Cartography. MOOC

Exercise

Mapping Terrain in 3D

Section 5 Exercise 1

05/2020

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 screen shots that you see in the course materials.

Time to complete

Approximately 30-40 minutes

Software requirements

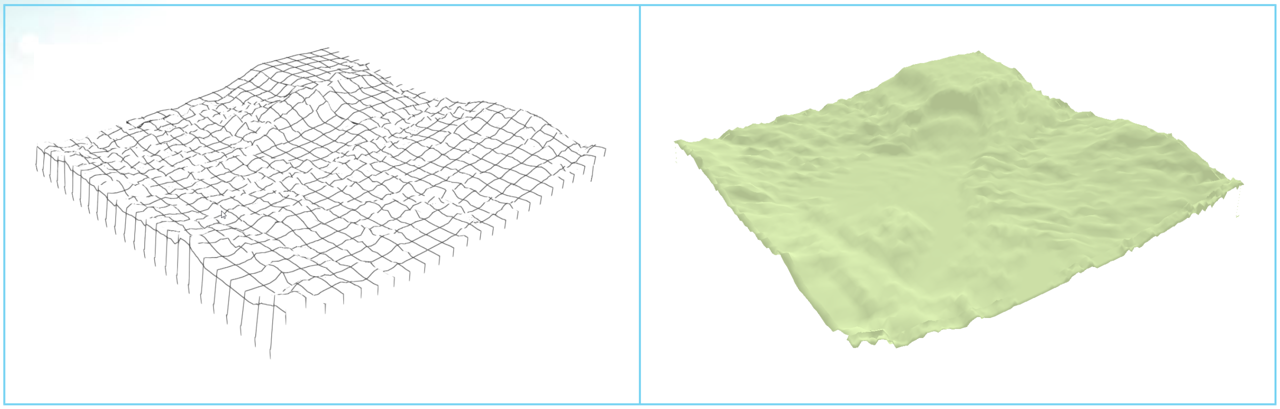
ArcGIS Pro 2.5
ArcGIS Pro Standard license (or higher)

Note: The MOOC provides a separate ArcGIS account (user name and password) that you will need to use to license ArcGIS Pro and access other software applications used throughout the MOOC exercises. This account (user name ending with _cart) provides the appropriate ArcGIS Online role, ArcGIS Pro license, ArcGIS Pro extensions, and credits. We strongly recommend that you use the provided course ArcGIS account to ensure that you have the appropriate licensing to complete the exercises. Exercises may require credits. Using the provided course ArcGIS account ensures that you do not consume your organization's credits. Esri is not responsible for any credits consumed if you use a different account. Moreover, Esri will not provide technical support to students who use a different account.

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 that 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," which represents the surface of the earth. 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, United States. 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 (the shape and arrangement of mountains, hills, valleys, and other features on the earth's surface) 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/2AAu4Om).

Step 1: Download the exercise data files

In this step, you will download the exercise data files.

a. Open a new web browser tab or window.

b. Go to https://bit.ly/2Lk5uDP and download the exercise data ZIP file.

Note: The complete URL to the exercise data file is https://www.arcgis.com/home/item.html?id=e90811068f024d3cb6dc8403e91f405a. The file is 208 MB.

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

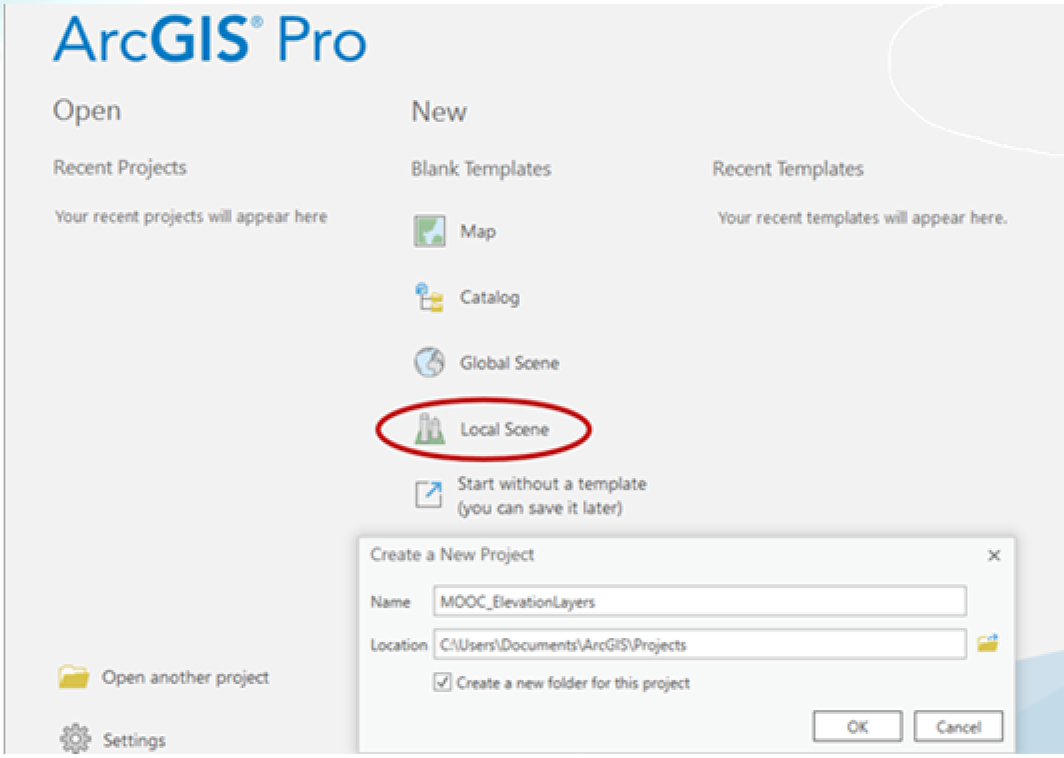
Step 2: Create a new map

You will start by creating a new ArcGIS Pro project based on a project template (https://bit.ly/2Ko6GTP).

a. Start ArcGIS Pro and, if necessary, sign in using your provided course ArcGIS credentials (user name ending with _cart).

b. From the main ArcGIS Pro start page, in the New section, under Blank Templates, click Local Scene.

c. In the Create A New Project dialog box, save the project as **MOOC_ElevationLayers** in the folder on your computer where you are saving your work.



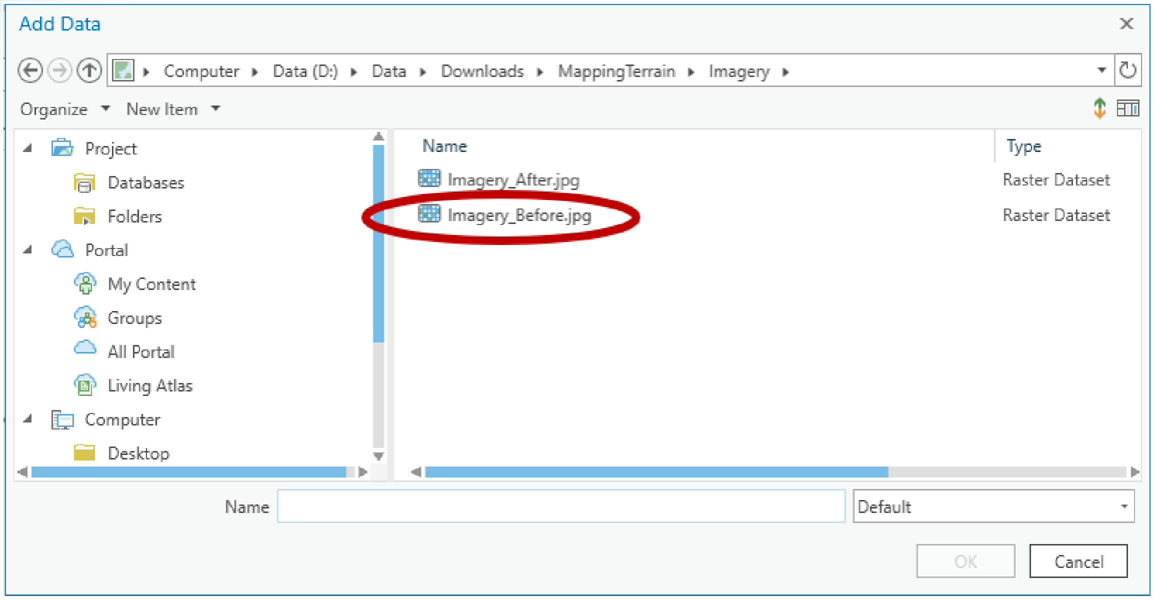
Step 3: Add imagery to a scene

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 will 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.

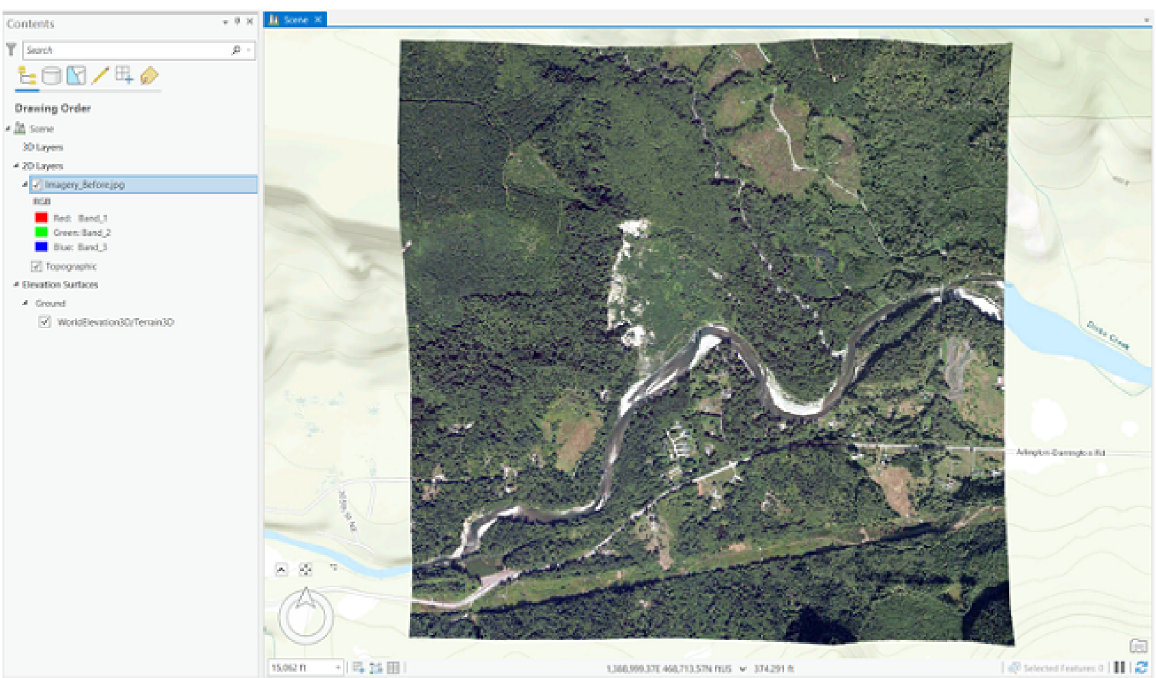
b. In the Add Data dialog box, browse to the location where you extracted the contents of the exercise data ZIP file.

c. Open the Imagery folder and select the 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 and add the data to your scene.

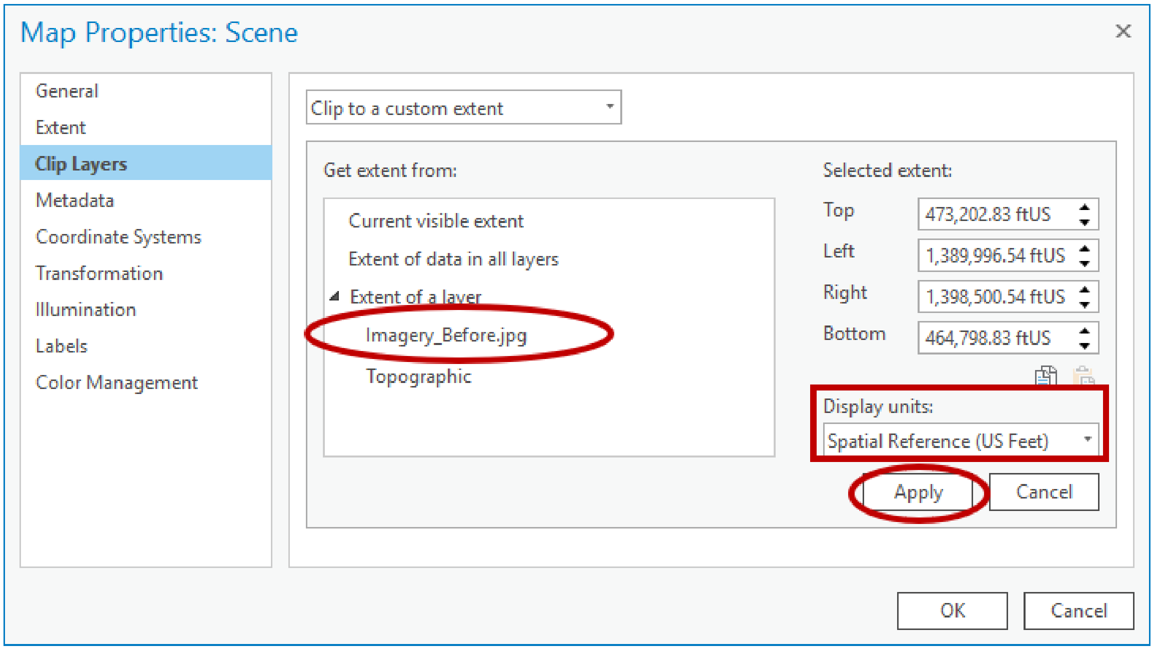


The scene is still being rendered with basemap content off into the distance, so the small swatch of imagery looks a little out of place. You will clip (https://bit.ly/2MijD36) the scene down to the data area.

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. For this exercise, 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. In the Map Properties dialog box, click the Clip Layers tab.
c. From the drop-down list, choose Clip To A Custom Extent.
d. For Get Extent From, under Extent Of A Layer, select Imagery_Before.jpg.
e. Ensure that Display Units is set to Spatial Reference (US Feet).
f. Click Apply.



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

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

h In the Contents pane, right-click the Topographic basemap layer and choose Remove.

Note: The Topographic basemap layer may also be called the World Topographic Map.

Step 5: Navigate a view

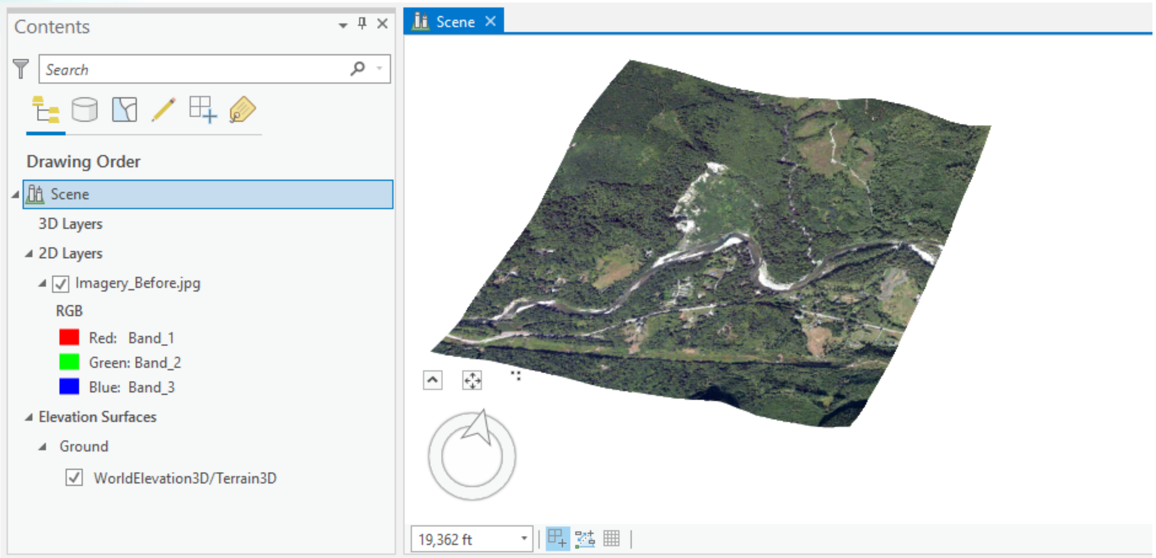
You can explore the area of interest by navigating around the view using the Explore tool, which is active by default.

a In the view, right-click, hold down the mouse button, 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 In the view, click and hold down the mouse button 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 do not 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.

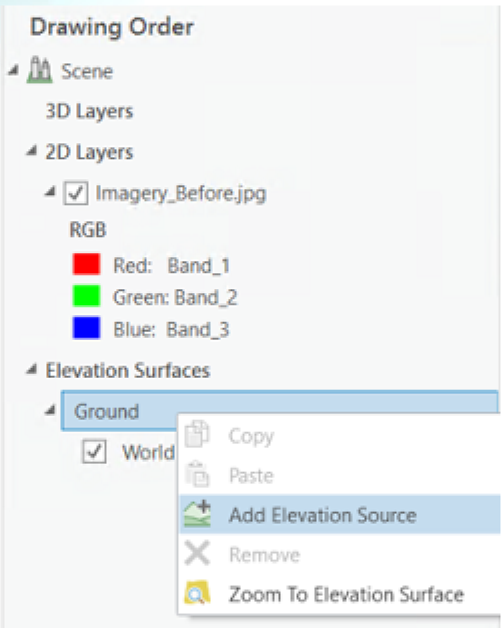
Step 6: Add a DEM of the area of interest before the mudslide

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/2YUeqlf) 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).

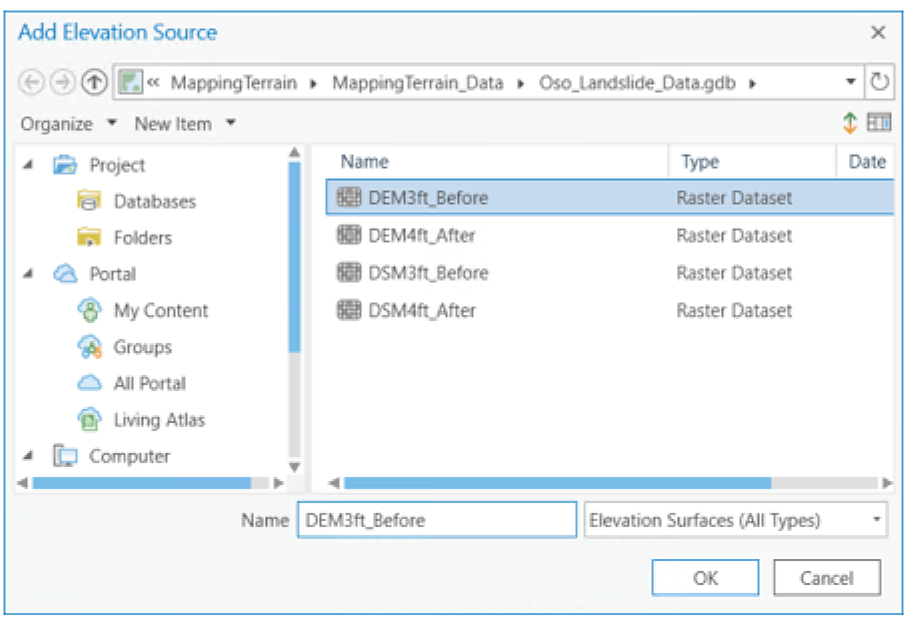
A DEM is useful for many analytical workflows, such as calculating the flow direction of rainfall runoff or revealing the elevation profile for a walking trail. A DEM surface also often acts as a foundation surface upon which other features can be placed.

a. In the Contents pane, in the Elevation Surfaces category, right-click Ground and choose Add Elevation Source.



b In the Add Elevation Source dialog box, browse to the location where you extracted the exercise data ZIP file and open the MappingTerrain_Data folder.

c Open Oso_Landslide_Data.gdb and select the DEM3ft_Before item.



d Click OK to select the data source and close the Add Elevation Source dialog box.

e Navigate around the view and notice 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. Click and hold down the mouse wheel button and drag to tilt your view or rotate around the point that 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 do not have that kind of additional data, you might be able to use a DSM elevation layer instead.

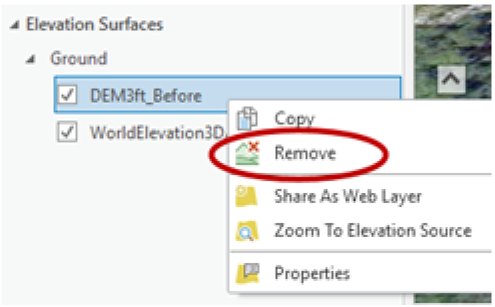
A DSM (https://bit.ly/2KmXUp4), or digital surface model, is a different kind of elevation layer than the DEM. It captures everything into the surface, including elements above the ground, and thereby includes real-world obstructions. These obstructions would have an impact on visibility, shadows, and 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 that 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.

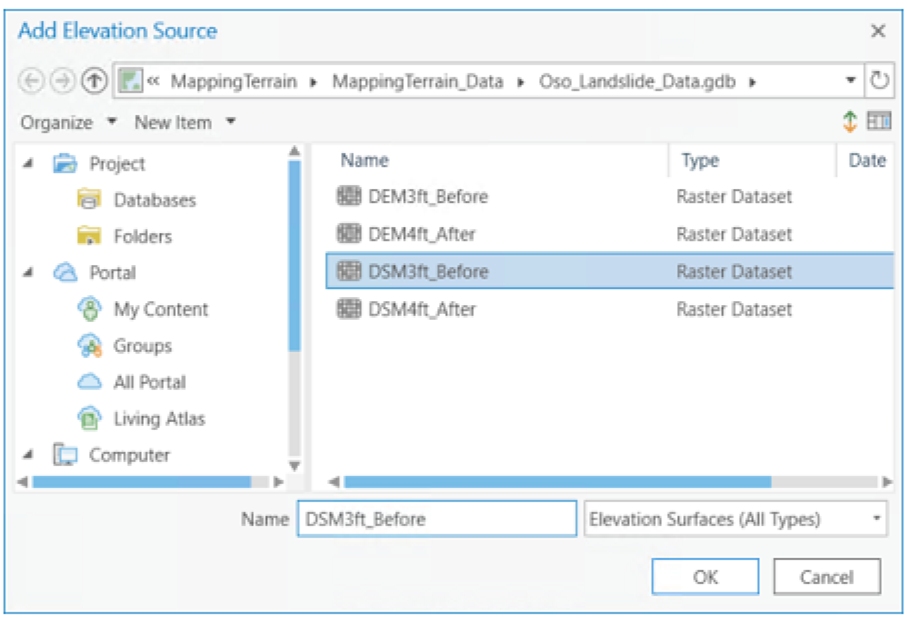
a In the Contents pane, in the Elevation Surfaces category, right-click DEM3ft_Before and choose Remove.



b Right-click Ground and choose Add Elevation Source.

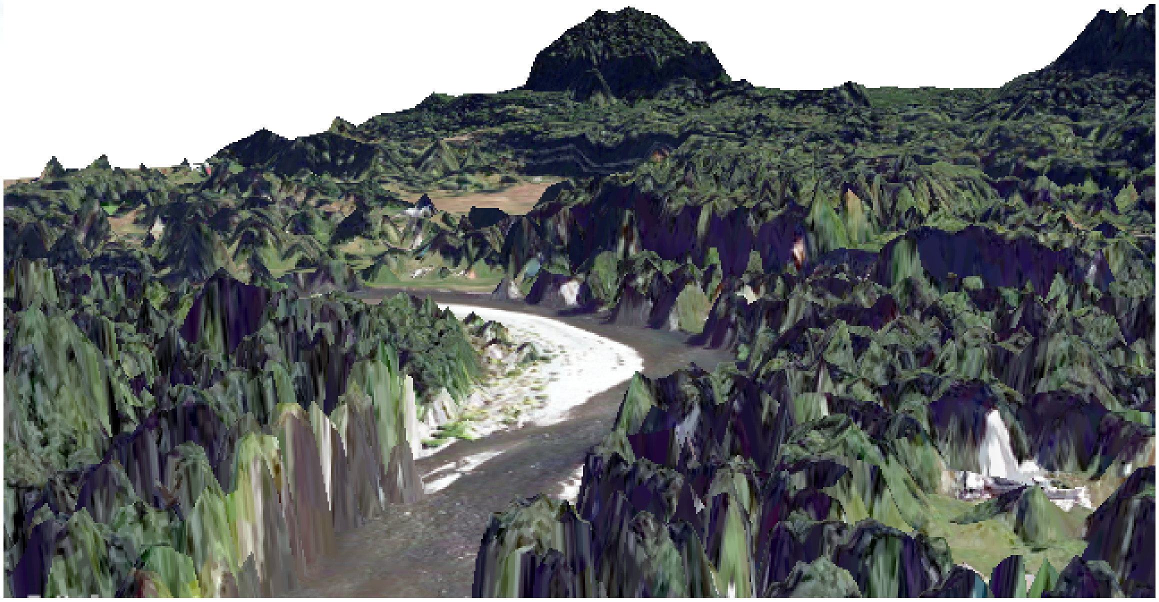
c If necessary, in the Add Elevation Source dialog box, browse to the location where you extracted the exercise data ZIP file and open the MappingTerrain_Data folder.

d Open Oso_Landslide_Data.gdb and select the DSM3ft_Before item.



e Click OK to select the data source and close the Add Elevation Source dialog box.

f Navigate around the view and notice how the surface has become more dramatic now that above-ground features have been incorporated into the surface.



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

h 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 10:37 a.m.

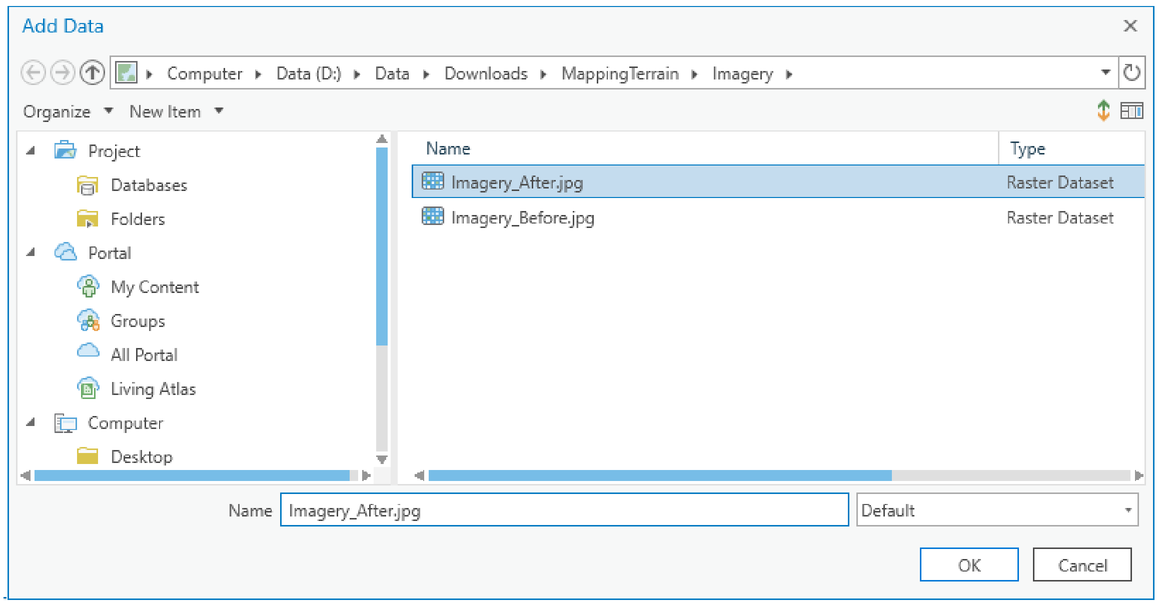
Step 8: Create a second surface to represent the ground after the mudslide

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.

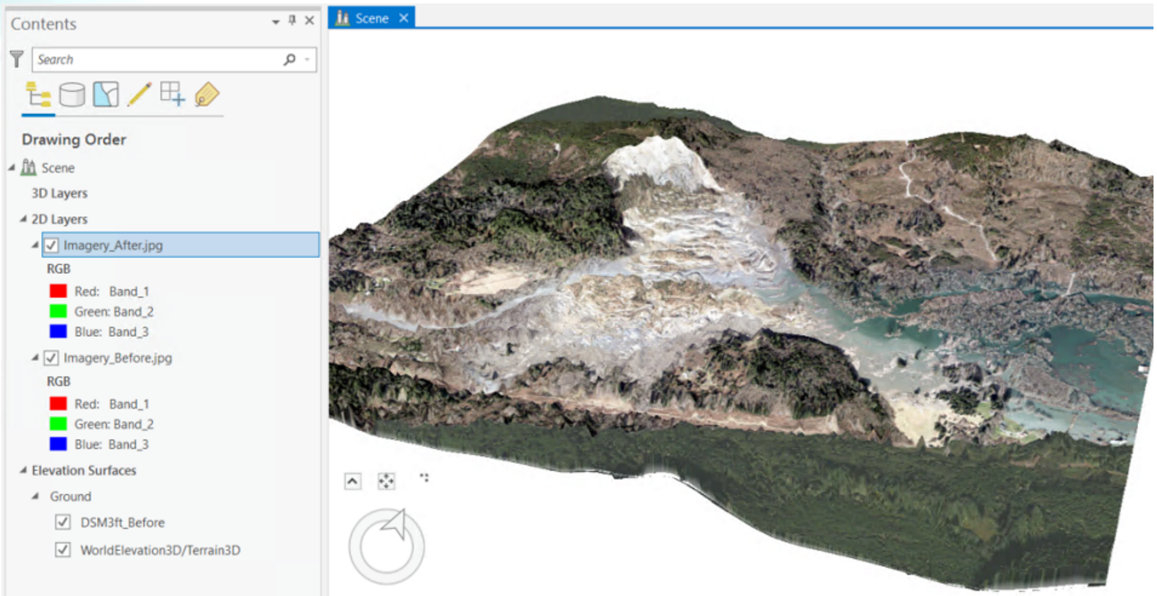
a. From the Map tab, in the Layer group, click Add Data.

b. Browse to the location where you extracted the exercise data ZIP file and open the Imagery folder.

c. Select the Imagery_After.jpg file and click OK to close the Add Data dialog box.

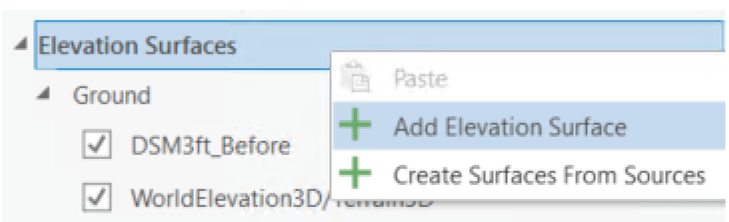


In the Contents pane, at the top of the 2D Layers category, you can now see the "after" imagery. By default, the new imagery layer will be drawn on the ground surface (that is, on top of the "before" elevation surface). As you can tell from the imagery, that is no longer an accurate representation of 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.

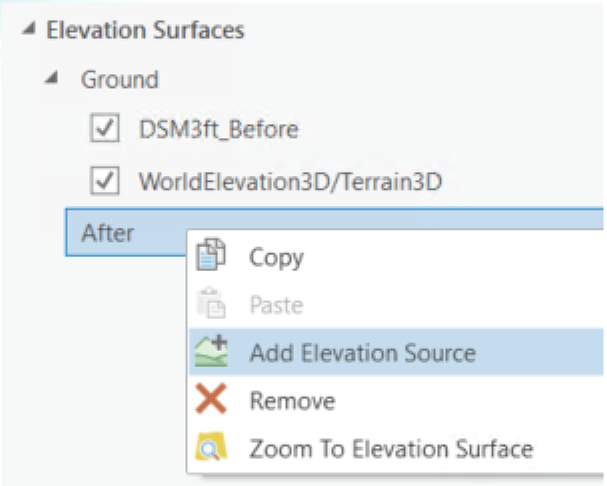
d In the Contents pane, right-click the Elevation Surfaces category and choose Add Elevation Surface.



e In the Contents pane, rename the surface from Surface 1 to **After**.

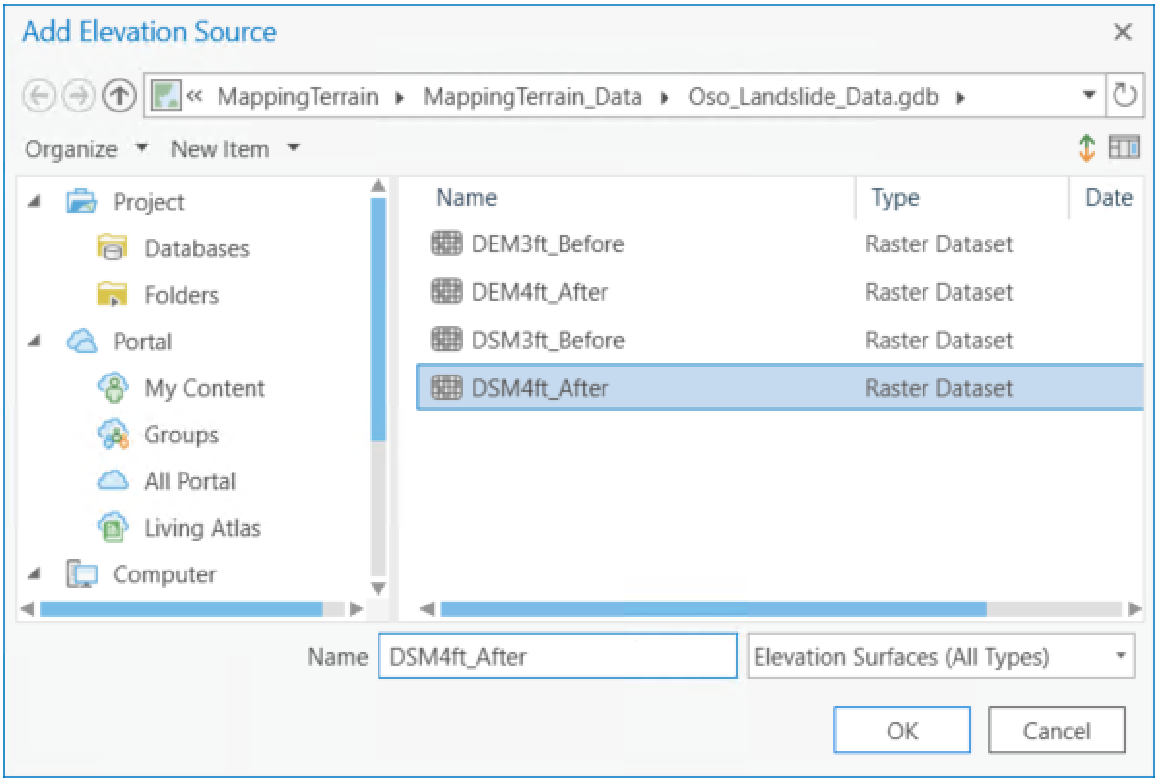
Hint: Press F2 to rename the surface.

f In the Contents pane, right-click After and choose Add Elevation Source.

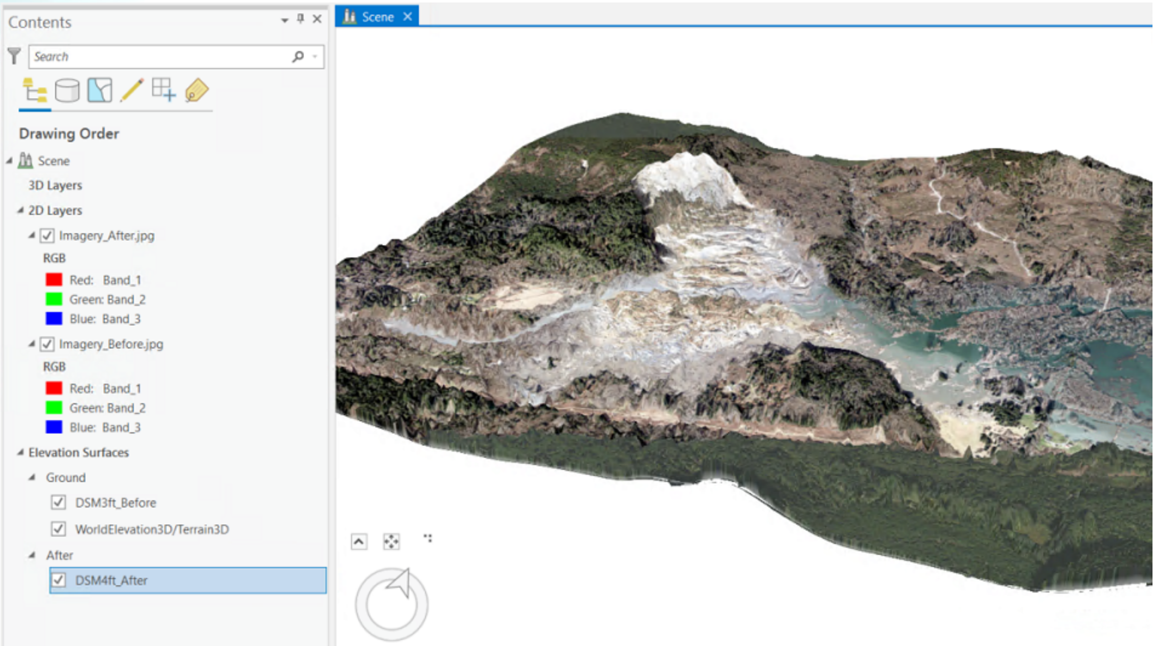


g. If necessary, browse to the location where you extracted the exercise data ZIP file, and then in the MappingTerrain_Data folder, open Oso_Landslide_Data.gdb.

h. Select the DSM4ft_After item.



i. Click OK to close the Add Elevation Source dialog box.

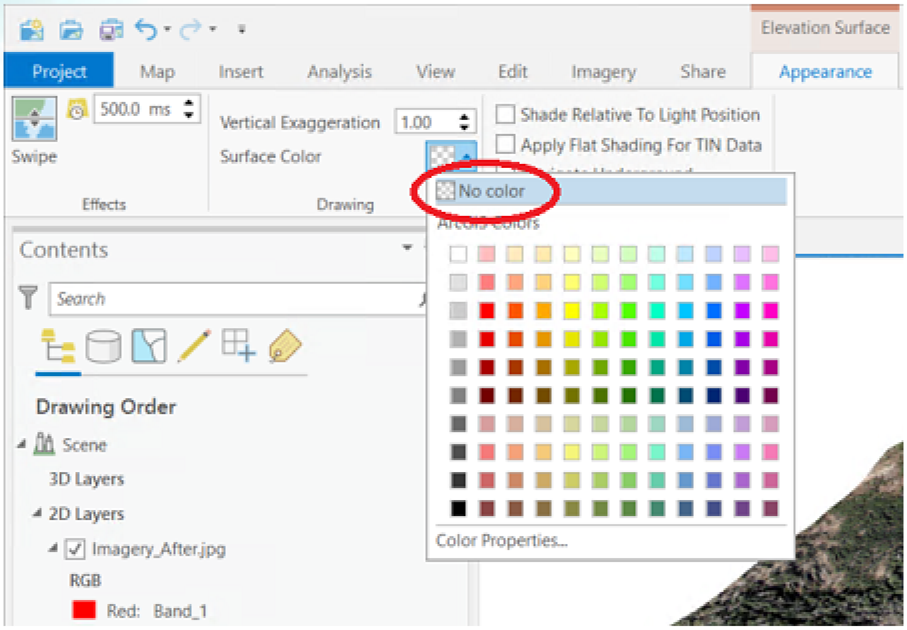


You will set the default surface color for the Ground to be transparent. This means that the elevation surface will not display a solid color on the ground, and you can focus solely on the overlaid aerial imagery.

j. In the Contents pane, in the Elevation Surfaces category, select Ground.

k. On the ribbon, click the Appearance tab.

l. In the Drawing group, click the Surface Color swatch to open the color palette and choose No Color.



This will ensure that the Ground surface will be fully transparent when no other layers—such as the Before imagery layer—are being draped and rendered on top of it.

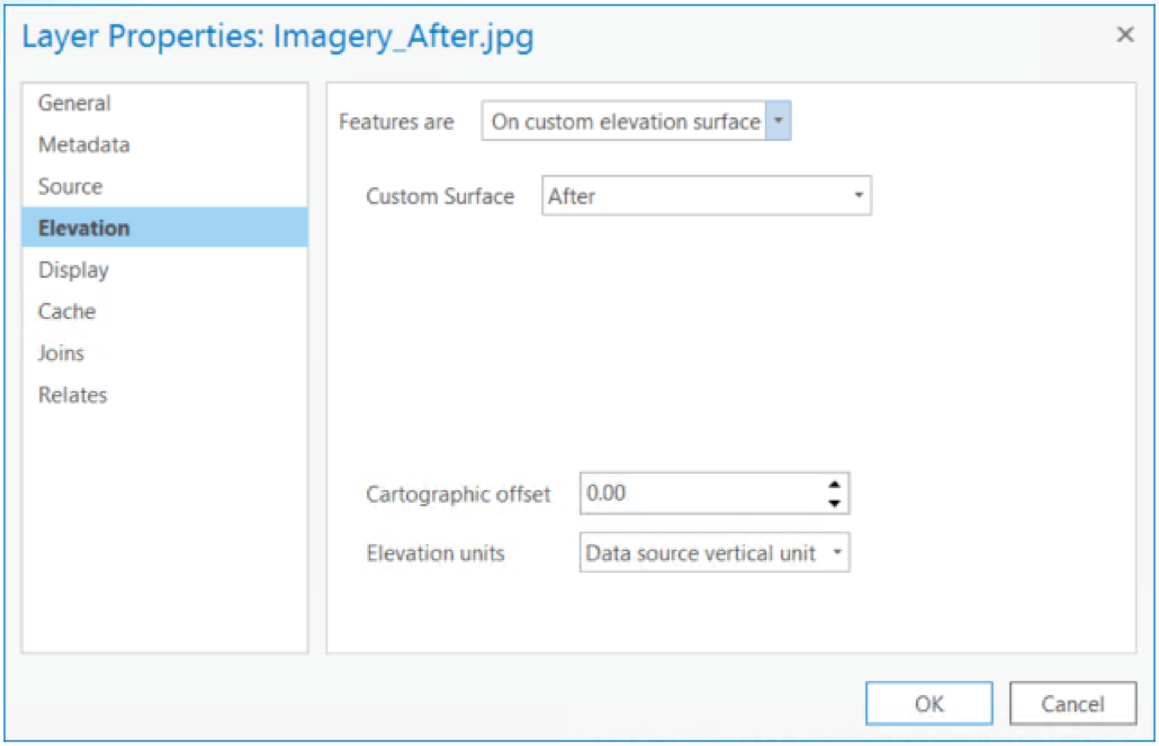
You will use the After surface as the elevation source for the "after" aerial image layer.

m In the Contents pane, right-click the Imagery_After.jpg layer and choose Properties.

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

o For Features Are, choose On Custom Elevation Surface.

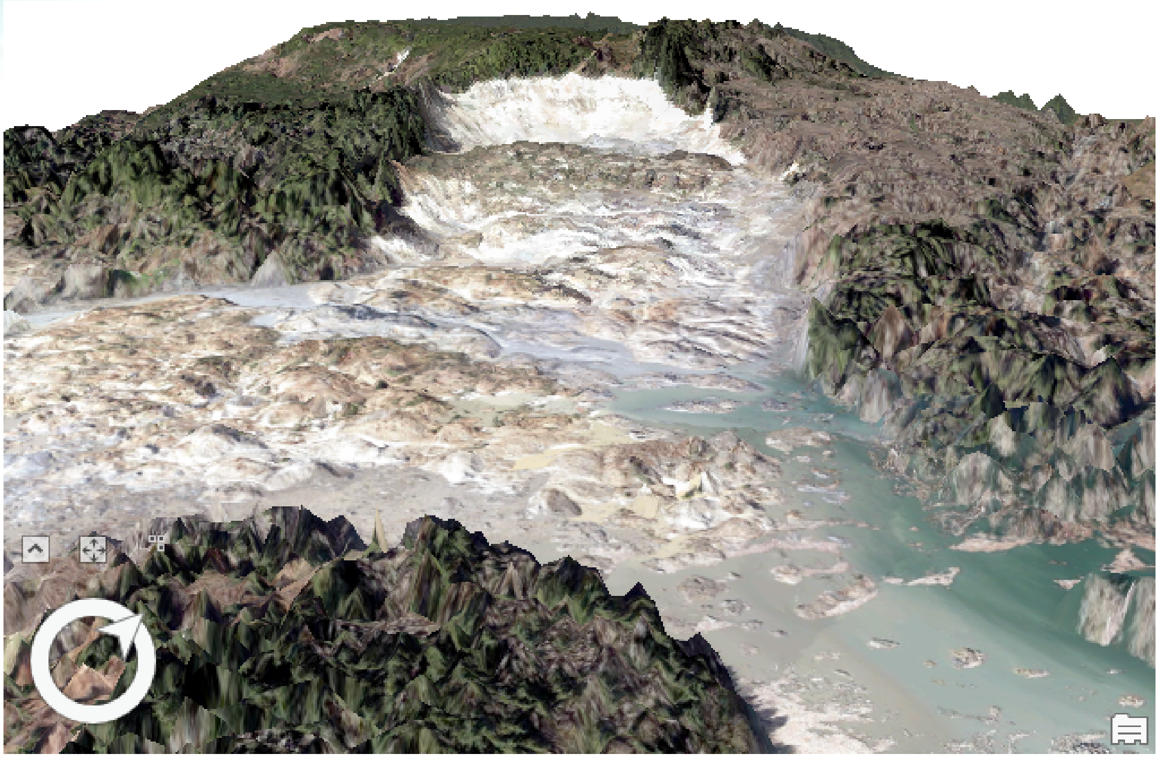
p For Custom Surface, confirm that the After surface is selected.



q Click OK close the Layer Properties dialog box.

r In the Contents pane, turn off the following:

- Imagery_Before.jpg layer
- DSM3ft_Before surface
- WorldElevation3D/Terrain3D surface



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.

s Navigate around the view and switch between the before and after layers and surfaces 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 that you downloaded at the beginning of the exercise. It is named Final_OsoMudSlide_ProScene.mpkx. You can drag a map package from Windows Explorer and drop it in the Catalog pane to import it to a project.

t Save your project and exit ArcGIS Pro.

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 and observations.

Learn More

- Learn ArcGIS lesson: *Oso Mudslide - Before and After* (https://bit.ly/2H9NICV)
- Before and After the Hwy 530 Landslide Application (https://bit.ly/2JQ6rTI)