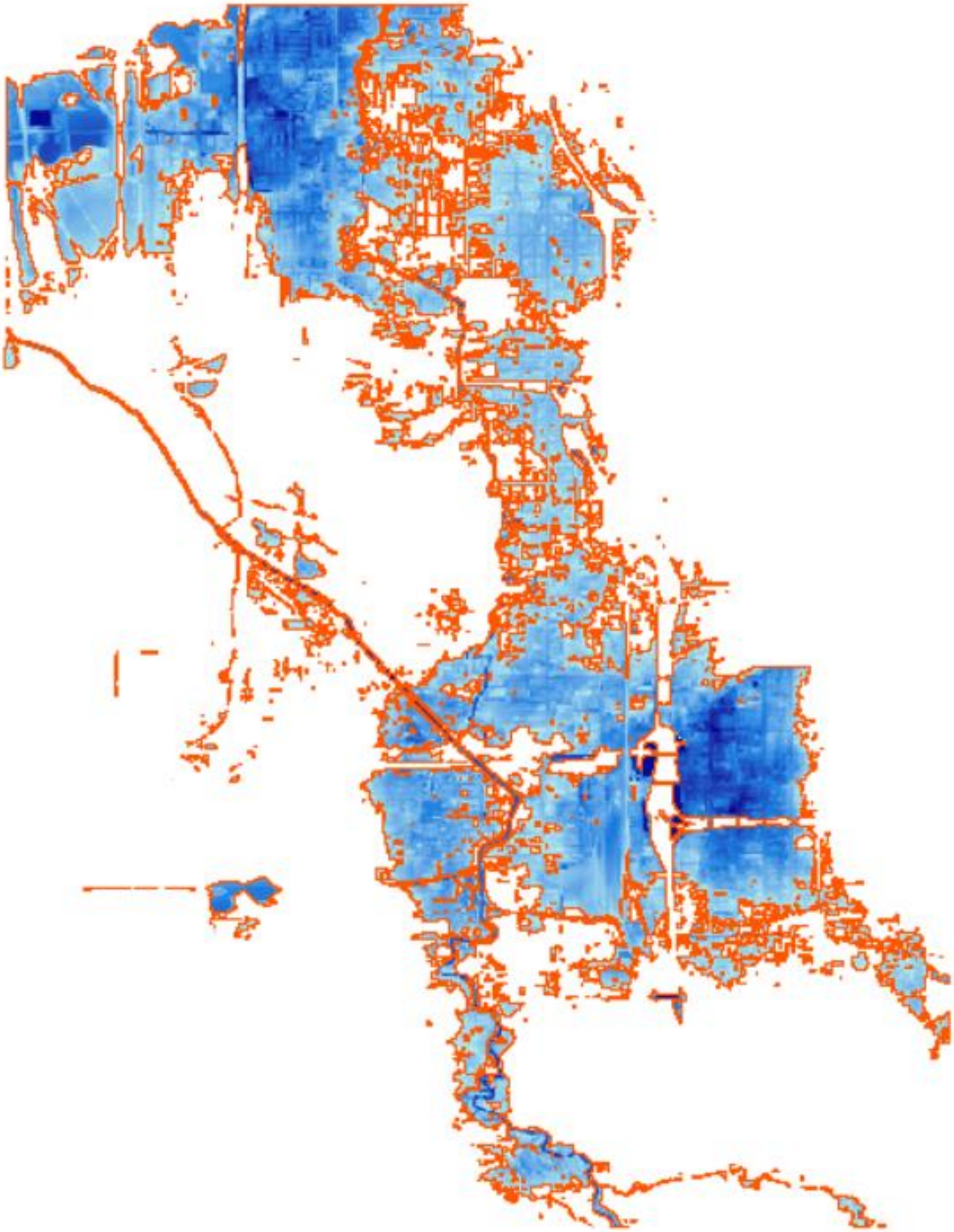


- Click “OK.”
- From the Conversion Toolbox, open the “From Raster” Toolset.
- Open the “Raster to Polygon” tool and complete the parameters as shown below.
  - Input raster: RECLASS
  - Field: Value
  - Output polygon features: \SaltLake\HWM\HWMOutput\Flood_Boundary
  - Uncheck “Simplify Polygons.”



- Click “OK.”

  Note: You should now have a flood depth grid and flood boundary that looks similar to the following image depending on how you decided to symbolize the layers.



Demonstration 11.1: ShakeMap using Hazus Interface - Background

Type: Instructor-Led Demonstration

Time: 25 minutes

Goal: Use the Hazus interface to find a ShakeMap.

Note: A new feature of Hazus 4.2 is the ability to add ShakeMaps via the Hazus Interface. The HAZUS USGS shakemap database is a combination of multiple sources including ATLAS, which holds 6,100 earthquakes.

Task 1: Create New Salt Lake City Study Region

- Open Hazus 4.2.
- Click “Create a new study region” and then “OK.”
- The Create New Region window will appear. Click “Next.”
- Name the study region “Salt_Lake_City_EQ” and enter a brief description such as, “Shakemap exercise for Salt Lake City earthquakes.” Click “Next.”
- Check the box “Earthquake” and click “Next.”
- Click “County” and then “Next.”
- Select “Utah” and click “Next.”
- Select “Salt Lake” County and click “Next.”
- Click “Finish.”

Task 2: Open Salt Lake City Study Region

- Click “Open a region” and then “OK.” The “Open Region” window will appear.
- Click “Next.”
- Select “Salt_Lake_City_EQ” and click “Next.”
- Click “Finish.” ArcMap will open your Salt Lake City region.

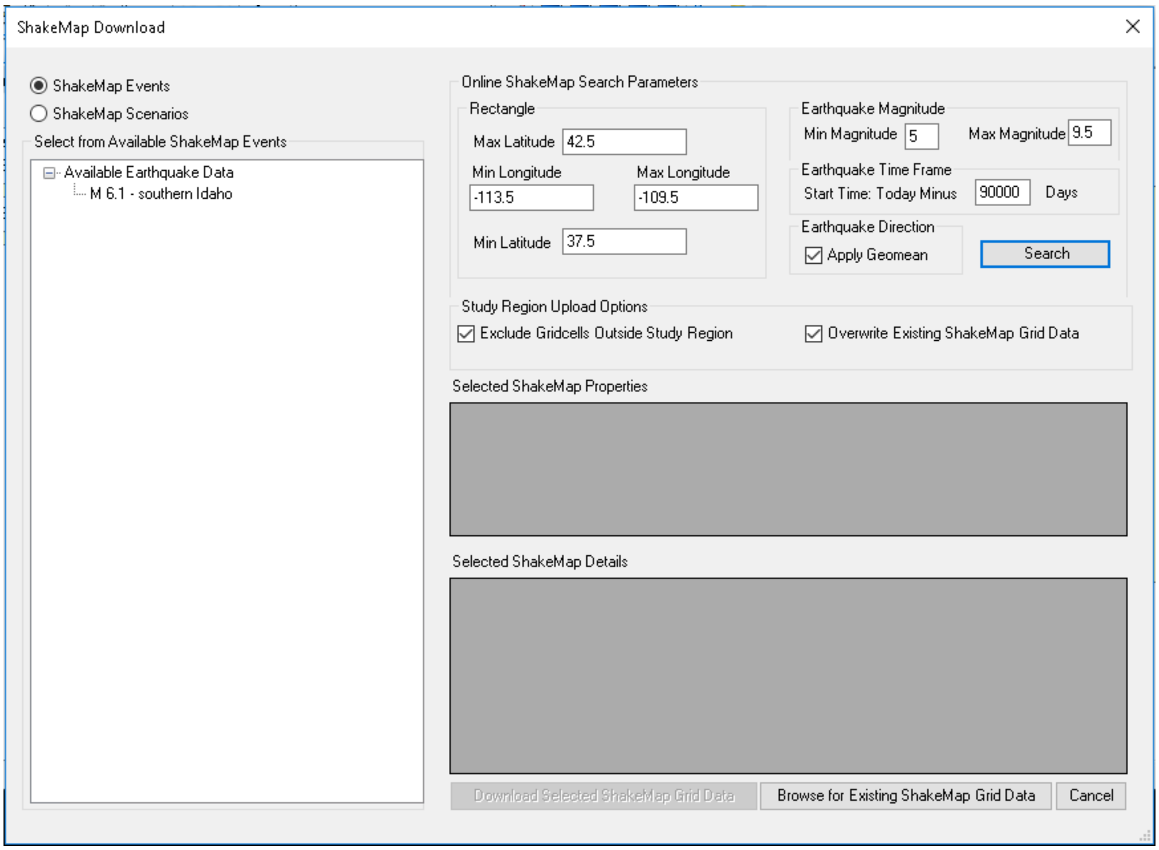
Task 3: Use Hazus Interface to Define USGS ShakeMap

Note: There is a new scenario option in Hazus 4.2 to directly analyze ShakeMaps from available data. We will import one of these earthquakes and evaluate losses.

- In the top menu bar, navigate to “Hazard > Scenario…”
- The Scenario Wizard window will appear. Click “Next.”
- Click “Define a new scenario” and click “Next.”
- Click “USGS ShakeMap…” and click “Next.”
- The “ShakeMap Download” window will appear.

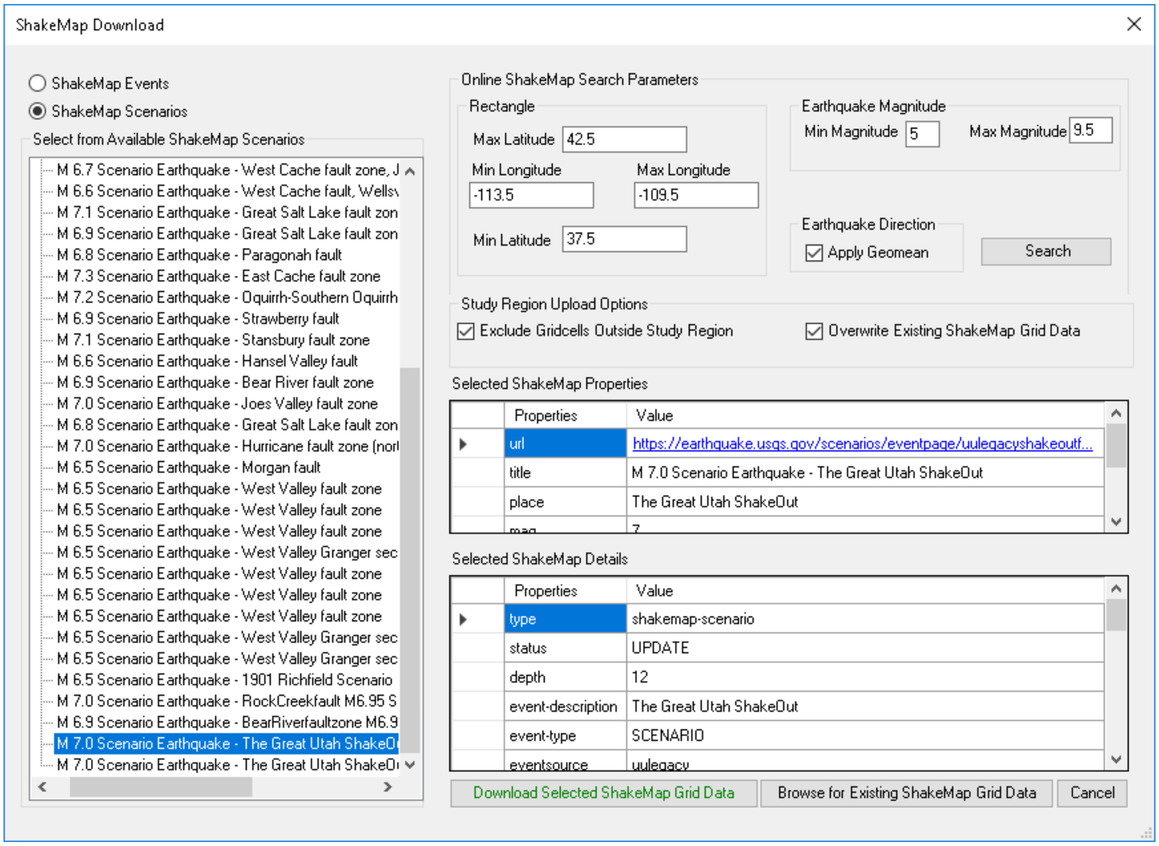
Note: This will initially show the available earthquake data for earthquakes between 5 and 9.5 magnitude in the rectangular extent of your study region for the last 90 days. By expanding the amount of days and the rectangular extent, you will find available archived historical events.

- Change the following search attributes:
  - Max Latitude: 42.5
  - Min Latitude: 37.5
  - Max Longitude: -109.5
  - Min Longitude: -113.5
  - Start Time: Today Minus 90000 Days



- Click “Search.”
- One earthquake with Available Earthquake Data will be shown.
- Select the earthquake to populate the Event Properties and ShakeMap Details areas.

- Click the "ShakeMap Scenarios" radio button in the top left of the dialog box. This will cause Hazus to search for all ShakeMaps of hypothetical earthquake scenarios that are within the search parameters.



- Select the "M 7.0 Scenario Earthquake - The Great Utah ShakeOut" earthquake to populate the Event Properties and ShakeMap Details areas.
- Review the data shown (EX: where you can find the date, time, source of the earthquake data, other information).
- Click “Download Grid Data.”
  - This will take approximately one to two minutes.
- After the grid data has downloaded, the Scenario Wizard window will appear with all defaults filled in. Click “Next.”
- The name window will appear. Click “Next.”
- Click “Finish.”
- To see the hazard study region parameters, go to “Hazard > Show Current” in the top menu bar.
- The Current Hazard Selection window will show the current analyzable scenario.

- Navigate to “Analysis > Run.”
    - This will bring up the Analysis Options window. Unselecting the options that do not interest you will decrease the processing time required to run an analysis.
- Click “Select All.”
- Select “Yes” to indicate that you do NOT want Contour Maps and click “OK.”
- Click “Yes” to run the analysis.
    - It should take approximately four to five minutes.
    - After your analysis finishes, a window will appear with the elapsed time. Click “OK.”

Task 4: View Direct Economic Loss

- Navigate to “Results > General Building Stock > Building Economic Loss > Direct Economic Loss.” The “Direct Economic Loss (in thousands of dollars)” window will now appear.
- Select the “Total” tab and scroll all the way to the right.
- Click the “Total Loss (thous. $)” tab. Click “Map” and then “Close.”

Exercise 11.2: Source Event

Type: Student-Led Activity

Time: 25 minutes

Goals:

- Create a Source Event Scenario.
- Create a map of economic loss.

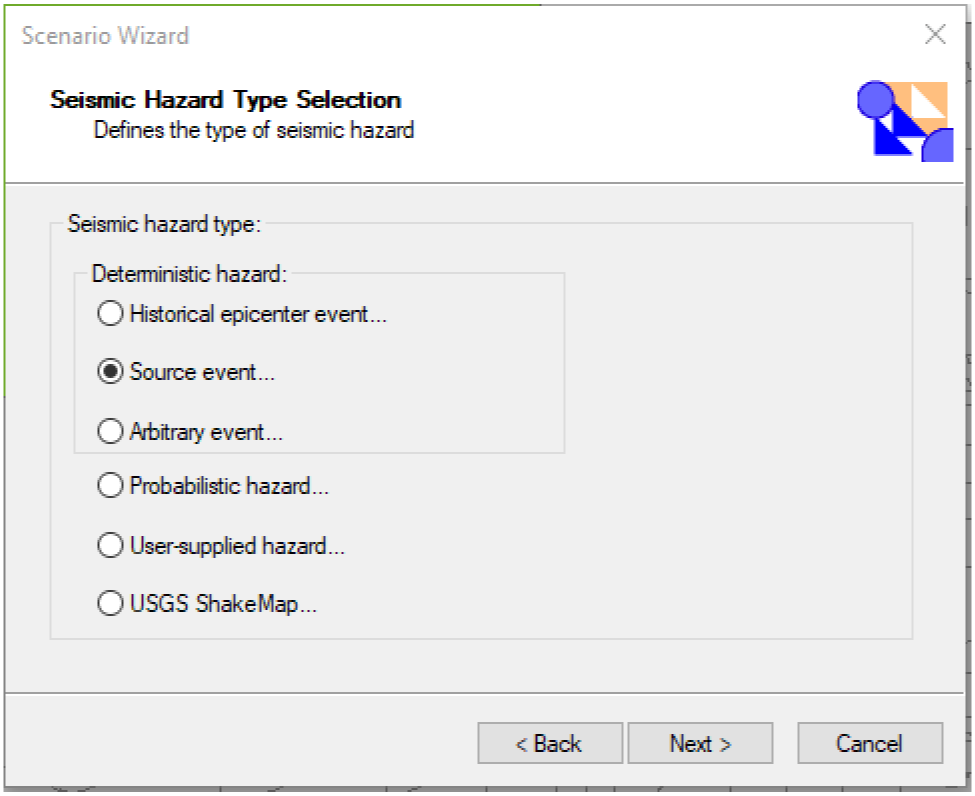
Background: Modeling source events in Hazus is a powerful tool to use when developing a portfolio of losses or impacts. For example, running numerous source events can provide a variety of case studies or scenarios that can inform disaster operations managers how the terrain or soil type may correlate with ground shaking, where losses are most likely, or what attributes or buildings are most likely to be damaged (such as building type). All of this information can inform response plans, mitigation measures, and general risk assessments. For example, if damages to a specific school district are projected to be similar across different source events, that school district might need additional mitigation resources or attention during response and recovery efforts.

Task 1: Open Study Region Salt_Lake_City_EQ

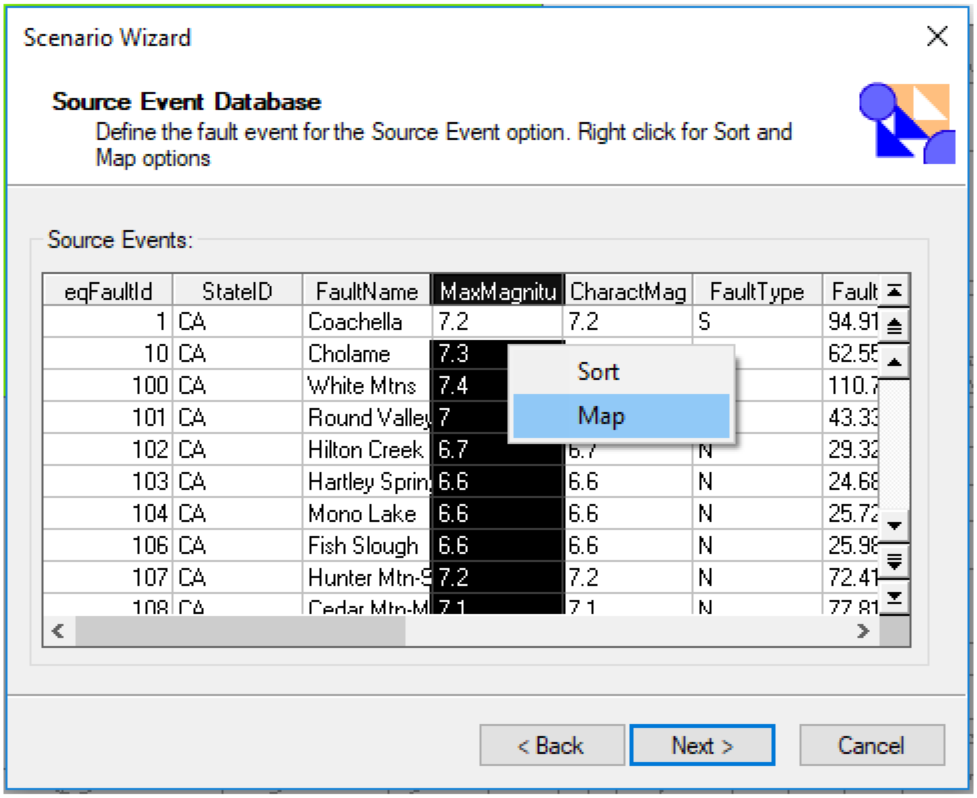
- Open Hazus 4.2.
- Click “Open a region” and then click “OK.”
- Click “Next.”
- Select “Salt_Lake_City_EQ” and click “Next.”
- Click “Finish.”

Task 2: Define the Scenario

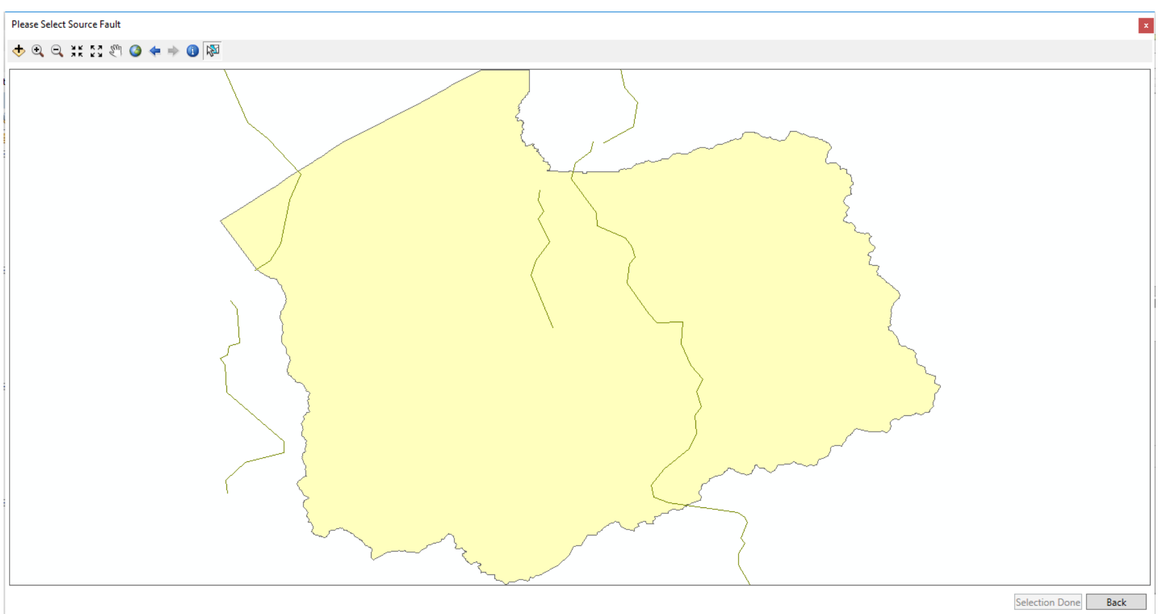
- In the top ribbon, navigate to “Hazard > Scenario…”
- This will open the “Scenario Wizard” window. Click “Next.”
- Click “Define a new scenario” and then “Next.”
- Click “Source Event…” and then “Next.” A California Fault Disclaimer will appear. Click “ACCEPT.”



- Click the “MaxMagnitude” column and then right-click to select “Map.”

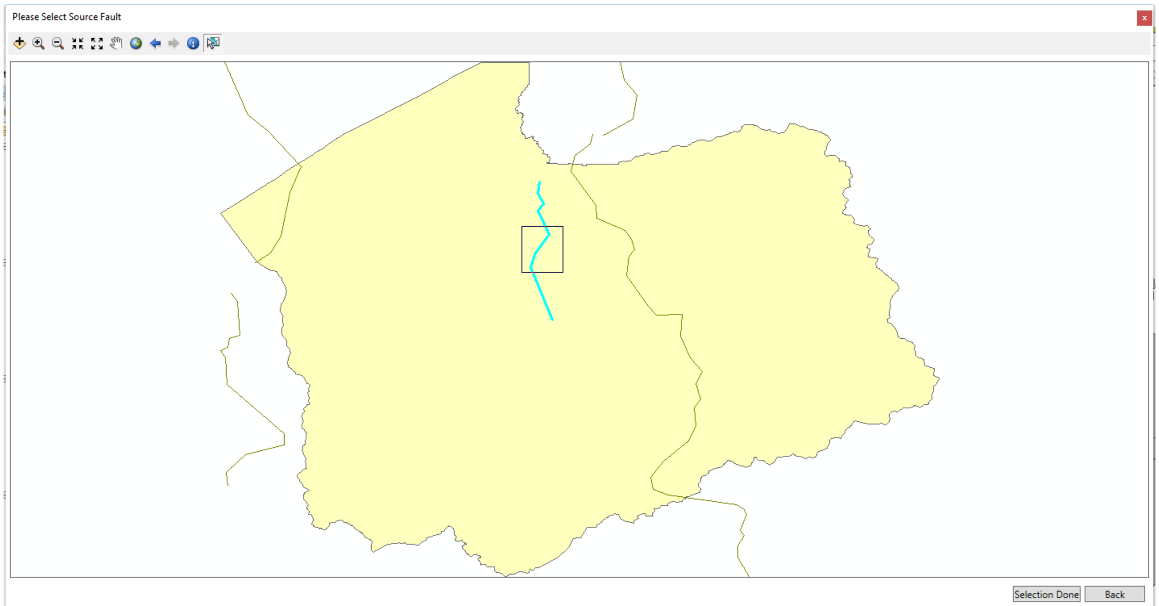


- The “Please Select Source Fault” window will appear.

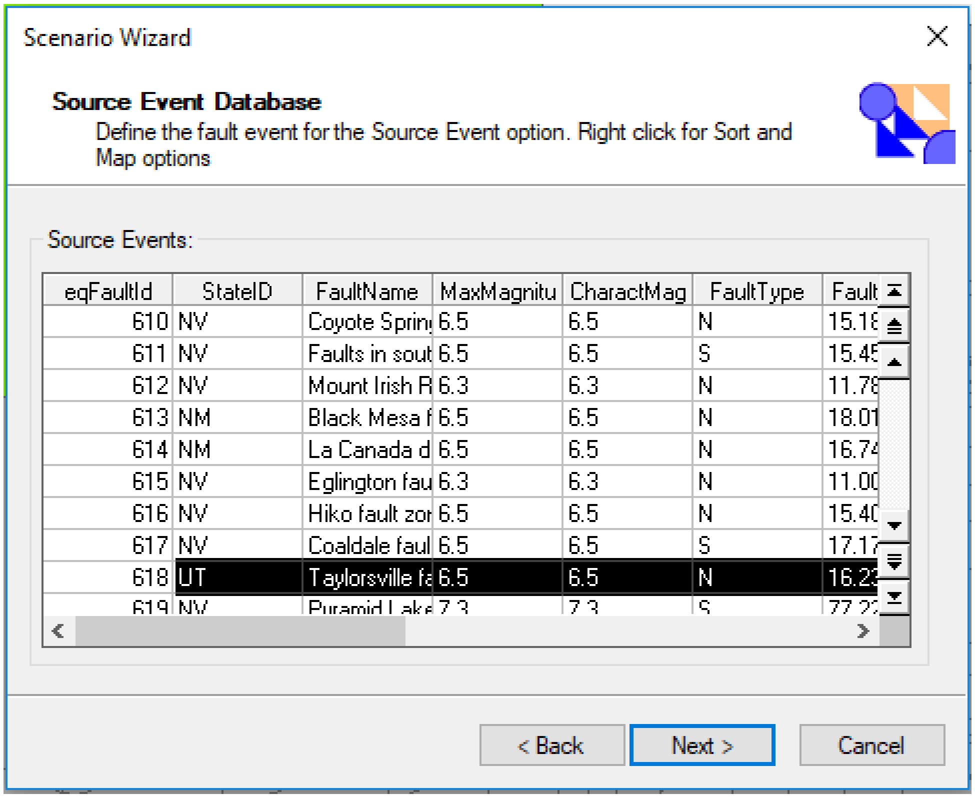


- Select the small central fault by clicking and dragging your cursor. Click “Selection Done.”

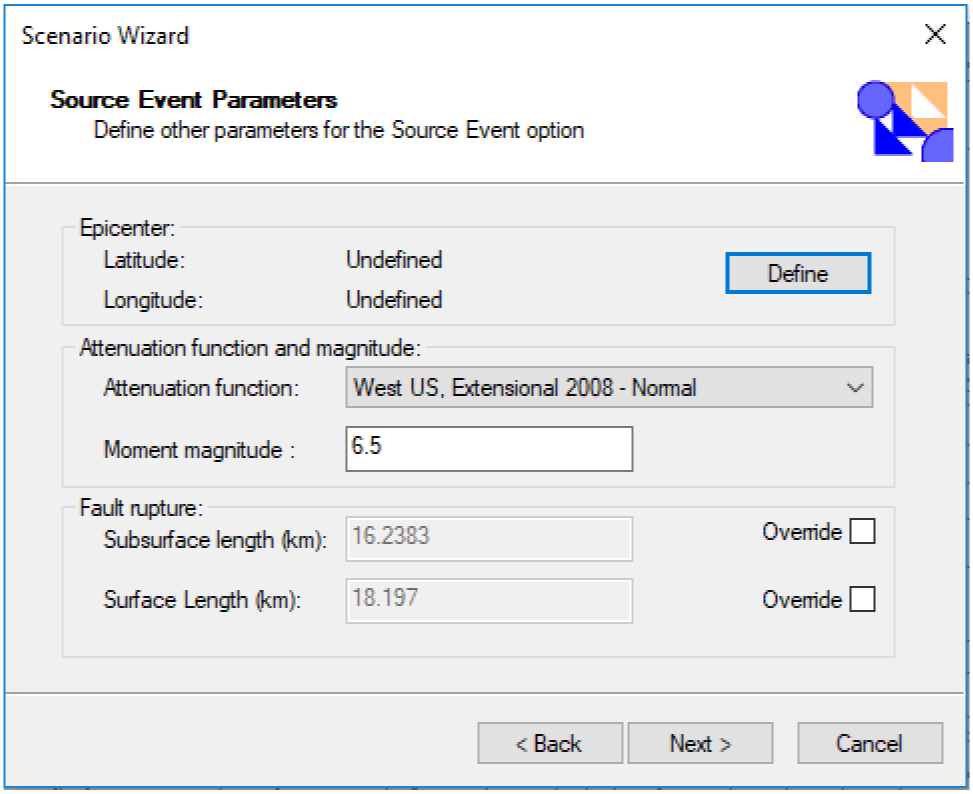
  Note: The Scenario Wizard window will show this is the Taylorsville fault with a max magnitude of 6.5.



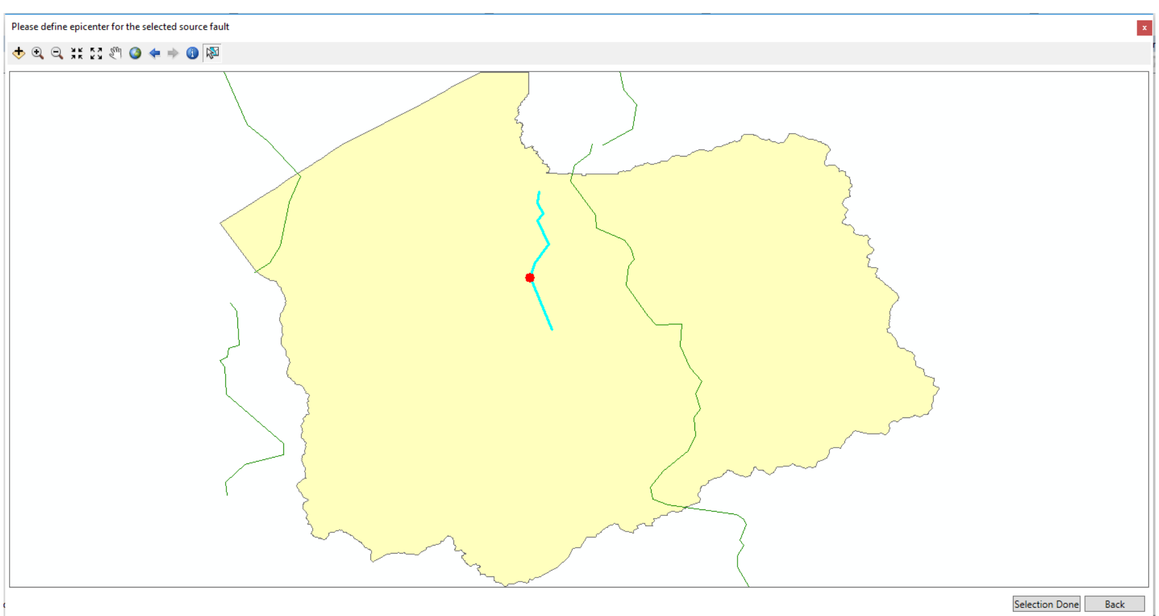
- Click “Next” to define the “Source Event Parameters.”



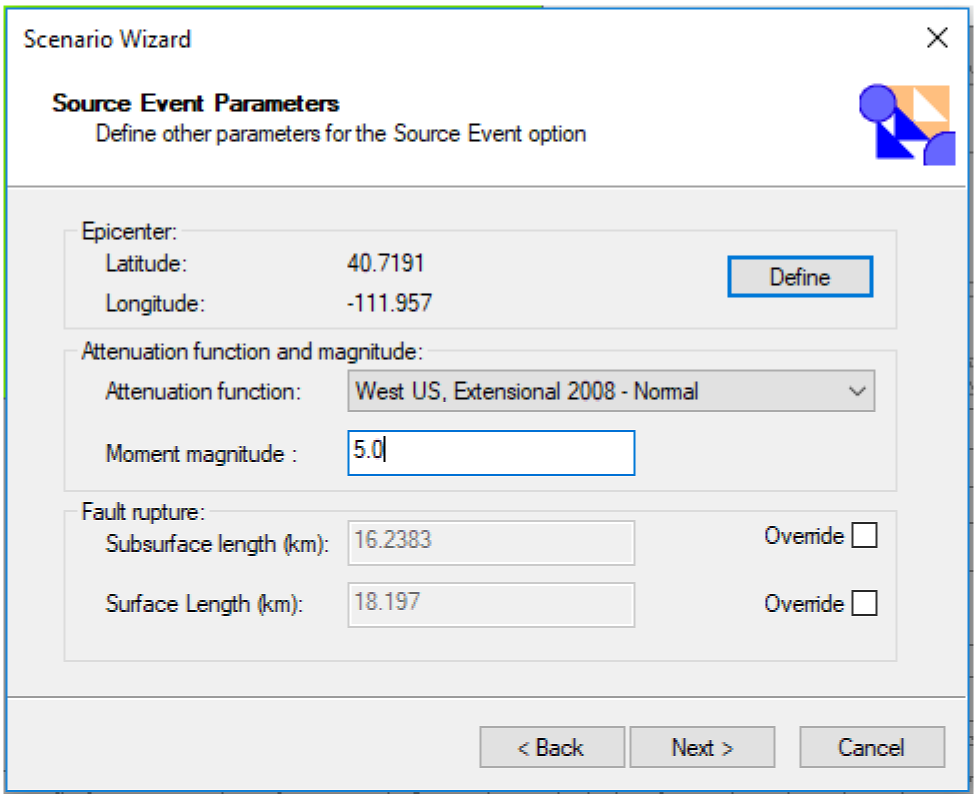
- Click “Define” to choose the epicenter of the earthquake on the fault.



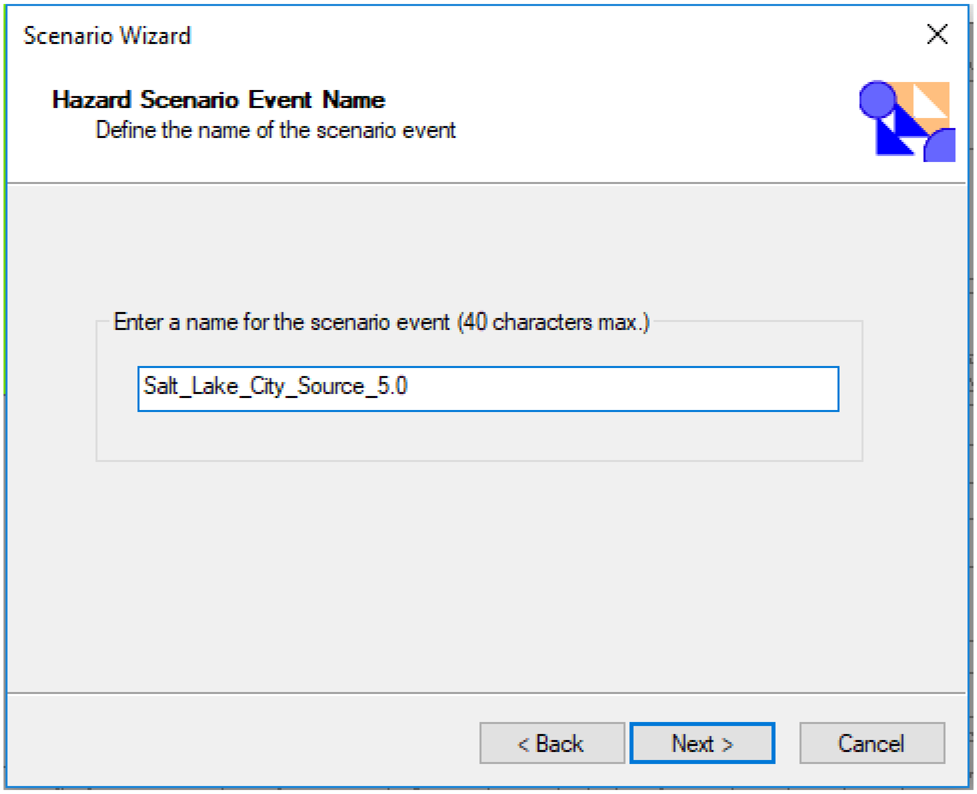
- Click the furthest westward point, as shown, and click "Selection Done."
  Note: This will populate the Latitude and Longitude.



- Enter “5.0” for the Moment Magnitude to ensure the ShakeMap damage and the Source Event damage will be as similar as possible (even though the ShakeMap damage shows 4.3 magnitude damage). Click “Next.”



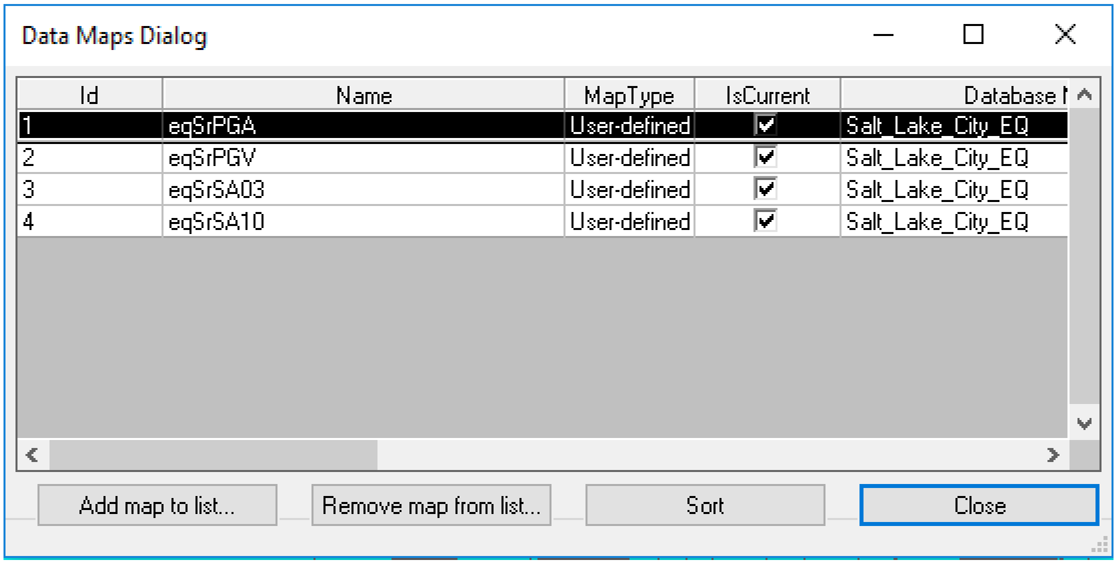
- Name the Source Event “Salt_Lake_City_Source_5.0” and click “Next.”



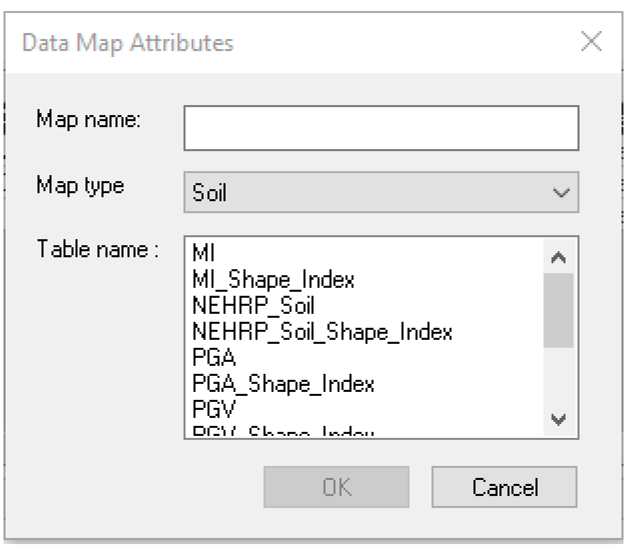
- Click “Finish.”

Task 3: Define the Soil Map

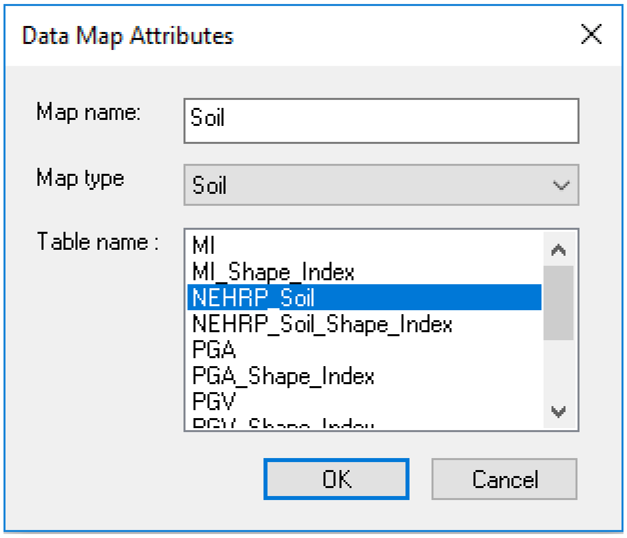
- Go to Hazard > Data Maps
- This will bring up the “Data Maps Dialog” window



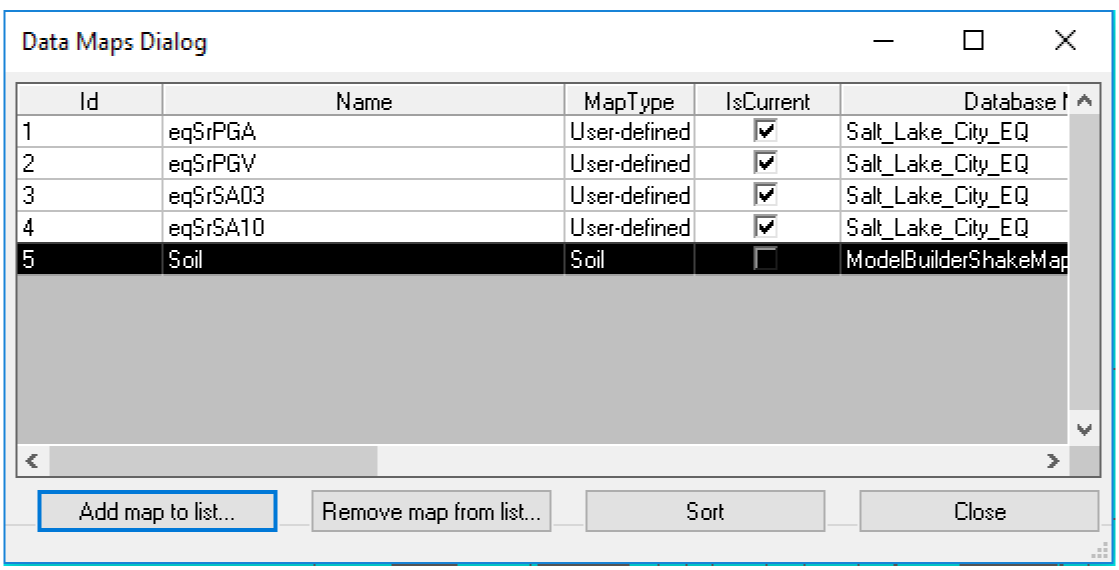
- This shows the current ShakeMap layers that are in use from the last scenario. If no scenarios have been input, this window would be blank.
- Click “Add map to list…” which will bring up a file browser window.
- Browse to the Activities folder double-click ModelBuilderShakeMap.mdb.
- This will bring up a “Data Map Attributes” window



- Type “Soil” for “Map name:” and select “NEHRP_Soil” for “Table name:” Maintain “Map Type” as “Soil.”

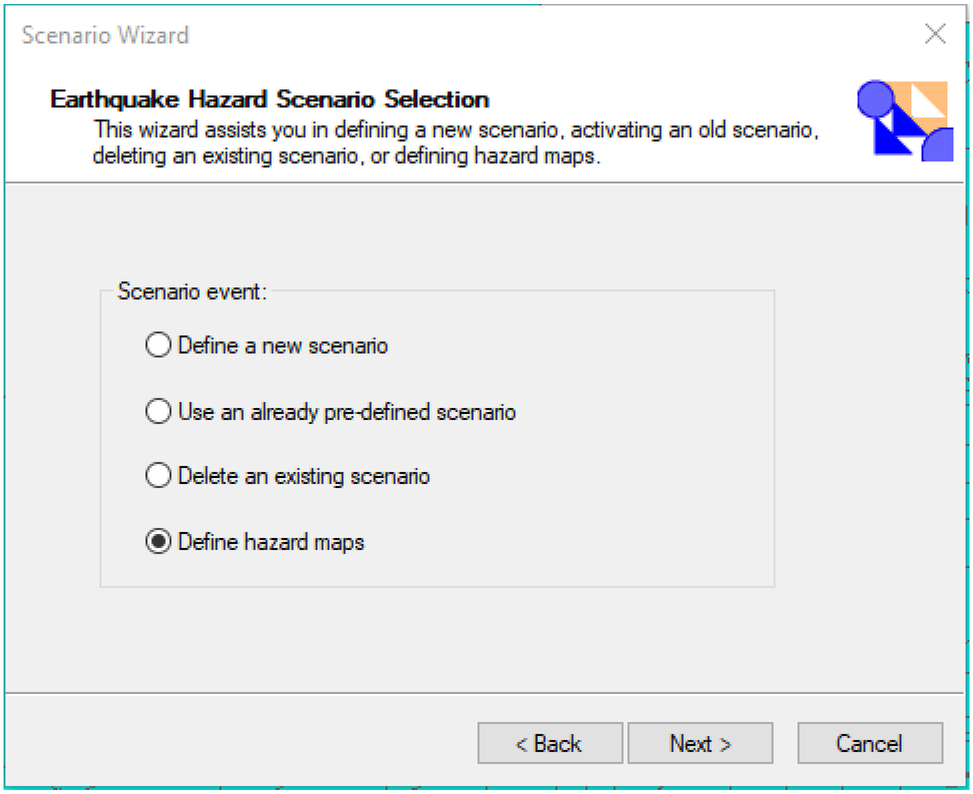


- Click “OK”



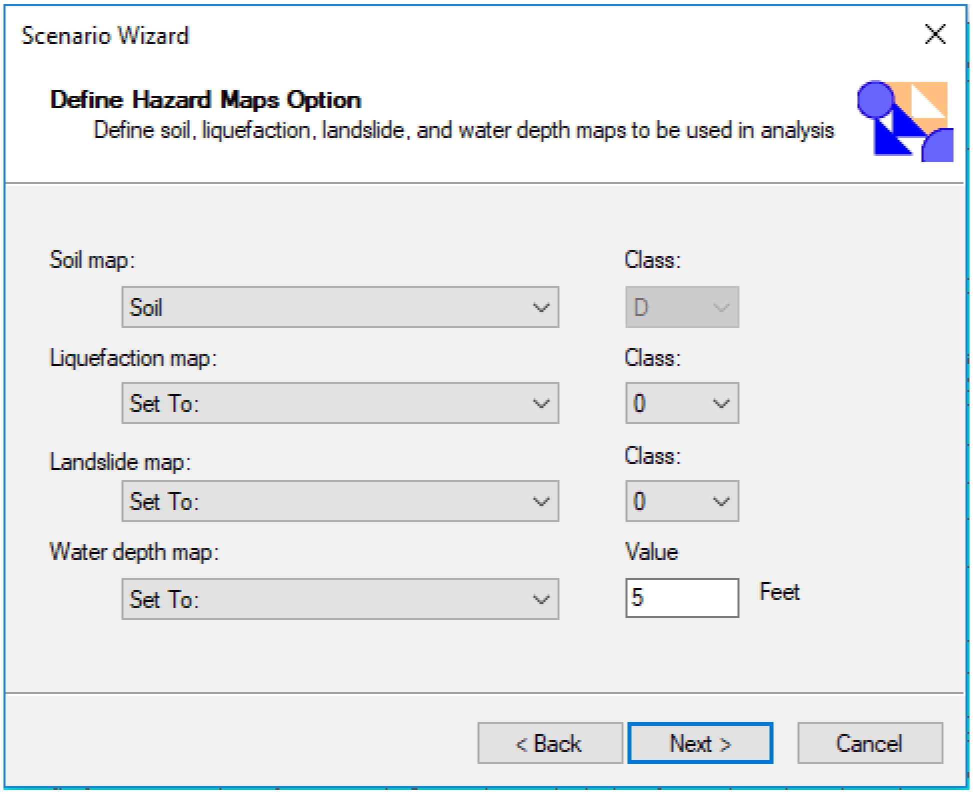
- This added a new soil map to the study region but it did not define it for use in this analysis.
- Click "Close".
- To define the soil map, navigate to “Hazard > Scenario…”

- Click "Next."
- Click "Define hazard maps" and then "Next."

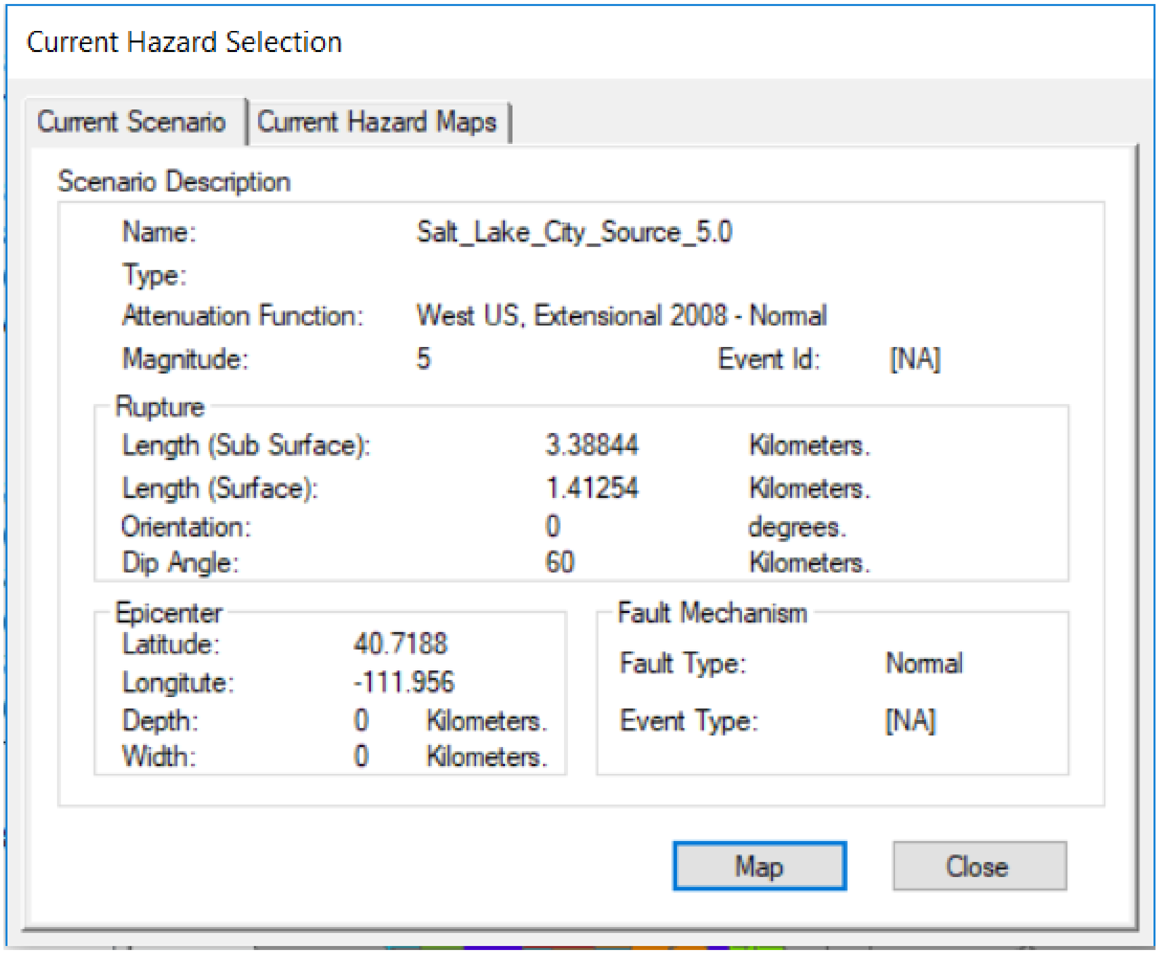


- Under "Soil map" select "Soil" from the drop-down menu. Click "Next" and then "Finish."

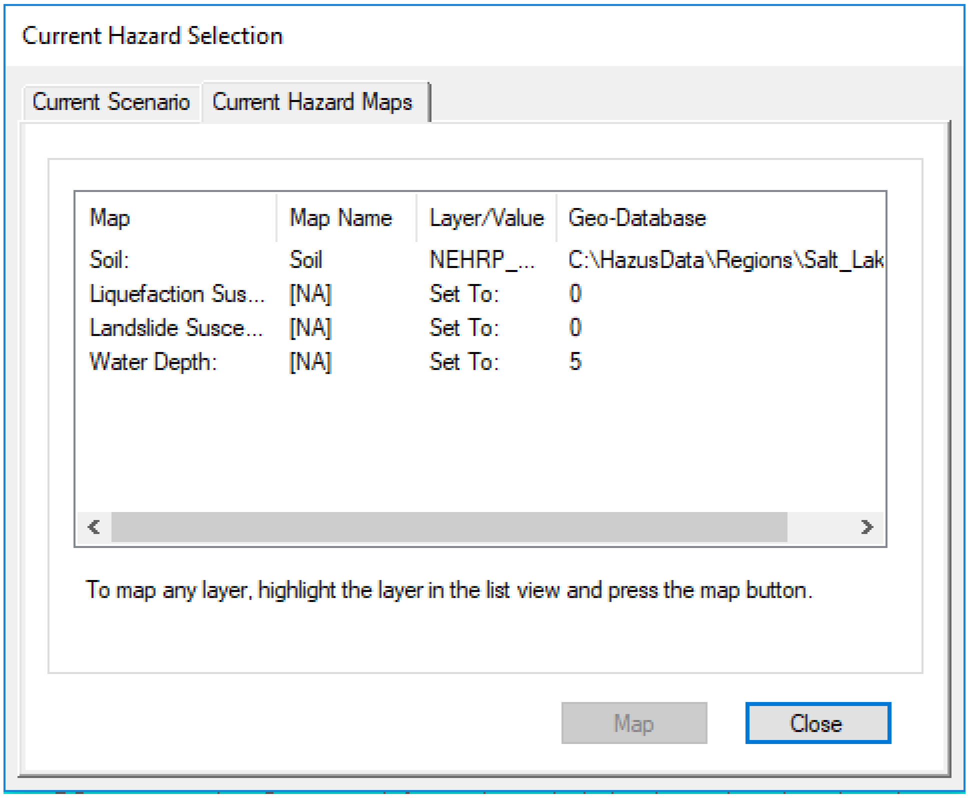
   Note: This added a new soil map to the study region.



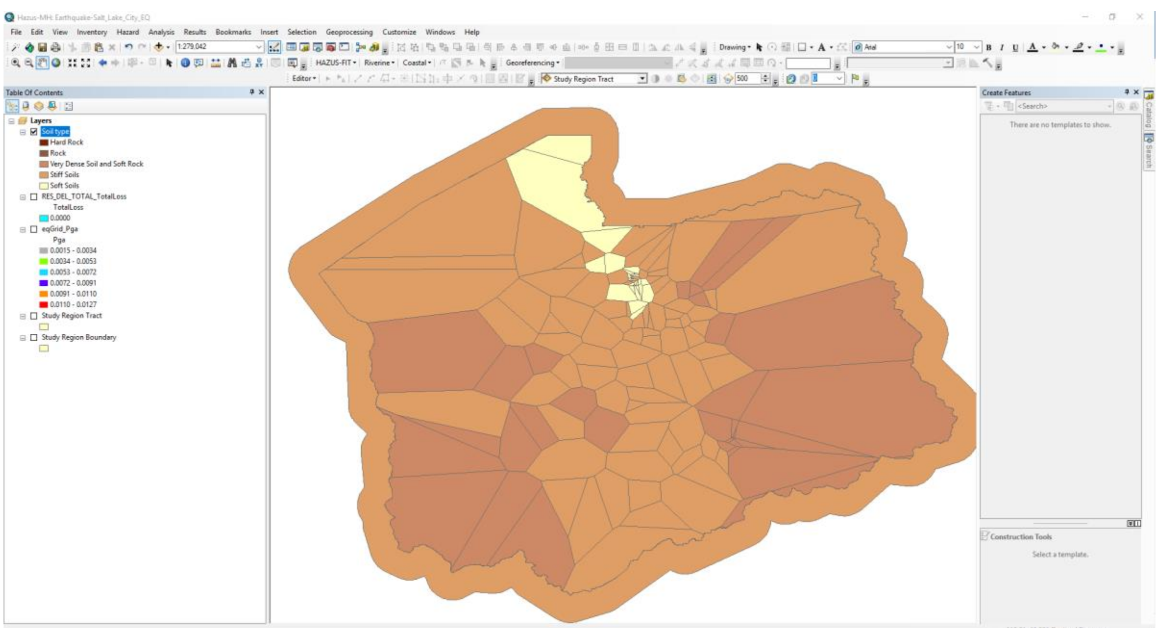
- Navigate to “Hazard > Show Current.”



- You can now see the ShakeMap source event parameters that will be used.
- Click the “Current Hazard Maps” tab and you can see that in the soil for the study region has now been set.

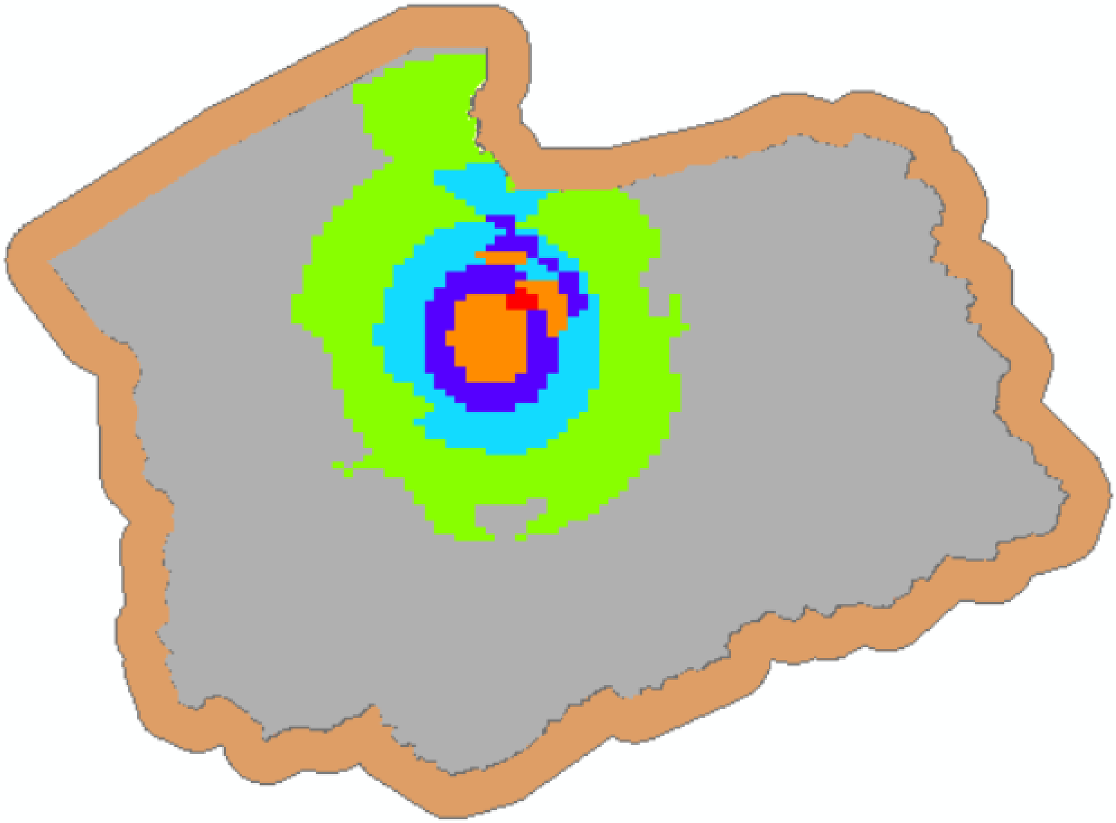


- Click “Soil” and then “Map.” You cannot click anywhere in the row, you must click the word “Soil.” Close the window and the soil variation will now appear over the region.

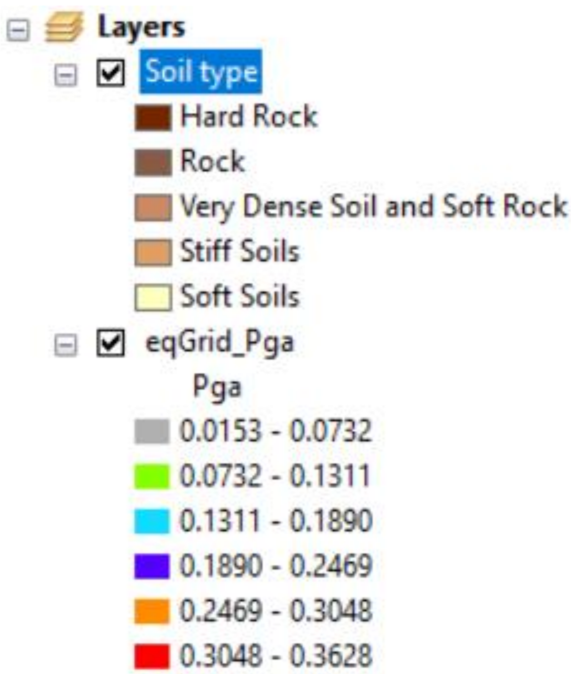


Task 4: Run Analysis

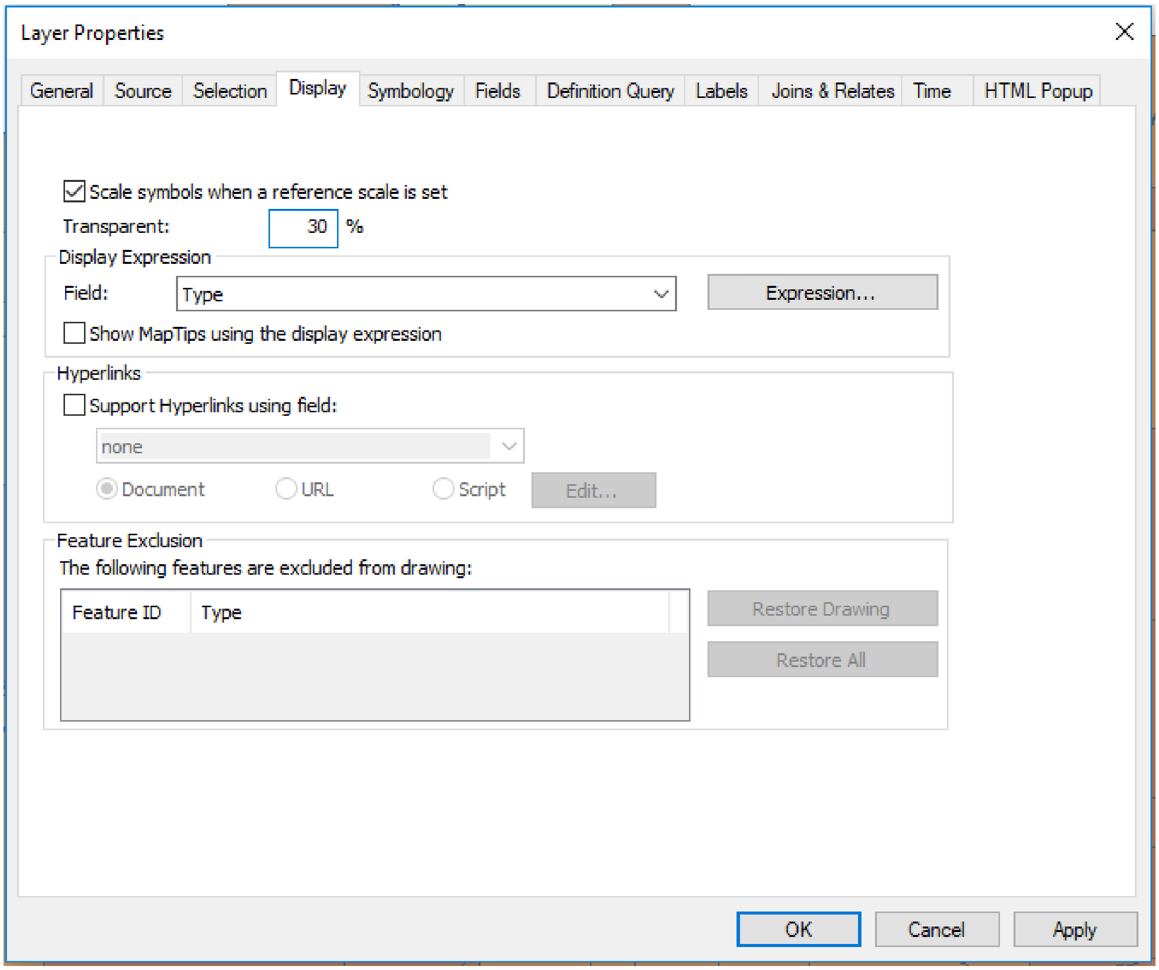
- Navigate to “Analysis > Run” and click “Select All.”
- Click “No” to indicate to Hazus that you would like it to create Contour Maps.
- Click “OK” and then “Yes” to run the analysis. After your analysis finishes, a window will appear with the elapsed time. Click “OK.”
    - This will take approximately 4 minutes.
- Navigate to “Results > Ground Motion or Ground Failure > Contour or Ground Failure Maps.”
    - A Contour Maps window will appear.
- Click “PGA Contour” and then “Map.”
    - Hazus will add another layer called “eqGrid_PGA” in the Table of Contents of ArcMap. NOTE: Now there are three PGA contour layers with the same name. Since the first two scenarios are no longer current, if you click to see the old data it will no longer appear. If you went back to the old scenario, you would have to map the PGA contours again for it to reappear.
- Close the Contour Maps window.



- Move the “Soil type” layer to the top of the Table of Contents so it appears above the PGA contour map.

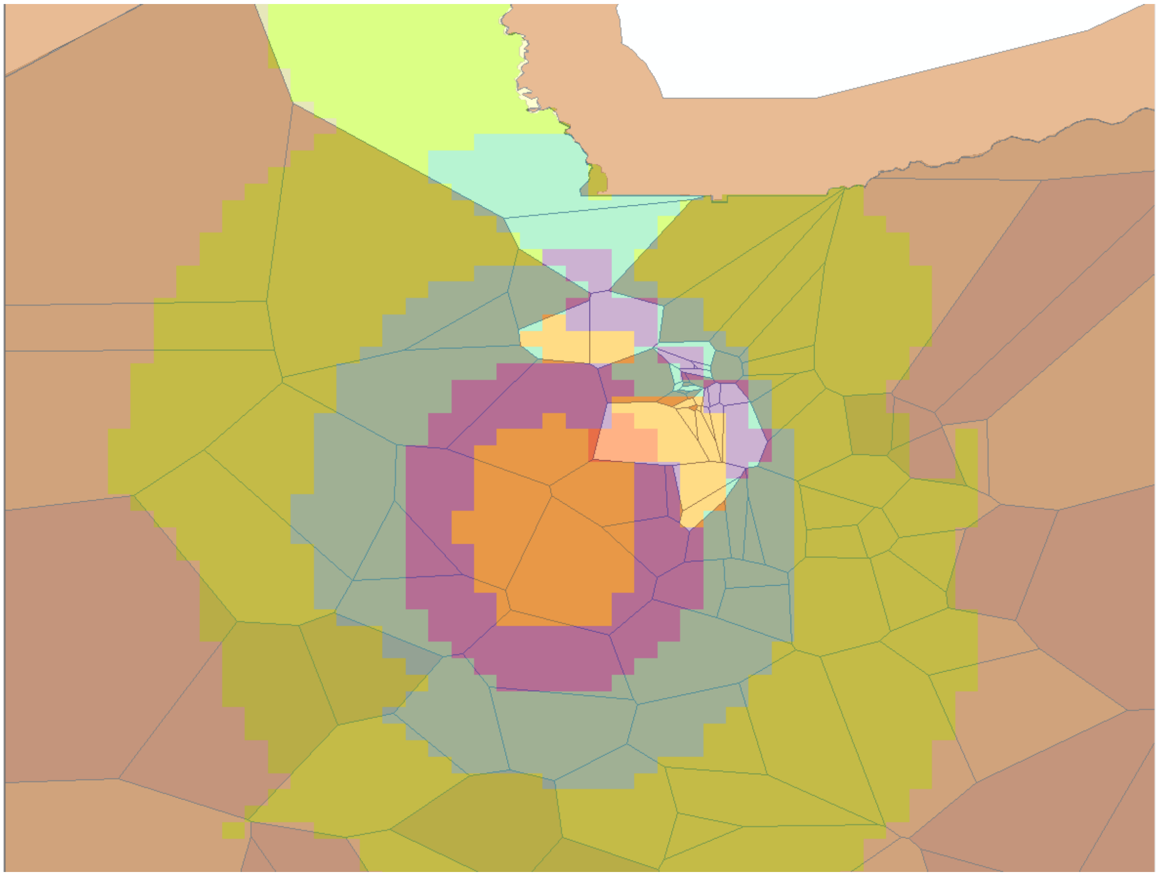


- Go to the layer properties in the Display tab and change the layer to be “30% transparent” and click “OK.”



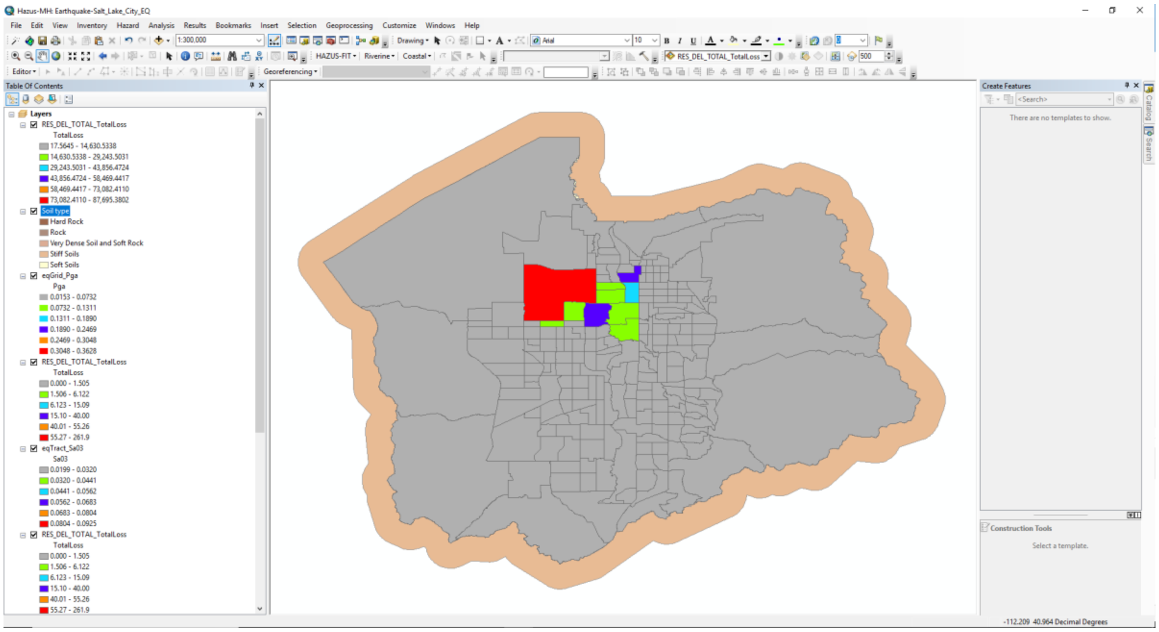
- Zoom in to the epicenter to see how the Soil Classifications have influences that ground acceleration.

  Note: If the study region was all one soil class then the acceleration would be symmetrical around the epicenter.

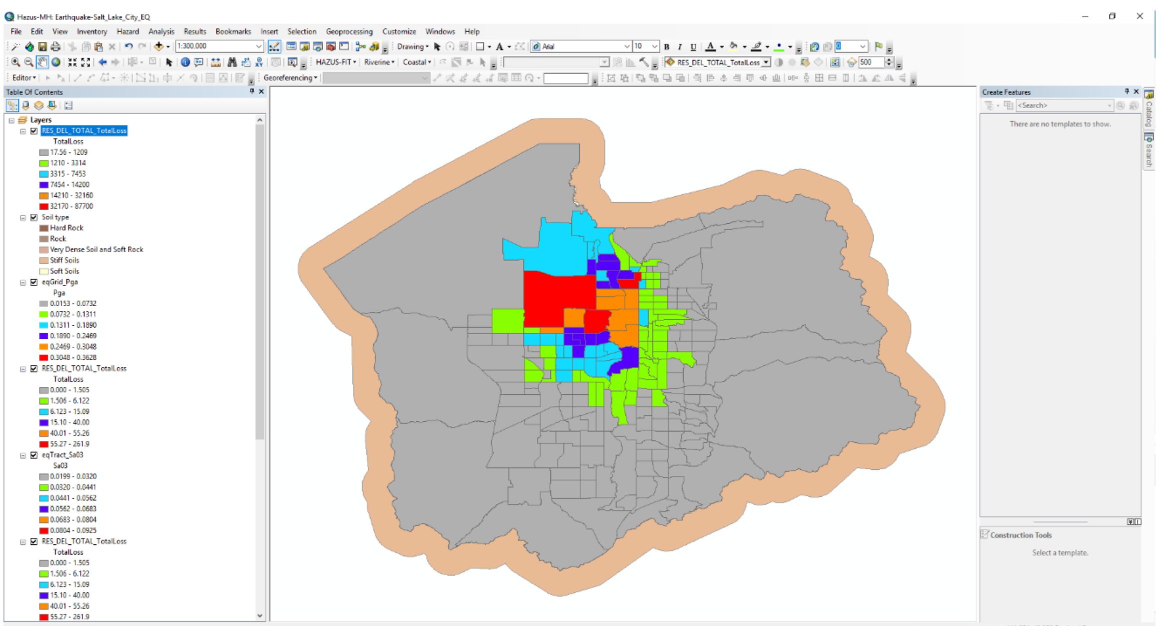


Task 5: View Direct Economic Loss Results

- Navigate to “Results > General Building Stock > Building Economic Loss> Direct Economic Loss.”
- Go to the “Total” tab and scroll all the way to the right.
- Click the “Total Loss (thous. $)” tab and then “Map.” Click “Close.”



- You can again change the symbology properties to "Natural Breaks (Jenks)" to get a better depiction of losses in the area.



- Navigate to "Results > Summary Reports…"

- Go to the “Other” tab and select the “Global Summary Report” and click “View.”
- Navigate to page 8 by clicking the single right-pointing arrow.

Direct Earthquake Damage

Building Damage

Hazus estimates that about 4,921 buildings will be at least moderately damaged. This is over 2.00 % of the buildings in the region. There are an estimated 57 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

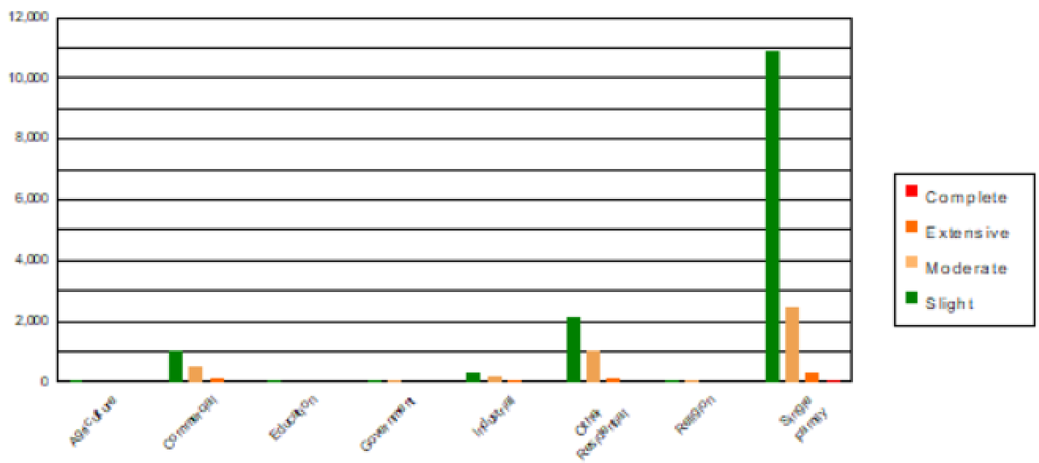


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	769.94	0.26	35.65	0.25	14.65	0.34	2.54	0.43	0.22	0.38
Commercial	17615.61	6.05	1039.92	7.16	538.08	12.58	109.39	18.68	11.01	19.00
Education	503.37	0.17	23.43	0.16	10.23	0.24	1.82	0.31	0.15	0.26
Government	580.57	0.20	45.98	0.32	23.64	0.55	4.43	0.76	0.37	0.64
Industrial	5036.02	1.73	308.07	2.12	172.71	4.04	33.65	5.75	2.53	4.38
Other Residential	19874.93	6.83	2096.48	14.44	1015.57	23.74	139.81	23.87	7.20	12.44
Religion	1198.92	0.41	61.82	0.43	25.49	0.60	4.36	0.74	0.40	0.70
Single Family	245548.66	84.34	10910.57	75.13	2477.13	57.91	289.62	49.45	36.03	62.20
Total	291,128		14,522		4,278		586		58	

Exercise 12.1: ShakeMap

Type: Student-Led Activity

Time: 25 minutes

Goals:

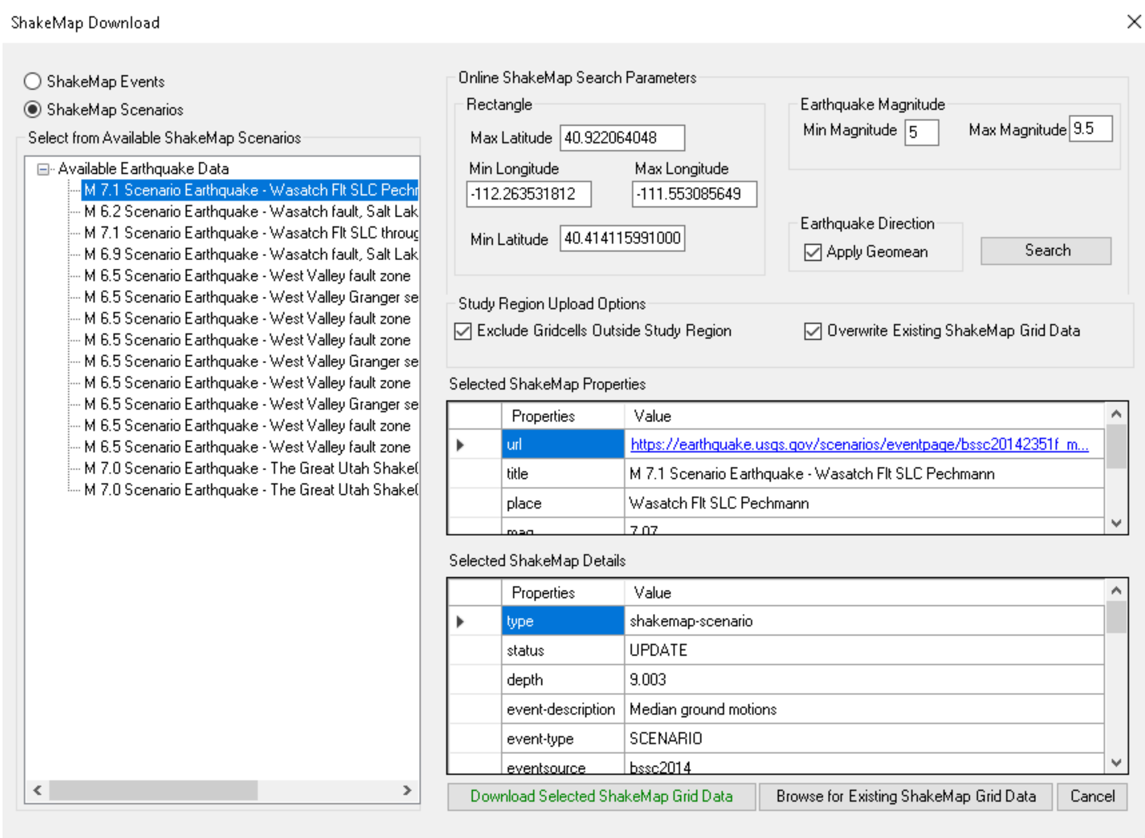
- Import a ShakeMap
- Create a map of economic loss

Part 1: Open Study Region Salt_Lake_City_EQ

- Open Hazus 4.2
- Click "Open a region.” Click “OK.”
- Click “Next.”
- Select “Salt_Lake_City_EQ.” Click “Next.”
- Click “Finish.”

Part 2: Define the Scenario

- Navigate to “Hazard > Scenario…”
- Click “Next.”
- Click “Define a new scenario.” Click “Next.”
- Click “USGS ShakeMap” and Click “Next.”
- The “ShakeMap Download” dialog box will appear.
- Click the “ShakeMap Scenarios” radio button in the top left of the dialog box in order to search for scenario instead of event ShakeMaps.
- Select the “M 7.1 Scenario Earthquake – Wasatch Flt SLC Pechmann” earthquake.



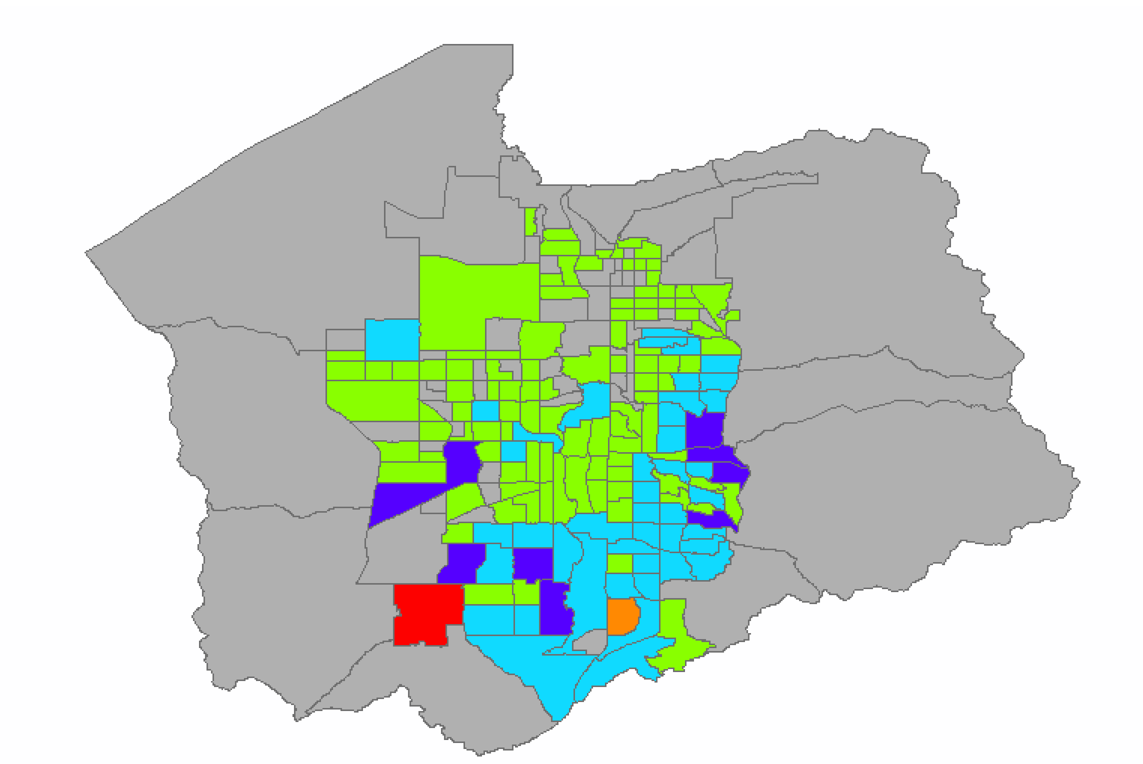
- Click “Download Selected ShakeMap Grid Data.”
  - This will take approximately one to two minutes.
- After the grid data has downloaded, the Scenario Wizard window will appear with all defaults filled in. Click “Next.”
- The name window will appear. Click “Next.”
- Click “Finish.”

Part 3: Run Analysis

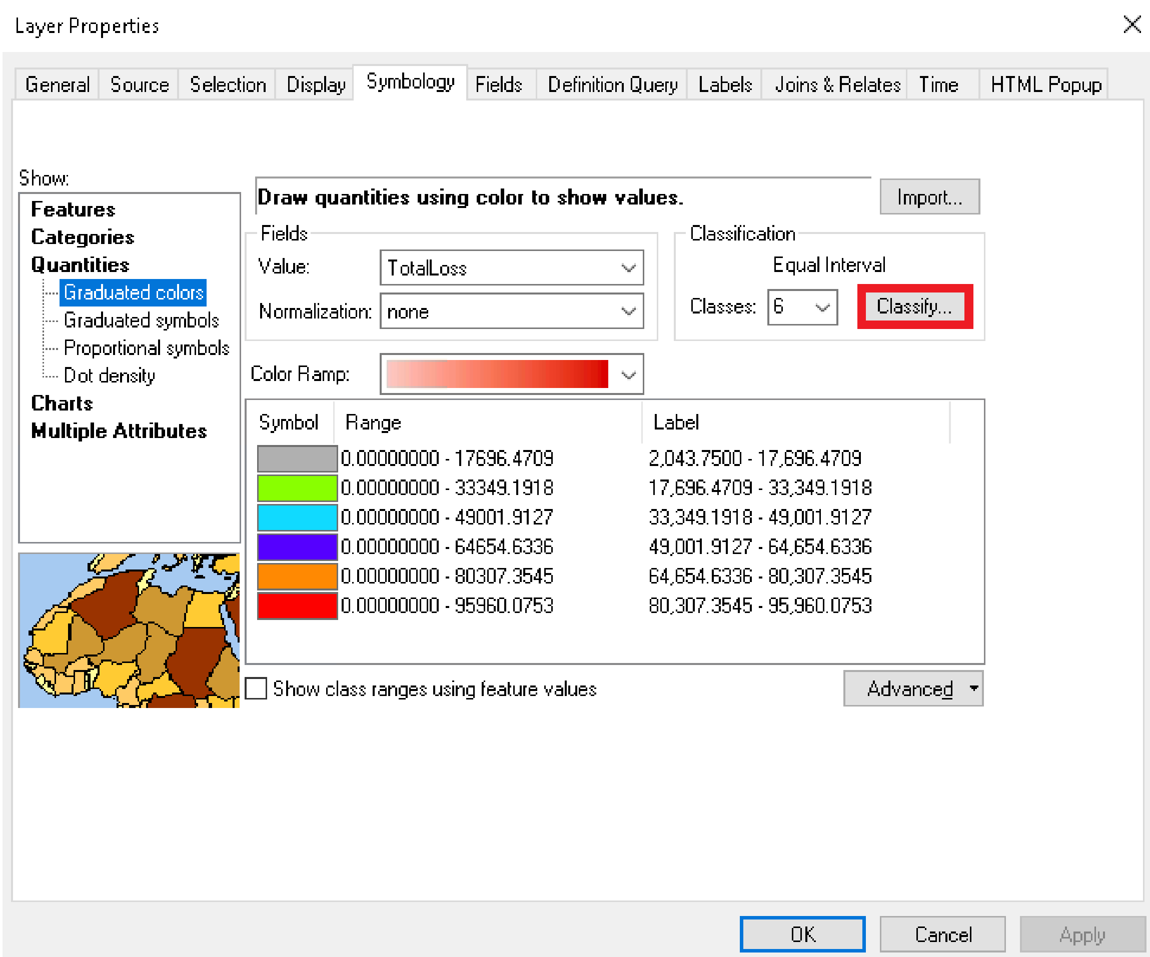
- Navigate to “Analysis > Run.”
- Click “Select all.”
- Click “Yes” to indicate to Hazus that you would like it to skip Contour Maps.
- Click “OK” and then “Yes” to run the analysis. After your analysis finishes, a window will appear with the elapsed time. Click “OK.”
  - This will take approximately 4 to 5 minutes.

Part 4: View Direct Economic Loss Results

- Navigate to "Results > General Building Stock > Building Economic Loss> Direct Economic Loss."
- Go to the "Total" tab and scroll all the way to the right.
- Click the "Total Loss (thous. $)" tab and then "Map." Click "Close."
    - This map is still not very descriptive of the damage because of its symbology.

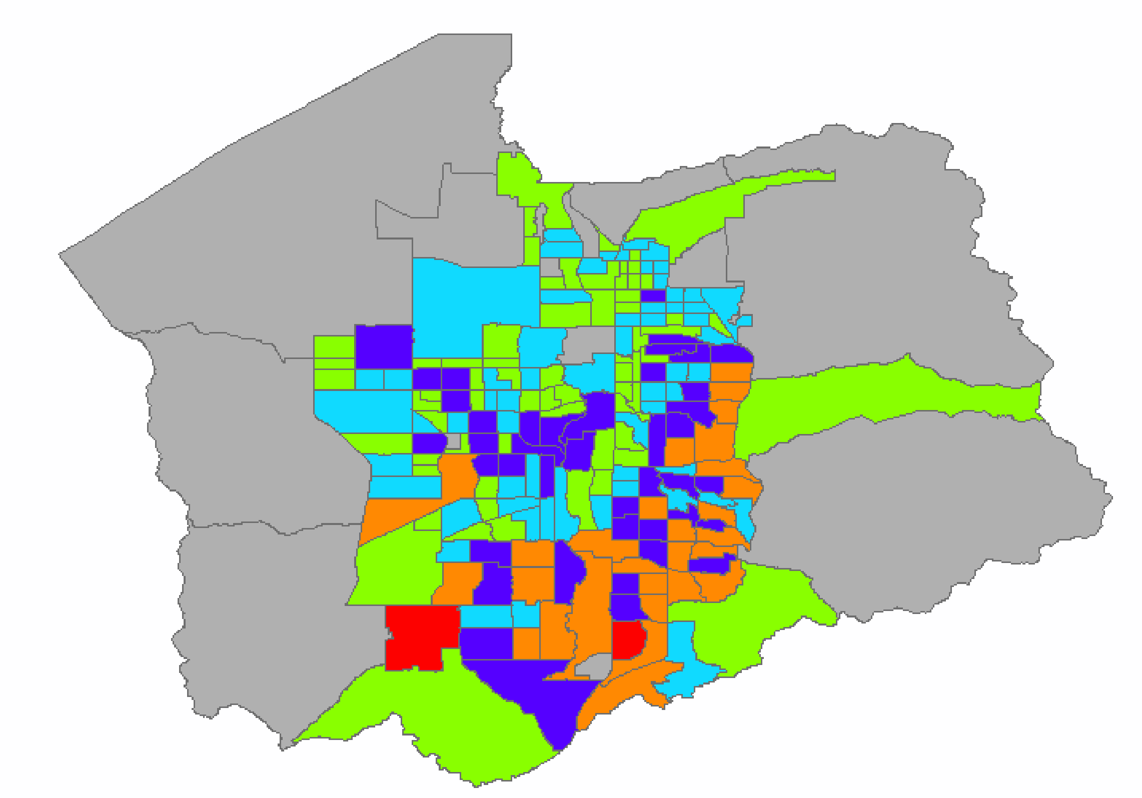


- Right click on the Layer and go to "Properties."
- Click the "Symbology" tab.
- Click "Classify" in the Classification area.



- Click the drop-down menu for the "Method:" and select "Natural Breaks (Jenks)." Click "OK."
- Click "OK" in the Layer Properties window.

  Note: That is a much more descriptive map and shows the power of Hazus and ArcMap together.



Exercise 13.1: ShakeMap with UDF

Type: Student-Led Activity

Time: 45 minutes

Goals:

- Run a ShakeMap Analysis with UDF Results.
- Create a map of economic loss.

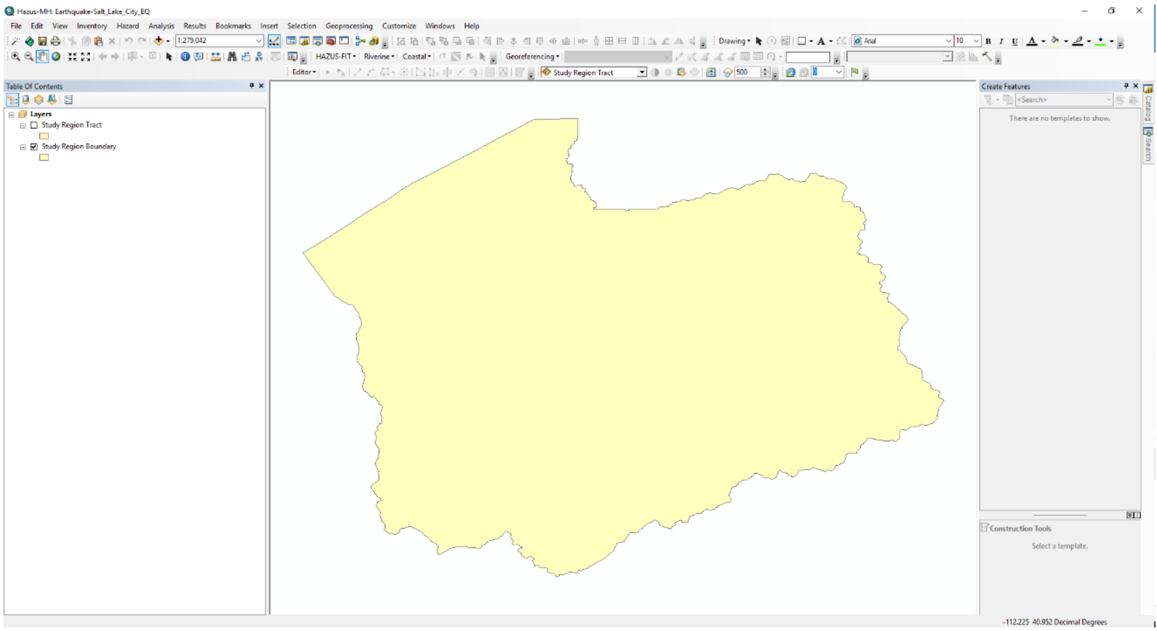
Background: User-defined facilities data can be used to enhance the quality of loss estimation and improve the results of Hazus. Including UDF data in your analysis also allows you to customize the scenarios to your unique community and its needs. UDF data may include essential facilities like schools or hospitals, but it can also include details on residences or structures of interest to a community, such as a church or community center.

Task 1: Create a New Study Region for Salt Lake City

- Open Hazus 4.2.
- Click “Create a new study region” and then click “OK.” Note that these steps are very similar to those utilized in creating other regions.
- The “Create New Region” window will appear. Click “Next.”
- Name the study region “Salt_Lake_City_UDF.”
- Write a brief description such as “XML ShakeMap exercise for Salt Lake City earthquakes with UDF.” Click “Next.”
- Check the box “Earthquake” and click “Next.”
- Click “County” and then click “Next.”
- Select “Utah” and then click “Next.”
- Select “Salt Lake” county and then click “Next.”
- Click “Finish.”

Task 2: Open the Salt Lake City Study Region

- Click “Open a region” and then click “OK.” The “Open Region” window will appear.
- Click “Next.”
- Select “Salt_Lake_City_UDF” and then click “Next.”
- Click “Finish.” ArcMap will open your Salt Lake City region.



Task 3: Add a ShakeMap

Note: In this task, the user will import a new XML file.

- Navigate to “Hazard > Scenario…” and then click “Next.”
- Click “Define a new scenario” and then click “Next.”
- Click “USGS ShakeMap…” and then click “Next.”
- Click the “ShakeMap Scenarios” radio button in the top left to switch the ShakeMap search from events to scenarios.
- Select the earthquake scenario entitled “M 7.0 Scenario Earthquake – The Great Utah ShakeOut.”
- Click the “Download Selected ShakeMap Grid Data” Button. This may take several moments.
- Click “Next” and you’ll see Hazus has named the scenario for you. Click “Next” and then click “Finish.”

Task 4: Run the Earthquake Analysis

- Navigate to “Analysis > Run.”
- Click “Select All.”
- Click “Yes” to indicate to Hazus that you would like it to skip Contour Maps.
- Click “OK” and then “Yes” to run the analysis. After your analysis finishes, a window will appear with the elapsed time. Click “OK.” This will take approximately 2 minutes.

Task 5: View Direct Economic Loss Results

- Go to “Results > General Building Stock > Building Economic Loss > Direct Economic Loss.”
- Go to the “Total” tab and scroll all the way to the right.
- Click the “Total Loss (thous. $)” tab and then “Map.” Click “Close.”

- You can again change the symbology properties to “Natural Breaks (Jenks)” to get a better depiction of losses in the area.

- Go to “Results > User-Defined Facilities.”
- Scroll to the right and select the “At Least Moderate” column header.

- Click “Map” and then “Close.”

Exercise 14.1: Tsunami Study Region

Type: Student-Led Activity

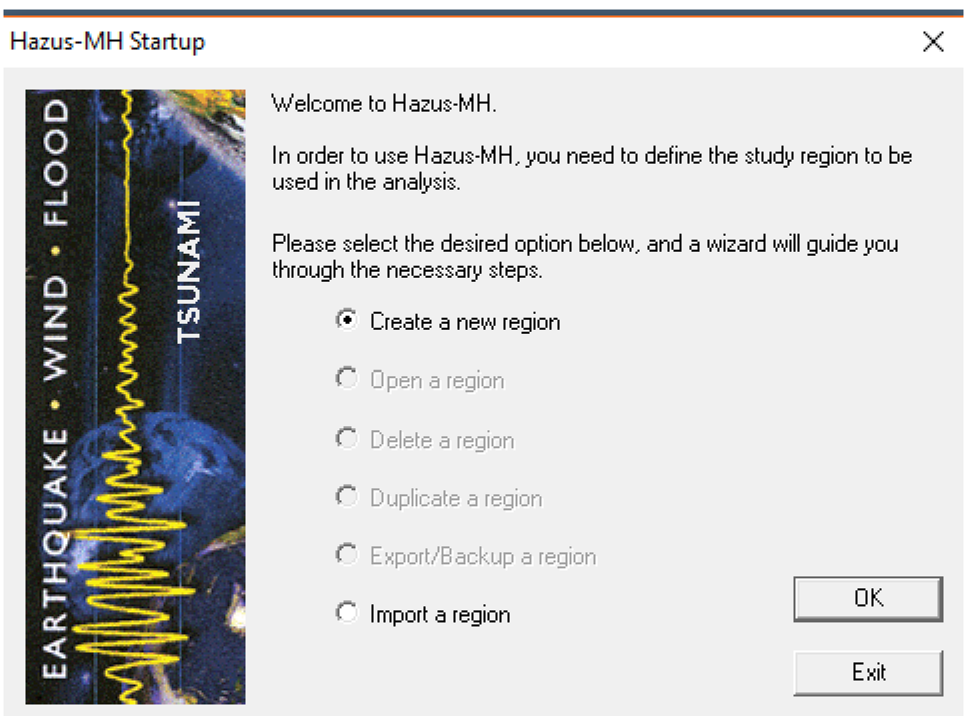
Time: 15 minutes

Goal: Build a Tsunami Study Region

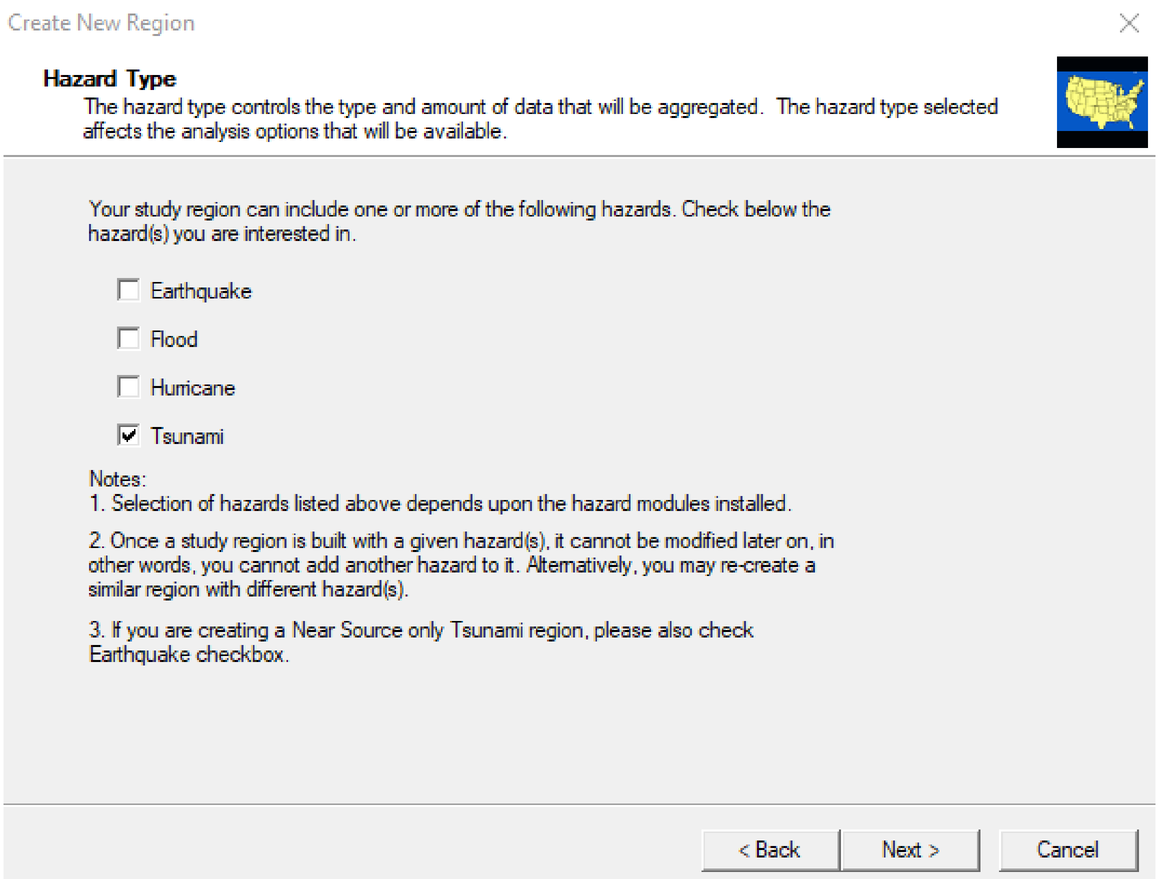
Background: This document describes how to build the student region for a Tsunami Level 1 analysis in Tillamook, Oregon. This analysis will use sample hazard data from FEMA that may be downloaded from the FEMA hazard website. Expand the Download section, click to confirm you are not a robot. Scroll down past the state geodatabases and click "here" at the bottom, right above the "State Managed Download" button to download the Tsunami data. This data has been downloaded for you and is in the HazardSampleData.gdb.

Task 1: Build a Tsunami Study Region

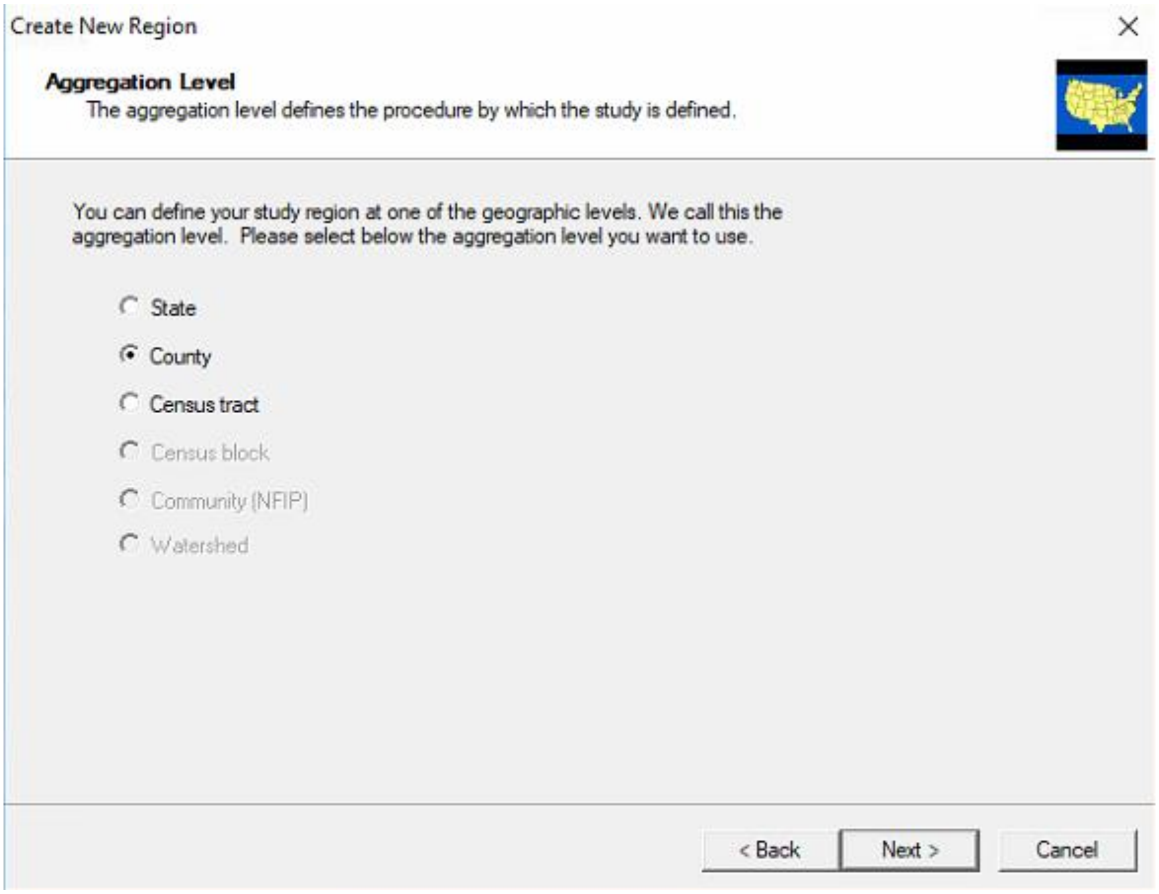
- Download and extract the FEMA sample data to the C:\HazusData folder.
- Start the Hazus application.
- Select the "Create a new region" option in the startup dialog and click "OK." Then click "Next".



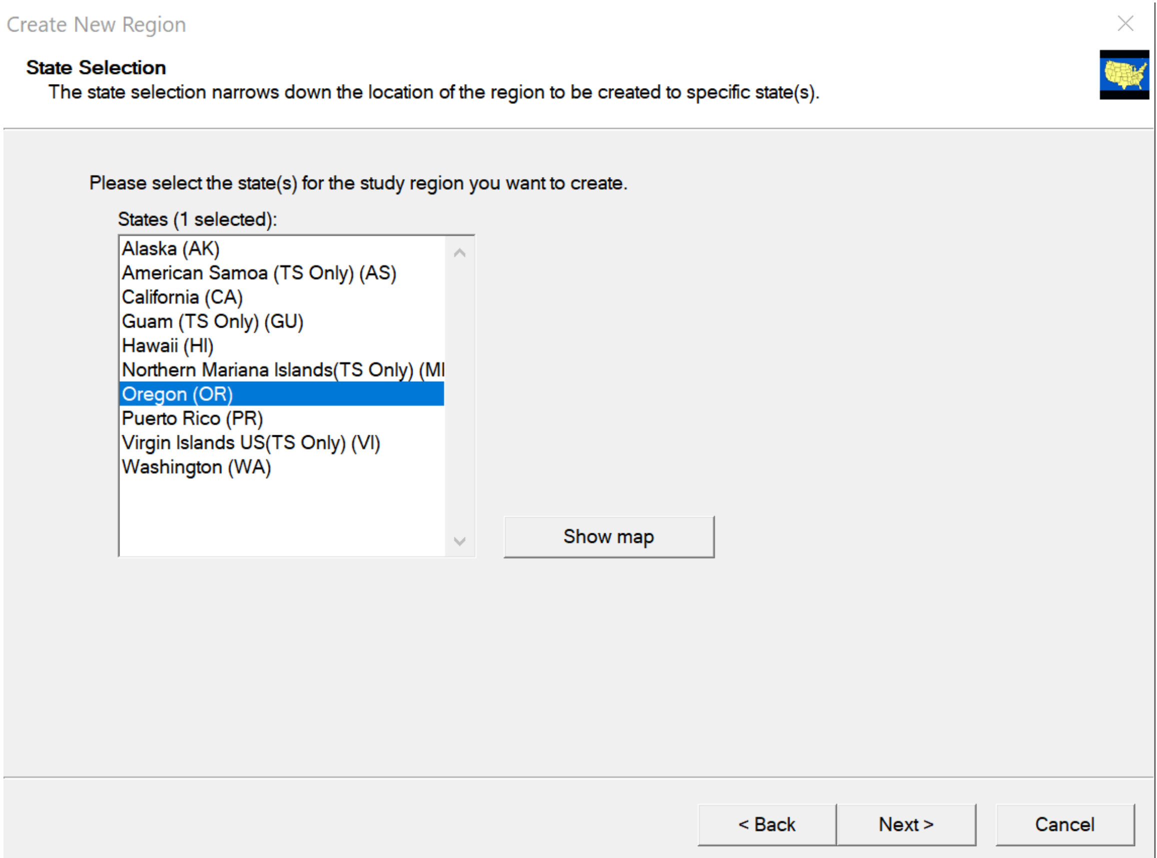
- Name the region “Tillamook_OR,” enter a description (such as “Case study for Tsunami scenario”), and click “Next.”
- Check only the “Tsunami” box in the list of hazards and click “Next.” This is because we are going to analyze a distant-source tsunami (not a near-source/combined earthquake and tsunami).



- In the Aggregation Level dialog, select “County” from the choices and click “Next.”

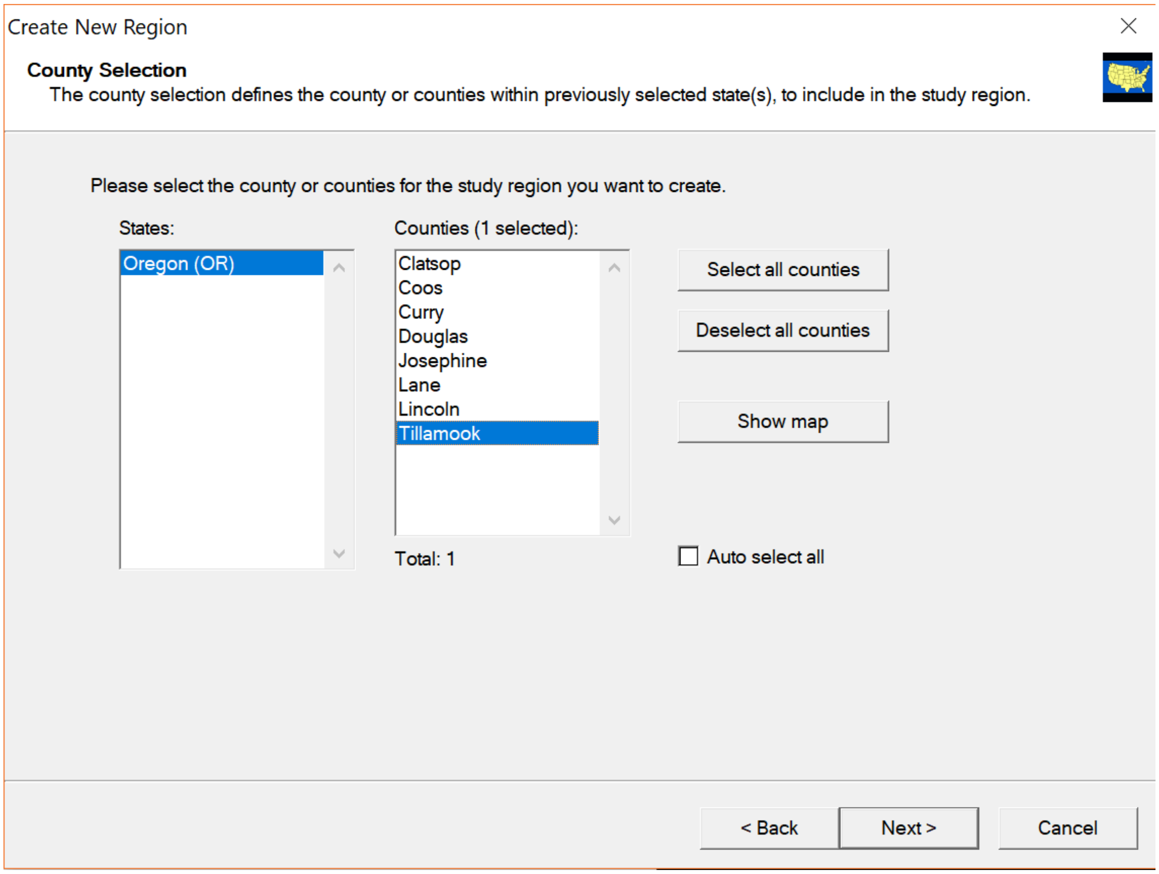


- In the State selection dialog, select “Oregon” and click “Next.”



- In the County Selection dialog, select “Tillamook” and click “Next.”

  Note: In the case of modeling a tsunami occurring on a state border, multiple counties can be selected from multiple states.



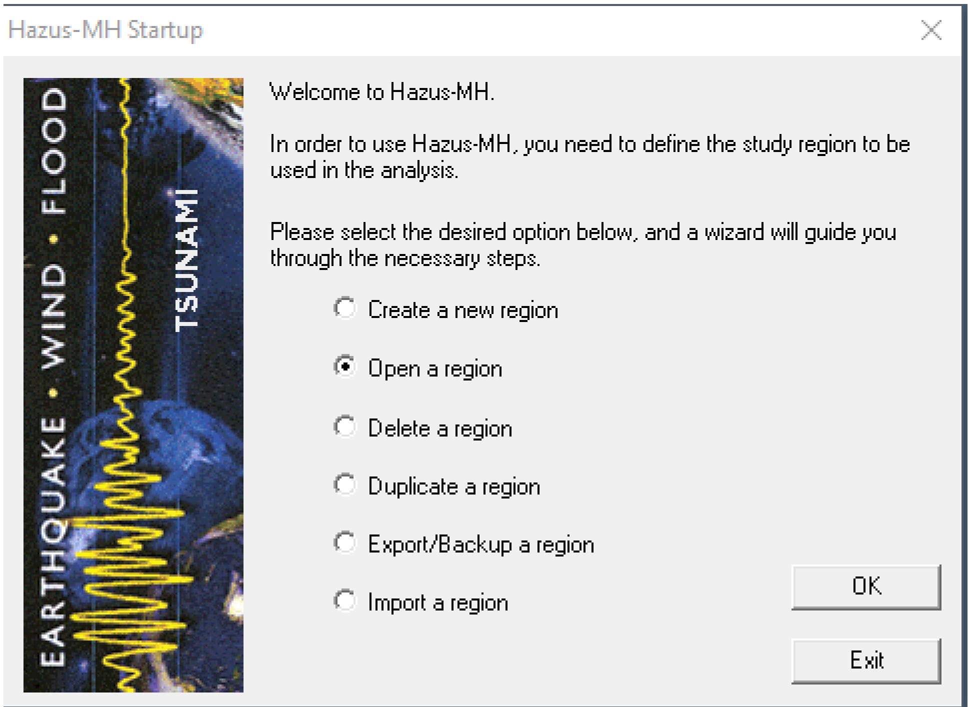
- You have now successfully selected all the required options to create the new region. Click “Finish” on the dialog.

  Note: At this point, if you do not already have the Oregon data downloaded, you will be prompted to:

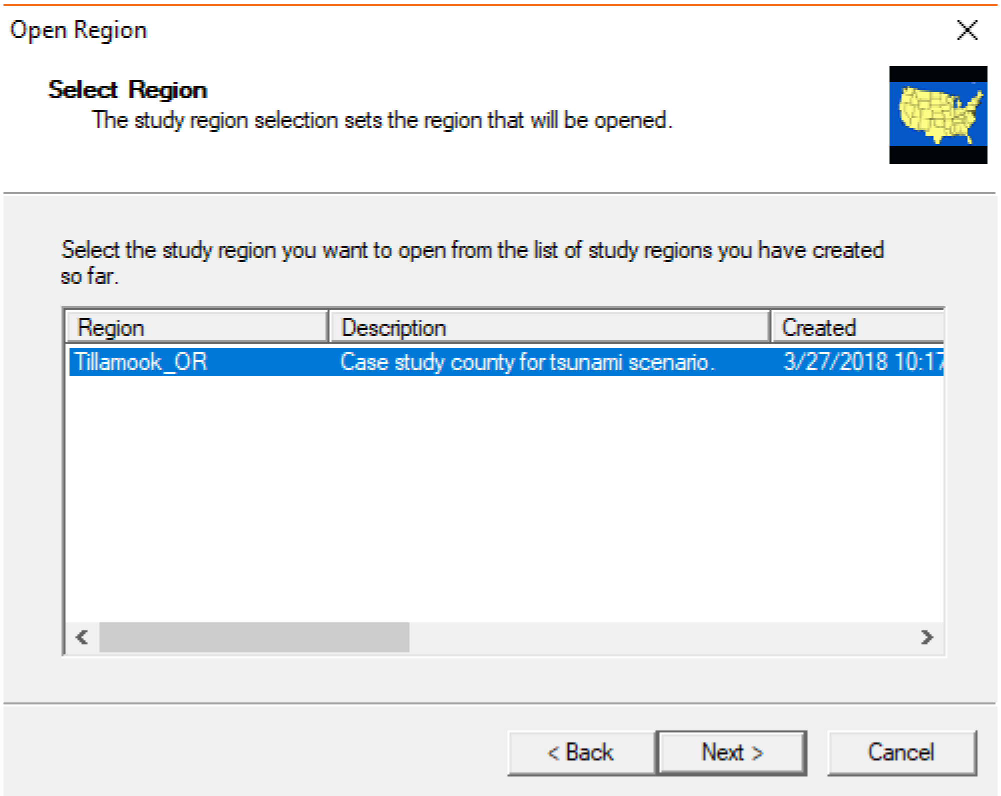
  - Copy the state data into C:\HazusData\Inventory.
  - Visit the Hazus portal page at https://msc.fema.gov/portal/resources/hazus
  - Select “Oregon” for Direct Download.
  - Extract the data into the C:\HazusData\Inventory\OR folder.
  - After extraction, click “Retry” to aggregate data into the selected region.
  - If the Oregon data already existed in the C:\HazusData\Inventory folder, Hazus will proceed to the next steps without a prompt to copy the state data.

Task 2: Open the Region and Input Tsunami User Data

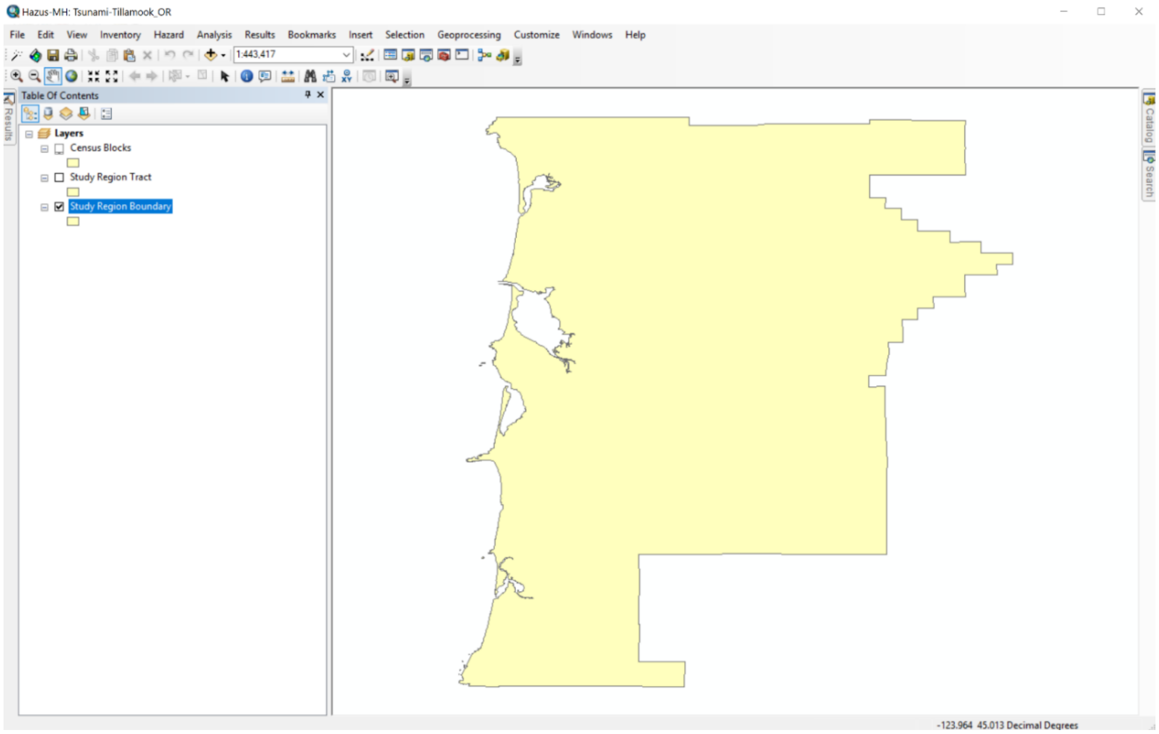
- Upon successful region aggregation, a confirmation will appear.
- Click “OK” then select “Open a region” to start the analysis using the Open Region Wizard. Click “OK.”



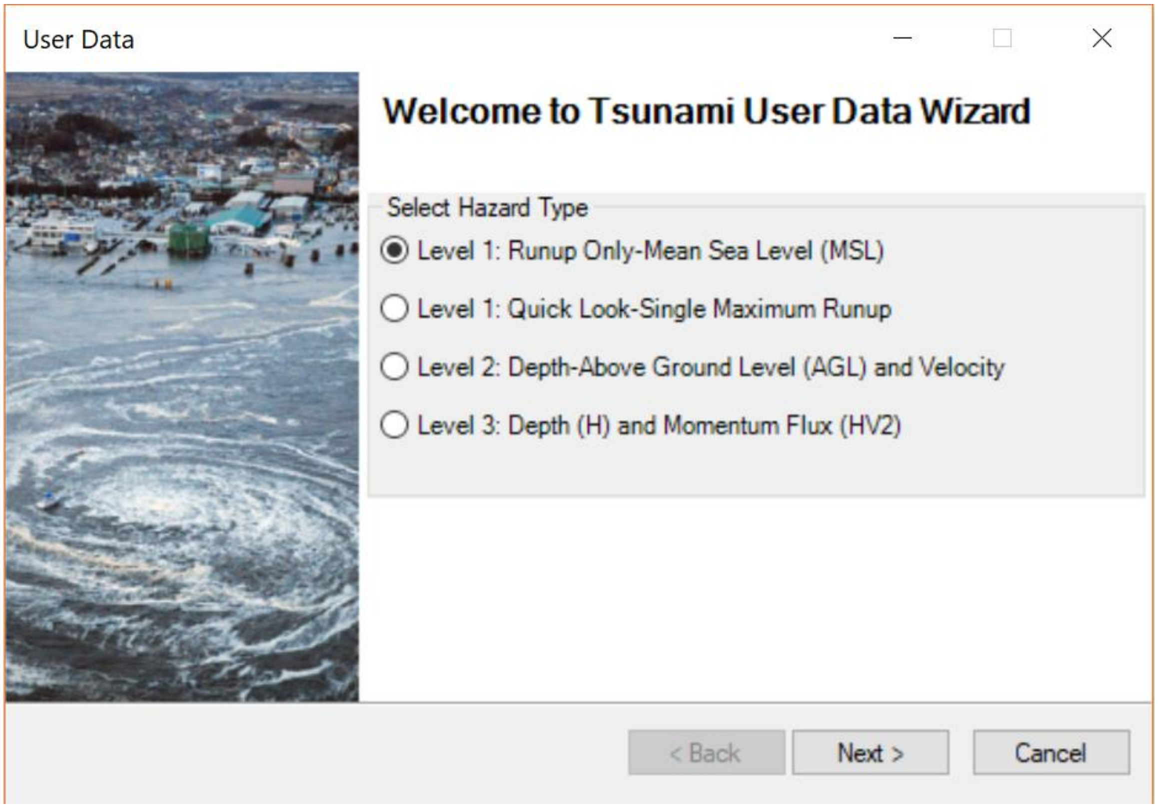
- Select the “Tillamook_OR” region and click “Next” in the Select Region dialog.



- You have now completed the steps to open the region and start an analysis. Click “Finish” to open the region.
- The ArcMap window should show the case study area in Tillamook County, Oregon.

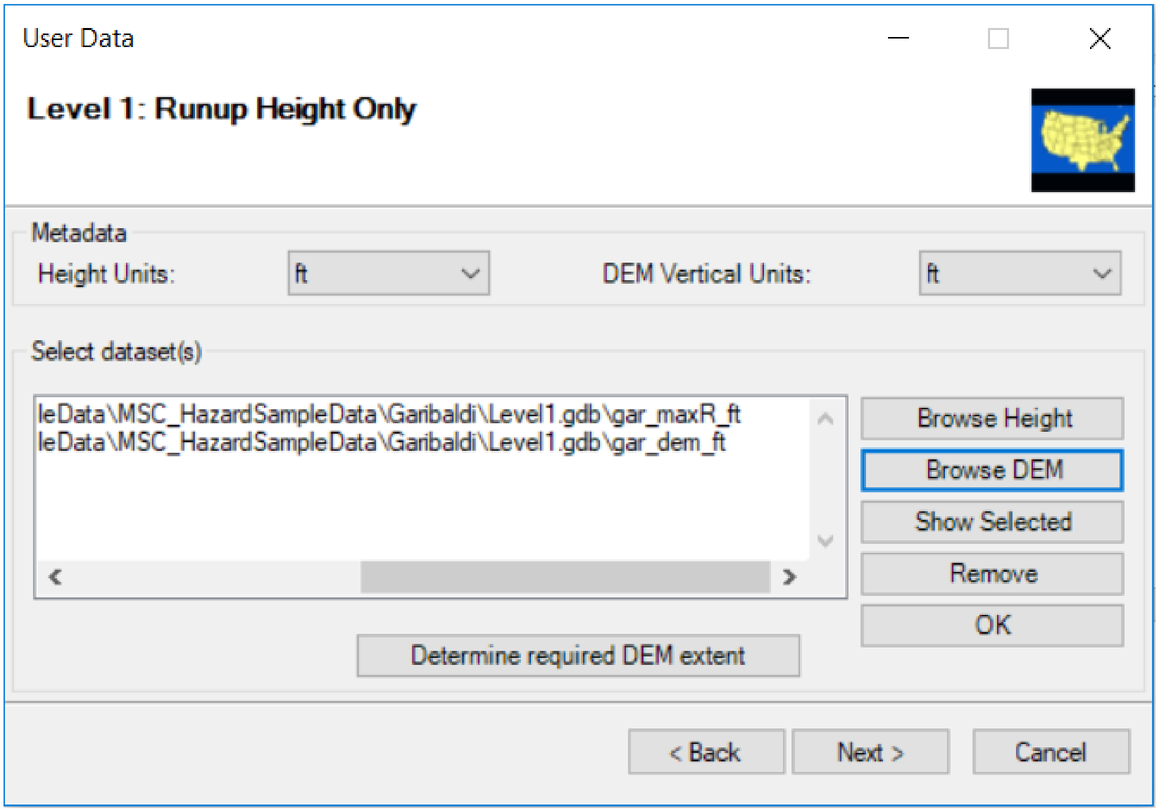


- Start the tsunami hazard analysis by selecting the “Hazard” menu, then “Tsunami Hazard Type.”
- Choose “Distant Source” in the Tsunami Hazard Type window. Then click "OK".
- Return to the Tsunami Hazard Type drop-down menu and select “User Data.” This will open the User Data Wizard.
- Choose “Level 1: Runup Only-Mean Sea Level (MSL)” and click “Next.”



- To specify the runup height grid and DEM from our downloaded sample data that has been extracted into the C:\HazusData\MSC_HazardSampleData folder:
  - Click “Browse Height” and navigate to the runup grid, then click "Select": C:\HazusData\MSC_HazardSampleData\Garibaldi\Level1.gdb\gar_maxR_ft.
  - Click “Browse DEM” and navigate to the DEM, then click "Select": C:\HazusData\MSC_HazardSampleData\Garibaldi\Level1.gdb\gar_dem_ft.
  - Make sure that height units are in “feet” and DEM vertical units are in “feet.”
  - Click “OK” to process the data and create two layers: Median Momentum Flux and Median Inundation Depth.
  - Click “Next.”

    Note: In this example, the DEM data has been provided for you. However, you can download a DEM directly from Hazus by clicking “Determine required DEM extent.” Hazus then determines the required DEM extent based on the study region and automatically downloads and extracts the necessary layers.



- Name the scenario “Garibaldi_20ft_Scenario.” Click “Next.”
- Click “OK” to complete the User Data Wizard.
    - The next exercise will build upon this exercise. If exiting ArcMap, please click “Save.”

Exercise 15.1: Tsunami Analysis

Type: Student-Led Activity

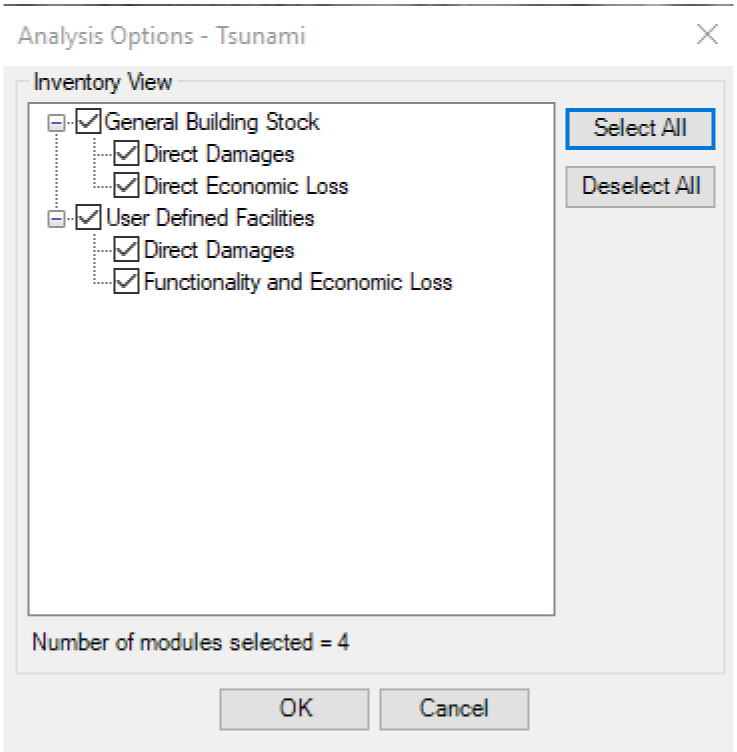
Time: 30 minutes

Goal: Run a Tsunami and Casualty Level 1 Analysis

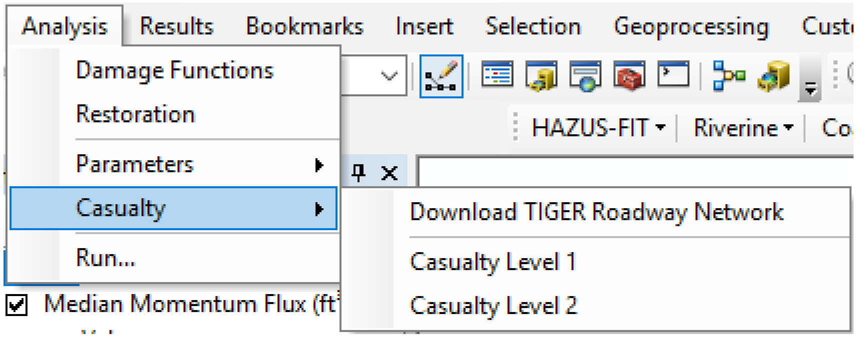
Background: This exercise describes how to run a Tsunami Level 1 analysis for the study region that was created in Exercise 14.1 in Tillamook, Oregon. A casualty analysis will be run after the Tsunami damages are modeled. The options and requirements for tsunami analysis in Hazus are unique compared to the other hazards. It is important to remember that as a disaster operations manager or responder, the quality of the tsunami model results is directly correlated to the quality of the input data. This exercise follows sample data to see how the datasets are utilized, but the case study data may not represent the true analysis options available for your region or data supplied.

Task 1: Specific Tsunami Analysis Options and Run Analysis

- Make sure the Tillamook, OR study region is open. If it is not open, open the region in Hazus.
- On the Analysis drop-down menu, select “Run” and then “OK” on the Combined Analysis notice. The notice refers to the combined Earthquake and Tsunami Analysis for Near Source events. This combined analysis will be run in the next lesson. See Chapter 11 of the Tsunami User Manual for more information.
- In the “Analysis Options > Tsunami” menu, select all options in the inventory view and click “OK.” Updating the tsunami direct damages and economic values will take a few moments.



- When the Analysis is complete, a window will appear showing the elapsed time to run the analysis. Click “OK.” This will take roughly 5 minutes.
- To calculate Level 1 Casualty estimates after the Tsunami General Building Stock (GBS) Analysis is complete, choose “Casualty” on the Analysis drop-down menu.
- On the Casualty submenu, choose “TIGER Roadway Network” to download the road data.
  - Note: If a download error occurs, the TIGER road network can be obtained from the TIGER data website based on County Federal Information Processing Standards [FIPS]) https://www2.census.gov/geo/tiger/TIGER2016/ROADS/
  - Note: For reference, county FIPS codes are available for download as a spreadsheet from the U.S. Census Bureau. https://www2.census.gov/programs-surveys/popest/geographies/2016/all-geocodes-v2016.xlsx
  - The model will save the road network data to the C:\HazusData\HazardInput\TS\TIGER\ folder under the County FIPS code for the study region.



- When the TIGER road network has been downloaded, you will receive a notification of where the files are located. Make a note of the file location and click “OK” to proceed with the casualty analysis.
- From the Analysis drop-down menu, choose “Casualty > Casualty Level 1.”
- In the Casualty Level 1 Wizard, click each of the four buttons (DEM Data, Roadway Network, Hazard Boundary, and Fatality Boundary), and browse to the corresponding files as follows:
  - DEM Data: C:\HazusData\MSC_HazardSampleData\Garibaldi\Level1.gdb\gar_dem_ft
  - Roadway Network: C:\HazusData\HazardInput\TS\TIGER\Roads\tl_2016_41057_roads
  - Hazard Boundary: C:\HazusData\Regions\Tillamook_OR\tsHazardBoundary.shp
  - Fatality Boundary: C:\HazusData\Regions\Tillamook_OR\tsFatalityBoundary.shp

  Note: The Hazard Boundary and Fatality Boundary were created by the model. The Hazard Boundary is the inundation hazard boundary (depth > 0), and the Fatality Boundary is the portion of the inundation hazard where the flood depths are expected to be 2 meters or greater in depth (Fatality Rate = 99%).
- Once the input data is selected, enter the Casualty Time Parameters in the boxes below.

  Note: The model will enter default values once there is a value for Arrival Time (10 minutes in this exercise).

  - The user should review these and modify as needed.
  - Warning time cannot exceed arrival time; if values are entered that are inconsistent with this, Hazus will prompt the user to change them.
  - In addition, for a near source event where the ground shaking provides the trigger for warning, a warning time value of 0 minutes may be entered.
- Click “Next.”

Task 2: Run Casualty Analysis

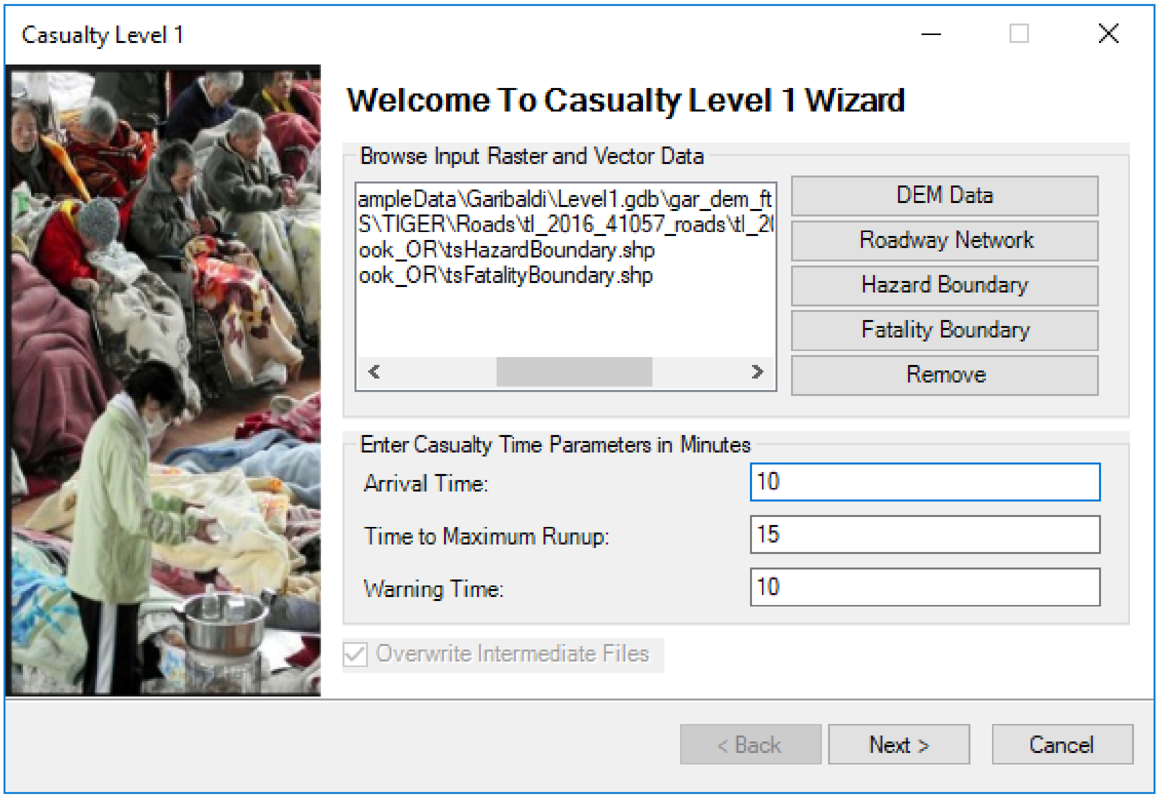
- From the Analysis drop-down menu, choose “Casualty > Casualty Level 1.”

- In the Casualty Level 1 Wizard, click each of the four buttons (DEM Data, Roadway Network, Hazard Boundary, and Fatality Boundary), and browse to the corresponding files as follows:
  - DEM Data: C:\HazusData\MSC_HazardSampleData\Garibaldi\Level1.gdb\gar_dem_ft
  - Roadway Network: C:\HazusData\HazardInput\TS\TIGER\Roads\tl_2016_41057_roads
  - Hazard Boundary: C:\HazusData\Regions\Tillamook_OR\tsHazardBoundary.shp
  - Fatality Boundary: C:\HazusData\Regions\Tillamook_OR\tsFatalityBoundary.shp

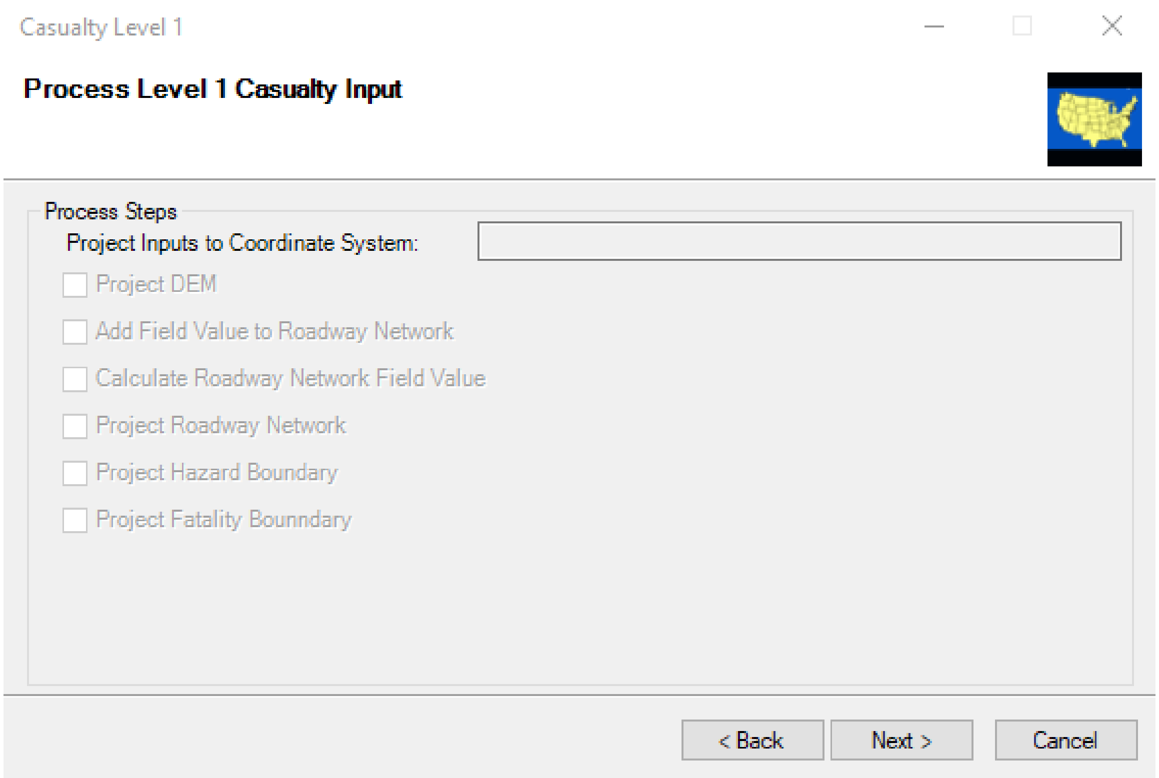
  Note: The Hazard Boundary and Fatality Boundary were created by the model. The Hazard Boundary is the inundation hazard boundary (depth > 0), and the Fatality Boundary is the portion of the inundation hazard where the flood depths are expected to be 2 meters or greater in depth (Fatality Rate = 99%).
- Once the input data is selected, enter the Casualty Time Parameters in the boxes below.

  Note: The model will enter default values once there is a value for Arrival Time (10 minutes in this exercise).

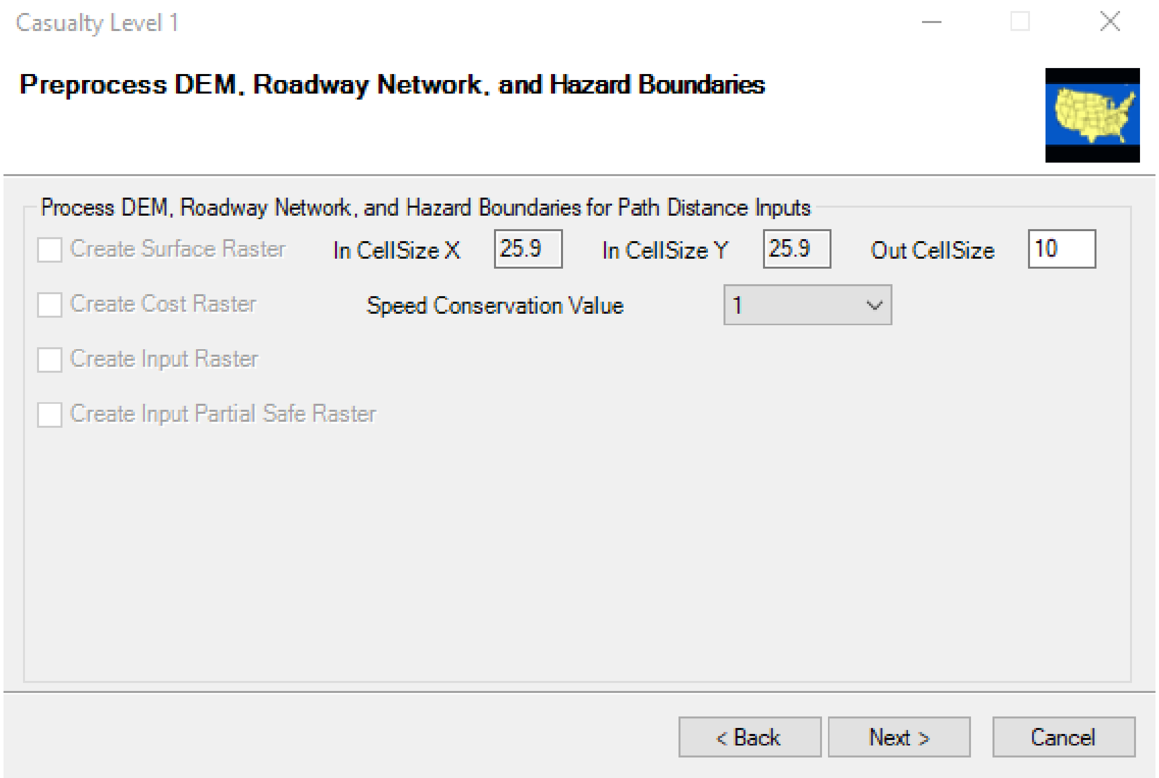
  - The user should review these and modify as needed.
  - Warning time cannot exceed arrival time; if values are entered that are inconsistent with this, Hazus will prompt the user to change them.
  - In addition, for a near source event where the ground shaking provides the trigger for warning, a warning time value of 0 minutes may be entered.
- Click “Next.”



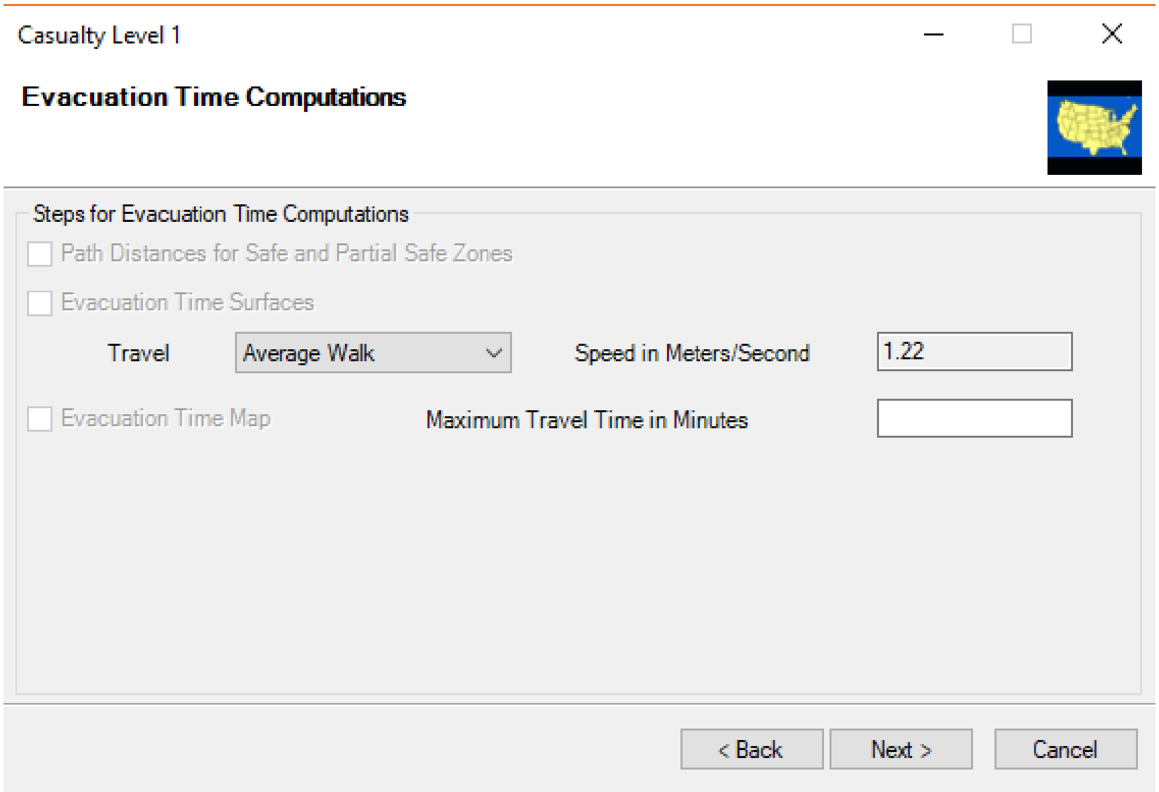
- For the next few steps, the user will accept the program defaults. The model is projecting the data into the same projected coordinate system. Click “Next.”



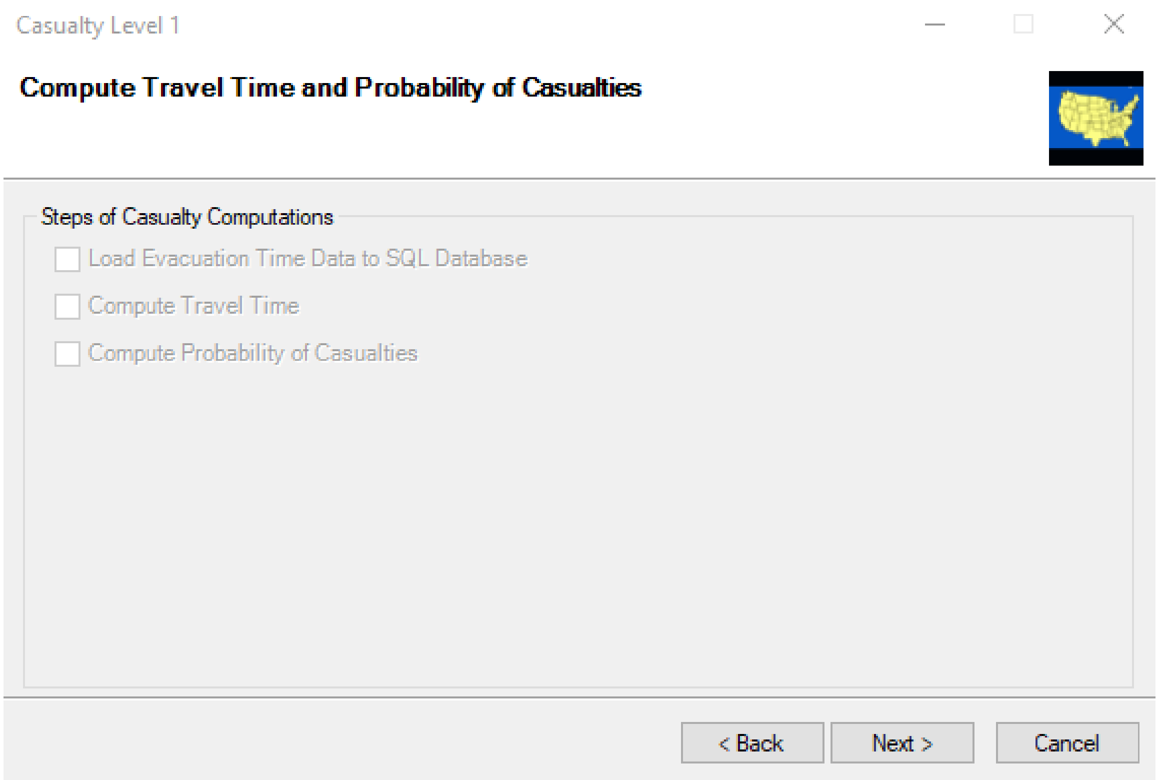
- The model then preprocesses the DEM, Roads and Hazard Boundaries.
  - The default output cell size is 10 meters.
  - The Speed Conservation Value (SCV) default is 1, which assumes that road networks have no reduction in the capability to support evacuation. A SCV of less than 1.0 reduces the capability of the road network to support evacuation.



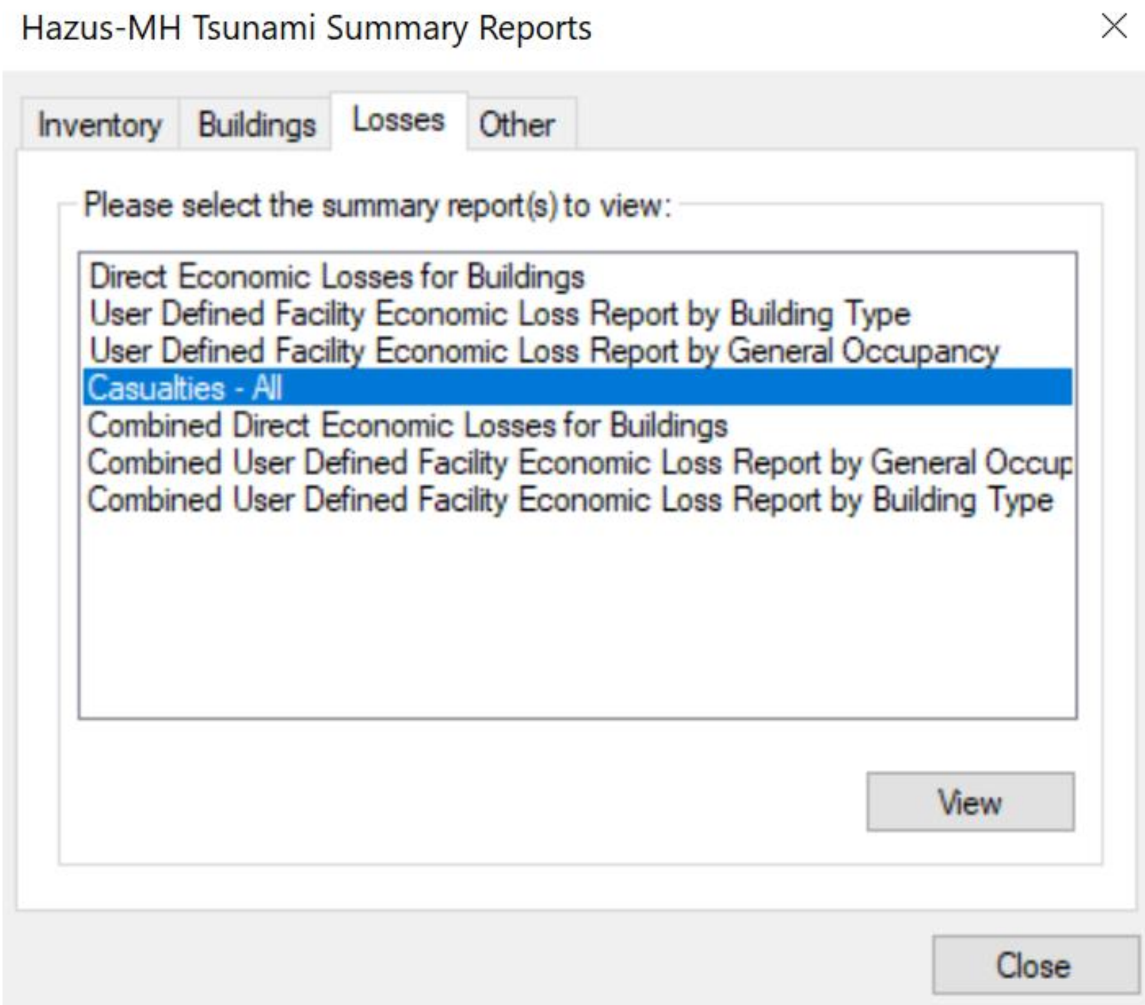
- Click “Next.”
- The model calculates the Evacuation Time required at the selected Travel Speed. The default speed is Average Walk. The Maximum Travel Time in Minutes, by default, is blank. Click “Next.”



- Next, the model computes travel time and the probability of casualties. Click “Next.”



- This completes the Casualty Level 1 Estimate. Click “OK.”
  - The results and reports are accessible under the Results drop-down menu and are very similar to viewing results and reports of other disasters modeled in Hazus.
- To view casualty analysis results, select “Results > Casualties > Probability of Casualties” to view a table and map features.
  - The Good, Fair, and Poor categories indicate the study region’s level of preparedness.
- To view casualty analysis reports, select “Results > Summary Reports.”
- Click on the “Losses” tab and select the “Casualties-All” report. Click “View” to open the report.


Hazus-MH Tsunami Summary Reports
Inventory
Buildings
Losses
Other
Please select the summary report(s) to view:
Direct Economic Losses for Buildings
User Defined Facility Economic Loss Report by Building Type
User Defined Facility Economic Loss Report by General Occupancy
Casualties - All
Combined Direct Economic Losses for Buildings
Combined User Defined Facility Economic Loss Report by General Occup
Combined User Defined Facility Economic Loss Report by Building Type
View
Close

Exercise 16.1: Combined Earthquake and Tsunami Exercise

Type: Student-Led Activity

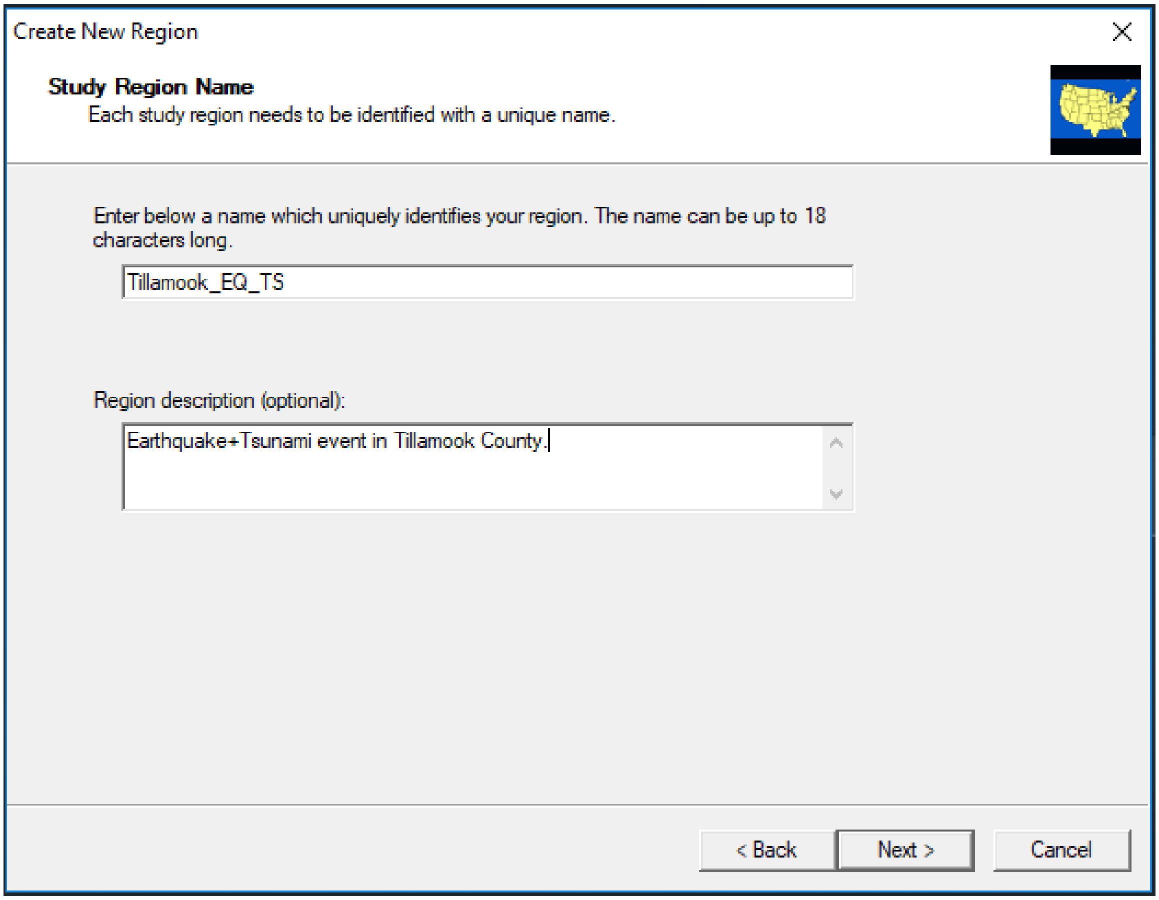
Time: 60 minutes

Goal: Run a Combined Near Source Earthquake and Tsunami Analysis.

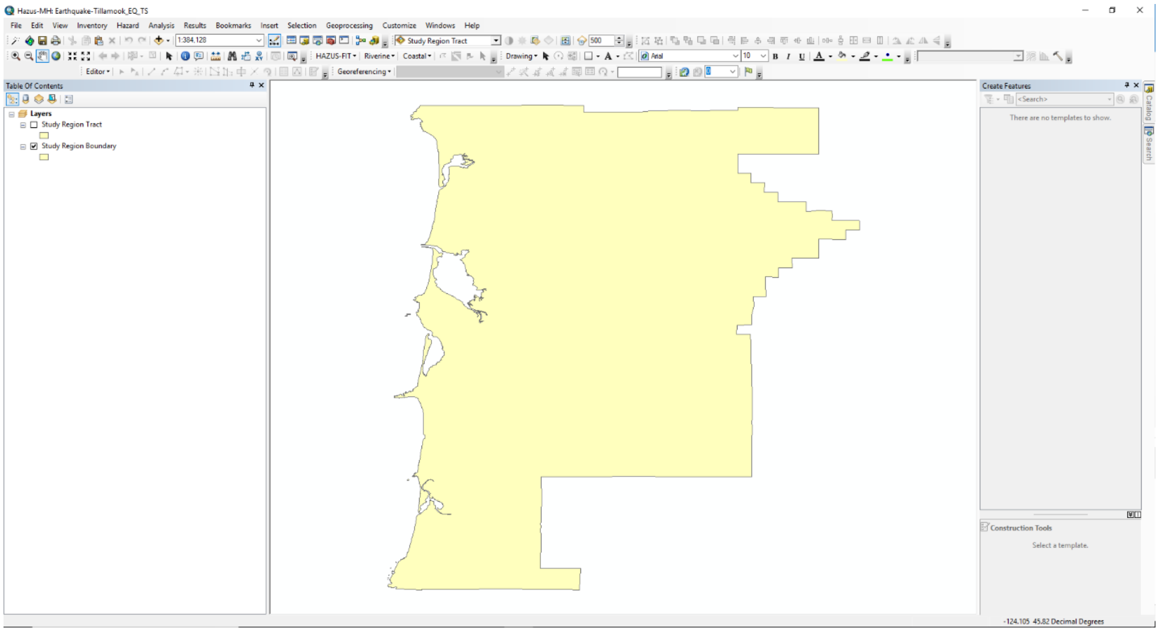
Background: This exercise utilizes a ShakeMap from a U.S. Geological Survey (USGS) Cascadia earthquake scenario to simulate a magnitude 9.0 earthquake and a resulting tsunami for damage results in Tillamook County, Oregon.

Task 1: Download the state database to create and open a study region

- If the Oregon state dataset has already been downloaded and appears in your HazusData\Inventory folder, skip to creating a new region. Otherwise, continue with the next step.
- Go to the Federal Emergency Management Agency's (FEMA) Flood Map Service Center (MSC) website https://msc.fema.gov/portal/resources/hazus.
- Download and extract the "Oregon State Database" to "C:\HazusData\Inventory\OR."
- Open Hazus 4.2.
- Click "Create a new region" and then "OK."
- The Create New Region window will appear. Click "Next."
- Name the Study Region "Tillamook_EQ_TS" and add the description "Earthquake+Tsunami event in Tillamook County."



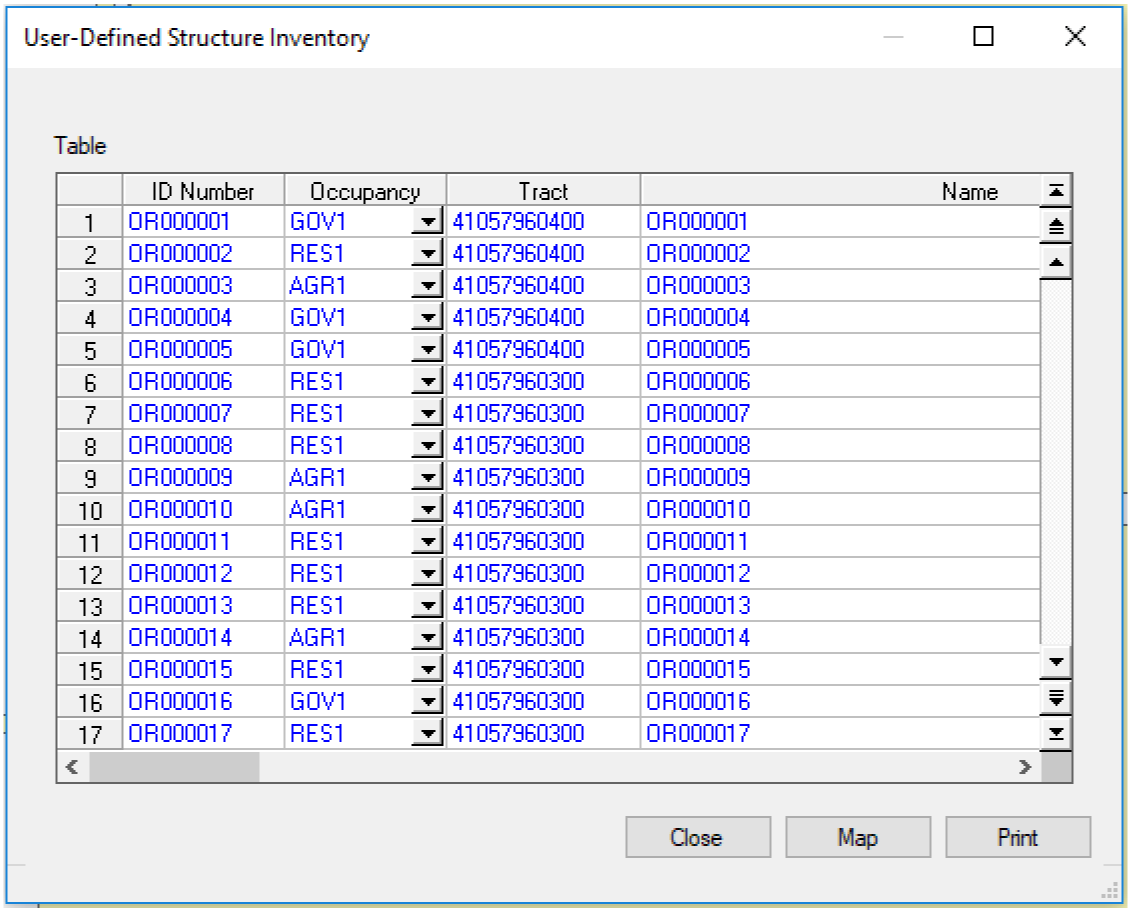
- Click “Next.”
- Check the boxes for “Earthquake” and “Tsunami” and click “Next.”
- Select “County” and click “Next.”
- Select “Oregon (OR)” and click “Next.”
- Select “Tillamook” and click “Next.”
- Click “Finish.”
- A window will appear once the region has been successfully aggregated. Click “OK.”
- Select “Open a region” and click “OK.”
- Click “Next.”
- Select “Tillamook_EQ_TS” and click “Next.”
- Click “Earthquake.” You must define the near source earthquake before evaluating the Tsunami. Click “Next.”
- Click “Finish.” An ArcMap document with Tillamook County, OR will appear.



Optional Task 2: View user defined facilities in Tillamook County, Oregon

This task will be completed if there is sufficient time in class. Otherwise, students are encouraged to complete these steps on their own to review the UDF data for a combined earthquake and tsunami analysis.

- Navigate to “Inventory > User Defined Facilities,” located in the top ribbon.
- Scroll to the right to see more information about these facilities.



	ID Number	Occupancy	Tract	Name
1	OR000001	GOV1	41057960400	OR000001
2	OR000002	RES1	41057960400	OR000002
3	OR000003	AGR1	41057960400	OR000003
4	OR000004	GOV1	41057960400	OR000004
5	OR000005	GOV1	41057960400	OR000005
6	OR000006	RES1	41057960300	OR000006
7	OR000007	RES1	41057960300	OR000007
8	OR000008	RES1	41057960300	OR000008
9	OR000009	AGR1	41057960300	OR000009
10	OR000010	AGR1	41057960300	OR000010
11	OR000011	RES1	41057960300	OR000011
12	OR000012	RES1	41057960300	OR000012
13	OR000013	RES1	41057960300	OR000013
14	OR000014	AGR1	41057960300	OR000014
15	OR000015	RES1	41057960300	OR000015
16	OR000016	GOV1	41057960300	OR000016
17	OR000017	RES1	41057960300	OR000017

- Click the “YearBuilt” column header and click “Map.” NOTE: Build year is frequently related to the types of seismic and tsunami codes used when the building was constructed. Maintaining accurate UDF data is crucial to producing accurate and reliable results that rely on building data.

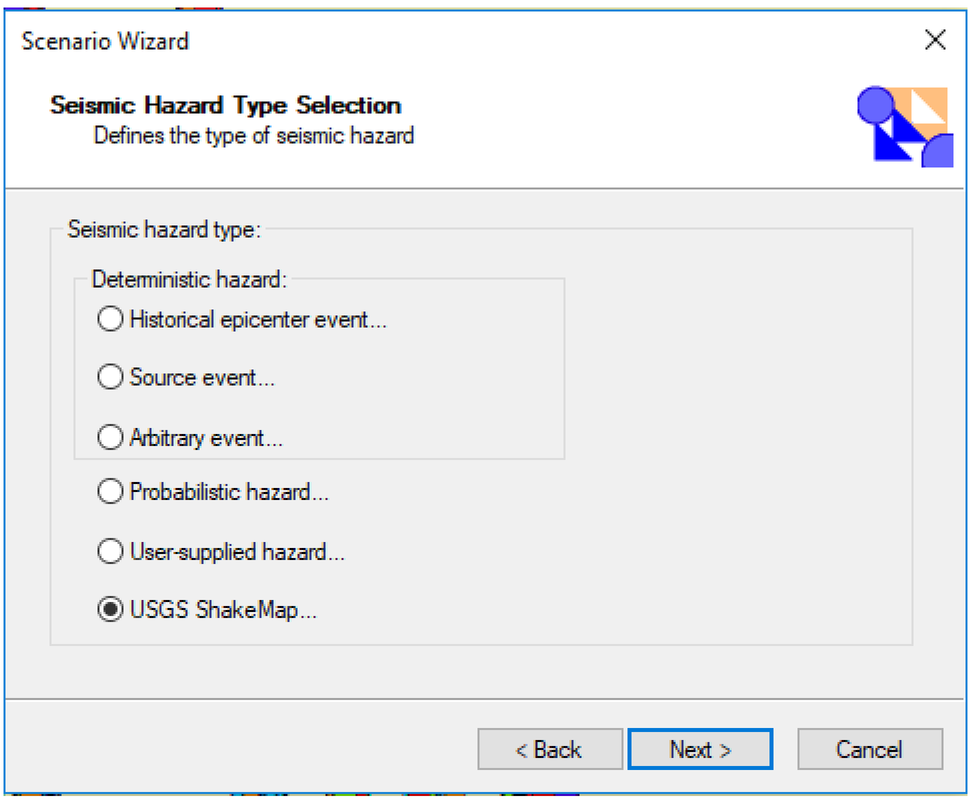
Task 2: Download Cascadia near source earthquake ShakeMap

- Navigate to the USGS M9.0 Scenario Earthquake – Cascadia 9.0 Scenario webpage https://earthquake.usgs.gov/scenarios/eventpage/uscasc9.0_expanded_peak_se#shakemap?source=us&code=uscasc9.0_expanded_peak_se.
- Scroll down and expand the “Downloads” section.
- Underneath “XML Grids” (the first download option), click to download the “ZIP (7.5MB)” file. Click “Save.”
- Click “Open Folder.”
- “Grid.xml.zip” will appear in your downloads folder.
- Right-click the zipped file and select “Extract All…” An extraction window will appear. Click “Extract.”

- A grid.xml folder will be created. Move the folder into your study region folder in C:\HazusData\Regions\Tiillamook_EQ_TS. If the download did not work, this file can be found in the Activities data folder.

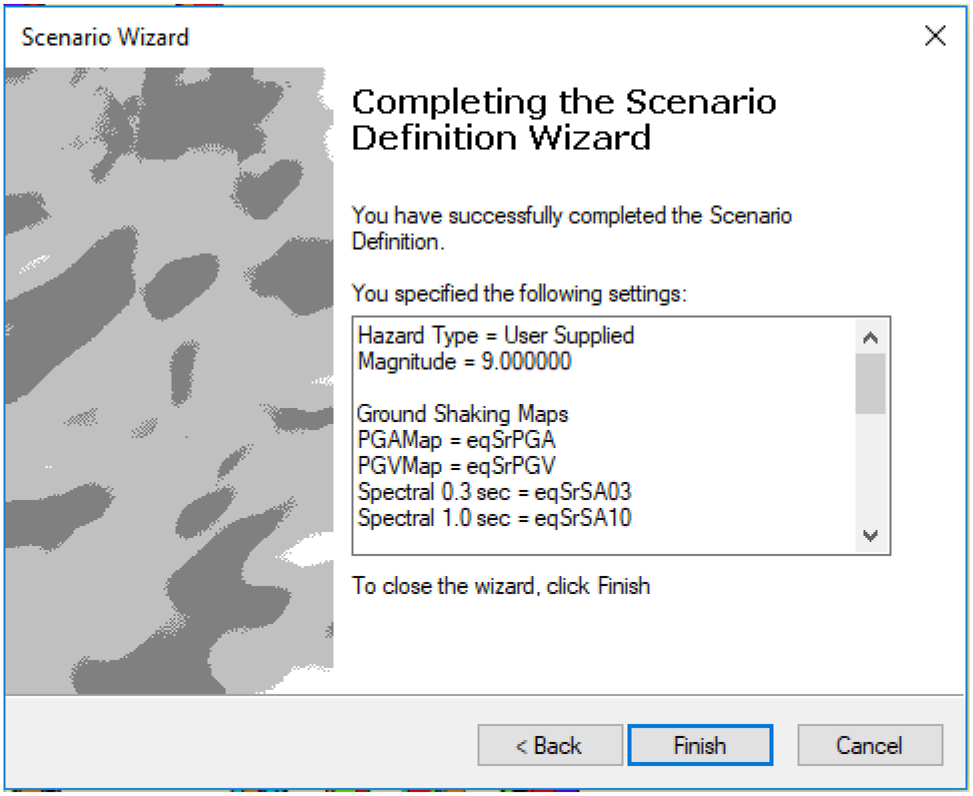
Task 3: Open ShakeMap in Hazus and run an analysis

- In Hazus, go to Hazard > Scenario…,” located in the top ribbon.
- The “Scenario Wizard” window will appear. Click “Next.”
- Click “Define a new scenario” and then “Next.”
- Click “USGS ShakeMap” and click “Next.”



- A “ShakeMap Download” window will appear. Click “Browse grid.xml” at the bottom right on the new window.
- Browse to “C:\HazusData\Regions\Tillamook_EQ_TS\grid.xml\.” Select “grid” and click “Open.”
- Hazus will then process the grid.xml. It will take approximately 1 minute. A new window will appear for other hazard parameters. Accept the pre-populated values and click “Next.”

- Click “Next” again to name the event if it is not populated already.
- Click “Finish” in the “Scenario Wizard” window.



- Navigate to “Analysis > Run.”
- An Analysis Options window will appear. Unselecting the options that do not interest you will decrease the processing time required to run an analysis. Click “Select All.”
- Click “Yes” to indicate that you do want to skip Contour Maps. Then click “OK.”
- Click “Yes” to run the analysis. It should take less than 5 minutes.
- After your analysis finishes, a window will appear with the elapsed time. Click “OK.”

Task 4: Explore earthquake results

- Navigate to “Results > User-Defined Facilities.”
- Scroll to see the damages sustained. Click on the “At Least Moderate” column header and “Map.” Then click "Close".
- Navigate to “Results > Summary Reports…”
- Select the “Other” tab and then “Global Summary Report.” Click “View.”
- Go to page 8 by clicking the single arrow pointed right.

Direct Earthquake Damage

Building Damage

Hazus estimates that about 11,005 buildings will be at least moderately damaged. This is over 60.00 % of the buildings in the region. There are an estimated 1,949 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

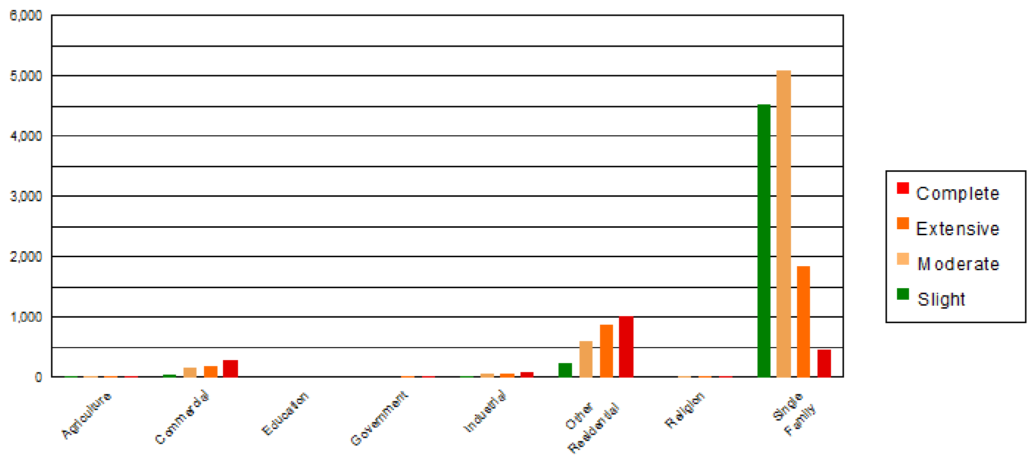
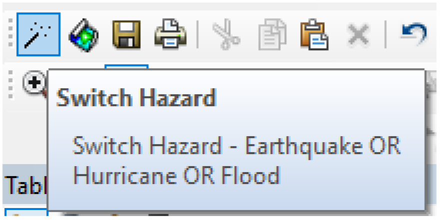


Table 3: Expected Building Damage by Occupancy

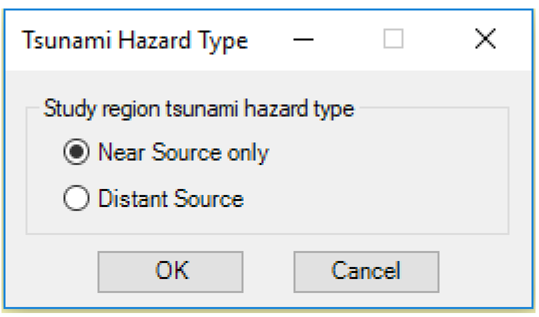
	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	11.49	0.45	19.21	0.39	28.15	0.47	26.22	0.85	31.93	1.64
Commercial	26.01	1.02	54.57	1.12	163.05	2.73	204.29	6.61	284.07	14.57
Education	2.48	0.10	4.02	0.08	7.73	0.13	8.71	0.28	10.06	0.52
Government	1.62	0.06	2.92	0.06	8.21	0.14	11.16	0.36	14.09	0.72
Industrial	9.55	0.38	19.58	0.40	62.19	1.04	79.51	2.57	101.18	5.19
Other Residential	95.99	3.78	238.47	4.90	593.92	9.96	884.78	28.63	1016.84	52.16
Religion	5.37	0.21	9.69	0.20	18.33	0.31	21.08	0.68	29.53	1.52
Single Family	2387.10	93.99	4520.66	92.84	5084.12	85.22	1854.55	60.01	461.57	23.68
Total	2,540		4,869		5,966		3,090		1,949	

Task 5: Run a tsunami analysis

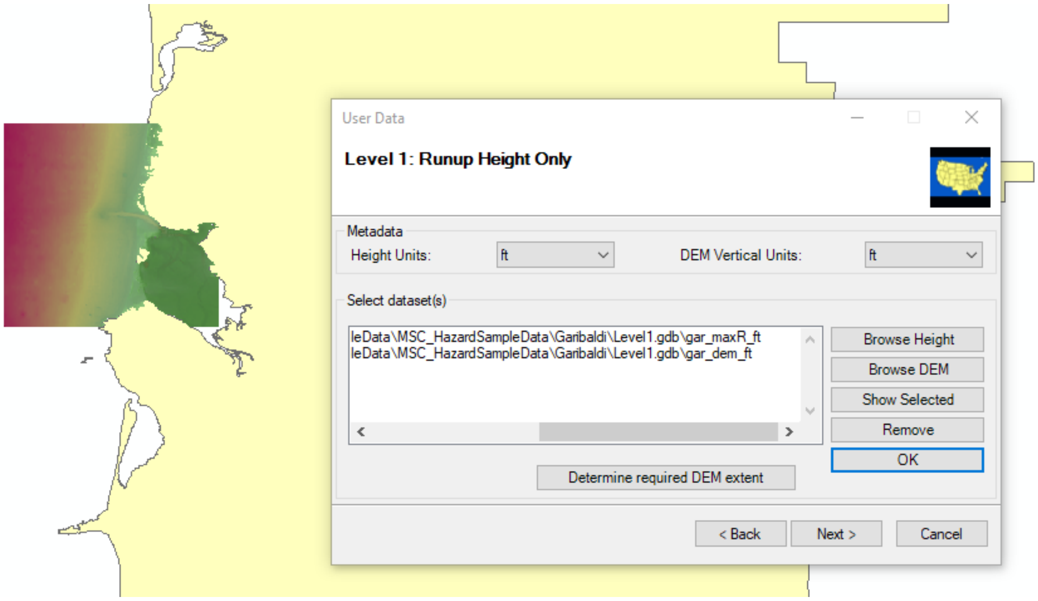
- Click the "Switch Hazard" button on the far left underneath "File".



- The “Select Hazard” window will appear. Select “Tsunami” and click “OK.” It may take a minute for ArcMap to close and open the study region to the Tsunami Hazard.
- A blank ArcMap of the study region will open.
- Navigate to “Hazard > Tsunami Hazard Type…”
- This will open the “Tsunami Hazard Type” window. Click “Near Source only” and click “OK.”



- Navigate to “Hazard > User Data.”
- The “User Data” window will appear. Click “Level 1: Runup Only-Mean Sea Level (MSL)” and then “Next.”
- Select the Height Units as “ft” and the DEM Vertical Units as “ft.”
- Click “Browse Height.” The same process will be done that was done for Exercises 14.1 and 15.1.
- Browse to the Activities folder and navigate to MSC_HazardSampleData/Garibaldi/Level1.gbd/. Choose “gar_maxR_ft” as the runup height grid. Click “Select.”
- The file will be added to the “Select dataset(s).”
- Click “Browse DEM.”
- Browse to the Activities folder and navigate to /MSC_HazardSampleData/Garibaldi/Level1.gbd/. Select “gar_dem_ft” as the DEM grid. Click “Select.”
- The file will be added to the “Select dataset(s).” Click “OK.”
- The max run-up and a deformed DEM (post-earthquake) will appear on in the study region. Click “Next.”



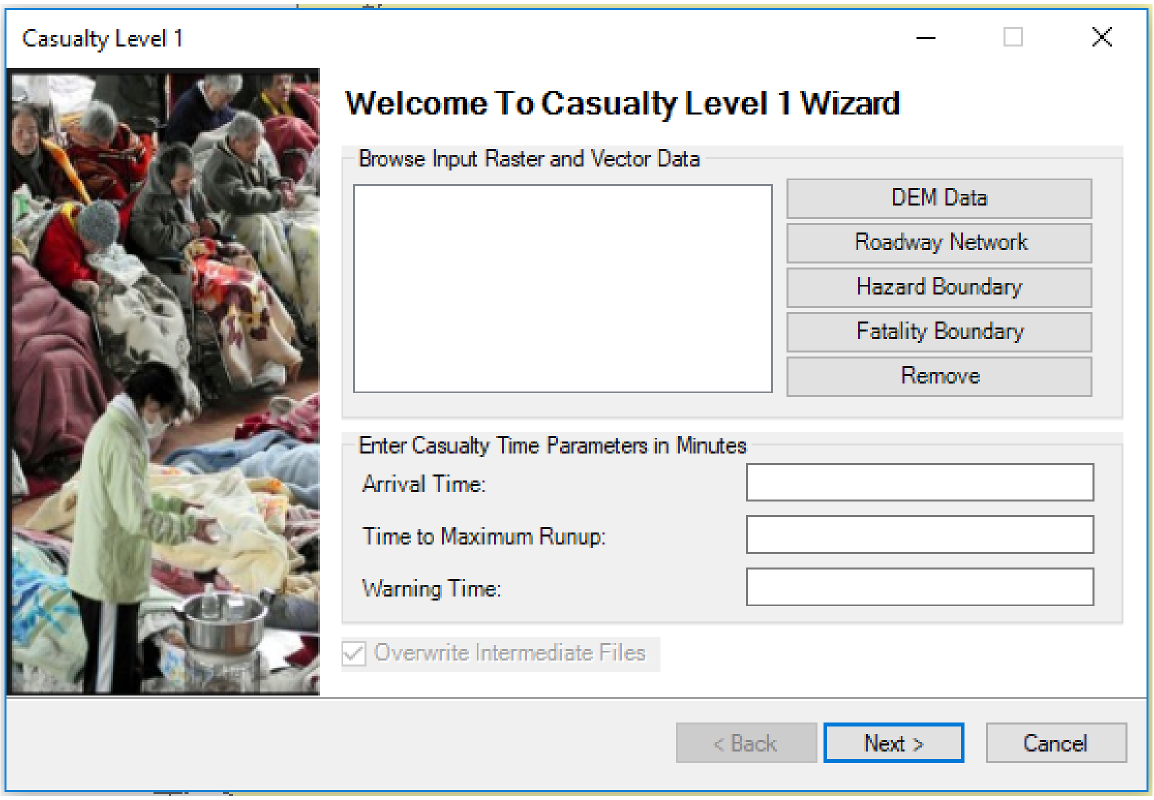
- Enter the name “Cascadia_9.0_EQ_TS” and click “Next.” A depth polygon will be created in your table of contents.
- Click “OK” to complete the User Data Wizard.

Task 6: Run the combined analysis

- Navigate to “Analysis > Run…”
- Click “Select All” to select all analysis options and then “OK.”
- It should take approximately 3 to 4 minutes. After your analysis finishes, a window will appear with the elapsed time. Click “OK.”

Task 7: Download the roadways and run a level 1 casualty analysis

- Navigate to “Analysis > Casualty > Download TIGER Roadway Network.”
- Take note of where the roadways were downloaded and unzipped. Click “OK.”
- Navigate to “Analysis > Casualty > Level 1.”
- The Casualty Level 1 window will appear.

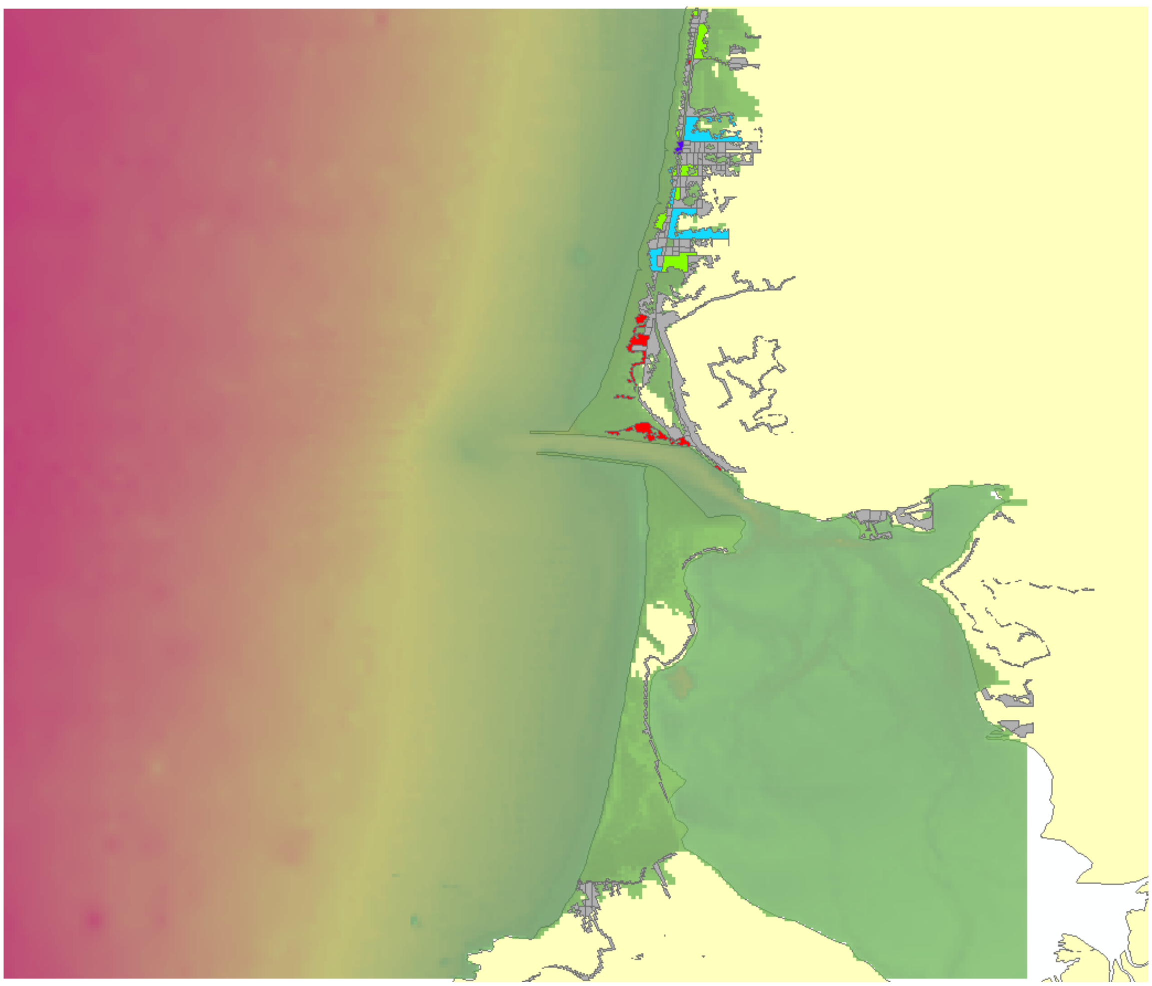


- Click “DEM Data.”
- Browse to /MSC_HazardSampleData/Garibaldi/Level1.gbd/. Choose “gar_dem_ft” and click “Select.”
- Click “Roadway Network” and browse to the location noted earlier with the TIGER roadway. Navigate to C:\HazusData\HazusInput\TS\TIGER\Roads\tl_2016_41057_roads and select the shapefile.
- Click “Hazard Boundary.” Browse to C:/HazusData/Regions/Tillamook_EQ_TS/ and select “tsHazardBoundary.shp.” Click “Select.”
- Click “Fatality Boundary.” Browse to C:/HazusData/Regions/Tillamook_EQ_TS/ and select “tsFatalityBoundary.shp.” Click “Select.”
- Enter an arrival time of “10” minutes. The other fields will automatically populate to 15 for Time to Maximum Runup and 10 for Warning Time. Click “Next.”
- Click “Next” on the “Process Level 1 Casualty Input” screen.
- Click “Next.” The cell size fields will automatically populate. If they do not, enter the following:
    - In CellSize X: 52.4
    - In CellSizeY: 52.4
    - Out CellSize: 10
- Click “Next” in the Evacuation Time Copulations window for Average Walk of 1.22 meter/second.

- Click “Next” in the Compute Travel Time and Probability of Causalities window. No boxes should be checked.
- Click “OK” to complete the Casualty Level 1 Wizard.

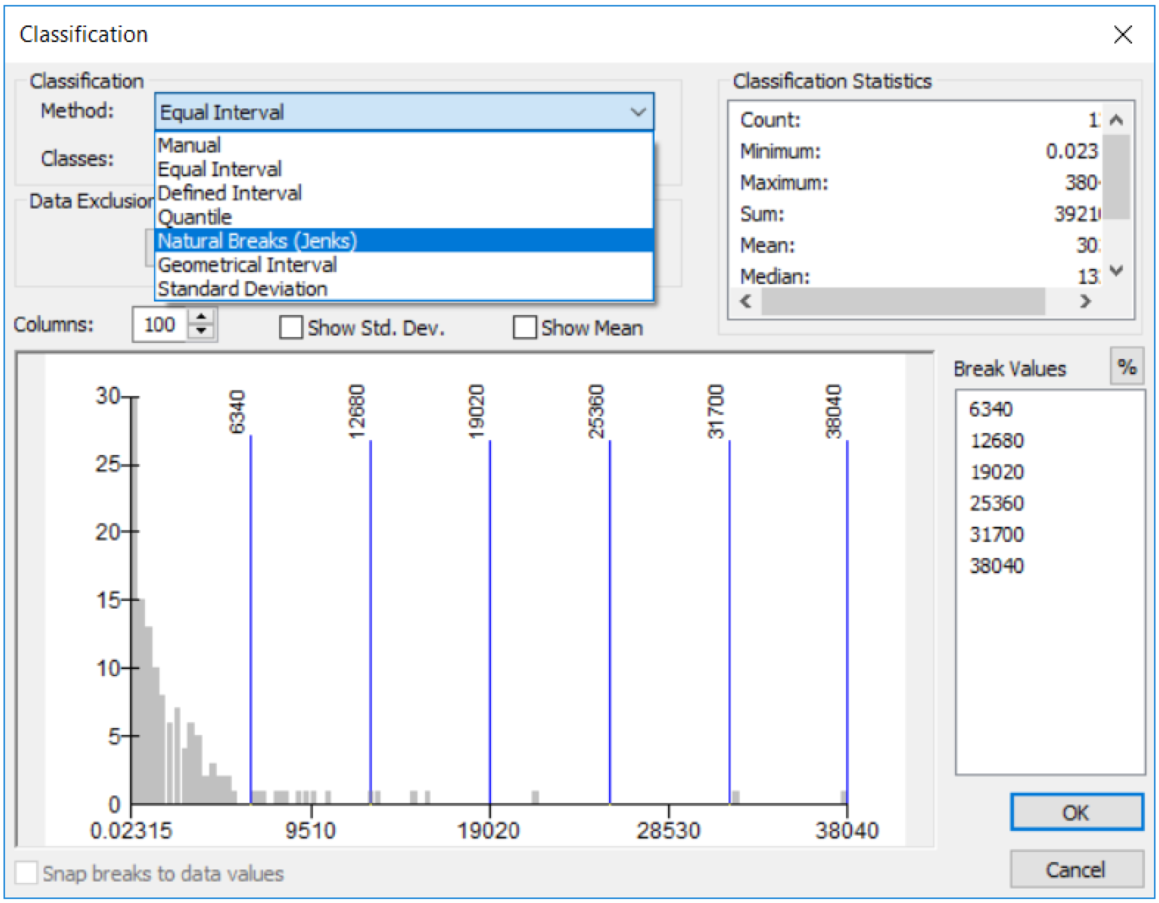
Task 8: Explore tsunami and combined analysis results

- Navigate to “Results” > “General Building Stock” > “Direct Economic Loss.”
- Select the “Total” tab and scroll to the right.
- Click the “Total Loss(thous. $)” column header and click “Map.” Then click "Close".
- Zoom in to the tsunami study area.



- Right-click on the total losses layer in the Table of Contents and go to "Properties." Click the “Symbology” tab.

- In the "Quantities" menu on the left, select "Graduate colors".
- Under Classification, select “Classify.” This will open the Classification menu.
- In the drop down menu under "Method" select "Natural Breaks (Jenks)" and click "OK".

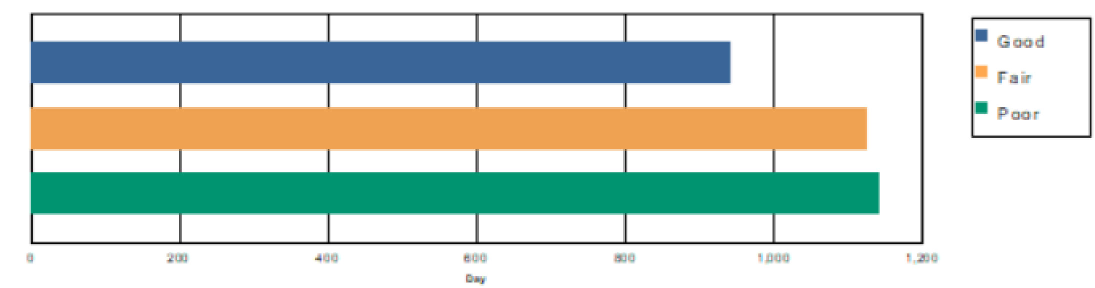


- Click “OK” in the “Layer Properties” window to close it.
- The map is now better classified for this data. Observe the changes in colors on the map.
- To explore Combined Losses Results, navigate to “Results” > “Combined User Defined Facilities” > “Combined Building Damage State.”
- Scroll to the right. Click the “PDsExcExtStruct” column and click “Map.”
- In the Table of Contents, turn off the UDF Damage State and the Tsunami Total Loss Layers by unchecking them. Only the Exceeded Structure Damages for User Defined Facilities layer should be visible.
- Navigate to “Results” > “Casualties” > “Probability of Casualties.”

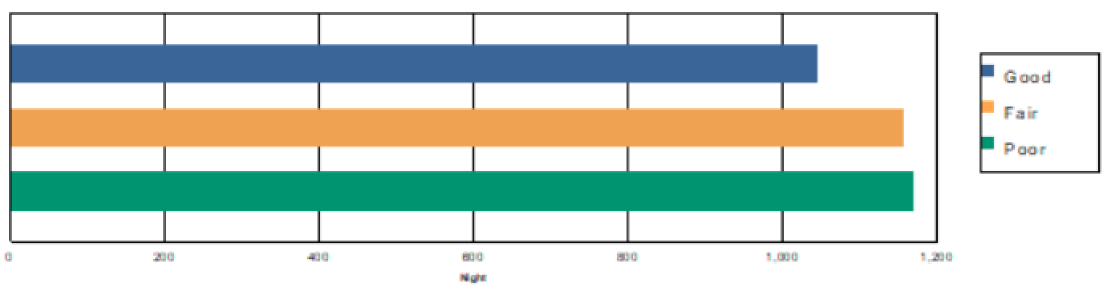
- In the “DayGood” tab, select the “FatalityDayTotal” column header. Click “Map.” Then click "Close".
- View the fatality results on the map.
- Navigate to “Results > Summary Reports…”
- Select the “Other” tab and click “Combined Earthquake and Tsunami Global Risk Report” and then “View.”
- Explore the Report document.

Tsunami Casualties by Community Preparedness Level

Casualties - Day



Casualties - Night



Casualties - Day

Exposed Population			Community Preparedness Level								
			Good			Fair			Poor		
Under 65	65 and Over	Total Population	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties
817	352	1,169	821	121	**942**	1,049	76	**1,125**	1,098	44	**1,142**

Casualties - Night

Exposed Population			Community Preparedness Level								
			Good			Fair			Poor		
Under 65	65 and Over	Total Population	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties
859	329	1,188	923	121	**1,044**	1,088	69	**1,158**	1,129	41	**1,169**

Exercise 17.1 - Packaging Data

Type: Instructor-Led Activity

Time: 10 minutes

Goals:

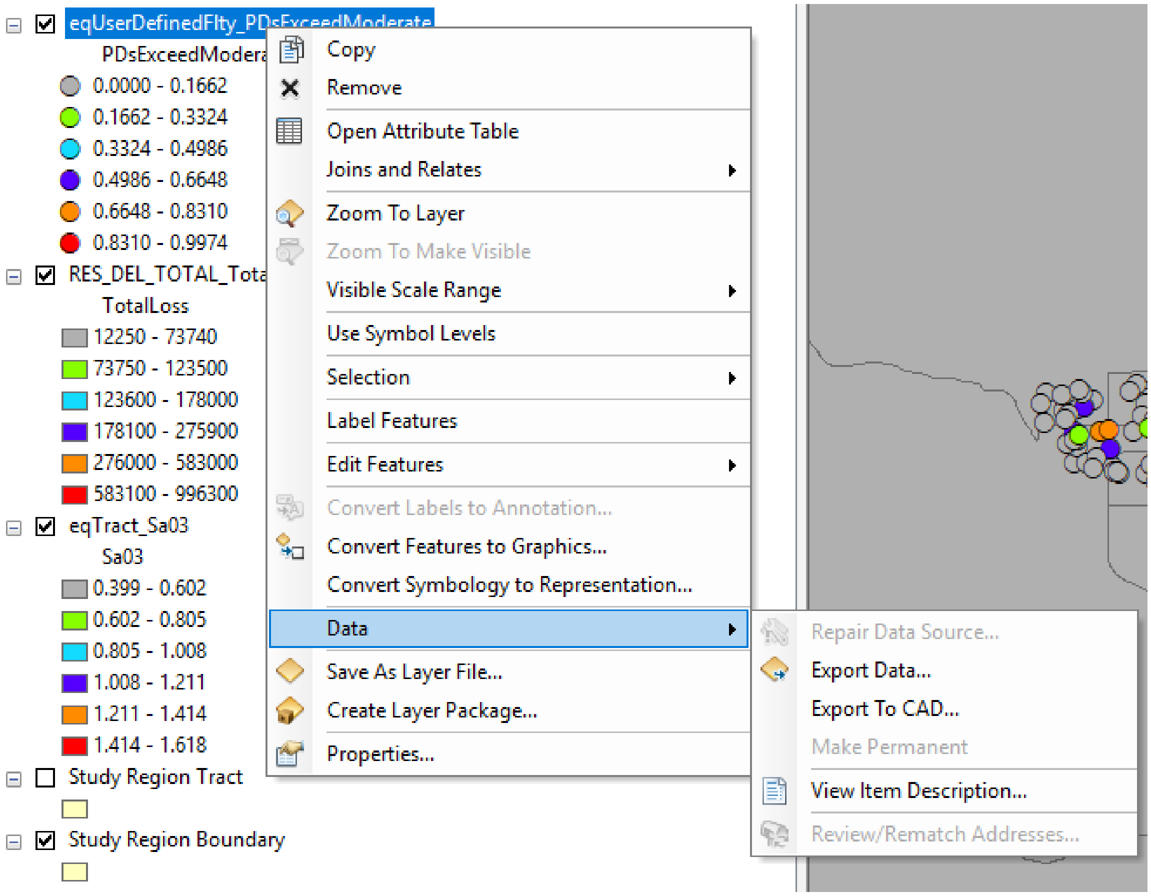
- Export User Defined Facilities (UDF) shapefile.
- Export HAZUS HPR file.

Task 1: Open a Study Region

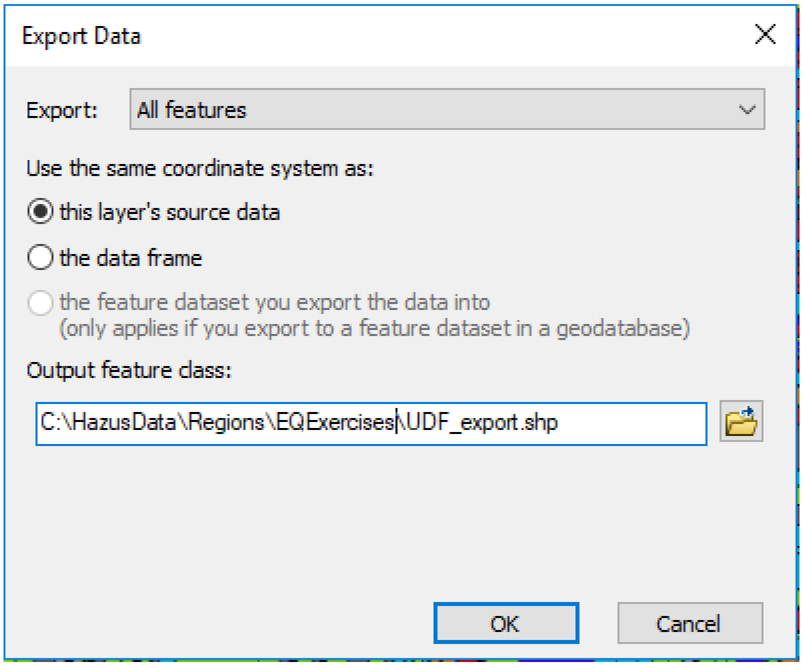
- Open Hazus 4.2.
- Click “Open a region” and then click “OK.”
- Click “Next.”
- Select “Salt_Lake_City_UDF” and click “Next.” Use the region created in Activity 13.1 (ShakeMap with UDF).
- Click “Finish.”

Task 2: Export the UDF Data

- Right-click on the “UDF layer” in the Table of Contents. Navigate to “Data > Export Data.”



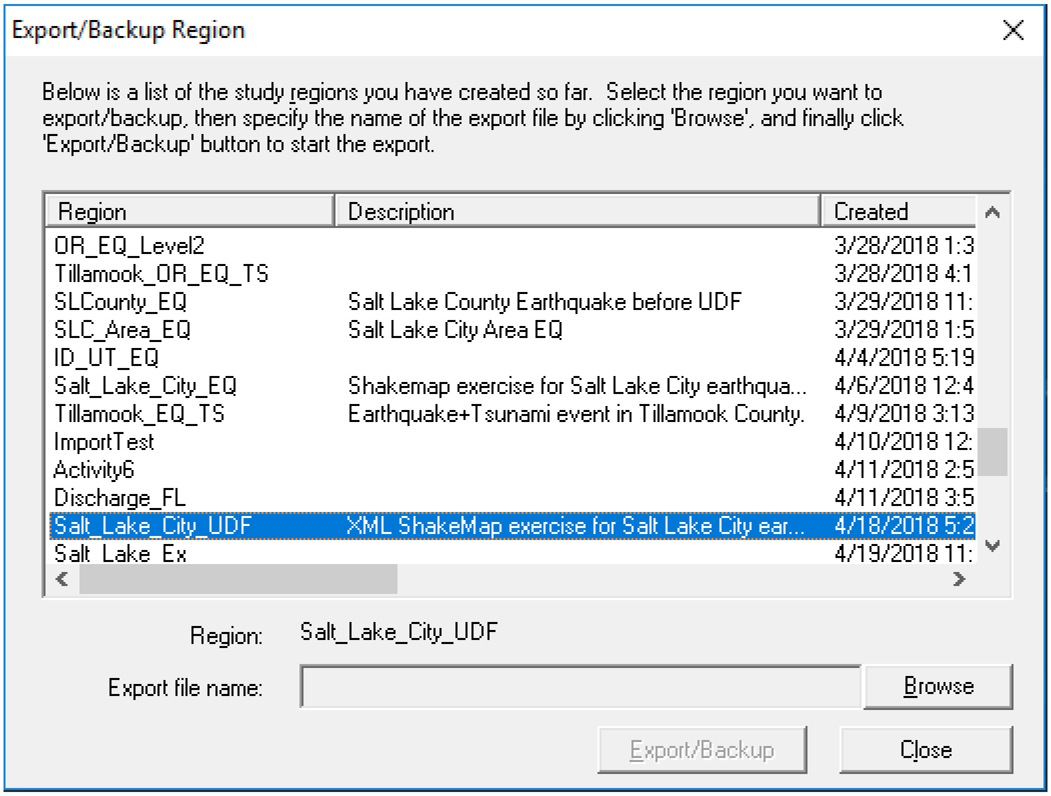
- Click the folder icon and browse to the destination folder. Name the shapefile "UDF_export.shp."



- Click "No" when asked if you want to add the exported data to the map as a layer (it would be repeated).

Task 3: Export Hazus HPR

- Close the Hazus Study region and open Hazus 4.2.
- Click "Export/Backup a region" and click "OK."
- Select "Salt_Lake_City_UDF."



- Click “Browse.”
- Browse to the destination folder. Name the HPR file “SLC_UDF.hpr” and click “Save.”
- Click “Export/Backup.”
- Hazus will indicate the region export was successful. Click “OK.” Then click “Close.”

  Note: Now the user can send the HPR file to another user and maintain their data and layers. Results will have to be selected or re-run to be seen in some cases.

Exercise 17.3 - GIS Online

Type: Instructor-Led Activity

Time: 20 minutes

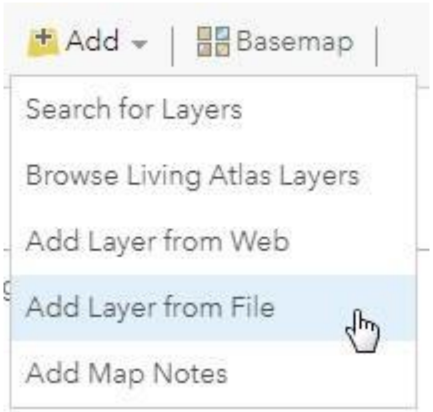
Goal: Explore GIS online options for creating maps and communicating information.

Task 1: Access ArcGIS Online

- Go to the ArcGIS Online website https://www.arcgis.com
- You can sign in or create an account if desired, but it is not necessary for this activity. If you signed in, skip to the next part of this activity. If not, continue here.
- Click "Map" at the top of the page, then "Modify Map."

Task 2: Load Data of Choice

- From the user dashboard, click "Content" to begin creating an online map.
- Click Create and from the drop down select Map.
- Enter a title, tags, and select the folder to save the map to.
- To upload a new dataset, choose "Add," and then "Add Layer from File."



- You may choose any of the data layers used during this course to upload.
    - ArcGIS Online accepts multiple file types, including Shapefiles, comma-separated values, Excel spreadsheets, and zip files. Shapefiles must be imported as a single compressed zip file.
- Once the file has been located, click "Import Layer" and the file will upload to a new map.

Task 3: View Online Map

- In the left-side table of contents move your mouse over the name of the uploaded data file.
- Click on the diagram of the circle, square, and triangle to change the style of the map.

- Make some styling changes to familiarize yourself with the options.
- After you have made alterations and select “Share.”
- Your map is now published to your account and the ArcGIS Online community.
- You also have a direct link to your map to share and you can create a web app including this map.

Task 4: View geoplatform.gov

- Navigate to geoplatform.gov
- Scroll through the website to familiarize yourself with the Apps & Services and Featured Applications this resource offers.

Task 5: View Carto Online

- Navigate to https://carto.com
- Scroll and click through the website to see options of online maps and other resources available. This is just another example of online platforms available for GIS development and communication.

Activity 17.4: Static Maps

Type: Instructor-Led Activity

Time: 10 minutes

Goal: Create a static map from the results of one of the activities you completed in this course.

Task 1: Open Region and Scenario of Your Choice.

- Choose an exercise from this course to use as the source for your map.
- Export the study region you used in the exercise (such as Tillamook_EQ_TS) as an hpr.
- Make a copy of the hpr you wish to use and re-label the file with a .zip extension. Click yes if prompted to confirm the change.
- Unzip the folder and find the map document.
- Open the map document in ArcMap.

Task 2: Define Resolution (default: 300dpi) and Output Image Quality

- Zoom in and out, change colors, or select layers to be viewed in the map document.
- At the bottom of the map window, toggle between the “Data” View and the “Layout” view.
    - The “Layout” View is used to design and author a map for printing, exporting, or publishing. You can manage map elements within the page space (typically, in inches or centimeters), add new map elements, and preview what the map will look like before exporting or printing it.
    - Common map elements include data frames with map layers, scale bars, north arrows, symbol legends, map titles, text, and other graphic elements. The “Layout” Toolbar allows you to move around the page layout without changing the data. The data can be moved within the data frame.
- As you develop your map, keep in mind what information you are trying to communicate. Who is the audience? What is the purpose? What is your message? Is this map going to be read by emergency responders? Is this map for a local government when discussing economic recovery?
- Add a title, a legend, a scale bar, and a north arrow.
- Export the map as a PDF to see an example of a final product.