GIS Institute

Center for Geographic Analysis

Working with Rasters and other Spatial Models

Outline

- Surfaces
  - DEM
- Overlaying rasters
  - Map algebra
- Rasters from vectors
  - Density
  - Interpolation
  - Trend surface
  - GWR

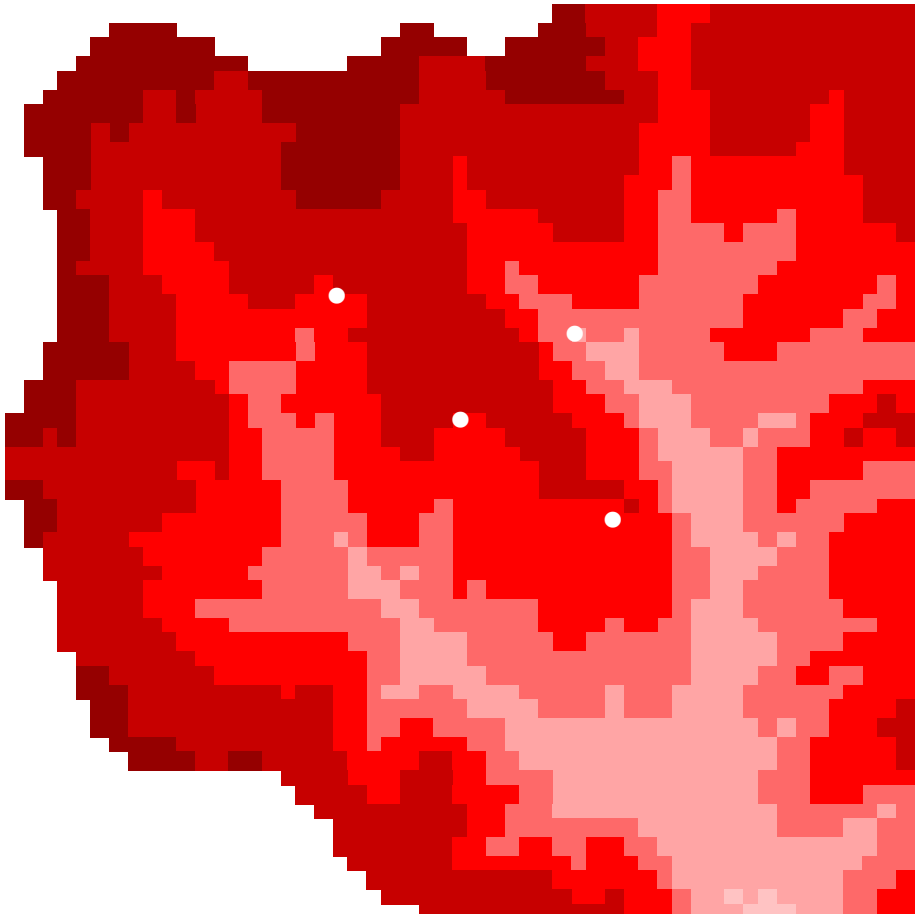
Representing Surfaces

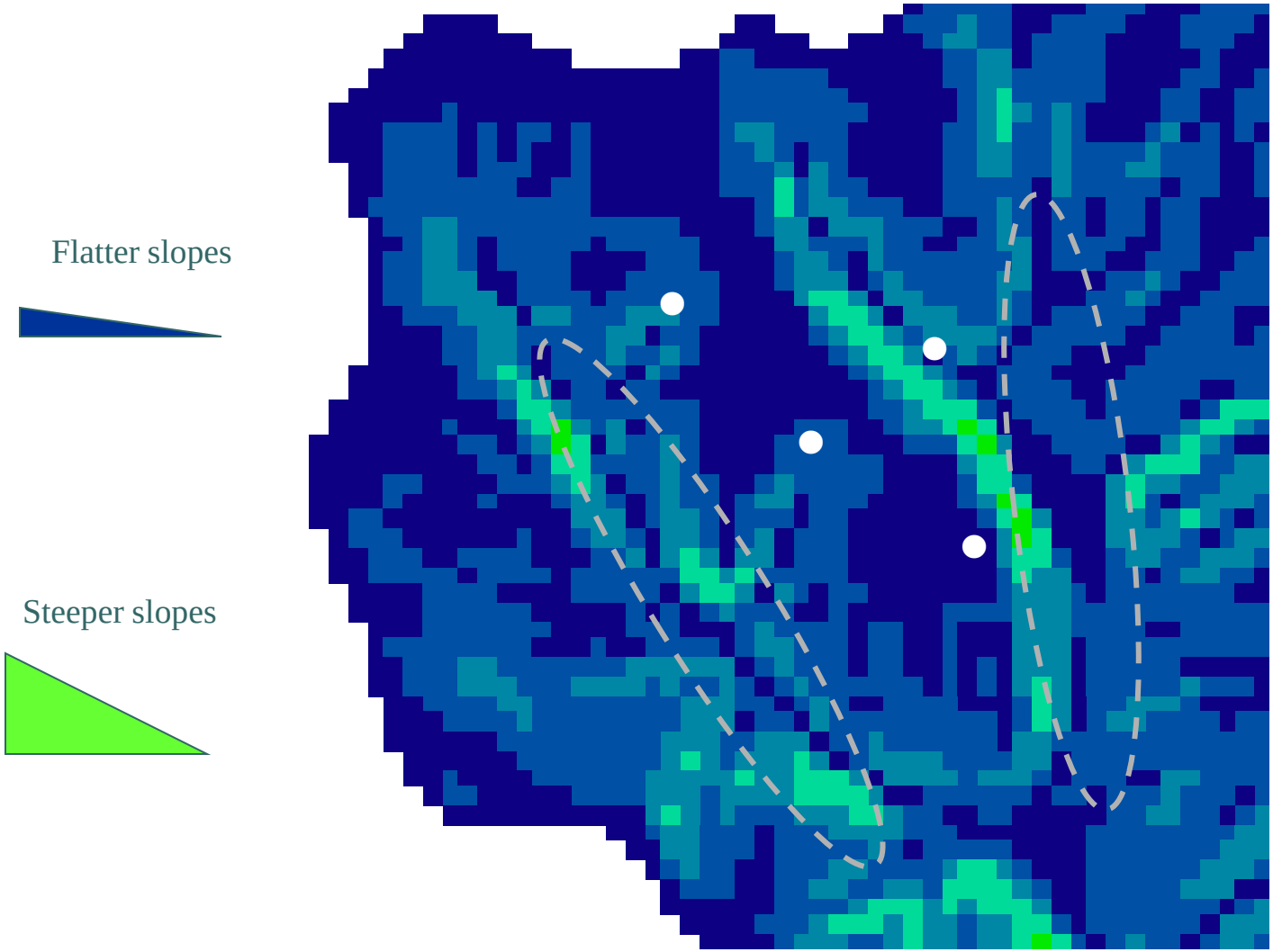
- Surfaces involve a third elevation value (z) in addition to the x,y horizontal values
- Digital terrain model approaches:
  - Raster-based digital elevation model (DEM)
  - Vector based triangulated irregular networks (TIN)

Surface Models

- Two approaches for determining the surface z value of a location between sample points:
  1. In a **lattice**, each mesh point represents a value on the surface
  2. A **surface grid** considers each sample as a square cell with a constant surface value

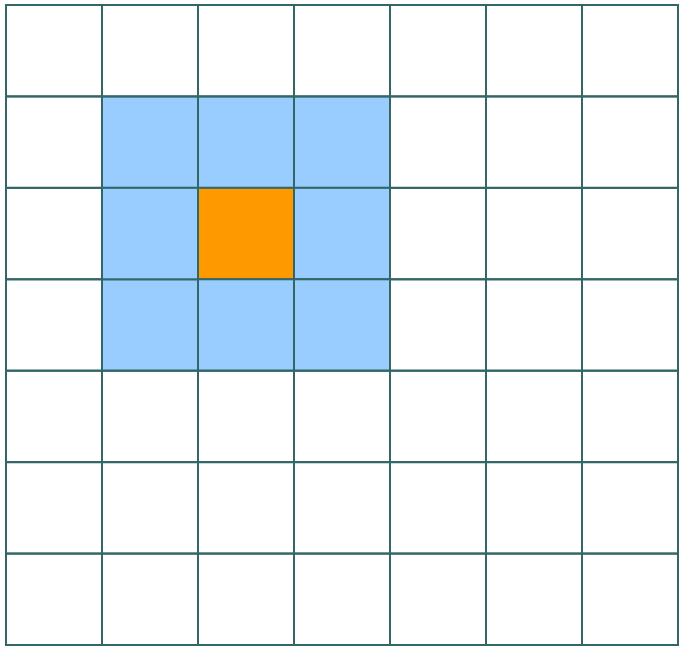
DEM




Flatter slopes
Steeper slopes

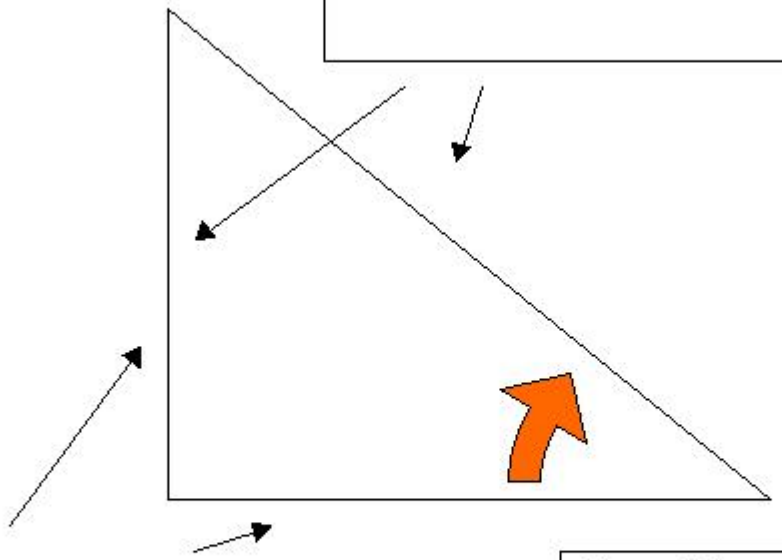
Calculating DEM Slope

- When the slope is derived the slope value assigned to each cell in the elevation coverage comes from the elevation data in the 8 cells surrounding the “cell of interest.”



Slope Definitions (cont.)

The *ratio* of the change in elevation to the actual distance traveled, range 0 to 1



The *ratio* of the change in elevation to the horizontal distance traveled, range 0 to infinity

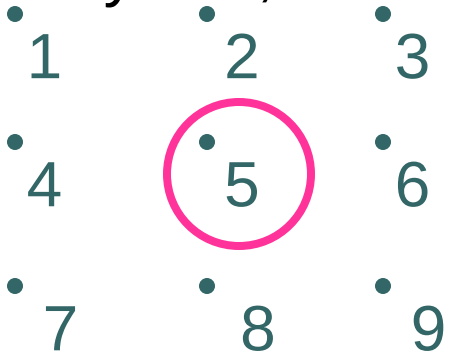
The *angle* between the surface and the horizontal, range 0 to 90

Terrain Analysis

- Slope (Landslide susceptibility)
- Aspect (Solar insolation, vegetation)
- Viewshed (visibility)
- Catchment or dispersal area (Runoff volume, soil drainage)
- Flow path (Distance of water flow to point)

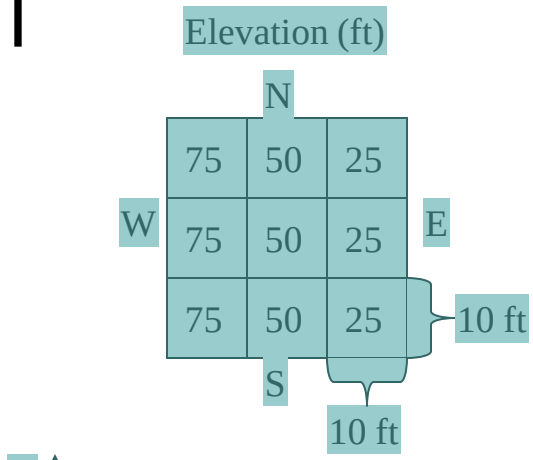
Slope and Aspect

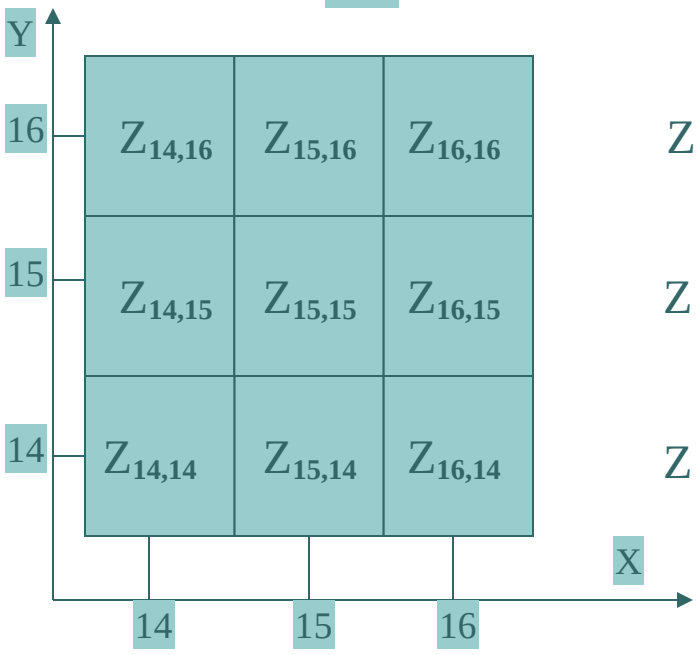
- measured from an elevation
  - compare elevations of points in a 3x3 neighborhood
  - slope and aspect at one point estimated from its elevation and that of surrounding 8 points
- number points row by row, from top left from 1 to 9

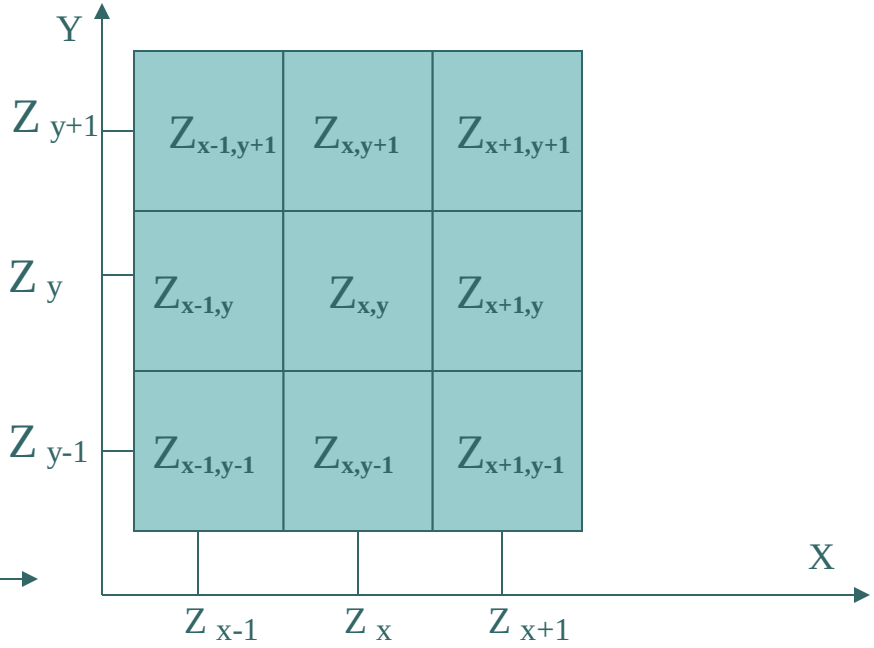


Calculating Slope and Aspect

From: H. Whiffen, University of Georgia, Athens







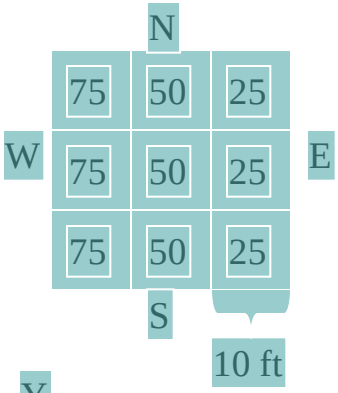
Calculating Slope and Aspect

From: H. Whiffen, University of Georgia, Athens

Elevation (ft)

$$\text{tangent} = \sqrt{b^2 + c^2}$$

S = cell size = 10 ft



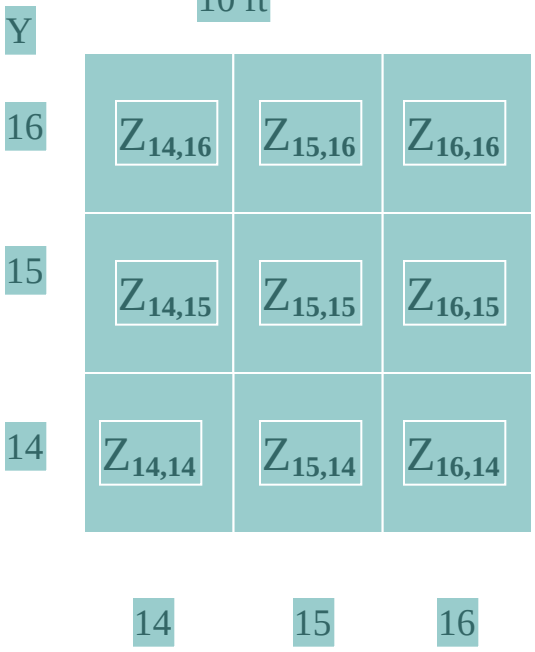
$$b = ((Z_{x-1, y+1} + 2Z_{x, y+1} + Z_{x+1, y+1}) - (Z_{x-1, y-1} + 2Z_{x, y-1} + Z_{x+1, y-1}))/8S$$

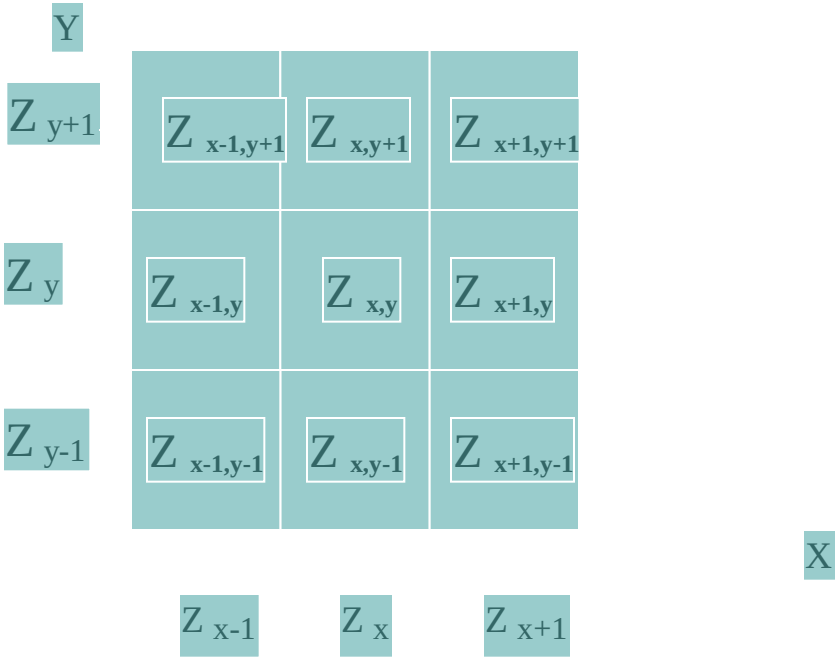
$$c = ((Z_{x+1, y-1} + 2Z_{x+1, y} + Z_{x+1, y+1}) - (Z_{x-1, y-1} + 2Z_{x-1, y} + Z_{x-1, y+1}))/8S$$

$$b = ((75 + 2(50) + 25) - (75 + 2(50) + 25))/ (8(10)) = 0$$

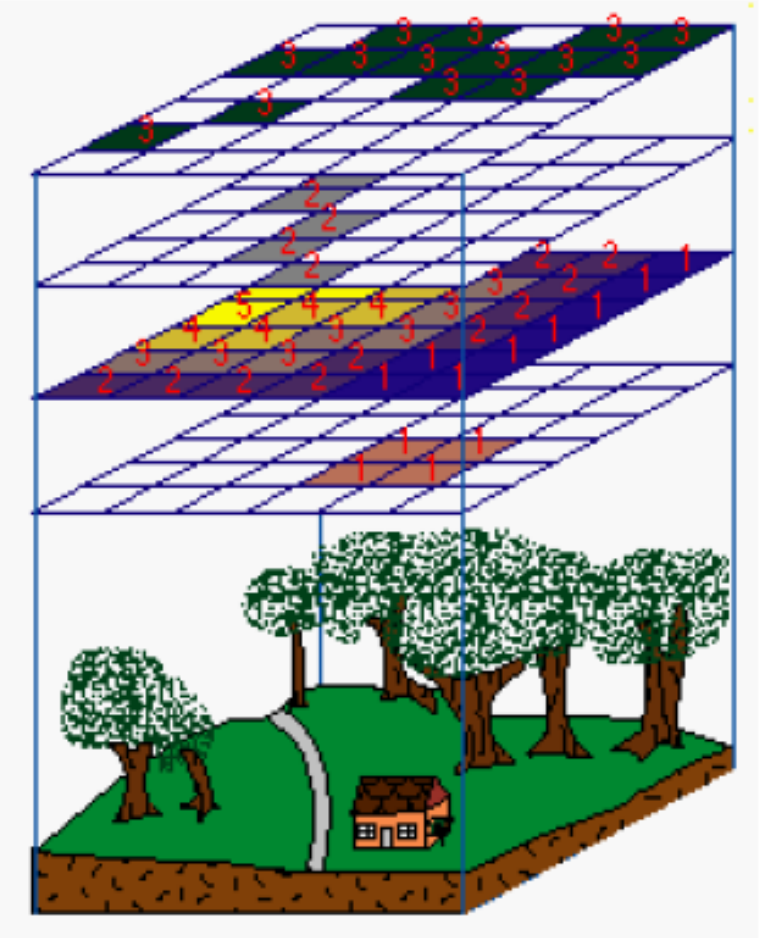
$$c = ((25 + 2(25) + 25) - (75 + 2(75) + 75))/ (8(10)) = -2.5$$

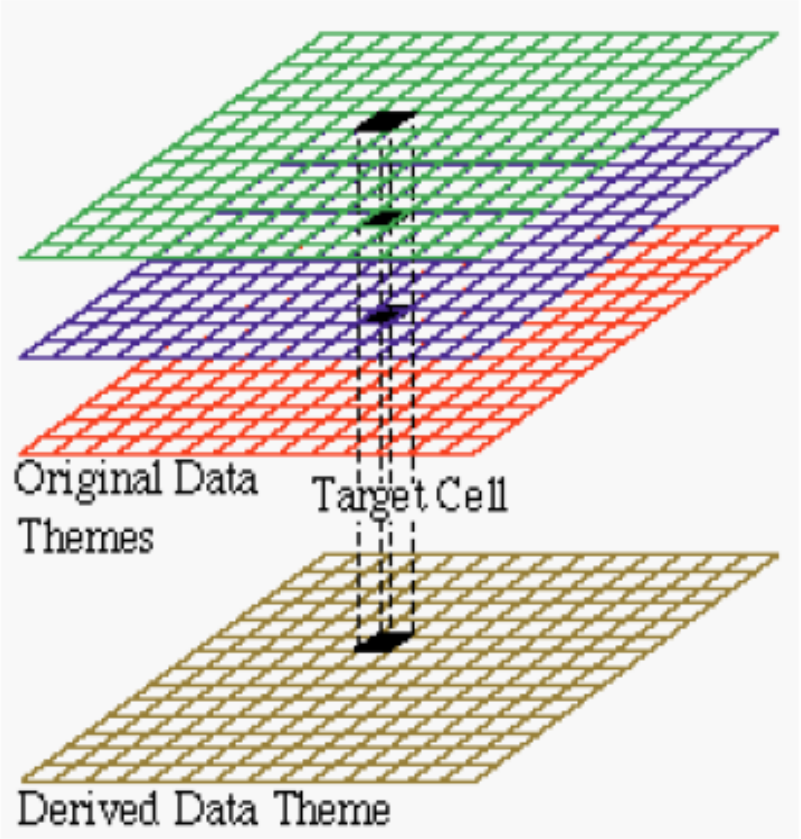
$$\text{tangent} = \sqrt{0^2 + -2.5^2} = 2.5$$





Raster Overlay





Arithmetic Operations

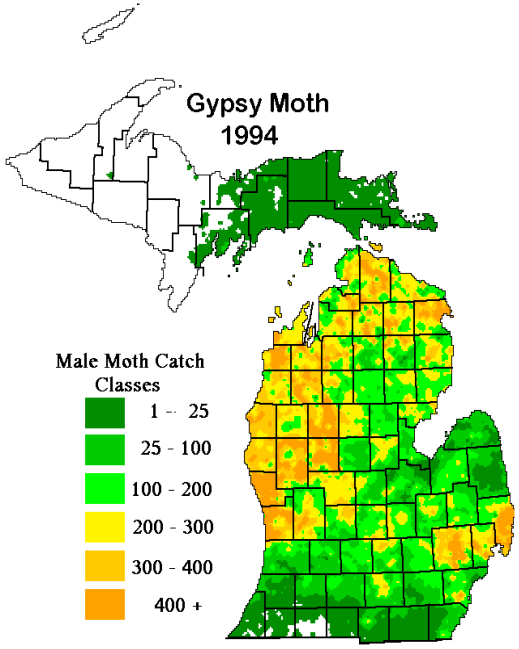
Change detection for new urban areas for each county

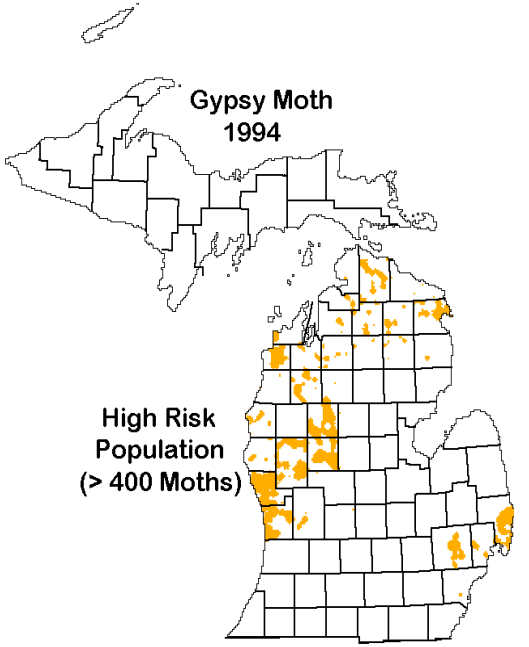
	1975-1980	1980-1990	1990-2000	total urban area
A	x1	y1	z1	x1+y1+z1
B	x2	y2	z2	x2+y2+z2
C	x3	y3	z3	x3+y3+z3

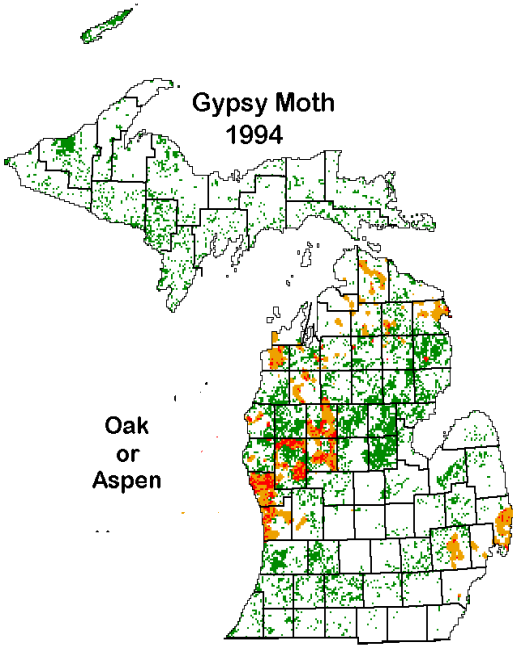
county	1975	2000	new urban area
A	x1	y1	y1-x1
B	x2	y2	y2-x2
C	x3	y3	y2-y3

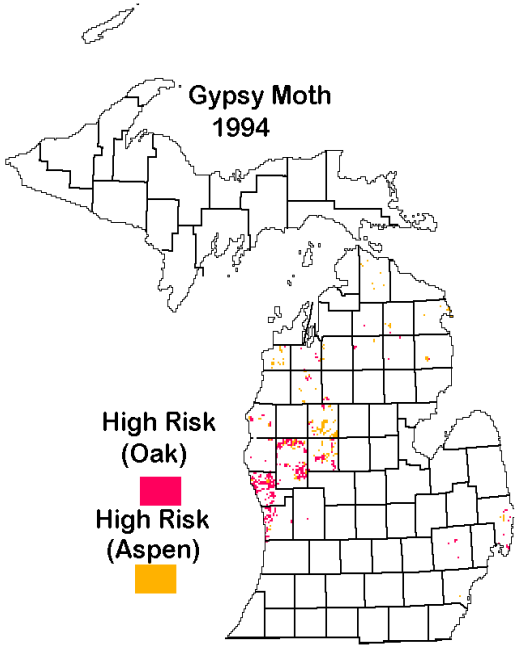
Risk to Trees from Gypsy Moth

1. Gypsy moth distribution
2. High risk map
3. Overlay analysis between forest types and gypsy moth distribution
4. Final map for forests at high risk to gypsy moth

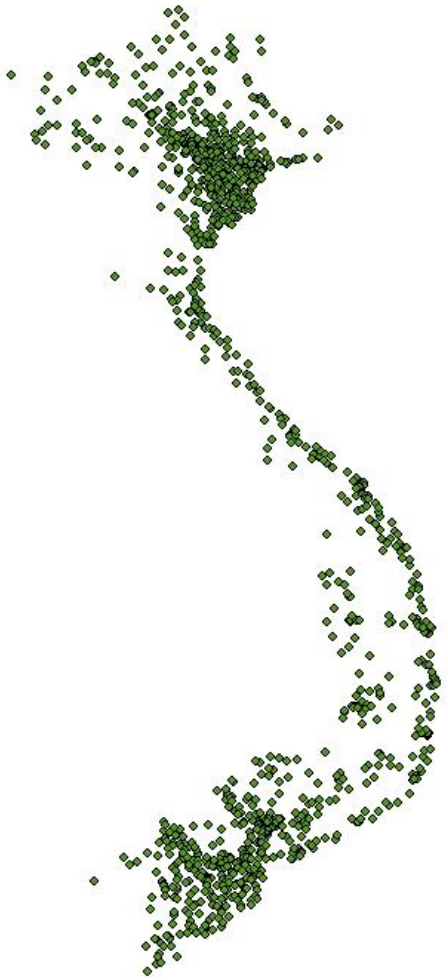




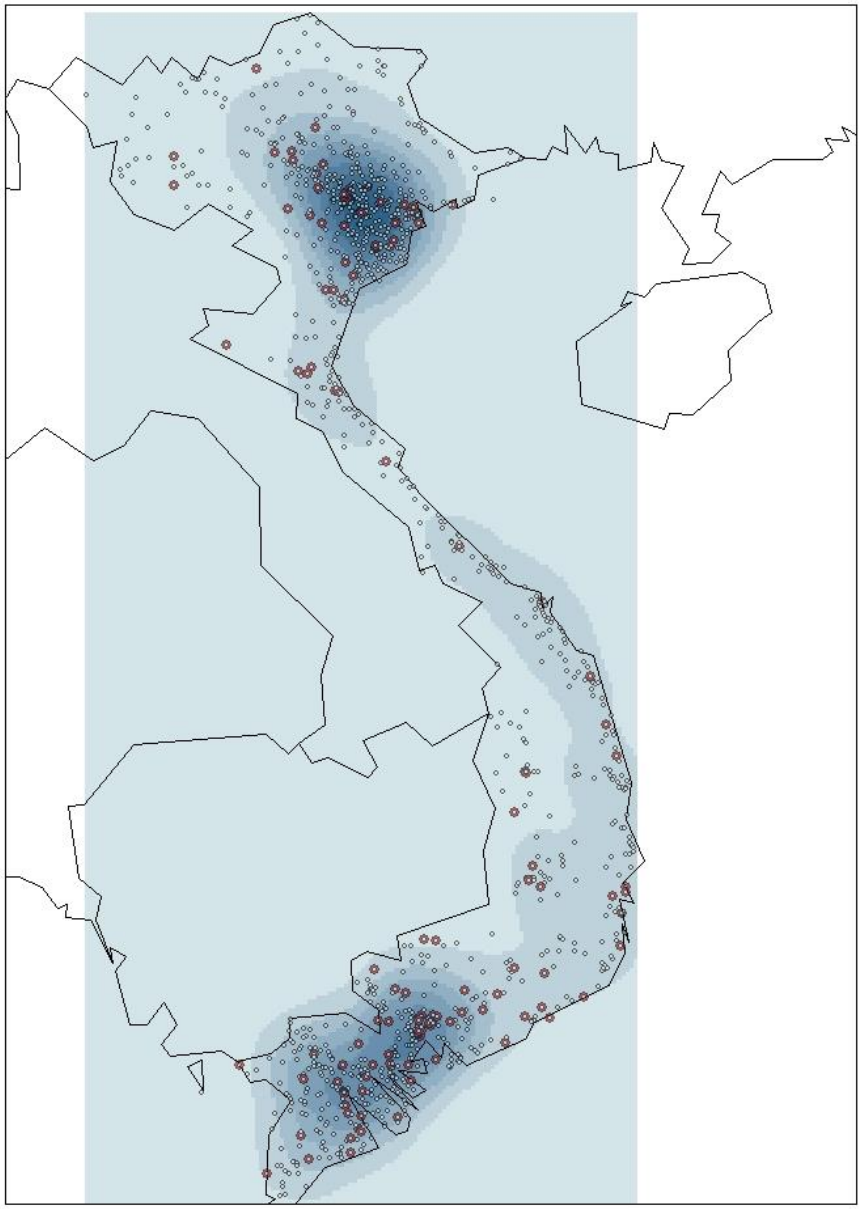




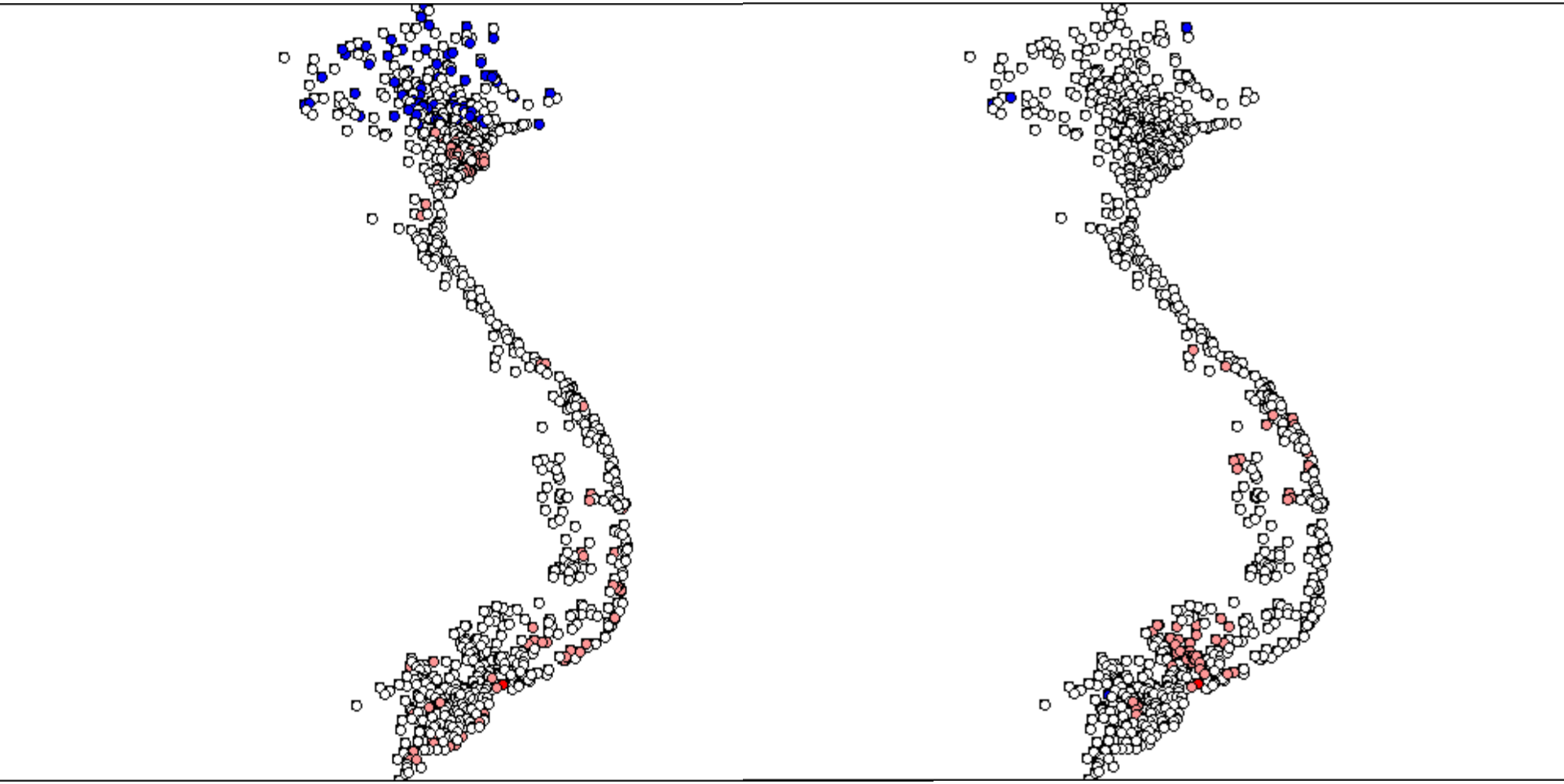
Vietnam Cancer incidence Example



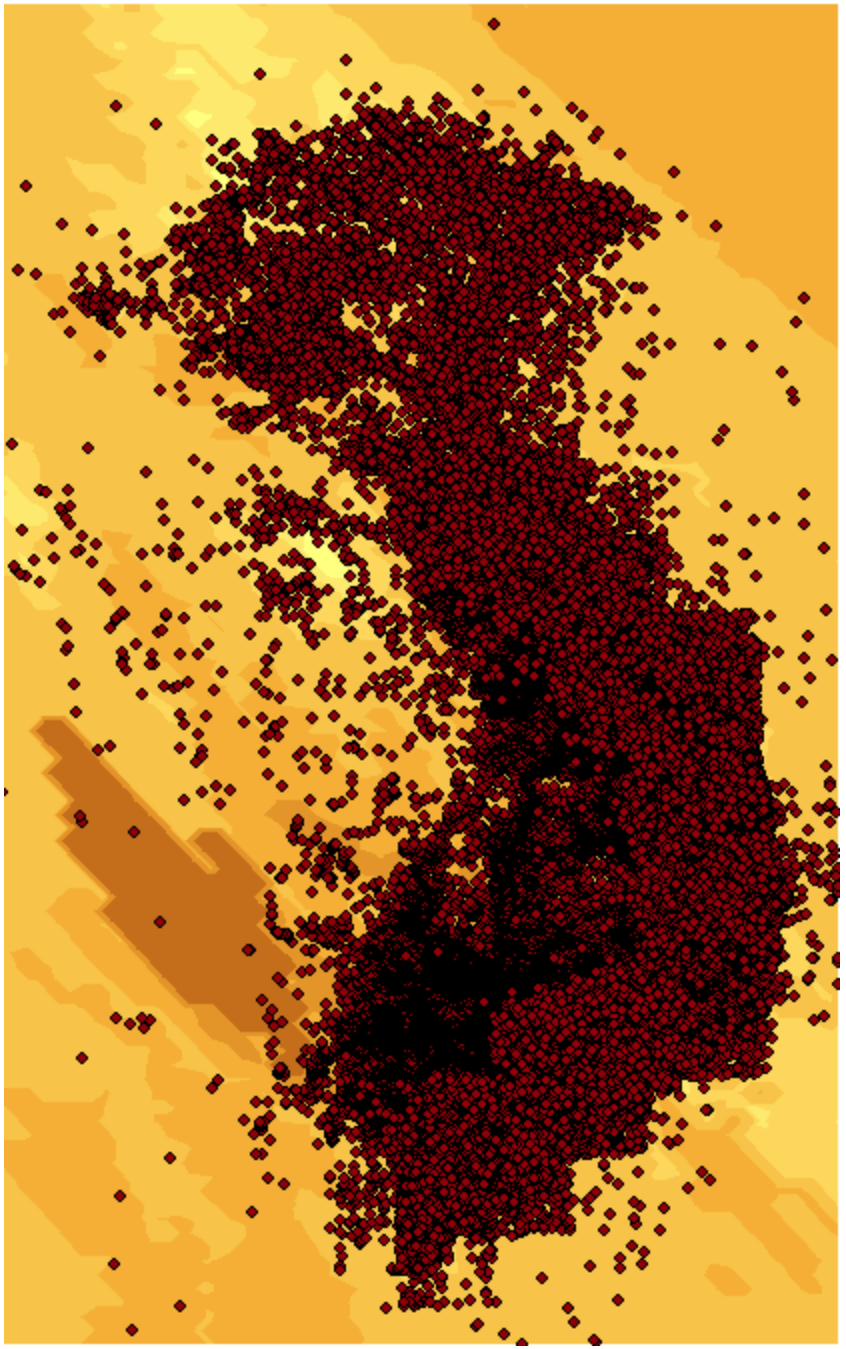
Density of Cancer Cases in Vietnam



Hot spot analysis

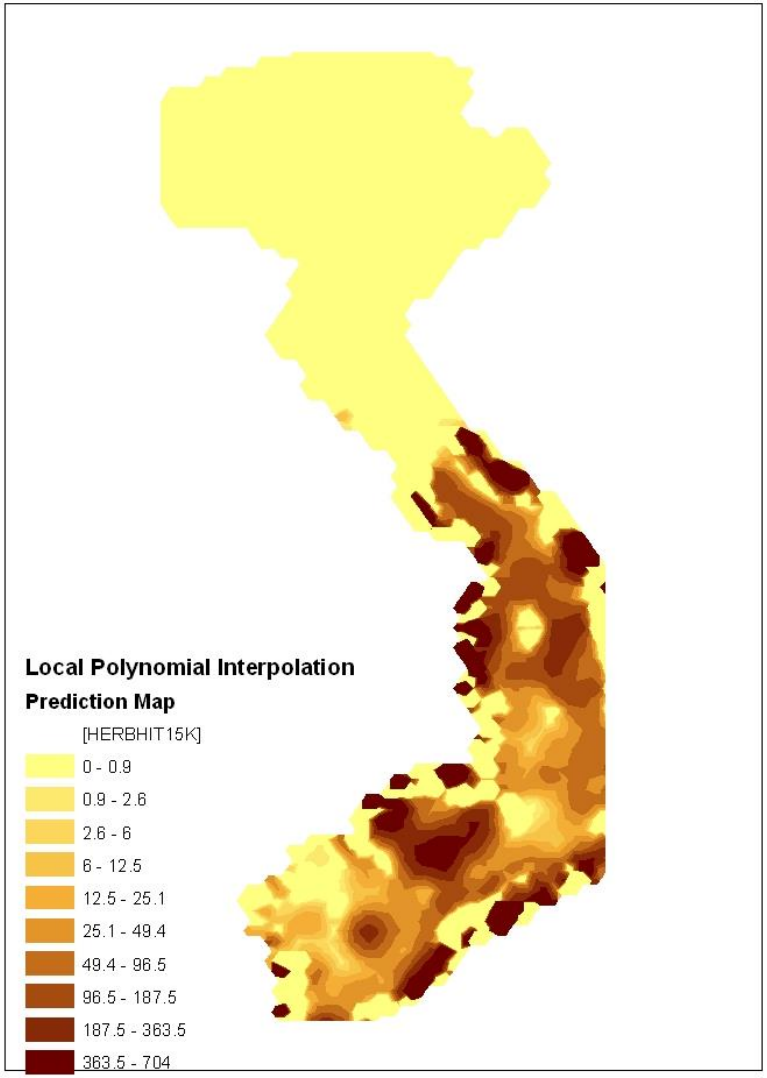


Bombing in Vietnam



Herbicide hits trend surface in Vietnam

Variable	Coefficient	Std.Error	t -Stat
CONSTANT	-2.39e+007	588005.7	-40.6
LONGITUDE	244444.5	5452.89	44.8
LATITUDE	-45260.15	1427.16	-31.7



Spatial Interpolation

Data Integration

- merging spatially incompatible data sets

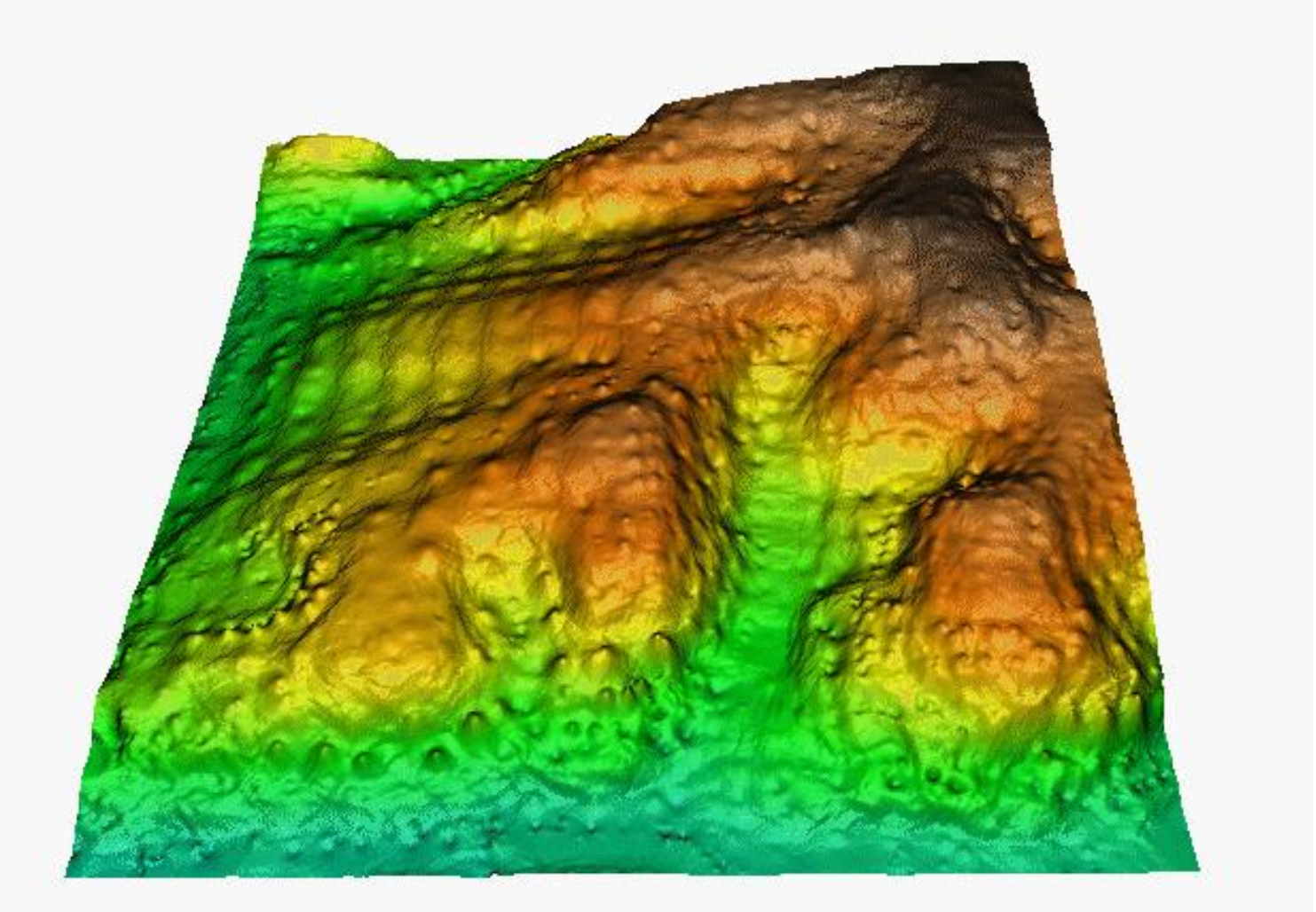
Predicting Values for Locations with no Observations

- use information on (spatial) pattern at one set of locations/scale
- to predict values at different locations/scale

Inverse distance weighting

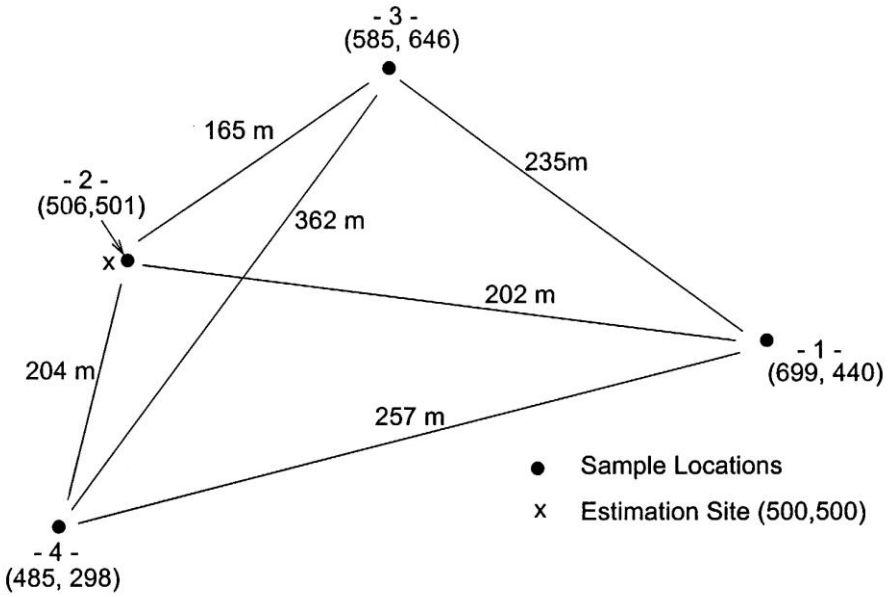
- Estimates value in output surface by weighting the relative influence of input points in the local area by inverse function of distance from location to be estimated

IDW



Kriging

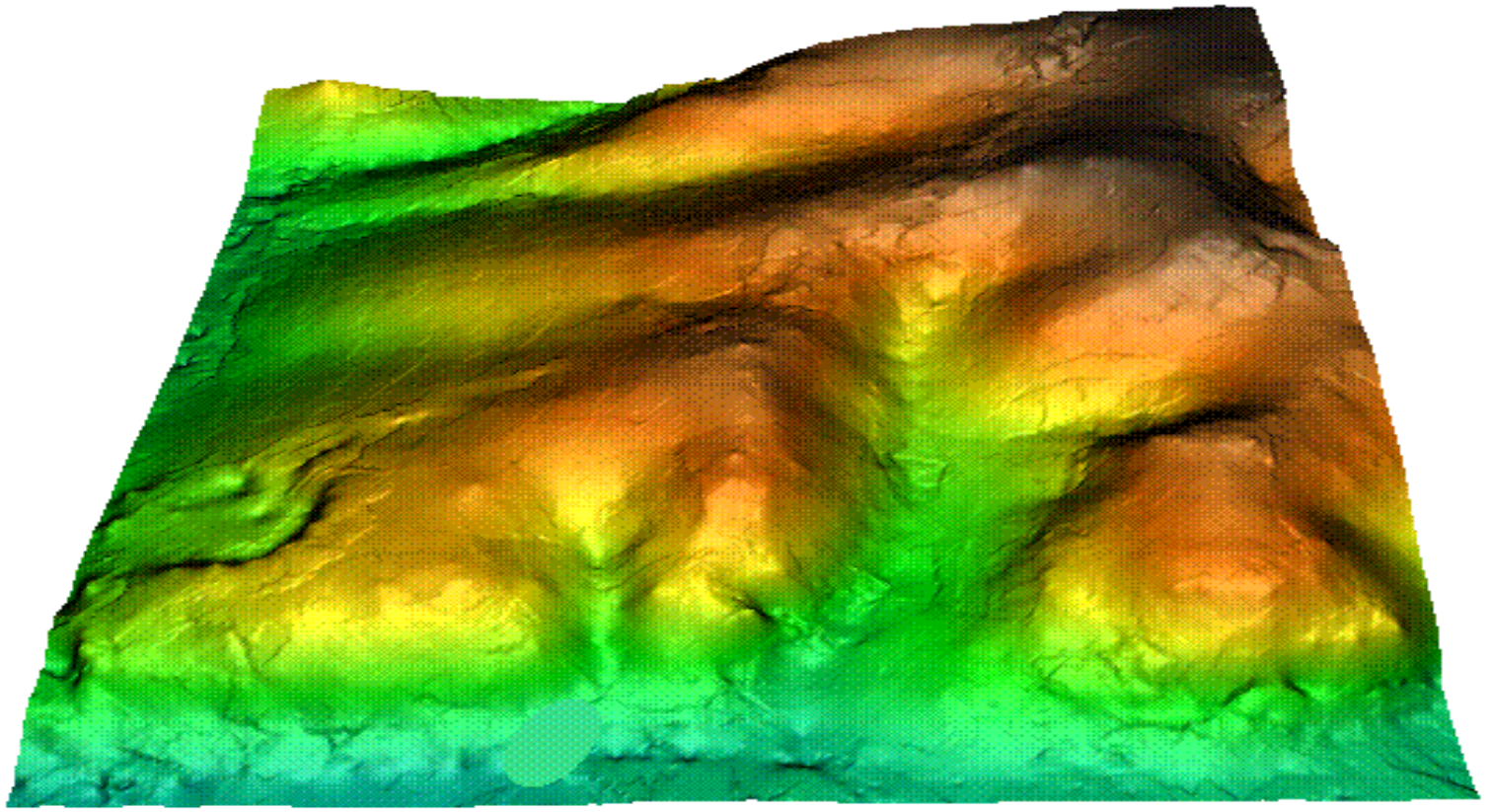
Kriging is based on the idea that you can make inferences regarding a random function Z(x), given data points $Z(x_1)$, $Z(x_2)$, …$Z(x_n)$.



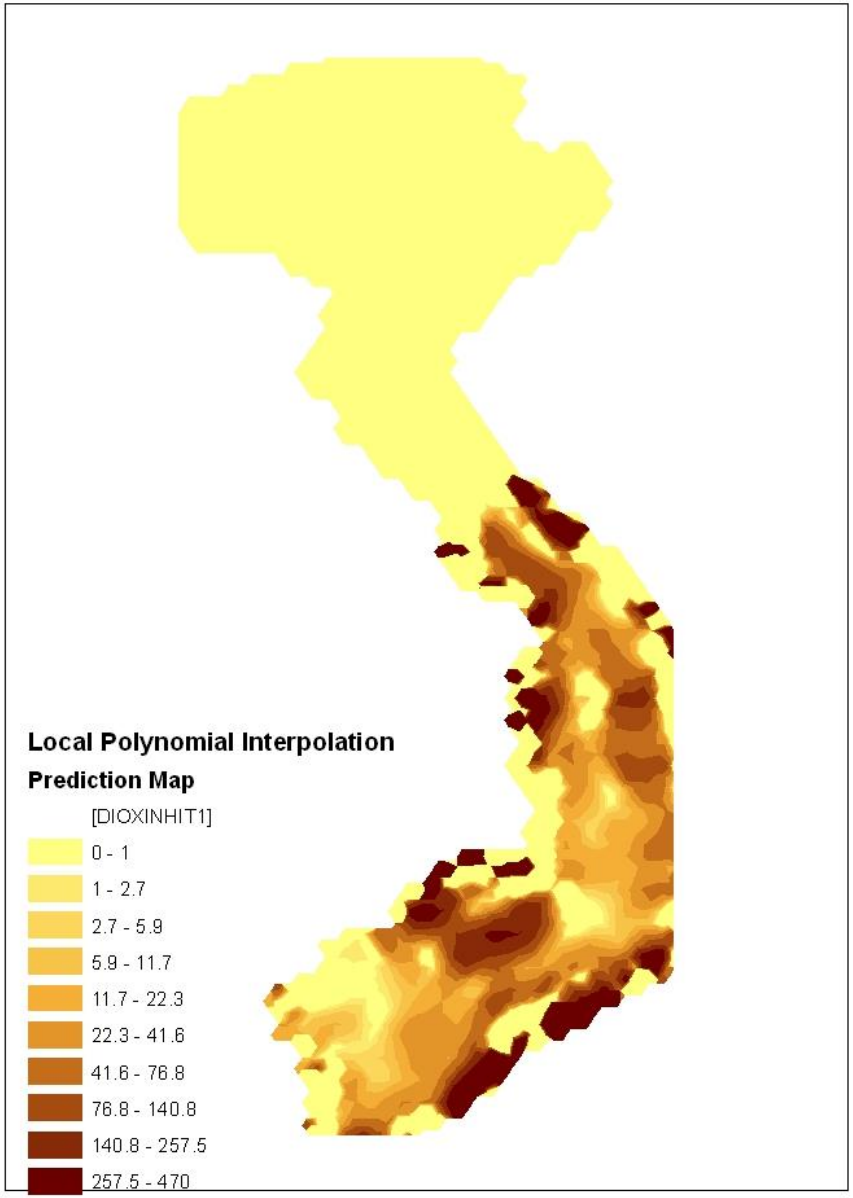
$$Z(x) = m(x) + \gamma(h) + \varepsilon$$

3 components: structural (constant mean), random spatially correlated component and residual error.

Kriging

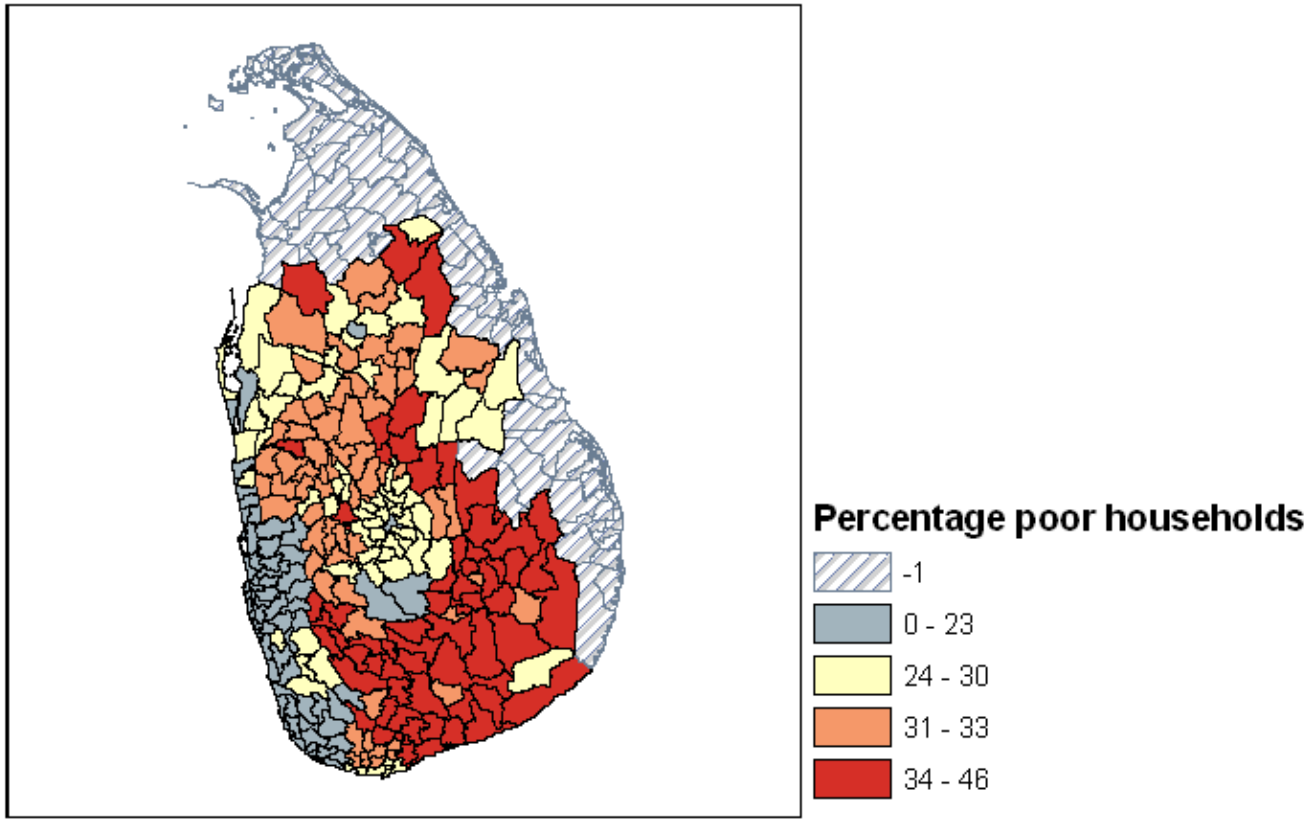


Interpolation of dioxin in Vietnam

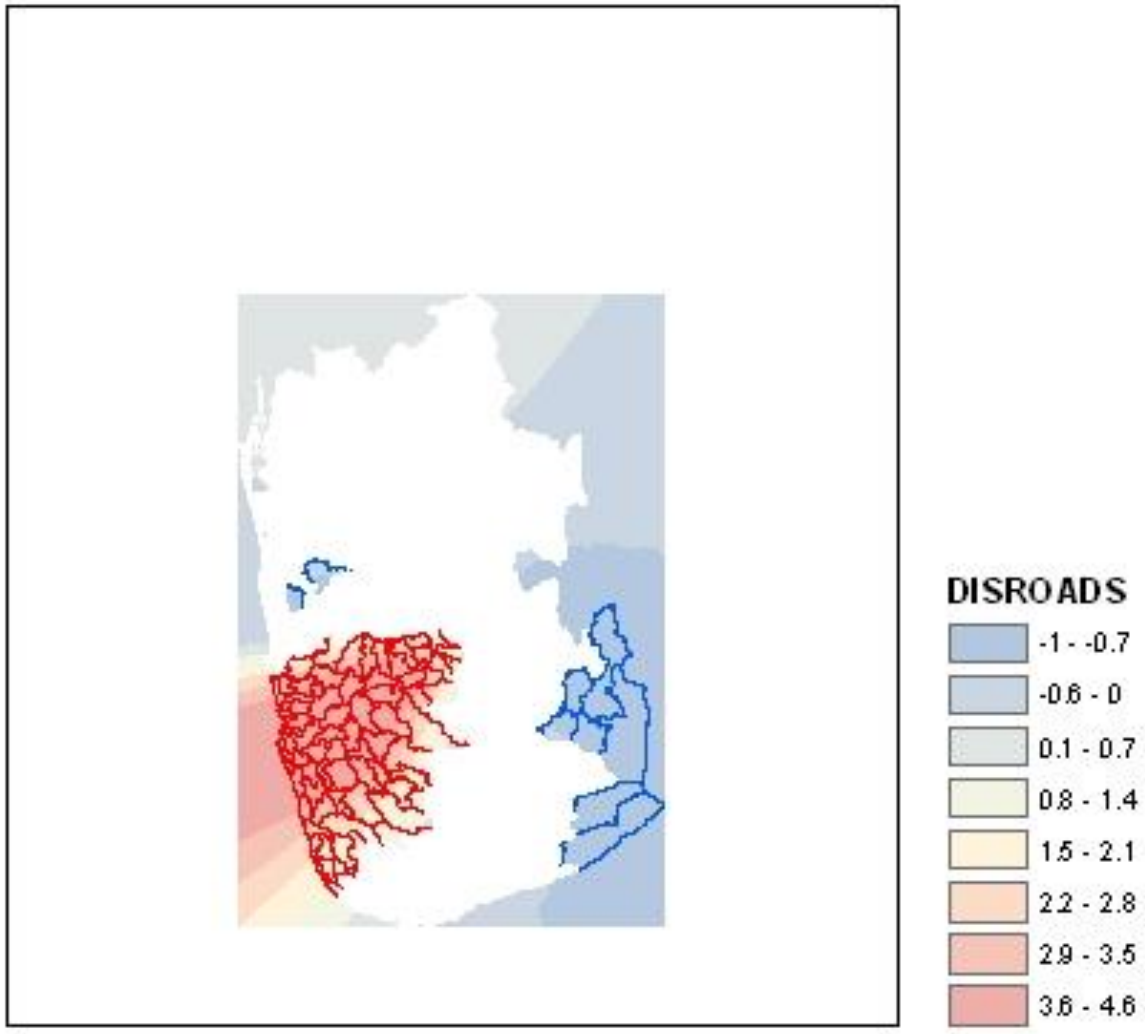


Kriging of bombing load in Vietnam

Geographically Weighted Regressions (GWR) of poverty in Sri Lanka



Effect of distance from Roads



At the end of the raster lab you should be able to

- Identify a DEM (or any raster)
- Process a DEM for
  - Slope, hillshade, etc
- Know what it means to
  - Reclass rasters
  - (optional) Overlay rasters (using the raster calculator)
- Use 3D Analyst to visualize
- (optional) Overlay rasters with vectors
  - Using zonal statistics