Exercise 2: Analyze 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

Shared Socioeconomic Pathways (SSPs), also known as scenarios, use historical greenhouse gas emissions to model future emission projections. Five categories of SSP-based scenarios are used in climate models to visualize the possible effects of climate change on climate-related hazards, like sea level rise. These scenarios range from best-case to worst-case scenarios for adding greenhouse gas emissions into the atmosphere. NOAA provides sea level rise data based on climate scenarios.

Scenario

Imagine the following scenario: The city of Miami Beach wants to be proactive in its response to climate change. The city has asked you to analyze the potential impact of rising sea levels based on the intermediate-high climate scenario for the years 2030, 2050, and 2090 to help plan and design a resilient future for the city.

Using the 3D model that you created for the city of Miami Beach, you will work through a spatial analysis to identify the infrastructure that would be affected by sea level rise. You will add sea level rise data from ArcGIS Living Atlas of the World that represents the intermediate-high scenario for the years 2030, 2050, and 2090.

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: Add data from ArcGIS Living Atlas

After creating your 3D model of Miami Beach, you are ready to add sea level rise data from ArcGIS Living Atlas of the World. The sea level rise data available in ArcGIS Living Atlas was created from NOAA's Digital Coast. You will work with three layers that represent the intermediate-high scenario for sea level rise for the years 2030, 2050, and 2090.

You will now add the sea level rise data to your 3D model.

a If necessary, start ArcGIS Pro and sign in with your course ArcGIS account username (ending in _CLIM) and password.

b Open the SeaLevelRise project.

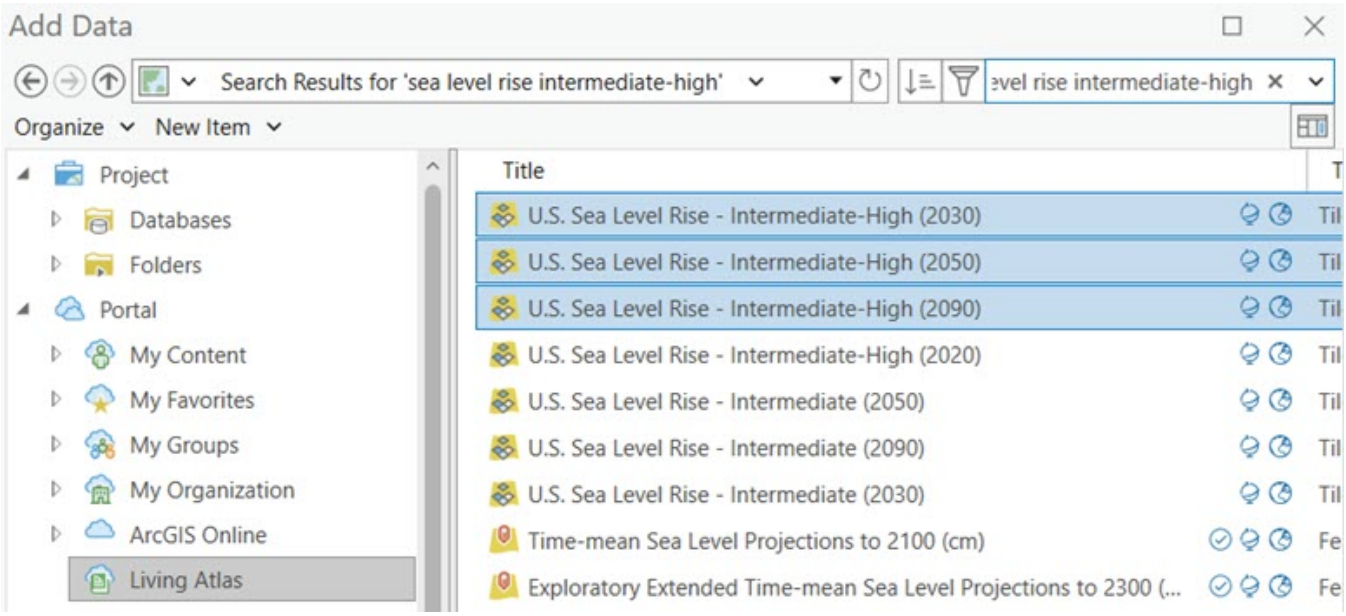
c On the ribbon, click the Map tab and, in the Layer group, click Add Data.

d In the Add Data dialog box, under Portal, click Living Atlas.

e In the Search Living Atlas field, type **sea level rise intermediate-high** and press Enter.

f Click the U.S. Sea Level Rise - Intermediate-High (2030) layer.

g Press and hold Ctrl on your keyboard, and then select the U.S. Sea Level Rise - Intermediate-High (2050) and the U.S. Sea Level Rise - Intermediate-High (2090) layers.



*Step 1g***: Add data from ArcGIS Living Atlas.*

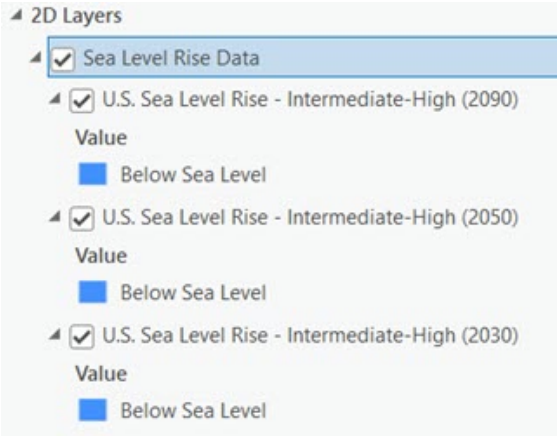
h Click OK.

You have added the three sea level rise layers to your map. You will group the layers in the Contents pane to keep your project organized.

i Press and hold Ctrl on your keyboard, and then, in the Contents pane, select the three U.S. Sea Level Rise - Intermediate-High layers.

j Right-click the selection and choose Group.

k Click New Group Layer, rename the group as **Sea Level Rise Data**, and press Enter.



*Step 1k***: Add data from ArcGIS Living Atlas.*

You have added sea level rise data from ArcGIS Living Atlas of the World.

l Save your project.

- Step 2: Configure sea level rise data

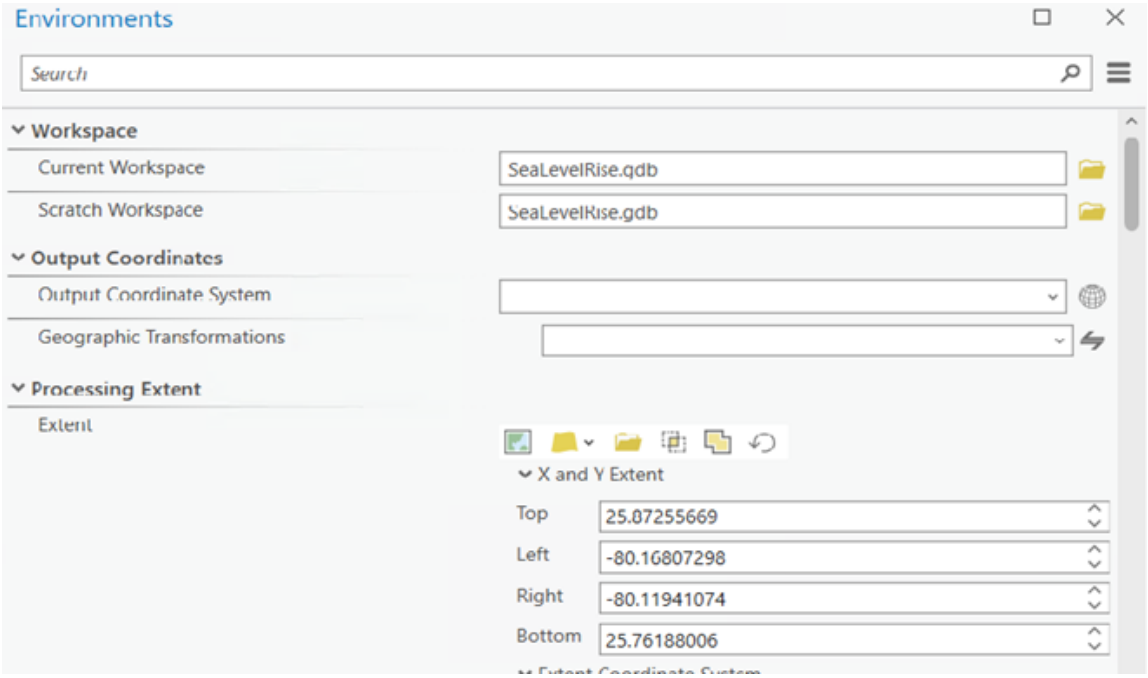
ArcGIS Pro has the option to set a processing extent that defines the geographic area of interest to be applied to a geoprocessing tool. By setting a processing extent, you can reduce the amount of time it takes to configure the sea level rise data.

In this step, you will configure the sea level rise data. You will first set the processing extent in the environments of your project to the extent of the Buildings3D_MiamiBeach layer.

a On the ribbon, click the Analysis tab.

b In the Geoprocessing group, click Environments.

c In the Environments dialog box, under Processing Extent, to the right of the Extent Of A Layer button, click the down arrow and choose Buildings3D_MiamiBeach.



*Step 2c***: Configure sea level rise data.*

d Click OK.

The sea level rise data that you added consisted of raster layers; for your analysis, you will need to convert these raster layers to polygon layers so that the data pieces are compatible with one other. You will convert the layers using the Raster To Polygon geoprocessing tool.

e In the Geoprocessing pane, search for **raster to polygon**.

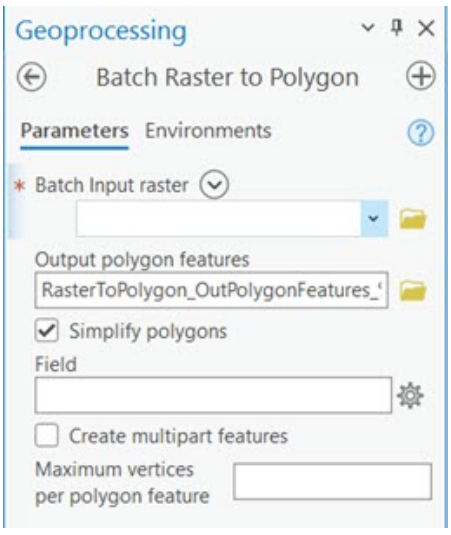
- Hint

  - On the ribbon, click the the Analysis tab and, in the Geoprocessing group, click Tools.
  - In the Find Tools field, type **raster to polygon** and press Enter.

f Right-click Raster To Polygon (Conversion Tools) and choose Batch.

Batch mode allows you to run a geoprocessing tool multiple times using multiple input datasets or parameter settings at the same time. You will use batch geoprocessing to convert all three sea level rise datasets from rasters to polygons.

g In the Geoprocessing pane, leave the default parameters and click Next.



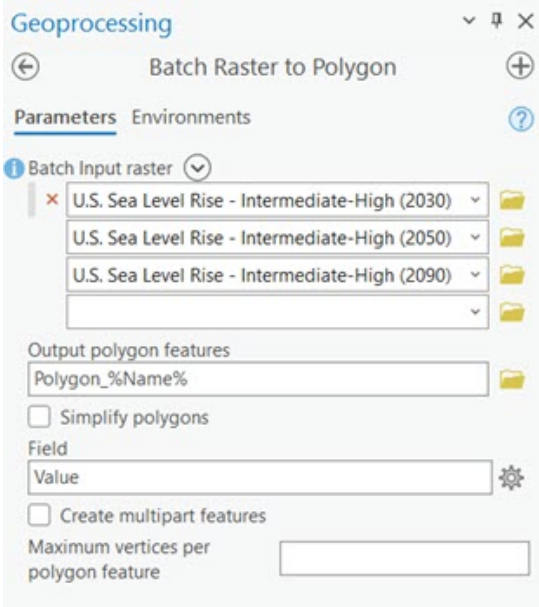
*Step 2g***: Configure sea level rise data.*

h Next to Batch Input Raster, click the Add Many button, check the three Sea Level Rise Data layers, and click Add.

i For Output Polygon Features, change the name to **Polygon_%Name%**.

Polygon_%Name% instructs the tool to add the word "Polygon" to the beginning of the layer name during batch processing. %Name% lets the tool know that you want to keep the same name as the original layer.

j For Simplify Polygons, uncheck the box.



*Step 2j***: Configure sea level rise data.*

k Click Run.

Note: The tool may take a couple of minutes to run because it is processing the three layers simultaneously.

Because you have now converted the raster layers to polygons, you no longer need the other datasets in your project—you will use the polygons to complete your analysis.

l In the Contents pane, right-click the Sea Level Rise Data group layer and choose Remove.

For better visualization, you will next change the water symbology.

m In the Contents pane, for each of the sea level rise layers, click its symbol to open the Symbology pane.

n Using the ArcGIS 2D Gallery, change the color of each layer to a Water (Area) symbol.

o Explore the sea level rise layers by turning the layers on and off, zooming in or out, and changing the view of the map.

You have used the Raster To Polygon geoprocessing tool to configure the sea level rise data for your analysis.

p Save your project.

- Step 3: Calculate affected buildings

In this step, you will select the buildings that will be affected by sea level rise for 2030, 2050, and 2090 in Miami Beach. After selecting the buildings, you will calculate their year of inundation based on the sea level rise data for your analysis.

a On the ribbon, click the Map tab and, in the Selection group, click Select By Location.

You want to apply the selection to the Buildings3D_MiamiBeach layer, so you will make Buildings3D_MiamiBeach your input feature. You also want to identify all the buildings that intersect with the 2090 sea level rise data layer that you

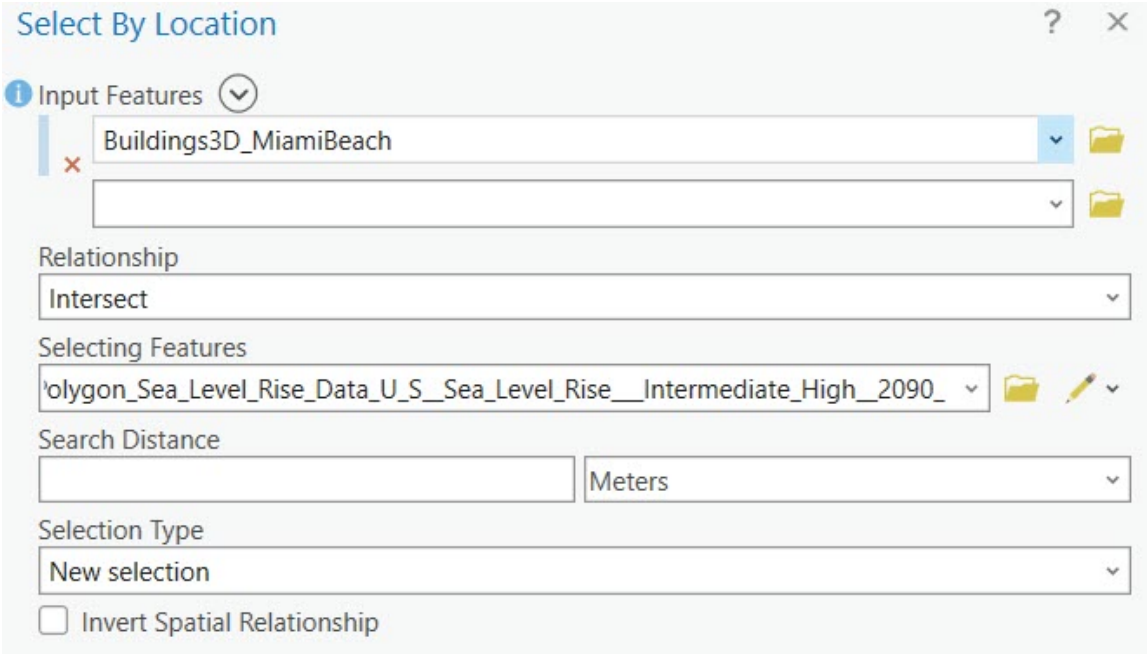
converted to a polygon, so you will make Polygon_Sea_Level_Rise_Data_U_S_Sea_Level_Rise_Intermediate_High_2090 your selecting features layer.

b In the Select By Location dialog box, for Input Features, click the first down arrow and choose Buildings3D_MiamiBeach.

c For Relationship, confirm that Intersect is selected.

d For Selecting Features, choose Polygon_Sea_Level_Rise_Data_U_S_Sea_Level_Rise_Intermediate_High_2090.

e For the remaining parameters, leave the default options.



*Step 3e***: Calculate affected buildings.*

f Click Apply.

*Step 3f***: Calculate affected buildings.*

You now have a selection of 8,535 buildings in the Buildings3D_MiamiBeach layer. You will add a field to the layer's attribute table to record the buildings affected by sea level rise in 2090. When a layer has a selection, the geoprocessing tools in ArcGIS Pro honor that selection.

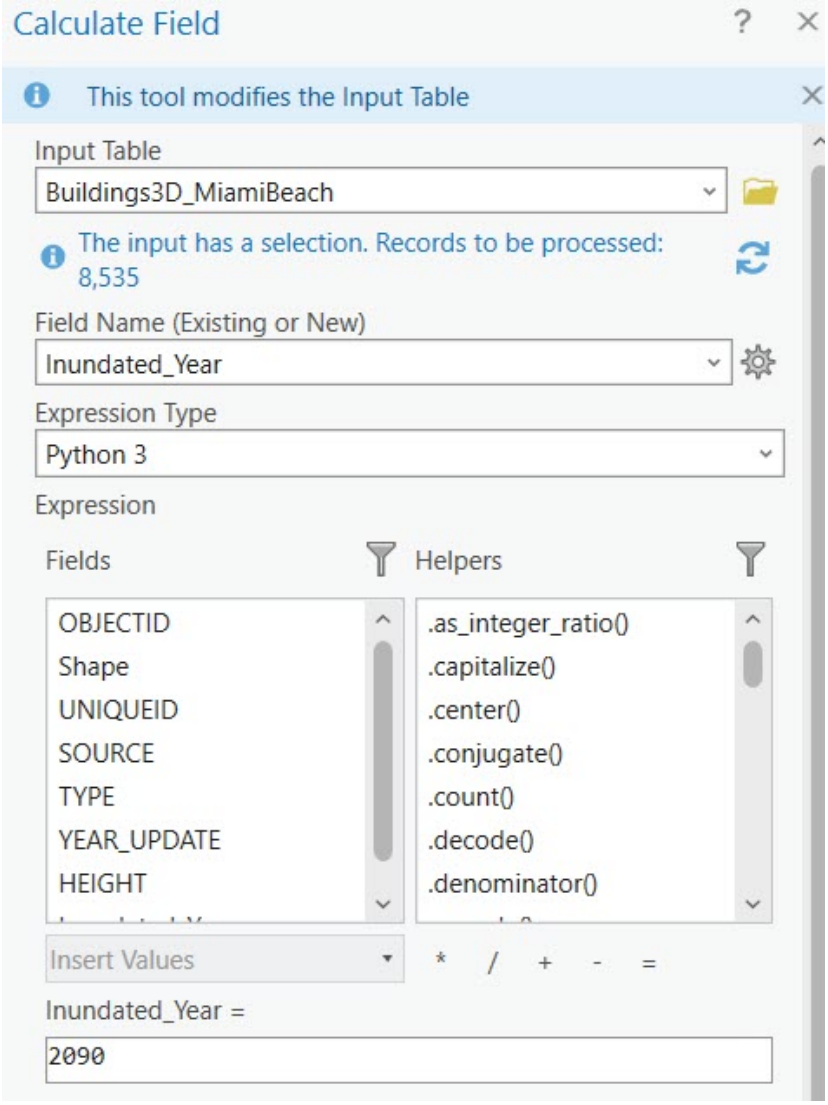
g Click OK.

h Open the Buildings3D_MiamiBeach attribute table.

i In the attribute table, click Calculate to open the Calculate Field tool.

j In the Calculate Field dialog box, set the following parameters:

- For Field Name, type **Inundated_Year**.
- For Field Type, choose Short (16-bit Integer).
- For Expression, after `Inundate_Year =`, type **2090**.



*Step 3j***: Calculate affected buildings.*

k Click Apply.

You have added a new field called Inundated_Year to your attribute table and calculated which buildings will be affected by sea level rise in the year 2090. You will now complete the same workflow for the years 2050 and 2030.

l Click OK.

m In the attribute table, click the Clear button to clear the selection.

Clearing your selection prepares you to perform the steps for the year 2050.

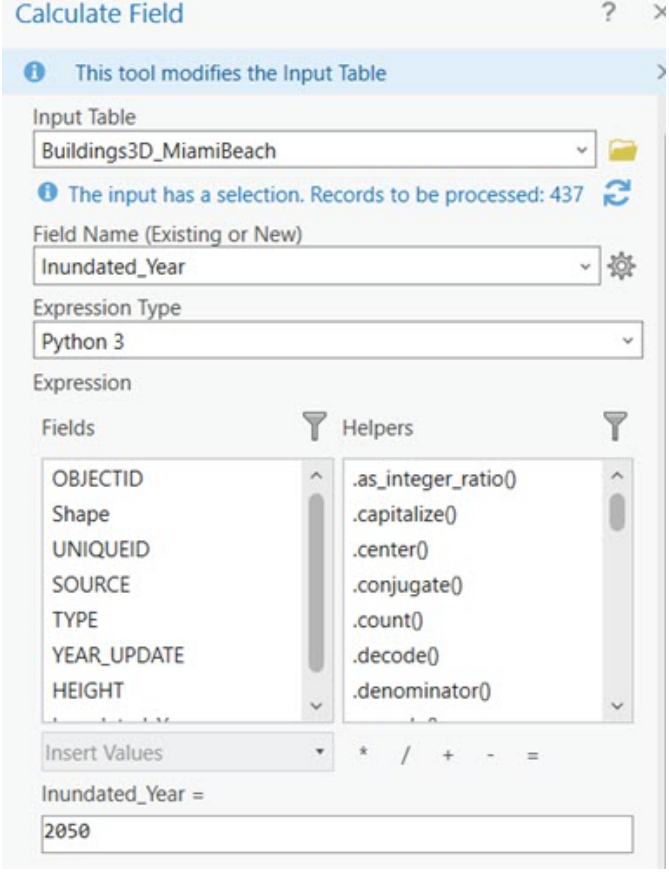
n Open the Select By Location tool.

o Select the buildings that will be affected in the year 2050.

- Hint

  There are 437 buildings selected in the Buildings3D_MiamiBeach layer.

p Use the Calculate Field tool to identify which buildings will be affected in 2050 in the attribute table.



*Step 3p***: Calculate affected buildings.*

q Clear the selection in the attribute table so that you can perform the steps for the year 2030.

r Complete the workflow for the year 2030.

- Hint

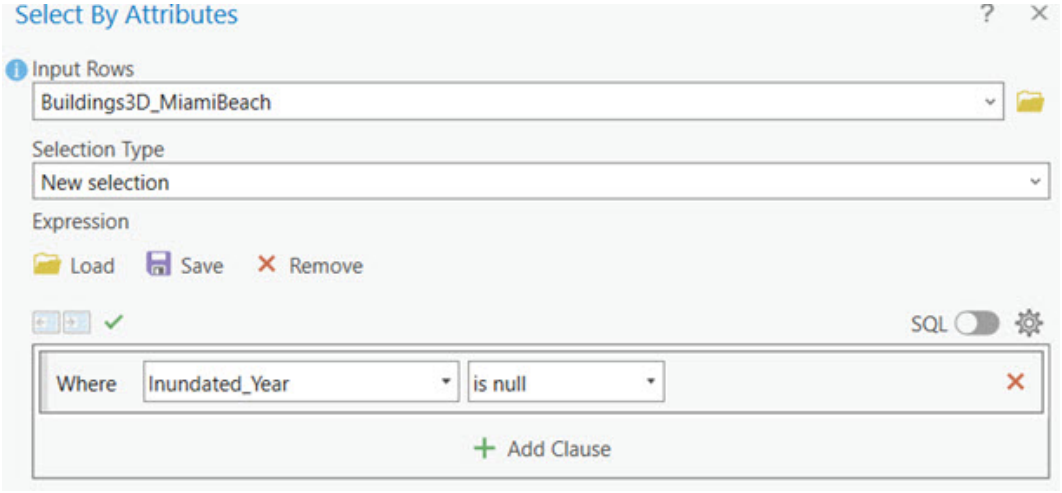
  In 2030, 106 buildings will be selected in the Buildings3D_MiamiBeach layer.

s Clear the selection in the attribute table.

To symbolize the buildings that are *not* affected by sea level rise, or null, you will select the null values for Inundated_Year and classify them as zero.

t Open the Select By Attributes tool.

u Create the expression `Where Inundated_Year Is Null`.



*Step 3u***: Calculate affected buildings.*

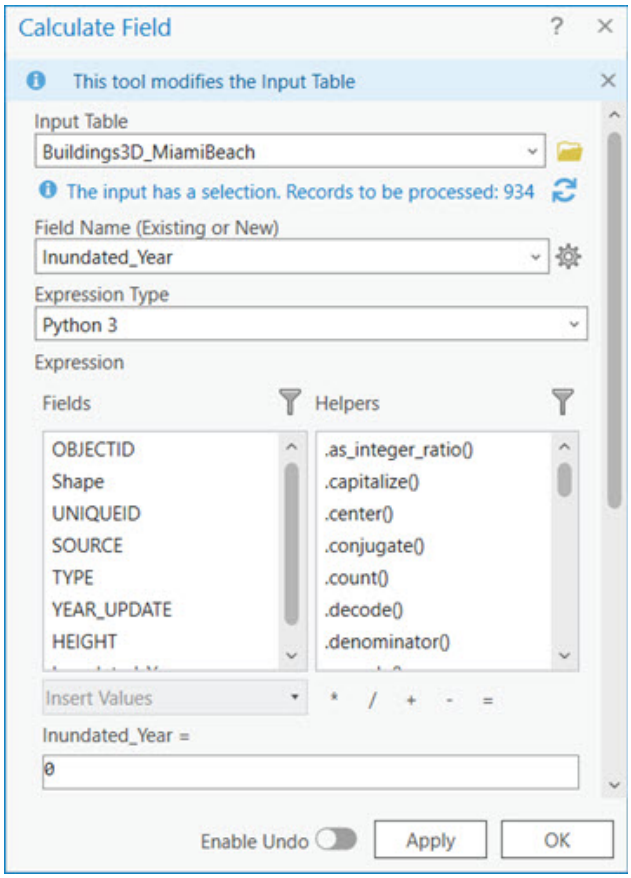
v Click Apply, and then click OK.

- Hint

There are 934 buildings selected in the attribute table.

You will use the Calculate Field tool to set the selected features to zero.

w Open the Calculate Field tool and set `Inundated_Year =` to **0**.



*Step 3w***: Calculate affected buildings.*

x Click Apply, and then click OK.

y Clear the selection and close the attribute table.

z Save your project.

You have calculated the buildings that will be affected by sea level rise for the years 2030, 2050, and 2090 in Miami Beach by using sea level rise data that represents an intermediate-high scenario.

- Step 4: Visualize your 3D analysis

For your analysis, you identified which buildings in Miami Beach would be affected by sea level rise by year of inundation. However, the results of your analysis are only calculated in the attribute table and are not currently visualized on the map. You can use the data in the attribute table to symbolize your analysis results based on year of inundation. Symbolizing data helps to clearly visualize analysis results.

In this step, you will visualize the results of your analysis by symbolizing your results.

a Navigate to the Mid Beach bookmark.

b In the Contents pane, turn off the sea level rise data layers.

*Step 4b***: Visualize your 3D analysis.*

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

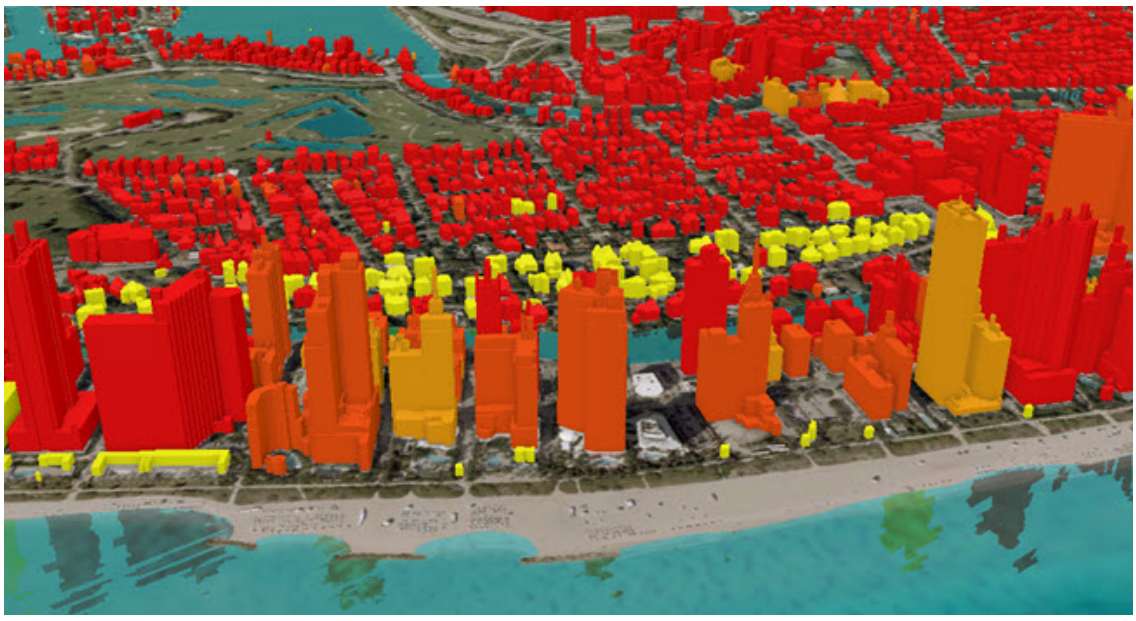
d In the Symbology pane, under Primary Symbol, click Single Symbol and choose Graduated Colors.

e For Field, choose Inundated_Year.

By selecting the field that you created, Inundated_Year, three classes are created and symbolize the building colors by year of inundation. You will change the colors for better visualization.

f For Color Scheme, click the down arrow and check Show Names.

g Scroll through the list of colors to find and select the Yellow To Red color scheme.



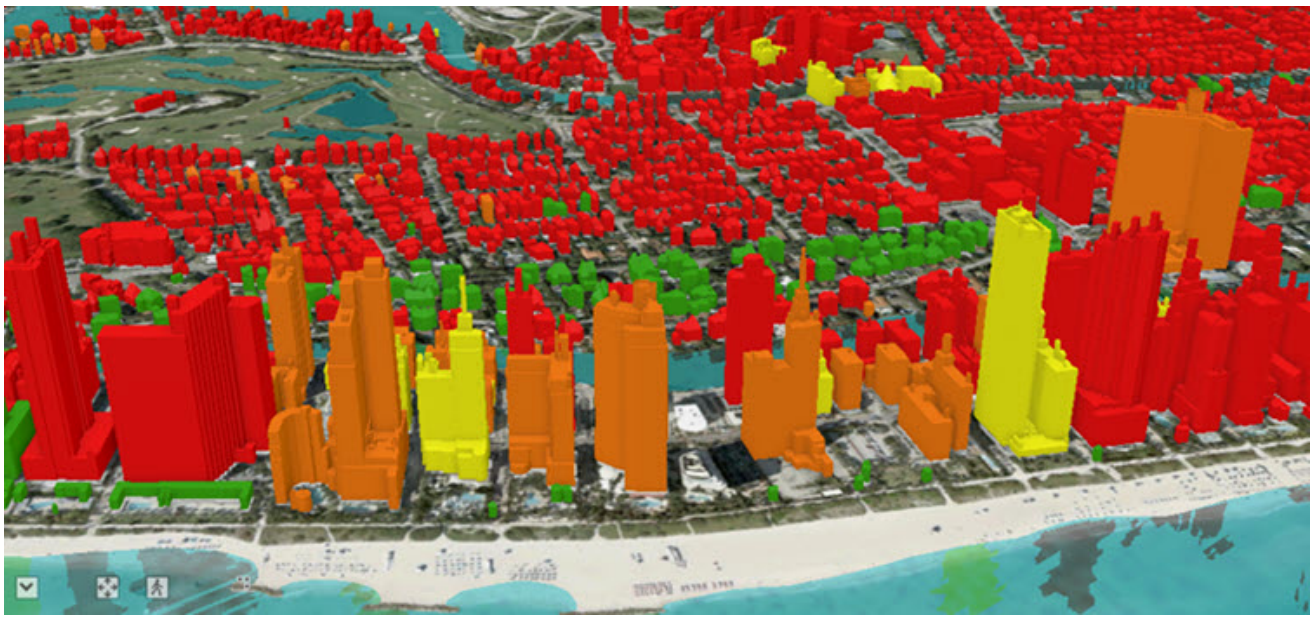
*Step 4g***: Visualize your 3D analysis.*

By symbolizing the buildings by inundation year, you can easily visualize which buildings will be affected by 2030 (light orange), by 2050 (dark orange), and by 2090 (red). You will update the colors to show buildings that will not be affected in green and then make the orange shades easier to differentiate.

h Under Classes, right-click the yellow square and choose a green color, such as Leaf Green.

i Right-click the orange square for 2030 and choose a yellow color, such as Solar Yellow.

j Right-click the dark orange square for 2050 and choose an orange color, such as Electron Gold.



*Step 4j***: Visualize your 3D analysis.*

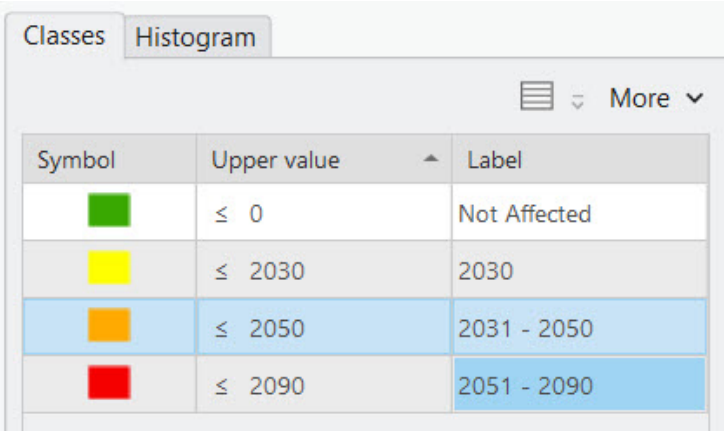
The building colors have been updated.

You will now update the labels to make the legend easier to read.

k Under Label, double-click 0, replace the text with **Not Affected**, and press Enter.

l Under Label, replace 1 - 2030 with **2030**.

m Leave the other labels as the default.



*Step 4m***: Visualize your 3D analysis.*

By updating the symbology colors, you can now easily see the green buildings on the map that will not be affected by sea level rise in Miami Beach.

In this step, you visualized the results of your analysis by symbolizing the buildings based on year of inundation. Symbolizing the analysis results allows you to visually communicate your results to the city's decision makers.

n Save your project.

- **Step 5: Use 3D exploratory tools**

There are many possibly explanations for why your analysis shows that some buildings will not be affected by sea level rise. For example, the buildings could have been more recently built—with sea level rise in mind—and are therefore less susceptible. Another reason could be that the buildings are located at a slightly higher elevation than the affected buildings.

ArcGIS Pro includes 3D exploratory analysis tools. In this step, you will use the Elevation Profile tool to determine whether buildings not affected by sea level rise are located at a higher elevation.

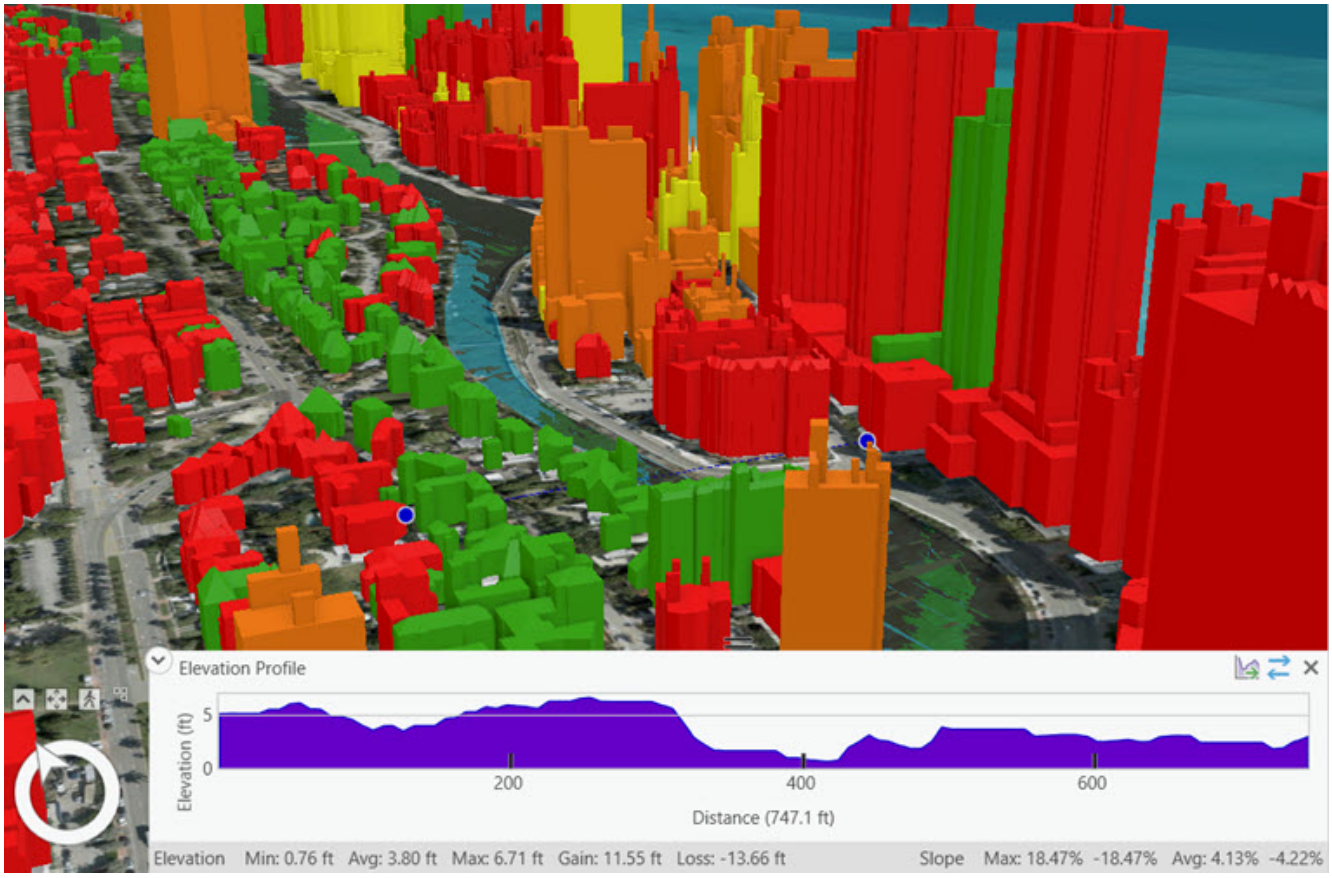
a Navigate to the Exploratory Analysis bookmark.

b On the ribbon, click the Analysis tab.

c In the Workflows group, click the Exploratory 3D Analysis down arrow and choose Elevation Profile.

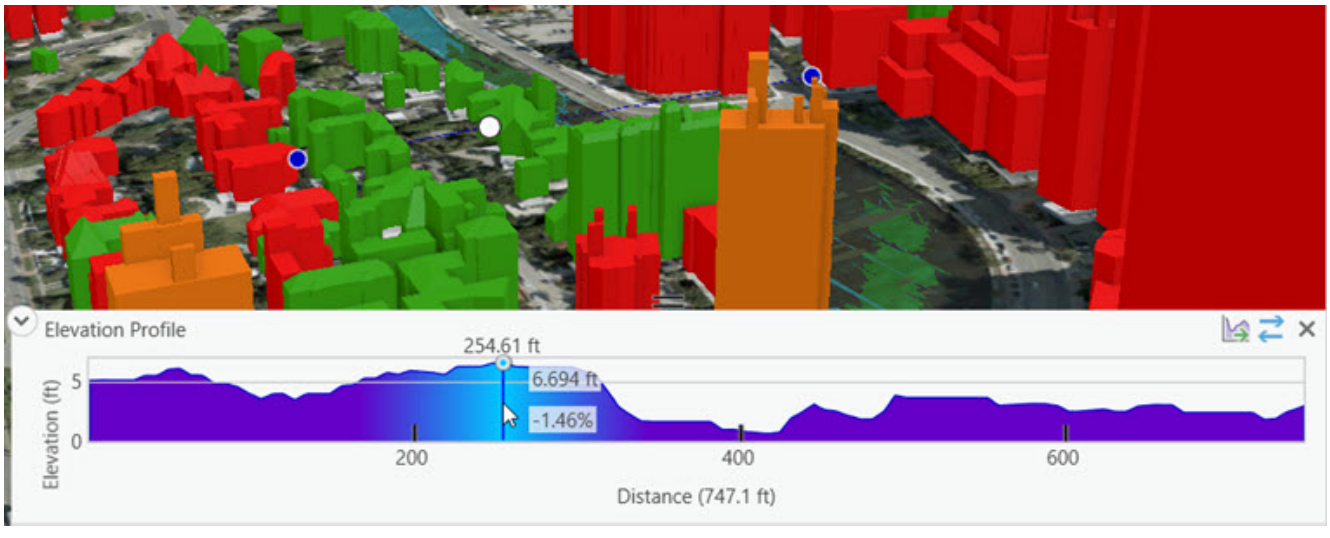
Note: You can change the distance units from Feet to Meters in the Exploratory Analysis pane.

d On the left side of the scene, click a green building, draw a line across the water to the red buildings on the right side of the scene, and then double-click to release the tool.



*Step 5d***: Use 3D exploratory tools.*

e Move your mouse across the Elevation Profile results to interact with the chart, as shown in the following graphic.



You will notice that, in this area of Miami Beach, the green buildings identified as not affected by sea level rise are located at a higher elevation than the affected buildings. This information can help the city plan accordingly. However, even if buildings are not affected, critical infrastructure such as roads may still be impacted.

For more sharing options, the Elevation Profile tool also allows you to export your results as an image, feature, geodatabase table, or CSV table.

f Close the Elevation Profile results and save your project.

You have used a 3D exploratory analysis tool to explore the results of your analysis and to evaluate why certain buildings will not be affected by sea level rise.

- Step 6: Share a web scene to ArcGIS Online

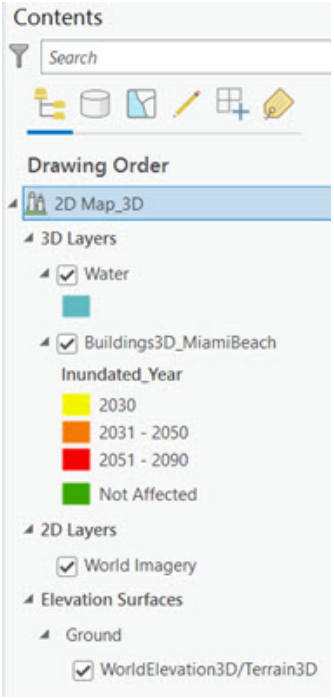
Now that your analysis is complete, you want to share the results as a web scene from ArcGIS Pro to ArcGIS Online. The city of Miami Beach encourages colleagues to collaborate through ArcGIS Online and therefore has asked you to share the web scene to your ArcGIS Online organization.

In this step, you will prepare your scene in ArcGIS Pro.

First, you will remove any layers from the Contents pane that you do not want in the web scene. Removing layers from the Contents pane does not delete the layers from your geodatabase—your data is still stored in the project's geodatabase in ArcGIS Pro. However, removing layers from the Contents pane prevents them from being published to ArcGIS Online, thereby avoiding storing unnecessary data layers in ArcGIS Online.

a In the Content pane, right-click Buildings2D_MiamiBeach and choose remove.

b Remove all three sea level rise data layers.



*Step 6b***: Share a web scene to ArcGIS Online.*

You are ready to share your scene as a web scene.

c Save your project.

d On the ribbon, click the Share tab and, in the Share As group, click Web Scene.

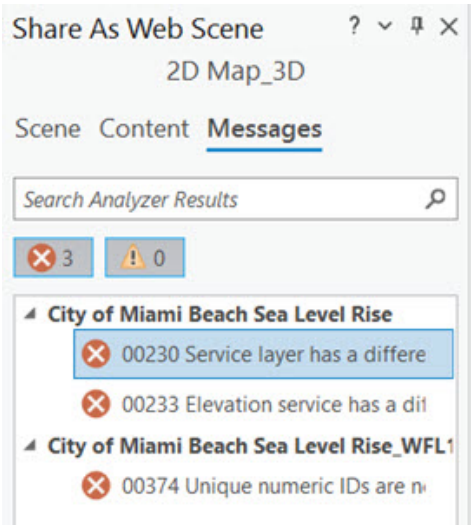
Note: MOOC participants will be sharing their scenes to the same ArcGIS Online organization. Therefore, you must give your web scene a unique name by adding your full name to the web scene name; for example, City of Miami Beach Sea Level Rise_StudentName.

e Complete the item details using the following information:

- For Name, type **City of Miami Beach Sea Level Rise_<your first and last name>**.
- For Summary, type **A 3D scene of buildings in Miami Beach.**
- For Tags, type **Miami Beach, Sea level rise, Climate-related hazards**.
- For Folder, leave the default.
- For Share With, check Everyone.

When sharing content to ArcGIS Online, it is a best practice to fill out the item details with as much information as possible.

f Click Analyze.



*Step 6f***: Share a web scene to ArcGIS Online.*

Three errors appear, including two regarding the need to update the coordinate system that the scene is projected to. You will resolve the errors now.

g Right-click the 00230 error and choose Update Map To Use Basemap's Coordinate System.

h Right-click the 00374 error and choose Auto-Assign ID's Sequentially.

i Click Analyze.

You have resolved the errors and may continue with sharing.

j Click Share.

Note: It may take a few minutes to share your web scene.

You have created a scene in ArcGIS Pro and shared it to ArcGIS Online. By sharing your scene to ArcGIS Online, you have created a web scene that can be used to create a web app.

k Save your project and close ArcGIS Pro.

In this exercise, you explored creating, using, and symbolizing 3D data. You completed a spatial analysis that created a 3D model of the city of Miami Beach and identified buildings that would be affected by sea level rise. This analysis will aid designs for a more resilient future for Miami Beach.