StreamBurningwND -
Stream burning with national dataset with ArcGIS Pro 3.0 (Version 1.0)

Introduction

This manual describes a hydro-correction tool that utilizes national datasets published by U.S. federal agencies. The aim of hydro-correction is to modify digital elevation models (DEMs) to improve the accuracy of hydrological modeling. Common hydro-conditioning techniques include sink filling, stream burning, and ridge walling. The stream burning process entails integrating vector streamlines into a DEM layer to either lower the elevation at streamline locations or raise the surrounding terrain.

Allen and Howard (2015) devised a stream-burning technique employing high-resolution airborne Light Detection and Ranging (LiDAR) DEMs for a low-lying region in northeastern North Carolina, complemented by ditch features from the National Hydrography Dataset (NHD). This ArcGIS tool is built upon their research. The toolbox encompasses four codes. Refer to the flowchart (Figure 1) for a detailed overview of the processes.

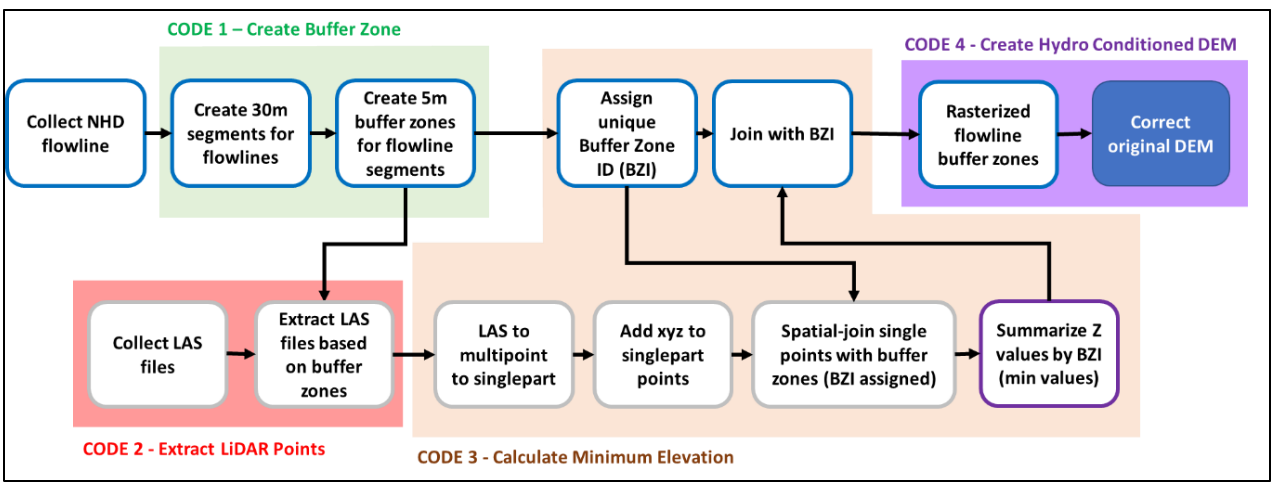


Figure 1. Detailed flow chat for four codes included in StreamBurningwND.

For your practices, we also include a sample dataset for a watershed in Norfolk, Virginia. These files including:

1. **Five Las files**: Light detection and ranging (LiDAR) point clouds data from The National Map v2. (https://apps.nationalmap.gov/downloader/).
2. **NHDFlowline_Sample.shp**: National Hydrography Dataset (NHD) Flowline from The National Map v2 (https://apps.nationalmap.gov/downloader/).
3. **NOAA_SLR_3mDEM_Sample.tif**: A 3-m digital elevation model (DEM) from NOAA Sea Level Rise Data Download (https://coast.noaa.gov/slrdata/).
4. **StreamBuringwND.atbx**: A Toolbox for stream burning with ArcGIS Pro 3.0.

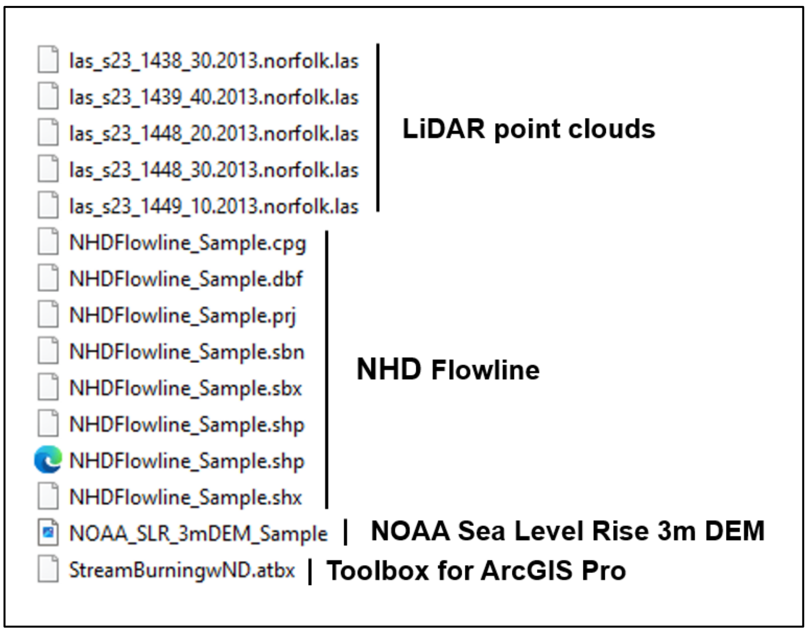
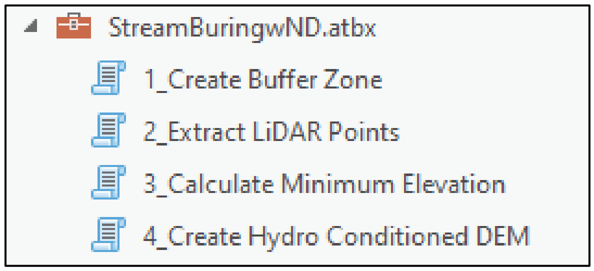


Figure 2. Sample files and a toolbox provided in this use case.

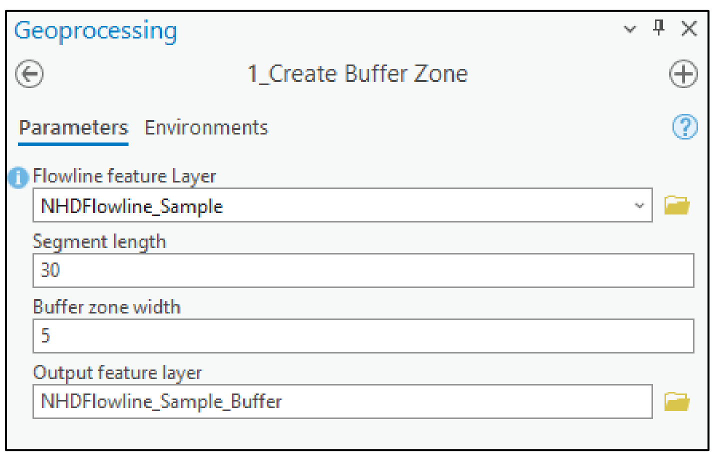
- Before running this tool, make sure your ArcGIS Pro is licensed with **3D Analyst** and **Spatial Analyst** Extensions.

How to use?

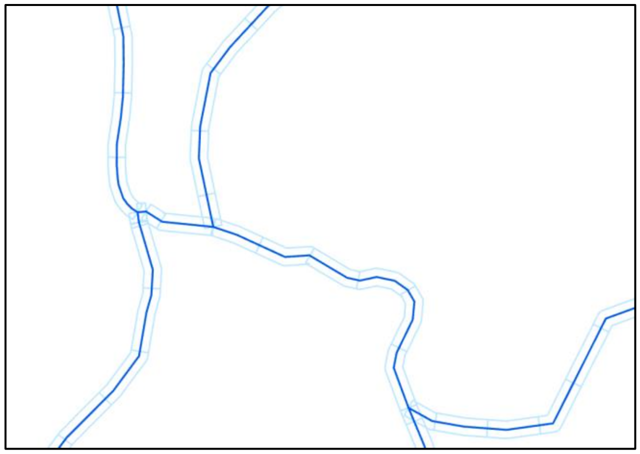
1. Unzip the file and add the "*StreamBuringwND.atbx*" toolbox into ArcGIS Pro by right clicking the Toolboxes and selecting "Add ToolBox" in Catalog pane. You should see 4 script-based tools showing in the added toolbox.



2. Save sample files in a proper place. Create a geodatabase for data processing. Here a geodatabase named "*StreamBurningToolSample_Project*" is created and used in following steps. Make sure you save all feature layers into geodatabase.
3. Run "**1_Create Buffer Zone**" tool (**Code 1**)
   - This tool creates buffer zones based on the NHD flowline.

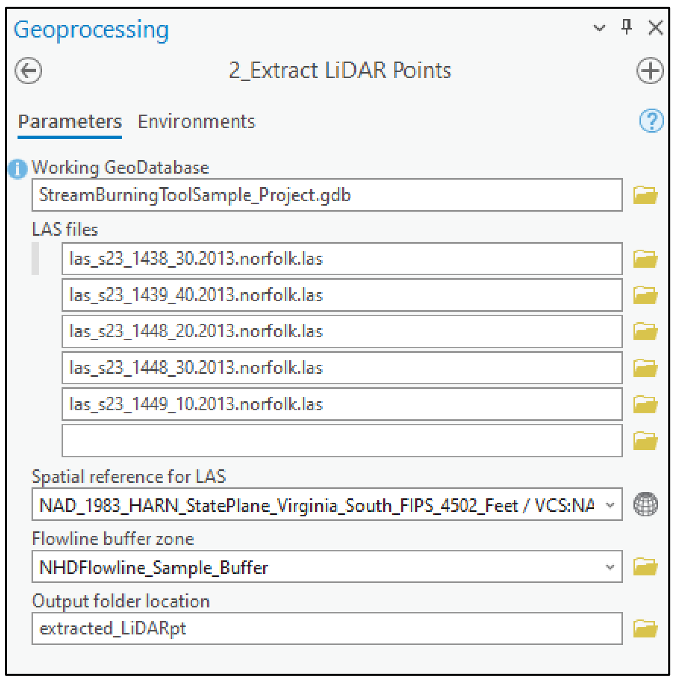


   - For flowline feature layer, select "*NHDFlowline_Sample*". You can change the segment length and buffer zone width if desired.
   - Save file as "*NHDFlowline_Sample_Buffer.*"



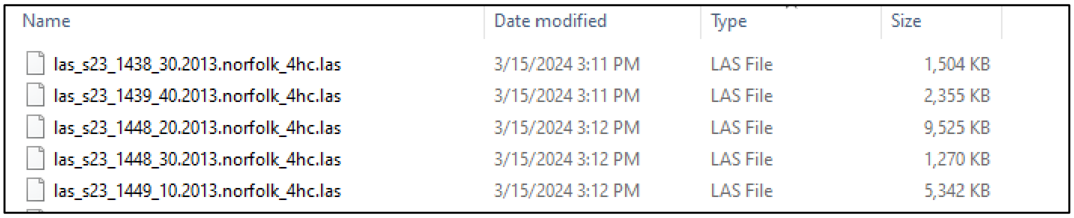
- Buffer zones (light blue) are created based on the NHD flowline (dark blue)

4. Run "**2_Extract LiDAR Points**" tool (**Code 2**)
    - This tool extracts LiDAR point clouds based on the flowline buffer zones.



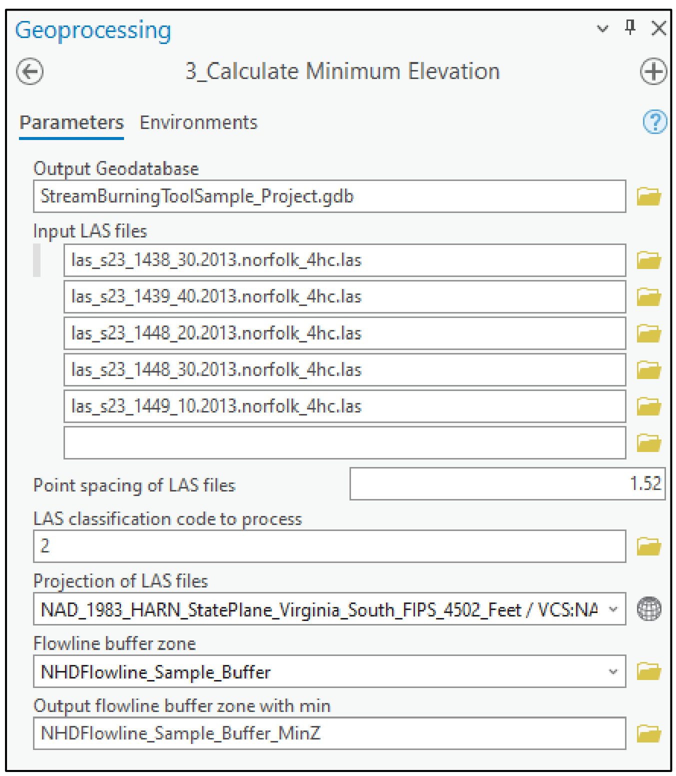
- For the Working GeoDatabase, select "*StreamBurningToolSample_Project*".
- Add the LAS files from the sample layer folder.
- For the spatial reference, select "*NAD 1983 HARN StatePlane Virginia South FIPS 4502 (US Feet)*." Note that this coordinate system is specific for the LAS file applied in this use case. For future applications, you must find out what the coordination system is for the LAS file.

- For the Flowline buffer zone field, select "*NHDFlowline_Sample_Buffer.*"
- Finally, select a folder for the output of extracted LiDAR point clouds. It's suggested to create a separated folder. Here a folder names "*extracted_LiDARpt*" is created for outputs.



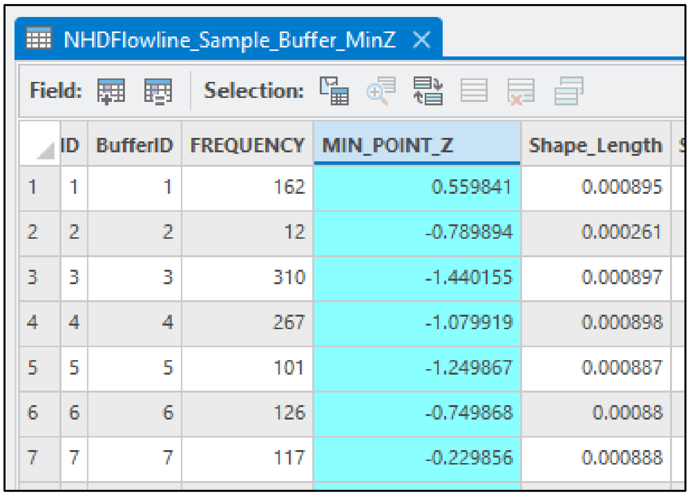
- Five new LAS files are created. "*_4hc*" is added behind the original file name.

5. Run "**3_Calculate Minimum Elevation**" tool (**Code 3**)
    - This tool computes the minimum value within each flowline buffer zone based on the extracted LiDAR point cloud.



- Select "*StreamBurningToolSample_Project*" for output location.
- Selected the extracted LAS files (…*_4hc.las*) as the input LAS files.

- The average point spacing for these LAS files is approximately 1.52. You can find this information by creating a las dataset. See Assessing lidar coverage and sample density.
- The projection is "*NAD 1983 HARN StatePlane Virginia South FIPS 4502 (US Feet)_1*" and select "*NHDFlowline_Sample_Buffer*" as the Flowline buffer zone.
- Finally, save the output as "*NHDFlowline_Sample_Buffer_MinZ.*"

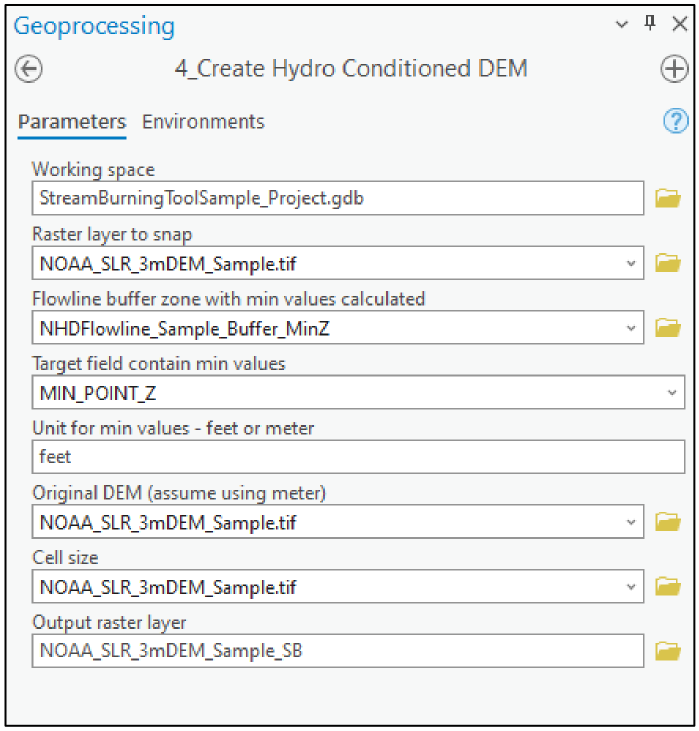


	ID	BufferID	FREQUENCY	MIN_POINT_Z	Shape_Length
1	1	1	162	0.559841	0.000895
2	2	2	12	-0.789894	0.000261
3	3	3	310	-1.440155	0.000897
4	4	4	267	-1.079919	0.000898
5	5	5	101	-1.249867	0.000887
6	6	6	126	-0.749868	0.00088
7	7	7	117	-0.229856	0.000888

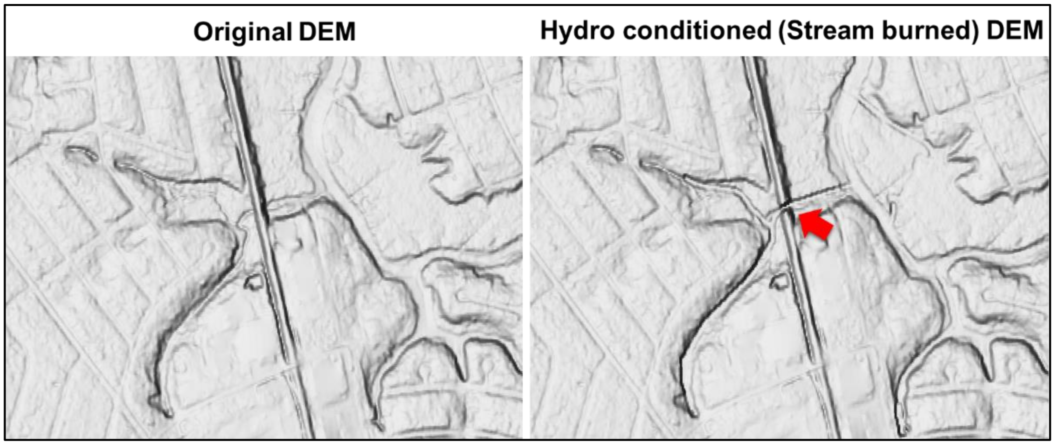
- This tool writes a new column "*MIN_POINT_Z*" which indicate the lowest elevation value within each flowline buffer zone.

6. Run "**4_Calculate Minimum Elevation**" tool (**Code 4**)

- This tool burns the flowline buffer zones onto the original DEM.



- Select "*StreamBurningToolSample_Project*" for working space.
- Select "*NOAA_SLR_3mDEM_Sample.tif*" for snap option.
- Select "*NHDFlowline_Sample_Buffer_MinZ*" for the Flowline buffer zone with min values calculated. Once select the layer, select "*MIN_POINT_Z*" for Target field contain min values.
- For the Unit, use the default unit, feet. Note that here feet is applied because the elevation unit of sample LAS files is feet.
- Select "*NOAA_SLR_3mDEM_Sample.tif*" for Original DEM and Cell size.
- Finally, name "*NOAA_SLR_3mDEM_Sample_SB*" as the output hydro corrected DEM.



- The hillshade on the right-hand side depicts the flowline buffer zones "burned" onto the original DEM, facilitating the connection of the stream across the road (see red arrow).

Reference

Allen, T. R., & Howard, R. (2015). Improving Low-Relief Coastal LiDAR DEMs with Hydro-Conditioning of Fine-Scale and Artificial Drainages. Frontiers in Earth Science 3. 10.3389/feart.2015.00072