

## Creating a LAS Dataset and Raster Derivatives From Point Cloud Data

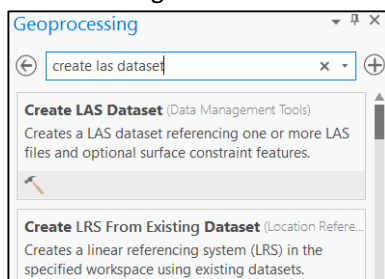
We are going to use a single .las point cloud dataset, that has been downloaded from the National Land Survey's open data service. The dataset is in Euref-FIN TM35FIN coordinate system. ArcGIS Pro supports .las file so you can open a single point cloud dataset to ArcGIS Pro's 2D map or 3D scene. However, usually we are dealing with tens or hundreds of .las files, so it's not practical to open them as individual layers to Pro. Therefore, the ArcGIS Pro uses a 'LAS Dataset' data frame to manage and analyze vast quantities of point cloud data.

It is important to notice that, while often we speak that we import or include .las files to LAS Dataset structure, the LAS Dataset by itself does not storage any of the point cloud data files. It is only reading or referencing them from hard drive, web folders, cloud storage etc. Basically, what it means is that end-user can have a locally stored LAS Dataset that is referencing the .las files from i.e. web drive (as long as it has the necessary rights to do so). Bear in mind, that usually reading massive files via web from shared drives is not very wise performance-wise. In that sense, it is better to have the .las files stored locally.

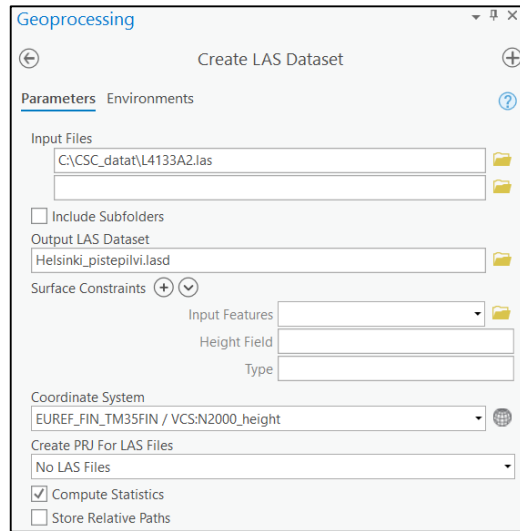
Also, take notice that if you do classification changes via a LAS Dataset, those changes go to the .las files the LAS Dataset is referencing. Usually, that's the so-called master data from lidar surveys. In some cases, it might be wise to take backups.

### Creating a LAS Dataset in ArcGIS Pro

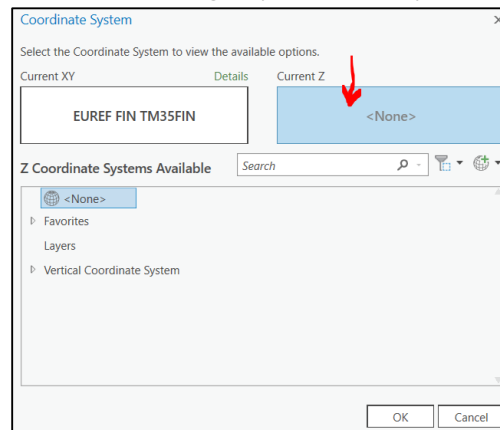
1. Open ArcGIS Pro and search for "Create LAS Dataset" tool from the Geoprocessing window; select the tool with left-click
  - The Geoprocessing window can be opened from the Analysis-ribbon atop the Pro UI and selecting 'Tools'.



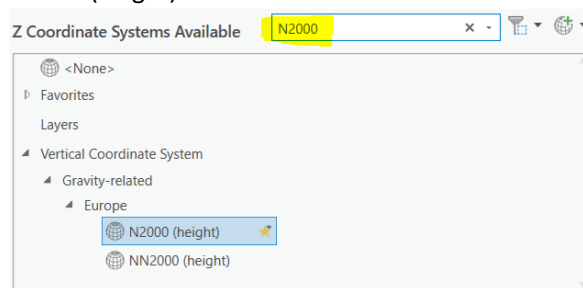
2. Fill the Create LAS Dataset tool dialog as below in picture.
  - Notice: Use folder browsing to get to your own .las file location folder
  - Notice: Use your own 'Output LAS Dataset' -folder and layer name. The LAS Dataset uses a .lasd file ending. The LAS Dataset is also an uncommon dataset in the sense that it's saved into a folder as a file (not to geodatabase as is often in ArcGIS).



- Determine the XY coordinate system as 'EUREF FIN TM35FIN' and the Z-system as 'N2000'.
  - i. The dialog to enter coordinate system information opens from the globe icon.
  - ii. XY-system: 'Projected Coordinate System' -> 'National Grids' -> 'Finland' -> 'EUREF FIN TM35FIN'.
  - iii. When determining Z-system, start by clicking the 'Current Z'-box...







- iv. Into 'Search'-field write 'N2000' and hit Enter. After search, open 'Vertical Coordinate System' -> 'Gravity-related' -> 'Europe' and choose by clicking 'N2000 (height)'.



Afterwards, both the 'Current XY' and 'Current Z' -boxes should have the proper coordinate system information visible.

Select the Coordinate System to view the available options.

Current XY	Details	Current Z	Details
EUREF FIN TM35FIN		N2000 (height)	

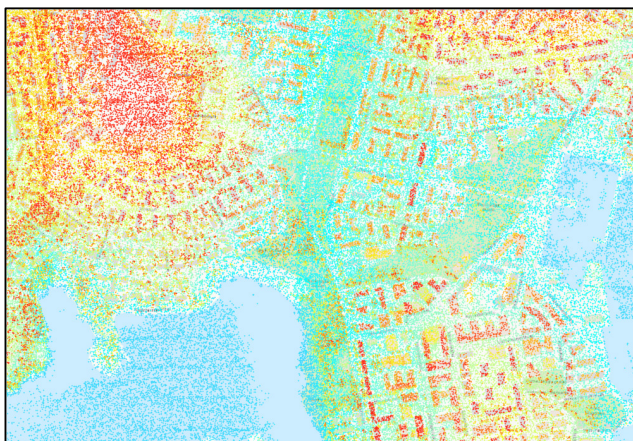
XY Coordinate Systems Available     

Accept the changes by clicking 'OK'.

- Check the 'Compute Statistics' is on and execute the tool by clicking 'Run'.

After the tool successfully executes, a new LAS Dataset layer is automatically added to ArcGIS Pro Table Of Contents at the left-hand side. You can zoom into the new layer by right-clicking it and choosing 'Zoom To Layer'.

In small scale, the LAS Dataset is visualized by red bounding box. This is because the computers GPU unit cannot render all the millions of points at the given scale. Only, when zooming closer to the dataset, the GPU starts rendering points (usually after 1: 8 000 – 10 000 scale; this depends on your computer's GPU and overall performance capabilities).

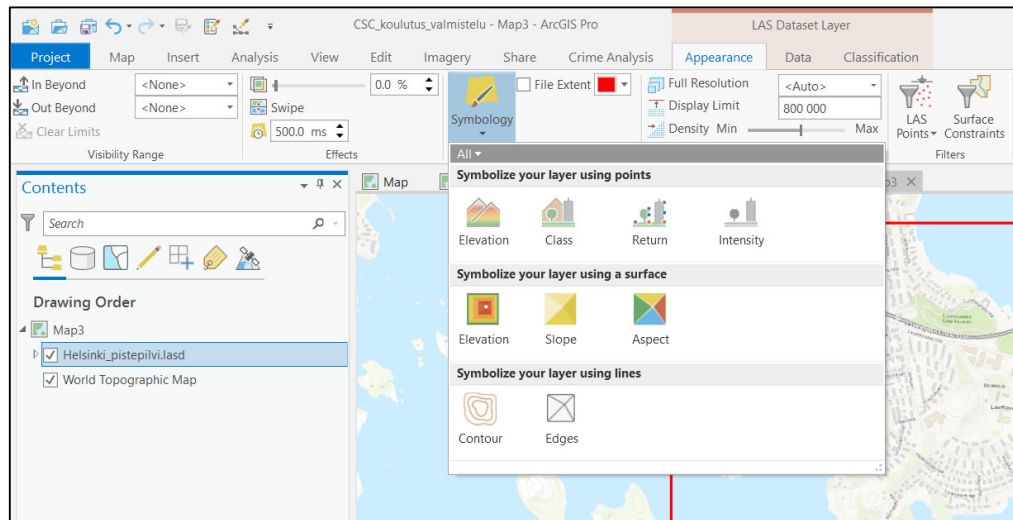


## LAS Dataset Visualizations

When activating the LAS Dataset layer in ArcGIS Pro with left click on the Table Of Contents, the ribbons at the top of Pro adapt to chosen dataset type. Depending on whether the selected layer is vector, raster or point cloud data, different menus are displayed. As seen in picture below, 'LAS Dataset Layer' category menus with 'Appearance', 'Data' ja 'Classification', are visible. These menus support different tasks the user can do with point cloud data.

From Appearance-menu the user can change the visualization of the point cloud by choosing a rendering option from the 'Symbology' drop-down menu.

- Go through the different rendering options
  - o At the first row are the point-based renderings
    - The fifth supported point rendering is 'RGB', but that is not included in the NLS (MML) point cloud data
  - o At second row are the surface type renderings
  - o Third row has all the special type renderings

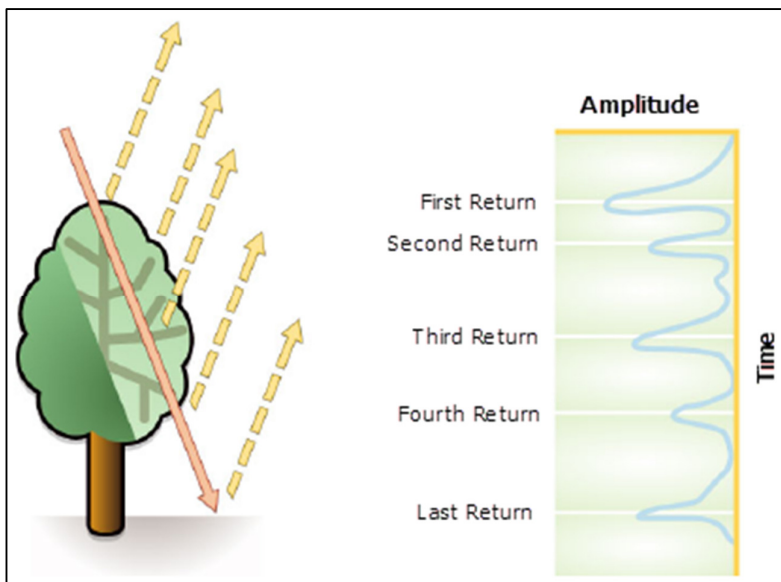


## LAS Dataset Filtering

Common analysis workflow with LAS Dataset begins with filtering the point cloud data to serve data needs. If the need is to create a Digital Terrain Model raster (DTM; often also DEM is used) that represents the bare ground elevation as a surface, then we need to use only the Last Return information from the point cloud, as i.e. the canopy returns from trees would result in erroneous height values to the end-product.

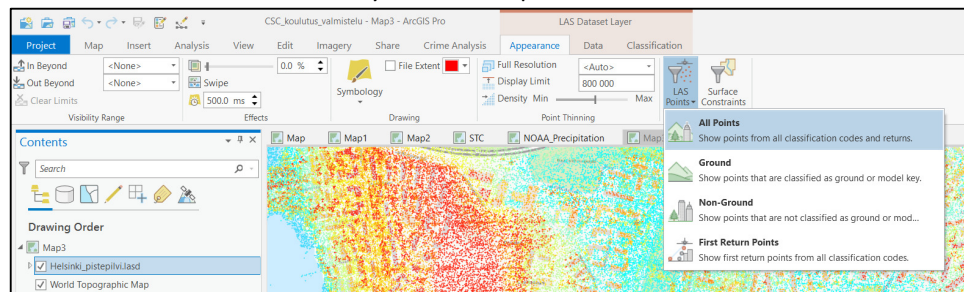
If the need is to create a Digital Surface Model raster (DSM), then it is vice-versa; we only use the first return values from the point cloud to determine the output raster values. The result raster's pixel values represent the height levels of tree canopies or building roofs etc.

Also, some use-cases exist, where we want to control what point cloud classification classes are used for the result layer. The common classification schema used is the 'ASPRS' classification. Search online to find more information on it.

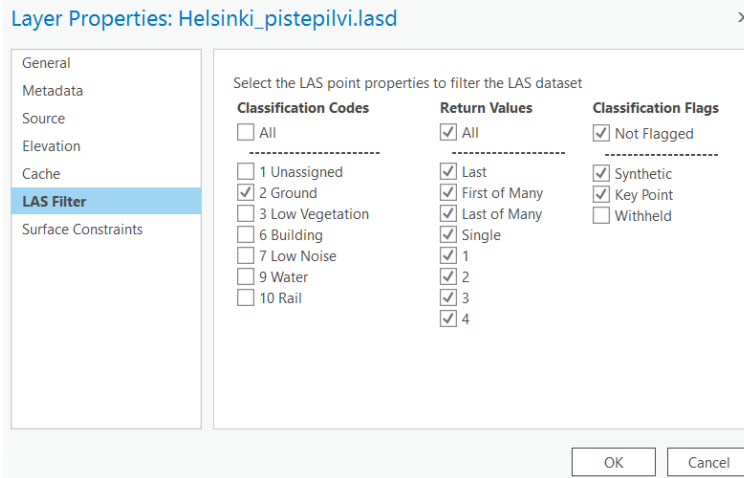


In order to filter in only the wanted return pulses and classes, the ArcGIS Pro offers two ways to do it. Remember, the active rendering i.e. the point or surface rendering adapts to the filtered data.

1. Using the quick way to filter – when the LAS Dataset layer is active in the Table Of Contents, use the 'LAS Points' drop-down selection on the 'Appearance' menu.
  - All Points = Show everything
  - Ground = Only ground class points are on and visible
  - Non-Ground = Only non-ground classes are on and visible
  - First Return Points = Only first-return points from all classes are on and visible



2. Right-click the LAS Dataset layer in Table Of Contents (left-hand side in Pro) and choose 'Properties' and then 'LAS Filter' page. Manually select what information is to be visualized.



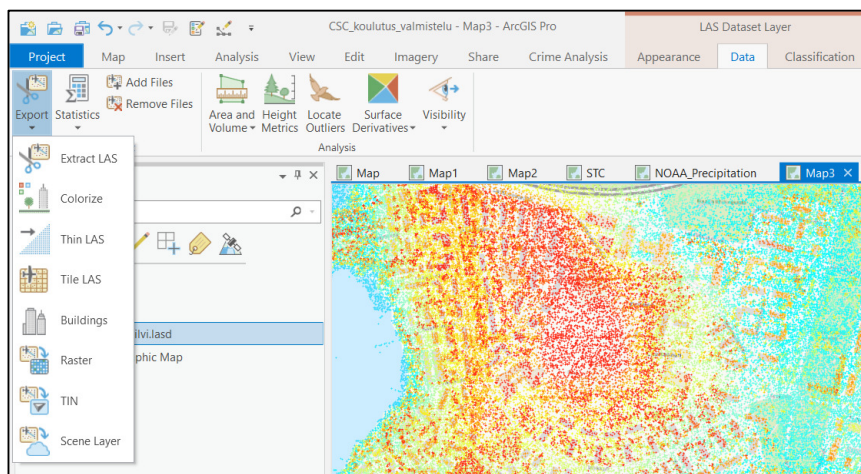
After having a proper filtering done, derivative datasets i.e. rasters, can be made.

### LAS Dataset Derivatives (DTM, DSM and nDSM)

Often, we want to analyze the point cloud by doing the Digital Terrain Model (DTM) and the Digital Surface Model (DSM) exports. The DTM models the bare ground elevation changes as a continuous surface and the DSM the height levels when both the natural and built environments features' elevations are applied. A normal procedure is to calculate the difference of these two, to get the so-called 'Normalized Digital Surface Model' or the 'nDSM'. This is calculated simply: DSM minus the DTM. The nDSM models the true heights of different features: buildings, trees, bridges (also bare ground!) etc. It's also a good method to use, when change detection is wanted (comparing two point clouds of the same area from different time periods).

To create a DTM or DSM, first make the appropriate filtering active. If you want to do it quick & dirty – use the drop-down selection menu. If a more sophisticated approach is needed i.e. to select specific classes – use the Properties -> LAS Filter page approach.

When the filtering is in place, go to 'Data'-ribbon atop the Pro's user-interface and select 'Export' -> 'Raster'. Notice there are other options available also.



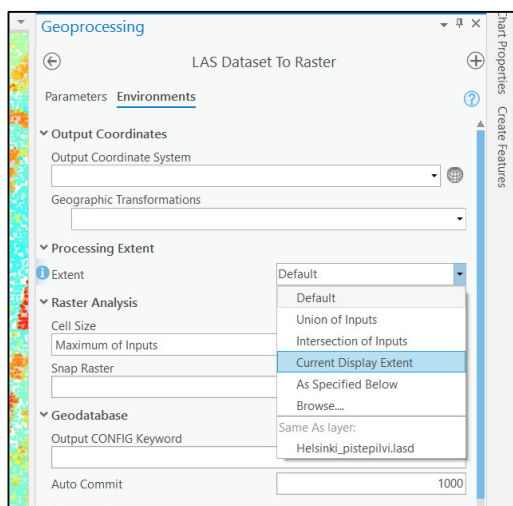
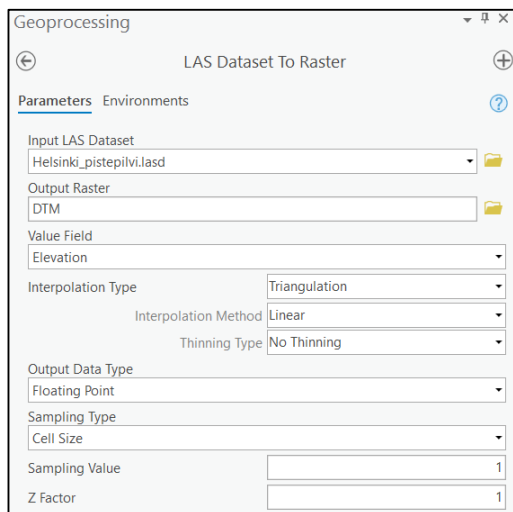


Selecting the raster export option starts the 'LAS Dataset To Raster' tool in Geoprocessing window. From the dialogue, determine what is the output raster's storage folder or geodatabase and name. Notice, if you are saving the results raster into a Windows folder: use raster type file ending i.e. .tif, .png, .jpg etc. If you are saving the raster into a geodatabase, do not use a file ending – only the name!

As for Value field, keep 'Elevation' since you are making a DTM or DSM. The 'Interpolation Type' depends on whether you are making a DTM or DSM. If you are creating a DTM – use Triangulation. With DSM – use Binning. Notice that the output raster's resolution is set at the 'Sampling Value' parameter. At training it is recommendable not to use a value smaller than 1 (meter).

Before you execute the tool a reminder: the NLS point cloud is rather large geographically. Depending on your computer's specifications (and the i.e. Sampling Value determined), the execution might take some time. To counter unnecessary waiting time in training, go to the 'Environments' sheet at the tool dialogue.

The Environments section has all the environment settings that the tool uses. From the 'Processing Extent', choose 'Current Display Extent' to process only the area that is displayed in your map window (zoom i.e. to 1 :3 000 scale at the map; scale is displayed at bottom center part of Pro). This speeds up the processing.



When ready, click the 'Run' button to execute the tool.

When the first derivate raster (DTM or DSM) is ready and done, change the LAS Dataset filtering, to create the other raster of the two (DTM or DSM) using the same workflow as described above.

Create both the DTM and DSM rasters.

#### The nDSM Calculation

When both the DTM and DSM rasters are at hand, the nDSM can be calculated with a simple tool named 'Minus'. The Minus tool has only two input parameters: the input raster 1 and input raster 2. In case of wanting to calculate the nDSM, the input raster 1 is the DSM and the input raster 2 is the DTM. Determine the output storage path and dataset name and hit the 'Run' button calculate the difference.

More Information on point clouds:

<https://pro.arcgis.com/en/pro-app/help/data/las-dataset/what-is-lidar-.htm>