Toolkit for Assessing and Monitoring Stream Channels and Riparian Corridors Using LiDAR

Dyan Pursell, GIS Specialist
• FY16 Learning Project
• GIS based Toolkit
• Riparian corridor condition assessment
• Sites of bank instability
• Model headcuts
• Prioritize where Best Management Practices would be most effective
• Transferability
LiDAR Overview
Missouri LiDAR
msdis.missouri.edu

Extents of LiDAR Available For Download
As Of
17 August 2017

Lidar
Derived DEM Only

Jointly hosted by
MSDIS
and
Washington University
Grand River Grasslands
GRG LiDAR

- QL0 at lower elevation
- 3.5 cm RMSE vertical accuracy
- 15.24 cm RMSE horizontal accuracy
- Flown in December for Leaf Off
- Flown in May for Leaf On
- $170,000
- Deliverables: raw LiDAR points, .5m DEM
Tools Included

• Create DEM from LiDAR
• Create DSM from LiDAR
• Create Vegetation Height Raster
• Aspect
• Hillshade
• Slope
• Get Filled Flow Direction
• Make Streams
• Bankfull
• Stream Shade
• Vegetation Stats by Catchment

• Assign Stream Gradient
• Assign Stream Order
• Assign Flow Direction
• Sinuosity
• Measuring Stream Incision
• Landcover
• Headcut Finder
• Locating Ephemeral Gullies
• Cross-section
• Gradient Plot
DEM Comparison
Stream Channel and Riparian Corridor Toolbox

STREAM CHANNEL AND RIPARIAN CORRIDOR TOOLBOX

This is an instruction manual for using the Stream Channel and Riparian Corridor Toolbox created by Resource Science Div. staff for the Missouri Department of Conservation.

Dawn Pursell & Ryan W. Rowan
With assistance from: Alice Strickhoff, Chris Poyet, David Bajcicky, and Lena Ventrella

Figure 11. Double click on LAS Dataset to open it. On the LAS (Figure 13). On the Statistics tab, select Calculate button. OK.

10. Run these tools first.

Input LAS Dataset. Define path and name of Output in creation name. Do not begin the name with a number. Using value. Change Sampling Value to 1. OK.
DEM & DSM Production

**DEM** = **LiDAR** = **DSM**

**LiDAR**
- Last Returns
- First Returns

**ERDAS Imagine 2016**
Point Cloud > Tools > Filter

**ArcCatalog**
New LAS Dataset > LAS Dataset to Raster
Generating Vegetation Height Raster

ArcMap > Raster Calculator > Conditional Statements

Conditional statements remove negative values and higher elevation noise.
Aspect, Slope, and Hillshade

DEM

Aspect
Slope
Hillshade
Creating a Hydrologically Sound DEM

DEM ➔ Resample ➔ Resampled DEM ➔ Flow Dir ➔ Flow Dir ➔ Sink ➔ Sink

Zonal Statistics

Zonal Fill ➔ Sink Min Elev

Sink Max Elev ➔ Minus

Minus ➔ Fill ➔ Z limit for Fill ➔ Fill ➔ Flow Dir ➔ Filled Flow Dir
Make Stream Tools

Filled Flow Dir → Flow Accum → Flow Accum → Con > # = Raster → Reclassify → Make Streams

Make Streams

Make Streams is tool 2 of 2 needed to create streams from a DEM. Its inputs are the Filled Flow Direction raster created by the Filled Flow Direction tool, a flow accumulation threshold value, a geodatabase to place all of tool’s outputs, and a naming field that assigns a uniform naming prefix to each of the outputs.

The tool outputs include:
- Flow_Accum: a Flow Accumulation raster
- Reclassified_FlowAccum: a reclassified version of Flow Accum
- Arcified_FlowAccum: a reclassified version of Flow Accum
- Arcified_FlowAccum: a reclassified version of Flow Accum
- Arcified_FlowAccum: a reclassified version of Flow Accum
Extracting Bankfull and Active Channels Polygons using Lidar Data

By: Ryan Wortmann
Goal of Project

- Create a python script tool that can automatically extract bankfull and active channel polygons.
- Make tool easy to use for novice GIS users.
- Make tool able to produce an accurate output while at the same time taking a reasonable amount of time to process.
Why Do This?

- Outputs allows the potential to monitor riparian corridors
- Allows Vegetation Statistics to be calculated for each stream segment and catchment
- Normally this process is digitized by hand and would take many man hours to complete.
What is Bankfull?

- Bankfull is the point in a stream channel where water would spill out onto the floodplain.
- An abrupt slope break usually indicates the edge of bankfull.
What is Active Channel?

- The visibly definable channels in stream beds
- When water is not flowing through them they typically consist of sand, gravel, dried mud, or barren bedrock
Sample Output of Tools
Goal of Extract Active Channel Tool

- Extract areas of lowest elevation around streamlines
- Extract data so that active channel polygons come out as continuous as possible without over extracting.
- Make extracting Bankfull polygons much easier and more accurate.
Input: Streamlines from Make Stream Tool
Input: Digital Elevation Model
Workflow

- Place a point every 20 meters on streamlines
Workflow

- Create a 10 meter buffer around every point on the streamlines
Workflow

- Mask the input DEM to the streampoint buffers
Workflow

- Use **Raster to Point** to place a point at the center of every cell in masked DEM. Point will contain cell’s elevation.
Workflow

- Use **Raster to Polygon** on buffers to create OBJECTID raster.
Workflow

- Use **Zonal Statistics** on streampoint buffers to obtain minimum elevation inside each buffer.
Workflow

- Use **Extract Multivalues to Points** to extract Buffer OBJECTID and Minimum Elevation to each point created by **Raster to Point**.
## Workflow

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Workflow

- Iterate through every buffer OBJECTID and add points to Active Channel point list that are no greater than 0.5 meter of the buffer neighborhood minimum elevation.
- Extract points in list to their own feature class.
Workflow

- Use **Aggregate Points** to create polygons from the point data.
Extract Active Channel Sample Output
Extract Active Channel Sample Output

- Active_Channel_Polygons
- Slope

Value
- High: 70.7129
- Low: 0
Flaws in tool

- Inaccurate in cases where the streamlines drawn by Make Streams tool veer too far away from where the stream channel actually exists.
- Tool still needs to be tested on areas with wider streams where buffer width may be too small to include the entire stream.
- Small gaps sometimes occur due to sudden change in elevation in buffer neighborhoods.
Extract Active Channel Sample Output
Make Bankfull Polygons

- Now that Active Channel is extracted, it is much simpler to extract Bankfull Polygons.
- Use Make Bankfull Polygons custom script tool to do this.
Sample Output of Extract Bankfull Polygons
Input: Slope
Input: Active Channel Polygons

- Active Channel Polygons
Workflow

- Calculate Slope from DEM.
- Place a 10 meter buffer around the Active Channel Polygons.
Workflow

- Mask Slope Raster to Active Channel Polygon buffers
- Convert to points using Raster to Point
Workflow

- Use Select By Attribute to select all points with >=20 degree slope, extract to separate feature class, and use aggregate points to convert them into polygons.
Final Result Sample
Final Results Sample
Final Results Sample
Final Result Samples
Final Results Samples

- Active_Channel_Polygons
- Bankfull
Possibilities for this data

- Monitoring Riparian Corridor
- Calculating Vegetation Statistics for stream segments and catchments.
- Experimenting with these outputs to build another script tool that can identify headcuts.
Stream Shade

- Make Streams
- Stream Segmentation
- Bankfull
- Segmented Bankfull
- Veg height with predefined values
- Zonal Statistics

Stream Shade

This tool allows the user to determine the percentage of which each stream segment polygon is shaded. The tool's only output is a polygon feature class that is the input Bankfull polygons segmented by stream segment. Each polygon will have the percentage that is it shaded in the feature class's attribute table. The polygon feature class will be shaded.

- Streamlines
- Bankfull Polygon
- Vegetation Raster
- Workspace
- Naming

OK Cancel Environment... <<Hide Help
Measuring Stream Incision

A Python Add-in Toolbar
Tools in Progress
Generating Objects and Land Cover Classification

CIR

Imagine Image Segment.

Objects

Custom Python Script (still in development)

LULC
Locating Possible Headcuts - Redesign (in progress)

Custom Python Script Headcuts

Bankfull

Potential Headcuts

Headcut Finder

Headcuts are erosional features of streams where an abrupt vertical drop occurs. Headcut Finder identifies these areas by taking an input line feature class representing a network of streams and placing points on the lines a user specified distance width apart. A Digital Elevation Model (DEM) is then used to give the points an elevation value. These points are outputted to the output geodatabase and will have an attribute field labeled "Elevation" that contains the elevation of each point in meters. The tool then looks for neighboring points that have a greater than 2 inch difference in elevation and outputs these points to the output geodatabase.
Locating Ephemeral Gullies (in progress)
Cross-section (in progress)
Gradient Plot (in progress)
Answering Questions

- LULC
- Parcel Data
- Riparian Zones
- Stream edge farming

[Map showing LULC, Parcel Data, Riparian Zones, and Stream edge farming]
Answering Questions

- LULC
- Plus
- Low Veg or Understory

Close crop, understory density, riparian corridor width, etc.
Answering Questions

DEM

Slope

Bank instability
Tools Included

- Create DEM from LiDAR
- Create DSM from LiDAR
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- Assign Stream Gradient
- Assign Stream Order
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- Cross-section
- Gradient Plot
Challenges

- Software Licensing limitations
  - Advanced Arc license necessary
  - ERDAS license necessary

- Building for inexperienced ESRI users

- Lack of LiDAR\Python experience
  - Didn’t know what QL needed
  - Team had to learn Python

- Processing Power

- Digitizing Stream Banktops
  - No process could be found, resulting in custom Python script

- Digitizing Headcuts
  - No process could be found, resulting in custom Python script

- 2,000+ man hours so far
Questions?