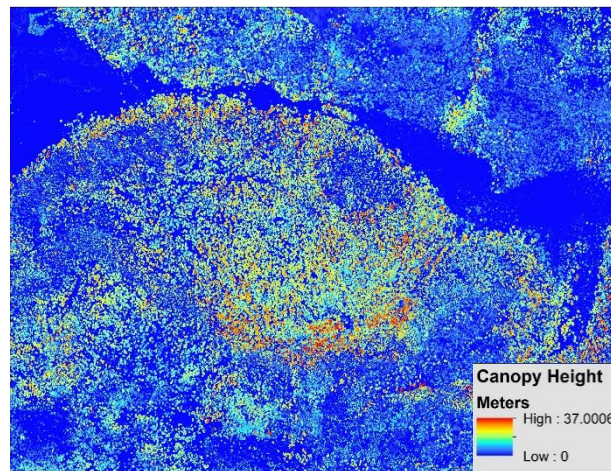
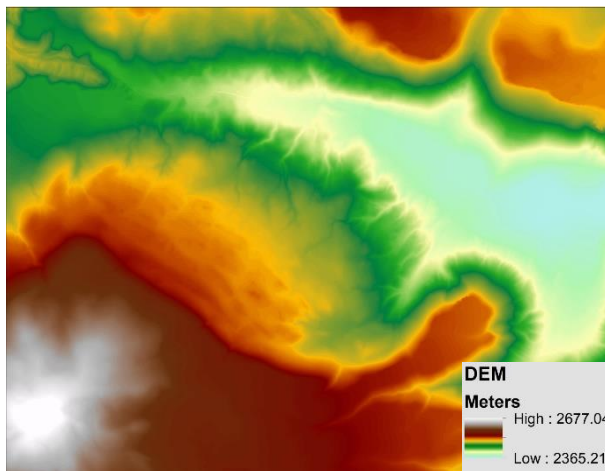


# Lidar Raster Data as ArcGIS Image Services



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## Part 1: Background

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The USDA Forest Service (USFS) requires information about terrain and vertical vegetation structure to support many natural resource management decisions. Lidar data can provide high-resolution, three-dimensional (3D) information, and it has quickly become a data source the USFS relies on to understand the terrain and forest canopy structure across large landscapes. Due to the availability and high demand of lidar data, GTAC provides lidar-derived elevation and canopy structure data on the GTAC Image Server, which can be easily accessed through ArcMap and ArcGIS Pro. The primary datasets include the following lidar-derived raster datasets:

1. Bare Earth Surface (BE) or digital elevation model (DEM)
2. BE Hillshade
3. Canopy Height Hillshade
4. Canopy Height Model
5. Canopy Cover Model

This document will explain what these raster services are, how they might be useful to you, and how to access them in ArcMap and ArcGIS Pro. It also includes instructions on how to request that your own lidar derivatives be added to the GTAC Image Server. You must be within the USFS Intranet firewall to access the server. This requires either being connected to the Forest Service VPN if working offsite or being connected to the FS web at a Forest Service office.

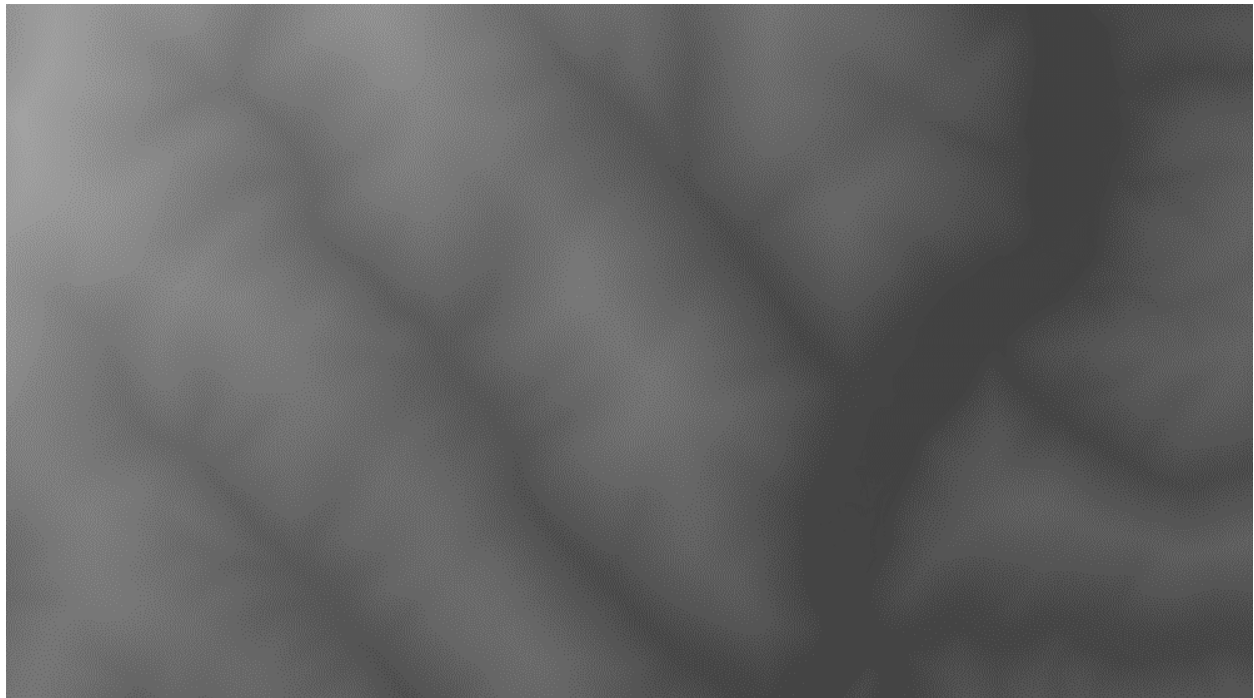
## Part 2: Description of Hosted Lidar Derivatives

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This section describes common lidar-derived raster and some of their applications to ensure all users are aware of the layers being hosted and how they can be used in everyday geospatial workflows.

### A. Bare Earth Raster:

1. A digital elevation model (DEM), also referred to as a digital terrain model (DTM), created from lidar returns (typically 1 meter spatial resolution) that have been classified as “ground” (figure 1). The layer contains actual elevation (z) values and can be used to create a variety of geospatial products. This layer can potentially be used to:
  - i. Define watersheds and viewsheds
  - ii. Model flood and fire behavior
  - iii. Measure elevation changes
  - iv. Produce topographic maps
  - v. Generate contours
  - vi. Generate more accurate stream networks

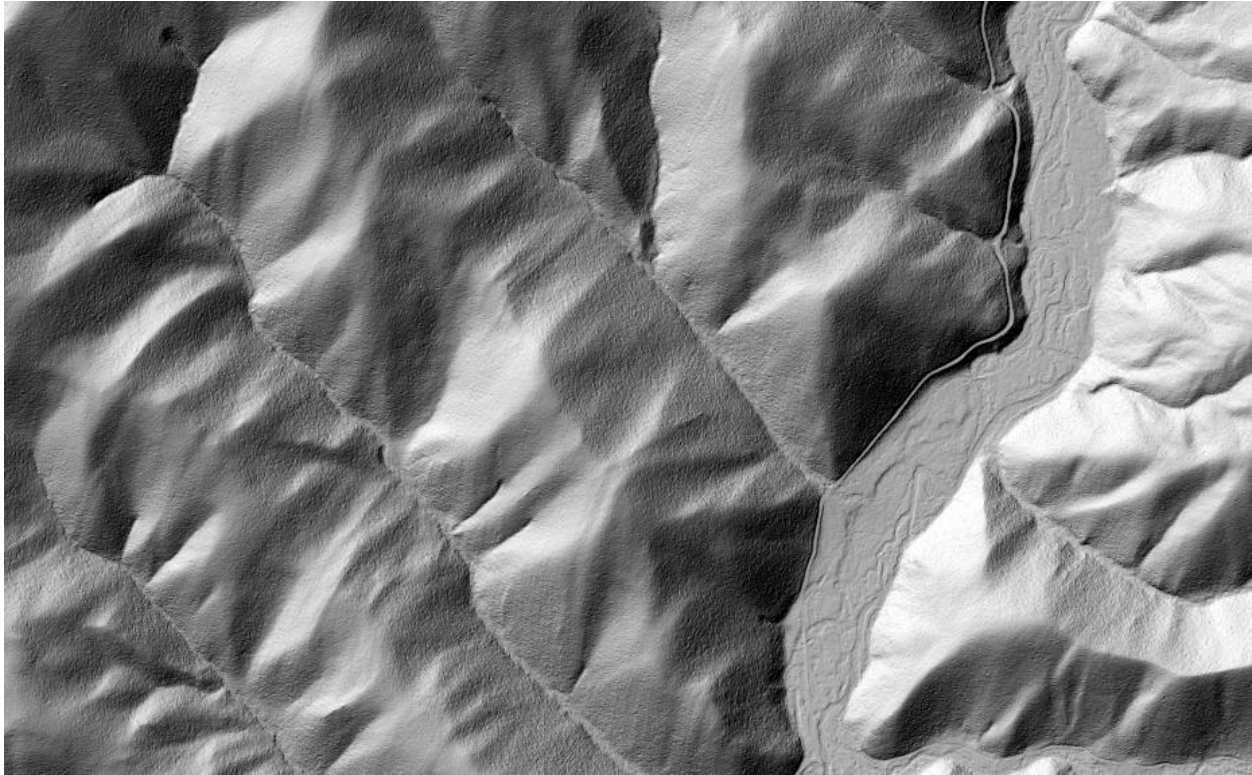


*Figure 1: A DEM created from lidar data.*

## **B. Bare Earth Hillshade:**

1. Gray-scale relief model of the bare earth DEM created using the standard sun azimuth of 315° and sun elevation of 45° (figure 2). Pixel values represent relative illumination (1-255), not actual elevation data, and are used for visual interpretation, not analysis. This layer can potentially be used to:
  - i. Map road center and sidelines
  - ii. Monitor quarries and find abandoned mines
  - iii. Assess property remotely
  - iv. Support archaeological investigations
  - v. Find landslides, old road cuts and grades
  - vi. Display steep denuded streambanks (figure 2)

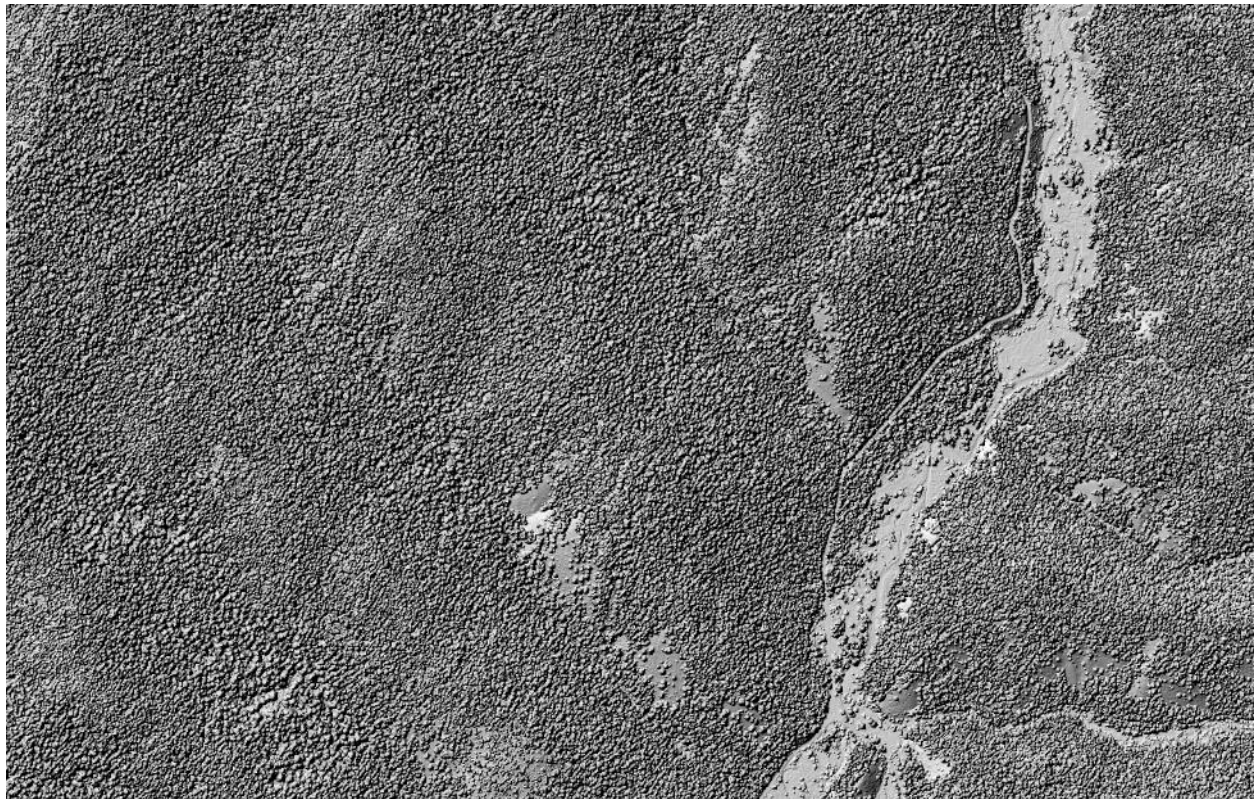




*Figure 2: A DEM hillshade with the surface illuminated to highlight surface features.*

### C. Highest Hit Hillshade:

1. Gray-scale relief created from canopy height raster or digital surface model showing trees, structures, and open ground (figure 3). Pixel values represent relative illumination (1-255), not actual elevation data, and are used for visual interpretation, not analysis. This layer can potentially be used to:
  - i. Characterize land cover
  - ii. Locate power lines and power poles
  - iii. Identify individual tree crowns
  - iv. Delineate building footprints



*Figure 3: A highest hit hillshade layer.*

#### D. Canopy Height Model:

1. Created by subtracting a DEM from a digital surface model (first return only raster). Pixel values represent height above ground (figure 4). Lidar vendors typically don't provide this layer, but you can produce it with GIS software such as ArcGIS. This layer can potentially be used to:
  - i. Model general forest structure
  - ii. Help identify specific wildlife habitat
  - iii. Measure the size and height of buildings and bridges
  - iv. Locate and measure individual trees in the forest. Draping this 2D layer with a 50% transparency over a 3D highest hit hillshade makes interpreting individual tree crowns easier (figure 4).



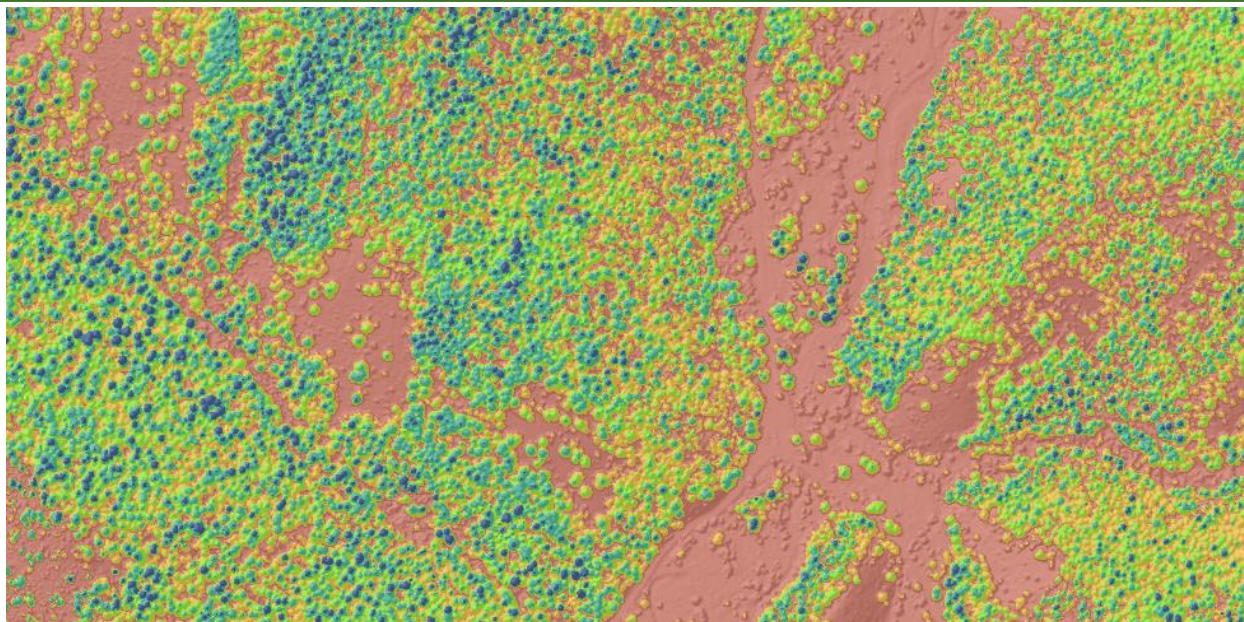


Figure 4: A canopy height model (with a 40% transparency applied) draped over the highest hit hillshade to highlight tree crowns, colored by height classes, with cooler colors (e.g., blue) representing taller trees.

## E. Canopy Cover Model:

1. Each pixel value in this model represents the percent canopy cover as modeled by lidar first returns above a specific height threshold, divided by all 1<sup>st</sup> returns in the pixel (figure 5). Lidar vendors typically don't provide this layer, but you can produce it in a point cloud processing environment such as FUSION. This layer can potentially be used to:
  - i. Model landscape level canopy cover
  - ii. Represent relative canopy density
  - iii. Model insolation and stream shading
  - iv. Map forest canopy openings to identify specific habitat



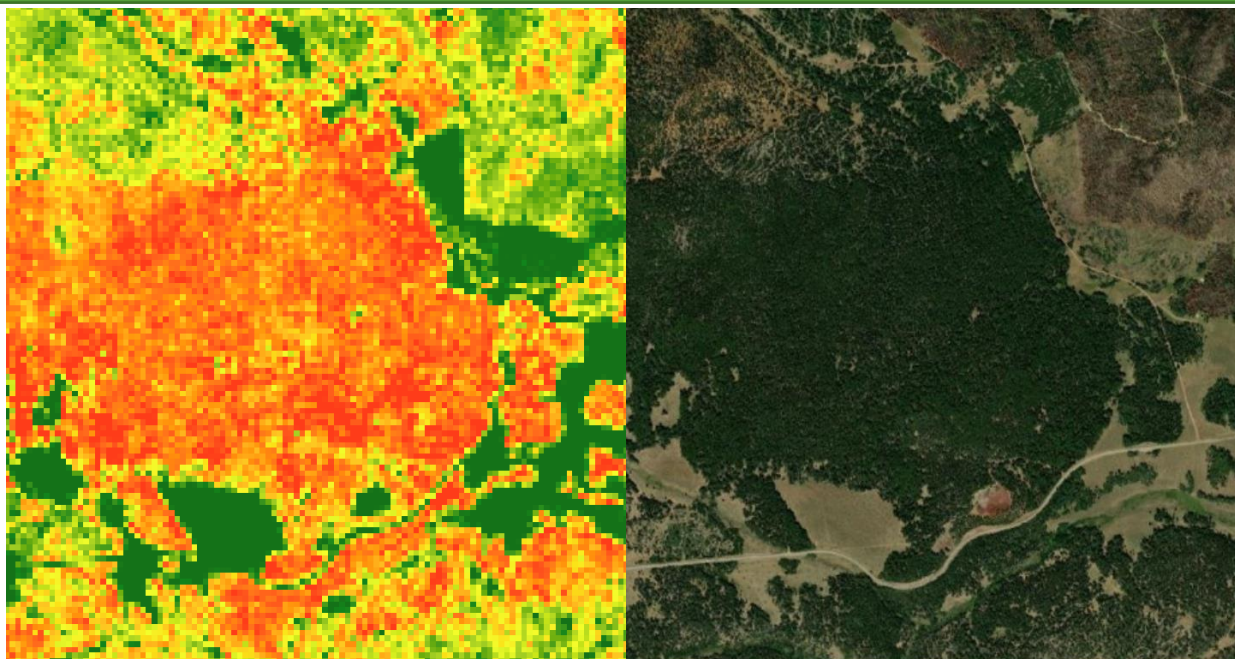


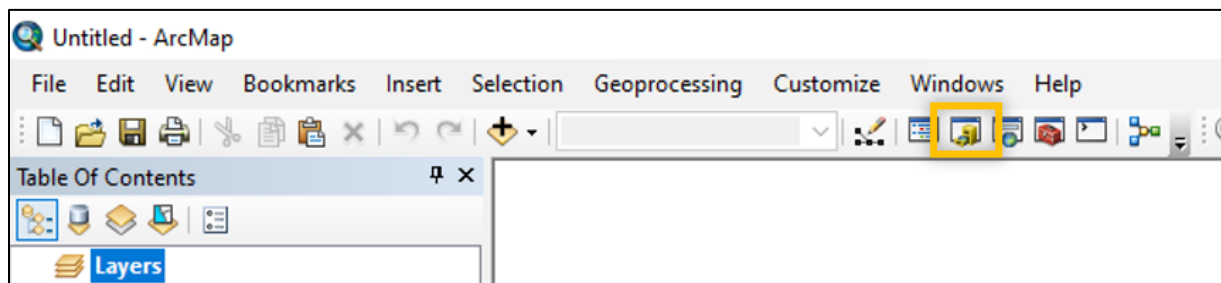
Figure 5: Percent canopy cover model (left) (low values represented as green and high values represented as red) and a NAIP image (right) of the same area.

## Part 3: Connect to the GTAC Image Server Using ArcMap

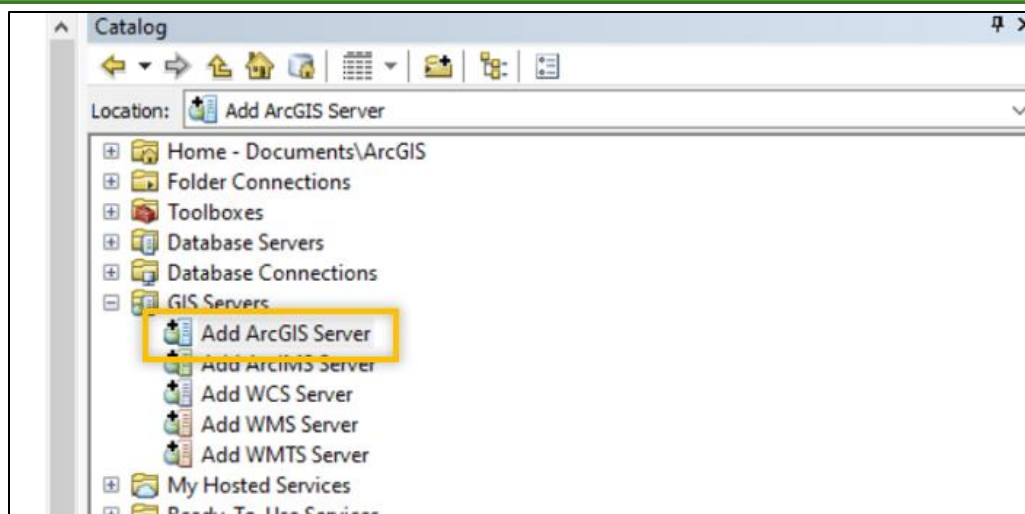
If your lidar derivatives are loaded on the GTAC Image Server, they are easily accessed through a locally installed version of ArcGIS desktop or on Citrix. Follow the instructions below to connect and start exploring the available layers now.

### A. Connect to the GTAC Image Server

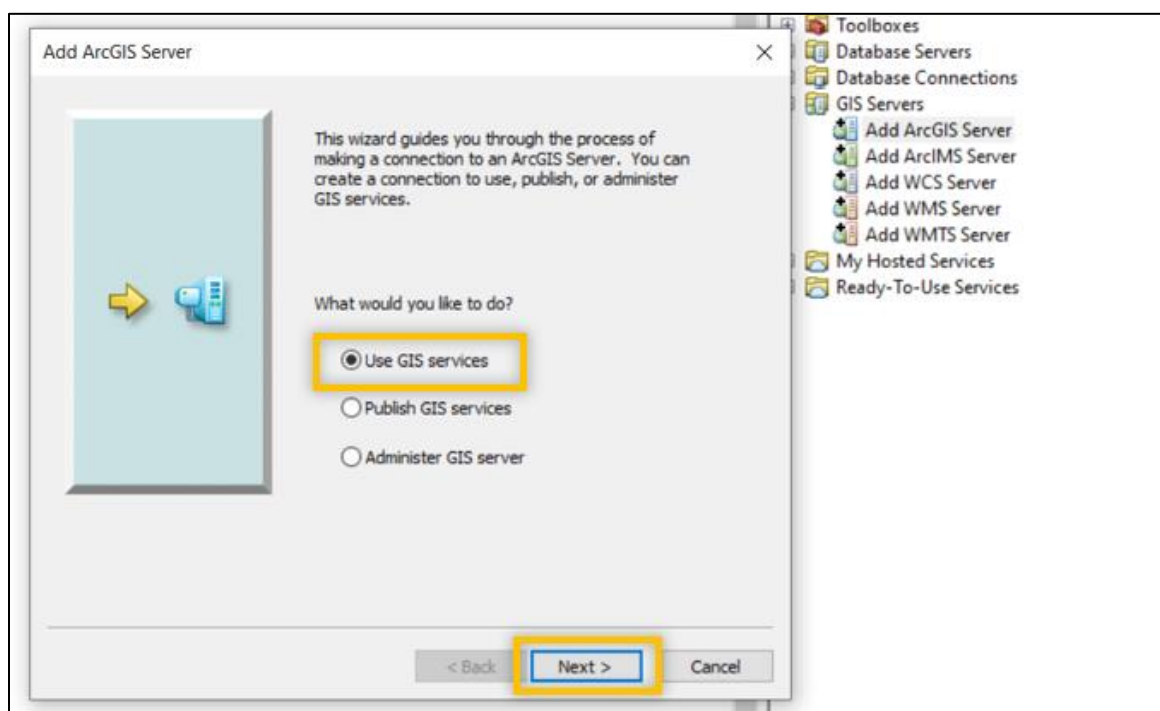
1. From within ArcMap activate the Catalog pane by either clicking on the Windows menu **and then clicking Catalog** or by clicking on the Catalog icon in the main toolbar (see below).



1. Find the **GIS Servers** item and click the plus sign next to it to expand the list.
2. Double-click on **Add ArcGIS Server** (see below).



3. Ensure that **Use GIS services** is selected and click **Next >**.

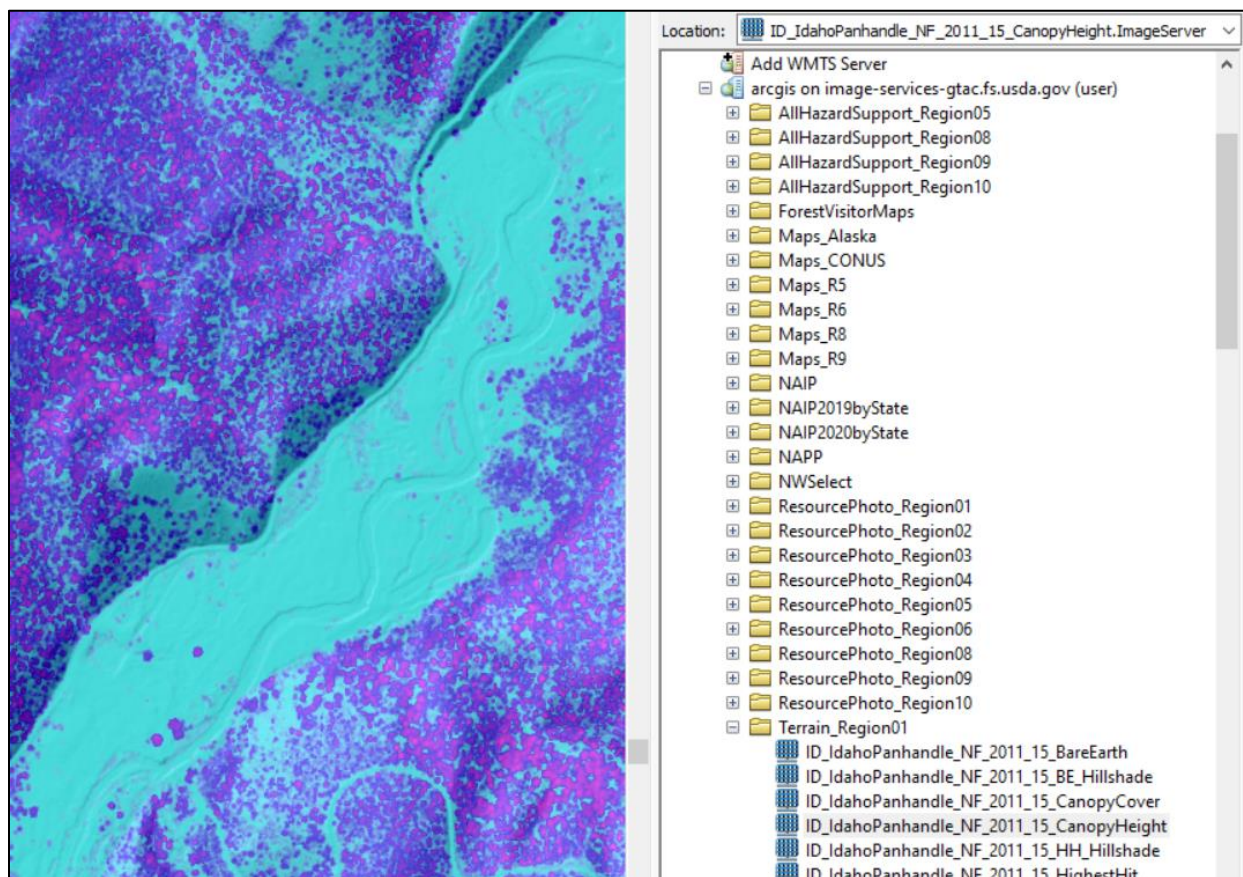


4. In the box next to **Server URL** (see below), copy and paste this address: <https://image-services-gtac.fs.usda.gov/arcgis/services>.

- i. You may need to delete the existing https:// in the window before pasting the new URL.
- ii. Ensure that there is no space or period included at the end of the URL when you paste it.



5. Leave the User Name and Password boxes blank and click **Finish**.
6. The GTAC Image Server will be added to the list under GIS Servers. Expand the lists by clicking on the plus signs to see the available data. Notice that there are numerous folders containing different datasets. Lidar rasters are stored in the **Terrain\_RegionXX** folders.

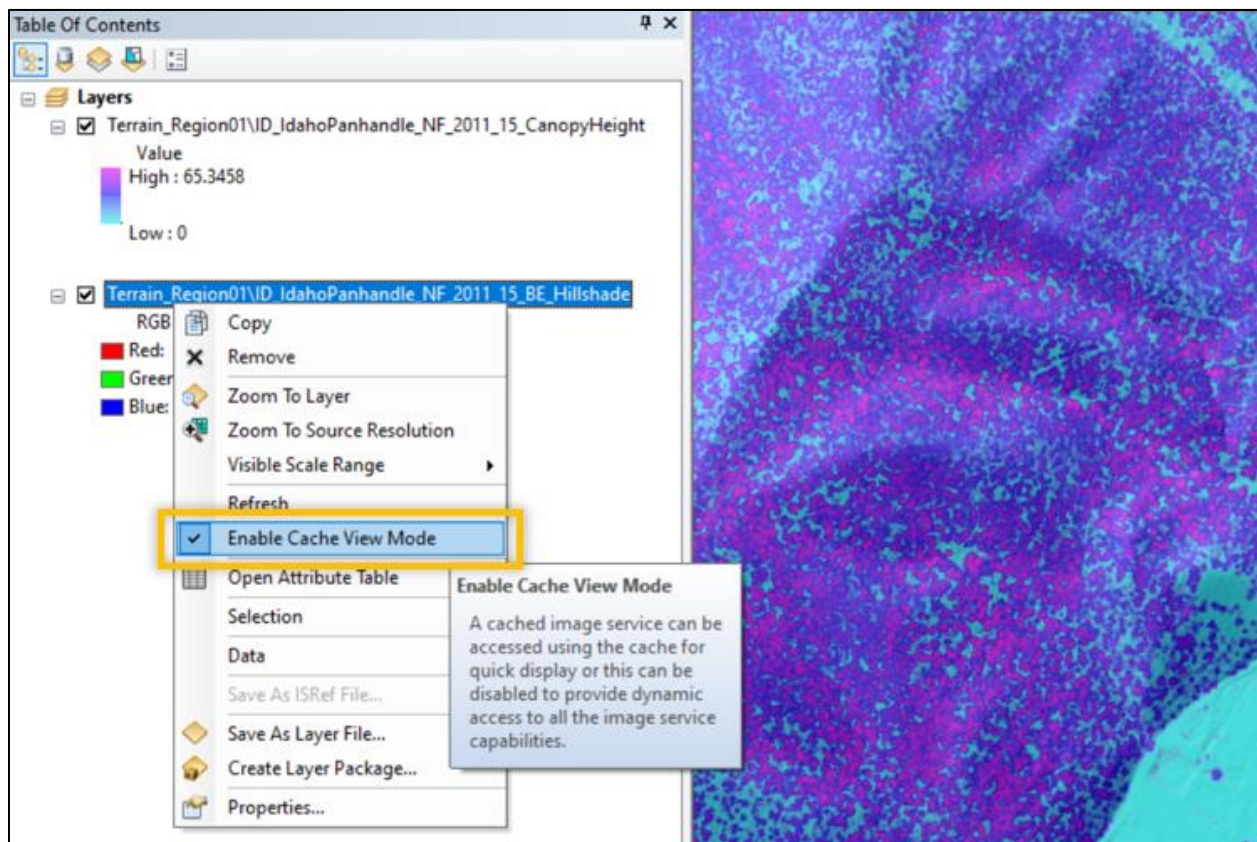


7. To add a service to your map, navigate to the service then click-and-drag it into your map window or Table of Contents.

**Note:** Data from the GTAC Image Server are sometimes stored on sets of tiles called *cached imagery*. These are sets of images created at reduced resolution (similar to image pyramids) that allow for improved refresh rates and better performance of the imagery. By default, these are saved to a folder on your computer to allow for faster navigation. However, there are many functions (color ramping, hillshade, aspect layer, etc.) that cannot be done with the cached imagery, and instead require you to explore the dynamic version of the data. Let's do that now.



8. In the Table of Contents, right-click on an image service that you've loaded.
9. In the menu that appears, click on **Enable Cache View Mode** (see below) to remove the check mark and turn off caching.

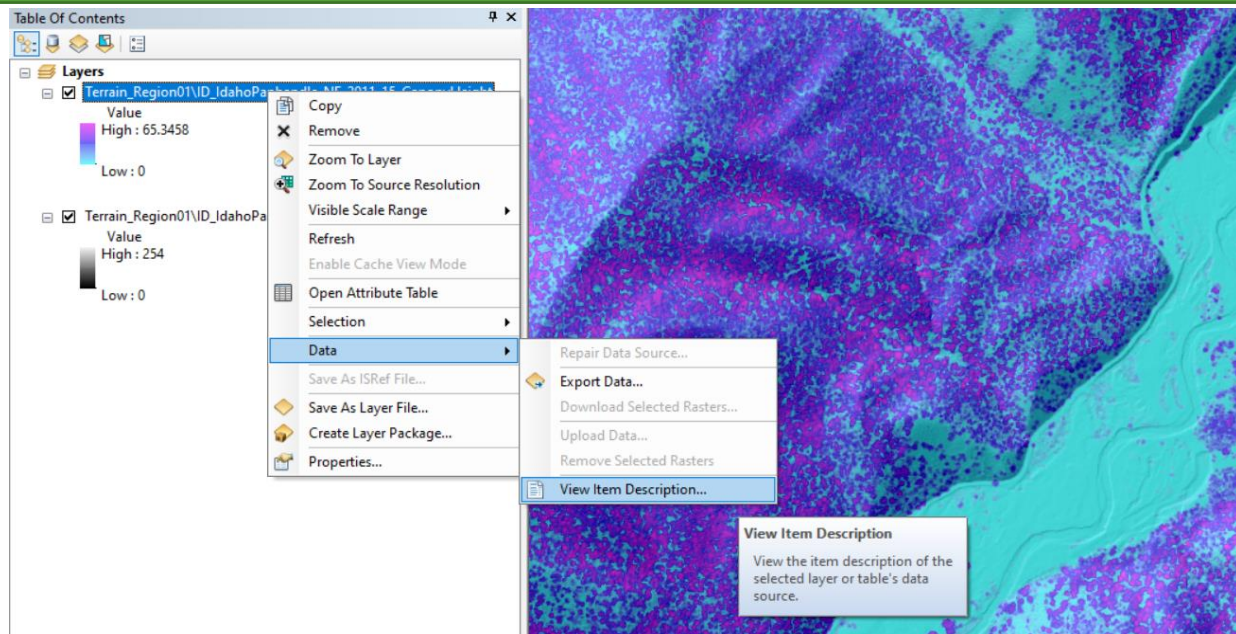


- i. If a checkmark is not present and the Enable Cache View Mode is greyed out, then the service has been published without a cache.
10. If the layer was in cache view mode, the screen will take a few moments to refresh.
11. To return to cached view mode for the data, right-click on the image service and click on **Enable Cache View Mode**.

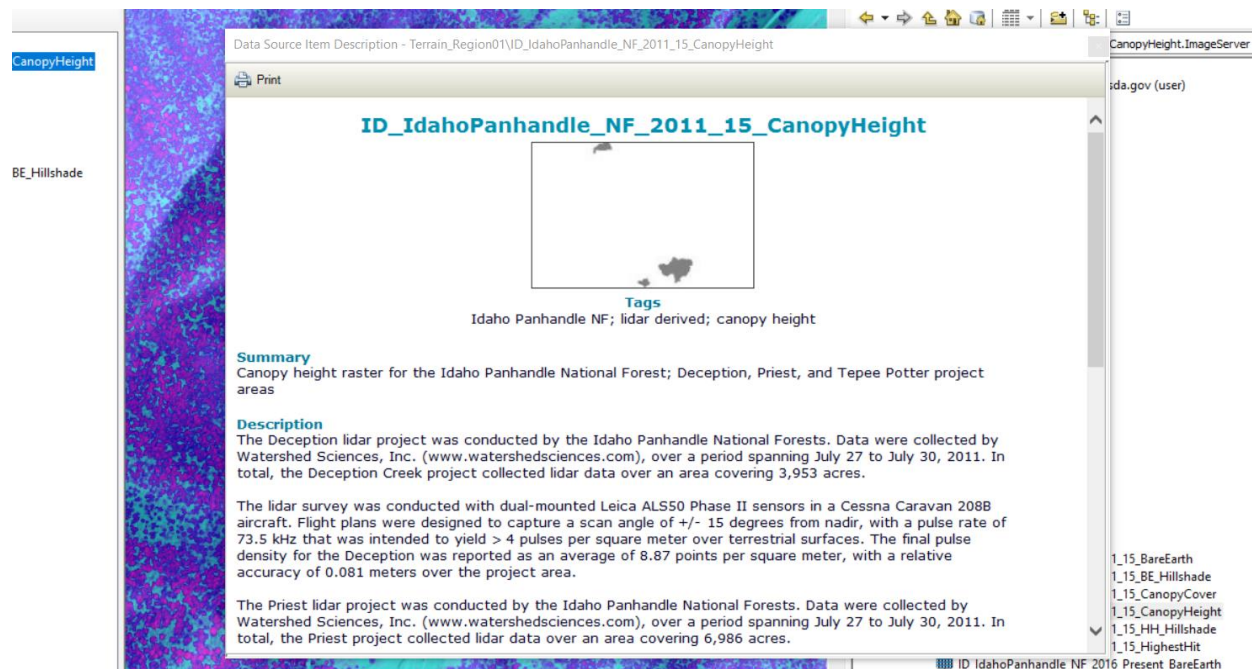
## B. Viewing Metadata in ArcMap

Metadata documentation is a useful way of learning the background information about an image service. Metadata can tell you how data was collected, when it was collected, and who to contact about errors or updates, among other things. Opening Metadata is easy in ArcMap.

1. To open a layer's metadata be sure the layer is visible in the table of contents. If it isn't, then follow the instructions in Section A of this document to add an image service to your map document.
2. Right click on the layer in the table of contents to open layer's the context menu then hover your cursor over the data option and then click View Item Description on the window that appears.



3. A new window will open with the Metadata description for the layer you clicked on. It may be helpful to resize the window to be larger if needed.



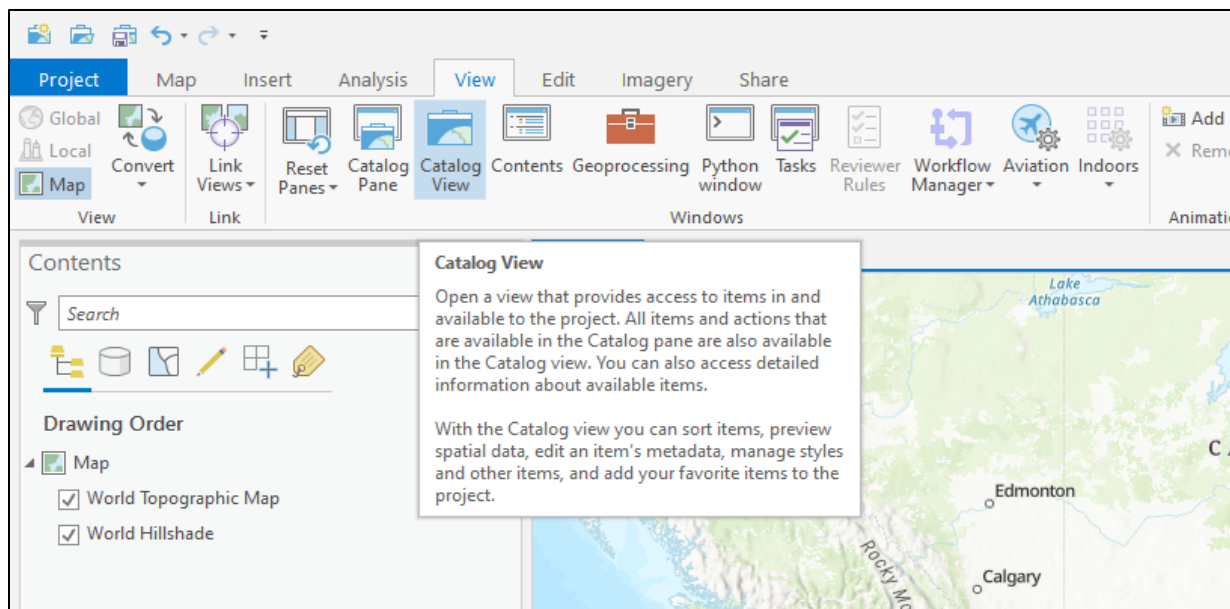
*A good metadata description will include a description of the data in the layer including information like how the data was collected and what techniques or tools were used to manipulate the data if it was post processed. It should also include contact information or at least the name of a group or department responsible for the collection or creation of the data.*

## Part 4: Connect to the GTAC Image Server Using ArcGIS Pro

ArcGIS Pro is only available as a local installation as of Summer 2021. It can be installed through the Software Center on any Forest Service Computer. It is not available on the Forest Service Citrix platform.

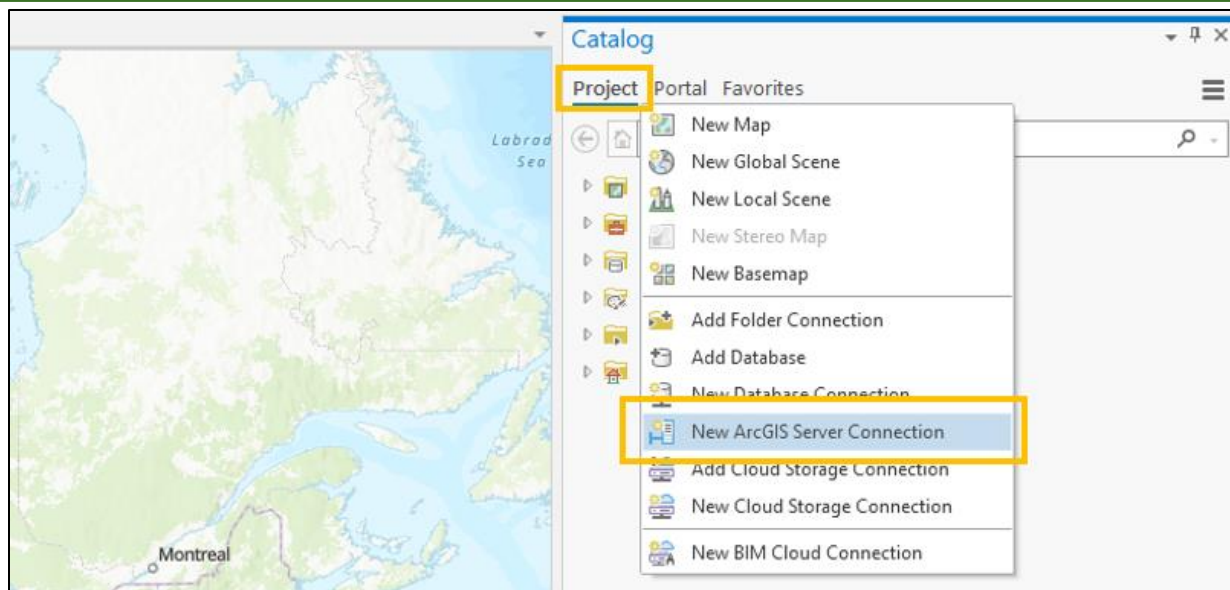
### A. Connect to the GTAC Image Server

1. ArcGIS Pro usually defaults to having the Catalog Pane visible.
  - i. If you already have a map open and have closed the catalog pane, then click on the **View** ribbon and then **Catalog Pane** or **Catalog View**, which is a full screen version of Catalog.

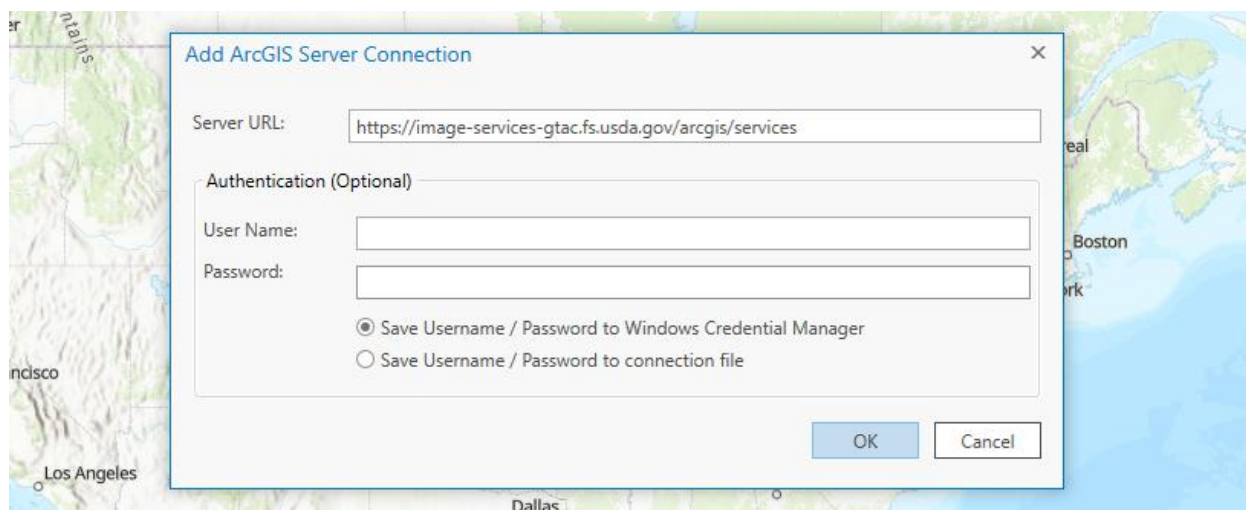


2. On the Catalog Pane right click on the word Project at the top of the Catalog Pane and choose New ArcGIS Server Connection.

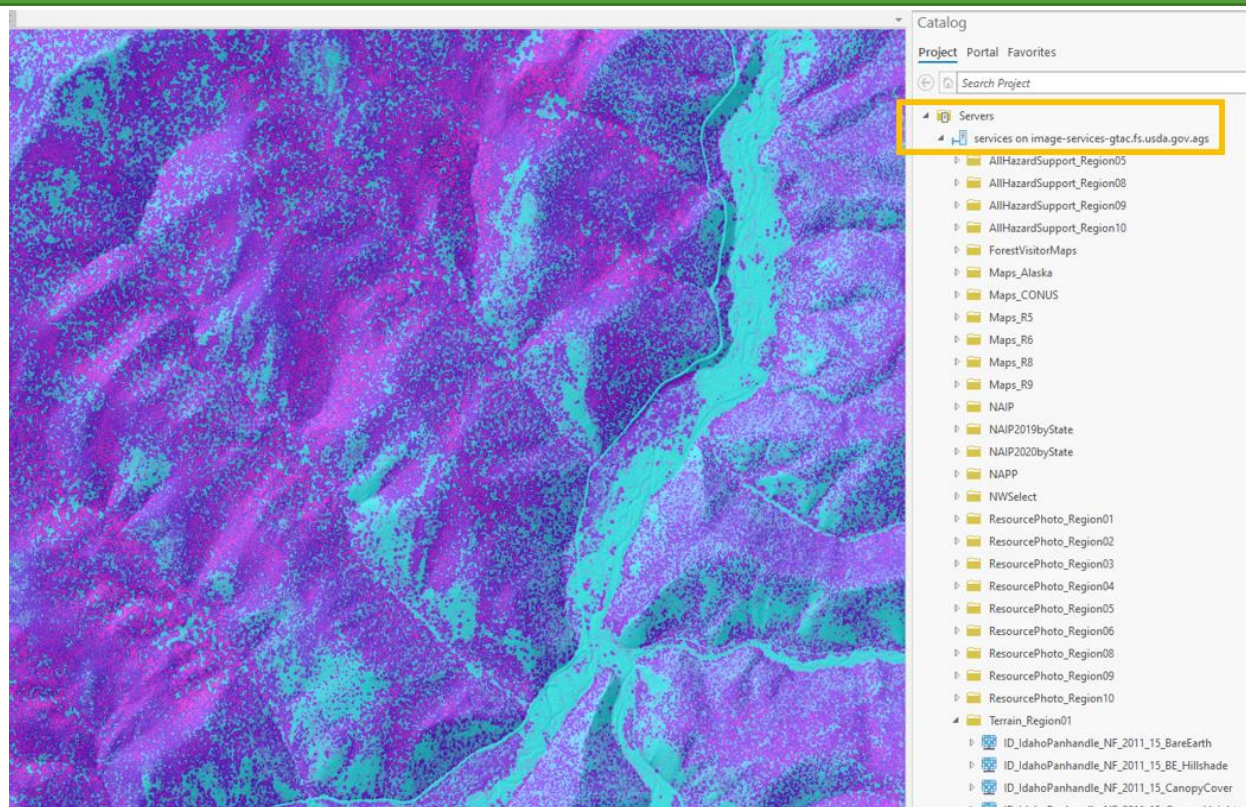




3. In the window that appears paste the image server URL (<https://image-services-gtac.fs.usda.gov/arcgis/services>) into the Server URL option.
  - i. You may need to delete the https:// that is already in the window before pasting the new URL in.
4. Leave the Authentication section blank and click **OK**.



5. After clicking OK, a **Servers** option should appear as a drop-down menu in your Catalog Pane. Click on the arrow beside the Servers option and then click again on the arrow beside the image server address to reveal the contents of the GTAC Image Server.
6. Notice that there are numerous folders containing different datasets. Lidar rasters are stored in the **Terrain\_RegionXX** folders.
7. To add a service to your map just click and drag the service from the Catalog Pane into the map window or into the Contents Pane.

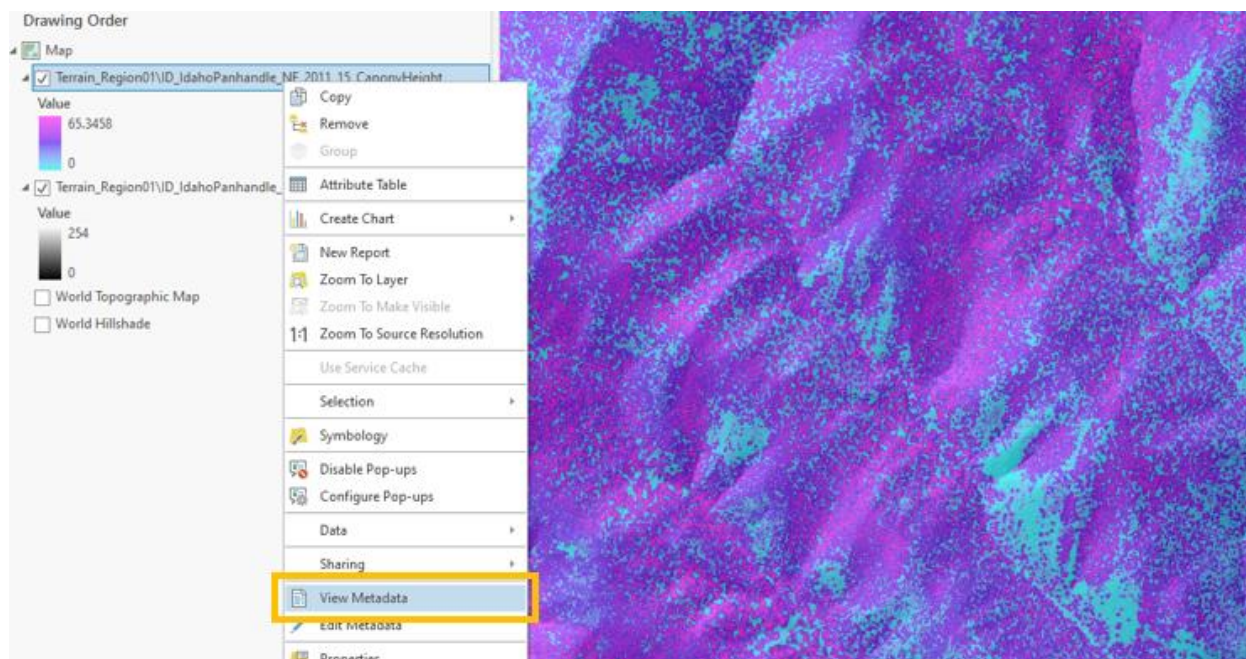


## B. Viewing image metadata in ArcGIS Pro.

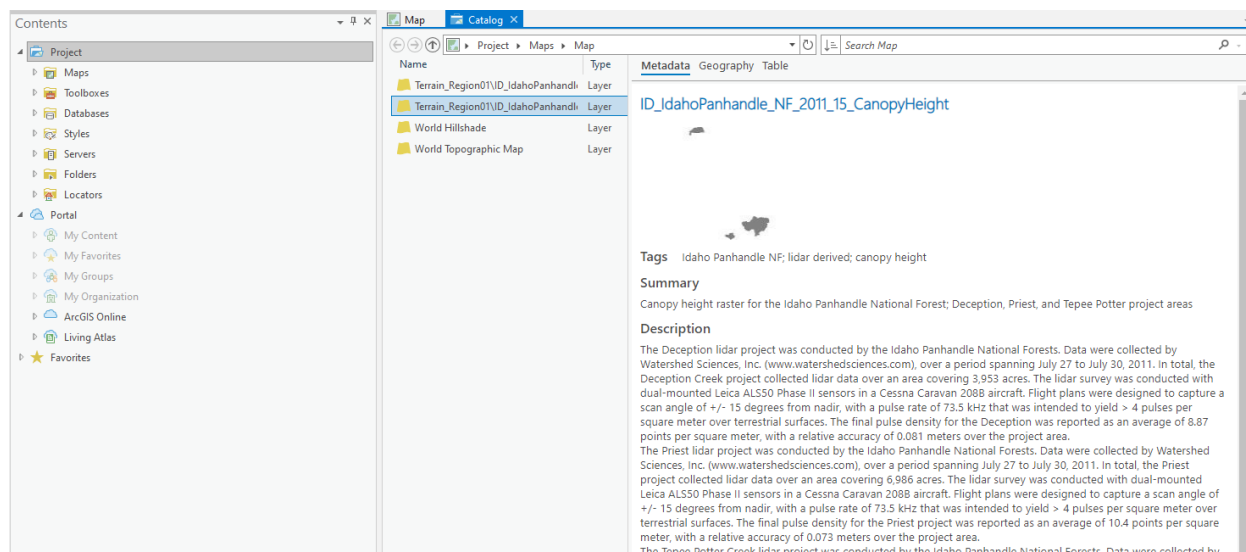
Metadata documentation is a useful way of learning the background information about an image service. Metadata can tell you how data was collected, when it was collected, and who to contact about errors or updates, among other things. Opening Metadata is easy in ArcGIS Pro.

1. To view an image layers metadata right click on the desired layer and choose **View Metadata** from the context menu that appears.





2. After clicking the View Metadata option, ArcGIS Pro will add a Catalog View window to your ArcGIS Pro project. In this window, you can click on any of the layers that are listed in your table of contents.



3. To return to your map click the map tab beside the Catalog tab at the top of the Catalog View window. Alternatively, if you are finished viewing metadata for your layers, you can click the X beside the Catalog View tab to close the Catalog View window and return to your Map.

## Part 5: Adding Your Region's Lidar Derivatives

If you would like to have your region's lidar derivatives hosted on the GTAC Image server, contact Nancy





Carlson ([nancy.carlson@usda.gov](mailto:nancy.carlson@usda.gov)). Include as much information about the data as you can. Your request will be reviewed for appropriateness, and Nancy or someone else will contact you if there are any questions or to let you know if your request has been approved. Depending on the size of the dataset and internet connection speeds, it can either be loaded onto the T drive and then transferred to the Image Server or a hard drive can be mailed. Once your data has been uploaded your hard drive will be returned.