Details of microshed delineation

Generating microshed lines on the Little Miami River watershed (LMR) required the use of ArcHydro tools. Hydrologic unit boundaries, or drainage areas, coinciding with valley peaks were generating by the user defining a minimum stream threshold. These drainage areas were created by taking the following steps:

1. Filled the 1/3 arc second DEM (source: http://ned.usgs.gov/)
2. Created the standard 8 directional flow matrix
3. Generated the flow accumulation grid
4. Used the 'Stream Definition' tool using a 2km stream threshold. This threshold defines the minimum drainage area need to define a stream
5. Ran the 'Stream Segmentation' tool using the flow direction grid and stream grid layers as inputs
6. Ran the 'Catchment Grid Delineation' tool using the flow direction grid and link grid created from the stream segmentation.
7. Transformed the catchment grid raster to a polygon using the 'Catchment Polygon Processing' tool
8. Convert polygon to line features
9. Erased all line features within the valley floor polygon

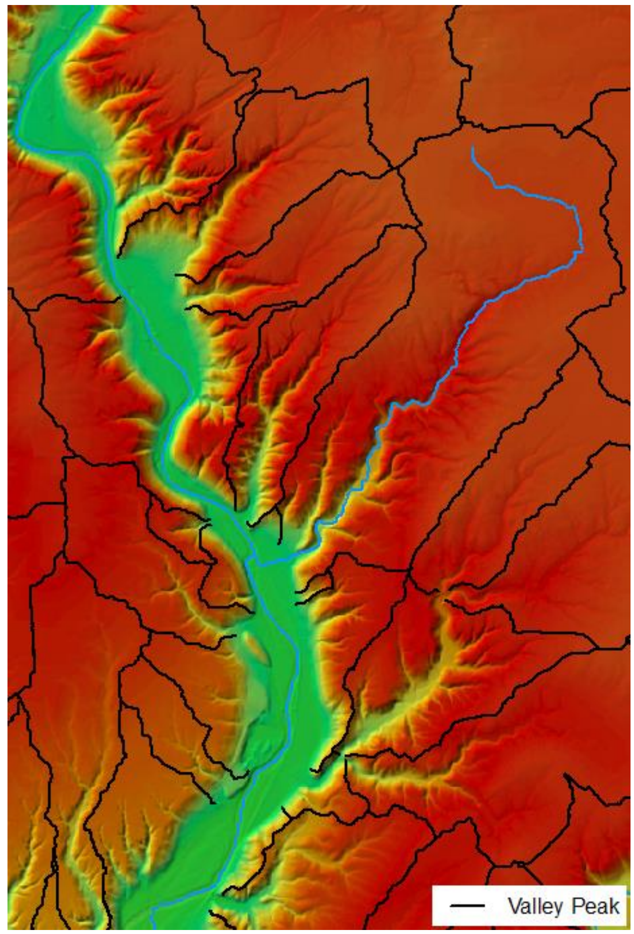
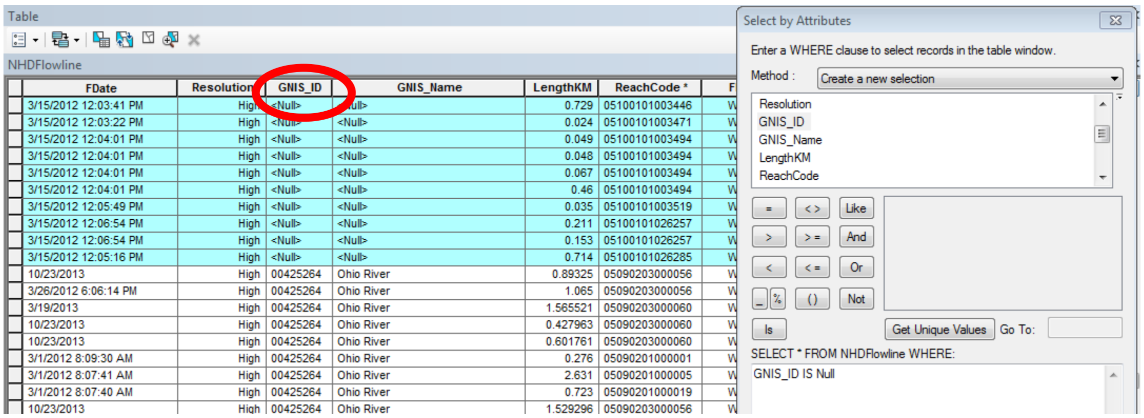


Figure 1 Example of microsheds

The line segments that remain were used to identify valley peaks. The microshed boundaries essentially envelop the valley walls on both sides of the channel. For any particular valley location on the two sided transect, elevation values at these lines and horizontal separation between these lines enable automatic estimation of valley width (VW), the ratio of VW and VFW (VW_VFW), and left and right valley side slopes (LVS and RVS).

NHD Conditioning

The RESonate tool requires that the input stream line be a single continuous line for each unique stream. The National Hydrography Dataset (NHD) was reconditioned in order to run the RESonate toolbox. All GNIS_ID field with <Null> values in the 'NHD_Singleline' feature class were deleted.



FDate	Resolution	GNIS_ID	GNIS_Name	LengthKM	ReachCode *	F
3/15/2012 12:03:41 PM	High	<Null>	<Null>	0.729	05100101003446	W
3/15/2012 12:03:22 PM	High	<Null>	<Null>	0.024	05100101003471	W
3/15/2012 12:04:01 PM	High	<Null>	<Null>	0.049	05100101003494	W
3/15/2012 12:04:01 PM	High	<Null>	<Null>	0.048	05100101003494	W
3/15/2012 12:04:01 PM	High	<Null>	<Null>	0.067	05100101003494	W
3/15/2012 12:04:01 PM	High	<Null>	<Null>	0.46	05100101003494	W
3/15/2012 12:05:49 PM	High	<Null>	<Null>	0.035	05100101003519	W
3/15/2012 12:06:54 PM	High	<Null>	<Null>	0.211	05100101026257	W
3/15/2012 12:06:54 PM	High	<Null>	<Null>	0.153	05100101026257	W
3/15/2012 12:05:16 PM	High	<Null>	<Null>	0.714	05100101026285	W
10/23/2013	High	00425264	Ohio River	0.89325	05090203000056	W
3/26/2012 6:06:14 PM	High	00425264	Ohio River	1.065	05090203000056	W
3/19/2013	High	00425264	Ohio River	1.565521	05090203000060	W
10/23/2013	High	00425264	Ohio River	0.427963	05090203000060	W
10/23/2013	High	00425264	Ohio River	0.601761	05090203000060	W
3/1/2012 8:09:30 AM	High	00425264	Ohio River	0.276	05090201000001	W
3/1/2012 8:07:41 AM	High	00425264	Ohio River	2.631	05090201000005	W
3/1/2012 8:07:40 AM	High	00425264	Ohio River	0.723	05090201000019	W
10/23/2013	High	00425264	Ohio River	1.529296	05090203000056	W

Figure 2 NHD attribute table

RESonate's PrepareHydrography tools require there to be a unique GNIS ID, used as the dissolve field, essential for creating equal distance transect lines on NHD features. Eliminating the GNIS IDs with <NULL> values created a less dense, but still contiguous, stream network.

Details of channel belt construction process

Channel belts, or meander belts, defines the area in which river processes have or can potentially occurred. Accurately defining the channel's meander belt is essential for measuring the watercourse width because it is expected to move and change within the meander belt.

Creating the NHD meander belts in the LMR required the valley floor layer to be created first because the meander belt can only occupy the space within the valley floor. Valley floors act as a confining layer, defining the maximum potential meander amplitude.

The belts were digitized using the valley floor layer, 10 meter DEM, and NHD as reference layers. Lines were drawn connecting local maximum meanders to the nearest local maximum meanders for the left and right sides of NHD stream lines. All meanders on the stream channel were contained entirely within the channel belt envelope—the envelope was completely contained by the valley floor.

Not all streams had channel belts digitized. Streams constrained by constricted valleys did not have a channel belt drawn. Likewise, streams that appeared to have been channelized, appearing unnaturally straight, did not have meander belts drawn.

A 'side' field in the attribute table was added to the meander feature class. This field was populated with either "right" or "left" identifying the side the meander line was on. This field is required in the RESonate tool.

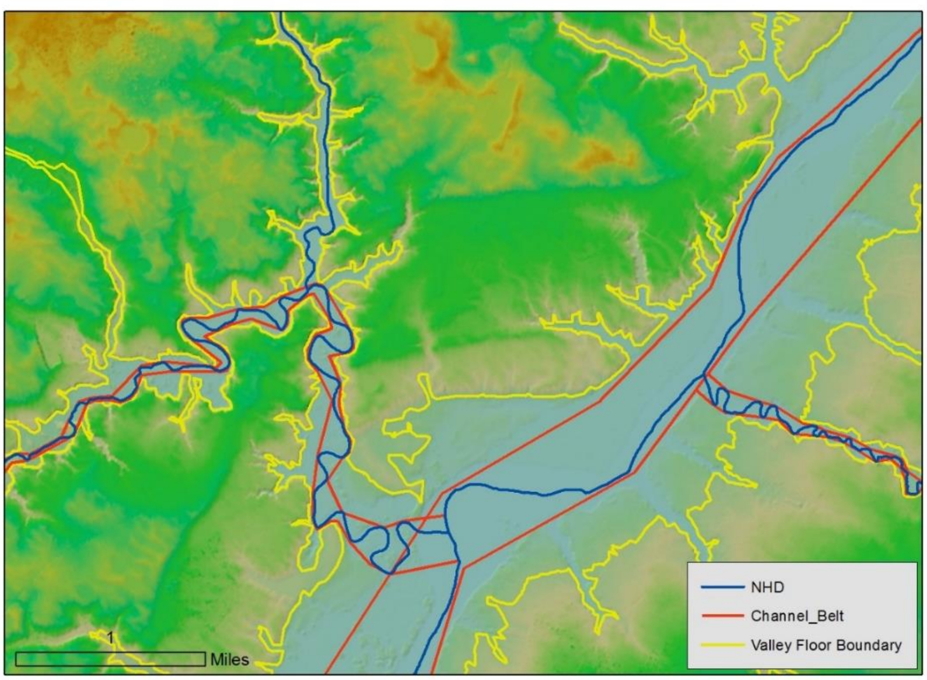


Figure 3 Example of digitized meander belts

Details on how/why transects were fixed and an estimate of how many were fixed manually

Transects were oriented on a generalized stream line, created in RESonate, following parallel to the river's valley (figure 4). The generalized valley line irons out the sinuousness of the NHD stream lines. This allows transects to be placed perpendicular to the river's valley rather than the NHD streamline itself. A perpendicular transect to the river valley most accurately captures the hydrogeomorphic variables being measured—valley floor width, valley peak width, ratio of valley peak to valley floor, left side slope, right side slope, and channel belt width.

Although the transects generated using the generalized stream network better approximates perpendicularity to the valley than using the NHD stream line, some manual adjustments of the transect orientation were made on the LMR dataset. Estimate on how many transects were manually adjusted: 1/4-1/3

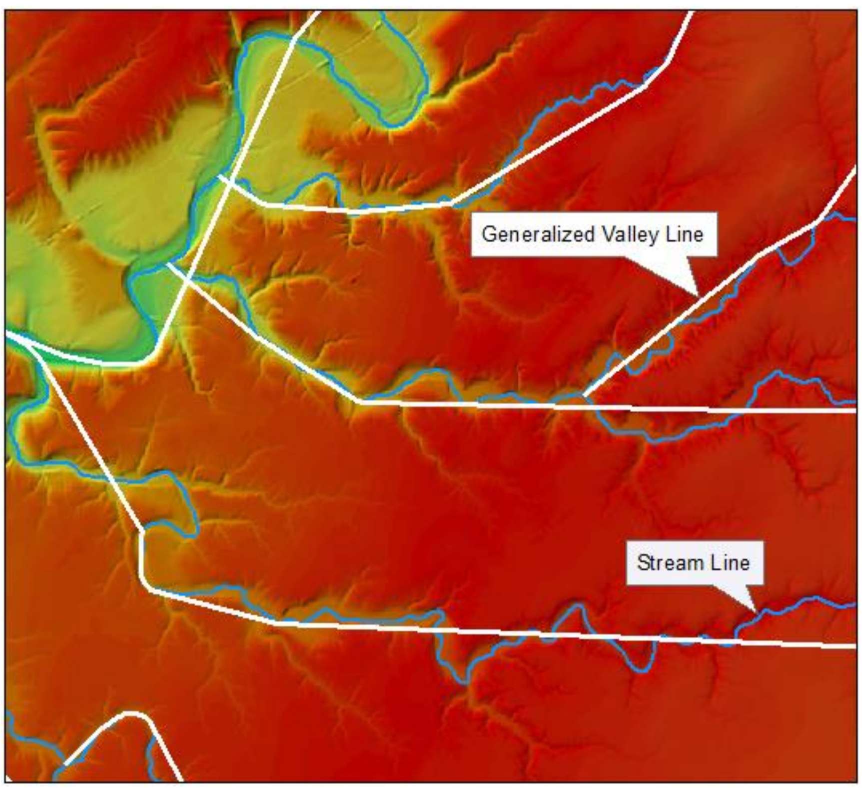


Figure 4 Example of RESonate generated valley lines

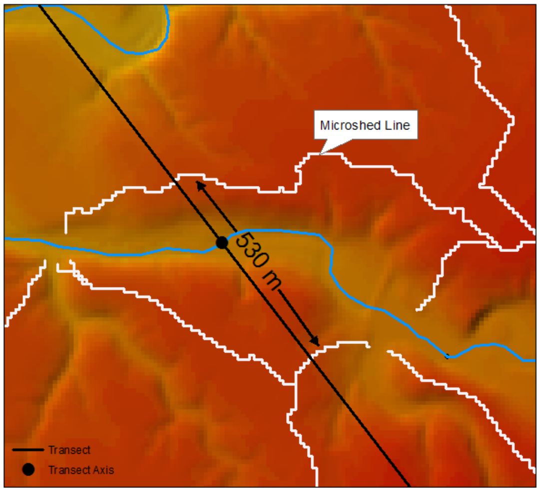


Figure 5 Transect perpendicular to streamline

Figure 5 shows how a transect would lay if it were placed perpendicular to the stream channel. This placement overestimates the river channel's valley peak width.

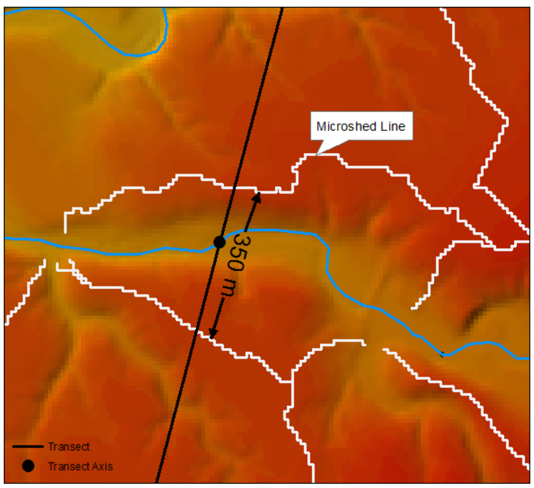


Figure 6 Transect perpendicular to generalized valley line

Figure 6 depicts how a transect was placed using the RESonate algorithm for generalizing the river valley. The valley width is more accurate than the figure above.

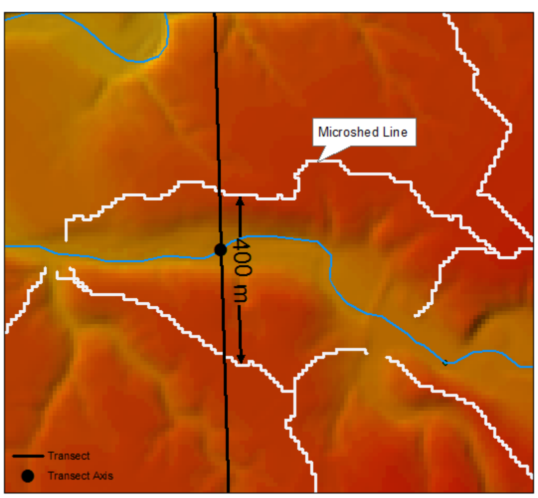


Figure 7 Manually corrected transect

In some instances, while QCing the RESonate transects, transects were manually rotated to better approximate valley, channel belt and valley floor measurements. In figure 7 the transect was slightly rotated from figure 6's position.

Details of valley floor calculation

The Valley Floor Mapper 1.0 was used to delineate valley floor extent in the Little Miami River watershed. This software uses hydrologic flow principles to generate a nested library of floodplain extents as a function of floodwater depth relative to nearby stream surface elevation. A detailed user's manual on how this software works can be found here.

Below depicts the values, inputs, and outputs used in the 3-step graphic interface of the Valley Floor Mapper in creating valley floors for the LMR.

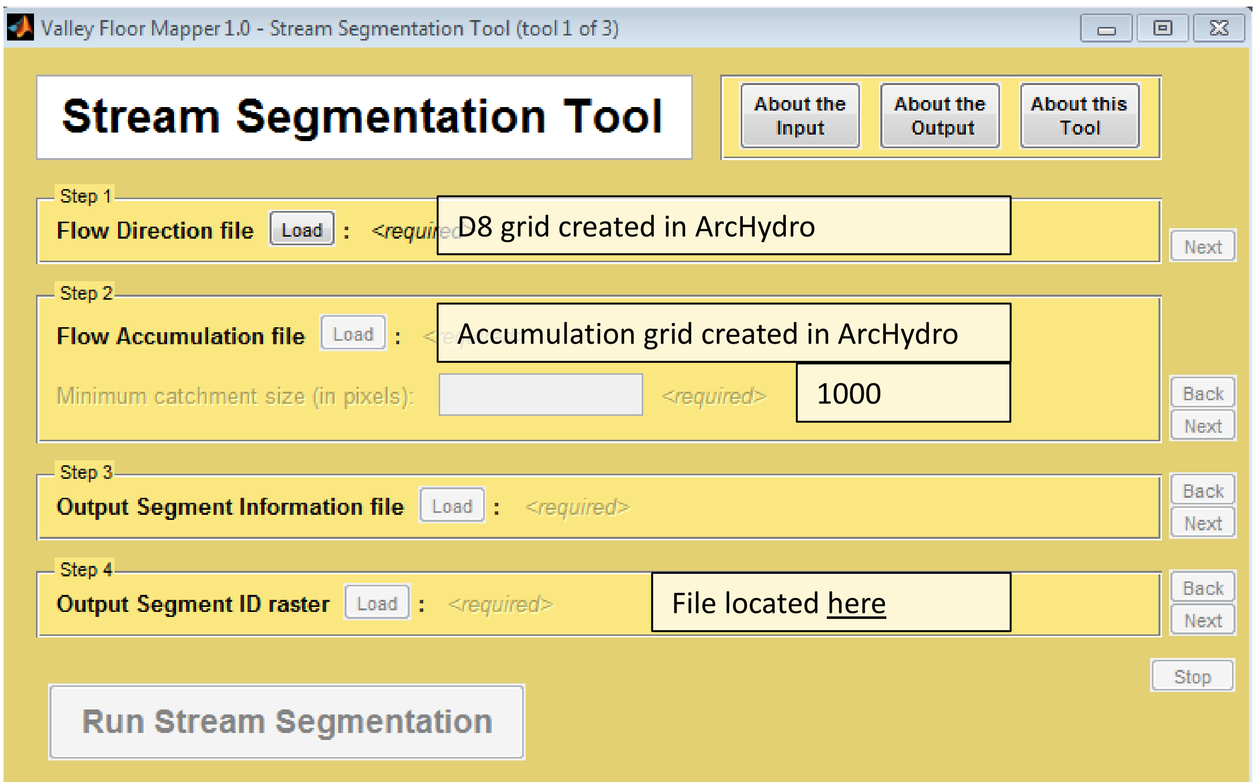


Figure 8 Stream Segmentation Tool

The output segment ID raster created 23,265 confluence to confluence drainage lines. This network was too dense for the NHD stream network used in RESonate. In order to de-densify this stream network the segment ID raster was converted to a line feature. A select by location was performed selecting all segment_ID lines intersecting the NHD. All selected features were given a depth to flood value in the 'Depth to Flood' table used in the FLDPLN Model Tool (figure 9), while everything not selected was not given a depth to flood value.

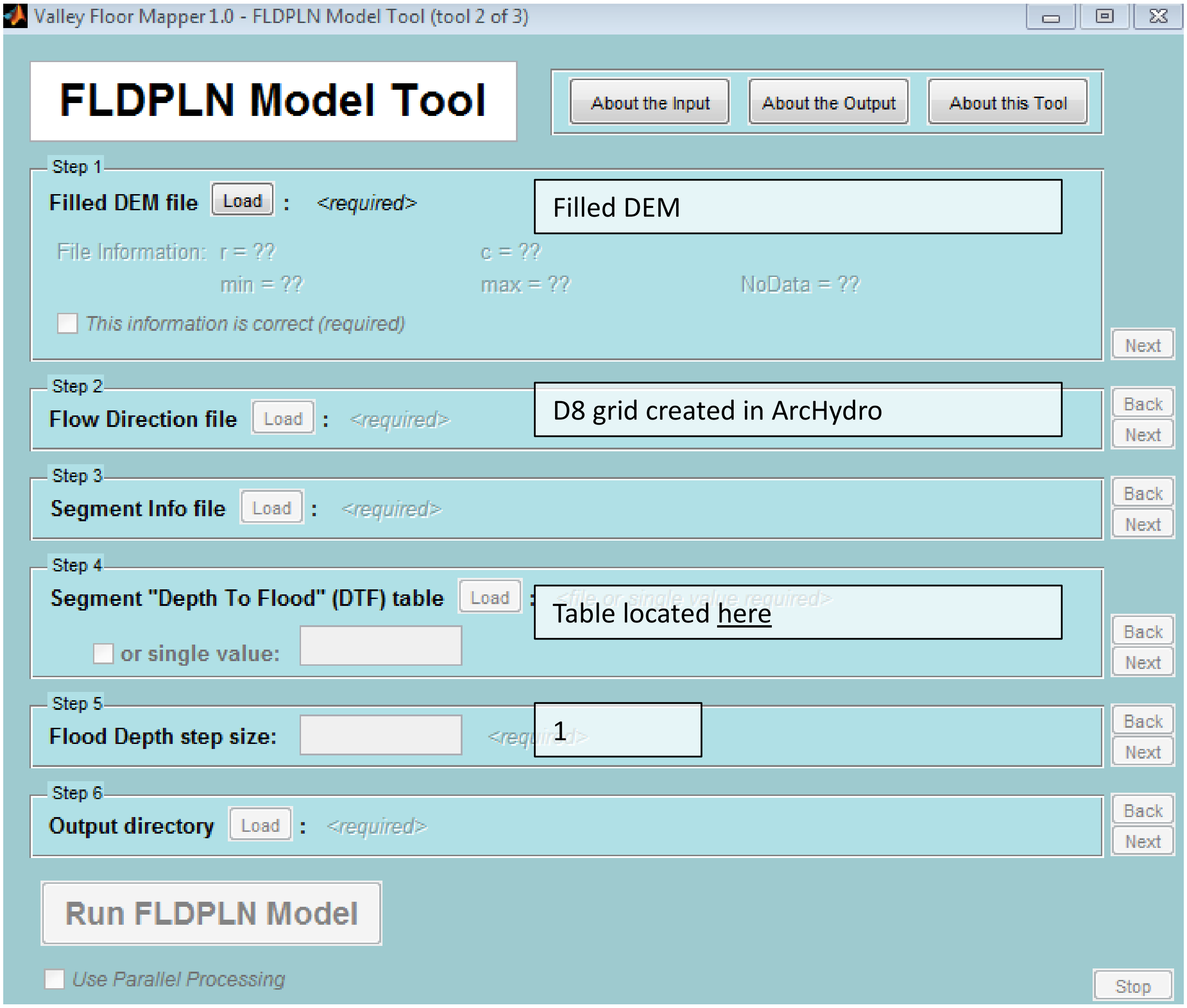


Figure 9 FLDPLN Model Tool

6,838 segment ID rasters were given depth to flood values in the "Depth to Flood" table, inputed in step 4 of the FLDPLN Model Tool. Values were assigned based on manual inspection of the DEM for each segment ID. The DTF values were determined by subtracting the difference between each raster IDs stream channel elevation and the elevation at the valley floor extent.

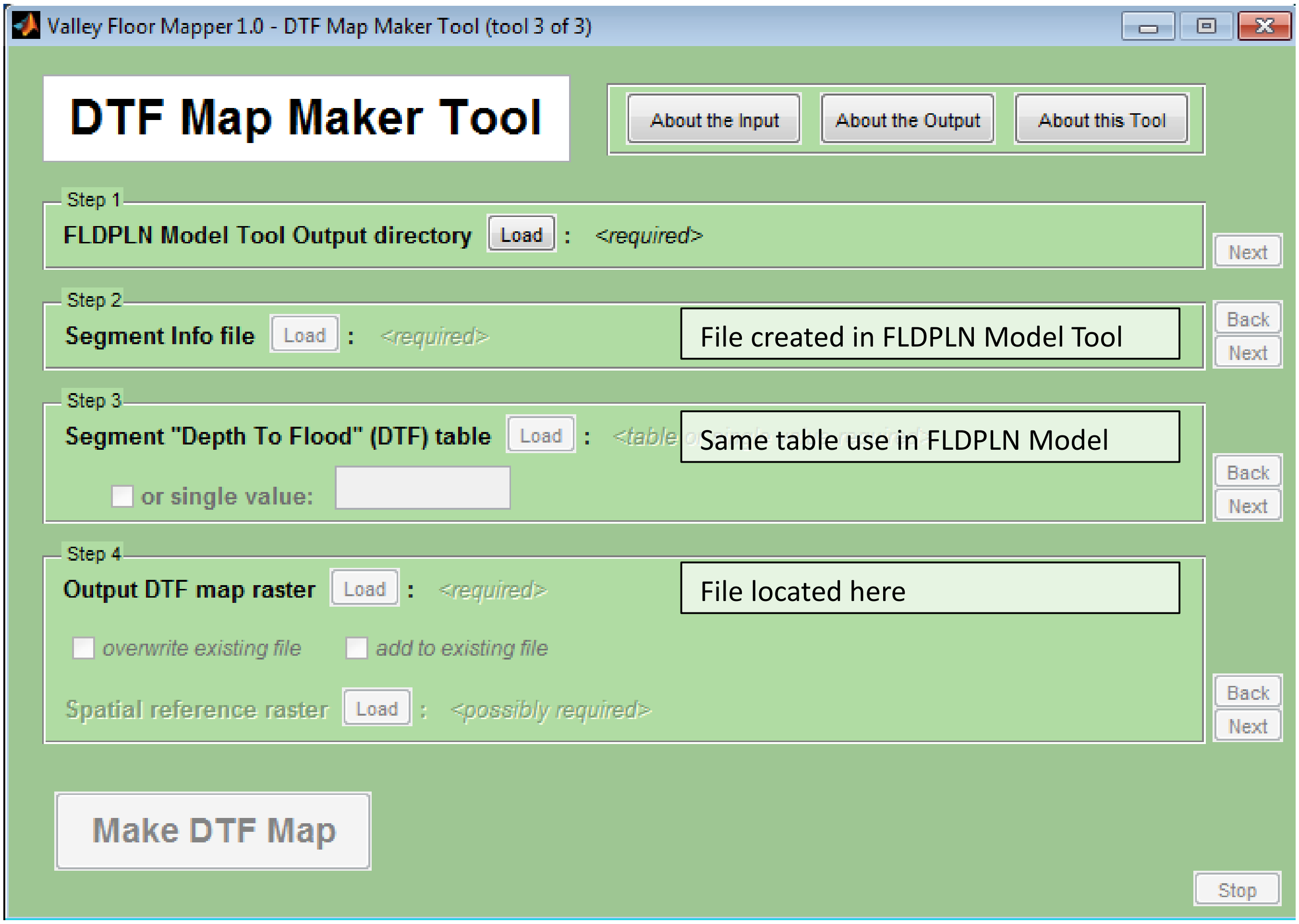


Figure 10 DTF Map Maker Tool

The output DTF map was reclassified into a grid with any value>0 =1. The reclassified grid was then converted into a feature class to be used in the RESonate tool.

List and brief description of the different valley floor algorithms Alex has reviewed

Multiresolution valley bottom index:

Dr. Thoms suggested the following algorithm for delimiting valley floor for FPZs:

- Gallant, J.C., Dowling, T.I. (2003): 'A multiresolution index of valley bottom flatness for mapping depositional areas', Water Resources Research, 39/12:1347-1359. Article can be found here.

Normalized height:

Deriving normalized height grids (NH) from digital elevation models enables the delimiting of low lying surface features over broad scales. NH is a function of slope height and valley depth. Slope height provides the relative height above the closest modeled drainage accumulation. Normalized height defines the normalized difference between standardized height and the valley depth (i.e. the height below summit accumulation. NH uses the normalization form of NDVI—stretching pixel values from 0 (valley bottom) and 1 (valley peaks). In brief, NH provides a continuous estimations of altitude above drainage culmination—allowing for low lying areas to be extracted.

Bohner—Uses NH and other complex terrain attributes and climate variables to predict soil attributes. Bohner used NH (labeled Normalized Altitude in Plate 2) to identify valley troughs. The mathematical expression of NH is on pg. 5 of this manuscript.

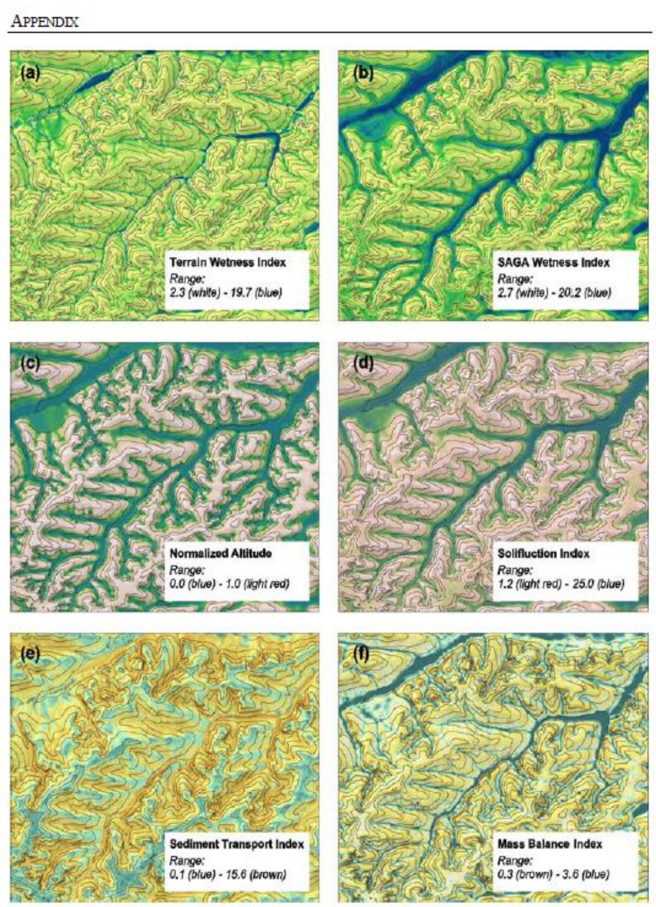


Plate 2: Complex secondary terrain attributes (modelling domain: 1088 x 876 grid cells, grid cell spacing: 25 m^2)

Eisank—Employs NH as a method to extract drumlin landforms. In addition to NH, Eisank uses a wetness index, slope height, and vertical distance to channel network to delimit these upper elevation landforms.

Topographic Position index:

Topographic Position Index (TPI) calculation as proposed by Guisan et al. (1999). This is literally the same as the difference to the mean calculation (residual analysis) proposed by Wilson & Gallant (2000).

References:

- Guisan, A., Weiss, S.B., Weiss, A.D. (1999): GLM versus CCA spatial modeling of plant species distribution. Plant Ecology 143: 107-122.

- Wilson, J.P. & Gallant, J.C. (2000): Terrain Analysis - Principles and Applications.

-Weiss, A.D. (2000): Topographic Position and Landforms Analysis. This provides a good overview here

Deviation from mean center:

The Deviation from mean center (DEV) measures the topographic position as a fraction of local relieve normalized to local surface roughness.

$$DEV=\frac{z_0-\overline{z}}{\sqrt{\frac{1}{n_{r-1}}\sum i=1(z_i-\overline{z})^2}}$$

Where z_0 is elevation and $\overline{z}$ is mean elevation. The denominator is elevation SD. See PPT found here for more detail regarding this algorithm, normalized height and the topographic position index.

Multiresolution Deviation from Mean Center:

Same algorithm as the Deviation from mean center except for introducing multiple roving window sizes in order to capture multiple scales—local, meso, broad, and regional. This article provides an excellent introduction to the topic.

FEMA FIRM:

Simply the national floodplain layer, found here.

SSURGO:

Soils that have fluvial soil taxonomy and/or flood frequently and/or have a geomorphic floodplain description and/or is classified as a water feature can be considered floodplains. Raw data can be found here. The article explaining this method and FIRMs is below:

Sangwan, Nikhil and V. Merwade, A faster and economical approach to floodplain mapping by using soil information, Journal of American Water Resources Association, 52 pages. (in press). Found here.

List of variables and original data sources/websites

Hydrology

24k stream network attributed with unique id or stream name. Each individual stream must be represented by a single line. (http://nhd.usgs.gov/)

Digital Elevation Map (DEM)

10 Meter DEM. (http://ned.usgs.gov/)

Precipitation Grid

Grid showing precipitation in known units. (30 yr Mean Annual Precipitation (PRISM) http://www.prism.oregonstate.edu/)

Geology

A polygon shapefile/ data layer that has primary geologic type. (http://mrdata.usgs.gov)

Special Layers

Floodplain Data

Polygon shapefile or data layer showing the floodplain. The user can generate his/her own floodplain layer or use existing datasets.

Microshed

Line shapefile data layer of the smallest possible watershed.

Generated in ArcHydro using a high density stream network, stream segmentation grid, and smallest possible watershed layer.

Channel Belt

Line shapefile of the section of valley floor that contains the meandering channel. Must be attributed with bank side (left or right) and stream name. This layer is hand digitized.

Software Requirements:

ArcGIS 10.0 or later, Spatial Analyst, 3D Analyst, ArcHydro