Session 7: Rasters and Terrain Analysis

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Class Schedule

Monday	Tuesday	Wednesday	Thursday	Friday
08/05/19 **Introduction to Geographical Information Systems** 10:45 am–12:15 am	08/06/19 **Cartography and Spatial Data Display** 8:30am – 11:00pm	08/07/19 **Querying Data for Spatial & Attribute Selections** 8:30am – 11:00pm	08/08/19 **Data Formats and Open-Source GIS** 8:30am – 11:00pm	08/09/19 **Map Projections and Coordinate Systems** 8:30am – 11:00pm
08/12/19 **Spatial Analysis Tools** 8:30am – 11:00pm	08/13/19 **Raster and Terrain Analysis** 8:30 am – 10:00 am **Scripps Institution of Oceanography** 1:00pm – 4:00pm	08/14/19 **Image Analysis** 8:30am – 11:00pm	08/15/19 **Editing Spatial Data and Geocoding** 8:30am – 11:00pm	08/16/19 **Web Mapping/ Wrap up** 8:30am – 11:30am

Outline: Rasters and Terrain Analysis

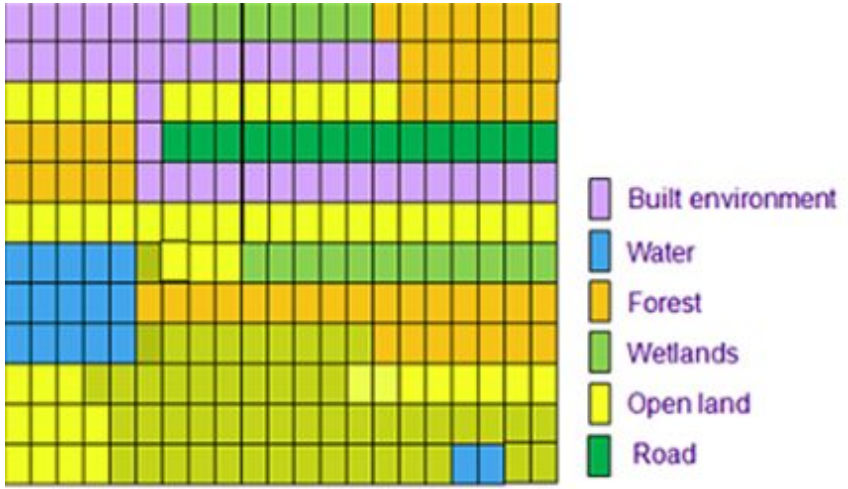
- Introduction
- Map Algebra
- Local Functions
- Neighborhood, Zonal, and Global Functions
- Terrain Analysis
- Demonstration

Introduction: Raster Analysis

- Raster cells store data
  - Integer or floating point values
- Connected cells can form networks
  - Grouped into neighborhoods
- Examples:
  - Predict fate of pollutants
  - Model spread of disease

Raster Data Models

- Each cell represents some variable (e.g. temperature or elevation)
- Groups of cell share a value representing some sort of geographic characteristic



Source: ESRI - Displaying Raster Data

Raster Cells

Example: Raster cells representing land use classes

Value Attribute Table (VAT)

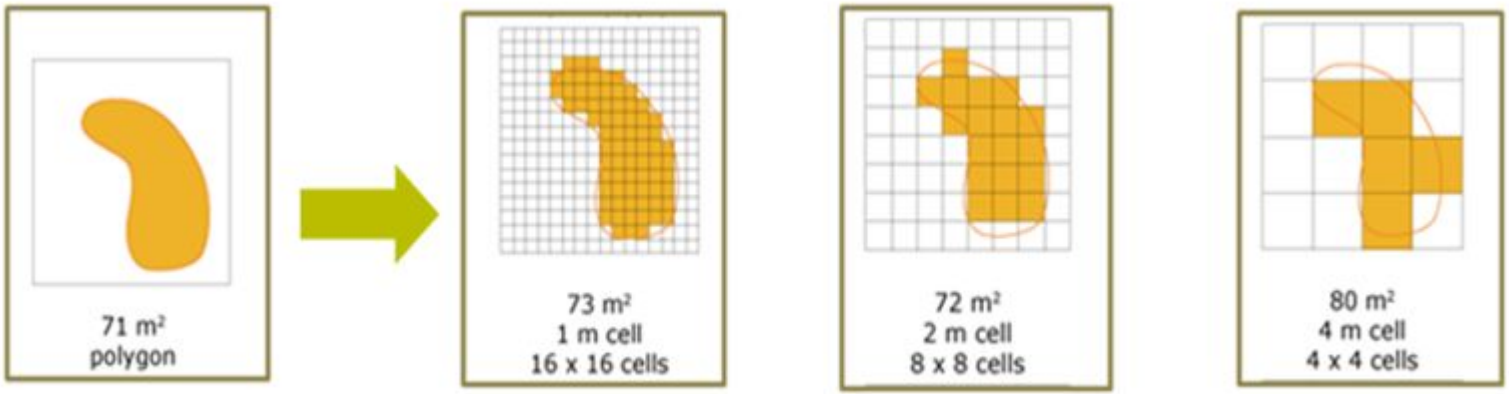
OID	VALUE	COUNT	TYPE	AREA	CODE
0	1	5	Forest	2345	F010
1	2	9	Water	3256	W010
2	3	11	Cropland	3867	CL030
3	4	9	Urban area	3256	UA040

Source: ESRI - Displaying Raster Data

Raster Cell Size

- **Cell size** = Spatial resolution
- Determines how coarse or fine features are represented

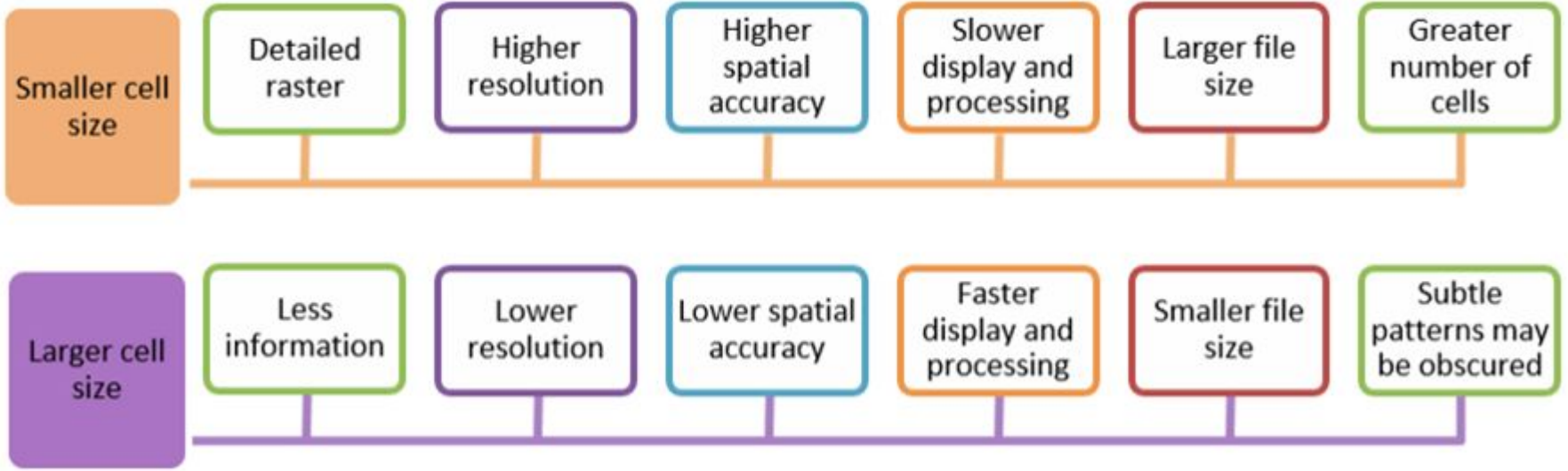
Example: Lake polygon represented as rasters



Source: ESRI - Displaying Raster Data

Raster Cell Size

- **Choosing right cell size is important!**

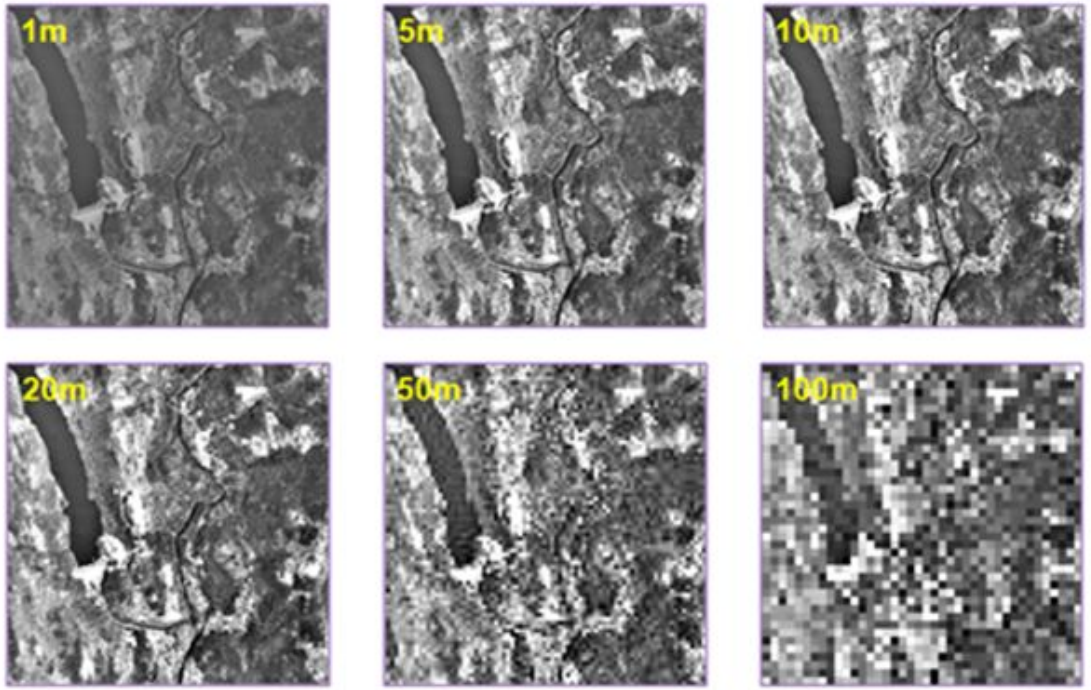


This comparison of large and small cell size in a raster shows how cell size affects the level detail represented by a raster.

Source: ESRI - Displaying Raster Data

Choosing Cell Size

- Not simple choice
- Considerations:
  - Display time
  - Processing time
  - Storage
- Smaller cell size = greater spatial resolution



Source: ESRI - Displaying Raster Data

Choosing Cell Size

The following factors should be considered when specifying cell size:

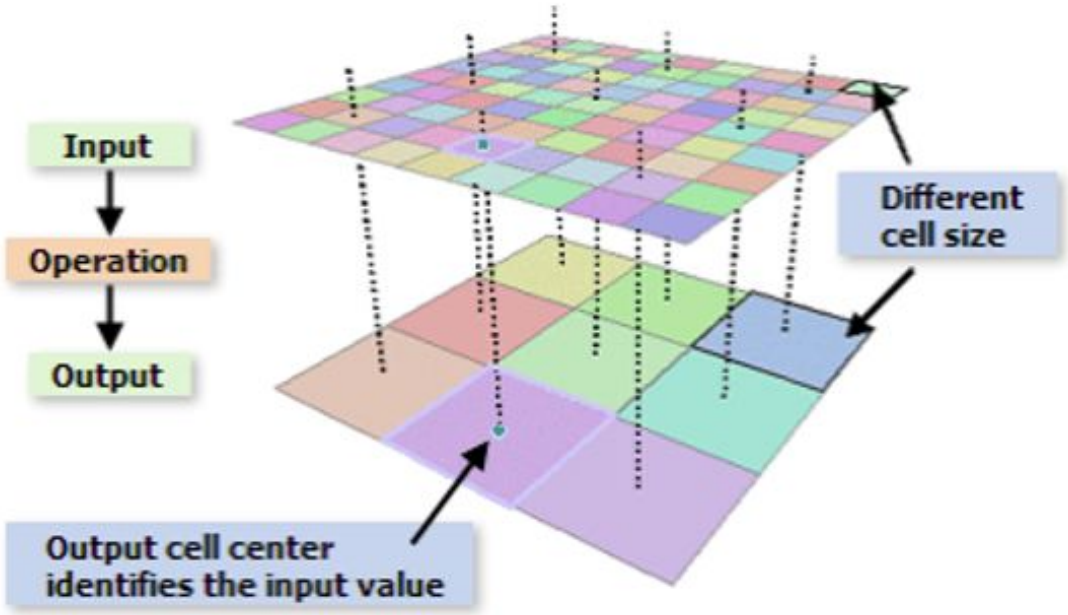
- The spatial resolution of the input data and the storage size of the raster
- The application and analysis to be performed
- The level of detail you want for the analysis to be performed
- Accuracy and precision and the desired response time

Raster and Images

- Raster and Image are often interchanged
  - Image: 2-D pictorial representation
  - Raster: Data model describing how image is stored
- All images are rasters
- Not all rasters are images

Resampling Rasters

- Processing or displaying rasters requires resampling
- Datasets with different cell sizes are resampled to match coarsest cell size



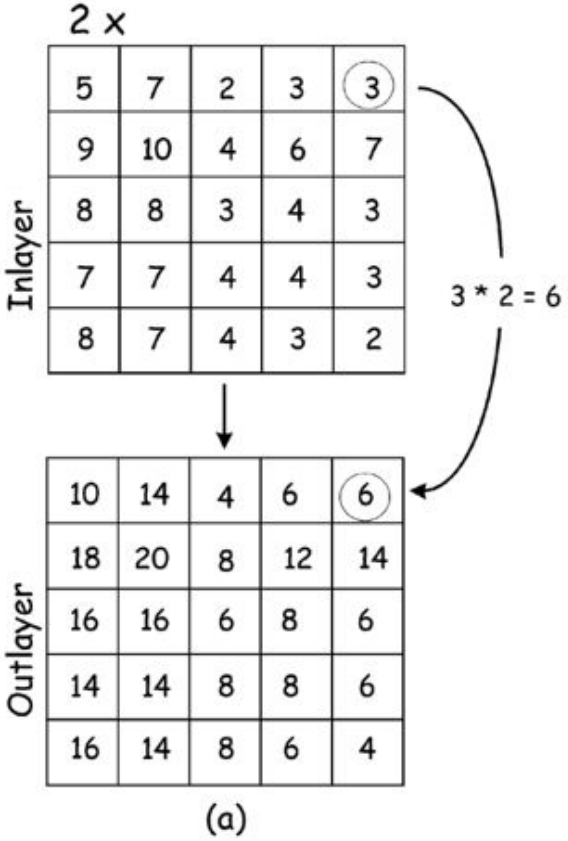
Map Algebra

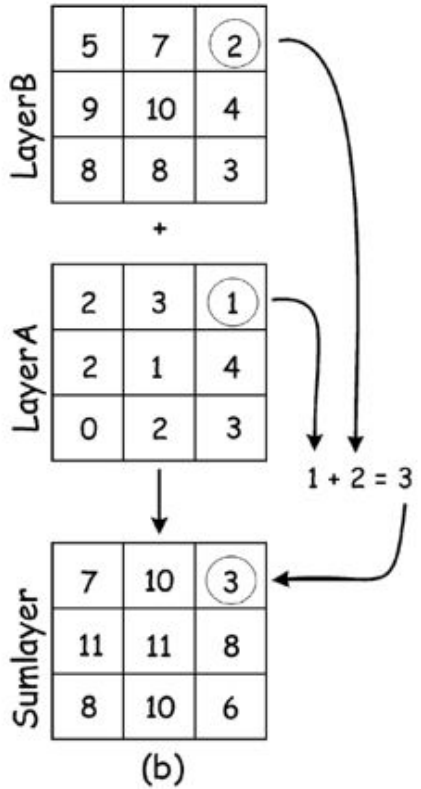
- Cell-by-cell combination of raster data layers
- Raster layers are combined through operations:
  - Addition
  - Subtraction
  - Multiplication

Map Algebra

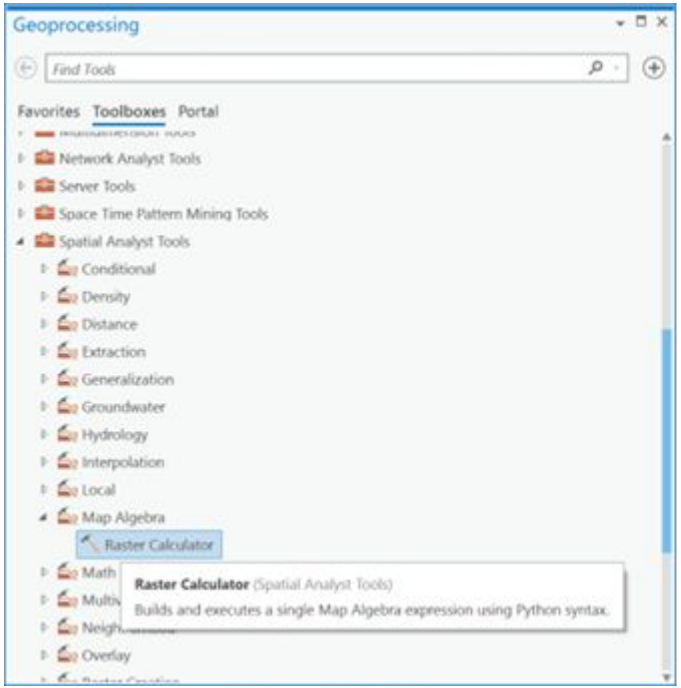
a) Inlayer * 2 = Outlayer

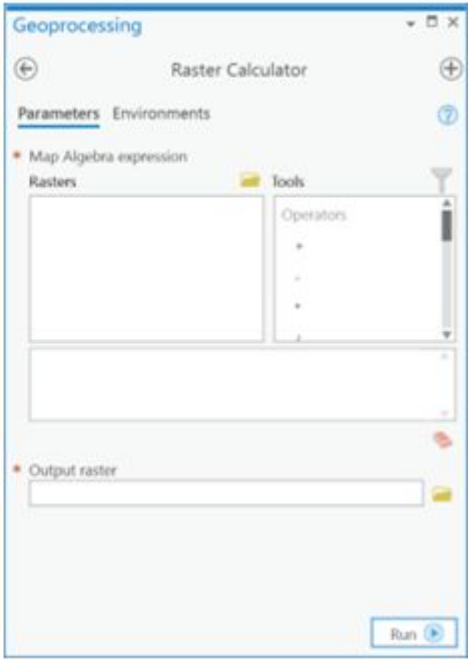
b) LayerB + LayerA = SumLayer





ArcGIS Pro: Raster Calculator

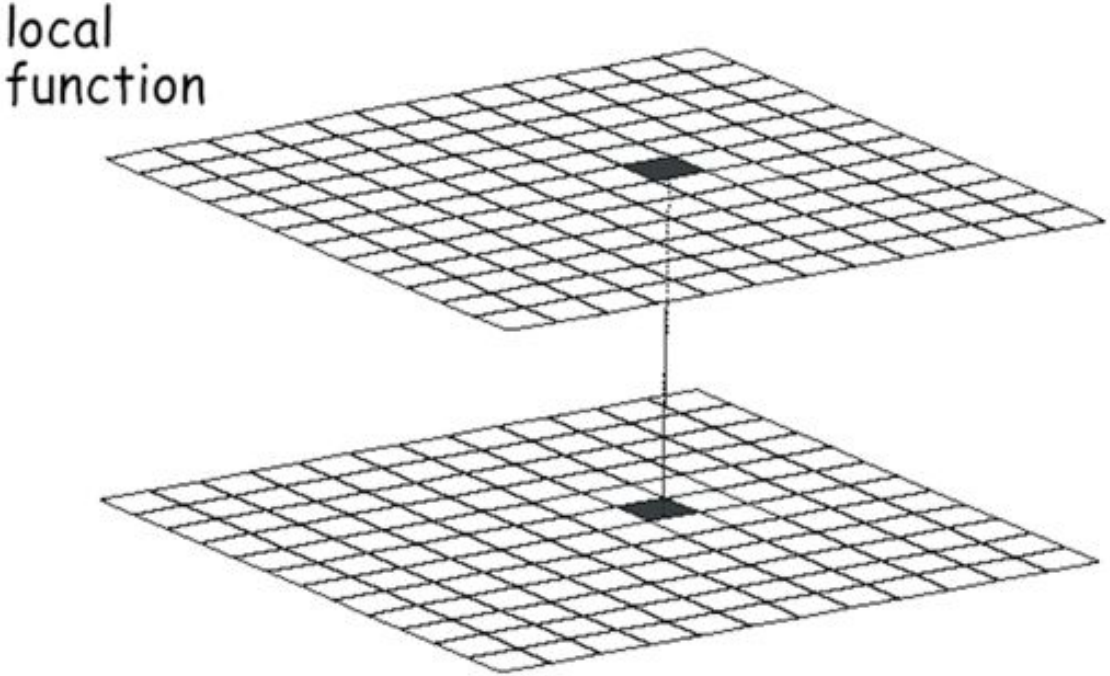


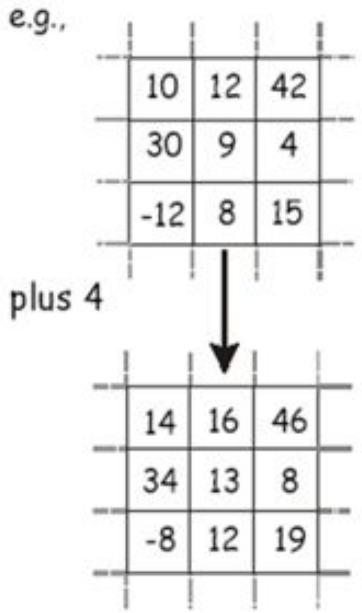


Raster Analysis: Scope

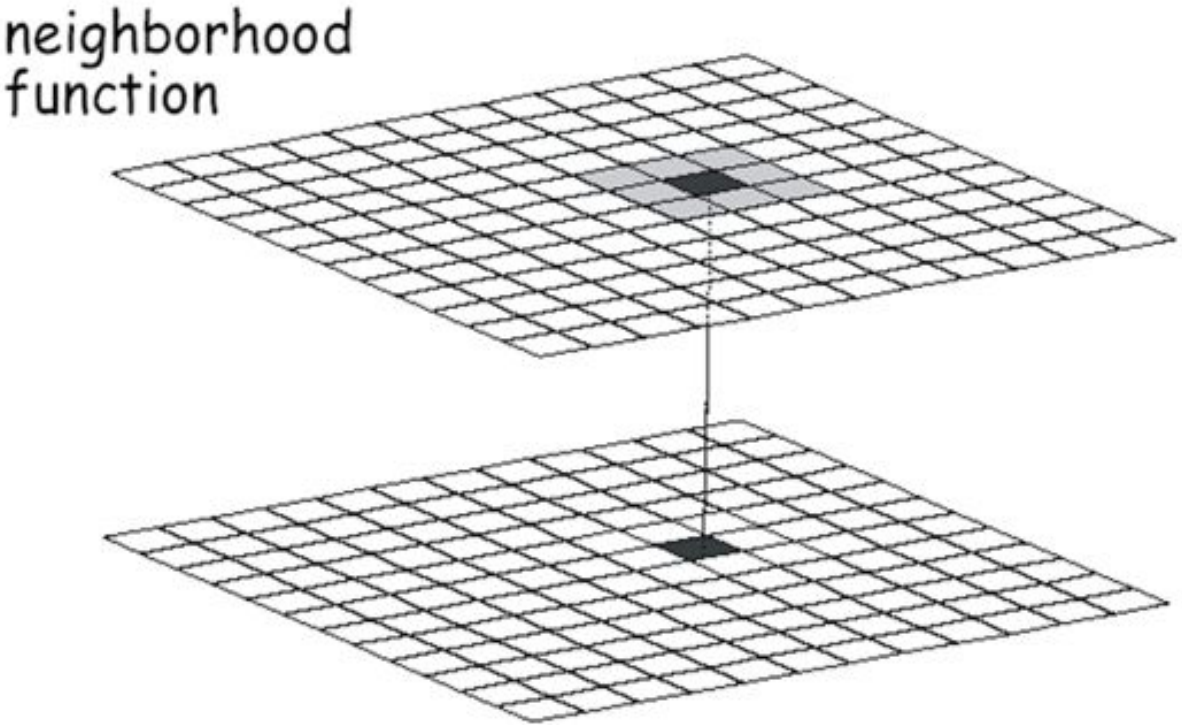
- Local operations
  - Single cell used
- Neighborhood operations
  - Set of cells in a specified arrangement
- Global operations
  - Every cell involved

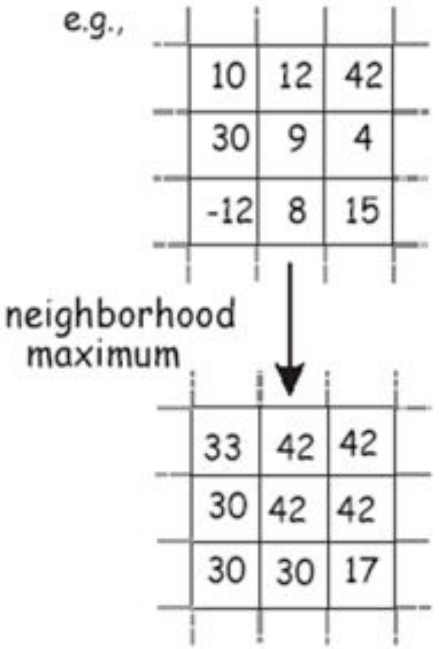
Scope: Local Operations





Scope: Neighborhood Operations





Local Functions/Operations

Four classes of local operations:

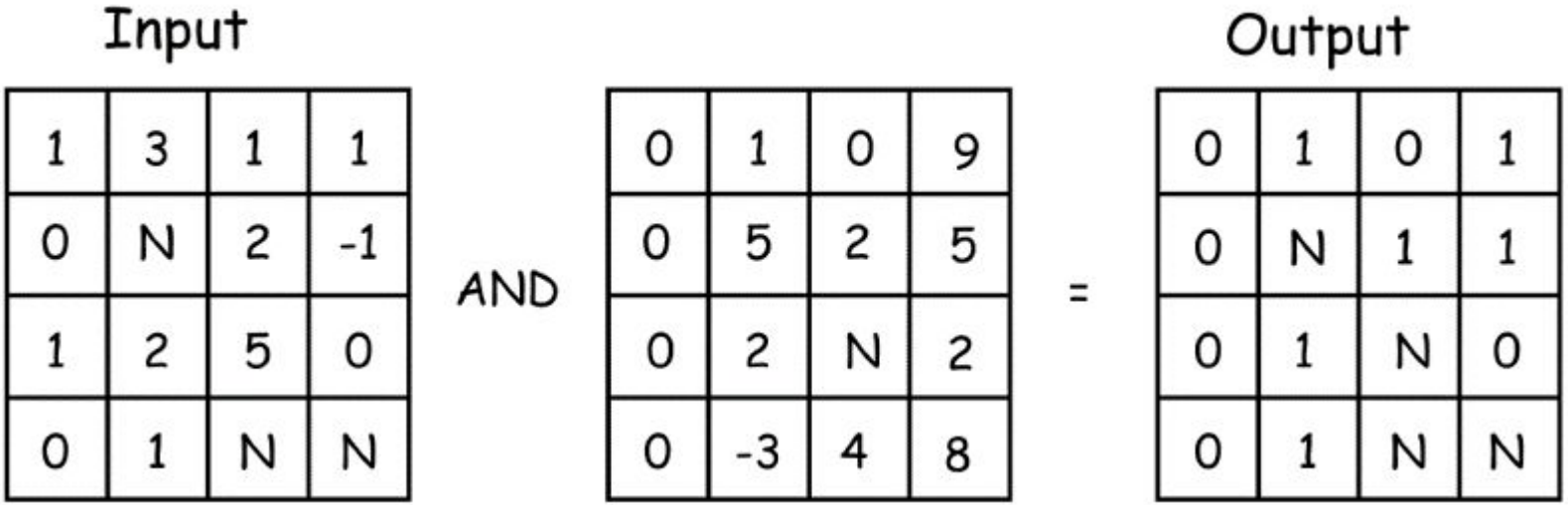
- Mathematical functions
- Boolean/Logical functions
- Reclassification
- Multi-layer overlay

Logical Operations

- Also known as Boolean operations
- Involves comparison of a cell to single scalar value
- Outputs a “true” or “false” value
  - TRUE: represented by “1”
  - FALSE: represented by “0”
- Three types of operations: AND, OR, and NOT

Logical Operations Example: AND

Assigns true to the output if both of the corresponding input cells is true



Raster Reclassification

- Raster reclassification assigns output values based on a specific set of input values
- Assignment can be defined by:
  - Input table
  - Range of values
  - Conditional test (“con” function)
- Used in creating raster “masks”

Reclassification: Conditional

- Reclassify raster based on a condition statement
- Condition results in a TRUE or FALSE outcome

Output = CON (test, out_if_true, out_if_false)

CON: conditional function

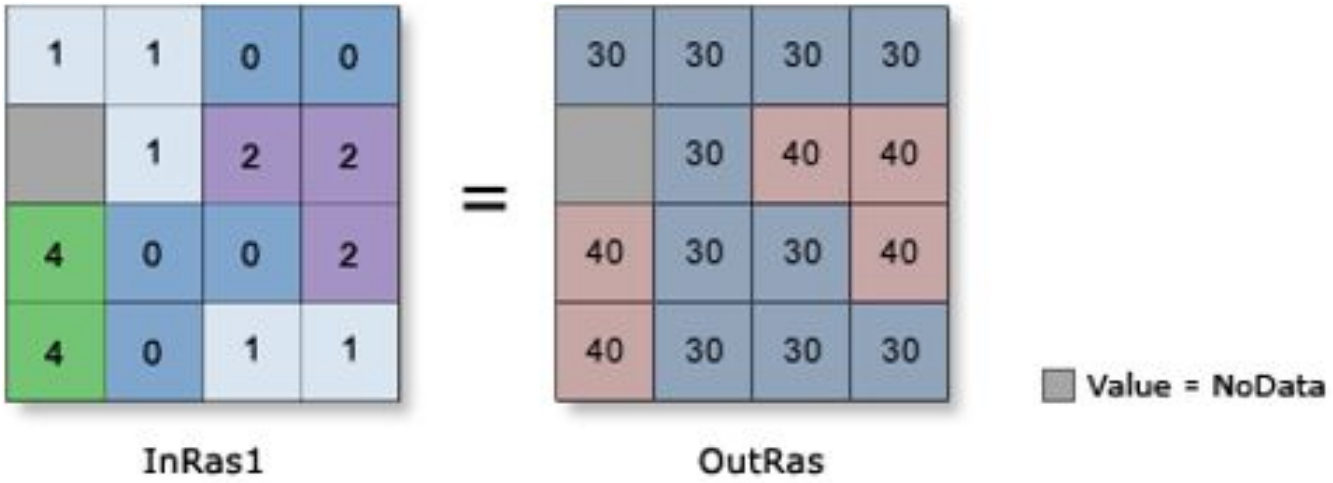
test: condition to be tested

out_if_true: value assigned if true

out_if_false: value assigned if false

Example Con Function

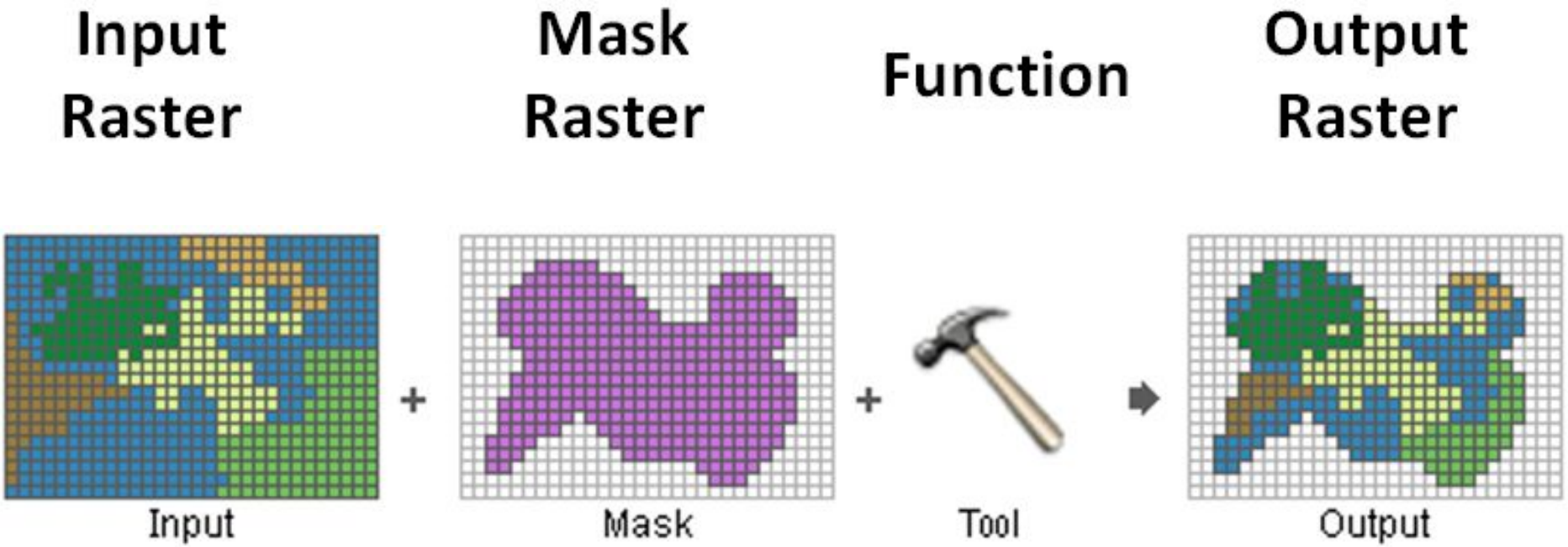
OutRas = Con(InRas1, 40, 30, "Value >= 2")



Raster Overlay

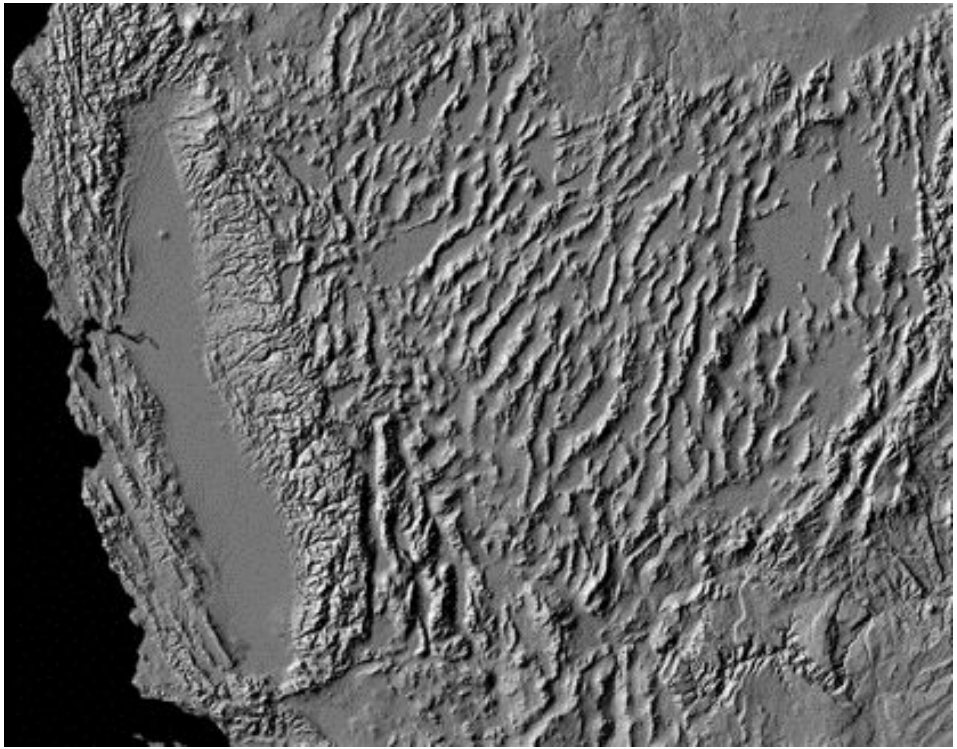
- Raster overlay combines features from two or more layers
- Raster overlay limited to nominal data (not continuous data)
- Overlay examples
  - Clipping/Extraction
  - Union

Raster Overlay: Mask Grid



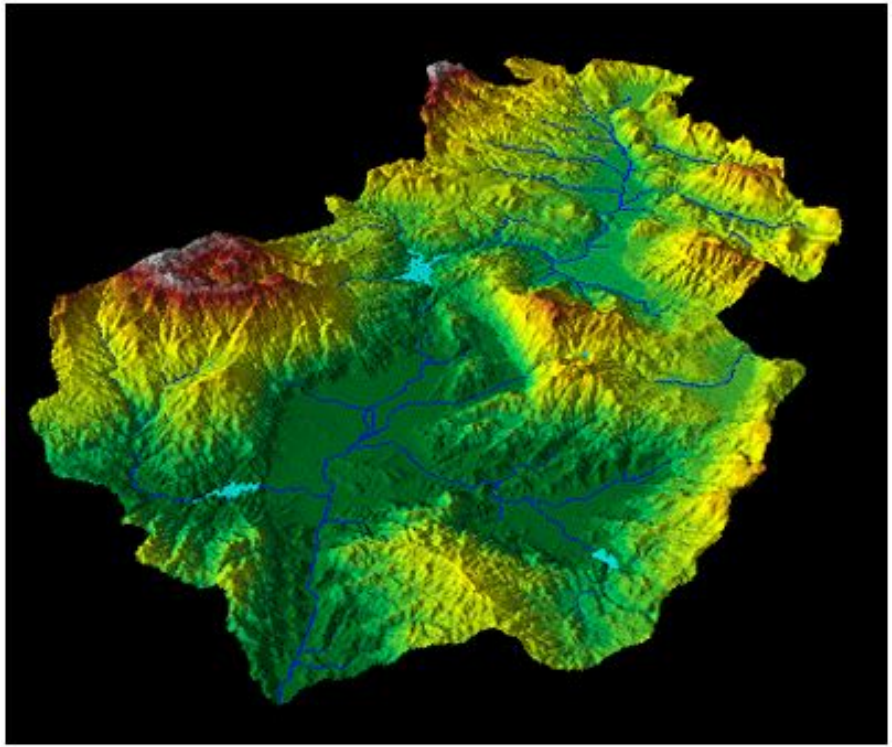
Terrain Analysis

- Digital Elevation Models (DEMs)
- Slope/Aspect
- Shaded Relief
- Contour Lines
- Viewsheds



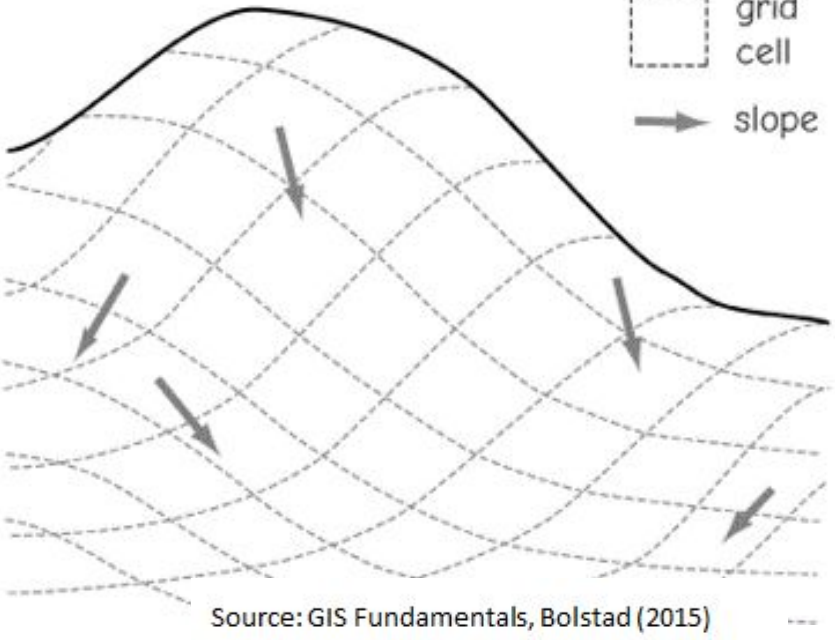
Digital Elevation Models (DEM)

- Raster representation of the earth surface
- Cells contain continuous elevation values
- Accuracy determined by raster resolution

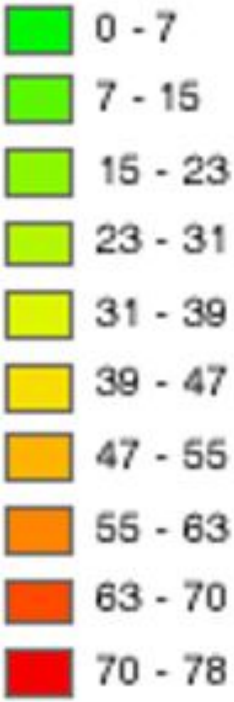


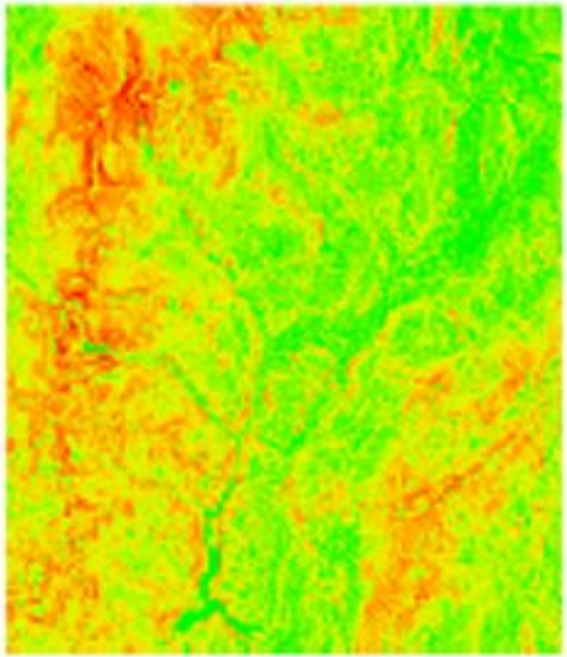
Terrain Analysis: Slope

- Slope: Rise over run
- % Slope



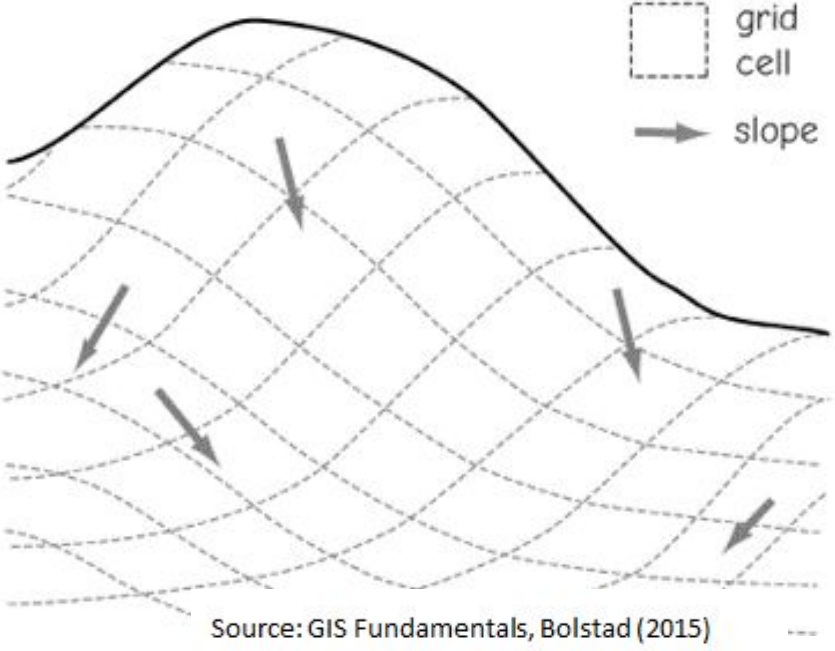
Source: GIS Fundamentals, Bolstad (2015)





Terrain Analysis: Aspect

- Slope: Rise over run
- % Slope



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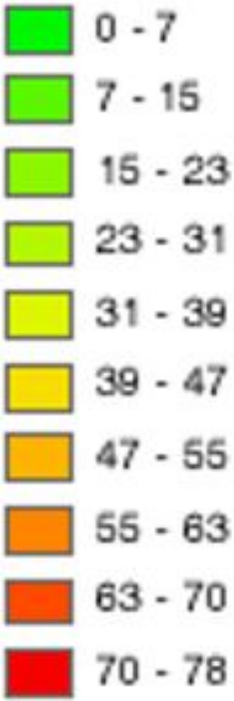
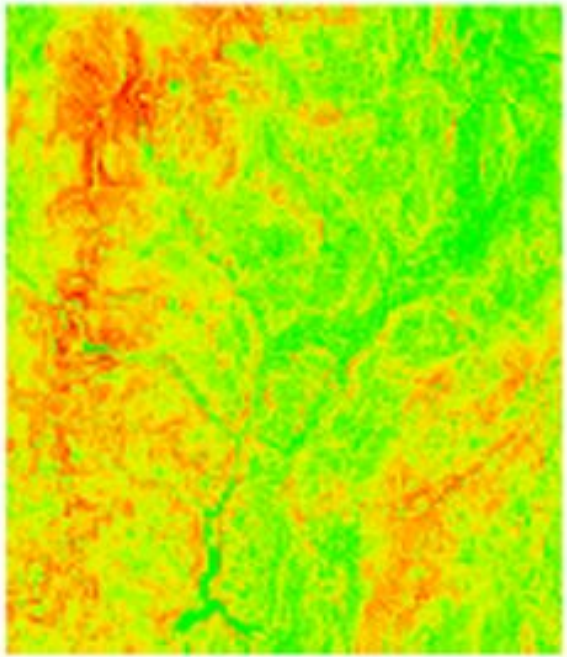
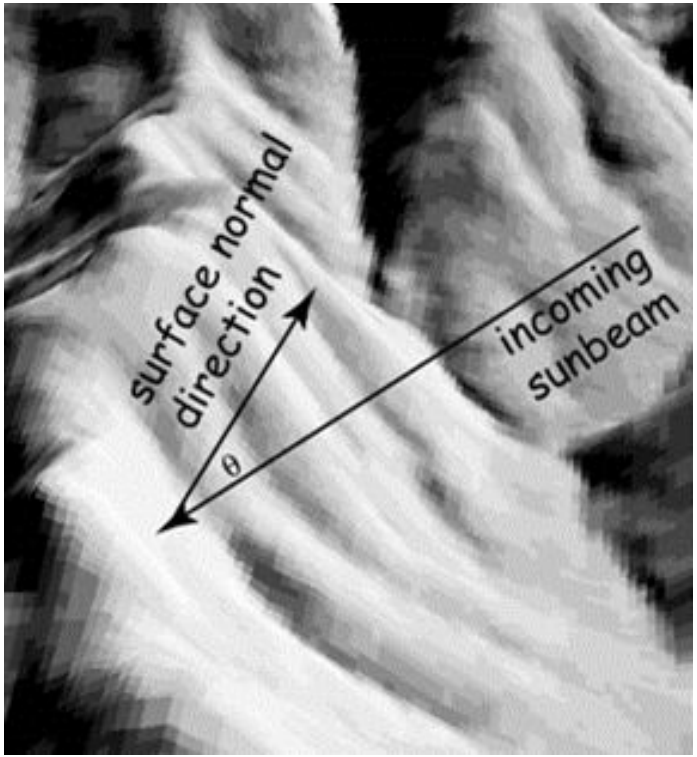
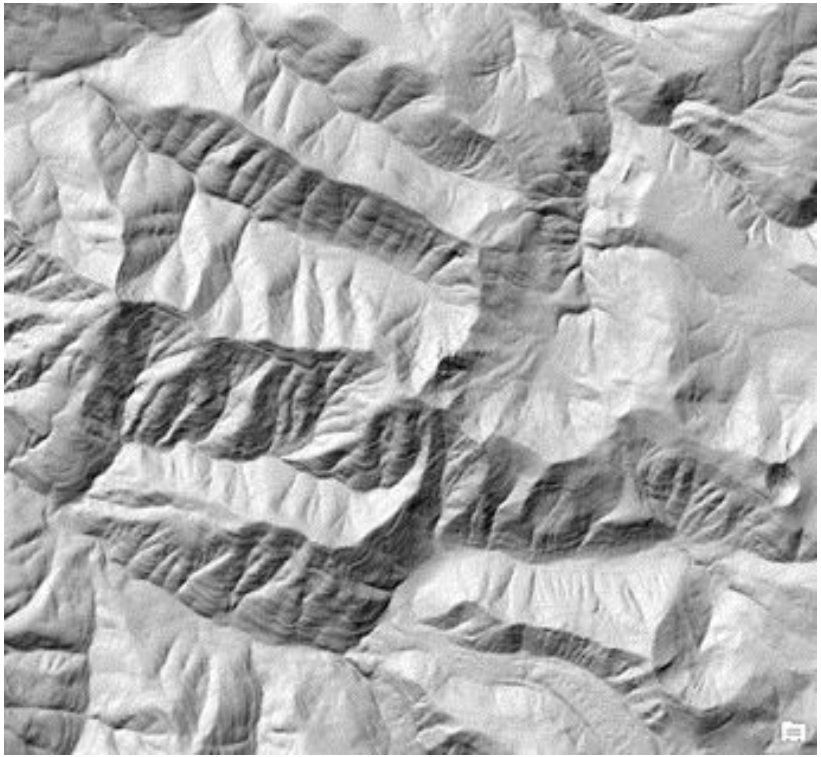




Terrain Analysis: Hillshade

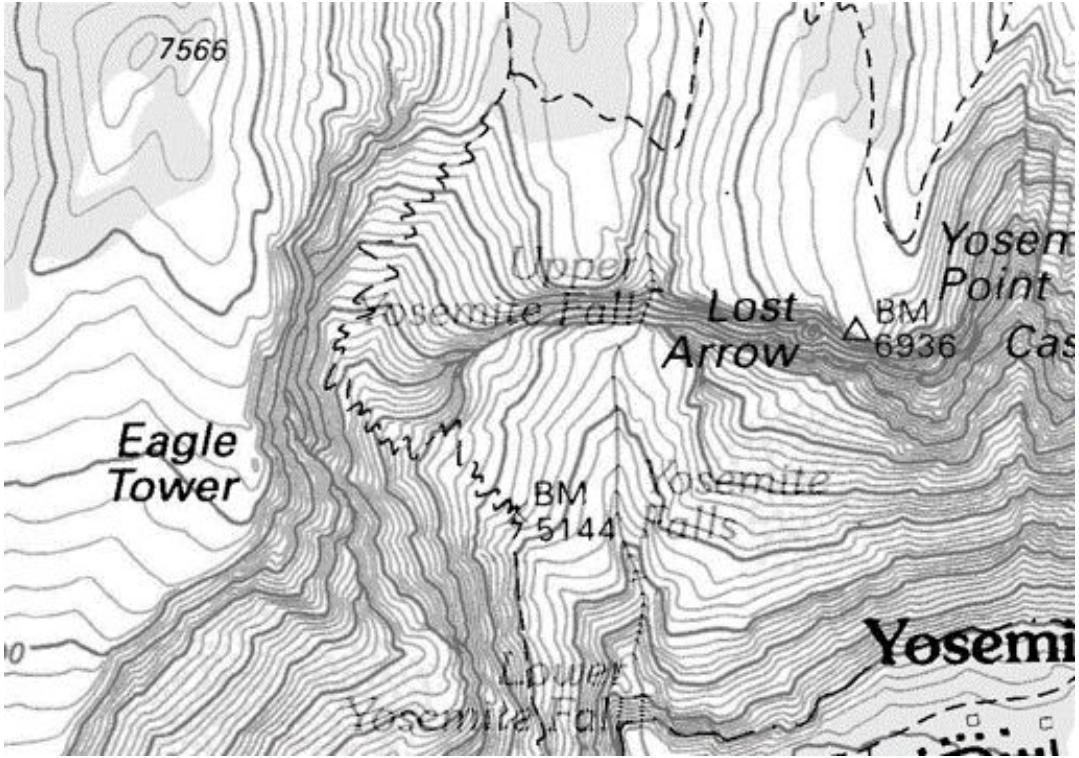
- Shaded Relief = Terrain reflections





Contour Lines

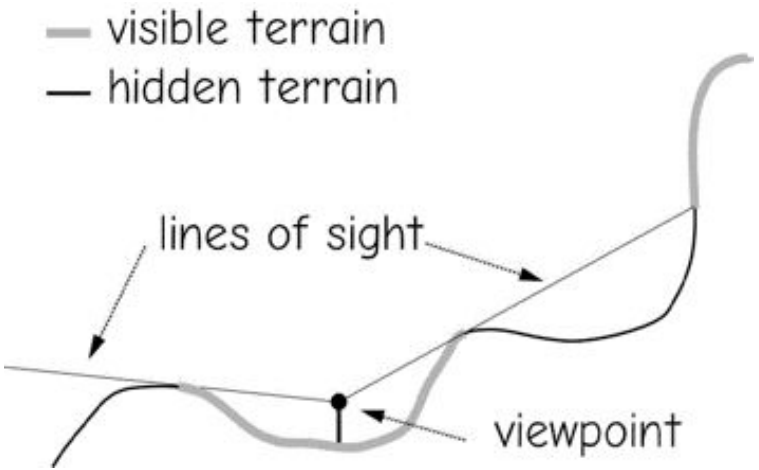
- Connected lines of uniform elevation
- Also called Isolines
- Density of lines indicate terrain steepness

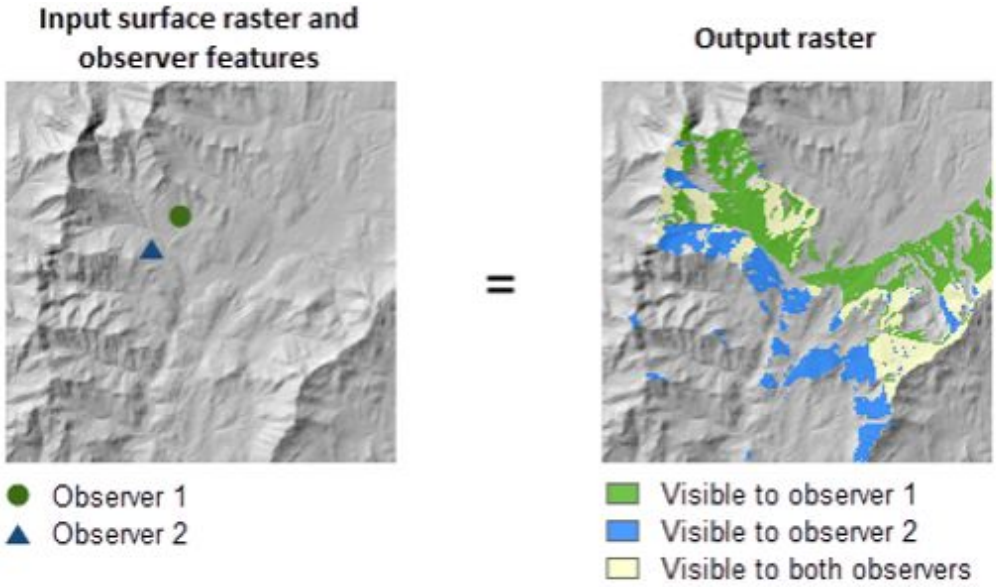


Source: GIS Fundamentals, Bolstad (2015)

Viewsheds

Visible lines of sight





Source: ESRI