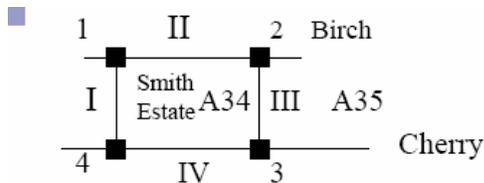# Geographical Information Systems
Vector processing and map overlay
16 APR 07

The objective of this session is to be able to perform basic overlay operations and present the results in map format. Editing of existing vector layers as well as the creation of new ones is discussed. Image registration is also presented.

A. Symbols

Revision exercise: Displaying data in ArcGIS

1. open podepro2007 project (c:\PODEPRO_strudent\vector_exercise). Discuss how symbols are defined.

2. start a new project.

3. add the following layers and assign symbols of your choice.

    a. Settlements

    b. Administrative

      c.   Countries

      d.   Rivers

      e.   Lakes

      f.   Settlements_area

      g.   dem

4. switch to layout view and make a quick map.

5. export in pdf.

6. back in view mode display only countries, settlements (point) and DEM.

7. Do you see any patterns?

B. Map operations and overlay

1. The toolbox

2. Find the area around all settlements within 5 km (point buffer settlements 5 km, dissolve ALL)

3. Find the area around all rivers within 3 km. (linear buffer 3 km, dissolve ALL)

4. Find the area around all settlements_area within 10 km. (polygon buffer 10km, dissolve ALL)

5. Make a list of the settlements (points) that are within 10 km of the settlements_area (polygon).

      a.   Clip settlements with the buffer of settlements_area

      b.   Open the attribute table of the output.

      c.   Notice that you can export (e.g. to excel)

6. Select only the parts of rives within 10km of settlements_area (clip)(AND)

7. Select only the parts of rivers NOT within 10km of settlements_area (erase) (NOT)

8. find the elevation for each settlement. (SA tool->extraction->extract values to points)

9. OPTIONAL: Greece is considering the possibility to extent its territorial sea area to 12 miles from 6 miles currently. Plot a map.

C. Editing

1. creating / modifying points and their attributes (editor->start editing)

2. creating / modifying lines and their attributes

      a.   move nodes

      b.   add segments

      c.   set snapping (editor -> snapping)

3. creating / modifying polygons and their attributes

4. OPTIONAL: Image registration

      a.   Add GYS_DEM.tif

      b.   Notice the use of zoom to layer

      c.   Transformation based on common points called *control points*. Which vector layer should be selected to get the common points? (investigate settlements, rivers, coastline)

      d.   Make sure the georeferencing toolbar is activated.

      e.   Add control points. Remember: First new raster then reference data

      f.   You can add and delete points based on the results. Only 3 points are enough. More sometimes recommended.

      g.   Reset transformation if you are not happy with the results you get.

5.   OPTIONAL: digitize the sea border with between Greece and Turkey in a new line shapefile.

      a.   Notice that digitizing is a sampling process. Different strategies exist. Discuss.

Geographical Information Systems
Raster – map algebra
17 APR 07

Raster processing

In GIS there are two main data structures. The Vector structure is used to represent reality as a set of points, lines and polygons. The Raster structure resembles an image. Pixels, mainly square, are used to represent reality. The two structures have different advantages and disadvantages with respect to storage, modeling efficiency, graphical representation quality and so no. The selection of which of the two to be used is task-dependent. State-of-the-art GIS software currently permits the seamless integration of the two structures. Rasters are made up of a collection of pixels (picture elements) arranged in a grid layout that can be easily referenced by x and y coordinates. Rasters have four characteristic resolutions, namely spatial, radiometric, temporal and spectral.
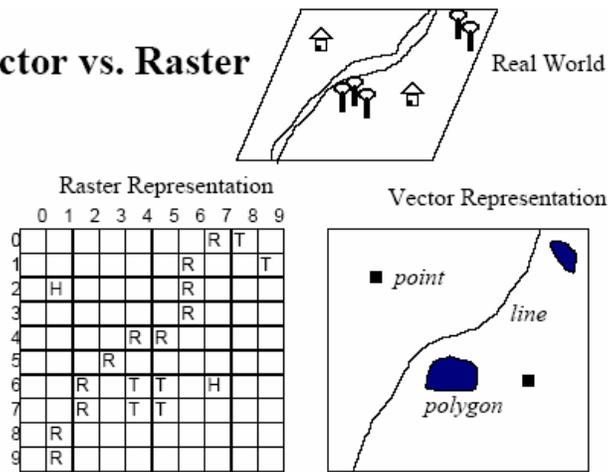
1. Open c:\PODEPRO_student\raster_exersice\global_population.mxd

2. Each raster represents the population at 1 degree cells per decadal. Some of the dates are forecasted estimates.

3. What are the four characteristic dimensions of each population raster?

4. Find the difference of population between 1990 and 2000.

5. open the *Single Output Map Algebra* tool under *Map Algebra* toolbox.

6. type as the expression (can also use browse tool):

   C:\PODEPRO_student\raster_exercise\pop2000 - C:\PODEPRO_student\raster_exercise\pop1990

   Specify as output c:\PODEPRO_student\raster_exercise\diff2000_1990 and run the tool

7. Display the results by selecting a meaningful color schema based on stretched values.

8. Try something based on the temperature metaphor.

9. Comment on which the continent that grows old is. In which areas on the planet is the population increasing?

10. Try a color schema based on classifying the categories.

11. How do we select class intervals.

12. apply popedro_difference_2000_to_1990.lyr This schema has 6 classes, 3 below the mean and 3 above it. The beaks are min, -2stdv, -1stdev, mean, +1stdev, +2stdev, max. What are the advantages and disadvantages of such a classification?

13. Find the average population of all dates be using the MEAN function in *Single Output Map Algebra* tool under the *Map Algebra* toolbox

14. Find the difference of year 2000 to the average.

15. Create a new raster that has the value of 1 if the difference between population 1990 and 2000 is positive and the value of -1 if the difference is negative or zero (CON)

16. Create a new raster than contains the maximum value of each cell for all rasters

17. Create a new raster than contains the median value of each cell for all rasters

18. Calculate the average population value for all population rasters provided (including the forcasted)

19. Calculate the standard deviation of all population rasters provided (including the forecasted) using the known formula $stdev = \sqrt{\dfrac{\sum (x - \overline{x})^2}{(n-1)}}$ where $\overline{X}$ is the mean (average) value and x is each population raster. Note that stdev is also a raster (not a single variable).

20. Make a new raster by resampling values to 0.5 degrees resolution. (resample, 0.5, nearest)

21. Display the resampled raster. Do we actually gain information compared to the original raster?

22. convert the values of pop2015 to a contour file. (contour, 500000). Does this make information clearer?

23. OPTIONAL: Calculate statistics with in pop2000 raster per regions (Zonal statistics as table, zone_filed = LONG_NAME). Open output in Excel and check the population for your country of origin.

24. OPTIONAL presentation of rainfall tests.

Geographical Information Systems
True 3D maps
2007.4.18

The objective of this section is to understand how three-dimensional maps are created, the data sets that are normally required as well as how to create and use them. A practical example on state of the art software is presented.

A.Working with 3D data in 2D

Currently most of the high quality maps in publish and electronic media contain fusion of a Digital Elevation Model (DEM) and shaded relive data.

Practical excessive in ArcGIS, DEM and relief fusion

1. add countries (in c:\PODEPRO_student\3D_exersice\)
2. choose monochrome symbols of your preference.
3. choose unique values according to CNTRY_NAME.
4. choose classified symbols based on population (POP_CNTRY) (quantities -> graduated colors)
5. close the rest and add the global shaded relief (global_shade)
6. add global DEM
7. the fusion of the two is a standard in modern cartography
8. make dem 50% transparent.
9. zoom to include Italy and Greece
10. play with DEMs color and transparency.
11. add counties
12. symbology->show->charts-> bar/column->pop_den. Also remove the color of the outline.
13. where are the most densely populated areas in Europe? (use the identify tool)
14. make a draft map in layout view and export to pdf.
15. OPTION creation of pop_density field.
    Pop_cntr has a -9999 as a flag value
    Calculate field->advanced
    ```
    dim pop as double
    If ( [POP_CNTRY]  < 0) Then
    pop = 0
    Else
    pop = [POP_CNTRY]
    End If

    POP_CNTRY = pop
    ```

    Add field
    Pop_den (float)

    ```
    [POP_CNTRY] / ([SQMI])   TRIC = [POP_CNTRY] / ([SQMI]+1)  because sqmi sometime ~0
    ```

B. DEMS and derivatives.

How is a DEM created?
Can be created mainly from contours or spot heights. Also by means of remote sensing (see http://www2.jpl.nasa.gov/srtm/). Each cell contains the value of the height. Height can be any variable (e.g. population), i.e. does not have to be topographic.

Practical excessive in ArcGIS, how is the relief created?

1. New project
2. Add global dem
3. Zoom to the Alps
4. Tools-options-geoprocessing-environments-general settings – ouputextent-same as display
5. Open hillshade tool (z = 0.001 – output file name relif001)
6. What happens for z = 0.0001?
7. For z = 0.00001?
8. For z = 0.0001 put the sun in the opposite direction.
9. Compare with the original (315 azimuth) what do you see?

10. Why has this happened?
11. For z = 0.0001 put the sun lower to 25 degrees.
12. Compare with original
13. What do you see and why?

C. Working in 3D (arc scene)

1. add countries
2. Symbology – extrusion [pop_den]/1000
3. familiarize with arc scene (explain mainly rotation buttons)
4. Add global dem
5. Symbology use some of the pre-made for DEM.
6. assign base heights from global DEM (z=0.0005)
7. make a population 3D map using pop2000. (you will have to select an appropriate z factor)
8. drape counties on top of your 3D population map. (z factor has to be the same)
9. offset countries based on population density. Base heights -> offset -> [pop_den]
10. offset countries ([pop_den]/1000) on top of a flat countries layer.
11. OPTION Relevant projects: Athens 2004 security, visibility.

D. Familiarization with Arc globe

1. Add pop1990 raster.
2. N.B. layer properties->cache-compress to 16 bit
3. select monochrome pallet of your preference.
4. add countries making fill transparent and outline black.
5. zoom in and out
6. Rotate
7. spin and spin speed.
8. Fly
9. export
10. Symbology->Quantities-> value pop_den, 6 classes.
11. Selection of appropriate class intervals.

F.4D maps

The fourth dimension is time. The objective in normally to make a video file (e.g. spinning globe)

1. Open all population rasters in arcGlobe
2. in pop layer properties -> cache -> compress pixel value range to 16 bits (check this)
3. OPTION: show European space science week avis.
   (see http://agrifish.jrc.it/marsfood/ecmwf.htm)
4. OPTION: What is required to make a global population growth video?

OPTION: presentation of 3D maps (also Le monde)