DTMs

ALS data can be used to create a number of products based on elevation data. The most common ALS product created is the bare earth DTM. The bare earth DTM provides the basis for analyses in hydrology, flood risk mapping, landslides, and numerous other fields.

Hydro-enforced DTMs include breaklines, importantly stream centerlines and edges, and breaklines delimiting standing water bodies such as ponds. While auto-extraction of breaklines is improving, the creation of hydro-enforcing features is still by and large a manual task.
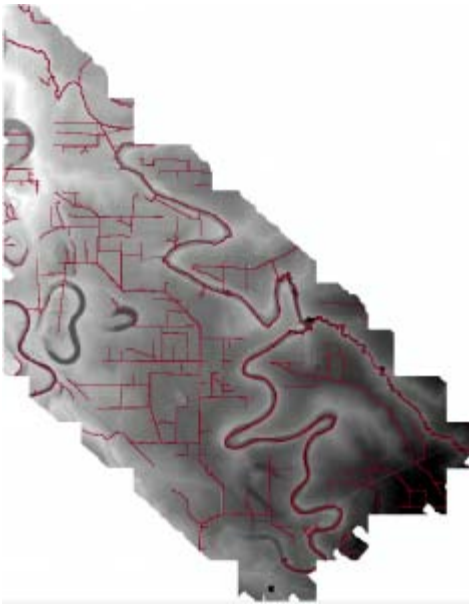

Deliverables include hydro-DTMs.

DSMs

Digital Surface Models (DSMs) can include only returns from the terrain, buildings and specific classes of off-terrain objects like bridges, or can also incorporate returns from vegetation. DSMs are commonly used in urban environment analyses such as noise pollution modeling and inter-visibility analyses to assess the impact of new building.
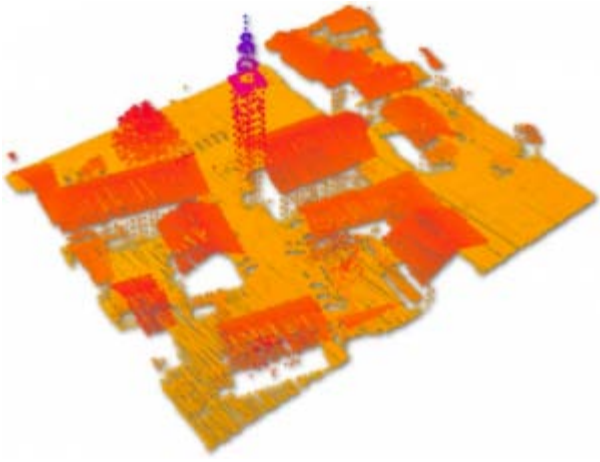
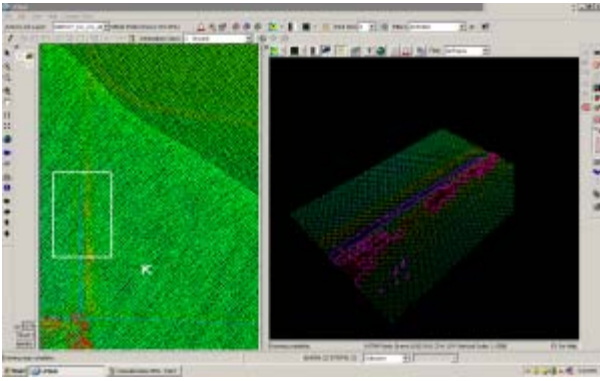DSMs are often used for modeling in urban areas.

CHM

Canopy height models, and per-stand or individual tree metrics are important ALS-based products for forestry applications. These models often include returns separated into low- mid- and high- vegetation classes, and are sometimes normalized based on local terrain heights to facilitate comparisons between different forest areas.
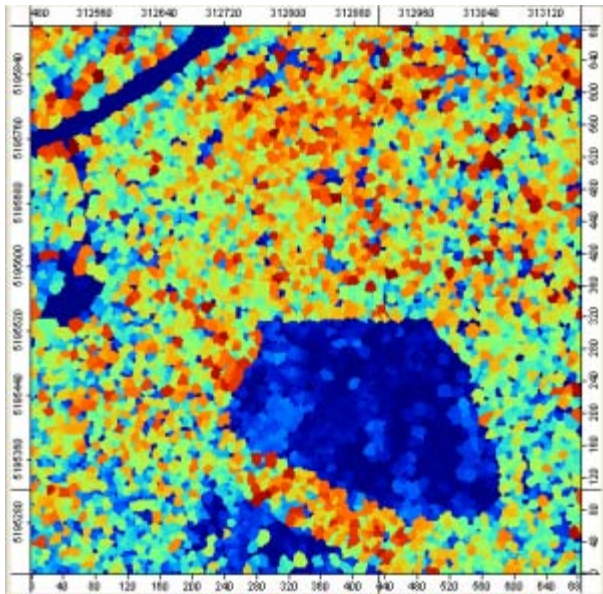
Canopy height model generated using SAGA GIS.

Contours

Contour maps at standard intervals, e.g. 1m, 5m, or 20m contours, can be generated from bare earth DTMs. Contour maps can be generated with or without breaklines.

Contours developed based on the terrain model.

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Initial Automatic Classification

In most ALS projects, in the first instance, the data is automatically classified. No automatic classification is perfect, and therefore visual assessment and the manual re-classification of some returns are important steps in the creation of a high quality hydro-enforced terrain model, and the development of other derivatives of ALS point clouds. The Bayou Meto terrain model developed at CAST was processed using TIFFS, a software program which implements a morphological filter. Other good low cost or open source software for automatic classification includes LASTools and MCC-Lidar.
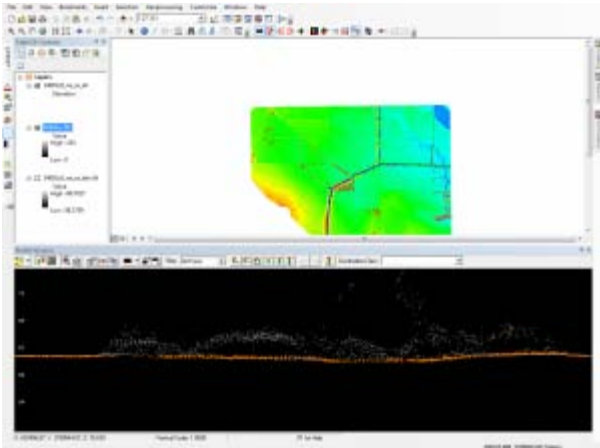
Automatically classified Point Cloud seen in profile. Terrain points (class 2) are orange, and off-terrain points are grey.

## Create DTMs and Hillshades

To facilitate visually identifying incorrectly classified returns, it's useful to interpolate the automatically classified ground points into a DTM, and to create basic hillshades. Many classification errors will be readily apparent in the hillshaded models. The DTMs for the Bayou Meto project were created using LP360 for ArcGIS.

Bare earth DTM created before
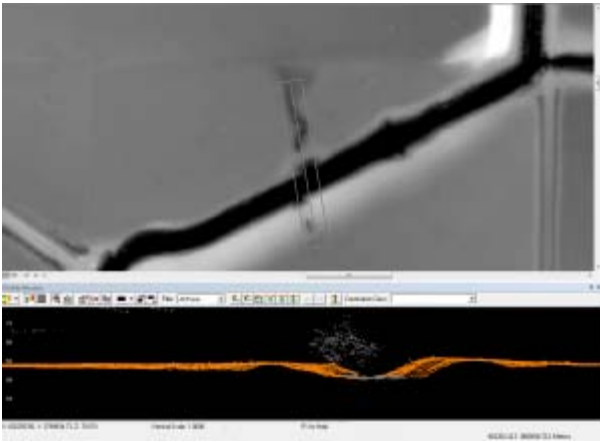manual re-classification.

Linked Viewers

Viewing the point cloud simultaneously with the hillshaded terrain model, you can navigate quickly to 'problem areas'
to re-classify any incorrect points in the ALS point cloud.
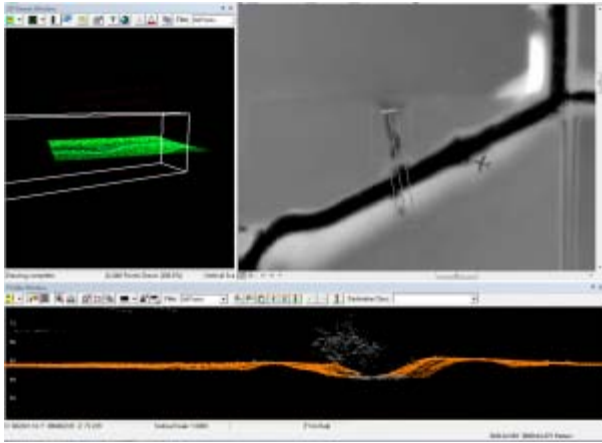
Linked viewers allow simultaneous viewing as
a 3d point cloud, in profile, and at a shaded
DTM.

Drawing Profiles

Draw a profile across an area of the terrain model where potential mis-classifications have been identified. Depending
on how regular the terrain surface is, set the depth of the profile. Areas where the elevation of the terrain varies
greatlygenerally require narrower profiles to clearly visualize the separation between the ground surface and low
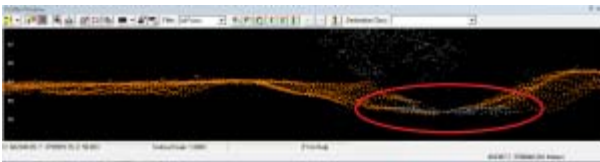vegetation.

Drawing the profile on the DTM.

Editing classifications

When editing the classification of the points it's best to set the point cloud coloring style to 'by class' rather than by elevation or by return, as it's then easier to see which points should be re-classified. In LP360 you can change the classification of points by selecting them in the profile view using a 'brush' or 'lasso' tool and then typing the number of the class they should be and hitting enter.
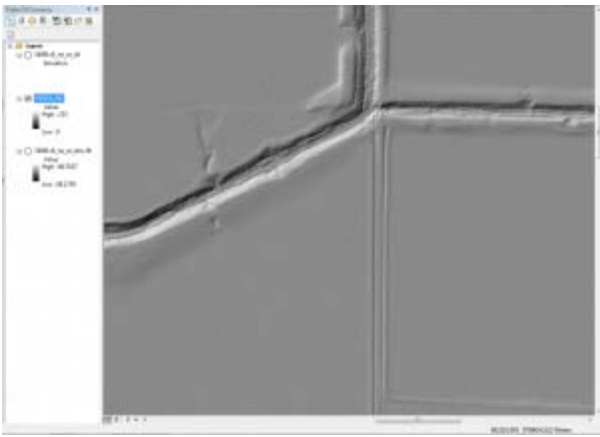
Typical problem areas

Work across the dataset systematically, until all problem areas have been improved. Note that areas with dense, low vegetation, large numbers of small buildings, and mixed steep slopes and vegetation are the most likely to contain mis-classified returns, and will require more effort. In the Bayou Meto dataset, the edges of streams proved typical problem areas, combining sloping terrain and low, dense vegetation.

Typical problem area circled in red, located under vegetation at the base of the slope.

Re-creating the terrain models

After re-classifying the ALS returns, it is necessary to re-create the terrain models and any other derivatives. These new models are the basis for further processing and analysis.

Hillshades and other derivatives are created
from the cleaned point clouds.

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ALS data

ALS data is often collected in strips, with each strip representing an individual flightline. Typical ALS surveys have at least 20% overlap between adjacent flightlines and a few cross-strips where data is collected at an orientation perpendicular to that used for the main survey, improving accuracy.
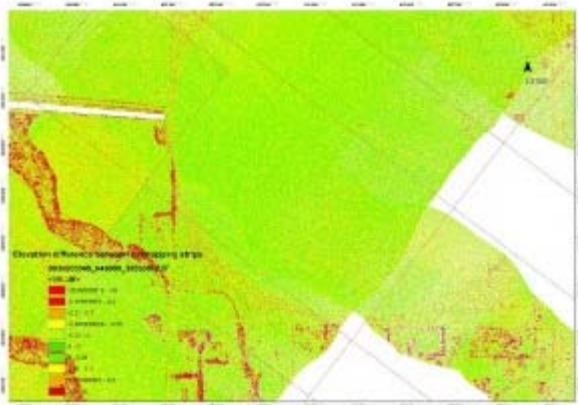
A tie strip can be seen here overlapping with
two flightlines.

Tile Schemes

Because ALS datasets are usually very large, they are often divided into regularly sized tiles. These tiling schemes can help with the speed of data loading, and allow users to load areas of the dataset selectively for processing or analysis.
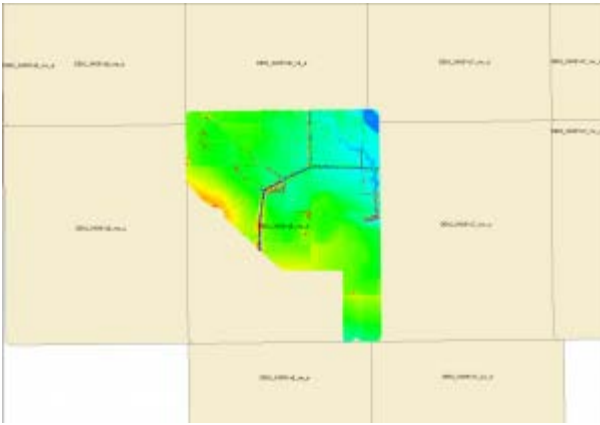
Tiles represent .las file locations, one file is loaded. Note that the tiles are regular rectangles, and don't always exactly match the extents of the .las file.

LP360 tiling tools

LP360, like most ALS software, provides tools to perform the tiling task. Typical tile sizes include 0.5×0.5km or 1x1km tiles. The naming convention for the tiles should follow a sensible progression, for example reflecting official map grid designations for the area, or following an east to west progressive sequence across the survey area.
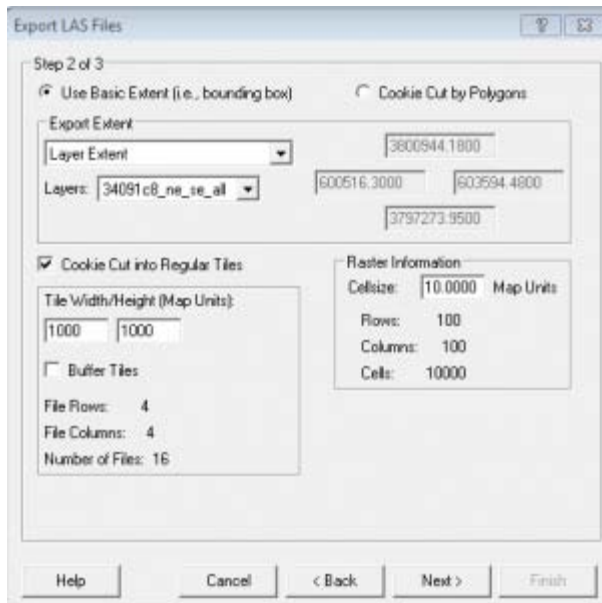
The LP360 .las subsetting tool

Creating Footprints

A vector file containing the footprints for each tile, designating the area covered and linking to the .las file or derived terrain models, are a common way of efficiently representing the ALS dataset in a GIS environment. Using LP360, individual files or groups of files can be loaded by selecting their footprints.

Las file footprints are outlined in dark blue; a selected footprint is highlighted.

Metadata

Metadata for ALS is typically generated for the entire survey, rather than per tile. This project level metadata is usually stored in a long form report. That said, some metadata will be stored in the .las header for each tile. Attributes including the total number of points in the file, whether or not it has been classified, and the software used to process the data are typical items found in the header. Further, non-standard, metadata can be stored as a series of attributes in the vector footprint for each .las tile.

Project level metadata provided by the vendor, Aeroquest, provides important information about the survey.

laz compression

The ASPRS standard .las format is commonly used for storing ALS data. The compressed .laz format is also useful, particularly for the datasets which are being archived. Data can be converted from .las to .laz (and back) using LASzip.

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