

# DEVELOPMENT OF A GEO-REFERENCED DATABASE FOR IMPROVED PROGRAM PLANNING AND IMPLEMENTATION: TASK ORDER FINAL REPORT

Task Order No. 816 under the Biodiversity & Sustainable Forestry  
(BIOFOR) IQC

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## ACRONYMS

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BIOFOR	Biodiversity & Sustainable Forestry
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CCAD	Central American Commission for Environment and Development
GIS	geographic information system
MIS	management information system
PROARCA	Regional Environmental Program for Central America (USAID/G-CAP)
SICA	System for Central American Integration
USAID	U.S. Agency for International Development



## A. Background

As described in the Scope of Work, this BIOFOR task order facilitated the creation of two products. One is a geographic information system (GIS) to assist staff working on USAID/G-CAP's Regional Environmental Program for Central America (PROARCA). The other product is a geo-referenced management information system (MIS) to assist the System for Central American Integration's (SICA) Central American Commission for Environment and Development (CCAD) in coordinating and facilitating environmental and natural resource activities throughout the region.

The purpose of this document, the Final Report, is to:

- Summarize our methodology used to complete this task order
- Discuss the utility of products prepared through this task order
- Provide recommendations for PROARCA's next steps in the use of GIS technology
- Provide recommendations on how the MIS could be enhanced to provide greater value for CCAD

## B. Project Methodology

Chemonics directed and oversaw CATIE's hands-on development of the GIS, MIS, and training. Chemonics' technical advisors, Mike Paquette and Mohamed Khatouri, worked closely with CATIE to establish design specifications and product standards for task order deliverables. As the project progressed, the Chemonics' technical advisors tested the GIS and MIS tools and explored additional methods for organizing and analyzing data specific to PROARCA and CCAD's distinct missions. Claudio Saito and Amy Bodmann facilitated communication between the task order team and local stakeholders. This helped ensure that team members understood the needs of these stakeholders, and that these needs were addressed appropriately during development.

This task order started up in Central America on the week of April 15. The Chemonics team of Mike Paquette, Mohamed Khatouri, Claudio Saito, and Amy Bodmann, together with Jeff Jones of CATIE, met with USAID and PROARCA personnel in Guatemala and with CCAD staff in El Salvador, and finished the week with a two-day work planning session in Costa Rica. The goal of these meetings was to gain a more detailed understanding of the user requirements and expectations for each of the task order products. Another important goal was the identification of individuals from PROARCA and CCAD who would participate during the development process by responding to information requests, critiquing development artifacts, and providing feedback on interim products.

An important step in the execution of this task order was production of the Inception Report which made our development effort more transparent and participatory. Produced in early May, this document:

- Presented our proposed methodology for completing the task order
- Provided a description of the two primary products based on the requirements gathered by that time
- Described the training to be provided and its role in the overall success of the project
- Presented the schedule of key events and milestones

In the second week of June, Chemonics and CATIE conducted meetings with CCAD to explore and uncover user requirements of the geo-referenced MIS. As a result of this dialog, the team obtained a fairly significant understanding of CCAD's broader project management information needs. The key to success in this portion of the task order was determining what part of their broader information management requirements would benefit from visualization and analysis using GIS technology.

Throughout the entire project, Chemonics worked closely with CATIE on the design, development, and review of PROARCA's geographic databases. Chemonics personnel worked, at times, side-by-side with CATIE's analysts to evaluate production problems and remedy data layer specific issues.

At project mid-term, the Chemonics team met with the task order reference groups and others to discuss progress to date. In addition, issues that were unforeseen at the onset of the project were presented and explored further by those in attendance. The Chemonics team met with USAID and PROARCA personnel in Guatemala and with CCAD staff in El Salvador. These meetings contributed in a substantial way to the success of the project by keeping reference groups engaged and involved in task order decisions.

The final phase of the project focused on training PROARCA and CCAD staff in the use of GIS technology to support their specific missions. Our goal was to equip individuals with a good foundation in GIS principals and provide a significant hands-on experience using the PROARCA GIS or the CCAD MIS product. The trainees received instruction on the basic operation of ArcView, methods of investigating data, procedures for integrating data, and communication techniques using map products.

## **C. Utility of Task Order Products**

### **C1. PROARCA GIS**

The PROARCA GIS is a project administration tool for use by USAID and PROARCA personnel in planning the location of field activities, and as a coordination and communication tool. The system allows users to visually analyze pertinent data and produce communication outputs such as maps and tabular reports. This GIS facilitates the planning of project activities in relation to other relevant projects, natural terrain features (river network, land cover, elevation, etc.), environmental characteristics (ecosystems, protected areas), physical infrastructure (transportation network), and administrative boundaries. The system enables USAID and

PROARCA staff to integrate and analyze multiple factors while coordinating current and future field activities.

The PROARCA GIS consists of a custom ArcView project file; one file for each of the four PROARCA focus areas (Gulf of Honduras Watershed, Moskitia Coastal Zone Watershed, Gulf of Fonseca Watershed, and Gandoca Bocas del Toro Watershed). Within each project file, a primary ArcView *View* contains each of the system’s data layers. Each layer is appropriately symbolized using point markers, line styles, or fill patterns as required.

The full suite of data editing, spatial analysis, and map development functions are available through ArcView’s standard user interface. The USAID and PROARCA staffs, however, are expected to rely primarily on visual analysis to accomplish their mission, which requires use of the more fundamental functions (such as pan, zoom, turn off/on select data layers). The PROARCA staff also needs to use data editing functions to maintain spatial data layers that represent their field activities. ArcView’s standard user interface includes those functions that allow representing field activities using points, lines, or more complex polygon symbology.

The PROARCA GIS include the data layers shown in the following table.

<b>Item</b>	<b>Data Layer Description</b>
1	Country, department, and municipality boundaries
2	Principal cities or towns
3	Road network (primary, secondary, tertiary)
4	Unclassified LANDSAT Imagery
5	River network
6	Watershed boundaries
7	Elevation contours
8	Land use
9	Ecosystems
10	Protected area locations
11	Rainfall
12	Length of dry season

Each of the GIS data products consists of four separate pieces. Each piece covers the geographic extent of one of the four PROARCA focus areas (Gulf of Honduras Watershed, Moskitia Coastal Zone Watershed, Gulf of Fonseca Watershed, and Gandoca Bocas del Toro Watershed).

## **C2. CCAD MIS**

The CCAD MIS is an executive information system for use by SICA’s General Directorate for the Environment and associated staff. It is expected that users would spend no more than 10 minutes at one sitting to assess the status of environmental activities throughout Central America. This MIS tool requires minimal training. It can answer questions such as, “How many ongoing activities in Central America will contribute to improved biodiversity and forests? Where specifically are these activities occurring? What is the current funding level for these activities? What partners are funding these activities?”

CCAD can use the MIS to communicate environment and natural resource management activity levels. The tool will produce maps and related text products depicting the entire region or portions thereof.

The CCAD MIS consists of a highly customized ESRI ArcView application. The user interface contains a limited number of menu and tool bar items to facilitate panning, zooming, and the display of data layers. In addition to visual analysis, the interface contains a query tool to allow selection and identification of environmental activities using a number project attributes (such as project strategic focus, value, period of performance, and financing source) Furthermore, menu items generate standard map and report products.

The MIS contains three types of data. First, it contains base geography layers (e.g., administrative boundaries, principal cities and towns, and road network) to provide a relative geographic framework for locating environmental activities. Second, it contains select environmental layers (ecosystem boundaries and protected areas) with broad natural resource management utility. Third, it contains the CCAD Project layer. The CCAD Project layer is a dynamic data layer that represents CCAD's current project portfolio.

Data fields within the CCAD Project layer include:

- Identification Number
- Title
- Project Type
- Start Date
- End Date
- Status
- Objective
- CCAD Strategic Area (permits up to 4 entries)
- Environmental Classification Theme (permits up to 3 entries)
- CCAD Coordinator
- Financing Source (permits up to 3 entries)
- Financing Source Contact (permits up to 3 entries)
- Funding Total
- Implementing Organization (permits up to 3 entries)
- Implementing Organization Contact (permits up to 3 entries)
- Countries Benefited
- Geographic Zones Benefited
- Results
- Event Total
- Attendance Women
- Attendance Men

The CCAD MIS product is a functioning pilot application. With its current capabilities, the MIS is beneficial to CCAD's General Directorate for managing some of its project data. However, the Chemonics team determined at the onset of this effort that CCAD's project information management requirements go well beyond the scope of this task order. In addition to the previously stated utility of the MIS, use of the system should contribute to CCAD's effort in uncovering the broader information management requirements for its oversight mission.

## D. Recommendations

### D1. PROARCA GIS

As a result of this task order, PROARCA personnel have a readily accessible base set of geographic data useful for planning and coordination of field activities. To make broader use of this data product investment, the following steps should be taken:

- Provide training opportunities, similar to that supplied under this task order, for other key PROARCA personnel. This will enable more staff to make use of GIS technology for planning, coordination, and other tasks that involve basic analysis or presentation of spatially related data.
- Procure additional ArcView licenses and low volume color printers (paper sizes up to 13"x19") as needed for technical staff.
- Perform a GIS needs assessment to determine:
  - Which PROARCA processes would benefit significantly from the application of advanced spatial analysis, environmental modeling, and/or information management techniques
  - What supplemental data products would be needed to undertake these advanced GIS applications
  - What additional training would be needed for staff to employ advanced techniques

Examples of such applications include protected area management, watershed erosion control, watershed pollution control, water resources management, land use evaluation, and coastal resources management.

### D2. CCAD MIS

During the first phase of this task order, it became evident that CCAD needed a substantial Project Information Management System to house the various pieces of data tracked for its projects. Working within the limits of this task order, the Chemonics team established an information system that manages a select set of these project attributes. The following steps need to be taken to effectively manage the entire set of project attributes:

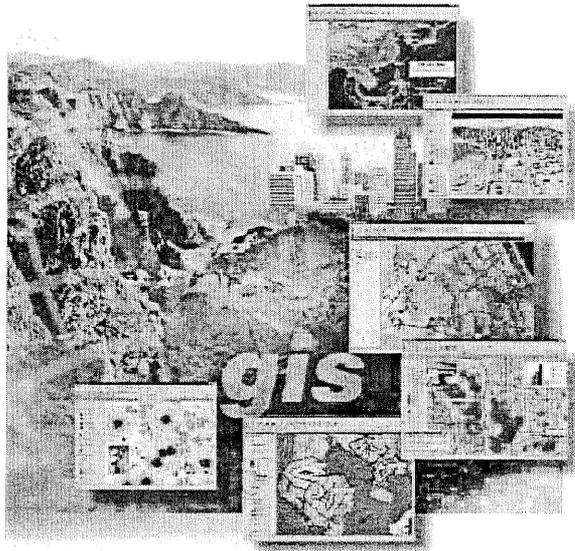
- Perform a formal information system requirements analysis to establish CCAD's static and temporal project information needs
- Design and develop a Project Information Management System that facilitates local and remote data entry, querying, and reporting of CCAD's environmental and natural resource projects
- Design and develop a GIS interface to the Project Information Management System that facilitates local and remote spatial queries and creation of map and tabular outputs. The design should be based on the staff's hands-on experience gained while using the MIS developed under this task order

ANNEX A

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**Manual for Using ArcView 3.2 and the GIS of G-CAP**

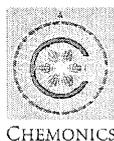
# Manual for Using ArcView GIS 3.2 and the GIS of G-CAP



## USAID/G-CAP PROARCA/TRANSNATIONAL PRIORITARY WATERSHEDS

Task Order No. 816 under the Biodiversity & Sustainable Forestry  
(BIOFOR) IQC  
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## ***I. Introduction to ArcView 3.2***

ArcView is a tool to make analysis and to display geographical information. It allows the user to combine different geographical themes and it prints satisfactory results without a lot of effort. In this exercise we will use ArcView to make some geographical analyses. At the same time we will be able to appreciate the capacity of analysis of geographical systems of information (SIG). See the support documentation ArcView (Help) for further details on the terminology of ArcView.

### **The process to display of geographical information**

The process to display geographical information in ArcView is quite simple. One only has to take into account the most important steps:

To create a view (view)

To add themes (themes [layers, coverages, etc.]) to the view.

Each step has its details that help to manage and to make the display of geographical information more efficient. For example, after creating a view it is convenient to give it a unique name, with its respective description, and to specify the information on the reference system in use. In a similar way when adding a theme in the view, one should give it a unique name, classify it and to improve its colors. Finally, the design is the cartographic touch that is applied, to print a good map. With all this the process is as follows:

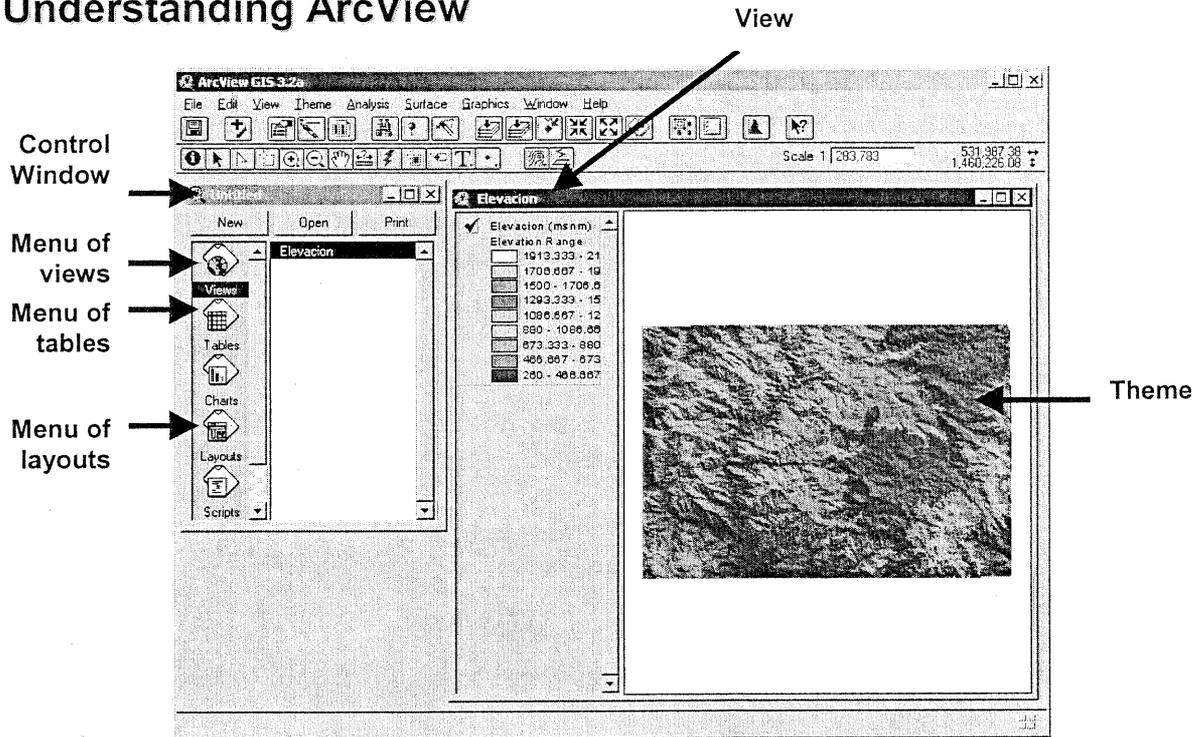
#### **To create a view:**

- Give a name to the view.
- Provide descriptive information of the view.
- Specify the units of the reference system.

#### **To add themes:**

- Give a name to the theme.
- Classify the theme.
- Improve the colors.

## Understanding ArcView



## Definitions of ArcView

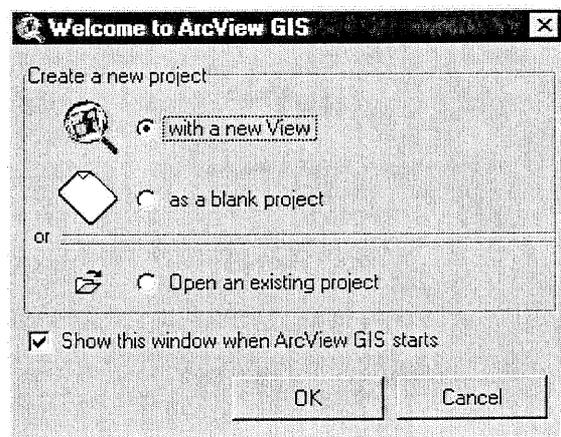
- View : Window where themes are inserted.
- Theme : Class or geographical object (layers, coverage, etc.)
- Design : Cartographic leaf to print views (layout).
- Table : Electronic leaf that has information on themes.
- Project : Group of views, themes, tables, and designs, of a session ArcView.
- Coverage : Class or native geographical object of ArcInfo.
- Shape : Class or native geographical object of ArcView.
- Attributes : Information in table form on each geographical object.
- Relationship : Connection between the table of attributes of a theme and other tables of data.

## Working with ArcView

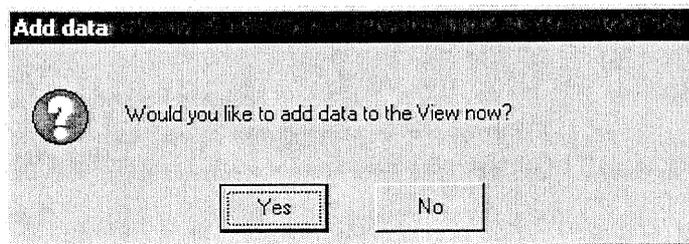
In the following practice you will display information of the Cuenca river, Lempa in ArcView. You will create a view, to add themes and to classify them, and to print the results. Execute the following instructions step for step. Don't forget to read the Notes.

### To create a view and to add a theme

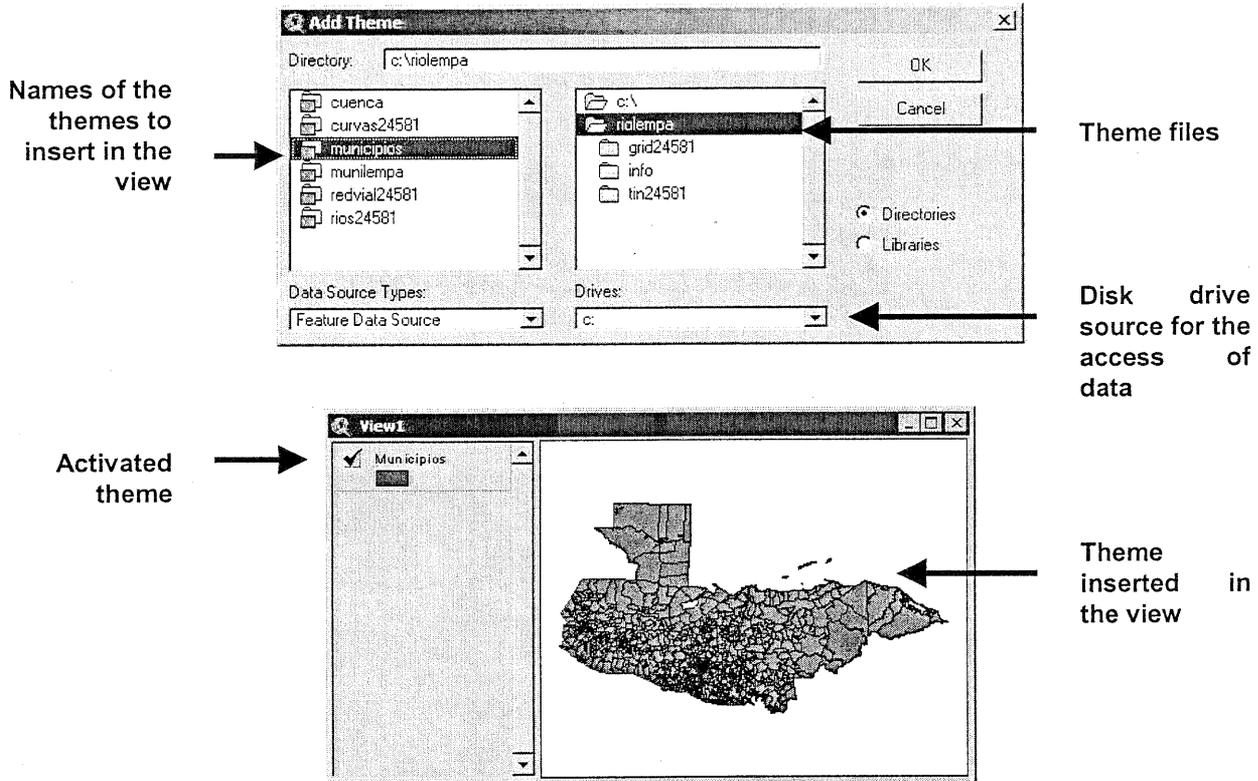
1. Begin ArcView / \* **START || PROGRAMS || ESRI || ARCVIEW GIS || ARCVIEW GIS**
2. Click on the option **with a new View**, and click **OK**. (a view will be created)



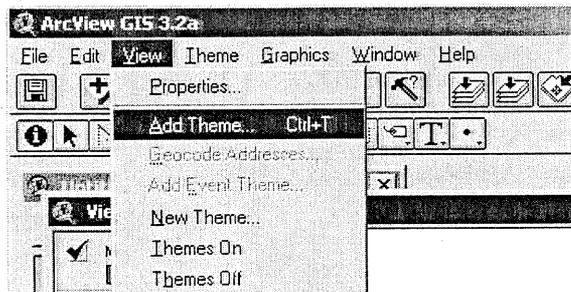
3. Click **Yes** when asked to add a theme to the view. (A theme will be inserted.)



4. Specify the unit of disks in **Drives**. / \* to see image below
5. Double-click the portfolio where its themes are.
6. Double-click the theme **municipalities**.
7. Click the square that precedes the name **municipalities** in the legend.



**Note:** to insert subsequent themes in the view, you only have to click in the menu **View** || **Add Theme** and to specify (click) the name of the new theme.



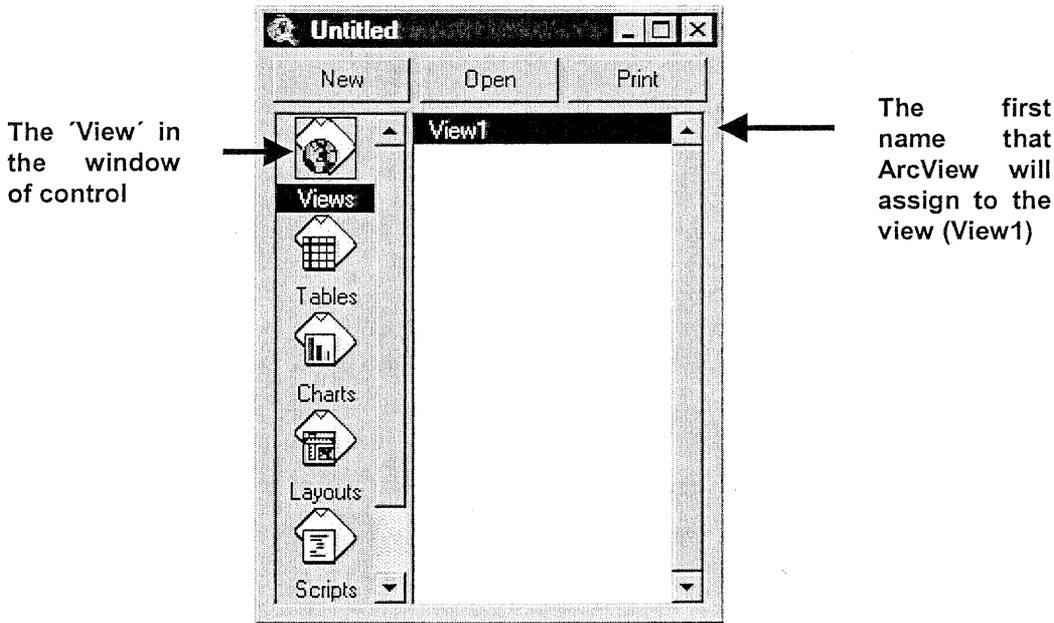
The specified theme should be displayed on the screen, inserted in the view that you created. The color of the theme is assigned automatically. Later on, it will be necessary to classify it and to improve its colors. Up until now we have executed 2 of the 3

necessary steps to display themes: we have created a view and inserted a theme. Now all we have to do is print.

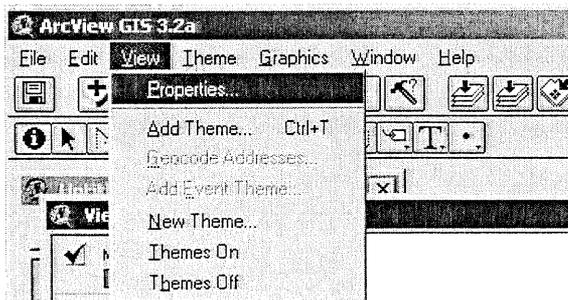
### Giving names to the views

The views should have specific names to be differentiated. A project can have many views, each containing different themes or groups of themes. This process is relatively simple to very easy.

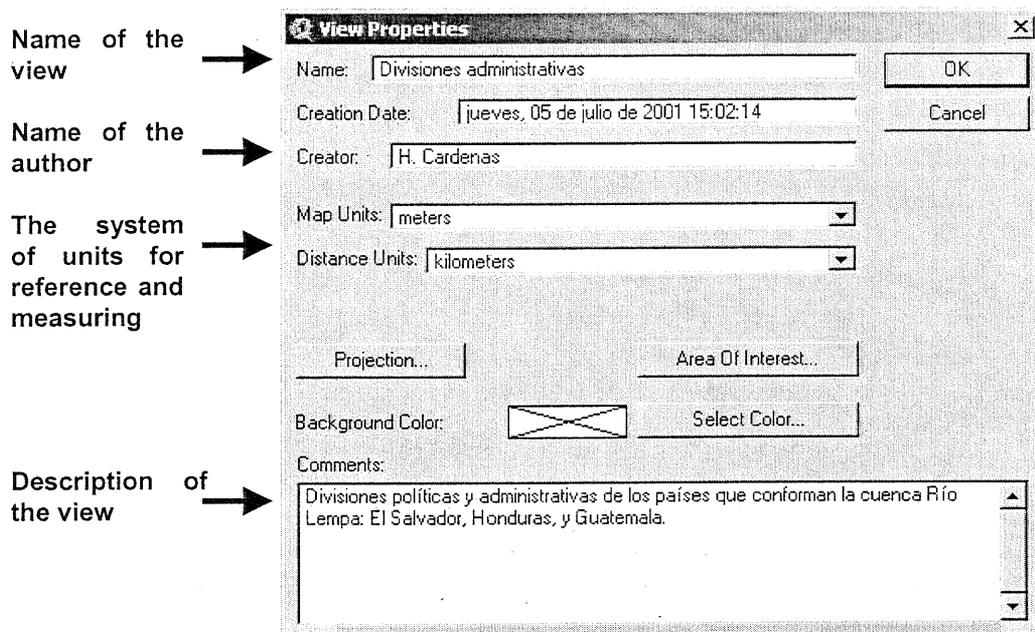
1. Select the 'control window' of ArcView. Click on the **Views** icon, click on the name of the view (in general 'View1 '), and finally click on **Open**. The view with its respective themes will be activated.



2. Go to the menu and click on **View || Properties**.



3. In the section **Name** write the new name of the view. See example.
4. In the section **Creator** write your name.
5. Specify the units of the reference system in meters in the **Map Units** and the **Distance units** in kilometers.
6. And in the section of **Comments** write a more complete description of this view.
7. Finally click **OK**.



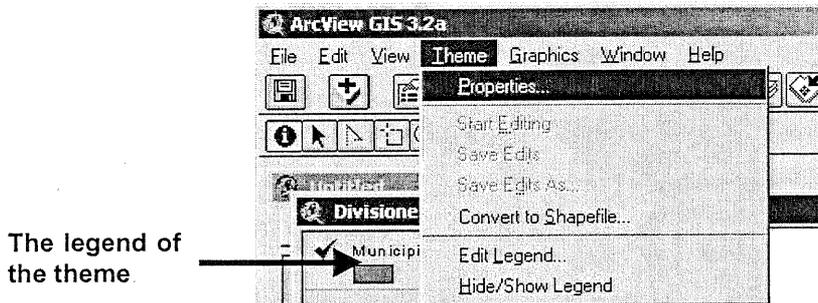
**Note :** you will see the new name in the upper part of the window of the view. One can alter the name and other details of the view in its properties at any time by clicking on View || Properties. Always have in mind that the name of the view tries to explain its content in a brief form; this is very useful when one has several views that represent several themes in a single project of ArcView. The units of the reference system should be specified to be able to display the corresponding scale in the design. In the section of **Comments** there is more space to rewrite the view and its content.



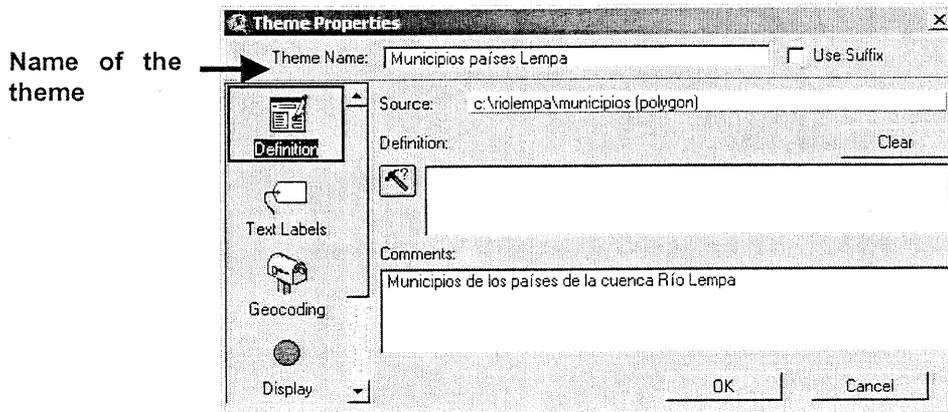
### Giving names to themes

To give names to each theme that we insert in a view is very important. When a theme is inserted it takes the name of the coverage or file shape in which it has been kept; in general, these names are not so explanatory, since they obey the restrictions imposed by the operating system of the computer. It is a good habit to give a more explanatory name to each theme that we insert; the convenient thing is to change the name when you insert the theme to avoid confusions in the future: each theme that is inserted should have a different name. Further on you will see that when you open the database of a theme, the table takes the name of the theme automatically; if the theme does not have a clear name, the table will also reflect that problem.

1. Make sure that the view is active. Click on the theme Legend to activate it.



2. Click **Theme || Properties**. (The window of **Theme Properties** will be activated)
3. Click on the **Definition** icon and on the section of Theme Name write the new name of the theme (it is brief). In Comments you write a description of the theme.
4. Click **OK**



**Note:** The legend of the theme in the view will reflect the new name. Click in **File || Set Working Directory** to specify the work portfolio. Write **c:\proarca** if their portfolio is in 'C:' and is called 'proarca.'

Review

Until this moment you have learnt the following things:

**To create a view:**

- To create a view and add a theme.
- To provide descriptive information of the view.
- To specify the units of the reference system.

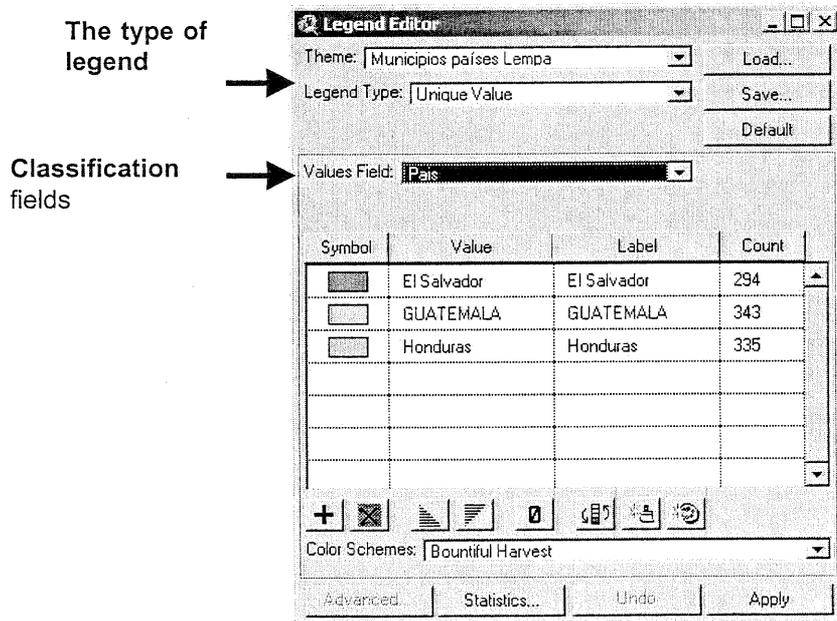
**To add themes:**

- To give names to a theme.

### Classifying themes

In this part of the exercise we will assign better colors to the theme that we have in the view. ArcView has assigned a uniform color to the whole theme. In our case, the theme that we have reflects the municipalities of the 3 countries, El Salvador, Guatemala, and Honduras. We will classify the municipalities by country to be able to determine where each country belongs.

1. Make sure that the theme is active. Click **Theme || Edit Legend**. (The window of **Legend Editor** will be activated.)
2. The **Legend Type** should be **Unique Value** (nominal classification.)
3. The **Value Field** should be **Country**.
4. Click **Apply** and close the window of **Legend Editor**.

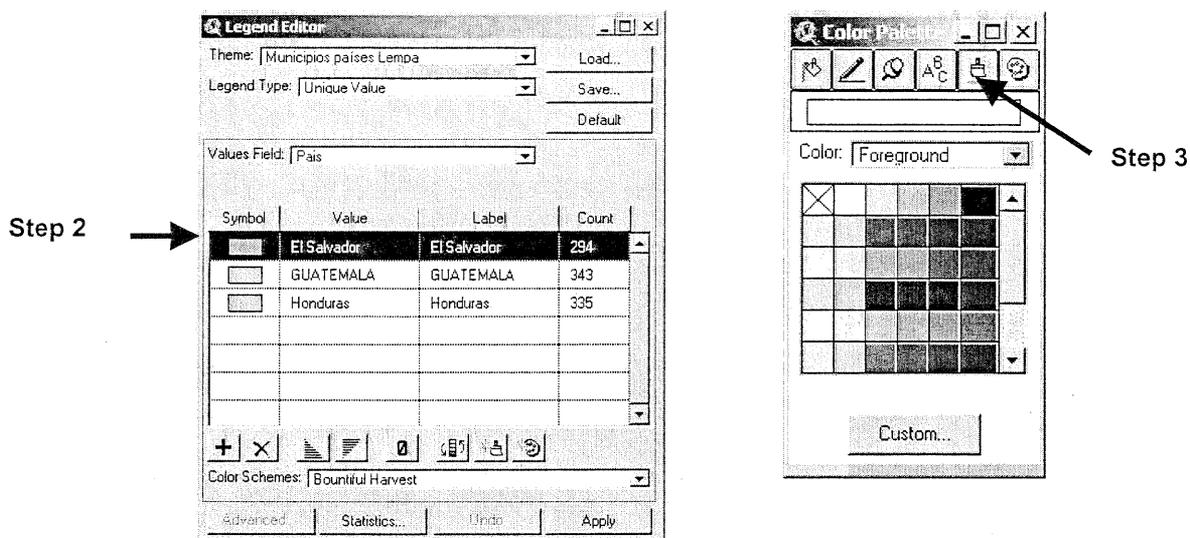


**Note:** The theme displays the municipalities classified for each country. The classification type to use is important and goes according to the values of the classification field. In our case, the classification field is 'Country' and its values are EI SALVIDOR, GUATEMALA, HONDURAS; therefore, the ideal thing is to make a nominal classification (**Unique Valued**). When the field to use is numeric and each value represents a hierarchical scale, then the ideal thing is to make an ordinal classification (**Graduated Colors**); an example would be population, data or levels of agricultural and industrial production, elevation, types of slopes, etc. Classifications of the use of the earth and coverage of the floor are in general, nominal classifications, although a number is assigned to represent each class or use.

### **Changing the colors of the classification**

In general the colors generated automatically by ArcView are not the best. It is for that reason that we should change them or alter them to our pleasure and obey conventions that are already established (hydrological objects are assigned blue colors and greens for forest).

1. Activate the window **Legend Editor** of the theme. (Double-click the legend of the theme in the view, or go to the **Theme || Legend Editor**.)
2. In the **Legend Editor** window, double-click in the first legend symbol. (The window **Color Palette** will be activated.)



3. Click the brush of the **Color Palette**.
4. Click the color that you wish to assign to the legend.
5. Repeat step 2 and 4 for the other legends.
6. Click **Apply** when finished. Close the **Legend Editor** and **Color Palette**.

**Note:** you can alter the colors as many times as you want, by repeating the **process**. Remember that when printed the clear colors are dark and the dark colors are too dark. There is a great difference between the colors shown on the screen and the colors actually on the printer.

## Review

Until this moment you have learnt the following things:

### To create a view:

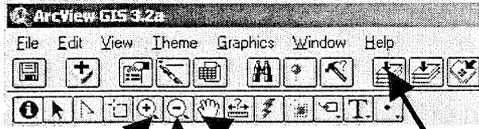
- To give a view a visible name.
- To provide descriptive information of the view.
- To specify the units of the reference system.

### To add themes:

- To give a name to the theme.
- To classify the theme.
- To improve their colors.

## Zooming In & Out and Panning

1. Click the button of Zoom In.



Zoom In    Zoom Out    Pan    Full Extent

2. Move the cursor to the center of the map
3. Press the left button of the mouse and pull the mouse down, then, pull the mouse toward the right, and finally release the button. (You will see a 'zoom' of the delineated area.)
4. To execute **Pan**, single click the corresponding button. Press the left button of the mouse, and pull the mouse to the side while continuing to press the mouse button. Release the button to stop Panning.
5. To execute **Zoom Out**, press the corresponding button and click in the map.
6. To return to the original map press the button **Full Extent**.

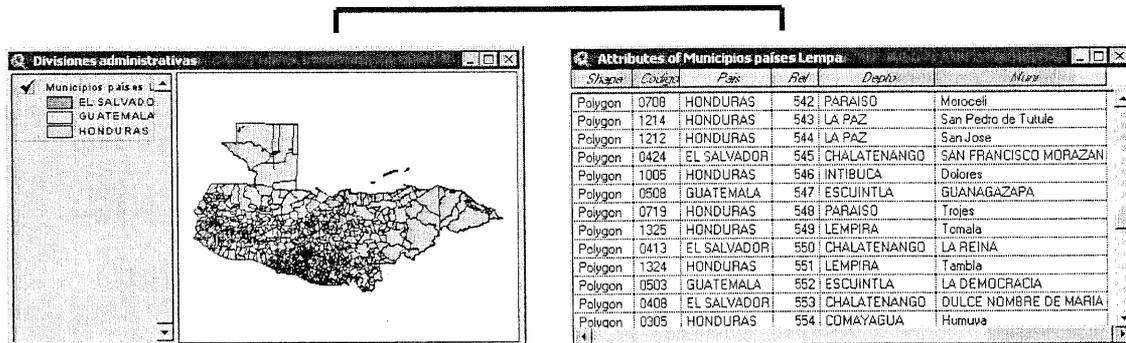
**Note:** Practice 'Zoom' and 'Pan' for about 2 or 3 minutes.

## Obtaining information on geographical objects

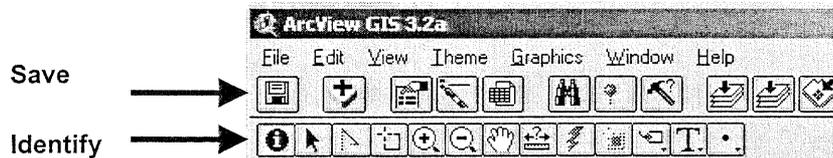
The theme of the view on the screen contains information or **attributes** on the geographical geometric objects (vector) that it represents. The table of attributes is essential for each theme or geographical class. Each geographical geometric class (vector layers) has a table of attributes. One can add fields to these tables of attributes to record vital information on each geographical object; however, one should only add the **relationship** fields to these tables of **attributes**, additional information should be recorded in other **tables of data**.

Geographical geometric class (Vector)

Table of attributes for the vector



1. Make a 'zoom in' on an area of El Salvador.
2. Click the **Identify** button, to obtain information.



3. Click inside any municipality. The window **Identify Results** will appear in the screen displaying information on the geographical object.

**Note: Obtaining information for other municipalities of El Salvador.** Make sure of using **Pan** and **Zoom** to move from an area to another. Repeat the step 3 for Guatemala and Honduras. Every time that you click, ArcView opens the table of attributes of the vector and show its contents in the window of **Identify Results**. Close the sale **Identify Results** when finished.

## Saving an ArcView project

*Keeping the project for the first time. . .*

1. Click **File || Save Project**.
2. Double-click on the portfolio where you record your data.
3. Click and write the name of the project in **File Name**. You can use the name ejercicio1.apr
4. Click **OK**.

**Note: The name ejercicio1.apr is the name of the project.** The view and the theme have been kept in this project. All the projects ArcView takes the extension '.apr' at the end of the name, which means 'ArcView Project'.

*Keeping the project for second time and other times. . .*

1. Click the **Save** button of the list of icons of ArcView.

**Note: This time saving the project was easier.** The project can be saved many times as one wants. One can create views and insert more themes, but the project will be the same one. When the project is saved, ArcView keeps the position of all the windows within the project until to the moment of saving. When one opens the project again, ArcView displays the most recent state in which the project was saved.

## Leaving ArcView

We have to leave ArcView to learn how to open projects that we have created previously. The process is very simple.

1. Click **File || Exit**.

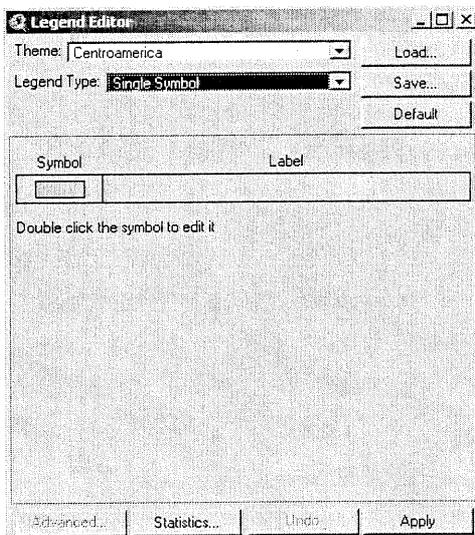
**Note:** ArcView will sometimes ask him if you if you want to keep the project before closing. ArcView detects any changes made in the project from the last save.

## II. Legends: Types of Legends, Creation and Editing

1. Start ArcView (a portfolio exists called ESRI in the menu of programs). Indicate to the program that you want
2. Open the called project `c:\proarca\ejer2_av\editor_leyendas.apr`. The view called **Central America** shows the theme of the same name and it represents the political division of the area at the municipality level (equivalent to canton in Costa Rica).

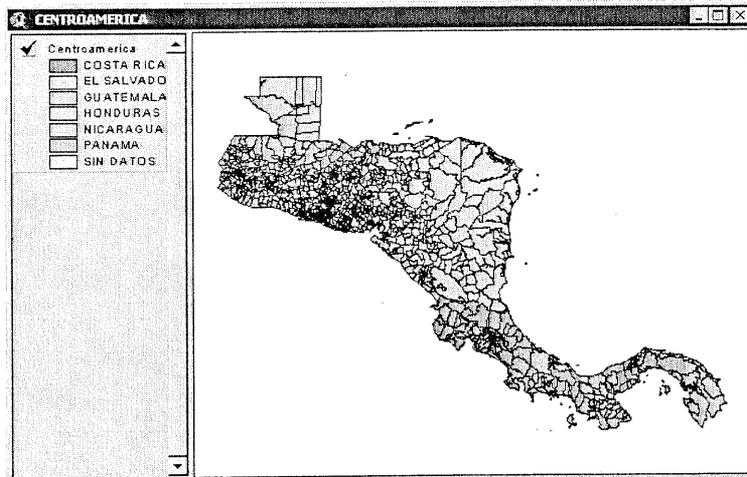
### Color and types of legends

3. Open the **Legend Editor** making a double click on the theme **Central America** in the table of contents.



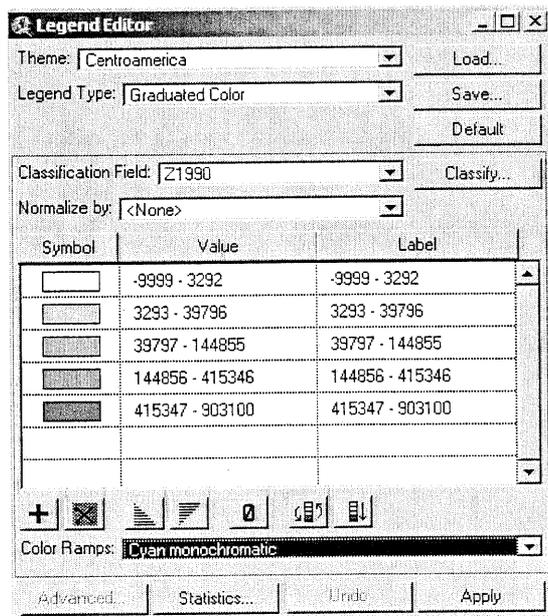
Change the legend type to **Unique Value**. Select the Value Field like `admin._l1` which is the name of the field in the table that contains the names of all the countries. Click in **Apply**. The program chooses an outline of colors (color schemes) called Bountiful Harvest, but you try with other outline colors.

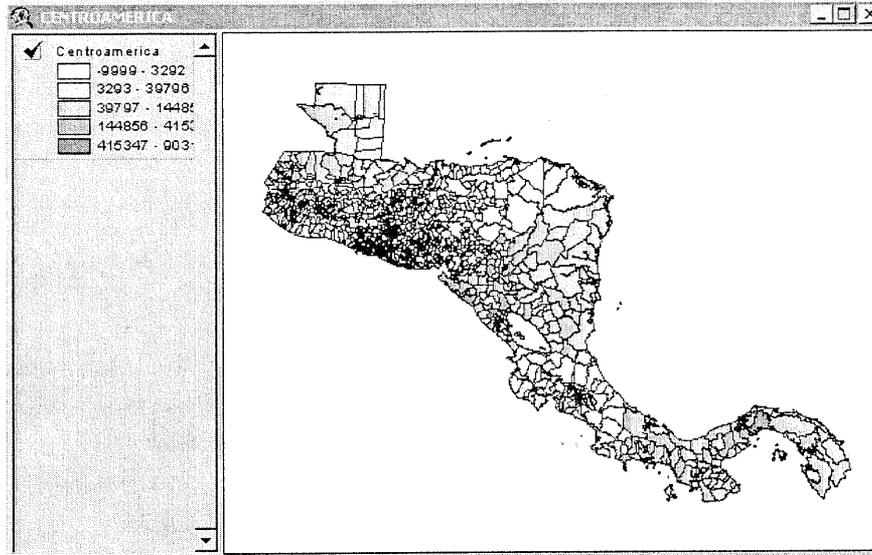
4. Click on **Apply** and close the **Legend Editor**. The map of Central America spreads in function of the field that contains the name of the country to which each municipality belongs on the map and therefore each country has a different color.



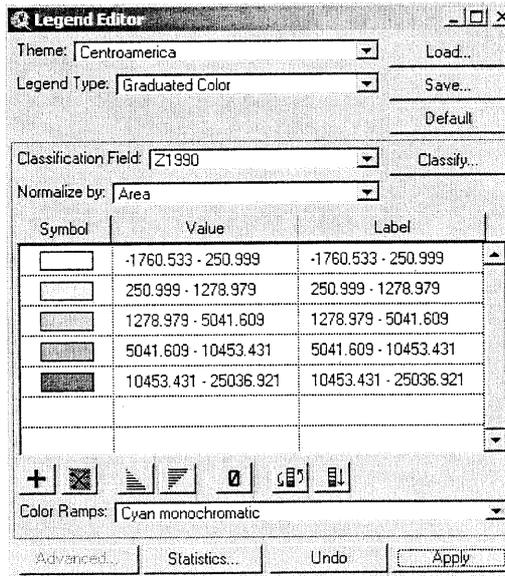
## Classification methods

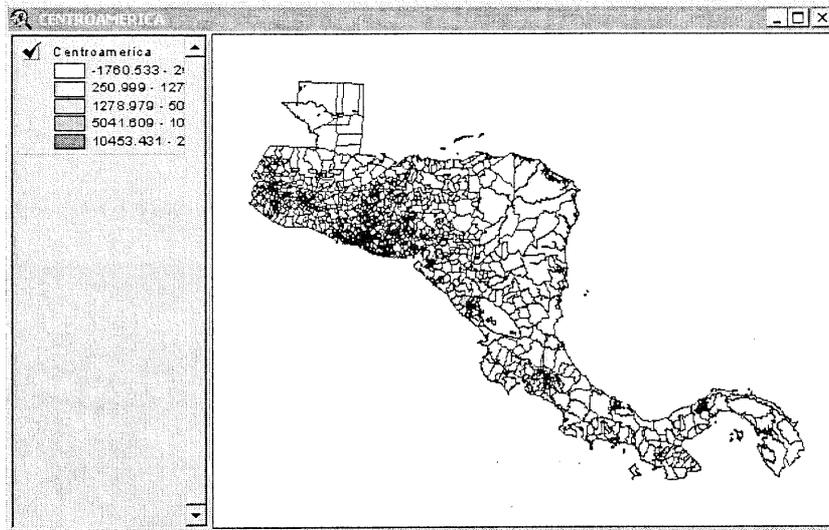
- Again, go to the **Legend Editor** and change the legend type to **Graduated Color** and the **Classification Field** z1990 (Population of each municipality at 1990). Select a different Color Ramp—**Cyan Monochromatic** and click on **Apply**.





- Again enter to the **Editor** window of the **Legend** and normalize the classification choosing **Normalized by Area**. Click On **OK**.

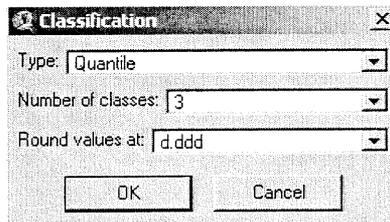


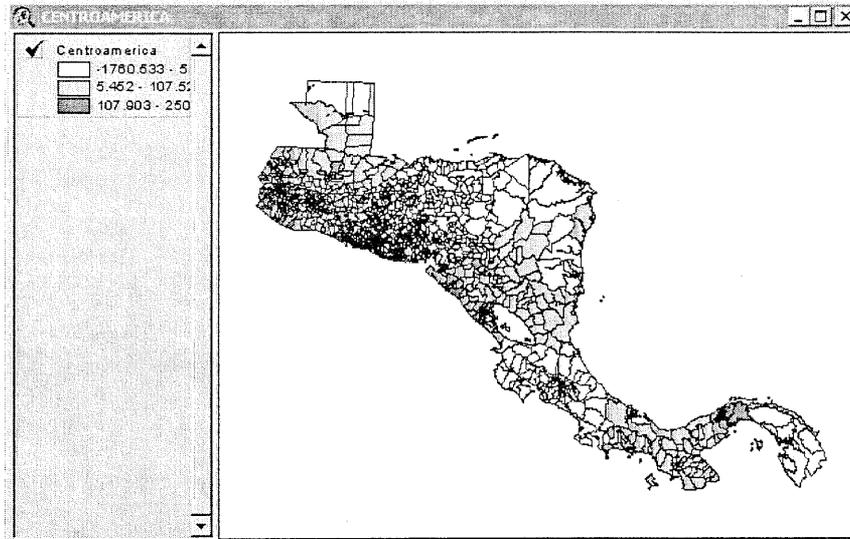


What difference do you find among the classification of step 17 and the normalized classification? Why?

To change the classification method, the number of classes and labels

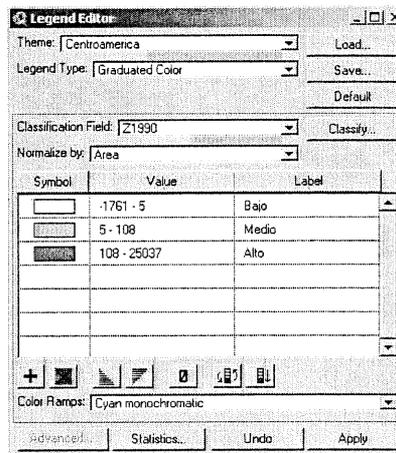
7. Again go to the **Editor** window of the **Legend** and make on the button **Classify...** Change the type to **Quantile**. Select **3** as the number of classes and click on **OK**.

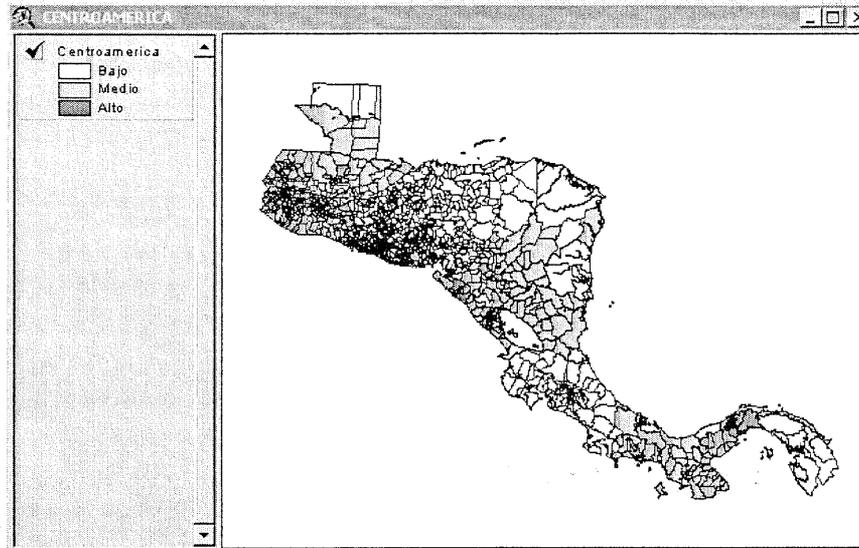




What difference do you find among the classification of the step 17, 18 and the classification for cuantiles? (Do you remember what is a cuantil)

8. Still in the **Legend Editor**, in the **Label** column, click on the first value and write the word **Bajo** and press Enter. On the second value write **Medio** and press Enter and then on the last value write **Alto** and then press Enter. Now press **Apply**.



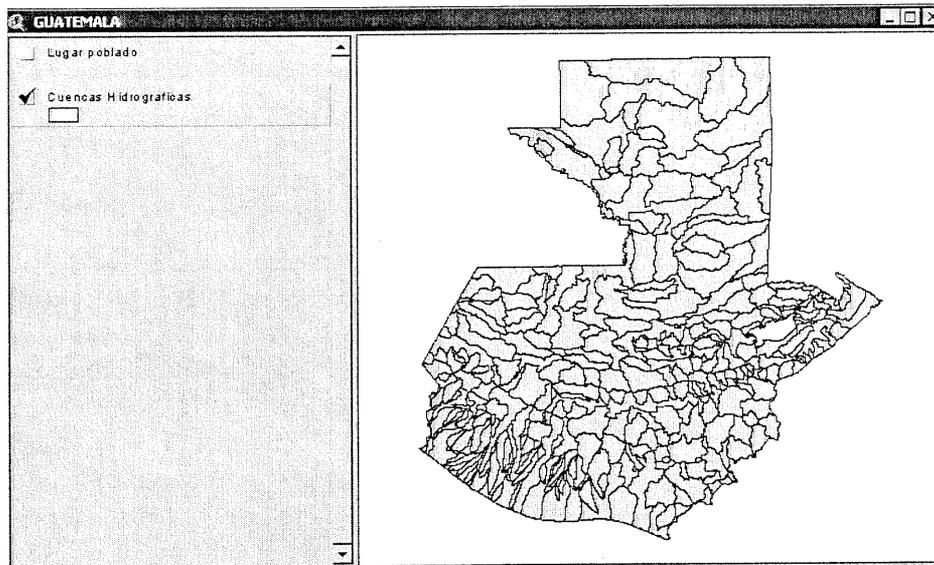


9. Close the view called Central America

## Point density maps

Suppose now that as part of a program of environmental education, you want to examine the pattern of distribution of the number of students in that educational level at a level of **hidrográfica basin**. A way to present this information is to use a map of density points to show the concentration of an attribute.

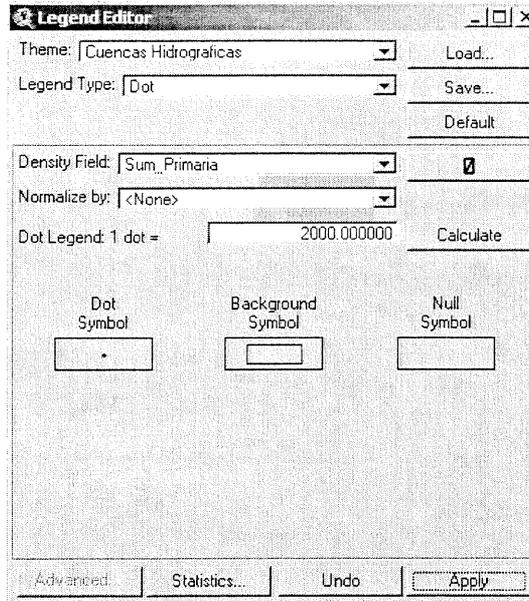
10. Open the view called GUATEMALA. In it, you will find two themes: one corresponding to the populated places of the Republic of Guatemala with more than 10000 inhabitants and the other corresponding to the division of the country in their respective main **hidrográficas basins**. Activate the theme **Cuencas Hidrográficas**.



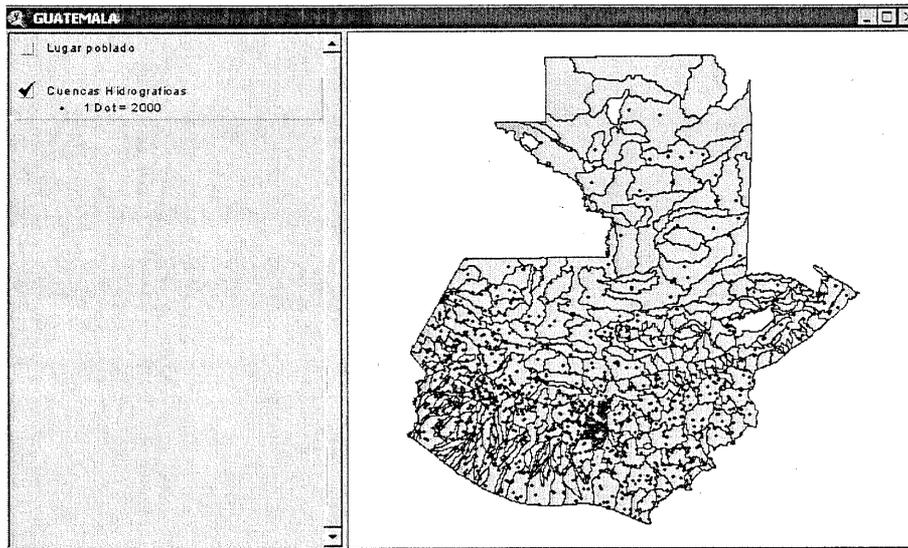
11. Open the **Legend Editor** and choose **Dot** from the menu list of the legend type. In the menu list of the field of density (Density Field), select **Sum\_Primary** (see figure at the end of step 26).

Notice that the field **Dot Legend** shows that 1 point is similar to 0.00000 students. To fix the number of students that each point represents, you can type in a value or click on the **Calculate** button. In the last case the program calculates the number of students that better represents a point in relation to the size of the window of the view.

12. Click on **Calculate**. ArcView calculates the number of students that will represent each point in this case. (it depends on the resolution of the monitor). ArcView has determined that a point will represent 2000 students. Now the color of the background will be selected for the density map.
13. Double click on the rectangle **Background Symbol** to display the Palette (**Palette Fill**). In the **Palette** change the pattern for omission from transparent to solid (the black rectangle).
14. Click on the **Color Palette**  button, and select the rose color . Click on **Apply**.



15. One can observe that the biggest concentration of primary school students is in the central part of Guatemala and very few are in the north part (Petén).

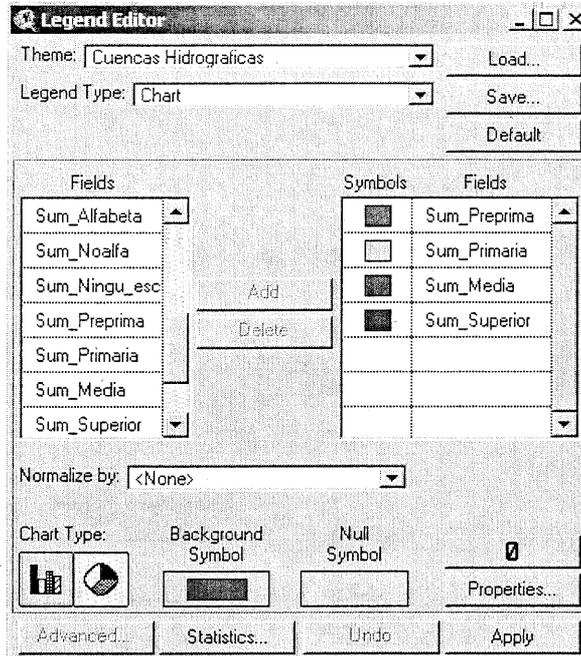


### Classification with graphics

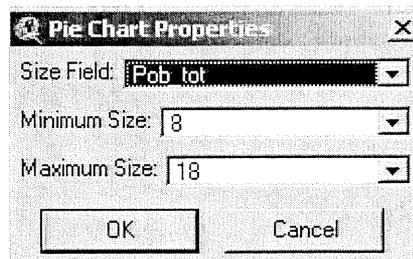
Now the map of the population's distribution will be used for all the educational levels (pre-primary, primary, secondary and higher). A pie table will be used.

16. In the menu of the Legend Type choose **Table**. The pie table is the graph for omission. In the list of fields to the left click on **Sum\_Preprima**. Continue to press the Shift key and click in **Sum\_Primary**, **Sum\_media** and **Sum\_upper**. Click on the **Add** button.

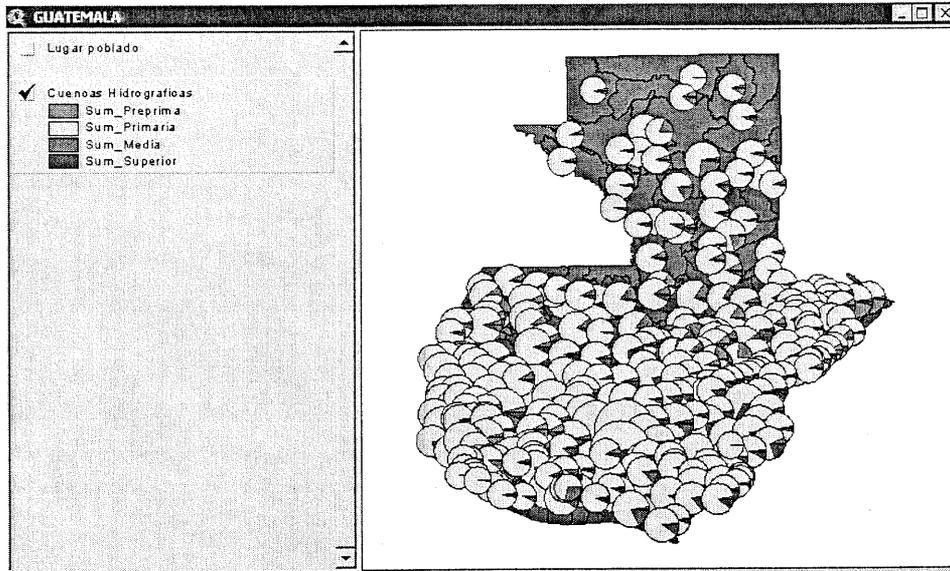
Now the fields are shown to the right with a symbol for each. You may change these symbols with a double click on the color, but for now leave them as they are.



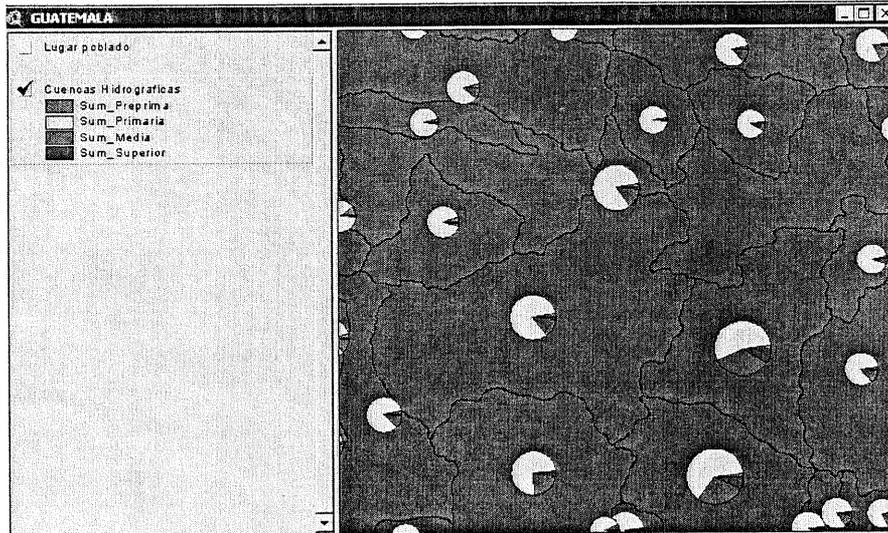
17. Click on the **Properties** button to display the dialogue box of the properties of the pie table.
18. In the list menu of **Size Field**, select **Pob\_tot**. The values of this field will control the size of each piece of the pie table.
19. In the list menu of **Minum Size** and **Maximun Size**, type **8** and **18**, respectively. This fixes the radii (in points) for the smallest and the biggest graph. Click on **OK** in the dialogue box of the properties of the pie table and then **Apply** in the **Legend Editor**.



ArcView displays the four fields using the pie table. The table seem a little big for that scale so we will use the zoom.



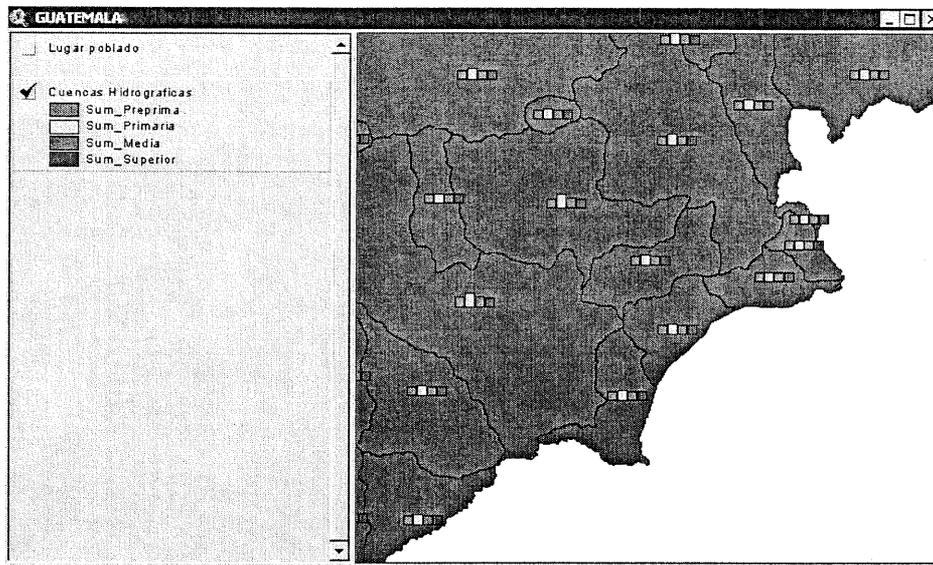
20. Click on the **Zoom In** tool and drag a box around the central basins. Now you will be able to see a pie table for each basin.



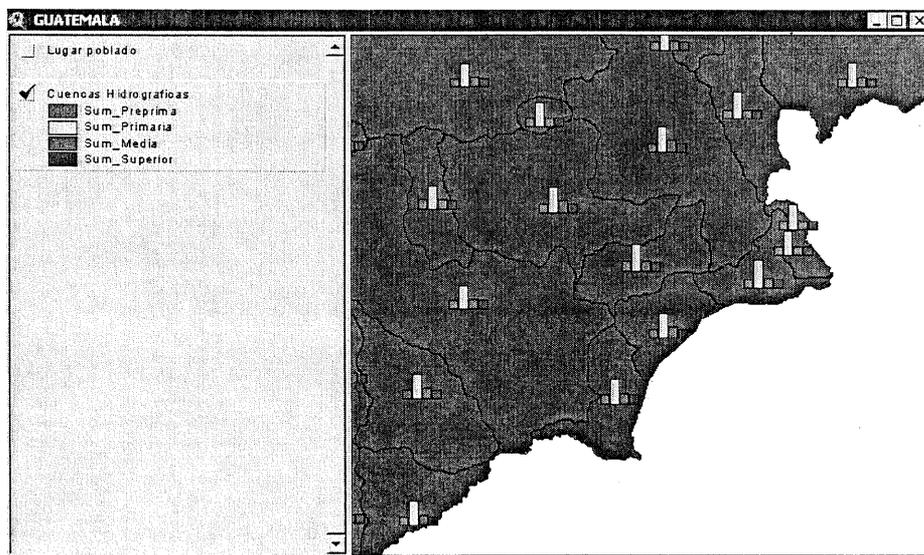
Now we will be change the pie table to a bar table.

21. In the **Legend Editor**, locates the icon for **Legend Type (Table Type)**  and click on the symbol **Bar Table**, then click on **Apply**. ArcView displays the same four fields using a bar table. As you will be able to observe, a great quantity of graphics present relatively same amounts of information when in fact the difference among students of primary and the other levels is significantly bigger. This is a difficulty that you have with the program to

represent values too dissimilar. Therefore we will proceed to normalize according to the population's total.



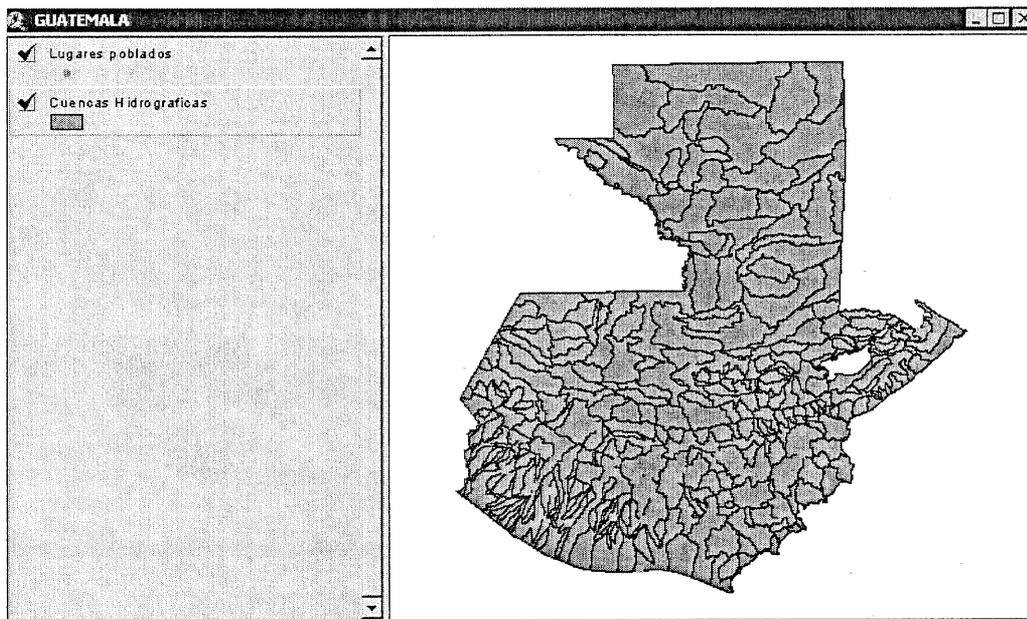
22. Display the Legend Editor and in the menu of **Normalized by**, choose the field **Pob\_tot**.
23. Click on the **Properties** button to display the dialogue box of the properties of the bar tables. Choose **8** as the minimum height and **18** as the maximum height and then click **OK**.
24. Click **Apply** on the **Legend Editor**. Now you will notice that the bars are more representative of the comparative value of each one of them.



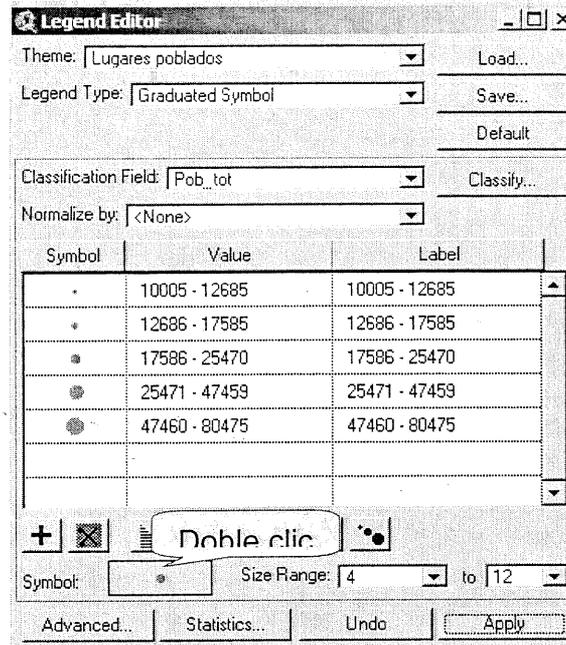
## Use of graduated symbols

Now we will display the populated Places based on their total population.

25. Using the **Legend Editor** fix the **Legend Type** of the theme Cuencas Hidrográfica to **Single Symbol** and put a background color that contrasts with the color of the points that define the Populated Places.
26. Make visible the theme of Populated Places

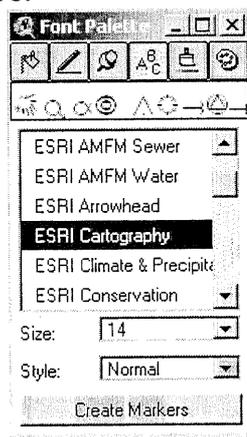


27. Double click on the theme **Populated Places** to display the **Legend Editor**. In the **Legend Editor**, change the **Legend Type** to **Graduated Symbol** and fix the classification field to **Pob\_tot**. Click on **Apply**.

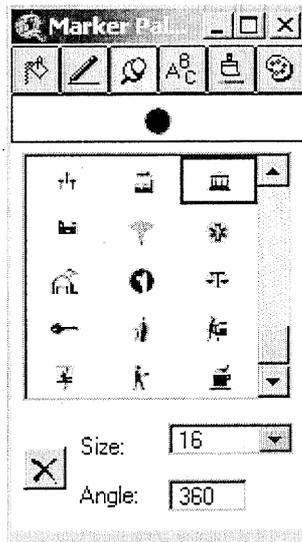


Now one can observe five classes, each with a different symbol size. Now the symbol will be changed to one that is more distinctive. To make it, we will add municipal markers to the Marker Palette.

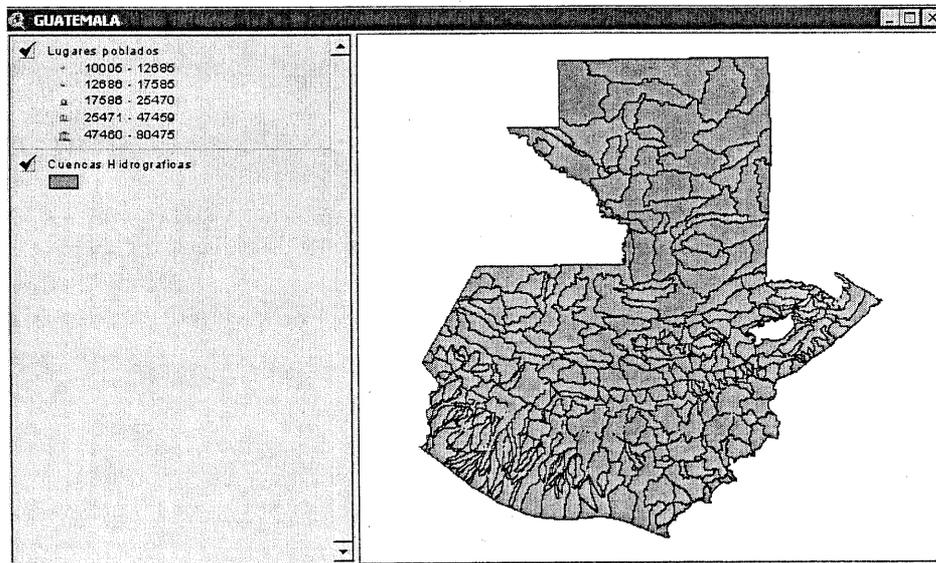
28. Double click on the rectangle **Symbol** in the left lower part to open the Marker Palette.
29. Click on the **Font Palette** in the upper part of the window of palettes.
30. Widen the window to be able to see the complete name of each source. Locate the source **ESRI Cartography** and click to illuminate it. Click on the button **Create Markers** in the lower part of the window. This button converts the characters of the source selected in the symbols markers and adds them to the Palette's of Markers.



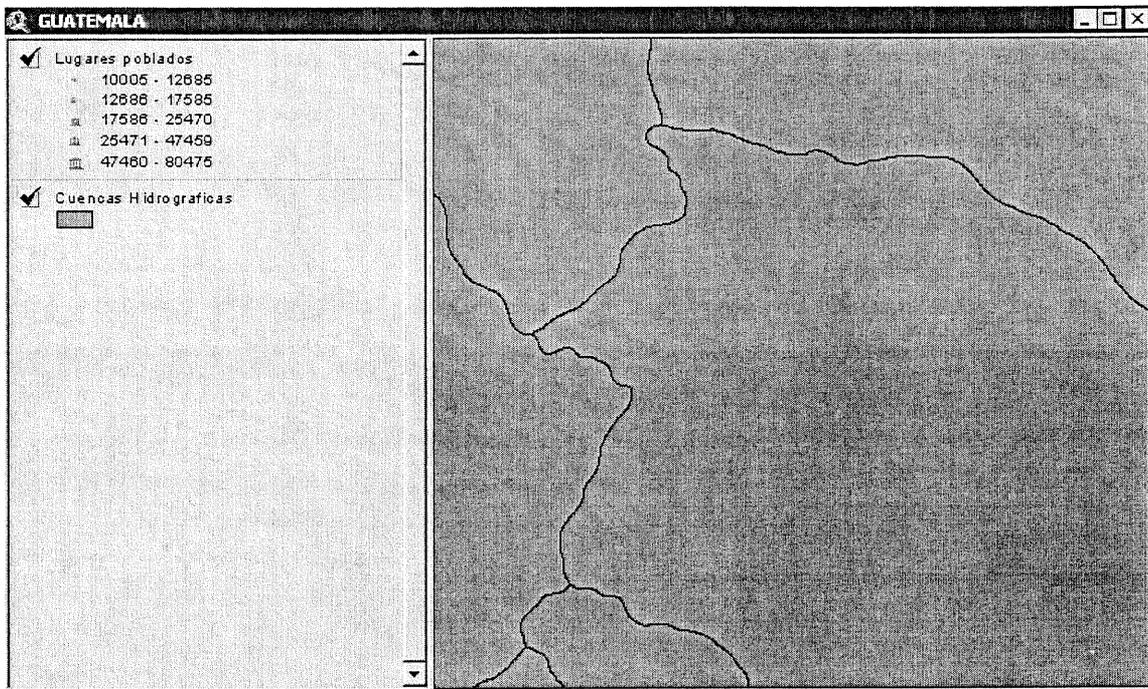
31. Change to the Marker Palette  after pressing Create Markers. The characters of the source ESRI Cartography is added to the end of the palette.
32. Move down the contents of the window until you see the symbol of the Greek temple in the upper part of the window. Click on the symbol



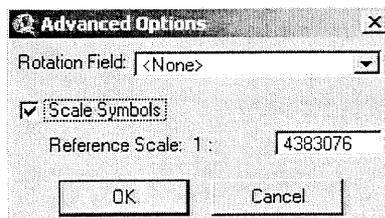
33. Close the Marker Palette.
34. Click in **Apply** in the **Legend Editor**. The map that shows the places populated with more than 10000 inhabitants, categorized according to size and represented by a Greek temple.



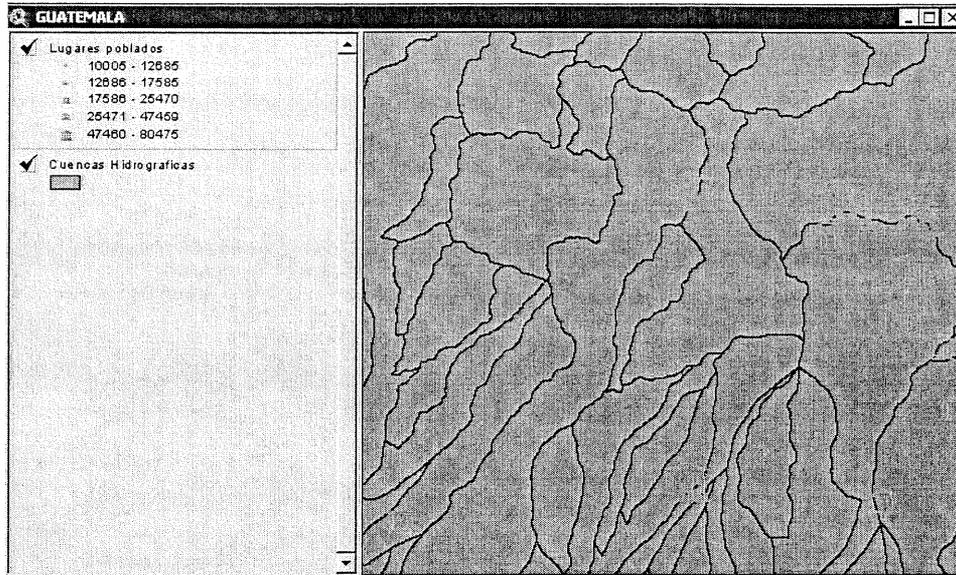
35. To observe the results more closely, zoom in onto an area. You will notice that when you makes an approach, the symbols don't become bigger. If you want the symbols to become bigger when making an approach, you will need to activate the scaling.



36. First it is necessary to return to the window that displays the complete map. Click on the button of **Zoom to Previous Extent**  , to return to the previous scale, until you return to the complete view.
37. In the final part of the **Legend Editor**, click on the **Advanced** button. In the dialogue box of the advanced options, click on the checkbox of **Scale Symbols** to activate the scaling. Click on **OK**, then click on **Apply** in the **Legend Editor**.



38. Zoom again to an area of the map. Now you will see that the symbols appear bigger.



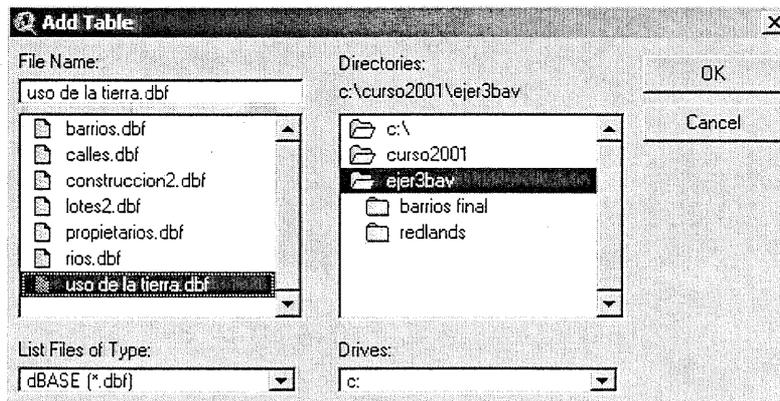
39. Close the project and don't save the changes made.

### III. Managing databases: Creating and Editing Tables

In this part of the exercise we will work with a table of earth data that is kept separately from the table of the theme. First the table will be added to the project, then we will make changes in its appearance, we will edit the values and add a new registration and a field.

#### Adding tables in ArcView

1. If it is necessary start ArcView (a portfolio called **ESRI** exists in the menu of programs).
2. Open the project called **c:\proarcalejer3av\edicion\_tablas.apr**. When the view opens up you will have a view of the lots that correspond to the urban area of the City of Turrialba, Carthage, Costa Rica. Now you will add a table called **Use** from the **Tierra.dbf** to this project and then edit it. Close the **View** and click on the Project Window to make it activate. From the Project menu select **Add Table**. In the dialogue box that appears select **dBase (\*.dbf)** from the list of file types. Navigate to the directory where the data are (**c:\proarcalejer3av**). Click on **Use** of the **Tierra.dbf** to highlight it and then click on **OK**.



What other file type can be loaded when you want to add a table (notice the list of file types) and what characteristics does each one of them have?

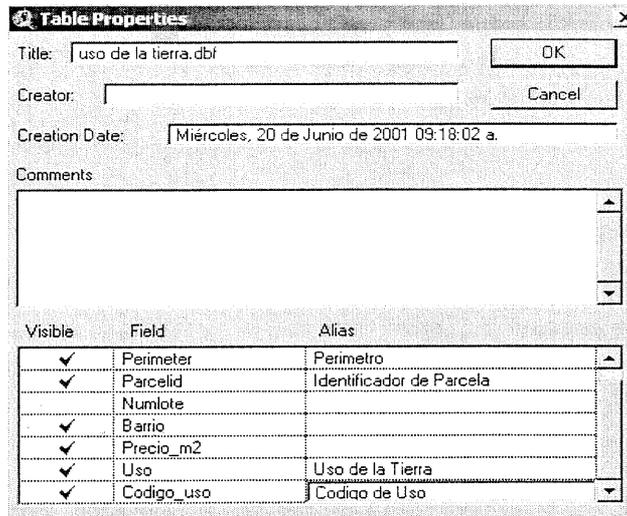
3. The table that appears contains the area, perimeter, the parcel identification, the lot number, the neighborhood, the price / m2 of the earth, the use to which the lot is dedicated and the use code. Examine the table to familiarize with it.

<i>Area</i>	<i>Perimeter</i>	<i>Parcelid</i>	<i>Numlote</i>	<i>Ramo</i>
203378.800000	2010.410000	11661	700248	El Silencio
259.768100	75.892960	13141	712129	El Silencio
246.557600	74.250590	13140	712128	El Silencio
263.752400	74.854500	13139	712127	El Silencio
240.303700	72.910570	13138	712126	El Silencio
248.356400	73.663080	13137	712125	El Silencio
251.660200	74.069280	13136	712124	El Silencio
223.415000	72.205990	13135	712123	El Silencio
221.340900	72.125250	11698	712122	El Silencio
210.784700	71.568660	11697	712121	El Silencio
224.994100	72.663280	11696	712120	El Silencio
217.689500	72.095790	11695	712119	El Silencio
133.405300	47.774720	11662	711201	El Silencio
163.621600	51.056220	11663	711202	El Silencio
245.621100	74.064310	11694	712118	El Silencio

## Changing the display of the table

When you edit the data of a table (for example: change the values of the fields, add or to erase registrations and fields) the data source of the table modifies. This means that if you add a table to another project the change will be reflected in it. When changes are made to the appearance of the table (to rename the table, to hide fields or to change the width of the field), the changes only apply inside the project where they were made. First we will change the appearance of the table.

4. From the **Table** menu, select **Properties** to open the respective dialogue box.
5. In the column called **Visible**, click the checkbox of the field **Numlote** to hide it in the display.
6. Click on the Perimeter line of the Alias column and write **Perimeter** (to make a rename for the display). Make all the changes that are observed in the following figure.



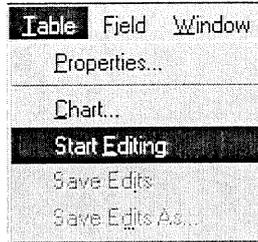
- Now we will make the fields wider so that you can write a title in each one of them. Position the cursor in the vertical line among the header of the field Parcel identification and the header of Neighborhood (**Barrio**). The cursor changes to an arrow with double head. Click and drag more or less a half inch toward the right. Repeat the same step with other fields where it is not possible to read the complete name.

Area	Perimetro	Identificador de Parcela	Barrio	Precio m2
203378.800000	2010.410000	11661	El Silencio	8E
259.768100	75.892960	13141	El Silencio	8E
246.557600	74.250590	13140	El Silencio	8E
263.752400	74.854500	13139	El Silencio	8E
240.303700	72.910570	13138	El Silencio	8E
248.356400	73.663080	13137	El Silencio	8E
251.660200	74.069280	13136	El Silencio	8E
223.415000	72.205990	13135	El Silencio	8E
221.340800	72.125250	11698	El Silencio	8E
210.784700	71.568660	11697	El Silencio	8E
224.994100	72.663280	11696	El Silencio	8E
217.689500	72.095790	11695	El Silencio	8E
133.405300	47.774720	11662	El Silencio	8E
163.621600	51.056220	11663	El Silencio	8E
245.621100	74.064310	11694	El Silencio	8E

### Adding values and adding a records

- Go to the first registration of the table. From the **Table** menu select **Start Editing**. The proprietor of the lot with **Parcel identification No.11852**, has communicated to the municipal registration of property that it built a house

and therefore it will be necessary to change the use of the ground to low medium class Residence and the use code 503.



- Now we will look for the registration that has changed. Select the header corresponding to the name of the field **Parcel identification** making a click in the name of the table, in such a way that it changes from a gray color to a dark gray and that it appears to be sunken.



- Then press the tool for ordering fields in descending sequence (there is also a tool for an upward sequence) and now look for the **Parcel identification No. 11852**.

- Press the edit button  (only when this button is pressed is it possible to write in the cells of the table). Click on the cell that corresponds to the field **Useo de la tierra (Use of the Earth)** and change it to **low middle class residence**. Make sure that the writing in this field is the same as the other fields that already existent (with uppercase, lowercase and symbols), because if you writes it differently, it affects the database, and would be recognized as a new **Use of the Earth**. Now change the value from the **Code of Use to 503**.

Area	Perimetro	Parcel identification	Banio	Precio m2	Uso de la Tierra	Codigo de Uso
59.088380	31.214730	11857	El Mora	850.00	Habitacional clase baja	501
67.147460	33.866980	11896	El Mora	850.00	Habitacional clase baja	501
52.910640	29.464590	11855	El Mora	850.00	Habitacional clase baja	501
121.828100	50.842780	11854	El Mora	850.00	Habitacional clase media baja	503
122.286100	50.630890	11853	El Mora	850.00	Habitacional clase media baja	503
117.942900	49.799250	11852	El Mora	850.00	Lote Vacio	603
105.667500	48.433250	11851	El Mora	850.00	Habitacional clase media baja	503
117.018600	49.617090	11850	El Mora	850.00	Habitacional clase media baja	503
202.210900	58.767790	11849	El Mora	850.00	Habitacional clase media baja	503
123.121600	49.971890	11848	El Mora	850.00	Habitacional clase media baja	503
138.108400	51.463620	11847	El Mora	850.00	Habitacional clase media baja	503
148.472700	52.546300	11846	El Mora	850.00	Habitacional clase media baja	503
148.446300	52.468200	11845	El Mora	850.00	Habitacional clase media baja	503
128.843300	50.214260	11844	El Mora	850.00	Habitacional clase media baja	503
136.159700	50.997200	11843	El Mora	850.00	Habitacional clase media baja	503
136.683100	51.093760	11842	El Mora	850.00	Habitacional clase media baja	503
128.484400	50.134290	11841	El Mora	850.00	Habitacional clase media baja	503
142.395500	51.588160	11840	El Mora	850.00	Habitacional clase media baja	503

Area	Perimetro	Identificador de Parcela	Barrio	Precio_m2	Uso de la Tierra	Codigo de Uso
59.088380	31.214730	11857	El Mora	850.00	Habitacional clase baja	501
67.147460	33.866580	11856	El Mora	850.00	Habitacional clase baja	501
52.910640	29.464590	11855	El Mora	850.00	Habitacional clase baja	501
121.828100	50.842780	11854	El Mora	850.00	Habitacional clase media baja	503
122.286100	50.630890	11853	El Mora	850.00	Habitacional clase media baja	503
117.942900	49.799250	11852	El Mora	850.00	Habitacional clase media baja	503
105.667500	48.433250	11851	El Mora	850.00	Habitacional clase media baja	503
117.018600	49.617090	11850	El Mora	850.00	Habitacional clase media baja	503
202.210900	58.767790	11849	El Mora	850.00	Habitacional clase media baja	503
123.121600	49.971890	11848	El Mora	850.00	Habitacional clase media baja	503
138.108400	51.463620	11847	El Mora	850.00	Habitacional clase media baja	503
148.472700	52.546300	11846	El Mora	850.00	Habitacional clase media baja	503
148.446300	52.468200	11845	El Mora	850.00	Habitacional clase media baja	503
128.843300	50.214260	11844	El Mora	850.00	Habitacional clase media baja	503
136.159700	50.997200	11843	El Mora	850.00	Habitacional clase media baja	503
136.669100	51.093760	11842	El Mora	850.00	Habitacional clase media baja	503
128.484400	50.134290	11841	El Mora	850.00	Habitacional clase media baja	503
142.395500	51.588160	11840	El Mora	850.00	Habitacional clase media baja	503

- When making a visual inspection of the **Barrio del Silencio**, it was found that a registration doesn't exist for one of the lots for that neighborhood. We will add a registration (line) to the database. From the **Edit** menu selects **Add Record**, then go to the lowest part of the table. A new registration is added to the table. You have zeros in the numeric fields and there is white in the field of characters (string).
- Click on the **Uso de la tierra** field and on the area of the new registration and write **921.659**, then press the **Tab** key.

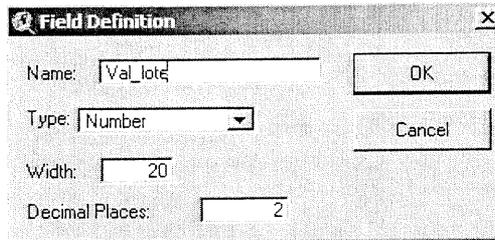
Area	Perimetro	Identificación de Parcela	Barrio	Precio_m2	Uso de la Tierra	Código de Uso
921.659200	121.872200	10816	El Silencio	850.00	Almacen/Bodega	200

- In the **Perimeter** field write **121.8722** and press the **Tab** key.
- Continue this procedure until the cells are fill like as is shown in the previous figure. When finished typing the **Code of Use** press the **Enter** key.

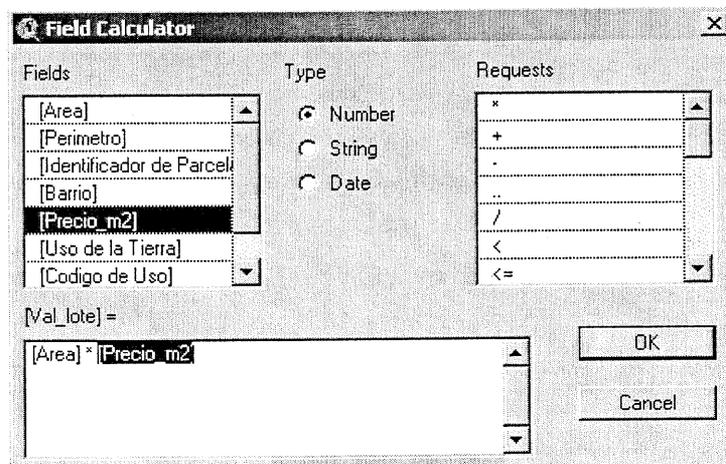
### Add a field and calculate values

Now the value each lot will be calculated for each one of the properties. To do this we will add a field and fill it making a mathematical operation in the fields.

- From the **Edit** menu choose **Add Field** to display the respective dialogue box. In the entrance box for the name write **Val\_lote**. The type of data is a **Number** and the width is **20** characters. The number of decimals will be **2**. Click on **OK** to add the new field to the table. The new field appears selected in the new table.



17. Click on the button **Field Calculator**.  The calculator field appears. In the text box an expression will be built telling ArcView which values to put in the new field.
18. In the Fields list locate the field **Val\_lote** and double click on it. In the Requests list double click on the multiplication sign ("\*"). Again, in the Fields list locate the field **Precio\_m2** (it values the earth for a square meter in Colons) and double click on it. The expression will appear this way:



19. Click on **OK**. Each cell in the new field contains the value of the lot.

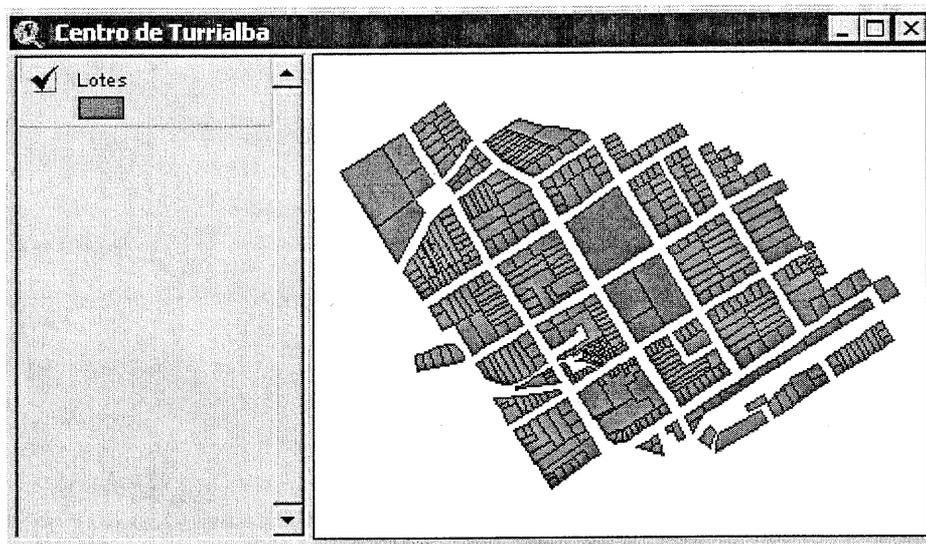
## Using ArcView 3.2

Perimetro	Identificador de Parcela	Barrio	Precio_m2	Uso de la Tierra	Codigo de Uso	Valor
2010.410000	11661	El Silencio	850.00	Cafetal	600	172871980.00
75.892960	13141	El Silencio	850.00			220802.89
74.250590	13140	El Silencio	850.00			209573.96
74.854500	13139	El Silencio	850.00			224189.54
72.910570	13138	El Silencio	850.00			204258.14
73.663080	13137	El Silencio	850.00			211102.94
74.069280	13136	El Silencio	850.00			213911.17
72.205990	13135	El Silencio	850.00			189902.75
72.125250	11698	El Silencio	850.00	Habitacional clase media baja	503	188139.68
71.568660	11697	El Silencio	850.00	Habitacional clase media baja	503	179167.00
72.663280	11696	El Silencio	850.00	Habitacional clase media baja	503	191244.99
72.095790	11695	El Silencio	850.00	Habitacional clase media baja	503	185036.08
47.774720	11662	El Silencio	850.00	Habitacional clase media baja	503	113394.51
51.056220	11663	El Silencio	850.00	Habitacional clase media baja	503	139078.36
74.064310	11694	El Silencio	850.00	Habitacional clase media baja	503	208777.94
54.536930	11664	El Silencio	850.00	Habitacional clase media baja	503	161869.83
73.506940	11693	El Silencio	850.00	Habitacional clase media baja	503	202493.80
1724.953000	13158	El Silencio	850.00			66106395.50

20. Add a new **Field** called “**Tax**” and fill it with values that signify 0.5% of the value of the property. Apply what was learnt previously.
21. From the **Table** menu, select **Stop Editing**. Click on **Yes** to save the changes.
22. Close the project. Click on **No**, we have already saved the changes on the table in the previous step.

## Associating and linking tables

23. Start ArcView (a portfolio called **ESRI** exists in the menu of programs).
24. Open the project called `c:\proarcalejer4av\lasoc_tablas.apr`. When the view opens up you will have a view with the lots of a part of downtown Turrialba.



25. Click on the button **Open Theme Table**  to display the respective table.
26. Move to the right of the table and observe the fields, with which you should be familiar with. It was used in the previous exercise.

Shape	Area	Perimeter	Ramifin_i	Fancceld	Numilote	Ramio
Polygon	157.559600	51.769870	1776	1776	29301	Centro Turrialba
Polygon	196.278300	66.046960	1777	1777	29302	Centro Turrialba
Polygon	181.563500	56.635230	1775	1775	29201	Centro Turrialba
Polygon	193.981900	66.348320	1778	1778	29303	Centro Turrialba
Polygon	186.639600	57.036320	1774	1774	29106	Centro Turrialba
Polygon	212.194300	68.313440	1779	1779	29304	Centro Turrialba
Polygon	537.582000	113.428300	1864	1864	34301	Centro Turrialba
Polygon	302.732900	78.299890	1788	1788	29105	Centro Turrialba
Polygon	211.027800	68.863090	1780	1780	29305	Centro Turrialba
Polygon	165.708500	52.830170	1907	1907	40001	Centro Turrialba
Polygon	841.054200	132.904200	1865	1865	34302	Centro Turrialba
Polygon	158.023400	51.881270	1906	1906	40002	Centro Turrialba

### To add a table to the project

27. Click on the window of the project to make it active. In the icons panel, click on the icon **Tables**.



28. Notice that in addition to the **Attributes of Lots** table, the project already contains a table called **Proprietors** (you will open this table later). Click on the **Add** button. In the dialogue box **Add Table**, navigate to the directory **c:\proarcalejer4av**. Double click in **vulnerabilidad.dbf** to add it to the project. This table contains the data of a survey that was carried out to determine the number of levels (floors) that the constructions have, the construction material and if they have some degree of vulnerability to landslides or floods.

### To associate tables in ArcView

When you unite tables, ArcView temporarily annexes the fields of a table (the table source) to another table (the table destination). To associate two tables, the tables should share a common field of information (it is not necessarily to have the same name, but should mean the same thing within their content). ArcView uses the values of this field to pair the registrations in the two tables. It is important therefore that the relationship of the registrations between the destination tables and the source is from one to one or of many to one.

29. Move the table **vulnerabilidad.dbf** to the left corner of the upper window of the application (you can maximize the screen to have more observation space). The table **vulnerabilidad.dbf** is the **source table** in the association operation. Their fields will be annexed to the table of the theme.
30. In the table **vulnerabilidad.dbf**, click on the header of the field **Parcelid** to make it active. This will be the common field to be used in the association of the tables.
31. Click on the table **Attributes of Lots** to make it activates. Move to the right of the table and click on the header of the field **Parcelid** to make it active. **Attributes of Lots** is the **destination table**. Notice that the destination table contains **454** registrations (one for each parcel), while the source contains

6595 registrations (one for each lot in the whole database). The relationship among the registrations is **from one to one**.

vulnerabilidad.dbf			Attributes of Lotes			
Numero	Piso	Material	Area	Perimeter	RAMIFIN	Numero
11698	1 piso	Concret	157.559600	51.769870	1776	29301
11697	1 piso	Concret	196.278300	66.046960	1777	29302
11696	1 piso	Concret	181.563500	56.635230	1775	29201
11695	1 piso	Concret	193.981900	66.348320	1778	29303
11662	1 piso	Concret	186.639600	57.036320	1774	29106
11663	1 piso	Madera	212.194300	68.313440	1779	29304
11694	1 piso	Concret	597.582000	113.428300	1864	34301
11664	1 piso	Madera	302.732900	78.299890	1788	29105
11693	1 piso	Concret	211.027800	68.883090	1780	29305
11665	1 piso	Madera	165.708500	52.830170	1907	40001
11692	1 piso	Concret	841.054200	132.904200	1865	34302

32. Move the table **Attributes of Lotes** to the lower right corner of the application window. Make sure that the table **Attributes of Lotes** is active (The cintillo of the title appears in blue color) The **destination table** in an association is **always the table that should be active**.
33. Click on the **Join** button. The table **vulnerabilidad.dbf** closes and its fields are annexed to the table of the theme (**Attributes of Lotes**).
34. Move to the right of the table. The vulnerability fields at the end of the table have been annexed by the association operation. These fields now can be used for classification and analysis.

## Using an associated field to display the theme

Now we are ready to classify and display the theme **Lotes** based on the associate field **Material**.

35. Click on the view to make it activate. Then double click on the legend to open the **Legend Editor**. 
36. Select **Unique Value** as the legend type.
37. Select **Material** as the value for the classification field. Each class of construction material is assigned a color, according to the color outline for omission. We will change this outline.
38. In the lowest part of **Legend Editor**, click on the button **Random Colors**. Make successive clicks until you obtain a color outline that you like. 

39. Click on the **Apply** button to make the color outline visible, then close the **Legend Editor**.



It is noticed that the descriptions don't fit in the view of the legend. There are some ways to remedy this situation. You can enlarge the width of the view of the legend, but to the cost of making the display of the map smaller. A better solution is to edit the labels in the **Legend Editor**. In this case, however, it will simply hide the legend, since it is too long and too wide.

40. From the **Theme** menu, select **Hide/Show Legend**. Now the legend is no longer shown.
41. From the **Window** menu, select **Attributes of Lots** to make the table of the theme activate. From the **Table** menu selects **Remove All Joints**. The table of the theme loses the annexed fields and the theme is reverted to a monochrome symbol.

## Linking tables

When the relationship between the destination tables and source is **one to many**, you should link the tables in the places of association. The same as association, the link requires that the two tables share a field in common. When the tables are connected, selecting a registration in the table destination selects all the registrations in the **source table that have the same value for the common field**.

42. Click on the window of the project to make it active. Click on the icon for **Tables**. In the list of tables, click on the **Proprietors** table and then click on **Open** to open the table.

Parcelid	Numlote	Nombre	Apellido	Apel
11709.00000	270001	Trinidad	Nuñez	Araya
11710.00000	270002	Sonia	Cascante	Carpio
11711.00000	270003	Gerardo	Cambriero	Brenes
11712.00000	270004	Luis	Correa	Míndez
11713.00000	270005	Milagro	Coto	González
11714.00000	270006	Juan	Monestel	Sandí
11715.00000	270007	Minor	Mejía	Cascante
11716.00000	270008	Isalla	Castillo	Rivera
11717.00000	270009	Luis	Calvo	Brenes
11718.00000	270010	Gilberth	Avendaño	Hidalgo
11719.00000	270011	Juan	Cerdas	Obando
11722.00000	270201	Carmen	Sánchez	Hidalgo

The table contains the name and the address of the proprietors of the parcels. The table of the proprietors like the table of the theme, contain a field called **Parcelid**, which serves as the **common field**. The relationship between the table of the theme and the table of the proprietors is **one to many**, because each earth parcel can have more than a proprietor. Therefore we will make a connection instead of an association for the table.

43. Move the **Proprietors** table to the left upper part of the application window, then click on the field **Parcelid** to stand out it.
44. Make the table **Attributes of Lots** activate and move it to the lower right part of the application window. Click on the field **Parcelid** to highlight it.

Apellido?	Cedula	Shape	Area	Perimeter	Basim i
		Polygon	157.559600	51.769970	1776
Jiménez		Polygon	196.278300	66.046960	1777
Jiménez		Polygon	181.563500	56.635230	1775
Monge		Polygon	193.981900	66.348320	1778
A.		Polygon	186.639600	57.036320	1774
Velázquez	3-276-555	Polygon	212.194300	68.313440	1779
Calvo		Polygon	597.582000	113.428300	1864
H.		Polygon	302.732900	78.299890	1788
		Polygon	211.027800	68.883090	1780
Cedeño		Polygon	165.708500	52.830170	1907
Roman	3-144-973	Polygon	841.054200	132.904200	1865

45. With the table **Attributes of Lots** activated, from the menu select **Theme Link** to unite the tables. The tables are associated, but the fields are not annexed to the destination table and the table source remains open.
46. Make sure that the **Select Record** tool is stood out . Select any registration in the table **Attributes of Lots**. The corresponding registrations are selected and they stand out in the **Proprietors** table. The earth parcel is also stood out in the view. Inside the parcels there are some that have multiple proprietors.

47. In the table **Attributes of Lots** looks for the field **Parcelid**. Click on the header **Parcelid** to highlight it and then click on the **Sort Descending** button to order the registrations from bigger to smaller values.
48. With the **Select Record** tool still projected, click on the registration with a value of **Parcelid** equal to **1964**.
49. Click on the **Proprietors** table to make it activate, click on the **Promote** button. The selected registrations move to the upper part of the table.

propietarios.dbf				meter	Parcelid	Parcelid	Parcelid
Parcelid	Nombre	Apellido	Apellido				
46305	Eduardo	Cispedes	Arie	864990	1967	1967	46101
46305	Miguel	Cispedes	Arie	000290	1966	1966	46002
46305	Yancy	Cispedes	Arie	373550	1965	1965	46001
46305	Diego	Cispedes	Arie	682600	1964	1964	4630E
46305	Rodolfo	Cispedes	Arie	047840	1963	1963	46304
10303				289640	1962	1962	4630E
14303				434840	1961	1961	46302
165207	Lote para Construcci			332680	1960	1960	46301
				756650	1959	1959	4620E
165208	Lote para Construcci			623750	1958	1958	46204
90003				616040	1957	1957	4620E
				250000	1956	1956	4600E

50. With the table of **Attributes of Lots** activate, from the **Theme** menu, select **Remove All Links**.

**For you to explore:**

Repeat the steps from 42, but this time instead of selecting **Link** use **Join**. What happens with the parcels that have multiple proprietors?

**Close the project**

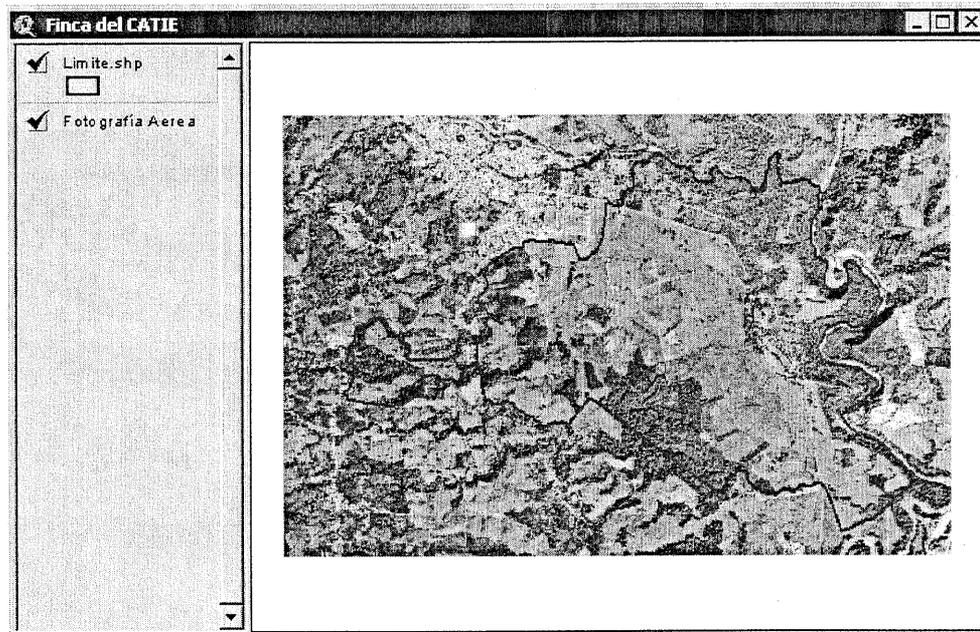
51. Click on the window of the project to make it activate. From the **File** menu chooses **Close Project**.

## ***IV. Handling Primary Data: Creating and Editing Themes in ArcView***

CATIE has requested us to elaborate a map and a database with the lots that are managed in the administrative area of the property of the institution (we won't make the whole area for matter of time). This cartographic database could later be connected to the system of database of administration of the property and would this way visualize a series of variables that could contribute to a better taking of decisions.

### **Starting ArcView and opening a project**

1. Start ArcView (a portfolio exists called ESRI in the menu of programs).
2. Open the called project `c:\proarca\ejer5av\edit_temas.apr`. When the view opens up you will have a view that shows an orthorectified aerial photograph of the area that corresponds to the property of CATIE. It is also observed in red the limit of the property of CATIE.



You can create a new theme (polygon, line or theme) in a view that uses the coordinates of the places of an existing theme (aerial photography in this case). For example, starting from this example we can create a map of the use of the land for the property, a map of communication roads, a map of the lots of the property and constructions, etc. Once a new theme is created, elements can be added and then their attributes. This procedure is known as **on screen digitalization**. We will proceed now

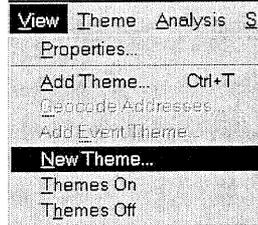
to trace the lots of the property of CATIE with reference to the **polygons** that are shown next, with their respective table (you can **Zoom** on the picture to observe the areas of interest):



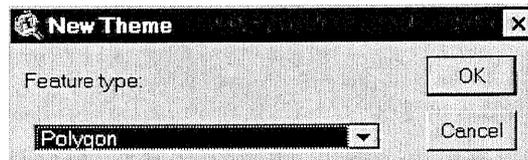
The first thing to do will be to create a new theme that receives the polygons corresponding to the lots that we will digitize and then to modify the legend in such a way that only the borders of the polygon are drawn (**outlines**).

### Creating a new theme and modifying its legend

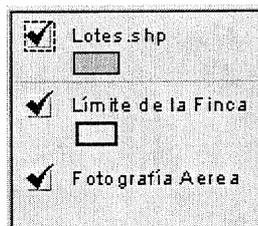
3. From the **View** menu, choose **New Theme** to display the dialogue box.



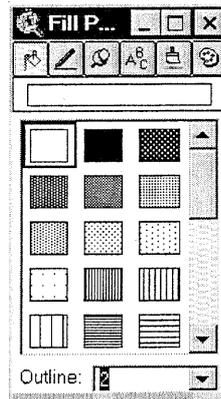
4. From the **Feature Type** list, select **polygon** and then click on **OK**.



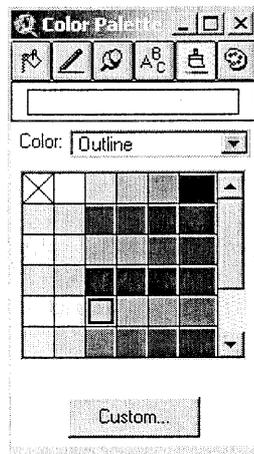
5. In the next dialogue box, navigate to the directory **c:\proarcalejer5av** and change the **File name** to **lotes.shp**. Click on **OK**. A new file of polygons is added to the list and it is ready to be edited.
6. Click on the checkup box of **lotes.shp** to make it activate.



7. For omission, the theme **Lotes.shp** has a pattern of solid filling. The polygons that we add to this theme will cover the themes that are under them. Since we want to see behind the polygons, we will change the legend for **Lotes.shp** to a transparent symbol with a border that stands out.
8. Double click in the box of **Lotes.shp** in the Table of Contents to open the **Legend Editor**. Double click in the rectangle Symbol to display the **Fill Palette**.
9. In the **Fill Palette**, change the pattern from solid to transparent, making a click in the first white box. Make the line thicker by going to **Outline**, (selecting 2 from the list that is presented).



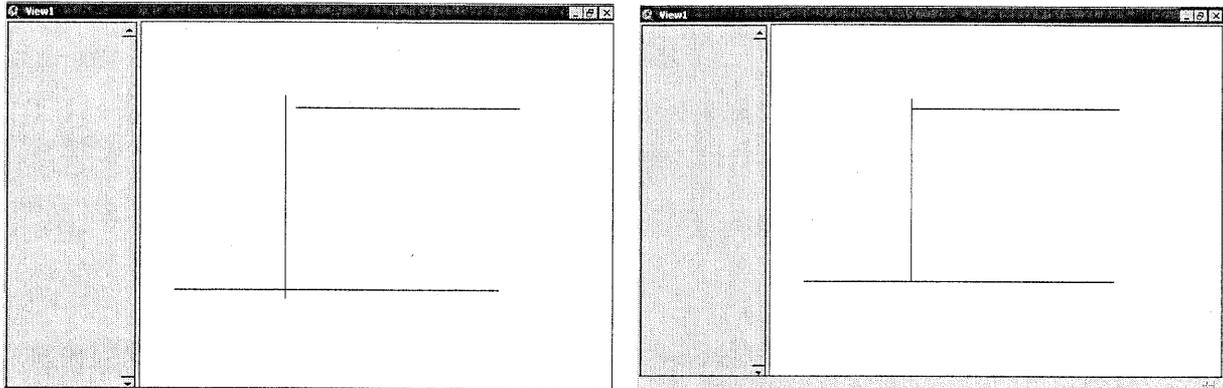
10. Now click on the **Color Palette**  to display the colors. From the **Color** list choose **Outline**, and then click on the square of the celestial blue (cyan). The polygons with a celestial blue border will be easy to see in conjunction with the border of the property.



11. Click on **Apply** in the **Legend Editor** in order to apply their changes to the legend of **Lotes.shp**.
12. Close the **Legend Editor** and the **Color Palette** box.

## Fixing the automatic alignment

If you add lines to the theme and want to intersect lines that meet at the same final point without having extra lines (overshoots) or lines that do not reach the line they should intersect (undershoots), you use the automatic alignment.



DISABLED AUTOMATIC ALIGNMENT

ACTIVATED AUTOMATIC ALIGNMENT

When the automatic alignment is fixed, ArcView moves the vertices or the segments of the line of the new line that you added and aligns them with the vertices of the line segments of the lines already existing that are within the specified distance.

You can also use the automatic alignment when polygons are added to a theme and if you want the new polygons to join with the existent polygons in such a way that holes or over positioning don't occur between adjacent polygons.

When you want the new elements join to existing elements inside a specific distance, uses the general alignment (**General Snapping**). The general alignment is a characteristic of alignment from element to element that is applied after a new element is added.

If you wants to have more control in how the new elements join the existing elements, use the aligned interactive (**Interactive Snapping**). With the aligned interactive you can apply different rules of alignment for each vertex while a new element is added. You can choose one of the following rules:

**To align to the vertex:** align the next vertex that you add to the nearest vertex in a line or existent polygon.

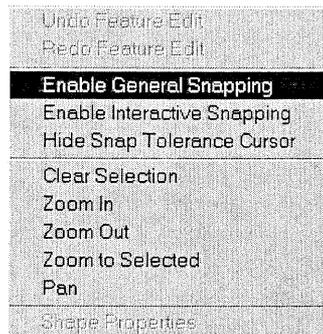
**To align to the border:** align the next vertex that you add to the nearest line segment in a line or border of existing polygon.

**To align to the intersection:** align the next vertex that you add to the nearest common vertex between two lines or existing polygons.

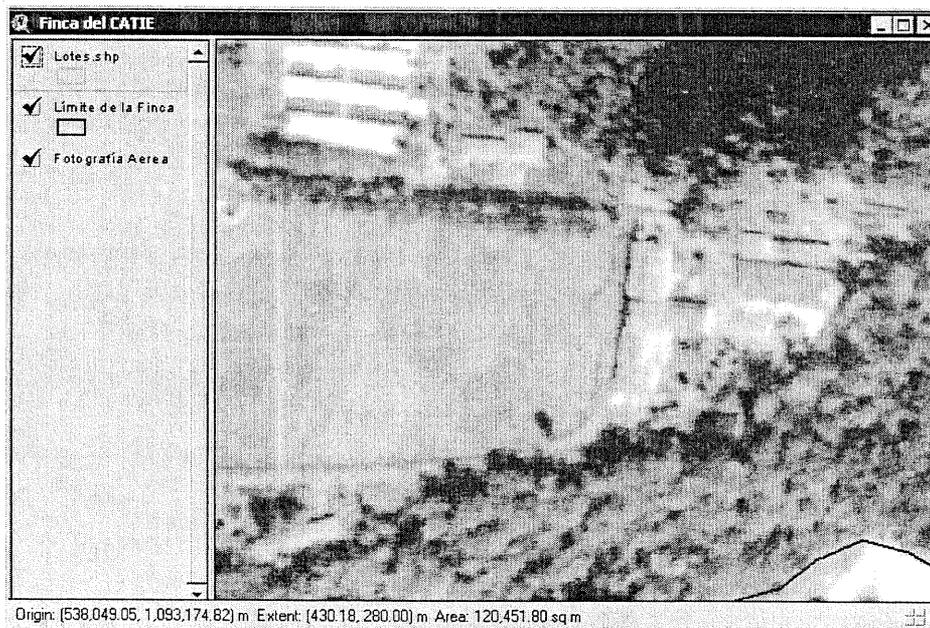
**To align to the Final Point:** align the next vertex that you add to the final point of the nearest line.

Now you can fix the automatic alignment by using the mouse

13. Put the cursor in the view and press the right button of the mouse to display the menu. Move the mouse down until you reach **Enable General Snapping**, then release the right button of the mouse. You will fix the tolerance of automatic closing in the view using the **General Snap** tool. To make it easier, you will first **Zoom In** on the view.



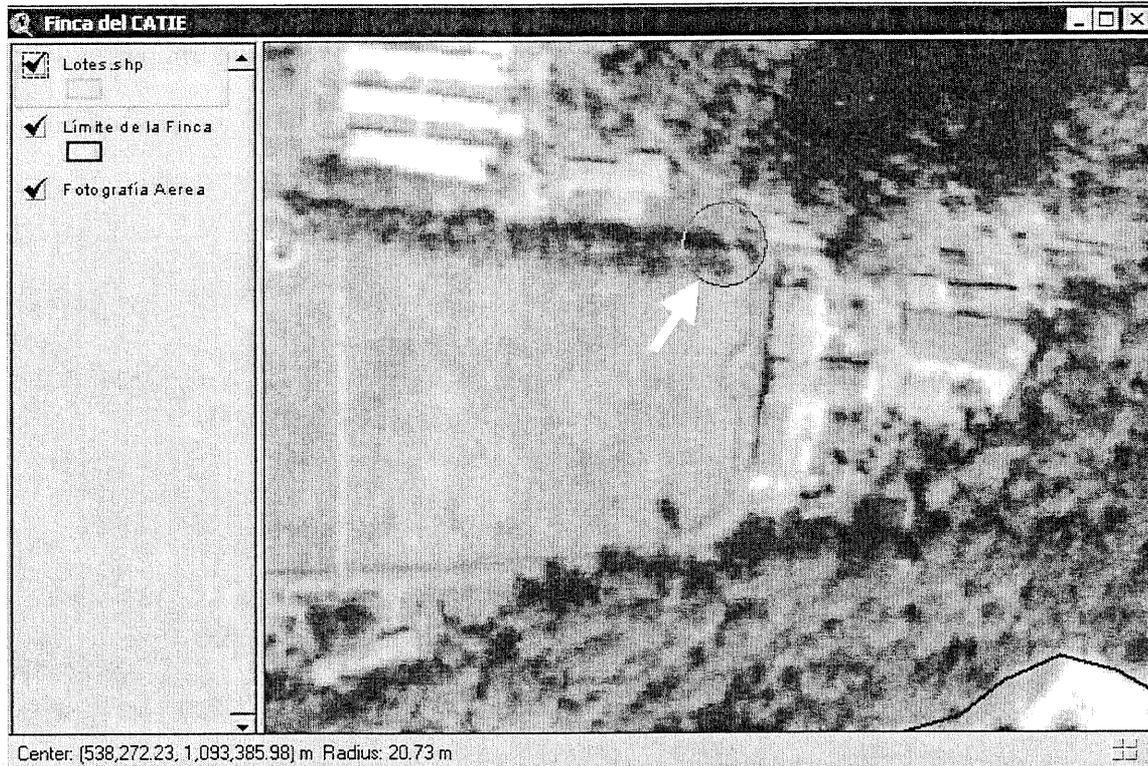
14. Click on the **Zoom In**  tool and then draw a rectangle in the center of the main square of CATIE to bring a smaller area closer, as is shown next.



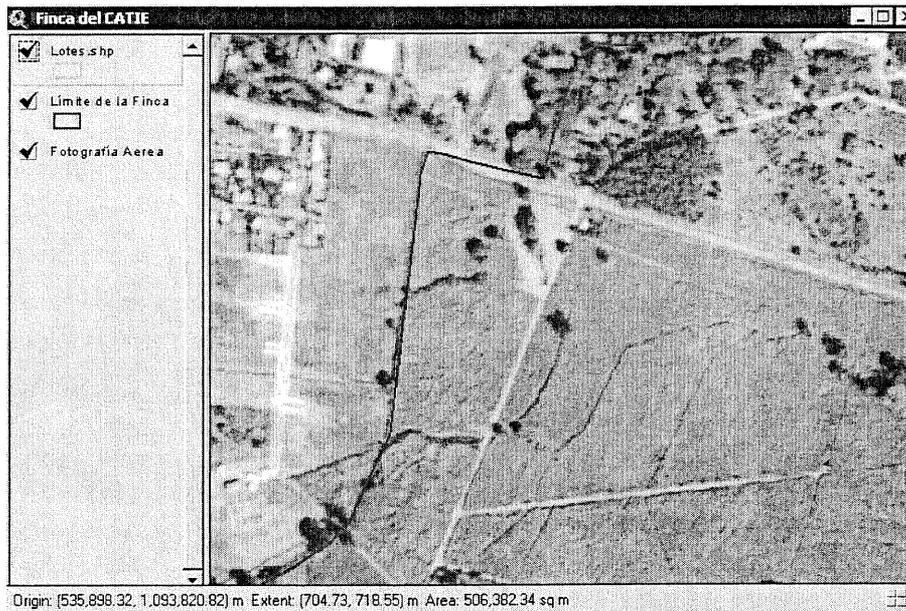
15. Click on the **General Snap** tool . Position the cursor in the view, then click and pull a circle with a radius of 20 meters (the radius of the circle is in

the bar at the bottom of the screen). This radial value becomes the automatic tolerance for alignment or snapping.

16.



17. Now that you have seen the closing tolerance, we will add elements to the new theme. First we will make an adjustment to the previous extension.
18. Click on the button **Zoom to Previous Extent**  , and then zoom that to the area that is contiguous to the entrance of Cabiria, on the highway that leads from Turrialba to CATIE (almost in front of the University). This does not corresponds to the lot with **Identification 1**.

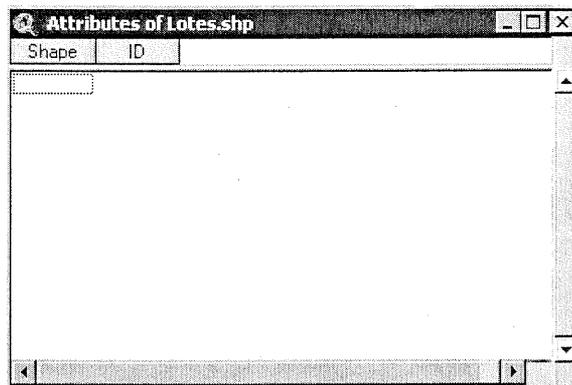


## Adding elements and attributes to the new theme

Now we will add **polygon 1**. Previous to this we need to create the fields that the table needs to take the lots. First you will add a new field to the **theme table** to store the data of the table:

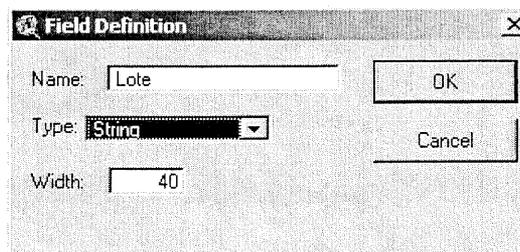
<i>Id</i>	<i>Lote</i>	<i>Detalle</i>
1	Los Olivos	Caña
2	Los Bonilla	Caña - Area de Investigación
3	Caña	Caña
4	ICE	Propiedad del ICE
5	Caña	Caña
6	Las Palmeras	Café
7	Caña	Caña
8	Amarillo	Café
9	Potrerros frente a Oficina	Potrerros de terneras y vacas secas
10	Caña	Caña
11	Potrerros de Lechería	Bancos de proteínas (Oficina)
12	La Guardia	Café
13	Llama	Café orgánico
14	Las Cabras	Moreral
15	Las Mulas	Caña
17	Bosque	Parche boscoso
18	Las Mulas	Caña
19	Los Zanjeros	Potrerros y Pastera
20	Charral	Charral
21	Potrerros de Lechería	Alrededores de lechería
22	Establo y El Teca	Potrerros
23	Potrero	Potrero
24	Caña	Caña
25	Semiestabulado	Potrero
26	Las Peñas	Potrerros de caballos
27	Altos de Don Enrique	Potrerros de vacas secas y novillas
28	La Bomba	Caña
29	Pajarito	Café
30	El Teca	Caña
31	Lote Siete	Café
32	Abandono	Caña
33	Potrero	Potrero
34	El Cinco	Café
35	Florencia Norte	Caña
36	Los Sotos	Café
37	Bosque	Parche boscoso

19. Click on the button **Open Theme Table**  to open the table of **Lotes.shp**.

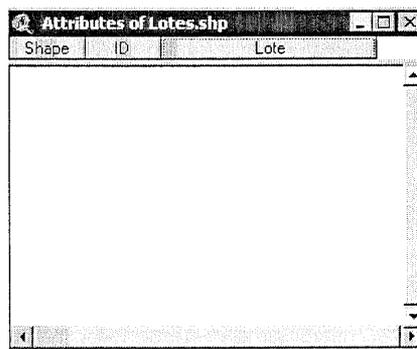


Notice that there is a field called **Shape** and another called **ID**, but there are no records in the boxes. Now you will add a field called **Lote** and another field called **Details** to the table.

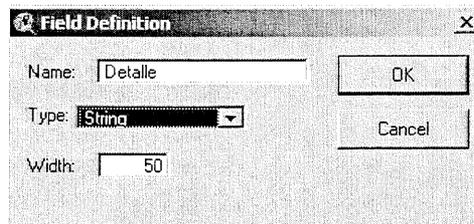
20. From the **Edit** menu, select **Add Field** to display the respective dialogue box.
21. In the **Field Name**, write **Lote** and in the **Type** list select **String**, so we can enter a text chain. Select **40** as the field width.



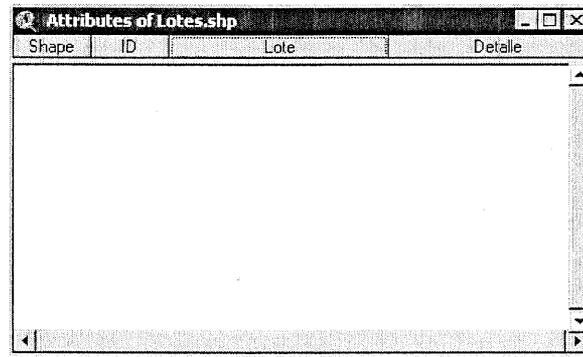
22. Click on **OK**. The new field **Lote** is added to the table of the theme.



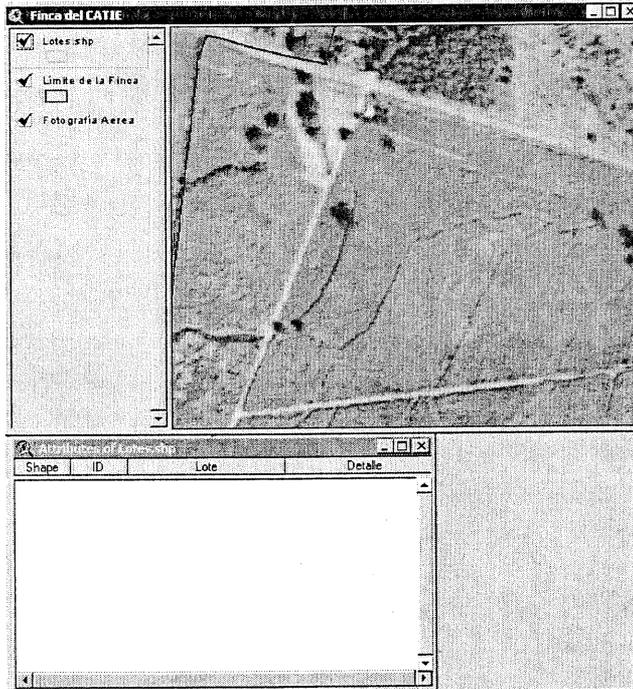
23. From the **Edit** menu, again select **Add Field** to display the respective dialogue box.
24. In the **Field Name**, write **Detalle** and in the **Type List** select **String**, so we can enter a text. Select **50** as the field width.



25. Click on **OK**. The new field **Detalle** is added to the table of the theme.



26. Position the viewer and the theme table on the same screen, in such a way that they don't overlap, then make the view active.



Now we will use the **Polygon** tool to draw a polygon representing the area of the **Lote No. 1**.

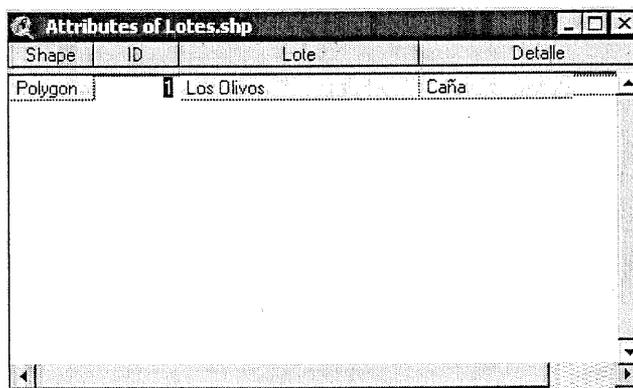
27. Of the list of hanging tools for drawing, choose the **Polygon** tool .



28. Now you will add the polygon like it is shown below. Click to enter each vertex and double click to complete the polygon.



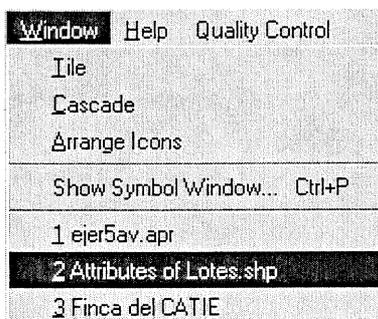
29. Now make the **Theme Table** active. A record has been added for the polygon that you made. Now you need to enter a **1** as your ID, **Los Olivios** as the Lote, and **Caña** as the Detalles
30. Click on the **Edit** tool.
31. Now Click on the lowest record in the field and write **1**, then press **Enter**. Click on the lowest record in the Lote field and write **Los Olivios**, press the **Tab** key to move to the following field and write **Caña** in the Details field. Press the **Enter** key.



32. Now you will add a similar polygon for 2. Follow the steps from the 26 to the 30 to add this polygon. Make a convenient **Zoom In** of the area where the polygon is in such a way that whole of the area is displayed in the window. To digitize on the screen it will be necessary to maximizes the display screen of the program in such a way that it takes advantage the whole area of the monitor.



33. Make the table window active again (if it has disappeared behind the window of the view, can go to the **Window** menu and select it by clicking on the name **Attributes of Table.shp**.

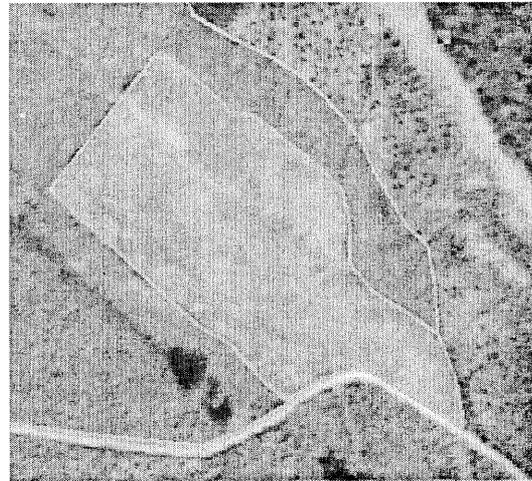
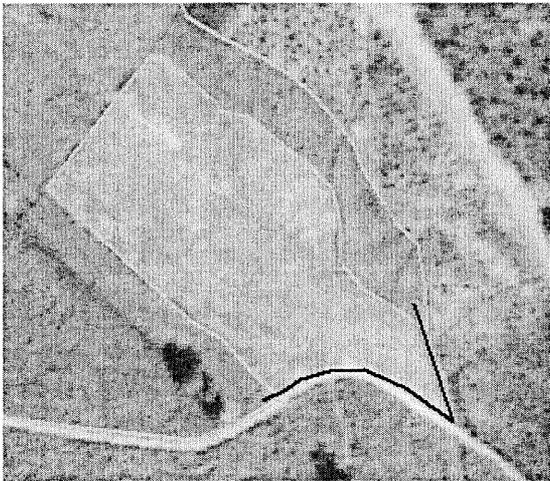


34. Insert ID number 2, the name of the Lote and the corresponding details, then return again to the window of the view.

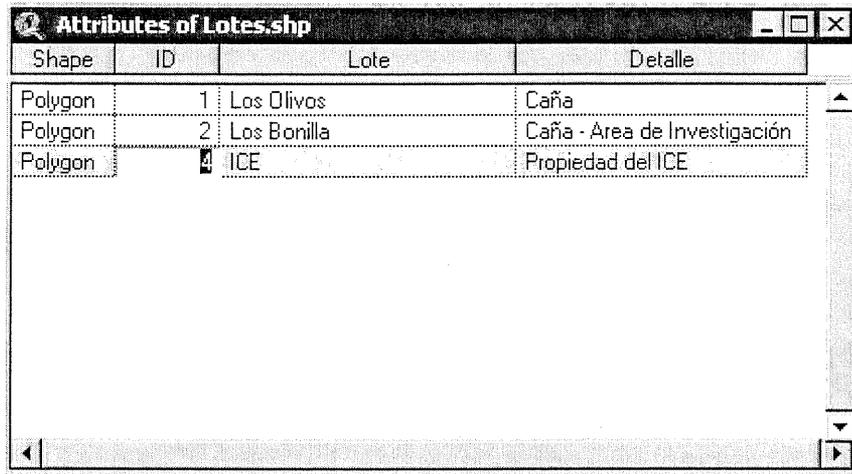
## Editing adjacent elements

Now we will add lot. 4. In this case the lot is adjacent to lot. 2 (lot. 4 shares a single side with the lot. 2). For we will use the tool called **AutoComplete**.

35. From the list of hanging tools for drawing, choose the tool **AutoComplete** 
36. Draw a line beginning in (or inside of) the border of the adjacent polygon (Lot No. 2). Click to enter each vertex and double click to conclude the line in (or inside of) the border of the adjacent polygon. *Note: The two polygons share a common border, so it is not necessary to complete the polygon where the common border exists.*

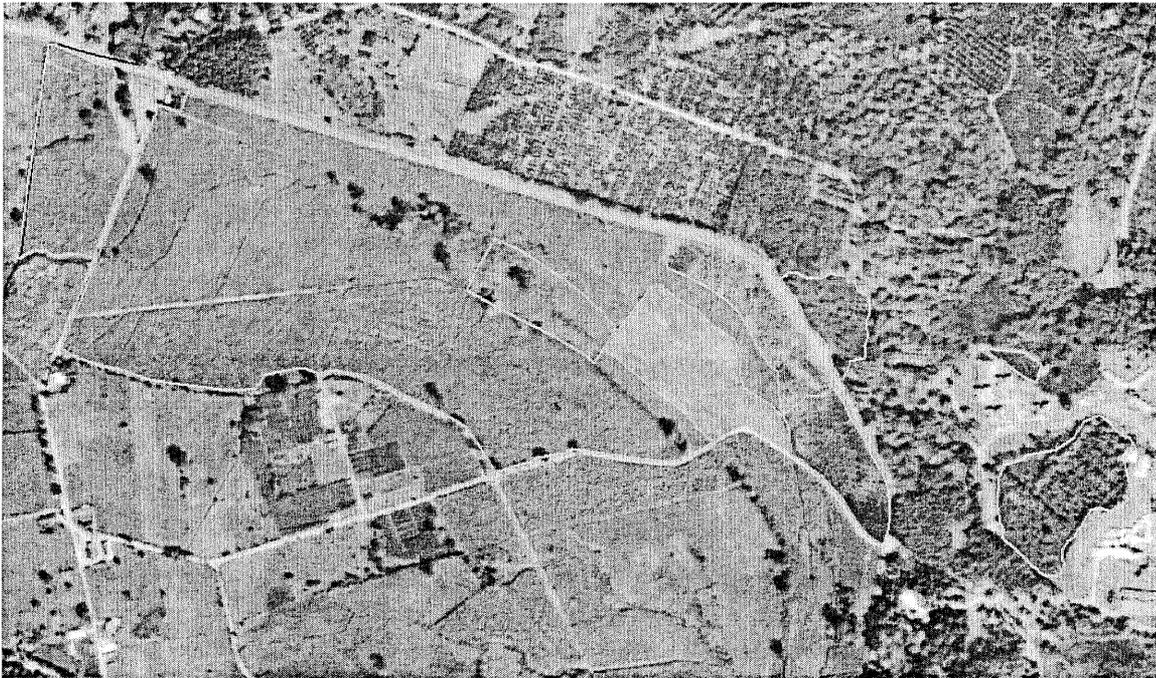


37. Now make database for the theme active. With the **Edit** tool selected, click on the illuminated record in yellow under the field ID and write **4**, then complete the other two respective fields.



Shape	ID	Lote	Detalle
Polygon	1	Los Olivos	Caña
Polygon	2	Los Bonilla	Caña - Area de Investigación
Polygon	4	ICE	Propiedad del ICE

Now add the polygons 3, 12, 6, 8 and 13 following the procedures seen in the previous steps. When you finish this process the theme and table should appear like this. You can vary the order of the records according to the order that you introduces the polygons, without effecting the final result.



Attributes of Lotes		
Id	Lote	Detalle
1	Los Olivos	Caña
2	Los Bonilla	Caña - Area de Investigación
3	Caña	Caña
4	ICE	Propiedad del ICE
6	Las Palmeras	Café
8	Amarillo	Café
12	La Guardia	Café
13	Llama	Café orgánico
20	Charral	Charral
15	Las Mulás	Caña

## Addition of polygon islands

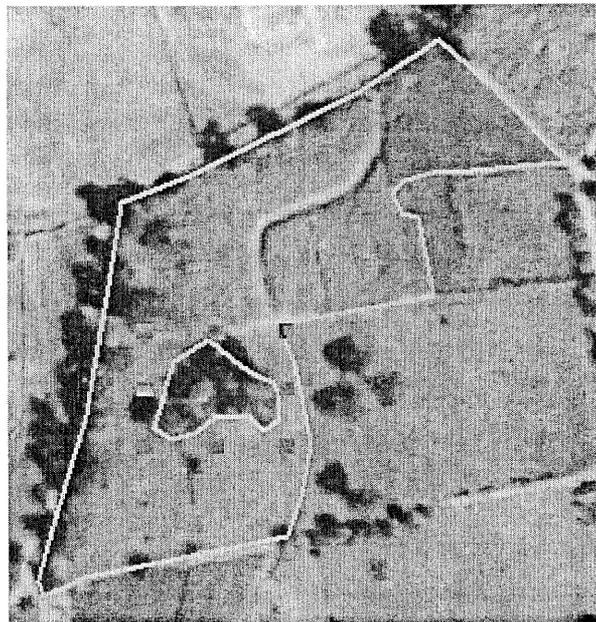
The polygon islands are completely contained inside another polygon. For this effect, ArcView provides an operation called **Subtraction of Polygons**. The strategy in this case is to digitize the biggest polygon first and then the polygon island. This is because when the subtraction operation is executed, the element that is on top is subtracted from the element that is below. The part of the feature which is beneath the overlay is removed, and the upper layer remains unchanged.

45. Digitize the polygon **No. 7** and introduce the data to the database, like it is shown below.



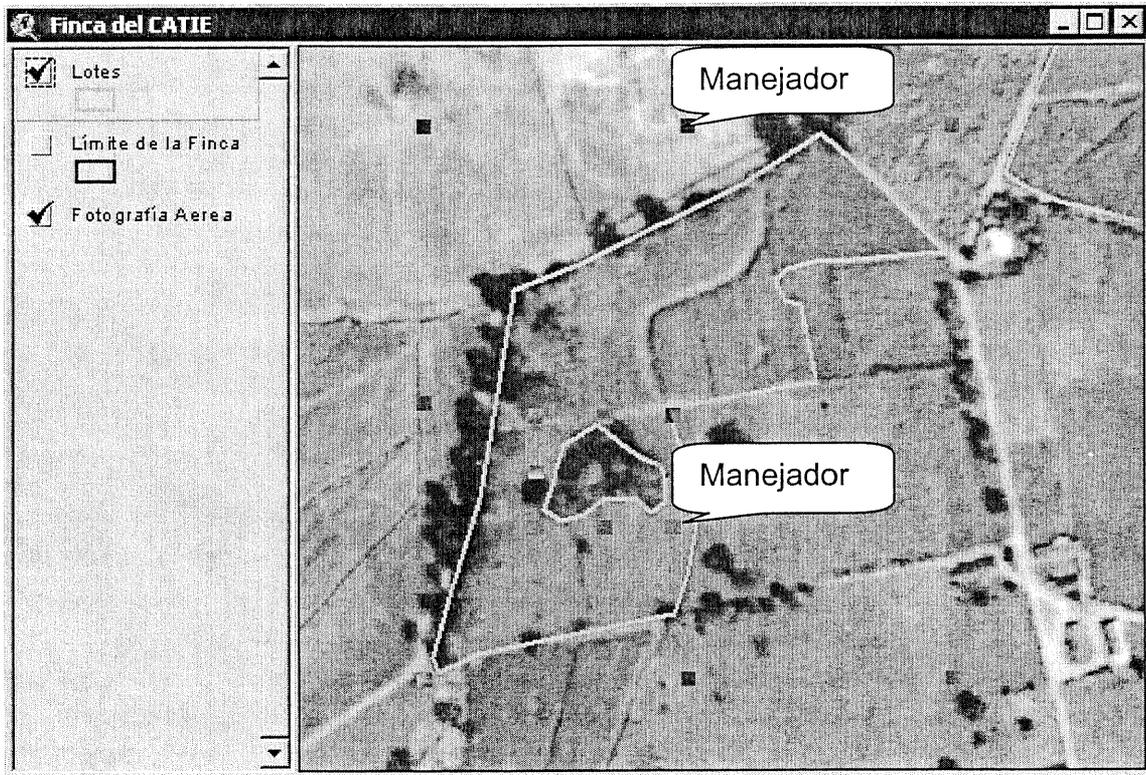
Attributes of Lotes		
Id	Lote	Detalle
2	Los Bonilla	Caña - Area de Investigación
3	Caña	Caña
4	ICE	Propiedad del ICE
6	Las Palmeras	Café
8	Amarillo	Café
12	La Guardia	Café
13	Llama	Café orgánico
20	Charral	Charral
15	Las Mulas	Caña
7	Caña	Caña

46. Change the value of the tolerance of the automatic Alignment to more or less 5 meters (see step 15). Later digitize the polygon **No. 17** and introduce the respective data in the table.

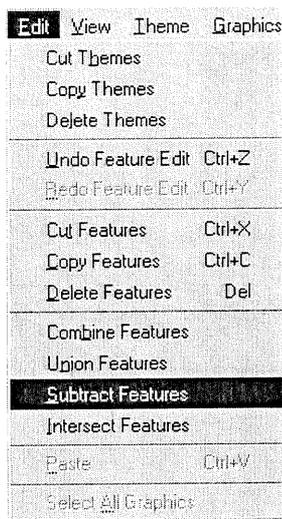


Attributes of Lotes		
Id	Lote	Detalle
3	Caña	Caña
4	ICE	Propiedad del ICE
6	Las Palmeras	Café
8	Amarillo	Café
12	La Guardia	Café
13	Llama	Café orgánico
20	Charral	Charral
15	Las Mulas	Caña
7	Caña	Caña
17	Bosque	Parche Boscoso

47. Select both elements (polygons) make a click with the selection tool  and then make a click in the external polygon (big), press the **Shift** key and then click on the small polygon (handles will be noticed around each one of the elements, 8 handles for the graph). Another way to select is to highlight them both in yellow directly from the table.



48. Once the two polygons are selected, from the **Edit** menu select the option **Subtract Features**. Although seemingly nothing happens, the area that represents the polygon island has been subtracted from the area of the external polygon. If one doesn't make the subtraction operation the polygons would be overlaid and the area of the external polygon would include the area of the internal polygon. You can revert the order of this operation (to subtract the one beneath from the one above) by continuing to press the **SHIFT** key when you choose to **Subtract Features** of the **Edit** menu.



There are three more options that exist in the previous menu:

**Combine Features** is used to create polygons that have a hole in the interior. In this case we digitize the external polygon first and later the island. The two polygons are selected and you click on made in the **Combine Features** option of the **Edit** menu it. If the polygons are not overlapping they behave as the union.

**Union Features** if the polygons are adjacent (they share a common frontier), the union removes that frontier to form a single polygon. If the polygons are not adjacent is a polygon is formed with multiple sides. If the polygons are overlapping, the frontiers are removed from the overlap and only one polygon is formed. The result of the union creates a unique record in the database, even for numerous polygons.

**Intersect Features** creates a new polygon of the shared area among the selected polygons.

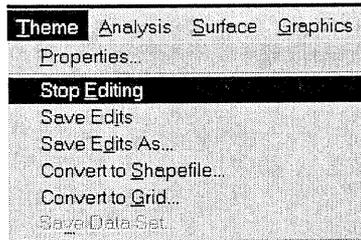
With these instructions you have the capability to finish the digitization of the remaining polygons in order to complete the rest of the table.

If you do not finish in a single day of work, you can keep their changes by using the following procedure.

### ***To stop editing and save the data***

When the editing is complete we will be ready to save the data.

49. From the **Theme** menu selects **Stop Editing**.



50. When asked if you want to save the edits, click on **YES**. You have successfully mapped and updated the areas of lots on the property CATIE.

## Close the project

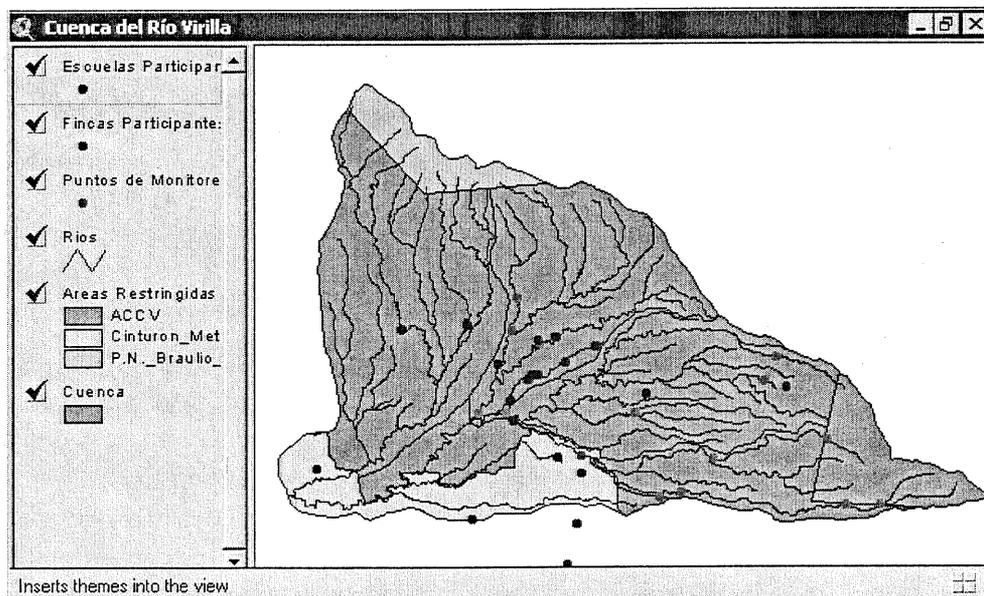
51. Click on the window of the project to make it activate. From the **File** menu, choose **Close Project**. Click **NO** to the changes, they were previously saved.

## V. Managing 'Layouts': Production of Printed or electronic Maps, Projection, Scales, Symbols

The data of this exercise corresponds to the area of influence of the **Project Plama-Virilla** and it covers the high part of the **Basin of the River Virilla** in **Costa Rica**. The data are without a projection (in geographical coordinated).

### Beginning ArcView and opening a project

40. Start ArcView (a portfolio exists called ESRI in the menu of programs).
41. Open the project called `c:\proarcalejer6av\layouts.apr`. When the view opens up you will see a project window that contains the view **Cuenca** (basin) of the **River Virilla**. You will utilize the view and the view of Costa Rica as elements for the design of your map.

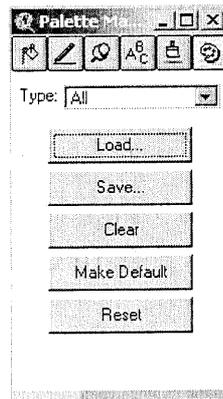


The map consists of a layer that shows the **Schools** that participate in the project of environmental education, the **properties** that participate in the reforestation project, the **points** where the superficial water quality monitoring of the basin is made, the main **rivers**, the **restricted areas** of use inside the basin and the basin with its division in **micro-basins** (5 in total). In this exercise you must liberate the choice of colors, and locate the symbols that you desire for the design and creation of the map. The present tutorial is only a guide so that you may develop your creativity.

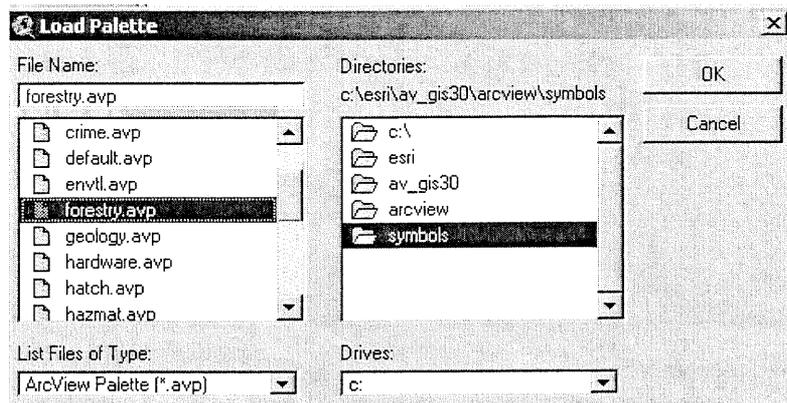
## To create the symbols for each one of the elements to represent in the map

Making use of that you have learnt up to now in the course, choose the symbols that to you represent the elements for points and lines. You will only be given an example of how to load additional symbols that come with ArcView and that can be used to represent punctual and lineal elements, as well as new palettes of colors.

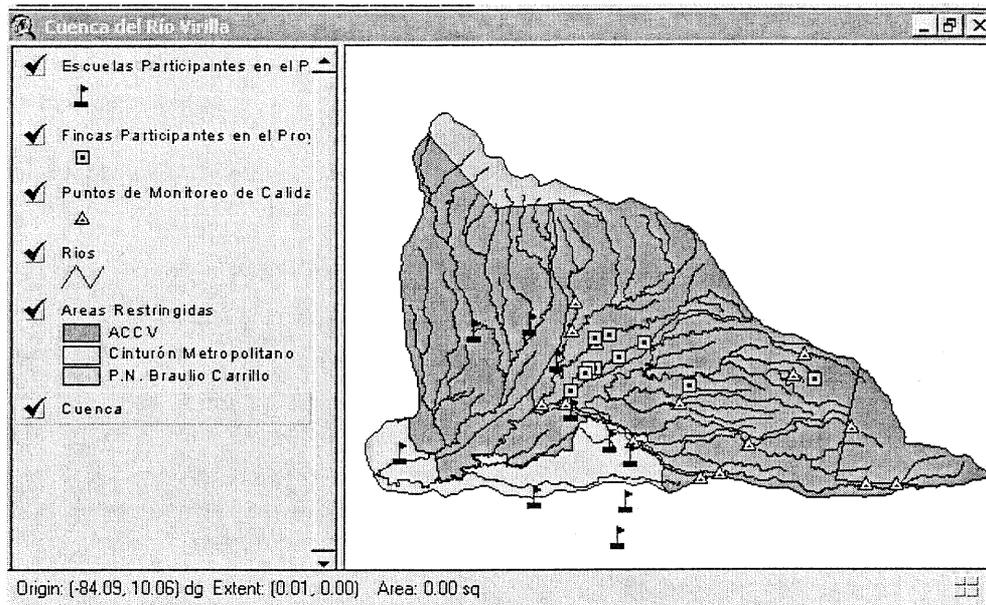
42. Double click on the name of the theme **Participant Schools** to display the Dialogue box of the legend.
43. Double click on the symbol that represents the Participant Schools to display the Marker Palette.
44. Click on the button for adding palettes  and then click on the button you **Load**.



45. Navigate to the directory **c:\esri\av\_gis30\arcview\symbols** and choose the outline of a symbol called **forestry.avp** and click on **OK**.



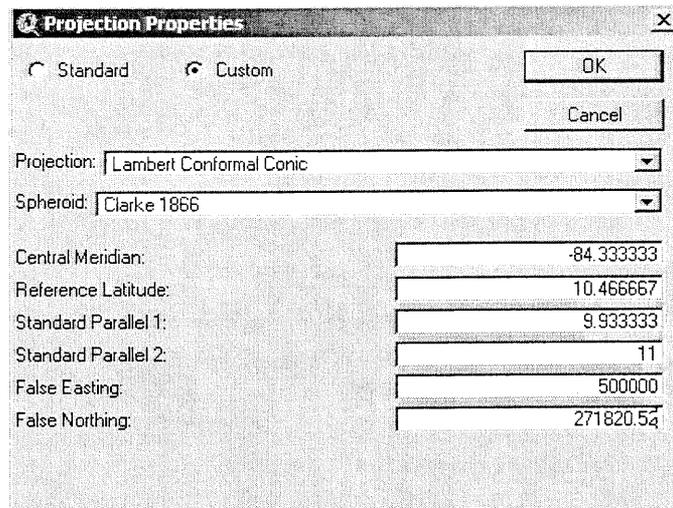
46. Repeat the previous step for the palettes **C256.avp**, **envtl.avp**, **colormrk.avp** and **municipl.avp**. The first palette adds 256 solid colors to display polygons. The second, third and fourth add environmental symbols, additional markers and municipal signs to display point data. The palette for points that was loaded in the previous step is for symbols related with forest activities.
47. Now return to the Marker Palette window and select the symbol to represent the schools . If you want to choose other more appropriate symbol, do so now. You can vary the color of the symbol to your pleasure by clicking on the **paintbrush** icon  so that the color palette displays (observe that now there are more available colors).
48. Change the symbols for the points that represent monitoring **superficial water** and **participant properties**. Also change the colors with which the themes polygons are represented until you find one that you like. Verify that the legend of the theme Restricted Areas coincides with what is next observed. Also, hide the legend for the theme **Cuenca**.



## To project the views to Lambert Conic Conformal

As it was mentioned in the beginning, the views of the Cuenca of the River Virilla and Costa Rica, are without data projection. So that the data is displayed in plane coordinates, it is necessary to project them. You will project the view of the Cuenca of the River Virilla, but you will remember that this projection is only for display effects and that the file continues being in Latitude/Longitude.

49. Choose **Properties** from the **View Menu** and Click on the button **Projection** to fix the projection of the view.
50. From the window of the projection you choose the option **Custom** and select the Projection **Lambert Conical Conformal** and the Spheroid of **Clarke 1866**. Then copy the parameters of the Projection that are shown next and click on **OK**. It indicates you that now you have a plane projection in places for the geographical coordinates.

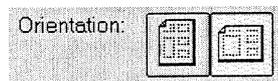


51. When you return to the properties window of the of the view it fixes the distance units as Kilometers.

### TO CREATE A DESIGN IN THE PROJECT

52. Click on the window of the project to make it activate. Double click on the **Layouts** icon  to create a new design.

53. From the **Layout** menu, choose **Page Setup** and change the orientation of the page to **Horizontal** (oblong), and then click on **OK**.



54. Make the drawing window bigger by dragging the lower right corner. Notice that a grid appears in the design page to help locate the elements of the map on the page. This grid is for display purposes and you won't appear in the printed design.

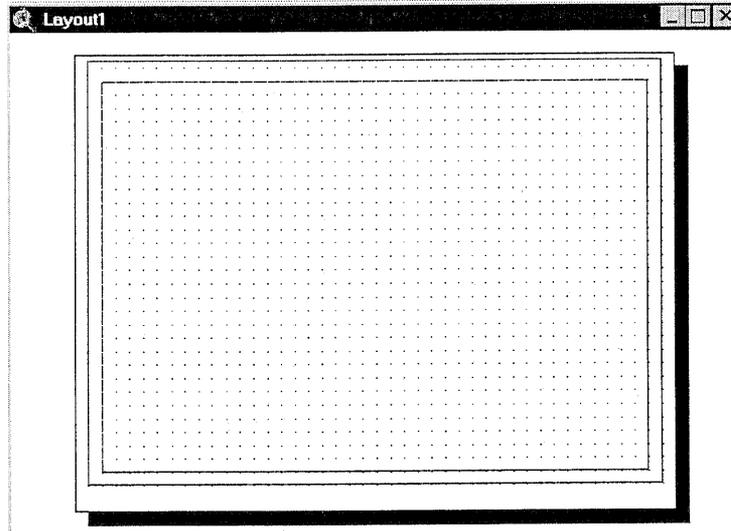
#### In order to explore:

1. Go to the **Layout** menu and select **Properties**. Make use of **Help** describes the meaning of each one of the options that you find in that dialogue box (**Grid Spacing**, **Snap to Grid**).

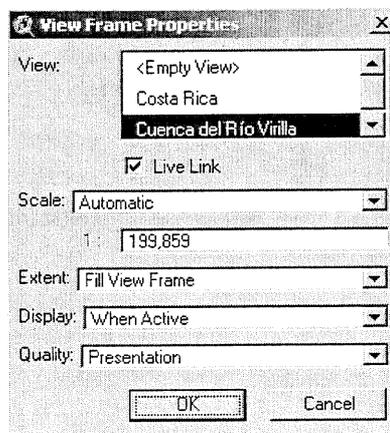
### Adding a view and legend to the design

To add the view **Cuenca of the River Virilla** to the design, you should first add a mark to the page.

55. Click on the **View Frame** tool (Mark View)  .
56. Move the cursor to the page of the design (it changes to a cross). As it is shown below, click on the left button and keep it pressed while you drag it to the lower right corner and then releases the button of the mouse.



57. When the **View Frame Properties** dialogue box appears, click on the view **Cuenca of the River Virilla** to select it. To accept the other options for omission, click on **OK**.

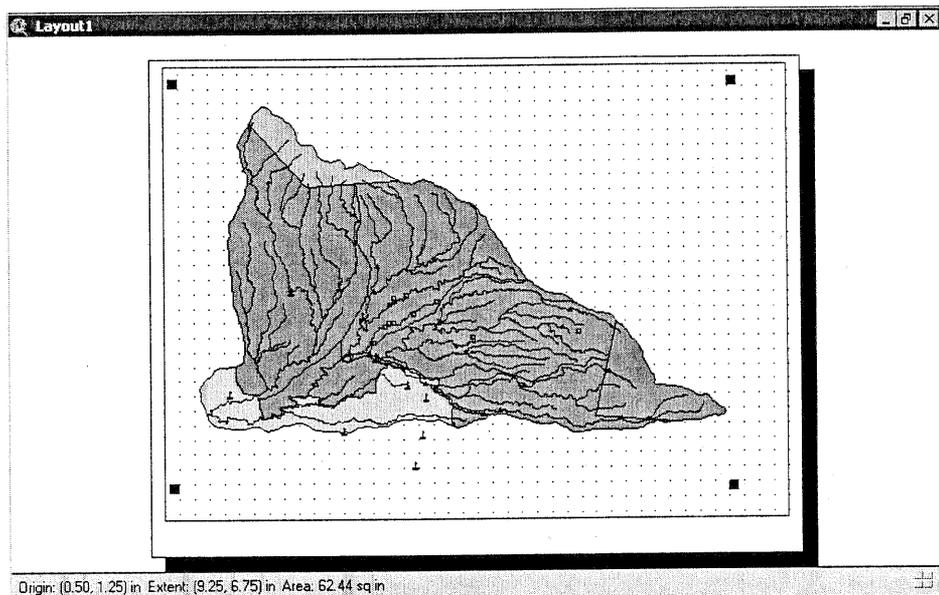


**In order to explore:**

2. Making use of **Help** in ArcView, which give an explanation of the options that there is for **Live Link**, **Scale**, **Extent**, **Display** and **Quality of the previous window**.

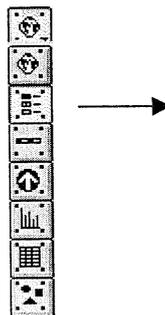
58. The view Cuenca of the River Virilla appears in the design.

Note: If you are not satisfied with the size or the position of the mark of the view, you can use the pointer tool to select it, to move it or rescale the image.

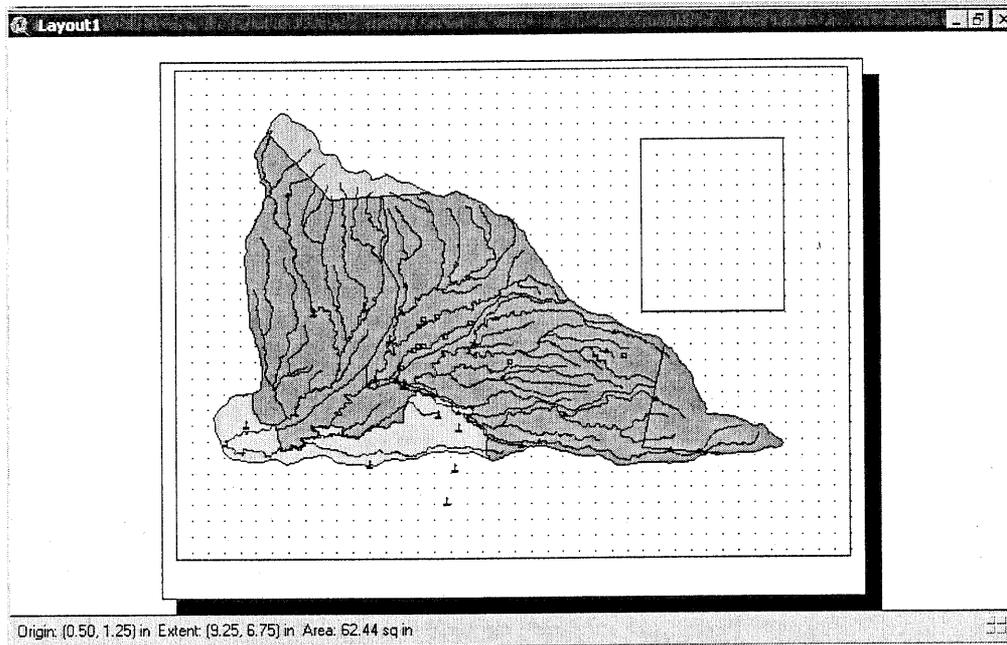


Now you will use the legend of the theme in the view to create a legend in the design.

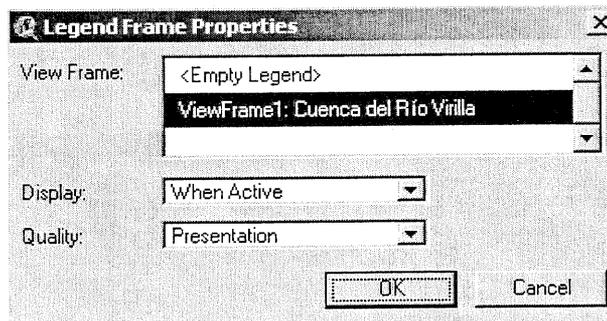
59. Before you can add a legend, a legend mark should be added to the design. Click and hold the button of the mouse in the **Frame** tool, drag the mouse down and select the **Legend Frame** tool and then release the button of the mouse.



60. As it is shown below, click and hold the button of the mouse, drag it to define a legend mark and then release the button.

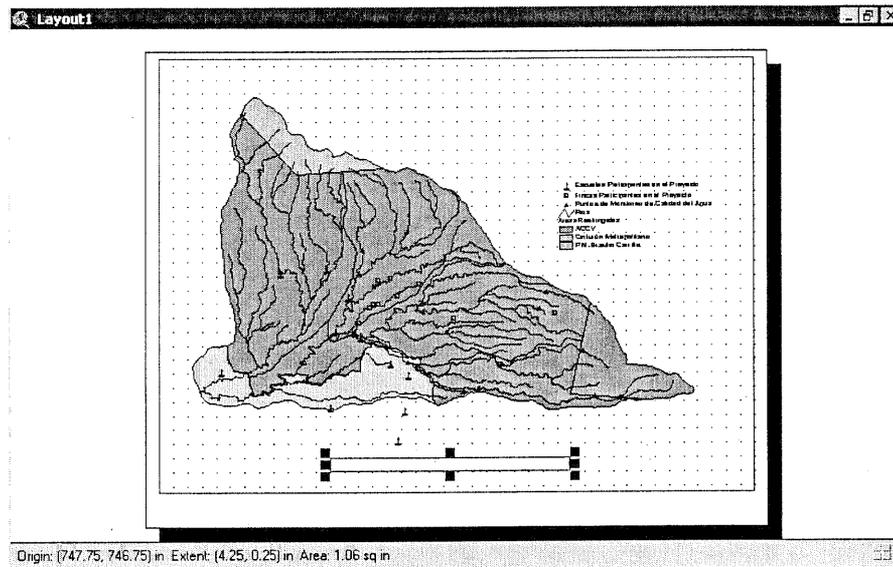


The dialogue box of the **Legend Frame Properties** appears.



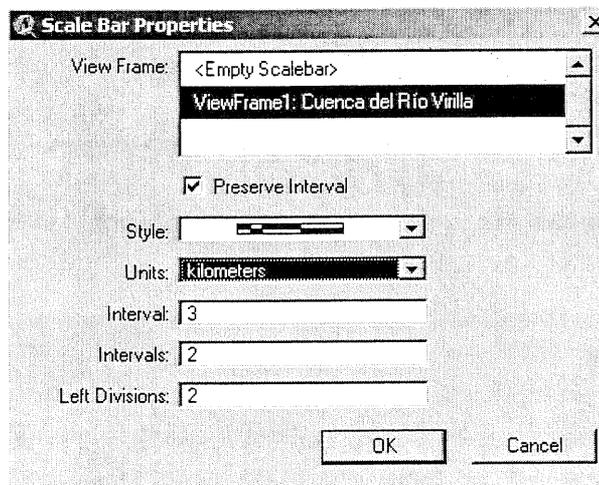
61. To join the mark from the legend to the mark of the view, double click in **ViewFrame1: Cuenca of the River Virilla** and then press **OK**. The legend of the view Cuenca of the River Virilla appears in the design.



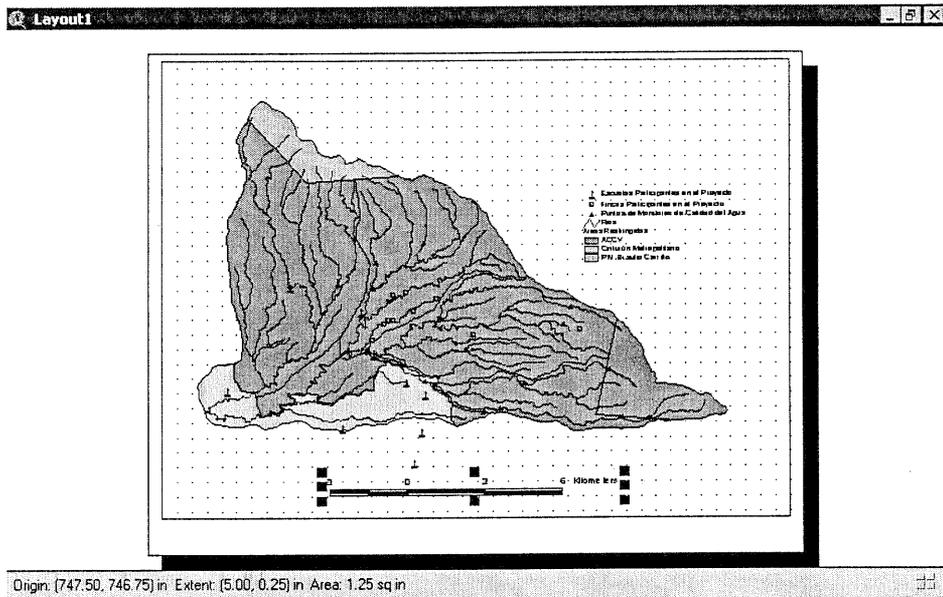


The **Scale Bar Properties** dialogue box appears.

64. To join the mark of the scale bar, double click in **ViewFrame1: Cuenca of the River Virilla**. Fix the units to **Kilometers** and the intervals to **3**. ArcView fixes the number of intervals according to the size of the mark of the legend bar. Fix the divisions to the left to **2**. This will create a scale bar in which each division to the right of the zero represents 3 kilometers, and each division to the left of it represents 1.5 kilometers. Click on **OK**.



65. The scale bar appears in the design.

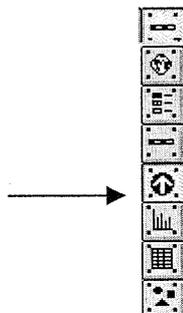


If the scale bar is not centered under the mark of the view, you may wish to change the position. To adjust the position of the marks in the design, the **pointer** tool is used  .

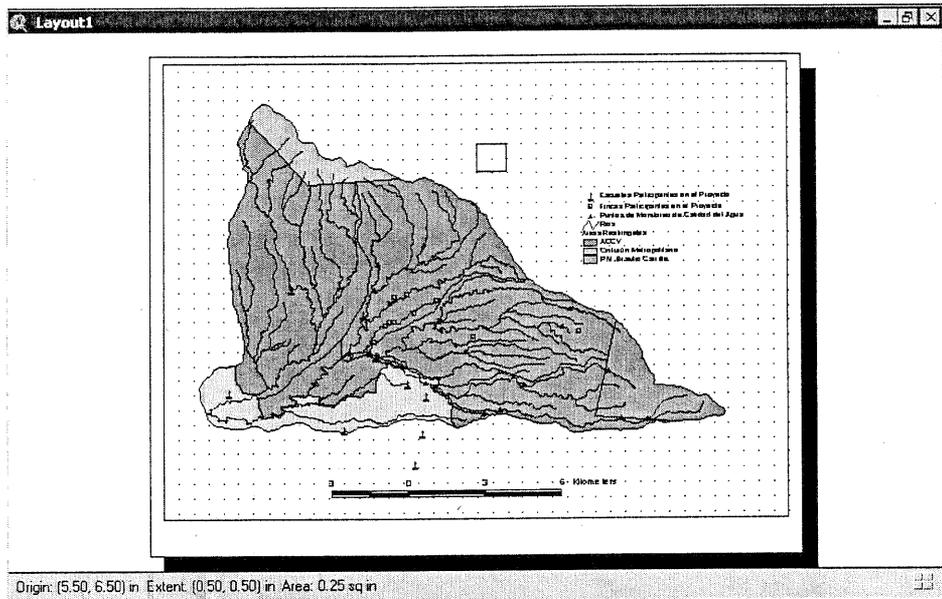
66. Click on the **Pointer** tool, then position the cursor on the edge of the scale bar until the cursor changes to an arrow with four heads. Drag the scale bar to the new position.

Now you will add a North Arrow for the design.

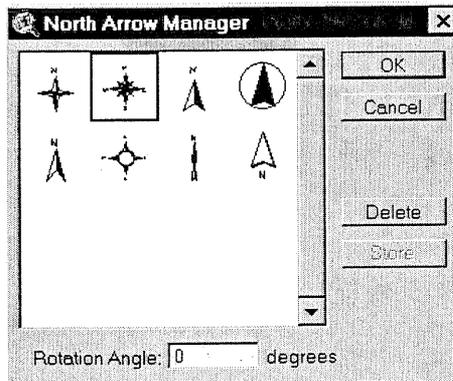
67. Click and hold the button of the mouse in the **Frame** tool, drag the mouse down and select the **North Arrow** tool and then release the button of the mouse.



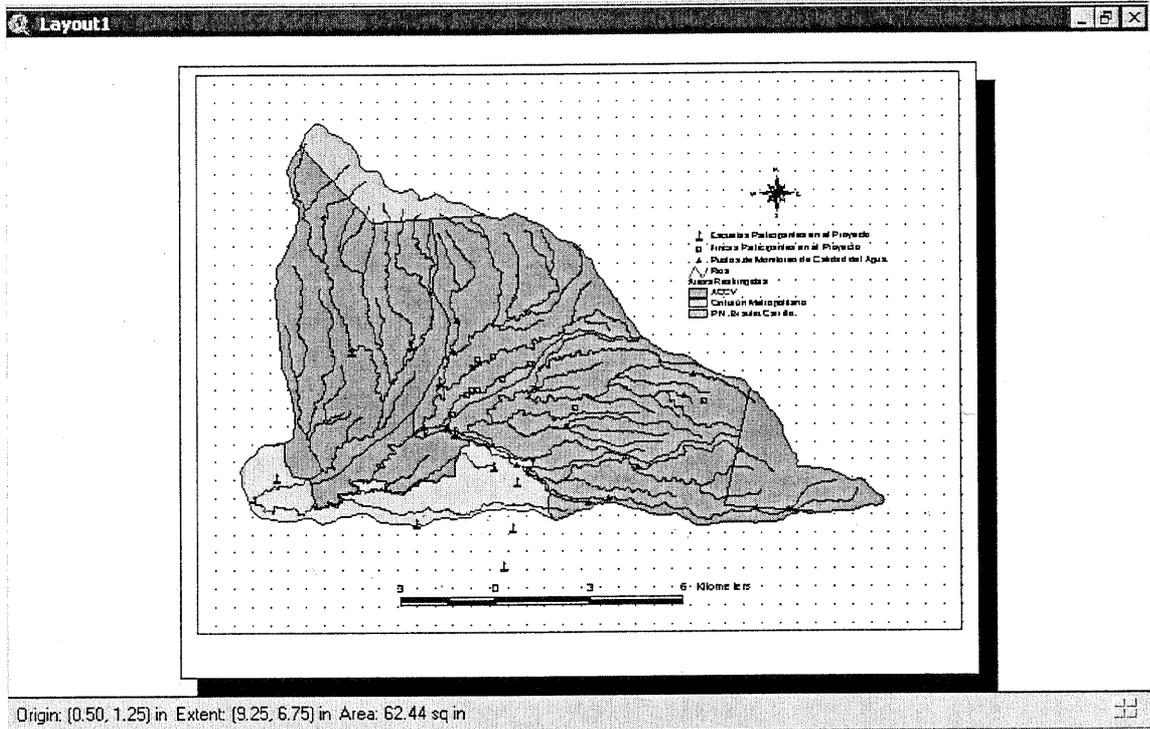
68. As it is shown below, click and hold the button of the mouse, drag it to define a mark for the **North Arrow** and then release the button.



69. The **North Arrow Manager** dialogue box. Select a north arrow. Click on **OK**.



70. Move the North Arrow to a location that you feel is the most appropriate.



## To add a title and an image to the design

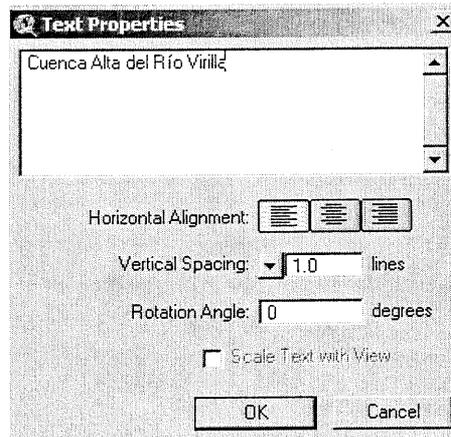
Before adding a title to the design, you first must determine the size and the source of the title.

71. From the **Window** menu select **Show Symbol Window**. Click on the **Font Palette**  button to open the respective box.
72. Fix the source to **Arial**, the size of the text to **36** and the style to **Bold**.



73. Close the window.

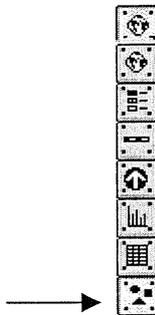
74. Click on the **Text** tool .
75. Move the cursor inside the page of the design, click near the upper part of the design to position an insert point for the text. The **Text Properties** window appears.
76. Type **Cuenca Alto del River Virilla** as the title of the map. Click on **OK**.



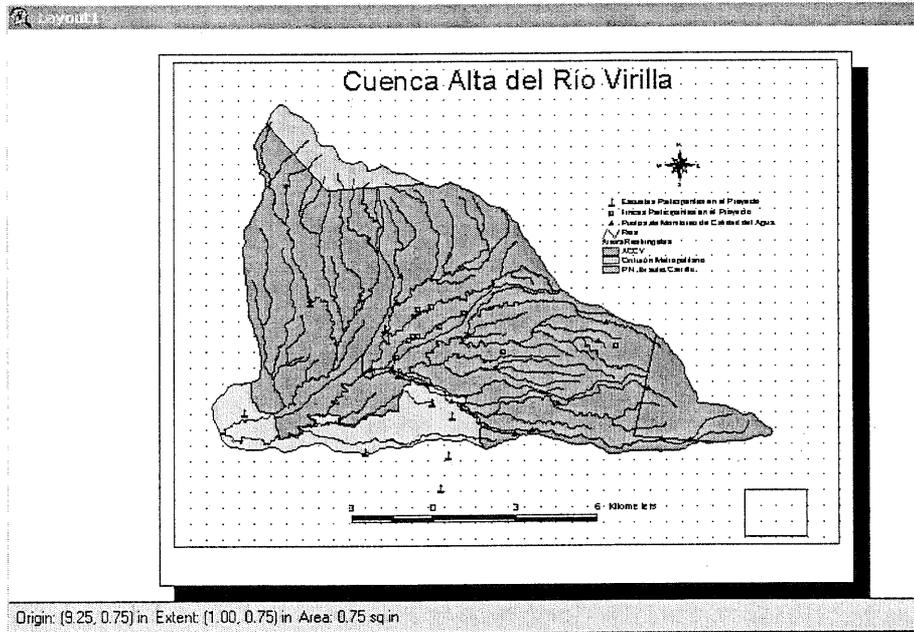
77. Using the pointer, position the title in the place that you consider most appropriate.

To make the map more distinct, you will add a logo (this could be the logo of your company) beside the title. To do this, you need to add a mark for the image.

78. From the **Frame** tool, select the **Picture Frame** tool.



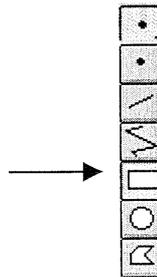
79. Make a box in the lower right part of the page.



80. Click on the **Browse** button in the **Picture Properties** dialogue box and navigate to the directory **c:\proarca\ejr6av** and select **logoplama.bmp**. Click on **Open** and **OK** in the dialogue box.
81. Click on **OK** on the **Picture Properties** dialogue box. A graph with the logo of the project Plama-Virilla appears.
82. If the logo appears covered by the window of the map, select the image, go to the **Graphics** menu and press the option **Bring to Front** (to bring to the front). This will place the image in the foreground of the display. Move the logo to where it suits you.

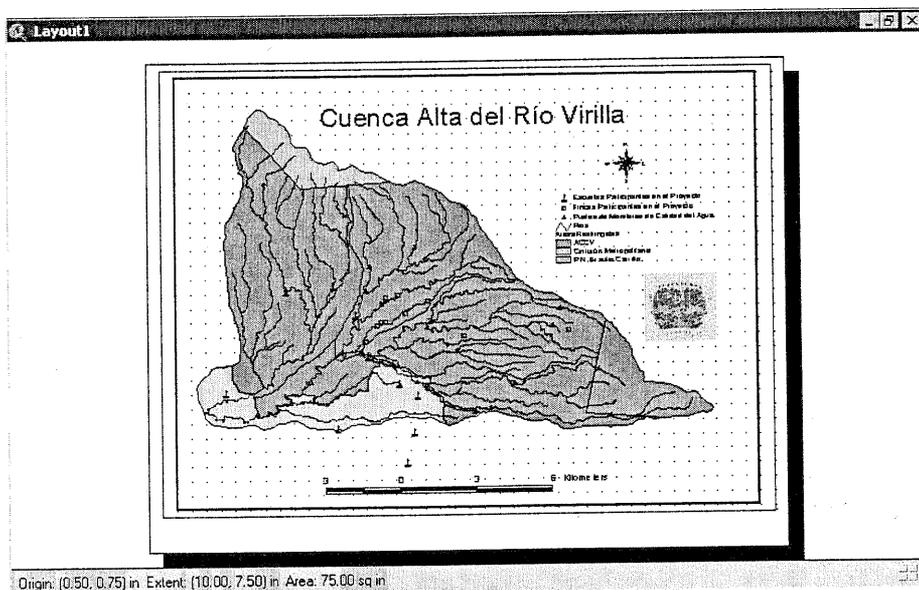
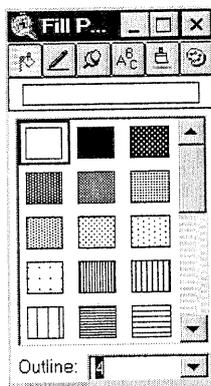
### Adding a border to the design

83. From the **Draw** tool, select the **Rectangle** tool.



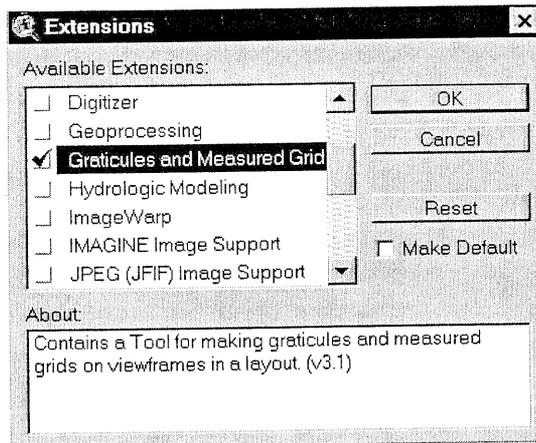
84. Use the tool to draw a rectangle around the whole design like it is shown below.

85. From the **Window** menu, select **Show Symbol Window** to open the **Fill Palette**. Fix the width of the **outline** to **4**. This will make it thicker.

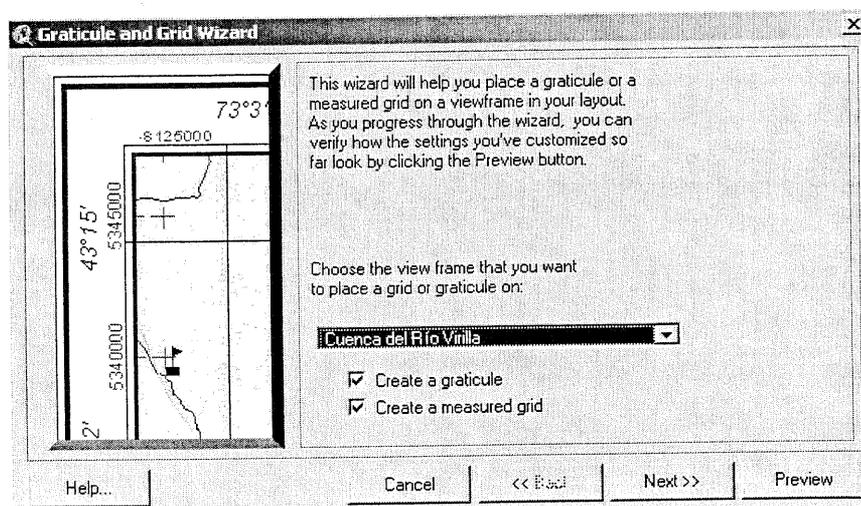


### Adding graticules and measurement grids to the design

86. From the **File** menu chooses the **Extensions** option and activate the extension **Graticules and Measured Grids**. Once selected click on **OK**. This will load an extension that allows to add graticules and measured grids to the map in the design.

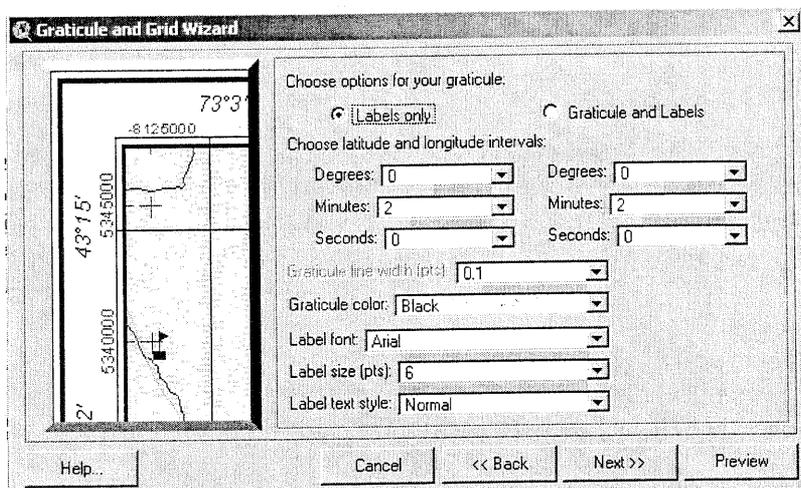


87. Click on the button of **Adding Graticules and Grids**  and the respective dialogue box will be displayed.
88. In the dialogue box that appears we will only select the option to create a graticule and a grid. The graticule is used when the data are not projected (the original file is in lat/long) and also when we do not have a fixed projection for the map. When the map is not projected but the projection is fixed (using the **View Properties**) it is therefore possible to fix a graticule (lat/long) as well as a measuring grid (for the flat projection). If the data are projected because the original file already is projected, it is only possible to add a measuring grid, and not a graticule.
89. Select **Cuenca del Rio Virilla** as the view to which you want to add the graticule. Click on **Next**.

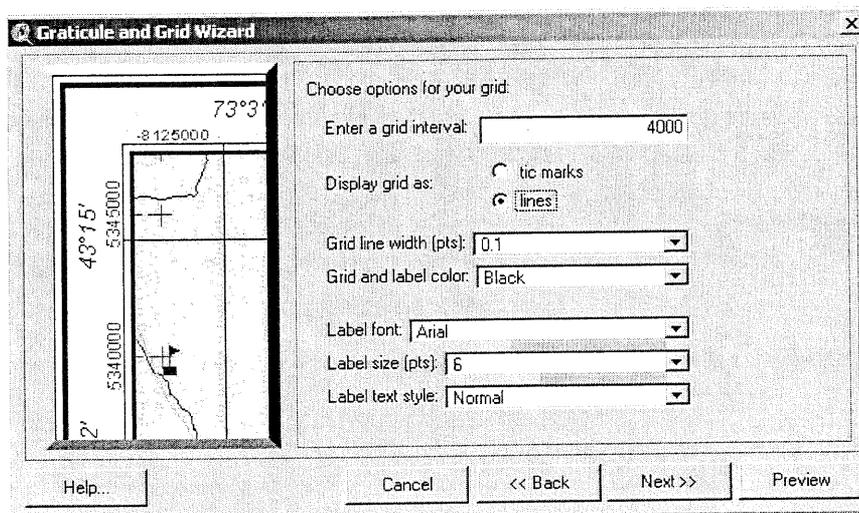


90. In the following dialogue box we must choose the spaces of the graticules in the horizontal sense as much as in the vertical one. The

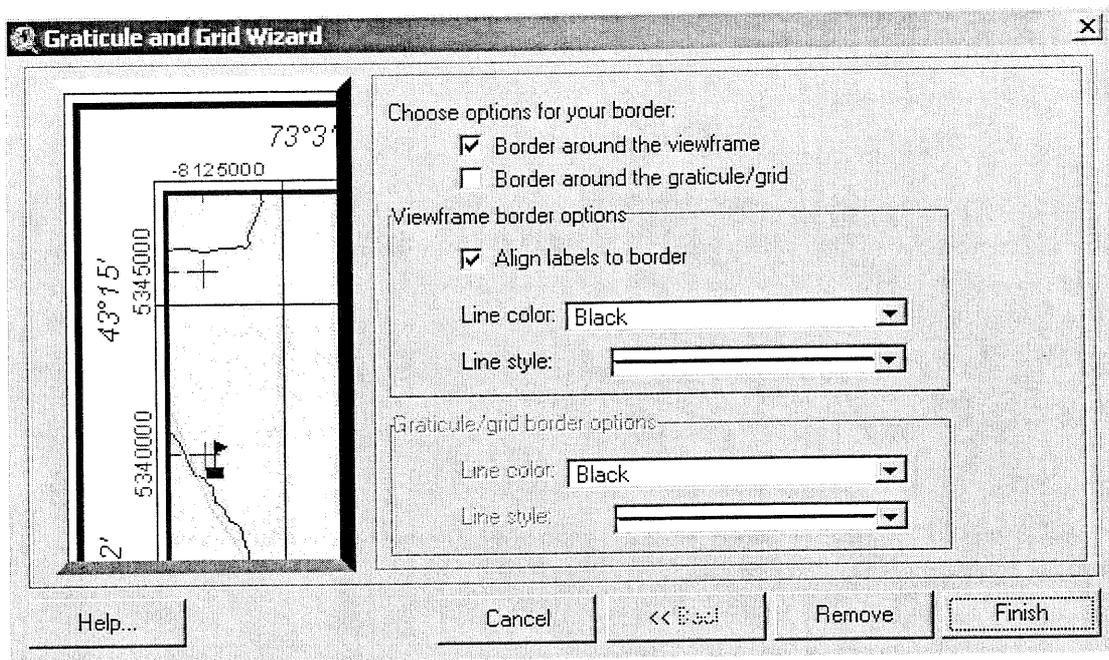
area that we have only frames an area approximately 11 x 7 minutes, so we will fix the spacing of the graticules to 2 minutes. Choose **Labels Only** in order to it only generate labels in the margin of the map, fix the **letter size to 6 points**, the **source to Arial** and leave the other options for omission.



91. In the following dialogue box we will choose the spaces of the grid in the horizontal sense as much as the vertical one. The area that we have frames only an area approximately of 21 x 13 km, so we will fix the spacing of the graticules to 4 kilometers. Choose to **display the grid as lines**, fix the **letter size in 6 points**, the **source to Arial** and leave the other options for omission.

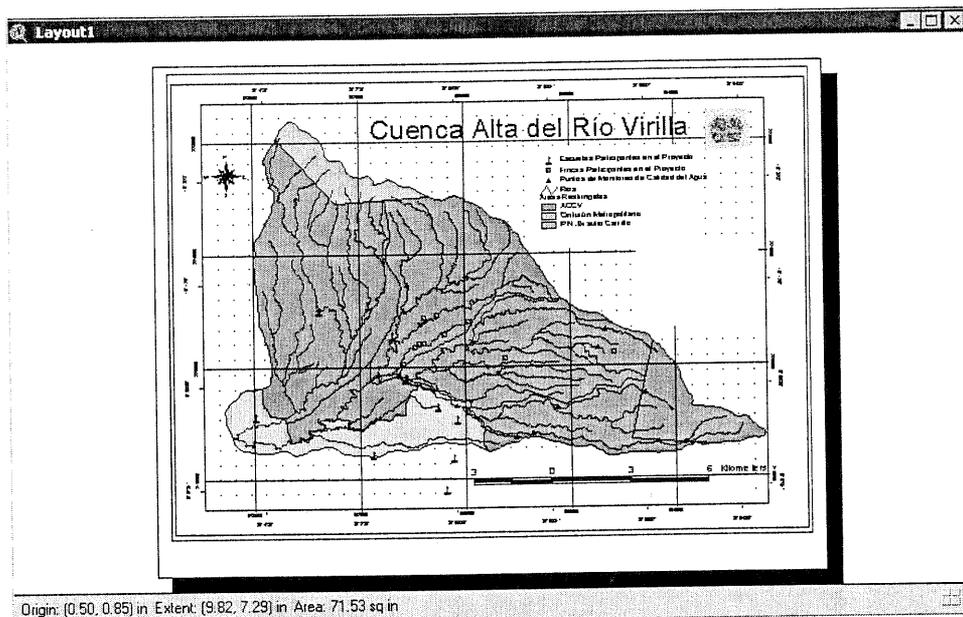


92. In the following dialogue box we must choose the border around the square of the view (we won't choose a border around the graticules/grid). We will also choose to align the labels to the borders.



Now we can have see a preview of how our graticules will look and we will be able to modify it before putting it onto the our design.

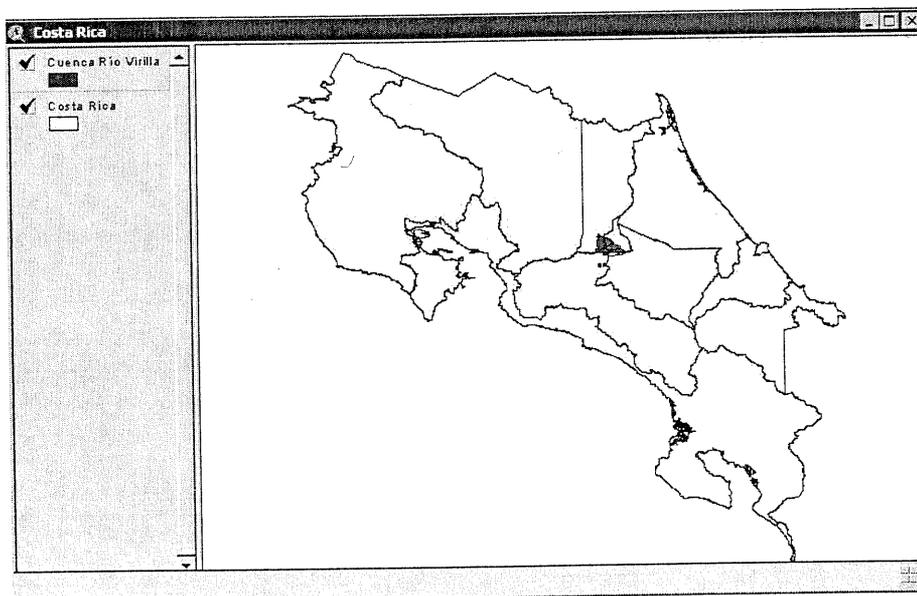
93. Click on **OK** and observe if your graticules and grid are as you expected. If you are satisfied then presses the **Finish** button. If you believes that you should make more changes then presses the **Remove** button to erase the previous view and to change what you want.
94. Make any necessary adjustments so that there are no overlapping among the different elements of the design and/or hide undesirable elements by adding blank rectangles filled with white.



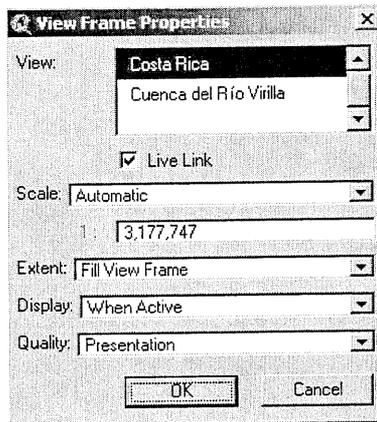
### Adding another image as a location map

Now we will add an image of Costa Rica to locate the High Cuenca of the River Virilla in the design.

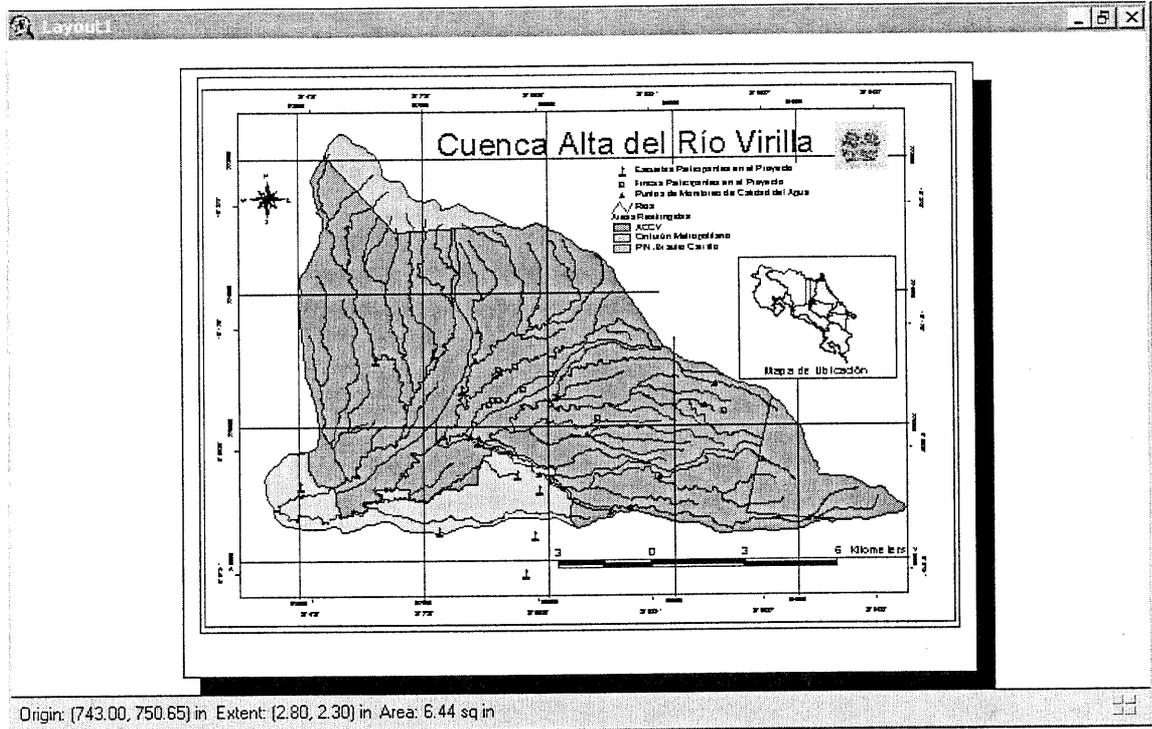
95. Minimize the window **Layout1** and make the window active of the project, by clicking on the cintillo of the name.
96. Click on the **Views** icon of the window of the project and open the view **Costa Rica**. An enlarged view of Costa Rica and the Cuenca of the River Virilla in units of Lat/Long, will be displayed.



97. Return to the window of the design **Layout1** and maximize it.
98. Click on the **View Frame** tool 
99. Move the cursor to the page of the design (it changes to a cross). Click on the left button of the mouse and hold, while you drag it to the place that you have chosen to locate the location map.
100. When the dialogue **View Frame Properties** box appears, click on the view **Costa Rica** to select it. To accept the other options for omission you must click on **OK**.



101. The view Costa Rica is displayed in the design. Add the title "**Map of Location**" and a rectangle around the map as is shown below.



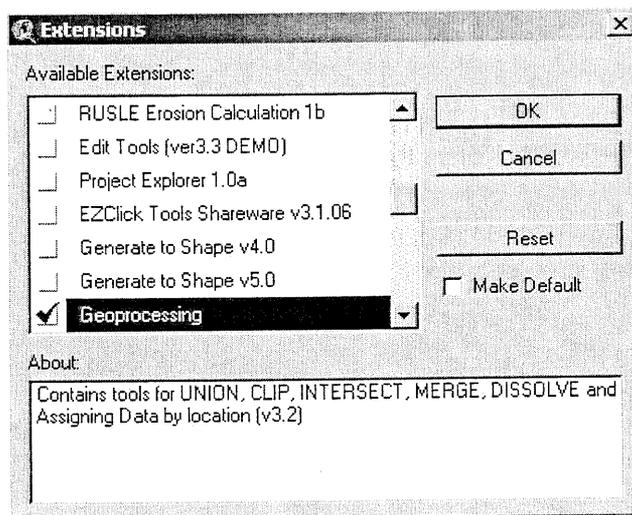
102. Now if you want, you could print this design by selecting the **Print** option from the **File** menu. If you want to configure the printer first, select the **Print Setup** option of the **File** menu (see design at the end of this tutorial)

Note: If you are not satisfied with the size or the with the position of the frame of the view, you can use the **pointer** tool to select it, to move it or change the dimensions.



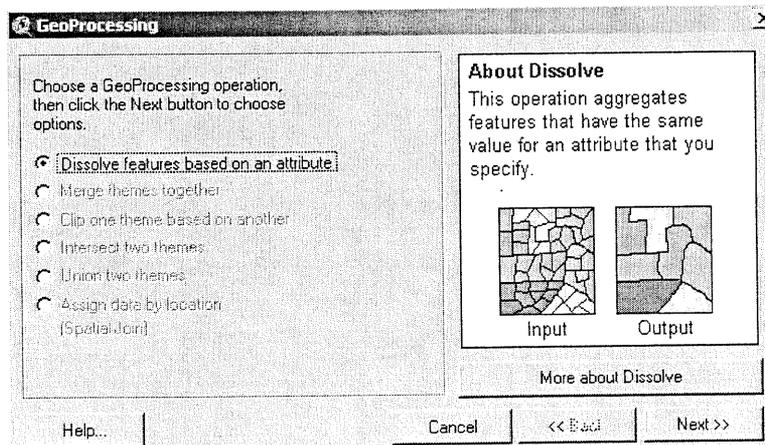
## VI. GIS Management: Geoprocessing of maps

Many of the new functions in ArcView Version 3.2 are accessed through extensions that come with the program and that can be activated or disabled as needed. When one chooses the **Extensions** option from the **File** menu you open up the **Extensions dialogue box**. Projecting an extension provides information about it. When one makes a click in the checkbox, the Extension is loaded in ArcView.



When the extension of Geoprocessing is loaded, an option appears in the menu called **View Geoprocessing Wizard**. This application executes the automatic help (wizard) and can carry out six tasks for spatial data processing.

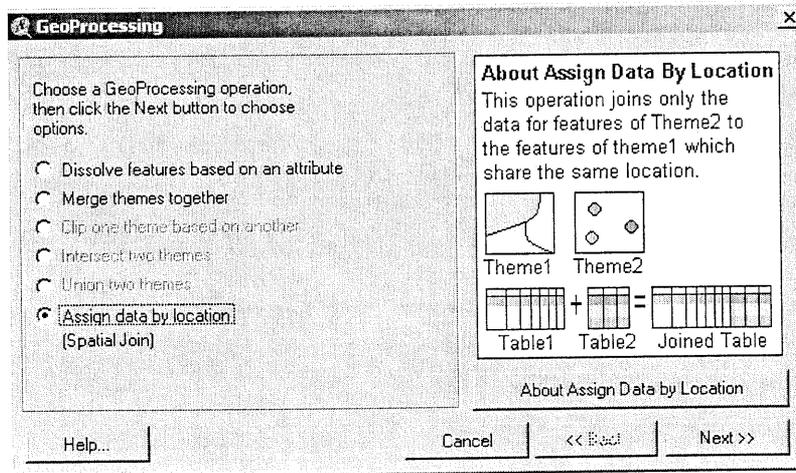
**Dissolve features based on an attribute** is the process of association of spatial data. Technically, it is the same to show a table of attributes for a theme and later choose summarize where you can select the option to unite the shapes.



**Assigning data by location** is the same process as the spatial merge seen in exercise 6b. The operation of assigning data by location will carry out a spatial merge between the two themes selected. A spatial merge is similar to a merge of attributes, however, it is based on the spatial relationship between the elements of the two themes. For each element represented in the output table, ArcView looks to see if the elements have one of the spatial relationships with any element represented in the source table; if it has any, the register of the source table will be annexed in the destination table.

	Point	Line	Polygon
Point	Nearest	Nearest	Inside
Line	Nearest	Part of	Inside
Polygon	N/d	N/d	Inside

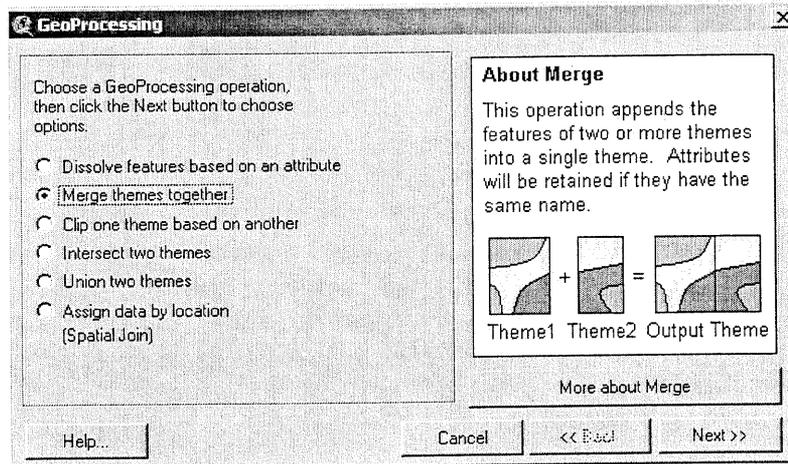
When the spatial fusion is based on the relationship “nearer” (i.e. none of the two involved themes contains polygons and one of them contains points), ArcView adds a field called “**Distances**” in the destination table. This field is calculated automatically in ArcView and it contains the distance to the nearest element represented in the table source for each element represented in the table destination. The distance is calculated in the units that the view has. When the spatial fusion is based on the relationship “part of” (i.e. both involved themes contain lineal elements), the lineal elements represented in the table destination have to be segments of the lineal elements represented in the table source in order to satisfying the spatial coalition. In other words, the lines of a theme are part of the lines of another theme. For example, if the River Virilla is in one theme and all the rivers of the basin of River Tárcoles are in another theme, all the elements in the first theme are considered “part of” the elements of the second theme. This is because the River Virilla is a tributary of the Tárcoles and the elements that represent the River Virilla are present in the second theme.



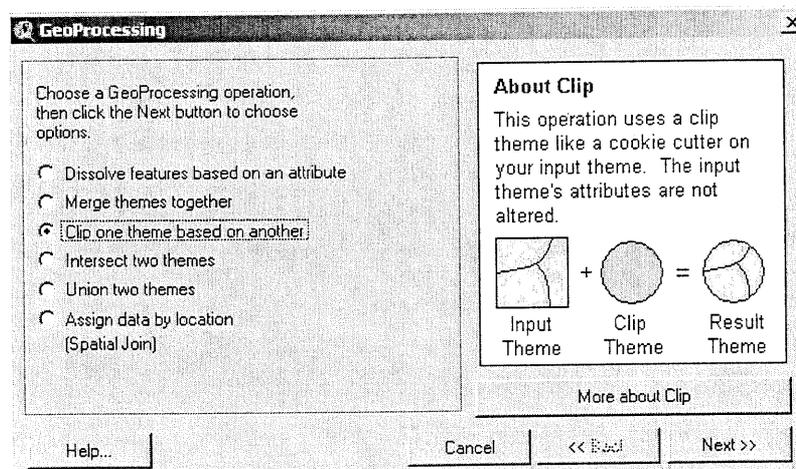
**Merge themes together** adds the elements of one or more themes to those of another theme of the same type. A new exit file is created that contains all the elements of each one of the entrance themes. The names of the fields in the exit theme are taken off the

selected entrance theme. The attributes of the other themes are included in the exit theme if the names of its fields coincide with those of the selected entrance theme.

The new theme will contain the fields of one of the entrance themes. If each one of the themes has at least the same fields, then all the cells in the table of attributes of the new theme will be filled. If some of the other entrance themes have additional fields, these data won't be included. If some of the other entrance themes have lost fields, then the data won't be added to these fields for the elements of this other theme.



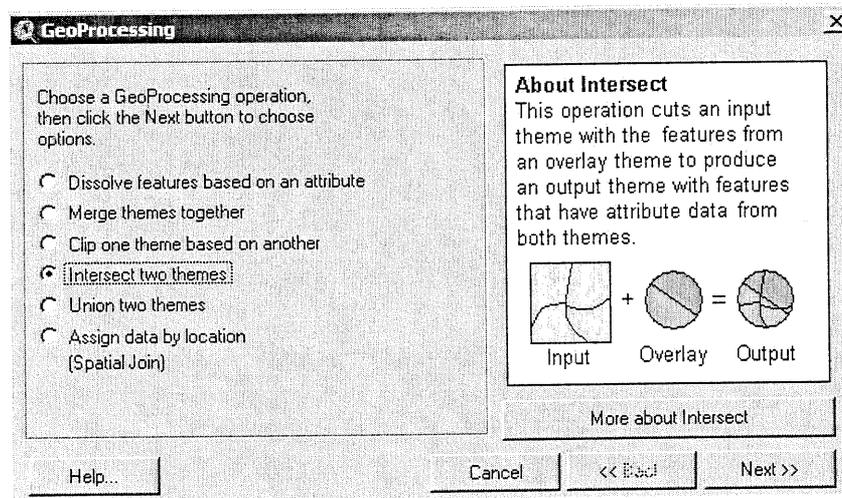
**Clip one theme based on another** is applied to a polygonal theme (call the theme a "cut out") that acts as a mould for making cookies. The result is a new theme in which the elements of the entrance theme are cut at the borders of the theme "cut out" (or to the borders of the elements selected in the theme "cut out")



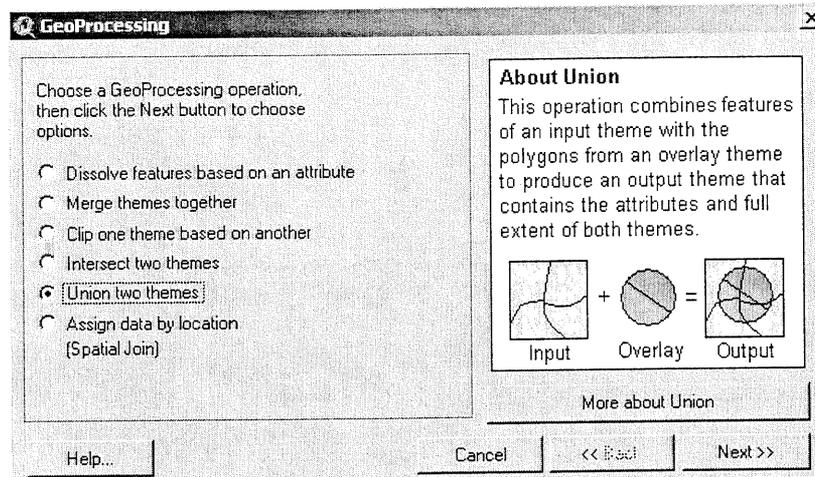
The process creates a new shape file by means of overlaying the two themes. One of the themes should be a polygon (also call the theme "overlay") which will be used to define the region to clip. Only those elements in the other theme (called the theme "entrance") inside the region of clip will be kept in the new shape file. The elements of

the exit theme will be of the same type as the elements of the entrance theme. The elements of the table of attributes for the new file contain the same fields as the entrance theme. The table of attributes of the new file contains the same objects of the table as the entrance theme.

**Intersect two themes** calculates the geometric intersection of the two themes and adds to the view a new theme. The overlay theme should be a polygonal type. Its elements cut the entrance theme. Any elements in the entrance theme that are not covered by the elements of the superimposing theme will be ignored. Only the areas that are common to the superimposing theme and to entrance theme will be included in the exit theme. The elements of the entrance theme can be polygons or lines. The elements of the exit file will be of the same type as the elements of the entrance theme. The table of attributes of the exit file will include the attributes of the entrance theme and that of superimposing.

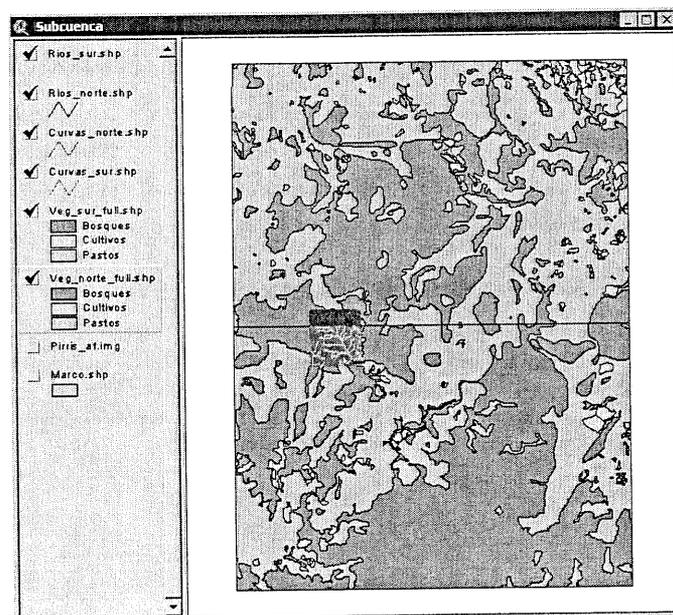


**Union two themes** creates a new process for superimposing two polygonal themes. The exit theme contains the combined polygons and the attributes of both themes. The polygons of the entrance theme are cut in the intersection with polygons of the overlay theme. The table of attributes of the theme to be produced contains the attributes of the tables of attributes of the input theme and output.



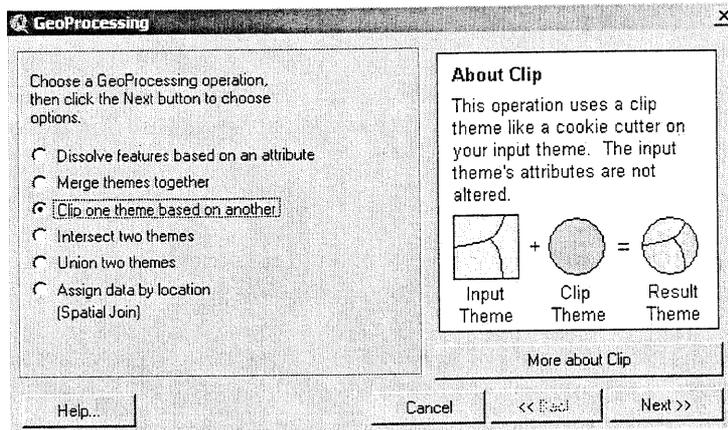
## To clip, combine and dissolve themes

1. Open the file called **ejer10\_geo**, which will create the directory **c:\proarca\ejer6av** and will display the necessary files for this exercise.
2. Open the project called **"geoproceso.apr"** that is in the directory of work **c:\proarca\ejer6av**. You will see the cartographic database that corresponds to a sub-basin of the river Pirris displayed. The information that is presented (as can be observed) consists of a map of the rivers, vegetation and the river curves on two pages of cartographic sheets, divided by north and south. We also have a file corresponding to an aerial photo that we will observe later.

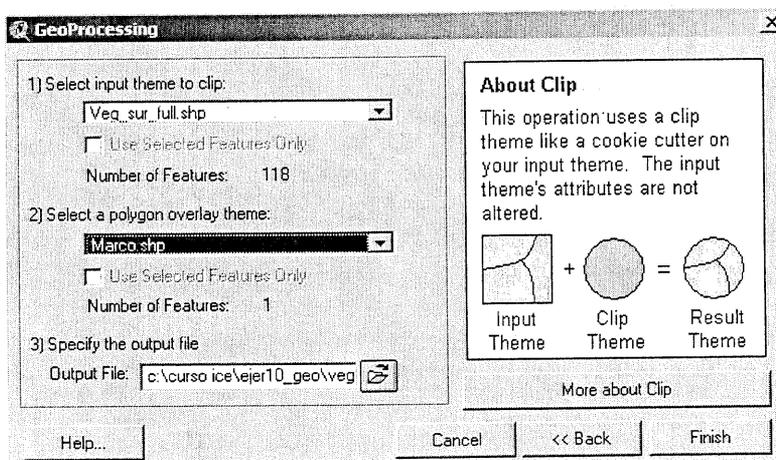


In the case of the rivers and the curves at the level, the files have already been clipped to the study area defined by the theme "marco.shp." However, the curves of the rivers are divided in two files: **rios\_sur** and **rios\_norte**, and **curvas\_sur** and **curvas\_norte**, for what will be necessary to combine them so that they conform a single file. In the case of the vegetation, first the files will be clipped to the study area (**clip**) and then they will be combined to form one whole (**merge**)

3. From the **View** menu choose the **Geoprocessing Wizard** option. Select the option "Clip one theme based on another." Press the **Next** button.

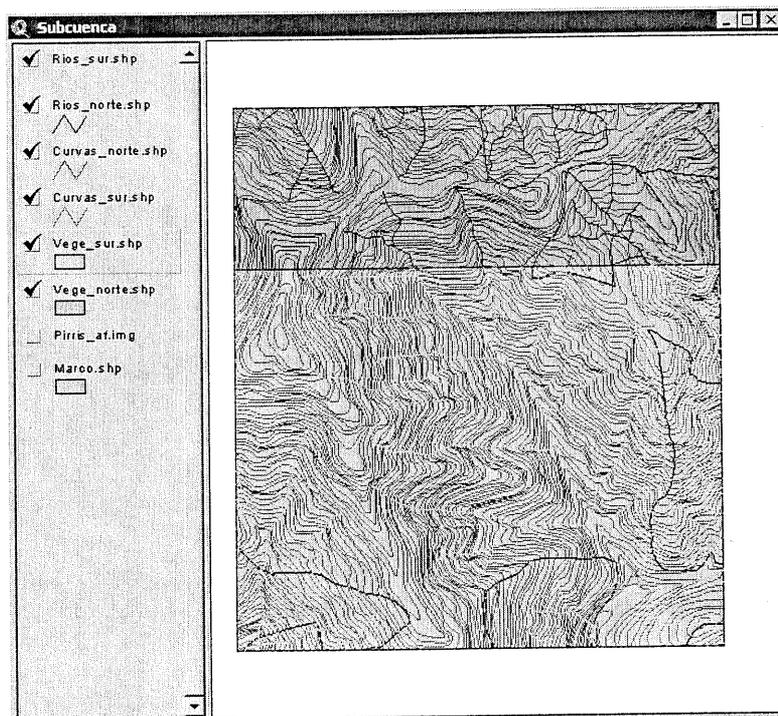


4. In the following dialogue box, select the entrance theme (1) as **Veg\_sur\_full.shp**, for the superimposing theme (2) select **Marco.shp** and for the exit file theme (3) select **c:\proarcalejer6av\vege\_sur** and then press the "Finish" button. The new theme will be added to the table of contents.

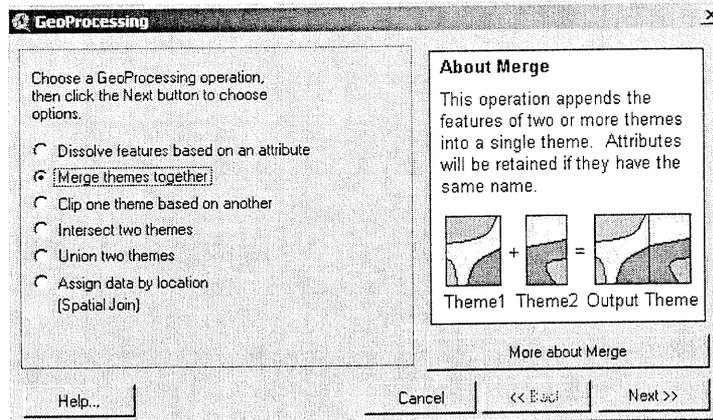


5. Activate the theme **Veg\_sur\_full.shp** in the contents table and select the option **Delete Themes** from the **Edit** menu and then choose the option "Yes" to conclude the erasing process. Drag the new theme to the place that occupied the file erased in the table of contents.

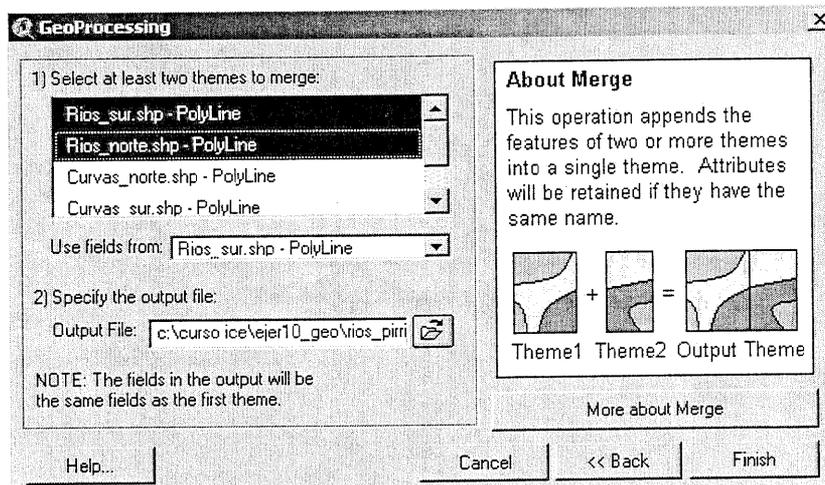
- Repeat step 4 but this time for the entrance theme use **Veg\_norte\_full**, the superimposing theme (2) the theme **Marco.shp** and the exit file **c :\proarcalejer6av\vege\_norte** and then press the “**Finish**” button.
- Erase the theme **Veg\_norte\_full** from the table of contents and move the new theme to the place that occupied the file that was just erased. Click on the themes so that they are displayed in the window of maps. Zoom if it is necessary to enlarge the study area.



- Now we will combine the themes of the rivers, curves and vegetation so that all of the files form a single file. Open the **Geoprocessing Wizard** again and choose the option “**Merge**”.

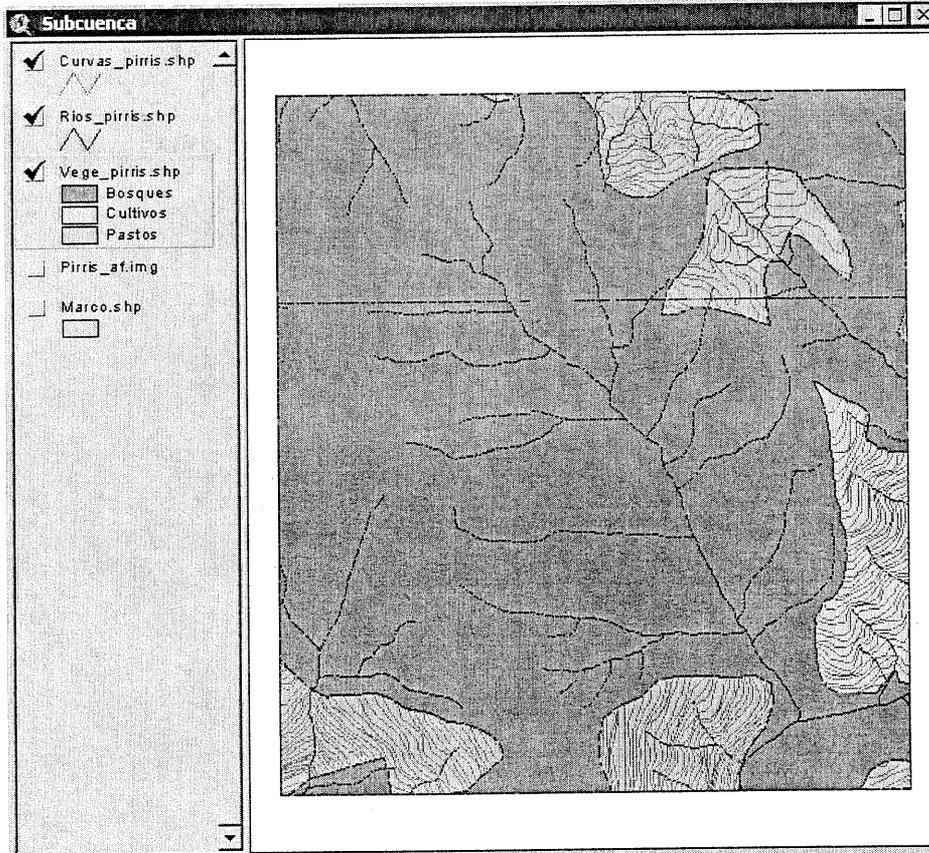


9. In the following dialogue box select the two themes of entrance (1) **Rios\_sur.shp** and **Rios\_norte.shp** (to select the two files, click on one file and then Shift+Clic on the other), as the themes to combine. It does not matter which fields you use to make the combination since the two tables themes have the same fields. Specify the exit file (2) **c:\proarcalejer6av\vege\_pirris** and then press the **“Finish”** button. The new theme will be added to the table of contents.



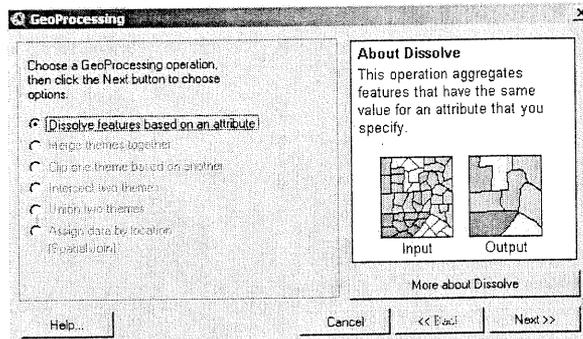
10. Repeat the previous step for the files **Curvas\_norte.shp** and **Curvas\_sur.shp** and name the exit file **curvas\_pirris.shp**.
11. Repeat the previous step for the files **vege\_norte.shp** and **vege\_sur.shp** and name the exit file **vege\_pirris.shp**.
12. Erase the individual files (north-south) from the table of contents and order the files in such a way that in the upper part the rivers are located, then the curves, then the vegetation, then the aerial photograph and finally the mark. Change the color of the rivers to blue or celestial, the color of the curves to black or gray dark and display the vegetation with a legend type **“Unique Value”** and the field relations to **“Type.”**

Highlight the themes **Curvas\_pirris**, **Rios\_pirris** and **Vege\_pirris** and observe the results.

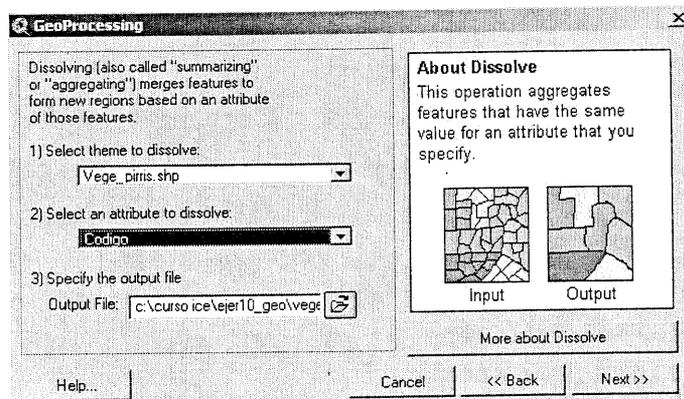


As you will observe the maps of the rivers and the maps of the curves are complete. However, the map of vegetation presents a division line between the north part and south. This is because the polygons are closed in their respective pages and when merging, the program doesn't recognize that they have the same attributes, leaving them separated as two different entities. To remedy this, we will proceed to “**dissolve**” the lines that separate the polygons with same identification that in this case correspond to the called field “**Code**.”

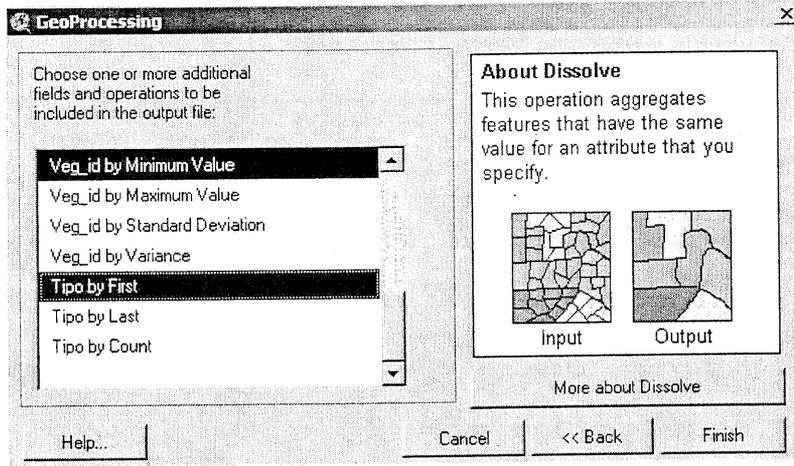
13. Open the **Geoprocessing Wizard** and select the option “**Dissolve features based on an attribute**.” Then press the **Next** button.



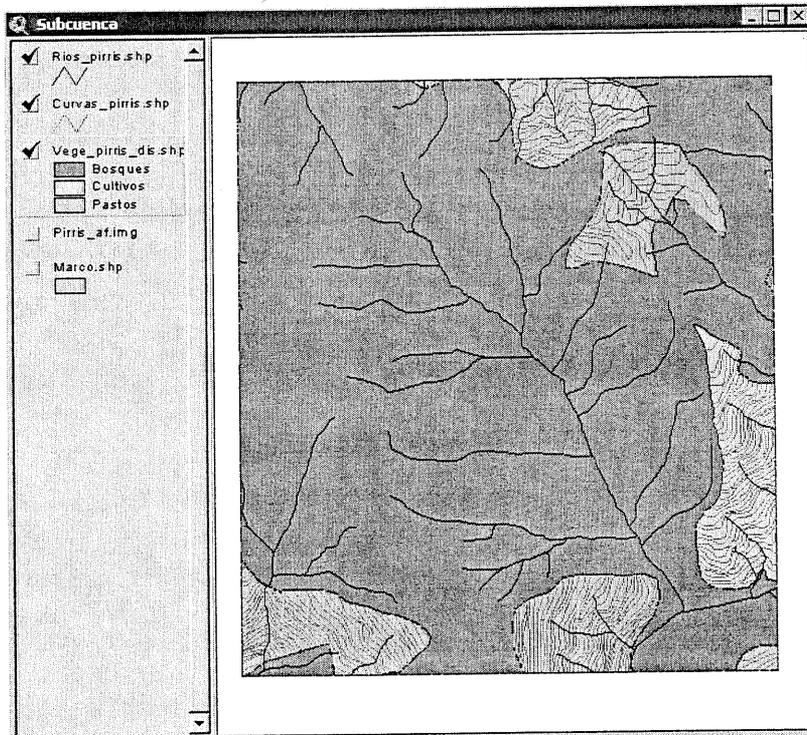
14. Select **Vege\_pirris.shp** as the theme to dissolve (1). Select **Code** as the attribute with which the breakup of the polygons will be made (2). Specify **c:\proarcalejer6av\Vege\_pirris\_dis** as the exit file. Press the **Next** key.



15. In the following dialogue box you can choose to add one or more fields to the table of attributes. These fields summarize in the way it is specified. To select more than one or a range of themes and summarize operations use the keys Control or Shift together with a click of the mouse. In this case we will use only **Type by First**. Then press the **Finish** button. The new theme is added to the table of contents.



16. Erase the theme **Vege\_pirris.shp** from the contents table and move the new theme to the place that occupied the one that was erased. Create a legend based on the field "Type", as is shown next.

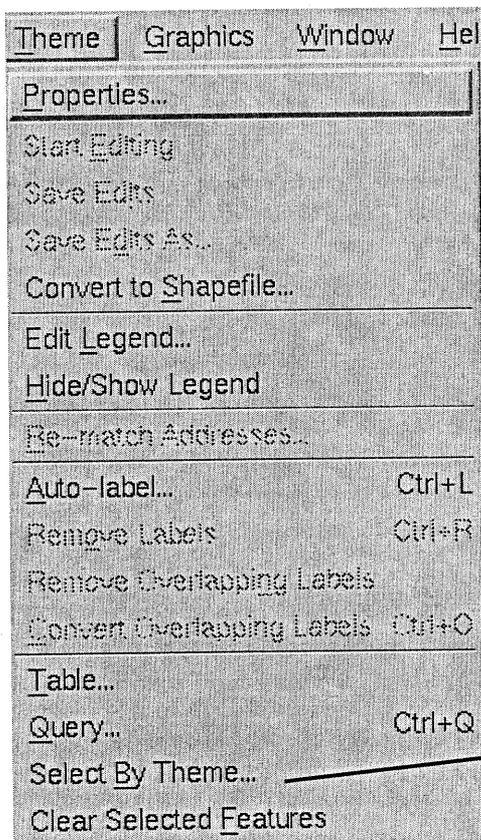


## VII. Queries and Analysis of Spatial Relationships

ArcView has several available operations of space analysis that you allows you to determine the relationships between two topics:

You can find elements which are adjacent to other features. This relationship type can be made with the selection **Theme-on-Theme**, allowing you to analyze a space relationship, trying to find:

**Adjacency,  
Proximity,  
Intersection,  
Inside.**



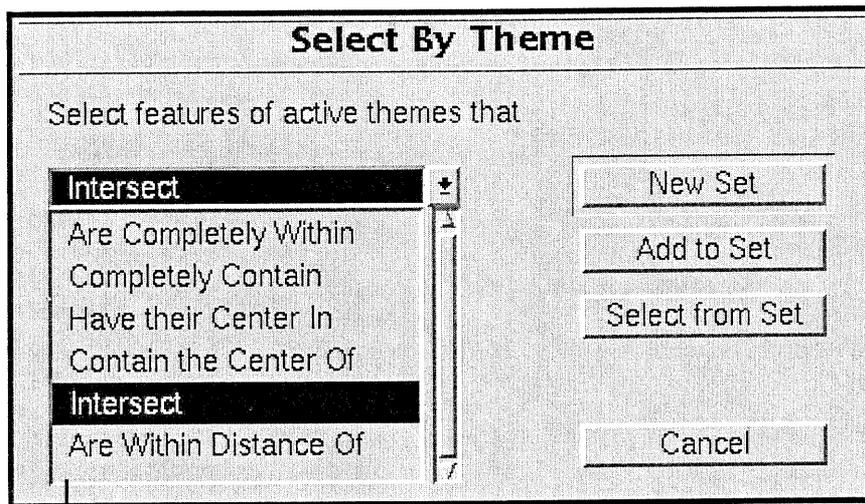
ArcView allows us to make a selection of the theme selected, (theme-on-theme). To utilize this option **Select By Theme**, go to the *Theme Menu* in the view

## Selection of Theme-on-Theme

This option allows you the use of multiple themes to examine the space relationship among the features of the topics.

-Types of Space Relationship

When we click on **Select By Theme**, we will see a dialogue box, where we will be able to choose the type of space relationship that we want for the theme.



In this display menu, we may choose the type of space relationship that we want from ArcView

Completely Within	The features related with our selection that are entirely inside the theme: you can use points, lines or polygons that are within another polygon.
Completely contain	The features that are totally contained in the related theme
Have their center in	The features whose center falls inside the related theme
Contain the center of	That contains the center of the related theme
Intersect	That intersection of the related theme
Are within distance of	That are inside a specific distance of the related theme

**Examples.** At this point you will be given an example of the type of selection that you should use for some described common cases:

**-Intersection:** you have a limited study area with an intersection of a highway, cutting a particular side off from the plot.

**-inside of:** we have a **coverage** of protected areas and another of cultivated areas. The Selection would be all the **cultivated areas** that are inside the **Protected Areas**.

**-inside of a distance:** imagine a **coverage** of points that represent the towns of a country and another **coverage** of points for the highways of the same country. This selection could determine the information on population from the points that are within a specific distance from the highway.

### Selecting Points Near to a Line

At this point of Space Analysis we are mixing the tools that ArcView provides with the objectives of our analyses.

1. We should know what our main objective is
2. What is it that you want us to find

When this is very clear, we go to ArcView and open the project called **Gulf of Fonseca**. A view will open up with the data that CATIE has developed before from **PROARCA** in the area mentioned.

If we want to know which are the smallest cities that are less than 1 km of distance from the main highways, then our main objective is the **Cities and Towns** (this is represented by a coverage of points)

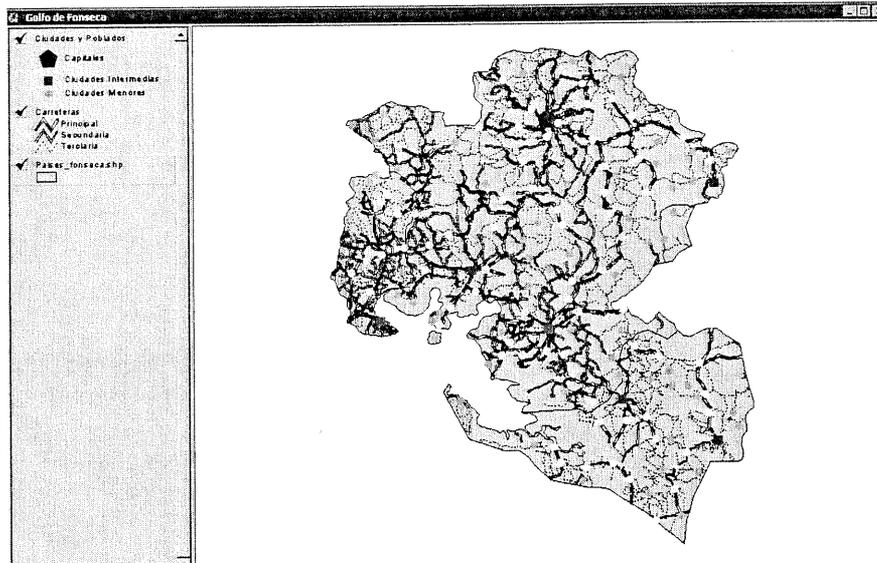
- 1) First select the principle streets on our new theme of Highways
- 2) Make our Objective Topic active (**Cities and Towns**)
- 2) Choose from the **Theme Menu** the **Select By Theme** option
- 3) Choose the topic that is related to your selection (that would be the **Highways**)
- 4) Choose the type of space relationship

In this case we are looking for the nearest population to the **Main Highways**, and we have to have a distance that will be of **1 Km**. Now you already have the relationship type that we will use (i.e.: choose **Are Within Distance Of**)

Enter the distance that you want to have (the proximity range) (i.e.: 1 Km) (These distance units are the units that are used in the **View Properties**).

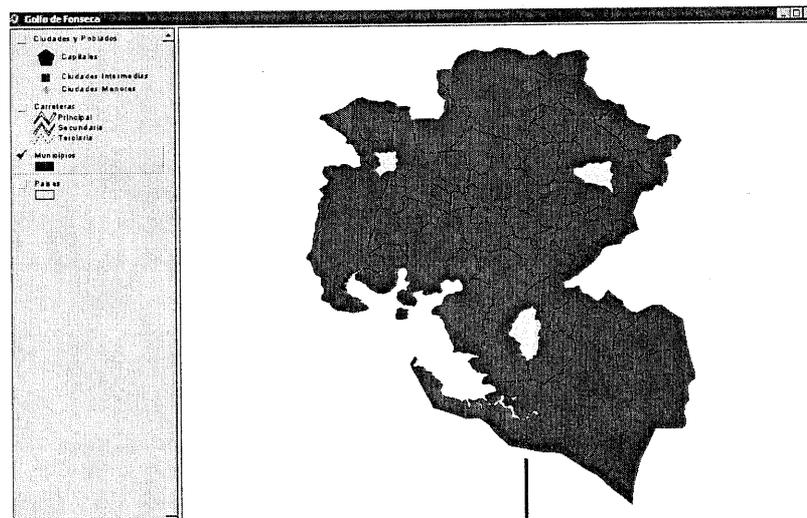
- 5) Once you obtain this first result, select from the shape Cities and Population only the smallest Cities.

ArcView highlights the points that fulfill the given criteria.



### Selecting adjacent polygons

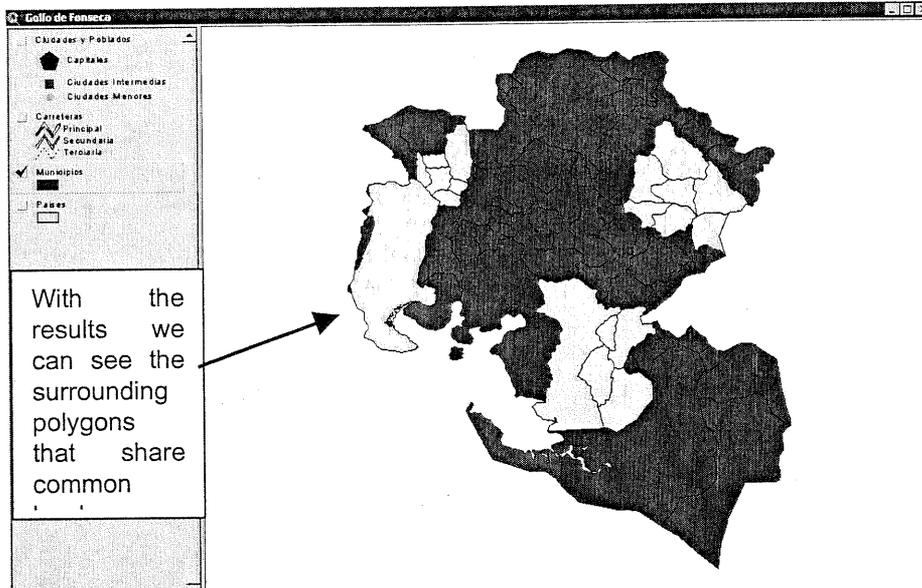
The same as in the previous example, the main topic should be selected, (In this case our new polygons). Our new example: Try to find the adjacent municipalities to the municipalities that we have selected on the view.



We select three municipalities that are of interest, and we have with which municipalities they share a common border

1. Selected the Municipalities with the **Select Feature Tool**
2. Choose the theme with which we will relate it (in this case the same one).

3. Leave the distance to 0 (Because we are looking for adjacent polygons, we don't need a specific distance)

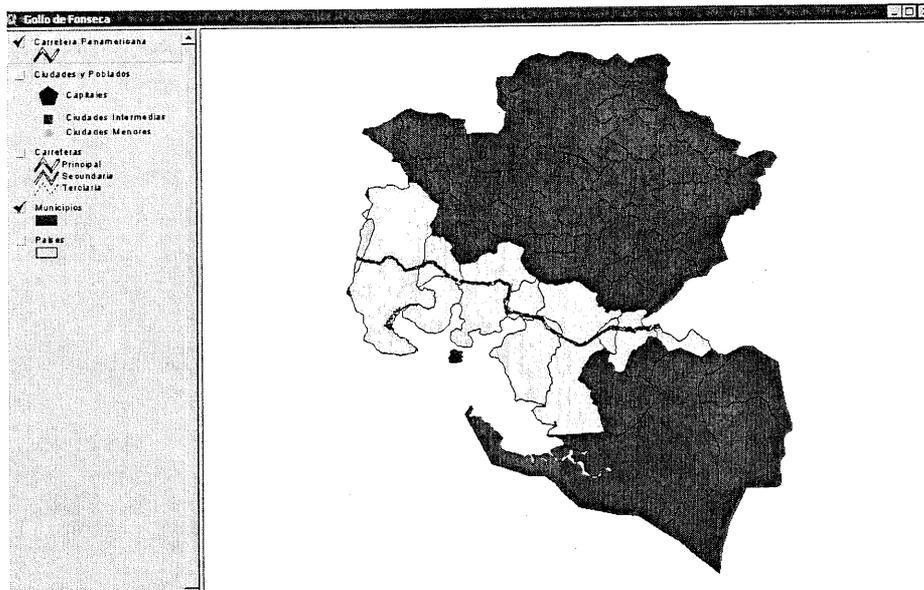


### Selection of Lines above Polygons

We show an example Know the municipalities that you passes we will use a net, to which we will call the Pan-American Highway.

1. Activate the main objective theme (or boundary proposal). In this case the new objective (Target Theme) are the places that may come from a coverage of cities.
2. We choose the theme with which we want to relate it (In this case it will be the Pan-American Highway)
3. We choose the type of space relationship (in this case it would be an **intersection**)

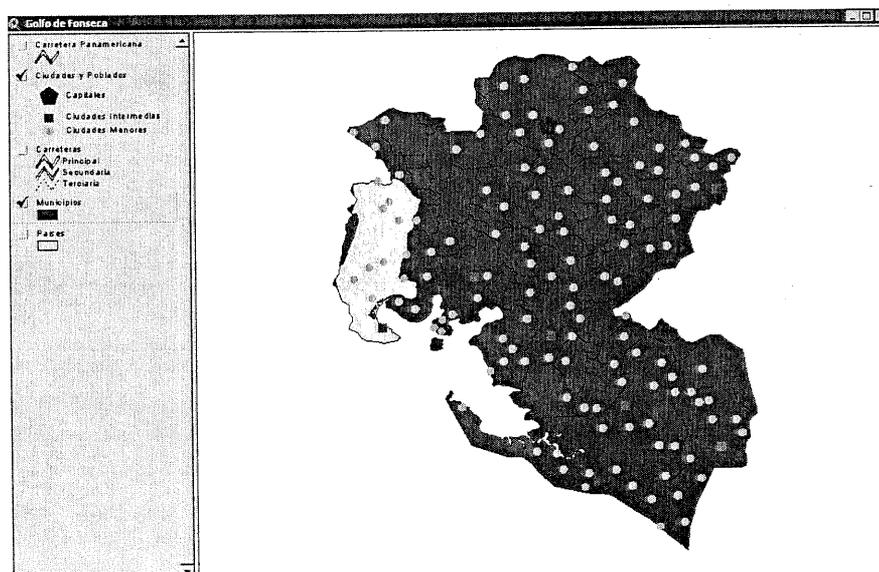
ArcView selects the municipalities that are connected to the Pan-American Highway. Therefore we will have a selection of Polygons (municipalities) that are intersected with a line (Pan-American Highway).



### Selecting Points on Polygons

We show an example to identify the cities that are inside the selected municipalities.

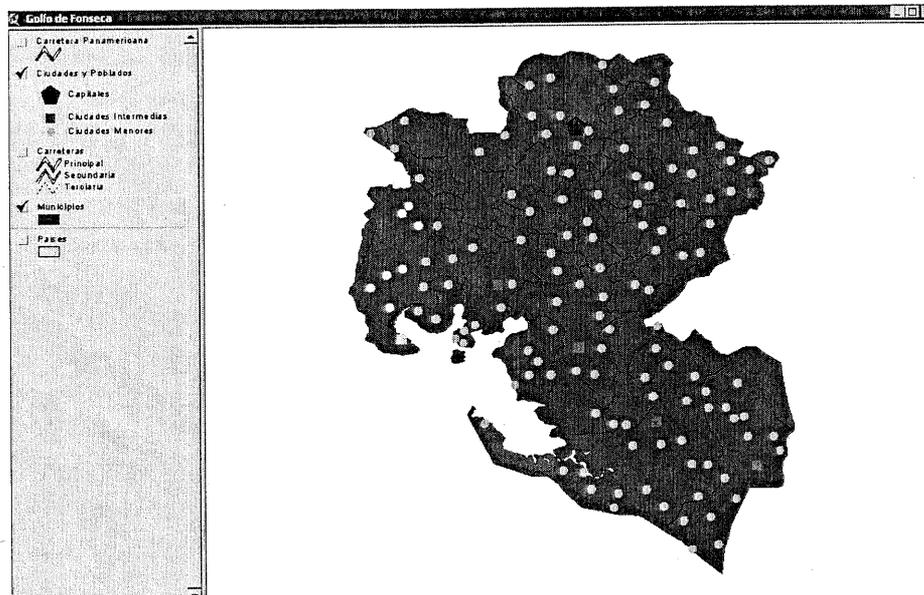
1. To activate the theme with the **coverage** of polygons (in this case the municipalities) use the **Select Feature** tool if we need a single polygon of a **coverage** of polygons.



2. Choose our objective topic (in this case the **Cities and Towns**) and activate it. In this case we need to know the number of points on a certain polygon therefore we choose **POINTS**

3. We choose the topic with which we want to relate it (**municipalities**)
4. We choose the type of space relationship. In this case we will use the space relationship '**Are Completely Within**'. We use it to select the points, lines or polygons that are completely inside another polygon.

The results are observed next.



**A final challenge for the course:**

With the data that you have on the **Gulf of Fonseca**, carry out an analysis that allows you to deduce which are the percentages for each ecosystem that are found under different levels of protection in the area that the maps cover. For this effect, you will use the layer of data for the protected areas and for the ecosystems. Present a map design of the protected areas. We will use the logo of **CATIE**, **Chemonics**, **CCAD** and of **USAID**.