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2022 ESRI USER CONFERENCE

Spatial Analyst: New Surface and Hydro Tools

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Surface

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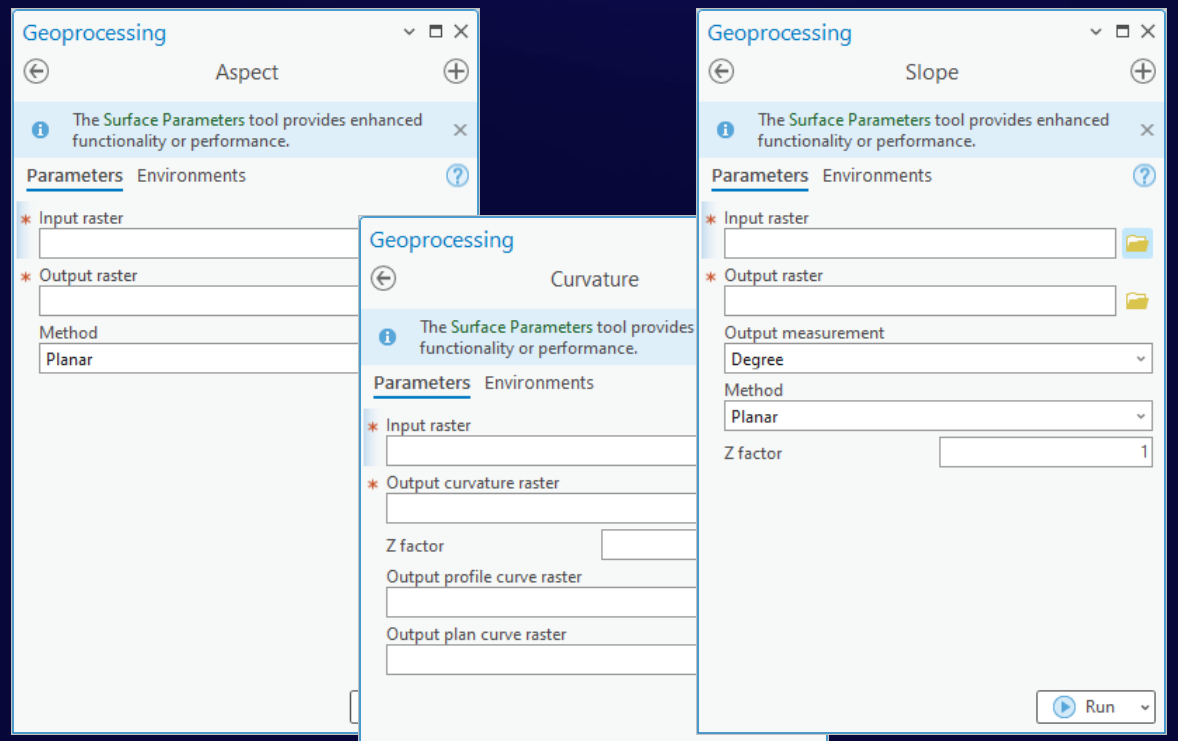
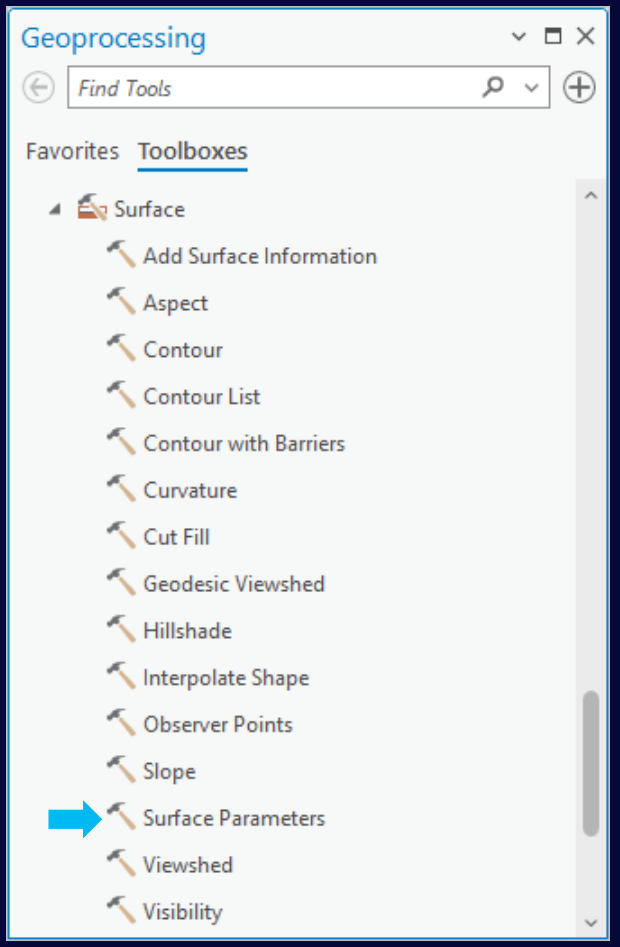
Surface Tools: Aspect, Curvature, Slope Surface Parameters

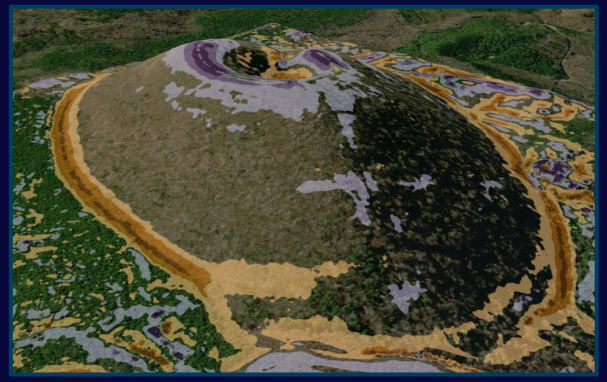


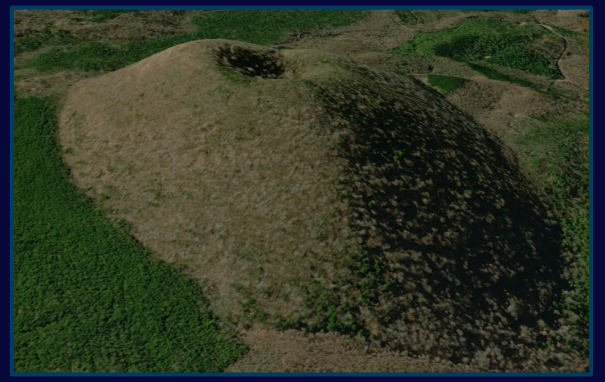


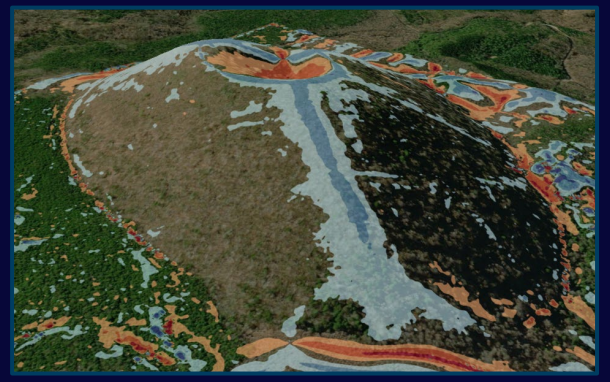
Does One Size Fit All?

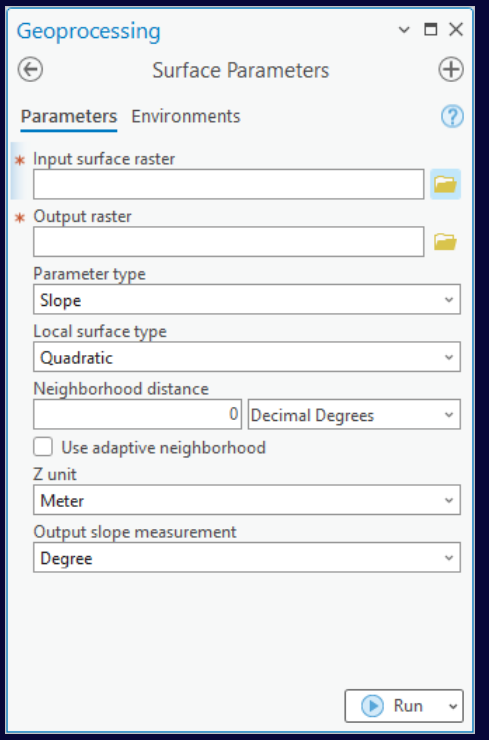
Surface Parameter: A Single Tool

- Many terrain analysis metrics in a single ArcGIS tool
  - Easy to find many methods
  - Easy to rerun with similar parameters
- Neighborhood window size appropriate for DEM resolution
- Support for spatial scaling
- Surface fitting options to improve results from noisy high resolution DEMs
- Remove map projection distortion
- Clarity of curvature names and formulas



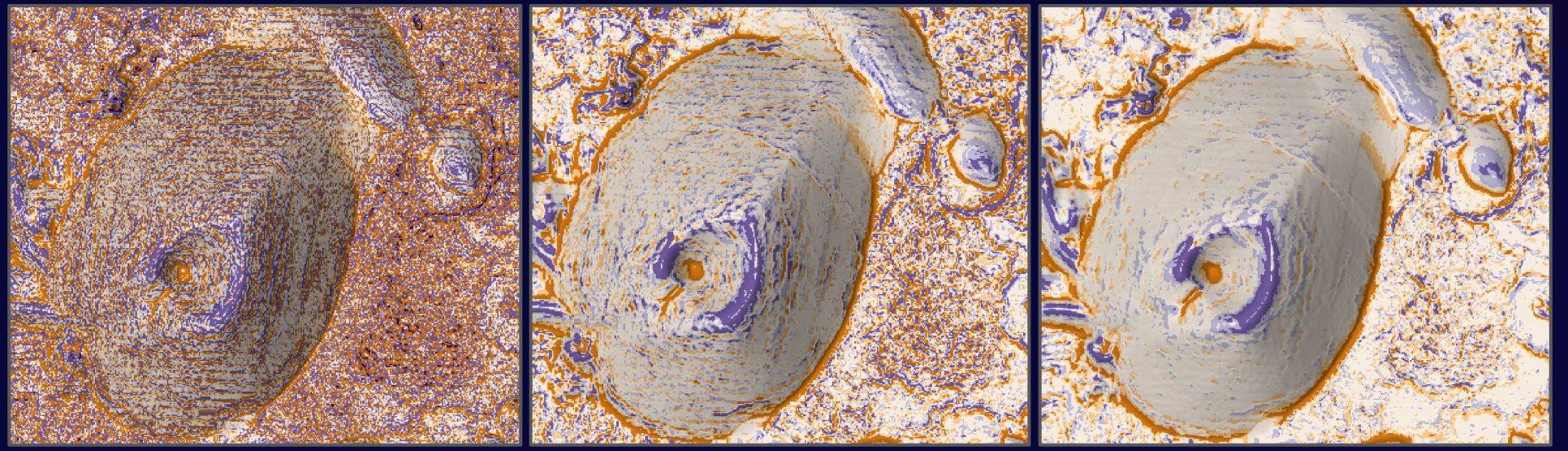






User Specified Neighborhood Window

- Specify a window size that matches the cellsize of your elevation and the size of landscape features of interest.
- Run multiple times with different window sizes for multiscale analysis
- The neighborhood window is square, in odd intervals; 3x3, 5x5, etc.

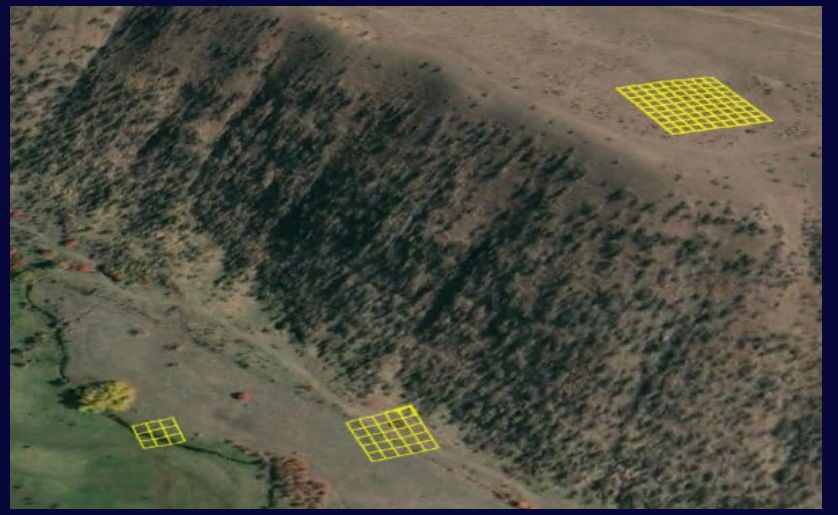


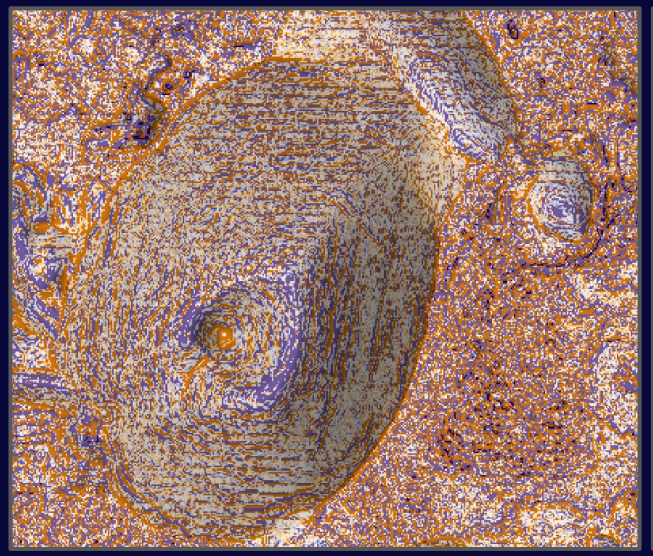
3x3 9x9 15x15

Optional Adaptive Neighborhood Window

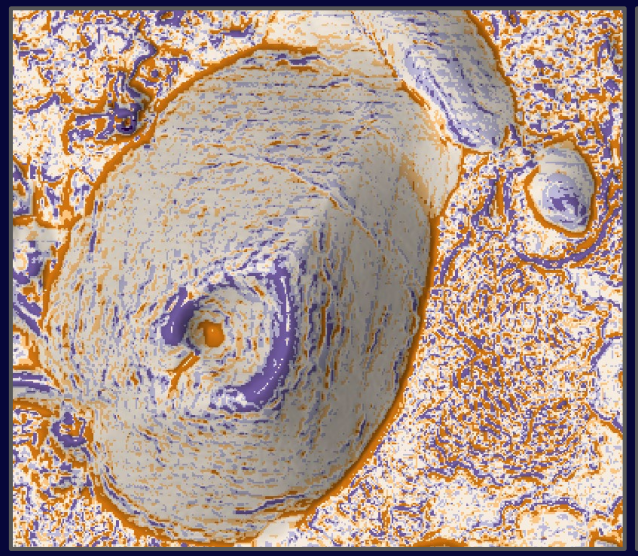
Auto adapts from 3x3 to user specific maximum

- Evaluates surface complexity for each cell at progressively smaller window sizes until a threshold is met.
- Uses deviation from mean elevation. $\mathrm{DEV} = \frac{z_0 - \overline{z}}{\mathrm{SD}}$
- Follows approach of *James et al., 2014*

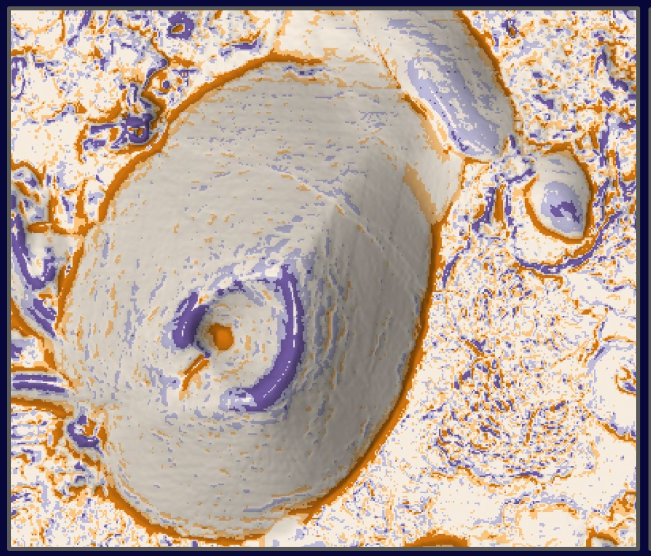




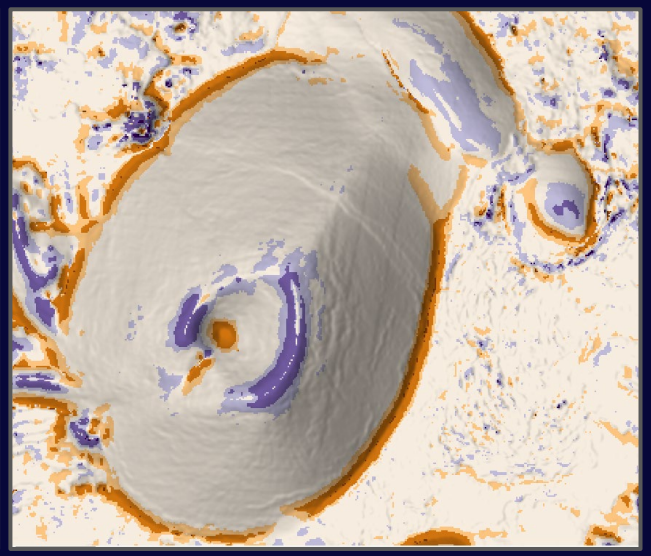
3x3



9x9



15x15



3x3 to 15x15 Adaptive

Surface Fitting Options

- QUADRATIC (default)

  aka second order polynomial

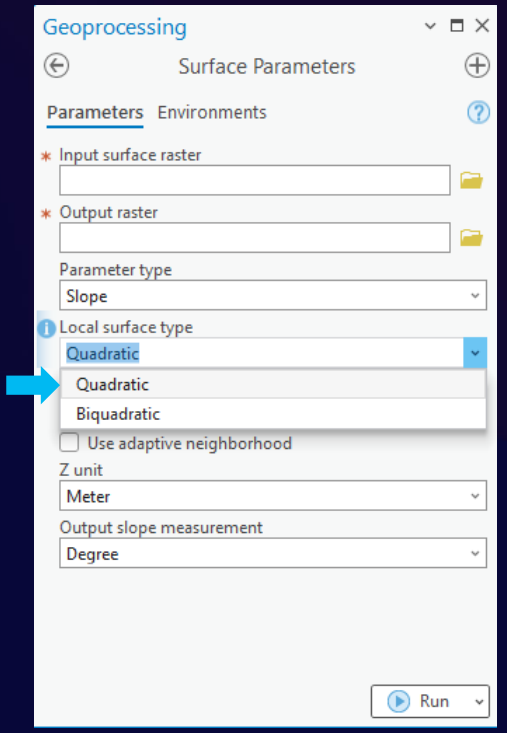
$$z = f(x, y) = a_0 + a_1x + a_2y + a_3xy + a_4x^2 + a_5y^2$$

- BIQUADRATIC

  aka fourth order polynomial

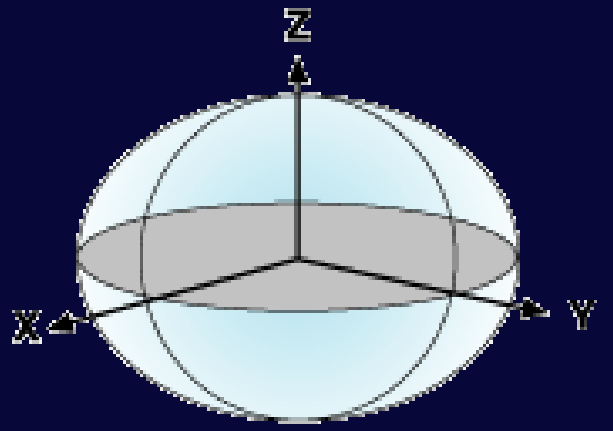
  aka partial quartic

$$z = f(x, y) = a_0 + a_1x + a_2y + a_3xy + a_4x^2 + a_5y^2 + a_6x^2y + a_7y^2 + a_8y^2x^2$$



No Map Projection Distortion

- All calculations in the ArcGIS Surface Parameters tool are geodesic.
- Coordinate system of input data does not matter (spherical or planar).
- Eliminates map projection distortion of distances and angles.



New Geometric Curvatures

Following naming system of *Minár, Evans, and Jenčo 2020*

Contour (projected contour) curvature

Profile (normal slope line) curvature

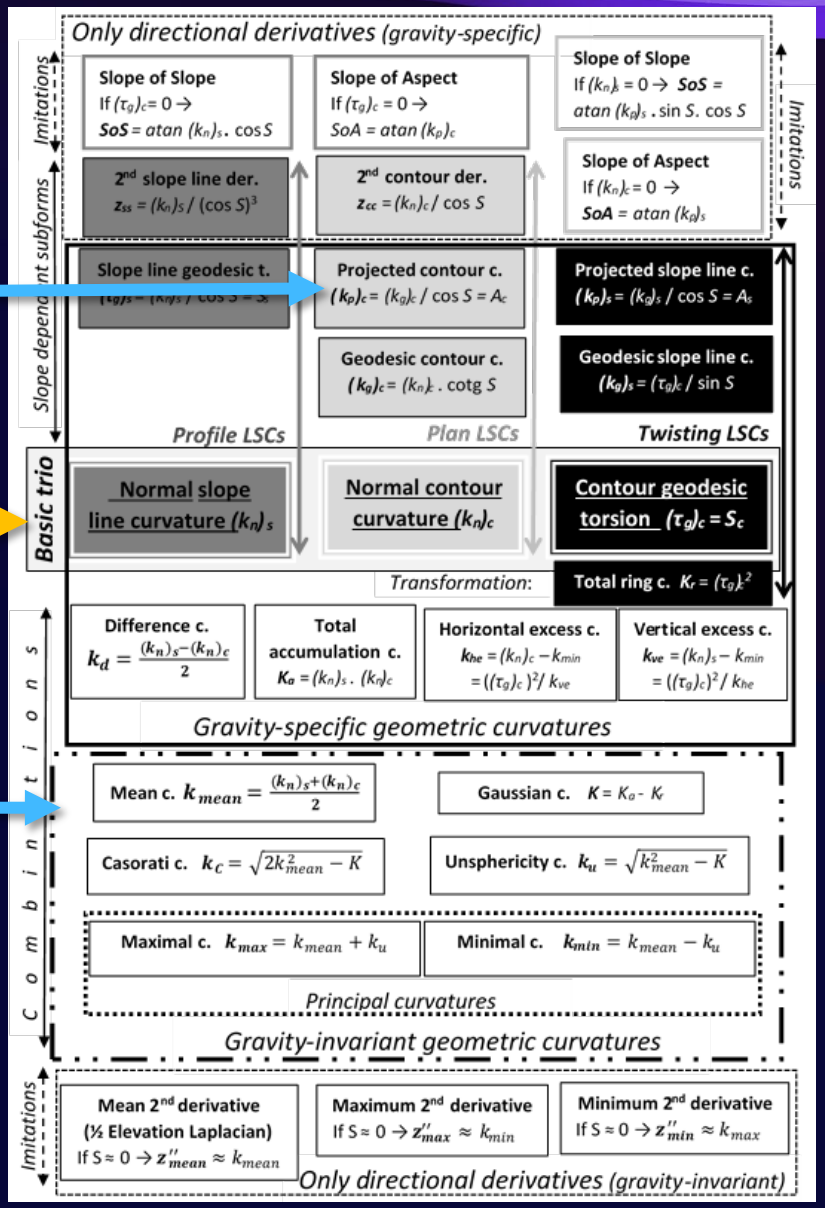
Tangential (normal contour) curvature

Contour geodesic torsion curvature

Mean curvature

Gaussian curvature

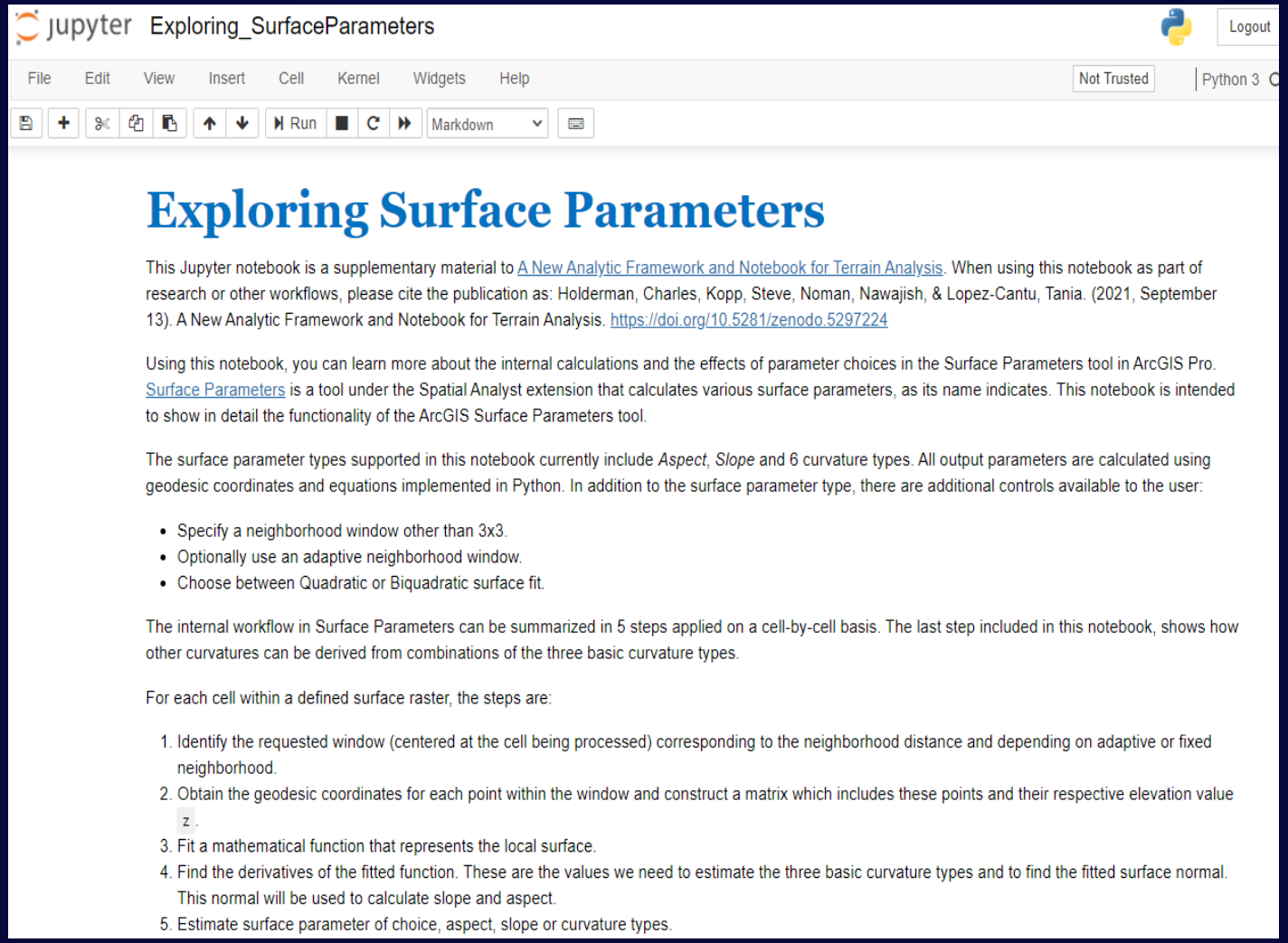
Casorati curvatur

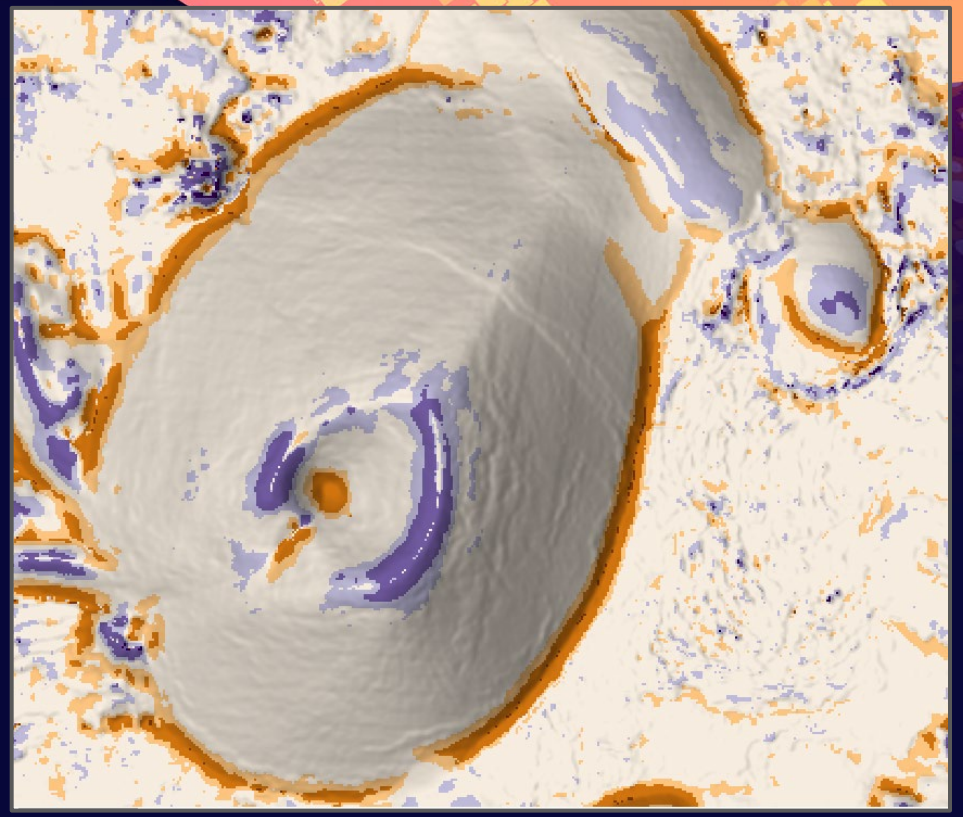


from Minár, Evans, and Jenčo 2020

A Jupyter Notebook to Explore Surface Parameters

https://www.esriurl.com/SurfaceParameters (download) https://www.esriurl.com/SurfaceParametersPreview (preview)





Determine Surface Characteristics

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Hydrology

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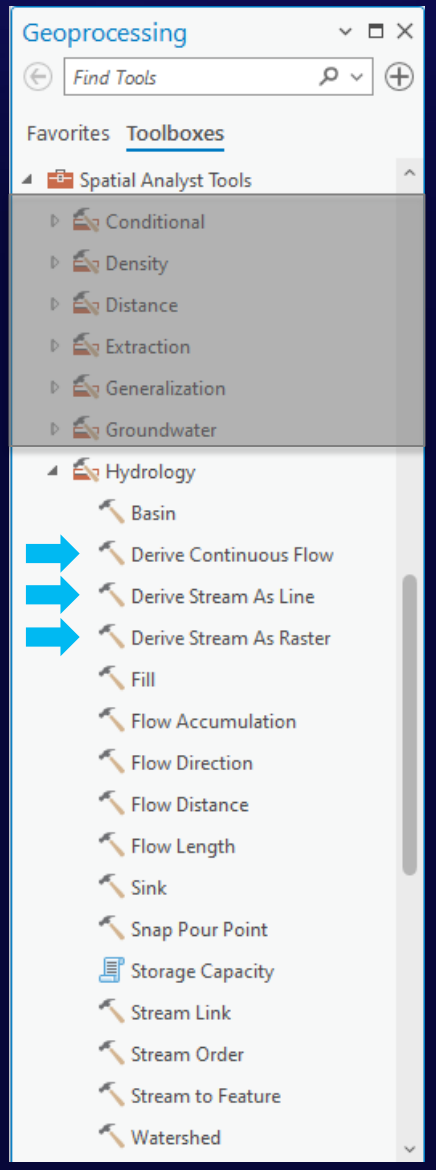
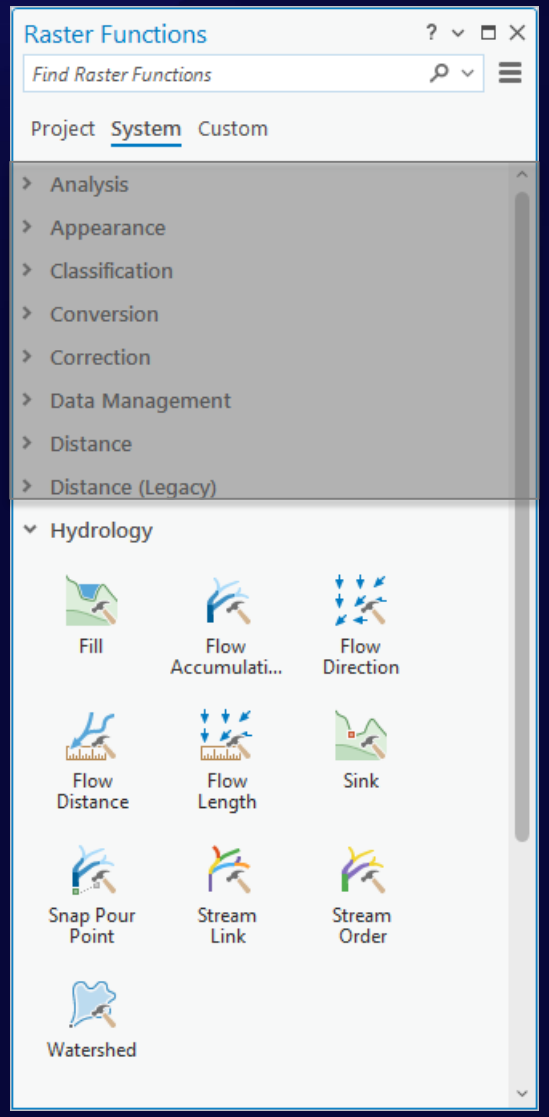
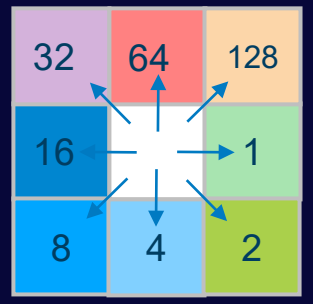
Hydrology Tools and Raster Functions in Spatial Analyst Extension



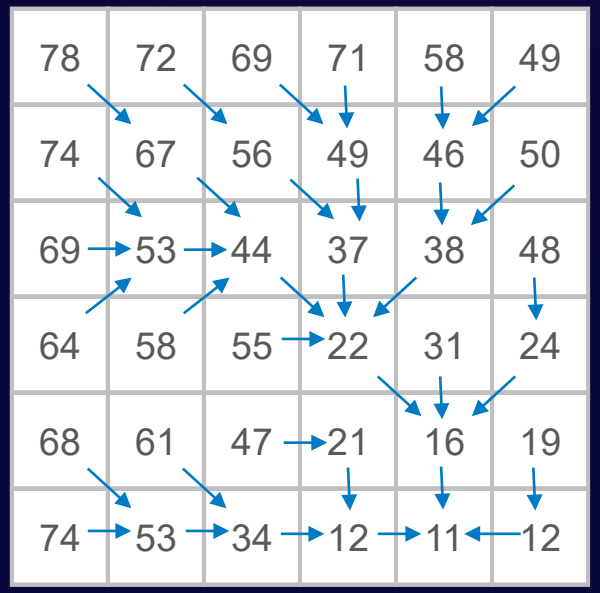


Flow Direction

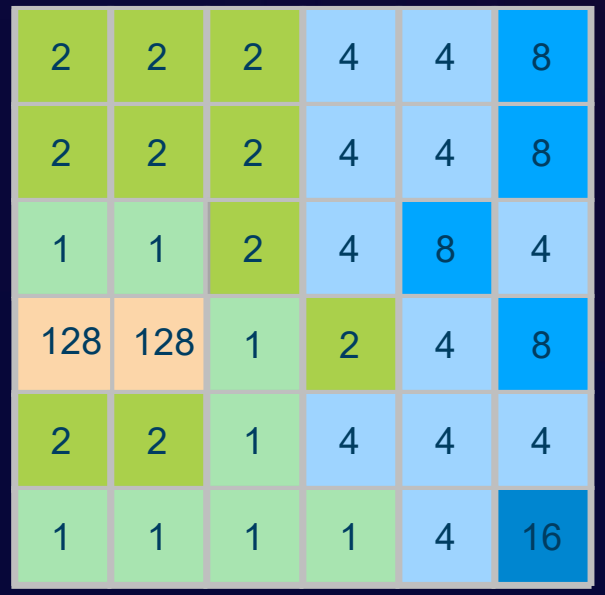
Creates a raster of flow direction from each cell to its downslope neighbor, or neighbors, using D8, Multiple Flow Direction (MFD) or D-Infinity (DINF) methods.



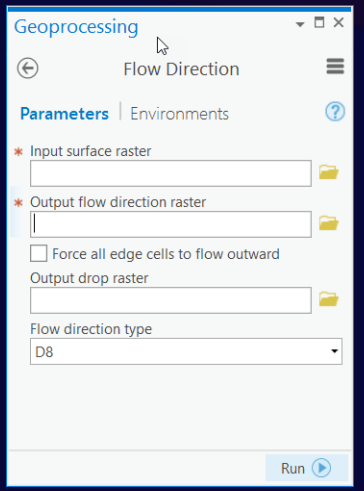
Direction Coding



Elevation

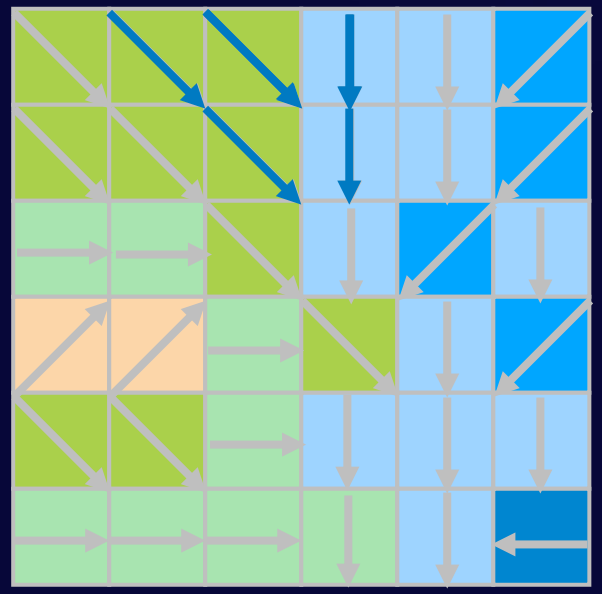


Flow Direction



Flow Accumulation

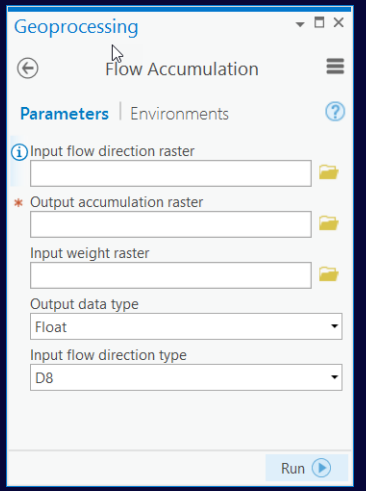
Creates a raster of accumulated flow into each cell. A weight factor can optionally be applied.



Flow Direction

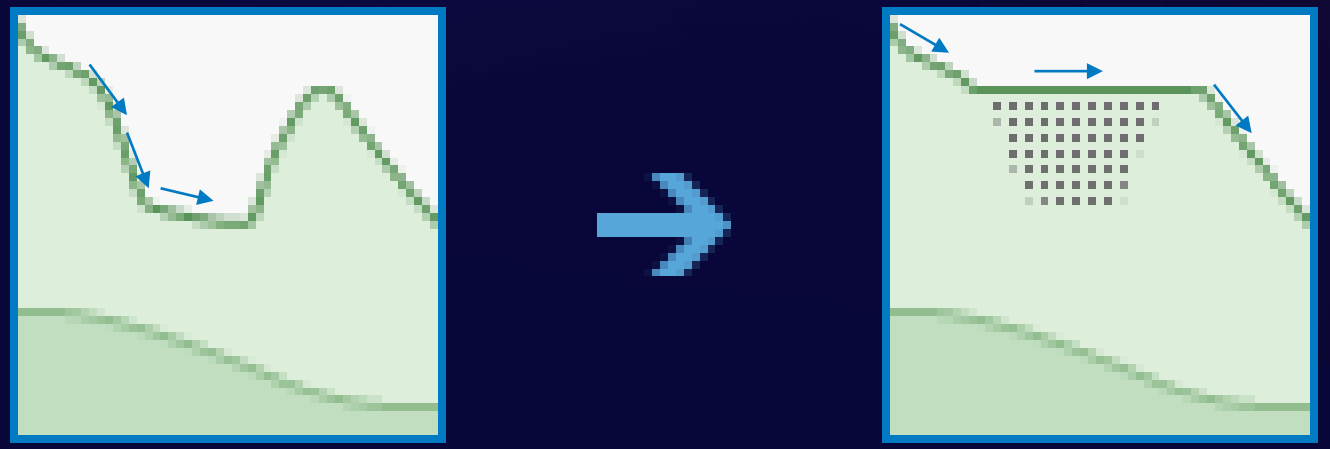
0	0	0	0	0	0
0	1	1	2	2	0
0	3	7	5	4	0
0	0	0	20	0	1
0	0	0	1	24	0
0	2	4	7	35	2

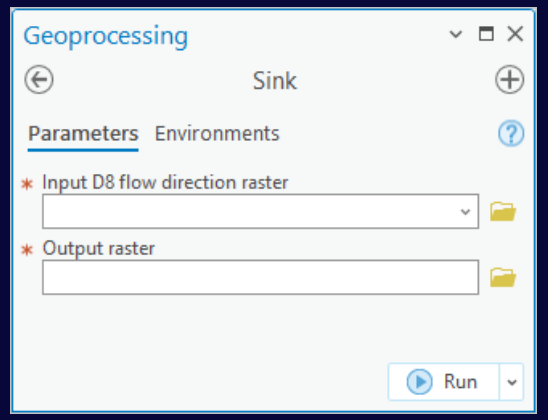
Flow Accumulation

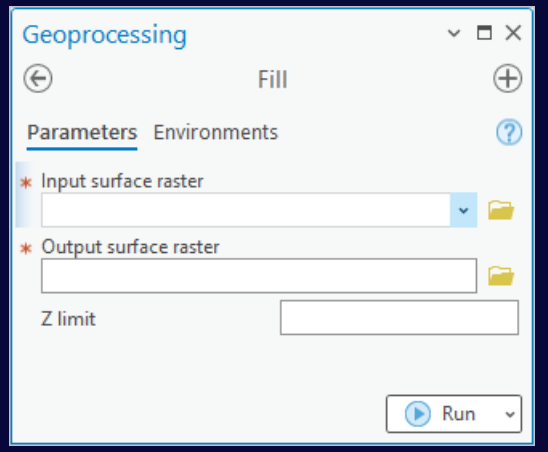


Sink and Fill

Fills sinks in a surface raster to remove small imperfections in the data.

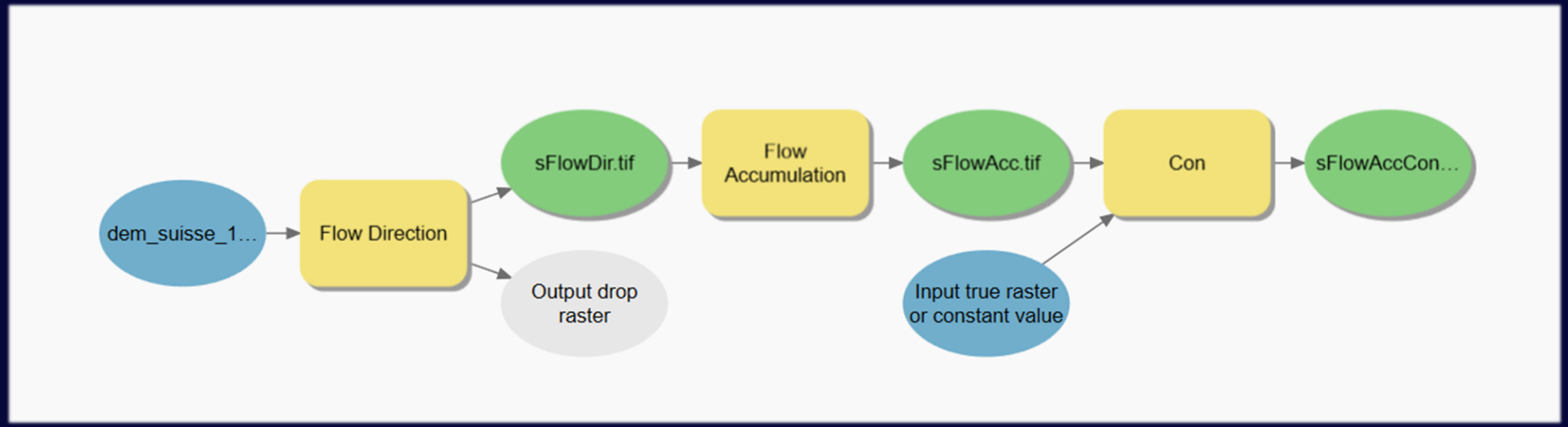




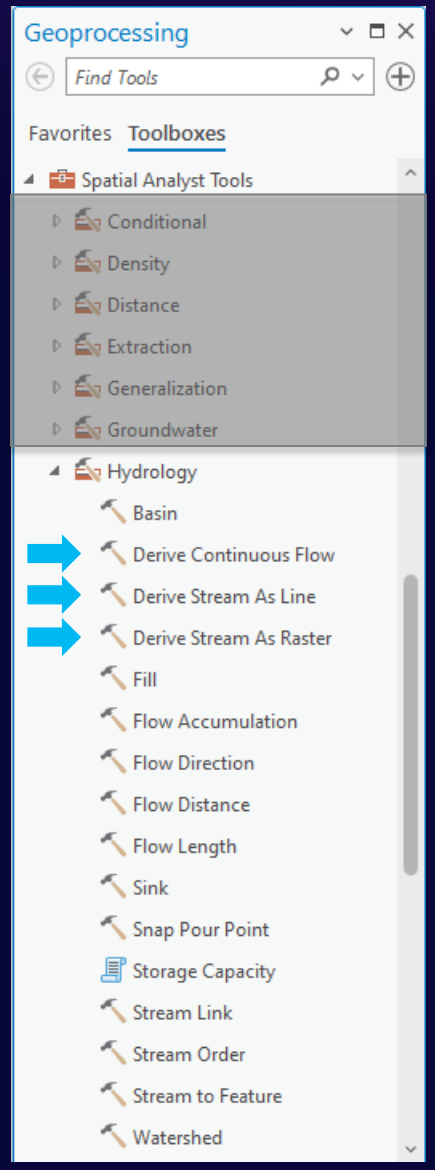


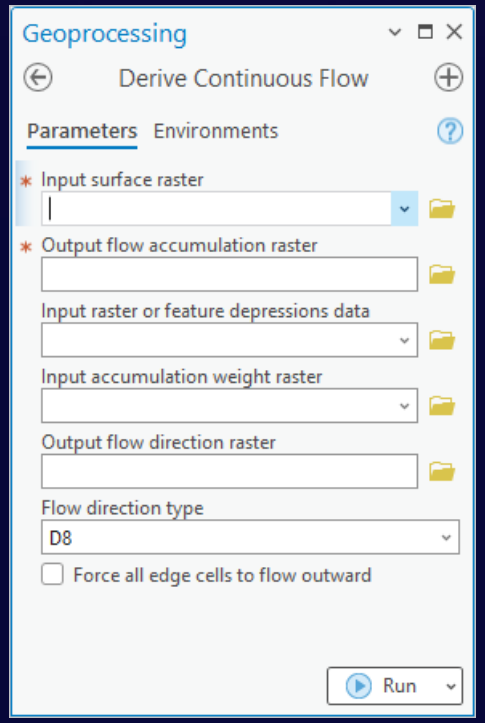
Stream Extraction from a DEM

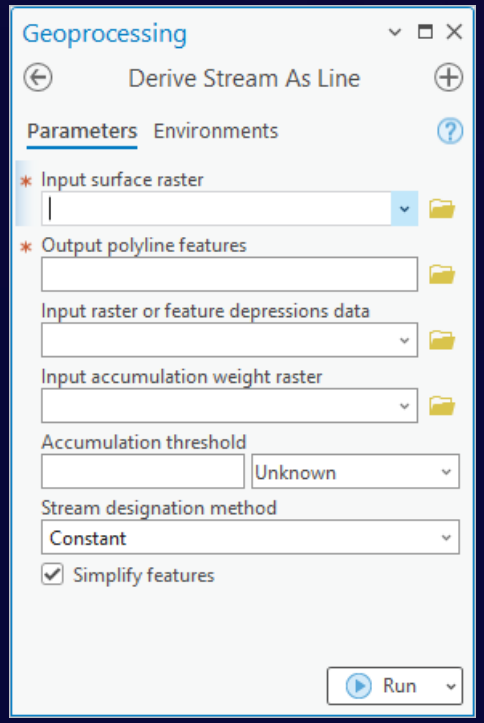
- Hydrocondition the DEM (Filling is the easy way out, but not always appropriate)
- Execute a multi-steps process

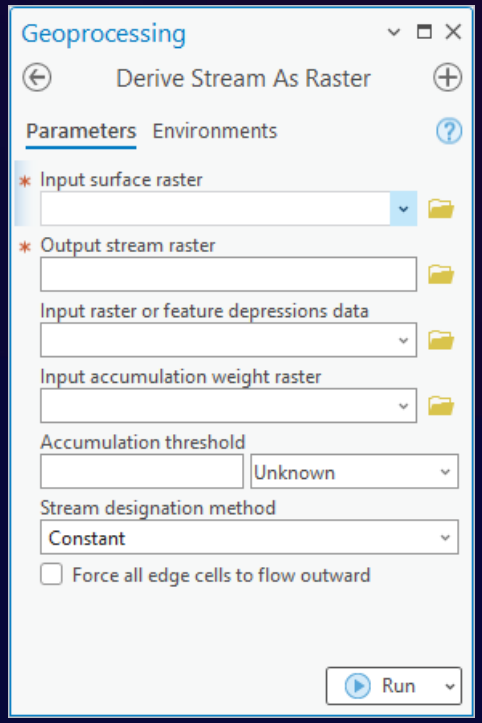


Derive Continuous Flow and Streams Tools in Pro 3.0









Derive Continuous Flow: How it works

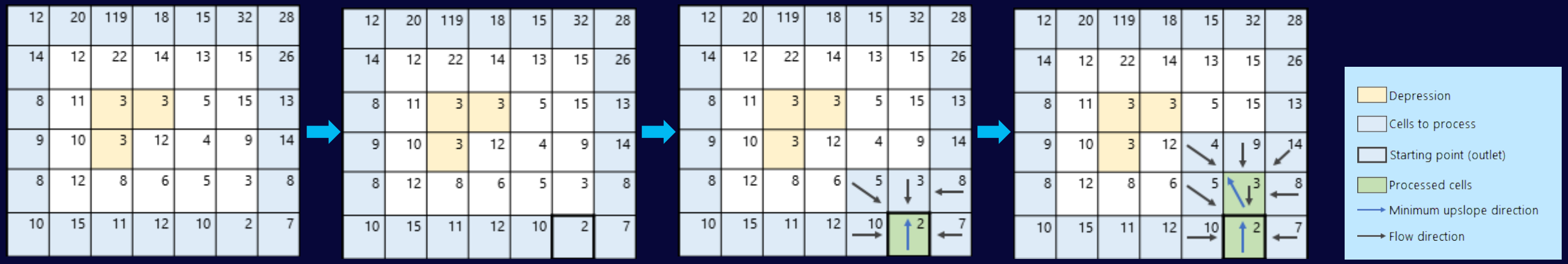
- It uses the least-cost path algorithm to move uphill across the surface while minimizing elevation difference.

Identify outlets around the edge.

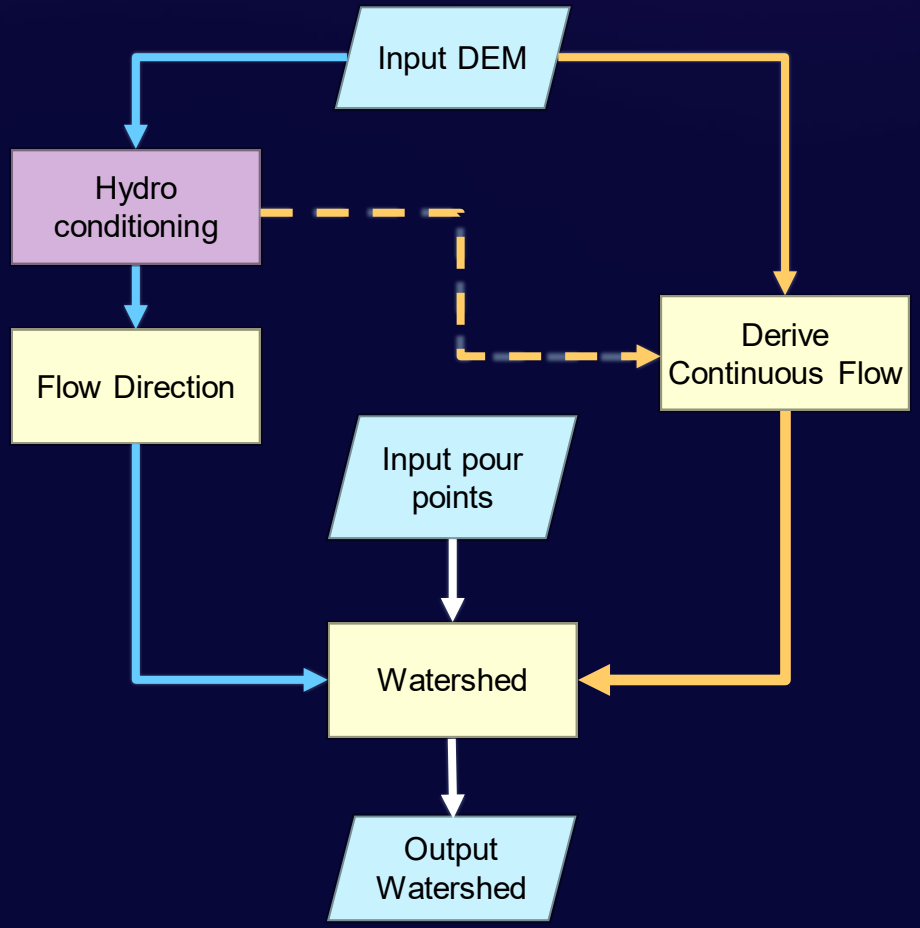
Identify lowest elevation to start the search.

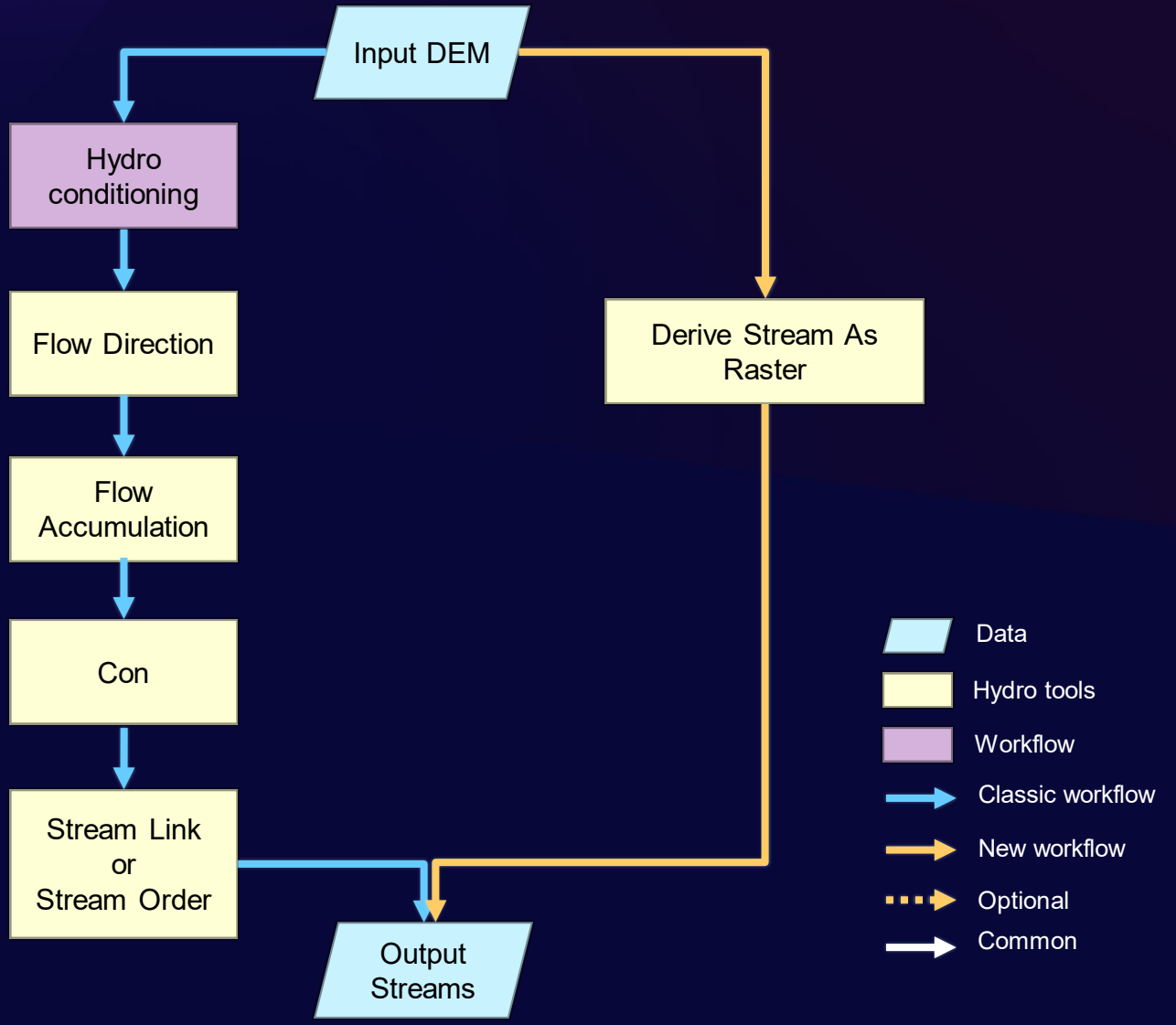
Identify the neighbors, determine flow direction and find the next cell to process.

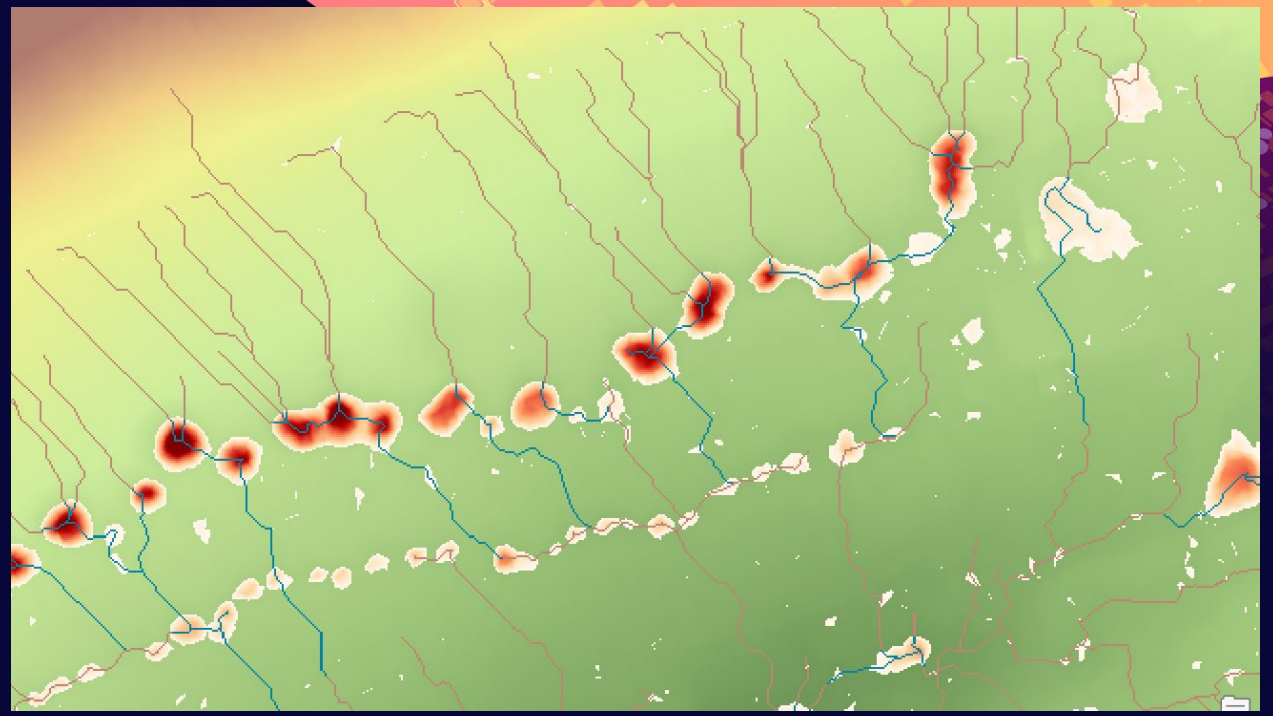
Move towards minimum upslope direction and repeat the process



Watershed Delineation and Stream Extraction







Extracting Streams and Watershed from DEM

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