GIS Workshop

Elevation Analysis & 3D Visualization

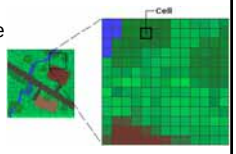
Chieko Maene
c-maene@northwestern.edu
Maps and State Documents Librarian
Government and Geographic Information and Data Services
University Library (Evanston)
Northwestern University

Elevation Analysis

Raster Manipulation & Analysis

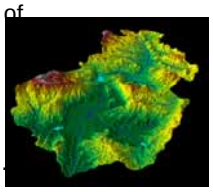
- By the way…
  - In order to conduct advanced raster analysis that involves data manipulation or analysis, you need a special extension, called **Spatial Analyst**

- **Spatial Analyst**
  - A collection of powerful tools to create, analyze, and manipulate raster data
  - If you have a fund to buy only one ArcGIS extension, you should definitely get **Spatial Analyst**



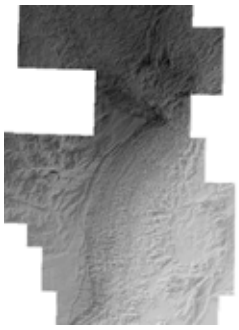
DEM

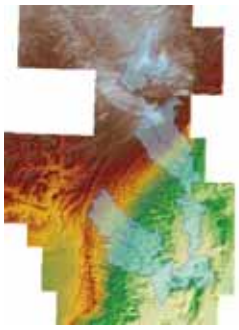
- DEM is a raster representation of continuous surface, consisting of terrain elevation values
- Enable us to examine relationship between spatial objects in vertical
- Available in various resolution…
  - Worldwide : 1km (GTOPO), 90m (NASA SRTM)
  - USA : 90m, 30m, 10m, 3m (USGS)



DEM in 3D Analysis

DEM

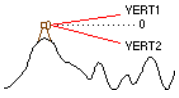




Web source: http://seamless.usgs.gov

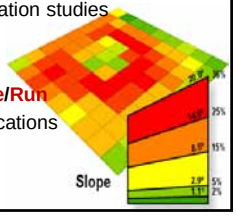
What can we do with DEM ??

- Add meaningful visual effect based on the elevation cell values
  - Hillshading
    - visual 3D effect in 2D space
  - Creating contours
- Or derive new data:
  - Slope
  - Aspect
  - Viewsheds (visibility test – which parts of area are visible or hidden from view from a particular location)



Slope

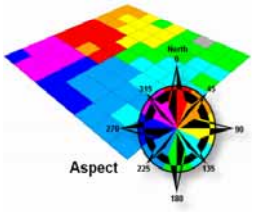
- Slope is a measure of the steepness of a surface and can be expressed in either:
  - Percent of slope
    - **Rise (Elevation difference)/Run (distance)**
    - Commonly used in transportation studies
      - "Caution! 8 % grade ahead!"
  - Degree
    - Or, angle: arctangent of **Rise/Run**
    - Used often in scientific applications



Aspect

- Aspect is the orientation or compass direction of slope
- In ArcGIS, aspect is measured clockwise in degrees from 0 to 360

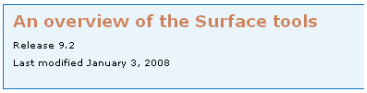
Degree	Orientation
0	North
90	East
180	South
270	West



Just one problem, though -

- DEM is GREAT! ……if your study area is happen to in mountainous or dynamic terrain area, not in flat land..
- Probably not much use in Illinois or Iowa… (Well, you never know -)

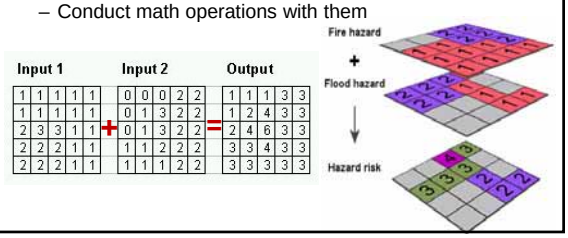
To Learn more…



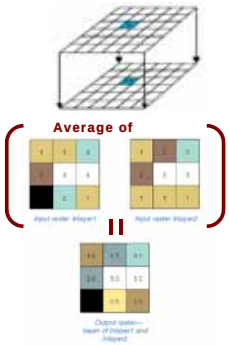
http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=An%20overview%20of%20the%20Surface%20tools

Map Algebra

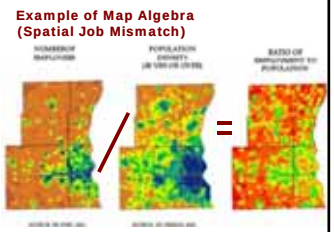
- Conceptualized by Dr. Dana Tomlin (PennState)
- Map Algebra is math applied to rasters
  - Stack up raster like sandwich layers
  - Conduct math operations with them



Raster (Map) Calculator

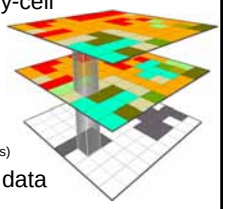


- Arithmetic operators: *, /, -, +



Cell Statistics

- Like **Map Algebra**, consider rasters as a stack of sandwich layers
- **Cell statistics** allow us to compare two or more rasters on a cell-by-cell basis (if they occupy the same location)
- Statistical methods include:
  - Majority – Minority, Maximum – Minimum
  - Range, Mean, Median, SD, Sum
  - Variety (determines the number of different values)
- Useful to compare time-series data



Exercise 14

- This exercise is based on concepts used in the free online lesson, **Plant Distribution: Slope and Aspect** by **Professor Lyn Koller** of **Pierce College**. Her original course material was included in the folder, including her Presentation File (note: her course was designed for the previous version of ArcView, 3.x. Also, some material showed in her PPT seems to be missing from her file.) This course incorporates her lesson concepts and uses GPS plant distribution data collected by her students.
- New data and instruction were also added.
- Except for her GPS data, GIS data files were updated for this workshop. Most files are downloaded from the USGS website, http://seamless.usgs.gov
- **Reference:** ESRI ArcLesson, http://gis.esri.com/industries/education/arclessons/

Exercise 14 : Data

DRG 24K

DEM 30m

DEM 10m

NAIP

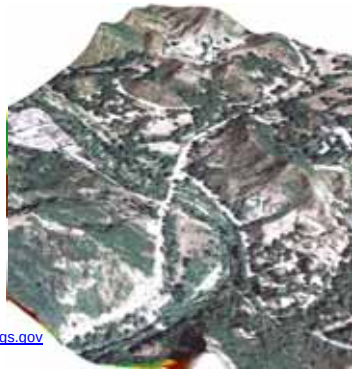
High Reso. Photo 2006

Landcover 1992

Landcover 2001

Composite

Source: http://seamless.usgs.gov



Advanced Raster Analysis (no execersize)

Using multiple raster layers

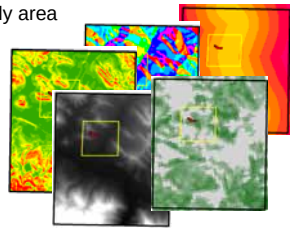
- Some possible analysis examples
  - Sustainability analysis (weighted map algebra model)
  - Regression analysis
  - Classification analysis
- Example – Regression Analysis
  - Make a species distribution prediction map using environmental variables
  - Disclaimer
    - The statistical method, logistic regression, used in the exercise may not be suitable for this study case

Example – Regression Analysis

- Suppose our researchers collected the GPS data thoroughly in the following study area
  - No GPS data means no presence
  - Data will be converted to presence/absence surface data
- Still, we have data limitatio
  - Too few cases
    - Only 28 lilacs
  - Too small study area
    - Hard to generalize

Example - Regression (cont..)

- Let's predict the distribution of lilacs
  - Make a prediction model for a smaller study area
  - Apply it to a larger study area
- Using:
  - Distance from a road
  - Aspect
  - Slope
  - Elevation
  - Canopy/greenness



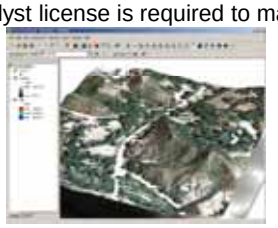
(We won't use climatic or geological data assuming there aren't much difference in the overall study area in a black line)

3D Visualization
with 3D Analyst (ArcScene)

Exercise 15 : 3D Visualization

ArcScene

- 3D Analyst license is required to make a 3D scene



http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=An_overview_of_3D_Analyst