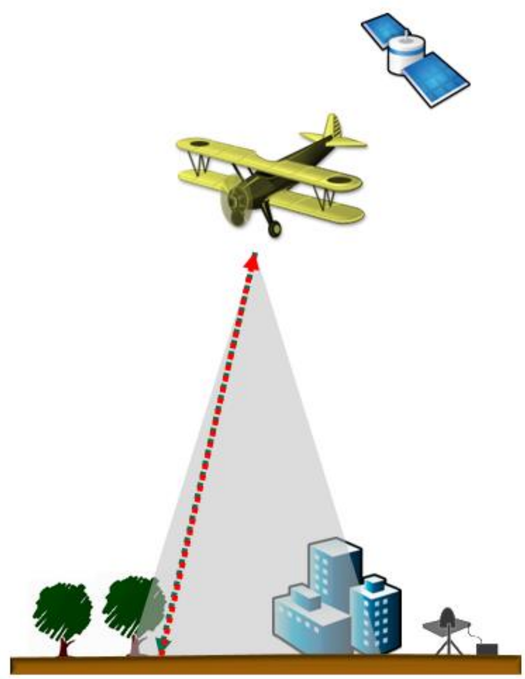
LiDAR Workshop

Introduction

What is lidar data?

http://desktop.arcgis.com/en/arcmap/latest/manage-data/las-dataset/what-is-lidar-data-.htm

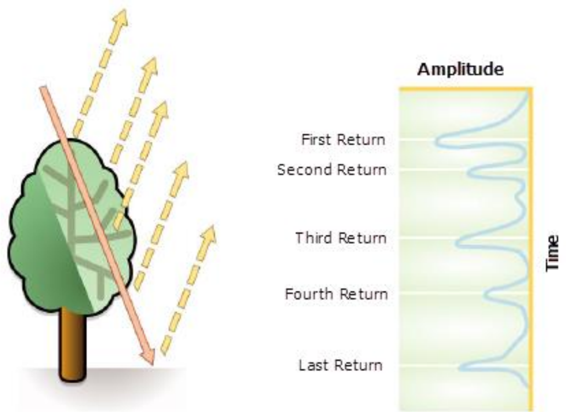
Lidar (light detection and ranging) is an optical remote-sensing technique that uses laser light to densely sample the surface of the earth, producing highly accurate x,y,z measurements. Lidar, primarily used in airborne laser mapping applications, is emerging as a cost-effective alternative to traditional surveying techniques such as photogrammetry. Lidar produces mass point cloud datasets that can be managed, visualized, analyzed, and shared using ArcGIS.



Lidar laser returns

Laser pulses emitted from a lidar system reflect from objects both on and above the ground surface: vegetation, buildings, bridges, and so on. One emitted laser pulse can return to the lidar sensor as one or many returns. Any emitted laser pulse that encounters multiple reflection surfaces as it travels toward the ground is split into as many returns as there are reflective surfaces.

The first returned laser pulse is the most significant return and will be associated with the highest feature in the landscape like a treetop or the top of a building. The first return can also represent the ground, in which case only one return will be detected by the lidar system.

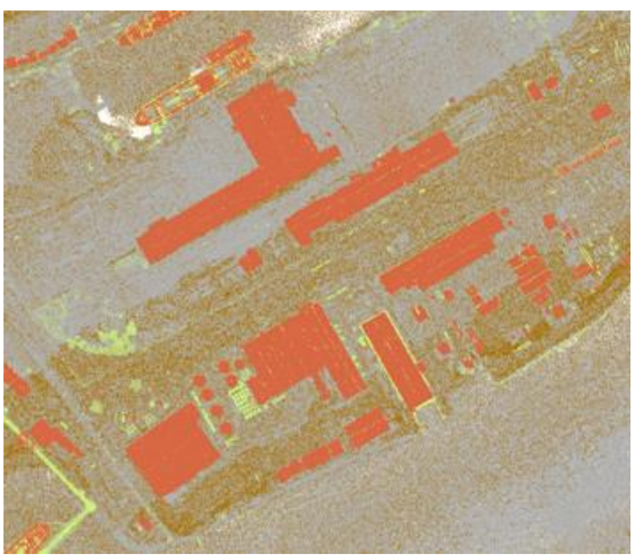


Lidar point attributes

Additional information is stored along with every x, y, and z positional value. The following lidar point attributes are maintained for each laser pulse recorded: intensity, return number, number of returns, point classification values, points that are at the edge of the flight line, RGB (red, green, and blue) values, GPS time, scan angle, and scan direction. The following table describes the attributes that can be provided with each lidar point.

What is a point cloud?

Post-processed spatially organized lidar data is known as point cloud data. The initial point clouds are large collections of 3D elevation points, which include x, y, and z, along with additional attributes such as GPS time stamps. The specific surface features that the laser encounters are classified after the initial lidar point cloud is post-processed. Elevations for the ground, buildings, forest canopy, highway overpasses, and anything else that the laser beam encounters during the survey constitutes point cloud data.



Types of lidar

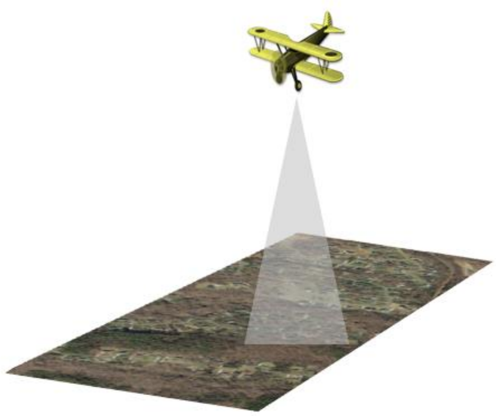
There are two basic types of lidar: airborne and terrestrial.

Airborne

With airborne lidar, the system is installed in either a fixed-wing aircraft or helicopter. The infrared laser light is emitted toward the ground and returned to the moving airborne lidar sensor. There are two types of airborne sensors: topographic and bathymetric.

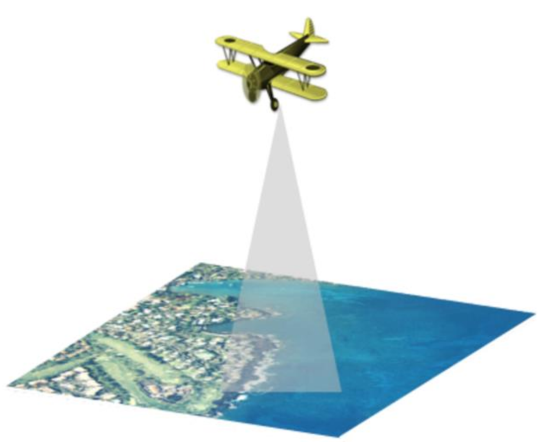
Topographic lidar

Topographic lidar can be used to derive surface models for use in many applications, such as forestry, hydrology, geomorphology, urban planning, landscape ecology, coastal engineering, survey assessments, and volumetric calculations.



Bathymetric lidar

Bathymetric lidar is a type of airborne acquisition that is water penetrating. Most bathymetric lidar systems collect elevation and water depth simultaneously, which provides an airborne lidar survey of the land-water interface. With a bathymetric lidar survey, the infrared light (traditional laser system) is reflected back to the aircraft from the land and water surface, while the additional green laser travels through the water column. Analyses of the two distinct pulses are used to establish water depths and shoreline elevations. Bathymetric information is very important near coastlines, in harbors, and near shores and banks. Bathymetric information is also used to locate objects on the ocean floor.



Terrestrial lidar

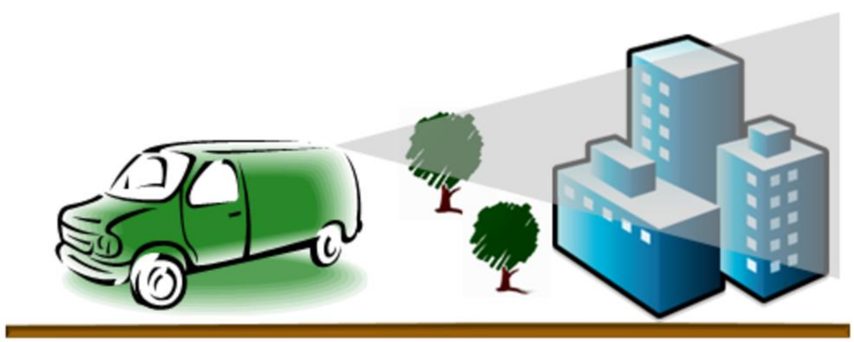
There are two main types of terrestrial lidar: mobile and static. In the case of mobile acquisition, the lidar system is mounted on a moving vehicle. In the case of static acquisition, the lidar system is typically mounted on a tripod or stationary device. Both lidar sensors consist of eye-safe lasers.

Terrestrial lidar collects very dense and highly accurate points, which allows precise identification of objects. These dense point clouds can be used to manage facilities, conduct highway and rail surveys, and even create 3D city models for exterior and interior spaces, to name a few examples.

Mobile

Mobile lidar is the collection of lidar point clouds from a moving platform. Mobile lidar systems can include any number of lidar sensors mounted on a moving vehicle. These systems can be mounted on vehicles, trains, and even boats. Mobile systems typically consist of a lidar sensor, cameras, GPS (Global Positioning System), and an INS (inertial navigation system), just as with airborne lidar systems.

Mobile lidar data can be used to analyze road infrastructure and locate encroaching overhead wires, light poles, and road signs near roadways or rail lines.



Static

Static lidar is the collection of lidar point clouds from a static location. Typically, the lidar sensor is mounted on a tripod mount and is a fully portable, laser-based ranging and imaging system. These systems can collect lidar point clouds inside buildings as well as exteriors. Common applications for this type of lidar are engineering, mining, surveying, and archaeology.

Storing lidar data

http://desktop.arcgis.com/en/arcmap/latest/manage-data/las-dataset/storing-lidar-data.htm

Originally, lidar data was only delivered in ASCII format. With the massive size of lidar data collections, a binary format called LAS was soon adopted to manage and standardize the way in which lidar data was organized and disseminated. Now it is quite common to see lidar data represented in LAS. LAS is a more acceptable file format, because LAS files contain more information and, being binary, can be read by the importer more efficiently.

LAS is an industry format created and maintained by the American Society for Photogrammetry and Remote Sensing (ASPRS). LAS is a published standard file format for the interchange of lidar data. It maintains specific information related to lidar data. It is a way for vendors and clients to interchange data and maintain all information specific to that data.

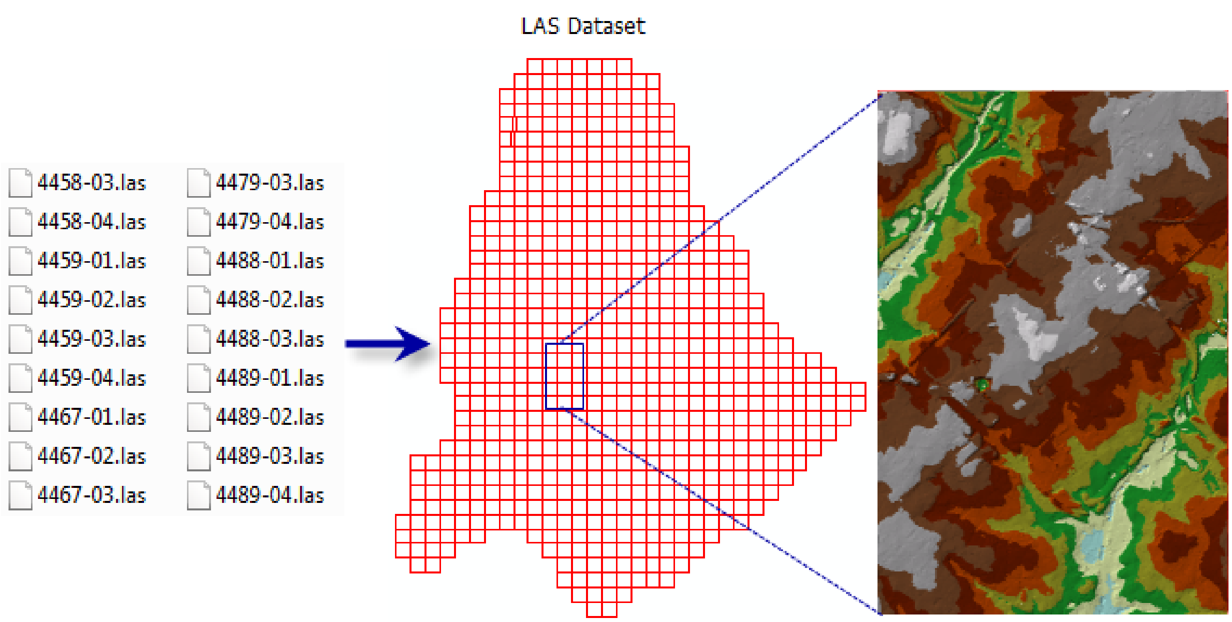
Each LAS file contains metadata of the lidar survey in a header block followed by individual records for each laser pulse recorded. The header portion of each LAS file holds attribute information on the lidar survey itself: data extents, flight date, flight time, number of point records, number of points by return, any applied data offset, and any applied scale factor. The following lidar point attributes are maintained for each laser pulse of a LAS file: x,y,z location information, GPS time stamp, intensity, return number, number of returns, point classification values, scan angle, additional RGB values, scan direction, edge of flight line, user data, point source ID and waveform information.

What is a LAS dataset?

http://desktop.arcgis.com/en/arcmap/latest/manage-data/las-dataset/what-is-a-las-dataset-.htm

A LAS dataset stores reference to one or more LAS files on disk, as well as to additional surface features. A LAS file is an industry-standard binary format for storing airborne lidar data. The LAS dataset allows you to examine LAS files, in their native format, quickly and easily, providing detailed statistics and area coverage of the lidar data contained in the LAS files.

A LAS dataset can also store reference to feature classes containing surface constraints. Surface constraints are breaklines, water polygons, area boundaries, or any other type of surface feature that is to be enforced in the LAS dataset.



Downloading lidar data

United State Interagency Elevation Inventory

https://coast.noaa.gov/inventory/

OpenTopography

http://www.opentopography.org/

Ohio lidar data

http://ogrip.oit.ohio.gov/ProjectsInitiatives/OSIPDataDownloads.aspx

http://gis5.oit.ohio.gov/geodatadownload/

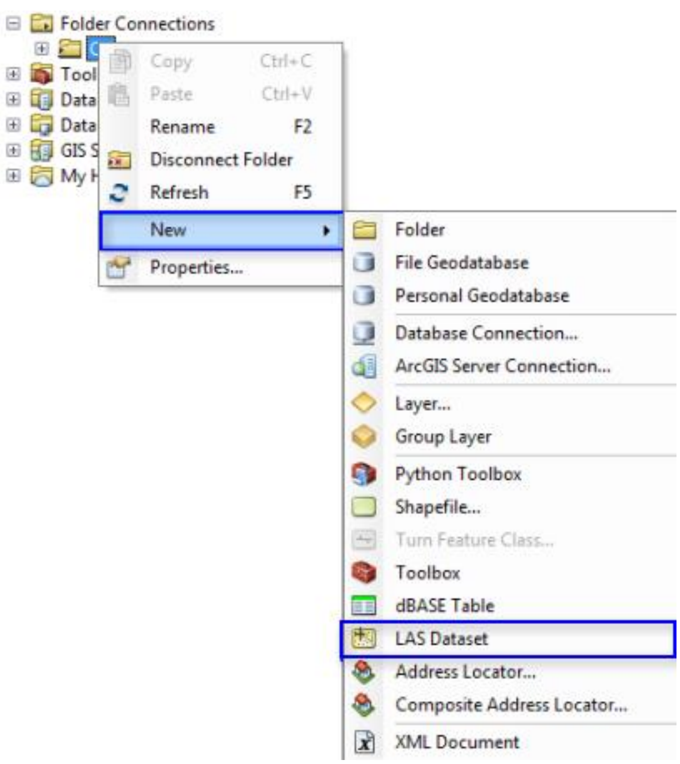
Creating a LAS dataset

http://desktop.arcgis.com/en/arcmap/latest/manage-data/las-dataset/creating-a-las-dataset.htm

Create a LAS Dataset using the context menu

The context menu for folders in ArcCatalog or the **Catalog** window provides one way of creating a LAS dataset.

1. Right-click the folder where the LAS dataset is to be created to display the folder context menu.
2. From the context menu, click **New > LAS Dataset**.



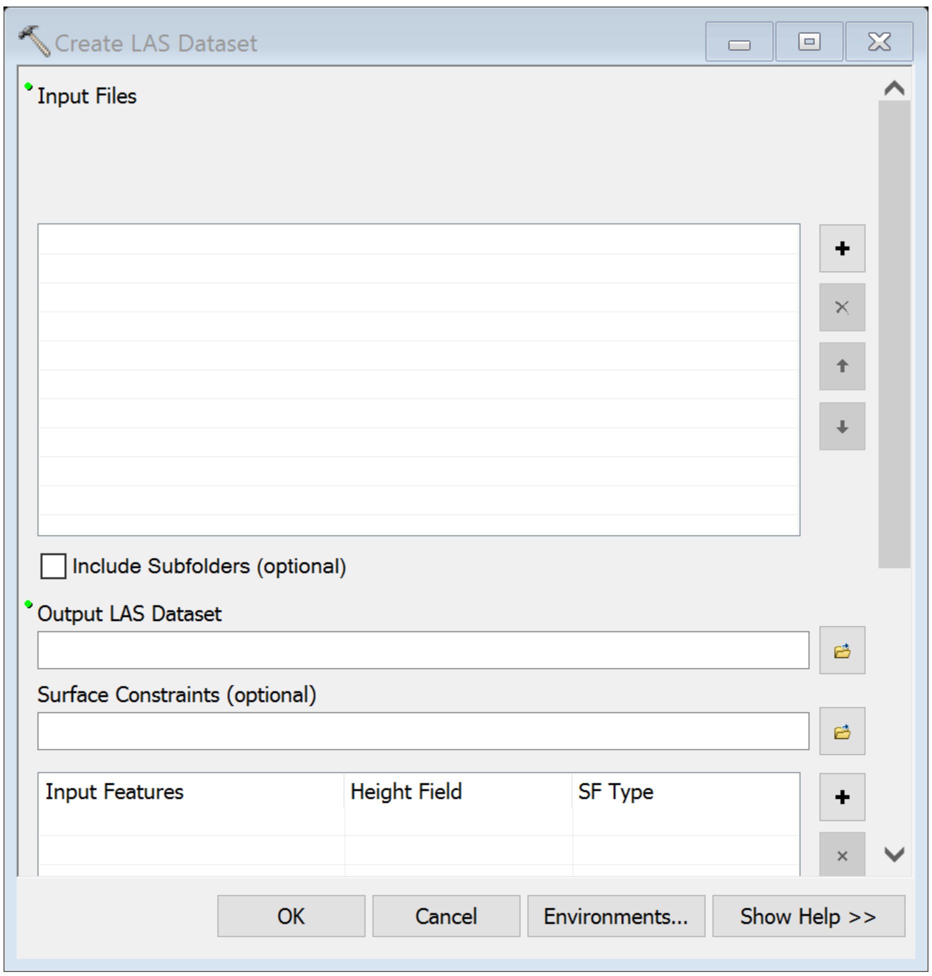
3. Rename the LAS dataset from **New Las Dataset** to an appropriate name for the project.
4. Double-click the new LAS dataset to open the **LAS Dataset Properties** dialog box.
5. Select the **LAS Files** tab to add LAS files to the LAS dataset. You can either select the **Add Files** button or the **Add Folder** button to add LAS files to the new LAS dataset.

6. Select the **Surface Constraints** tab to add additional surface constraint data to the LAS dataset.
7. Select the **Statistics** tab and click the **Calculate** button to create LAS auxiliary files that contain the statistical information and spatial index for the LAS file. Creating the LAS auxiliary files (.lasx) improves the overall performance of the LAS dataset. Exclude the calculation only if that data scan and computation requires too much time. The process to generate LAS auxiliary files does not take long; however, certain situations require immediate access to the data (for example, in emergency response applications).

Create a LAS Dataset using the geoprocessing tool

The Create LAS Dataset geoprocessing tool provides another means of constructing a LAS dataset, which can also be used to automate the process scripts and geoprocessing models. As a general rule, it is highly advised that statistics are computed. Exclude the calculation of statistics only if you have a need for rapidly accessing the LAS points and wish to avoid the time required for completing the calculations (for example, emergency response needs requiring immediate use of data collection).

Open the Create LAS Dataset tool in the **Data Management toolbox > LAS Dataset toolset**.

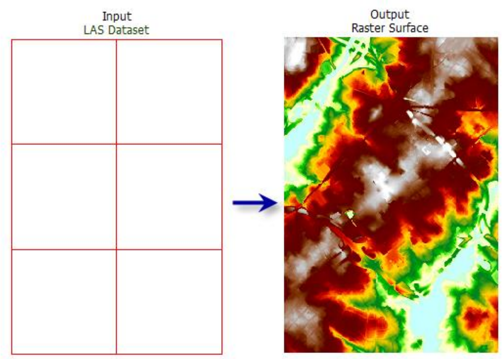


Creating lidar DEMs

LAS Dataset To Raster

http://desktop.arcgis.com/en/arcmap/latest/tools/conversion-toolbox/las-dataset-to-raster.htm

Creates a raster using elevation, intensity, or RGB values stored in the lidar points referenced by the LAS dataset



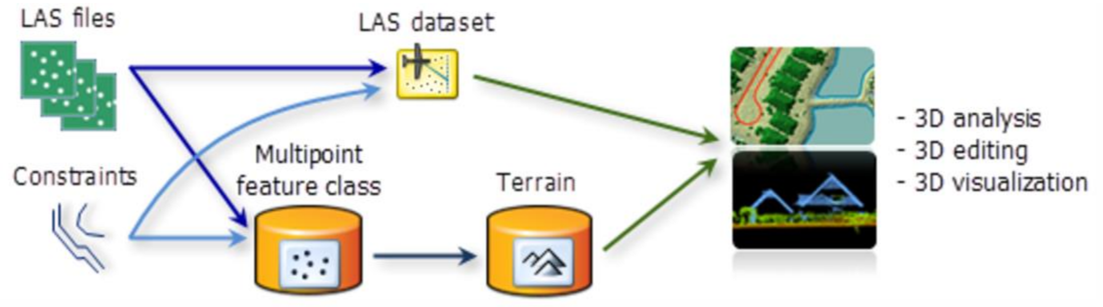
Creating intensity images from lidar

http://desktop.arcgis.com/en/arcmap/latest/manage-data/las-dataset/lidar-solutions-creating-intensity-images-from-lidar.htm

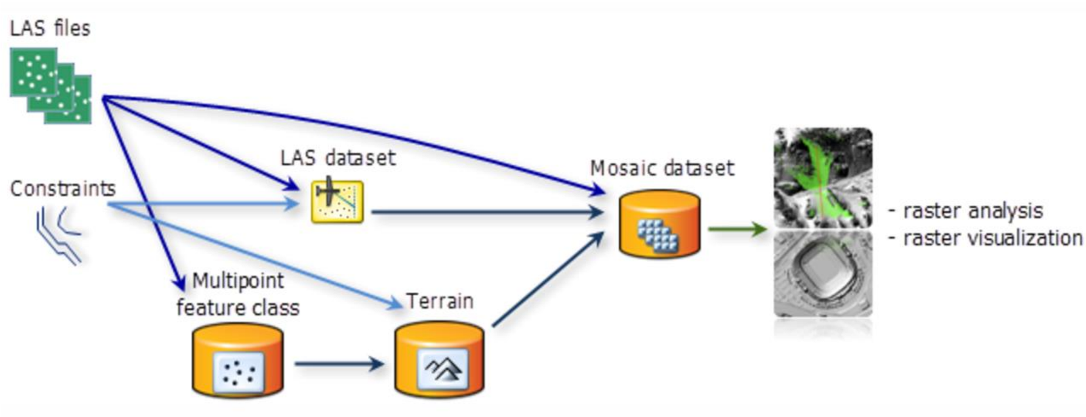
Import LAS files into multipoint features

- Build and manage a terrain dataset
- Use the multipoint features to build raster DEMs and DSMs
- Import LAS workflow through multipoints into a geodatabase based terrain dataset.

Using the ArcGIS 3D Analyst extension



Using the ArcGIS Spatial Analyst extension or raster tools



Managing multiple lidar collections