RASTER ANALYSIS

Introduction to Raster and Raster Data Model

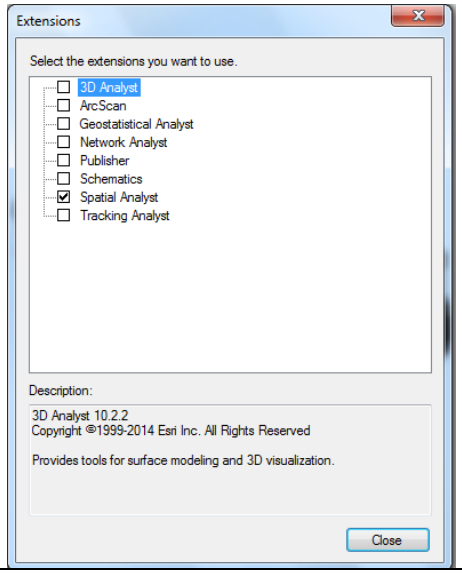
A GIS raster data model is a data set in which square cells of the same size hold numeric values and are representing a geographic area by creating a square or a rectangle grid in which the cells form horizontal (east-west) rows and vertical (north-south) columns.

The structure of the raster and its cells allow for the cell positions to be calculated by knowing the position(x, y coordinates) of one of the raster corners. Raster's data type and data depth are set for the entire raster; it cannot be changed in total or partially. Raster cells can hold only numeric values, either integer or decimal.

Adding a Raster data

- Connect to folder Lecture 8.
- Add the data Raster 1 from the folder.
- To perform raster analysis we will use Arc GIS spatial analyst extension. To activate the extension go to **customize** ⟶ **extension** and check in the spatial analyst option.





Arc GIS Spatial Analyst

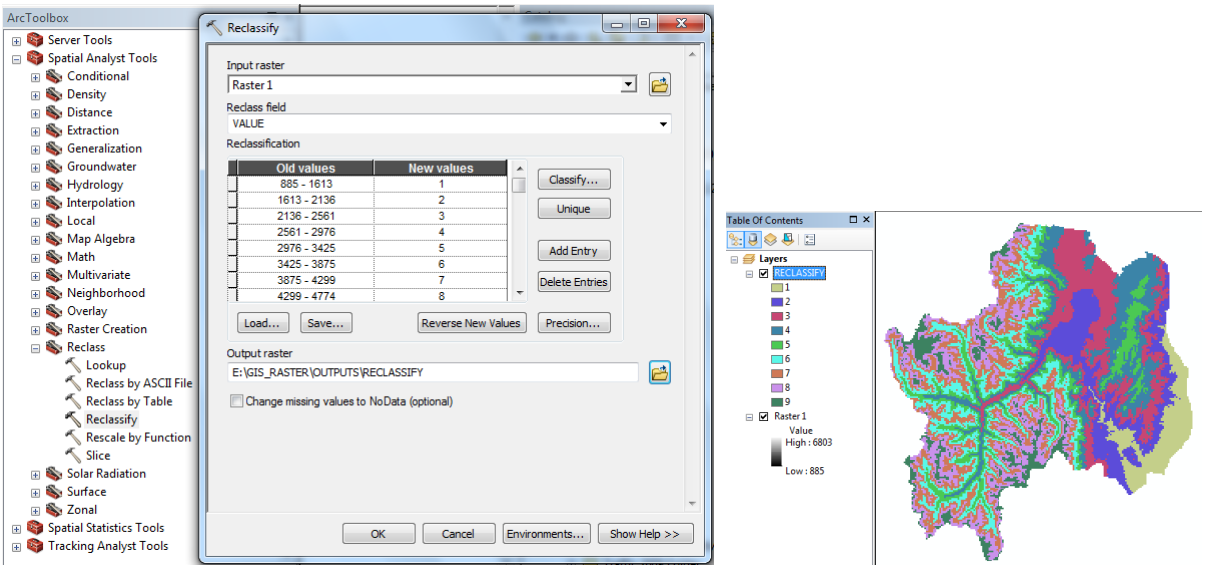
Arc GIS Spatial Analyst allows us to perform tasks such as:

- **Reclassification -** per-cell, single raster, value sorting
- **Surface analysis** – how steep is a location?
- **Surface creation** – a DEM from points.
- **Raster calculation** – helps combine different data (map algerbra)
- **Distance Analysis** – what is the shortest distance between two locations?

Reclassify an Elevation Raster

Reclassification is the process of reassigning a value, arrange of values, or a list of values in a raster to new output values.

- In the Arc toolbox go to spatial analyst tools ⟶ Reclass ⟶ Reclassify. A box will pop up.
- Use Raster 1 as input raster. VALUE field will be automatically selected as Reclass field. Keep the default new values and observe the changes.



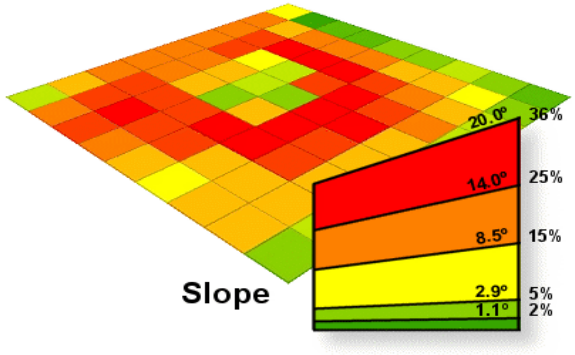
Surface Analysis

Surface Analysis tools derive useful geospatial information from elevation surfaces such as

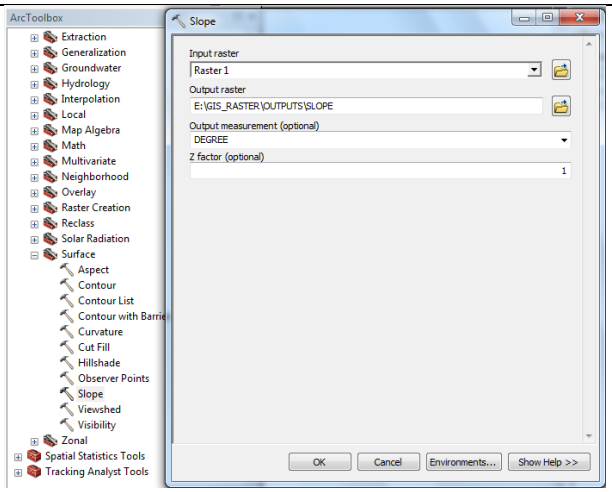
- Slope
- Aspect
- Hillshade
- Viewshed

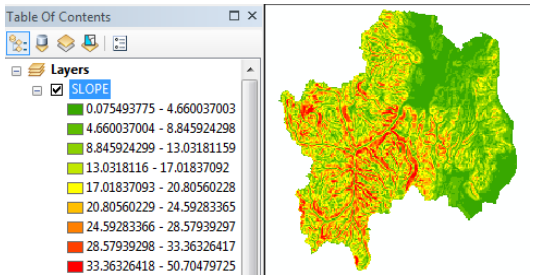
Slope Tool

Slope is a measure of the steepness of a surface and may be expressed in either degrees or percent of slope. Slope tool is used to analyse the angular component of a terrain - Can answer questions like where to build a structure based on the degree of slope. Slopes can be calculated as degree or as percent rise.



- In the Arc toolbox go to spatial analyst tools ⟶ Surface ⟶ Slope. A box will pop up.
- Use Raster 1 as input raster. Keep the default values and observe the changes.

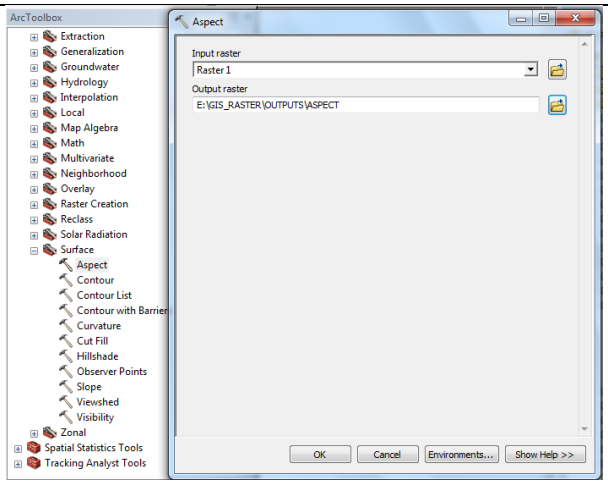


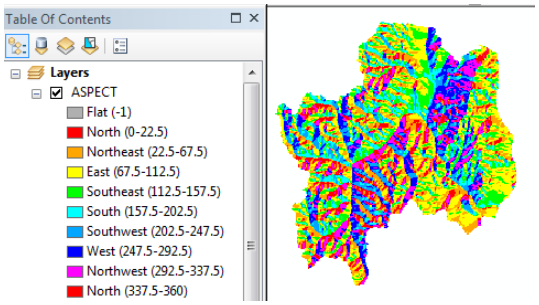


Aspect Tool

Aspect tool helps to identify slope direction or the compass direction a hill faces.

- In the Arc toolbox go to spatial analyst tools⟶ Surface ⟶ Aspect. A box will pop up.
- Use Raster 1 as input raster. Keep the default values and observe the changes.



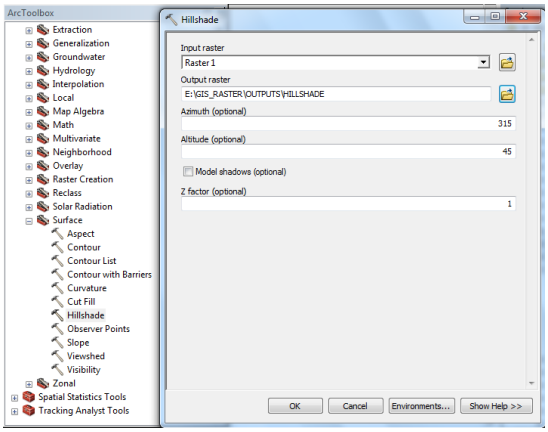


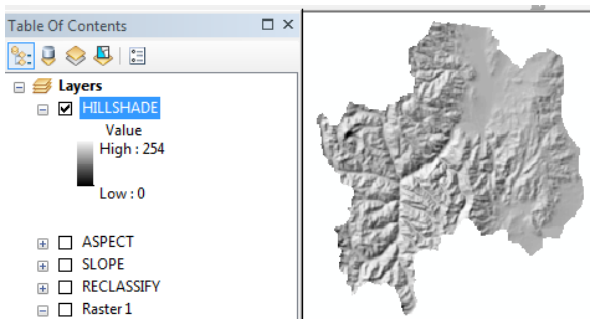
Hillshade Tool

Hillshade is used to determine the Hypothetical illumination of a surface.

For e.g. hillshade can be used to determine the length of time and intensity of the sun in a given location

- In the Arc toolbox go to spatial analyst tools ⟶Surface ⟶ Hillshade. A box will pop up.
- Use Raster 1 as input raster. Keep the default values and observe the changes.





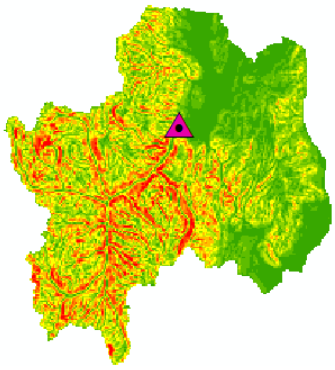
Viewshade Tool

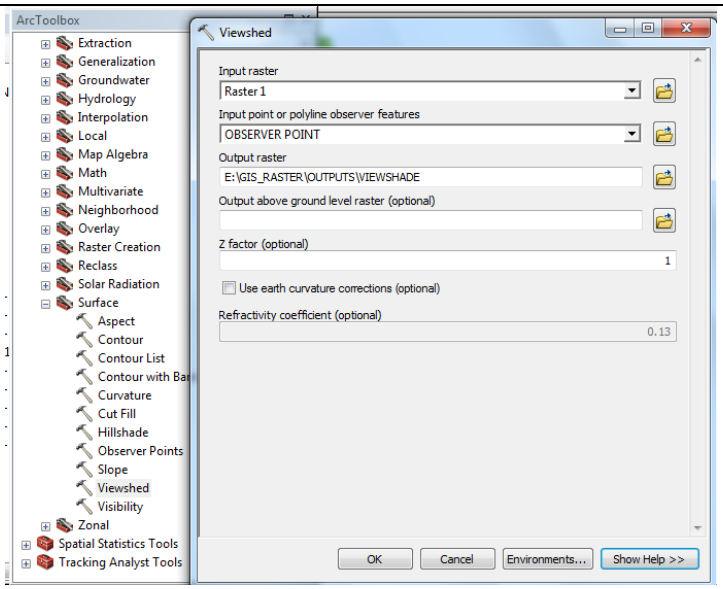
Viewshed identifies the cells in an input raster that can be seen from one or more observation points or lines.

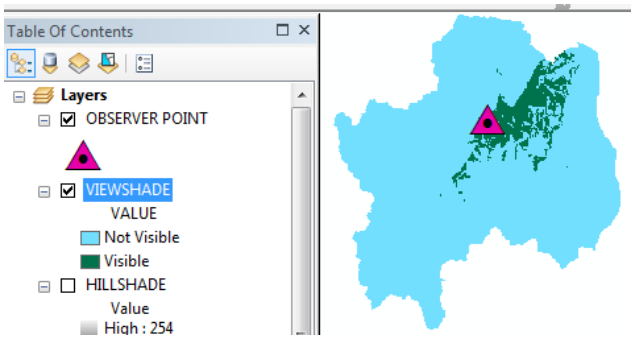
- First create a point feature class to show the location of observer point.
- In the Arc toolbox go to spatial analyst tools ⟶ Surface ⟶ Viewshade. A box will

pop up.

- Use Raster 1 as input raster and observer point feature class as input point or polyline feature class. Keep other default values unchanged and observe the changes.



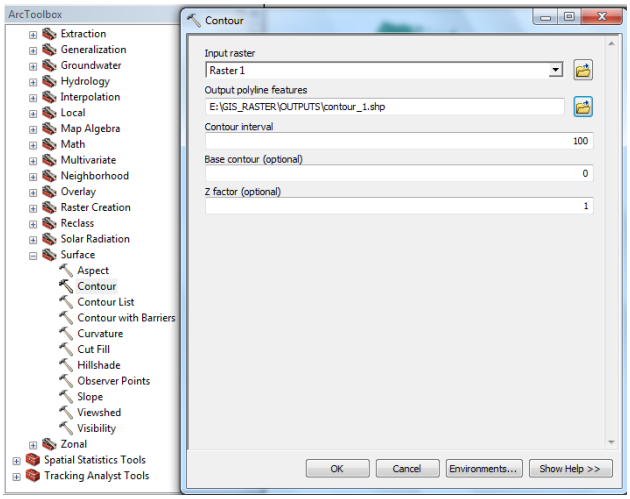




Creating contours

Contour lines can be used to represent surfaces. A contour line is a line following an equal value.

- In the Arc toolbox go to spatial analyst tools ⟶ Surface ⟶ Contour. A box will pop up.
- Use Raster 1 as input raster and assign a contour interval of 100.





Surface Creation

ArcGIS Spatial Analyst includes the following interpolation tools to create a surface from sample data measurements

- **Inverse Distance Weighting (IDW)**
- **Spline**
- **Kriging (Ordinary, Universal)**

Interpolation

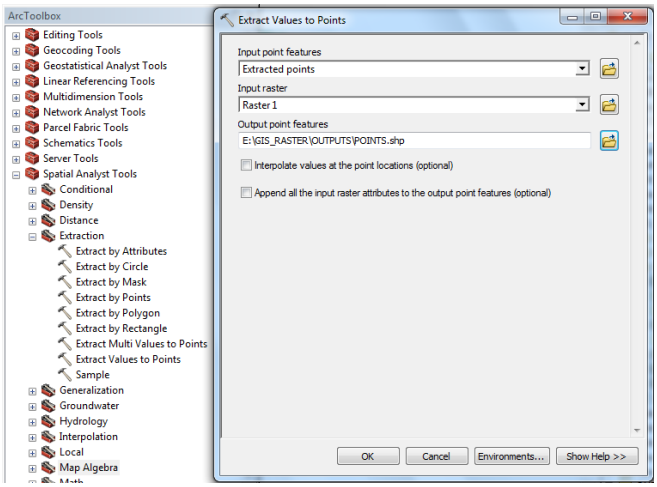
The purpose of interpolation is to produce a continuously varying smooth surface over a region using point values at particular locations as inputs. Surface interpolation is carried out in hydrology for constructing maps of variables, such as **water table elevation**, annual or storm **precipitation**, **air temperature**, and **evaporation**

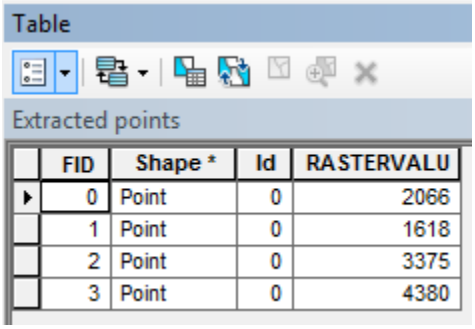
Inverse Distance Weighting (IDW)

Inverse Distance Weighting (IDW) is a method of interpolation that assumes each sample point has a local influence that diminishes with distance. In estimating the value for a given cell, this method gives greater weight to points closer to the cell than to those farther away.

Extract by points

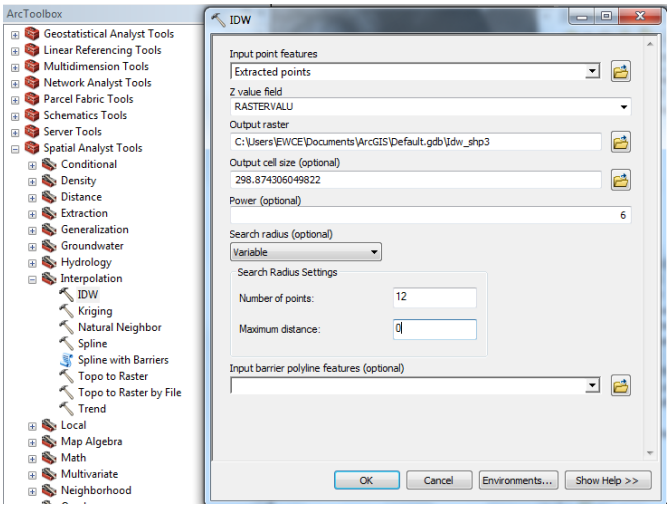
- Create or import point feature.
- In the Arc toolbox go to spatial analyst tools ⟶ Extraction ⟶ Extract values to points
- Use your point feature in input point features and Raster 1 as input raster
- Save the file to your destination folder and click ok.
- Open the attribute table of the extracted point feature class and observe the changes.

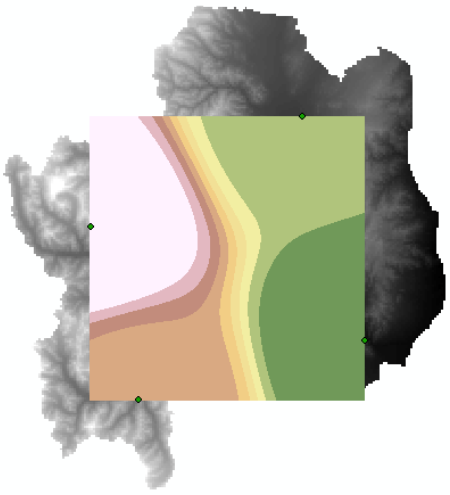




IDW

- In the Arc toolbox go to spatial analyst tools ⟶Interpolation ⟶IDW. A box will pop up.
- Use Extracted points as input point features and keep the following settings.
  Z value field = RASTERVALUE,
  output cell size = default
  power = 6
  search radius = variable
  number of points = 12
  maximum distance = 0
- Change the power value to1 and observe the difference.





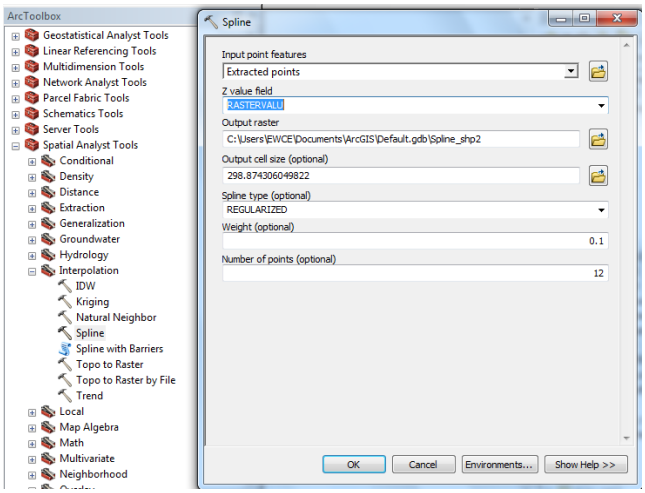
Spline

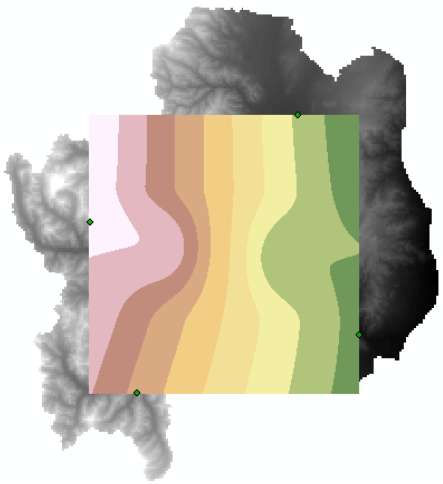
Unlike IDW, which interpolates values from sample points near the processing cell, Spline models surface by forming a mathematical function over the domain.
Spline is intended to fit a minimum-curvature surface to the sample points. The surface passes exactly through the sample points. Because it generates smooth surfaces, the Spline method is best suited **to sample data that varies smoothly**, for instance, **groundwater elevation**. It's not appropriate if there are large changes in value within a short horizontal distance.

There are two types of Spline that can be used to interpolate a surface: **regularised** and **tension.**

- **Regularised Spline** offers a looser fit, but may have overshoots and undershoots.
- **Tension Spline** forces the curve. The weight parameter makes a coarser surface.

- In the Arc toolbox go to spatial analyst tools ⟶ Interpolation ⟶ spline. A box will pop up.
- Use Extracted points as input point features and keep the following settings.
  Z value field = RASTERVALUE,
  output cell size = default
  spline type = REGULARIZED
  keep other default values
- Change the spline type to tension and observe the difference.





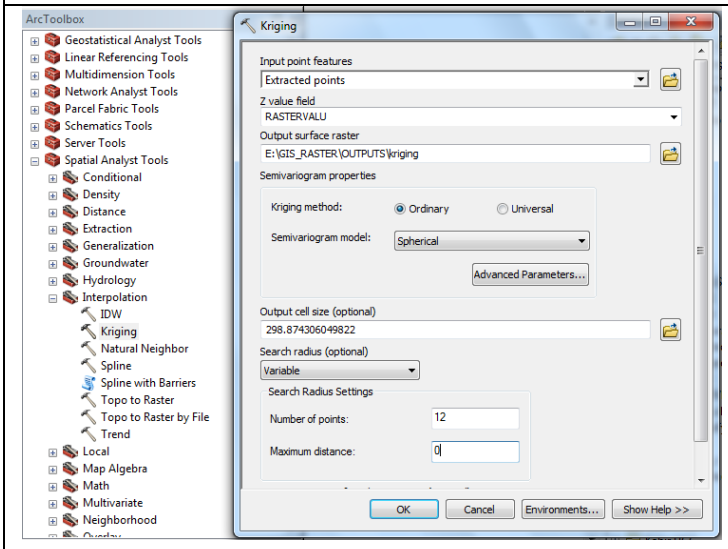
Kriging

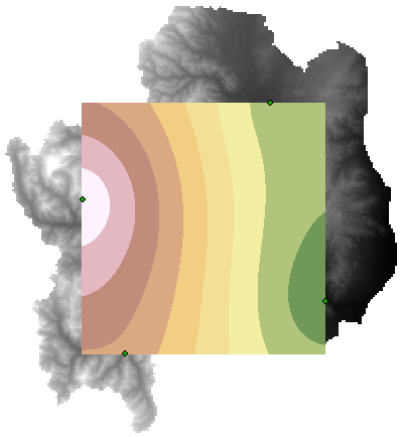
Kriging is based on statistical models that include autocorrelation.
Weights are based on:

- The distance between the measured points and the predicted location and
- The overall spatial arrangement among the points.

- In the Arc toolbox go to spatial analyst tools ⟶ Interpolation ⟶ Kriging. A box will pop up.
- Use Extracted points as input point features and keep the following settings.
  Z value field = RASTERVALUE,
  Kriging method = ordinary
  Semivariogram model = spherical
  Search radius = variable
  number of points = 12
  maximum distance = 0

Change the kriging method to universal and observe the difference





Raster Calculation

Raster Calculation takes any number of data sets and combine them with certain parameters. It is a tool for:

- Map algebra
- Statistics
- Queries

Map Algebra

Map algebra is used to perform spatial analysis using raster data. Map algebra uses expressions that normally return numeric values to an output grid.Map Algebra supports three types of expressions:

- Arithmetic operators (+, -)
- Boolean operators (AND, OR)
- Relational operators (>, <)

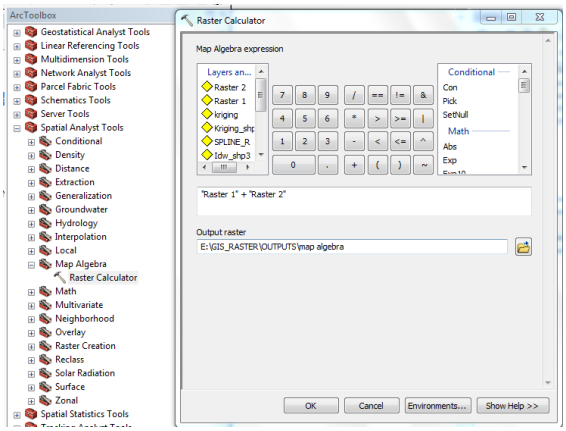
Statistics

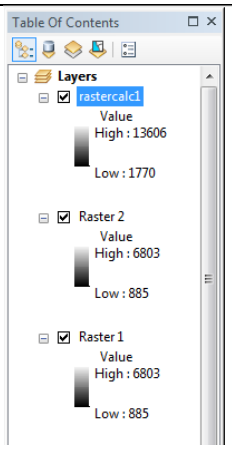
Cell Statistics

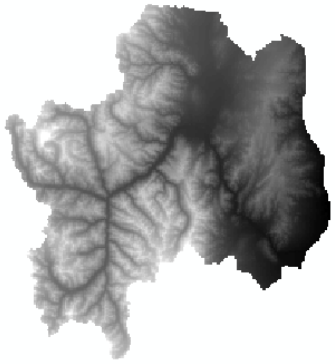
Only use data in a single cell to calculate an output value. Used to analyse a certain phenomenon over time – land use over a period of time.
Two main types of local operation:

- reclassification and
- overlay

- Add raster 2 file from folder Lecture 8
- In the Arc toolbox go to spatial analyst tools ⟶ Map Algebra ⟶ Raster calculator. A box will pop up.
- Write the expression **"Raster 1" + "Raster 2"** save the output raster to your destination folder. Click ok.



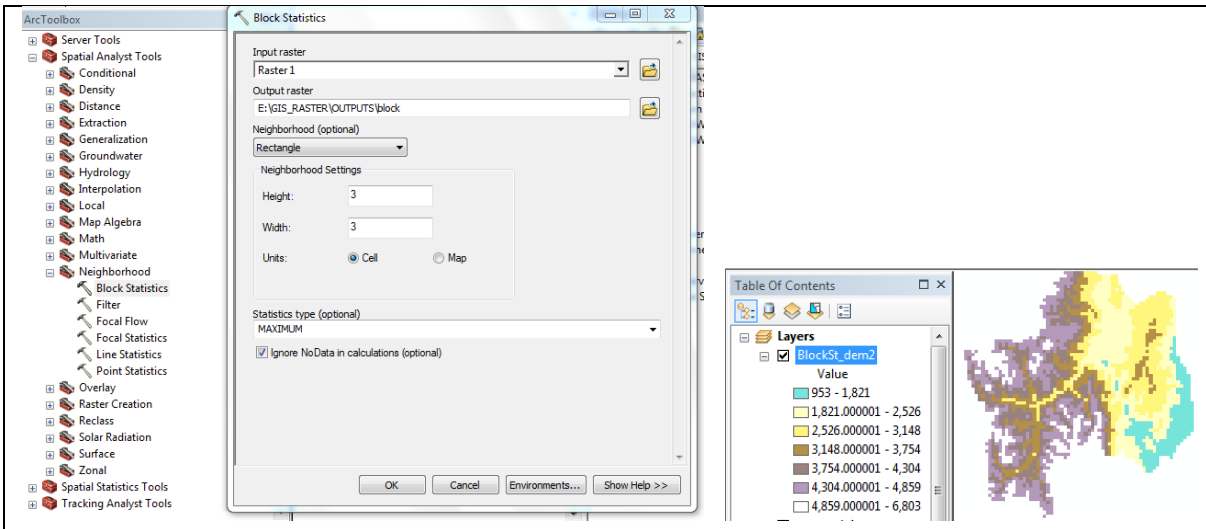




Neighbourhood

It is a function of the input cells in some specified neighbourhood of the location. e.g. variety of different land cover types in each neighbourhood.

- In the Arc toolbox go to spatial analyst tools ⟶ Neighbourhood ⟶ Block Statistics. A box will pop up. Keep the settings as below
  Input raster = Raster 1
  Neighbourhood = Rectangle
  Height =3
  Width = 3
  Units = Cell
  Statistics type = Maximum
- Save the output raster in your destination folder and click ok.



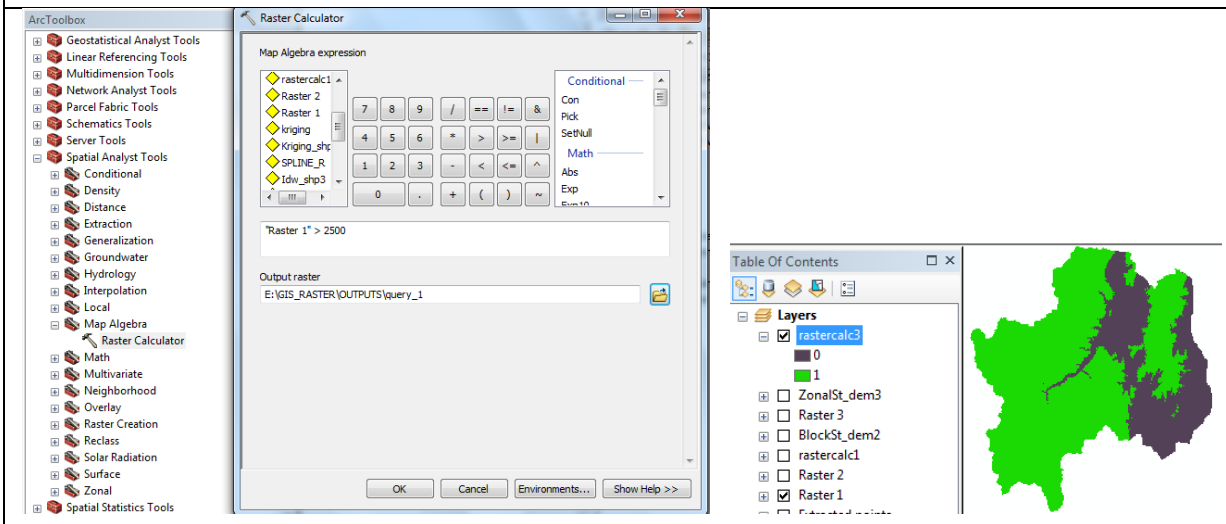
Zonal Statistics

Mainly calculated for each zone,based on values from another dataset. A zone is all the cells in a raster that have the same value. e.g. Rainfall per Borough

Raster Calculation: Query

Find out the palces of elevation > 2500

- In the Arc toolbox go to spatial analyst tools ⟶ Map Algebra ⟶ Raster calculator. A box will pop up.
- Write the expression **"Raster 1" > 2500** save the output raster to your destination folder. Click ok.



Raster Calculation: Distance analysis

a. Straight Line Distance functions (Euclidean)
b. Cost Weighted Distance functions
c. Shortest/least cost distance between

- In the Arc toolbox go to spatial analyst tools ⟶Distance ⟶Euclidean Distance. A box will pop up. Use Raster 1 as input raster. Keep the default settings and click ok.

