Exercise 1: Visualize sea level rise

How can I print an exercise to PDF format?

Technical note

This exercise uses 3D features that may be slow to render depending on your computer's hardware.

Software requirements

- ArcGIS Online
- ArcGIS Pro 3.2
- ArcGIS 3D Analyst extension

Introduction

According to the Intergovernmental Panel on Climate Change, the amount of sea level rise between 1993 and 2010 was almost twice that of the entire previous century. And the World Economic Forum estimates that vast numbers of people are already experiencing the effects of sea level rise: 70 percent of Europe's largest cities, the 19 cities in Africa with 1 million or more residents, and the 78 million residents of low-elevation cities in China. If sea levels continue to rise at this rate or faster, hundreds of millions of people will be affected by the year 2050. For example, just a 0.5-meter change in sea level—lower than current projections—would result in more than 10 percent of land being lost in Bangladesh and as many as 15 million people being displaced.

Coastal inundation due to sea level rise affects not only global communities but also local and global economies. If countries, cities, and businesses do not act to protect themselves and become resilient to sea level rise and other climate-related hazards, vulnerable infrastructure, such as energy plants, water treatment facilities, underground communications cables, and transportation networks like ports and railways, could be damaged, causing widespread disruption both locally and globally. By modeling sea level rise, communities and organizations can identify infrastructure that will be affected by coastal inundation and make informed decisions.

In ArcGIS Pro, you work with 3D data in scenes. In a scene, you can visualize and analyze 3D data by way of functionality such as viewing modes and illumination properties. By adding 3D data to a scene, you can create a 3D model of your study area.

Scenario

Imagine the following scenario: You are a GIS analyst for Miami Beach, a coastal city in the state of Florida in the United States. The city of Miami Beach wants to visualize and analyze the future impact of sea level rise on its community. In this exercise, you will use ArcGIS Pro to create a 3D model of Miami Beach. You will learn three methods to create a 3D model in ArcGIS Pro: extruding, using attribute data to extrude, and adding 3D data layers.

Note: The exercises in this course include View Result links. Click these links to confirm that your results match what is expected.

Estimated completion time in minutes: 80

Expand all steps | Collapse all steps

- Step 1: Download the exercise data files

In this step, you will download the exercise data files for the sea level rise exercises.

a Open a new web browser tab or window.

b Go to CLIM Section 3: Visualize sea level rise.

Note: The full URL for the exercise data file is

https://www.arcgis.com/home/item.html?id=14346e9b79514b06a590859f0752800a .

c On the right, click Download to download the exercise data ZIP file.

d In File Explorer, extract the exercise data ZIP file to the EsriTraining folder that you created previously.

*Step 1d***: Download the exercise data files.*

Remember that, throughout the course, you will save all your data to the EsriTraining folder. Do not add spaces or special characters to the folder name.

e After you extract the ZIP file, confirm that the data files are stored in the SeaLevelRise folder.

f Close File Explorer.

You have downloaded and extracted the exercise data files that you will need to complete the exercise.

- Step 2: Open an ArcGIS Pro project

In this step, you will open an ArcGIS Pro project for your spatial analysis of Miami Beach.

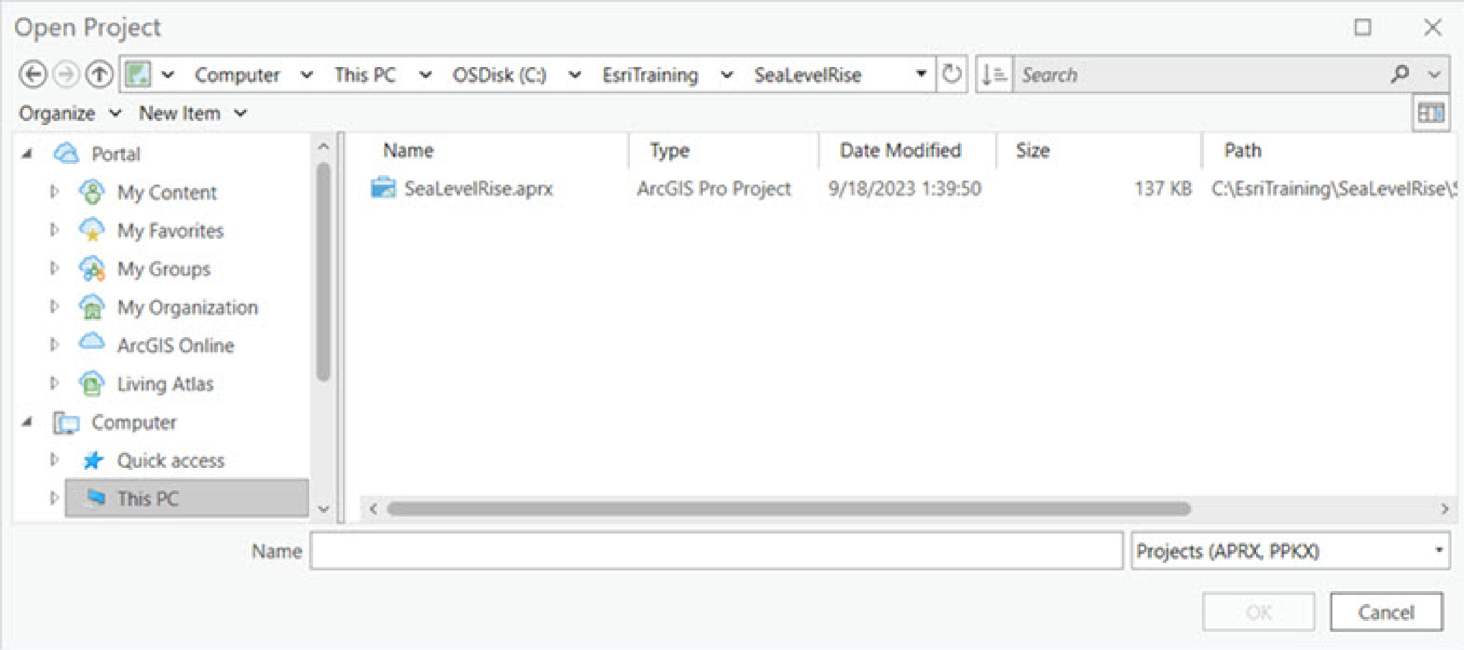
a From the Windows Start menu on your computer, expand the ArcGIS folder and click ArcGIS Pro.

Note: If you are signed in to ArcGIS Pro with a different organizational account, at the top-right corner, click Sign Out and then sign in again using your course ArcGIS username (ending in _CLIM) and password.

b Click Open Another Project.

c In the Open Project dialog box, browse to your EsriTraining folder.

d In the EsriTraining folder, double-click the SeaLevelRise folder.



*Step 2d***: Open an ArcGIS Pro project.*

e Double-click the SeaLevelRise.aprx file.

*Step 2e***: Open an ArcGIS Pro project.*

Your project opens in ArcGIS Pro with a map showing the Imagery basemap and a layer of polygon features representing 2D building footprints in Miami Beach, Florida.

You have opened the ArcGIS Pro project that you will use to model and analyze sea level rise in Miami Beach.

- Step 3: Extrude building height

To extrude buildings in a 2D layer, you can use the extrusion tools in ArcGIS Pro to select a height for the buildings in your layer, for example, 3 meters (approximately 10 feet). Extrusion is the process of vertically stretching a flat, 2D shape to create a 3D object. By extruding building footprints in the 2D layer, you can create a 3D layer that you can then use to create a 3D model of the city.

In this step, you will extrude the 2D buildings layer to create a 3D layer.

a In the Contents pane, right-click the Buildings2D_MiamiBeach layer and choose Attribute Table.

The Height field in the attribute table shows <Null>, because no values have been assigned. If values had been assigned for the height of the buildings, you could have used those values to extrude the buildings to create the 3D layer.

b Close the attribute table.

To view the buildings in 3D after they are extruded, you must first convert your map to a scene.

c In the Catalog pane, expand Maps.

d Right-click 2D Map, point to Convert, and choose To Local Scene.

A new tab opens with the local scene that you created from the 2D map. When creating a scene in ArcGIS Pro, you choose either global scene or local scene depending on the extent of your map. Global scenes are used to display data that spans the globe when the curvature of the earth is more important than the coordinate system. Local scenes are used to view data for smaller extents, such as cities. Because data in a local scene remains in a projected coordinate system, it is the better choice for editing, analysis, or measurement.

You will now extrude the buildings in the Buildings2D_MiamiBeach layer.

e In the Contents pane, click Buildings2D_MiamiBeach to select the layer.

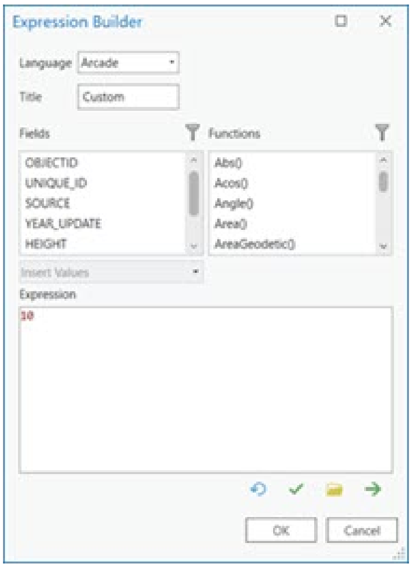
f On the ribbon, click the Feature Layer tab.

g In the Extrusion group, click Type and choose Base Height.

In the Contents pane, you will notice that the layer has moved from the 2D Layers group to the 3D Layers group. However, you have not yet selected the height of the extrusion. You will use an expression builder to set the height of the buildings.

h On the ribbon, in the Extrusion group, click the Extrusion Expression button .

i In the Expression Builder dialog box, in the field below Expression, type **10**.



*Step 3i***: Extrude building height.*

j Click OK.

k On the ribbon, click the Map tab, and then navigate to the South Pointe Park bookmark.

*Step 3k***: Extrude building height.*

You have extruded the buildings to 10 meters, or about 32 feet, which made all the buildings in the map the same height. In ArcGIS Pro, the default extrusion unit of measurement is meters. If the layer had had a defined vertical coordinate system, then the default extrusion unit of measurement would have been the vertical unit of the data source.

In this step, you extruded all the buildings to a height of 10 meters to create a 3D layer. However, buildings in a city typically vary in height. Therefore, you will create a more accurate 3D model that shows the varying heights of the buildings in the city next.

l Save your project.

- Step 4: Join a table to extrude by attribute

Currently, the attribute table for the buildings layer that you are working with does not include height values. However, because you work for the city of Miami Beach, you have access to building height values in a separate table that you will join to the buildings layer. Joining data allows information that is stored in one table to be transferred to another table if the tables share a common field. By joining the height data and using it to extrude the buildings, you will produce a more accurate 3D model of the city.

In this step, you will join a table with height values to your buildings layer to extrude the buildings to their exact heights.

a On the ribbon, click the Analysis tab and, in the Geoprocessing group, click Tools.

b In the Geoprocessing pane, in the Find Tools field, type **Join Field** and press Enter.

c Click Join Field (Data Management Tools).

The Join Field tool permanently updates the attribute table of the layer that is selected as the input table with the selected fields from the join table.

d In the Join Field tool, for Input Table, click the down arrow and choose Buildings2D_MiamiBeach.

The input table is the table that you are modifying by adding height values.

e For Input Join Field, click the down arrow and choose Unique_ID.

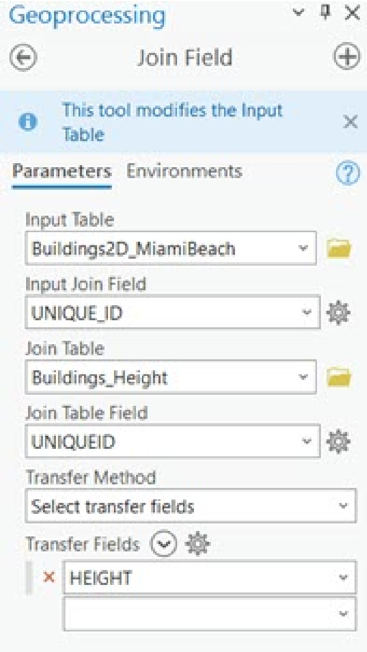
f For Join Table, click the Browse button .

g In the Join table Dialog box, on the left, under Project, click Databases, and then, on the right, double-click SeaLevelRise.gdb.

h Double-click Buildings_Height.

i For Join Field, click the down arrow and choose UniqueID.

j For Transfer Fields, click the down arrow and choose Height.



*Step 4j***: Join a table to extrude by attribute.*

The input table will update with the fields from the join table. The UniqueID field will be used as the common attribute field to transfer the height field from the join table to the input table.

k Click Run.

l Open the Buildings2D_MiamiBeach attribute table.

The height field that you just joined displays the height values for the buildings.

m Close the attribute table.

You will use this new field to extrude the buildings.

n On the ribbon, click the Feature Layer tab.

o In the Extrusion group, click Type and choose Absolute Height.

p Click the Field down arrow and choose Height.

*Step 4p***: Join a table to extrude by attribute.*

You have extruded buildings with different heights based on values that you joined in a table. This step made for a more accurate 3D model of the city. Creating an accurate 3D model is especially important when you will be using the model for data visualization and spatial analysis.

q Save your project.

- Step 5: Symbolize a multipatch layer

Extruding your data is a great way to create 3D data from 2D data. However, the buildings in your 3D layer are all shown with flat roofs and you know that not every building actually has a flat roof. To create a realistic 3D model of your city, you need an accurate representation, including roof shapes. Realistic 3D representations can be created by combining multiple data sources, like drone imagery, aerial imagery, and building footprints.

Multipatch layers are a commonly used data type for 3D building data. A multipatch layer is a geometry type that is used to define the exterior shell representation for 3D objects. ArcGIS Solutions offers the 3D Buildings solution, which helps local governments combine data to create a multipatch layer. For this exercise, the multipatch layer has already been created for you.

In this step, you will symbolize a 3D multipatch layer to create an even more accurate 3D model.

a Navigate to the Rooftops bookmark.

b In the Catalog pane, expand Databases, and then expand SeaLevelRise.gdb

c Right-click the Buildings3D_MiamiBeach layer and choose Add To Current Map.

d Turn on the Buildings2D_MiamiBeach layer.

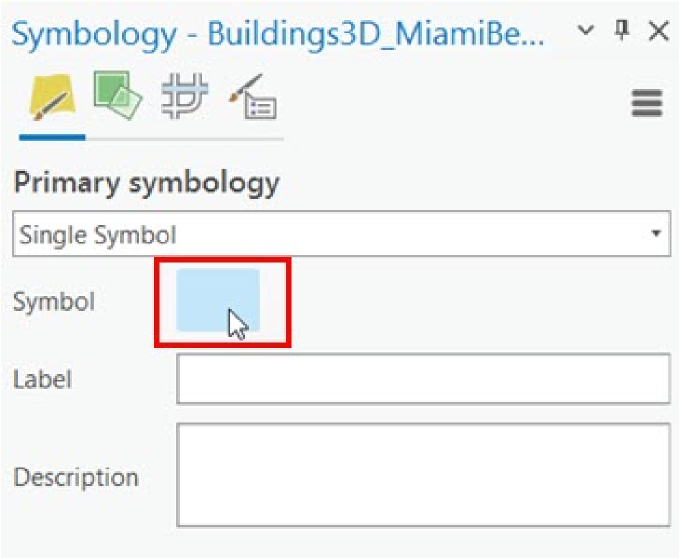
You will notice that the roof shapes differ between the extruded 2D layer and the multipatch layer. The multipatch layer contains more details in terms of building and roof shapes.

Now that you have added a multipatch layer with more accurate building shapes to your scene, you can symbolize the buildings using a rule package, or RPK file, to give the buildings a realistic exterior. An RPK file uses procedural symbology that defines the rules for symbolizing an object based on attribute fields. The RPK file that you will be using has only one rule for symbolizing buildings.

You can also create your own RPK files using ArcGIS CityEngine or find publicly shared RPK files in ArcGIS Online and ArcGIS Living Atlas of the World.

e In the Contents pane, right-click the Buildings3D_MiamiBeach layer and choose Symbology.

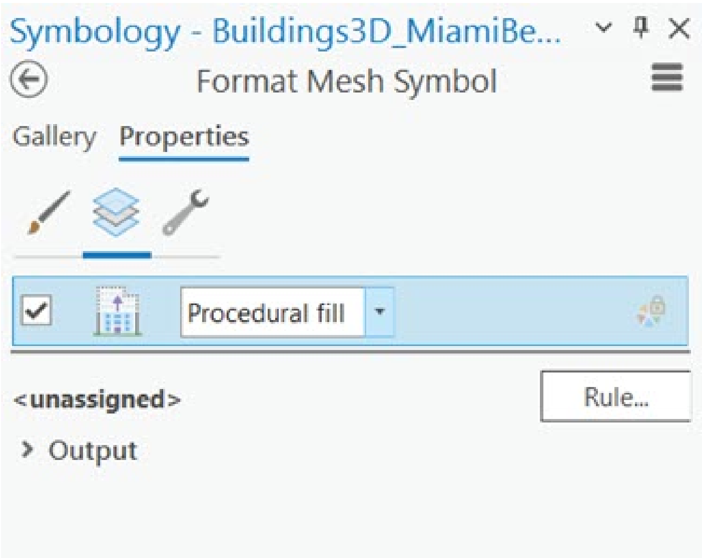
f In the Symbology pane, to the right of Symbol, click the colored rectangle, as shown in the following graphic.



g Click the Properties tab.

h Click the Layers tab .

i Click Material Fill and choose Procedural Fill.



*Step 5i***: Symbolize a multipatch layer.*

Selecting Procedural Fill enables the option to choose an RPK file.

j Click the Rule button.

k In the Select Rule Package dialog box, under Project, click Folders, and then double-click the SeaLevelRise folder.

l Select the Building_Textured.rpk file and click OK.

m In the Symbology pane, click Apply.

n Close the Symbology pane.

*Step 5n***: Symbolize a multipatch layer.*

Using an RPK file, you symbolized the buildings to achieve a more realistic appearance in your model.

- Save your project.

You have added a multipatch layer to your map and symbolized it using an RPK file from ArcGIS Living Atlas of the World. Adding the multipatch layer allowed you to create an accurate 3D model of the city.

Next, you will continue to add features to make your 3D model look even more realistic.

- Step 6: Add water to a local scene

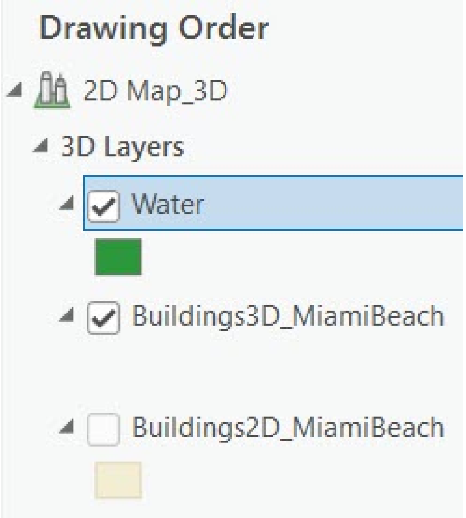
Currently, your scene uses the World Imagery basemap, which showcases the water surrounding Miami Beach. When updating a 3D model in a scene, you can add a water feature layer that gives movement to the water, as opposed to the the static image of the basemap. Scenes can also include visual effects options, like illumination. With illumination, you can adjust a scene for time of day, shadows, and ambient light. When you add a water feature layer, illumination will change the lighting on the water as well. Adding water and adjusting visual effects enhance your 3D model, rendering it increasingly realistic.

In this step, you will add illumination effects by adding a water feature layer to your scene.

a In the Catalog pane, if necessary, expand Databases and SeaLevelRise.gdb.

b Right-click Water and choose Add To Current Map.

c In the Contents pane, click the Water layer and drag it into the 3D Layers group.



*Step 6c***: Add water to a local scene.*

The water layer is now added to your map. Moving the water layer into the 3D Layers group also changed the symbology options available for the layer—you can now choose 3D drawing effects for the water layer.

d Zoom out from the buildings to show more of the ocean on the east side of the buildings, as shown in the following graphic.

Next, you will symbolize the water layer using a default ArcGIS 3D symbology option.

e In the Contents pane, click the color symbol under the Water layer to open the Symbology pane.

f In the Symbology pane, click the Gallery tab.

g Under ArcGIS 3D, click Tropical Water.

*Step 6g***: Add water to a local scene.*

You can adjust the properties of the symbology to create a 3D model that better represents your area of interest.

h In the Symbology pane, click the Properties tab.

i Under Appearance, for Waterbody Size, click the down arrow and choose Large.

j For Wave Direction, click the down arrow and choose 270.

k Click Apply, and then close the Symbology pane.

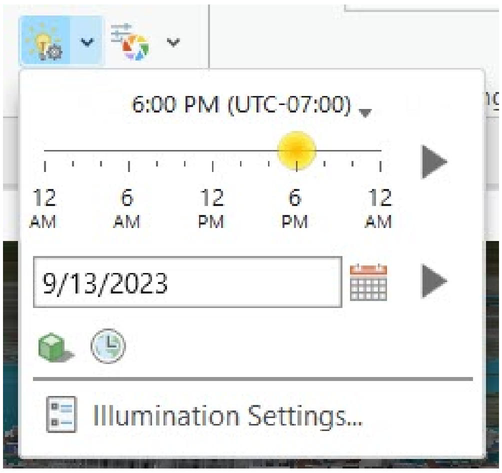
By adjusting the symbology properties, you have not only made the waves of the ocean appear larger but you have also made them move toward the beach, which better reflects how waves typically move.

You will now explore and adjust the scene's illumination properties.

l On the ribbon, click the View tab.

m In the Effects group, click the Illumination button .

n Next to the Illumination button, click the down arrow and drag the yellow time slider button to 6:00 PM.



*Step 6n***: Add water to a local scene.*

o Now change the time to 10:00 AM.

With the illumination effects, you can change the amount of daylight in the scene and the shadows that are cast by buildings and other objects. Many other visual effects can be adjusted to enhance your scene as well.

For more information on visual effects in scenes, see ArcGIS Pro Help: Apply visual effects in scenes.

You have explored applying illumination effects to a water feature layer that you added to your scene.

p Save your project.

In this exercise, you explored methods for creating and using 2D and 3D data to create a 3D model of a city. One method involved adding and symbolizing a multipatch layer to create a more accurate 3D model of your city. To complete your 3D model, you added a water feature layer and adjusted the illumination effects.

q If you are continuing to the next exercise, leave ArcGIS Pro open; otherwise, exit ArcGIS Pro.