GIS: Metadata for Grid Interpolation

Summary

The tutorial focuses on the sampling points (weather stations) used for interpolation of a precipitation grid. Students use a weather station dataset for Minnesota. They also look at a U.S. dataset. Metadata defines data used for interpolation.

Materials

AV 3x Spatial Analyst software
data and documents found in wetgrid.zip attached

Background for Teachers

All of these files should be put into a folder called wetgrid, and the wetgrid folder should be placed under c:.
Note: The "states.shp" theme in View1 comes from the normal c:\esri\esridata\usa folder. Other themes and the project (precip_grid.apr) file should be inside the folder called wetgrid. You must have the Spatial Analyst extension to complete the tutorial.
This project looks at precipitation data in two modes: as vector data (weather stations as points) and as grid data (raster cells with each having a precipitation value). Spatial Analyst is an ArcView extension that allows us to create and then to work with grid or raster data. Please see the Word file called cg-Interpolate-precip-grid.rtf for the tutorial about the project.
Main learning goals:

Understand how vector and raster data differ
Appreciate the need to provide metadata about the sample points that are the basis for interpolation of a grid

Instructional Procedures

Spatial Analyst Tutorial -- Grid Interpolation and Masking
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Launch ArcView: Choose Start--Programs--ESRI--ArcView GIS 3.2--ArcView GIS 3.2
From the pull-down menu select File - Open Project and select this path: c:\ wetgrid and then select precip_grid.apr
Check File -- Extensions to see what is in effect. Spatial Analyst should be checked.
Next, simply check what the current working directory is:
File -- Set working directory.
When working with Spatial Analyst and grid files, it's helpful to know this.

U.S. precipitation data in vector form
Start with View-U.S. Climate and spend a few minutes getting acquainted with a weather station data set (the table for the points in the US City Weather Stations theme).

How many weather stations are included in this table?
What two types of climate data are in this table?
Right now, we are interested in visualizing annual precipitation data (the Pyr field).
Highlight the Pyr field title with the select tool. Use the sort field tools to locate the cities with the highest and lowest annual precipitation. Do you see any patterns just by viewing the table?
Close the data table, and open the legend editor for mnmontp.shp. (We downloaded this shape file about mean monthly temperature and precipitation from ESRI.) Change the legend type to Graduated Symbol, and then change the classification field to Pyr. Experiment with a few options:

You can change the symbol color in the bottom right hand corner by double clicking on the dot.
You can change the min and max sizes in the bottom left corner.
Equal interval is usually used as the category method for this type of data.
You might try to change the number of categories.

Notice that you can see how precipitation varies within the U.S. because you have symbolized precipitation data collected at specific weather stations. Where do you suppose these weather stations are located? Are these particular weather stations in small towns, rural areas, or wilderness areas? What places are missing weather stations?

Interpolating a Surface -- Minnesota Weather Stations
This section deals with interpolation (estimation of values for an entire surface of grid cells based on a limited number of sample points).
Turn to the View called Minnesota Weather Stations.
- Important information about how this View is set up: Both themes (weather station points and Minnesota polygon) come "frozen" in UTM 1983 Zone 15 coordinates. Under View -- Properties, we put "map units" as meters and distance units as kilometers, and the View is <u>not</u> projected.
- Make the anprecip_utm.shp theme <u>active</u>. These are MN weather station points. Earlier, we found weather station data in a book called *Minnesota Weather* by Richard A. Keen. The University of Minnesota also provides weather/climate data via website.
- Look briefly at the table for this "point" theme. We'll focus on one field Annual_pre or total annual precipitation in inches.
We'd like to see what happens with INTERPOLATION when you make different decisions.
Go to the top menu and choose: Surface- Interpolate Grid
Output Grid Extent: *Everyone*
Same as Mn_utm.shp
Output Grid Cell Size:
Some students 10000 meters *other students* 1000 meters
These things change automatically after you choose a cell size.
And click OK .
Summary thus far: Output Grid Extent: Same as Mn_utm.shp for everyone.
Cell Size: 10000 or 1000 meters.
In the Interpolate Surface dialogue box
- Leave the Method as IDW (Read more about IDW at end of tutorial.)
- Change the Z Value Field to Annual_pre
- Nearest Neighbors is a good choice.
- Everyone should take the same defaults:
12 for No. of Neighbors and 2 for Power and No Barriers.
- Click OK
At this point, you each will have created a new surface, "sfacex" or Surface from Anprecip_utm.shp.
Look at the properties of this new surface; use Theme -- Properties. NOTE the following especially:
Theme name: Please type in Mnpre01 (short for your first Minnesota precip surface)

- Source:

  _____
- Cellsize:

  _____
- Type:

  _____
- Status:

  _____

Be sure that the Anprecip_utm.shp theme *(original dots)* is the top theme.
Use Legend Editor and Graduated Symbol to classify the annual_pre field so that you have more visual information to evaluate the new surface that you created.
Check the new Mnpre01 (Surface for Anprecip_utm.shp) theme so you can see it.
Use Legend Editor to make sure that the highest values are darkest. Notice the button with arrows that will nicely switch the legend box order!
Use the Identify tool to see what values were assigned to particular cells. Do the cell values make sense in light of the original points? _____
What have we done thus far?

Everyone has used the *same* output extent: Same as Mn_utm.shp
We have *two* cell sizes: 10000 and 1000 meters
Everyone has used the *same* topic or Z-value field: Annual_pre
Everyone has used the *same* method: IDW
Create layouts and JPEG files, name them carefully (here longer names are ok), and be ready to share your results with the rest of the class.
Optional: For comparison, you might do one more Surface -- Interpolate Grid.
Make a new View and Add (rather than Copy) the two necessary themes Mn_utm.shp and Anprecip_utm.shp from C: \wetgrid \
Be sure to keep the same output extent (Mn_utm.shp) and the same Z-value field (Annual_Pre).
Change only one factor among those shown above; for example,
Another cell size (e.g., 5000 or 20000 meters)
OR try a different number of nearest neighbors (e.g., 6 instead of 12)
OR instead of IDW, try Spline.
NOTE your decisions here: _____
For this second precipitation surface, go to Theme -- Properties and put a new Theme name:
Please type in Mnpre02 (short for Minnesota precip surface 2)
Be sure that you know how each precipitation surface was made:
Mnpre02 was made with these decisions: _____

Masking ("Clipping") a Grid - THIS IS OPTIONAL, but interesting!!!!
Now that you have created a precipitation surface, it would be nice to "mask" the rectangular surface so that it only includes the surface within Minnesota's state boundary. Earlier, when we worked with vector files, Geoprocessing Wizard allowed us to "clip," but it does not work on grid surfaces. Therefore, we will use the following masking procedures.
First, we must convert the Minnesota boundary shapefile (Mn_utm.shp) into a grid so we can use this new Minnesota boundary grid as a mask.

Make Mn_utm.shp active.
Click on Theme -- Table so you can quickly look at its table.
Next comes a crucial step!
Theme -- Convert to Grid
Save in c: \windows \temp *shortname (8 characters)* [Carol put cgmnbdry]

Click OK
Output Grid Extent: Same As Mn_utm.shp (the Minnesota boundary)
Output Grid Cell Size: Same As Surface from Anprecip_utm.shp (aka Mnpre01)
Click OK
In the Conversion Field choose Name
Click OK
You may have to WAIT more than a few minutes for this to be completed!!!!! This would be a good time to look at the "extra" pages about Interpolation and also
about Grid Files/Folders.
Join Feature Attributes? Yes
Add Grid as Theme to View? Yes

Take a look at this new grid (created from the vector polygon of Minnesota).

Use Theme -- Properties to check:

Source: _____
Cell size: _____ It's important that this is the same as your Mnpre1.
Type: _____
Status: _____

Use Legend Editor to give a color to the "No Data" category.
Use the Identify tool to check out a few particular cells *(BOTH inside AND outside the Minnesota boundary).*

Next come the procedures that essentially "mask" your precipitation surface.
Make Surface from Annprecip.shp (Mnpre01) the active theme.

- Analysis -- Properties
  Analysis Extent -- Choose Same As Mn_utm.shp
- Analysis Cell Size
  -- Choose Same As Surface from Annprecip.shp (Mnpre1)
- Analysis Mask
  -- Choose the new Minnesota boundary grid that you made. (Carol had called hers cgmnbdry)
  Click OK and proceed to the final step.
- Analysis -- Map Calculator
  In the Layers Box, double click on Surface from Anprecip_utm.shp (or Mnpre01).
  Finally, press the Evaluate box near bottom left.

Yahoo! You should end up with a grid that has colored cells only for Minnesota against a black background. Again, be sure this newest grid is active and use the Identify tool to check cell values both inside and outside the Minnesota boundary.

WARNING -- Before you stop working on this tutorial:
All of the Grids and Surfaces that you have created are temporary files. In order to save them as permanent files, make each grid/surface active and then Theme -- Save Data Set
Navigate to C:\wetgrid AND type a short name (8 characters starting with your initials) (for example, Carol put cgpre01) You can check any theme with Theme -- Properties to check where and how it is saved. Carol had to do something different to "save" the grid that she called cgmnbdry -- the "mask" or grid that showed what was within Minnesota. Carol made cgmnbdry active and then chose Theme -- Convert to Grid and saved it in C: \wetgrid.
A fun thing (if you have time): Make anprecip_utm.shp (MN weather station points) theme

active and then Surface -- Create contours. Choose the annual_pre field.
File -- Save project as in C: \wetgrid with a name starting with your initials.

Conclusions

Compare the "quality" of weather station data sets:

- What is available for the whole U.S. in this tutorial?
- What is available for Minnesota in this tutorial?
- What would happen if we had half as many weather stations for MN?

Compare what results from different interpolation decisions:

- When cell size differs…(10000 vs. 1000)
- When method differs …(IDW vs. Spline)

Your Journal - What did you learn?

- about metadata for an interpolated grid?
- about interpolation?
- about masking?
- about ...?

Bibliography

Authors

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