Identifying Riparian Vegetation with LiDAR Point Clouds

General guidelines and ArcGIS-specific instructions

This document outlines the procedure for generating a raster dataset that shows vegetative coverage in the riparian buffer using only a LiDAR point cloud.

Procedure

1. Obtain LiDAR data that covers your study area
   1. Many states host their own repository of LiDAR point clouds. Alternatively, LiDAR can be obtained from the National Map (<https://viewer.nationalmap.gov/basic/>)
   2. If your data is in .laz format, decompress it to .las format. If it is in .zlas format, RapidLasso’s LASLiberator can decompress from proprietary format to .las.
2. Generate primary rasters
   1. For each LiDAR point cloud, generate a digital height model (DHM) and return splitting raster. This can be done in ArcGIS, QGIS, Whitebox, or another geospatial software package. A digital height model represents the elevation of any structures rising above the bare earth (such as tree canopies) and a return splitting raster represents that average number of LiDAR returns at a given point.
      1. Generating the DHM
         1. Filter the LiDAR point cloud so only last-return elevations remain. Optionally apply an additional filter that keeps only points classified as ‘Ground’ or ‘Unclassified’. Convert this to a raster using the interpolation algorithm of your choice and elevation as the parameter for export. The resulting raster is a digital elevation model (DEM).
         2. Remove the previous filters. Filter the LiDAR point cloud so only first returns remain. Convert this to a raster using the interpolation algorithm of your choice and elevation as the parameter for export. The resulting raster is a digital surface model (DSM).
         3. Using a raster calculator tool (or similar tool), subtract the DEM from the DHM. The resulting raster is the DHM.
         4. (OPTIONAL) Instead of generating a separate DHM and DSM, some GIS programs have implemented a white top-hat transformation that can be applied to LiDAR data. The resulting point cloud—when converted to a raster using elevation as the export parameter—is a DHM.
      2. Generating the return splitting raster
         1. Convert the LiDAR point cloud to a raster using the interpolation algorithm of your choice and number of returns as the parameter for export. The resulting raster is a return splitting raster.
            1. NOTE: Most geospatial software does not natively support creating rasters using anything but elevation or return intensity as the parameter for export. To get around this, use a command-line tool like las2txt to convert the .las point cloud to a text file, and then use the inverse of that tool (e.g., txt2las) to convert it back to .las. When reconverting, swap that columns for elevation (z) and return number (n) so that the program is “tricked” into thinking the return numbers are actually elevations. You can then convert the LiDAR point cloud to a raster using “elevation” (return number) as the parameter for export.
3. Use raster math to generate coverage raster
   1. Using a raster calculator tool (or similar tool), apply the following formula:

where *p* is the coverage raster, *d* is the DHM and *n* is the return splitting raster. In general, *x* is a value between 2 and 4 meters and *y* is between 1.3 and 2. The ideal values for *x* and *y* will vary depending on the exact nature of the study site.

* 1. The output of this calculation will be a Boolean (True/False) raster showing whether or not a particular cell is covered by vegetation.
     1. Depending on the results, you may wish to smooth/generalize the raster output. One options is *Sieve* in GDAL (and QGIS). A similar result is achievable in ArcGIS but involves multiple tools.

1. Clip study area to riparian buffer
   1. Using a vector file that delineates the riparian buffer, clip your coverage raster to the extent of the riparian buffer.