

# ***An introduction to ArcView GIS for EDEN-LEI partners***

***Barcelona, 12-13 December 2005***

## ***Overview of practicals***

The purpose of these practicals is to explore and become familiar with ArcView GIS software using real-life datasets connected to recent EDEN fieldwork in southern France. The following exercises will not turn you into GIS experts, but they will provide you with a solid basis from which to further explore GIS techniques on your own.

By the end of these exercises you will hopefully have become fairly familiar with the ArcView software and its different elements. More specifically, on completion of the practical you should be able to:

1. Produce customised displays of geographical and tabular data
2. Perform simple queries and calculations using GIS attribute data
3. Load and extract environmental data from raster grids

This practical is designed to take you through a series of exercises using a 'self-study' format. This means that you can continue working on the practicals at a later date if we are unable to complete them in the time available in this workshop. The exercises may also be useful for refreshing your ArcView skills in the future.

## Example datasets

The datasets we will be using in this practical have already been introduced to you and include:

### Tabular data

- **Survey data** derived from recent sampling of *P. ariasi* and *P. perniciosus* in southern France (extracted from Palm databases). The table contains information on the number of each species trapped at 168 sites, as well as information on the number of papers used and some basic site characteristics.

### Vector GIS coverages

- **Administrative boundaries** (national and department level) for France
- **Urban** areas
- Geographic boundary file for the current geographical **area of interest**

### Raster GIS grids

- Average annual **temperature, rainfall** and **relative humidity** for 1961-1990 (spatial resolution 10' (0.1667 degrees or ~15 km); source Climate Research Unit, UK).
- **Land cover** classification from the CORINE Land Cover Project (spatial resolution 50 m; source European Environment Agency)
- Satellite-based **Vegetation Index** data for Aug/Sep 2005 from MODIS 16 day composites (spatial resolution 250 m; source NASA)
- **Altitude** from SRTM Digital Elevation Model (DEM) (spatial resolution 90 m; source NASA).

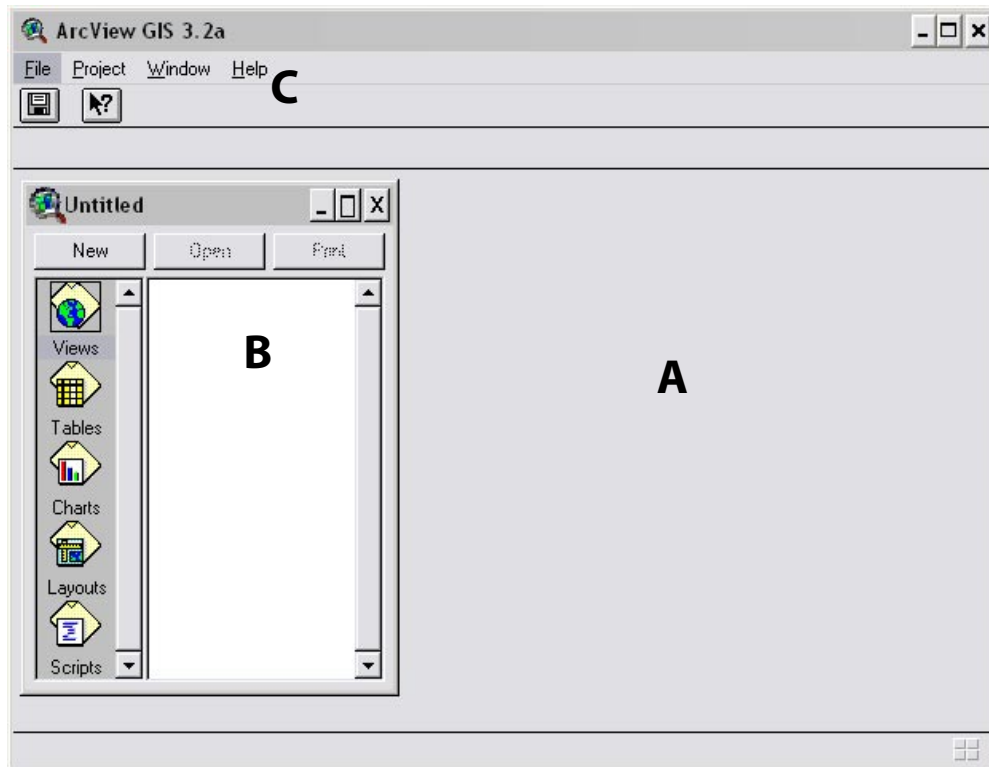
Note: these datasets should already be loaded on your computer in a directory called `C:\Barcelona_GIS`.

## Starting ArcView

ArcView should already be installed on the machine you are using and there should be the following shortcut icon on your desktop:



► Double-click the icon to start the programme. The following window should appear:



This window is made up of two main parts: the main ArcView window (labelled '**A**' here) and the smaller **Project** window ('**B**'). Down the left-hand side of the Project window you can see a set of icons representing various ArcView 'Project elements': namely Views, Tables, Charts, Layouts and Scripts. This window allows you to change between these different elements.

Note that slightly darker grey shading indicates which element is currently active (i.e. 'Views' in the current case).

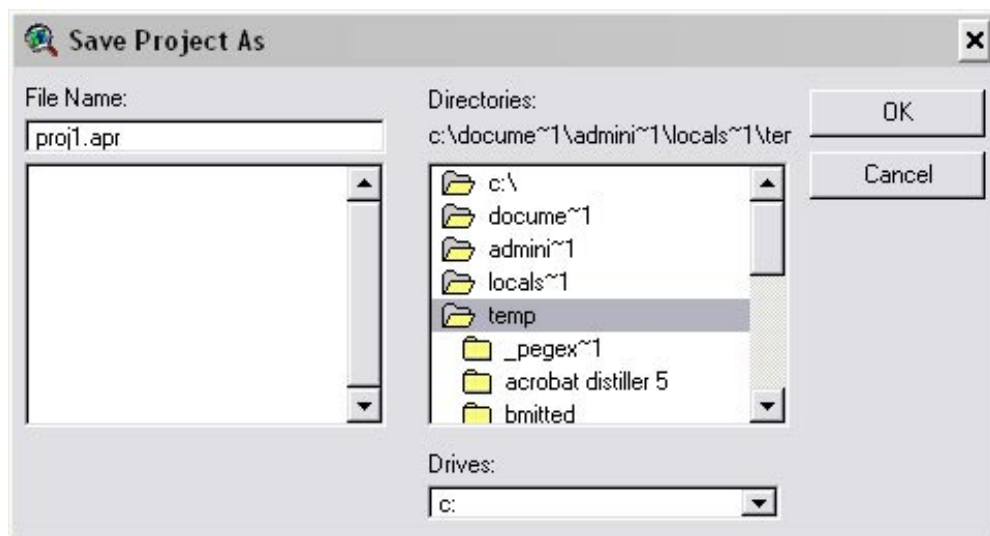
Across the top of the ArcView window is a context-specific menu (the **Main menu**, labelled '**C**'). The specific items contained in this menu will vary depending on which Project element is active (see below).

## Creating a new ArcView Project

ArcView **Projects** are a useful means of keeping track of the work you have been doing. When you create a Project a file with an *.apr* extension is created which contains information on what work has been done, what datasets are being used and what tables and maps have been created or displayed. When you open a project at a later date, ArcView reads this information and re-establishes your Project exactly as it was the last time it was saved.


For this practical we are going to create a Project called '**Eden**' in which to carry out our various GIS tasks.

- To create (and save) the Project, click the **Save Project** button, , located towards the top left of the ArcView window. The following dialogue box will appear:



It is always worth taking extra care to ensure files are saved in the correct directory. In order to save our new Project in the same place as our GIS data (*C:\Barcelona\_GIS*):

- Select *C:* under the pull-down list for **Drives** and then in the **Directories** window double-click first on the topmost *C:* directory and then double-click again on the *Barcelona\_GIS* subdirectory.
- Next, replace the text in the field **File Name** with new text: *Eden.apr*.
- Click on **OK**. The text in the title bar of the Project window should now change to '**Eden.apr**'.

From this point, any changes to the project can be saved simply by clicking on the **Save Project** button, .

It is good practice to save your Project regularly as you go along, in the same way that you would for a word processing document or a spreadsheet.

## Creating a new View

**Views** are the Project element used to display map data. A single View can contain several map layers and an individual project might contain a number of Views, each showing different map features or the same features displayed in a different way. Views are 'live' in the sense that any changes to the original data are automatically reflected in the View.

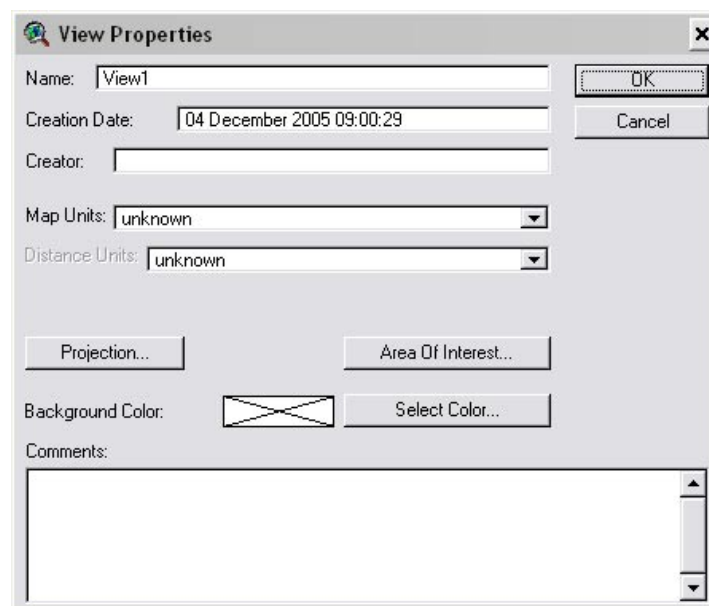
In this exercise we will begin by opening a general outline map of France so that we can get a broad perspective on where recent sandfly sampling has been taking place. To display the map of France we must first create a View:

- Single-click on the **Views** icon in the **Project** window and then single-click on **New**. A new **View** window will appear.
- Single-click on the View's title bar to make sure that the window is active. You will notice that the **Main menu** changes to something like this:



Next, we need to provide some information about this new View, including a name and the map units of the data to be displayed in it.

- Under **View** in the **Main menu**, select **Properties**. The **View Properties** window should appear as shown here:

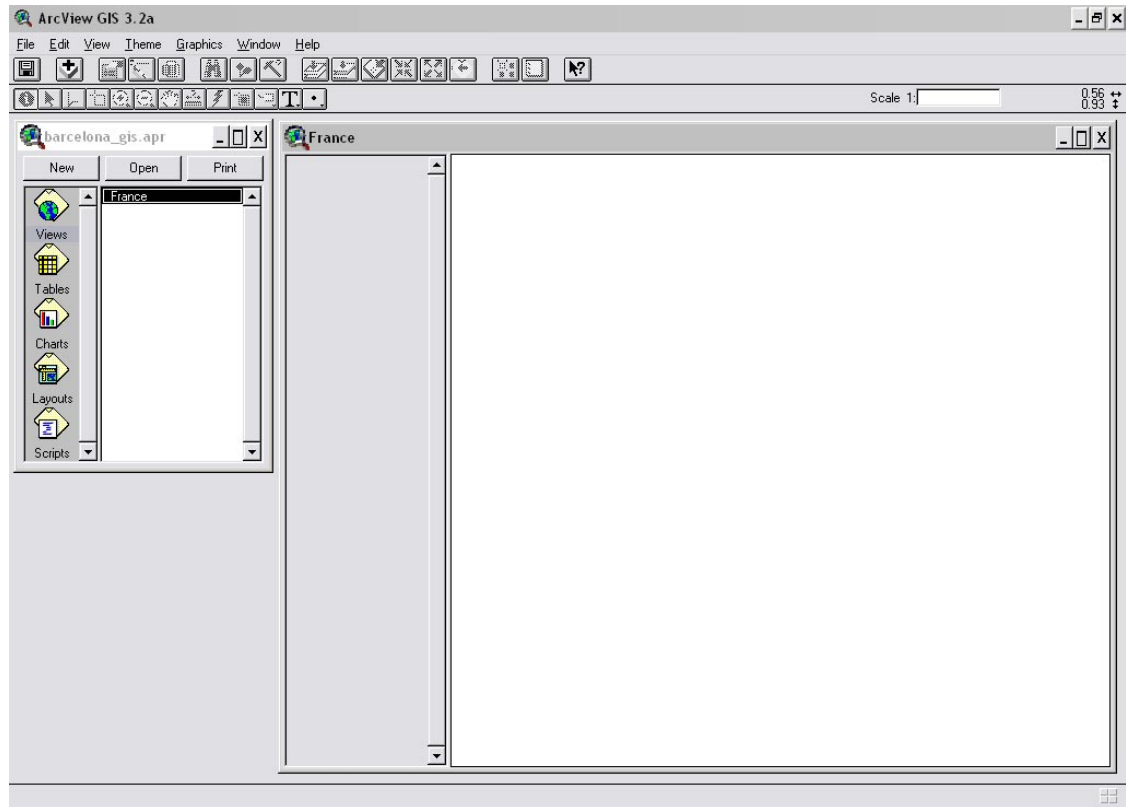


- In the field called **Name**, type a new name for the View; '**France**'.

The map projection we are using is called the Universal Transverse Mercator projection (UTM), in which coordinates are expressed as distances in metres from an arbitrary origin. We need to set the **Map Units** for our View to reflect this (but we will leave the rest of the projection information unchanged).

- Set the **Map Units** field to **Metres**.


- Next, set the **Distance Units** field to **Metres** also (this specifies how we would like distances to be expressed when we calculate distances etc.) .
- Click on **OK**. 'France' should now appear in the View's title bar.
- Finally, move and resize the View and Project windows so that the ArcView window looks something like this:

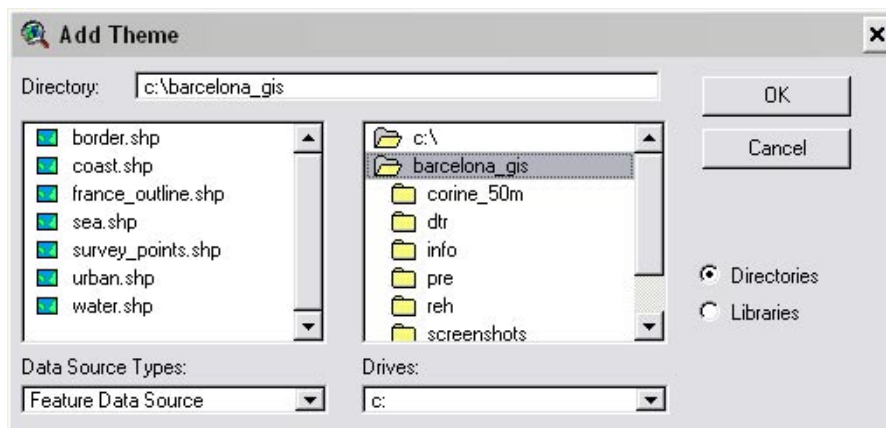


## Displaying geographical data

You are now ready to display some geographical data in the View window. You do this by adding **Themes** to the View. A Theme is a geographical dataset, normally containing one type of feature (e.g. roads, administrative areas, coastlines etc.). ArcView calls them Themes to get around the fact that it can display geographical data from several sources, including ArcView Shapefiles (which is what we will use here), GIS data from other ESRI software and coordinates from text files.

Before we add a Theme to a View we need to ensure that the View is active by clicking (once) on the View's title bar. Next we will add a Theme containing the outline of France:

- Click on the **Add Theme** button . A window similar to the one below should appear:

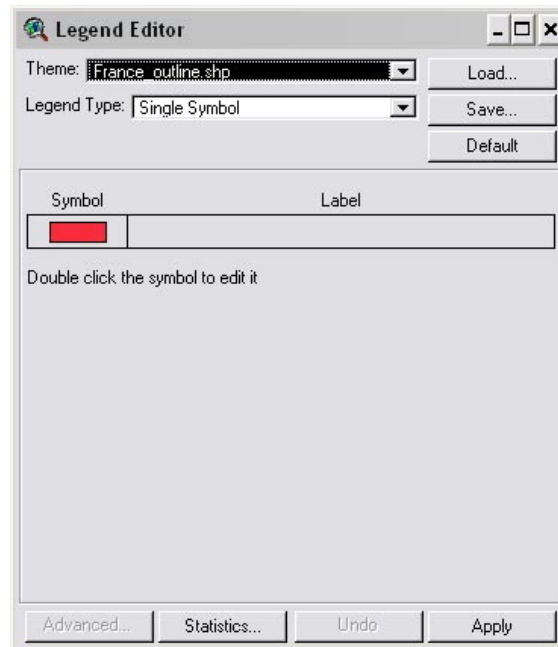


- Find the file *France \_ outline.shp*, located in the directory *C:\Barcelona \_ GIS*.
- Click on *France \_ outline.shp* to highlight it and then on click on **OK**. '**France \_ outline.shp**' should now appear in the legend to the left side of the View window.
- To display the Theme click on the check box next to the text '**France \_ outline.shp**'. You can then hide the Theme and make it reappear again by toggling the check box as necessary.

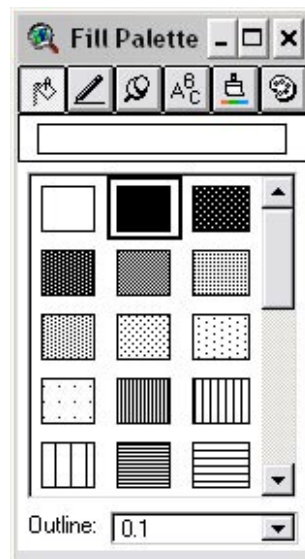
## Changing map symbols

When you load a Theme, ArcView uses a randomly selected symbol to display it. Often, you will want to choose your own symbols instead. To change the symbol used to display **France\_outline.shp**:






- Double-click on the symbol currently being used to display 'France\_outline.shp' in the legend to the left hand side of the **View** window. This will bring up the **Legend Editor**:



- To change the symbol, double-click on the symbol itself to bring up the **Palette Editor**:




The buttons across the top of this window represent the different palettes available:


Shade  , Line  , Marker  , Text  , Colour  . Click on the respective buttons to change between each palette.





For the moment we will shade the map of France using a solid, pale green colour.

- First, make sure that the **Fill Palette** dialogue is open in the **Palette Editor** by single-clicking on the  icon.


Most of the options in this palette should be self-explanatory – although it is probably worth pointing out that the first symbol does not represent white, but transparent.

- To select a solid fill, single-click on the solid fill symbol (the black rectangle located in the middle of the top row). To change the colour of the fill, single-click on the **Colour** button, , and select the a pale green **Foreground** colour by clicking on it.

The symbol in the Legend Editor window changes to the new symbol.





- Close the Palette Editor using the  button and then click on **Apply** in the Legend Editor window. The map should now update itself to show the new symbol. If this looks OK, close the Legend Editor, again using the  button.

The method of selecting symbols, fills and colours is essentially the same for point, line or polygon features. To illustrate this we will add some additional Themes to the current View and modify their legends.




- Click on the **Add Theme** button, . Note that you can select more than one dataset from the list of files by holding down the **Shift** key on your keyboard and then clicking on each of the datasets required with the left hand button of your mouse (keeping the Shift key pressed at the same time). Use this method to select the following Themes from the current file list: *Border.shp*, *Sea.shp*, *Urban.shp* and *France \_departement.shp*.
- Click on **OK**. Display the new Themes in the View by clicking in their checkboxes.

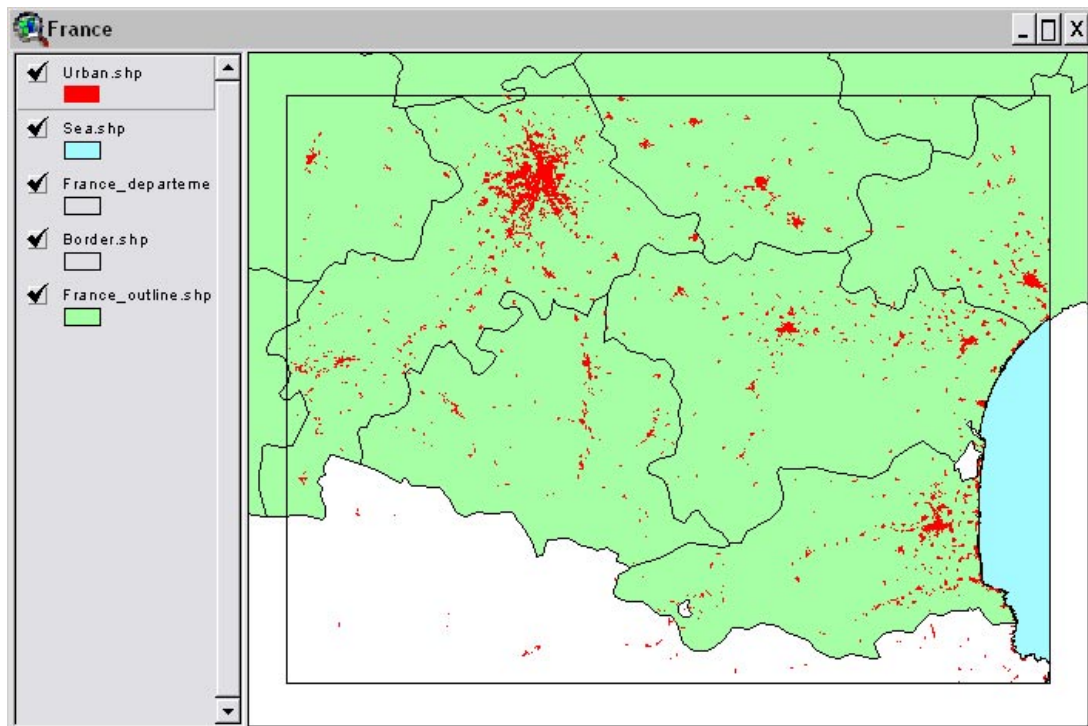
## Zooming

The Themes you have just added are specific to the study area for this year's sandfly surveys in southern France. At present you can probably not see the new features clearly because the study area is relatively small. To zoom to the area of interest there are several options:

- Click on the **Zoom In** button,  at the top of the ArcView window. Then single-click on the location that you want to zoom in to. You can repeat this process until you are happy with the way the screen looks.
- Click on the **Zoom In** button, . Move the cursor to the top left corner of the area of interest and then, holding the left mouse button down, drag out a box to cover the area required and release the mouse button. The screen will then redraw to that area.
- Click on the Theme(s) of interest in the View's legend and then click on the **Zoom to Active Theme** button, . This method is the easiest as it zooms to the area covered by the features in the selected Themes. Try this in the current Project by first highlighting **Border.shp** in the current View's legend and then clicking on the  button.

As you have done before, next change the symbols for each Theme to make your View better looking:

- Double-click on **Urban.shp** in the View's legend and then again on the current symbol in the Legend Editor. Click on  and change the **Foreground** colour to red. Next, set the **Outline** colour as transparent (by choosing the top left option within the Colour Palette). Next, close the Colour Palette using the  button and then click on Apply in the Legend Editor. Close the Legend Editor using the  button.
- Repeat this process to show **Sea.shp** as blue and to make the fills colours of **Border.shp** and **France\_departement.shp** transparent. Your View should look something like this:



- Now is a good time to save your Project. Click on the  icon to do this.

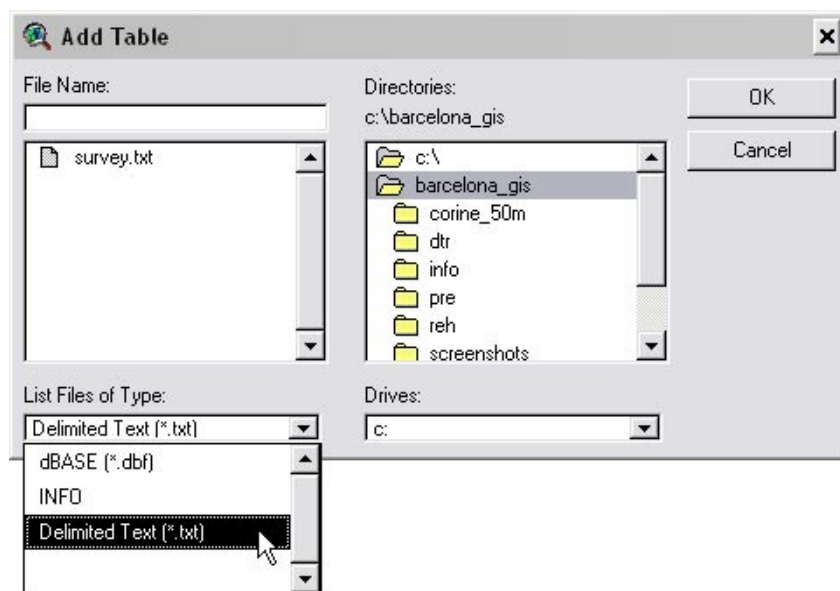
## Using tabular data: opening tables

Like Views, **Tables** are one the the main Project elements used in ArcView and in this exercise will illustrate the use of data tables by first loading our table of sandfly data into the current Project and then displaying the data in our View.

Within the directory *C:\Barcelona\_GIS*, our data table is found in a text file called **Survey.txt**. Each line in this data table provides information on the number of *P. ariasi* and *P. perniciosus* trapped (at a total of 168 sites), as well as information on the number of papers used and some basic site characteristics.

We will start by opening the table containing the sandfly survey data:

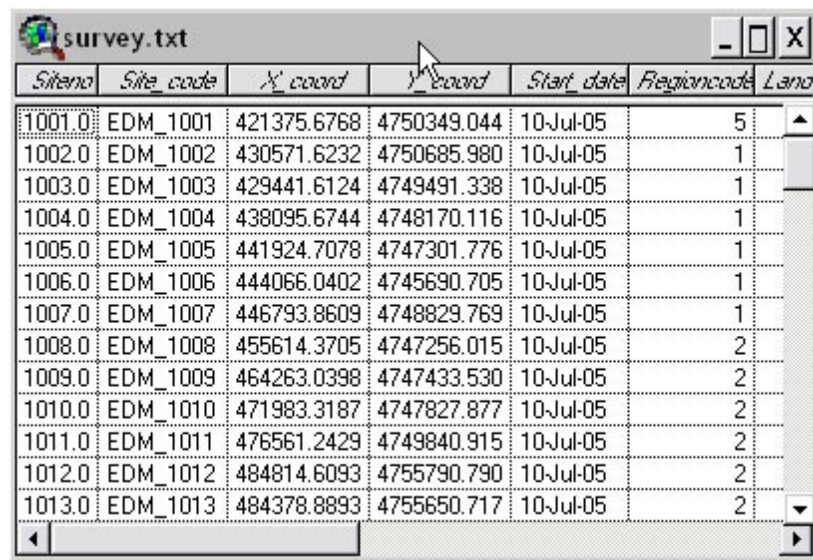
- In the **Project** window, single-click on the **Tables** icon. You now have the option to create a **New** Table or **Add** an existing one. In this case, because we want to incorporate our existing Table into the project, click on **Add**. The **Add Table** window should appear as shown here:



*Note: if you have inadvertently **double-clicked** on the Tables icon, or have selected '**New**' instead of '**Add**', ArcView will display the **Create Table** window. Click on **Cancel** and then in the Project Window click on **Add** to bring up the correct window.*

ArcView can display tables stored in in dBASE (\*.dbf), Arc/Info or delimited text (\*.txt) formats. In the current case the Table we are using was saved in Excel as a **tab-delimited text file** with a .txt extension.


- In the current dialogue, set the **List Files of Type** option to **Delimited Text** and navigate to the correct directory as above if necessary (set the **Drives** option to **C:** and then select the sub-directory *Barcelona \_ GIS* ). The list of available text files will be shown.
- Click once on *Survey.txt* and then click on **OK** (note that double clicking on the file of interest will have the same effect). The Table should open as shown here:



SiteNo	Site_code	X_coord	Y_coord	Start_date	Regioncode	Lano
1001.0	EDM_1001	421375.6768	4750349.044	10-Jul-05	5	
1002.0	EDM_1002	430571.6232	4750685.980	10-Jul-05	1	
1003.0	EDM_1003	429441.6124	4749491.338	10-Jul-05	1	
1004.0	EDM_1004	438095.6744	4748170.116	10-Jul-05	1	
1005.0	EDM_1005	441924.7078	4747301.776	10-Jul-05	1	
1006.0	EDM_1006	444066.0402	4745690.705	10-Jul-05	1	
1007.0	EDM_1007	446793.8609	4748829.769	10-Jul-05	1	
1008.0	EDM_1008	455614.3705	4747256.015	10-Jul-05	2	
1009.0	EDM_1009	464263.0398	4747433.530	10-Jul-05	2	
1010.0	EDM_1010	471983.3187	4747827.877	10-Jul-05	2	
1011.0	EDM_1011	476561.2429	4749840.915	10-Jul-05	2	
1012.0	EDM_1012	484814.6093	4755790.790	10-Jul-05	2	
1013.0	EDM_1013	484378.8893	4755650.717	10-Jul-05	2	

You will see also that the **Main menu** has changed to the **Tables** version, shown here:



Table windows can be moved, resized and closed in the same way as other windows in ArcView. For the moment use the  button to close the Table. This removes it from the display and from the main ArcView window, but the Table remains present in the Project (notice that **Survey.txt** now appears in the list of Tables in the Project window).

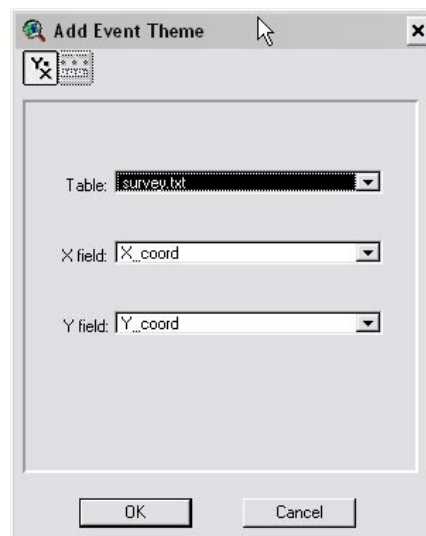
► Now is a good time to save your Project.

## Using tabular data: displaying data as maps

If, as in the case of **Survey.txt**, a table of point features contains columns for X coordinates ('Longitude' or 'Easting') and Y coordinates ('Latitude' or 'Northing'), it is possible to display the Table in a View by means of an '**Event Theme**'

To display the data in **Survey.txt** in our current View:

- Make the current View window for '**France**' active by single-clicking on its title bar (or, alternatively by clicking once on **Views** in the Project window and then double-clicking on '**France**' to make the View active).
- Next, under the **View** section of the **Main Menu** select **Add Event Theme**. This should bring up the following window:



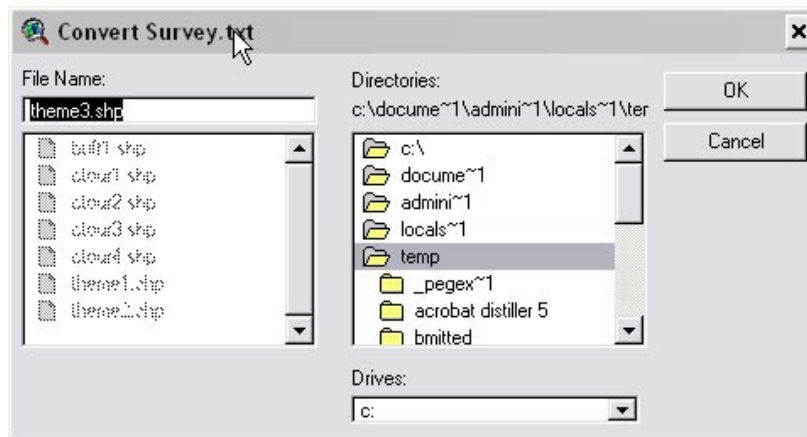
In this case ArcView has assumed (correctly) that the columns in the text file called **X\_coord** and **Y\_coord** represent the X coordinates and Y coordinates of our survey locations respectively. In other situations you may need to use the pull-down lists to point the software towards the columns containing your coordinate data.

- Click on **OK**. A new Theme, **Survey.txt**, will appear in the View window. Click on its checkbox to view it.

Although the survey locations now appear in the View as a map, at the moment they are only a graphical representation of the coordinates in the data table. For further analysis we need to convert the Event Theme into a **Shapefile** – which is the native ArcView file format.

To do this:

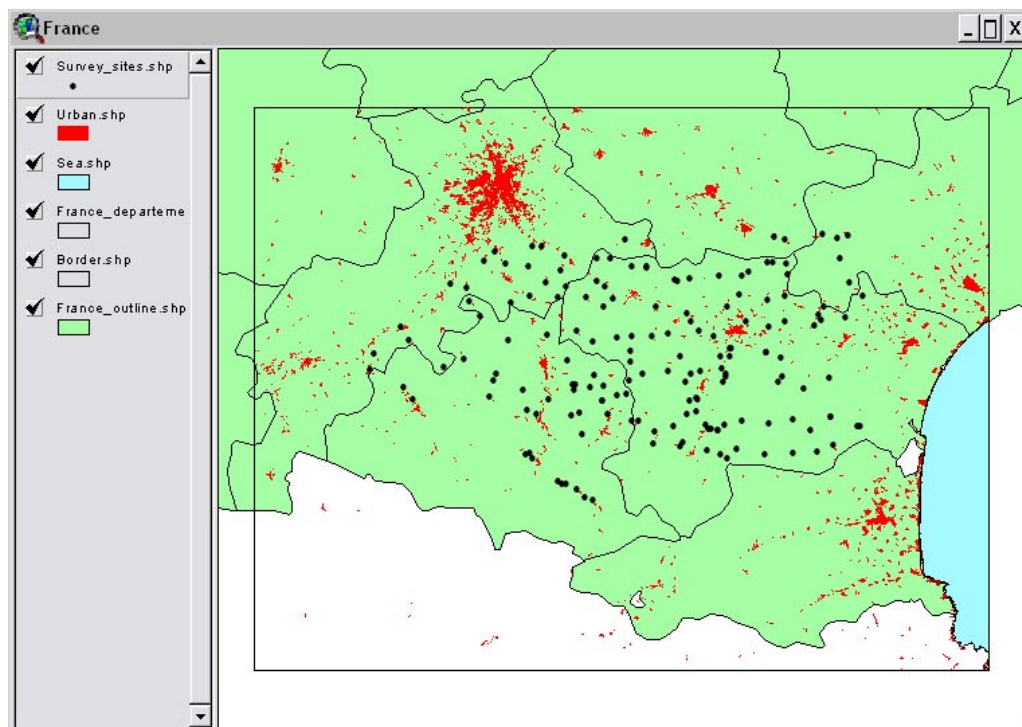
- Make sure that the file **Survey.txt** is selected (and highlighted) within the legend of the current View window.
- Next, under **Theme** in the **Main Menu**, select **Convert to Shapefile**. This should bring up the following window:



- In the **Directories** window double-click on C:\ and then double-click on the sub-directory Barcelona \_ GIS.
- Next, in the **File Name** field, change the file name to **Survey\_sites.shp**. Click on **OK**. You will be asked if you want to display the new Shapefile as a Theme in the current View, click on **Yes**.
- Click on the checkbox for **Survey\_sites.shp** to view it and then double-click on its current symbol. Change the current symbol to a small black circle.

As you do no longer need the Event Theme for the data table **Survey.txt** you can remove it from the View:


- Highlight **Survey.txt** in the View's legend. Select **Edit** from the **Main menu** and then click on **Delete Theme**. Choose **Yes** to confirm. Your View should now look similar to this:







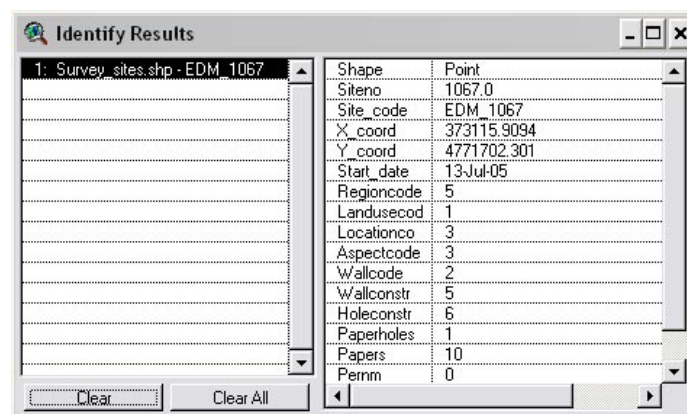
## Theme attributes: getting information about features

So far the practical has concentrated on the location or geography of features – but the key to a GIS is linking these **spatial** features with their associated **attributes**.

Probably the easiest way to look at the feature attributes of a Theme is by using the **Identify** button, . This allows you to point to individual features to find out information about them.

We will use the Identify button to explore data for our survey sites in the current View window.

- To enable us to see our survey points more clearly, first ensure that **Survey\_sites.shp** is highlighted in the View's Legend and then click once on the  button to **Zoom to Active Theme**.
- Next, click once on the **Identify** button, . The button should become highlighted, and you should also notice that when you move the cursor over the View window it changes to a cross.
- Move the cursor over a survey location and click once. The **Identify Results** window should appear as shown below:




The left hand panel of this window shows which **Feature** has been identified together with the **Theme name** and an **identifier** for the feature itself (the 'label' item). The right hand panel shows the attributes associated with the features in the Theme. For our survey points items include site ID and site coordinates and characteristics, as well as the number of *perniciosus* and *ariasi* trapped.

You will also see an item called **Shape**. This is an auto-generated feature which tells ArcView what type of feature the Theme contains (in this case points).

- Click on another survey location. A second record should appear in the left panel, while the values in the right hand panel change to those of the most recent point selected.

At this point it is worth bearing in mind many ArcView function buttons (e.g. Zoom, Identify) will stay active until another function is selected. This means that whichever button is highlighted in the Main Menu will determine what happens when you click in a View. As it is possible to click in the View by accident it is useful to have a function which has no effect on the View.


- Click on the Pointer button, . It is now safe to click in the View (as nothing will happen when you do). Close down the Identify Results window.

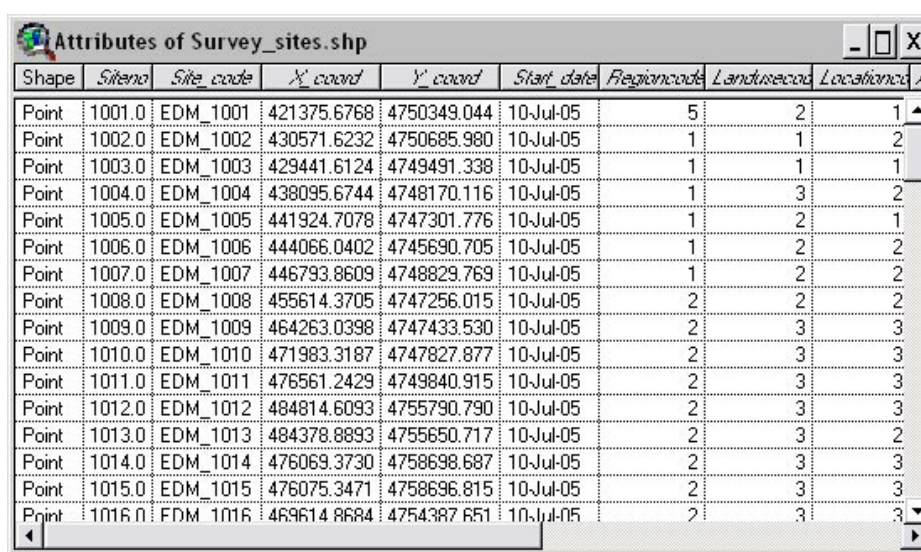
## Theme attributes: using Theme attribute tables

The attributes we have just explored using the **Identify** function are directly linked to the geography of the Theme through its **Theme attribute table** (sometimes just referred to as a 'Theme table' or 'attribute table').

Every Theme that is displayed in a View will have an attribute table. Clearly, the content of different attribute tables will vary between different Themes and will depend on the features they contain. However, all attribute tables will have at least one item ('Shape').

Although it is possible to examine attributes using the Identify function (as we have just done), it is often more informative to examine the attribute table itself.

- To open the attribute table for our survey points, first make sure that **Survey\_sites.shp** is highlighted in the Legend and then click on the **Open Theme Table** button, . The attribute table for **Survey\_points.shp** should appear as shown below:



Shape	SiteNo	Site_code	X_coord	Y_coord	Start_date	Regioncode	Landusecod	Locationcode
Point	1001.0	EDM_1001	421375.6768	4750349.044	10-Jul-05	5	2	1
Point	1002.0	EDM_1002	430571.6232	4750685.980	10-Jul-05	1	1	2
Point	1003.0	EDM_1003	429441.6124	4749491.338	10-Jul-05	1	1	1
Point	1004.0	EDM_1004	438095.6744	4748170.116	10-Jul-05	1	3	2
Point	1005.0	EDM_1005	441924.7078	4747301.776	10-Jul-05	1	2	1
Point	1006.0	EDM_1006	444066.0402	4745690.705	10-Jul-05	1	2	2
Point	1007.0	EDM_1007	446793.8609	4748829.769	10-Jul-05	1	2	2
Point	1008.0	EDM_1008	455614.3705	4747256.015	10-Jul-05	2	2	2
Point	1009.0	EDM_1009	464263.0398	4747433.530	10-Jul-05	2	3	3
Point	1010.0	EDM_1010	471983.3187	4747827.877	10-Jul-05	2	3	3
Point	1011.0	EDM_1011	476561.2429	4749840.915	10-Jul-05	2	3	3
Point	1012.0	EDM_1012	484814.6093	4755790.790	10-Jul-05	2	3	3
Point	1013.0	EDM_1013	484378.8893	4755650.717	10-Jul-05	2	3	2
Point	1014.0	EDM_1014	476069.3730	4758698.687	10-Jul-05	2	3	3
Point	1015.0	EDM_1015	476075.3471	4758696.815	10-Jul-05	2	3	3
Point	1016.0	EDM_1016	469614.8684	4754387.651	10-Jul-05	2	3	3

- Click once on the title bar of the window called **Attributes of Survey\_sites.shp** to ensure that it is active and then move the Table window so that it does not obscure the Project window. You will see that the **Main menu** has changed, and that the table called **Attributes of Survey\_sites.shp** now appears in the Project window.

The 'Tables' Project element in the Project window now contains two different types of table. The first is the data table, **Survey.txt**, which we added earlier in the practical. The second is the **Attributes of Survey\_sites.shp**, which we have just opened via the View window.

*Note: it can sometimes be important to be able to tell the difference between data tables and Theme attribute tables. The simplest way to do this is to look at the Table window's title bar: when a title begins with the words 'Attributes of ...' it indicates that the table in question is an attribute table and is associated with a specific Theme. Data tables, on the other hand, are not linked to Themes (other than Event Themes) and are opened though the Tables element in the Project window.*

As with Views, you can control the Table window using the standard techniques of resizing, maximizing or minimizing. Once closed, tables can be re-opened by double-clicking on them in the Project window.

- For the moment, close down the Theme attribute table using the  button.



## Mapping feature attributes

We can use a Theme's attribute data to make meaningful maps of specific variables. For example, in the case of **Survey\_sites.shp**, all we have at the moment is a map of where the sites are located. However, if we are a little more imaginative about our choice of symbols we can use the Shapefile's attribute table as a basis for maps of various site characteristics (e.g. aspect, land use type or number of *perniciosus* or *ariasi* trapped).

Earlier, you changed the symbol for displaying survey sites from the default symbol to a small black circle. This time you will select a symbol that can vary to represent certain attribute values.

- To do this first make sure that the legend for **Survey\_sites.shp** is highlighted in the legend panel of the View window. Double-click on the current symbol (a black circle) to bring up the **Legend Editor**.

If we want the new symbol to represent certain attribute values we need to change the **Legend Type**. There are several legend types available in the drop-down list:

*Single Symbol* – One symbol is used for all features

*Graduated Colour* – Features are coloured according to their attribute value

*Graduated Symbol* – Features vary in size depending on their attribute value

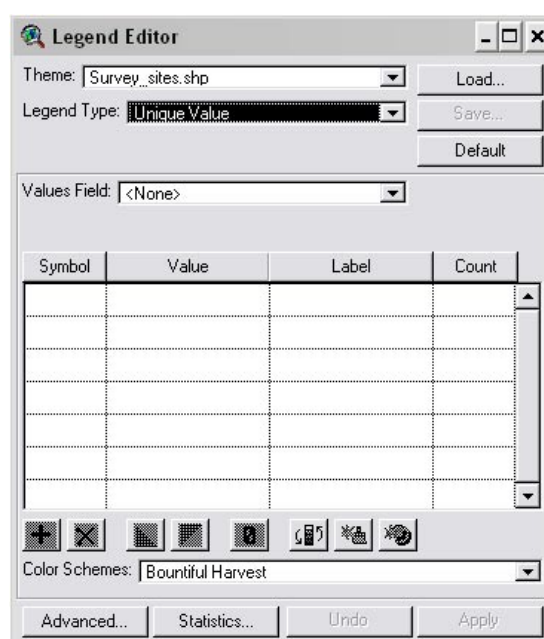
*Unique Value* – Individual symbols are used for each attribute value

*Chart* – Charts show attribute values instead of symbols

The first stage is therefore to choose how the attribute values of interest are to be represented.

In situations where there are only a few categorical (coded) 'outcomes' to map, it is most common to use a **Unique Value** for each. In the current dataset, **Survey\_sites.shp**, for example, there is a data field called '**Locationco**' (location code) which has only 3 possible codes (1-3). A **Unique Value** legend is the most appropriate in such a case.

- To make a **Unique Value** legend for **Locationco**, set the **Legend Type** to **Unique Value**. The menus in the Legend Editor will change as shown below:



It is now possible to select the attribute to display using the **Values Field** pull-down list.

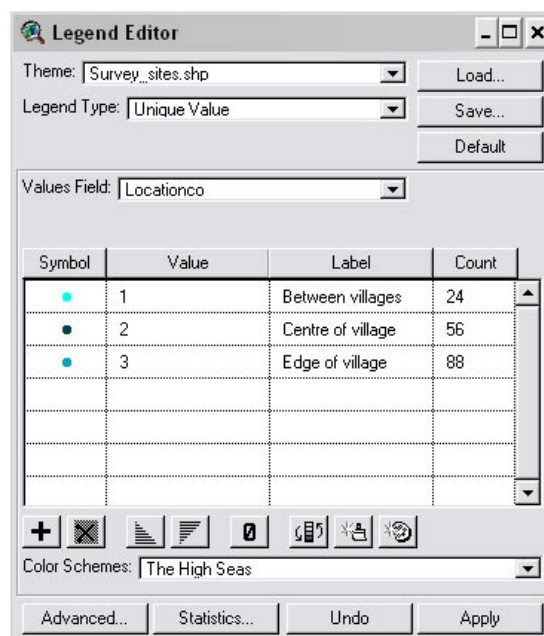
- Click on the down-arrow to the right of the pull-down list and then scroll down and click once on **Locationco**.

The main window now shows the the full range of values for **Locationco**, with an automatically-selected symbol for each. The **Label** field shows how each value for Locationco will be displayed in the View's legend, while **Count** indicates the number of features corresponding to each attribute value.

From here you can either modify the symbol colour for each value manually or, alternatively, use the **Colour Schemes** pull-down list at the bottom of the Legend Editor to specify a system-generated colour scheme. In this case, choose '**The High Seas**' at the bottom of the list of Colour Schemes and leave the symbol shapes as circles.

At the moment our legend contains just code values for our regions. To change the text to something more meaningful, simply click in each box in the **Label** column and replace the existing codes with new text.

- Use this approach to change the labels for each code as in the example below:

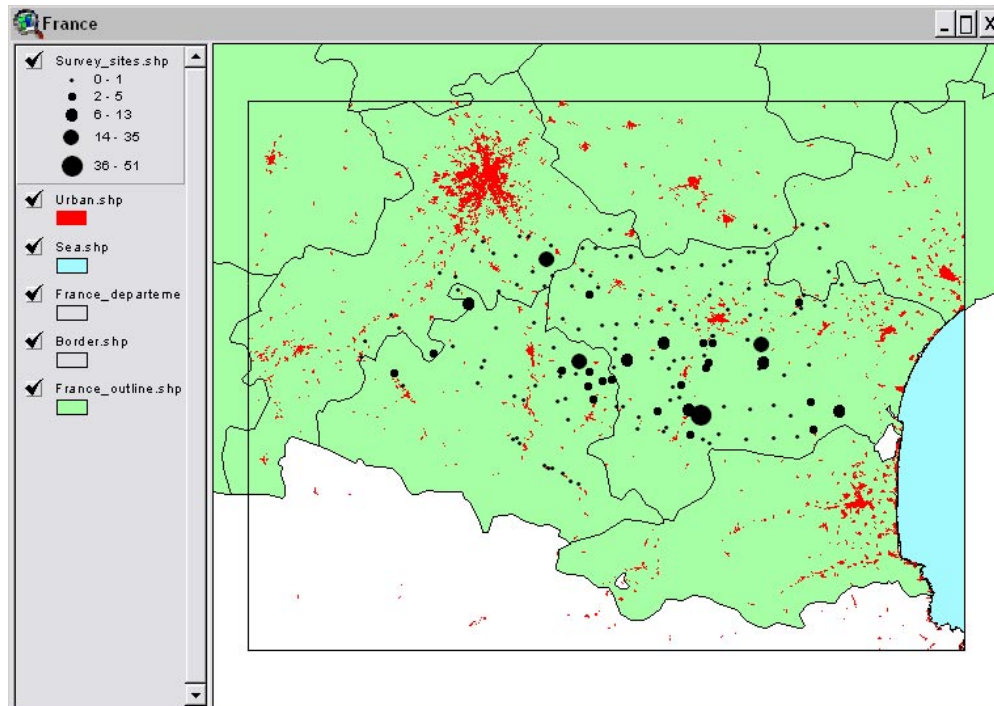


- Click on **Apply** and then close down the Legend Editor window. You will now see that the legend for **Survey\_sites.shp** now incorporates the changes you have made to its symbols and text.

In this example, we elected to use a **Unique Value** legend because the attribute **Locationco** contains only three categorical outcomes. However, when dealing with continuous variables we are more likely to use either a **Graduated Color** or **Graduated Symbol** legend because the number of unique values for the attribute is likely to be large. In the current dataset, for example, we have two data fields representing the total numbers of male *ariasi* and *perniciosus* sampled at each site.

- To change the legend of **Survey\_sites.shp** to show varying numbers of *perniciosus* sampled, repeat the steps above but select **Graduated Symbol** as the **Legend Type** and **Pernm** as the classification field.


- Double-click on the **Symbol** field (located near the bottom of the Legend Editor window) and change the symbol foreground colour to black using the **Color Palette**. Close the palette and in the Legend Editor change the upper limit of the **Size Range** to 18. Click on **Apply** and close the Legend Editor window. Your View should now look something like this:






- Now is a good time to save your Project.








## ***Theme attributes: selecting data using the cursor***

Earlier in the practical we saw how the **Identify** button can be used to display information about geographical features. In this exercise we will look at alternative ways of selecting features and displaying information about them.

We will start by selecting features using the cursor, using the **Select Feature** button, .

- We will again be using the Shapefile **Survey\_sites.shp** in this exercise, so ensure that the Theme is highlighted in the View's legend.
- Next, click on the **Select Feature** button, . Move your cursor over one of the survey sites (preferably one with a large symbol) and click once. The selected feature will turn yellow.
- Practice using the **Shift** key on your keyboard in combination with your left hand mouse button to select (and unselect) more than one feature. You can also select all the survey points within a rectangle by holding down the left button of your mouse and then moving the mouse to define a selection box.
- To view the attributes of the features you have just selected you need to bring up the attribute table for **Survey\_sites.shp** using the  button. Make the table as large as possible on your screen.
- If you scroll down the table you will see that some records are highlighted in yellow; these are the records that you have just selected using the cursor. To see these records grouped together, click on the **Promote** button,  and you will see that all the selected records are 'promoted' to the top of the table.

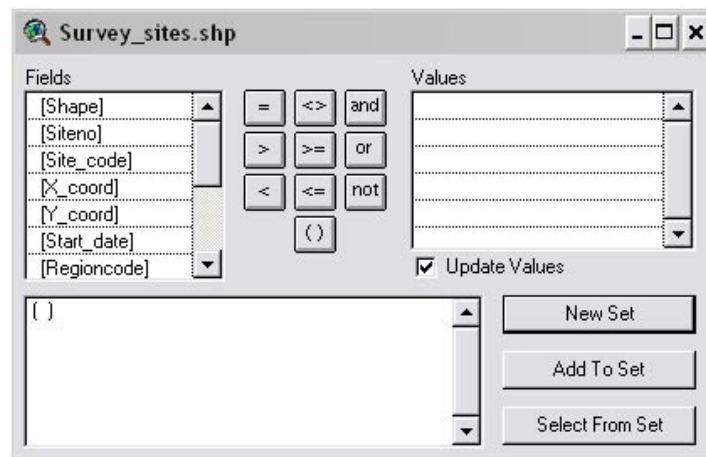
As the Theme attribute table is directly linked to its geography, it is also possible to select records in the table and see where there are in the View.

- Start by clearing the current selection by clicking on the **Select None** button, . (Note that this has exactly the same effect as the **Clear Selected Features** button in the View window, which also uses the same icon, .)
- To select records in the attribute table using the cursor, click on the **Select** button, . Click on any row in the Table. The row should turn yellow. Hold the Shift key down while using your mouse to select multiple records.
- Next, close down the attributes table and activate the **View** window by clicking on its title bar. The selected records should now appear as yellow points. Use the **Zoom to Selected** button, , to zoom to the area covered by the selected features.
- Use the **Zoom to Previous Extent** button, , to go back to the previous view. Next, click on the **Clear Selected Features** button, , to clear the current selection of records.
- Finally, click on the 'neutral' **Pointer** button, , in the Main menu. This means that if you inadvertently click within the View window, nothing will happen.

## Theme attributes: selecting data using data queries

In ArcView the **Query Builder** dialogue, which can be accessed directly from both View and Table windows, offers a flexible and powerful way of selecting data in an attribute table. To illustrate the use of queries, we will start by selecting all survey points at which more than five sandflies have been trapped.

- Make sure that **Survey\_sites.shp** is highlighted in the legend of the View window. Click on the **Query Builder** button, . The Query Builder menu will appear as shown here:




All the items in the Theme attribute table should now appear in the **Fields** panel of the dialogue box. We can now define the query:

- Scroll down the list of available fields to find and highlight the item *[Pernm]*.
- Double-click on *[Pernm]*; the field should now appear in the bottom panel.
- Next, click once on '>' and then double-click on '5' from the **Values** field. To run this query click on **New Set**.


If the query runs properly a set of survey locations will be selected and will turn yellow in the View (these should correspond to points with relatively large symbols and so should be easy enough to see). If the query is unsuccessful an error message will appear (if this happens, close the error message window and the Query Builder menu and then start again).

So far we have only selected sites where more than five *perniciosus* have been sampled. To add to this selection sites where more than five *ariosi* have been sampled:

- Close the current query window, click on  and re-run the query above – but this time select *[Ariam]* from the first list. When you are ready to run the query choose the option **Add to Set** (rather than **New Set**). When you do this, the newly selected records should be added to the pre-existing selected set.

*Note: this is actually a rather longwinded way of choosing the current set of features and was specifically designed to illustrate the difference between the options **New Set** and **Add to Set**.*


*In reality, it would have been more elegant to build the queries for Ariam and Pernm into the following single query: ( [Pernm] > 5 or [Ariam] > 5 ).*

- Close the Query Builder window and click on the **Clear Selected Features** button, , to clear the current selection of records.

## Theme attributes: altering tables

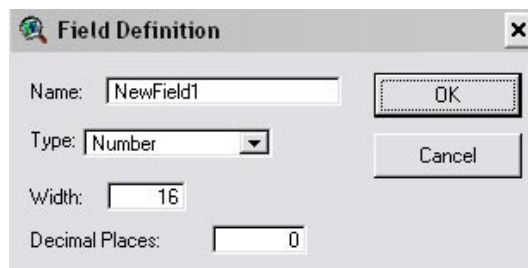
We often need to alter Theme attribute tables, either to update values for existing items/ columns or to add new columns and data. In this exercise we are going to convert the raw counts of *ariasi* and *perniciosus* trapped into figures for the average number of each species trapped *per paper*, which is a much better basis for making inter-site comparisons.

To do this we firstly need to generate two new columns in the Theme attribute table for **Survey\_points.shp** (in which to store the new variables) and then calculate the number of sandflies per paper using data from existing columns.

- Bring up the attribute table for **Survey\_points.shp** using the  button in the View window.
- Under **Table** in the **Main menu**, select **Start Editing** and then maximize the size of the attribute table on your screen.

We can now start to change the Table. The first change we will make is to create a new column called **Pernpp** which we will use to store data for the average number of *perniciosus* per paper at each site.

- Under the **Edit** menu select **Add Field**. The **Field Definition** window should appear:



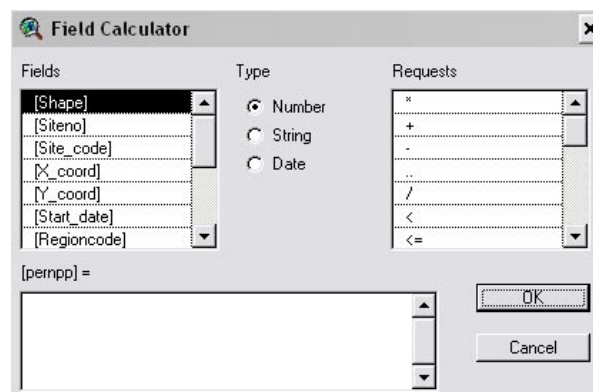
The 'Field Definition' dialog box is shown. It has a title bar with a question mark icon and a close button. The 'Name' field contains 'NewField1'. The 'Type' dropdown is set to 'Number'. The 'Width' field contains '16'. The 'Decimal Places' field contains '0'. There are 'OK' and 'Cancel' buttons on the right.

You can see that when adding a new field you need to define four settings: the field name; the data type; the column width (i.e. the number of spaces/characters required to store the data); and the number of decimal points, if required.

- In the **Name** field, type **Pernpp**. Keep the **Type** field as **Number**. Set the **Width** field as '5' and **Decimal Places** as '2'. Click on **OK**.
- Repeat this process to add a second new column 'Ariapp'. Click on **OK**.

We will now use ArcView's **Calculate** function to fill these empty columns with new data:

- In the table, click on the column heading **Pernpp** so it turns dark grey. Next, under **Field** in the **Main menu**, select **Calculate**. This will bring up the following screen:



The 'Field Calculator' dialog box is shown. It has a title bar with a question mark icon and a close button. It is divided into three sections: 'Fields', 'Type', and 'Requests'. The 'Fields' list contains '[Shape]', '[Siten]', '[Site\_code]', '[X\_coord]', '[Y\_coord]', '[Start\_date]', and '[Regioncode]'. The 'Type' section has three radio buttons: 'Number' (selected), 'String', and 'Date'. The 'Requests' section has a list of operators: '\*', '+', '-', '..', '/', '<', and '<='. Below these sections is a large text area for the expression, currently containing '[pernpp] ='. There are 'OK' and 'Cancel' buttons on the right.

You will see that the text '**[Pernpp] =**' appears to the top of the lower panel in the **Field Calculator** window. This indicates that **Pernpp** will be the field to be updated according to the logical statement to be inserted in the panel below.


In this case we want to set the values in the **Pernpp** field to be the number of *perniciosus* trapped at each site (**Pernm**) divided by the number of papers set out (**Papers**).

- In the **Fields** panel, scroll down the list of attributes and double-click on **[Pernm]**. Next, in the panel called **Requests**, double-click on the division symbol ('/'). Finally, double-click on the item **[Papers]** in the **Fields** panel.

The following logical statement should now appear in the lower panel: '[Pernm] / [Papers]'.

- Click on **OK**. You will now see that in the Theme attribute table the column **Pernpp** has now been filled with the appropriate data for number of sandflies per paper at each site.
- Repeat this process for *ariasi* (making sure that you first highlight the **Ariapp** column in the table).

Now that the table contains the new items, we can either save the changes we have made to the existing Theme attribute table or save it as a new Theme with a different name. The second option is often safer (as you then still have the unaltered Theme table as backup) – and is what we will do in this case.


- Close the Theme attribute table, using the  button.
- In the View window, ensure that the Theme **Survey\_sites.shp** is highlighted. Next, from the **Main menu** select **Theme** and then click on **Convert to Shapefile**.
- As you have done on previous occasions, navigate to *C:\Barcelona \_ GIS* in the **Directories** box and then choose an appropriate filename (e.g. '**Sandfliespp.shp**') in the **File Name** box. Click **OK**.
- This time, when asked, choose *not* to include the new Theme in the current view.
- Save your Project.



## Working with raster grids

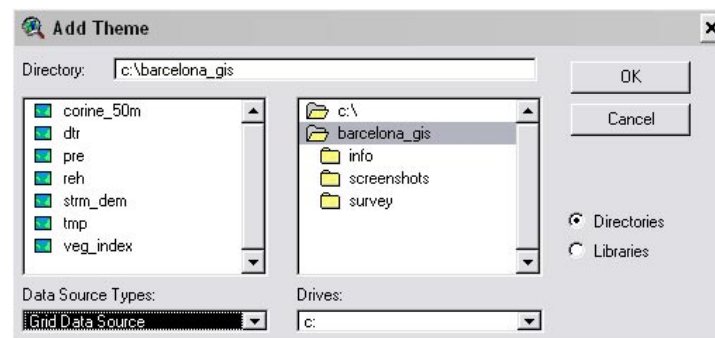
As we saw in the introductory lecture, GIS data for environmental information such as climate variables, elevation or remotely sensed variables such as vegetation indices, are usually stored in the form of raster grids rather than in the vector data model that we have been using so far.

In the final exercise of these practicals we will be exploring the use of raster grids in our project. We will begin by loading a series of grids, representing a variety of environmental datasets, into our current View. We will then overlay our survey locations on these grids, in order to extract environmental data for our sampling points.

- First, make sure that the View window is active. Click on the **Add Theme** button, .


You will notice that towards the bottom of the window is a pull-down list called **Data Source Types** which is currently set to **Feature Data Source** (which means that the file list currently includes only vector GIS Themes).

- To display available grids, select **Grid Data Source** from the pull-down list. The **Add Theme** window should now show a list of available grid datasets:

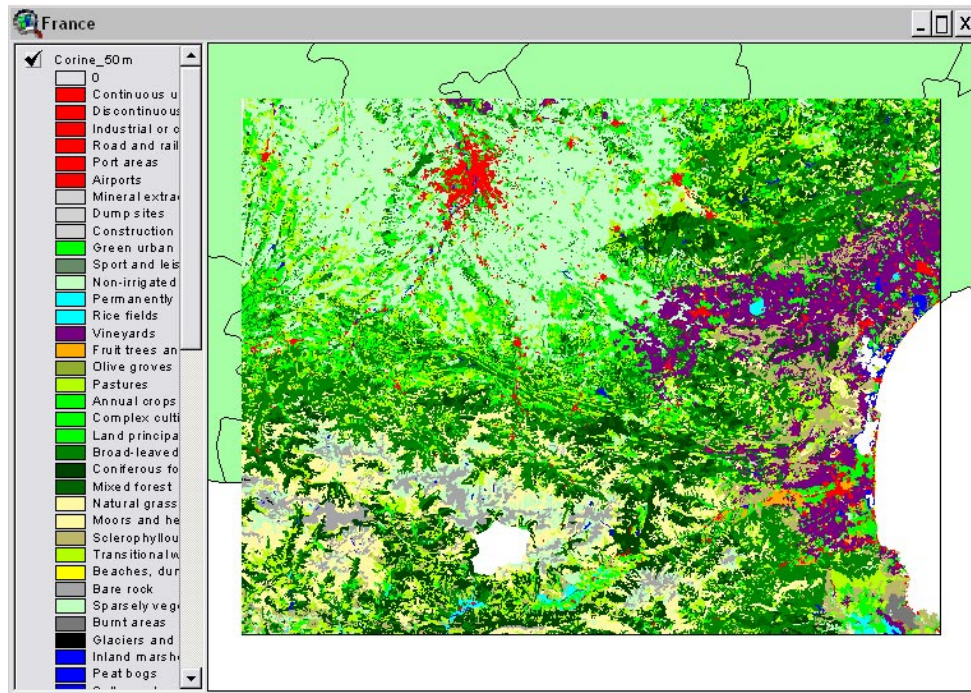


- Double-click on the file **corine\_50m**. '**Corine\_50m**' should now appear in the View's legend. Click on the grid's check box to display the land cover data.

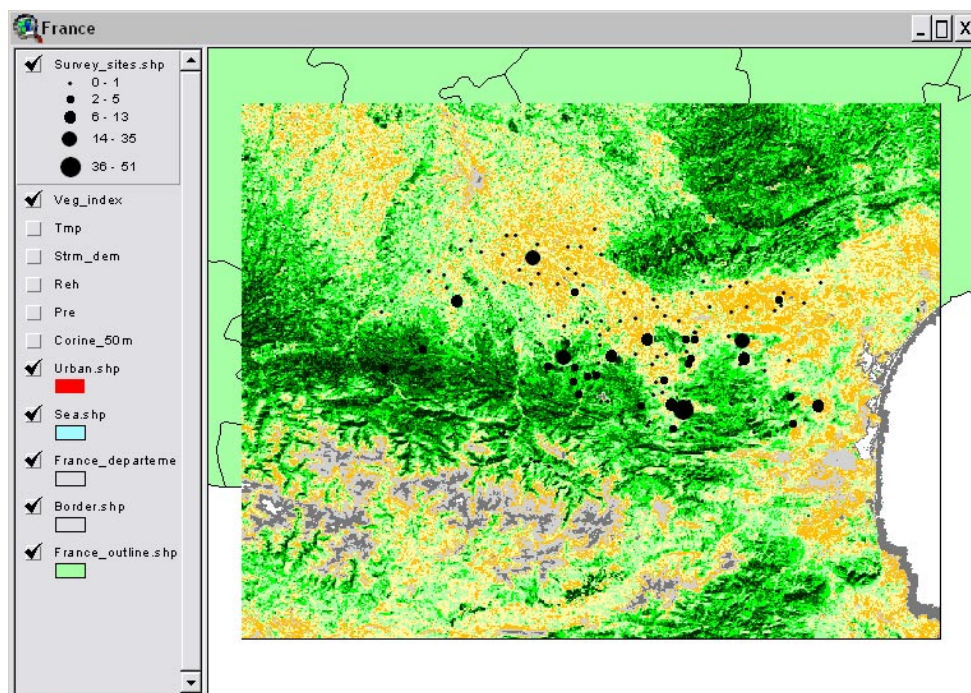
An appropriate legend has already been defined for the Corine dataset and has been saved as an ArcView Legend (\*.avl) file called *Corine \_ 50m.avl*.

- Double-click on the text '**Corine\_50m**' in the View's legend to open up the **Legend Editor**. Click on the **Load...** button to reveal a list of available legend files. Double-click on the file called *Corine \_ 50m.avl* and in the next window (the **Load Legend** dialogue) click on **OK**.
- You should now be back in the main Legend Editor. Click on **Apply** to update the Corine data with the new legend. Close the Legend Editor window using the  button. The View window should look something like this:





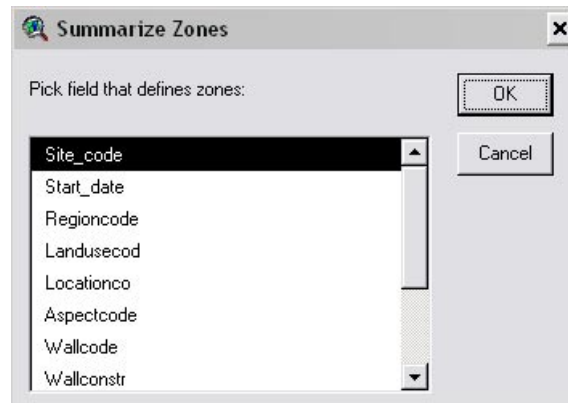
- You will notice that a very long, detailed list of land cover types has now appeared in the View's legend. To make the legend area more tidy, click on **Theme** in the **Main menu** and select **Hide/Show Legend**. This hides the information about individual land cover classes and makes it easier to manage the order in which Themes are displayed. (You can repeat this process to make the full legend visible again).
- Next, add the remaining grids to the current View: *pre*, *reh*, *strm\_dem*, *tmp* and *veg\_index*. As before, you can use the **Shift** key in combination with the left hand button of your mouse to select and load multiple files. For each grid, load the corresponding legend (\*.avl) file and then hide the legend in each case. Finally, re-order the current dataset list in the View's legend so that the Shapefile **Survey\_sites.shp** is uppermost. Your View window should now look something like this:



- Now take some time to use the check boxes associated with each grid to toggle the display for each on and off. Notice how the 'blockiness' of each grid varies depending on its spatial resolution (refer to the dataset descriptions at the beginning of this practical for more details).

Now that we have our various grids open, the next step is to extract data for the various environmental parameters for our survey points. We will illustrate this process by extracting values for vegetation index for our sites.

- Make sure that the Theme **Survey\_sites.shp** is highlighted in the View's legend. Next click on **Analysis** within the **Main menu** and then select **Summarize Zones** from the list. The following dialogue box should appear:




- At this point we need to choose which attribute from our survey data will be used to summarise the grid data. In this case, because we want to derive an individual estimate of vegetation index for each of our sites, we should accept the automatically-selected field **Site\_code**. Click **OK**.
- Next, we are presented with a list of possible variables to summarize, based on the set of grids that we currently have open. Again, the current variable of interest, **Veg\_index**, is already highlighted, so we just have to click on **OK**.
- ArcView now proceeds to calculate and extract the vegetation index data for each survey site. By default it then tries to produce a chart showing the summarised data. However, in this case, because the number of unique zones is greater than 25, it is not able to create the chart. Click on **OK** in the resulting message box to acknowledge this.
- The following table should now appear on your screen, and within the listing in the Project window:

Site_code	Zone-code	Count	Area	Min
EDM_1001	1	1	62500.0000	40
EDM_1002	2	1	62500.0000	37
EDM_1003	3	1	62500.0000	34
EDM_1004	4	1	62500.0000	46
EDM_1005	5	1	62500.0000	36
EDM_1006	6	1	62500.0000	42
EDM_1007	7	1	62500.0000	41
EDM_1008	8	1	62500.0000	41
EDM_1009	9	1	62500.0000	34
EDM_1010	10	1	62500.0000	35
EDM_1011	11	1	62500.0000	24
EDM_1012	12	1	62500.0000	33

- Maximize the size of the table window and examine the column headings and data within the table.

The first column contains data for **Site\_code**, which we deliberately selected as the basis for our summary. The second column, **Count**, tells us how many grid cells intersect with the features being used to summarise the grid. Because we are summarising the grid using a point Theme, this value will always be equal to 1 (this probably wouldn't be the case if we were summarising a set of polygons, as each polygon would probably overlap with a number of grid cells). Because only one grid cell per site is being summarised, much of the data in the rest of the table contains the same value. (In other words, because  $n=1$ , the mean value is equal to the maximum. minimum and median values etc.)

In reality, the easiest way to edit this table is to convert it to a spreadsheet format and use an external software programme such as Excel. To export the table to a suitable format:

- Click on **File** within the Main menu and select **Export**. In the **Export Table** window that follows, choose **dBase** as the **Export Format** (it should actually be highlighted already) and click on **OK**.
- A dialogue box called **Export Table** should now appear. As you have done on previous occasions, navigate to *C:\Barcelona \_ GIS* in the **Directories** box and then choose an appropriate filename for the new dBase file (e.g. '**veg.dbf**') in the **File Name** box. Click **OK**.
- Next, close down the current data table using the  button and then activate the Project window. Within the Project window, highlight the **Tables** element if it is not already highlighted. From the list of available tables highlight **Stats of Veg\_index within Zones of Survey\_sites.shp**. Press the delete key on your keyboard or, alternatively, choose **Project** and then **Delete 'Stats of Veg\_index within Zones of Survey\_sites.shp'** from the Main menu.

You have now successfully extracted the vegetation index data for each of your sites. You should now be able to repeat this process to extract site-specific environmental data for contained in each of the remaining grids for elevation and climate and export the results as a series of dBase files. From there it is a question of using your preferred spreadsheet or database software to merge the various dBase files and delete any redundant columns. However, as we have now come to the end of the current practical, this is something that you will need to practice in your own time!

CONGRATULATIONS ON FINISHING THIS ARCVIEW PRACTICAL!