

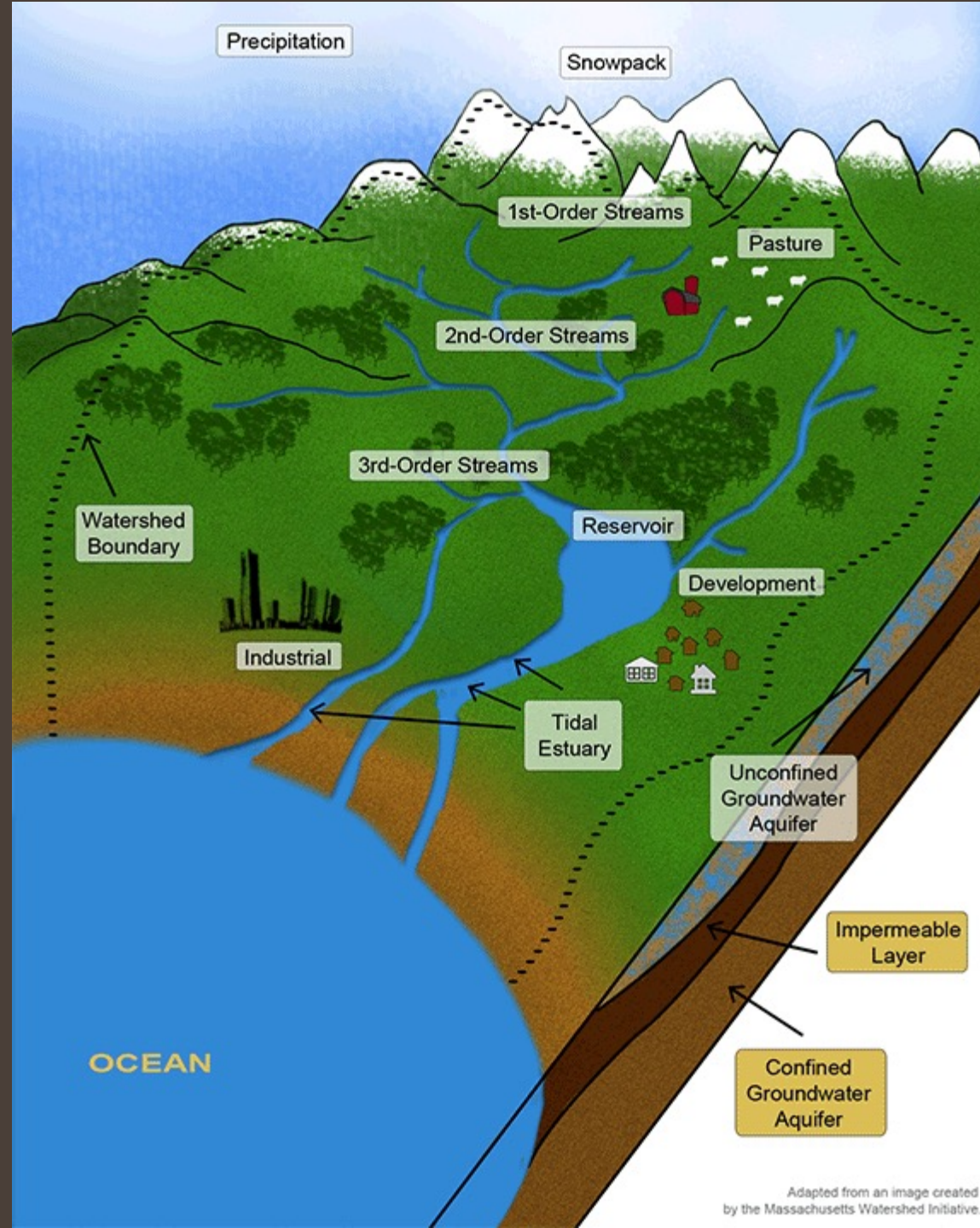
# Watersheds and Hydrologic Terrain Analysis using GIS

Patrick Benson, M.S. Student - Geography

# Housekeeping

- Lab 4 due @ 2pm of your lab day
- Office Hours Wednesday 1-2pm SH213
- Kyle is back tomorrow
- Final Project important dates: Presentations week of April 30 (details to come) and final story map due April 29
- Final Exam Wednesday, May 8, 1:10 – 3:10
- Voices of GIS with Kimothy Smith this Thursday!





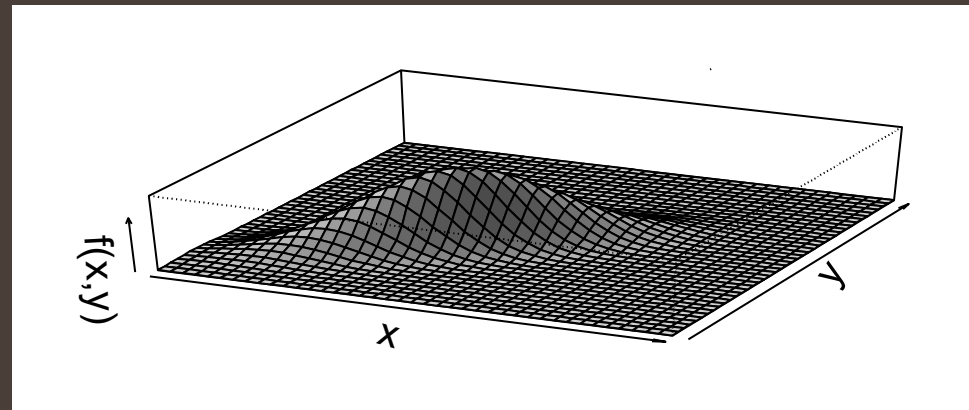
Adapted from an image created  
by the Massachusetts Watershed Initiative.

# Two fundamental ways of representing geography: **discrete objects** and **fields**.

The **discrete object view** represents the real world as objects with well defined boundaries in empty space.

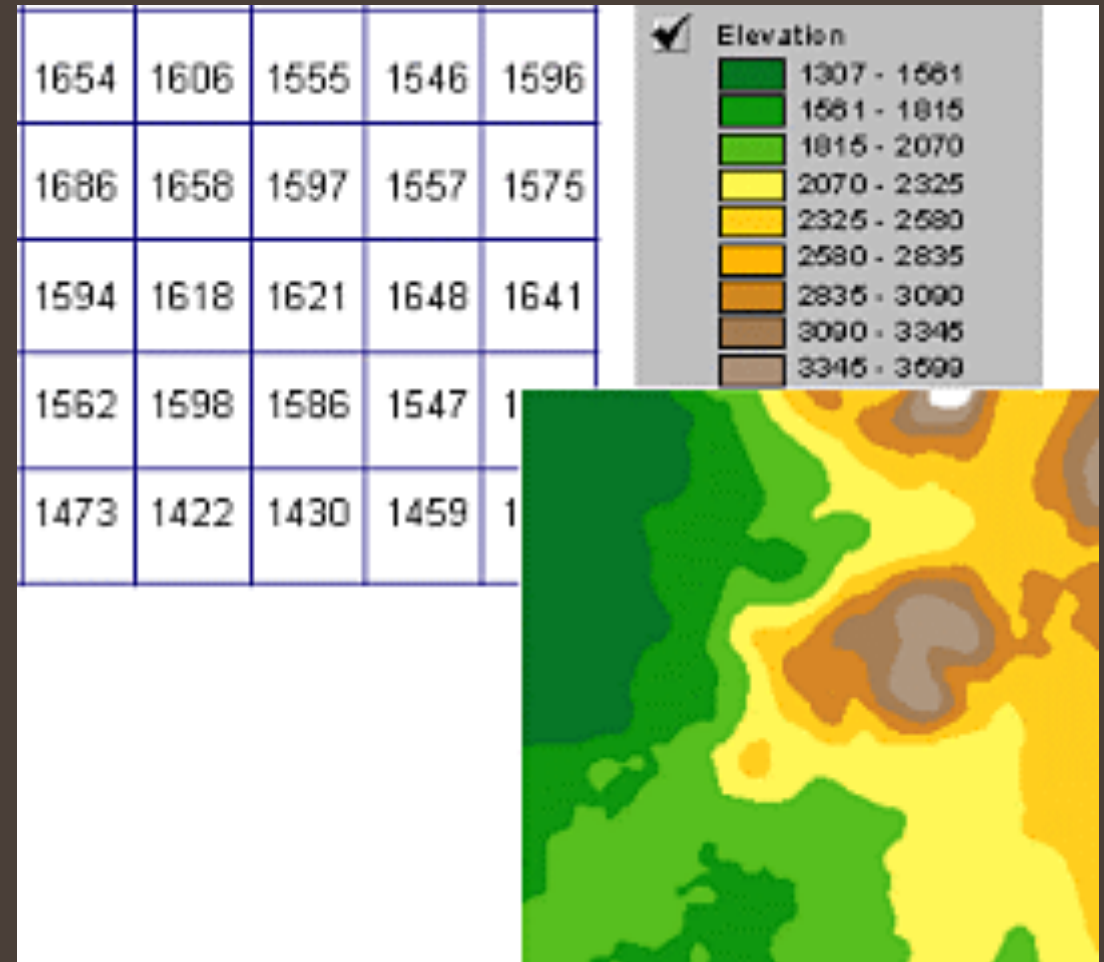


The **field view** represents the real world as a finite number of variables, each one defined at each possible position.

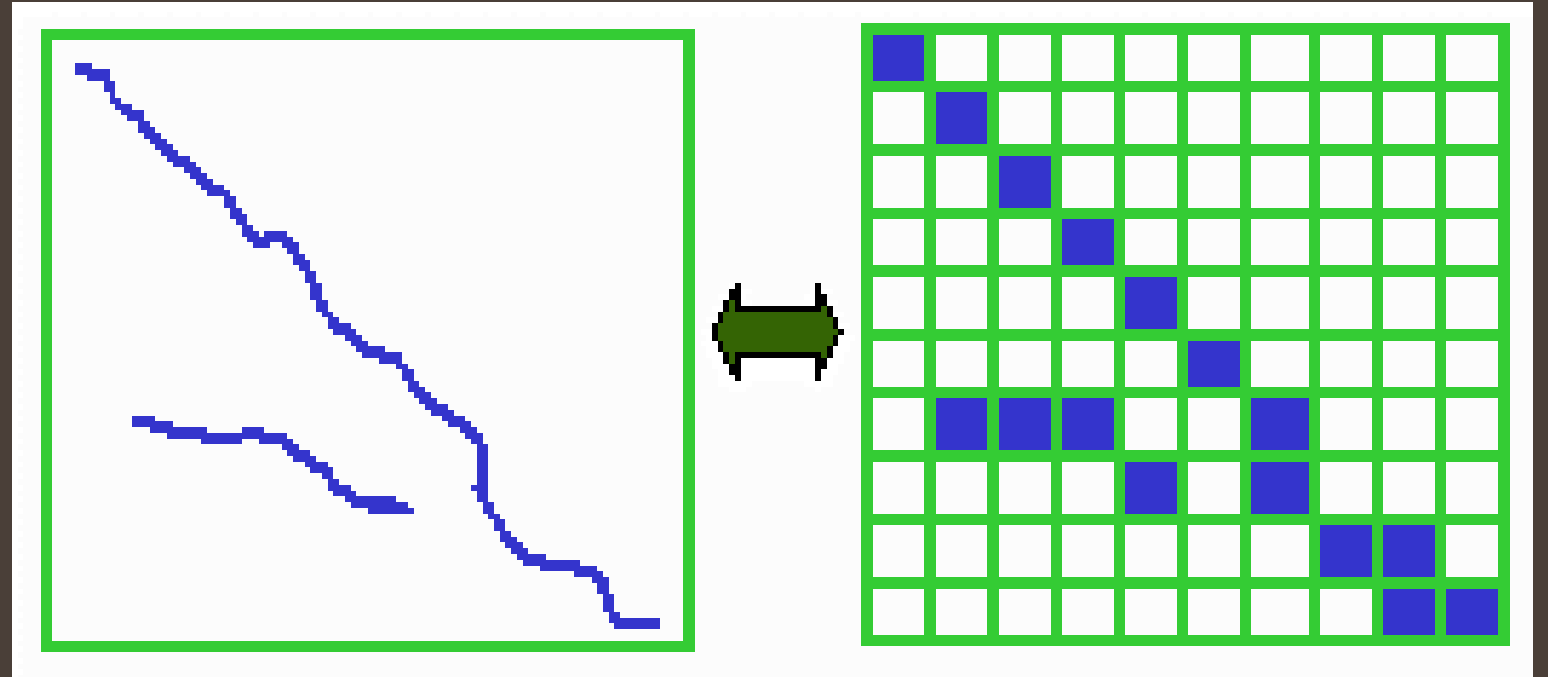


Continuous surface  
(raster)

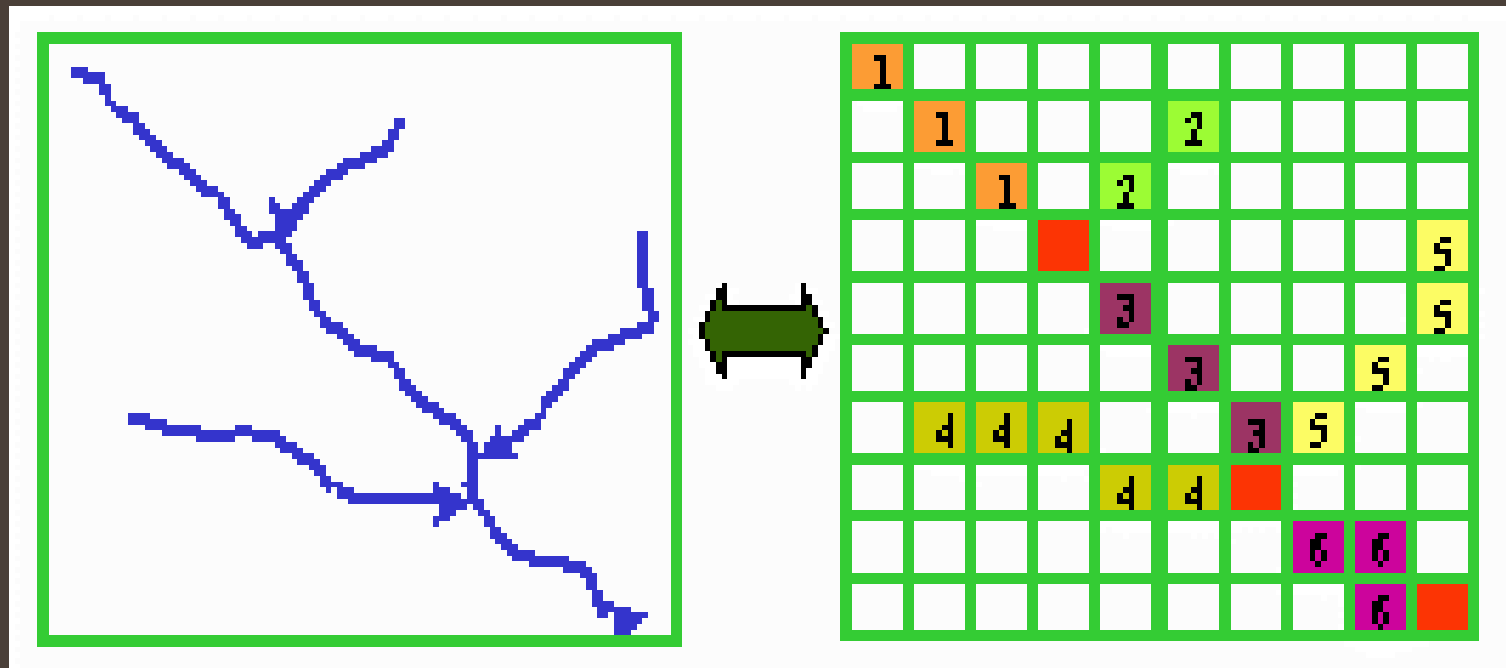
A **grid or field** defines geographic space as a collection of identically-sized square cells. Each cell holds a numeric value that measures a geographic attribute (like elevation) for that unit of space.



# Line as a Sequence of Cells

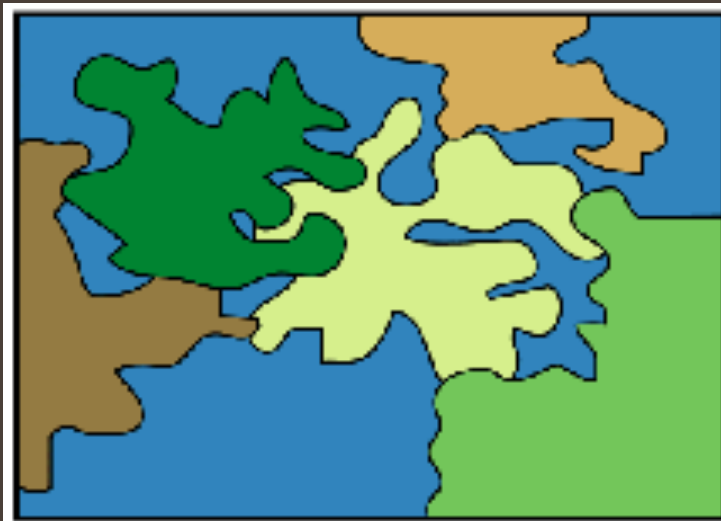


# Cell Networks

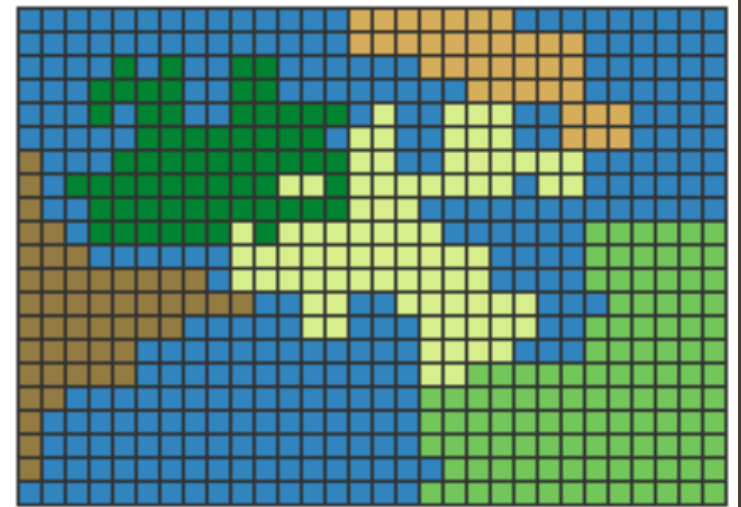




# Polygon as Zone of Grid Cells



Polygon features



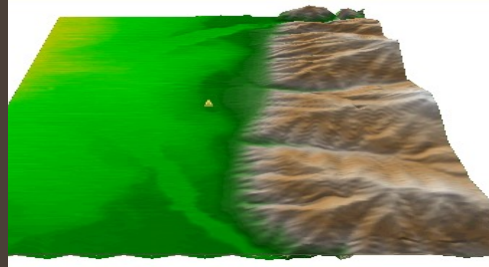
Raster polygon features

From:

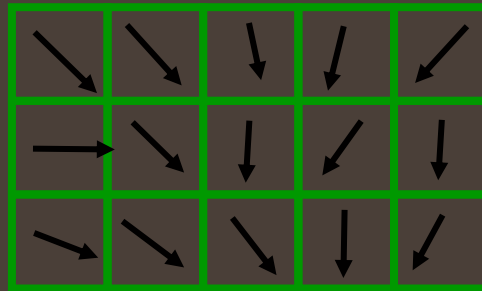
[http://resources.arcgis.com/en/help/main/10.2/index.html#/How features are represented in a raster/009t000000006000000/](http://resources.arcgis.com/en/help/main/10.2/index.html#/How%20features%20are%20represented%20in%20a%20raster/009t000000006000000/)

# Overview of Delineation Process

**Raw DEM**



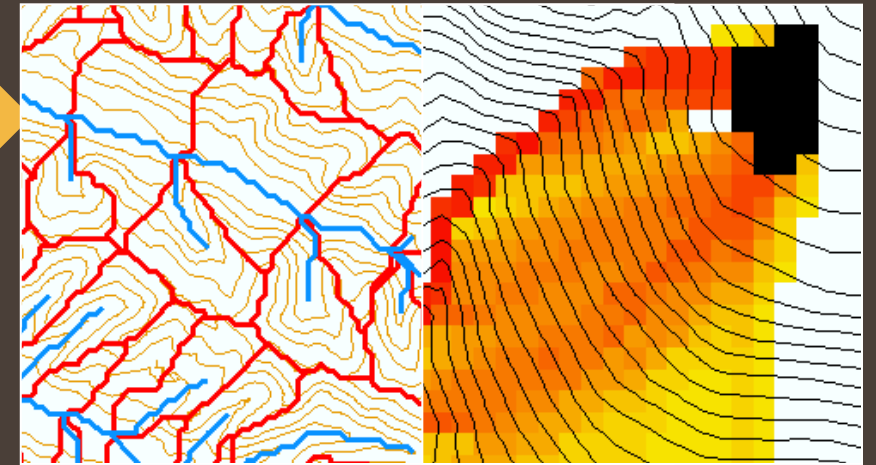
**Flow Field**



**Sink Removal (Filling)**



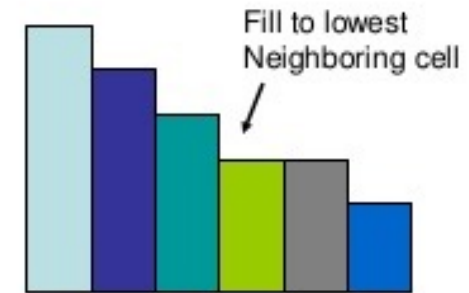
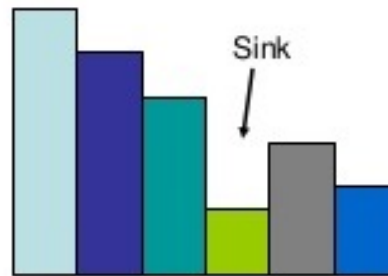
**Channels, Watersheds, Flow  
Related Terrain Information**



## Step 1: DEM Sinks

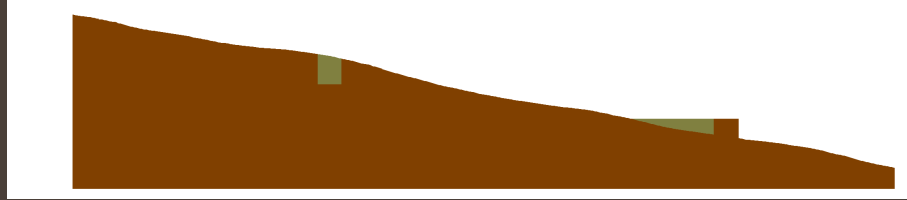
### ➤ Fill Sinks:

Removing Small imperfections in the data.



# Conditioning the DEM - Sink Filling

Increase elevation until the sink drains to a neighbor and ultimately out of the domain



Original DEM

7	7	6	7	7	7	7	5	7	7
9	9	8	9	9	9	9	7	9	9
11	11	10	11	11	11	11	9	11	11
12	12	8	12	12	12	12	10	12	12
13	12	7	12	13	13	13	11	13	13
14	7	6	11	14	14	14	12	14	14
15	7	7	8	9	15	15	13	15	15
15	8	8	8	7	16	16	14	16	16
15	11	11	11	11	17	17	6	17	17
15	15	15	15	15	18	18	15	18	18

Sinks Filled

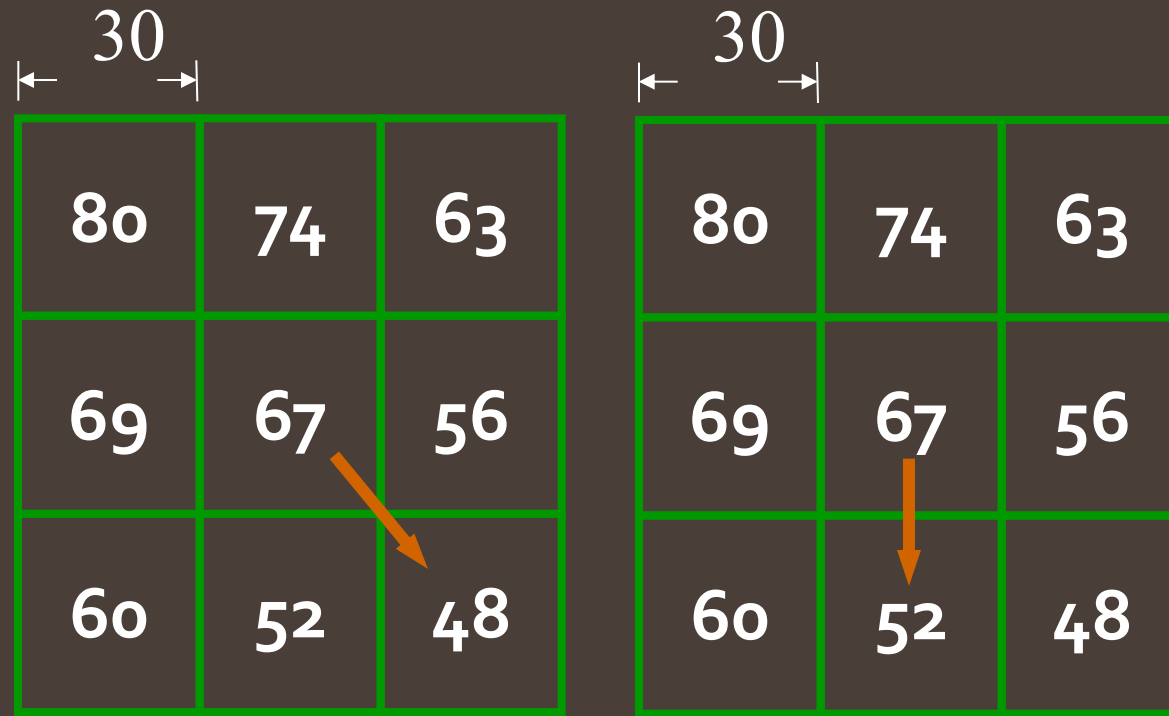
7	7	6	7	7	7	7	5	7	7
9	9	8	9	9	9	9	7	9	9
11	11	10	11	11	11	11	9	11	11
12	12	10	12	12	12	12	10	12	12
13	12	10	12	13	13	13	11	13	13
14	10	10	11	14	14	14	12	14	14
15	10	10	10	10	15	15	13	15	15
15	10	10	10	10	16	16	14	16	16
15	11	11	11	11	17	17	14	17	17
15	15	15	15	15	18	18	15	18	18

Sinks

Grid cells or zones completely surrounded by higher terrain

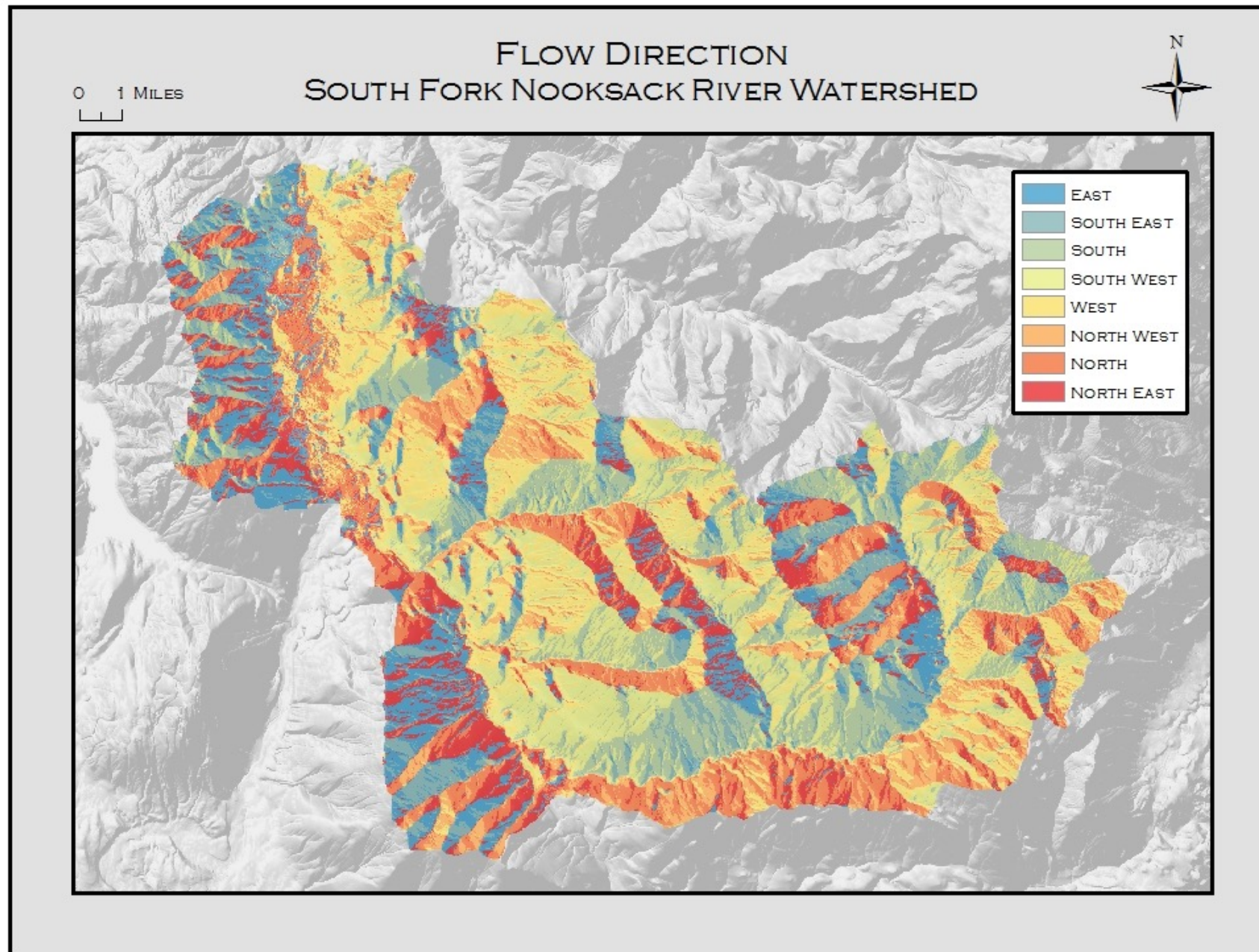
# Hydrologic Slope (Flow Direction Tool)

## - Direction of Steepest Descent

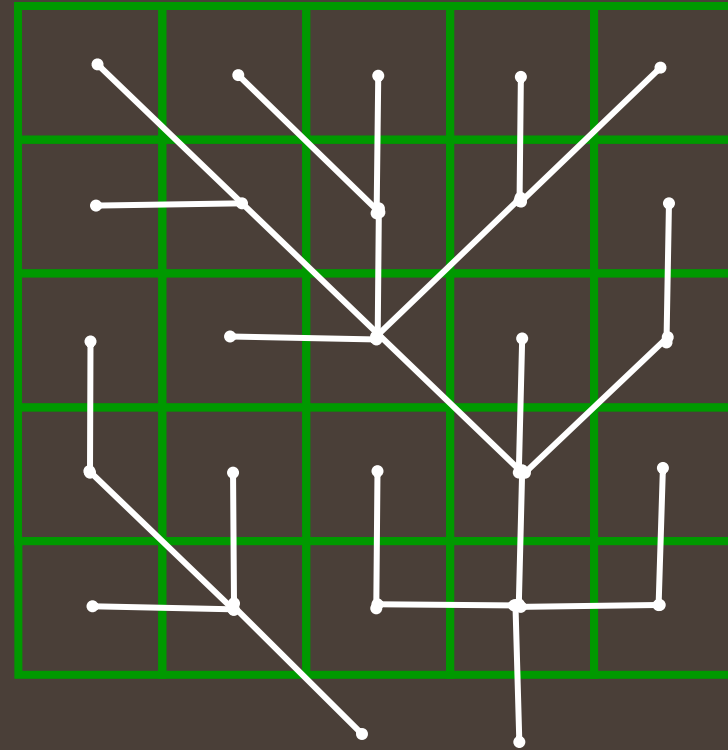
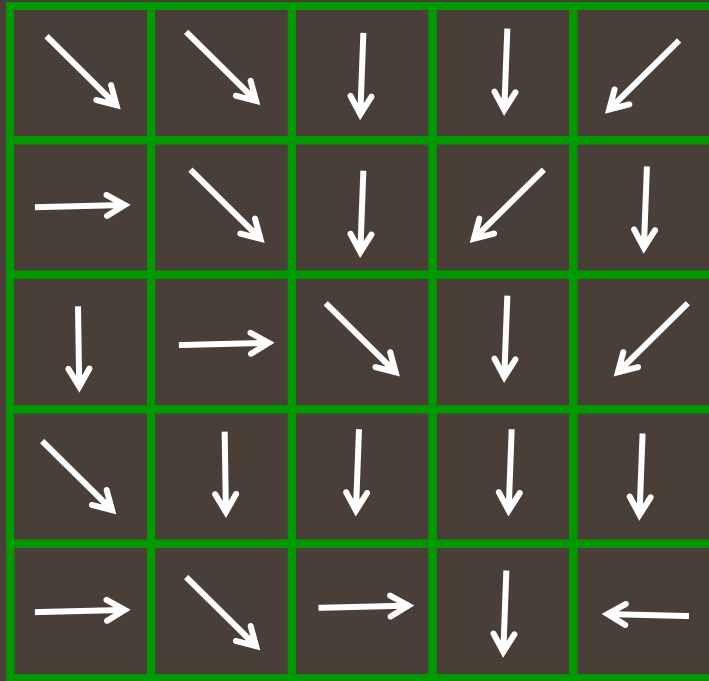


Slope:  $\frac{67 - 48}{30\sqrt{2}} = 0.45$

$\frac{67 - 52}{30} = 0.50$



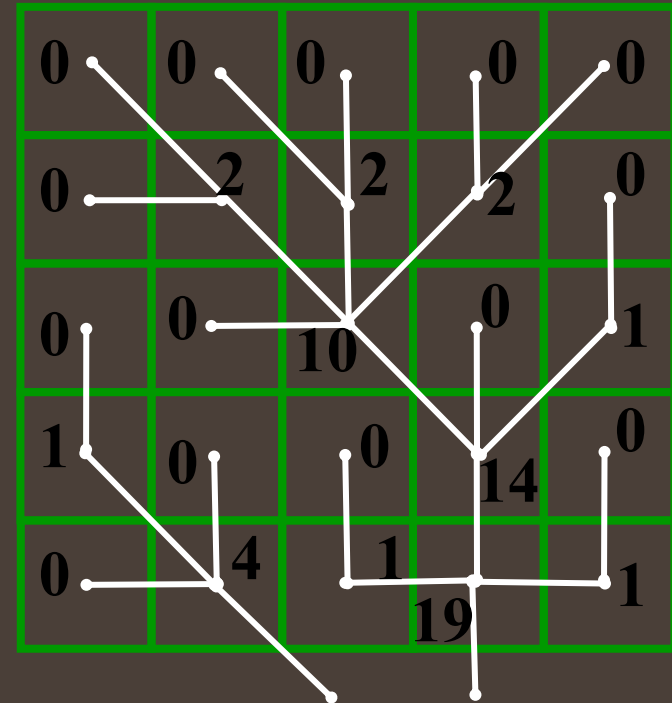
# Grid Network



# Flow Accumulation Grid.

Area draining **into** a grid cell

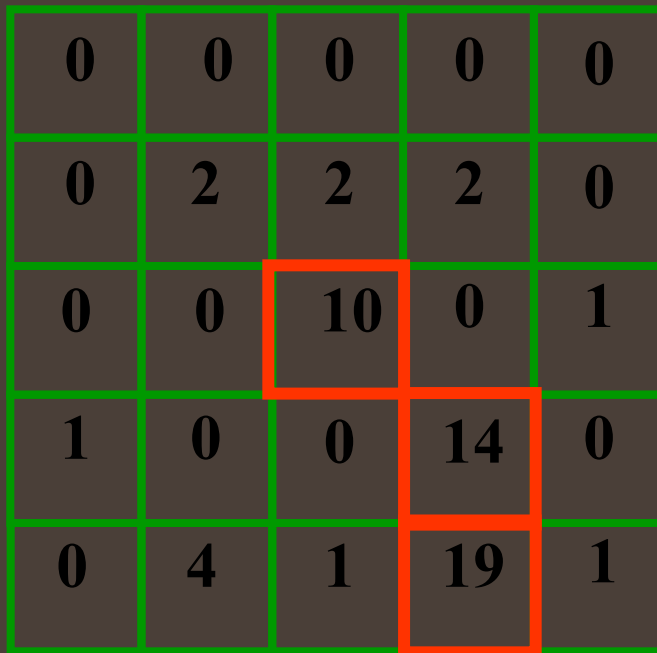
0	0	0	0	0
0	2	2	2	0
0	0	10	0	1
1	0	0	14	0
0	4	1	19	1



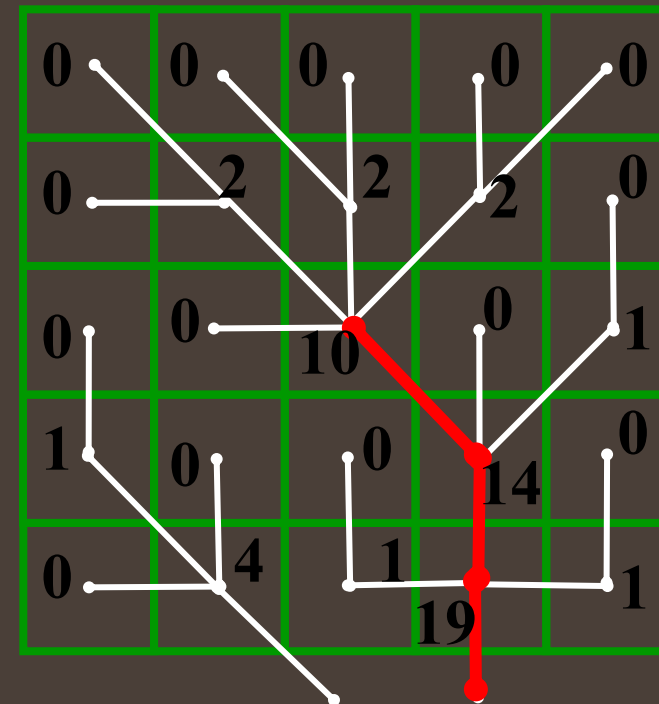


# Stream Definition

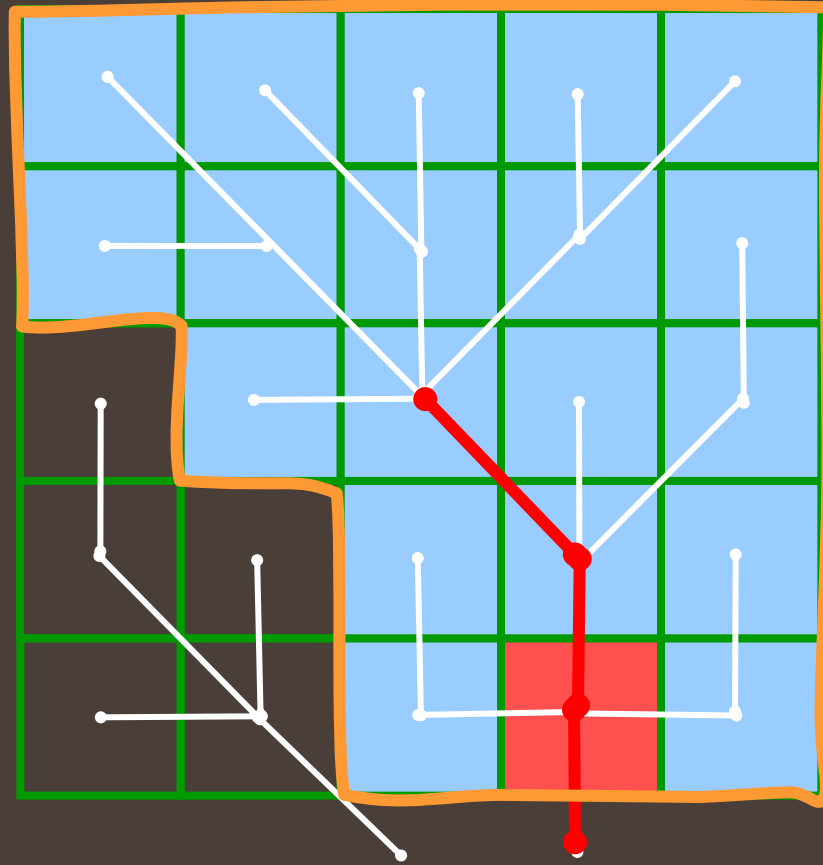
Flow Accumulation  
> 10 Cell Threshold



Stream Network for  
10 cell Threshold  
Drainage Area



# Watershed Draining to Outlet

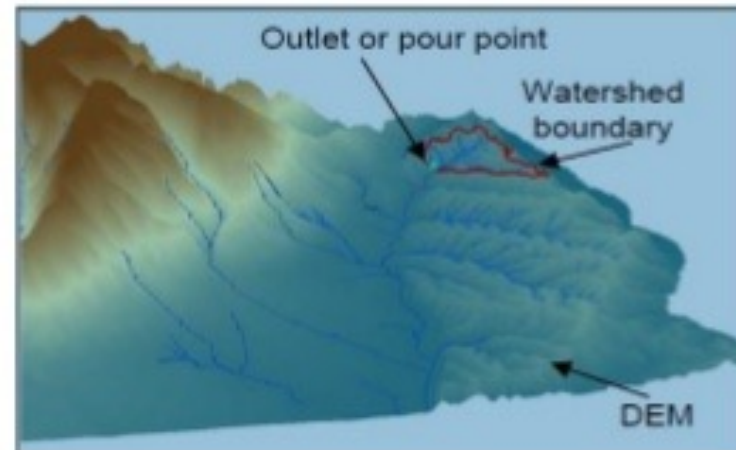


- Watershed mapped as all grid cells that drain to an outlet
- Streams mapped as grid cells with flow accumulation greater than a threshold

## ➤ Snap Pour Points

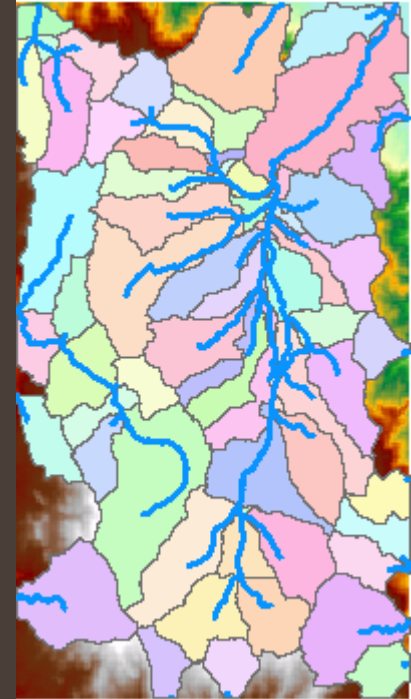
Tool used to ensure the selection of points of high accumulation flow where original pour point locations are snapped to locations of higher accumulated flow.

Snap pour point with snap distance around specified point for cell of high accumulation.



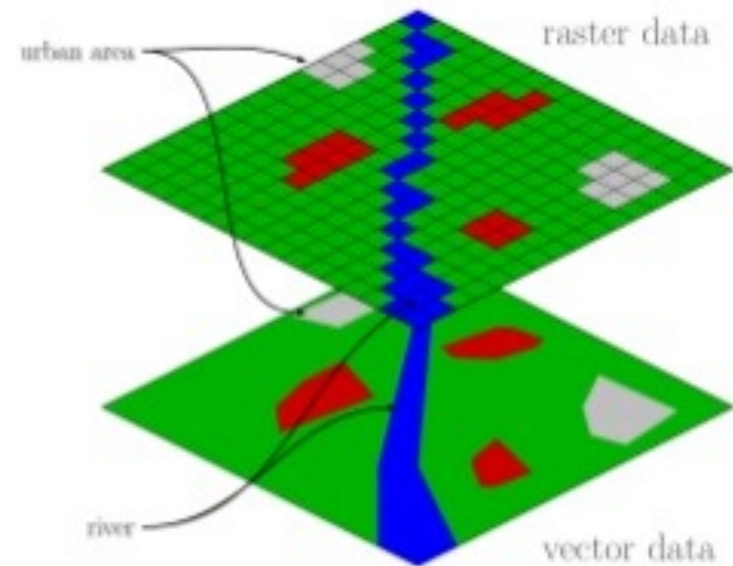
# Catchments

- For every stream segment, there is a corresponding **catchment**
- Catchments are created by dividing the landscape based on a defined set of physical guidelines.

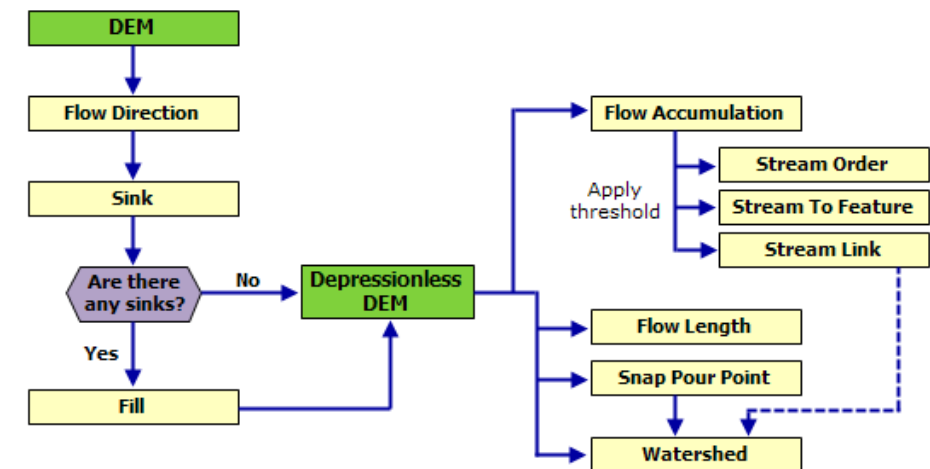
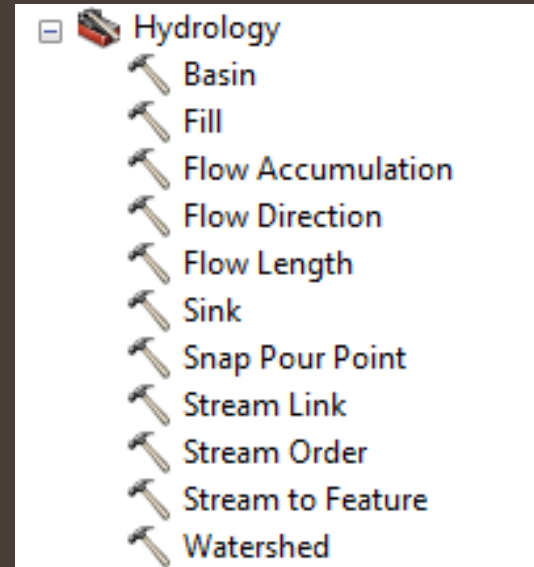
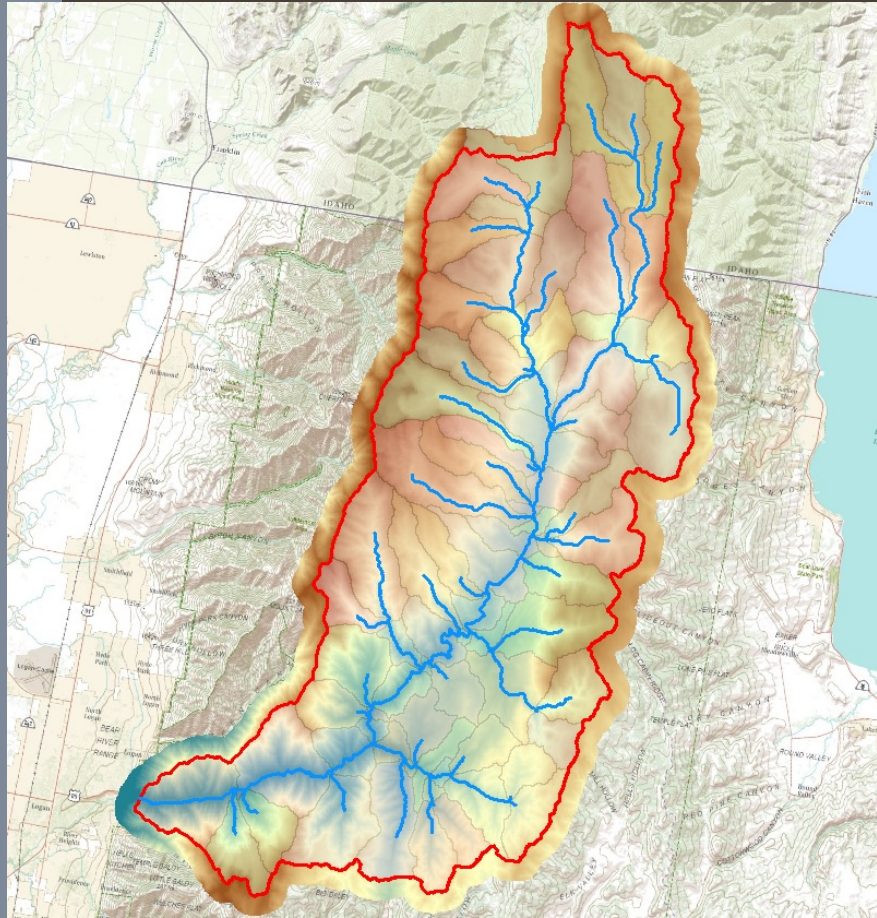


## ➤ Stream to feature

Tool used to convert  
raster data to vector.  
Make high show for flow.



# ArcGIS Hydrology Toolset



Hydrological modeling flowchart

