Cartography. MOOC

Exercise

Mapping Terrain in 3D

Section 5 Exercise 1

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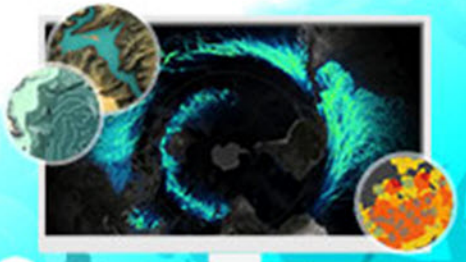


Mapping Terrain in 3D

Instructions

Use this guide and ArcGIS Pro to reproduce the results of the exercise on your own.

Note: The version of ArcGIS Pro that you are using for this course may produce slightly different results from the screenshots you see in the course materials.

Time to complete

Approximately 25-30 minutes.

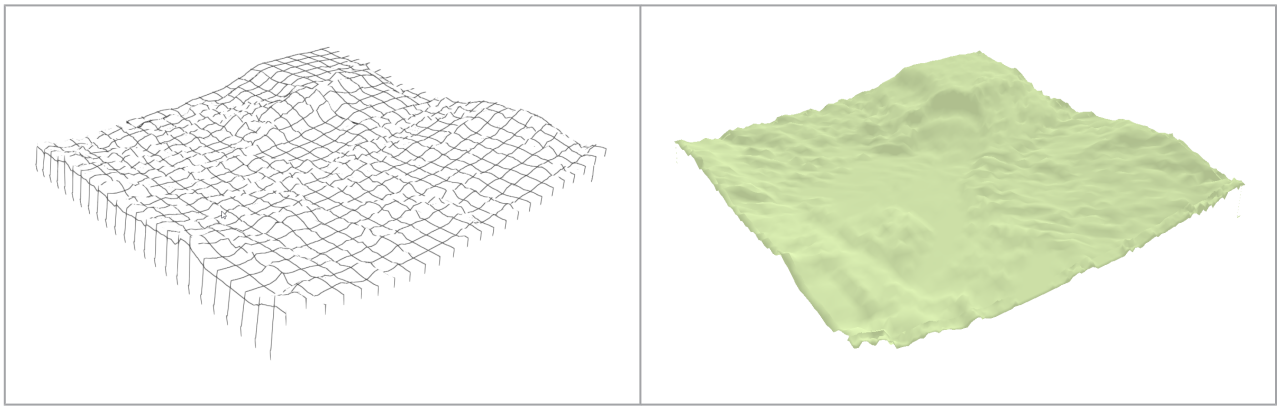
Software requirements

ArcGIS Pro 2.1

Introduction

Maps are representations of reality and include information to enhance your understanding of the world around you. Although they can incorporate the third dimension through contours, hillshading, and profile view elements, maps are ultimately limited in how much vertical information they can convey. In cases where the vertical axis is important, ArcGIS Pro includes the ability to view spatial relationships in a 3D scene, which is another term for a 3D map. In this exercise, you will learn about several important concepts and techniques to be aware of when authoring a 3D map.

Elevation surface layers are an integral component of a 3D view. They represent height values at every point across their extent, and they are often used to provide height values for other content in the map. You define elevation surfaces (https://bit.ly/2FC33ak) as part of the map, and then layers in the map can use them as needed.



The most common elevation surface in a map is "the ground." Other examples of real-world physical surfaces include underground geological strata and the ozone layer. You can also create thematic surfaces based on numerical values, including things like heat, property values, or crime statistics. It is also possible to create multiple surfaces through time, such as before and after a key event, which is the use case that you will be working through in this exercise.

What will you learn?

In this exercise, you will learn several things:

- The different kinds of surfaces you might deal with
- How to author multiple surfaces for a 3D map
- How to assign a specific surface to 2D content so it renders in 3D
- Tips and tricks for creating an interactive 3D view that uses elevation content to communicate

Exercise scenario

On the morning of March 22, 2014, there was a mudslide (https://bit.ly/23yUKql) near the town of Oso in the state of Washington, USA. The mud engulfed nearly 50 homes, dammed the Stillaguamish River, blocked State Route 530, and took the lives of 43 people. As you can imagine, the difference in the topography (https://bit.ly/2Hd3zR6) after this event was tremendous.

You will be exploring this change in a 3D map using two sets of ground elevation data and aerial imagery: one pair for the "before" state and another pair for the "after" state.

We are only interested in a small area-of-interest, and we want to view our content in a projected coordinate system, so we will use a "local" scene – which draws content in a planimetric 3D view - for this exercise.

Where possible, it is best practice to view your content in either its native coordinate system or a coordinate system that maintains an important property of your content, such as area or distance. In this case, you will view the imagery in its native State Plane coordinate system (https://bit.ly/2HrM6SP).

Step 1: Download the exercise files

In this step, you will download the exercise files.

a. Open a new web browser tab or window.

b. Go to https://bit.ly/2Hbtys9, and download the exercise ZIP file.

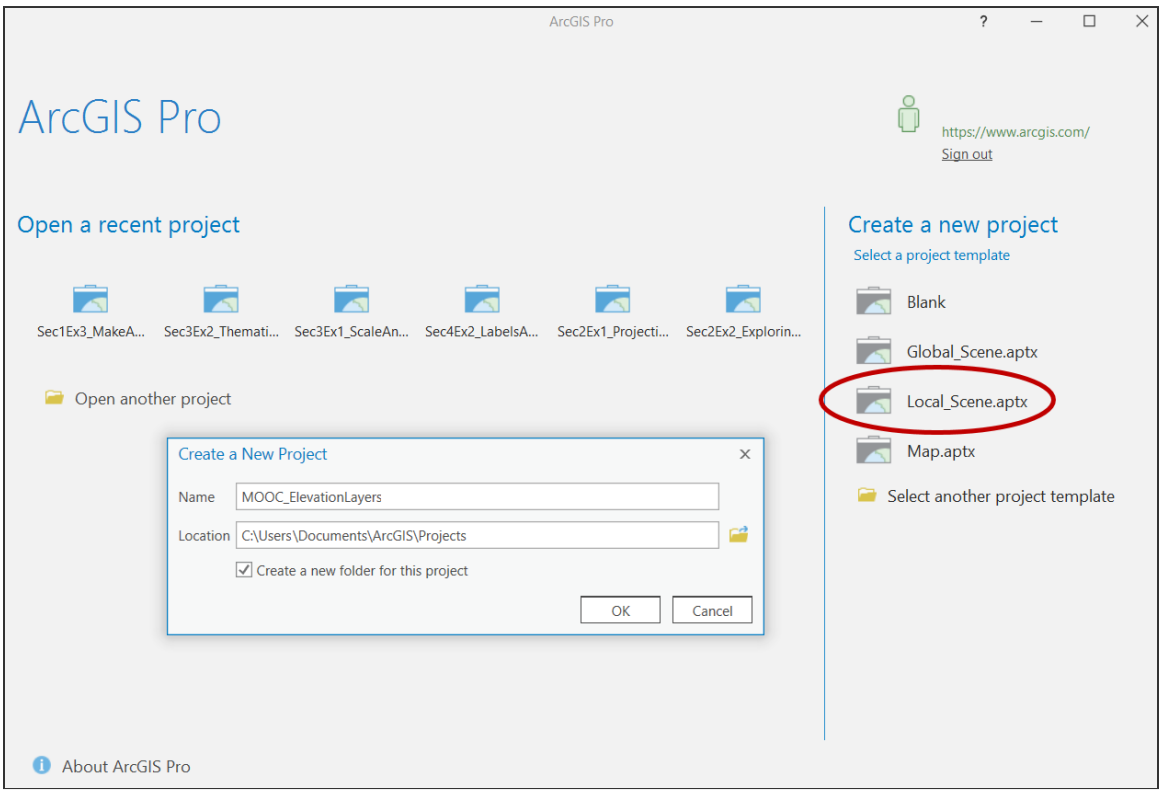
c. Extract the files to a folder on your local computer, saving them in a location that you will remember.

Step 2: Create a new map

a. Start ArcGIS Pro and create a new ArcGIS project, based on the Local_Scene project template.

Hint: From the main ArcGIS Pro window, in the Create A New Project area, click Local_Scene.aptx. Or, from within ArcGIS Pro, click the Project tab, and then click Local_Scene.aptx to create a new project based on the Local Scene project template.

b. Save the project as **MOOC_ElevationLayers** in the folder on your computer where you are saving your work.



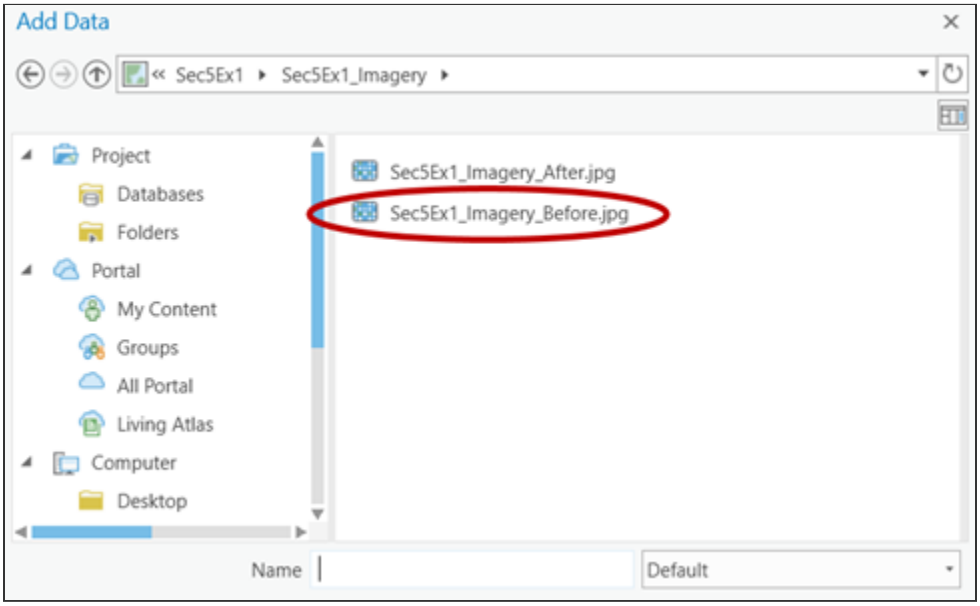
Step 3: Add imagery to a scene

ArcGIS Pro includes the ability to "tilt up" your 2D map and view spatial relationships in a 3D scene. This makes the data more understandable and helps reveal new insights in the process. To gain an understanding of the area around Oso, Washington, that was affected by the mudslide, you'll add some imagery of the area from before the mudslide.

a. From the Map tab, in the Layer group, click the Add Data down arrow and choose Data.

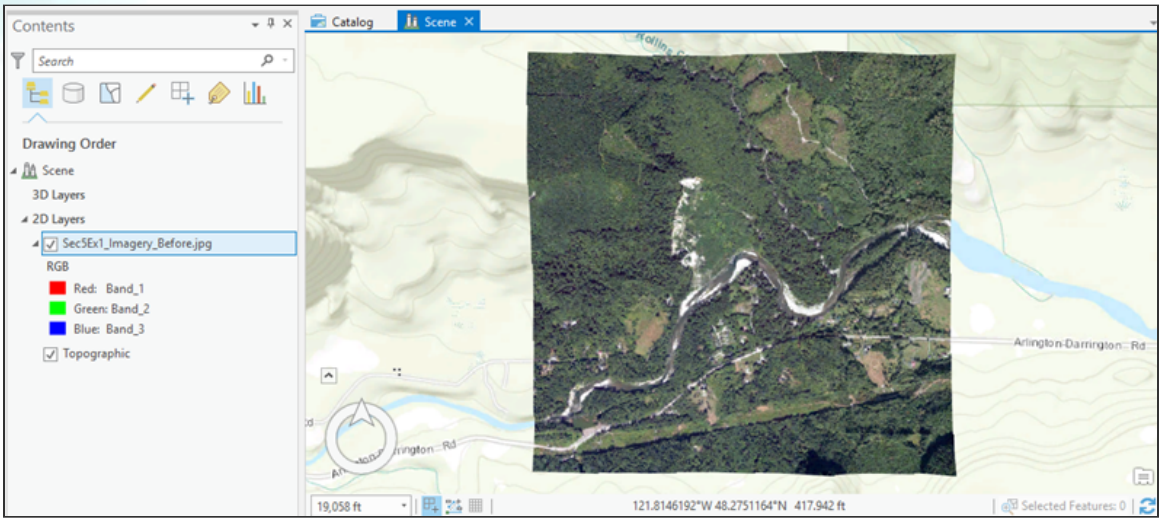
b. In the Add Data dialog box, browse to the location where you extracted the contents of the exercise ZIP file.

c. Open the Sec5Ex1_Imagery folder and select the Sec5Ex1_Imagery_Before.jpg file.



This file depicts how the area of interest looked before the mudslide.

d. Click OK to close the Add Data dialog box.



The scene is still being rendered with basemap content off into the distance, so the small swatch of imagery looks a little out of place. Let's clip (https://bit.ly/2qmcdTM) the scene down to our data area.

Step 4: Clip a scene to a data area

You can clip the visible area of a local scene to a limited extent. The extent can be manually typed in, calculated from the current view point, or imported from a layer in the scene. You will use the last method to limit the view to the data extent.

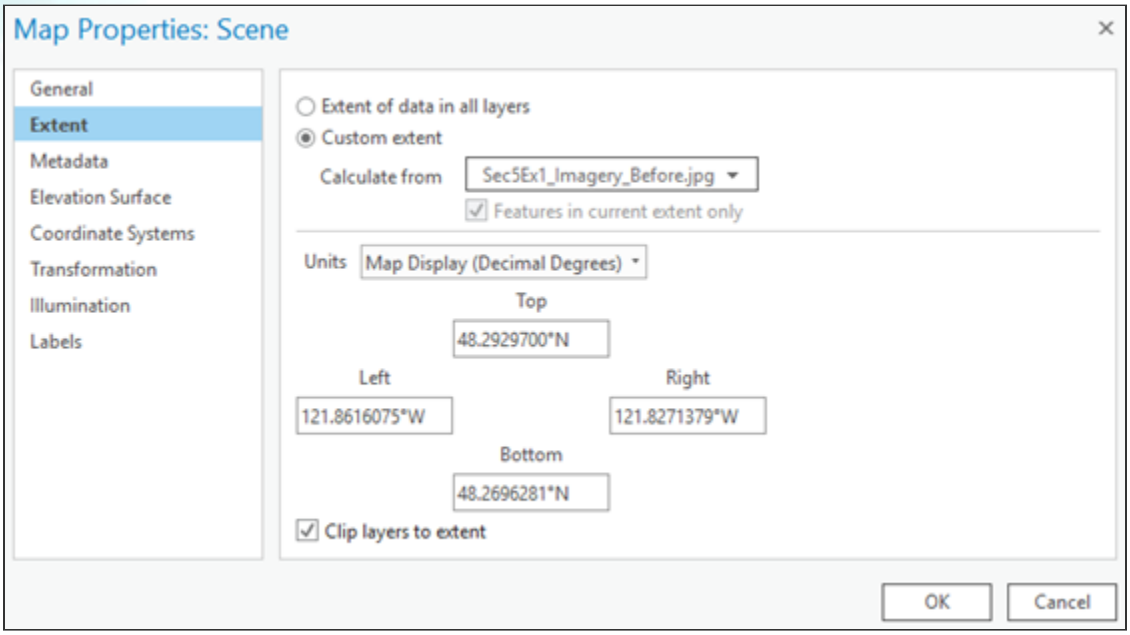
a. In the Contents pane, right-click Scene and choose Properties.

b. Click the Extent tab, and then choose the Custom Extent option.

c. For Calculate From, choose Sec5Ex1_Imagery_Before.jpg from the drop-down list.

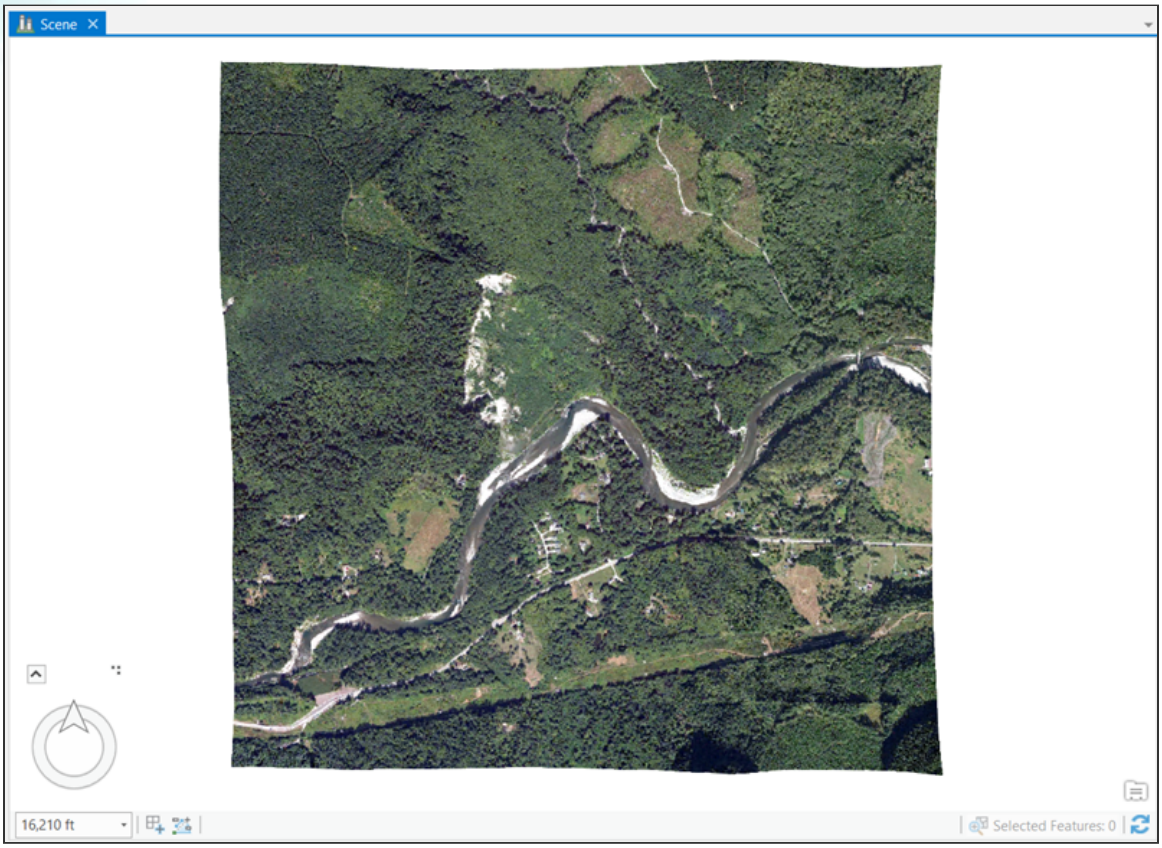
d. Set Units to Map Display.

e. At the bottom of the window, check the Clip Layers To Extent box.



f Click OK to apply the changes.

The basemap is hidden, and only the imagery layer is now visible in the scene.



g. In the Contents pane, turn off the Topographic basemap layer.

Step 5: Navigate a view

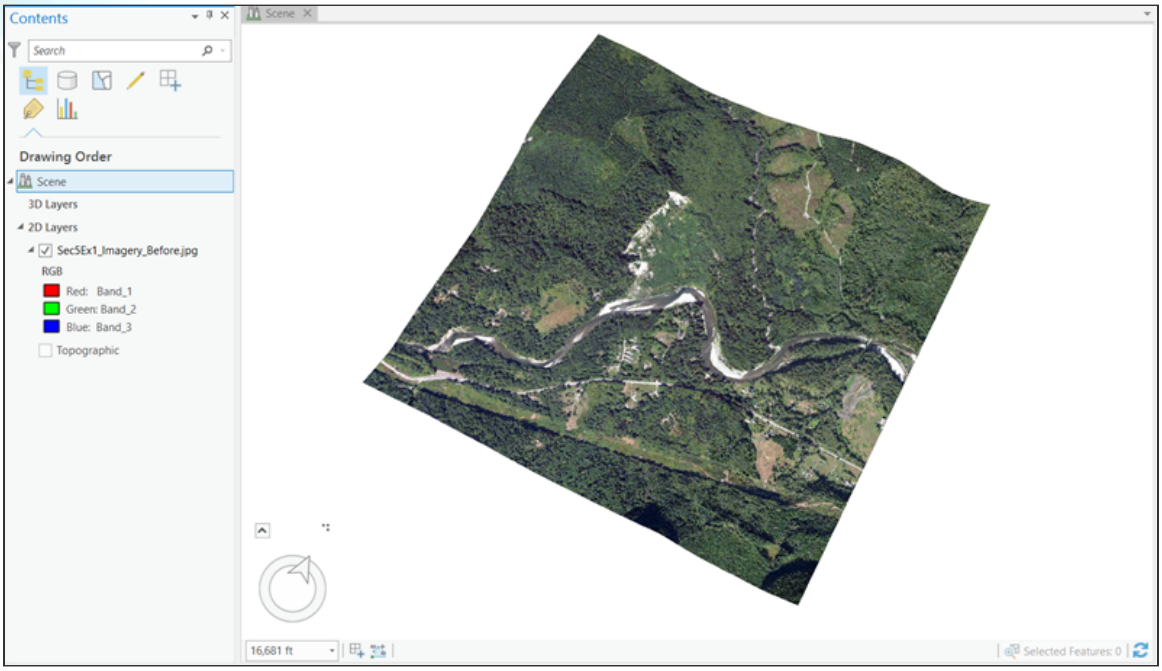
You can explore the area of interest by navigating around the view using the Explore tool, which is active by default.

a. Right-click in the view, hold the button down, and drag down to zoom in.

b. Click the middle mouse button (the scroll wheel on a two-button mouse), hold it down, and move the mouse around to rotate the view.

c. Click in the view, hold the button down, and move around to pan.

Note: Refer to ArcGIS Pro help for more information about navigation in ArcGIS Pro (https://bit.ly/2Jy0aLb). You can also use the on-screen Navigator control (https://bit.ly/2Hdd3vK).



Note that the ground and the imagery don't fully complement each other; the ground is too smoothed out and simple to properly match the higher-resolution imagery. This is because the only elevation surface in the scene is the default global service, which has a resolution between 10m x 10m and 30m x 30m per cell. This means that, best case, there is a single elevation value for almost 1,000 square feet of area.

Step 6: Add a DEM of the area of interest before the mudslide

For the data to more accurately reflect the real world, you will add a higher resolution data source known as a DEM.

The DEM (https://bit.ly/2EBTMP4) portion of the data source name stands for "digital elevation model." This type of elevation content captures the underlying "bare-earth" terrain of the surface and excludes elements above the ground, such as structures and trees. This type of elevation layer is also sometimes referred to as a DTM (digital terrain model).

A DEM is useful for many analytical workflows, such as calculating the flow direction of rainfall runoff or revealing the elevation profile for a walking trail. A DEM surface also often acts as a foundation surface upon which other features can be placed.

a. In the Contents pane, right-click the Scene at the top of the list and choose Properties.

b. In the Map Properties dialog box, if necessary, click the Elevation Surface tab.

c. Expand the Elevation Sources category.

d. Click Add Elevation Source.

e. Browse to the location where you extracted the exercise ZIP file, open the Sec5Ex1_MappingTerrain_Data folder and open the Sec5Ex1_Oso_Landslide_Data.gdb.

f. Select the DEM3ft_Before item.

g. Click OK to choose the data source, and then click OK to close the dialog box.

h. Navigate around the view, and note how the elevation and imagery align much better, especially along the river's edge and in locations without trees.

Hint: Use the Explore tool for scene navigation. Hold down the wheel button on your mouse and drag to tilt your view or rotate around the point you clicked.

When making a 3D map, you usually require additional 3D vector content (such as buildings, trees, and power poles) that stick up from your bare-earth surface to make it more complete. If you don't have that kind of additional data, you might be able to use a DSM elevation layer instead.

A DSM (https://bit.ly/2Eyafnz), or "digital surface model," is a different kind of elevation layer than the DEM. It captures everything into the surface, including elements above the ground, and thereby includes real-world obstructions. These obstructions would have an impact on

visibility, shadows, and proximity analysis. From a certain viewing distance, it represents a more true-to-life surface. This approach is generally less effective when viewed closer to the surface, though, as limitations with data resolution and vertical walls become apparent.

For this scene, though, you intend to keep a reasonable viewing distance, so a DSM is an option you can use.

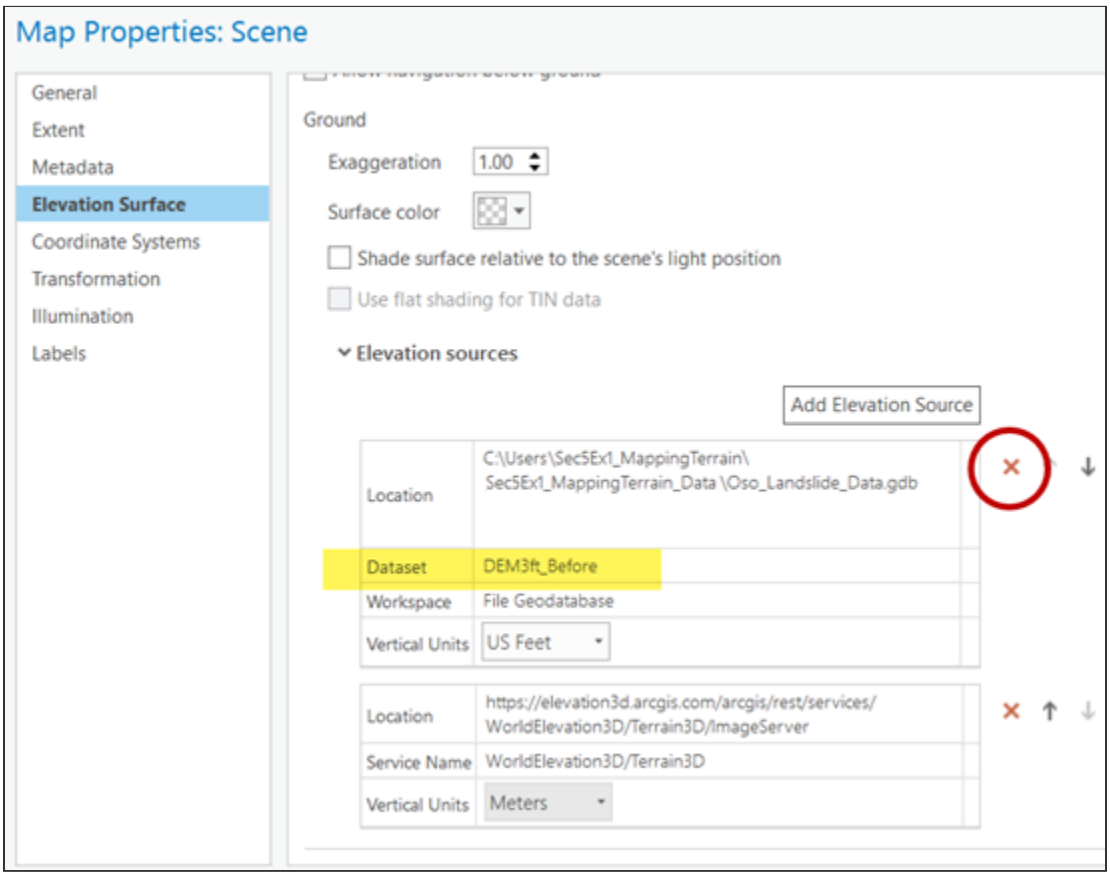
Step 7: Add a DSM elevation layer

For the ground surface, you will replace the DEM data source with the DSM data source.

a. In the Contents pane, right-click the Scene and choose Properties.

b. In the Map Properties dialog box, from the Elevation Surface tab, expand the Elevation Sources category.

c. Next to the DEM3ft_Before data source that you added earlier, click the red "x" to remove it.



Now, you will add the DSM data source.

d. Click Add Elevation Source.

e. Browse to the location where you extracted the exercise ZIP file, open the Sec5Ex1_MappingTerrain_Data folder and open the Sec5Ex1_Oso_Landslide_Data.gdb.

f. Select the DSM3ft_Before item.

g. Click OK to choose the data source, and then click OK to close the dialog box.

h. Navigate around the view, and note how the surface has become more extreme now that above-ground features have been incorporated into the surface.

i. Zoom in close to the surface to see its limitations.

j. Zoom back out again to see it in a more visually pleasing way.

The content now looks more realistic. This is the "before" state of the 3D map, where the houses on the small peninsula and their surrounding trees look idyllic.

All of that changed on March 22, 2014, at 10:37AM.

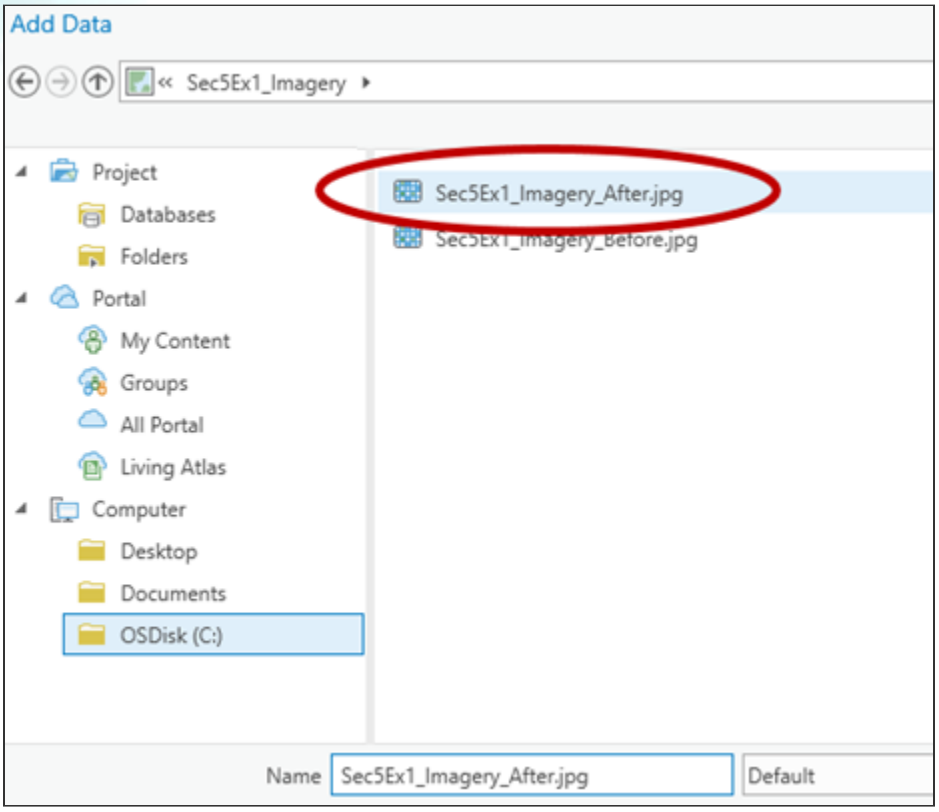
Step 8: Create a second surface to represent the ground after the mudslide

To further enhance the 3D scene, you will add aerial imagery for this area from after the mudslide. You need two surfaces: one for the "before" state of the terrain and one for the "after" state.

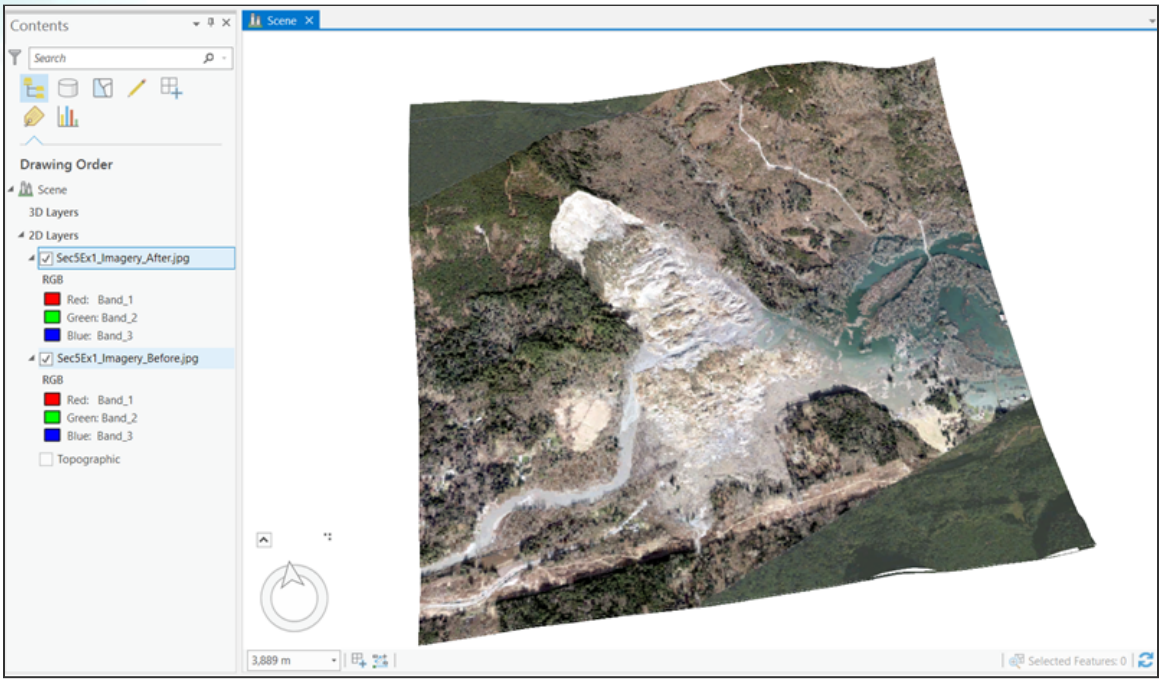
a. From the Map tab, in the Layer group, click Add Data.

b. Browse to the location where you extracted the exercise ZIP file, and open the Sec5Ex1_Imagery folder.

c. Select the Sec5Ex1_Imagery_After.jpg file, and click OK to close the dialog box.



At the top of the 2D Layers in the Contents pane, you can now see the "after" imagery. By default, the new imagery layer will be drawn on the ground surface (that is, on top of the "before" elevation surface). As you can tell from the imagery, that is no longer an accurate representation of the ground. You need a separate and distinct surface for the post-mudslide elevation. To correct this, you will create a new surface for the "after" state.



Note: You may need to zoom out to see the full imagery layer.

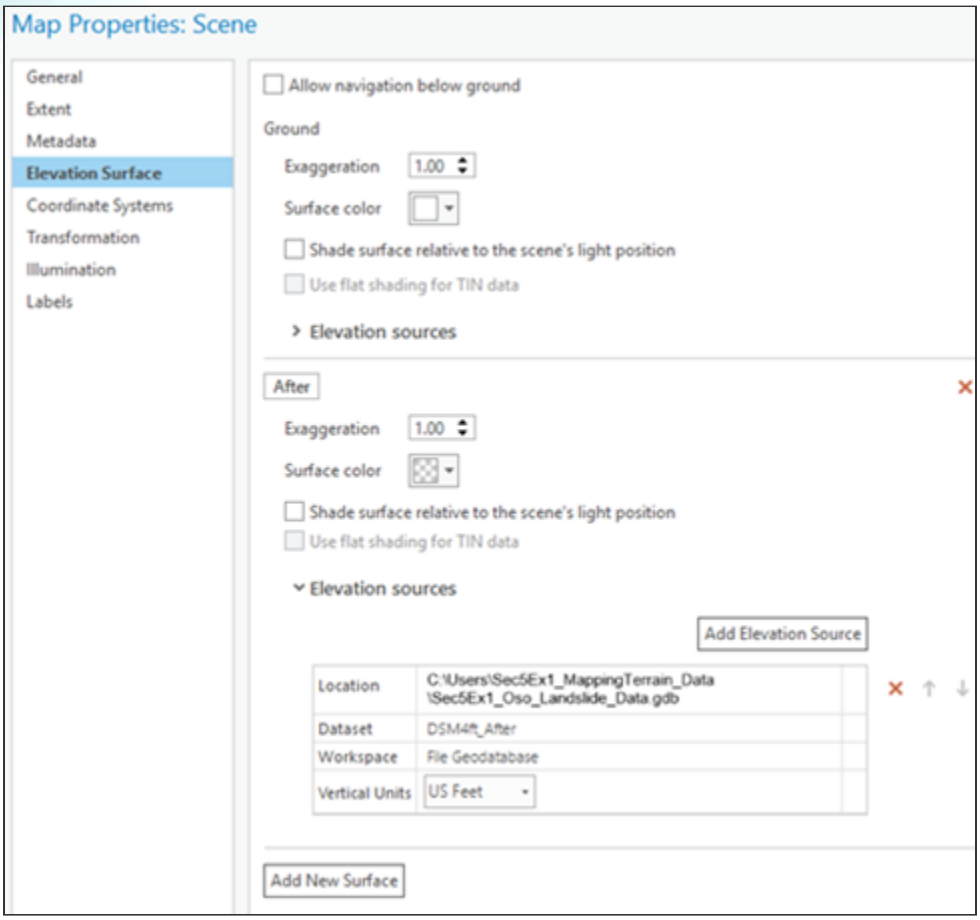
d. In the Contents pane, right-click Scene and choose Properties.

e. In the Map Properties dialog box, from the Elevation Surface tab, click Add New Surface.

f. Rename the surface from Surface 1 to **After**.

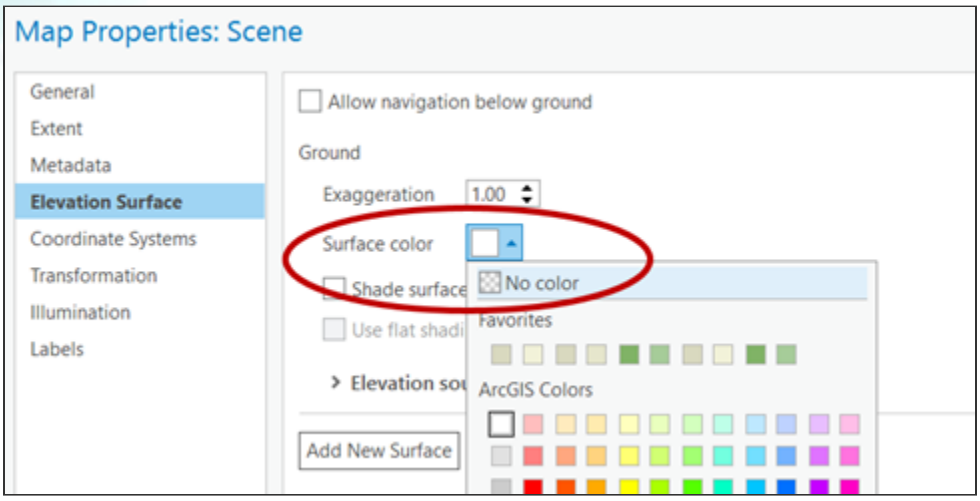
g. Expand the Elevation Sources category, and click Add Elevation Source.

h. Browse to the location where you extracted the exercise ZIP file, and in the Sec5Ex1_MappingTerrain_Data folder, open the Sec5Ex1_Oso_Landslide_Data.gdb, and then add DSM4ft_After.



Let's set the default surface color for the Ground to be transparent. This means that the elevation surface will not display a solid color on the ground, and you can focus solely on the overlaid aerial imagery.

- For the Ground, click the Surface Color down arrow, and in the color palette, choose No Color.



j. Click OK to close the Map Properties dialog box.

You will use the After surface for the "after" aerial image layer.

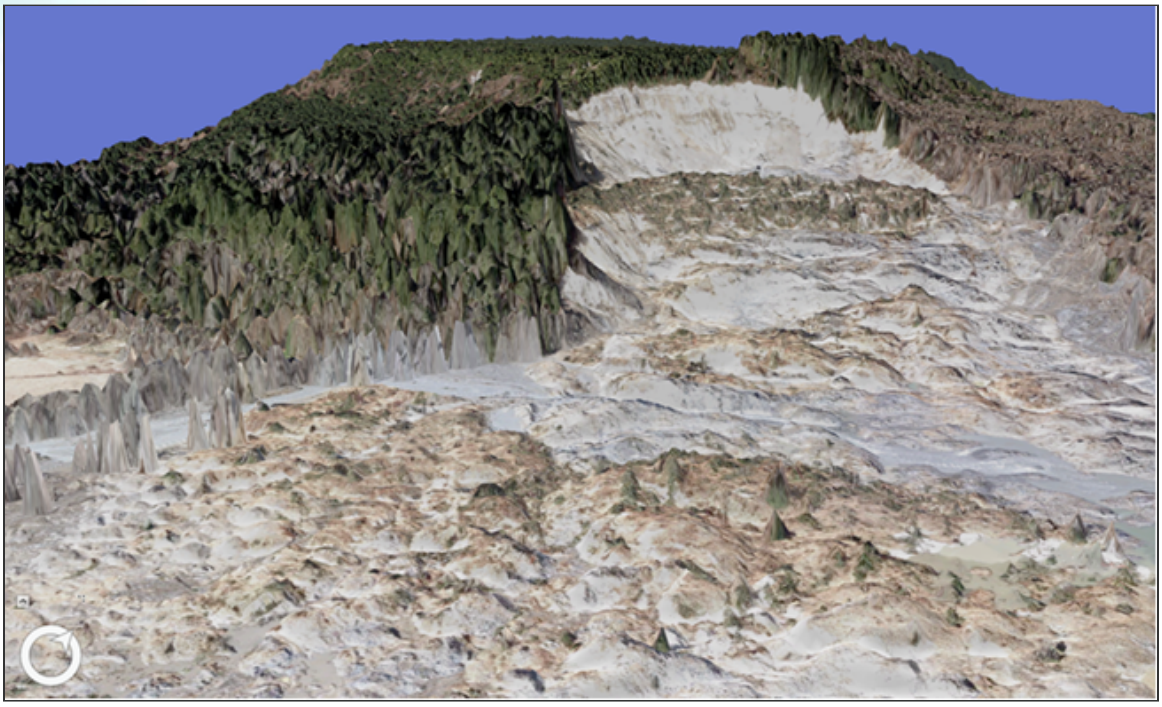
k. In the Contents pane, right-click the Sec5Ex1_Imagery_After.jpg layer and choose Properties.

l. In the Layer Properties dialog box, click the Elevation tab.

m. For Features Are, choose On Custom Elevation Surface from the drop-down list.

n. In the Custom Surface drop-down list, confirm that the After surface is selected, and then click OK close the Layer Properties dialog box.

o. In the Contents pane, turn off the Sec5Ex1_Imagery_Before.jpg layer.



The change is dramatic. The huge volume of the hillside that slipped away and the homes on the peninsula that were swallowed up by the mudslide are clearly shown with the updated imagery and elevation layers.

p Navigate around the view, and switch between the two layers to see the change.

Note: For comparison purposes, the final scene state is available in the map package (https://bit.ly/2rv0oKR) that is part of the data you downloaded at the beginning of the exercise. It is named Sec5Ex1_Final_OsoMudSlide_ProScene.mpkx. You can drag a map package from Windows Explorer and drop it on the Catalog pane to import it to a project.

q Leave ArcGIS Pro open for the next exercise.

Conclusion

In this exercise, you used different data sources to represent the ground surface of the scene. There were two types of surfaces—a bare-earth elevation surface and an above-ground elevation surface—that were captured at two distinct moments in time. By combining an elevation surface with a matching imagery layer, you were able to observe and understand how a natural disaster could catastrophically change the area's terrain.

Use the Lesson Forum to post your questions, observations, and map examples.

Learn More

- *Before and After the Hwy 530 Landslide* Application (https://bit.ly/1pBYWhF)
- Learn ArcGIS lesson *Oso Mudslide - Before and After* (https://bit.ly/2H9NICV)