

THE ENGINEERING HYDROLOGY AND GIS COOKBOOK

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Introduction

Purpose of this Cookbook

This cookbook is intended to help hydrologists to begin using GIS as a tool as quickly as possible. It is written based on the assumptions that it is best to learn by doing and that students' time should not be consumed by having to recall or look up minute details about how to run computer programs. In this cookbook, "recipes" are presented for various hydrologic "casseroles" that can be cooked in ArcView GIS. The recipes give step-by-step directions for the tedious processes of loading data in a GIS (Geographic Information System), manipulating those data and running some other, related computer programs. Hopefully, these pages will help students get to the "fun stuff" painlessly.

Cookbook Format

This cookbook describes how to use numerous programs. Rather than trying to present every step in every recipe, the author has chosen to present recipes as simple step by step procedures, assuming the user already knows how each program is run. Because the author is kind, he has also provided more detailed instructions on how to run each of the programs as Appendixes in the back of this cookbook.

Each recipe begins with a short description of the task at hand and a list of the ingredients (programs and data) needed to accomplish the task. Next, the steps to cook the casserole are presented. Finally, an example or some examples of output from the task are presented. Of course, there are likely several ways to do every task outlined in this report. But try to follow the steps in this report at

least the first time you try each recipe, since the various recipes illustrate particular features or functions of ArcView or the computer programs used in conjunction with ArcView.

It is essential that everyone read Appendix A. Appendix A describes ArcView projects and nomenclature and will help us all speak the same language.

As a further proof of his kindness, the author has assembled the programs and some of the data required to cook the recipes given in this cookbook. They are found on several floppy disks. The programs include:

- the UTMS coordinate transformation program (USGS);
- the GeoEAS geostatistical software (US EPA);
- the USStrm for generating statistics based on USGS stream flow time series data files (Bartrand, Ohio U);
- the dlg2shp.ave ArcView Avenue script for converting USGS Digital Line Graphs (DLGs) to ArcView shape files (share ware, WWW); and
- the centr.ave ArcView Avenue script for calculating the centroid of a polygon in ArcView (share ware, WWW).

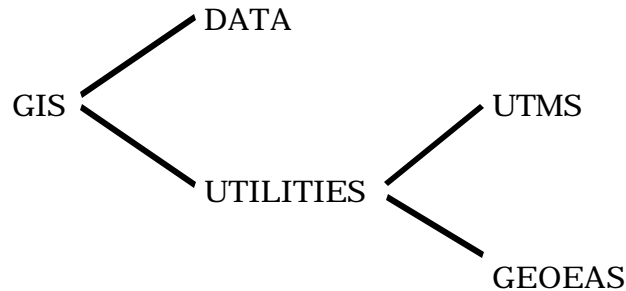
The data include:

- the Scioto River basin (a polygon theme);
- the rivers and lakes in the Scioto River basin (a line theme derived from USGS DLGs)
- a table of the names and locations of precipitation and temperature gaging stations in and near the Scioto River basin.

- data of the political boundaries and population density of Cambodia (from the UNEP/GRID data set [WWW] and for use in the exercise in *Recipe 2*).

A Few Notes Before You Begin

You will be well served to manage your files and data carefully in ArcView. Before you finish you will have amassed many files which will “own” much “real estate” on your computer’s hard drive. First, before you do anything, create a directory on your computer called “GIS.” Then create subdirectories within GIS called “DATA,” “UTILITIES,” “UTMS” and “GeoEAS” with the directory structure shown below.



If more than one user will be performing these exercises on computer, replace the directory name “GIS” with your own name.

When you have created the directories shown above, copy the file `geoeas.zip` from the diskette to the `C:\GIS\UTILITIES\GEOEAS` directory. Copy the file `UTMS.EXE` to the `UTMS` directory. Copy all the other files the `DATA` directory. Your working directory in all the exercises is the `C:\GIS\DATA` directory.

Have fun and make some good science!

Getting to Know View

Recipe 1: Reading a Theme and Making a Map

The first recipe makes a printed map of any country on Earth. It introduces how to get themes into ArcView and how to print your results out. Hopefully you have read Appendix A, so let's go.



Ingredients :

1. ArcView; and
2. The World map that comes as ArcView data.



Steps:

1. **Start a new project.** To do this, start ArcView and choose "New Project" from the "File" pull-down menu. The project window appears on the screen. The words and icons for "View," "Chart," "Table," "Layout" and "Script" are on the left side of the project window.
2. **Make a new view** by choosing the "View" icon from the left side of the project window, then click the "New" button on the top of the project window. A View window appears on the screen. You will likely need to move the view window and resize it to get it out of the way of the project window and make it large enough to see the map you will put in it.
3. From the "View" entry on the menu bar, select "properties." On the window that pops up, **select decimal degrees as the map units and kilometers or miles as the distance units.** Give the view the name "World Map."

4. From the button bar, choose the “**add theme**” button. It looks like a pat of butter with a large + in its middle. If you can’t tell which button is the correct one, look at the bottom of the window as you put the mouse over each button. There should be a brief description of each button.
5. In the window that pops up, **select the world map**. The path to the world maps is c:\esri\esridata\world and the file name is cntry94.shp. After hitting OK an entry will appear on the left side (the legend) of the view window.
6. To **display the world map** you have just put into the view, click on the small gray box found at the upper-left hand corner of the entry that just appeared in the legend. The world should appear in the view window.
7. Next, **zoom-in** on the country you want to isolate. To zoom, click the button that looks like a magnifying glass with a + in the lens. After clicking the zoom tool, go to the view window and click and hold down the left mouse button at the upper left corner where you want to zoom in. Without letting up the mouse button, drag open a rectangle by moving the mouse down and to the right. Let go of the mouse when the box covers the region to which you want to zoom.
8. **Select the country** you want to isolate. Click on the select button from the tool bar. It looks like a rectangle with a small star in one corner. Go to the country you want to map and click once on it. It should turn yellow. You have just “selected” that country.
9. Make the selected country into a shape file by clicking “Theme” from the menu bar and choosing “**Convert to shapefile**” from

the pull-down menu. A window pops up asking for a file name for the new shape file. Specify a new, unique file name for the file in the C:\GIS\DATA directory of the computer. After ArcView writes the new shape file, a window pops onto the screen asking whether you want to add the new shape file to the view. Answer “no.”

10. **Close the view window** containing the world.
11. **Create a new view**. From the project window, click on the “View” icon, then click on the “New” button at the top of the project window. A new view window appears on the screen. Like before, choose “View” from the menu bar and “Properties” from the pull-down menu. Again, give the view an appropriate name (the name of the country you are mapping), make the map units decimal degrees and the distance units either kilometers or miles.
12. Click the **add theme** button (butter pat with a + in the middle) and add your newly-created theme to the view. Click on the small gray box in the legend to display the country map you created. At this point, a map of the country could be printed by selecting “print” from the “file” pull-down menu. But we will use a layout to make the print.
13. **Create a new layout**. To do this, click once on the “Layout” icon on the left side of the project window, then click on the “New” button at the top right of the project window. A new window should appear with the title “Layout1” in the title bar.
14. The button on the far right of the bottom button bar is used next. It probably has a small globe in its center. **Click on that button** and hold it down. A number of other buttons should appear below the button that was clicked. These buttons allow the user

to put a map, a scale bar, a North arrow and other features onto the layout. First, select the button that looks like a 2-D picture of a globe. This button will allow you to show a map (view) on the layout. After clicking the button, move the mouse onto the layout window to where you want the upper-left-hand corner of the map. **Click and hold down the mouse button and drag open a window (down and to the right) enclosing the area where you want the map to appear.** Let go and answer the questions that pop onto the screen. Make sure to specify the proper view name from which to take the map. It should be something like “View2” or whatever name you gave to the view containing the country you are making a map of. After answering all the questions, a map of your country should appear on the layout.

15. Next, **add a North arrow.** Click and hold on the button you used to put the view onto the layout. This time, select the button that looks like a North arrow. Move the mouse onto the layout to the upper left corner of where you want to draw the North arrow. Click the mouse and hold. Drag open a rectangle within which you want the North arrow. If you want to change the position or size of the North arrow (or anything else on the view), select the solid arrow from the button bar, then click on the thing you want to change. After something has been selected like this, four black squares appear at the corners of the object. The object can now be moved around or resized. To move the object, put the mouse in the center of the selected object. It should look like a four-headed arrow. When you see the four-headed arrow, click and hold the mouse down. Move the mouse to move the object.

16. **Add a scale bar.** To do this, click and hold on the button you used in steps 14 and 15. This time, select the button that looks like a scale bar. Again, put the mouse on the upper left corner of the location on the layout where you want the scale bar, click and drag open a box in which you want the scale bar. Answer the ensuing questions, making sure to choose the view with the country in it as the view from which you are taking the scale. The author routinely misses this step. If you do, the scale bar pops up saying “empty scale bar.” To correct it, select the scale bar by clicking on the solid arrow on the button bar, then clicking on the scale bar with the mouse. Next, from the “Graphics” pull-down menu (from the menu bar) choose “Properties.” This will give you a second chance at getting the properties correct.

17. Finally, add any text you want to the layout. **Click the “T” button on the button bar, move the mouse to where you want the text and click.** A box pops up, into which you type the text you want to appear on the layout. when finished typing, click the “OK” button.

18. To change text properties, select “Symbols Window” from the “Windows” pull-down menu on the menu bar. A window pops onto the screen. That window will allow you to change the color, size and appearance of almost everything on the screen. Objects must be selected before they can be modified. To select objects, click on the solid arrow on the lower button bar, then click on the object that you want to modify. To change text font or size, select text, then click on the button in the symbols that has ABC on it and select the font and size you want. The color, line thickness and other properties of the text can also be changed.

19. Print the map using the “Print” command in the “File” pull-down menu.

Figure 1 (on the following page) shows a map of Cameroon created following the steps above.

Recipe 2: Creating a Population Density Map

The next recipe demonstrates how ArcView can display the attributes of a data set. In this recipe you will use data from a UNEP (United Nations Environmental Programme) GRID data set which was downloaded from the WWW and converted to an ArcView shape file. You should have copied the files cambodia.shp, cambodia.shx and cambodia.dbf from the diskette accompanying this report to the C:\GIS\DATA directory.



Ingredients:

1. ArcView; and
2. The data files cambodia.shp, cambodia.shx and cambodia.dbf.



Steps:

- 1. Start a new project.**
- 2. Create a new view.** Make the properties: map units of decimal degrees, distance units of kilometers and name “Cambodia.”
- 3. Add the theme Cambodia.shp.**
- 4. Display the map of Cambodia** by clicking on the small gray box found at the upper-left hand corner of the entry that just appeared in the legend. The districts of Cambodia should appear in the view window. The political divisions in Cambodia are provinces, districts, communes and villages. The map in the view shows Cambodia’s districts. It could be modified to show provinces.

5. **Double-click on the word “cambodia.shp”** in the legend to bring up the legend editor window.
6. **Change the type of display of the Cambodia districts theme.** To do this, find the line in the legend editor that gives legend type. It should have the words “Unique Value” in the white box given legend type. Change this “Graduated Color” by clicking on the downward arrow at the right of the box and clicking on “Graduated Color.” The entries for the legend (shown below in the legend editor) should change.
7. **Select population as the value** that will show up on the map. To do this, go to the “Classification Field” entry on the legend editor, click on the down-arrow at the right of that entry and scroll down to the field called “popest95.” Now the color of each district is determined by the 1995 population estimate.
8. **Convert population to population density.** To accomplish this, go to the box in the legend editor that says “Normalize by” and scroll down to the entry “Area” and click on it. Now the color of each district will correspond to the 1995 population estimate divided by the district’s area.
9. **Change the classification.** You probably want to change the way the data are classified. To do this, click on the “Classify” button to the right of the legend editor. A window pops up. In this window, change the number of intervals to some number larger than 5 (15 looks pretty good here). Also, replace “Natural Breaks” in the box at the top of the window to “Equal Areas.” Finally, at the bottom, change the classification display from d.ddd (or whatever it currently is) to something like dd,dddd. This will make the numbers shown in the legend easier to see and interpret. Click OK when all these steps are complete.

10. **Change the colors of the districts.** This is the step that the artistic among you have been waiting for. At the bottom of the legend editor (which should still be on the screen) is the color scheme box. It likely has the words “Red Monochromatic” in it. Click on the down-arrow to the right of the box and scroll to the color scheme you want. There are no wrong answers here. When you are happy with the color scheme, click the “Apply” button in the lower right corner of the legend editor window.
11. **Create a new Layout** (with the “New” button in the upper right corner of the project window).
12. **Add the map of Cambodia to the layout** via the button that looks like a 2-D picture of a globe. After clicking the button, move the mouse onto the layout window to where you want the upper-left-hand corner of the map. Click and hold down the mouse button and drag open a window (down and to the right) enclosing the area where you want the map to appear. Let go and answer the questions that pop onto the screen.
13. **Add a North arrow.**
14. **Add a scale bar.**
15. Finally, **add any text you want to the layout.**
- 16. Print the map**

Your resulting layout should look something like the one shown in Figure 2.

Showing Gage Locations in ArcView

Recipe 3: Creating a Table of Gage Locations

The following steps yield a table of stream flow gauging station locations in the UTM (Universal Transverse Mercator) projection. Following these steps yields a table like Table 1. The location and names of the gaging stations can be found at the top of USGS on-line stream flow data files, which can be found the world wide web (WWW) at the URL <http://usgs.gov> ...

Ingredients:

1. USGS stream flow gaging station data files
2. Coordinate conversion routine UTMS.EXE (DOS executable)
3. ArcView

Steps:

1. **Download historic stream flow data** for each gaging station in the Scioto Basin.
2. **Read and record the geographic coordinates** (in latitude/longitude, degrees, minutes, seconds) from the header information at the top of the historic stream flow record data file.
3. **Run the UTMS program** to convert latitude and longitude to Universal Transverse Mercator (UTM) coordinates. See Appendix B for a detailed description of using UTMS).

4. **Start ArcView** and **create a new project** called “Scioto.apr.” see Appendix A and recipe 1 for a detailed description of ArcView projects and how to make new projects.
5. **Create a new table** by activating the “Tables” icon on the project window and clicking the “New” button at the top of the project window. A table appears on the screen.
6. **Change the table name** to “streamg.dbf” by selecting “Properties” from the Table pull-down on the menu bar and editing the “Name” field in the box that pops up. Click “OK” when finished.
7. **Start editing the table** by choosing “Start Editing” from the “Table” pull-down menu.
8. **Add a field for the station name** by selecting “Add Field” from the “edit” pull-down menu. Fields are columns of data and Records are rows of data. Give the field the name “Station,” set the data type to “string” and set the width equal to 24 characters. Click “OK”
9. **Add the fields “Easting” and “Northing”** in the same way the “Station field was added. Select “Number” for their data type and 1 for the number of decimal places. When you finish there should be three columns on your table with the labels “station,” “Easting” and “Northing.”
10. **Select “Add Record” from the “Edit” pull-down menu.** A row appears on your table.
11. **Enter the data into the table** as follows. On the tool bar, there are three buttons to the far right. Click the middle button (the “Change cell values” button). Next, click in the “station” field

and **type the name** of the first gaging station. **Tab** to the “Easting” field **and type the Easting value** from the output of the UTMS program (step 2). Likewise, **tab** to the “Northing” and **enter the appropriate Northing**. Repeat steps 9 and 10 until you have entered all the gaging station names and coordinates.

12. **Save your edits and stop editing** by selecting “Stop Editing” from the “Edit” pull-down menu and answering “Yes” when ArcView asks whether you want to save your edits.

Your table should look like the one found below in Table 1.

| <i>Station</i> | <i>Easting</i> | <i>Northing</i> |
|--------------------------|----------------|-----------------|
| Scioto R. nr Prospect | 313591.0 | 4476631.2 |
| Mill Cr. nr Bellep. | 315104.0 | 4457587.3 |
| Scioto R. nr Dublin | 319362.0 | 4445821.6 |
| Olentangy R. @ Clari. | 331675.8 | 4494344.1 |
| Olentangy R. nr Dela. | 324453.5 | 4469211.0 |
| Scioto R. @ Columbus | 328265.5 | 4419638.8 |
| B. Walnut Cr @ C. Col. | 339406.5 | 4440958.4 |
| Alum Cr @ Africa | 332877.6 | 4449953.4 |
| Alum Cr @ Columbus | 334168.8 | 4423456.7 |
| B. Walnut Cr @ Rees | 332577.4 | 4413681.8 |
| B. Darby Cr @ Darbyville | 319075.3 | 4396651.5 |
| Deer Cr. nr Pancoast. | 310043.9 | 4387984.0 |
| Deer Cr. @ Williamsport | 317702.4 | 4383942.9 |
| Scioto R. @ Chillicothe | 330134.6 | 4356514.7 |
| Paint Cr nr Bainbr. | 297270.3 | 4347397.4 |
| Rocky Fork nr Bar. Mill | 294054.9 | 4343717.4 |
| Paint Cr nr Bourneville | 313049.8 | 4348268.5 |
| Scioto R. @ Higby | 339080.1 | 4341982.6 |

Recipe 4: Adding the Event Theme to a View



Ingredients:

1. ArcView
2. A database file (streamg.dbf) of stream flow gaging station names and coordinates (from *Recipe 3*).



Steps:

Note: you don't need to do perform the first four steps if you are continuing directly from *Recipe 3*. The first four steps are for adding event themes for tables that were created outside ArcView and are not currently part of your project.

1. **Activate the project window** by clicking on the title bar.
2. **Activate "Tables"** by clicking on the Table icon on the left side of the project window.
3. **Select the "Add" button** at the top of the project window.
4. **Navigate to the directory** where you database table is and **select the file** you wish to add. Note that the file must have a dBase format and must have the extension ".dbf". A table with columns of numbers and field headings should appear on the screen. Close the table window.
5. **Create a new view** by activating the project window and double-clicking the "View" icon. A new view window appears on your screen. You can move the view and resize it in the usual fashion. For now, don't block the project window with the view.

6. **Set the view properties** by choosing “properties” from the “View” pull-down menu. Give the view the same “Scioto Basin Streams,” set the map units to meters (since the you are using the UTM projection) and set the distance units to kilometers. Click “OK.” The title on the title bar of your view window should change.
7. **Add the event theme** by selecting “Add Event Theme” from the “View” pull-down menu. Specify “Easting” as the x-coordinate and “Northing” as the y-coordinate then click “OK.” An entry with the name “Streamg.dbf” and a colored marker appears in the legend at the left of your view window.
8. **Display the theme** by clicking on the small gray box in the upper left corner of the legend entry for streamg.dbf. Markers of stream gage locations appear in the view.
9. **Make the stream gage theme active** by clicking on the entry for the theme in the legend. The entry for the stream gage theme will appear shaded if it is selected.
10. **Identify a gaging station** by clicking the “information” button on the button bar then clicking directly on one of the markers in the view. A table giving the gaging station name and coordinates should appear. The information button is marked with an “i” in a black circle. Close the query window once you have identified several gages. This step will not work until the stream gage theme is active.

Recipe 5: Making a Map Showing Gage Locations

In this recipe, the ArcView Layouts function is used to generate a map of the stream flow gaging stations in the Scioto River basin suitable for putting in a report.



Ingredients:

1. ArcView
2. Streamg.dbf (the stream flow gaging station event theme from *Recipe 4*)
3. Scioto_Basin.shp (a polygon theme (shape file) of the Scioto River basin found in the C:\GIS\DATA folder on your hard drive)
4. Scioto_River.shp (a line theme (shape file) of hydrography in the Scioto River found in the C:\GIS\DATA folder on your hard drive)



Steps

If you have not already done so, copy the data files from the diskette accompanying this report to the C:\GIS\DATA directory, as described in the introduction section of this report.

1. Complete all the steps in *Recipe 4*. Make sure the Scioto Basin view window is the active window.
2. **Add the Scioto Basin polygon theme** to the view by either selecting “Add Theme” from the View pull-down menu or clicking on the add theme button (which looks like a pat of butter with a large “+” sign in its center). After you select to

“add theme” a window appears in which you must specify the appropriate directory and file name. Navigate to the C:\GIS\DATA directory and select the file Scioto_Basin.shp. A new entry appears in the theme legend in your Scioto Basin view window.

3. **Display the basin** by clicking on the small gray box in the upper left corner of the new entry. The basin should appear in your window. The basin will likely not all fit within the window. To change what is in the window, click the “zoom to the extent of all themes” button that looks like a stack of papers. The whole basin should now be in the view.
4. **Change the order of the themes** by clicking on the “Scioto_basin.shp” theme without letting up the mouse button and pulling the legend entry below the stream flow gaging station theme. This should move the “Scioto_basin.shp” entry below the Streamg.dbf” entry and your gaging stations should now be visible in the view.
5. **Edit the Basin’s properties** by selecting “Properties” from the “Theme” pull-down menu. Change the theme name from “Scioto_basin.shp” to “Basin Boundary.” Click “OK”
6. **Change the way the basin is displayed.** Double click on the legend entry for “Basin boundary.” Don’t click on the check-marked box the controls whether or not the theme is displayed. A legend editor window should appear on your screen. A diagram of the legend editor (with the various parts labeled) is found in Appendix A. **Double click on the symbol for the boundary.** The symbols window appears. A diagram of the symbol window is found in Appendix A. **Click the color palette button** and give the “no color” to the basin. Now only the basin

boundary will appear in the view. Also, **change the outline thickness from 0.1 to 1** (using the window at the bottom of the symbol window). After changing the color and line size of the basin, close the symbol window and click the “Apply” button at the bottom right of the legend editor window.

- 7. Change the way the rivers are displayed** by double clicking on the legend entry for the rivers and following a procedure similar to that in step 6. Make the rivers blue and make the line size 0.5. Also, **change the name of the theme to “Rivers and Streams”** choosing properties from the “Theme” pull-down menu.
- 8. Change the way the stream flow gaging stations are displayed** by double clicking the stream gages theme in the legend of the view and changing the marker shape, size and color.
- 9. Create a new layout** as you have in the past several recipes. As before, **add the map, a legend, a scale bar and relevant text** to the layout and print it.

The result should look like Figure 3.

Importing and Using GeoEAS data in ArcView

Recipe 6: Getting GeoEAS output into ArcView

Appendix C gives a blow-by-blow account of how to run GeoEAS. For this recipe, the output from GeoEAS is used as input to ArcView. Before attempting the steps below, run GeoEAS to produce a file named “stream.grd” containing Krige values for stream flow water equivalent depth over the Scioto basin. Note that the grid used in GeoEAS must cover the entire basin and that stream flow water equivalent depths are assigned to the centroid of the area which drains to each stream gage.

The GeoEAS output file stream.grd is in ASCII format and consists of header lines followed by columns of Eastings, Northings, stream flow water equivalent depths and Kriging errors. ArcView requires a dBase IV format file whose contents are column labels (Easting, Northing, Stream flow and Error) and columns of data. The first several steps in Recipe 6 tell how to convert the ASCII GeoEAS output to dBase format using the Excel spreadsheet program.



Ingredients:

1. GeoEAS
2. Microsoft Excel
3. GeoEAS output file stream.grd
4. ArcView



Steps:

1. **Open the file stream.grd** in Microsoft Excel. When Excel asks what type of delimiters to use in importing the file, select spaces (not tabs).
2. **Remove all rows except the four columns of data** giving Easting, Northing, Stream Flow Water Equivalent Depth and Kriging Error. You may also need to remove the first column of data, depending on how you opened the file.
3. **Add the column labels:** “Easting,” “Northing,” “Stream” and “Error” in a row immediately above the columns of data. To do this, open a new row above the columns of data and type the appropriate names in the cells above the data.
4. **Change the number formats** of the Easting and Northing columns so that two decimal places are shown and change the formats of the other two columns so that three decimal places are shown.
5. Select “Save As” from the File pull-down menu **and save the file as a dBase IV data base file**. The file should have a name like stream.dbf and should be saved in the C:\GIS\DATA directory. The “.dbf” extension must be used. Exit Excel when finished.
6. **Make a new project** called stream.apr in ArcView.
7. **Add the table “stream.dbf” to the project** by clicking on the “Tables” icon in the project window and clicking the “Add” button at the top of the project window.

8. **Make a new view** called “Kriged Stream flow Water Equivalent Depth.”
9. **Add the theme “Scioto_basin.shp”** to the view.
10. **Add an event theme** by selecting “Add Event Theme” from the View pull-down menu. Add the theme “stream.dbf” that you created in step 5 (in Microsoft Excel).
11. **Display the theme** by clicking on the small gray box in the legend entry. The theme should appear as a grid of points covering the entire Scioto River basin.
12. **Change the theme’s display** by double-clicking the “stream.dbf” entry in the view legend, changing “unique value” to “graduated color” and choosing a color scheme. Click the “Apply” button on the lower right corner of the legend editor.

A layout showing the resulting image is found in Figure 4

Recipe 7: Converting the Event Theme to a Grid

We're nearly to some "real hydrology" in ArcView. But first, the vector-format event theme from *Recipe 6* must be converted to a raster-format grid theme. In ArcView, raster themes are called grids. Each grid you create lives in a folder on your hard drive. To work with grid themes, the spatial analyst extensions must be loaded in ArcView. This recipe should be "cooked" immediately after *Recipe 6*.



Ingredients:

1. ArcView with the spatial analyst extensions
2. The file "Stream.grd" used in *Recipe 6*



Steps:

1. **Make sure the spatial analyst extension is turned on** by clicking on the project window title bar (to activate the project window), selecting "Extensions" from the "File" pull-down menu and making certain the "Spatial Analyst" box is checked. If it isn't, check it by clicking it with your mouse. Also, make certain the working directory is set to C:\GIS\DATA. Use the "File" pull-down menu and the "Set Working Directory" entry to do this.
2. **Make certain the "stream.dbf" theme is active** in the legend of the view by clicking it. An outline should appear around the theme if it is active.
3. **Select "Interpolate" from the Analysis pull-down menu.**

4. **Answer the questions that appear** by selecting stream as the field to interpolate and using a spline interpolation with a tension of 0.1. 500 m is a suitable size for grid cells. After you click “OK, ”a new theme appears showing contours of stream flow water equivalent depth.
5. **Add the theme “Scioto_basin.shp” to the view.**
6. **Make the interpolation surface into a grid.** Select “Convert to grid” from the “Theme” pull-down menu and specify the name “Stream” for the grid name and the directory C:\GIS\DATA for the directory. There is debate among the current civil engineering graduate students about the necessity of this step. Select a cell size of 500 m and make the extent of the grid the same as Scioto_basin.shp.
7. **Convert the Scioto_basin theme to a grid** by activating the theme (clicking it) and selecting “convert to grid” from the “theme” pull-down menu. Give the new grid the name “basin” and place it in the C:\GIS\DATA directory. Choose the same cell size and grid extent as for the Streams grid.
8. Exit or minimize ArcView and look at the C:\GIS\DATA directory using the Windows Explorer (File Manager). Notice that there are two new directories called “Stream” and “Basin” in the directory.

Recipe 8: Map Algebra

The final recipe in this report demonstrates use of map algebra functions of ArcView. This is officially the “fun stuff.” The result is a good looking map. Start this recipe with a completely new project, so you can learn how to add an existing grid theme to a project.



Ingredients:

1. ArcView with the spatial analyst extensions
2. Scioto_Basin.shp
3. The “Streams” grid from *Recipe 7*
4. The “Basin” grid from *Recipe 7*



Steps:

1. Make a new project called “streams.apr” and make a new grid called “Scioto Basin Streamflow” with map units of meters and distance units of kilometers.
2. **Add the Basin grid theme and the streams grid theme you created in *Recipe 7*.** This is done by clicking the add theme (butter pat with a +) button, then, for the data type (in the lower-left corner of the box that appears) select “grid data source.” The data type is likely “Feature data source” when the window first pops up. Navigate to the C:\GIS\DATA directory and you should see the two grid themes you want. Highlight them both (click one of them, then hold the shift key and click the other) and hit the “OK” button.

- 3. Add the Scioto_basin.shp theme, too.** Note that its data type is “Feature data source.” Move the Scioto_basin.shp theme above the other two themes and display all the themes
- 4. Select “Map Calculator” from the “Analysis” pull-down menu.** There is a list of grid themes at the upper-left of the calculator that appears and some operators next to them. Double click on the “Streams” grid. Single-click the multiplication operator (*) and then double-click the “Basin” grid. Finally, click the “Evaluate” button at the bottom of the calculator. A new grid appears in your view. Each attribute of each cell in the new grid is the product of the attributes of the cells from the basin and streams grids. In the basin grid, any cell lying inside the basin has the attribute “1” and any cell outside the grid has the attribute “0.” As you see, multiplying the two grids together eliminated all points outside the basin. Convert the theme to a grid and give it a new name.
- 5. Double click the new theme to bring up the legend editor.** Select “Graduated color” as the legend type and edit the legend to eliminate the black region surrounding the basin and to make more sensible intervals. Note that you can specify intervals for the various colors simply by typing the intervals you want. Experiment with the “Classify” button, too.
- 6. Turn of all themes but the new theme and make a layout** showing the streamflow water equivalent depth in the Scioto River basin. It should look similar to that of Figure 5.

Recipe 9: Importing an ArcInfo Export File

Arc/Info export files can be easily imported into Arcview. The import files can be spotted by their file type. Some examples of the file extensions are .e00. These files can be found on the Internet. After downloading an export file follow these following steps to import into Arcview.



Ingredients:

- 1 ArcView
- 2 Import 71



Steps:

- 1 **Open Import 71.** The program will be in your ESRI Program Folder.
- 2 Either type in the name of the file you want to import (e.g. sample.e00) or click the Browse button to search for the file.
- 3 **Enter the directory** and folder you would like to save this imported file under. Most likely you will prefer the same directory as the project you have already started. Name the folder something simple that will be easy to remember what it is.
- 4 **Open a project in Arcview** in which you would like to view this imported file in.
- 5 In a view, **add a theme.** Select the directory in which you saved the import file. This file will actually be a folder. Once clicked the folder will open and the themes in the folder will be

exposed. Select the theme you want or all of the themes. These themes will be added to the current view.

6 You can now see the theme.

Recipe 10: Digitization of a Lake from a DLG

Arcview along with dlg2shp avenue script can assist you in digitization of a lake. One problem with the Avenue script is that it only forces closure on 1 line at a time. The lake outline is most generally not 1 line. Thus you will get the amount of shapes as there is lines. Parts of these shapes may have to be flipped over the line to make the lake correct.



Ingredients:

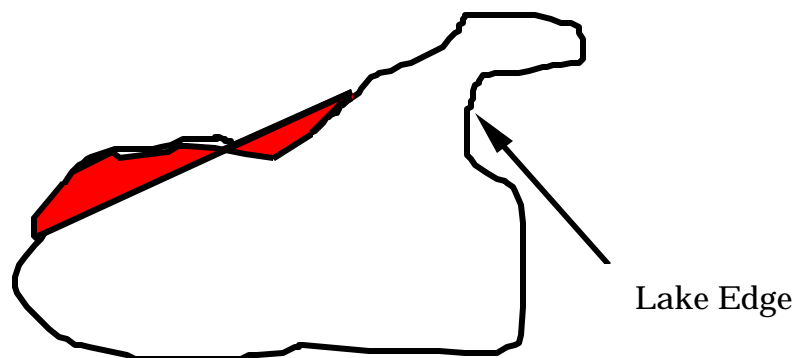
- 1 Arcview
- 2 dlg2shp avenue script
- 3 cvtplply avenue script



Steps:

1. **First obtain the DLGs** you need and proceed to correct them if needed. See chapter on correcting DLGs.
2. **Bring the DLGs into Arcview** as described in the chapter on DLGs.
3. **Open a new script** from the Project window.
4. **Select Load Text File...** from the Script pulldown menu. Go to c:\esri\av_gis30\arcview\samples\scripts\ directory. Select cvtplply.ave.
5. **Now to Compile the script.** Select Compile from the Script pulldown menu. After the script is compiled you can run the script on the DLG theme

6. **In the View select the theme you want to digitize.** Then select the script box (which should still be open from before). Select Run from the Script pulldown menu.
7. Once the script is running it will ask for a name of a file to output to in a Output Shape File box. Type in a name that is appropriate.
8. Then the script will ask you to force closure. Click Yes. The script file then will go to work. After it is done it will tell you how many shapes it converted It will then ask you if you want it to add it to the view. Click Yes. Then it will ask you which view to add it to. Click the one you want and Click OK. The theme is then added to the view.
9. Now that you are started it may look like that you have created a mess. Its true. The next step is to clean the mess up. You may notice that the shapes created by the script outline the edge of the lake, but they only go part way and then a straight line back. (see figure). The edge of the lake is made up of more than one line. The avenues script forces each line closed. To continue to digitize the lake you have to follow some steps. When a shape is on the opposite side of the line of what you want it to be, you have to flip it over the line. If a shape is split like in the figure you only want to flip part of the shape over the line. Each polygon has to be fixed one at a time.



10. **To correct the problem**, first highlight the lake shape file theme. Then click on Start Editing under the Theme pulldown menu.
11. **Click on the draw polygon icon**. This icon is on a pulldown icon located directly to the right of the Text icon that looks like a T. The cursor will turn into a cross when the mouse is over the active theme.
12. **Draw a polygon** that covers the polygon that needs flipped over the line. Continue the polygon into where the lake is.
13. **Select the two polygons**, with the select features box, that are on top of one another and click on Intersect Features under the Edit pulldown menu.
14. What is left is to **subtract a polygon from the polygon you just created**. Draw another polygon over the section you want to subtract and then select both items with the select features box. Then click on the Subtract Features under the Edit pulldown menu.

Recipe 11: Delineating a Watershed

One of the most important things to do in any environmental or water resources project is to delineate the watershed to see what land, industry, and geology is within the watershed that flows through your project. This recipe will help you to do this.



Ingredients:

- 1 Arcview
- 2 Dlg2shp.ave avenue script



Steps:

- 1 **First obtain the DLGs you need** and proceed to correct them if needed. See chapter on correcting DLGs. You will need hydrography and hypsography files for all the area surrounding the project.
- 2 **Bring the DLGs into Arcview** as described in the chapter on DLGs.
- 3 The key is to decide on a point that is immediately downstream from the project. Once this point is found the delineation can be started.
- 4 Now is the time to draw a polygon that encompasses the watershed. Click on New Theme under the View pulldown menu. Choose polygon. Then select the Draw polygon icon.
- 5 Now viewing the

11a. Delineating a Watershed -Bayes

Things Needed:

- topography for the whole watershed (e.g. USGS 1:24k Hypsography files)
- stream data for the whole watershed (e.g. USGS 1:24k Hydrography files)

Steps:

1. A base level, or outlet point, needs to be determined. This determines the size of the watershed. If the base level is set on a large stream or river, the watershed will be large.
2. In ArcView, create a new theme for the watershed boundary. With the view open, select New Theme... from the View Toolbar.
3. A line or polygon can be selected out of the pop-up box. The best way to do it is to use a polygon theme so that the watershed can be done in phases rather than all at once.
4. The New Theme Window will pop-up so that the new theme can be saved. Select an appropriate place and name to save this theme and press OK.
5. In the Tool Buttons there will be a rectangle. Click and hold this button down. This will cause buttons to drop down. Select the polygon button. When selected the button will appear where the rectangle by itself.
6. Start drawing the polygon at the base level. When the cursor is at a point in which a vertex is desired, click the left mouse button once.
7. Continue selecting points by clicking the left mouse button once on the boundary of the watershed. Be careful not to double-click the button.

Notes:

- Always keep in mind how water will flow.
- The polygon can be drawn left or right. Go the direction that is most comfortable.
- Water flows perpendicular to contour lines, so the boundary of the watershed will have to be perpendicular to the contour lines.
- Keep track of the stream network so that the watershed does not over stretch or under stretch its boundary. This can happen easily on ridges that splice.
- Ridges are generally easy to determine where water will flow, but complex hills can be tricky. Try to visualize the hill in 3D in your mind. This will help you figure out which way water will flow and ultimately where the watershed boundary should lie.
- The view can be panned, zoomed in, zoomed out, or the last point in which you selected can be deleted by clicking and holding the right mouse button and selecting the desired action.

Steps (Cont):

8. Continue until fatigue sets in. At this time, continue the polygon into the watershed so that the polygon will not cut itself and that no part of the theme is outside of the watershed.
9. When the polygon is acceptable at this phase, double click the left mouse button. This will complete the polygon. When done select Stop Editing from the Theme Menu.
10. More polygons can be created at a later time by selecting Start Editing from the Theme Menu and then using steps 7-9.
11. Once another polygon of the watershed is completed it can be unioned with the first polygon. Use the Select Tool Button to select both of the polygons.
12. Select Union Features from the Edit Menu to union the two polygons. When finished, repeat step 9.

Recipe 12: Importing Text Files into an Arcview Shapefile

This recipe demonstrates how to import text files (*.txt) or other ASCII files into Arcview and finally converting it into a shapefile. This would be done so that a program that would not ordinarily be used with Arcview or data that is not in Arcview format can be added into projects and used as a layer with other layers.



Ingredients:

1. ArcView
2. Text file (*.txt) or ASCII files (these files must have fields or in a format that has x and y coordinates as well as other attributes.)
3. Microsoft Excel (95 or higher with dBASE converter)



Steps:

- 1. Open MS Excel and open a file.** Note: If the file is in delimited text format (either separated by commas or tabs) – go to step 3. For “Files of Type”, select “All Files (*.*)”. Select the directory so that you can see the text file that you want to import. Once you have selected the file to open select the “Open” button. The “Text Import Wizard” should pop-up. Follow the instruction that the wizard gives to bring the text file into Excel.
- 2. Format and Save the data in a dBASE file.** Once the file is in Excel in columns of x, y, and other fields of attributes correctly, add a new row at the top with identifying labels such as Latitude and Longitude, or Northing and Easting if the labels are not already present. If columns include numbers select the columns and format the cells to number format and select the number of

decimal places that satisfies you. If this is not done, conversion to dBase format will round the numbers. Next select “Save As” to save the file as a different type. In the “Save as Type” menu select dbf 4 (dBASE IV) (*.dbf) and type the name and select the directory where you need to save this file as.

**Note the following dBASE file formats*

-The dBASE file formats DBF 2 (dBASE II), DBF 3 (dBASE III), and DBF 4 (dBASE IV) save only the text and values as they are displayed in cells of the active worksheet. All cell formatting, page layout settings, graphics, objects, and other Microsoft Excel 97 features are lost. The data displayed in the current view of a PivotTable are saved; all other PivotTable data are lost.

-All rows are saved; the following numbers of columns are saved.

| <i>Format</i> | <i>Columns</i> |
|--------------------------|----------------|
| <i>DBF 2 (dBASE II)</i> | <i>32</i> |
| <i>DBF 3 (dBASE III)</i> | <i>128</i> |
| <i>DBF 4 (dBASE IV)</i> | <i>256</i> |

-If a range of cells is named "Database," only that range of cells is converted. If you have added new records after naming the database range, you must redefine the range to include the new records before you save the file in dBASE format. If a database range is not defined, the list of data in the current region is converted.

-Text values in the first row of the range are used as dBASE field names, which are limited to 10 characters; subsequent characters are truncated. If the first row contains all numbers, automatic field names (N1, N2, and so on) are inserted in the converted file.

-Data types of values in the first row of data in the converted range determine the data types of each field (column) of data. If the first row of data contains a blank value for a field, the field is converted as a text field, even if subsequent rows contain numbers in that field; the numbers are converted as text.

-Only data visible in the worksheet cells is saved. Widen the columns in Microsoft Excel, and make sure all the data is visible before you save the sheet in dBASE format.

-If cells contain decimal fractions but are formatted in Microsoft Excel with the General number format, the values are rounded to the closest whole number. To preserve numbers to the right of the decimal point, format the cells with the Number format, and then specify the number of decimal places you want saved.

-If cells in the converted range contain formulas, only the resulting values of formulas are saved, even if the sheet display options are set to show formulas in the worksheet cells instead of values. To ensure that the formula values are converted correctly, click Options on the Tools menu, click the View tab, and clear the Formulas check box. Then make sure that all values are visible before you save the file. If you want to save a formula as text, insert an apostrophe (') before the formula.

- 3. Adding a Table to an Arcview project.** Open Arcview, and open a new project. Select Table in the project window. Click on the “Add” button. A window will pop up to ask you what file you want to add. If you have delimited text to add select the “Delimited Text (*.txt)” from the “List of File Types” menu, select the file, and press “OK”. Otherwise select dBASE (*.dbf), select the file, and press “OK”.
- 4. Add Event Theme.** Once the file is in the project as a table. Open a view so that the table can be viewed. In the “View” menu, select “Add Event Theme ...”. Select the table, X field, and Y field before pressing “OK”. The table will show up in the view. Select the theme to verify the data.
- 5. Convert the Event Theme to a Shapefile.** Make the theme active by clicking on the area around the theme in the legend. This will make it look like part of the legend ‘pulled out’. Under the “Theme” menu, select “Convert to Shapefile”. Make sure that none of the points are selected or ‘highlighted’. Select a name for the new shapefile in a chosen directory. Press “OK”. The point theme then is converted. Arcview will ask if the theme should be added to the view. Select yes or no. Now a shapefile is available for analysis and evaluation or for future interpolation.

Recipe 13: Interpolating Surfaces with Spatial Analyst

This recipe is to understand the background and usefulness of spatial interpolation. The different interpolation models create grids that are useful for the evaluation, analysis, and visualization of data and also can be utilized with the map calculation that is described in previous recipes. The result is a good looking map that can be used for many applications.

Ingredients:

1. ArcView with the spatial analyst extensions.
2. Point Shapefile in the theme.

Steps:

1. **Activate the point shapefile** in the legend of a view that contains the point theme.
2. **Select “Interpolate Grid”** from the “Surface” menu. The “Output Grid Specifications” pop up menu will appear. The grid specifications are very important for further analysis. The output grid extent is the overall size and limits to the grid. Select the default here for now. Later it will be valuable to select the “Same as ‘another grid’” so that comparison and map calculations will be simpler. The “Grid Size” becomes important in further analysis of data. The grid size is the dimensions of each individual cell in the delineation. Small cell sizes will produce high resolution grids that take up more space for storage. The key is to develop a cell size that has an acceptable resolution and an acceptable storage size. Also the smaller the

cell size the longer the time will take to interpolate and to process the data. For now use the default values.

- 3. Interpolating the Surface.** In the “Interpolate Surface” pop up window, the method is selected. The following are notes on the different methods.

-IDW Method

-Note: Gives values to each cell in the output grid theme by weighting the value of each point by the distance from the point to the cell being analyzed and then averaging the values.

-Dialog box options

-Nearest Neighbors - Uses the N nearest points to the cell being analyzed. Type in a value for N in the No. of Neighbors type-in box.

-Fixed Radius - Uses all points within a distance of the cell being analyzed. Type in a value for the distance in the Radius type-in box. If the distance units for the view are set, then the distance will be in distance units. If the distance units are not set, then the distance will be in map units.

-Power - The exponent of distance used in the calculation. Controls the significance of surrounding points on the value given to the cell being analyzed. A higher power results in less influence from distant points.

-Barriers - Used to limit certain points from being used in the calculation of a new value for a cell, even if the point is one of the nearest neighbors or within a certain distance. You wouldn't want to use an elevation point on one side of a ridge to create an elevation value on the other side of the ridge. Barriers can be

- No Barriers

- <Line Theme> - Sets the barriers to whichever line theme you choose in the view.

-Spline Method

-Fits a curve through the points surrounding the cell being analyzed and gives the cell the value of the curve at that location.

-Dialog box options

-Type - The type of curve fitting. Type can be

- Regularized - Creates a smoother flowing surface.

- Tension - Results in a more rough surface that tightly conforms to the input data points.

-Weight - Controls the tautness of the curves. As the Weight increases with the Regularized Type, the output surface will become increasingly smoother. With the Tension Type, increasing the Weight will cause the surface to become stiffer, eventually conforming closely to the input points.

-No. of Points - The number of nearest points around the cell being analyzed that will be used to fit the curve.

- 4. Saving Grids.** Once the interpolation of the grid is done, the grid is shown in the view. The amount of colors as well as the range and colors can be changed by double clicking the grid in the legend. Playing with this can be fun and very useful later. The grid is temporarily saved as a surface grid. To save this permanently, first find where it is to be saved. To do this select "Properties" under the "Theme" menu. In this pop up window the directory for the grid is shown. Next, while a view is active, select "Manage Data Sources ..." under the "File" menu. Go to the directory that the grid is to be saved as and select "Grid" in the "Source Types:" drop down. Highlight the grid and press the "Copy" button. Select a directory that is convenient and a name that describes the grid and press "OK". Then press "Cancel" if this is the only grid that is to be copied.

RECIPE 14: WORKING WITH AVRAS (ARCVIEW/RAS INTERFACE)

By Nan Shi, Last Modification: 01/27/98

Modified by David Beekman, 08/22/00

AVRas is an ArcView interface to RAS (HEC-RAS, River Analysis System, developed by Hydrological Engineering Center). The objective of AVRas is to show the inundation area in the ArcView after the hydraulic analysis is finished in HEC-RAS. This recipe is to show users how to work with AVRas, including the preparation of GIS data, using the AVRas Preprocessing to obtain input geometric file (*.geo) for HEC-RAS, performing hydraulic analysis in HEC-RAS, getting output file (*.gis) from HEC-Ras, and using AVRas Post-processing to delineate the floodplain.



Ingredients:

1. ArcView
2. AVRas
3. HEC-RAS
4. 1: 24,000 / 1: 100,000 DLG data, it is used for creating terrain TIN (triangulated irregular network) for the watershed, or for the study area.



Steps:

AVRas is a convenient extension for ArcView GIS. Prepare spatial information (spatial data) carefully for the preprocessing part by the following steps. Then, it should be easy to work it out!

Before you get a start, make sure that you can do the following:

- a. familiar with working with dlg data, or any other type of data you want to use, in the ArcView GIS
- b. know how to create new themes (point, polyline and polygon) in the ArcView, including edit the table which is related to the created theme
- c. know how to perform "digitizing" in the ArcView
- d. know how to import text file(*.txt) or dbase file (*.dbf) into an ArcView shape file
- e. know how to create a terrain TIN by using topographical data

Now, let's start!

1. Prepare the following ArcView themes for the spatial information of a river:

- Centerline theme (line theme of the river channel): This is used for the determination of stations, and stream and reach names. The lines should be digitized *starting from upstream to downstream* (the "FROM" node is upstream of the "TO" node). Each reach is defined by a single polyline. Make sure that the polylines are snapped at end nodes. The stream item (Stream_ID) should contain the stream identifier, while the reach item (Reach_ID) should contain the unique reach identifier. Outlet reach for each stream needs to have its "is_Outlet" value set to 1 (numeric).

Notes: all the items, such as "FROM" node, "TO" node, "Stream_ID", "Reach_ID", and "is_Outlet", should be added as new fields in the table of the centerline theme.

- Cross-sections theme: One polyline for each cross-section. Digitizing should be performed consistently from left to right bank (facing downstream). If cross-sections are not available for digitizing, they must be created using HEC 2 data. The cross-sections should be created in ArcView based on parameters found in the HEC 2 data such as length between adjacent cross-sections, width of cross-sections, and elevations. Be sure the cross-sections are created from left to right bank (facing downstream).
- Stream banks theme: Used to calculate bank locations at cross-sections.
- Flow path theme: Used to calculate the downstream reach length for HEC-RAS input. The lines should be digitized starting from upstream to downstream. Each flow line needs to have its "LineType" set as l, r, or m (indicating left, right, or main flow path). Also, you need to add the LineType fields and records to the table of the flow path line theme.

Notes: to save time, you can combine stream banks theme and centerline theme together to make a theme for flow path lines

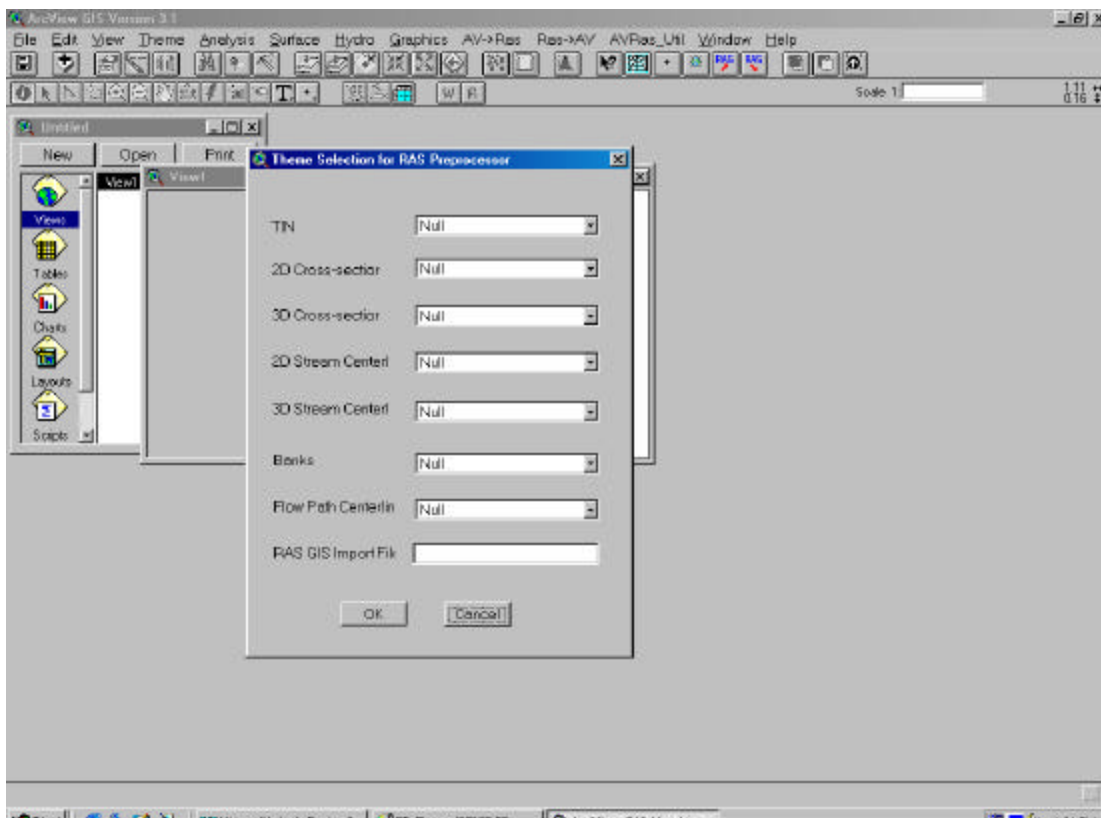
2. Prepare a terrain Tin

To prepare a terrain tin in the watershed, topographical data can be obtained and used, for instance, 1:100,000 dlg, 1:24,000 dlg, DEM data, recent survey data of the river, the datum of gage station, etc.

For any type of the dlG data, topography information can be obtained in different detail or resolution. However, all of those data couldn't offer information about the river bed topography. Thus, when you are trying to make a tin for the whole terrain, you may need to combine dlG data with some other information inside the main channel. This information can be surveyed data, or approximately interpolated elevations along the river centerline according to the general slope. If you don't know how to make a tin, you may find and learn these from other recipes later on.

3. Use AV→Ras to perform AV/Ras pre-processing

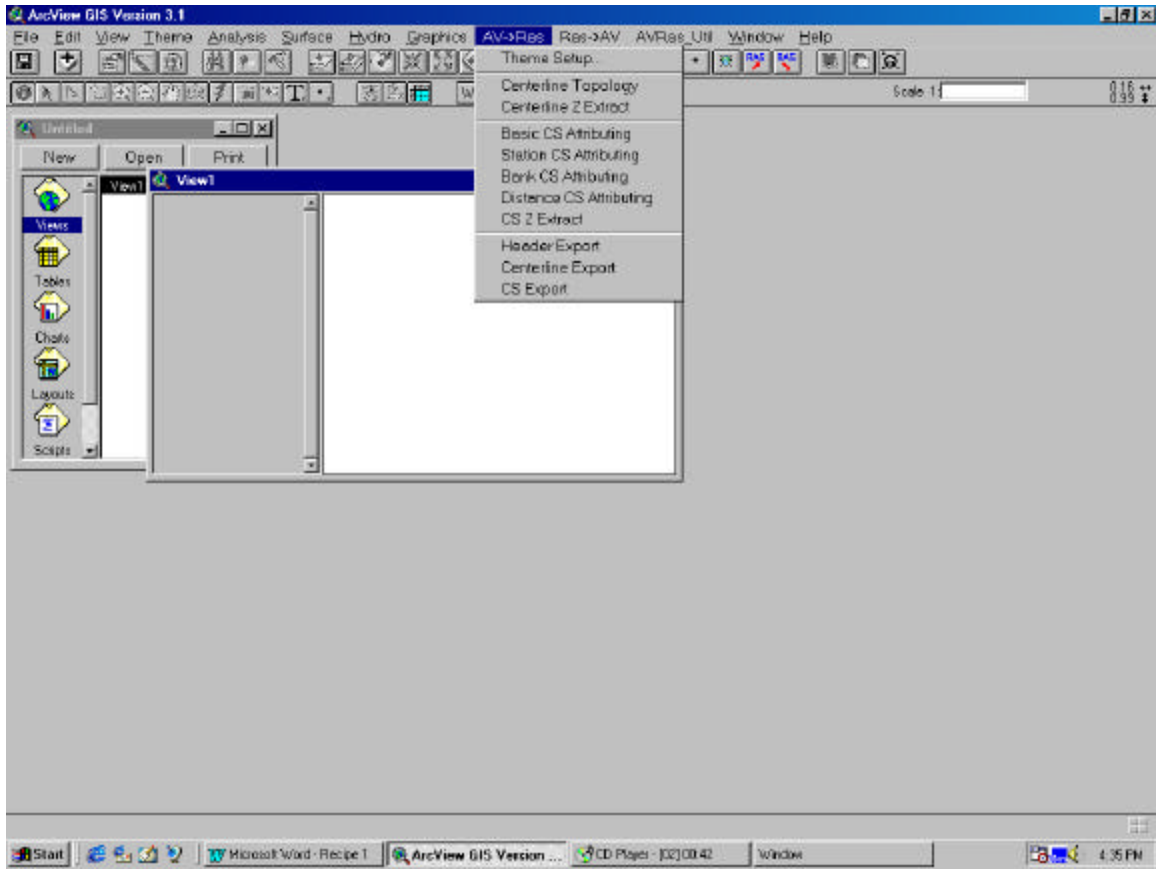
When you finish the steps 1 and 2, you are ready to perform AV/Ras pre-processing functions. The AV→Ras functions are used to generate a *.geo



import

file for HEC-RAS. The information offered by the import file is mostly the geometric information of streams, including cross-sections, centerline, bank stations, etc.

From the main menu bar of Arc/View, select the AV→Ras option, then click on the Theme Setup. A window will pop-up as the above figure to let user to input or select the theme names for tin, cross-sections, flowlines, and banks. You also need to fill in a file name (*.geo) for the RAS GIS import file. You may not have 3D cross-section and 3D stream centerline themes ready at this point. This step will be finished later by AV→Ras.



Now, you need to go to the AV→RAS menu again, finish each step by clicking on the options in chronological order. This includes Centerline Topology, Centerline Z Extract, Basic CS Attributing, Station CS Attributing, Bank CS Attributing, Distance CS Attributing, CS Z Extract. After you finish these, the two 3D themes mentioned above should be generated automatically. You need to check the theme setup again. Then, perform the Header Export, Centerline Export, and CS Export (cross-sections). Now, the import file is generated. If a problem is experienced, check the options under GeoRAS_Util from the menu bar.

4. Import the geometry file generated by step 3 to HEC-RAS, and perform the hydraulic computation (Suppose you are familiar with HEC-RAS already)

After the geometry file (*.geo) is imported into HEC-RAS, you can see every cross-section. You may need to delete some unnecessary data points, if you get more than 500 points of data for one cross-section. HEC-RAS can't deal with more than 500 points on one cross-section.

In order to perform the hydraulic computation, Manning's n values and friction and expansion coefficients for each cross-section should be assigned. Discharge data and boundary conditions should be input.

The .geo file will need to be opened as a separate project from the original HEC 2 data project. The cross-section data, streamflow data, and Manning's n values must be copied from the Original project to the .geo project. This can be accomplished by using ctrl-c and ctrl-v to copy and paste.

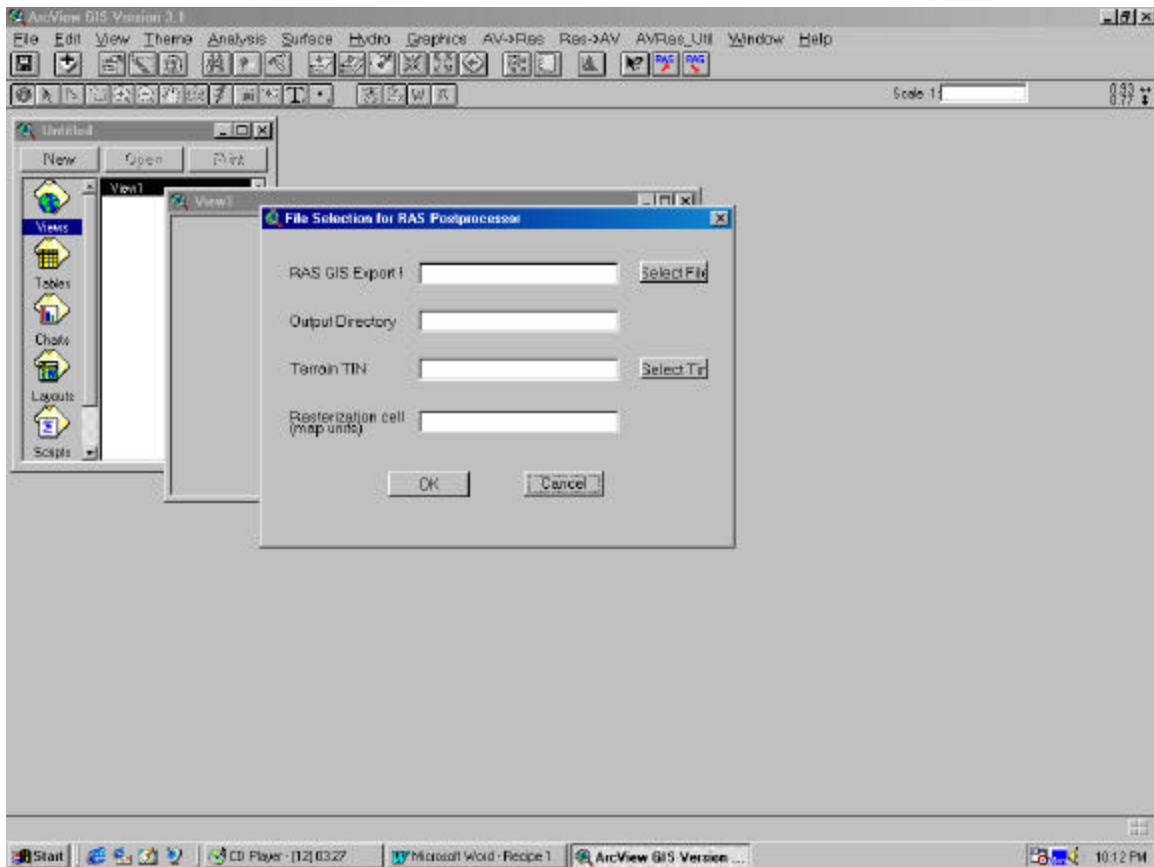
Next, you may add some other structures, such as bridge, weir, and culvert. All of these can be done in HEC-RAS.

After the computation is finished, under the File option in the main menu, an export file with an extension *.gis can be generated. It is composed of river geometry information and water surface elevation. This file can be used by AV/Ras to make a water surface tin. This water surface tin will be used to compare with the former terrain tin to delineate the floodplain.

Before creating this water surface tin, cross-section and point themes must be created in ArcView using the script *GeoRasConverter.ave*. This script creates ArcView themes based on the HEC-RAS geometry data. The tin can then be generated from this point theme.

5. AV/Ras post-processing and floodplain delineation

Comparing with the pre-processing part of the AV/Ras, the post-processing is easier to be used. You don't need to do other preparations. Open your project



in Arc/View and make sure the AV/Ras extension has already been loaded. Go to the main menu bar and click on the Ras→AV option. Then, select theme setup. A RAS post-processing window should pop-up as follows:

According to the dialog window, the names of RAS-GIS export files and terrain tin need to be selected correctly. The RAS-GIS file is the .gis file and the terrain tin is the previously created water surface tine. Then, you need to give an output directory such as fppf_3 (for a case like the 100-year flood elevation). A cell size value is to be assigned. You may start from 10 map units. If it's too small, you need to adjust it, and try several times.

After you fill in all the information, click on OK, and following the proper instructions. The water surface tin and the floodplain should be obtained and displayed automatically in a new view. Then execute the remaining

commands CS/BP Generation, WS TIN Generation, and Floodplain Delineation in chronological order.

RECIPE 15: WORKING ON A WHOLE BASIN BY USING AVRAS

By Nan Shi, Last Modification: 01/23/98

In order to know the inundation area along the river from the most upstream to the most downstream, you may need a bunch of data including topographical information of the studied basin, main channel and its tributary distribution information (hydrographical data), and the river geometry information. If these data are available, it makes possible to plot the floodplain by using ArcView, HEC-RAS, and AVRas interface.

The topographical and hydrographical data can be downloaded from some GIS data support center. Then, the essential issue here is that how to get the river geometry data. "Survey data?" Of course, if you can find out the survey data along the main channel, you should use it. But this kind of information is generally not easy to find out. Or, if you have time and money, you can do this survey to... However, in this industrial society, you always want to find out some method to improve the efficiency both on your time and money. "Is there any other method to stay in your office with your computer and Internet to work it out?" Yes, read this recipe, and you will get it!



Ingredients:

1. ArcView

2. AVRas

3. HEC-RAS

4. UTMS program

5. 1: 24,000 / 1: 100,000 DLG data

-- Topography. This data is used for creating terrain TIN (triangulated irregular network) for the watershed, or for the study area

-- Hydrography. This data is used for you to know the river shape and digitize the stream.

6. The gage stations along the river and the datum of the gage

-- It's used to interpolate a centerline for the stream



Steps:

1. Downloading the 1: 24,000 dlg data quads in the basin and run script "dlg2shp" in ArcView GIS to get the themes

-- This may cause some problem such as the quads are not well matched with each other. You may have to adjust all the quads to let them match well. Although I write a script to solve this problem, sometimes it can not be used. Because the 1:24,000 dlg data is new, and for some reason, the identification on the 4tics of the quad is not follow the same standard.

2. Digitizing the main stream according to the position of the stream on the 1:24,000 hydrographical dlg data themes

-- You need to digitize two banks, and one centerline. Follow the rule that digitizing from the upstream to downstream. Make one theme for the banks, and another theme for the centerline. When you finish digitizing one bank, you'd better save it before you start to digitize the second bank.

3. Preparing a line theme in the with all the cross-sections you want to have along the stream

-- The cross-sections should be drawn from left bank to right bank of the stream (facing downstream). Draw one line for one cross-section.

4. Finding out the available gage stations, with the information of the location (lat. and long.), and the datum of the gage (elevation above sea level)

-- You may need to run UTMS to get the UTM coordinates in meters

5. Run a script, to change the centerline theme to point theme (find the approximate position of gages)

6. Run a script (written by Nan Shi), to read the points' coordinates and ids to a dbase file (*.dbf)

7. Open *.dbf file, created in step 6, in Excel. Using the datum of the gages to interpolate the elevation along the stream centerline

8. Creat a terrain tin

-- Because you have a bunch of quads data in the whole basin, and it takes a lot of memory. You may need to change topographical lines to points, then delete the points you don't need.

-- Combine the topographical data and interpolated centerline's point data to create a tin.

9. Run AVRas preprocessing, HEC-RAS and AVRas postprocessing

-- Refer to the Recipe 1. Steps omit here.

Notes: The information in this recipe let you know the general steps for working on the entire basin. For any questions, please either contacts Nan Shi or my advisor Dr. Tiao J. Chang. Thanks.

RECIPE 16: A SIMPLE DIGITIZING RECIPE

Description: This is a recipe to teach you how to digitize a map by using the ADS program in ARC/INFO, and how to export the digitized coverages. Of course, there are still some other methods in ARC/INFO to perform digitizing, such as ARC/EDIT. However, it's not in the scope of this recipe.



Steps: include steps for digitizing, transforming and exporting

Step 1: Digitizing

1. **Arc: &station dig**
2. **Arc: ads <coverage_name>** (e.g. "quad17")
3. Now we are in the ADS program. We are ready to digitize the ticks. The screen looks like this: (from now on only the cursor works, the keyboard doesn't work)

Tic ID:

4. Use the cursor to insert 4 tics this way:

1A1 - 1st tic

2A2 - 2nd tic

3A3 - 3rd tic

4A4 - 4th tic

The screen will be like this:

Tic ID: 1*

Tic ID: 2*

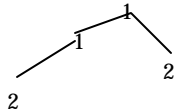
Tic ID: 3*

Tic ID: 4*

5. Finish inserting the tics by hitting "**OA**".
6. The program then asks you to enter the boundary. We enter the boundary by defining the locations of the lower left corner and upper right corner:
 - Locate the lower left corner of the map by clicking "1" on the cursor;
 - Locate the upper right corner of the map by clicking "2" on the cursor.
7. The screen displays the message

8. Once finished, the digitizing menu pops up like this:
1) Add Arcs 3) Add labels 5) Draw coverage 7) Add Tics
2) Remove Arcs 4) Remove labels 6) Define windows 8) set options
9) Exit Enter functions:

9. Begin adding arcs by hitting "1" (Add Arcs), then we're ready to digitize arcs one by one. Starting the first node by hitting "2", input the following vertices by hitting "1" and finish the arc by entering "2".
 The style looks like this:



10. When you're digitizing, the following appears on the screen:

```
<Vertex#>      1# of coordinates = 0
<Vertex#>      2# of coordinates = 0
...
...
```

11. Exit ADS program by entering "9", before you actually exit the program, remember save the file following the instructions on the screen.

12. Remember use the text editor to create a tic coordinates table like this.

| Tic-ID | x(longitude) | y(latitude) |
|---------------|---------------------|--------------------|
| 1 | -83.00 | 43.792 |
| 2 | -83.00 | 43.65 |

STEP 2: TRANSFORMING

1. Now we'll project tics from digitizer units to real-world coordinates. Firstly create a new coverage which is a copy of an existing coverage only with the TIC and BND files.

Arc: create <new_cover> <original cover> (e.g. **Arc: create quad17_real quad17**)

2. Update the TIC file in INFO with the real-world coordinates. Do the following:

Arc: info

The INFO program starts. Using caption letters for all entries.

ENTER USER NAME: Arc

ENTER COMMAND: SELECT <new_cover_ticfile>

(e.g. **SELECT QUAD17_REAL.TIC**)

ENTER COMMAND: UPDATE

\$RECNO?>1 (enter "1" to update the 1st tic)

?>XTIC = -83.00 ("-" is needed)

?>YTIC = 43.792

?>

\$RECNO?>2..... (the rest will be done in the same pattern)

3. Finish UPDATE by hitting a carriage return, go back to **ARC** by typing as below:

ENTER COMMAND: Q STOP

4. Now transform the whole coverage into the real-world coordinates by the following command:

Arc: transform <original cover> <real-world cover>

(e.g. **Arc: transform quad17 quad17_real**)

step 3: Exporting

1. Clean the attribute table by typing in the command below:

Arc: clean <in_cover> <out_cover> 0-1 line

(e.g. **Arc: clean quad17_real quad17a 0-1 line**)

2. Export Arc file to a new shape file.

Arc: **arcshape <real-world cover> <feature_class> <output_shapefile_prefix>**

(e.g. **Arc: arcshape quad17a arcs quad17**)

The output shapefile will include three files of the following type:

*.dbf, *.shp, and *.shx

Recipe 17: Downloading and Converting 1:24,000 Optional and Standard Format DLGs

In order to execute many of the recipes in this cookbook, it is necessary to obtain a desired DLG. These DLGs can be downloaded from the Ohio DAS ftp site with no charges. This recipe presents a step by step format to effectively download and convert 1:24,000 DLGs to shape files.



Ingredients:

Arcview

Internet Browser (i.e. Internet Explorer)

WinZip

Dlg2shp.ave avenue script



Steps:

1. Open the Ohio DAS ftp site with an Internet Browser. The web address is <ftp.geodata.gis.state.oh.us>. The web address is www.geodata.state.oh.us.
2. Enter the folders geodata, dlg, and 24000 in order. Open 24k_idx.pdf to view and determine the location of the quads that are needed.
3. Return to the 24000 folder.

4. Open the status folder and then open the dec2398.txt folder to determine the directory and prefix name of the quad(s) needed.
5. Return to the 24000 folder
6. Open the data folder and the folder in which the quads are located from the dec2398.txt file
7. Select the quad with the desired prefix. There will be seven files with this prefix. The files are for boundaries, hypsography, hydrography, miscellaneous transportation, roads, railroads, and public land data.
8. Download the selected files by clicking or double clicking on the desired filename.
9. Open up the Windows Explorer. Go to the location in which the files were saved.
10. Double click the *.zip file to open the file. Drag the *.dlg file from the WinZip window to the desired folder in the Windows Explorer window.
11. In ArcView, open a new script window by selecting the script tab from the project window and click the new button.
12. From the Script menu select Load Text File...
13. Find dlg2shpe.ave. Compile this avenue script by clicking on the check mark button.
14. Run the script by clicking on the running guy button.

15. In the box, select the folder and the dlg(s) to convert to shapefiles.
16. If multiples are selected add the shapefile theme from the folder into a view. The most preferred shapefile will be the *_line.shp.
17. If a single dlg is converted follow the directions from the script.

Appendix A: ArcView Nomenclature

Some Windows Basics

The commands a user gives to ArcView are found on the “Menu bar” and “Tool bars” at the top of the ArcView screen. The menu bar and tool bars are probably familiar to most Windows users. The menu bar is a list of words such as “File,” “Edit,” “View” and “Theme” stretching across the top of the ArcView window on the computer screen. When any of the words on the menu bar are clicked with the mouse, a pull-down menu appears giving a set of commands that can be performed. The tool bars are the two rows of buttons that appear below the menu bar. Menu bars, tool bars and title bars are all identified below on Figure A.1.

Every Window has a “title bar” running across its top. At the left and right ends of the title bar are the buttons used to close, minimize and maximize the window. The title bar tells whether a window is “active.” When a window is active, the color of the title bar is different from the color of other title bars. Typically, the title bar of an active window is blue, while that of inactive windows is gray. The title bar both gives the title of the window and also provides a convenient means for moving the window around. To move a window, click on the words at the center of the title bar and don’t let up the mouse. Next, move around the mouse to relocate the window.

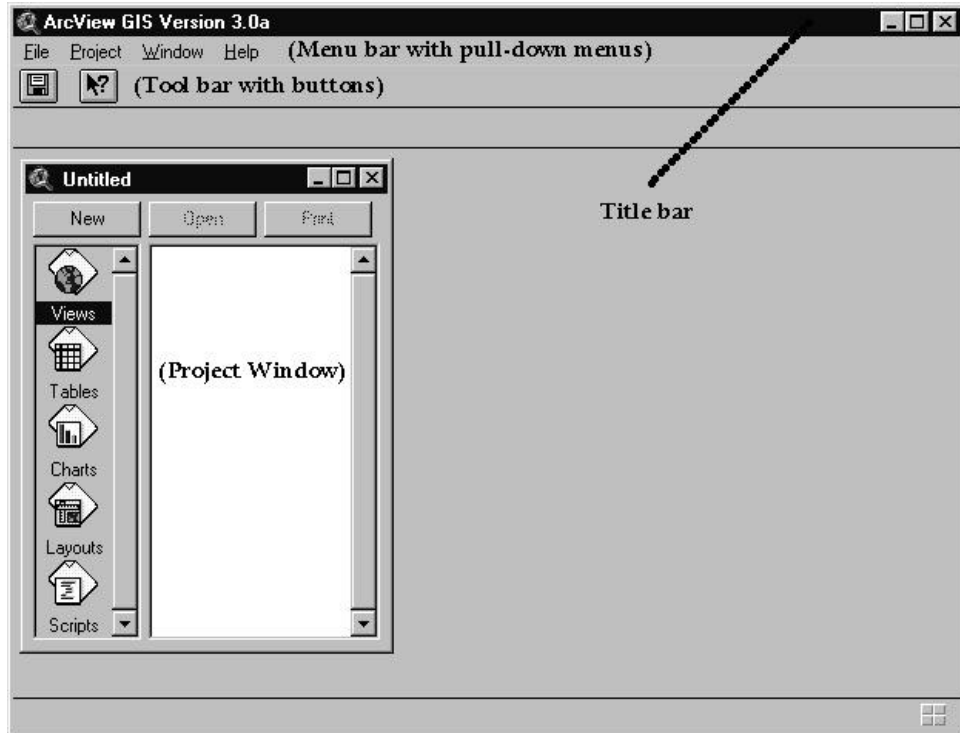


Figure A.1: ArcView Desktop

ArcView Projects

When a user starts ArcView, the ArcView window appears on the screen. The window has a menu bar, two tool bars and a big empty space below the tool bars. Numerous other windows can be opened in the empty space. The first window opened in that space always is the “Project Window.” This window is a sort of project accountant which keeps track of all the different files and jobs associated with the project. To get the project window onto the screen, go to the menu bar and select either “New Project” or “Open Project” from the “File” pull-down menu. If the “New Project” command was selected, the project window appears alone in the empty space.

There are five entities in ArcView: Views, Tables, Layouts, Charts and Script. These are the five different products ArcView can generate. A view is a working version of a map. Tables and charts are tables and charts of the data. The author commends the sensible choice of these names. A layout is a prettied-up picture of a view or chart, complete with text, scale bar, North arrow or any other fancy graphic intended to score extra credit. Scripts are programs written specifically for ArcView. Many scripts are available in ArcView distribution files and over the internet.

An ArcView project can be comprised of multiple views, tables, charts, layouts and scripts. To make a new, blank one of any of these products, click on the icon associated with the desired one (on the left side of the project window) and click the “New” button at the top of the project window.

As shown in Figure A.2, a view window has two parts: the view (map) itself and a legend.

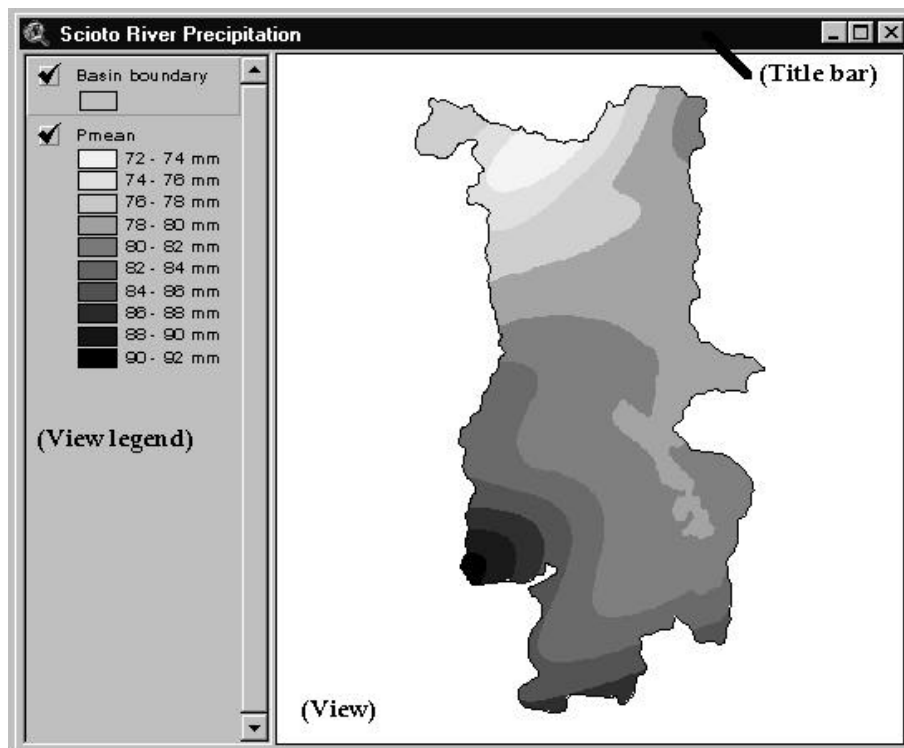


Figure A.2: A View Window

The legend is a column on the left side of the view window and contains information about all the data that are shown in the view. The data are arranged into “themes” such as political boundaries, roads, rivers, micro-brewery locations, etc. By clicking on boxes found in the legend of a view, the various features can be turned off and on. Double clicking on the various entries in the legend enables the user to edit the way the theme is displayed. The user can change display features such as color, font, line thickness, marker size, fill and other features.

Appendix B: The UTMS Program

The UTMS program is a DOS program written by USGS personnel and freely available on the WWW. It is simple to run. simply change directories to the directory where UTMS.EXE is located and type "UTMS" at the DOS prompt. Using the directory structure given in this report, type

```
C:\> cd GIS
```

```
C:\GIS> cd Utilities
```

```
C:\GIS\UTILITIES> UTMS
```

then follow the on-screen instructions. The output from UTMS should be directed to a file. The output file will be ASCII format and can be converted to a dBase (.dbf) file using Microsoft Excel or any other spreadsheet program.

Appendix C: Getting data into Arcview

ArcView is delivered with fairly detailed data of the United States' political boundaries, roads, waterways and zip code zones, as well as a coarse coverage of the world's political boundaries and rivers. These data are a good jumping-in place, since finding data and getting it into ArcView can be a struggle. There are also a lot of detailed, free data available on the Internet and from other sources that can be readily used in ArcView. In this report, an outside (and free!) data source is used and the steps to get the data into ArcView are explained. Two excellent sources of data are the US government and the UN. Both organizations have a lot of detailed data available on the Internet.

The two types of data files easiest to use in ArcView (other than files made specifically for ArcView) are USGS DLGs (US Geologic Survey Digital Line Graphs) and ARC/Info Export files. How to get each of these file types into ArcView's format is described below.

USGS Digital Line Graphs

USGS DLGs can be found at the world wide web site:

<http://usgs.gov/...>

The files can be downloaded in either "standard" or "optional" format. The following steps use the "optional" format. Following links on the web page given above leads to a map of the United States. On this map, click (with the mouse) on the approximate region of the country where the DLG data are desired. A second map pops onto the screen showing rectangles with names. The USGS has divided the country into rectangles, each one 1°H 1°. The rectangles are further divided into sectors, as shown in the figure

below. Clicking on the rectangle where the data are desired leads to a pages from which the desired data can be downloaded. When downloading USGS DLGs, the sectors are downloaded one at a time. Several types of DLGs are available for downloading, including political boundaries, hydrography, hypsography (elevation contours) and transportation (both road and rail). The boundary files are fairly small, but all the others are quite large and may not fit on a floppy disk.

| | | | |
|------|---|------|---|
| 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 |
| West | | East | |

Figure 1: USGS DLG Sector Numbering Scheme

To make life easier, the author of this report gives such as:

parb1.opt.gz

to files downloaded from the USGS DLG site. In the above name, the “**par**” is an abbreviation for the name of the sector for which the DLG was downloaded (in this case, the first three letters of Parkersburg). The “**b**” refers to the DLG type; **b** stands for boundary, **h** stands for hydrography, **r** stands for roads, **rr** stands for railroads and **y** stands for hypsography. The “**1**” refers to the sector number, as shown in Figure 1. The “**opt**” denotes that the

DLG is in optional format and the “gz” is used because the file has been compressed using the gunzip utility and must be unzipped with a program that can handle files compressed with gunzip.

The files that are downloaded from the USGS are compressed (“zipped”) and are simply long streams of data without distinct lines. The popular Windows program Winzip can unzip files that are compressed in gunzip format. Winzip produces an uncompressed file whose name should be something like:

parb1.opt

Once the DLG files are uncompressed, they have to be converted to files with line lengths of 80 characters per line. The USGS has available on one of its web sites a program called **chop** to accomplish this task. The **chop** utility can be downloaded at the ever-popular cost of \$0.00. To “chop” a file using the **chop** program, go to a DOS prompt and type the following line:

```
chop 80 < parb1.opt > parb1.dlg
```

Note that this command must be issued in the same directory where both the program **chop** and the file **parb1.opt** are found.

Otherwise, a path must be supplied along with the file names for the files **parb1.opt** and **parb1.dlg**.

A mere single step remains before the data can be used in ArcView: using an Avenue script to create a “shape file” as used by ArcView. Briefly, a script is a list of commands (like a program) that “do something” in ArcView. Avenue is the name of the programming language used in a script. In general, other people really fond of ArcView write scripts and the rest of us use them. Such is the case with the script DLS2SHP. DLG2SHP was written by someone at ESRI, the company that sells ArcView. It takes the DLG file

created in the preceding steps and produces ArcView data. The copy used in the Water Resources Group in the OU Civil Engineering Department was downloaded from ESRI's web site. Scripts are run inside of ArcView. To run the script, make sure to know where (which directory on the computer) the script is located. Start ArcView and create a new project (as described above). From the "project" window, click on the Script icon. Next, from the menu above, select "Load Text." Selecting "Load Text" makes a window appear. In that window, go to the appropriate directory and click on the file `dlg2shp`. Hit the "OK" button and ArcView loads the text file containing the script. Next, the script is compiled. To compile the script, select "Compile" from the "Script" pull-down menu. Finally, run the script. To run the script, be sure the "Script" icon is active in the project menu. Click on the "Run" button at the top of the projects window and enter the file name and path of the DLG being converted.

ARC/Info Export files

Making ARC/Info Export files into ArcView files is considerably easier than converting USGS optional format DLGs.

One source of ARC/Info Export files is the world wide web page

`http://erdas...`

This page contains political boundaries, populations, land use, climate zones and soil types of Asian countries. The data were compiled by the USGS and UNEP (UN Environmental Programme). Data from this source were used in the preceding demonstration. Inmost cases, the ARC/Info export files are compressed and must be "unzipped" before being converted.

To import ARC/Info export files, use the ArcView Import utility. In Windows 95, the Import 71 utility can be found in the “Start Programs” menu, underneath the entry for ArcView. Simply start the Import 71 program and follow the directions. In the upper box, enter the path and file name for the export file (the file you want to convert). In the lower box, enter the directory in which the converted files should be placed.

Appendix D: GeoEAS

Following is a step-by-step example demonstrating Kriging with GeoEAS. The example demonstrates all the steps normally performed in Kriging, but does not use all of GeoEAS's functions. The particular example presented below is the Kriging of stream flow data for stream flow gaging stations in the basin.

The steps involved in the process are:

- creation of a new data file;
- preprocessing of the data file to create a “pairs file;”
- plotting of a variogram and fitting a model to it;
- Kriging of the data; and
- checking the validity of the Kriged estimates.

Before starting, here are some hints for using GeoEAS. First, to exit any screen or function you want to get out of, type the “q” key. Other control sequences (such as escape) will not work. Second, each GeoEAS project uses several files. It is strongly urged that each GeoEAS user creates a separate directory and keeps all his/her files in that directory. The files required in each project are:

- *file.dat* (an ASCII file containing gaging locations and data);
- *file.pcf* (a pairs comparison file generated by GeoEAS); and
- *file.grd* (the GeoEAS output file of Kriged data).

In addition to these three files, the user can create a Kriging parameters file. Since this is not essential, it is not described in this Appendix. For all the files above, , *file* should be replaced with

a descriptive name (such as *stream*) preferably with 6 characters or fewer in the name.

Finally, all the operations you perform are selected from menus running across the bottom of the GeoEAS window. The first thing you need to do in a GeoEAS function is to set the working directory to the one where your data are located. To do this, select “Prefix” from the menu at the bottom of the screen and type the correct path, **FOLLOWED BY A **. Otherwise, the program will not be able to find your data.

Creating and Viewing a Data File

A GeoEAS data file (input file) contains measurement locations (Eastings and Northings) and the data associated with those locations (e.g., precipitation, temperature, wind velocity). In addition to data, labels for axes and units for data values are included in the input file. The format of the input data is import. Some of the input lines to GeoEAS are “fixed format” and the number of blanks between the numbers and characters is important. Because of this, it is best to use the DOS editor to create data files for GeoEAS.

The input file you need for this lesson is given in Table D.1. Use the DOS editor to type it in, exactly as it is shown below and save it with the name “stream.dat.” Notice that there are three columns of data: the Easting (in meters) of a drainage centroid, the Northing (in meters) of the drainage centroid and the stream flow water equivalent depth (in inches) associated with the centroid.

The lines of this data file are described in detail on the following page.

Table D.1: GeoEAS Input

| Mean Annual Flow in Water Equivalent Depth | | |
|--|------------|--------|
| 3 | | |
| Easting | m | |
| Northing | m | |
| Stream | in | |
| 293230.83 | 4495743.98 | 10.819 |
| 294813.20 | 4465663.28 | 12.095 |
| 293357.85 | 4481828.54 | 11.051 |
| 343200.56 | 4505356.15 | 13.609 |
| 338474.59 | 4493189.60 | 12.210 |
| 303676.23 | 4468760.69 | 11.654 |
| 345487.27 | 4464596.05 | 13.832 |
| 337719.53 | 4469377.35 | 13.396 |
| 332356.45 | 4456205.55 | 13.244 |
| 341694.95 | 4450812.25 | 11.883 |
| 297863.70 | 4432063.65 | 11.818 |
| 294875.55 | 4407139.09 | 13.197 |
| 299298.24 | 4407301.56 | 13.265 |
| 313949.13 | 4436461.27 | 12.137 |
| 282160.89 | 4381296.67 | 13.739 |
| 282022.62 | 4343847.01 | 14.883 |
| 291002.61 | 4375571.65 | 13.645 |
| 313949.13 | 4425297.57 | 12.134 |

Line 1 - Title

This line is a descriptive title which may contain up to 80 characters. Most of the programs in GeoEAS display this title on the screen in graphics screens.

Line 2 - Number of Variables (NVAR)

This line tells the program how many columns of data there are in the data file. The minimum number of columns is 3, as in the example input file. The limit to NVAR is 48 and the limit to the number of measurement locations is 1000.

Line 3 @ NVAR + 2

The next several lines tell what the names are for the x- and y-axes and the parameter that is being Kriged. There is one

line for each variable. The first ten characters give the parameter name and characters 11-20 give the units.

Line NVAR + 3 ® the end of the data file: columns of data

Columns represent the different variables and the row represent measurement locations. The data may be in “free format,” which means that in a given line, variables must be separated by at least one blank or a comma.

Starting GeoEAS and preprocessing your data

Once the data are properly entered, begin GeoEAS by changing directories to the GeoEAS directory and typing “GEOEAS” (in DOS) or double-clicking the GeoEAS.EXE icon (from the Windows Explorer in Windows '95). The main menu for GeoEAS should appear. You now see the various programs that make up GeoEAS. They include:

- VARIO (for generating variograms)
- KRIGE (for Kriging)
- POSTPLOT (for viewing the data locations)
- XVALID (for cross-validating your variogram model)
- PREVAR (for generating a “pairs file”)

and others. Use the cursor keys to highlight “Prevar” and hit enter.

Look at the menu at the bottom of the screen. First, you need to specify the directory where your data file is located. To do that, cursor to the “Prefix” entry in the menu and hit enter. Specify the correct directory at the top of the window. It should look something like C:\GIS\GEOEAS\YOURNAME\

Once the directory is specified, select “Data” from the menu and type the name of your data file (Stream.dat). Your data should load

now and you will be prompted to give the data for the x-axis, y-axis and variable. Choose Easting, Northing and Stream, respectively. Once the variables are properly specified, select “Execute” from the menu. Prevar creates a “pairs comparison file” called stream.pcf and returns you to the main menu.

Examine your Data

To make sure that the data you got are the data you want, you should use the programs “STAT1” and “POSTPLOT” to generate basic statistics about your data and to view the data locations. These routines are straight-forward and are not described here.

Generate and Model a Variogram

From the main menu, select “Vario.” As usual, make sure the prefix is correct and specify the file “Stream.pcf” as your data file. Once the data are specified, select “Option/Execute” and a new window appears. For this example, omni-directional Kriging is used and no changes are made in the direction field. Next, select a lag spacing. This is a trial and error process. (See the flow chart at the end of this Appendix). For now, simply use the default lag spacing. Select “Execute” and VARIO calculates the variogram.

A new window appears with the options “Plot” and “Model” at the bottom of the screen. First, plot the variogram you just created. Cursor to “Plot” and hit enter. The variogram appears on your screen. Take note of the shape because later you will need to estimate a sill and range. To exit this screen, hit the “q” key. Next, choose the variogram model by selecting “Model” from the menu at the bottom of the screen. Enter the Nugget, Model Sill and Range you want. To specify the model, tap the space bar until the model you want appears. When you have entered the model you want, hit

“Enter” until you are back in the menu at the bottom of the screen. Select “Plot” to see how well you did in choosing the variogram model. It will likely take you several tries before your model matches your variogram. If there is no trend apparent in the variogram, increase the lag spacing. Once you are satisfied with the model, write down the parameters and quit to the GeoEAS main menu.

Cross Validate Your Model

Select “XVALID” from the main menu to enter the cross-validation routine.

Kriging the Data

Select “KRIGE” from the GeoEAS main menu. If the prefix is correct in the window that appears, select “Options/Execute.” Specify your data file (stream.dat) and give the output file the name stream.grd. The Kriging type should be “Ordinary” and “Point.” For now, accept the default grid values by selecting “Grid” from the menu at the bottom of the screen and hitting “enter” until you are back at the menu. KRIGE choosing values for the minimum Easting and Northing and grid spacing. Later you should change these to values that encompass the entire Scioto Basin.

Specify search parameters. Again, use the default values for now. Select “Model” from the menu and enter the model parameters corresponding to the variogram you generated in a step above. When the model is properly entered, quit to the previous screen and select “Execute.” A Kriging image should appear on your screen. If the program was unable to get a value for a grid point, a white X appears at that grid point. This indicates that you need a larger search radius or you should choose a smaller number of

minimum points in the search. Continue trying to Kriging until all the grid points are filled. Congratulations. You have successfully Kriged and your output file "Stream.grd" is ready to be put into a GIS.