

# Digitální modely terénu (9-10)

## DMT v ArcGIS Desktop

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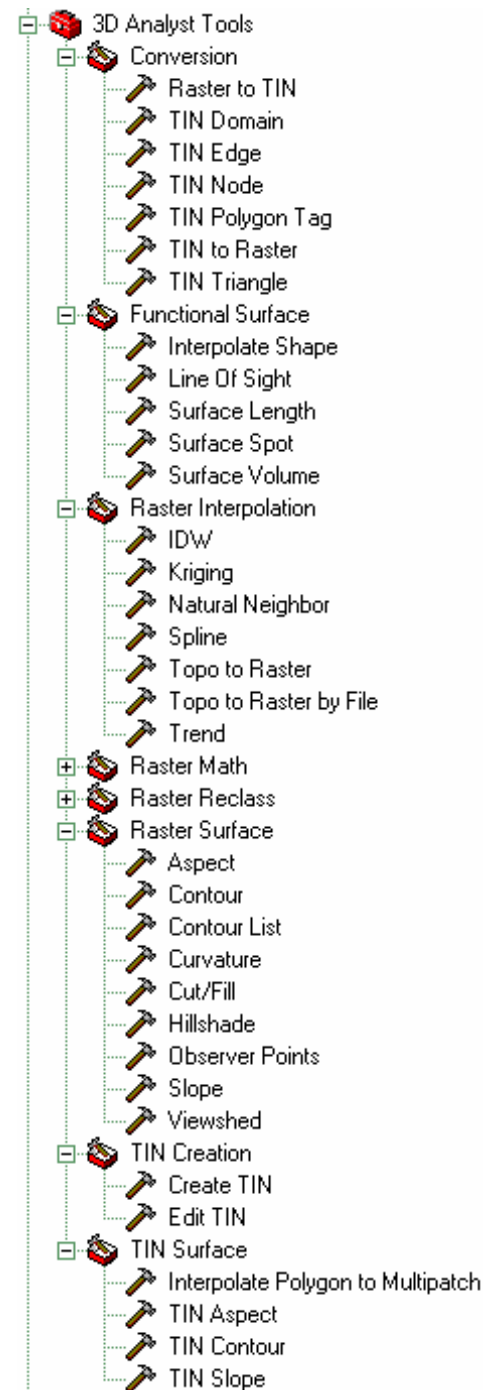


# **Digitální modely terénu (9)**

## **DMT v ArcGIS Desktop**

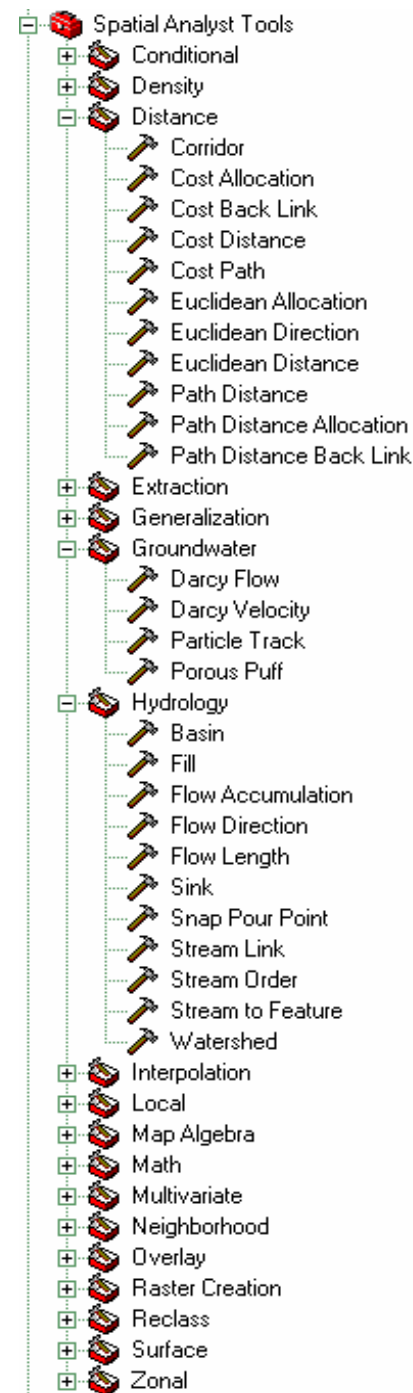
## ArcGIS 3D Analyst

je zaměřen na tvorbu, analýzu a zobrazení dat ve 3D. Poskytuje jak nástroje pro interpolaci rastrových povrchů (**Raster Interpolation**), tak možnosti pro konstrukci TIN (**TIN Creation**). Jako jediný z nástaveb umožňuje pracovat s TIN strukturou – konverze na rastr včetně práce s jednotlivými částmi této struktury (**Conversion**), a dále výpočty sklonu, expozice a vrstevnic z TIN (**TIN Surface**). Součástí jsou i nástroje pro mapovou algebru (**Raster Math**), reklasifikaci rastrů (**Raster Reclass**) a analýzu DMT. Sem patří výpočty sklonu, expozice, křivosti, stínovaného reliéfu, extrakce vrstevnic (**Raster Surface**) a analýzy viditelnosti (**Raster Surface**, **Functional Surface**).



## ArcGIS Spatial Analyst

umožňuje vytvářet a zpracovávat data v rastrovém formátu a provádět jejich analýzy i v kombinaci s vektory. K dispozici jsou sice stejné metody interpolace povrchů (**Interpolation**), mapové algebry (Math, Map Algebra, Overlay), reklasifikace (Reclass) a základních analýz DMT (**Surface**) jako v 3D Analystu, ale možnosti dalších specifických analýz jsou podstatně širší. Je zde možné provádět distanční analýzy (Distance), analýzy hustoty (Density) a statistické výpočty v rastru (Local, Zonal, Neighborhood). Dále jsou velmi propracovány hydrologické analýzy (Hydrology) – výpočty směrů odtoku, akumulovaného odtoku, definování povodí k dílčí části toku nebo k bodu, označování řádů a délek pro jednotlivé části toku, včetně možnosti odstranění bezodtokých depresí a také zcela ojediněle možnosti modelování podpovrchových vod (Groundwater).



## Nástroj **IDW**

- interpolace vektorových bodových dat metodou inverzních vzdáleností
- modifikace mocniny vzdálenosti (power) a způsobu prohledávání okolí pro interpolaci (variabilně nebo fixně)
- možnost zadání „bariér“

## Nástroj **Kriging**

- interpolace vektorových bodových dat
- varianty Ordinary kriging a Universal kriging
- možnosti výběru modelu semivariogramu a jeho parametrů

## Nástroj **Spline**

- interpolace vektorových bodových dat metodou minimální křivosti
- interpolovaný povrch musí procházet vstupními body a jeho zakřivení bude minimální
- varianty „Regularized“ a „Tension“ – obě metody interpolují povrch po blocích (regionech), v závislosti na zadaném minimálním počtu bodů
- nelze modelovat žádné singularity terénu

**TIN** je možné vytvořit z bodového pole a dále definovat zlomové linie (singularity). Tímto způsobem linií definovat tzv. „hard breaklines“ nebo tzv. „soft breaklines“. Kromě linií mohou vstupovat do TIN i polygony. Dále lze z vytvořené TIN struktury vyjmout jednotlivé prvky (hrany, vrcholy, trojúhelníky), konvertovat TIN na rastr a naopak a také odvodit z triangulace vrstevnice, sklony a expozice.

## Nástroj **Topo to Raster**

- Specificky navržen pro vytvoření hydrologicky korektního DMT
- Interpolační metoda se zakládá na programu ANUDEM verze 4.6.3.
- Algoritmus je primárně přizpůsoben pro práci s vrstevnicovými daty a základní úvaha vychází z předpokladu, že hlavním faktorem, který modeluje tvar terénu, jsou hydrologické procesy
- Podle typu interpolace se jedná o diskrétní spline metodu s modifikací kritéria „roughness penalty“, které dovoluje modelovat náhlé změny v reliéfu terénu.
- Prvním krokem je tvorba zjednodušené odtokové sítě identifikací lokálního maxima křivosti v každé vrstevnici a také výpočty maximálních sklonů. Tato informace je potom využita v následné interpolaci DMT a při dalším zpřesnění pomocí identifikace bezodtokých depresí, které nebyly dosud odstraněny (drainage enforcement).
- Pro zpřesnění interpolace je možné použít další data, která jsou pro dané území k dispozici. Jedná se zejména o linie toků (směr linií musí být ve směru toku, a to pouze jedna linie pro jeden tok), břehové linie jezer (pokud je známa i nadmořská výška hladiny, je možné ji použít do vstupu s vrstevnicemi), výškové kóty a hranice zájmového území (maska).
- Součástí výsledků jsou i další podpůrná data (dosud neodstraněné deprese, soubor s parametry apod.). Celkově se jedná o ojedinělý algoritmus, který dokáže velmi zkvalitnit výsledný DMT, ale pouze pokud jsou dobře chápány a definovány všechny parametry.

## Cvičení:

**Zdrojová data:** výřez pro list 24-32-05 ZM ČR 1:10 000

- GL\_CA010 (vrstevnice základní)
- GL\_CA011 (vrstevnice zesílená)
- GL\_CA012 (vrstevnice doplňková)
- vody
- toky
- landuse

- 1. Sloučit vrstevnice do jediného SHP**
- 2. Interpolovat povrch (linie – Topo To Raster)**
- 3. Základní analýzy (aspect, slope, hillshade)**
- 4. Hydrologické analýzy**



**Layers**

- gl\_ca010
- gl\_ca011
- gl\_ca012
- toky
- landuse
- vody

**ArcToolbox**

- 3D Analyst Tools
- Analysis Tools
- Cartography Tools
- Conversion Tools
- Data Interoperability Tools

**Data Frame Properties**

Annotation Groups | Extent Rectangles | Frame | Size and Position  
 General | Data Frame | Coordinate System | Illumination | Grids | Map Cache

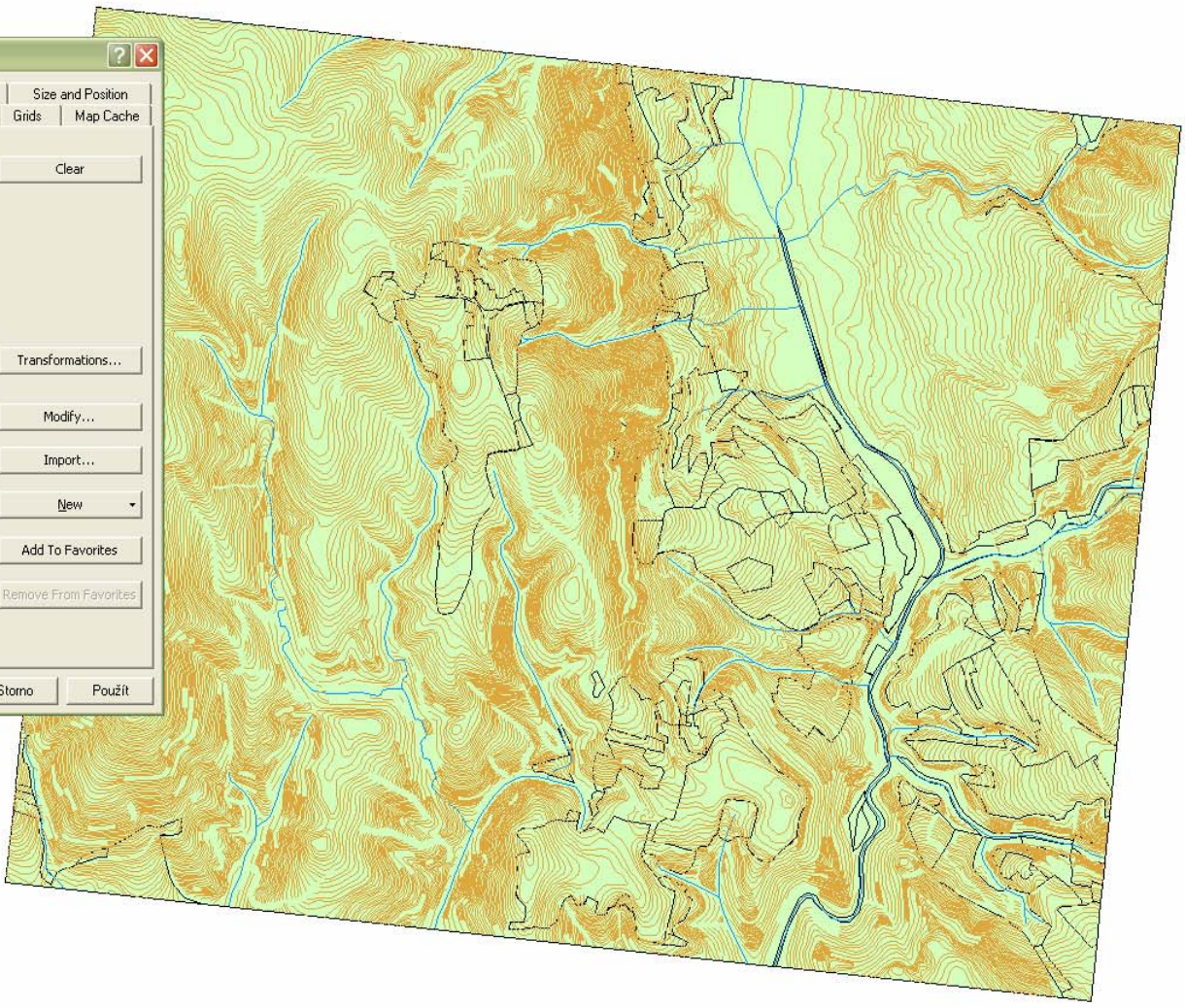
Current coordinate system:

S-JTSK\_Krovak\_East\_North  
 Projection: Krovak  
 False\_Easting: 0.000000  
 False\_Northing: 0.000000  
 Pseudo\_Standard\_Parallel\_1: 78.500000  
 Scale\_Factor: 0.999900  
 Azimuth: 30.288140  
 Longitude\_Of\_Center: 24.833333  
 Latitude\_Of\_Center: 49.500000  
 X\_Scale: -1.000000  
 Y\_Scale: 1.000000  
 XY\_Plane\_Rotation: 90.000000

Select a coordinate system:

- Roma 1940 Gauss Boaga Est
- Roma 1940 Gauss Boaga Ovest
- S-JTSK (Ferro) Krovak
- S-JTSK (Ferro) Krovak EastNorth
- S-JTSK Krovak
- S-JTSK Krovak EastNorth
- SAD 1969 Brazil Polyconic
- Sahara
- Sahara (degrees)
- Saipan Az Eq 1969
- Sierra Leone 1924 New Colony Grid

Buttons: Clear, Transformations..., Modify..., Import..., New, Add To Favorites, Remove From Favorites, OK, Storno, Použit





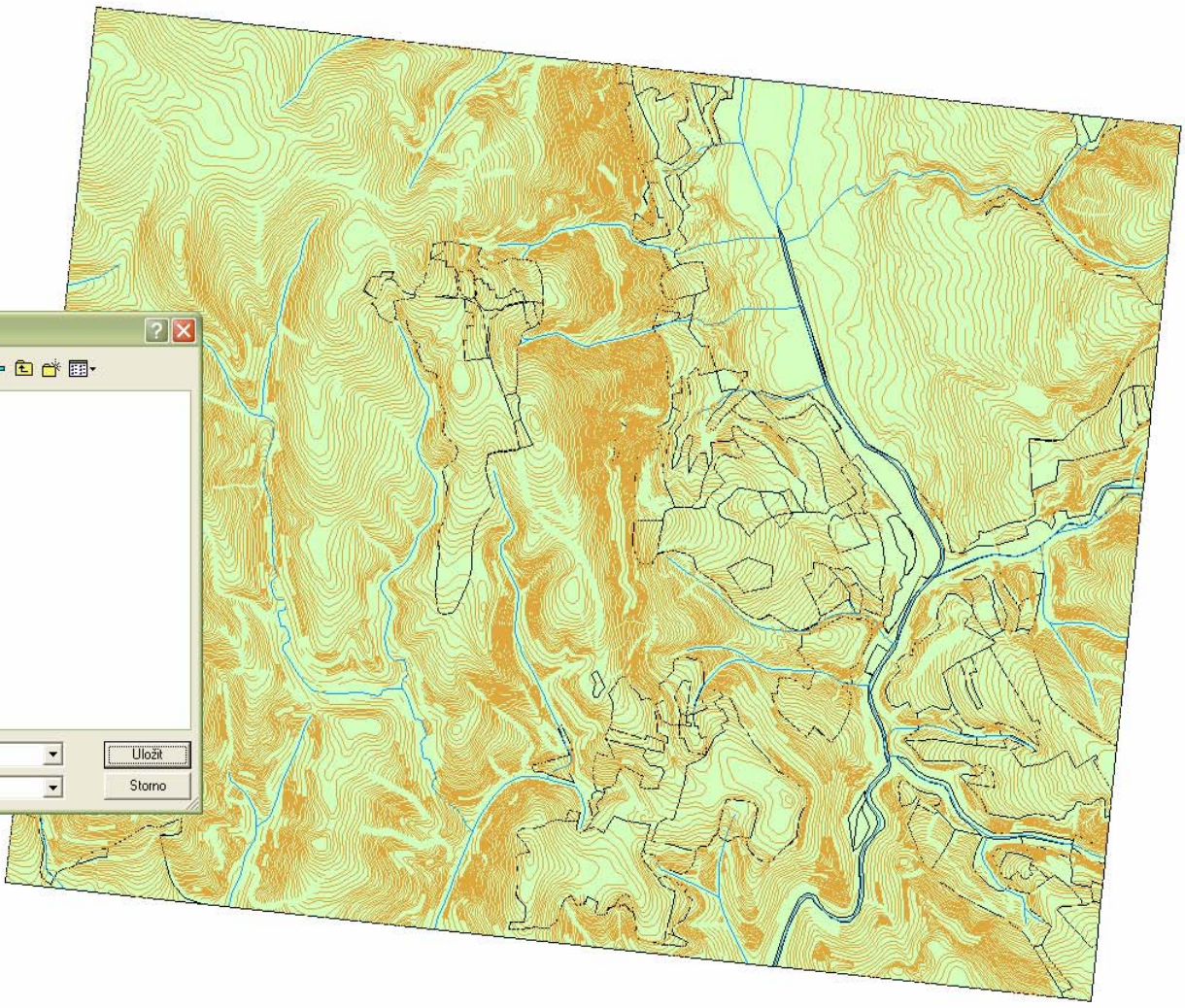


**Layers**

- gl\_ca010
- gl\_ca011
- gl\_ca012
- toky
- landuse
- vody

**ArcToolbox**

- 3D Analyst Tools
- Analysis Tools
- Cartography Tools
- Conversion Tools
- Data Interoperability Tools
- Data Management Tools
- Geocoding Tools
- Geostatistical Analyst Tools
- Linear Referencing Tools
- Multidimension Tools
- Network Analyst Tools
- Samples
- Server Tools
- Spatial Analyst Tools
- Spatial Statistics Tools
- Tracking Analyst Tools



**Uložit jako**

Uložit do: dmt

Název souboru: DMT.mxd

Uložit jako typ: ArcMap Document

Buttons: Uložit, Storno

**Layers**

- GL\_CA010
- GL\_CA011
- GL\_CA012

**ArcToolbox**

- 3D Analyst Tools
- Analysis Tools
- Cartography Tools
- Conversion Tools
- Data Interoperability Tools
- Data Management Tools
  - Database
  - Disconnected Editing
  - Domains
  - Feature class
  - Features
  - Fields
  - General
    - Append
    - Copy
    - Delete
    - Merge
    - Rename
    - Select Data
  - Generalization
  - Indexes
  - Joins
  - Layers and Table Views
  - Projections and Transformations
  - Raster
  - Relationship Classes
  - Subtypes
  - Table
  - Topology
  - Versions
  - Workspace
- Geocoding Tools
- Geostatistical Analyst Tools
- Linear Referencing Tools
- Network Analyst Tools
- Samples
- Spatial Analyst Tools
  - Conditional
  - Density
  - Distance
  - Extraction
  - Generalization
    - Aggregate
    - Boundary Clean
    - Expand
    - Majority Filter
    - Nibble
    - Region Group
    - Shrink
    - Thin
  - Groundwater
  - Hydrology
    - Basin
    - Fill
    - Flow Accumulation
    - Flow Direction
    - Flow Length
    - Sink
    - Snap Pour Point
    - Stream Link

**Merge**

Input Features

- GL\_CA010
- GL\_CA011
- GL\_CA012

Output Features

D:\DIKAV\wrs.shp

Field Map (optional)


- MAPNO (Text)
- VAL (Double)
- ID (Double)

Help


**Merge**

Combines input features from multiple input sources (of the same data type) into a single, new, output feature class. The input data sources may be point, line, or polygon feature classes or tables.

**INPUT**



**OUTPUT**



OK Cancel Environments... << Hide Help

**Topo to Raster**

Input feature data

Feature Layer	Field	Type
vrs	VAL	Contour
landuse		Boundary
toky		Stream
vody		Lake

Output surface raster  
D:\DIKAV\WRS\dmt

Output cell size (optional)  
5

Output extent (optional)

Y Maximum  
-1141697.542722

X Minimum X Maximum  
-597290.638695 -592063.827098

Y Minimum  
-1145986.453831

Margin in cells (optional)  
20

Smallest z value to be used in interpolation (optional)

Largest z value to be used in interpolation (optional)

Help

**Output diagnostic file (optional)**

The output diagnostic file listing all inputs and parameters used and the number of sinks cleared at each resolution and iteration.

**Topo to Raster**

Largest z value to be used in interpolation (optional)

Drainage enforcement (optional)  
ENFORCE

Primary type of input data (optional)  
CONTOUR

Maximum number of iterations (optional)  
40

Roughness penalty (optional)

Discretisation error factor (optional)  
1

Vertical standard error (optional)  
0

Tolerance 1 (optional)  
1

Tolerance 2 (optional)  
100

**Optional outputs**

Output stream polyline features (optional)  
D:\DIKAV\WRS\outstreams.shp

Output remaining sink point features (optional)  
D:\DIKAV\WRS\outsinks.shp

Output diagnostic file (optional)  
D:\DIKAV\WRS\outdiagnostics.TXT

Output parameter file (optional)

Help

**Output diagnostic file (optional)**

The output diagnostic file listing all inputs and parameters used and the number of sinks cleared at each resolution and iteration.

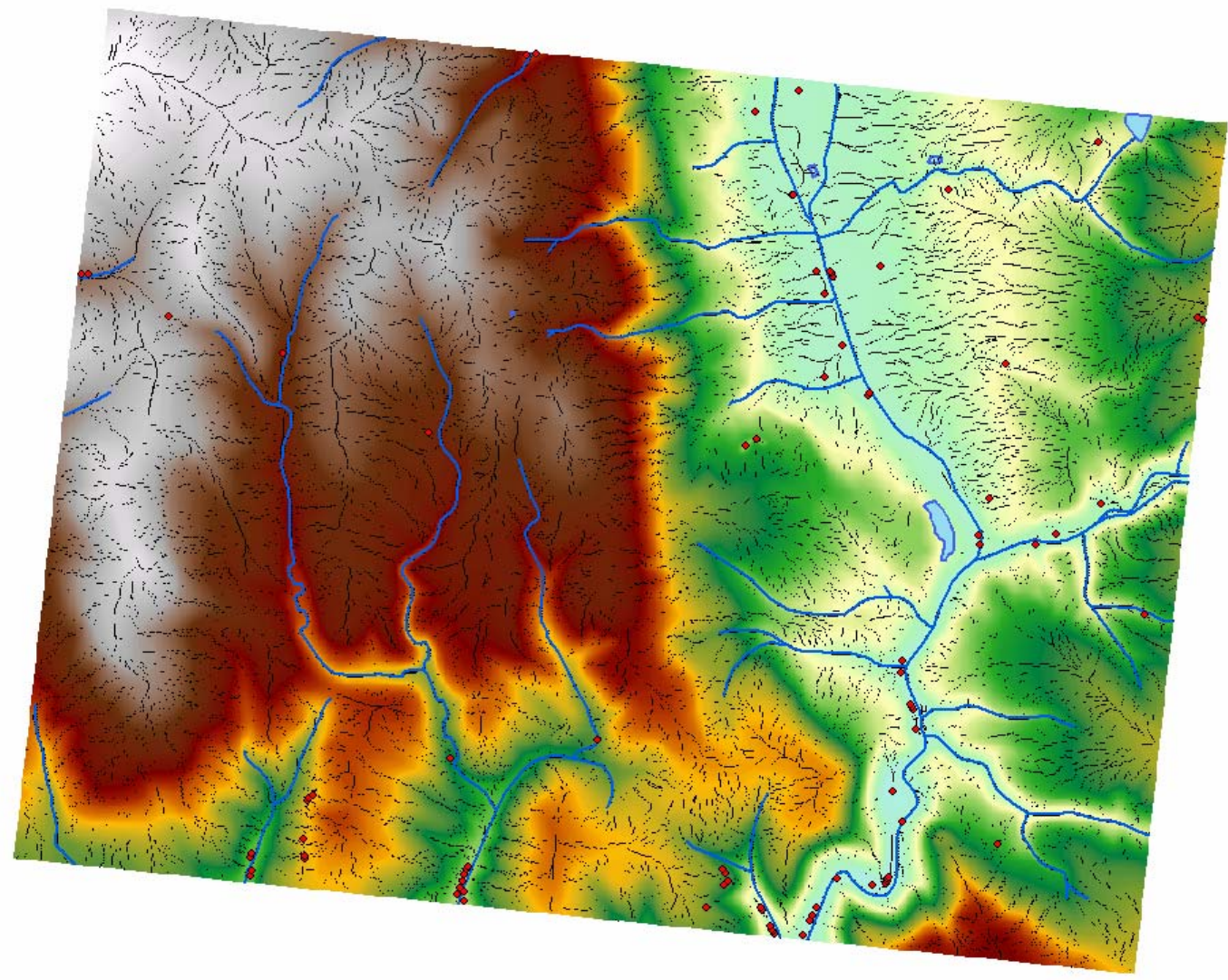
**Layers**

- outinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt

Value

High : 586.518921

Low : 257.305969



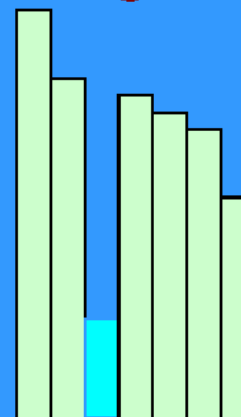
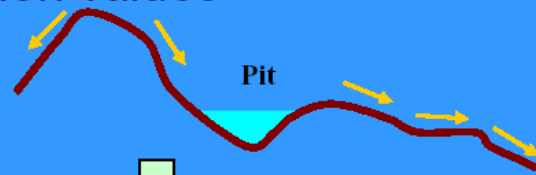
- An area surrounded by higher elevation values
- Known as pit/depression
- Area of internal drainage
- Should know morphology of area

37	35	40	42
30	26	32	35
32	30	25	38
37	38	40	20

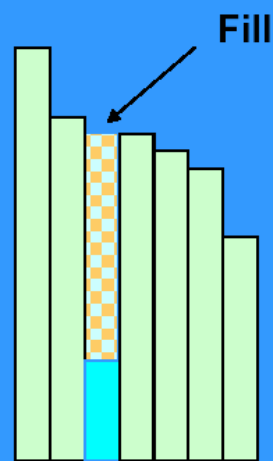
Natural flow

37	35	40	42
30	5	32	35
32	30	25	38
37	38	40	20

Sink



Sink/Pit



**Layers**

- outsinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt

Value  
High : 586.518921  
Low : 257.305969

**Spatial Analyst Tools**

- Conditional
- Density
- Distance
- Extraction
- Generalization
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Surface
  - Aspect
  - Contour
  - Contour List
  - Curvature
  - Cut/Fill
  - Hillshade
  - Observer Points
  - Slope
  - Viewshed

**Fill**

Input surface raster: dmt

Output surface raster: D:\DIKAV\WRS\dmt\_fill

Z limit (optional):

OK Cancel Environments... << Hide Help

**Fill**

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

**Layers**

- outsinks
- toky
  - Value
  - High : 586.518921
  - Low : 267.954773
- outstreams
- vrs
- vody
  - Value
  - High : 586.518921
  - Low : 257.305969
- landuse
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 257.305969
- dmt
  - Value
  - High : 586.518921
  - Low : 257.305969

- Linear Referencing Tools
- Network Analyst Tools
- Samples
- Spatial Analyst Tools
  - Conditional
  - Density
  - Distance
  - Extraction
  - Generalization
  - Groundwater
  - Hydrology
    - Basin
    - Fill
    - Flow Accumulation
    - Flow Direction
    - Flow Length
    - Sink
    - Snap Pour Point
    - Stream Link
    - Stream Order
    - Stream to Feature
    - Watershed
  - Interpolation
    - IDW
    - Kriging
    - Natural Neighbor
    - Spline
    - Topo to Raster
    - Topo to Raster by File
    - Trend
  - Local
  - Map Algebra
  - Math
  - Multivariate
  - Neighborhood
  - Overlay
  - Raster Creation
  - Reclass
  - Surface
    - Aspect
    - Contour
    - Contour List
    - Curvature
    - Cut/Fill
    - Hillshade
    - Observer Points
    - Slope
    - Viewshed

### Hillshade

Input raster:

Output raster:

Azimuth (optional):

Altitude (optional):

Model shadows (optional)

Z factor (optional):

Buttons: OK, Cancel, Environments..., << Hide Help

Help

### Hillshade

Computes hillshade values for a raster surface by considering the illumination angle and shadows.

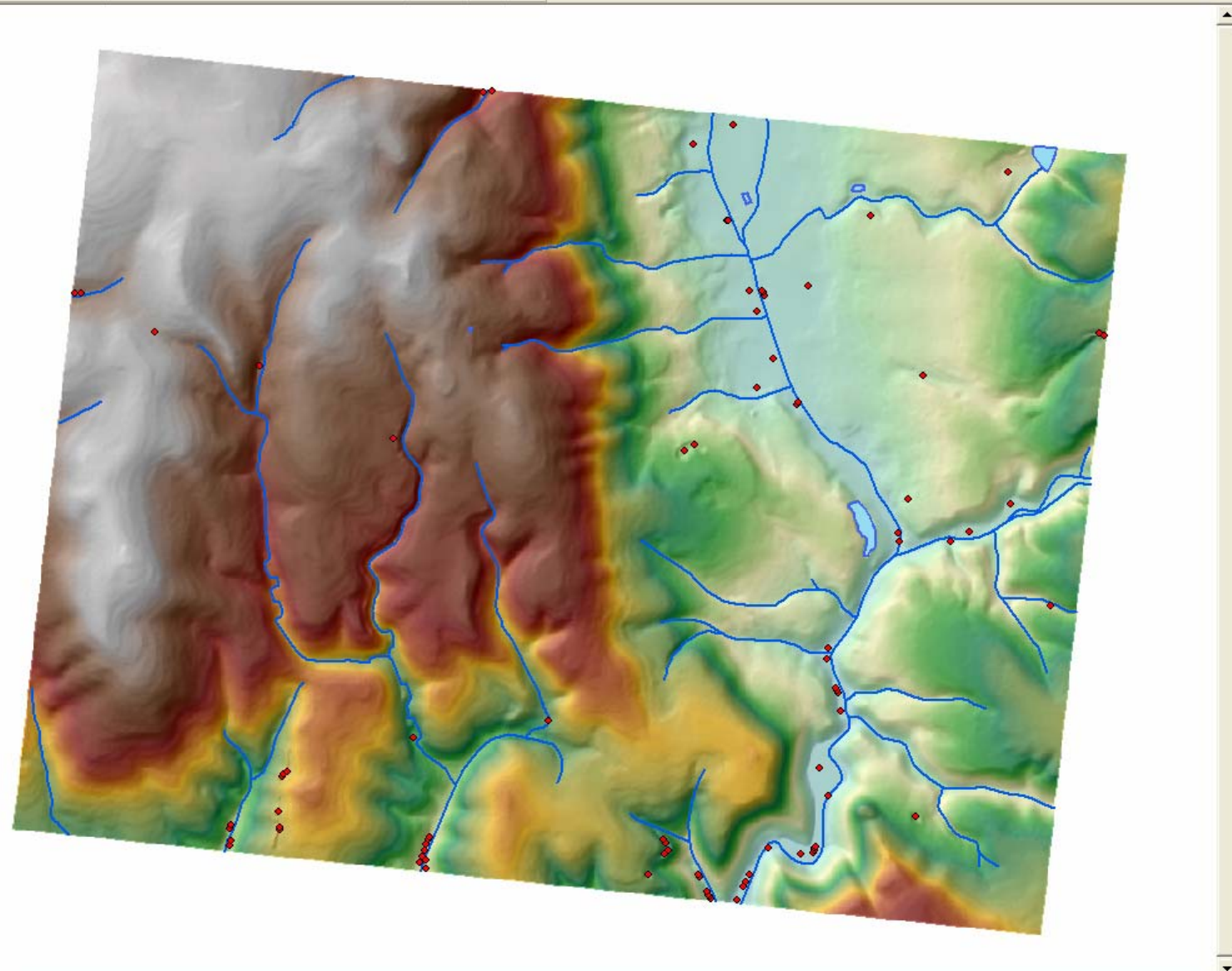


1:22 182 100%

Editor Create New Feature Target:

**Layers**

- outinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0
- dmt
  - Value
  - High : 586.518921
  - Low : 257.305969



**Layers**

- outsinks
- outstreams
- toky
- vrs
- vody
- landuse
- dmt**
  - 257.3059692 -
  - 293.8851862 -
  - 330.464403 -
  - 367.0436199 -
  - 403.6228367 -
  - 440.2020536 -
  - 476.7812704 -
  - 513.3604873 -
  - 549.9397041 -

**ArcToolbox**

- 3D Analyst Tools
- Conversion
- Functional Surface
- Raster Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Raster Math
- Raster Reclass
- Raster Surface
  - Aspect
  - Contour
  - Contour List
  - Curvature
  - Cut/Fill
  - Hillshade
  - Observer Points
  - Slope
  - Viewshed
- TIN Creation
- TIN Surface
- Analysis Tools
- Cartography Tools
- Conversion Tools
- Data Interoperability Tools
- Data Management Tools
- Geocoding Tools
- Geostatistical Analyst Tools
- Linear Referencing Tools
- Network Analyst Tools
- Samples
- Spatial Analyst Tools
- Spatial Statistics Tools

**Slope**

Input raster: dmt

Output raster: D:\DIKAV\slope

Output measurement (optional): DEGREE

Z factor (optional): 1

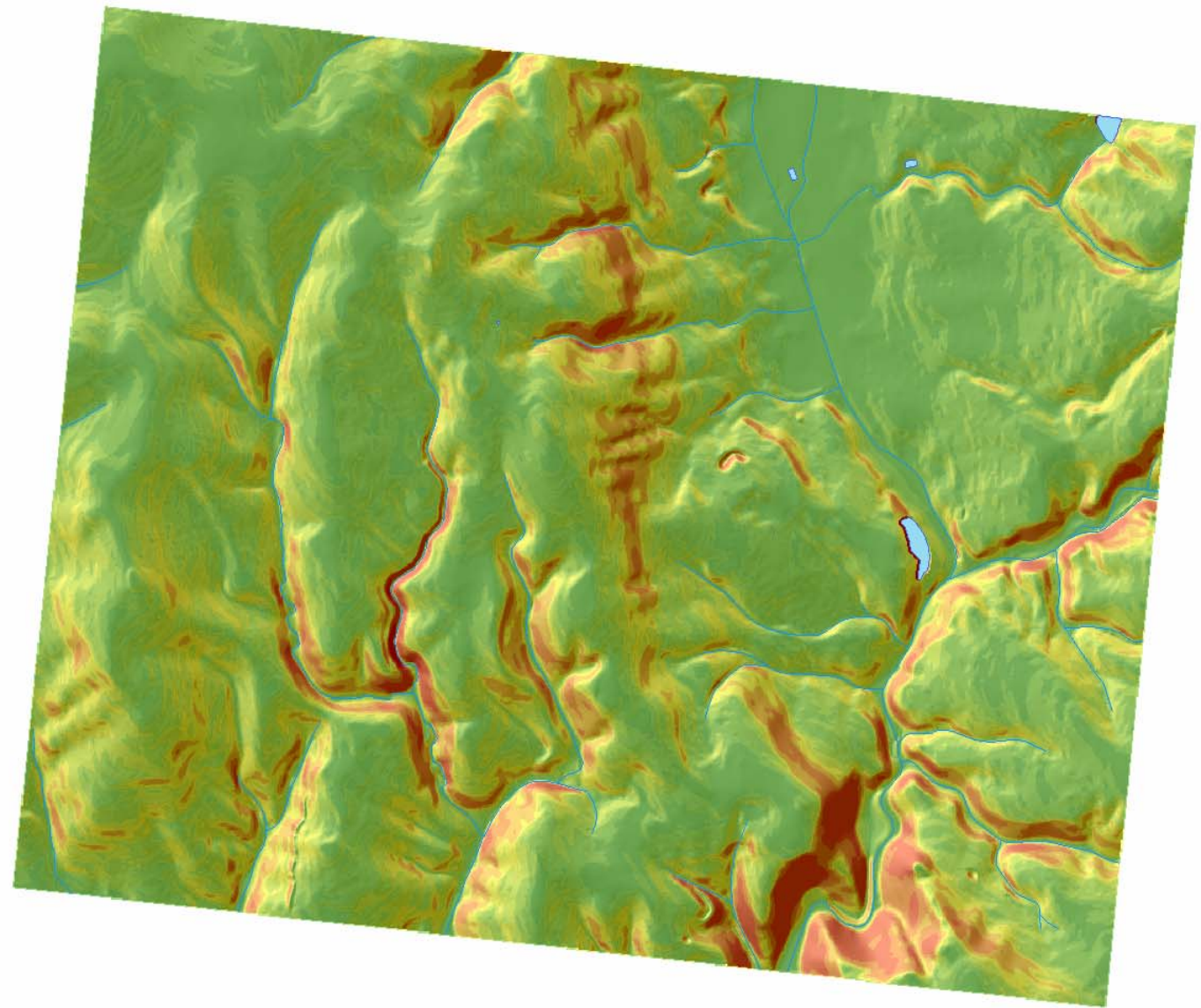
OK Cancel Environments... << Hide Help

**Help**

Identifies the rate of maximum change in z-value from each cell.

**Layers**

- outinks
- outstreams
- toky
- vrs
- vody
- landuse
- slope
  - 0 - 4.3066312
  - 4.306631201 - 8.326153654
  - 8.326153655 - 12.34567611
  - 12.34567612 - 16.65230731
  - 16.65230732 - 21.24604726
  - 21.24604727 - 26.4140047
  - 26.41400471 - 32.73039712
  - 32.73039713 - 46.79872571
  - 46.79872572 - 73.21273041
- dmt\_hs
  - Value
  - High : 254
  - Low : 0



**Layers**

- outsinks
- outstreams
- toky
- vrs
- vody
- landuse
- dmt\_hs
  - Value
  - High : 254
  - Low : 0

**ArcToolbox**

- 3D Analyst Tools
- Conversion
- Functional Surface
- Raster Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Raster Math
- Raster Reclass
- Raster Surface
  - Aspect
  - Contour
  - Contour List
  - Curvature
  - Cut/Fill
  - Hillshade
  - Observer Points
  - Slope
  - Viewshed
- TIN Creation
- TIN Surface
- Analysis Tools
- Cartography Tools
- Conversion Tools
- Data Interoperability Tools
- Data Management Tools
- Geocoding Tools
- Geostatistical Analyst Tools
- Linear Referencing Tools
- Network Analyst Tools
- Samples
- Spatial Analyst Tools
- Spatial Statistics Tools

**Aspect**

Input raster  
D:\DIKAY\dmt

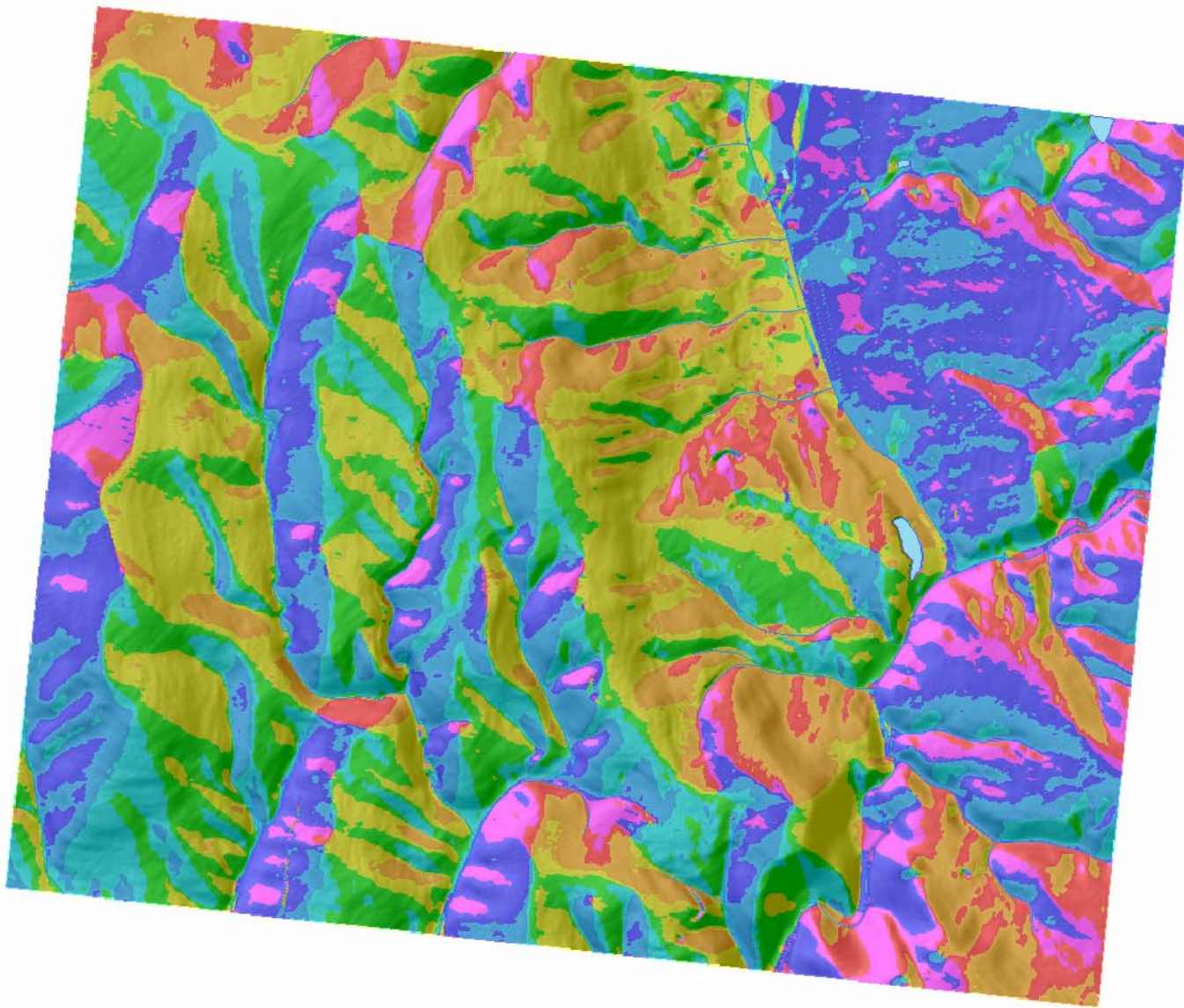
Output raster  
D:\DIKAY\aspect

Help  
**Aspect**  
Derives aspect from a raster surface.

OK Cancel Environments... << Hide Help

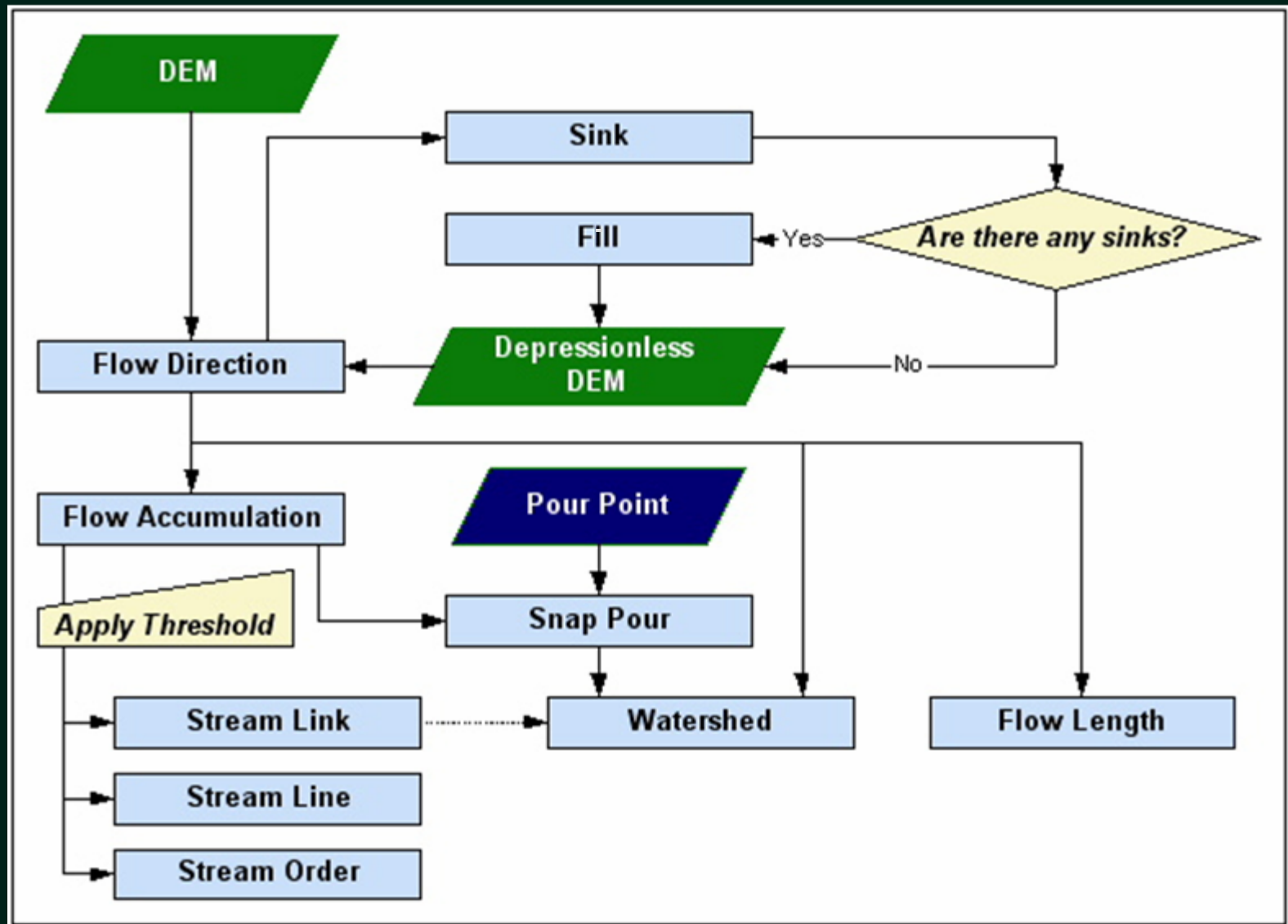
**Layers**

- outinks
- outstreams
- toky
- vrs
- vody
- landuse
- aspect
  - Flat (-1)
  - North (0-22.5)
  - Northeast (22.5-67.5)
  - East (67.5-112.5)
  - Southeast (112.5-157.5)
  - South (157.5-202.5)
  - Southwest (202.5-247.5)
  - West (247.5-292.5)
  - Northwest (292.5-337.5)
  - North (337.5-360)
- dmt\_hs
  - Value
  - High : 254
  - Low : 0



# Digitální modely terénu (10)

## Hydrologické modelování v ArcGIS



**Layers**

- outsinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0
- dmt
  - Value
  - High : 586.518921
  - Low : 257.305969

**Spatial Analyst Tools**

- Conditional
- Density
- Distance
- Extraction
- Generalization
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Surface
  - Aspect
  - Contour
  - Contour List
  - Curvature
  - Cut/Fill
  - Hillshade
  - Observer Points
  - Slope
  - Viewshed

**Flow Direction**

Input surface raster: dmt\_fill

Output flow direction raster: D:\DIKAV\WRS\dmt\_flow

Force all edge cells to flow outward (optional)

Output drop raster (optional): D:\DIKAV\WRS\dmt\_drop

OK Cancel Environments... << Hide Help

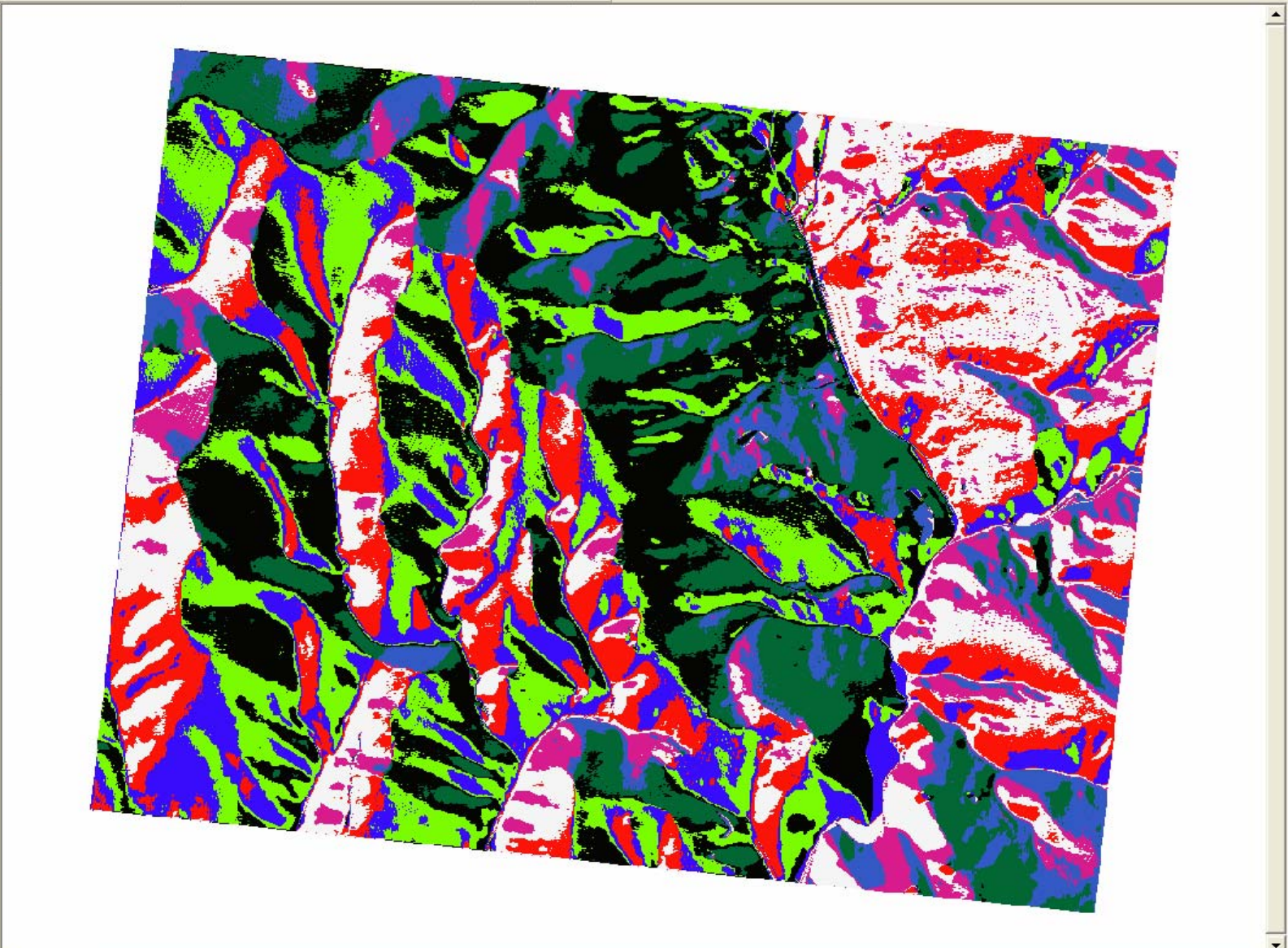
**Flow Direction**

Creates a raster of flow direction from each cell to its steepest downslope neighbor.



**Layers**

- outinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt\_FlowAcc
  - Value
  - High : 377646.00000
  - Low : 0.000000
- dmt\_flow
  - 1
  - 2
  - 4
  - 8
  - 16
  - 32
  - 64
  - 128
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0



**Layers**

- outsinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt\_drop
  - Value
    - High : 580
    - Low : 0.0217391
- dmt\_flow
  - 1
  - 2
  - 4
  - 8
  - 16
  - 32
  - 64
  - 128
- dmt\_fill
  - Value
    - High : 586.518921
    - Low : 267.954773
- dmt\_hs
  - Value
    - High : 254
    - Low : 0
- dmt
  - Value
    - High : 586.518921
    - Low : 257.305969

**Toolbox**

- Linear Referencing Tools
- Network Analyst Tools
- Samples
- Spatial Analyst Tools
  - Conditional
  - Density
  - Distance
  - Extraction
  - Generalization
  - Groundwater
  - Hydrology
    - Basin
    - Fill
    - Flow Accumulation
    - Flow Direction
    - Flow Length
    - Sink
    - Snap Pour Point
    - Stream Link
    - Stream Order
    - Stream to Feature
    - Watershed
  - Interpolation
    - IDW
    - Kriging
    - Natural Neighbor
    - Spline
    - Topo to Raster
    - Topo to Raster by File
    - Trend
  - Local
  - Map Algebra
  - Math
  - Multivariate
  - Neighborhood
  - Overlay
  - Raster Creation
  - Reclass
  - Surface
    - Aspect
    - Contour
    - Contour List
    - Curvature
    - Cut/Fill
    - Hillshade
    - Observer Points
    - Slope
    - Viewshed

**Flow Accumulation**

Input flow direction raster: dmt\_flow

Output accumulation raster: D:\DIKAV\WRS\dmt\_FlowAcc

Input weight raster (optional):

**Input weight raster (optional)**

Weight to be assigned to each cell. If no weight raster is specified, a default weight of 1 will be applied to each cell.

For each cell in the output raster, the result will be the number of cells that flow into it.

OK Cancel Environments... << Hide Help

**Layers**

- outinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt\_FlowAcc
  - Value
  - High : 377646.00000
  - Low : 0.000000
- dmt\_flow
  - 1
  - 2
  - 4
  - 8
  - 16
  - 32
  - 64
  - 128
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0

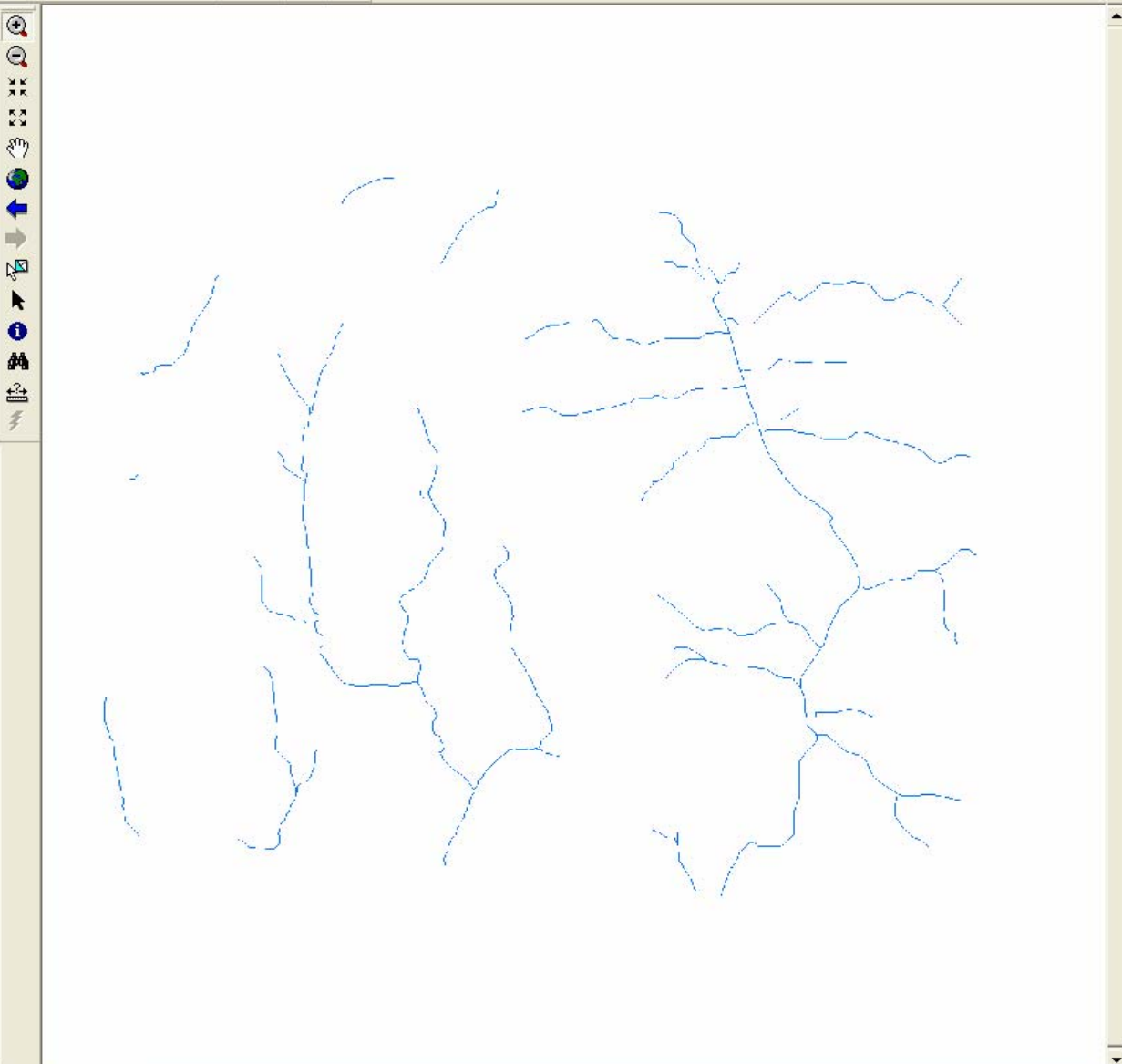


**Layers**

- outinks
- toky
- outstreams
- vrs
- vody
- landuse
  - <VALUE>
  - 0 - 5 000
  - 5 000.000001 - 377 646
- dmt\_flow
  - 1
  - 2
  - 4
  - 8
  - 16
  - 32
  - 64
  - 128
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0

**Spatial Analyst Tools**

- Conditional
- Density
- Distance
- Extraction
- Generalization
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Surface
  - Aspect
  - Contour
  - Contour List
  - Curvature
  - Cut/Fill
  - Hillshade
  - Observer Points
  - Slope
  - Viewshed
- Zonal
- Spatial Statistics Tools



**Layers**

- outsinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt\_FlowAcc
  - <VALUE>
  - 0 - 5 000
  - 5 000.000001 - 377 646
- dmt\_flow
  - 1
  - 2
  - 4
  - 8
  - 16
  - 32
  - 64
  - 128
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0

**ArcToolbox**

- 3D Analyst Tools
- Analysis Tools
- Cartography Tools
- Conversion Tools
- Data Interoperability Tools
- Data Management Tools
- Geocoding Tools
- Geostatistical Analyst Tools
- Linear Referencing Tools
- Network Analyst Tools
- Samples
- Spatial Analyst Tools
  - Conditional
    - Con
    - Pick
    - Set Null
  - Density
  - Distance
  - Extraction
  - Generalization
  - Groundwater
  - Hydrology
    - Basin
    - Fill
    - Flow Accumulation
    - Flow Direction
    - Flow Length
    - Sink
    - Snap Pour Point
    - Stream Link
    - Stream Order
    - Stream to Feature
    - Watershed
  - Interpolation
    - IDW
    - Kriging
    - Natural Neighbor
    - Spline
    - Topo to Raster
    - Topo to Raster by File
    - Trend
  - Local
    - Map Algebra
    - Math
    - Multivariate
    - Neighborhood
    - Overlay

**Set Null**

Input conditional raster: dmt\_FlowAcc

Input false raster or constant value: 1

Output raster: D:\DIKAV\WRS\dmt\_strmnet

Expression (optional): Value LT 5000

Buttons: OK, Cancel, Environments..., << Hide Help

**Help**

**Expression (optional)**

Where clause defining the desired logical query.

**Environment Settings**

- General Settings
- Coverage Settings
- Geodatabase Settings
- Raster Analysis Settings
  - Cell Size: Maximum of Inputs
  - Mask: landuse
- Raster Geodatabase Settings

Buttons: OK, Cancel, Show Help >>

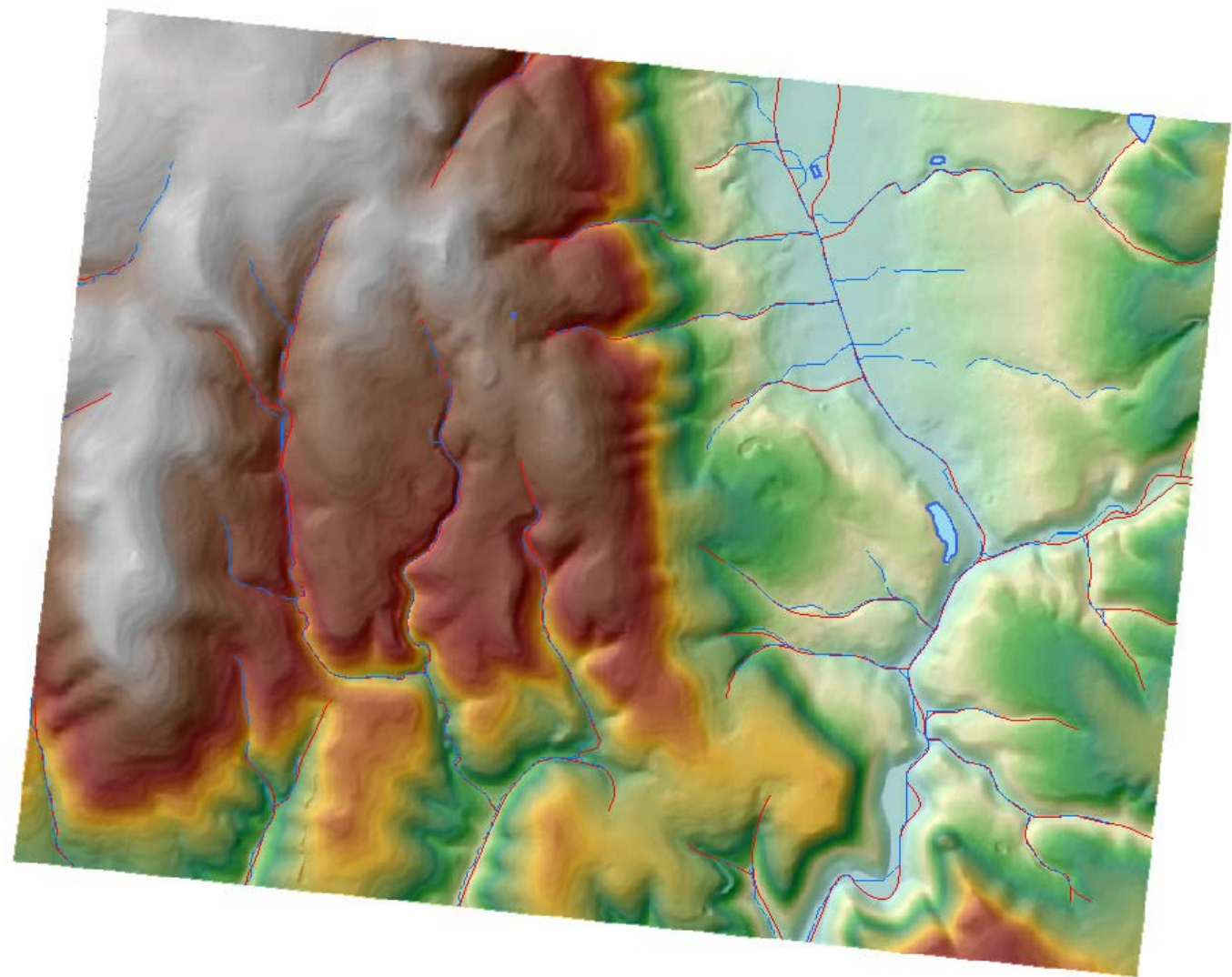
**Help**

**Environment Settings**

Environment settings specified in this dialog box are values that will be applied to appropriate results from running tools. They can be set hierarchically, meaning that they can be set for the application you are working in, so they apply to all tools; for a model, so they apply to all processes within the model; or for a particular process within a model. Environments set for a process within a model will

Layers

- dmt\_strmnet  
Value
- outsinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt\_FlowAcc  
<VALUE>
- dmt\_flow
- dmt\_fill  
Value  
High : 586.518921  
Low : 267.954773
- dmt\_hs  
Value  
High : 254  
Low : 0



**Layers**

- dmt\_strmnet  
Value
- 1
- outsinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt\_FlowAcc  
<VALUE>
- dmt\_flow
- dmt\_fill  
Value
- dmt\_hs  
Value

**Spatial Analyst Tools**

- Conditional
- Density
- Distance
- Extraction
- Generalization
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Surface
  - Aspect
  - Contour
  - Contour List
  - Curvature
  - Cut/Fill
  - Hillshade
  - Observer Points
  - Slope
  - Viewshed
- Zonal
- Spatial Statistics Tools

**Stream Link**

Input stream raster: dmt\_strmnet

Input flow direction raster: dmt\_flow

Output raster: D:\DIKAV\VRS\dmt\_strmlink

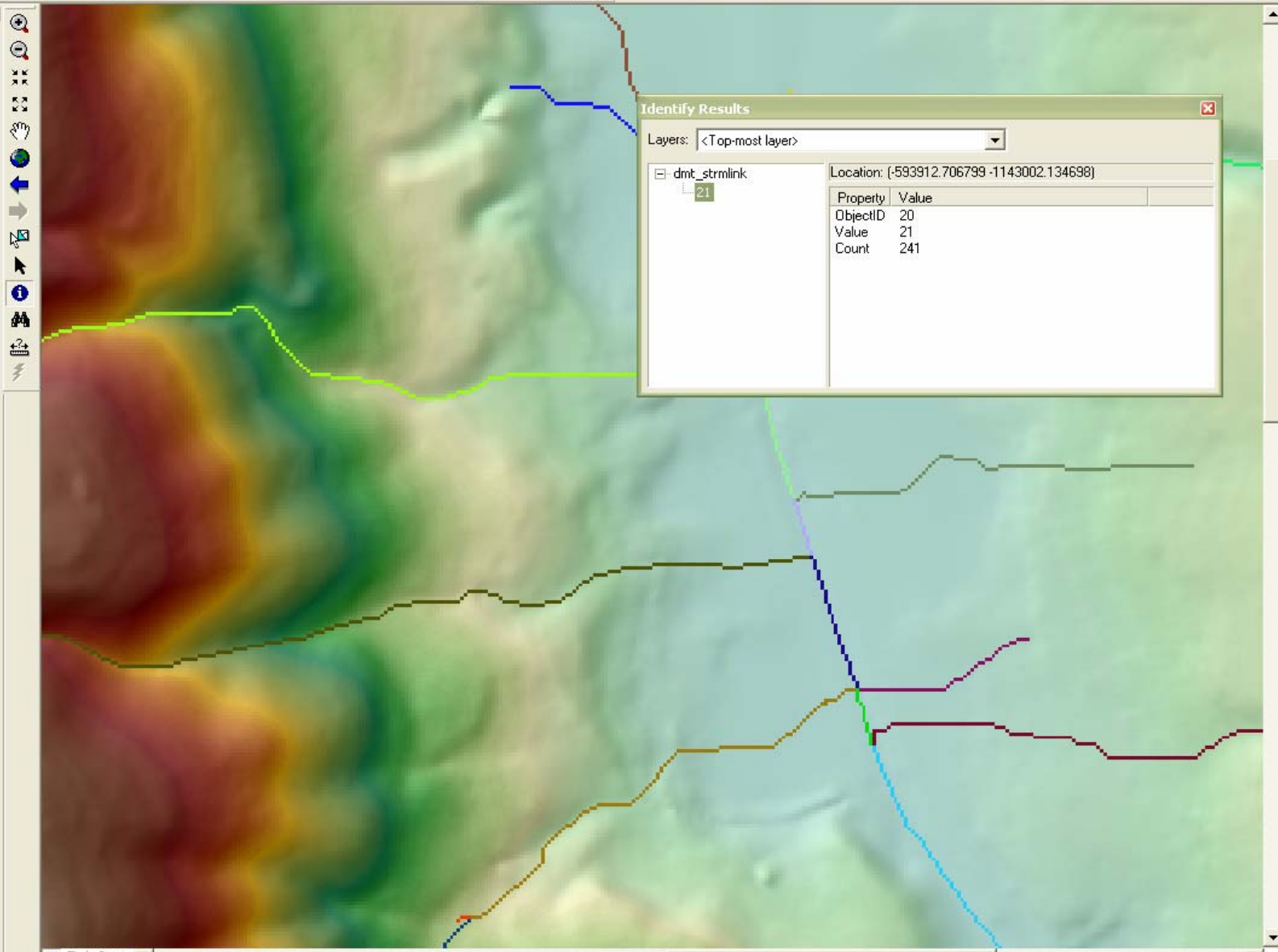
OK Cancel Environments... << Hide Help

**Stream Link**

Assigns unique values to sections of a raster linear network between intersections.

**Layers**

- dmt\_strmlink
- dmt\_strmnet
  - Value
  - 1
- outsinks
  - toky
- outstreams
- vrs
- vody
- landuse
- dmt\_FlowAcc
  - <VALUE>
  - 0 - 5 000
  - 5 000.000001 - 377 646
- dmt\_flow
  - 1
  - 2
  - 4
  - 8
  - 16
  - 32
  - 64
  - 128
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0





**Layers**

- vody
- toky
- dmt\_basin
  - Value
    - 1 - 16
    - 16.00000001 - 17
    - 17.00000001 - 42
    - 42.00000001 - 43
    - 43.00000001 - 76
- Strmord\_strah
- dmt\_strmlink
- dmt\_strmnet
  - Value
    - 1
- outsinks
- outstreams
- vrs
- landuse
- dmt\_FlowAcc
  - <VALUE>
    - 0 - 5 000
    - 5 000.000001 - 377 646
- dmt\_flow
- dmt\_fill
  - Value
    - High : 586.518921
    - Low : 267.954773
- dmt\_hs
  - Value
    - High : 254
    - Low : 0

**Spatial Analyst Tools**

- Conditional
- Density
- Distance
- Extraction
- Generalization
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Surface
  - Aspect
  - Contour
  - Contour List
  - Curvature
  - Cut/Fill
  - Hillshade
  - Observer Points
  - Slope
  - Viewshed
- Zonal
- Spatial Statistics Tools

### Flow Length

Input flow direction raster:

Output raster:

Direction of measurement (optional):

Input weight raster (optional):

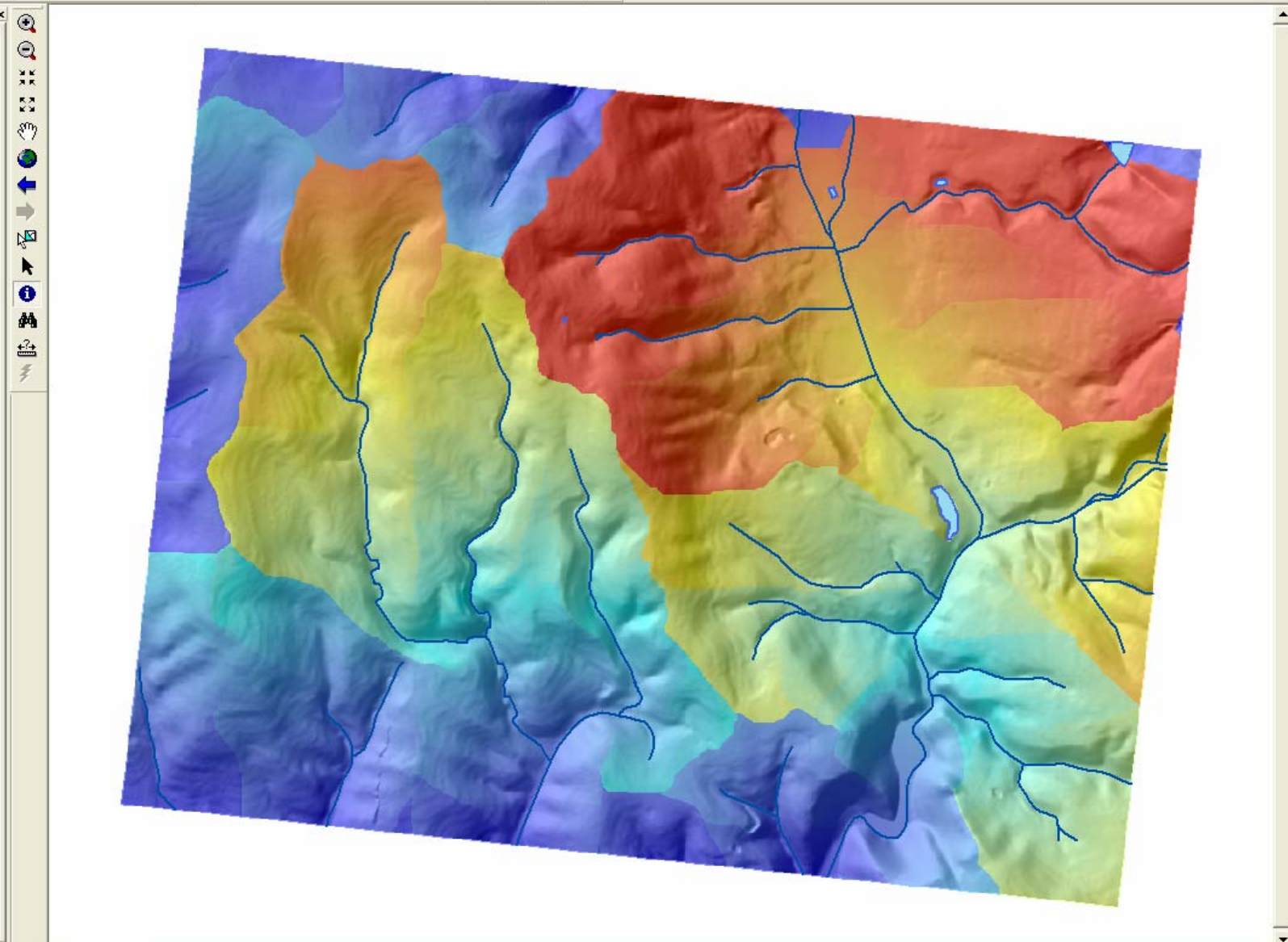
OK Cancel Environments... << Hide Help

#### Flow Length

Calculates distance or weighted distance along a flow path.

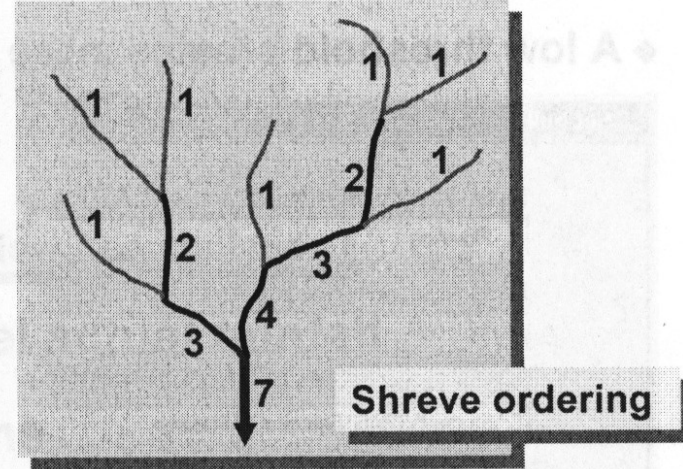
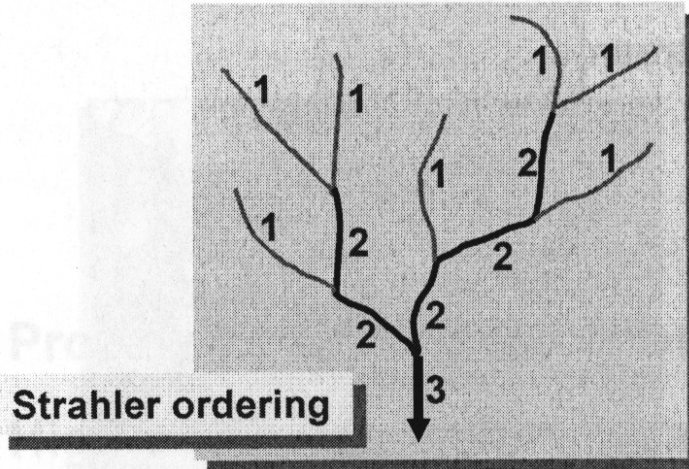
**Layers**

- vody
- toky
- dmt\_flowleng  
Value  
High : 6503.355469  
Low : 0.000000
- dmt\_basin  
Value  
1 - 16  
16.00000001 - 17  
17.00000001 - 42  
42.00000001 - 43  
43.00000001 - 76
- Strmord\_strah
- dmt\_strmlink
- dmt\_strmnet  
Value  
1
- outsinks
- outstreams
- vrs
- landuse
- dmt\_FlowAcc  
<VALUE>  
0 - 5 000  
5 000.000001 - 377 646
- dmt\_flow
- dmt\_fill  
Value  
High : 586.518921  
Low : 267.954773
- dmt\_hs  
Value  
High : 254  
Low : 0



## Stream Order tool

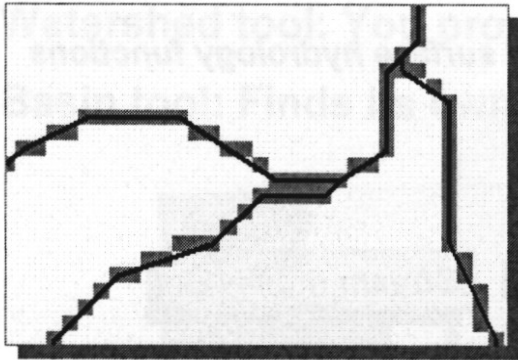
- ◆ Assigns relative ranking to stream segments
  - ◆ Based on the number of tributaries
  - ◆ Two methods: Shreve or Strahler



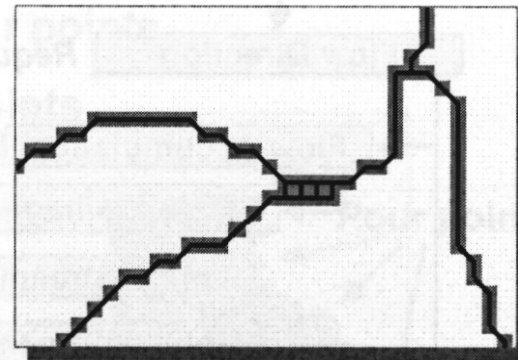
- ◆ Requires stream network and flow direction inputs

## Stream to Feature tool

### ◆ Raster-to-vector conversion tool



Stream to Feature tool



Raster to Polyline tool

### ◆ Designed for stream networks

- ◆ Handles parallel stream segments properly
- ◆ Requires stream network and flow direction inputs

**Layers**

- Strmord\_strah
  - 1
  - 2
  - 3
- dmt\_strmlink
- dmt\_strmnet
  - Value
    - 1
- outsinks
- toky
- outstreams
- vrs
- vody
- landuse
- dmt\_FlowAcc
  - <VALUE>
    - 0 - 5 000
    - 5 000.000001 - 377 646
- dmt\_flow
  - 1
  - 2
  - 4
  - 8
  - 16
  - 32
  - 64
  - 128
- dmt\_fill
  - Value
    - High : 586.518921
    - Low : 267.954773
- dmt\_hs
  - Value
    - High : 254
    - Low : 0

**Spatial Analyst Tools**

- Conditional
- Density
- Distance
- Extraction
- Generalization
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Surface
  - Aspect
  - Contour
  - Contour List
  - Curvature
  - Cut/Fill
  - Hillshade
  - Observer Points
  - Slope
  - Viewshed
- Zonal
- Spatial Statistics Tools

**Basin**

Input flow direction raster: dmt\_flow

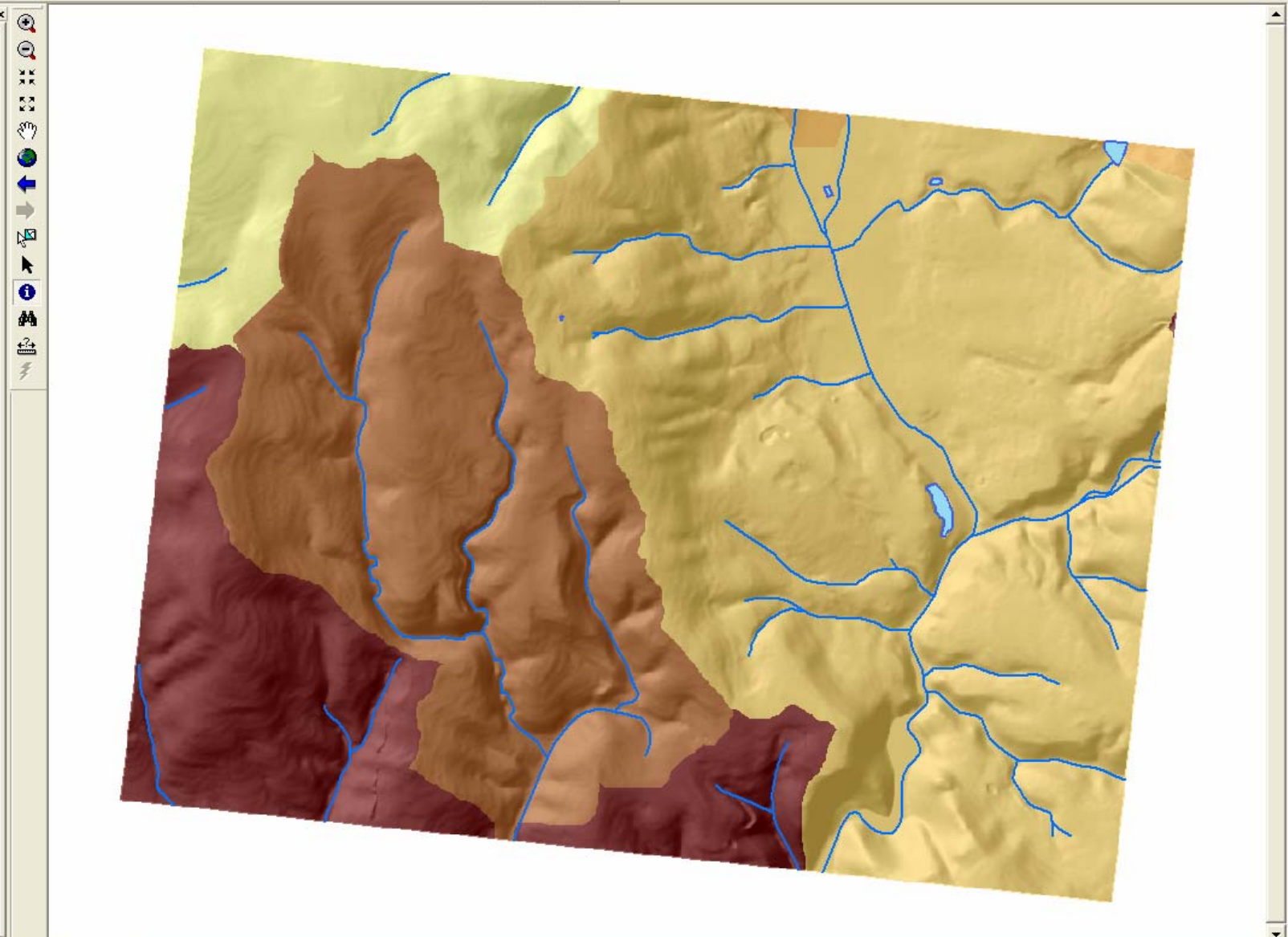
Output raster: D:\DIKAV\VRS\dmt\_basin

Help: Basin  
Creates a raster delineating all drainage basins.

OK Cancel Environments... << Hide Help

**Layers**

- vody
- toky
- dmt\_basin
  - Value
  - 1 - 16
  - 16.00000001 - 17
  - 17.00000001 - 42
  - 42.00000001 - 43
  - 43.00000001 - 76
- Strmord\_strah
- dmt\_strmlink
- dmt\_strmnet
  - Value
  - 1
- outsinks
- outstreams
- vrs
- landuse
- dmt\_FlowAcc
  - <VALUE>
  - 0 - 5 000
  - 5 000.000001 - 377 646
- dmt\_flow
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0



**Layers**

- vody
- toky
- dmt\_flowleng
- dmt\_basin
- Strmord\_strah
- dmt\_strmlink
- dmt\_strmnet**
- outsinks
- outstreams
- vrs
- landuse
- dmt\_FlowAcc
- dmt\_flow
- dmt\_fill
- Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
- Value
  - High : 254
  - Low : 0

**Spatial Analyst Tools**

- Conditional
- Density
- Distance
- Extraction
- Generalization
  - Aggregate
  - Boundary Clean
  - Expand
  - Majority Filter
  - Nibble
  - Region Group**
  - Shrink
  - Thin
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Surface
  - Aspect
  - Contour
  - Contour List

### Region Group

Input raster: dmt\_strmnet

Output raster: D:\DIKAV\WRS\strmnet\_group

Number of neighbors to use (optional): EIGHT

Zone grouping method (optional): WITHIN

Add link field to output (optional)

Excluded value (optional):

OK Cancel Environments... << Hide Help

#### Region Group

Records for each cell in the output the identity of the connected region to which it belongs within the Analysis window. A unique number is assigned to each region.

**Layers**

- vody
- toky
- strmnet\_group**
- dmt\_flowleng
- dmt\_basin
- Strmord\_strah
- dmt\_strmlink
- dmt\_strmnet
- outsinks
- outstreams
- vrs
- landuse
- dmt\_FlowAcc
- dmt\_flow
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0

- Extraction
  - Generalization
    - Aggregate
    - Boundary Clean
    - Expand
    - Majority Filter
    - Nibble
    - Region Group
    - Shrink
    - Thin
  - Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Surface
- Zonal
  - Tabulate Area
  - Zonal Fill
  - Zonal Geometry
  - Zonal Geometry as Table
  - Zonal Statistics
  - Zonal Statistics as Table

### Zonal Statistics

Input raster or feature zone data:

Zone field:

Input value raster:

Output raster:

Statistics type (optional):

Ignore NoData in calculations (optional)

OK Cancel Environments... << Hide Help

#### Zonal Statistics

Calculates statistics on values of a raster within the zones of another dataset.



**Layers**

- vody
- toky
- flow\_max
  - Value
  - High : 377436
  - Low : 6017
- strmnet\_group
- dmt\_flowleng
- dmt\_basin
- Strmord\_strah
- dmt\_strmlink
- dmt\_strmnet
- outsinks
- outstreams
- vrs
- landuse
- dmt\_FlowAcc
  - High : 586.518921
  - Low : 267.954773
- dmt\_flow
- dmt\_fill
  - Value
  - High : 254
  - Low : 0

- Extraction
  - Aggregate
  - Boundary Clean
  - Expand
  - Majority Filter
  - Nibble
  - Region Group
  - Shrink
  - Thin
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
- Map Algebra
  - Multi Output Map Algebra
  - Single Output Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Surface
- Zonal
  - Tabulate Area
  - Zonal Fill
  - Zonal Geometry
  - Zonal Geometry as Table

### Single Output Map Algebra

Map Algebra expression  
 CON (dmt\_FlowAcc EQ flow\_max, strmnet\_group)

Output raster  
 D:\DIKAV\WRS\pourpoint1

Input raster or feature data to show in ModelBuilder (optional)

#### Grid Map Algebra Usages

COMBINE	Usage: (out_grid) CON (<condition>, <true_expression>, <condition>, <true_expression>), ...
CON	{<condition>, <true_expression>}, {<condition>, <true_expression>}, {false_expression}
COR	
CORRIDOR	
COS	
COSH	
COSTALLOCATION	
COSTBACKLINK	
COSTDISTANCE	
CNSTP&TH	

OK Cancel Environments... << Hide Help

**Layers**

- vody
- toky
- pourpoint1
  - 2
  - 3
  - 7
  - 8
  - 11
  - 12
  - 15
  - 18
  - 22
  - 24
  - 26
  - 29
  - 31
  - 32
  - 33
  - 34
- flow\_max
  - Value
  - High : 377436
  - Low : 6017
- strmnnet\_group
- dmt\_flowleng
- dmt\_basin
- Strmord\_strah
- dmt\_strmlink
- dmt\_strmnet
- outsinks
- outstreams
- vrs
- landuse
- dmt\_FlowAcc
- dmt\_flow
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254

- Extraction
  - Aggregate
  - Boundary Clean
  - Expand
  - Majority Filter
  - Nibble
  - Region Group
  - Shrink
  - Thin
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
  - Cell Statistics
  - Combine
  - Equal To Frequency
  - Greater Than Frequency
  - Highest Position
  - Less Than Frequency
  - Lowest Position
  - Popularity
  - Rank
- Map Algebra
  - Multi Output Map Algebra
  - Single Output Map Algebra
- Math
- Multivariate
- Neighborhood

**Combine**

Input rasters

- pourpoint1
- dmt\_FlowAcc

Output raster

D:\DIKAV\WRS\pourpoint2

OK Cancel Environments... << Hide Help

**Combine**

Combines multiple rasters so a unique output value is assigned to each unique combination of input values.

**Layers**

- vody
- toky
- pourpoint2
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6
  - 7
  - 8
  - 9
  - 10
  - 11
  - 12
  - 13
  - 14
  - 15
  - 16
- pourpoint1
  - 2
  - 3
  - 7
  - 8
  - 11
  - 12
  - 15
  - 18
  - 22
  - 24
  - 26
  - 29
  - 31
  - 32
  - 33
  - 34
- flow\_max
  - Value
  - High : 377436
  - Low : 6017
- strmnet\_group
- dmt\_flowleng
- dmt\_basin
- Strmord\_strah

- Extraction
  - Aggregate
  - Boundary Clean
  - Expand
  - Majority Filter
  - Nibble
  - Region Group
  - Shrink
  - Thin
- Groundwater
- Hydrology
  - Basin
  - Fill
  - Flow Accumulation
  - Flow Direction
  - Flow Length
  - Sink
  - Snap Pour Point
  - Stream Link
  - Stream Order
  - Stream to Feature
  - Watershed
- Interpolation
  - IDW
  - Kriging
  - Natural Neighbor
  - Spline
  - Topo to Raster
  - Topo to Raster by File
  - Trend
- Local
  - Cell Statistics
  - Combine
  - Equal To Frequency
  - Greater Than Frequency
  - Highest Position
  - Less Than Frequency
  - Lowest Position
  - Popularity
  - Rank
- Map Algebra
  - Multi Output Map Algebra
  - Single Output Map Algr
- Math
- Multivariate
- Neighborhood

**Watershed**

Input flow direction raster  
dmt\_flow

Input raster or feature pour point data  
pourpoint2

Pour point field (optional)  
Pourpoint1

Output raster  
D:\DIKAV\WRS\watershed

OK Cancel Environments... << Hide Help

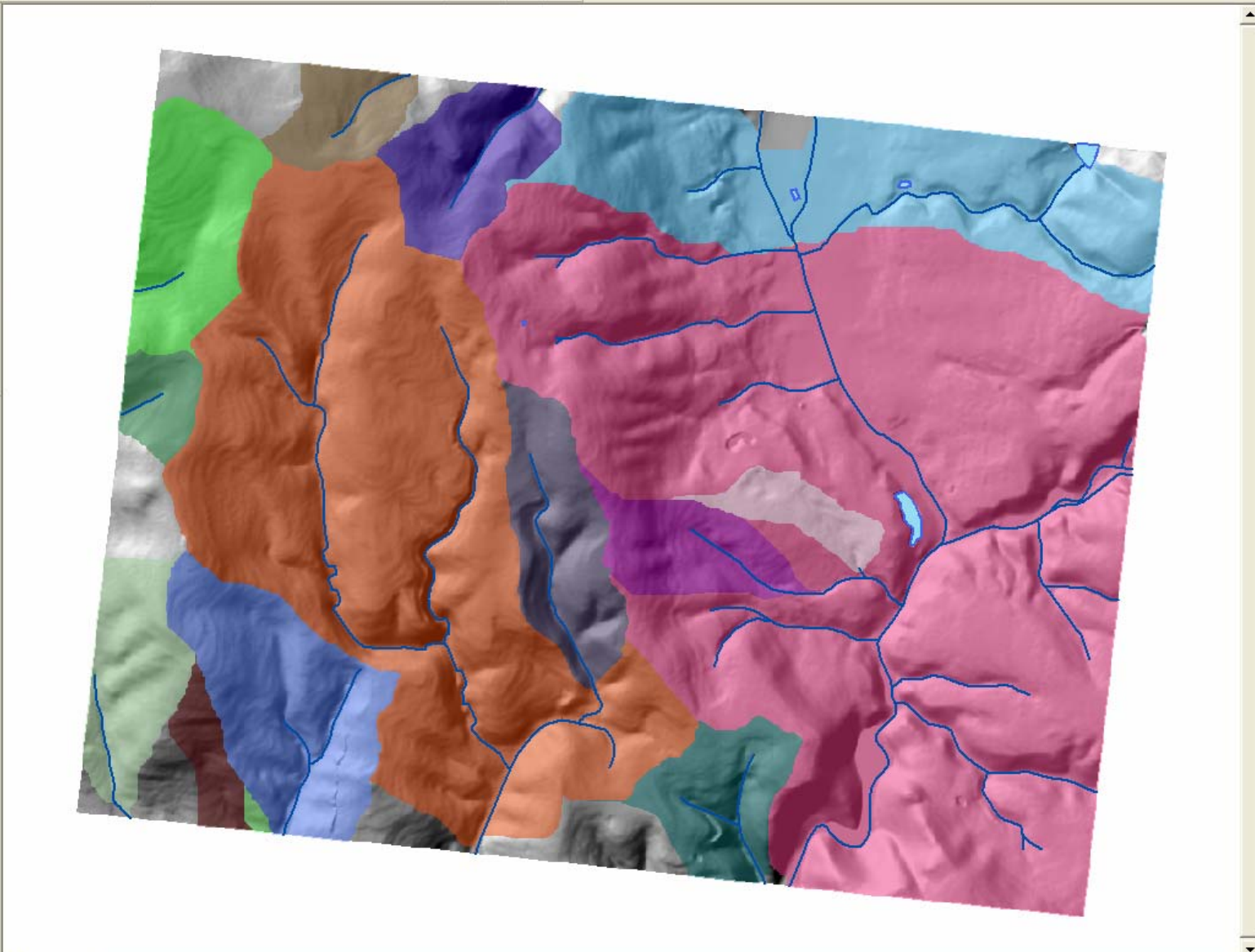
**Watershed**  
Determines the contributing area above a set of cells in a raster.

1:22 182 100%

Editor Task: Create New Feature Target:

### Layers

- vody
- toky
- watershed
  - 2
  - 3
  - 7
  - 8
  - 11
  - 12
  - 15
  - 18
  - 22
  - 24
  - 26
  - 29
  - 31
  - 32
  - 33
  - 34
- pourpoint2
- pourpoint1
- flow\_max
- strmnet\_group
- dmt\_flowleng
- dmt\_basin
- Strmord\_strah
- dmt\_strmlink
- dmt\_strmnet
- outsinks
- outstreams
- vrs
- landuse
- dmt\_FlowAcc
- dmt\_flow
- dmt\_fill
  - Value
  - High : 586.518921
  - Low : 267.954773
- dmt\_hs
  - Value
  - High : 254
  - Low : 0



**Layers**

- Watershed4  
23
- Watershed3  
48
- Watershed2  
13
- Watershed1  
66
- vody
- toky
- watershed
- pourpoint2
- pourpoint1
- flow\_max
- strmnnet\_group
- dmt\_flowleng
- dmt\_basin
- Strmord\_strah
- dmt\_strmlink
- dmt\_strmnet
- outsinks
- outstreams
- vrs
- landuse
- dmt\_FlowAcc
- dmt\_flow
- dmt\_fill
- dmt\_hs  
Value  
High : 586.518921  
Low : 267.954773
- dmt\_hs  
Value  
High : 254  
Low : 0

**Hydrology Modeling**

Hydrology

