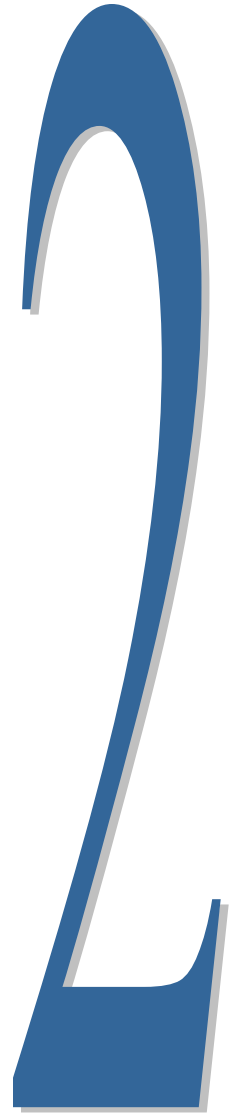




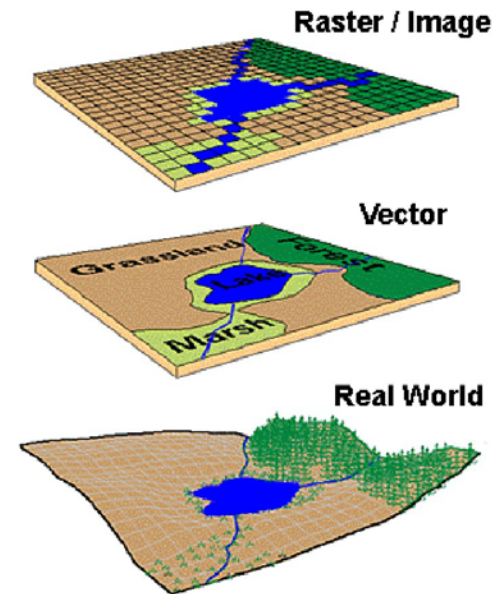
## **Raster Concepts**



# Geography as raster

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- ❑ Divides space into a matrix of equally-sized cells
  - Cells store a sample of geography in their area
  
- ❑ Advantages of raster over vector
  - Simpler data model
  - Faster processing and display
  - Additional analytic tools
  - Better for un-bounded phenomena (like soil pH and elevation)
  
- ❑ Disadvantages of raster
  - Generalization
  - Loss of feature uniqueness

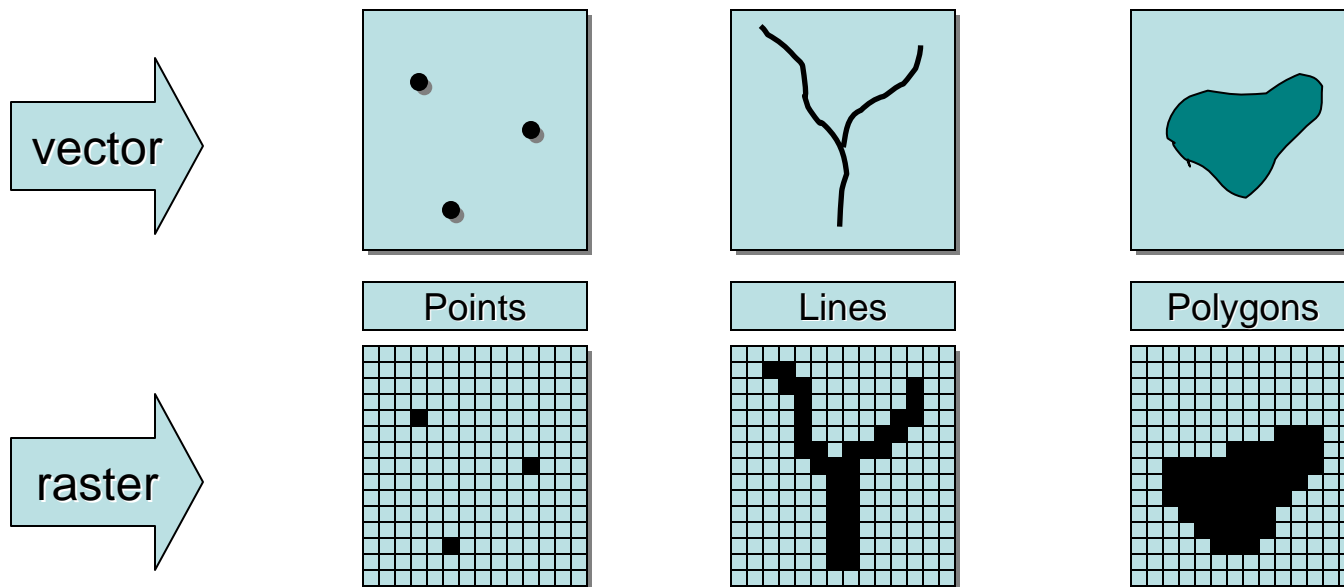


# Features as raster

---

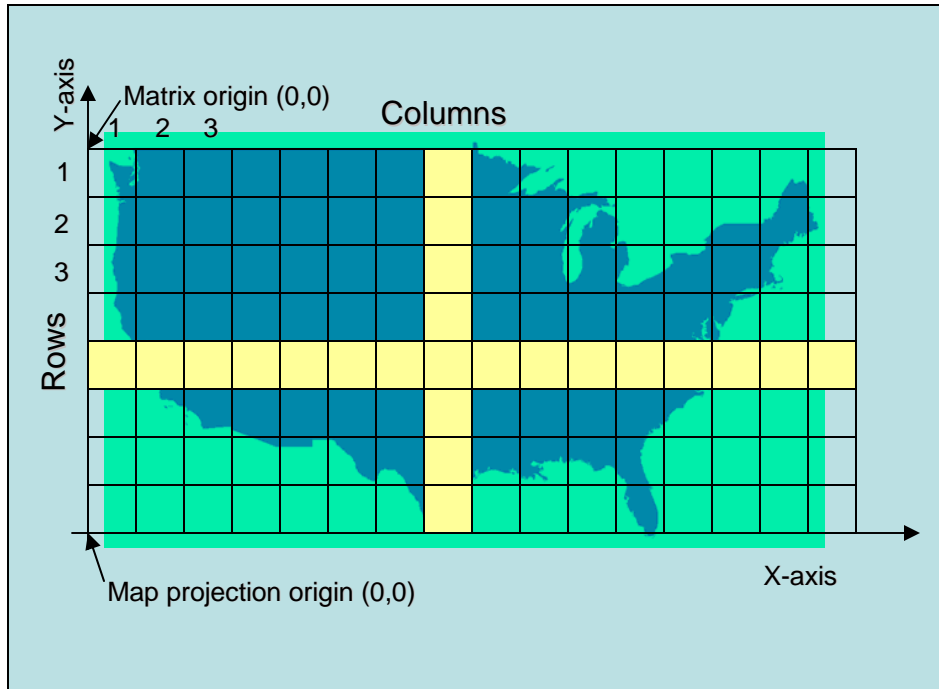
## ❑ Features lose uniqueness with raster representation

(a line becomes a collection of cells, not one feature)



# Raster coordinate systems

---



## Matrix

- Cells located by row/column position
- Origin at upper-left
- Rows and columns always perpendicular

## Cartesian

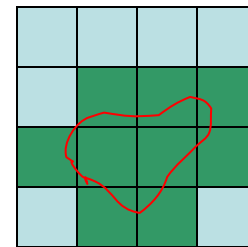
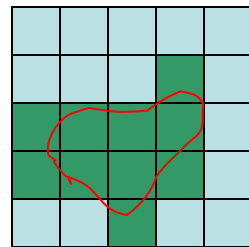
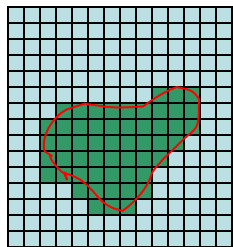
- Cells located by x,y
- May register to a map projection
- Used in ArcMap

# Raster resolution

---

## □ Rasters always generalize spatial data

- A function of cell size (smaller cells = higher resolution)
- Impacts accuracy, processing speed, storage space

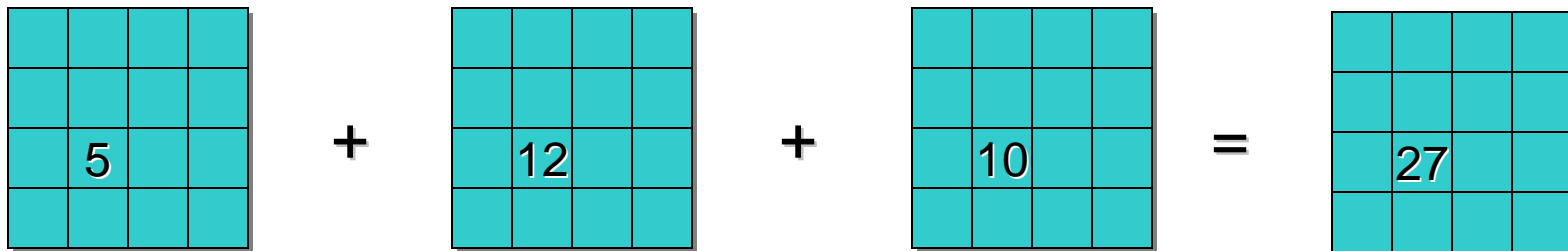


Cell size	100m	200m	400m
Matrix	16 x 16	5 x 5	4 x 4
Lake Cells	68	10	9

# Raster cell coincidence

---

- ❑ Analysis between rasters compares values for cells
- ❑ Rasters must be registered to a common coordinate system

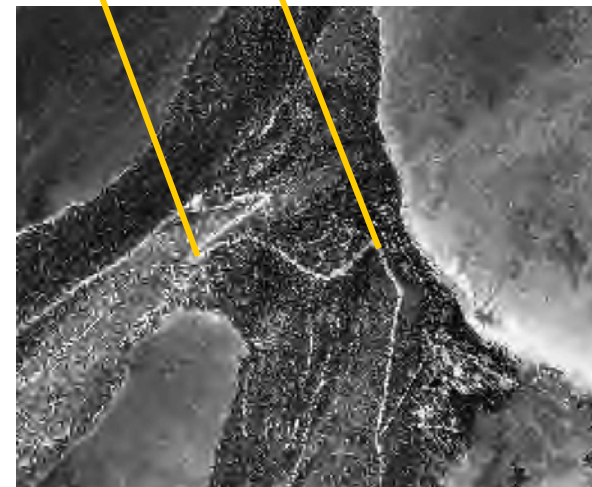


# Raster registration

---

- ❑ **Rasters should be registered to a map projection**
  - Just like vector datasets
  
- ❑ **Use georeferencing tools**
  - Register to a projection
  - Set coordinates for cell locations
  - Part of ArcGIS  
(do not need Spatial Analyst)
  
- ❑ **Use projection tools**
  - Change projection

Map projection coordinate space

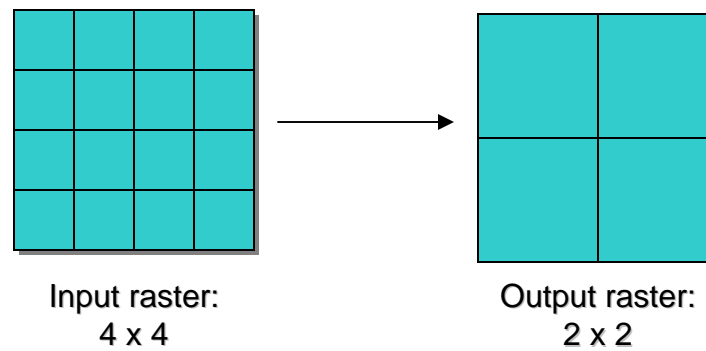


Raster coordinate space

# Raster resampling

---

- ❑ How rasters with different cell geometries are combined
- ❑ Controlled by the output raster environment
  - Output cell center is compared to input cell centers
  - Nearest input cell value is used (other techniques available)





# Raster cell values

---

- ❑ Raster cell values
- ❑ Integer or floating point — depends on raster format
  - ESRI grid, TIF, 1MG, and
  - ER Mapper support both
  - See help for details
- ❑ Integer: Discrete data (like land use and vegetation)
- ❑ Floating point: Continuous data (like distance and rainfall)
- ❑ NoData: Special flag value
  - Indicates no measurement for a cell
  - Numeric value varies with format

Integer

0	1	1	2
No data	1	1	1
no data	1	2	2
1	1	2	2

Vegetation  
0 = Rock  
1 = Forest  
2 = Water

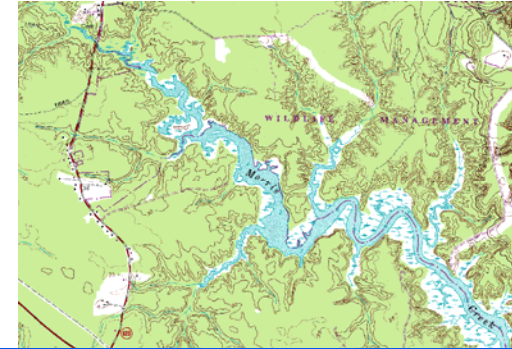
Floating

1.12	1.75	1.81	2.03
0.26	1.63	1.87	1.98
0.00	0.91	0.73	1.98
10.00	0.18	no data	no data

Rainfall  
(inches)

# Raster attribute tables

- ❑ All single-band, integer rasters have “virtual” tables
  - Created on-the-fly by ArcGIS
  - Support ArcMap joins and relates



Attributes of 037076CB.TIF

ObjectID	Value	Red	Green	Blue
0	0	0	0	0
1	1	0.996108949416342	0.996108949416342	0.996108949416342
2	2	0	0.589852750438697	0.640634775310903
3	3	0.79298084992752	0	8.98451209277485E-02
4	4	0.511726558327611	0.257816433966583	0.144533455405508
5	5	0.785168230716411	0.914076447699702	0.613290608072023
6	6	0.535164415960937	0.199221789883266	0.500007629510948
7	7	0.996108949416342	0.914076447699702	0
8	8	0.652353704127565	0.882825970855268	0.882825970855268

Record: 1 | Show: All Selected | Records (0 out of 256 Selected.) | Options

- ❑ Integer ESRI grids have real tables
  - Support ArcMap joins and relates
  - Support user-defined fields
  - Use fields in analysis and queries



Attributes of topoelev2

ObjectID	Value	Count
0	-3.27999997138977	1
1	-2.77999997138977	1
2	-2.57999992370605	1
3	-2.38000011444092	2
4	-2.27999997138977	2
5	-2.07999992370605	5
6	-1.9800001907349	4
7	-1.8799999523163	9
8	-1.77999997138977	3

Record: 1 | Show: All Selected | Records (0 out of 256 Selected.) | Options

# Raster zones and regions

---

- ❑ **Organizations of cells within an integer raster**
  - **Zone: All same-value cells in a raster, connected or not**
    - Part of data model — a row in the attribute table
  - **Region: A group of connected same-(unique)-value cells**
    - Not part of data model — concept only — also a zone
  
- ❑ **Some Spatial Analyst tools work with zones and regions**

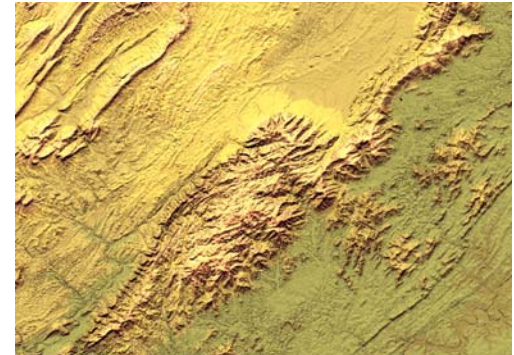
0	1	1	2
No data	1	1	1
no data	1	2	2
1	1	2	2

Vegetation  
0 = Rock  
1 = Forest  
2 = Water

# Raster formats

---

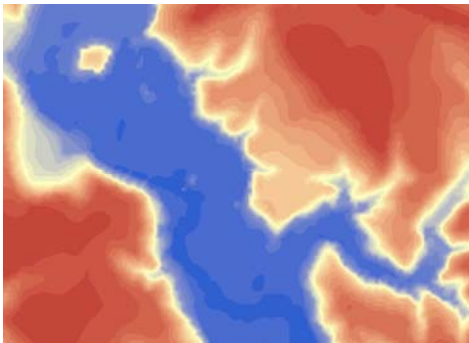
- ❑ The format is how cells are stored in a raster
  
- ❑ ArcGIS supports dozens of raster formats
  - Various image formats (SID, 1MG, TIF, more...)
  - ESRI grid and grid stack
  - ESRI ArcSDE raster
  - ESRI raster dataset
  - ESRI raster catalog
  
- ❑ All may be managed in ArcCatalog
  
- ❑ All may be used with Spatial Analyst tools



# Raster format essentials

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- • **All raster formats are basically the same**
  - **Cells organized in a matrix of rows and columns**
  - **Content is more important than format: data or picture?**



## Raster data

- Elevation
- Land use codes
- Population density

Good for analysis

- Slope from elevation

Good for mapping

- Thematic layers
- Derivative products  
(like shaded relief)



## Raster pictures

- Scanned maps
- Satellite images  
(classified)
- Photos of buildings

Good for mapping

- Backgrounds

Good for attributes

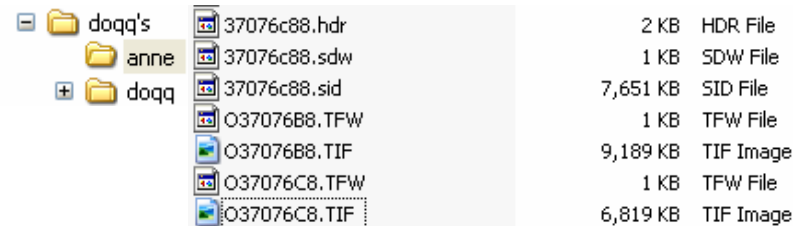
- Picture of house

Bad for analysis

# Image formats

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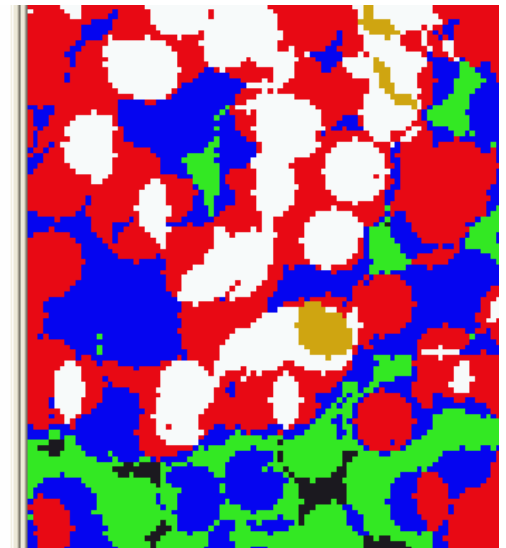
- ❑ **Often have multiple files**
  - Like O37076C8.TIF and O37076C8.tfw
  - Easy to manage with ArcCatalog
  
- ❑ **Some are designed for pictures**
  - Do not store spatial information like projection
  - ArcGIS “enhances” with AUX, RRD files
  
- ❑ **Some are designed for geospatial data**
  - Have built-in support for spatial information
  - ERDAS IMG, Lizard Tech MrSID, GeoTIFF, etc.
  
- ❑ **Compression can slow analysis**
  - Spatial Analyst must de-compress first



doqq's	37076c88.hdr	2 KB	HDR File
anne	37076c88.sdw	1 KB	SDW File
doqq	37076c88.sid	7,651 KB	SID File
	O37076B8.TFW	1 KB	TFW File
	O37076B8.TIF	9,189 KB	TIF Image
	O37076C8.TFW	1 KB	TFW File
	O37076C8.TIF	6,819 KB	TIF Image

# ESRI grid format

- ❑ **Native format for Spatial Analyst**
  - Default output from most tools
  - A folder containing multiple files
  - Have associated INFO tables (manage grids with ArcCatalog only)
  
- ❑ **Two types:**
  - Floating point — continuous data (usually)
  - Integer — discrete data (usually)
    - Integer grids may have user-defined attribute fields



A screenshot of the 'Attributes of vegvar' dialog box. It displays a table with three columns: ObjectID, Value, and Count. The table contains 8 rows of data. Below the table, there are navigation controls for records and a 'Show' dropdown menu.

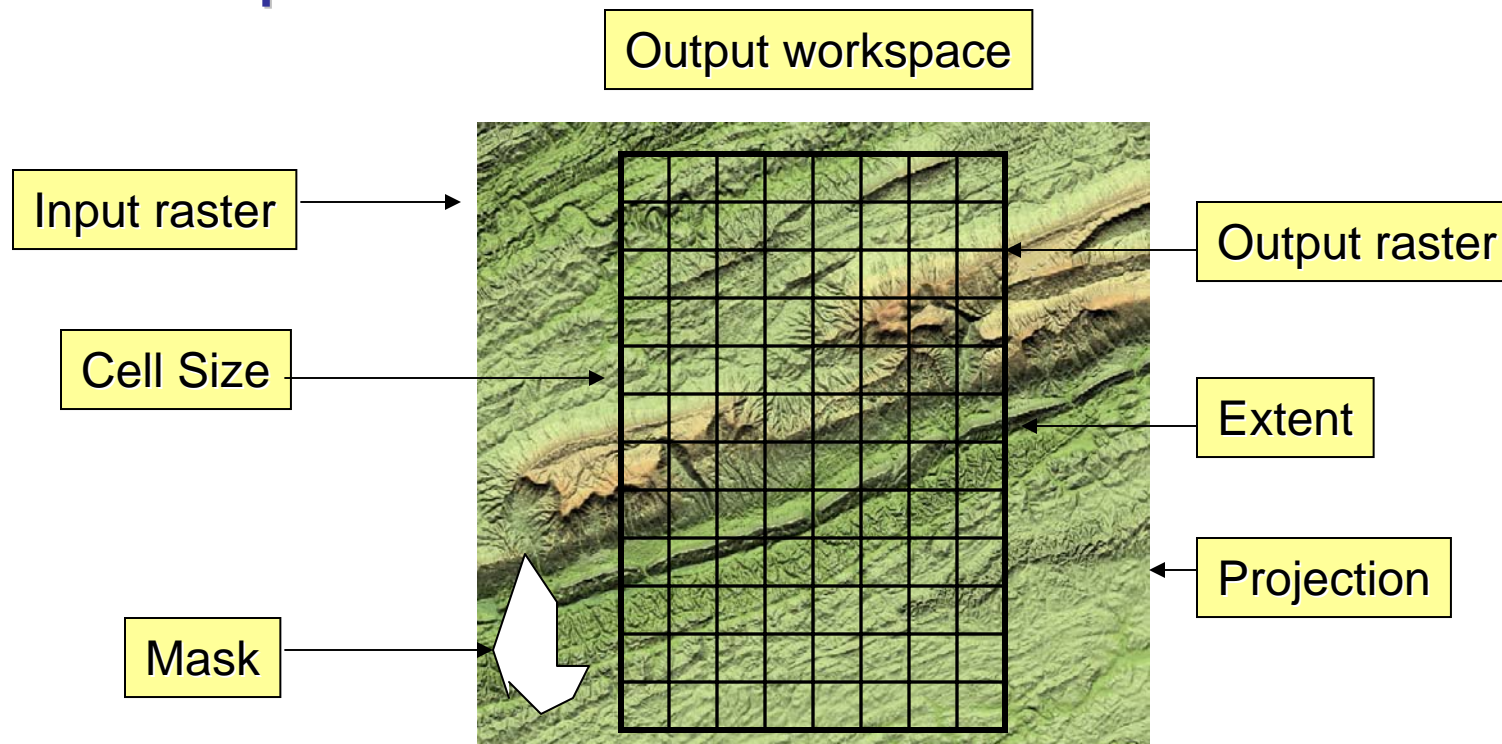
ObjectID	Value	Count
0	1	30227
1	2	30384
2	3	43810
3	4	42495
4	5	23292
5	6	3703
6	7	515
7	8	73

Record: 1 Show: All Selected Records: (0 out of 8 Selected.) Options

# The analysis environments

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- Control how an output raster is created
  - Set for geoprocessing and Spatial Analyst toolbar — independent



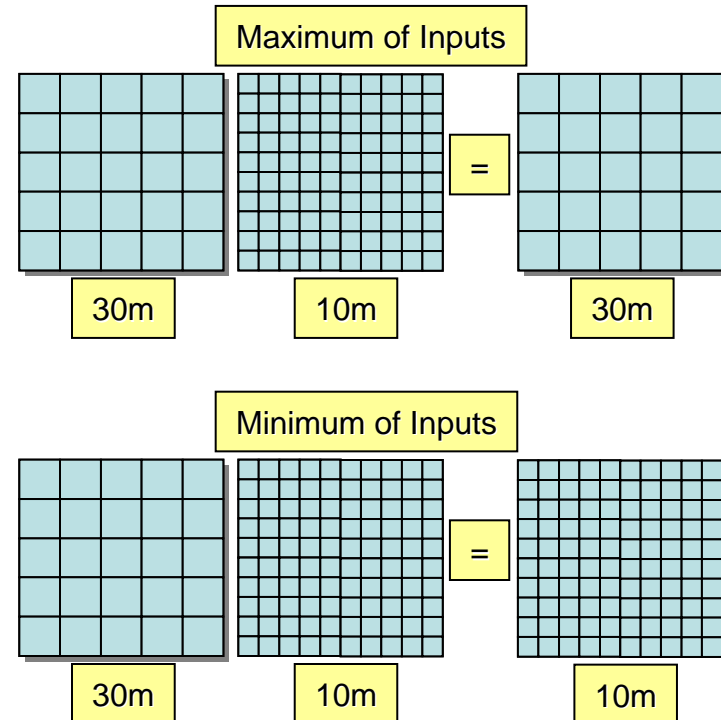


# Setting the output cell size

---

- ❑ **Rasters are resampled during analysis**
  - Combine rasters with different cell sizes, output another size

- ❑ **Output options:**
  - **Maximum of inputs (default)**
  - **Minimum of inputs**
  - **Same as layer**
  - **As specified**

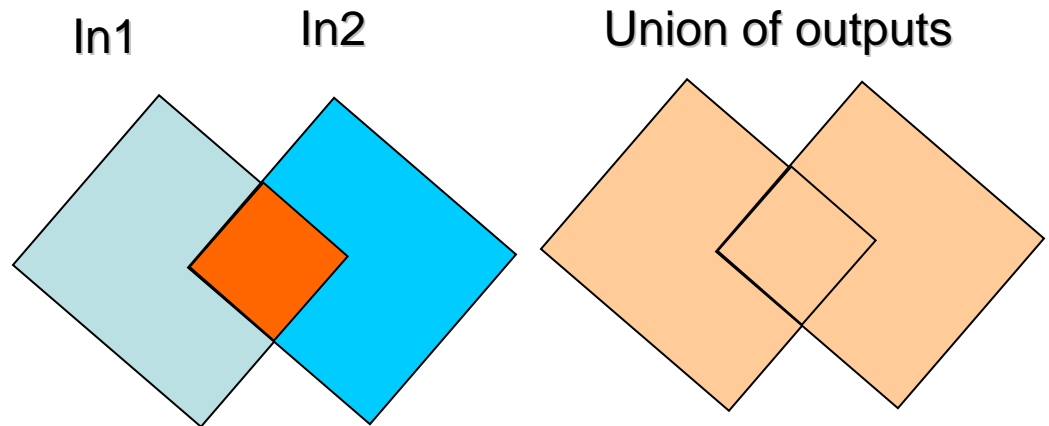


# Setting the output extent

---

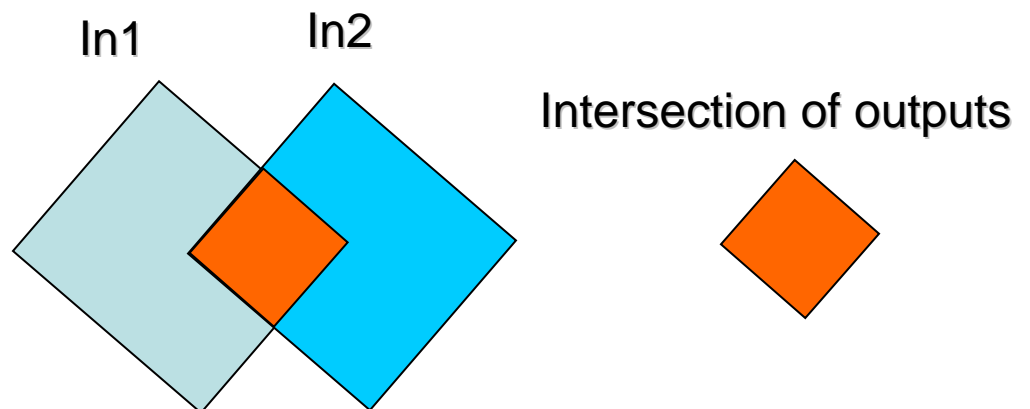
- **Controls the width and height of the output raster**

- Combine rasters with different extents, output another extent



- **Output options:**

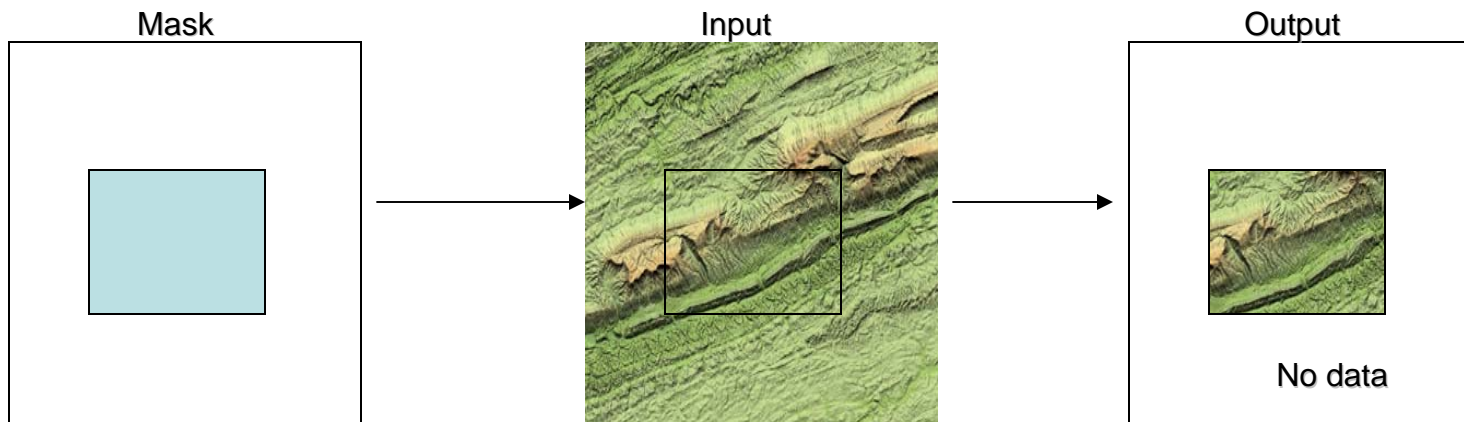
- Union of inputs (default)
- Intersection of inputs
- Same as layer
- Same as display
- As specified



# Setting the analysis mask

---

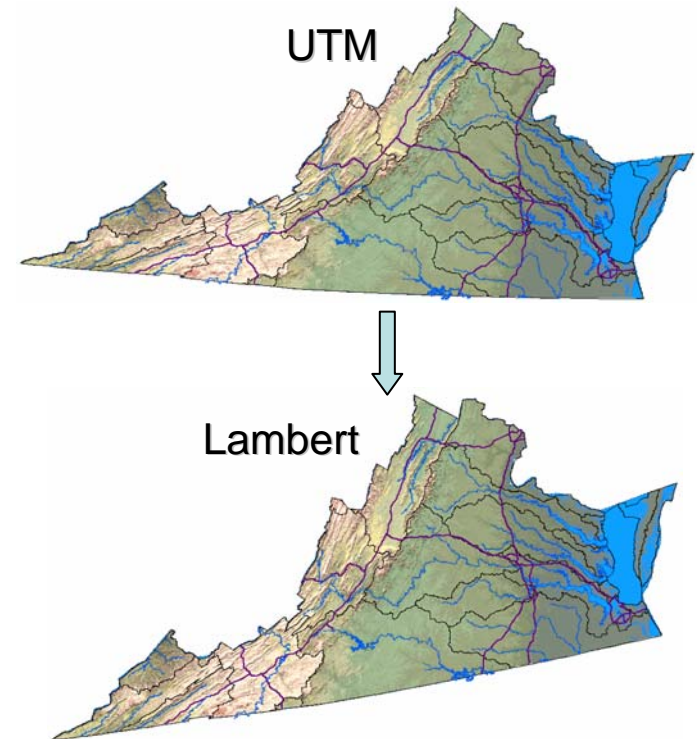
- ❑ **Defines areas where analysis is performed**
  - Useful for clipping to irregular shapes
- ❑ **Vector mask**
  - Only cells covered by features are output (others set to NoData)
  - Create a feature mask with selection and export
- ❑ **• Raster mask**
  - Only cells covered by valued cells are output (others set to NoData)
  - Create a raster mask with several Spatial Analyst techniques



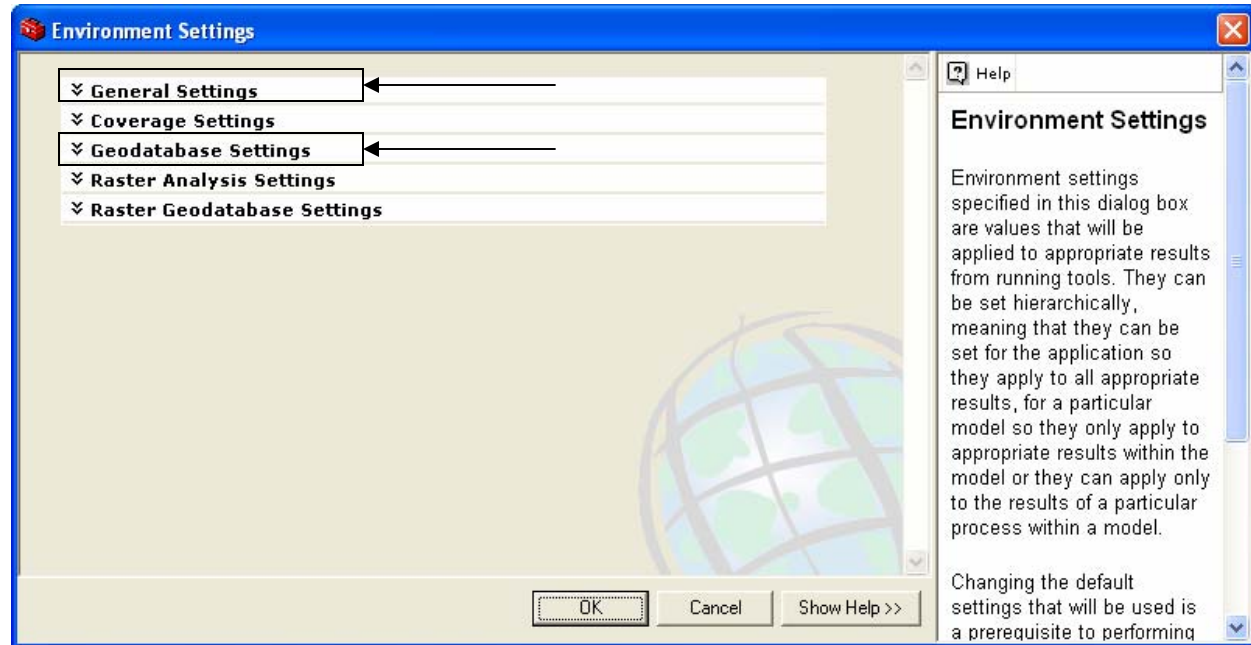
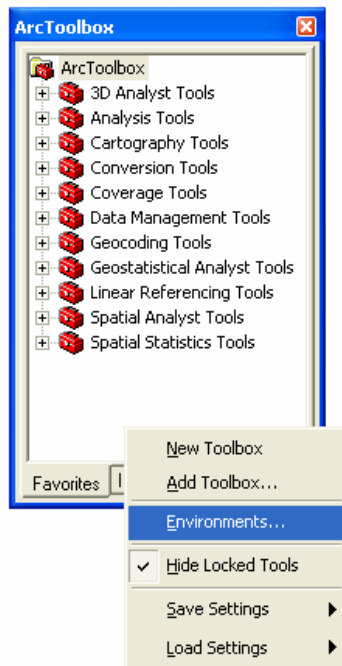
# Setting the output projection

---

- ❑ Rasters may be projected during analysis
  - Combine rasters in different projections, output to another
  
- ❑ Output options:
  - Same as input
  - Same as display
  - Same as layer (geoprocessing only)
  - As specified (geoprocessing only)
  
- ❑ Uses “Fast project”
  - Best for small areas at low latitudes

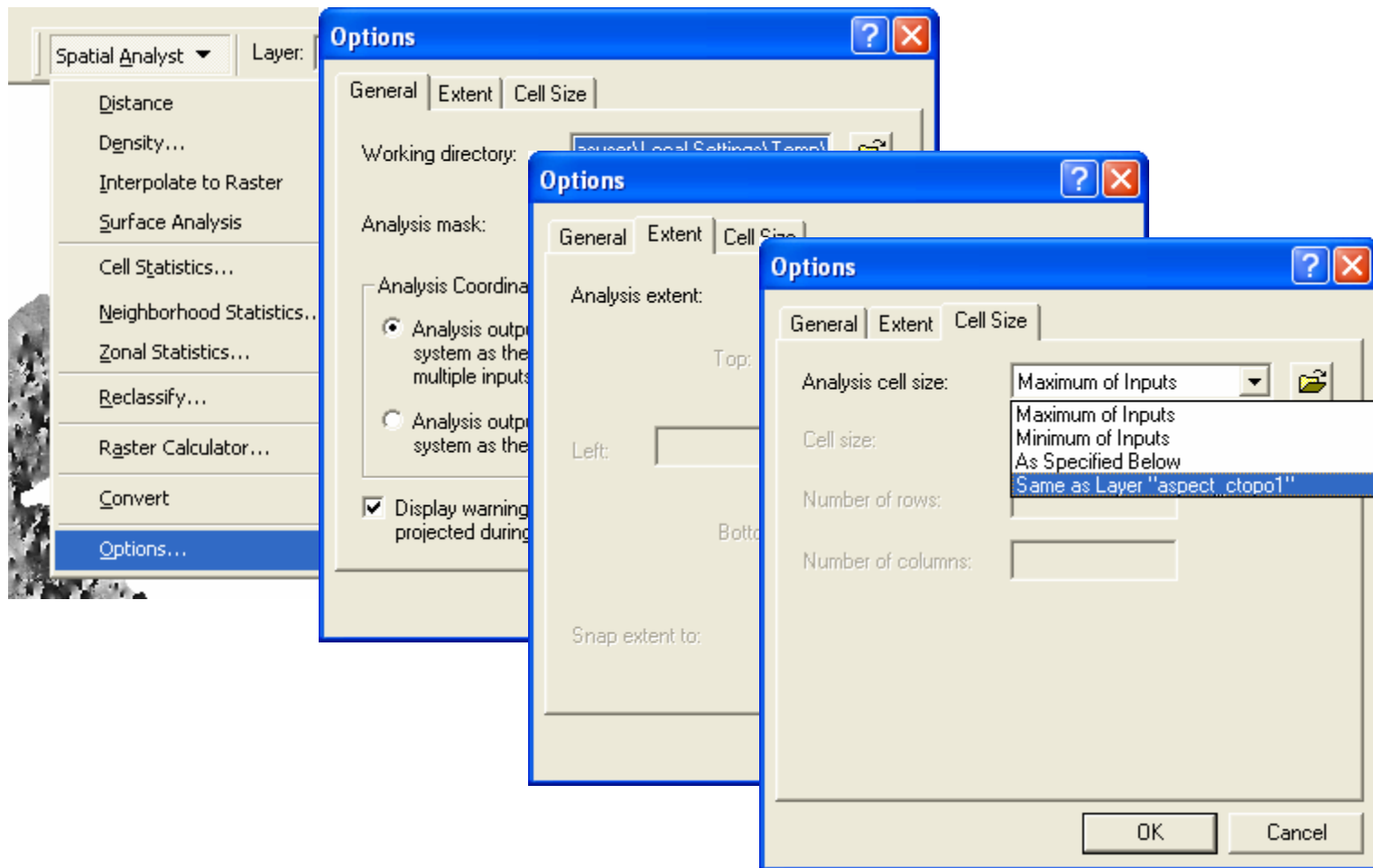


# Setting the geoprocessing environments



# Setting the toolbar environments

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# Exercise 3 overview

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- ❑ **Explore the analysis environment**
  - Cell size
  - Extent and snap raster
  - Mask
  - Projection
  
- ❑ **Clipping with the analysis environment**
  - With the extent (rectangular shape)
  - With the extent and mask (irregular shape)